Scientific articles (including abstracts) identified in the Web of Science database on August 29 and 30, 2018, applying the following categories in the search (see Table 5.1): *(LaU OR LaC OR FoC) AND BpE AND ClV AND (ObD OR MoD) AND NoP* (in alphabetical order)

Abdi, A. M., et al. (2017). "Evaluating Water Controls on Vegetation Growth in the Semi-Arid Sahel Using Field and Earth Observation Data." Remote Sensing **9**(3).

Water loss is a crucial factor for vegetation in the semi-arid Sahel region of Africa. Global satellite-driven estimates of plant CO2 uptake (gross primary productivity, GPP) have been found to not accurately account for Sahelian conditions, particularly the impact of canopy water stress. Here, we identify the main biophysical limitations that induce canopy water stress in Sahelian vegetation and evaluate the relationships between field data and Earth observation-derived spectral products for up-scaling GPP. We find that plant-available water and vapor pressure deficit together control the GPP of Sahelian vegetation through their impact on the greening and browning phases. Our results show that a multiple linear regression (MLR) GPP model that combines the enhanced vegetation index, land surface temperature, and the short-wave infrared reflectance (Band 7, 2105-2155 nm) of the moderate-resolution imaging spectroradiometer satellite sensor was able to explain between 88% and 96% of the variability of eddy covariance flux tower GPP at three Sahelian sites (overall = 89%). The MLR GPP model presented here is potentially scalable at a relatively high spatial and temporal resolution. Given the scarcity of field data on CO2 fluxes in the Sahel, this scalability is important due to the low number of flux towers in the region.

Adjahossou, S. G. C., et al. (2016). "EFFECTIVENESS OF PROTECTED AREAS FOR THE CONSERVATION OF FAVOURABLE AND PRIORITY HABITATS FOR VALUABLE TREE SPECIES IN BENIN." Bois Et Forets Des Tropiques(328): 67-77.

The aim of this study was to assess the effectiveness of protected areas in Benin for the conservation of favourable and priority habitats for the following tree species of socio-economic importance: Afzelia africana, Anogeissus leiocarpa, Burkea africana, Daniellia oliveri, Detarium microcarpum, Prosopis africana and Khaya senegalensis. We combined maximum entropy (Maxent) techniques with GIS to predict potentially favourable areas for cultivating and conserving these species. Zonation software was used to model priority habitats. Data points where the species were present were collected and linked to bioclimatic variables derived from monthly temperature and rainfall figures from the Africlim database and to edaphic (soil) variables. In term of environmental determinism, the most favourable areas were predicted by bioclimatic variables such as mean diurnal temperature range (Bio2), mean annual rainfall (Bio12), potential evapotranspiration (PET) and a biophysical ground variable. The most favourable protected areas for the seven tree species extended northwards from the Ketou listed forest (7 degrees 43'N) in the Guinean zone, from the Agoua listed forest (8 degrees 30'N) in the Sudano-Guinean zone and from the Pendjari National Park area (10 degrees 35'N) in the Sudanian zone. Gap analysis of habitat conservation showed that the protected area network was effective in the Sudanian zone (9 degrees 75'-12 degrees 27'N), minimally effective in the Guinean zone (6 degrees 50'-7 degrees 40'N) and not effective at all in the Sudano-Guinean zone.

Ahlswede, B. J. and R. Q. Thomas (2017). "Community Earth System Model Simulations Reveal the Relative Importance of Afforestation and Forest Management to Surface Temperature in Eastern North America." Forests **8**(12).

Afforestation changes the land surface energy balance, though the effects on climate in temperate regions is uncertain, particularly the changes associated with forest management. In this study, we used idealized Community Earth System Model simulations to assess the influence of afforestation and afforestation management in eastern North America on climate via changes in the biophysics of the land surface. Afforestation using broadleaf deciduous trees maintained at high leaf area index (LAI) in the southern part of the study region provided the greatest climate benefit by cooling summer surface air temperatures (T-sa). In contrast, the greatest warming occurred in the northern extent of the study region when afforesting with needleleaf evergreen trees maintained at high LAI. Forest management had an equal or greater influence on T-sa than the overall decision to afforest land in the southern extent of the region. Afforestation had a greater influence on T-sa than forest management in the northern extent. Integrating our results, focused on biophysical processes, with other research quantifying carbon cycle sensitivity to management can help guide the use of temperate afforestation to optimize climate benefits. Further, our results highlight the potential importance of including forest management in simulations of past and future climate.

Ahmed, M. A. A., et al. (2017). "Spatially-explicit modeling of multi-scale drivers of aboveground forest biomass and water yield in watersheds of the Southeastern United States." Journal of Environmental Management **199**: 158-171.

Understanding ecosystem processes and the influence of regional scale drivers can provide useful information for managing forest ecosystems. Examining more local scale drivers of forest biomass and water yield can also provide insights for identifying and better understanding the effects of climate change and management on forests. We used diverse multi-scale datasets, functional models and Geographically Weighted Regression (GWR) to model ecosystem processes at the watershed scale and to interpret the influence of ecological drivers across the Southeastern United States (SE US). Aboveground forest biomass (AGB) was determined from available geospatial datasets and water yield was estimated using the Water Supply and Stress Index (WaSSI) model at the watershed level. Our geostatistical model examined the spatial variation in these relationships between ecosystem processes, climate, biophysical, and forest management variables at the watershed level across the SE US. Ecological and management drivers at the watershed level were analyzed locally to identify whether drivers contribute positively or negatively to aboveground forest biomass and water yield ecosystem processes and thus identifying potential synergies and tradeoffs across the SE US region. Although AGB and water yield drivers varied geographically across the study area, they were generally significantly influenced by climate (rainfall and temperature), land-cover factor1 (Water and barren), land-cover factor2 (wetland and forest), organic matter content high, rock depth, available water content, stand age, elevation, and LAI drivers. These drivers were positively or negatively associated with biomass or water yield which significantly contributes to ecosystem interactions or tradeoff/synergies. Our study introduced a spatially-explicit modelling framework to analyze the effect of ecosystem drivers on forest ecosystem structure, function and provision of services. This integrated model approach facilitates multi-scale analyses of drivers and interactions at the local to regional scale. (C) 2017 Elsevier Ltd. All rights reserved.

Ahongshangbam, J., et al. (2016). "Estimating Gross Primary Production of a Forest Plantation Area Using Eddy Covariance Data and Satellite Imagery." Journal of the Indian Society of Remote Sensing **44**(6): 895-904.

Gross primary production (GPP) is the basic biophysical parameter of an ecosystem. The quantification of GPP has been a major challenge in understanding the global carbon cycle. Eddy covariance (EC) measurements at flux tower provide valuable direct information on seasonal dynamics of GPP and allow model optimization. In this paper, the GPP of forest plantation was estimated using light use efficiency (LUE-based) model and validated with flux tower GPP observations in Terai Central Forest Division, Nainital, India. The LUE model is mainly based upon the photosynthetically active radiation (PAR), satellite-derived normalized difference vegetation index (NDVI), land surface wetness index (LSWI), and the air temperature. The simulation of the model was carried out using vegetation indices generated from Landsat imagery and the meteorological data from flux tower. The predicted GPP showed distinct significance of spatio-temporal dynamics of GPP. The environmental variables, viz., PAR and NDVI showed distinct effect on the GPP prediction. Comparison between predicted and the measured GPP on flux tower site showed good agreement (R (2) = 0.626, RMSE = 2.08 and MAPE = 18.46). The study demonstrated the potential of LUE model for estimating GPP and scaling up of GPP over large areas, which is a major parameter in the study of the carbon cycle on regional to global scales.

Albertson, J. D., et al. (2001). "Relative importance of local and regional controls on coupled water, carbon, and energy fluxes." Advances in Water Resources **24**(9-10): 1103-1118.

This paper reports the first effort to include carbon, water, and heat exchange in a Large Eddy Simulation (LES) model for 3D canopy flows with dynamic response of leaf temperature and stomatal aperture. The LES model simulates eddy motion from 3D), transient integration of a filtered form of the Navier-Stokes equations. Carbon exchange between the vegetation and air is predicted in space and time following biophysical considerations, which act to maximize carbon assimilation while minimizing water loss. The vegetation's stomatal conductance is inferred from these same considerations and used to regulate both transpiration and carbon assimilation rates. Variations in transpiration and radiation distribution propagate to foliage temperature and ultimately heat exchange through a local, transient vegetation energy balance. The wind field is affected by the foliage patterns and by the temperature profile's control on vertical mixing. These temperature and mixing patterns control the concentration profiles that, in turn, affect water and CO2

exchange processes. By comparing a simulation of horizontally heterogeneous canopy behavior to simulations of several homogeneous canopies with different leaf area index (LAI) values we evaluate the relative importance of local and regional LAI values on the local microenvironment variables and fluxes from the forest canopy. We focus on a pine forest with ample soil moisture as a case study. We demonstrate from these simulations that primitive state variables (e.g. concentrations and velocity) exhibit noticeable non-local controls. However, these features are offset in their effects on land surface fluxes, such that the local fluxes scale well with local LAI values. Furthermore, the resulting relationships between LAI and fluxes are quasi-linear (for the forest morphology studied here) allowing for robust relationships between forest averaged LAI and forest averaged fluxes. The offsetting nature of the non-local effects is described in the context of the dual regulation of stomatal conductance by the rates of carbon assimilation and water loss as opposed to independent regulating effects of the various state variables. Hence, non-local variations in state variables naturally induce offsetting variations in stomatal conductance thereby buffering the water use efficiency of the plant from environmental excursions associated with the turbulent microclimate. (C) 2001 Elsevier Science Ltd. All rights reserved.

Alemayehu, A. and W. Bewket (2017). "Determinants of smallholder farmers' choice of coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia." Environmental Development **24**: 77-85.

This study presents analysis of determinants of smallholder farmers' choice of coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. A distinction was made between coping and adaptation, as short-term responses to shocks and long-term responses to stressors, respectively. Binary logistic regression modeling was used based on a survey of 200 farmers. Socio-demographic, economic, biophysical, and institutional and infrastructural characteristics of the study setting and sample households were considered to identify key determinants of farmers' choice of coping and adaptation strategies. This is premised on the fact that understanding significant determinants of farmers' choice of coping and adaptation strategies is useful to design impactful adaptation interventions in the locality. The results showed that the significant factors affecting choice of adaptation strategies include perceived soil fertility status, perception of land tenure security, access to extension service, and ages of household heads. For the choice of coping options, agroecological zone, access to markets, farmer-to-farmer extension, landholding size, access to information on climate change, rainfall amount, and educational level of household heads were the significant determinants. Agroecological zone had negative influence to use selling livestock as coping strategy while the other variables had positive influences on farmers' choice of coping and adaptation strategies. Off-farm income, community participation, ownership of livestock and temperature on the other hand had no significant influence on the choice of coping and adaptation strategies to climate change. Adaptation planning for the study locality should take into account the potential influence of these determinant factors into account.

Alessandri, A., et al. (2017). "Multi-scale enhancement of climate prediction over land by increasing the model sensitivity to vegetation variability in EC-Earth." Climate Dynamics **49**(4): 1215-1237.

The EC-Earth earth system model has been recently developed to include the dynamics of vegetation. In its original formulation, vegetation variability is simply operated by the Leaf Area Index (LAI), which affects climate basically by changing the vegetation physiological resistance to evapotranspiration. This coupling has been found to have only a weak effect on the surface climate modeled by EC-Earth. In reality, the effective sub-grid vegetation fractional coverage will vary seasonally and at interannual time-scales in response to leaf-canopy growth, phenology and senescence. Therefore it affects biophysical parameters such as the albedo, surface roughness and soil field capacity. To adequately represent this effect in EC-Earth, we included an exponential dependence of the vegetation cover on the LAI. By comparing two sets of simulations performed with and without the new variable fractional-coverage parameterization, spanning from centennial (twentieth century) simulations and retrospective predictions to the decadal (5-years), seasonal and weather time-scales, we show for the first time a significant multi-scale enhancement of vegetation impacts in climate simulation and prediction over land. Particularly large effects at multiple time scales are shown over boreal winter middle-to-high latitudes over Canada, West US, Eastern Europe, Russia and eastern Siberia due to the implemented time-varying shadowing effect by tree-vegetation on snow surfaces. Over Northern Hemisphere boreal forest regions the improved representation of vegetation cover

tends to correct the winter warm biases, improves the climate change sensitivity, the decadal potential predictability as well as the skill of forecasts at seasonal and weather time-scales. Significant improvements of the prediction of 2 m temperature and rainfall are also shown over transitional land surface hot spots. Both the potential predictability at decadal time-scale and seasonal-forecasts skill are enhanced over Sahel, North American Great Plains, Nordeste Brazil and South East Asia, mainly related to improved performance in the surface evapotranspiration.

Alessandri, A. and A. Navarra (2008). "On the coupling between vegetation and rainfall inter-annual anomalies: Possible contributions to seasonal rainfall predictability over land areas." Geophysical Research Letters **35**(2).

It's well known that rainfall affects vegetation through its effect on soil moisture content, but the extent to which vegetation could in turn impact precipitation occurrence is poorly understood. Here we focus on the assessment, from observations, of the reciprocal forcing of seasonal-mean vegetation and rainfall interannual anomalies over land areas using the coupled manifold technique. Considering global lands, we estimate at the 1% significance level that 19% (12%) of the vegetation (precipitation) variance is forced by precipitation (vegetation). Our analysis reveals that the dominant component of the vegetation-forced rainfall variability is a delayed response to ENSO cycles. Vegetation appears to provide a biophysical memory of ENSO and is supposed to act through delayed feedbacks on rainfall. As ENSO cycles are currently well predicted by dynamical seasonal forecasting systems, this result displays the potential for a reliable soil moisture-vegetation initialization to improve rainfall prediction over lands.

Alkama, R. and A. Cescatti (2016). "Biophysical climate impacts of recent changes in global forest cover." Science **351**(6273): 600-604.

Changes in forest cover affect the local climate by modulating the land-atmosphere fluxes of energy and water. The magnitude of this biophysical effect is still debated in the scientific community and currently ignored in climate treaties. Here we present an observation-driven assessment of the climate impacts of recent forest losses and gains, based on Earth observations of global forest cover and land surface temperatures. Our results show that forest losses amplify the diurnal temperature variation and increase the mean and maximum air temperature, with the largest signal in arid zones, followed by temperate, tropical, and boreal zones. In the decade 2003-2012, variations of forest cover generated a mean biophysical warming on land corresponding to about 18% of the global biogeochemical signal due to CO2 emission from land-use change.

Alkama, R., et al. (2011). "Trends in Global and Basin-Scale Runoff over the Late Twentieth Century: Methodological Issues and Sources of Uncertainty." Journal of Climate **24**(12): 3000-3014.

While human influence has been detected in global and regional surface air temperature, detection-attribution studies of direct (i.e., land use and water management) and indirect (i.e., climate related) effects of human activities on land surface hydrology remain a crucial and controversial issue. In the present study, a set of global offline hydrological simulations is performed during the 1960-94 period using the Interactions between Soil, Biosphere, and Atmosphere-Total Runoff Integrating Pathways (ISBA-TRIP) modeling system. In contrast to previous numerical sensitivity studies, the model captures the observed trend in river runoff over most continents without including land use changes and/or biophysical CO2 effects, at least when the comparison is made over 154 large rivers with a minimum amount of missing data. The main exception is northern Asia, where the simulated runoff trend is negative, in line with the prescribed precipitation forcing but in contrast with the observed runoff trend. The authors hypothesize that the observed surface warming and the associated decline of permafrost and glaciers, not yet included in most land surface models, could have contributed to the increased runoff at high latitudes. They also emphasize that the runoff trend is a regional-scale issue, if not basin dependent. In line with recent observational studies, their results suggest that CO2 stomatal conductance effects and land use changes are not the primary drivers of the multidecadal runoff variability at continental scales. However, the authors do not rule out a human influence on land runoff, at least through the high-latitude surface warming observed over recent decades.

Anderson, M. C., et al. (2015). "Comparison of satellite-derived LAI and precipitation anomalies over Brazil with a thermal infrared-based Evaporative Stress Index for 2003-2013." Journal of Hydrology **526**: 287-302.

Shortwave vegetation index (VI) and leaf area index (LAI) remote sensing products yield inconsistent depictions of biophysical response to drought and pluvial events that have occurred in Brazil over the past decade. Conflicting reports of severity of drought impacts on vegetation health and functioning have been attributed to cloud and aerosol contamination of shortwave reflectance composites, particularly over the rainforested regions of the Amazon basin which are subject to prolonged periods of cloud cover and episodes of intense biomass burning. This study compares timeseries of satellite-derived maps of LAI from the Moderate Resolution Imaging Spectroradiometer (MODIS) and precipitation from the Tropical Rainfall Mapping Mission (TRMM) with a diagnostic Evaporative Stress Index (ES!) retrieved using thermal infrared remote sensing over South America for the period 2003-2013. This period includes several severe droughts and floods that occurred both over the Amazon and over unforested savanna and agricultural areas in Brazil. Cross-correlations between absolute values and standardized anomalies in monthly LAI and precipitation composites as well as the actual-to-reference evapotranspiration (ET) ratio used in the ESI were computed for representative forested and agricultural regions. The correlation analyses reveal strong apparent anticorrelation between MODIS LAI and TRMM precipitation anomalies over the Amazon, but better coupling over regions vegetated with shorter grass and crop canopies. The ESI was more consistently correlated with precipitation patterns over both landcover types. Temporal comparisons between ESI and TRMM anomalies suggest longer moisture buffering timescales in the deeper root. ed rainforest systems. Diagnostic thermal-based retrievals of ET and ET anomalies, such as used in the ES!, provide independent information on the impacts of extreme hydrologic events on vegetation health in comparison with VI and precipitation-based drought indicators, and used in concert may provide a more reliable evaluation of natural and managed ecosystem response to variable climate regimes. Published by Elsevier B.V.

Arganaraz, J. P., et al. (2015). "Human and biophysical drivers of fires in Semiarid Chaco mountains of Central Argentina." Science of the Total Environment **520**: 1-12.

Fires are a recurrent disturbance in Semiarid Chaco mountains of central Argentina. The interaction of multiple factors generates variable patterns of fire occurrence in space and time. Understanding the dominant fire drivers at different spatial scales is a fundamental goal to minimize the negative impacts of fires. Our aim was to identify the biophysical and human drivers of fires in the Semiarid Chaco mountains of Central Argentina and their individual effects on fire activity, in order to determine the thresholds and/or ranges of the drivers at which fire occurrence is favored or disfavored. We used fire frequency as the response variable and a set of 28 potential predictor variables, which included climatic, human, topographic, biological and hydrological factors. Data were analyzed using Boosted Regression Trees, using data from near 10,500 sampling points. Our model identified the fire drivers accurately (75.6% of deviance explained). Although humans are responsible for most ignitions, climatic variables, such as annual precipitation, annual potential evapotranspiration and temperature seasonality were the most important determiners of fire frequency, followed by human (population density and distance to waste disposals) and biological (NDVI) predictors. In general, fire activity was higher at intermediate levels of precipitation and primary productivity and in the proximity of urban solid waste disposals. Fires were also more prone to occur in areas with greater variability in temperature and productivity. Boosted Regression Trees proved to be a useful and accurate tool to determine fire controls and the ranges at which drivers favor fire activity. Our approach provides a valuable insight into the ecology of fires in our study area and in other landscapes with similar characteristics, and the results will be helpful to develop management policies and predict changes in fire activity in response to different climate changes and development scenarios. (C) 2015 Elsevier B.V. All rights reserved.

Armenteras, D., et al. (2011). "Understanding deforestation in montane and lowland forests of the Colombian Andes." Regional Environmental Change **11**(3): 693-705.

Colombian Andean forests cover nine million ha. These forests provide an informative case study of mountain deforestation in South America. They are surrounded by tropical lowland forests, and they host most of the country's human population. This study evaluates the relative importance of human and natural variables in deforestation of the Colombian Andes between 1985 and 2005 using remote sensing methods, geographic information system (GIS) technology and general linear models (GLM). The following factors affected the annual deforestation in the region positively: forced population migration, unsatisfied basic needs, economic activity, crops, pastures, illicit crops, protected areas and slope. Factors having a negative effect were tenure of small land parcels, road density, water scarcity and mean temperature. The results of this study also provide insight into the differences between the dynamics of lowland forests and those of montane forests. Montane forests had a lower annual rate of deforestation than did forests in the lowlands. Socio-economic, demographic and biophysical factors explain overall deforestation rates for the region. However, when altitude variation is taken into account, intraregional differences in the Andes become evident. Deforestation processes differ between those areas adjacent to the high Andean valleys where most of the country's population concentrates and those areas in the tropical lowlands north, west and east of the Andean chain. Differences between lowland and montane forest dynamics are due partly to the accessibility of forests and differences in wealth and economic activities. In montane forests, deforestation is positively influenced by economic activity, the presence of protected areas and higher slopes. Deforestation in montane forests is negatively affected by tenure of small land parcels, road density, water scarcity and mean temperature. Lowland deforestation rates are more closely related to rural population, pasture percentage, crops, protected areas and temperature. Our results suggest that montane forests appear to be in a more advanced stage of colonisation and economic development, whereas lowland forests are closer to the colonisation frontier and to rapidly growing colonist populations. This study reinforces the idea that although the most common tropical drivers of deforestation are found in the Andes, these drivers operate differently when intraregional differences are considered.

Arneth, A., et al. (2012). "Future challenges of representing land-processes in studies on land-atmosphere interactions." Biogeosciences **9**(9): 3587-3599.

Over recent years, it has become increasingly apparent that climate change and air pollution need to be considered jointly for improved attribution and projections of human-caused changes in the Earth system. Exchange processes at the land surface come into play in this context, because many compounds that either act as greenhouse gases, as pollutant precursors, or both, have not only anthropogenic but also terrestrial sources and sinks. And since the fluxes of multiple gases and particulate matter between the terrestrial biota and the atmosphere are directly or indirectly coupled to vegetation and soil carbon, nutrient and water balances, quantification of their geographic patterns or changes over time requires due consideration of the underlying biological processes. In this review we highlight a number of critical aspects and recent progress in this respect, identifying in particular a number of areas where studies have shown that accounting for ecological process understanding can alter global model projections of land-atmosphere interactions substantially. Specifically, this concerns the improved quantification of uncertainties and dynamic system responses, including acclimation, and the incorporation of exchange processes that so far have been missing from global models even though they are proposed to be of relevance for our understanding of terrestrial biota-climate feedbacks. Progress has also been made regarding studies on the impacts of land use/land cover change on climate change, but the absence of a mechanistically based representation of human response-processes in ecosystem models that are coupled to climate models limits our ability to analyse how climate change or air pollution in turn might affect human land use. A more integrated perspective is necessary and should become an active area of research that bridges the socio-economic and biophysical communities.

Ashraf, M. I., et al. (2013). "Integrating biophysical controls in forest growth and yield predictions with artificial intelligence technology." Canadian Journal of Forest Research **43**(12): 1162-1171.

Growth and yield models are critically important for forest management planning. Biophysical factors such as light, temperature, soil water, and nutrient conditions are known to have major impacts on tree growth. However, it is difficult to incorporate these biophysical variables into growth and yield models due to large variation and complex nonlinear relationships between variables. In this study, artificial intelligence technology was used to develop individual-tree-based basal area (BA) and volume increment models. The models successfully account for the effects of incident solar radiation, growing degree days, and indices of soil water and nutrient availability on BA and volume increments of over 40 species at 5-year intervals. The models were developed using data from over 3000 permanent sample plots across the province of Nova Scotia, Canada. Model validation with independent field data produced model efficiencies of 0.38 and 0.60 for the predictions of BA and volume increments, respectively. The models are applicable to predict tree growth in mixed species, even-or uneven-aged forests in Nova Scotia but can easily be calibrated for other climatic and geographic regions. Artificial neural network models demonstrated better prediction accuracy than conventional regression-based approaches. Artificial intelligence techniques have considerable potential in forest growth and yield modelling.

Asner, G. P., et al. (2004). "Drought stress and carbon uptake in an Amazon forest measured with spaceborne imaging spectroscopy." Proceedings of the National Academy of Sciences of the United States of America **101**(16): 6039-6044.

Amazonia contains vast stores of carbon in high-diversity ecosystems, yet this region undergoes major changes in precipitation affecting land use, carbon dynamics, and climate. The extent and structural complexity of Amazon forests impedes ground studies of ecosystem functions such as net primary production (NPP), water cycling, and carbon sequestration. Traditional modeling and remote-sensing approaches are not well suited to tropical forest studies, because (i) biophysical mechanisms determining drought effects on canopy water and carbon dynamics are poorly known, and (ii) remote-sensing metrics of canopy greenness may be insensitive to small changes in leaf area accompanying drought. New spaceborne imaging spectroscopy may detect drought stress in tropical forests, helping to monitor forest physiology and constrain carbon models. We combined a forest drought experiment in Amazonia with spaceborne imaging spectrometer measurements of this area. With field data on rainfall, soil water, and leaf and canopy responses, we tested whether spaceborne hyperspectral observations quantify differences in canopy water and NIPP resulting from drought stress. We found that hyperspectral metrics of canopy water content and light-use efficiency are highly sensitive to drought. Using these observations, forest NIPP was estimated with greater sensitivity to drought conditions than with traditional combinations of modeling, remote-sensing, and field measurements. Spaceborne imaging spectroscopy will increase the accuracy of ecological studies in humid tropical forests.

Austin, J., et al. (2010). "Climate change impact on water and salt balances: an assessment of the impact of climate change on catchment salt and water balances in the Murray-Darling Basin, Australia." Climatic Change **100**(3-4): 607-631.

Climate change has potentially significant implications for hydrology and the quantity and quality of water resources. This study investigated the impacts of climate change and revegetation on water and salt balance, and stream salt concentration for catchments within the Murray-Darling Basin, Australia. The Biophysical Capacity to Change model was used with climate change scenarios obtained using the CSIRO DARLAM 125 (125 km resolution) and Cubic Conformal (50 km resolution) regional climate models. These models predicted up to 25% reduction in mean annual rainfall and a similar magnitude of increase in potential evapotranspiration by 2070. Relatively modest changes in rainfall and temperature can lead to significant reductions in mean annual runoff and salt yield and increases in stream salt concentrations within the Basin. The modelled reductions in mean annual runoff were up to 45% in the wetter/cooler southern catchments and up to 64% in the drier/hotter western and northern catchments. The maximum reductions in salt yield were estimated to be up to 34% in the southern catchments and up to 49% in the northern and western catchments. These changes are associated with average catchment rainfall decreases of 13 to 21%. The results suggest that percentage changes in rainfall will be amplified in runoff. This study demonstrates that climate change poses significant challenges to natural resource management in Australia.

Avellan, T., et al. (2012). "The influence of input data quality in determining areas suitable for crop growth at the global scale - a comparative analysis of two soil and climate datasets." Soil Use and Management **28**(2): 249-265.

The assessment of biophysical crop suitability requires datasets on soil and climate. In this study, we investigated the differences in topsoil properties for the dominant soil mapping units between two global soil datasets. We compared the ISRIC World Soil Information Centers World Inventory of Soil Emissions Potential 5 by 5 arc min Soil Map of the World (ISRIC-WISE 5by5 SMW?) with the Harmonized World Soil Database (HWSD) in 0.5 arc min. We also incorporated annual mean temperature and mean precipitation from two global climate datasets that were the WorldClim measurement-based climate dataset and the Kiel Climate Model (KCM) modelled results of global climate from 1960 to 1990. We then applied a fuzzy logic approach using different combinations and resolutions of the datasets to determine the effects on the extent and distribution of suitable areas for 15 crops. We only used the spatially dominant soil class in the mapping units in the soil databases (resampled to the same resolution of 5 arc min), and we found that the estimates of topsoil properties (020 cm in ISRIC-WISE and 030 cm in HWSD) of the seven analysed parameters were up to 40% lower in most of the HWSD than in the ISRIC-WISE 5by5 SMW. Results from the KCM are 0.1 degrees C (1%) lower in mean global annual temperature and 20% higher in average global annual precipitation

compared with the WorldClim data. The HWSD-based runs resulted in 10% less crop-suitable land than the ISRIC-WISE 5by5 SMW-based results. The KCM simulations predicted 1% less crop-suitable land than the WorldClim model. Despite generalizations, our results demonstrate that discrepancies in crop suitable areas are largely due to the differences in the soil databases rather than to climate.

Badia, A., et al. (2011). "Identifying dynamics of fire ignition probabilities in two representative Mediterranean wildland-urban interface areas." Applied Geography **31**(3): 930-940.

This paper focuses on determining ignition probabilities of forest fires in Wildland-Urban Interface (WUI) areas to more effectively develop prevention plans. Multivariate Logistic Regression methodology was used to identify the most important biophysical and human variables to explain the emergence of ignition points, incorporating spatial analysis from Remote Sensing and Geographical Information Systems (GIS) data. To test this model we used two representative Wildland-Urban Interface landscapes in a Mediterranean environment, located in Catalonia (northeast Spain): an example of dispersed housing in a forested area associated to metropolitan processes and an agro-forestry mosaic connected with tourism development. For a better understanding a temporal comparison has been made, analyzing data from 1990s and from 2000s. Results show differences in the explicative models; in the former study area, high ignition probabilities are associated to human activity, mainly distance to urban areas and road networks, whereas in the latter they are related with land-use (scrubland and coniferous forest) and mean maximum temperatures. As a consequence, prevention tasks seem to be less difficult in the more metropolitan study area because the spatial model is further disperse in the agro-forestry mosaic. Finally, temporal analysis indicates that both areas were more prone to forest fires in the most recent decade than in the 1990s. (C) 2011 Elsevier Ltd. All rights reserved.

Bajocco, S., et al. (2016). "Modeling the ecological niche of long-term land use changes: The role of biophysical factors." Ecological Indicators **60**: 231-236.

Land use/land cover changes (LULCCs) represent the result of the complex interaction between biophysical factors and human activity, acting over a wide range of temporal and spatial scales. The aim of this work is to quantify the role of biophysical factors in constraining the trajectories of land abandonment and urbanization in the last 50 years. A habitat suitability model borrowed from animal ecology was used to analyze the ecological niche of the following LULCC trajectories occurred in Emilia-Romagna (northern Italy) during 1954-2008: (i) land abandonment (LA) and (ii) urbanization (URB), both from agricultural areas (URB_agr) and from semi-natural areas (URB_for). Results showed that the different LULCC trajectories were driven by different combinations of biophysical factors, such as climate, topography and soil quality. In particular, slope and elevation resulted as the main driving factors for rural processes, while slope and temperatures resulted as the main constraints underlying urban processes. This approach may represent a conceptual and technical step toward the systematic assessment of LULCC processes, thus providing an effective support tool to inform decision makers about land use transformations, their underlying causes, as well as their possible implications. (C) 2015 Elsevier Ltd. All rights reserved.

Baldocchi, D., et al. (2016). "The impact of expanding flooded land area on the annual evaporation of rice." Agricultural and Forest Meteorology **223**: 181-193.

The amount of published data on annual evaporation on rice remains extremely limited despite the role of rice as a key food source. We report on six years of rice evaporation measurements, based on the eddy covariance method. This rice was cultivated in the hot dry climate of California, where water is a scarce and precious resource. During the first year, we found that rice evaporation exceeded potential evaporation rates and summed to 1155 mm y(-1). In following years, we found that annual evaporation decreased yearly, yielding a 15% reduction (to 982 mm y(-1)) by the sixth year. The remainder of the paper examined the how and why of this unexpected decreasing trend in annual evaporation occurred. We inspected trends in variations in biophysical variables (net radiation, temperature, leaf area index) associated with evaporation and potential biases in the flux measurements using energy balance closure and co-spectral analysis. None of the biophysical variables varied enough to explain this observation. What did change was the area of rice, and nearby flooded wetlands. During the first year, the flooded rice field was less than 1 km(2) in area and was relatively isolated. This situation promoted an 'oasis effect' that enabled warm dry air to be entrained from across the top of the planetary boundary layer; this contention was supported by the co-spectral analysis and analysis with a coupled surface energy balance-planetary boundary layer model. By the sixth year of this project, the area of flooded rice and wetlands approached 6 km2, a horizontal scale that seemed to inhibit the 'oasis effect'. We conclude that the amount of water used, on an area basis, by wetland restoration projects will depend upon the spatial extent of these projects.

Baldocchi, D. and S. Y. Ma (2013). "How will land use affect air temperature in the surface boundary layer? Lessons learned from a comparative study on the energy balance of an oak savanna and annual grassland in California, USA." Tellus Series B-Chemical and Physical Meteorology **65**.

We investigated the effect of land use on differences in air temperature. We based our analysis on a decade of weather and energy flux measurements, collected over two contrasting landscapes, an oak savanna and an annual grassland, growing under the same climate conditions. Over the decade, the daily-averaged, potential air temperature above the aerodynamically rougher and optically darker oak savanna was 0.5 degrees C warmer than that above the aerodynamically smoother and optically brighter annual grassland. However, air temperature differences were seasonal. Smallest differences in potential air temperature occurred towards the end of spring, when much of the soil moisture reservoir was depleted. Largest differences in potential air temperature occurred during the winter rain season when the grass was green and transpiring and when the trees were senescent or deciduous. To understand the effect of land use on the local climate, we examined the concomitant changes in net radiation, sensible and latent heat exchange, the aerodynamic roughness (R-a), the surface resistance to water transfer (R-s), aerodynamic surface temperature and the growth of the planetary boundary layer, with measurements and model computations. Overall, these biophysical variables provide us with mechanistic information to diagnose and predict how changes in air temperature will follow changes in land use or management. In conclusion, land use change is responsible for having a marked impact on the local climate of a region. At the local level, the change in the surface energy balance, towards a darker and rougher surface, will produce an additive increment to climate warming induced by a greater greenhouse gas burden in the atmosphere.

Baldocchi, D. D. and D. R. Bowling (2003). "Modelling the discrimination of (CO2)-C-13 above and within a temperate broad-leaved forest canopy on hourly to seasonal time scales." Plant Cell and Environment **26**(2): 231-244.

Fluxes and concentrations of carbon dioxide and (CO2)-C-13 provide information about ecosystem physiological processes and their response to environmental variation. The biophysical model, CANOAK, was adapted to compute concentration profiles and fluxes of (CO2)-C-13 within and above a temperate deciduous forest (Walker Branch Watershed, Tennessee, USA). Modifications to the model are described and the ability of the new model (CANISOTOPE) to simulate concentration profiles of (CO2)-C-13 , its flux density across the canopy-atmosphere interface and leaf-level photosynthetic discrimination against (CO2)-C-13 is demonstrated by comparison with field measurements. The model was used to investigate several aspects of carbon isotope exchange between a forest ecosystem and the atmosphere. During the 1998 growing season, the mean photosynthetic discrimination against (CO2)-C-13 , by the deciduous forest canopy (Delta(canopy)), was computed to be 22.4parts per thousand, but it varied between 18 and 27parts per thousand. On a diurnal basis, the greatest discrimination occurred during the early morning and late afternoon. On a seasonal time scale, the greatest diurnal range in Delta(canopy) occurred early and late in the growing season. Diurnal and seasonal variations in Delta(canopy) resulted from a strong dependence of Delta(canopy) on photosynthetically active radiation and vapour pressure deficit of air. Model calculations also revealed that the relationship between canopy-scale water use efficiency (CO2 assimilation/transpiration) and Delta(canopy) was positive due to complex feedbacks among fluxes, leaf temperature and vapour pressure deficit, a finding that is counter to what is predicted for leaves exposed to well-mixed environments.

Baldocchi, D. D., et al. (2005). ""Wet/dry Daisyworld": a conceptual tool for quantifying the spatial scaling of heterogeneous landscapes and its impact on the subgrid variability of energy fluxes." Tellus Series B-Chemical and Physical Meteorology **57**(3): 175-188.

We modified the "Daisyworld" model of Watson and Lovelock to consider the energy balance of vegetation with differing potential to evaporate water vapour across a 2-D landscape. High-resolution spatial fields of surface temperature, latent heat exchange and net radiation are computed using cellular automata (CA). The

CA algorithm considers competition between actively transpiring "wet daisies" and "dry daisies" for bare ground through temperature-dependent birth and death probabilities. This paper examines how differences in biophysical properties (e.g. surface albedo and surface conductance) affect the composition and heterogeneity of the landscape and its energy exchange. And with high resolution and gridded spatial information we evaluate bias errors and scaling rules associated with the subgrid averaging of the nonlinear functions used to compute surface energy balance. Among our key findings we observe that there are critical conditions, associated with albedo and surface resistance, when wet or dry/dark or bright "daisies" dominate the landscape. Second, we find that the heterogeneity of the spatial distribution of "daisies" depends on initial conditions (e.g. a bare field versus a random assemblage of surface classes). And third, the spatial coefficient of variation of land class, latent heat exchange, net radiation and surface temperature scale with the exponential power of the size of the averaging window. Though conceptual in nature, the 2-D "wet/dry Daisyworld" model produces a virtual landscape whose power-law scaling exponent resembles the one derived for the spatial scaling of a normalized difference vegetation index for a heterogeneous savanna ecosystem. This observation is conditional and occurs if the initial landscape is bare with two small colonies of "wet" and "dry" daisies. Bias errors associated with the nonlinear averaging of the surface energy balance equation increase as the coefficient of variation of the surface properties increases. Ignoring the subgrid variability of latent heat exchange produces especially large bias errors (up to 300%) for heterogeneous landscapes. We also find that spatial variations in latent heat exchange, surface temperature and net radiation, derived from our "Daisyworld" model, scale with the spatial variation in surface properties. These results suggest that we may be able to infer spatial patterns of surface energy fluxes from remote sensing data of surface features. "Wet/dry Daisyworld", therefore, has the potential to provide a link between observations of landscape heterogeneity, deduced from satellites, and their interpretation into spatial fields of latent and sensible heat exchange and surface temperature.

Balkovic, J., et al. (2018). "Impacts and Uncertainties of+2 degrees C of Climate Change and Soil Degradation on European Crop Calorie Supply." Earths Future **6**(3): 373-395.

Even if global warming is kept below +2 degrees C, European agriculture will be significantly impacted. Soil degradation may amplify these impacts substantially and thus hamper crop production further. We quantify biophysical consequences and bracket uncertainty of +2 degrees C warming on calories supply from 10 major crops and vulnerability to soil degradation in Europe using crop modeling. The Environmental Policy Integrated Climate (EPIC) model together with regional climate projections from the European branch of the Coordinated Regional Downscaling Experiment (EURO-CORDEX) was used for this purpose. A robustly positive calorie yield change was estimated for the EU Member States except for some regions in Southern and South-Eastern Europe. The mean impacts range from +30 Gcal ha(-1) in the north, through +25 and +20 Gcal ha(-1) in Western and Eastern Europe, respectively, to +10 Gcal ha(-1) in the south if soil degradation and heat impacts are not accounted for. Elevated CO2 and increased temperature are the dominant drivers of the simulated yield changes in high-input agricultural systems. The growth stimulus due to elevated CO2 may offset potentially negative yield impacts of temperature increase by +2 degrees C in most of Europe. Soil degradation causes a calorie vulnerability ranging from 0 to 50 Gcal ha(-1) due to insufficient compensation for nutrient depletion and this might undermine climate benefits in many regions, if not prevented by adaptation measures, especially in Eastern and North-Eastern Europe. Uncertainties due to future potentials for crop intensification are about 2-50 times higher than climate change impacts.

Balthazar, V., et al. (2013). "Human impact on sediment fluxes within the Blue Nile and Atbara River basins." Geomorphology **180**: 231-241.

A regional assessment of the spatial variability in sediment yields allows filling the gap between detailed, process-based understanding of erosion at field scale and empirical sediment flux models at global scale. In this paper, we focus on the intrabasin variability in sediment yield within the Blue Nile and Atbara basins as biophysical and anthropogenic factors are presumably acting together to accelerate soil erosion. The Blue Nile and Atbara River systems are characterized by an important spatial variability in sediment fluxes, with area-specific sediment yield (SSY) values ranging between 4 and 4935 t/km(2)/y. Statistical analyses show that 41% of the observed variation in SSY can be explained by remote sensing proxy data of surface vegetation cover, rainfall intensity, mean annual temperature, and human impact. The comparison of a locally adapted regression model with global predictive sediment flux models indicates that global flux models such as the ART and BQART models are less suited to capture the spatial variability in area-specific sediment yields (SSY), but they are very efficient to predict absolute sediment yields (SY). We developed a modified version of the BQART model that estimates the human influence on sediment yield based on a high resolution composite measure of local human impact (human footprint index) instead of countrywide estimates of GNP/capita. Our modified version of the BQART is able to explain 80% of the observed variation in SY for the Blue Nile and Atbara basins and thereby performs only slightly less than locally adapted regression models. (C) 2012 Elsevier B.V. All rights reserved.

Barr, J. G., et al. (2013). "Summertime influences of tidal energy advection on the surface energy balance in a mangrove forest." Biogeosciences **10**(1): 501-511.

Mangrove forests are ecosystems susceptible to changing water levels and temperatures due to climate change as well as perturbations resulting from tropical storms. Numerical models can be used to project mangrove forest responses to regional and global environmental changes, and the reliability of these models depends on surface energy balance closure. However, for tidal ecosystems, the surface energy balance is complex because the energy transport associated with tidal activity remains poorly understood. This study aimed to quantify impacts of tidal flows on energy dynamics within a mangrove ecosystem. To address the research objective, an intensive 10-day study was conducted in a mangrove forest located along the Shark River in the Everglades National Park, FL, USA. Forest-atmosphere turbulent exchanges of energy were quantified with an eddy covariance system installed on a 30-m-tall flux tower. Energy transport associated with tidal activity was calculated based on a coupled mass and energy balance approach. The mass balance included tidal flows and accumulation of water on the forest floor. The energy balance included temporal changes in enthalpy, resulting from tidal flows and temperature changes in the water column. By serving as a net sink or a source of available energy, flood waters reduced the impact of high radiational loads on the mangrove forest. Also, the regression slope of available energy versus sink terms increased from 0.730 to 0.754 and from 0.798 to 0.857, including total enthalpy change in the water column in the surface energy balance for 30-min periods and daily daytime sums, respectively. Results indicated that tidal inundation provides an important mechanism for heat removal and that tidal exchange should be considered in surface energy budgets of coastal ecosystems. Results also demonstrated the importance of including tidal energy advection in mangrove biophysical models that are used for predicting ecosystem response to changing climate and regional freshwater management practices.

Bax, V. and W. Francesconi (2018). "Environmental predictors of forest change: An analysis of natural predisposition to deforestation in the tropical Andes region, Peru." Applied Geography **91**: 99-110.

The spatial patterns of deforestation are usually non-randomly distributed across the landscape. While anthropogenically driven processes are often addressed in land-use regulation policies and deforestation research, less attention is given to the environmental factors that influence tropical deforestation. This study investigates to what extent climate conditions (temperature and precipitation) and biophysical landscape characteristics (elevation, slope, soil type, forest type, and distance to rivers) facilitate or mitigate deforestation processes in Peru's tropical Andes. A Random Forest regression model was constructed for the entire Peruvian tropical Andes, and separate models were developed for some of the known direct deforestation drivers in the region (coca production, gold mining, and land-use by indigenous and non-indigenous communities). Soil type and precipitation were identified as the most important deforestation predictors when the entire Peruvian tropical Andes was considered, whereas distance to rivers was associated with deforestation by mining activities, and elevation and temperature with coca cultivation areas. Using the regression results, a Random Forest classification model was constructed to locate areas where the composition of environmental factors could either facilitate or mitigate deforestation processes. It was found that almost 85% of the forests classified as having high to very high probability to deforestation were located outside current protected areas. In order to increase conservation impacts, the results suggest that greater consideration should be given to the distribution of environmental factors when designing land-use regulation policies and establishing protected areas.

Belem, M., et al. (2011). "CaTMAS: A multi-agent model for simulating the dynamics of carbon resources of West African villages." Ecological Modelling **222**(20-22): 3651-3661.

Carbon is an important determinant of the sustainability of West African farming systems and of the

atmospheric greenhouse effect. Given the complexity of C dynamics, various simulation models have been developed. Few include socioeconomic factors or handle system heterogeneity. This study proposes a generic, multi-agent model for the analysis of C dynamics at village level. It assumes that a better analysis of carbon dynamics at village level requires account to be taken of social, economic, physical and biological factors as well as of the actions of individuals and their interdependence. The Carbon of Territory Multi-Agent Simulator (CaTMAS) model is based on the Organization-Role-Entity-Aspect (OREA) meta-model and the Multi-Agent Systems (MAS) approach. OREA enables C dynamics to be studied from various points of view through the roles played by entities within organizations and also allows various entities to play the same role in various ways through the notion of aspects. The model was coupled with the Century model and a geographical information system to provide a realistic representation of C dynamics. CaTMAS provides not only a framework for the explicit description of the carbon dynamics of farming systems but can also be used to assess the viability of farming systems using various socioeconomic and biophysical scenarios. The model includes interactions between human activities and the environment. Simple simulations involving two cropping systems and focusing on the impact of population growth and different climate regimes on the C dynamics indicate that CaTMAS accounts realistically for the relationships between population, agriculture, climate and SOC dynamics. In simulation, population growth, which drives food demand, leads to agricultural expansion, land scarcity and decrease in fallow duration. These effects are accentuated by increasing temperature and decreasing rainfall which affect the SOC dynamics controlling soil fertility and thus crop production. Improvements to the model should make it possible to extend the scale of the simulation of C dynamics and include refinements such as the inclusion of the trading of carbon credits. (C) 2011 Elsevier B.V. All rights reserved.

Benomar, L., et al. (2018). "Thermal acclimation of photosynthesis and respiration of southern and northern white spruce seed sources tested along a regional climatic gradient indicates limited potential to cope with temperature warming." Annals of Botany **121**(3): 443-457.

Background and Aims Knowledge of thermal acclimation of physiological processes of boreal tree species is necessary to determine their ability to adapt to predicted global warming and reduce the uncertainty around the anticipated feedbacks of forest ecosystems and global carbon cycle to climate change. The objective of this work was to examine the extent of thermal acclimation of net photosynthesis (A(n)) and dark respiration (R-d) of two distant white spruce (Picea glauca) seed sources (from south and north of the commerial forest zone in Quebec) in response to latitudinal and seasonal variations in growing conditions. Methods The temperature responses of A(n), its biochemical and biophysical limitations, and R-d were measured in 1-year-old needles of seedlings from the seed sources growing in eight forest plantations along a regional thermal gradient of 5.5 degrees C in Quebec, Canada. Key Results The average optimum temperature (T-opt) for A(n) was 19 +/- 1.2 degrees C and was similar among seed sources and plantation sites along the thermal gradient. Net photosynthesis at T-opt (A(opt)) varied significantly among plantation sites and was quadratically related to the mean July temperature (MJT) of plantation sites. T-opt for mesophyll conductance, maximum electron transport rate and maximum rate of carboxylation were 28, 22 and 30 degrees C, respectively. Basal respiration rate (R-d at 10 degrees C) was linearly and negatively associated with MJT. Q(10) of R-d (the rate of change in R-d with a 10 degrees C increase in temperature) did not show any significant relationship with MJT and averaged 1.5 +/- 0.1. The two seed sources were similar in their thermal responses to latitudinal and seasonal variations in growing conditions. Conclusions The results showed moderate thermal acclimation of respiration and no evidence for thermal acclimation of photosynthesis or local genetic adaptation for traits related to thermal acclimation. Therefore, growth of local white spruces may decline in future climates.

Betts, R. A. (2004). "Global vegetation and climate: Self-beneficial effects, climate forcings and climate feedbacks." Journal De Physique Iv **121**: 37-60.

Vegetation strongly affects climate by influencing the exchanges of energy and moisture between the land and atmosphere. This paper uses climate modelling studies to discuss four perspectives on the influence of vegetation on climate through biophysical properties of the land surface: (i) the extent to which present-day patterns of climate are modified by the presence of vegetation. and the importance of this for the vegetation itself; (ii) anthropogenic vegetation change as a driver (forcing) of climate change; (iii) the physiological impact of elevated CO, on vegetation as a forcing of climate change through the surface energy budget; and

(iv) the responses of vegetation to radiatively-forced climate change and resulting feedbacks on the climate change itself. Contemporary vegetation increases continental precipitation while generally reducing temperature extremes, and this is crucial for maintaining present-day global vegetation patterns. Mid-latitude deforestation has acted to cool the climate by increasing surface albedo, while continued tropical deforestation may exert a warming and reduce precipitation. Elevated CO, may cause a warming through reduced transpiration by plants in addition to the greenhouse warming. Forest die-back may accelerate a projected precipitation reduction in Amazonia, while expansion of the boreal forests may provide a positive feedback on local warming.

Betts, R. A., et al. (2018). "Changes in climate extremes, fresh water availability and vulnerability to food insecurity projected at 1.5 degrees C and 2 degrees C global warming with a higher-resolution global climate model." Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences **376**(2119).
We projected changes in weather extremes, hydrological impacts and vulnerability to food insecurity at global warming of 1.5 degrees C and 2 degrees C relative to pre-industrial, using a new global atmospheric general circulation model HadGEM3A-GA3.0 driven by pattern of sea-surface temperatures and sea ice from selected members of the 5th Coupled Model Intercomparison Project (CMIP5) ensemble, forced with the RCP8.5 concentration scenario. To provide more detailed representations of climate processes and impacts, the spatial resolution was N216 (approx. 60 km grid length in mid-latitudes), a higher resolution than the CMIP5 models. We used a set of impacts-relevant indices and a global land surface model to examine the projected changes in weather extremes and their implications for freshwater availability and vulnerability to food insecurity. Uncertainties in regional climate responses are assessed, examining ranges of outcomes in impacts to inform risk assessments. Despite some degree of inconsistency between components of the study due to the need to correct for systematic biases in some aspects, the outcomes from different ensemble members could be compared for several different indicators. The projections for weather extremes indices and biophysical impacts quantities support expectations that the magnitude of change is generally larger for 2 degrees C global warming than 1.5 degrees C. Hot extremes become even hotter, with increases being more intense than seen in CMIP5 projections. Precipitation-related extremes show more geographical variation with some increases and some decreases in both heavy precipitation and drought. There are substantial regional uncertainties in hydrological impacts at local scales due to different climate models producing different outcomes. Nevertheless, hydrological impacts generally point towards wetter conditions on average, with increased mean river flows, longer heavy rainfall events, particularly in South and East Asia with the most extreme projections suggesting more than a doubling of flows in the Ganges at 2 degrees C global warming. Some areas are projected to experience shorter meteorological drought events and less severe low flows, although longer droughts and/or decreases in low flows are projected in many other areas, particularly southern Africa and South America. Flows in the Amazon are projected to decline by up to 25%. Increases in either heavy rainfall or drought events imply increased vulnerability to food insecurity, but if global warming is limited to 1.5 degrees C, this vulnerability is projected to remain smaller than at 2 degrees C global warming in approximately 76% of developing countries. At 2 degrees C, four countries are projected to reach unprecedented levels of vulnerability to food insecurity. This article is part of the theme issue 'The Paris Agreement understanding the physical and social challenges for a warming world of 15 degrees C above pre-industrial levels'.

Binita, K. C., et al. (2015). "Climate change vulnerability assessment in Georgia." Applied Geography **62**: 62-74.
Climate change is occurring in the Southeastern United States, and one manifestation is changes in frequency and intensity of extreme events. A vulnerability assessment is performed in the state of Georgia (United States) at the county level from 1975 to 2012 in decadal increments. Climate change vulnerability is typically measured as a function of exposure to physical phenomena (e.g., droughts, floods), sensitivity to factors affecting the social milieu, and the capacity of a given unit to adapt to changing physical conditions. The paper builds on previous assessments and offers a unique approach to vulnerability analyses by combining climatic, social, land cover, and hydrological components together into a unified vulnerability assessment, which captures both long-term and hydroclimatic events. Climate change vulnerability indices are derived for the 1980s, 1990s, 2000s, and 2010s. Climate change exposure is measured as: 1) departure of decadal mean temperature and precipitation from baseline temperature and precipitation (1971-2000) using the United States Historical Climatology Network version 2.5 and 2) extreme hydroclimatic hazards indicated

by flood, heat wave and drought events. Sensitivity and adaptive capacity are measured by well-established conceptualizations and methods built derived from socioeconomic variables. Impervious surface and flood susceptibility area are also incorporated to account for place-based vulnerability. Anomalies in temperature and precipitation with an overall trend towards drying and warming have been observed. The anomalous cooling period in Georgia during the 1970-1980 period as well as the post-1980 warm-up have been captured with a clearly established increase in extreme hydroclimatic events in recent decades. Climate vulnerability is highest in some metropolitan Atlanta and coastal counties. However, the southwestern region of Georgia, and part of the rural Black belt region are found to be especially vulnerable to climate change. (C) 2015 Elsevier Ltd. All rights reserved.

Bisrat, S. A., et al. (2012). "Predicting the distribution potential of an invasive frog using remotely sensed data in Hawaii." Diversity and Distributions **18**(7): 648-660.

Aim Eleutherodactylus coqui (commonly known as the coqui) is a frog species native to Puerto Rico and non-native in Hawaii. Despite its ecological and economic impacts, its potential range in Hawaii is unknown, making control and management efforts difficult. Here, we predicted the distribution potential of the coqui on the island of Hawaii. Location Puerto Rico and Hawaii. Methods We predicted its potential distribution in Hawaii using five biophysical variables derived from Moderate Resolution Imaging Spectroradiometer (MODIS) as predictors, presence/absence data collected from Puerto Rico and Hawaii and three classification methods Classification Trees (CT), Random Forests (RF) and Support Vector Machines (SVM). Results Models developed separately using data from the native range and the invaded range predicted potential coqui habitats in Hawaii with high performance. Across the three classification methods, mean area under the ROC curve (AUC) was 0.75 for models trained using the native range data and 0.88 for models trained using the invaded range data. We achieved the highest AUC value of 0.90 using RF for models trained with invaded range data. Main conclusions Our results showed that the potential distribution of coquis on the island of Hawaii is much larger than its current distribution, with RF predicting up to 49% of the island as suitable coqui habitat. Predictions also show that most areas with an elevation between 0 and 2000 m are suitable coqui habitats, whereas the cool and dry high elevation areas beyond 2000 m elevation are unsuitable. Results show that MODIS-derived biophysical variables are capable of characterizing coqui habitats in Hawaii.

Bogelein, R., et al. (2017). "Leaf water O-18 and H-2 enrichment along vertical canopy profiles in a broadleaved and a conifer forest tree." Plant Cell and Environment **40**(7): 1086-1103.

Distinguishing meteorological and plant-mediated drivers of leaf water isotopic enrichment is prerequisite for ecological interpretations of stable hydrogen and oxygen isotopes in plant tissue. We measured input and leaf water delta H-2 and delta O-18 as well as micrometeorological and leaf morpho-physiological variables along a vertical gradient in a mature angiosperm (European beech) and gymnosperm (Douglas fir) tree. We used these variables and different enrichment models to quantify the influence of Peclet and non-steady state effects and of the biophysical drivers on leaf water enrichment. The two-pool model accurately described the diurnal variation of leaf water enrichment. The estimated unenriched water fraction was linked to leaf dry matter content across the canopy heights. Non-steady state effects and reduced stomatal conductance caused a higher enrichment of Douglas fir compared to beech leaf water. A dynamic effect analyses revealed that the light-induced vertical gradients of stomatal conductance and leaf temperature outbalanced each other in their effects on evaporative enrichment. We conclude that neither vertical canopy gradients nor the Peclet effect is important for estimates and interpretation of isotopic leaf water enrichment in hypostomatous trees. Contrarily, species-specific non-steady state effects and leaf temperatures as well as the water vapour isotope composition need careful consideration.

Bonan, G. B., et al. (2002). "Landscapes as patches of plant functional types: An integrating concept for climate and ecosystem models." Global Biogeochemical Cycles **16**(2).

[1] While most land models developed for use with climate models represent vegetation as discrete biomes, this is, at least for mixed life-form biomes, inconsistent with the leaf-level and whole-plant physiological parameterizations needed to couple these biogeophysical models with biogeochemical and ecosystem dynamics models. In this paper, we present simulations with the National Center for Atmospheric Research land surface model (NCAR LSM) that examined the effect of representing vegetation as patches of plant

functional types (PFTs) that coexist within a model grid cell. This approach is consistent with ecological theory and models and allows for unified treatment of vegetation in climate and ecosystem models. In the standard NCAR LSM the PFT composition and leaf area for each grid cell are obtained by classifying grid cells as 1 of 28 possible biomes. Here, we develop a data set from 1-km satellite data that provides each model grid cell a unique PFT composition and leaf area for each PFT. Global simulations at 3degrees x 3degrees spatial resolution showed that ground temperature, ground evaporation, and northern high-latitude winter albedo exhibited direct responses to these landscape changes, which led to indirect effects such as in soil moisture and sensible and latent heat fluxes. Additional simulations at 2degrees x 2degrees and 1degrees x 1degrees spatial resolution showed that low-resolution simulations masked landscape heterogeneity in both approaches but the satellite-based, continuous representation of vegetation reduced model sensitivity to resolution. It is argued that the use of spatially continuous distributions of coexisting PFTs is a necessary step to link climate and ecosystem models.

Boone, A. A., et al. (2016). "The regional impact of Land-Use Land-cover Change (LULCC) over West Africa from an ensemble of global climate models under the auspices of the WAMME2 project." Climate Dynamics **47**(11): 3547-3573.

The population of the Sahel region of West Africa has approximately doubled in the past 50 years, and could potentially double again by the middle of this century. This has led to the northward expansion of agricultural areas at the expense of natural savanna, leading to widespread land use -land cover change (LULCC). Because there is strong evidence of significant surface-atmosphere coupling in this region, one of the main goals of the West African Monsoon Modeling and Evaluation project phase II is to provide basic understanding of LULCC on the regional climate, and to evaluate the sensitivity of the seasonal variability of the West African Monsoon to LULCC. The prescribed LULCC is based on the changes from 1950 through 1990, representing a maximum feasible degradation scenario in the past half century. It is applied to 5 state of the art global climate models (GCMs) over a 6-year simulation period. Multiple GCMs are used because the magnitude of the impact of LULCC depends on model-dependent coupling strength between the surface and the overlying atmosphere, the magnitude of the surface biophysical changes, and how the key processes linking the surface with the atmosphere are parameterized within a particular model framework. Land cover maps and surface parameters may vary widely among models; therefore a special effort was made to impose consistent biogeophysical responses of surface parameters to LULCC using a simple experimental setup. The prescribed LULCC corresponds to degraded vegetation conditions, which mainly cause increases in the Bowen ratio and decreases in the surface net radiation, and result in a significant reduction in surface evaporation (upwards of 1 mm day(-1) over a large part of the Sahel). This, in turn, mainly leads to less moisture convergence and precipitation over the LULCC zone. The overall impact is a rainfall reduction with every model, which ranges across models from 4 to 25 % averaged over the Sahel, and a southward shift of the rainfall peak in three of the five models which evokes a precipitation dipole pattern which is consistent with the observed pattern for dry climate anomalies over this region. The African Easterly Jet shifts equator-ward, although the strength of this change varies considerably among the models. In most of the models, the main factor causing diabatic cooling of the upper troposphere and enhanced subsidence over the region of LULCC is the reduction of convective heating rates linked to reduced latent heat flux and moisture flux convergence. In broad agreement with previous studies, the impact of degradation on the regional climate is found to vary among the different models, however, the signal is stronger and more consistent between the models here than in previous inter-comparison projects. This is likely related to our emphasis on prioritizing a consistent impact of LULCC on the surface biophysical properties.

Bourque, C. P. A. and Q. K. Hassan (2008). "Projected impacts of climate change on species distribution in the Acadian Forest region of eastern Nova Scotia." Forestry Chronicle **84**(4): 553-557.

A modelling framework is presented for the calculation of potential species habitat based on species vital attributes and spatial calculations of growing season averages of growing degree day accumulation, incident solar radiation, and soil moisture. Soil moisture and incident solar radiation are calculated from first principles; i.e., hydrological cycle and earth-sun geometry. Growing degree days and mean air temperature are based on processing remote sensing data, mean air temperatures serves as one of several inputs to model calculation of soil moisture. Both the growing degree days and soil moisture are modified to account for anticipated climate change in 2040. Potential species habitat distributions are presented for current and future (2040) climate for a portion of the Acadian Forest of eastern Nova Scotia.

Boyd, D. S., et al. (2006). "Dynamics of ENSO drought events on Sabah rainforests observed by NOAA AVHRR." International Journal of Remote Sensing **27**(11): 2197-2219.

Drought, associated with the El Nino Southern Oscillation (ENSO), can have considerable impact on tropical rainforests. Concern over drought, particularly given the possibility of an increase in its occurrence and intensity, has fostered a desire for an increased understanding of drought events and their impact to inform the development of a drought monitoring system. This paper investigates the use of National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) data in a drought monitoring system for the rainforests of Sabah, Borneo. These rainforests are dynamic with respect to their coupling with ENSO processes and in their biophysical properties, and such dynamism may have implications for how NOAA AVHRR data may be used. In particular, this paper explores the transferability of relationships between a drought indicator (rainfall) and the response of the rainforest, as measured by four NOAA AVHRR variables (middle infrared reflectance; VI3; Ts/VI3 and Ts/NDVI), under particular site conditions. It was found that both spatial variability in forest biophysical properties and geographical variability in drought impact had implications for the transferability of relationships developed under local conditions across Sabah rainforests within a drought monitoring system. Suggestions are presented for how NOAA AVHRR data could be used, with a new drought monitoring index the Ts/VI3-recommended.

Brais, S., et al. (2000). "Impacts of wild fire severity and salvage harvesting on the nutrient balance of jack pine and black spruce boreal stands." Forest Ecology and Management **137**(1-3): 231-243.

In August of 1995, wildfires burnt over 50 000 ha of boreal forest in northwestern Quebec. A balance sheet approach was used in order to assess the long term effects of fire and subsequent salvage harvesting operations on nutrient site capital. Following a validation of burn severity indices and maps, we conducted an evaluation of soil nutrient pools in (1) lightly to moderately (2) severely burned, and (3) unburned stands with similar biophysical characteristics. Above-ground biomass values for unburned stands, precipitation and N biological fixation inputs were drawn from the literature. Weathering rates were drawn from previous work and estimated with the PROFILE model. Fire significantly reduced forest floor dry weight by 41% in the light/moderate class and by 60% in the severe class while forest floor total Ca concentrations increased following both types of burn. Forest floor exchangeable Ca and total Mg concentrations increased following a light/moderate burn. Fire increased exchangeable K concentrations in the 0-10 cm mineral layer but had no other effects on mineral soil concentrations or characteristics. Forest floor nutrient content was significantly reduced on severely burned areas only. Kjeldahl N content was reduced by 44%, exchangeable Mg by 53% and exchangeable K and total K by 60 and 51%, respectively. Reduction of K soil content was important enough that inputs through weathering and precipitation would take 278 years to compensate for soil losses following a severe fire. The projected effects of salvage harvesting on severely burned sites indicated that Ca, Mg and K would not return to their pre-burn level in the course of a 1 10-year rotation. (C) 2000 Elsevier Science B.V. All rights reserved.

Brandeis, T. J., et al. (2009). "Climate shapes the novel plant communities that form after deforestation in Puerto Rico and the US Virgin Islands." Forest Ecology and Management **258**(7): 1704-1718.

Environmental and past land use controls on tree species assemblages on the Commonwealth of Puerto Rico and the U.S. Virgin Islands were characterized to determine whether biophysical factors or land-use history has been more important in determining the species composition of secondary tropical forests after large-scale forest clearing for agriculture, widespread species introduction, and landscape-scale forest fragmentation. Post-deforestation, secondary forest assemblages are comprehensively described, both as broad general assemblages and island-specific variations by calculating species importance values from forest inventory data. Hierarchical clustering and indicator species analysis defined species assemblages, and then correlations between species assemblages and environmental variables were explored with non-metric multidimensional scaling, analysis of variance and chi(2) testing. These assemblages are arrayed along environmental gradients of decreasing spring moisture stress, decreasing maximum temperatures, and increasing minimum temperatures. Land-use history is not as important to determining variation in species composition across climatic zones, although several species assemblages are associated with certain geology types or land-use histories. Naturalized tree species are prominent in these secondary forests and contribute

to the formation of some novel assemblages, but native late and early successional species also colonize former agricultural land, all influenced by the degree of disturbance. We conclude that environmental factors have an overarching effect on forest species composition across the broader range of climatic, geologic and topographic conditions and larger geographic scales, while land-use history influences subtropical secondary forest species assemblages within a specific climatic zone or set of relatively narrow environmental conditions. Published by Elsevier B.V.

Bright, R. M., et al. (2014). "Climate change implications of shifting forest management strategy in a boreal forest ecosystem of Norway." Global Change Biology **20**(2): 607-621.

Empirical models alongside remotely sensed and station measured meteorological observations are employed to investigate both the local and global direct climate change impacts of alternative forest management strategies within a boreal ecosystem of eastern Norway. Stand-level analysis is firstly executed to attribute differences in daily, seasonal, and annual mean surface temperatures to differences in surface intrinsic biophysical properties across conifer, deciduous, and clear-cut sites. Relative to a conifer site, a slight local cooling of -0.13 degrees C at a deciduous site and -0.25 degrees C at a clear-cut site were observed over a 6-year period, which were mostly attributed to a higher albedo throughout the year. When monthly mean albedo trajectories over the entire managed forest landscape were taken into consideration, we found that strategies promoting natural regeneration of coniferous sites with native deciduous species led to substantial global direct climate cooling benefits relative to those maintaining current silviculture regimes - despite predicted long-term regional warming feedbacks and a reduced albedo in spring and autumn months. The magnitude and duration of the cooling benefit depended largely on whether management strategies jointly promoted an enhanced material supply over business-as-usual levels. Expressed in terms of an equivalent CO2 emission pulse at the start of the simulation, the net climate response at the end of the 21st century spanned -8 to -159Tg-CO2-eq., depending on whether near-term harvest levels increased or followed current trends, respectively. This magnitude equates to approximately -20 to -300% of Norway's annual domestic (production) emission impact. Our analysis supports the assertion that a carbon-only focus in the design and implementation of forest management policy in boreal and other climatically similar regions can be counterproductive - and at best - suboptimal if boreal forests are to be used as a tool to mitigate global warming.

Briscoe, N. J., et al. (2014). "Tree-hugging koalas demonstrate a novel thermoregulatory mechanism for arboreal mammals." Biology Letters **10**(6).

How climate impacts organisms depends not only on their physiology, but also whether they can buffer themselves against climate variability via their behaviour. One of the way species can withstand hot temperatures is by seeking out cool microclimates, but only if their habitat provides such refugia. Here, we describe a novel thermoregulatory strategy in an arboreal mammal, the koala Phascolarctos cinereus. During hot weather, koalas enhanced conductive heat loss by seeking out and resting against tree trunks that were substantially cooler than ambient air temperature. Using a biophysical model of heat exchange, we show that this behaviour greatly reduces the amount of heat that must be lost via evaporative cooling, potentially increasing koala survival during extreme heat events. While it has long been known that internal temperatures of trees differ from ambient air temperatures, the relevance of this for arboreal and semi-arboreal mammals has not previously been explored. Our results highlight the important role of tree trunks as aboveground 'heat sinks', providing cool local microenvironments not only for koalas, but also for all tree-dwelling species.

Bunn, A. G., et al. (2005). "Topographic mediation of growth in high elevation foxtail pine (Pinus balfouriana Grev. et Balf.) forests in the Sierra Nevada, USA." Global Ecology and Biogeography **14**(2): 103-114.

Aim Climate variability is an important mediating agent of ecosystem dynamics in cold, semi-arid regions such as the mountains of western North America. Climatically sensitive tree-ring chronologies offer a means of assessing the impact of climate variability on tree growth across temporal scales of years to centuries and spatial scales of metres to subcontinents. Our goal was to bring practices from landscape ecology that highlight the impact of landscape heterogeneity on ecological pattern and processes into a dendroclimatic study that shows that the biophysical setting of target trees affects ring-width patterns. Location This study was conducted at two sites near alpine treeline in the Sequoia National Park, USA (36degrees30' 00' N,

118degrees30' 00' W). Methods We collected stand information and increment cores from foxtail pines (Pinus balfouriana Grev. et Balf.) for eight tree-ring chronologies in four extreme biophysical settings at two sites using proxies for soil moisture and radiation derived from a digital elevation model. Results Biophysical setting affected forest age-class structure, with wet and bright plots showing high recruitment after 1900 AD, but had no obvious effect on immature stem density (e.g. seedlings). Biophysical setting strongly affected ring-width patterns, with wet plots having higher correlation with instrumental temperature records while dry plots correlated better with instrumental precipitation records. Ring-width chronologies from the wet plots showed strong low-frequency variability (i.e. hundreds of years) while ring-width chronologies from the dry plots showed strong variability on multidecadal scales. Main conclusions There was a strong association between biophysical setting and age-class structure, and with ring-width patterns in foxtail pine. The mediation of ring widths by biophysical setting has the potential to further the understanding of the expression of synoptic-scale climate across rugged terrain. When combined with remotely sensed imagery, a priori GIS modelling of tree growth offers a viable means to devise first-order predictions of climatic impacts in subalpine forest dynamics and to develop flexible and powerful monitoring schemes.

Burakowski, E., et al. (2018). "The role of surface roughness, albedo, and Bowen ratio on ecosystem energy balance in the Eastern United States." Agricultural and Forest Meteorology **249**: 367-376.

Land cover and land use influence surface climate through differences in biophysical surface properties, including partitioning of sensible and latent heat (e.g., Bowen ratio), surface roughness, and albedo. Clusters of closely spaced eddy covariance towers (e.g., < 10 km) over a variety of land cover and land use types provide a unique opportunity to study the local effects of land cover and land use on surface temperature. We assess contributions albedo, energy redistribution due to differences in surface roughness and energy redistribution due to differences in the Bowen ratio using two eddy covariance tower clusters and the coupled (land-atmosphere) Variable-Resolution Community Earth System Model. Results suggest that surface roughness is the dominant biophysical factor contributing to differences in surface temperature between forested and deforested lands. Surface temperature of open land is cooler (-4.8 degrees C to -0.05 degrees C) than forest at night and warmer (+0.16 degrees C to +8.2 degrees C) during the day at northern and southern tower clusters throughout the year, consistent with modeled calculations. At annual timescales, the biophysical contributions of albedo and Bowen ratio have a negligible impact on surface temperature, however the higher albedo of snow-covered open land compared to forest leads to cooler winter surface temperatures over open lands (-0.4 degrees C to -0.8 degrees C). In both the models and observation, the difference in mid-day surface temperature calculated from the sum of the individual biophysical factors is greater than the difference in surface temperature calculated from radiative temperature and potential temperature. Differences in measured and modeled air temperature at the blending height, assumptions about independence of biophysical factors, and model biases in surface energy fluxes may contribute to daytime biases.

Campos, C. A., et al. (2014). "Soil organic carbon stocks in Veracruz State (Mexico) estimated using the 1:250,000 soil database of INEGI: biophysical contributions." Journal of Soils and Sediments **14**(5): 860-871.

Purpose In this study, we quantified soil organic carbon (SOC) stocks and analyzed their relationship with biophysical factors and soil properties. Materials and methods The study region was Veracruz State, located in the eastern part of Mexico, covering an area of 72,410 km(2). A soil database that contains physicochemical analyses of soil horizons such as carbon concentration data was the source of information used in this study. The database consisted of 163 soil profiles representing 464 genetic horizons. Statistical analysis was used to investigate the effect of each factor (climate, altitude, slope) on SOC stock to 0.50 m depth and to assess differences in the distribution of SOC stock in terms of soil depth (0.0-0.20, 0.20-0.40, 0.40-0.60, 0.60-0.80, 0.80-1.0 m) and land use. In order to compute the spatial distribution of SOC stock to 0.50 m depth based on the soil sampling location, the kriging method was used. Results and discussion Results indicated that SOC stock (0.50 m depth) ranged between 0.44 and 41.2 kg C m(-2). Regression analysis showed that SOC stocks (0.50 m depth) are negatively correlated with temperature (r=-0.38; P<0.001) and positively correlated with altitude (r=0.40; P<0.001) and slope (r=0.40; P<0.001). In addition, by multiple regression, temperature combined with precipitation explained more SOC stock variations (r=0.43; P<0.001) than the regression model with precipitation (r=0.13; P=0.16) alone. Also, slope combined with temperature and precipitation explained more SOC stock variations (r=0.46; P<0.001) than the regression model with slope alone. Forest lands, grasslands, and croplands have higher SOC stocks in the 0.0-0.20-m soil layer than in deeper layers. On average, forest lands, grasslands, croplands, and other lands (wetland and dunes) had a SOC stock of 13.6, 14.6, 15.1, and 8.5 kg C m(-2) at 1 m depth, respectively. Soil color correlated (-0.25 <= r <=-0.89) with SOC content. Conclusions Overall, these results indicate the influence of major interactions between biophysical factors and SOC stocks. This research indicated that SOC stock decreased with soil depth, but with slight variations depending on land use. Thus, there remains a need for more SOC data that include an improved distribution of soil sampling points in order to entirely understand the contributions of biophysical factors to SOC stocks in Veracruz State.

Cao, Q., et al. (2015). "Impacts of land use and land cover change on regional climate: a case study in the agro-pastoral transitional zone of China." Environmental Research Letters **10**(12).

Assessing the impacts of land use and land cover change (LUCC) on regional climate is essential for understanding land-atmosphere interactions and for designing climate adaptation andmitigation strategies. Using the weather research and forecasting (WRF) model, we examined how different land use and land cover patterns affect regional climate in the agro-pastoral transitional zone of North China, whose environmental and socioeconomic conditions are sensitive to climate change. We parameterized WRF using land use and land cover maps corresponding to 2001 and 2010 conditions, which differ in the representation of four land surface biophysical parameters: vegetation fraction, leaf area index (LAI), albedo, and emissivity. From 2001 to 2010, vegetation fraction and LAI increased in summer, emissivity increased and albedo decreased in winter. Our WRF simulations show that differences in land use and land cover patterns led to widespread reduction in summer temperature with local cooling on the order of 1 degrees C, and extensive increase in winter temperature with local warming exceeding 0.8 degrees C. By contrast, simulations using the default landscape representation, provided by WRF itself, show only minor and random changes in temperature. Model evaluation further reveals that our simulations with appropriate land surface properties improve the performance of the WRF model. Our findings demonstrate that LUCC in Northern China has altered the regional climate over the past decade. The magnitude and spatial patterns of temperature changes quantified by our simulations provide useful information for understanding the impacts of LUCC on climate and for developing mitigation and adaptation strategies in arid and semiarid regions.

Cao, Q., et al. (2018). "Substantial impacts of landscape changes on summer climate with major regional differences: The case of China." Science of the Total Environment **625**: 416-427.

China's rapid socioeconomic development during the past few decades has resulted in large-scale landscape changes across the country. However, the impacts of these land surface modifications on climate are yet to be adequately understood. Using a coupled process-based land-atmospheric model, therefore, we quantified the climatic effects of land cover and land management changes over mainland China from 2001 to 2010, via incorporation of real-time and high-quality satellite-derived landscape representation (i.e., vegetation fraction, leaf area index, and albedo) into numerical modeling. Our results show that differences in landscape patterns due to changes in land cover and land management have exerted a strong influence on summer climate in China. During 2001 and 2010, extensive cooling of up to 1.5 degrees C was found in the Loess Plateau and 1.0 degrees C in northeastern China. In contrast, regional-scale warming was detected in the Tibetan Plateau (0.3 degrees C), Yunnan province (0.4 degrees C), and rapidly expanding urban centers across China (as high as 2 degrees C). Summer precipitation decreased in the northeastern region, with patchy reduction generally <1.8mm/day, but increased in the Loess Plateau, with local spikes up to 2.4mm/day. Our study highlights that human alterations of landscapes have had substantial impacts on summer climate over the entire mainland China, but these impacts varied greatly on the regional scale, including changes in opposite directions. Therefore, effective national-level policies and regional land management strategies for climate change mitigation and adaptation should take explicit account of the spatial heterogeneity of landscape-climate interactions. (c) 2017 Elsevier B.V. All rights reserved.

Carrer, M., et al. (2007). "Regional variability of climate-growth relationships in Pinus cembra high elevation forests in the Alps." Journal of Ecology **95**(5): 1072-1083.

1. The tree-ring growth response of stone pine (Pinus cembra L.) to climatic variability was studied in the Alps. The aims were (i) to assess tree-ring growth patterns at different spatial-temporal scales; (ii) to identify the climate parameters that explain most of the variability in radial growth at different time domains; and (iii)

to study past and current trends in radial growth and climate-growth relationships at different locations. 2. High- and low-frequency stone pine chronologies were compiled for 30 treeline sites on the French and Italian Alps. We used gridded climate data computed from 200 years of instrumental records from an extensive Alpine network. Climate-growth relationships were computed with bootstrap correlation functions and their stationarity and consistency over time assessed with moving correlation. 3. No spatial patterns were detected in stone pine chronology statistics despite the regional clustering observed in tree-ring series and climate responses. This can be attributed to (i) local weather variability; (ii) different biophysical conditions caused by soil moisture, solar radiation, snowmelt dynamics and growing season length; and (iii) forest stand history and age structure, the expression of long-term land use and disturbances. 4. The exceptionally long-term climate records allowed significant stone pine growth response changes to be assessed at both annual and decadal time scales. Winter conditions and spring-summer temperatures mainly affected the growing season length, in addition to site carbon and water balance. Most of these limiting factors varied spatially and temporally along the latitudinal and longitudinal gradients in response to the corresponding changes in local conditions. 5. Our results show evidence of a clear response variability of Pinus cembra to climate limiting factors, at both spatial and temporal scale. Such knowledge extended to other species and regions will provide better estimates of the effect of climate variability on species distribution and dynamics within global change scenarios and more accurate past climate reconstruction and forest ecosystem modelling.

Castillo, C. K. G. and K. R. Gurney (2013). "A Sensitivity Analysis of Surface Biophysical, Carbon, and Climate Impacts of Tropical Deforestation Rates in CCSM4-CNDV." Journal of Climate **26**(3): 805-821.

The biophysical-climate and combined biophysical and carbon-climate feedbacks of tropical deforestation rates are explored through sensitivity analyses using the Community Climate System Model 4 with prognostic carbon-nitrogen and dynamic vegetation. Simulations test 5%, 2%, 1%, and 0.5% annual deforestation rates, each paired with preservation targets of 10% per tropical tree type. Perturbations are applied over pan-tropical land but analyses also investigate responses over the subcontinental areas of the Amazon basin, central Africa, and Southeast Asia. Sensitivities [expressed as the change in a variable per million square kilometers (Mkm(2)) of change in tree cover] and means of selected biophysical, carbon, and climate variables during and after deforestation are compared across rates. The most apparent effect of the rates is in hastening/ postponing climate change, but otherwise results show no consistent differences across rates and vary more across subcontinents (with the Amazon basin reflecting highest sensitivities in albedo and ground temperatures, and Southeast Asia for total ecosystem carbon). Additionally, biophysical feedbacks alone were found to have significant impact on climate over subcontinental scales. In the Amazon, ground temperature increase due to biophysical feedbacks is as much as 55%, and precipitation decrease up to 61%, of combined biophysical and carbon impacts. Replication with other models is required. Although it is still unclear whether a slow but prolonged deforestation differs in impacts from one that is rapid but short, the rate can still be relevant to planning with regards to the timing of impacts.

Castillo, C. P., et al. (2015). "Modelling the spatial allocation of second-generation feedstock (lignocellulosic crops) in Europe." International Journal of Geographical Information Science **29**(10): 1807-1825.

This paper presents a modelling approach for the spatial allocation of second-generation feedstock (lignocellulosic crops) under a reference policy scenario in European Union of 28 Member State (EU-28). The land-use modelling platform (LUMP) was used in order to simulate the land-use changes from 2010 to 2050. Within the LUMP, the land demand for these lignocellulosic energy crops was derived from the Common Agricultural Policy Regionalised Impact analysis model. Suitability maps were generated for two main energy crop groups: herbaceous and woody lignocellulosic crops, using multicriteria analysis techniques. Biophysical factors (climate, soil properties and topographical aspects), natural and artificial constraints and location-specific land categories were defined as relevant components within the platform. A sensitivity analysis determined the most influential factors to be temperature, precipitation, length of growing period and number of frost-free days. The results of the modelling exercise in the LUMP reflect the significant renewable energy contribution from energy crops in EU-28, which was estimated to be between 2.3EJ/year (in 2020) and 6.3EJ/year (in 2050), accounting for 2.3% and 9.6% of total energy consumption in the EU-28. The results of the allocation were aggregated at regional level to analyse trends. Regions with considerably high demand were identified in Germany, the United Kingdom and Poland.

Catalano, F., et al. (2016). "Observationally based analysis of land-atmosphere coupling." Earth System Dynamics **7**(1): 251-266.

The temporal variance of soil moisture, vegetation and evapotranspiration over land has been recognized to be strongly connected to the temporal variance of precipitation. However, the feedbacks and couplings between these variables are still not well understood and quantified. Furthermore, soil moisture and vegetation processes are associated with a memory and therefore they may have important implications for predictability. In this study we apply a generalized linear method, specifically designed to assess the reciprocal forcing between connected fields, to the latest available observational data sets of global precipitation, evapotranspiration, vegetation and soil moisture content. For the first time a long global observational data set is used to investigate the spatial and temporal land variability and to characterize the relationships and feedbacks between land and precipitation. The variables considered show a significant coupling among each other. The analysis of the response of precipitation to soil moisture evidences a robust coupling between these two variables. In particular, the first two modes of variability in the precipitation forced by soil moisture appear to have a strong link with volcanic eruptions and El Nino-Southern Oscillation (ENSO) cycles, respectively, and these links are modulated by the effects of evapotranspiration and vegetation. It is suggested that vegetation state and soil moisture provide a biophysical memory of ENSO and major volcanic eruptions, revealed through delayed feedbacks on rainfall patterns. The third mode of variability reveals a trend very similar to the trend of the inter-hemispheric contrast in sea surface temperature (SST) and appears to be connected to greening/browning trends of vegetation over the last three decades.

Chacon, A., et al. (2016). "Biophysical Impacts of Land Use Change over North America as Simulated by the Canadian Regional Climate Model." Atmosphere **7**(3).

This study investigates the biophysical impacts of human-induced land use change (LUC) on the regional climate of North America, using the fifth generation Canadian Regional Climate Model (CRCM5). To this end, two simulations are performed with CRCM5 using different land cover datasets, one corresponding to the potential vegetation and the other corresponding to current land use, spanning the 1988-2012 period, driven by European Centre for Medium-Range Weather Forecasts Re-Analysis (ERA)-Interim at the lateral boundaries. Comparison of the two suggests higher albedo values, and therefore cooler temperatures, over the LUC regions, in the simulation with LUC, in winter. This is due to the absence of crops in winter, and also possibly due to a snow-mediated positive feedback. Some cooling is observed in summer for the simulation with LUC, mostly due to the higher latent heat fluxes and lower sensible heat fluxes over eastern US. Precipitation changes for these regions are not statistically significant. Analysis of the annual cycles for two LUC regions suggests that the impact of LUC on two meter temperature, evapotranspiration, soil moisture and precipitation are present year round. However, the impact on runoff is mostly restricted to the snowmelt season. This study thus highlights regions and variables most affected by LUC over North America.

Chakraborty, S. D., et al. (2015). "Assessment of land surface temperature and heat fluxes over Delhi using remote sensing data." Journal of Environmental Management **148**: 143-152.

Surface energy processes has an essential role in urban weather, climate and hydrosphere cycles, as well in urban heat redistribution. The research was undertaken to analyze the potential of Landsat and MODIS data in retrieving biophysical parameters in estimating land surface temperature & heat fluxes diurnally in summer and winter seasons of years 2000 and 2010 and understanding its effect on anthropogenic heat disturbance over Delhi and surrounding region. Results show that during years 2000-2010, settlement and industrial area increased from 5.66 to 11.74% and 4.92 to 11.87% respectively which in turn has direct effect on land surface temperature (LST) and heat fluxes including anthropogenic heat flux. Based on the energy balance model for land surface, a method to estimate the increase in anthropogenic heat flux (Has) has been proposed. The settlement and industrial areas has higher amounts of energy consumed and has high values of Has in all seasons. The comparison of satellite derived LST with that of field measured values show that Landsat estimated values are in close agreement within error of 2 degrees C than MODIS with an error of 3 degrees C. It was observed that, during 2000 and 2010, the average change in surface temperature using Landsat over settlement & industrial areas of both seasons is 1.4 degrees C & for MODIS data is 3.7 degrees C. The seasonal average change in anthropogenic heat flux (Has) estimated using Landsat & MODIS is up by

around 38 W/m(2) and 62 W/m(2) respectively while higher change is observed over settlement and concrete structures. The study reveals that the dynamic range of Has values has increased in the 10 year period due to the strong anthropogenic influence over the area. The study showed that anthropogenic heat flux is an indicator of the strength of urban heat island effect, and can be used to quantify the magnitude of the urban heat island effect. (C) 2013 Elsevier Ltd. All rights reserved.

Chambers, J. C., et al. (2017). "Using Resilience and Resistance Concepts to Manage Persistent Threats to Sagebrush Ecosystems and Greater Sage-grouse." Rangeland Ecology & Management **70**(2): 149-164.

Conservation of imperiled species often demands addressing a complex suite of threats that undermine species viability. Regulatory approaches, such as the US Endangered Species Act (1973), tend to focus on anthropogenic threats through adoption of policies and regulatory mechanisms. However, persistent ecosystem-based threats, such as invasive species and altered disturbance regimes, remain critical issues for most at-risk species considered to be conservation-reliant. We describe an approach for addressing persistent ecosystem threats to at-risk species based on ecological resilience and resistance concepts that is currently being used to conserve greater sage-grouse (Centrocercus urophasianus) and sagebrush ecosystems. The approach links biophysical indicators of ecosystem resilience and resistance with species-specific population and habitat requisites in a risk-based framework to identify priority areas for management and guide allocation of resources to manage persistent ecosystem-based threats. US federal land management and natural resource agencies have adopted this framework as a foundation for prioritizing sage-grouse conservation resources and determining effective restoration and management strategies. Because threats and strategies to address them cross-cut program areas, an integrated approach that includes wildland fire operations, postfire rehabilitation, fuels management, and habitat restoration is being used. We believe this approach is applicable to species conservation in other largely intact ecosystems with persistent, ecosystem-based threats. Published by Elsevier Inc.

Chang, C. T., et al. (2014). "Retrieving multi-scale climatic variations from high dimensional time-series MODIS green vegetation cover in a tropical/subtropical mountainous island." Journal of Mountain Science **11**(2): 407-420.

There are knowledge gaps in our understanding of vegetation responses to multi-scale climate-related variables in tropical/subtropical mountainous islands in the Asia-Pacific region. Therefore, this study investigated inter-annual vegetation dynamics and regular/irregular climate patterns in Taiwan. We applied principal component analysis (PCA) on 11 years (2001 similar to 2011) of high-dimensional monthly photosynthetically active vegetation cover (PV) derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) and investigated the relationships between spatiotemporal patterns of the eigenvectors and loadings of each component through time and multi-scale climaterelated variations. Results showed that the first five components contributed to 96.4% of the total variance. The first component (PC1, explaining 94.5% of variance) loadings, as expected, were significantly correlated with the temporal dynamics of the PV (r = 0.94), which was mainly governed by regional climate. The temporal loadings of PC2 and PC3 (0.8% and 0.6% of variance, respectively) were significantly correlated with the temporal dynamics of the PV of forests (r = 0.72) and the farmlands (r = 0.80), respectively. The low-order components (PC4 and PC5, 0.3% and 0.2% of variance, respectively) were closely related to the occurrence of drought (r = 0.49) and to irregular ENSO associated climate anomalies (r = -0.54), respectively. Pronounced correlations were also observed between PC5 and the Southern Oscillation Index (SOI) with one to three months of time lags (r = -0.35 similar to -0.43, respectively), revealing biophysical memory effects on the time-series pattern of the vegetation through ENSO-related rainfall patterns. Our findings reveal that the sensitivity of the ecosystems in this tropical/subtropical mountainous island may not only be regulated by regional climate and human activities but also be susceptible to large-scale climate anomalies which are crucial and comparable to previous large scale analyses. This study demonstrates that PCA can be an effective tool for analyzing seasonal and inter-annual variability of vegetation dynamics across this tropical/subtropical mountainous islandin the Pacific Ocean, which provides an opportunity to forecast the responses and feedbacks of terrestrial environments to future climate scenarios.

Chang, H. J., et al. (2013). "Water Supply, Demand, and Quality Indicators for Assessing the Spatial Distribution of Water Resource Vulnerability in the Columbia River Basin." Atmosphere-Ocean **51**(4): 339-356.

We investigated water resource vulnerability in the US portion of the Columbia River basin (CRB) using multiple indicators representing water supply, water demand, and water quality. Based on the US county scale, spatial analysis was conducted using various biophysical and socio-economic indicators that control water vulnerability. Water supply vulnerability and water demand vulnerability exhibited a similar spatial clustering of hotspots in areas where agricultural lands and variability of precipitation were high but dam storage capacity was low. The hotspots of water quality vulnerability were clustered around the main stem of the Columbia River where major population and agricultural centres are located. This multiple equal weight indicator approach confirmed that different drivers were associated with different vulnerability maps in the sub-basins of the CRB. Water quality variables are more important than water supply and water demand variables in the Willamette River basin, whereas water supply and demand variables are more important than water quality variables in the Upper Snake and Upper Columbia River basins. This result suggests that current water resources management and practices drive much of the vulnerability within the study area. The analysis suggests the need for increased coordination of water management across multiple levels of water governance to reduce water resource vulnerability in the CRB and a potentially different weighting scheme that explicitly takes into account the input of various water stakeholders.

Chappell, N. A., et al. (2001). "Modelling rainfall and canopy controls on net-precipitation beneath selectively-logged tropical forest." Plant Ecology **153**(1-2): 215-229.

Understanding spatio-temporal patterns in rainfall received beneath tropical forest is required for eco-hydrological modelling of soil-water status, river behaviour, soil erosion, nutrient loss and wet-canopy evaporation. As selective-logging of tropical forest leaves a very complex mosaic of canopy types, it is likely to add to the spatio-temporal complexity of this sub-canopy or net precipitation. As a precursor to addressing this problem, the analysis presented here will examine the two dominant biophysical controls on sub-canopy precipitation. These controls are: (a) the spatial and temporal patterns in above-canopy or gross rainfall, and (b) the rate of wet-canopy evaporation associated with each type of canopy structure created by selective-forestry. For this study, over 400 raingauges were installed within a 10 km(2) area of lowland dipterocarp forest affected by selective-forestry some 9-years prior to this work. Gauges were located beneath various canopy types and within large openings. The spatial distribution of gross rainfall (monitored within the openings) was modelled using variography, while the effects of different canopy types on sub-canopy preciptation was analysed by comparing 6-month totals. The temporal distribution of gross rainfall over an 11-year record collected at the same site (Danum Valley Field Centre) was modelled with Data-Based-Mechanistic (DBM) approaches. These DBM approaches were also applied to the rainfall time-series of the two adjacent meteorological stations; all three gauges being contained within a 5000 km(2) region of Eastern Sabah in Malaysian Borneo. Strong diurnal modulation was apparent within gross rainfall for the inland rainforest site, with a distribution consistent with a dominance of local convective rain cells. A similarly strong cycle coincident with the periodicity of the El Nino-Southern Oscillation (ENSO) was present within all of the region's rainfall records, though marked differences in annual and intra-annual seasonality were apparent. The preliminary variogram modelling indicated that a deterministic drift was present within the local-scale gross rainfall data, probably related to local topographic effects. Notwithstanding the need to remove this drift, the work indicated that spatial models of gross rainfall could be identified and used to interpret similar models of net-precipitation. During the ENSO drought-period monitored, the lowland dipterocarp forest allowed 91% of the gross rainfall to reach the ground as throughfall. These rates were, however, reduced to between 80%-86% beneath representative plots of moderately impacted to creeper-covered, highly damaged patches of forest.

Charusombat, U., et al. (2012). "Noah-GEM and Land Data Assimilation System (LDAS) based downscaling of global reanalysis surface fields: Evaluations using observations from a CarboEurope agricultural site." Computers and Electronics in Agriculture **86**: 55-74.

This study provides the first assessment of the Noah and Noah-GEM (photosynthesis-based Gas exchange Evapotranspiration Model) land surface model using observations from the Avignon, France CarboEurope agricultural site during 2006 and 2007. Noah and Noah-GEM are integrated within a Land Data Assimilation System (LDAS) framework. The LDAS fields of soil moisture, temperature field, and surface and subsurface water and energy budget terms are useful for meteorological model initial conditions, and agricultural applications. The models were integrated using 1 km grid spacing with meteorological forcing from the Japanese global reanalysis (JRA). Consistent with results compiled over the US Southern Great Plains, the

Noah and Noah-GEM based model performance was comparable for sorghum and wheat cropland. Both models had a relatively better performance during the low LAI plant growth stage however the performance deteriorated during peak green conditions and the bias between the observed and modeled latent heat flux was consistently higher by 100 W m(-2). To further diagnose this bias, a series of experiments were undertaken by considering observed biweekly dynamic leaf area index (LAI), vegetation height, roughness length (z(0)), and albedo changes. These experiments were conducted using Noah-GEM because of similar results between Noah and Noah-GEM and also because Noah-GEM has an explicit C3 and C4 photosynthesis model. The results were compared with the default model run as well as in situ surface flux and soil moisture/temperature observations. Prescribing onsite characteristics led to modest improvements in the model fields, however the model still could not capture the peak growing heat flux values of sensible heat for both C3 and C4 plants. Additional experiments were undertaken to investigate the inconsistencies in model parameterization. These include experiments with a CO2-based transpiration and thermal roughness formulation in surface-layer physics; the surface coupling coefficient through the "Zilitinkevich constant"; effect of soil texture and model spin-up time. Based on the study results and the experiments, we conclude that a high resolution LDAS/Noah setup can be driven using global reanalysis fields producing reasonably good results when evaluated against point observations. The model performance was enhanced after using dynamic LAI and albedo feedback; however the key feature was the tuning of the model structure through coupling and modifying V-max as a function of LAI. These results highlight the need for improvements in the turbulent surface layer and plant physiological modules, and model deficiencies cannot be overcome by onsite biophysical data alone. (C) 2011 Elsevier B.V. All rights reserved.

Chen, G. S., et al. (2012). "Simulated Local and Remote Biophysical Effects of Afforestation over the Southeast United States in Boreal Summer." Journal of Climate **25**(13): 4511-4522.

Afforestation has been proposed as a climate change mitigation strategy by sequestrating atmospheric carbon dioxide. With the goal of increasing carbon sequestration, a Congressional project has been planned to afforest about 18 million acres by 2020 in the Southeast United States (SEUS), the Great Lake states, and the Corn Belt states. However, biophysical feedbacks of afforestation have the potential to counter the beneficial climatic consequences of carbon sequestration. To assess the potential biophysical effects of afforestation over the SEUS, the authors designed a set of initial value ensemble experiments and long-term quasi-equilibrium experiments in a fully coupled Community Climate System Model, version 3.5 (CCSM3.5). Model results show that afforestation over the SEUS not only has a local cooling effect in boreal summer [June-August (JJA)] at short and long time scales but also induces remote warming over adjacent regions of the SEUS at long time scales. Precipitation, in response to afforestation, increases over the SEUS (local effect) and decreases over adjacent regions (remote effect) in JJA. The local surface cooling and increase in precipitation over SEUS in JJA are hydrologically driven by the changes in evapotranspiration and latent heat flux. The remote surface warming and decrease in precipitation over adjacent regions are adiabatically induced by anomalous subsidence. Our results suggest that the planned afforestation efforts should be developed carefully by taking account of short-term (local) and long-term (remote) biophysical effects of afforestation.

Chen, L. and P. A. Dirmeyer (2016). "Adapting observationally based metrics of biogeophysical feedbacks from land cover/land use change to climate modeling." Environmental Research Letters **11**(3).

To assess the biogeophysical impacts of land cover/land use change (LCLUC) on surface temperature, two observation-based metrics and their applicability in climate modeling were explored in this study. Both metrics were developed based on the surface energy balance, and provided insight into the contribution of different aspects of land surface change (such as albedo, surface roughness, net radiation and surface heat fluxes) to changing climate. A revision of the first metric, the intrinsic biophysical mechanism, can be used to distinguish the direct and indirect effects of LCLUC on surface temperature. The other, a decomposed temperature metric, gives a straightforward depiction of separate contributions of all components of the surface energy balance. These two metrics well capture observed and model simulated surface temperature changes in response to LCLUC. Results from paired FLUXNET sites and land surface model sensitivity experiments indicate that surface roughness effects usually dominate the direct biogeophysical feedback of LCLUC, while other effects play a secondary role. However, coupled climate model experiments show that these direct effects can be attenuated by large scale atmospheric changes (indirect feedbacks). When

applied to real-time transient LCLUC experiments, the metrics also demonstrate usefulness for assessing the performance of climate models and quantifying land-atmosphere interactions in response to LCLUC.

Chen, Z., et al. (2012). "The influence of socioeconomic and topographic factors on nocturnal urban heat islands: a case study in Shenzhen, China." International Journal of Remote Sensing **33**(12): 3834-3849.

Earlier studies on urban heat islands (UHIs) focused mostly on the phenomenon during the daytime, when temperature peaks could usually be observed. However, for people living and working in tropical and subtropical cities, night-time air temperatures are also important. Several studies have focused primarily on the impact of biophysical and meteorological factors on nocturnal land surface temperatures (LSTs). Less attention has been paid to study of the influence of socioeconomic and topographic factors on nocturnal UHIs within a city. In this study, the integration of remote sensing (RS), geographic information system (GIS) and landscape ecology methods was used to investigate the relationships between nocturnal UHIs and socioeconomic or topographic factors based on a case study of Shenzhen, China. Nocturnal Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and daytime Landsat Thematic Mapper (TM) images were used to derive and analyse night-and daytime LSTs, respectively. Land-use data were generated by onscreen digitizing, and an abundance of impervious surfaces was produced through a normalized spectral mixture analysis (NSMA) method with TM data. Socioeconomic variables were derived from the China 2000 census data. A 30 m digital elevation model (DEM) was used to calculate elevation and slope grids. The relationships between nocturnal UHIs and socioeconomic or topographic factors were analysed using traditional regression analysis. The results show that the nocturnal and daytime LST patterns in different land-use areas were significantly different. Nocturnal LSTs were closely related to socioeconomic and topographic factors. An increase of 5 K on nocturnal LST of sub-districts was associated with an increase of 66.0% on their impervious surface abundance, 39 810 people per km(2), 1000 Yuan per month on housing rent, 9.5 km per km(2) on road density or a decline of 217.5 m on elevation and 17.0 degrees on slope.

Cherubini, F., et al. (2018). "Quantifying the climate response to extreme land cover changes in Europe with a regional model." Environmental Research Letters **13**(7).

Many future scenarios expect a key role for the land use sector to stabilize temperature rise to 2 degrees C or less. Changes in land cover can influence the climate system, and the extent and magnitude of the anthropogenic modifications at local and regional scales is still largely unexplored. In this study, we use the regional climate model COSMO-CLM v.4.8 to quantify the climate response to idealized extreme land cover changes in Europe. We simulate four idealized land use transitions involving abrupt conversion of today forestland to bare land or herbaceous vegetation, and conversion of today cropland to evergreen needle-leaf forest or deciduous broad-leaf forest. We find that deforestation to bare land and herbaceous vegetation causes an annual mean regional cooling of -0.06 +/- 0.09 (mean +/- standard deviation) and -0.13 +/- 0.08, respectively. Afforestation to needle-leaf and broad-leaf forests leads to a mean warming of 0.15 +/- 0.09 degrees C and 0.13 +/- 0.09 degrees C, respectively. Precipitation declines after forest clearance and increases with afforestation, but the spatial variability is high. Temperature impacts are usually more significant in the grid cells affected by land cover change and show a clear latitudinal pattern and seasonal variability. The mean temperature response to deforestation turns from positive to negative between 50 and 55 degrees latitude, and shows the strongest cooling in spring (>2 degrees C, high latitudes) but warming in summer (>1 degrees C), when the average number of hot days is increased. Afforestation has the major average warming impacts in winter, where the frequency of cold temperature extremes is reduced. Overall, biophysical effects from land cover changes shape European climate in different ways, and further developments can ultimately assist decision makers to modulate land management strategies at different scales in light of climate change mitigation and adaptation.

Chhin, S., et al. (2018). "Dendroclimatic analysis of white pine (Pinus strobus L.) using long-term provenance test sites across eastern North America." Forest Ecosystems **5**.

Background: The main objective of this study was to examine the climatic sensitivity of the radial growth response of 13 eastern white pine (Pinus strobus L.) provenances planted at seven test sites throughout the northern part of the species' native distribution in eastern North America. Methods: The test sites (i.e., Wabeno, Wisconsin, USA; Manistique, Michigan, USA; Pine River, Michigan, USA; Newaygo, Michigan, USA; Turkey Point, Ontario, Canada; Ganaraska, Ontario, Canada; and Orono, Maine, USA) examined in this study

were part of a range-wide white pine provenance trial established in the early 1960s in the eastern United States and Canada. Principal components analysis (PCA) was used to examine the main modes of variation [first (PC1) and second (PC2) principal component axes] in the standardized radial growth indices of the provenances at each test site. The year scores for PC1 and PC2 were examined in relation to an array of test site climate variables using multiple regression analysis to examine the commonality of growth response across all provenances to the climate of each test site. Provenance loadings on PC1 and PC2 were correlated with geographic parameters (i.e., latitude, longitude, elevation) and a suite of biophysical parameters associated with provenance origin location. Results: The amount of variation in radial growth explained by PC1 and PC2 ranged from 43.4% to 89.6%. Dendroclimatic models revealed that white pine radial growth responses to climate were complex and differed among sites. The key dendroclimatic relationships observed included sensitivity to high temperature in winter and summer, cold temperature in the spring and fall (i.e., beginning and end of the growing season), summer moisture stress, potential sensitivity to storm-induced damage in spring and fall, and both positive and negative effects of higher winter snowfall. Separation of the loadings of provenances on principal component axes was mainly associated with temperature-related bioclimatic parameters of provenance origin at 5 of the 7 test sites close to the climate influence of the Great Lakes (i.e., Wabeno, Manistique, Pine River, Newaygo, and Turkey Point). In contrast, differences in radial growth response to climate at the Ganaraska test site, were driven more by precipitation-related bioclimatic parameters of the provenance origin location while radial growth at the easternmost Orono test site was independent of bioclimate at the provenance origin location. Conclusions: Study results suggest that genetic adaptation to temperature and precipitation regime may significantly influence radial growth performance of white pine populations selected for use in assisted migration programs to better adapt white pine to a future climate.

Cho, J., et al. (2016). "Satellite-based assessment of Amazonian surface dryness due to deforestation." Remote Sensing Letters **7**(1): 71-80.

Intensive deforestation due to human activities has been occurring in the Amazon over the last several decades, leading to a projected decrease in precipitation due to reduced evapotranspiration (ET) according to the prediction by climate model experiments. Such hydrological and climatic changes are closely related to the drying of soil moisture (SM) as a source of atmospheric water vapour via evaporation. We used a satellite-observed index, temperature-vegetation dryness index (TVDI), to assess the impact of deforestation on SM during the dry season. Thirteen-year (2002-2014) data for three representative areas (forest, deforesting and deforested) in the Rondonia, southwest (SW) of Amazon were used to evaluate the relative changes in SM corresponding to the extent of deforestation. We found the increase in dryness in the deforested Amazon using the moderate resolution imaging spectroradiometer (MODIS) satellite sensor. Furthermore, given that the impact of forest removal on surface SM can be distinguished from the associated changes in precipitation and vegetation conditions, it is found that the relative proportion of deforested areas is linearly correlated with that of SM. The results from this study are useful to validate climate model simulations of deforestation and to improve our understanding on the biophysical controls of Amazon deforestation.

Cho, M. H., et al. (2014). "Regional climate response to land surface changes after harvest in the North China Plain under present and possible future climate conditions." Journal of Geophysical Research-Atmospheres **119**(8): 4507-4520.

In this study, we investigated the impacts of land use alterations from harvesting practices on the regional surface climate over the North China Plain. The surface climate responses after harvest in June in regions where double-cropping is practiced were evaluated using observations and model simulations with the global climate model HadGEM2-Atmosphere. Responses were modeled under both present and possible future climate conditions. In the model, double-cropping was represented using the monthly varying fraction of vegetation. This contributed to an improvement in the model simulation over East Asia. Modeling results showed that the land surface was warmer and drier after harvest, and these simulation results were consistent with observations. The bare soil surface after harvest in June had biophysical impacts on the surface climate that were mediated by decreasing evapotranspiration and latent heat flux effects, which increased surface air temperatures and decreased surface humidity. An increase in shortwave radiation also contributed to the rise in temperatures. Under two Representative Concentration Pathways (RCP) scenarios for possible future climate conditions, land conversion induced additional warming in addition to greenhouse gases induced global warming. The RCP 8.5 and RCP 2.6 scenarios demonstrated a warming of 1.0 degrees C and 1.4 degrees C due to harvesting practices in June, respectively. The response magnitude was affected by the climate conditions in each RCP. Our results suggest that potential impacts of harvest on the local climate need to be considered in future projections of CO2-induced warming on a regional scale.

Christian, K. A., et al. (2006). "Evaluating thermoregulation in reptiles: An appropriate null model." American Naturalist **168**(3): 421-430.

Established indexes of thermoregulation in ectotherms compare body temperatures of real animals with a null distribution of operative temperatures from a physical or mathematical model with the same size, shape, and color as the actual animal but without mass. These indexes, however, do not account for thermal inertia or the effects of inertia when animals move through thermally heterogeneous environments. Some recent models have incorporated body mass, to account for thermal inertia and the physiological control of warming and cooling rates seen in most reptiles, and other models have incorporated movement through the environment, but none includes all pertinent variables explaining body temperature. We present a new technique for calculating the distribution of body temperatures available to ectotherms that have thermal inertia, random movements, and different rates of warming and cooling. The approach uses a biophysical model of heat exchange in ectotherms and a model of random interaction with thermal environments over the course of a day to create a null distribution of body temperatures that can be used with conventional thermoregulation indexes. This new technique provides an unbiased method for evaluating thermoregulation in large ectotherms that store heat while moving through complex environments, but it can also generate null models for ectotherms of all sizes.

Chybicki, A. and Z. Lubniewski (2017). "Optimized AVHRR land surface temperature downscaling method for local scale observations: case study for the coastal area of the Gulf of Gdansk." Open Geosciences **9**(1): 419-435.

Satellite imaging systems have known limitations regarding their spatial and temporal resolution. The approaches based on subpixel mapping of the Earth's environment, which rely on combining the data retrieved from sensors of higher temporal and lower spatial resolution with the data characterized by lower temporal but higher spatial resolution, are of considerable interest. The paper presents the downscaling process of the land surface temperature (LST) derived from low resolution imagery acquired by the Advanced Very High Resolution Radiometer (AVHRR), using the inverse technique. The effective emissivity derived from another data source is used as a quantity describing thermal properties of the terrain in higher resolution, and allows the downsampling of low spatial resolution LST images. The authors propose an optimized downscaling method formulated as the inverse problem and show that the proposed approach yields better results than the use of other downsampling methods. The proposed method aims to find estimation of high spatial resolution LST data by minimizing the global error of the downscaling. In particular, for the investigated region of the Gulf of Gdansk, the RMSE between the AVHRR image downscaled by the proposed method and the Landsat 8 LST reference image was 2.255 degrees C with correlation coefficient R equal to 0.828 and Bias = 0.557 degrees C. For comparison, using the PBIM method, it was obtained RMSE = 2.832 degrees C, R = 0.775 and Bias = 0.997 degrees C for the same satellite scene. It also has been shown that the obtained results are also good in local scale and can be used for areas much smaller than the entire satellite imagery scene, depicting diverse biophysical conditions. Specifically, for the analyzed set of small sub-datasets of the whole scene, the obtained RSME between the downscaled and reference image was smaller, by approx. 0.53 degrees C on average, in the case of applying the proposed method than in the case of using the PBIM method.

Connor, D., et al. (2008). "Impact of small-holder irrigation on the agricultural production, food supply and economic prosperity of a representative village beside the Senegal River, Mauritania." Agricultural Systems **96**(1-3): 1-15.

A considerable effort to rehabilitate and extend degraded irrigation schemes is taking place along the Mauritanian side in the Senegal River Valley. To increase understanding of the effects of these activities on the population, a model was used to analyse how the irrigated agriculture production interacts with other production systems, human food supply, and economic prosperity in a representative village in the Middle Valley. The activities in the village comprise grazing of mostly goats and sheep on shrubland, rain fed cropping, partly on saturated soil as river or plain floods recede, and an irrigation area of 32 ha soon to be

enlarged to 90 ha. The production environment is characterized by a long dry winter, small, highly variable summer rainfall, and high temperatures and evaporative conditions. River flooding is variable and dependant on rainfall at great distance from the village. Using a generated weather series, the model evaluates the fodder supply for livestock on the shrubland, the productivity of grain and stubble for human and animal consumption, respectively, together with the human labour, and fertilizer and fuel requirements to maintain optional production scenarios. A financial sector calculates cash balance. Established cropping practice uses cowpea, sorghum, millet and rice, the latter on irrigated land. All families have equal access to grazing on the shrubland but different access to rain fed, flood land, and irrigation cropping. The model evaluates the impact of production scenarios on identified family types with distinct resources, extending current practice to a more diverse use of irrigated land by introducing alternative summer (sorghum) and new winter (cowpea) crops. The analysis of the current scenarios reveals the small and variable productivity of the shrubland, the precarious situation facing a family with access to rain-fed cropping only, and the stabilizing, although still inadequate, impact of the initial irrigation project. Expansion of the irrigation area, and more diversified cropping, will provide more families with access to irrigation but the small area available to each family (0.50 ha) will not produce sufficient grain or straw unless cropping is intensified to include a second winter crop. With that, additional benefits will flow indirectly to villagers without access to irrigation, through increased requirement for labour and sale of grain and fodder. The expanded irrigation area increases the stock carrying capacity of the village, raising concerns for the sustainable management of the shrubland. (C) 2007 Elsevier Ltd. All rights reserved.

Contreras, S., et al. (2011). "Remote sensing estimates of supplementary water consumption by arid ecosystems of central Argentina." Journal of Hydrology **397**(1-2): 10-22.

Besides precipitation inputs, evapotranspiration of irrigated and natural oases, i.e. riparian and phreato-phytic ecosystems, of rain-shadow deserts is strongly influenced by lateral water inputs supplied by mountain rivers and foothill-recharged aquifers. A better understanding of these supplies and their imprint on the water consumption of those inflow dependent ecosystems (IDEs) across arid regions is critical to manage agricultural outputs and ecosystem conservation, and the hydrological trade-offs that emerge among them. Actual operative satellite and physically-based algorithms able to map evapotranspiration (ET) rates at regional scales still fail when they are applied in ungauged regions because of their high parameterization and meteorological data requirements. We introduce an ecological and satellite-based approach to explore the impacts of external water supplies on arid ecosystems, focusing on the Central Monte desert and its water supplies from the Andean Cordillera, in Argentina. Mean annual precipitation (MAP) and the Enhanced Vegetation Index (EVI) from MODIS imagery, used as a surrogate of ET, were the input variables of our empirical model. Two related biophysical indexes were generated for the whole territory of interest based on a MAP-EVI regional function calibrated for the region: the EVI Anomaly (i.e. deviation from a reference with similar MAP) and the ET Anomaly (i.e. additional water consumption besides MAP). These indexes allowed us to identify IDEs and to quantify the impact of remote lateral inflows as well as local constrains on the water balance of rangelands, and irrigated and natural oases. The performance of this satellite-based approach was evaluated through comparisons with independent ET estimates based on plot (known crop coefficients) and basin (measured water budgets) scale approaches. Relative errors in the 2-18% range at plot and basin scale are in agreement with those uncertainties reported by other satellite and physically-based approaches. Our approach provides a simple yet robust diagnostic tool to characterize water balance in arid regions, aimed to improve the identification of inflow dependent ecosystems and their management under the demanding pressures of land use and climate change. (C) 2010 Elsevier B.V. All rights reserved.

Cooper, L. A., et al. (2017). "Disturbance impacts on land surface temperature and gross primary productivity in the western United States." Journal of Geophysical Research-Biogeosciences **122**(4): 930-946.

Forest disturbances influence forest structure, composition, and function and may impact climate through changes in net radiation or through shifts in carbon exchange. Climate impacts vary depending on environmental variables and disturbance characteristics, yet few studies have investigated disturbance impacts over large, environmentally heterogeneous, regions. We used satellite data to objectively determine the impacts of fire, bark beetles, defoliators, and unidentified disturbances (UDs) on land surface temperature (LST) and gross primary productivity (GPP) across the western United States (U.S.). We investigated immediate disturbance impacts, the drivers of those impacts, and long-term postdisturbance LST and GPP recovery patterns. All disturbance types caused LST increases (degrees C; fire: 3.453.02, bark beetles: 0.763.04, defoliators: 0.493.12, and UD: 0.763.03). Fire and insects resulted in GPP declines (%; fire: -25.05 +/- 21.67, bark beetles: -2.84 +/- 21.06, defoliators: -0.23 +/- 15.40), while UDs resulted in slightly enhanced GPP (1.89 +/- 24.20%). Disturbance responses also varied between ecoregions. Severity and interannual changes in air temperature were the primary drivers of short-term disturbance responses, and severity also had a strong impact on long-term recovery patterns. These results suggest a potential climate feedback due to disturbance-induced biophysical changes that may strengthen as disturbance regimes shift due to climate change.

Costa, M. H. and G. F. Pires (2010). "Effects of Amazon and Central Brazil deforestation scenarios on the duration of the dry season in the arc of deforestation." International Journal of Climatology **30**(13): 1970-1979.
Climate change predictions tied to Amazon deforestation scenarios are increasingly being used by government and non-government organisations for near-future planning applications. Despite incorporating a wide range of biophysical variables, these models neglect future scenarios of land use for adjoining regions, such as the Central Brazil Cerrado, which has been deforested by more than 50%. In this study, we investigate the impact of different Amazon and Central Brazil deforestation scenarios on the rainfall regime of the 'arc-of-deforestation' in Amazonia. We demonstrate that both Amazon and Cerrado deforestation contribute to an increase of the duration of the dry season in this region. Combining the effects of both scenarios, the dry season may increase from 5 months to 6 months, which may change the biosphere-atmosphere equilibrium in this region. This study demonstrates that the assessment of future Cerrado land use scenarios is also necessary to understand the future climate and ecosystem health of Amazonia. Copyright (C) 2009 Royal Meteorological Society

Crouzeilles, R., et al. (2017). "Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests." Science Advances **3**(11).
Is active restoration the best approach to achieve ecological restoration success (the return to a reference condition, that is, old-growth forest) when compared to natural regeneration in tropical forests? Ourmeta-analysis of 133 studies demonstrated that natural regeneration surpasses active restoration in achieving tropical forest restoration success for all three biodiversity groups (plants, birds, and invertebrates) and five measures of vegetation structure (cover, density, litter, biomass, and height) tested. Restoration success for biodiversity and vegetation structure was 34 to 56% and 19 to 56% higher in natural regeneration than in active restoration systems, respectively, after controlling for key biotic and abiotic factors (forest cover, precipitation, time elapsed since restoration started, and past disturbance). Biodiversity responses were based primarily on ecological metrics of abundance and species richness (74%), both of which take far less time to achieve restoration success than similarity and composition. This finding challenges the widely held notion that natural forest regeneration has limited conservation value and that active restoration should be the default ecological restoration strategy. The proposition that active restoration achieves greater restoration success than natural regeneration may have arisen because previous comparisons lacked controls for biotic and abiotic factors; we also did not find any difference between active restoration and natural regeneration outcomes for vegetation structure when we did not control for these factors. Future policy priorities should align the identified patterns of biophysical and ecological conditions where each or both restoration approaches are more successful, cost-effective, and compatible with socioeconomic incentives for tropical forest restoration.

Dabrowska-Zielinska, K., et al. (2009). "Application of remote and in situ information to the management of wetlands in Poland." Journal of Environmental Management **90**(7): 2261-2269.
The protection and regeneration of wetlands has been of crucial importance as a goal in ecological research and in nature conservation for some time and is more important than ever now. Knowledge about the biophysical properties of wetlands' vegetation retrieved from satellite images enables us to improve the monitoring of these unique areas, which are otherwise very often impenetrable and therefore difficult to examine, analyze and assess by means of site visits. The Biebrza Wetlands are Situated in the North-East part of Poland and are one of the largest areas made LIP of marshes and swamps in the entire EU. This is still one of the wildest areas and one of the least destroyed, damaged or changed by human impact. However, in the

recent decades there have been attempts made to intensify and overexploit the natural resources of the region and implement new agriculture practices in the area. In this period, drainage canals have been built, and a good deal of the area has been drained. The area of this precious ecosystem covers 25494 ha. This valuable area of peat with unique vegetation species and with very special birds is one of the most valuable areas in Europe and in 1995 was added to the list of Ramsar sites. The investigation of wetlands in the Biebrza River Valley has been carried out at ground level by taking measurements of soil moisture, evapotranspiration, Leaf Area Index, wet and dry biomass and the levels of ground water and meteorological parameters. Also examined were radiative temperature, detailed vegetation mapping, and APAR. For some years the deterioration of peat lands has been noticed due to the drying out of the area and the frequent outbreak of fires. The consequence is the succession of new vegetation and the appearance of new ecosystems. The Remote Sensing Centre in the Institute of Geodesy and Cartography has undertaken the investigation by applying ERS-2.SAR and ENVISAT ASAR of IS2 and IS4 and VV, HH, HV polarization for the purpose of modeling soil moisture and humidity changes of the area under investigation. The investigation also aimed at finding the best biophysical properties of wetlands' vegetation to characterize marshland habitats and its changes. At the same time as registering the microwave data, the optical data from Landsat ETM+, SPOT VEGETATION, ERS-2.ATSR. ENVISAT MERIS, and NOAA/AVHRR have been registered and information about the biomass and heat fluxes as sensible and latent heat has also been calculated. The vegetation indices are calculated from EO satellite data taking into account jointly the features of vegetation responsible for reflection in various bands and combining this information from several spectral bands. Also, the changes in the humidity of the area have been examined by extracting the backscattering coefficients from two SAR images that were taken at a similar period of the year but with a gap of 5 years. The information about soil moisture as retention, soil moisture changes, heat fluxes and evapotranspiration are all very important for estimates of CO2 sequestration. The ENVISAT images have been obtained for the ESA AO-ID122 project. Also the SMOS and ALOS data will be applied for the Biebrza Wetlands in the future. (C) 2008 Elsevier Ltd. All rights reserved.

Danis, P. A., et al. (2012). "MAIDENiso: a multiproxy biophysical model of tree-ring width and oxygen and carbon isotopes." Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere **42**(9): 1697-1713.

MAIDENiso is a new version of the process-based biogeochemical model MAIDEN of tree growth. Isotopic modules have been implemented to simulate stable oxygen and carbon isotopes in tree-ring cellulose (TRC). In addition to annual increment biomass, this new model version estimates delta O-18 and delta C-13 associated with the daily amount of carbon allocated to the stem. MAIDENiso only requires daily input data: minimal and maximal air temperatures, amount of precipitation, CO2 atmospheric concentration, and delta C-13 in CO2. MAIDENiso simulates tree-ring width, delta O-18 in precipitation (delta O-18(P)), delta O-18 in soil water (delta O-18(SW)), delta O-18 in xylem water (delta O-18(XW)), delta O-18 in cellulose (delta O-18(TRC)), and delta C-13 in cellulose (delta C-13(TRC)). The model has been calibrated and validated with tree-ring series sampled in the Fontainebleau Forest (France) from 1953 to 2000. We first calibrated several parameters for the 1977-2000 period and then validated it for the independent 1953-1976 period. Over the complete interval (1953-2000), we obtained correlations between observations and simulations above 0.5 for both isotopic series and above 0.65 for tree growth series. An important feature of the model is its ability to simulate not only extreme values of tree growth, such as the effect of 1976 drought, but also its persistence over several years.

Dass, P., et al. (2013). "Can bioenergy cropping compensate high carbon emissions from large-scale deforestation of high latitudes?" Earth System Dynamics **4**(2): 409-424.

Numerous studies have concluded that deforestation of the high latitudes result in a global cooling. This is mainly because of the increased albedo of deforested land which dominates over other biogeophysical and biogeochemical mechanisms in the energy balance. This dominance, however, may be due to an underestimation of the biogeochemical response, as carbon emissions are typically at or below the lower end of estimates. Here, we use the dynamic global vegetation model LPJmL for a better estimate of the carbon cycle under such large-scale deforestation. These studies are purely theoretical in order to understand the role of vegetation in the energy balance and the earth system. They must not be mistaken as possible mitigation options, because of the devastating effects on pristine ecosystems. For realistic assumptions of land suitability, the total emissions computed in this study are higher than that of previous studies assessing the effects of boreal deforestation. The warming due to biogeochemical effects ranges from 0.12 to 0.32 degrees C, depending on the climate sensitivity. Using LPJmL to assess the mitigation potential of bioenergy plantations in the suitable areas of the deforested region, we find that the global biophysical bioenergy potential is 68.1 +/- 5.6 EJ yr(-1) of primary energy at the end of the 21st century in the most plausible scenario. The avoided combustion of fossil fuels over the time frame of this experiment would lead to further cooling. However, since the carbon debt caused by the cumulative emissions is not repaid by the end of the 21st century, the global temperatures would increase by 0.04 to 0.11 degrees C. The carbon dynamics in the high latitudes especially with respect to permafrost dynamics and long-term carbon losses, require additional attention in the role for the Earth's carbon and energy budget.

Davin, E. L., et al. (2007). "Impact of land cover change on surface climate: Relevance of the radiative forcing concept." Geophysical Research Letters **34**(13).

[1] We use the IPSL climate model to investigate biophysical impacts of Anthropogenic Land Cover Change (ALCC) on surface climate. Including both the changes in surface albedo and evapotranspiration, we find that ALCC represents a radiative forcing of -0.29 W/m(2) from 1860 to 1992 and of -0.7 W/m(2) from 1992 to 2100. The simulated surface temperature response to ALCC indicates a historical cooling of 0.05 K and an additional cooling due to future changes of 0.14 K, which is consistent with the sign of the radiative forcing. However, this cooling is substantially lower than the one we would have obtained if it was caused by a radiatively equivalent change in CO2 concentration. These results thus question the relevance of the radiative forcing framework in the context of land use change, since the radiative forcing due to ALCC may not be comparable to the one exerted by other anthropogenic perturbations.

Deng, C. B. and C. S. Wu (2013). "Examining the impacts of urban biophysical compositions on surface urban heat island: A spectral unmixing and thermal mixing approach." Remote Sensing of Environment **131**: 262-274.

Land surface temperature (LST) is a central parameter for surface urban heat island (SUHI) studies, in which thermal remote sensing plays a key role. Traditionally, normalized difference vegetation index (NDVI), percent green vegetation (%GV), and percent impervious surface area (%ISA), have been widely applied to examine the impacts of land cover compositions on SUHI. Urban thermal pattern, however, is a complicated physical phenomenon involving a series of environmental factors, and it is insufficient to employ only one indicator for the explanation of the SUHI phenomenon. Therefore, considering different thermal properties of various land cover compositions, this study proposed a two-step physically based method, the spectral unmixing and thermal mixing (SUTM) model, to examine the impacts of typical land cover compositions on urban thermal pattern. The performance of SUTM was compared with those of linear and non-linear (quadratic) regression models with NDVI, %GV, and %ISA as individual independent variables. Results indicate that SUTM outperforms all regression models, with the lowest root mean square error (2.89 K) and mean absolute error (2.11 K). Moreover, when the accuracy was assessed at five interval levels of percent impervious surface area, it indicates that SUTM performs consistently well in both rural and urban areas. Comparatively, NDVI and %GV-based regression models perform well in rural areas, but poor in urban areas, whereas %ISA-based models perform well in urban areas, but relatively poor in rural areas. This study found that soil, including both moist and dry soil, has significant impacts on modeling SUHI. (C) 2013 Elsevier Inc. All rights reserved.

Devaraju, N., et al. (2018). "Quantifying the Relative Importance of Direct and Indirect Biophysical Effects of Deforestation on Surface Temperature and Teleconnections." Journal of Climate **31**(10): 3811-3829.

In this study, the authors linearize the surface energy budget equation that disentangles indirect effects (resulting from changes in downward shortwave and longwave radiation and air temperature) from direct biophysical effects (resulting from changes in surface albedo, evapotranspiration, and roughness length) of deforestation on land surface temperature. This formulation is applied to idealized deforestation simulations from two climate models and to realistic land-use and land-cover change (LULCC) simulations from 11 models, and the contribution of each underlying mechanism to surface temperature change is quantified. It is found that the boreal region experiences dominant indirect effects and the tropics experience dominant direct effects in all seasons in idealized deforestation simulations. The temperate region response differs in the two models. However, five out of seven models in response to realistic historical LULCC show a dominance of indirect effects in the temperate region. In response to future LULCC, three out of four models

confirm the dominance of direct effects in the tropical region. It is found that indirect effects are always largely attributable to air temperature feedback and direct effects are essentially driven by changes in roughness length in both idealized and realistic simulations. Furthermore, teleconnections are shown to exist between deforested regions and the rest of the world, associated with the indirect effects. The study also shows that the partitioning between direct and indirect effects is highly model dependent, which may explain part of the intermodel spread found in previous studies comparing the total biophysical effects across models.

Diaz-Avalos, C., et al. (2001). "Space-time modelling of lightning-caused ignitions in the Blue Mountains, Oregon." Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere **31**(9): 1579-1593.

Generalized linear mixed models (GLMM) were used to study the effect of vegetation cover, elevation, slope, and precipitation on the probability of ignition in the Blue Mountains, Oregon, and to estimate the probability of ignition occurrence at different locations in space and in time. Data on starting location of lightning-caused ignitions in the Blue Mountains between April 1986 and September 1993 constituted the base for the analysis. The study area was divided into a pixel-time array. For each pixel-time location we associated a value of 1 if at least one ignition occurred and 0 otherwise. Covariate information for each pixel was obtained using a geographic information system. The GLMMs were fitted in a Bayesian framework. Higher ignition probabilities were associated with the following cover types: subalpine herbaceous, alpine tundra, lodgepole pine (Pinus contorta Dougl. ex Loud.), whitebark pine (Pinus albicaulis Engelm.), Engelmann spruce (Picea engelmannii Parry ex Engelm.), subalpine fir (Abies lasiocarpa (Hook.) Nutt.), and grand fir (Abies grandis (Dougl.) Lindl.). Within each vegetation type, higher ignition probabilities occurred at lower elevations. Additionally, ignition probabilities are lower in the northern and southern extremes of the Blue Mountains. The GLMM procedure used here is suitable for analysing ignition occurrence in other forested regions where probabilities of ignition are highly variable because of a spatially complex biophysical environment.

Diffenbaugh, N. S. (2005). "Sensitivity of extreme climate events to CO2-induced biophysical atmosphere-vegetation feedbacks in the western United States." Geophysical Research Letters **32**(7).

We have tested the sensitivity of extreme temperature and precipitation events to CO2-induced atmosphere-vegetation feedbacks (AVFs) in the western United States using an equilibrium vegetation model coupled to a regional climate model. Biophysical AVFs resulted in positive anomalies in the frequency and magnitude of extreme temperature events over much of the western United States, with the notable exception of key high elevation areas, where there were strong negative anomalies. Anomalies in extreme temperature events were largely associated with changes in surface albedo, LAI, upper layer water extracted and root zone depth. Negative anomalies in extreme precipitation along the Pacific coast were associated with reductions in low-level specific humidity, zonal wind speeds and eddy kinetic energy. These results suggest that AVFs could strongly influence the response of extreme climate regimes to anthropogenic greenhouse forcing, with the sign of that influence varying on horizontal scales of 10(1) to 10(2) km.

Djepa, V. (2011). "Drought prediction using the Along Track Scanning Radiometer (ATSR2) on board ERS2 satellite." Advances in Space Research **48**(1): 56-60.

Frequent monitoring and estimation of the areas under drought danger is important for agriculture, hydrology, weather, natural hazards and crop yield prediction. The evaporation fraction, calculated as a function of the evapotranspiration and net radiation over heterogeneous land surface, is used as a drought indicator in this study, where areas with low evaporation fraction are under drought danger. A two-source energy balance model has been applied to calculate the fluxes arising from the heterogeneous target, vegetation and soil. The fluxes have been retrieved from the Along Track Scanning Radiometer (ATSR2) on board the European Research Satellite (ERS2). The main advantage of the algorithm is the separation of the canopy and soil fluxes. The fluxes have been calculated as a function of the aerodynamic temperatures of the components of the surface (vegetation and soil), retrieved from the ATSR2 satellite data. The relationship between canopy biophysical properties and evaporation are examined, using the ATSR2 observations. All variables are retrieved from the ATSR2 satellite data corrected for the atmospheric effects. The algorithm for drought prediction has a long-term application for processing data from the ATSR2/ERS2, the Advanced Along Track Scanning Radiometer (AATSR) on board ENVISAT, ASTER/Terra/NASA and the future high

resolution ESA/Land Surface mission (SPECTRA). (C) 2011 COSPAR. Published by Elsevier Ltd. All rights reserved.

Drever, C. R., et al. (2008). "Fire and the relative roles of weather, climate and landscape characteristics in the Great Lakes St. Lawrence forest of Canada." Journal of Vegetation Science **19**(1): 57-66.

Question: In deciduous-dominated forest landscapes, what are the relative roles of fire weather, climate, human and biophysical landscape characteristics for explaining variation in large fire occurrence and area burned? Location: The Great Lakes-St. Lawrence forest of Canada. Methods: We characterized the recent (1959-1999) regime of large (>= 200 ha) fires in 26 deciduous-dominated landscapes and analysed these data in an information-theoretic framework to compare six hypotheses that related fire occurrence and area burned to fire weather severity, climate normals, population and road densities, and enduring landscape characteristics such as surficial deposits and large lakes. Results: 392 large fires burned 833 698 ha during the study period, annually burning on average 0.07% +/- 0.42% of forested area in each landscape. Fire activity was strongly seasonal, with most fires and area burned occurring in May and June. A combination of antecedent-winter precipitation, fire season precipitation deficit/surplus and percent of landscape covered by well-drained surficial deposits best explained fire occurrence and area burned. Fire occurrence varied only as a function of fire weather and climate variables, whereas area burned was also explained by percent cover of aspen and pine stands, human population density and two enduring characteristics: percent cover of large water bodies and glaciofluvial deposits. Conclusion: Understanding the relative role of these variables may help design adaptation strategies for forecasted increases in fire weather severity by allowing (1) prioritization of landscapes according to enduring characteristics and (2) management of their composition so that substantially increased fire activity would be necessary to transform landscape structure and composition.

Duveiller, G., et al. (2018). "A dataset mapping the potential biophysical effects of vegetation cover change." Scientific Data **5**.

Changing the vegetation cover of the Earth has impacts on the biophysical properties of the surface and ultimately on the local climate. Depending on the specific type of vegetation change and on the background climate, the resulting competing biophysical processes can have a net warming or cooling effect, which can further vary both spatially and seasonally. Due to uncertain climate impacts and the lack of robust observations, biophysical effects are not yet considered in land-based climate policies. Here we present a dataset based on satellite remote sensing observations that provides the potential changes i) of the full surface energy balance, ii) at global scale, and iii) for multiple vegetation transitions, as would now be required for the comprehensive evaluation of land based mitigation plans. We anticipate that this dataset will provide valuable information to benchmark Earth system models, to assess future scenarios of land cover change and to develop the monitoring, reporting and verification guidelines required for the implementation of mitigation plans that account for biophysical land processes.

Dwomoh, F. K. and M. C. Wimberly (2017). "Fire Regimes and Their Drivers in the Upper Guinean Region of West Africa." Remote Sensing **9**(11).

The Upper Guinean region of West Africa exhibits strong geographic variation in land use, climate, vegetation, and human population and has experienced phenomenal biophysical and socio-economic changes in recent decades. All of these factors influence spatial heterogeneity and temporal trends in fires, but their combined effects on fire regimes are not well understood. The main objectives of this study were to characterize the spatial patterns and interrelationships of multiple fire regime components, identify recent trends in fire activity, and explore the relative influences of climate, topography, vegetation type, and human activity on fire regimes. Fire regime components, including active fire density, burned area, fire season length, and fire radiative power, were characterized using MODIS fire products from 2003 to 2015. Both active fire and burned area were most strongly associated with vegetation type, whereas fire season length was most strongly influenced by climate and topography variables, and fire radiative power was most strongly influenced by climate. These associations resulted in a gradient of increasing fire activity from forested coastal regions to the savanna-dominated interior, as well as large variations in burned area and fire season length within the savanna regions and high fire radiative power in the westernmost coastal regions. There were increasing trends in active fire detections in parts of the Western Guinean Lowland Forests ecoregion and decreasing trends in both active fire detections and burned area in savanna-dominated ecoregions. These results portend that ongoing regional landscape and socio-economic changes along with climate change will lead to further changes in the fire regimes in West Africa. Efforts to project future fire regimes and develop regional strategies for adaptation will need to encompass multiple components of the fire regime and consider multiple drivers, including land use as well as climate.

Ebrahimi, A. and D. Or (2018). "On Upscaling of Soil Microbial Processes and Biogeochemical Fluxes From Aggregates to Landscapes." Journal of Geophysical Research-Biogeosciences **123**(5): 1526-1547.

Soil microbial communities respond to spatial and temporal variations in environmental conditions (e.g., saturation and ambient temperatures) as reflected in the dynamics of microbially produced greenhouse gas (GHG) fluxes (primarily CO2, N2O, and CH4) emitted from soil surfaces. Despite considerable progress in resolving key soil microbial processes, their quantification remains largely empirical with limited predictability. We report a mechanistic and analytical modeling framework for integrating local environmental effects on GHG-producing microbial processes primarily in soil aggregates (or other hot spots) and the upscaling of these to regional GHG fluxes. The mechanistic model enables systematic evaluation of how soil structural features (e.g., aggregation and layers), spatial variability, and dynamic ambient conditions (e.g., temperature and hydration) affect soil microbial functioning. The upscaling of microbial processes from aggregates of different sizes to soil profiles and landscapes implements mechanistically derived microbial response functions with spatial information on soil type, land cover, and resource distribution. The modeling framework was evaluated using reported field data for seasonal N2O emissions from subarctic regions resulting in reasonable agreement. The proposed analytical framework offers a practical compromise balancing a simplified representation of dynamic microbial processes that respond to local conditions with an upscalable representation of soil GHG fluxes over landscapes under changing environmental conditions.

Evans, M. E. K., et al. (2017). "Fusing tree-ring and forest inventory data to infer influences on tree growth." Ecosphere **8**(7).

Better understanding and prediction of tree growth is important because of the many ecosystem services provided by forests and the uncertainty surrounding how forests will respond to anthropogenic climate change. With the ultimate goal of improving models of forest dynamics, here we construct a statistical model that combines complementary data sources, tree-ring and forest inventory data. A Bayesian hierarchical model was used to gain inference on the effects of many factors on tree growth-individual tree size, climate, biophysical conditions, stand-level competitive environment, tree-level canopy status, and forest management treatments-using both diameter at breast height (dbh) and tree-ring data. The model consists of two multiple regression models, one each for the two data sources, linked via a constant of proportionality between coefficients that are found in parallel in the two regressions. This model was applied to a data set of similar to 130 increment cores and similar to 500 repeat measurements of dbh at a single site in the Jemez Mountains of north-central New Mexico, USA. The tree-ring data serve as the only source of information on how annual growth responds to climate variation, whereas both data types inform non-climatic effects on growth. Inferences from the model included positive effects on growth of seasonal precipitation, wetness index, and height ratio, and negative effects of dbh, seasonal temperature, southerly aspect and radiation, and plot basal area. Climatic effects inferred by the model were confirmed by a dendroclimatic analysis. Combining the two data sources substantially reduced uncertainty about non-climate fixed effects on radial increments. This demonstrates that forest inventory data measured on many trees, combined with tree-ring data developed for a small number of trees, can be used to quantify and parse multiple influences on absolute tree growth. We highlight the kinds of research questions that can be addressed by combining the high-resolution information on climate effects contained in tree rings with the rich tree-and stand-level information found in forest inventories, including projection of tree growth under future climate scenarios, carbon accounting, and investigation of management actions aimed at increasing forest resilience.

Ewert, F., et al. (2015). "Crop modelling for integrated assessment of risk to food production from climate change." Environmental Modelling & Software **72**: 287-303.

The complexity of risks posed by climate change and possible adaptations for crop production has called for integrated assessment and modelling (IAM) approaches linking biophysical and economic models. This paper attempts to provide an overview of the present state of crop modelling to assess climate change risks to food production and to which extent crop models comply with IAM demands. Considerable progress has been made in modelling effects of climate variables, where crop models best satisfy IAM demands. Demands are partly satisfied for simulating commonly required assessment variables. However, progress on the number of simulated crops, uncertainty propagation related to model parameters and structure, adaptations and scaling are less advanced and lagging behind IAM demands. The limitations are considered substantial and apply to a different extent to all crop models. Overcoming these limitations will require joint efforts, and consideration of novel modelling approaches. (C) 2014 Elsevier Ltd. All rights reserved.

Faivre, N. R., et al. (2016). "Spatial patterns and controls on burned area for two contrasting fire regimes in Southern California." Ecosphere **7**(5).

An improved understanding of the mechanisms that regulate wildfire risk at local to regional scales is needed for the design of effective fire and ecosystem management. We investigated the spatial distribution of burned area in Southern California during 1960-2009 using five different data-driven methods: multiple linear regression, generalized additive models (GAMs), GAMs with spatial autocorrelation, non-linear multiplicative models, and random forest models. We used each method to separately develop burned area risk maps for Southern California's two distinct wildfire regimes: Santa Ana (SA fires), which occur during high wind events mostly in autumn, and non-Santa Ana fires (non-SA fires), which occur mostly during the hot and dry Mediterranean-climate summer. The different methods explained 38-63% of the spatial variance in burned area for SA fires and 21-48% for non-SA fires. The two fire regimes had contrasting drivers, with Fosberg fire weather index, relative humidity, minimum temperature, and distance to housing most important for SA fires, and shrub cover, road density, and distance to minor and major roads most important for non-SA fires. Our modeling framework carries implications for the strategic placement of fire suppression resources, and for prevention planning in areas facing increasing human and climate pressures.

Falasca, S. L., et al. (2012). "Possibilities for growing queen palm (Syagrus romanzoffiana) in Argentina as a biodiesel producer under semi-arid climate conditions." International Journal of Hydrogen Energy **37**(19): 14843-14848.

Syagrus romanzoffiana is a palm native to Argentina, where it is known by the name 'Pindo'. This palm extends from the Misionera Forest through the gallery Forest, being the Parana Delta area the southern limit of dispersion. In this area, the large volumes of water from the rivers create a moderating effect, reducing the daily temperature range and the days of frosts. The aim of this study was to delimit the Argentina agro-climatic suitable area for the development of this crop as a potential biodiesel-producing species, using biophysical limits observed in our country and elsewhere in the world where the plant is grown. For a possible zoning in Argentina, agro-climatic indexes were obtained from monthly values of temperatures and precipitations from all the weather and agro-meteorological stations of the country, for the period 1971-2010. Afterward, maps with the thermal and hydric limits were superposed to define the probable areas for the crop. Copyright (C) 2011, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Falloon, P. D., et al. (2012). "Role of vegetation change in future climate under the A1B scenario and a climate stabilisation scenario, using the HadCM3C Earth system model." Biogeosciences **9**(11): 4739-4756.

The aim of our study was to use the coupled climate-carbon cycle model HadCM3C to quantify climate impact of ecosystem changes over recent decades and under future scenarios, due to changes in both atmospheric CO2 and surface albedo. We use two future scenarios - the IPCC SRES A1B scenario, and a climate stabilisation scenario (2C20), allowing us to assess the impact of climate mitigation on results. We performed a pair of simulations under each scenario - one in which vegetation was fixed at the initial state and one in which vegetation changes dynamically in response to climate change, as determined by the interactive vegetation model within HadCM3C. In our simulations with interactive vegetation, relatively small changes in global vegetation coverage were found, mainly dominated by increases in shrub and needleleaf trees at high latitudes and losses of broadleaf trees and grasses across the Amazon. Globally this led to a loss of terrestrial carbon, mainly from the soil. Global changes in carbon storage were related to the regional losses from the Amazon and gains at high latitude. Regional differences in carbon storage between the two scenarios were largely driven by the balance between warming-enhanced decomposition and altered

vegetation growth. Globally, interactive vegetation reduced albedo acting to enhance albedo changes due to climate change. This was mainly related to the darker land surface over high latitudes (due to vegetation expansion, particularly during December-January and March-May); small increases in albedo occurred over the Amazon. As a result, there was a relatively small impact of vegetation change on most global annual mean climate variables, which was generally greater under A1B than 2C20, with markedly stronger local-to-regional and seasonal impacts. Globally, vegetation change amplified future annual temperature increases by 0.24 and 0.15K (under A1B and 2C20, respectively) and increased global precipitation, with reductions in precipitation over the Amazon and increases over high latitudes. In general, changes were stronger over land - for example, global temperature changes due to interactive vegetation of 0.43 and 0.28K under A1B and 2C20, respectively. Regionally, the warming influence of future vegetation change in our simulations was driven by the balance between driving factors. For instance, reduced tree cover over the Amazon reduced evaporation (particularly during June-August), outweighing the cooling influence of any small albedo changes. In contrast, at high latitudes the warming impact of reduced albedo (particularly during December-February and March-May) due to increased vegetation cover appears to have offset any cooling due to small evaporation increases. Climate mitigation generally reduced the impact of vegetation change on future global and regional climate in our simulations. Our study therefore suggests that there is a need to consider both biogeochemical and biophysical effects in climate adaptation and mitigation decision making.

Fan, Z. S., et al. (2015). "Modeling pulsed soil respiration in an African savanna ecosystem." Agricultural and Forest Meteorology **200**: 282-292.

Savannas cover 60% of the African continent and play an important role in the global carbon (C) emissions from fire and land use. To better characterize the biophysical controls over soil respiration in these settings, half-hourly observations of volumetric soil-water content, temperature, and the concentration of carbon dioxide (CO2) at different soil depths were continually measured from 2005 to 2007 under trees ("sub-canopy") and between trees ("inter-canopy") in a savanna vegetation near Skukuza, Kruger National Park, South Africa. The measured soil climate and CO2 concentration data were assimilated into a process-based model that estimates the CO2 production and flux with coupled dynamics of dissolved organic C (DOC) and microbial biomass C. Our results show that temporal and spatial variations in CO2 flux were strongly influenced by precipitation and vegetation cover, with two times greater CO2 flux in the subcanopy plots (similar to 2421 g CO2 m(-2) yr(-1)) than in the inter-canopy plots (similar to 1290 g CO2 m(-2) yr(-1)). Precipitation influenced soil respiration by changing soil temperature and moisture; however, our modeling analysis suggests that the pulsed response of soil respiration to precipitation events (known as "Birch effect") is a key control on soil fluxes at this site. At this site, "Birch effect" contributed to approximately 50% and 65% of heterotrophic respiration or 20% and 39% of soil respiration in the sub-canopy and inter-canopy plots, respectively. These results suggest that pulsed response of respiration to precipitation events is an important component of the C cycle of savannas and should be considered in both measurement and modeling studies of carbon exchange in similar ecosystems.

Fang, Y., et al. (2016). "Monthly land cover-specific evapotranspiration models derived from global eddy flux measurements and remote sensing data." Ecohydrology **9**(2): 248-266.

Evapotranspiration (ET) is arguably the most uncertain ecohydrologic variable for quantifying watershed water budgets. Although numerous ET and hydrological models exist, accurately predicting the effects of global change on water use and availability remains challenging because of model deficiency and/or a lack of input parameters. The objective of this study was to create a new set of monthly ET models that can better quantify landscape-level ET with readily available meteorological and biophysical information. We integrated eddy covariance flux measurements from over 200 sites, multiple year remote sensing products from the Moderate Resolution Imaging Spectroradiometer (MODIS), and statistical modelling. Through examining the key biophysical controls on ET by land cover type (i.e. shrubland, cropland, deciduous forest, evergreen forest, mixed forest, grassland, and savannas), we created unique ET regression models for each land cover type using different combinations of biophysical independent factors. Leaf area index and net radiation explained most of the variability of observed ET for shrubland, cropland, grassland, savannas, and evergreen forest ecosystems. In contrast, potential ET (PET) as estimated by the temperature-based Hamon method was most useful for estimating monthly ET for deciduous and mixed forests. The more data-demanding PET method, FAO reference ET model, had similar power as the simpler Hamon PET method for estimating actual

ET. We developed three sets of monthly ET models by land cover type for different practical applications with different data availability. Our models may be used to improve water balance estimates for large basins or regions with mixed land cover types. Copyright (c) 2015 John Wiley & Sons, Ltd.

Findell, K. L., et al. (2007). "Modeled impact of anthropogenic land cover change on climate." Journal of Climate **20**(14): 3621-3634.

Equilibrium experiments with the Geophysical Fluid Dynamics Laboratory's climate model are used to investigate the impact of anthropogenic land cover change on climate. Regions of altered land cover include large portions of Europe, India, eastern China, and the eastern United States. Smaller areas of change are present in various tropical regions. This study focuses on the impacts of biophysical changes associated with the land cover change (albedo, root and stomatal properties, roughness length), which is almost exclusively a conversion from forest to grassland in the model; the effects of irrigation or other water management practices and the effects of atmospheric carbon dioxide changes associated with land cover conversion are not included in these experiments. The model suggests that observed land cover changes have little or no impact on globally averaged climatic variables (e.g., 2-m air temperature is 0.008 K warmer in a simulation with 1990 land cover compared to a simulation with potential natural vegetation cover). Differences in the annual mean climatic fields analyzed did not exhibit global field significance. Within some of the regions of land cover change, however, there are relatively large changes of many surface climatic variables. These changes are highly significant locally in the annual mean and in most months of the year in eastern Europe and northern India. They can be explained mainly as direct and indirect consequences of model-prescribed increases in surface albedo, decreases in rooting depth, and changes of stomatal control that accompany deforestation.

Fleming, S. W. and E. J. Quilty (2007). "Toward a practical method for setting screening-level, ecological risk-based water temperature criteria and monitoring compliance." Environmental Monitoring and Assessment **131**(1-3): 83-94.

We integrated basic concepts from fisheries science and toxicological risk assessment to form a potential method for setting screening-level, risk-based, site-specific water quality objectives for temperature. In summary, the proposed approach: (a) uses temperature impacts upon specific growth as a measure of chronic (cumulative) temperature effects; (b) explicitly incorporates the consequences of both magnitude and cumulative duration of exposures; (c) adjusts the result for local watershed conditions, reducing the likelihood that naturally warm systems are identified as thermally polluted while helping to ensure that naturally cool systems are closely monitored for ecologically harmful changes in thermal regime; and (d) expresses the net result both graphically and as a risk quotient, RQ, closely analogous to that used in toxicological risk assessments. The latter yields a site-specific, risk-based water quality objective and may serve as a straightforward decision rule for environmental managers. The method was applied to historical data from a small British Columbia stream subject to increasing urban development pressures. We also illustrate how the technique might be used to explore potential climatic change impacts, using coupled general circulation model predictions in conjunction with empirical downscaling. Overall, the method and results are presented as an introduction and illustration of concept, intended as a step toward the development of a logistically feasible risk-based approach to establishing screening-level, site-specific water temperature objectives, and monitoring compliance, in the context of large-scale, many-site, environmental monitoring networks. With further work, the technique offers potential to fill the gap between the temperature threshold-based targets typically specified in regulatory guidelines, which may be hydroecologically unrealistic, and detailed biophysical modelling, which typically is logistically infeasible in a day-to-day environmental monitoring and management context.

Forzieri, G., et al. (2017). "Satellites reveal contrasting responses of regional climate to the widespread greening of Earth." Science **356**(6343): 1140-1144.

Changes in vegetation cover associated with the observed greening may affect several biophysical processes, whose net effects on climate are unclear. We analyzed remotely sensed dynamics in leaf area index (LAI) and energy fluxes in order to explore the associated variation in local climate. We show that the increasing trend in LAI contributed to the warming of boreal zones through a reduction of surface albedo and to an evaporation-driven cooling in arid regions. The interplay between LAI and surface biophysics is amplified up to five times under extreme warm-dry and cold-wet years. Altogether, these signals reveal that the recent dynamics in global vegetation have had relevant biophysical impacts on the local climates and should be considered in the design of local mitigation and adaptation plans.

Fraser, G. W. and G. S. Stone (2016). "The effect of soil and pasture attributes on rangeland infiltration rates in northern Australia." Rangeland Journal **38**(3): 245-259.

Surface runoff is an important factor affecting rangeland pasture productivity and off-site sediment transportation. The application of rangeland biophysical models including sub-models of runoff and erosion provides one method to assess how management and climate variability affect the frequency and quantity of surface runoff events. However, there is often limited confidence in extrapolating runoff models developed from site-specific, hillslope field experiments to other locations due to variation in soil types and land condition states. To improve rangeland runoff models, we investigated three potentially important components at 18 paired land condition sites: (1) the importance of a variety of pasture attributes such as biomass and cover on infiltration rates; (2) the impact of surface soil texture on infiltration rates; and (3) whether soil carbon and/or soil bulk density provide valuable indicators of a site's infiltration rates. The study found that surface soil texture was important when aboveground biomass was low and was found to have a broken-stick' relationship with infiltration rates (i.e. lowest infiltration occurred at the pivot point of 64% sand). Aboveground biomass, (which included standing grass, grass litter and tree litter) was the best soil or pasture attribute for predicting a plot's infiltration capacity accounting for 68% of the variability. Plots with surface soil sand content greater than 60% and which had been exclosed for between 4 and 24 years had higher average surface soil carbon mass and concentration (similar to 10%) than adjacent grazed plots. The exclosed plots also had higher surface soil porosity, which was associated with very high infiltration rates.

Freier, K. P., et al. (2011). "Dynamic interactions between vegetation and land use in semi-arid Morocco: Using a Markov process for modeling rangelands under climate change." Agriculture Ecosystems & Environment **140**(3-4): 462-472.

Integrated scientific assessments of semi-arid agroecosystems with mathematical models are challenging because of computational constraints. These constraints arise from exponentially increasing decision options due to dynamic interactions between the biophysical states of rangeland vegetation and farsighted decisions taken by pastoral stakeholders. This study applies a methodology that integrates these interactions in a computationally feasible manner. We equip a dynamic land use decision model with a detailed representation of biophysical processes by using a Markov chain meta-model of EPIC (Environmental Policy impact Calculator). Using separate Markov chains for different weather scenarios, we investigate the economic and ecological impacts of droughts on rangeland management in southern Morocco. The drought simulations (2 years with 33% less precipitation) show a decrease in profits from pastoralism by up to 57%. Pastoral land use of the rangeland in our model increases surface runoff by 20%, doubles infiltration, and thus influences irrigation agriculture. The economic and ecological impacts of drought in our simulation go substantially beyond its meteorological time horizon. (C) 2011 Elsevier B.V. All rights reserved.

Gan, G. J. and Y. C. Gao (2015). "Estimating time series of land surface energy fluxes using optimized two source energy balance schemes: Model formulation, calibration, and validation." Agricultural and Forest Meteorology **208**: 62-75.

Due to the limited availability of land surface temperature (LST) images, thermal-based evapotranspiration (ET) models can only provide instantaneous ET snapshots. In contrast, models that are based on near surface soil moisture (SM) and leaf area index (LAI) can operate at daily scales. However, their transpiration schemes need to be more physically realistic and their model parameters usually need to be calibrated by flux measurements. In this study, we incorporated a biophysical canopy conductance (Gc) model into a two source energy balance (TSEB) scheme to replace the original Priestly-Taylor (PT) approximation and then optimized both models (Gc-TSEB and PT-TSEB) at pixel scales using qualified MODIS LST data. The results show that using [ST is almost as effective in the calibration as using flux measurements. This is promising because unlike flux measurements, [ST can be acquired at various spatial resolutions by remote sensing, which makes model calibration feasible for any land pixel. In addition, ET and its partitioning between the canopy and soil layers were found to be reasonable at both validation sites. The day to day and diurnal variations of the predicted ET generally matched the trends and peaks of the flux measurements, although systematic biases were also found due to the decoupling effect of soil moisture at different depths.

Furthermore, both models are robust with +/- 50% changes of SM or LAI because the parameters were automatically adjusted by the LST-calibration. The models are sensitive to LST. However, if the added noise of the LST is less significant than N(+/- 1, 2.5(2)), the medians of the RMSEs in the LE predictions from the LST-calibrated models were quite similar to those from the flux-calibrated models. Both models were found to be accurate, but Gc-TSEB provides slightly more precise and robust predictions than PT-TSEB. (C) 2015 Elsevier B.V. All rights reserved.

Gandu, A. W., et al. (2004). "Simulation of deforestation in eastern Amazonia using a high-resolution model." Theoretical and Applied Climatology **78**(1-3): 123-135.

This work evaluates the impact of deforestation on the climate of the eastern portion of the Amazon basin. This region is primarily an area of native tropical rainforest, but also contains several other natural ecosystems such as mangroves and savanna. It is the most densely populated area in Amazonia, and has been significantly affected by deforestation. In this study, numerical simulations were performed with a high spatial resolution, regional model that allows for consideration of mesoscale aspects such as topography, coastlines and large rivers. To evaluate the present situation and to predict potential future effects of deforestation on the climatic conditions of this region, two, one-year model simulations were made. In the first, "control simulation", an attempt was made to match the existing surface vegetation. The biophysical parameters used were derived from recent studies of similar Amazon-region ecosystems. In the second run, "deforested simulation", the forested-area biophysical parameters were replaced by those corresponding to the pasture areas of the region. The higher-resolution regional modelling revealed important climatic features of the deforestation process, displaying some associated mesoscale effects that are not typically represented in similar Global Circulation Model simulations. Near coastal zones and along large rivers, deforestation resulted in reduced cloud cover and precipitation. However, increased cloud cover and precipitation was predicted over upland areas, especially on slopes facing river valleys. The modelled surface sensible and latent heat fluxes also presented both positive and negative anomalies. The magnitudes of these anomalies were greater during the dry season. Windspeed near the surface was the meteorological variable that presented the most significant change due to deforestation. The reduction in roughness coefficient resulting from the shift from forest to pasture produced increased windspeeds near the Atlantic coast. The greater windspeeds diminished local humidity convergence and consequently reduced rainfall totals in nearby regions. The results obtained from these higher-resolution simulations show that, in general, orography, coastline profile and the distribution of large rivers play important roles in determining anomaly patterns of precipitation, wind, and energy exchange associated with deforestation in eastern Amazonia.

Garnaud, C. and L. Sushama (2015). "Biosphere-climate interactions in a changing climate over North America." Journal of Geophysical Research-Atmospheres **120**(3): 1091-1108.

This study focuses on projected changes to vegetation characteristics and their interactions with the atmosphere under future climatic conditions over North America, using four transient climate change simulations of the Canadian Regional Climate Model (CRCM5). Here CRCM5 performs dynamical downscaling of the Canadian Earth System Model (CanESM2) simulated data, for Representative Concentration Pathways (RCPs) 4.5 and 8.5. For each RCP, two CRCM5 simulations are performedone with static vegetation phenology and the other with dynamic vegetation phenologyfor the 1950-2100 period over North America. The dynamic vegetation model used here is the Canadian Terrestrial Ecosystem Model. Results show that the extension of the growing season under future climatic conditions in the dynamic phenology simulations leads to higher annual vegetation productivity and biomass. In comparison with projected changes based on CRCM5 with static phenology, CRCM5 with phenology dynamics leads to an albedo-mediated warming enhancement across most of North America in spring. In summer, results suggest a warming enhancement in the northern latitudes and an attenuation of warming for more southern regions due to hydrological feedbacks. Furthermore, results suggest that vegetation enhances its water-use efficiency with rising atmospheric CO_2 concentrations. Over southeastern United States, in the dynamic phenology simulation corresponding to the RCP8.5 scenario, the adverse effects of the projected increase in temperatures and decrease in precipitation on vegetation dominate the CO_2 fertilization effect, leading to decreasing trends in productivity during the 2071-2100 period. This study thus clearly demonstrates that phenology dynamics modulate greenhouse gas-mediated warming through various biophysical feedbacks.

Garreaud, R. D., et al. (2017). "The 2010-2015 megadrought in central Chile: impacts on regional hydroclimate and vegetation." Hydrology and Earth System Sciences **21**(12): 6307-6327.

Since 2010 an uninterrupted sequence of dry years, with annual rainfall deficits ranging from 25 to 45 %, has prevailed in central Chile (western South America, 30-38 degrees S). Although intense 1-or 2-year droughts are recurrent in this Mediterranean-like region, the ongoing event stands out because of its longevity and large extent. The extraordinary character of the so-called central Chile megadrought (MD) was established against century long historical records and a millennial tree-ring reconstruction of regional precipitation. The largest MD-averaged rainfall relative anomalies occurred in the northern, semi-arid sector of central Chile, but the event was unprecedented to the south of 35 degrees S. ENSO-neutral conditions have prevailed since 2011 (except for the strong El Nino in 2015), contrasting with La Nina conditions that often accompanied past droughts. The precipitation deficit diminished the Andean snowpack and resulted in amplified declines (up to 90 %) of river flow, reservoir volumes and groundwater levels along central Chile and westernmost Argentina. In some semi-arid basins we found a decrease in the runoff-to-rainfall coefficient. A substantial decrease in vegetation productivity occurred in the shrubland-dominated, northern sector, but a mix of greening and browning patches occurred farther south, where irrigated croplands and exotic forest plantations dominate. The ongoing warming in central Chile, making the MD one of the warmest 6-year periods on record, may have also contributed to such complex vegetation changes by increasing potential evapotranspiration. We also report some of the measures taken by the central government to relieve the MD effects and the public perception of this event. The understanding of the nature and biophysical impacts of the MD helps as a foundation for preparedness efforts to confront a dry, warm future regional climate scenario.

Gaumont-Guay, D., et al. (2008). "Biophysical controls on rhizospheric and heterotrophic components of soil respiration in a boreal black spruce stand." Tree Physiology **28**(2): 161-171.

We conducted a root-exclusion experiment in a 125-year-old boreal black spruce (Picea mariana (Mill.) BSP) stand in 2004 to quantify the physical and biological controls on temporal dynamics of the rhizospheric (R(r)) and heterotrophic (R(h)) components of soil respiration (R(s)). Annual R(r), R(h) and estimated moss respiration were 285, 269 and 57 g C m(-2) year(-1), respectively, which accounted for 47, 44 and 9% of Rs (6119 C m(-2) year(-1)), respectively. A gradual transition from Rh-dominated (winter, spring and fall) to R(r)-dominated (summer) respiration was observed during the year. Soil thawing in spring and the subsequent increase in soil water content (theta) induced a small and sustained increase in R(h) but had no effect on R(r). During the remainder of the growing season, no effect of theta was observed on either component of R(s). Both components increased exponentially with soil temperature (T(s)) during the growing season, but Rr showed greater temperature sensitivity than R(h) (Q(10) of 4.0 and 3.0, respectively). Temperature-normalized variations in R(r) were highly correlated with eddy covariance estimates of gross ecosystem photosynthesis, and the correlation was greatest when R(r) was lagged by 24 days. Within diurnal cycles, variations in T(s) were highly coupled to variations in R(h) but were-significantly decoupled from R(r). The patterns observed at both time scales strongly suggest that the flow of photosynthates to the rhizosphere is a key driver of below-ground respiration processes but that photosynthate supply may control these processes in several ways.

Ge, J. J. (2011). "Satellite-Observed Surface Temperature Changes after the 2004 Taylor Complex Fire in Alaska." Earth Interactions **15**.

Land-use and land-cover change has been recognized as a key component in global climate change. In the boreal forest ecosystem, fires often cause significant changes in vegetation structure and surface biophysical characteristics, which in turn dramatically change energy and water balances of land surface. Several studies have characterized fire-induced changes in surface energy balance in boreal ecosystem based on site observations. This study provides satellite-observed impacts of a large fire on surface climate in Alaska's boreal forest. A land surface temperature (LST) product from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) is used as the primary data. Five years after fire, surface temperature over the burned area increased by an average of 2.0 degrees C in the May-August period. The increase reached a maximum of 3.2 degrees C in the year immediately following the fire. The warm anomaly decreased slightly after the second year but remained until the fifth year of the study. These changes in surface temperature may directly affect surface net radiation and thus partition of surface available energy. By documenting continuous and synoptic surface temperature changes over multiple years, this paper demonstrates the value of Earth Observing System (EOS) observations for land-climate interaction research. The observed characteristics of surface temperature change as well as changes in key surface biophysical parameters such as albedo and leaf area index (LAI) can be used in the next generation of climate models to improve the representation of large-scale ecosystem disturbances.

Ge, J. J., et al. (2008). "Use of vegetation properties from EOS observations for land-climate modeling in East Africa." Journal of Geophysical Research-Atmospheres **113**(D15).

Land use/cover change has been recognized as a key component in global climate change. Information on land surface biophysical properties and climatic variables based on in situ data fail to resolve the fine-scale variability that exists in many parts of the world, including East Africa. In this study, we used the NASA's Earth Observing System (EOS) products to improve the representation of the land surface in a regional climate model as well as assess the model performance. The Moderate Resolution Imaging Spectroradiometer (MODIS) data of leaf area index (LAI) and vegetation fractional cover (VFC) were directly incorporated in the Regional Atmospheric Modeling System (RAMS). The model was validated in terms of the land surface temperature (LST), utilizing the MODIS LST data from both Terra and Aqua satellites. Compared with the built-in land surface, the ingested MODIS LAI and VFC greatly improved the spatial and temporal dynamics of vegetation in East Africa. Three experiments were carried out for the year of 2003 to test the impacts of land surface conditions. The results showed that the spatial, seasonal, and diurnal characteristics of the RAMS simulated LST were improved because of MODIS LAI and VFC. Specifically, the Intertropical Convergence Zone (ITCZ)-related migration, bimodal temporal variation, and monthly averaged diurnal cycles of LST were more realistically reproduced. The need to realistically represent the spatial and temporal distribution of vegetation is thus highlighted, and the value of the EOS observations for the land-climate modeling is demonstrated.

Georgescu, M., et al. (2009). "Potential impact of US biofuels on regional climate." Geophysical Research Letters **36**.

Recent work has shown that current bio-energy policy directives may have harmful, indirect consequences, affecting both food security and the global climate system. An additional unintended but direct effect of large-scale biofuel production is the impact on local and regional climate resulting from changes in the energy and moisture balance of the surface upon conversion to biofuel crops. Using the latest version of the WRF modeling system we conducted twenty-four, midsummer, continental-wide, sensitivity experiments by imposing realistic biophysical parameter limits appropriate for bio-energy crops in the Corn Belt of the United States. In the absence of strain/cropspecific parameterizations, a primary goal of this work was to isolate the maximum regional climate impact, for a trio of individual July months, due to land-use change resulting from bio-energy crops and to identify the relative importance of each biophysical parameter in terms of its individual effect. Maximum, local changes in 2 m temperature of the order of 1 degrees C occur for the full breadth of albedo (ALB), minimum canopy resistance (RC(MIN)), and rooting depth (ROOT) specifications, while the regionally (105 degrees W-75 degrees W and 35 degrees N-50 degrees N) and monthly averaged response of 2 m temperature was most pronounced for the ALB and RC(MIN) experiments, exceeding 0.2 degrees C. The full range of albedo variability associated with biofuel crops may be sufficient to drive regional changes in summertime rainfall. Individual parameter effects on 2 m temperature are additive, highlight the cooling contribution of higher leaf area index (LAI) and ROOT for perennial grasses (e. g., Miscanthus) versus annual crops (e. g., maize), and underscore the necessity of improving location-and vegetation-specific representation of RC(MIN) and ALB. Citation: Georgescu, M., D. B. Lobell, and C. B. Field (2009), Potential impact of U. S. biofuels on regional climate, Geophys. Res. Lett., 36, L21806, doi: 10.1029/2009GL040477.

Georgescu, M., et al. (2009). "Climatic effects of 30 years of landscape change over the Greater Phoenix, Arizona, region: 1. Surface energy budget changes." Journal of Geophysical Research-Atmospheres **114**.

This paper is part 1 of a two-part study that evaluates the climatic effects of recent landscape change for one of the nation's most rapidly expanding metropolitan complexes, the Greater Phoenix, Arizona, region. The region's landscape evolution over an approximate 30-year period since the early 1970s is documented on the basis of analyses of Landsat images and land use/land cover (LULC) data sets derived from aerial photography (1973) and Landsat (1992 and 2001). High-resolution, Regional Atmospheric Modeling System

(RAMS), simulations (2-km grid spacing) are used in conjunction with consistently defined land cover data sets and associated biophysical parameters for the circa 1973, circa 1992, and circa 2001 time periods to quantify the impacts of intensive land use changes on the July surface temperatures and the surface radiation and energy budgets for the Greater Phoenix region. The main findings are as follows: since the early 1970s the region's landscape has been altered by a significant increase in urban/suburban land area, primarily at the expense of decreasing plots of irrigated agriculture and secondarily by the conversion of seminatural shrubland. Mean regional temperatures for the circa 2001 landscape were 0.12 degrees C warmer than the circa 1973 landscape, with maximum temperature differences, located over regions of greatest urbanization, in excess of 1 degrees C. The significant reduction in irrigated agriculture, for the circa 2001 relative to the circa 1973 landscape, resulted in dew point temperature decreases in excess of 1 degrees C. The effect of distinct land use conversion themes (e. g., conversion from irrigated agriculture to urban land) was also examined to evaluate how the most important conversion themes have each contributed to the region's changing climate. The two urbanization themes studied (from an initial landscape of irrigated agriculture and seminatural shrubland) have the greatest positive effect on near-surface temperature, increasing maximum daily temperatures by 1 degrees C. Overall, sensible heat flux differences between the circa 2001 and circa 1973 landscapes result in a 1 W m(-2) increase in domain-wide sensible heating, and a similar order of magnitude decrease in latent heating, highlighting the importance of surface repartitioning in establishing near-surface temperature trends. In part 2 of this study, we address the role of the surface budget changes on the mesoscale dynamics/thermodynamics, in context of the large-scale environment.

Ghahramani, A. and D. Bowran (2018). "Transformative and systemic climate change adaptations in mixed crop livestock farming systems." Agricultural Systems **164**: 236-251.

Mixed crop-livestock farming systems provide food for more than half of the world's population. These agricultural systems are predicted to be vulnerable to climate change and therefore require transformative adaptations. In collaboration with farmers in the wheatbelt of Western Australia (WA), a range of systemic and transformative adaptation options, e.g. land use change, were designed for the modelled climate change projected to occur in 2030 (0.4-1.4 degrees increase in mean temperature). The effectiveness of the adaptation options was evaluated using coupled crop and livestock biophysical models within an economic and environmental framework at both the enterprise and farm scales. The relative changes in economic return and environmental variables in 2030 are presented in comparison with a baseline period (1970-2010). The analysis was performed on representative farm systems across a rainfall transect. Under the impact of projected climate change, the economic returns of the current farms without adaptation declined by between 2 and 47%, with a few exceptions where profit increased by up to 4%. When the adaptations were applied for 2030, profit increased at the high rainfall site in the range between 78 and 81% through a 25% increase in the size of livestock enterprise and adjustment in sowing dates, but such profit increases were associated with 6-10% increase in greenhouse gas (GHG) emissions. At the medium rainfall site, a 100% increase in stocking rate resulted in 5% growth in profit but with a 61-71% increase in GHG emissions and the increased likelihood of soil degradation. At the relatively low rainfall site, a 75% increase in livestock when associated with changes in crop management resulted in greater profitability and a smaller risk of soil erosion. This research identified that a shift toward a greater livestock enterprises (stocking rate and pasture area) could be a profitable and low-risk approach and may have most relevance in years with extremely low rainfall. If transformative adaptations are adopted then there will be an increased requirement for an emissions control policy due to livestock GHG emissions, while there would be also need for soil conservation strategies to be implemented during dry periods. The adoption rate analysis with producers suggests there would be a greater adoption rate for less intensified adaptations even if they are transformative. Overall the current systems would be more resilient with the adaptations, but there may be challenges in terms of environmental sustainability and in particular with soil conservation.

Ghent, D., et al. (2011). "Data assimilation into land surface models: the implications for climate feedbacks." International Journal of Remote Sensing **32**(3): 617-632.

Land surface models (LSMs) are integral components of general circulation models (GCMs), consisting of a complex framework of mathematical representations of coupled biophysical processes. Considerable variability exists between different models, with much uncertainty in their respective representations of

processes and their sensitivity to changes in key variables. Data assimilation is a powerful tool that is increasingly being used to constrain LSM predictions with available observation data. The technique involves the adjustment of the model state at observation times with measurements of a predictable uncertainty, to minimize the uncertainties in the model simulations. By assimilating a single state variable into a sophisticated LSM, this article investigates the effect this has on terrestrial feedbacks to the climate system, thereby taking a wider view on the process of data assimilation and the implications for biogeochemical cycling, which is of considerable relevance to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report.

Ghilain, N., et al. (2012). "Improving evapotranspiration in a land surface model using biophysical variables derived from MSG/SEVIRI satellite." Hydrology and Earth System Sciences **16**(8): 2567-2583.

Monitoring evapotranspiration over land is highly dependent on the surface state and vegetation dynamics. Data from spaceborn platforms are desirable to complement estimations from land surface models. The success of daily evapotranspiration monitoring at continental scale relies on the availability, quality and continuity of such data. The biophysical variables derived from SEVIRI on board the geostationary satellite Meteosat Second Generation (MSG) and distributed by the Satellite Application Facility on Land surface Analysis (LSA-SAF) are particularly interesting for such applications, as they aimed at providing continuous and consistent daily time series in near-real time over Africa, Europe and South America. In this paper, we compare them to monthly vegetation parameters from a database commonly used in numerical weather predictions (ECOCLIMAP-I), showing the benefits of the new daily products in detecting the spatial and temporal (seasonal and inter-annual) variability of the vegetation, especially relevant over Africa. We propose a method to handle Leaf Area Index (LAI) and Fractional Vegetation Cover (FVC) products for evapotranspiration monitoring with a land surface model at 3-5 km spatial resolution. The method is conceived to be applicable for near-real time processes at continental scale and relies on the use of a land cover map. We assess the impact of using LSA-SAF biophysical variables compared to ECOCLIMAP-I on evapotranspiration estimated by the land surface model H-TESSEL. Comparison with in-situ observations in Europe and Africa shows an improved estimation of the evapotranspiration, especially in semi-arid climates. Finally, the impact on the land surface modelled evapotranspiration is compared over a north-south transect with a large gradient of vegetation and climate in Western Africa using LSA-SAF radiation forcing derived from remote sensing. Differences are highlighted. An evaluation against remote sensing derived land surface temperature shows an improvement of the evapotranspiration simulations.

Gibson, K. E. B., et al. (2018). "Assessing explanatory factors for variation in on-farm irrigation in US maize-soybean systems." Agricultural Water Management **197**: 34-40.

Irrigation exhibits large variation across producer fields, even within same region and year. A knowledge gap exists relative to factors that explain this variation, in part due to lack of availability of high-quality irrigation data from multiple field-years. This study assessed sources of variation in irrigation using a large database collected during 9 years (2005-2013) from ca. 1400 maize and soybean producer fields in Nebraska, central USA (total of 12,750 field-year observations). The study area is representative of ca. 4.5 million ha of irrigated land sown with maize and soybean. Influence of biophysical (weather, soil, and crop type) and behavioral (producer skills, risk aversion) factors on irrigation was investigated. Field irrigation distributions showed a substantial number of fields received irrigation amounts that were well above average irrigation for same region-year. Variation in irrigation across fields, within the same region, was as large as year-to-year variation. Seasonal water deficit (defined as total reference evapotranspiration minus precipitation), soil available water holding capacity, and crop type explained about half of observed variation in field irrigation, indicating that producers adjusted irrigation depending upon site-year variation in these parameters. However, half of the variation in irrigation remained unexplained, indicating that producer behavior and skills play also an important role. There was evidence of a "neighbor" effect as fields that received large irrigation were surrounded by other fields with similarly large irrigation. Likewise, fields with above- or below-average irrigation in one year remained consistently above and below regional average irrigation, respectively, in other years despite similarity in weather and soil among fields. These findings indicate that irrigation decisions are influenced by both biophysical and behavioral factors, making predictions of field and regional irrigation extremely difficult. This study highlights the value of collecting on-farm irrigation data to understand producer decision-making and find opportunities to improve current water management in irrigated crop systems. (c) 2017 The Authors. Published by Elsevier B.V.

Gibson, L., et al. (2018). "Future land cover change scenarios in South African grasslands - implications of altered biophysical drivers on land management." Heliyon **4**(7).

Future land cover changes may result in adjustments to biophysical drivers impacting on net ecosystem carbon exchange (NEE), catchment water use through evapotranspiration (ET), and the surface energy balance through a change in albedo. The Land Change Modeller (Idrisi Terrset 18.08) and land cover for 2000 and 2014 are used to create a future scenario of land cover for two catchment with different land management systems in the Eastern Cape Province for the year 2030. In the S50E catchment, a dualistic farming system, the trend shows that grasslands represented 57% of the total catchment area in 2014 decreasing to 52% by 2030 with losses likely to favour a gain in woody plants and cultivated land. In T35B, a commercial system, persistence of grasslands is modelled with approximately 80% coverage in both years, representing a more stable system. Finally, for S50E, NEE and ET will increase under this land cover change scenario leading to increased carbon sequestration but less water availability and corresponding surface temperature increases. This implies that rehabilitation and land management initiatives should be targeted in catchments under a dualistic farming system, rather than those which are predominantly commercial systems.

Gomez-Mendoza, L. and L. Arriaga (2007). "Modeling the effect of climate change on the distribution of oak and pine species of Mexico." Conservation Biology **21**(6): 1545-1555.

We examined the vulnerability of 34 species of oaks (Quercus) and pines (Pinus) to the effects of global climate change in Mexico. We regionalized the HadCM2 model of climate change with local climatic data (mean annual temperature and rainfall) and downscaled the model with the inverse distance-weighted method. Databases of herbaria specimens, genetic algorithms (GARP), and digital covers of biophysical variables that affect oaks and pines were used to project geographic distributions of the species under a severe and conservative scenario of climate change for the year 2050. Starting with the current average temperature of 20.2 degrees C and average precipitation of 793 mm, under the severe warming scenario mean temperature and precipitation changed to 22.7 degrees C and 660 mm, respectively, in 2050. For the conservative warming scenario, these variables shifted to 21.8 degrees C and 721 mm. Responses to the different scenarios of climate change were predicted to be species-specific and related to each species climate affinity. The current geographic distribution of oaks and pines decreased 7-48% and 0.2-64%, respectively. The more vulnerable pines were Pinus rudis, P. chihuahuana, P. oocarpa, and P. culminicola, and the most vulnerable oaks were Quercus crispipilis, Q. peduncularis, Q. acutifolia, and Q. sideroxyla. In addition to habitat conservation, we think sensitive pine and oak species should be looked at more closely to define ex situ strategies (i.e., seed preservation in germplasm banks) for their long-term conservation. Modeling climatic-change scenarios is important to the development of conservation strategies.

Guillevic, P., et al. (2002). "Influence of the interannual variability of vegetation on the surface energy balance - A global sensitivity study." Journal of Hydrometeorology **3**(6): 617-629.

The degree to which the interannual variability of vegetation phenology affects hydrological fluxes over land is investigated through a series of simulations with the Mosaic land surface model, run both offline and coupled to the NASA Seasonal-to-Interannual Prediction Project (NSIPP) atmospheric general circulation model (GCM). Over a 9-yr period, from 1982 to 1990, interannual variations of global biophysical land surface parameters (i.e., vegetation density and greenness fraction) are derived from Normalized Difference Vegetation Index (NDVI) data collected by the Advanced Very High Resolution Radiometers (AVHRRs). First the sensitivity of evapotranspiration to interannual variations in vegetation properties is evaluated through offline simulations that ignore feedbacks between the land surface and the atmospheric models, and interannual precipitation variations. Evapotranspiration is shown to be highly sensitive to variations in vegetation over wet continental surfaces that are not densely vegetated. The sensitivity is reduced by a saturation effect over dense vegetation covers and physiological control due to environmental stress over arid and semiarid regions. Correlations between evapotranspiration and vegetation anomalies are reduced markedly in offline runs that impose interannual variations in both vegetation and precipitation. They are also strongly reduced in the coupled simulations. Although interannual variations in vegetation properties still influence transpiration and interception loss at the global scale in these runs, their impact on large-scale regional climate is much weaker, apparently because the impact is drowned out by atmospheric variability.

Gunderson, A. R. and M. Leal (2012). "Geographic variation in vulnerability to climate warming in a tropical Caribbean lizard." Functional Ecology **26**(4): 783-793.

1. Rising global temperatures are predicted to impact organisms in diverse ways. For ectotherms, recent broad-scale analyses have predicted global patterns of vulnerability to warming, with tropical species at higher risk of detrimental effects than temperate species. However, vulnerability results from complex interactions between environment, physiology and behaviour. For species that inhabit a diversity of habitat types, these interactions may change across their range. 2. We measured operative thermal environments (Te) and body temperatures (Tb) of the tropical Caribbean lizard Anolis cristatellus at nine sites representing two habitat types: mesic and xeric forest. The thermal sensitivity of whole-organism physiological performance (i.e. sprint speed) of one mesic and one xeric population was also measured. Thermal and performance data were integrated to determine how habitat thermal variation, behavioural thermoregulation and thermal physiology influence current physiological performance capacity in the field. We then evaluate if habitat suitability and physiological capacity would change assuming climate warming of 3 degrees C over the next century. 3. The mean Te of the xeric habitat was 4.5 degrees C warmer than that of the mesic habitat. However, behavioural thermoregulation by xeric lizards led to lesser differences in Tb (3.5 degrees C) between habitat types. The thermal sensitivity of sprint performance was similar for mesic and xeric lizards, and lizards from both habitats maintain sprint capacities near 100%. Climate warming is predicted to influence mesic and xeric lizards differently. Xeric lizards currently live in a thermal environment near their upper temperature threshold, while mesic lizards do not. As a result, the number of suitable perch sites is predicted to decrease dramatically in the xeric but not the mesic habitat. In addition, the physiological capacity of mesic lizards is predicted to increase by approximately 4%, whereas a decrease of approximately 30% is predicted for xeric lizards. 4. We characterized variation in the current biophysical and ecophysiological conditions experienced by A.cristatellus by integrating fine-scale measurements of thermal microhabitats with data on body temperatures and physiological performance capacities. These data allowed us to explicitly demonstrate how variation in these parameters can influence population susceptibility to climate warming across a species range and highlight the utility of a mechanistic approach in studies of global climate change.

Guo, G. H., et al. (2015). "Impacts of urban biophysical composition on land surface temperature in urban heat island clusters." Landscape and Urban Planning **135**: 1-10.

The spatio-temporal pattern of biophysical composition significantly affects land surface temperature (LST). Previous studies, however, mostly characterized urban heat island (UHI) clusters being spatially homogeneous. The landscape spatial heterogeneity in urban across UHI clusters challenges us to more accurately characterize the relationships between LST and corresponding urban biophysical composition. In this study, we introduced an innovative integrated approach that combined object-oriented image segmentation with local indicators of spatial autocorrelations (LISA) to extract UHI clusters from an LST image. We used a regression tree model to examine the nonlinear relationships between LST and each of three satellite-based indices within the UHI clusters: normalized differential vegetation index (NDVI), normalized differential build-up index (NDBI), and normalized difference bareness index (NDBaI). We found that both NDVI and NDBI are strongly correlated with the variations of LST whereas NDBaI has a weaker correlation with LST. We also found that the regression tree model built in this study enabled us to effectively detect the nonlinear relationship between LST and biophysical composition. Furthermore, based on a set of rules derived from a regression tree analysis, we found that urban landscapes strongly affect LST and its spatial heterogeneity within a UHI. These rules were used to detect the nonlinear impacts of complex urban biophysical composition on LST. The results of this study provided insights into how LST within UHI varies with urban surface characteristics at fine spatial scale and also a new method for investigating effects of land surface composition on LST in urbanized areas. (C) 2014 Elsevier B.V. All rights reserved.

Guuroh, R. T., et al. (2018). "Drivers of forage provision and erosion control in West African savannas-A macroecological perspective." Agriculture Ecosystems & Environment **251**: 257-267.

Rangelands' ability to provide ecosystem services (ESs) depends on ecosystem properties and functions, which are interactively driven by biophysical and land-use drivers. In West Africa's savanna rangelands, the relative importance of these drivers for ES supply is still poorly understood, hampering the identification of appropriate management strategies. In this context, trade-offs between the ES of forage provision and the regulating ES of erosion control are of particular importance. Taking a macroecological perspective, we aimed at detecting consistent patterns in ES drivers and identifying good predictors. The study area comprises a steep gradient of climatic aridity across West Africa's Sudanian savannas from northern Ghana to central Burkina Faso, in combination with local gradients of land-use intensity and topo-edaphic conditions. We used aboveground biomass, metabolisable energy and metabolisable energy yield as proxies for forage provision, and the cover of perennials in the grass layer as a proxy for erosion control. Linear mixed-effect models and model selection were used to test relationships between multiple environmental variables and ES proxies. We found differential responses of ES proxies to environmental drivers. Vegetation properties were important for all ESs. Antecedent rainfall was the most important predictor of aboveground biomass, while plants' phenology and land-use were most important for metabolisable energy. Environmental variables (such as aridity, soil properties and grazing intensity) mediated via vegetation properties were the most important predictors of erosion control followed by the direct effect of climatic aridity. Our finding that antecedent rainfall was more important for forage provision than climatic aridity implies that the effects of long-term climatic aridity may in a given year be overridden by current season's precipitation particularly in case of a good rain year. The observed importance of land-use and vegetation properties implies that well-conceived adaptation strategies could mitigate potential negative effects of climate change.

Haashemi, S., et al. (2016). "Seasonal Variations of the Surface Urban Heat Island in a Semi-Arid City." Remote Sensing **8**(4).

The process of the surface urban heat island (SUHI) varies with latitude, climate, topography and meteorological conditions. This study investigated the seasonal variability of SUHI in the Tehran metropolitan area, Iran, with respect to selected surface biophysical variables. Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature (LST) was retrieved as nighttime LST data, while daytime LST was retrieved from Landsat 8 Thermal Infrared Sensor (TIRS) using the split-window algorithm. Both data covered the time period from September 2013 to September 2015. To assess SUHI intensity, we employed three SUHI indicators, i.e., the LST difference of urban-rural, that of urban-agriculture and that of urban-water. Physical and biophysical surface variables, including land use and land cover (LULC), elevation, impervious surface (IS), fractional vegetation cover (FVC) and albedo, were selected to estimate the relationship between LST seasonal variability and the surface properties. Results show that an inversion of the SUHI phenomenon (i.e., surface urban cool island) existed at daytime with the maximal value of urban-rural LST difference of -4 K in March; whereas the maximal value of SUHI at nighttime yielded 3.9 K in May. When using the indicators of urban-agriculture and urban-water LST differences, the maximal value of SUHI was found to be 8.2 K and 15.5 K, respectively. Both results were observed at daytime, suggesting the role of bare soils in the inversion of the SUHI phenomenon with the urban-rural indicator. Maximal correlation was observed in the relationship between night LST and elevation in spring (coefficient: -0.76), night LST and IS in spring (0.60), night LST and albedo in winter (-0.53) and day LST with fractional vegetation cover in summer (-0.41). The relationship between all surface properties with LST possessed large seasonal variations, and thus, using these relationships for SUHI modeling may not be effective. The only exception existed in the correlation between elevation and IS, which may be useful to simulate the SUHI at night. This study suggests that in semi-arid cities, such as Tehran, with the urban-rural indicator, a surface urban cool island may be observed in daytime while SUHI at nighttime; with other indicators, SUHI can be observed in both day and night. Thus, SUHI studies require the acquisition of remote sensing image data at both daytime and nighttime and careful selection of SUHI indicators.

Hailu, B. T., et al. (2015). "Reconstructing pre-agricultural expansion vegetation cover of Ethiopia." Applied Geography **62**: 357-365.

Landscape reconstructions can be used to define a reference condition from which to assess the magnitude of land changes caused by human influence. Since the beginning of the last century, the population of Ethiopia has increased drastically with large effects on the natural vegetation and biodiversity. However, the original land cover patterns in Ethiopia have not been precisely mapped, which hinder the identification of the biophysical and socio-economic factors that contributed to the current landscape patterns. The objective of this study was to reconstruct the past century vegetation landscapes of Ethiopia (i.e. vegetation cover before agricultural expansion) and identify which ecosystems have been most affected by land changes. First, the net primary productivity (NPP) was modelled based on the climatic constraints of natural vegetation growth (water availability, solar radiation and minimum temperature) derived from remote sensing and climate data. This analysis showed that water availability is the most critical constraint for vegetation growth for all regions and land cover types in Ethiopia. Then, the past vegetation was mapped based on predicted NPP. Our results show that i) the extent of broadleaved evergreen or semi-deciduous forest, open broadleaved deciduous forest, closed to open shrubland, mosaic forest-shrubland/grassland, sparse vegetation and grassland was 18.8%, 12.4%, 20.6%, 31.5%, and 16.8%, respectively, and ii) current agricultural landscapes were previously covered mainly by broadleaved evergreen and deciduous forest, which encompassed 38.9%. The least affected by agricultural expansion were sparse vegetation and grassland. Our study provides novel insights on pre-agricultural expansion landscapes in Ethiopia with critical information for scientists and other stakeholders working on the restoration and rehabilitation of degraded areas. (C) 2015 Elsevier Ltd. All rights reserved.

Hales, K., et al. (2004). "Sensitivity of tropical land climate to leaf area index: Role of surface conductance versus albedo." Journal of Climate **17**(7): 1459-1473.

Tropical land climate sensitivities to surface properties are studied using an intermediate complexity atmosphere model. The focus here is on land surface vegetation feedbacks to the atmosphere through surface conductance and albedo. Both properties are linked by a parameterization on leaf area index so that their relative impacts can be compared. For a given percent change in leaf area index, it is found that low and moderate vegetation regions such as the Sahel have a higher sensitivity than rain forest regions such as the Amazon in local total precipitation anomaly, as well as fractional change in precipitation. Comparison of sensitivities to changes in surface conductance and albedo shows that neither is negligible and their relative influence differs among local climatic regions, typified by different vegetation types. High precipitation rain forest regions are more influenced by surface conductance due to the large water recycling ratio there, while albedo has a larger influence in arid, low vegetation regions by modifying the energy balance and large-scale atmospheric circulation. In regions of moderate precipitation and vegetation, altered surface conductance and albedo have comparable effects on precipitation. Surface conductance and albedo have opposing effects on surface temperature but surface conductance has the dominant impact on both surface temperature and evapotranspiration.

Hashemian, M., et al. (2015). "Improving root-zone soil moisture estimations using dynamic root growth and crop phenology." Advances in Water Resources **86**: 170-183.

Water Energy Balance (WEB) Soil Vegetation Atmosphere Transfer (SVAT) modelling can be used to estimate soil moisture by forcing the model with observed data such as precipitation and solar radiation. Recently, an innovative approach that assimilates remotely sensed thermal infrared (TIR) observations into WEB-SVAT to improve the results has been proposed. However, the efficacy of the model observation integration relies on the model's realistic representation of soil water processes. Here, we explore methods to fin prove the soil water processes of a simple WEB-SVAT model by adopting and incorporating an exponential root water uptake model with water stress compensation and establishing a more appropriate soil-biophysical linkage between root-zone moisture content, above-ground states and biophysical indices. The existing WEB-SVAT model is extended to a new Multi-layer WEB-SVAT with Dynamic Root distribution (MWSDR) that has five soil layers. Impacts of plant root depth variations, growth stages and phenological cycle of the vegetation on transpiration are considered in developing stages. Hydrometeorological and biogeophysical measurements collected from two experimental sites, one in Dookie, Victoria, Australia and the other in Ponca, Oklahoma, USA, are used to validate the new model. Results demonstrate that MWSDR provides improved soil moisture, transpiration and evaporation predictions which, in turn, can provide an improved physical basis for assimilating remotely sensed data into the model. Results also show the importance of having an adequate representation of vegetation-related transpiration process for an appropriate simulation of water transfer in a complicated system of soil, plants and atmosphere. (C) 2015 Elsevier Ltd. All rights reserved.

Hassan, Q. K. and C. P. A. Bourque (2009). "Potential Species Distribution of Balsam Fir Based on the Integration of Biophysical Variables Derived with Remote Sensing and Process-Based Methods." Remote Sensing **1**(3): 393-407.

In this paper we present a framework for modelling potential species distribution (PSD) of balsam fir [bF; Abies balsamea (L.) Mill.] as a function of landscape-level descriptions of: (i) growing degree days (GDD: a temperature related index), (ii) land-surface wetness, (iii) incident photosynthetically active radiation (PAR), and (iv) tree habitat suitability. GDD and land-surface wetness are derived primarily from remote sensing data acquired with the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on the Terra satellite. PAR is calculated with an existing spatial model of solar radiation. Raster-based calculations of habitat suitability and PSD are obtained by multiplying normalized values of species environmental-response functions (one for each environmental variable) parameterized for balsam fir. As a demonstration of the procedure, we apply the calculations to a high bF-content area in northwest New Brunswick, Canada, at 250-m resolution. Location of medium-to-high habitat suitability values (i.e., >0.50) and actual forests, with >50% bF, matched on average 92% of the time.

Haverd, V., et al. (2018). "A new version of the CABLE land surface model (Subversion revision r4601) incorporating land use and land cover change, woody vegetation demography, and a novel optimisation-based approach to plant coordination of photosynthesis." Geoscientific Model Development **11**(7): 2995-3026.

The Community Atmosphere-Biosphere Land Exchange model (CABLE) is a land surface model (LSM) that can be applied stand-alone and provides the land surface-atmosphere exchange within the Australian Community Climate and Earth System Simulator (ACCESS). We describe new developments that extend the applicability of CABLE for regional and global carbon-climate simulations, accounting for vegetation responses to biophysical and anthropogenic forcings. A land use and land cover change module driven by gross land use transitions and wood harvest area was implemented, tailored to the needs of the Coupled Model Intercomparison Project 6 (CMIP6). Novel aspects include the treatment of secondary woody vegetation, which benefits from a tight coupling between the land use module and the Population Orders Physiology (POP) module for woody demography and disturbance-mediated landscape heterogeneity. Land use transitions and harvest associated with secondary forest tiles modify the annually resolved patch age distribution within secondary vegetated tiles, in turn affecting biomass accumulation and turnover rates and hence the magnitude of the secondary forest sink. Additionally, we implemented a novel approach to constrain modelled GPP consistent with the coordination hypothesis and predicted by evolutionary theory, which suggests that electron-transport- and Rubisco-limited rates adjust seasonally and across biomes to be co-limiting. We show that the default prior assumption - common to CABLE and other LSMs - of a fixed ratio of electron transport to carboxylation capacity at standard temperature (J(max,0)/V-cmax,V-0) is at odds with this hypothesis; we implement an alternative algorithm for dynamic optimisation of this ratio such that coordination is achieved as an outcome of fitness maximisation. The results have significant implications for the magnitude of the simulated CO2 fertilisation effect on photosynthesis in comparison to alternative estimates and observational proxies. These new developments enhance CABLE's capability for use within an Earth system model and in stand-alone applications to attribute trends and variability in the terrestrial carbon cycle to regions, processes and drivers. Model evaluation shows that the new model version satisfies several key observational constraints: (i) trend and interannual variations in the global land carbon sink, including sensitivities of interannual variations to global precipitation and temperature anomalies; (ii) centennial trends in global GPP; (iii) coordination of Rubisco-limited and electron-transport-limited photosynthesis; (iv) spatial distributions of global ET, GPP, biomass and soil carbon; and (v) age-dependent rates of biomass accumulation in boreal, temperate and tropical secondary forests. CABLE simulations agree with recent independent assessments of the global land-atmosphere flux partition that use a combination of atmospheric inversions and bottom-up constraints. In particular, there is agreement that the strong CO2-driven sink in the tropics is largely cancelled by net deforestation and forest degradation emissions, leaving the Northern Hemisphere (NH) extratropics as the dominant contributor to the net land sink.

He, T., et al. (2015). "Satellite-Observed Energy Budget Change of Deforestation in Northeastern China and its Climate Implications." Remote Sensing **7**(9): 11586-11601.

Large-scale deforestation may affect the surface energy budget and consequently climate by changing the physical properties of the land surface, namely biophysical effects. This study presents the potential energy budget change caused by deforestation in Northeastern China and its climate implications, which was evaluated by quantifying the differences in MODIS-observed surface physical properties between cropland and forest. We used the MODIS land products for the period of 2001-2010 in 112 cells of 0.75 degrees x 0.75

degrees each, within which only best quality satellite pixels over the pure forest and cropland pixels are selected for comparison. It is estimated that cropland has a winter (summer) mean albedo of 0.38 (0.16), which is 0.15 (0.02) higher than that of forest. Due to the higher albedo, cropland absorbs 16.84 W.m(-2) (3.08 W.m(-2)) less shortwave radiation than forest. Compared to forest, cropland also absorbs 8.79 W.m(-2) more longwave radiation in winter and 8.12 W.m(-2) less longwave radiation in summer. In total, the surface net radiation of cropland is 7.53 W.m(-2) (11.2 W.m(-2)) less than that of forest in winter (summer). Along with these radiation changes, the latent heat flux through evapotranspiration over cropland is less than that over forest, especially in summer (-19.12 W.m(-2)). Average sensible heat flux increases in summer (7.92 W.m(-2)) and decreases in winter (-8.17 W.m(-2)), suggesting that conversion of forest to cropland may lead to warming in summer and cooling in winter in Northeastern China. However, the annual net climate effect is not notable because of the opposite sign of the energy budget change in summer and winter.

Heinemeyer, A., et al. (2012). "Exploring the "overflow tap" theory: linking forest soil CO_2 fluxes and individual mycorrhizosphere components to photosynthesis." Biogeosciences **9**(1): 79-95.

Quantifying soil organic carbon stocks (SOC) and their dynamics accurately is crucial for better predictions of climate change feedbacks within the atmosphere-vegetation-soil system. However, the components, environmental responses and controls of the soil CO_2 efflux (R-s) are still unclear and limited by field data availability. The objectives of this study were (1) to quantify the contribution of the various R-s components, specifically its mycorrhizal component, (2) to determine their temporal variability, and (3) to establish their environmental responses and dependence on gross primary productivity (GPP). In a temperate deciduous oak forest in south east England hourly soil and ecosystem CO_2 fluxes over four years were measured using automated soil chambers and eddy covariance techniques. Mesh-bag and steel collar soil chamber treatments prevented root or both root and mycorrhizal hyphal in-growth, respectively, to allow separation of heterotrophic (R-h) and autotrophic (R-a) soil CO_2 fluxes and the R-a components, roots (R-r) and mycorrhizal hyphae (R-m). Annual cumulative R-s values were very similar between years (740 +/- 43 g Cm-2 yr(-1)) with an average flux of 2.0 +/- 0.3 mu mol CO_2 m(-2) s(-1), but R-s components varied. On average, annual R-r, R-m and R-h fluxes contributed 38, 18 and 44 %, respectively, showing a large R-a contribution (56 %) with a considerable R-m component varying seasonally. Soil temperature largely explained the daily variation of R-s (R-2 = 0.81), mostly because of strong responses by R-h (R-2 = 0.65) and less so for R-r (R-2 = 0.41) and R-m (R-2 = 0.18). Time series analysis revealed strong daily periodicities for R-s and R-r, whilst R-m was dominated by seasonal (similar to 150 days), and R-h by annual periodicities. Wavelet coherence analysis revealed that R-r and R-m were related to short-term (daily) GPP changes, but for R-m there was a strong relationship with GPP over much longer (weekly to monthly) periods and notably during periods of low R-r. The need to include individual R-s components in C flux models is discussed, in particular, the need to represent the linkage between GPP and R-a components, in addition to temperature responses for each component. The potential consequences of these findings for understanding the limitations for long-term forest C sequestration are highlighted, as GPP via root-derived C including R-m seems to function as a C "overflow tap", with implications on the turnover of SOC.

Helman, D., et al. (2017). "A biophysical approach using water deficit factor for daily estimations of evapotranspiration and CO_2 uptake in Mediterranean environments." Biogeosciences **14**(17): 3909-3926.

Estimations of ecosystem-level evapotranspiration (ET) and CO_2 uptake in water-limited environments are scarce and scaling up ground-level measurements is not straightforward. A biophysical approach using remote sensing (RS) and meteorological data (RS-Met) is adjusted to extreme high-energy water-limited Mediterranean ecosystems that suffer from continuous stress conditions to provide daily estimations of ET and CO_2 uptake (measured as gross primary production, GPP) at a spatial resolution of 250 m. The RS-Met was adjusted using a seasonal water deficit factor (fWD) based on daily rainfall, temperature and radiation data. We validated our adjusted RS-Met with eddy covariance flux measurements using a newly developed mobile lab system and the single active FLUXNET station operating in this region (Yatir pine forest station) at a total of seven forest and non-forest sites across a climatic transect in Israel (280-770mmyr (-1)) RS-Met was also compared to the satelliteborne MODIS-based ET and GPP products (MOD16 and MOD17, respectively) at these sites. Results show that the inclusion of the fWD significantly improved the model, with R = 0.64-0.91 for the ET-adjusted model (compared to 0.05-0.80 for the unadjusted model) and R = 0.72-0.92 for the adjusted GPP model (compared to R = 0.56-0.90 of the non-adjusted model). The RS-Met (with the fWD)

successfully tracked observed changes in ET and GPP between dry and wet seasons across the sites. ET and GPP estimates from the adjusted RS-Met also agreed well with eddy covariance estimates on an annual timescale at the FLUXNET station of Yatir (266 +/- 61 vs. 257 +/- 58mmyr 1 and 765 +/- 112 vs. 748 +/- 124 gCm(-2)yr(-1) for ET and GPP, respectively). Comparison with MODIS products showed consistently lower estimates from the MODIS-based models, particularly at the forest sites. Using the adjusted RS-Met, we show that afforestation significantly increased the water use efficiency (the ratio of carbon uptake to ET) in this region, with the positive effect decreasing when moving from dry to more humid environments, strengthening the importance of drylands afforestation. This simple yet robust biophysical approach shows promise for reliable ecosystem-level estimations of ET and CO2 uptake in extreme high-energy water limited environments.

Hernandez, J. L., et al. (2012). "Land Use Change in Central Florida and Sensitivity Analysis Based on Agriculture to Urban Extreme Conversion." Weather Climate and Society **4**(3): 200-211.

This paper explored recent land use and land cover change in western central Florida, examining both socioeconomic and biophysical influences on land transformation and the impacts of that change. Between 1995 and 2006, a growth in population resulted in the conversion of agricultural areas, grasslands, and upland forests to urban areas. Additionally, the amount of extractive land uses (e.g., mining) increased by 21.8%, water reservoirs by 19.9%, and recreation areas by 13.3%. Regional climate modeling experiments suggest that the overall effects of land use change (LUC) on mesocale climates in summer days resulted in modified temperatures that were modulated by the new LU characteristics, local and synoptic atmospheric circulations, and the distance of rural and urban land uses from the shoreline. The difference between the extreme and actual LU simulations for temperature, wind speed, wind direction, and precipitation presented higher variability in the inland urbanized and rural zones. Results can be used to better understand the basic influences of LUC and urbanization on key climate parameters, and urban heat island effects in peninsular Florida under typical weather conditions.

Hernandez-Ramirez, G., et al. (2011). "Carbon dioxide fluxes in corn-soybean rotation in the midwestern US: Inter- and intra-annual variations, and biophysical controls." Agricultural and Forest Meteorology **151**(12): 1831-1842.

Quantifying carbon dioxide (CO(2)) fluxes in terrestrial ecosystems is critical for better understanding of global carbon cycling and observed changes in climate. This study examined year-round temporal variations of CO(2) fluxes in two biennial crop rotations during 4 year of corn (Zen mays L) and soybean [Glycine max (L) Merr.] production. We monitored CO(2) fluxes using eddy-covariance (EC) and soil chambers in adjacent production fields near Ames, Iowa. Under the non-limiting soil water availability conditions predominant in these fields, diel and seasonal variations of CO(2) fluxes were mostly controlled by ambient temperature and available light. Air temperature explained up to 81% of the variability of soil respiratory losses during fallow periods. In contrast, with full-developed canopies, available light was the main driver of daytime CO(2) uptake for both crops. Furthermore, a combined additive effect of both available light and temperature on enhanced CO(2) uptake was identified only for corn. Moreover, diurnal hysteresis of net CO(2) uptake with available light was also found for both crops with consistently greater CO(2) uptake in the mornings than afternoons perhaps primarily owing to delay in peak of soil respiration relative to the time of maximum plant photosynthesis. Annual cumulative CO(2) exchange was mainly determined by crop species with consistently greater net uptake for corn and near neutral exchange for soybean (-466 +/- 38 and -13 +/- 39 g C m(-2) year(-1)). Concomitantly, within growing seasons, CO(2) sink periods were approximately 106 days for corn and 90 days for soybean, and peak rates of CO(2) uptake were roughly 1.7-fold higher for corn than soybean. Apparent changes in soil organic carbon estimated after accounting for grain carbon removal suggested soil carbon depletion following soybean years and neutral carbon balance for corn. Overall, results suggest changes in land use and cropping systems have a substantial impact on dynamics of CO(2) exchange. (C) 2011 Elsevier B.V. All rights reserved.

Hessl, A. E. and L. J. Graumlich (2002). "Interactive effects of human activities, herbivory and fire on quaking aspen (Populus tremuloides) age structures in western Wyoming." Journal of Biogeography **29**(7): 889-902.

Aim Fire suppression, elk (Cervus elaphus Erxleben) browsing and drought have been suggested as possible explanations for low aspen (Populus tremuloides Michx.) ramet regeneration in elk winter range of the Greater Yellowstone Area (GYA) during the twentieth century. This study analyses the relationship between

the rates of aspen regeneration, biophysical factors and human land use since 1830. This approach reveals the importance of indirect human impacts, especially through fire and elk management strategies, on forest structure. Location This study was conducted in and around the winter range of the Jackson Hole elk herd in western Wyoming, USA. Aspen stands in this region represent the ecotone between coniferous forest and sagebrush-grassland vegetation. Methods Age structures of aspen stands were reconstructed from tree-rings in order to determine how variation in drought, elk populations and fire occurrence may have affected aspen ramet regeneration since 1830. The effects of recent prescribed fires and elk browse on aspen regeneration were also evaluated by measuring stem height, browse intensity and age of ramets <2 m tall in prescribed burns and in unburned areas. Results Aspen ramet regeneration has occurred consistently but at low frequencies since 1830, with three peaks of regeneration: 1860-85, 1915-40 and 1955-90. Periods of frequent ramet regeneration coincided with low to moderate elk populations and aspen regenerated only sporadically when elk populations were high. Based on a comparison of the age structures with a tree-ring reconstruction of Palmer drought severity index (PDSI), observed PDSI and annual precipitation, drought variability appears unrelated to episodes of aspen regeneration. Recent regeneration patterns suggest that fire does not enhance the recruitment of tree-sized aspen stems in the presence of elk browse, although sample sizes were small. Since 1900, elk hunting and spatially clustered elk feeding in the study area has facilitated low but consistent regeneration of aspen ramets in the twentieth century. In contrast, extremely low ramet regeneration has been observed in national parks of the Rocky Mountains, where elk have been managed according to the 'natural regulation' policy (no hunting or feeding) since 1969. Main conclusions Over time, different management strategies have altered the interactions between fire, herbivory and aspen regeneration suggesting that management history and the causes of change in management, should be explicitly included in ecological studies and future management strategies. These results also point to the value of using the spatial and temporal variation in human interactions with ecological systems as a method for understanding ecological relationships.

Higgins, P. A. T. (2004). "Biogeochemical and biophysical responses of the land surface to a sustained thermohaline circulation weakening." Journal of Climate **17**(21): 4135-4142.

Biotic responses to climate change may constitute significant feedbacks to the climate system by altering biogeochemistry (e.g., carbon storage) or biophysics (i.e., albedo, evapotranspiration, and roughness length) at the land surface. Accurate projection of future climate change depends on proper accounting of these biological feedbacks. Similarly, projections of future climate change must include the potential for nonlinear responses such as thermohaline circulation (THC) weakening, which is increasingly evident in paleoclimate reconstructions and model experiments. This article uses offline simulations with the Integrated Biosphere Simulator (IBIS) to determine long-term biophysical and biogeochemical responses to climate patterns generated by the third Hadley Centre Coupled Ocean-Atmosphere General Circulation Model (HadCM3) under forced THC weakening. Total land surface carbon storage decreases by 0.5% in response to THC weakening, suggesting that the biogeochemical response would not constitute a significant climate feedback under this climate change scenario. In contrast, large regional and local changes in leaf area index (LAI) suggest that biophysical responses may constitute significant feedbacks to at least local and regional climate. Indeed, the LAI responses do lead to changes in midday direct and diffuse beam albedo over large regions of the land surface. As a result, there are large local and regional changes in the land surface's capacity to absorb solar radiation. Changes in energy partitioning between sensible and latent heat fluxes also occur. However, the change in latent heat flux from the land surface is primarily attributable to changes in precipitation that occur under forced THC weakening and not a result of the subsequent changes in vegetation.

Higuera, P. E., et al. (2011). "Variability of tundra fire regimes in Arctic Alaska: millennial-scale patterns and ecological implications." Ecological Applications **21**(8): 3211-3226.

Tundra fires have important ecological impacts on vegetation, wildlife, permafrost, and carbon cycling, but the pattern and controls of historic tundra fire regimes are poorly understood. We use sediment records from four lakes to develop a 2000-yr fire and vegetation history in a highly flammable tundra region and compare this history with previously published fire records to examine spatial and temporal variability of tundra burning across Arctic Alaska. The four sites span a modern climatic gradient in the Noatak National Preserve, from warmer, drier down-valley locations to cooler, generally moister up-valley locations. Modern vegetation varies from herb-to shrub-dominated tundra from down-to up-valley sites, and pollen data suggest that this spatial pattern in vegetation persisted over the past two millennia. Peaks in macroscopic charcoal accumulation provide estimates of fire-event return intervals (FRIs), which did not vary significantly at millennial time scales but did vary across space. Down-valley sites burned relatively frequently over the past two millennia, with median FRIs of 150 years (95% CI 101-150) and FRI distributions statistically similar to those from ancient shrub tundra and modern boreal forest. At up-valley sites FRIs were significantly longer than those at down-valley sites, with a median FRI of 218 years (95% CI 128-285). These differences likely reflect the cooler growing-season temperatures and lower evaporative demand at up-valley sites, but local-scale variability in vegetation may have also shaped tundra fire regimes. Comparisons with other long-term fire records in Alaska reveal that the tundra biome can sustain a wide range of burning, with individual FRIs from as low as 30 years to more than 5000 years. These records together indicate that frequent tundra burning has occurred under a range of climatic and vegetation scenarios. The variety of tundra fire histories within Alaska suggests that the ecological impacts of tundra burning likewise vary widely, with important implications for wildlife-habitat maintenance and for the responses of tundra biophysical and biogeochemical processes to climatic change.

Hong, S., et al. (2018). "Satellite-based assessment of rapid mega-urban development on agricultural land." Journal of Agricultural Meteorology **74**(2): 87-91.

Observations of urbanization will provide a framework for understanding the biophysical processes caused by artificial land changes. Sejong Multifunctional Administrative City MAC is under development since 2006 to decentralize the function of Seoul, the capital city of South Korea. MAC was originally agricultural land and now is rapidly developing to mega-city. Using U.S. Air Force Defense Meteorological Satellite Program's Operational Linescan System DMSP-OLS and Moderate-resolution Imaging Spectroradiometer MODIS satellite data, the spatio-temporal characteristics of nighttime light NTL emission, normalized difference vegetation index NDVI, land surface temperature LST, and surface albedo were investigated in MAC and its adjacent cities. NTL was generally stronger in the presence of vegetation degradation and surface warming conditions. LST was negatively correlated with a growth in vegetation. Those relationships among NTL, LST, and NDVI were shown both in temporal change at MAC and spatial variation of MAC's adjacent cites. Further, because the ratio value of LST to NDVI was similar in temporal and spatial scales, these two indices can be used as important indicator of urbanization. However, surface albedo is not suitable to represent the temporal transition from rural to urban state because tall buildings can often bring relatively low surface albedo by blocking outgoing radiation.

Hossack, B. R., et al. (2009). "Thermal characteristics of amphibian microhabitats in a fire-disturbed landscape." Forest Ecology and Management **258**(7): 1414-1421.

Disturbance has long been a central issue in amphibian conservation, often regarding negative effects of logging or other forest management activities, but some amphibians seem to prefer disturbed habitats. After documenting increased use of recently burned forests by boreal toads (Bufo boreas), we hypothesized that burned habitats provided improved thermal opportunities in terrestrial habitats. We tested this hypothesis by conducting a radio telemetry study of habitat use (reported previously) and by using physical models that simulated the temperature of adult toads. We deployed 108 physical models in and adjacent to a 1-year old burn using a fully-replicated design with three burn severities (unburned, partial, high severity) and four microhabitats (open surface, under vegetation, under log, in burrow). Model temperatures were compared to a range of preferred temperatures in published studies. We found 70% more observations within the preferred temperature range of B. boreas in forests burned with high severity than in unburned areas. Burned forest was warmer than unburned forest across all microhabitats, but the largest relative difference was in burrows, which averaged 3 C warmer in high-severity burn areas and remained warmer though the night. More than twice as many observations were within the preferred temperature range in high-severity burrows than in unburned burrows. Areas burned with high severity were still warmer than unburned forest 3 years after the fire. Habitat use of toads during the concurrent radio telemetry study matched that predicted by the physical models. These results suggest there are fitness-linked benefits to toads using burned habitats, such as increased growth, fertility, and possibly disease resistance. However, increased soil temperatures that result from wildfire may be detrimental to other amphibian species that prefer cooler temperatures and stable environments. More broadly, our data illustrate the use of physical models to measure and interpret changes that amphibians may experience from disturbance, and highlight the need for research linking vital rates such as growth and survival to disturbance. (C) Published by Elsevier B.V.

Houborg, R., et al. (2009). "Intercomparison of a 'bottom-up' and 'top-down' modeling paradigm for estimating carbon and energy fluxes over a variety of vegetative regimes across the US." Agricultural and Forest Meteorology **149**(12): 2162-2182.

Biophysical models intended for routine applications at a range of scales should attempt to balance the competing demands of generality and simplicity and be capable of realistically simulating the response of CO_2 and energy fluxes to environmental and physiological forcings. At the same time they must remain computationally inexpensive and sufficiently simple to be effectively parameterized at the scale of application. This study investigates the utility of two modeling strategies for quantifying coupled land surface fluxes of carbon and water, which differ distinctly in their description of CO_2 assimilation processes. 'Bottom-up' models of land-atmosphere carbon exchange are based on detailed mechanistic descriptions of leaf-level photosynthetic processes scaled to the canopy whereas 'top-down' scaling approaches neglect the behavior of individual leaves and consider the canopy response to its environment in bulk. Effective intercomparisons of a light-use-efficiency (LUE)-based model of canopy conductance and a mechanistic model of leaf photosynthesis-stomatal response that employs a 'two-leaf' scaling strategy are facilitated by embedding both canopy sub-models in the Atmosphere-Land Exchange (ALEX) surface energy balance model. Water and carbon flux simulations are evaluated across time scales of hours, days, seasons and years for a variety of natural and agricultural ecosystems, using micrometeorological data from several AmeriFlux sites across the U.S. While both modeling paradigms reproduced observed magnitudes and variances of carbon and water vapor exchange on hourly and daily timescales with acceptable accuracy, the simpler LUE-based model often performed better than the more detailed scaled-leaf model, which has many adjustable species-specific model parameters. Actual light-use efficiencies vary significantly in response to changing environmental conditions and the success of LUE-based modeling frameworks rely on their ability to realistically respond to changes in light environment, atmospheric humidity, CO_2 concentration and a desiccating environment. (C) 2009 Elsevier B.V. All rights reserved.

Houspanossian, J., et al. (2013). "Radiation budget changes with dry forest clearing in temperate Argentina." Global Change Biology **19**(4): 1211-1222.

Land cover changes may affect climate and the energy balance of the Earth through their influence on the greenhouse gas composition of the atmosphere (biogeochemical effects) but also through shifts in the physical properties of the land surface (biophysical effects). We explored how the radiation budget changes following the replacement of temperate dry forests by crops in central semiarid Argentina and quantified the biophysical radiative forcing of this transformation. For this purpose, we computed the albedo and surface temperature for a 7-year period (20032009) from MODIS imagery at 70 paired sites occupied by native forests and crops and calculated the radiation budget at the tropopause and surface levels using a columnar radiation model parameterized with satellite data. Mean annual black-sky albedo and diurnal surface temperature were 50% and 2.5 degrees C higher in croplands than in dry forests. These contrasts increased the outgoing shortwave energy flux at the top of the atmosphere in croplands by a quarter (58.4 vs. 45.9Wm2) which, together with a slight increase in the outgoing longwave flux, yielded a net cooling of 14Wm2. This biophysical cooling effect would be equivalent to a reduction in atmospheric CO_2 of 22 Mg C ha1, which involves approximately a quarter to a half of the typical carbon emissions that accompany deforestation in these ecosystems. We showed that the replacement of dry forests by crops in central Argentina has strong biophysical effects on the energy budget which could counterbalance the biogeochemical effects of deforestation. Underestimating or ignoring these biophysical consequences of land-use changes on climate will certainly curtail the effectiveness of many warming mitigation actions, particularly in semiarid regions where high radiation load and smaller active carbon pools would increase the relative importance of biophysical forcing.

Hoyos, N., et al. (2017). "The environmental envelope of fires in the Colombian Caribbean." Applied Geography **84**: 42-54.

Fire is an important disturbance agent for terrestrial ecosystems, particularly in tropical and subtropical regions where its occurrence is controlled by multiple biophysical and anthropogenic variables. We assessed

the temporal and spatial patterns of active fire detections (MODIS product MCD14ML) in the Caribbean region of Colombia between 2003 and 2015, using time series, cross-correlation, hot spot and density techniques. We also assessed the environmental envelope of active fires by evaluating the effect of multiple biophysical and anthropogenic variables on fire presence/absence using generalized linear models (GLMs). Results show that fires follow a clear intra-annual cycle, with 86% of fire events taking place during the region's main dry season (December March). There is also inter-annual variability related to the Tropical North Atlantic (TNA) quasi-decadal climatic oscillation. Active fires exhibit a distinctive spatial pattern, with regional hotspots. The set of variables that best explain fire presence/absence include biophysical (TNA, temperature annual range, dry quarter precipitation), anthropogenic (minimum distance to towns and roads) and composite (NDVI) variables. The extensive and ongoing land cover transformation of this region, from forest to pasture and agriculture, will likely increase the extent of burned areas and future carbon fire emissions to the atmosphere. (C) 2017 Elsevier Ltd. All rights reserved.

Huang, C. Y. and W. R. L. Anderegg (2014). "Vegetation, land surface brightness, and temperature dynamics after aspen forest die-off." Journal of Geophysical Research-Biogeosciences **119**(7): 1297-1308.

Forest dynamics following drought-induced tree mortality can affect regional climate through biophysical surface properties. These dynamics have not been well quantified, particularly at the regional scale, and are a large uncertainty in ecosystem-climate feedback. We investigated regional biophysical characteristics through time (1995-2011) in drought-impacted (2001-2003), trembling aspen (Populus tremuloides Michx.) forests by utilizing Landsat time series green and brown vegetation cover, surface brightness (total shortwave albedo), and daytime land surface temperature. We quantified the temporal dynamics and postdrought recovery of these characteristics for aspen forests experiencing severe drought-induced mortality in the San Juan National Forest in southwestern Colorado, USA. We partitioned forests into three categories from healthy to severe mortality (Healthy, Intermediate, and Die-off) by referring to field observations of aspen canopy mortality and live aboveground biomass losses. The vegetation cover of die-off areas in 2011 (26.9% of the aspen forest) was significantly different compared to predrought conditions (decrease of 7.4% of the green vegetation cover and increase of 12.1% of the brown vegetation cover compared to 1999). The surface brightness of the study region 9 years after drought however was comparable to predrought estimates (12.7-13.7%). Postdrought brightness was potentially influenced by understory shrubs, since they became the top layer green canopies in disturbed sites from a satellite's point of view. Satellite evidence also showed that the differences of land surface temperature among the three groups increased substantially (>= 45%) after drought, possibly due to the reduction of plant evapotranspiration in the Intermediate and Die-off sites. Our results suggest that the mortality-affected systems have not recovered in terms of the surface biophysical properties. We also find that the temporal dynamics of vegetation cover holds great potential for assessing propensity of subsequent mortality during drought itself, which could provide effective monitoring and potentially a much needed "early warning" of drought-induced tree mortality.

Huang, S. P., et al. (2013). "Future advantages in energetics, activity time, and habitats predicted in a high-altitude pit viper with climate warming." Functional Ecology **27**(2): 446-458.

A future warmer climate is generally predicted to threaten reptiles. But many high-altitude reptiles that rely on external heat to survive current cold climate may benefit from future warmth. This prediction can be tested by simulating activity time and energetics of reptiles with a biophysical model. We modelled the potential response of a high-altitude snake, Trimeresurus gracilis, to a 3 degrees C increase in air temperature, using the biophysical/behavioural NicheMapper model. Using animal and environmental properties, we first analysed the effects of shade level (i.e. the reduction of solar radiation) on activity time and energetics of T.gracilis. We then computed activity time, energetics and potential habitats in its current range of Taroko National Park, Taiwan (>1800m in altitude), with a spatial climate, vegetation and topography data set. In the current climate, increased shade levels were predicted to decrease activity time, maintenance energy requirements and discretionary energy (i.e. energy left after maintenance costs are met). In heavy shade (i.e. 81100% reduction of solar radiation) at 3000 and 3500m, T.gracilis was predicted to have impaired digestive capacity and hence to be unable to meet basic maintenance costs for survival. In a warmer climate, the predicted digestive capacity, energetics and activity time of T.gracilis increase. But in heavy shade at 3500m, the digestive capacity was predicted to remain impaired for supporting basic energy requirements for survival. In the current climate, the predicted suitable habitat area (i.e. where T.gracilis obtains positive discretionary energy) in coniferous and coniferousbroadleaf forests decreased with increasing elevation. At elevations higher than 3000m, most suitable habitats were in open areas like grasslands where T.gracilis was also predicted to have more discretionary energy than in heavily forested habitats. Our field sightings agreed with model predictions. A warmer climate was generally predicted to increase the activity time, energetics and habitat area, given the current vegetation pattern. Overall, we demonstrate that metabolism, digestive function and vegetative shade levels are critical elements affecting T.gracilis' energetics and habitats with climate change. Trimeresurus gracilis is likely to benefit energetically from future warmth.

Huang, S. P., et al. (2014). "Forest cover reduces thermally suitable habitats and affects responses to a warmer climate predicted in a high-elevation lizard." Oecologia **175**(1): 25-35.

Warmer climates have affected animal distribution ranges, but how they may interact with vegetation patterns to affect habitat use, an important consideration for future wildlife management, has received little attention. Here, we use a biophysical model to investigate the potential thermal impact of vegetation pattern on the habitat quality of a high-elevation grassland lizard, Takydromus hsuehshanensis, and to predict the thermal suitability of vegetation for this species in a future warmer climate (assuming 3 A degrees C air temperature increase). We assess the thermal quality of vegetation types in our study area (Taroko National Park in areas > 1,800 m) using three ecologically relevant estimates of reptiles: body temperature (T (b)), maximum active time, and maximum digestive time. The results show that increasing forest canopy gradually cools the microclimates, hence decreasing these estimates. In the current landscape, sunny mountain-top grasslands are predicted to serve as high quality thermal habitat, whereas the dense forests that are dominant as a result of forest protection are too cold to provide suitable habitat. In simulated warmer climates, the thermal quality of dense forests increases slightly but remains inferior to that of grasslands. We note that the impact of warmer climates on this reptile will be greatly affected by future vegetation patterns, and we suggest that the current trend of upslope forest movement found in many other mountain systems could cause disadvantages to some heliothermic lizard species.

Hubbart, J. A., et al. (2007). "Cold air drainage and modeled nocturnal leaf water potential in complex forested terrain." Tree Physiology **27**(4): 631-639.

Spatial variation in microclimate caused by air temperature inversions plays an important role in determining the timing and rate of many physical and biophysical processes. Such phenomena are of particular interest in mountainous regions where complex physiographic terrain can greatly complicate these processes. Recent work has demonstrated that, in some plants, stomata do not close completely at night, resulting in nocturnal transpiration. The following work was undertaken to develop a better understanding of nocturnal cold air drainage and its subsequent impact on the reliability of predawn leaf water potential (Psi(pd)) as a surrogate for soil water potential (Psi(s)). Eight temperature data loggers were installed on a transect spanning a vertical distance of 155 m along a north facing slope in the Mica Creek Experimental Watershed (MCEW) in northern Idaho during July and August 2004. Results indicated strong nocturnal temperature inversions occurring from the low- to upper-mid-slope, typically spanning the lower 88 m of the vertical distance. Based on mean temperatures for both months, inversions resulted in lapse rates of 29.0, 27.0 and 25.0 degrees C km(-1) at 0000, 0400 and 2000 h, respectively. At this scale (i.e., < 1 km), the observed lapse rates resulted in highly variable nighttime vapor pressure deficits (D) over the length of the slope, with variable impacts on modeled disequilibrium between soil and leaf water potential. As a result of cold air drainage, modeled Psi(pd) became consistently more negative (up to -0.3 MPa) at higher elevations during the night based on mean temperatures. Nocturnal inversions on the lower- and mid-slopes resulted in leaf water potentials that were at least 30 and 50% more negative over the lower 88 m of the inversion layer, based on mean and maximum temperatures, respectively. However, on a cloudy night, with low D, the maximum decrease in Psi(pd) was -0.04 MPa. Our results indicate that, given persistent cold air drainage and nighttime stomatal opening, serious errors will result if Psi(s) is estimated from Psi(pd).

Jacob, F. and M. Weiss (2014). "Mapping Biophysical Variables From Solar and Thermal Infrared Remote Sensing: Focus on Agricultural Landscapes With Spatial Heterogeneity." Ieee Geoscience and Remote Sensing Letters **11**(10): 1844-1848.

This letter closes a Special Stream that focuses on spatial heterogeneity when mapping biophysical variables over agricultural landscape from solar and thermal infrared remote sensing. We propose an overview of the highlights from prior research, we report the main results of the Special Stream, and we discuss future directions. The main outcomes of the Special Stream are related to: 1) the impact on the remotely sensed signal of canopy vertical distribution, shadowing effects, and multiple scattering; 2) the notion of spatial resolution limit in relation to spatial heterogeneity; and 3) the definition of an optimal sampling strategy to spatialize ground measurements.

Jasper, K., et al. (2006). "Changes in summertime soil water patterns in complex terrain due to climatic change." Journal of Hydrology **327**(3-4): 550-563.

Climate change is expected to have a profound influence on soil moisture. According to that the present study aimed at the investigation of future soil water evolution by considering the relationship between soil moisture changes resulting from climate change projections, soil, and terrain characteristics, with special emphasis on slope and groundwater depth. The distributed hydrological model WaSiM-ETH was used to simulate root zone soil water content at a 1 km grid resolution in the 1700 km(2) Thur river basin (NE Switzerland) during the 6-month period from April to September. The model was driven by baseline climate data from national data records for 1981-2000, or by scenario data for 2081-2100. The latter were based on grid point projections of two global climate models (CSIRO [132] and HaclCM3 [A2]). The datasets were completed with observations and simulations for the exceptionalty warm and dry summer of 2003. The results suggested that a warmer climate with less summertime precipitation may significantly lower the seasonal mean soil water content in many parts of this basin, leading to frequent water stress conditions. Strongest effects occurred with HadCM3, and to a similar extent with 2003 weather data. The magnitude of soil moisture changes were related to [and use, soil texture, and slope. In relative terms, reductions in soil water were largest for sloping soils with low water storage capacity, and also larger for forests than for cropland and grasslands. In absolute (votumetric) units, most pronounced reductions were indicated for flat areas with good water supply (mostly dominated by cropland). Here, the rooting zone was often connected to the groundwater, and capillary rise counteracted soil water depletion under current climate during the first half of the season, but was disconnected much earlier under climate change conditions. In steeper areas, groundwater had no influence and thus soil water content changed mainly in response to decreased precipitation and increased evapotranspiration. It is concluded that soil water contents generally decline in this pre-alpine river basin with climate change, but that the degree of soil water depletion varies with climate scenario, land use, soil texture, and topographic conditions. Thus, realistic soil water projections require reliable predictions of summertime climate, and the use of a full representation of biophysical processes that control evapotranspiration, including vertical and lateral subsurface water flows. (c) 2005 Elsevier B.V. All rights reserved.

Jassal, R. S., et al. (2012). "Using automated non-steady-state chamber systems for making continuous long-term measurements of soil CO_2 efflux in forest ecosystems." Agricultural and Forest Meteorology **161**: 57-65.

Automated measurements of forest soil CO_2 efflux (F) using non-steady-state chamber systems are necessary to study the short- and long-term responses of soil respiration to temporal variations in abiotic and biotic variables. Increased use of automated chamber systems in regional flux networks results in large data sets that demand an efficient and reliable protocol to ensure good quality measurements, efficient and robust calculations, and post-processing data-quality control. Using half-hourly measurements and simulations with a process-based model, we show that underestimation of efflux due to disturbance of the soil CO_2 diffusion gradient arising from chamber closure for periods of up to 3 min is much less (< 4%) than is often assumed. Also, we found that use of simple linear regression for calculating the rate of change in the chamber headspace concentration is the best method in comparison to non-linear models; it is robust and, for lid closure periods < 3% of the chamber-soil system time constant, results in < 2% underestimation of the efflux, which is smaller than the overestimation using some non-linear methods. The effective volume of a chamber is significantly higher than its geometric volume and varies markedly seasonally so its determination is important for accurate efflux measurements. A procedure is described for determining the effective volume, which we recommend should be followed at least once a day. We also describe various steps to ensure accurate measurements, including the use of a seasonal threshold value of the ratio of root mean square error of the linear fit to headspace concentration versus time to its slope for rejecting

questionable measurements, and demonstrate the use of a procedure combining the use of automated and manual quality assurance/quality control in removing questionable measurements. (C) 2012 Elsevier B.V. All rights reserved.

Jenerette, G. D., et al. (2016). "Climate tolerances and trait choices shape continental patterns of urban tree biodiversity." Global Ecology and Biogeography **25**(11): 1367-1376.

AimWe propose and test a climate tolerance and trait choice hypothesis of urban macroecological variation in which strong filtering associated with low winter temperatures restricts urban biodiversity while weak filtering associated with warmer temperatures and irrigation allows dispersal of species from a global source pool, thereby increasing urban biodiversity. LocationTwenty cities across the USA and Canada. MethodsWe examined variation in tree community taxonomic diversity, origins and production of an aesthetic ecosystem service trait in a cross-section of urban field surveys. We correlated urban tree community composition indicators with a key climate restriction, namely mean minimum winter temperature, and evaluated alternative possible drivers: precipitation, summer maximum temperature, population size and the percentage of adults with a college education. ResultsSpecies accumulation curves differed substantially among cities, with observed richness varying from 22 to 122 species. Similarities in tree communities decreased exponentially with increases in climatic differences. Ordination of tree communities showed strong separation among cities with component axes correlated with minimum winter temperature and annual precipitation. Variation among urban tree communities in richness, origins and the provisioning of an aesthetic ecosystem service were all correlated with minimum winter temperature. Main conclusionsThe urban climate tolerance and trait choice hypothesis provides a coherent mechanism to explain the large variation among urban tree communities resulting from an interacting environment, species and human decisions. Reconciling the feedbacks between human decision making and biophysical limitations provides a foundation for an urban ecological theory that can better understand and predict the dynamics of other linked biotic communities, associated ecosystem dynamics and resulting services provided to urban residents.

Jeong, J. H., et al. (2016). "Random Forests for Global and Regional Crop Yield Predictions." PLoS ONE **11**(6).

Accurate predictions of crop yield are critical for developing effective agricultural and food policies at the regional and global scales. We evaluated a machine-learning method, Random Forests (RF), for its ability to predict crop yield responses to climate and biophysical variables at global and regional scales in wheat, maize, and potato in comparison with multiple linear regressions (MLR) serving as a benchmark. We used crop yield data from various sources and regions for model training and testing: 1) gridded global wheat grain yield, 2) maize grain yield from US counties over thirty years, and 3) potato tuber and maize silage yield from the northeastern seaboard region. RF was found highly capable of predicting crop yields and outperformed MLR benchmarks in all performance statistics that were compared. For example, the root mean square errors (RMSE) ranged between 6 and 14% of the average observed yield with RF models in all test cases whereas these values ranged from 14% to 49% for MLR models. Our results show that RF is an effective and versatile machine-learning method for crop yield predictions at regional and global scales for its high accuracy and precision, ease of use, and utility in data analysis. RF may result in a loss of accuracy when predicting the extreme ends or responses beyond the boundaries of the training data.

Jeong, S. J., et al. (2014). "Effects of double cropping on summer climate of the North China Plain and neighbouring regions." Nature Climate Change **4**(7): 615-619.

The North China Plain (NCP) is one of the most important agricultural regions in Asia and produces up to 50% of the cereal consumed in China each year(1,2). To meet increasing food demands without expanding croplands, annual agricultural practice in much of the NCP has changed from single to double cropping(3,4). The impact of double cropping on the regional climate, through biophysical feedbacks caused by changes in land surface conditions, remains largely unknown. Here we show that observed surface air temperatures during the inter-cropping season (June and July) are 0.40 degrees C higher over double cropping regions (DCRs) than over single cropping regions (SCRs), with increases in the daily maximum temperature as large as 1.02 degrees C. Using regional climate modelling, we attribute the higher temperatures in DCRs to reduced evapotranspiration during the inter-cropping period. The higher surface temperatures in June and July affect low-level circulation and, in turn, rainfall associated with the East Asian monsoon over the NCP and neighbouring countries. These findings suggest that double cropping in the NCP can amplify the magnitude of summertime climate changes over East Asia.

Jia, X., et al. (2013). "Temperature Response of Soil Respiration in a Chinese Pine Plantation: Hysteresis and Seasonal vs. Diel Q(10)." PLoS ONE **8**(2).

Although the temperature response of soil respiration (R-s) has been studied extensively, several issues remain unresolved, including hysteresis in the R-s-temperature relationship and differences in the long- vs. short-term Rs sensitivity to temperature. Progress on these issues will contribute to reduced uncertainties in carbon cycle modeling. We monitored soil CO2 efflux with an automated chamber system in a Pinus tabulaeformis plantation near Beijing throughout 2011. Soil temperature at 10-cm depth (T-s) exerted a strong control over R-s, with the annual temperature sensitivity (Q(10)) and basal rate at 10 degrees C (R-s10) being 2.76 and 1.40 mu mol m(-2) s(-1), respectively. Both R-s and short-term (i.e., daily) estimates of R-s10 showed pronounced seasonal hysteresis with respect to T-s, with the efflux in the second half of the year being larger than that early in the season for a given temperature. The hysteresis may be associated with the confounding effects of microbial population dynamics and/or litter input. As a result, all of the applied regression models failed to yield unbiased estimates of R-s over the entire annual cycle. Lags between R-s and T-s were observed at the diel scale in the early and late growing season, but not in summer. The seasonality in these lags may be due to the use of a single T-s measurement depth, which failed to represent seasonal changes in the depth of CO2 production. Daily estimates of Q(10) averaged 2.04, smaller than the value obtained from the seasonal relationship. In addition, daily Q(10) decreased with increasing T-s, which may contribute feedback to the climate system under global warming scenarios. The use of a fixed, universal Q(10) is considered adequate when modeling annual carbon budgets across large spatial extents. In contrast, a seasonally-varying, environmentally-controlled Q(10) should be used when short-term accuracy is required.

Jiang, C., et al. (2016). "Quantification and assessment of changes in ecosystem service in the Three-River Headwaters Region, China as a result of climate variability and land cover change." Ecological Indicators **66**: 199-211.

Rapid and periodic assessment of the impact of land cover change and climate variability on ecosystem services at regional levels is essential to understanding services and sustainability of ecosystems. This study focused on quantifying and assessing the changes in multiple ecosystem services in the Three-River Headwaters Region (TRHR), China in 2000-2012. Based on the widely used biophysical models including Integrated Valuation of Ecosystem Services and Trade-Offs (InVEST), Revised Wind Erosion Equation (RWSQ), and Carnegie-Ames-Stanford Approach (CASA) models, this study assessed the historical flow of regulating services, including soil conservation, water yield, and carbon sequestration, and provisioning service food provision. The soil conservation function of ecosystem was slightly enhanced as a whole, and water yield increased sharply, with both the soil conservation and water yield showing an increasing spatial homogenization. The net primary productivity (NPP) and food production increased substantially from 2000 to 2012. Ecosystem services are closely and complexly interlinked. The correlation analyses indicated a trade-off between the water yield and carbon sequestration, however, a synergy between soil conservation and carbon sequestration. Congruence between the three different ecosystem provisioning services, including pasture, meat, and grain, was found. There was also a synergy between food production and ecosystem carbon sequestration in the TRHR. Climatic variability and vegetation restoration are important for the ecosystem services flow. Correlation analyses showed that the increase in precipitation significantly enhanced the water yield ($P < 0.01$) and soil erosion ($P < 0.01$), while the temperature increase influenced positively the NPP ($P < 0.1$). The experience of ecological rehabilitation and the change in key ecosystem services in the TRHR exemplified the positive effects of environmental policies and the necessity of adopting an adaptive management approach. Thus the ecological construction and policy making should take climate variability into account, and facilitate synergies on multiple ecosystem services in order to maximize human well-being and preserve its natural ecosystems. (C) 2016 Elsevier Ltd. All rights reserved.

Jiang, C., et al. (2017). "Evaluating the coupling effects of climate variability and vegetation restoration on ecosystems of the Loess Plateau, China." Land Use Policy **69**: 134-148.

Restoring disturbed and over-exploited ecosystems is an important part of mitigating human pressures on natural ecosystems. An ambitious ecological restoration program, the Grain for Green Program (GFGP), was launched in 1999 in China. We selected the Loess Plateau (LP) as a case study, and evaluated ecosystem changes between 2000 and 2012 using biophysical models, observation records, and literature data. It was observed that both the warming and wetting of climate and the ecological program promoted vegetation growth and biomass production (i.e., carbon sequestration). Overall ecosystem patterns were relatively stable; grassland, residential land, and forest increased in area, while farmland area decreased slightly. Increasing precipitation throughout the study period was related to fluctuations in soil retention and hydrological regulation. Vegetation restoration induced by climate variability and the ecological program played a significant role in soil retention enhancement, which also substantially reduced sediment load. The land-use conversion in ecological restoration program promoted soil carbon sequestration, but featured differences in conversion types and rainfall zones. The ecosystem changes recorded in the LP, which resulted from both the ecological program and climate variability, might be temporary improvements rather than fundamental ecosystem shifts. The success of this ecological restoration in the LP exemplifies the positive effects of environmental policies and the necessity of adopting an adaptive management approach. However, the current assessment was not comprehensive, as it involved only three dominant regulating services, and there were still trade-offs among multiple ecosystem services. Therefore, a deeper understanding of the interactions and trade-offs among ecosystem services is required to explore in the context of emerging climate change, so as to support environmental management that maximizes ecosystem benefits to human well-being.

Jiang, C., et al. (2018). "Spatially explicit assessment of ecosystem services in China's Loess Plateau: Patterns, interactions, drivers, and implications." Global and Planetary Change **161**: 41-52.

Human deinands for natural resources have significantly changed the natural landscape and induced ecological degradation and associated ecosystem services. An understanding of the patterns, interactions, and drivers of ecosystem services is essential for the ecosystem management and guiding targeted land use policy-making. The Losses Plateau (LP) provides ecosystem services including the carbon sequestration and soil retention, and exerts tremendous impacts on the midstream and downstream of the Yellow River. Three dominant ecosystem services between 2000 and 2012 within the LP were presented based on multiple source datasets and biophysical models. In addition, paired ecosystem services interactions were quantified using the correlation analysis and constraint line approach. The main conclusions are as follows. It was observed that the warming and wetting climate and ecological program jointly promoted the vegetation growth and carbon sequestration. The increasing precipitation throughout 2000-2012 was related to the soil retention and hydrological regulation fluctuations. The vegetation restoration played a positive role in the soil retention enhancement, thus substantially reduced water and sediment yields. The relationships between ecosystem services were not only correlations (tradeoffs or synergies), but rather constraint effects. The constraint effects between the three paired ecosystem services could be classified as the negative convex (carbon sequestration vs. hydrological regulation) and hump-shaped (soil retention vs. carbon sequestration and soil retention vs. hydrological regulation), and the coefficients of determination for the entire LP were 0.78, 0.84, and 0.65, respectively. In the LP, the rainfall (water availability) was the key constraint factor that affected the relationships between the paired ecosystem services. The spatially explicit mapping of ecosystem services and interaction analyses utilizing constraint line approach enriched the understanding of connections between ecosystem services and the potential drivers, which had important implications for the land use planning and landscapes services optimizing.

Jin, M. and D. L. Zhang (2002). "Observed variations of leaf area index and its relationship with surface temperatures during warm seasons." Meteorology and Atmospheric Physics **80**(1-4): 117-129.

The leaf area index (LAI) is one of the most critical variables describing the biophysical and biochemical properties of the land cover in the remote sensing and climate models. In this study, the climatological variations of LAI is analyzed with NOAA's 14-year (1981-1994) Advanced Very High Resolution Radiometer (AVHRR) measurements. More attention is given to the 14 months of Julys or the warm seasons, in which interannual LAI variations contain more pronounced signals of dynamic forcing associated with the tropical rainforests and the temperate forests around 60degrees N. Furthermore, projecting the LAI anomalies into the empirical orthogonal function time series of El Nino and other climatologically important events shows that the large-scale circulations play an important role in determining the interannual variations of LAI, likely through the changes of surface insolation, precipitation and soil moisture. It is found that on the global scale LAI and the land surface and skin temperatures are negatively correlated, namely, decreasing LAI corresponds to warm temperatures. However, the regional LAI effects on the land surface climate vary significantly from regions to regions.

Jones, C., et al. (2010). "Role of terrestrial ecosystems in determining CO2 stabilization and recovery behaviour." Tellus Series B-Chemical and Physical Meteorology **62**(5): 682-699.
Terrestrial ecosystems are sensitive to climate and can also influence it through both biophysical and biogeochemical feedbacks. Natural carbon uptake by ecosystems will control future evolution of CO2 and climate, but the ecosystems themselves may be committed to long-term changes. Here we use a coupled climate-carbon cycle GCM with dynamic vegetation to investigate the policy-relevance of these feedbacks in several idealized scenarios. Our results show that the natural carbon cycle in the ocean and on land controls the recovery of atmospheric CO2 following emissions reductions at three action points during the 21st century. Initial rates of recovery are similar but for different reasons. Ocean carbon uptake exceeds terrestrial uptake, with higher CO2 levels leading to increased ocean uptake whereas on land greater climate change at higher CO2 leads to decreased carbon storage. There are long-term committed changes to terrestrial ecosystems which vary in sign regionally and create a complex dynamic response of terrestrial carbon storage as it slowly approaches a new steady state. Neither stabilization nor CO2 recovery allows ecosystems to recover back to their initial state and the ecosystems continue to respond for decades or even centuries following emissions reductions. These long-term committed changes, in addition to realized, transient changes, must be considered when defining dangerous climate change and identifying emission-pathways to avoid it.

Jones, L. A., et al. (2007). "Satellite microwave remote sensing of boreal and arctic soil temperatures from AMSR-E." Ieee Transactions on Geoscience and Remote Sensing **45**(7): 2004-2018.
Methods are developed and evaluated to retrieve surface soil temperature information for the Advanced Microwave Scanning Radiometer on Earth. Observing System for seven boreal forest and Arctic tundra biophysical monitoring sites across Alaska and Northern Canada. A multiple-band iterative radiative transfer process-based method producing dynamic vegetation and snow cover correction quantities and an empirical multiple regression method using several frequencies are employed. The seasonal pattern of microwave emission and relative accuracy of the soil temperature retrievals are influenced strongly by landscape properties, including the presence of open water, vegetation type and seasonal phenology, snow cover, and freeze-thaw transitions. The retrieval of soil temperature is similar for the two methods with an overall root-mean-square error of 3.1-3.9 K during summer thawed conditions, with a larger error occurring in winter during periods of dynamic snow cover and freeze-thaw state. These results indicate that at high latitudes, the influence of the atmosphere may be less important than that of surface conditions in determining the relative accuracy of the estimated soil temperature. Impacts of surface conditions on surface emissivity, observed brightness temperature, and estimated soil temperature are discussed.

Kang, S., et al. (2004). "The effects of spatial aggregation of complex topography on hydroecological process simulations within a rugged forest landscape: development and application of a satellite-based topoclimatic model." Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere **34**(3): 519-530.
We evaluated the effects of topographic complexity on landscape carbon and hydrologic process simulations within a rugged mixed hardwood forest by developing and applying a satellite-based hydroecological model at multiple spatial scales. The effects of topographic variability were evaluated by aggregating raster-based digital elevation model and satellite-derived leaf area index inputs across eight different spatial resolutions from 30 m (62 208 pixels) to 2160 m (12 pixels). Our modeling analysis showed that the effect of topography was the strongest on solar radiation and temperature, intermediate on soil water and evapotranspiration, and ambiguous on soil respiration. Spatial aggregation of model inputs smoothed heterogeneous spatial patterns of modeled output variables relative to fine-scale results. Model outputs varied nonlinearly with different levels of spatial aggregation, while spatial variability of model inputs and outputs were dampened at increasingly coarse aggregation levels. Biases in spatially aggregated model predictions were generally less than +/-10%, except for solar radiation, which showed biases of up to +50% at coarser spatial scales. The large positive bias in the solar radiation implies that overestimation of biophysical variables that are sensitive to solar radiation (e.g., photosynthesis and net primary production) may be considerable in rugged forested landscapes unless subgrid scale effects are accounted for.

Kang, X. M., et al. (2018). "Modeling Gross Primary Production of a Typical Coastal Wetland in China Using MODIS Time Series and CO2 Eddy Flux Tower Data." Remote Sensing **10**(5).

How to effectively combine remote sensing data with the eddy covariance (EC) technique to accurately quantify gross primary production (GPP) in coastal wetlands has been a challenge and is also important and necessary for carbon (C) budgets assessment and climate change studies at larger scales. In this study, a satellite-based Vegetation Photosynthesis Model (VPM) combined with EC measurement and Moderate Resolution Imaging Spectroradiometer (MODIS) data was used to evaluate the phenological characteristics and the biophysical performance of MODIS-based vegetation indices (VIs) and the feasibility of the model for simulating GPP of coastal wetland ecosystems. The results showed that greenness-related and water-related VIs can better identify the green-up and the senescence phases of coastal wetland vegetation, corresponds well with the C uptake period and the phenological patterns that were delineated by GPP from EC tower (GPP(EC)). Temperature can explain most of the seasonal variation in VIs and GPP(EC) fluxes. Both enhanced vegetation index (EVI) and water-sensitive land surface water index (LSWI) have a higher predictive power for simulating GPP in this coastal wetland. The comparisons between modeled GPP (GPP(VPM)) and GPP(EC) indicated that VPM model can commendably simulate the trajectories of the seasonal dynamics of GPP(EC) fluxes in terms of patterns and magnitudes, explaining about 85% of GPP(EC) changes over the study years ($p < 0.0001$). The results also demonstrate the potential of satellite-driven VPM model for modeling C uptake at large spatial and temporal scales in coastal wetlands, which can provide valuable production data for the assessment of global wetland C sink/source.

Keys, P. W. and L. Wang-Erlandsson (2018). "On the social dynamics of moisture recycling." Earth System Dynamics **9**(2): 829-847.

The biophysical phenomenon of terrestrial moisture recycling connects distant regions via the atmospheric branch of the water cycle. This process, whereby the land surface mediates evaporation to the atmosphere and the precipitation that falls downwind, is increasingly well-understood. However, recent studies highlight a need to consider an important and often missing dimension - the social. Here, we explore the social dynamics of three case study countries with strong terrestrial moisture recycling: Mongolia, Niger, and Bolivia. We first use the WAM-2layers moisture tracking scheme and ERA-Interim climate reanalysis, to calculate the evaporation sources for each country's precipitation, a.k.a. the precipitationshed. Second, we examine the social aspects of source and sink regions, using economic, food security, and land-use data. Third, we perform a literature review of relevant economic links, land-use policies, and land-use change for each country and its evaporation sources. The moisture-recycling analysis reveals that Mongolia, Niger, and Bolivia recycle 13, 9, and 18% of their own moisture, respectively. Our analysis of social aspects suggests considerable heterogeneity in the social characteristics within each country relative to the societies in its corresponding evaporation sources. We synthesize our case studies and develop a set of three system archetypes that capture the core features of the moisturerecycling social-ecological systems (MRSESs): isolated, regional, and tele-coupled systems. Our key results are as follows: (a) geophysical tele-connections of atmospheric moisture are complemented by social tele-couplings forming feedback loops, and consequently, complex adaptive systems; (b) the heterogeneity of the social dynamics among our case studies renders broad generalization difficult and highlights the need for nuanced individual analysis; and, (c) there does not appear to be a single desirable or undesirable MRSES, with each archetype associated with benefits and disadvantages. This exploration of the social dimensions of moisture recycling is part of an extension of the emerging discipline of socio-hydrology and a suggestion for further exploration of new disciplines such as socio-meteorology or socio-climatology, within which the Earth system is considered as a coevolutionary social-ecological system.

Kim, Y., et al. (2015). "New satellite climate data records indicate strong coupling between recent frozen season changes and snow cover over high northern latitudes." Environmental Research Letters **10**(8).

We examined new satellite climate data records documenting frozen (FR) season and snow cover extent (SCE) changes from 1979 to 2011 over all northern vegetated land areas (>= 45 degrees N). New insight on the spatial and temporal characteristics of seasonal FR ground and snowpack melt changes were revealed by integrating the independent FR and SCE data records. Similar decreasing trends in annual FR and SCE durations coincided with widespread warming (0.4 degrees C decade(-1)). Relatively strong declines in FR and SCE durations in spring and summer are partially offset by increasing trends in fall and winter. These contrasting seasonal trends result in relatively weak decreasing trends in annual FR and SCE durations. A dominant SCE retreat response to FR duration decreases was observed, while the sign and strength of this relationship was spatially complex, varying by latitude and regional snow cover, and climate characteristics. The spatial extent of FR conditions exceeds SCE in early spring and is smaller during snowmelt in late spring and early summer, while FR ground in the absence of snow cover is widespread in the fall. The integrated satellite record, for the first time, reveals a general increasing trend in annual snowmelt duration from 1.3 to 3.3 days decade(-1) ($p < 0.01$), occurring largely in the fall. Annual FR ground durations are declining from 0.8 to 1.3 days decade(-1). These changes imply extensive biophysical impacts to regional snow cover, soil and permafrost regimes, surface water and energy budgets, and climate feedbacks, while ongoing satellite microwave missions provide an effective means for regional monitoring.

Kirschbaum, M. U. F. and A. M. S. McMillan (2018). "Warming and Elevated CO2 Have Opposing Influences on Transpiration. Which is more Important?" Current Forestry Reports **4**(2): 51-71.

Plant transpiration is a key component of the terrestrial water cycle, and it is important to understand whether rates are likely to increase or decrease in the future. Plant transpiration rates are affected by biophysical factors, such as air temperature, vapour pressure deficits and net radiation, and by plant factors, such as canopy leaf area and stomatal conductance. Under future climate change, global temperature increases, and associated increases in vapour pressure deficits, will act to increase canopy transpiration rates. Increasing atmospheric CO2 concentrations, however, is likely to lead to some reduction in stomatal conductance, which will reduce canopy transpiration rates. The objective of the present paper was to quantitatively compare the importance of these opposing driving forces. First, we reviewed the existing literature and list a large range of observations of the extent of decreasing stomatal conductance with increasing CO2 concentrations. We considered observations ranging from short-term laboratory-based experiments with plants grown under different CO2 concentrations to studies of plants exposed to the naturally increasing atmospheric CO2 concentrations. Using these empirical observations of plant responses, and a set of well-tested biophysical relationships, we then estimated the net effect of the opposing influences of warming and CO2 concentration on transpiration rates. As specific cases studies, we explored expected changes in greater detail for six specific representative locations, covering the range from tropical to boreal forests. For most locations investigated, we calculated reductions in daily transpiration rates over the twenty-first century that became stronger under higher atmospheric CO2 concentrations. It showed that the effect of CO2-induced reduction of stomatal conductance would have a stronger transpiration-depressing effect than the stimulatory effect of future warming. For currently cold regions, global warming would, however, lengthen the growing seasons so that annual sums of transpiration could increase in those regions despite reductions in daily transpiration rates over the summer months.

Kirthiga, S. M. and N. R. Patel (2018). "Impact of updating land surface data on micrometeorological weather simulations from the WRF model." Atmosfera **31**(2): 165-183.

Land surface processes play a critical role in governing the surface energy partitioning and the atmospheric circulation within a climate system. Improper representations of present land state, particularly spatially specific fields such as land cover, topographical and biophysical parameters contribute to the uncertainty in the model's weather simulations extending from local to regional scales. The present study investigates the impact of superior land surface datasets on the performance of the Weather Research and Forecasting (WRF) model in simulating micrometeorological/near-surface weather, particularly sensible variables such as temperature, relative humidity, solar radiation and wind speed. The hypothesis is that the updated land surface datasets would help in improving micrometeorological forecasts over the domain comprising of Punjab, Haryana and Uttarakhand states in India. A land use land cover (LULC) dataset derived from Advanced Wide Field Sensor (AWiFS); an elevation dataset from the Shuttle Radar Topography Mission (SRTM), and a Leaf Area Index (LAI) based on the Moderate Resolution Imaging Spectroradiometer (MODIS), are used in model initialization. Performance evaluation of the model's simulation is done for controlled (default) and modified land boundary conditions with in situ weather from a network of automatic weather stations (AWS) operated by the Indian Space Research Organization (ISRO). In the modified run, the model more closely captured the temporal evolution of surface level temperature, relative humidity, wind speed, surface pressure and solar radiation. Improvement in 24-hr forecast ranges from 15 to 30% for these near-surface weather variables. Further testing of the model's performance on its capability to forecast 8-day micrometeorological weather variables revealed that the modified run gave consistent results. The average RMSE values for minimum and maximum temperature, wind speed, relative humidity and precipitation are 2.5 and 3 degrees C, 2 m s(-1), 18% and 3.5 mm, respectively. The modification helped in increasing the lead-time of the model's forecast by reducing the propagation error. Thus, this study emphasizes the fact that improved representation of land surface parameters has a definite effect on weather simulations at local to regional scales. For a country like India, where the feedback mechanisms between land and atmosphere are more prominent due to inherent climatic characteristics, it is critical to concentrate and improve on the inputs that represent the initial land state.

Klein, J. A., et al. (2014). "Unexpected climate impacts on the Tibetan Plateau: Local and scientific knowledge in findings of delayed summer." Global Environmental Change-Human and Policy Dimensions **28**: 141-152.

Knowledge of climate change and its impacts can facilitate adaptation efforts. However, complex system dynamics, data scarcity, and heterogeneity often generate both contradictory findings and unexpected climate change impacts. Here we present local ecological knowledge of climate and ecological change in central Tibet to support the finding of delayed summer on the Tibetan Plateau, a finding that has been subject to vigorous, ongoing debate based on Western scientific data. Tibetans who actively herd on a daily basis and are located at higher elevations were most likely to notice changes in seasonality, reported as later start of summer and green-up, and as delayed and shortened livestock milking season. Local meteorological data, indigenous observations of higher snowlines and long-term animal number data suggest that a regional warming trend, rather than land use change, may underlie the delayed phenology trends. We demonstrate that local ecological knowledge can reveal counter-intuitive outcomes and help resolve apparent contradictions through its strengths in situations of high variability, ability to integrate over a range of variables and time scales, and operation outside of Western scientific logic. This suggests local knowledge does not exist to be confirmed or disproved by Western science, but rather can also advance Western science and help contribute to its debates. It is precisely points of apparent contradiction within and between knowledge systems that are most productive for more extensive inquiry. Future research on climate change, and climate adaptation policy-making, will benefit from careful, contextual dialog with local observations, focusing on observable biophysical phenomena that are affected by temperature and precipitation and that are important to livelihoods. (C) 2014 Elsevier Ltd. All rights reserved.

Klos, P. Z., et al. (2015). "Indicators of Climate Change in Idaho: An Assessment Framework for Coupling Biophysical Change and Social Perception." Weather Climate and Society **7**(3): 238-254.

Climate change is well documented at the global scale, but local and regional changes are not as well understood. Finer, local- to regional-scale information is needed for creating specific, place-based planning and adaption efforts. Here the development of an indicator-focused climate change assessment in Idaho is described. This interdisciplinary framework couples end users' data needs with observed, biophysical changes at local to regional scales. An online statewide survey of natural resource professionals was conducted to assess the perceived impacts from climate change and determine the biophysical data needed to measure those impacts. Changes to water resources and wildfire risk were the highest areas of concern among resource professionals. Guided by the survey results, 15 biophysical indicator datasets were summarized that included direct climate metrics (e.g., air temperature) and indicators only partially influenced by climate (e.g., wildfire). Quantitative changes in indicators were determined using time series analysis from 1975 to 2010. Indicators displayed trends of varying likelihood over the analysis period, including increasing growing-season length, increasing annual temperature, increasing forest area burned, changing mountain bluebird and lilac phenology, increasing precipitation intensity, earlier center of timing of streamflow, and decreased 1 April snowpack; changes in volumetric streamflow, salmon migration dates, and stream temperature displayed the least likelihood. A final conceptual framework derived from the social and biophysical data provides an interdisciplinary case example useful for consideration by others when choosing indicators at local to regional scales for climate change assessments.

Kurum, M., et al. (2012). "Impact of Conifer Forest Litter on Microwave Emission at L-Band." Ieee Transactions on Geoscience and Remote Sensing **50**(4): 1071-1084.

This study reports on the utilization of microwave modeling, together with ground truth, and L-band (1.4-

GHz) brightness temperatures to investigate the passive microwave characteristics of a conifer forest floor. The microwave data were acquired over a natural Virginia Pine forest in Maryland by a ground-based microwave active/passive instrument system in 2008/2009. Ground measurements of the tree biophysical parameters and forest floor characteristics were obtained during the field campaign. The test site consisted of medium-sized evergreen conifers with an average height of 12 m and average diameters at breast height of 12.6 cm. The site is a typical pine forest site in that there is a surface layer of loose debris/needles and an organic transition layer above the mineral soil. In an effort to characterize and model the impact of the surface litter layer, an experiment was conducted on a day with wet soil conditions, which involved removal of the surface litter layer from one half of the test site while keeping the other half undisturbed. The observations showed detectable decrease in emissivity for both polarizations after the surface litter layer was removed. A first-order radiative transfer model of the forest stands including the multilayer nature of the forest floor in conjunction with the ground truth data are used to compute forest emission. The model calculations reproduced the major features of the experimental data over the entire duration, which included the effects of surface litter and ground moisture content on overall emission. Both theory and experimental results confirm that the litter layer increases the observed canopy brightness temperature and obscure the soil emission.

Kustas, W. P., et al. (2016). "Revisiting the paper "Using radiometric surface temperature for surface energy flux estimation in Mediterranean drylands from a two-source perspective"." Remote Sensing of Environment **184**: 645-653.

The recent paper by Morillas et al. [Morillas, L et al. Using radiometric surface temperature for surface energy flux estimation in Mediterranean drylands from a two-source perspective, Remote Sens. Environ. 136, 234-246, 2013] evaluates the two-source model (TSM) of Norman et al. (1995) with revisions by Kustas and Norman (1999) over a semiarid tussock grassland site in southeastern Spain. The TSM - in its current incarnation, the two-source energy balance model (TSEB) - was applied to this landscape using ground-based infrared radiometer sensors to estimate both the composite surface radiometric temperature and component soil and canopy temperatures. Morillas et al. (2013) found the TSEB model substantially underestimated the sensible H (and overestimated the latent heat LE) fluxes. Using the same data set from Morillas et al. (2013), we were able to confirm their results. We also found energy transport and exchange behavior derived from primarily the observations themselves to differ significantly from a number of prior studies using land surface temperature for estimating heat fluxes with one-source modeling approaches in semi-arid landscapes. However, revisions to key vegetation inputs to TSEB and the soil resistance formulation resulted in a significant reduction in the bias and root mean square error (RMSE) between model output of H and LE and the measurements compared to the prior results from Morillas et al. (2013). These included more representative ground-based vegetation greenness and local leaf area index values as well as modifications to the coefficients of the soil resistance formulation to account for the very rough (rocky) soil surface conditions with a clumped canopy. This indicates that both limitations in remote estimates of biophysical indicators of the canopy at the site and the lack of adjustment in soil resistance formulation to account for site specific characteristics, contributed to the earlier findings of Morillas et al. (2013). This suggests further studies need to be conducted to reduce the uncertainties in the vegetation and land surface temperature input data in order to more accurately assess the effects of the transport exchange processes of this Mediterranean landscape on TSEB formulations. Published by Elsevier Inc.

Lannom, K. O., et al. (2014). "Defining extreme wildland fires using geospatial and ancillary metrics." International Journal of Wildland Fire **23**(3): 322-337.

There is a growing professional and public perception that extreme' wildland fires are becoming more common due to changing climatic conditions. This concern is heightened in the wildland-urban interface where social and ecological effects converge. Mega-fires', conflagrations', extreme' and catastrophic' are descriptors interchangeably used increasingly to describe fires in recent decades in the US and globally. It is necessary to have consistent, meaningful and quantitative metrics to define these perceived extreme' fires, given studies predict an increased frequency of large and intense wildfires in many ecosystems as a response to climate change. Using the Monitoring Trends in Burn Severity dataset, we identified both widespread fire years and individual fires as potentially extreme during the period 1984-2009 across a 91.2x10(6)-ha area in the north-western United States. The metrics included distributions of fire size, fire duration, burn severity and distance to the wildland-urban interface. Widespread fire years for the study region included 1988, 2000,

2006 and 2007. When considering the intersection of all four metrics using distributions at the 90th percentile, less than 1.5% of all fires were identified as potentially extreme fires. At the more stringent 95th and 99th percentiles, the percentage reduced to <0.5% and 0.05%. Correlations between area burnt and climatic measures (Palmer drought severity index, temperature, energy release component, duff moisture code and potential evapotranspiration) were observed. We discuss additional biophysical and social metrics that could be included and recommend both the need for enhanced visualisation approaches and to weigh the relative strength or importance of each metric.

Lantz, T. C., et al. (2010). "Spatial Heterogeneity in the Shrub Tundra Ecotone in the Mackenzie Delta Region, Northwest Territories: Implications for Arctic Environmental Change." Ecosystems **13**(2): 194-204.

Growing evidence suggests that plant communities in the Low Arctic are responding to recent increases in air temperature. Changes to vegetation, particularly shifts in the abundance of upright shrubs, can influence surface energy balance (albedo), sensible and latent heat flux (evapotranspiration), snow conditions, and the ground thermal regime. Understanding fine-scale variability in vegetation across the shrub tundra ecotone is therefore essential as a monitoring baseline. In this article, we use object-based classifications of airphotos to examine changes in vegetation characteristics (cover and patch size) across a latitudinal gradient in the Mackenzie Delta uplands. This area is frequently mapped as homogenous vegetation, but it exhibits fine-scale variability in cover and patch size. Our results show that the total area and size of individual patches of shrub tundra decrease with increasing latitude. The gradual nature of this transition and its correlation with latitudinal variation in temperature suggests that the position of the shrub ecotone will be sensitive to continued warming. The impacts of vegetation structure on ecological processes make improved understanding of this heterogeneity critical to biophysical models of Low Arctic ecosystems.

Latimer, C. E. and B. Zuckerberg (2017). "Forest fragmentation alters winter microclimates and microrefugia in human-modified landscapes." Ecography **40**(1): 158-170.

With over half of earth's terrestrial biota living beneath forest canopies, our ability to accurately capture organism-climate relationships in forested ecosystems is imperative for predicting species' vulnerability to future climate change. Assessing the vulnerability of forest dependent species, however, hinges on quantifying microclimates that exist below the forest canopy and might be influenced by varying levels of disturbance in human-modified landscapes. The goal of our study was to examine the multi-scaled predictors of subcanopy microclimate variability across a heterogeneous landscape in Midwestern USA during winter, and to further evaluate whether a widely available interpolated climate model accurately captures this variability. By deploying a network of temperature sensors along a fragmentation gradient, we found that forests in more fragmented landscapes with greater amounts of forest edge and increasing distances between forest patches, experienced colder minimum and average daily temperatures throughout the winter than forests in less fragmented landscapes. We found that greater tree densities and higher elevations led to warmer microclimates while increasing distances from urban centers led to colder microclimates. The negative effect of forest edge on minimum temperatures was lessened by the effect of increasing basal area, highlighting the importance of local-and landscape-scale features on microclimate heterogeneity. Temperature discrepancies between subcanopy microclimates and climate interpolations were influenced by many of the same features, and could be of a similar magnitude as those predicted by future climate change scenarios. Using a biological threshold based on metabolic and demographic constraints for winter birds, we found that the variability in microclimates along our forest fragmentation gradient (50 km) was comparable to the magnitude captured by weather stations across a latitudinal gradient spanning more than 650 km. Our results suggest that biophysical properties of landscapes can alter spatial gradients of microclimates and should be considered when assessing species' vulnerabilities to future climate change.

Launiainen, S., et al. (2015). "Coupling boreal forest CO_2, H_2O and energy flows by a vertically structured forest canopy - Soil model with separate bryophyte layer." Ecological Modelling **312**: 385-405.

A 1-dimensional multi-layer, multi-species soil-vegetation-atmosphere transfer model APES (Atmosphere-Plant Exchange Simulator) with a separate moss layer at the forest floor was developed and evaluated for a boreal Scots pine forest situated in Hyytiala, Southern Finland. The APES is based on biophysical principles for up-scaling CO_2, H_2O, heat and momentum exchange from canopy element level to a stand scale. The

functional descriptions of sub-models were parametrized by literature values, previous model approaches and leaf and moss gas exchange measurements, and stand structural characteristics derived from multi-scale measurements. The model was independently tested against eddy-covariance fluxes of CO2, H2O and sensible heat measured above and within the canopy, and against soil heat flux and temperature and moisture profiles. The model was shown to well reproduce fluxes and resulting scalar gradients at diurnal and seasonal timescales. Also predictions for moss moisture content and soil moisture and temperature dynamics were acceptable considering the heterogeneity in soil hydraulic and thermal properties and uncertainties in boundary conditions. The model framework allows for (1) coupling above-ground with the soil domains through the feed-backs between soil water and vegetation mediated by the moss layer, (2) several vascular plant species or cohorts in a multi-species canopy, and (3) explicit treatment of bryophyte layer energy and water balance and bottom layer atmosphere exchange. These features make APES well-suited for exploring feedbacks between boreal forest structure, site conditions and vegetation processes controlling ecosystem-atmosphere exchange. (C) 2015 Elsevier B.V. All rights reserved.

Lee, S. J. and E. H. Berbery (2012). "Land Cover Change Effects on the Climate of the La Plata Basin." Journal of Hydrometeorology **13**(1): 84-102.

Deforestation and replacement of natural pastures by agriculture have become a common practice in the La Plata River basin in South America. The changes in land cover imply changes in the biophysical properties of the land surface, with possible impacts on the basin's hydroclimate. To help understand to what extent the climate could be affected, and through which processes, ensembles of seasonal simulations were prepared using the Weather Research and Forecasting Model for a control case and a scenario assuming an expansion of the agricultural activities to cover the entire basin. The La Plata River basin shows different climate responses to the land cover changes depending on the region. The northern part of the basin, where forests and savanna were replaced by crops, experiences an overall increase in albedo that leads to a reduction of sensible heat flux and near-surface temperature. A reduction of surface roughness length leads to stronger low-level winds that, in turn, favor a larger amount of moisture being advected out of the northern part of the basin. The result is a reduction of the vertically integrated moisture flux convergence (VIMFC) and, consequently, in precipitation. In the southern part of the basin, changes from grasslands to crops reduce the albedo and thus increase the near-surface temperature. The reduction in surface roughness length is not as large as in the northern sector, reducing the northerly moisture fluxes and resulting in a net increase of VIMFC and, thus, in precipitation. Notably, advective processes modify the downstream circulation and precipitation patterns over the South Atlantic Ocean.

Lee, X., et al. (2011). "Observed increase in local cooling effect of deforestation at higher latitudes." Nature **479**(7373): 384-387.

Deforestation in mid-to high latitudes is hypothesized to have the potential to cool the Earth's surface by altering biophysical processes(1-3). In climate models of continental-scale land clearing, the cooling is triggered by increases in surface albedo and is reinforced by a land albedo-sea ice feedback(4,5). This feedback is crucial in the model predictions; without it other biophysical processes may overwhelm the albedo effect to generate warming instead(5). Ongoing land-use activities, such as land management for climate mitigation, are occurring at local scales (hectares) presumably too small to generate the feedback, and it is not known whether the intrinsic biophysical mechanism on its own can change the surface temperature in a consistent manner(6,7). Nor has the effect of deforestation on climate been demonstrated over large areas from direct observations. Here we show that surface air temperature is lower in open land than in nearby forested land. The effect is 0.85 +/- 0.44 K (mean +/- one standard deviation) northwards of 45 degrees N and 0.21 +/- 0.53 K southwards. Below 35 degrees N there is weak evidence that deforestation leads to warming. Results are based on comparisons of temperature at forested eddy covariance towers in the USA and Canada and, as a proxy for small areas of cleared land, nearby surface weather stations. Night-time temperature changes unrelated to changes in surface albedo are an important contributor to the overall cooling effect. The observed latitudinal dependence is consistent with theoretical expectation of changes in energy loss from convection and radiation across latitudes in both the daytime and night-time phase of the diurnal cycle, the latter of which remains uncertain in climate models(8).

Lejeune, Q., et al. (2017). "Historical Land-Cover Change Impacts on Climate: Comparative Assessment of LUCID and

CMIP5 Multimodel Experiments." Journal of Climate **30**(4): 1439-1459.

During the industrial period, many regions experienced a reduction in forest cover and an expansion of agricultural areas, in particular North America, northern Eurasia, and South Asia. Here, results from the Land-Use and Climate, Identification of Robust Impacts (LUCID) and CMIP5 model intercomparison projects are compared in order to investigate how land-cover changes (LCC) in these regions have locally impacted the biophysical land surface properties, like albedo and evapotranspiration, and how this has affected seasonal mean temperature as well as its diurnal cycle. The impact of LCC is extracted from climate simulations, including all historical forcings, using a method that is shown to capture well the sign and the seasonal cycle of the impacts diagnosed from single-forcing experiments in most cases. The model comparison reveals that both the LUCID and CMIP5 models agree on the albedo-induced reduction of mean winter temperatures over midlatitudes. In contrast, there is less agreement concerning the response of the latent heat flux and, subsequently, mean temperature during summer, when evaporative cooling plays a more important role. Overall, a majority of models exhibit a local warming effect of LCC during this season, contrasting with results from the LUCID studies. A striking result is that none of the analyzed models reproduce well the changes in the diurnal cycle identified in present-day observations of the effect of deforestation. However, overall the CMIP5 models better simulate the observed summer daytime warming effect compared to the LUCID models, as well as the winter nighttime cooling effect.

Li, J. X., et al. (2011). "Impacts of landscape structure on surface urban heat islands: A case study of Shanghai, China." Remote Sensing of Environment **115**(12): 3249-3263.

Urbanization is taking place at an unprecedented rate around the world, particularly in China in the past few decades. One of the key impacts of rapid urbanization on the environment is the effect of urban heat island (UHI). Understanding the effects of landscape pattern on UHI is crucial for improving the ecology and sustainability of cities. This study investigated how landscape composition and configuration would affect UHI in the Shanghai metropolitan region of China, based on the analysis of land surface temperature (LST) in relation to normalized difference vegetation index (NDVI), vegetation fraction (Fv), and percent impervious surface area (ISA). Two Landsat ETM+ images acquired on March 13 and July 2, 2001 were used to estimate LST. Fv, and percent ISA. Landscape metrics were calculated from a high spatial resolution (2.5 x 2.5 m) land-cover/land-use map. Our results have showed that, although there are significant variations in LST at a given fraction of vegetation or impervious surface on a per-pixel basis, NDVI, Fv, and percent ISA are all good predictors of LST on the regional scale. There is a strong negative linear relationship between LST and positive NDVI over the region. Similar but stronger negative linear relationship exists between LST and Fv. Urban vegetation could mitigate the surface UHI better in summer than in early spring. A strong positive relationship exists between mean LST and percent ISA. The residential land is the biggest contributor to UHL followed by industrial land. Although industrial land has the highest LST, it has limited contribution to the overall surface UHI due to its small spatial extend in Shanghai. Among the residential land-uses, areas with low- to-middle-rise buildings and low vegetation cover have much high temperatures than areas with high-rise buildings or areas with high vegetation cover. A strong correlation between the mean LST and landscape metrics indicates that urban landscape configuration also influences the surface UHI. These findings are helpful for understanding urban ecology as well as land use planning to minimize the potential environmental impacts of urbanization. (C) 2011 Elsevier Inc. All rights reserved.

Li, Q., et al. (2014). "An approach for assessing impact of land use and biophysical conditions across landscape on recharge rate and nitrogen loading of groundwater." Agriculture Ecosystems & Environment **196**: 114-124.

Assessing the impact of agricultural practices on groundwater quality is a must for environment management, however, such assessment is difficult because of dynamics of land use in interaction with topographic and climatic conditions. In this study, a multiple regression approach for assessing land use impact on groundwater quality and quantity was developed by using the ANCOVA test to select regression model variables from key input variables to a widely used and well-calibrated SWAT (Soil and Water Assessment Tool) model system. This approach can upscale model prediction for a small watershed with the calibrated SWAT model to a large watershed, generating spatial and temporal estimations of groundwater recharge and nitrate loading for the large watershed. It can also be used to evaluate the impacts of land use, soil types and climatic factors on water quality and quantity. Precipitation, air temperature, evapotranspiration, land use and soil types are determined as the most important factors for estimating monthly groundwater recharge rates and nitrate loading with the developed approach. Among various agricultural crops examined, potato is determined as the critical crop to have the highest impact on groundwater nitrate loading. The predictions of the groundwater monthly recharge multiple regression models developed in this study show good agreement with the SWAT model prediction (R-2 > 0.77). The monthly nitrate loading models perform a little bit poorly but still show reasonable agreement with the SWAT model with R-2 values > 0.60. Furthermore, the developed approach can be easily plugged into large-scale groundwater simulation models (e.g., MODFLOW) to address spatial variability of landscape characteristics in terms of non-point source pollution. (C) 2014 Elsevier B.V. All rights reserved.

Li, S. G., et al. (2006). "Energy partitioning and its biophysical controls above a grazing steppe in central Mongolia." Agricultural and Forest Meteorology **137**(1-2): 89-106.

The objective of this paper was to explore the seasonal development of how net all-wave radiation (R.) above a typical steppe in central Mongolia is partitioned into the three components: sensible heat (H), latent heat and soil heat (G) flux. Seasonal variability of this partitioning in association with biotic and abiotic variables was addressed in detail using the evaporative fraction of R-n (E-F) and the canopy surface conductance (g,), which was derived from an inversion of the Penman-Monteith equation. The surface energy partitioning of this steppe ecosystem showed the following characteristics: (1) H dominated the energy partitioning, followed by a relatively large G, although this pattern was temporally altered under conditions when the canopy surface was wet and the vegetation was fully developed; (2) the correlation of the energy partitioning with canopy development and soil moisture conditions explained up to 79% of the observed variance in EF and g,. Both factors exhibited linear correspondences to leaf area index (A(L)) or soil water content (theta); (3) the effect of atmospheric vapour pressure deficit (delta e) on g(c) (R-2 = 0.97) was curvilinear and strongly influenced the energy partitioning. Due to the limitation of water supply, both EF and gc decreased significantly with increasing delta e; (4) the effect of short-wave solar radiation (K-d) on E-F and g(c) depended strongly on soil moisture conditions. When soil moisture was high, EF still showed a decrease with increasing Kd while g, seemed insensitive to Kd; and (5) on the daily scale, close coupling of the canopy with the atmosphere was often observed in the afternoon as represented by the declining role played by g(c) in lambda E and E-F. However, on the seasonal scale, variations in E-F and g(c) closely followed the variation in A(L) and the precipitation events or the dry-wet cycles at the site. (c) 2006 Elsevier B.V. All rights reserved.

Li, S. Y., et al. (2012). "Spatial analysis of the driving factors of grassland degradation under conditions of climate change and intensive use in Inner Mongolia, China." Regional Environmental Change **12**(3): 461-474.

In recent years, steppe degradation in North China has become a serious environmental problem. Most research on steppe degradation is conducted at the level of communities or at the scale of small regions. To better understand the spatio-temporal variation and driving factors of grassland degradation, monitoring and analysis at broad regional scales are needed. This paper systematically describes the state and characteristics of steppe degradation at the Xilinhot plateau, makes an in-depth empirical analysis of the natural and man-made causes leading to degradation, and analyzes what driving factors have influenced degradation in this typical steppe region over the last 20 years. Ten biophysical and socio-economic variables, including altitude, slope, precipitation, temperature, soil conditions, distance to river, distance to highway, population density, sheep unit density, and fencing policy, were evaluated on their impact on observed patterns of degradation. The results indicate that all of these factors had a significant influence on the process of steppe degradation. During the first 10 years, from 1991 to 2000, steppe degradation increased, but after 2000, the degradation trend has, to some extent, reversed. The analysis indicates that the measures taken by the government, such as fencing vulnerable areas, played an important role in this change. The results advance the understanding of grassland degradation and contribute to constructing an empirical and theoretical base for grassland management and planning.

Li, Y., et al. (2016). "The role of spatial scale and background climate in the latitudinal temperature response to deforestation." Earth System Dynamics **7**(1): 167-181.

Previous modeling and empirical studies have shown that the biophysical impact of deforestation is to warm the tropics and cool the extratropics. In this study, we use an earth system model of intermediate complexity to investigate how deforestation on various spatial scales affects ground temperature, with an emphasis on the latitudinal temperature response and its underlying mechanisms. Results show that the latitudinal pattern of temperature response depends nonlinearly on the spatial extent of deforestation and the fraction of vegetation change. Compared with regional deforestation, temperature change in global deforestation is greatly amplified in temperate and boreal regions but is dampened in tropical regions. Incremental forest removal leads to increasingly larger cooling in temperate and boreal regions, while the temperature increase saturates in tropical regions. The latitudinal and spatial patterns of the temperature response are driven by two processes with competing temperature effects: decrease in absorbed shortwave radiation due to increased albedo and decrease in evapotranspiration. These changes in the surface energy balance reflect the importance of the background climate in modifying the deforestation impact. Shortwave radiation and precipitation have an intrinsic geographical distribution that constrains the effects of biophysical changes and therefore leads to temperature changes that are spatially varying. For example, wet (dry) climate favors larger (smaller) evapotranspiration change; thus, warming (cooling) is more likely to occur. Our analysis reveals that the latitudinal temperature change largely results from the climate conditions in which deforestation occurs and is less influenced by the magnitude of individual biophysical changes such as albedo, roughness, and evapotranspiration efficiency.

Li, Y., et al. (2015). "Local cooling and warming effects of forests based on satellite observations." Nature Communications **6**.

The biophysical effects of forests on climate have been extensively studied with climate models. However, models cannot accurately reproduce local climate effects due to their coarse spatial resolution and uncertainties, and field observations are valuable but often insufficient due to their limited coverage. Here we present new evidence acquired from global satellite data to analyse the biophysical effects of forests on local climate. Results show that tropical forests have a strong cooling effect throughout the year; temperate forests show moderate cooling in summer and moderate warming in winter with net cooling annually; and boreal forests have strong warming in winter and moderate cooling in summer with net warming annually. The spatiotemporal cooling or warming effects are mainly driven by the two competing biophysical effects, evapotranspiration and albedo, which in turn are strongly influenced by rainfall and snow. Implications of our satellite-based study could be useful for informing local forestry policies.

Liao, W. L., et al. (2018). "Attribution of Local Temperature Response to Deforestation." Journal of Geophysical Research-Biogeosciences **123**(5): 1572-1587.

Land use and land cover change such as deforestation can directly induce changes in land surface temperature (LST). Using observational data from four paired eddy covariance sites, we attribute changes in LST induced by deforestation to changes in radiation, aerodynamic resistance, the Bowen ratio or surface resistance, and heat storage using two different methods: the intrinsic biophysical mechanism (IBM) method and the two-resistance mechanism method. The two models are first optimized to reduce the root-mean-square error of the simulated daily LST change by using daily-averaged inputs and a weighted average approach for computing the sensitivities. Both methods indicate that the daytime warming effect of deforestation is mostly induced by changes in aerodynamic resistance as the surface becomes smoother after deforestation, and the nighttime cooling effect of deforestation is controlled by changes in aerodynamic resistance, surface resistance, radiation, and heat storage. Both methods also indicate that changes in atmospheric temperature have a large impact on LST and need to be included in the LST attribution. However, there are significant differences between the two methods. The IBM method tends to overestimate the contribution of aerodynamic resistance due to the assumption that aerodynamic resistance and the Bowen ratio are independent. Additionally, the IBM method underestimates the contributions of radiation and heat storage during the daytime but overestimates them at night. By highlighting the similarity and dissimilarity between the two methods, this study suggests that acceptable agreement between observed and modeled LST change is the prerequisite for attribution but does not guarantee correct attribution.

Liu, F. S., et al. (2017). "Influences of agricultural phenology dynamic on land surface biophysical process and climate feedback." Journal of Geographical Sciences **27**(9): 1085-1099.

Response and feedback of land surface process to climate change is one of the research priorities in the field of geoscience. The current study paid more attention to the impacts of global change on land surface process, but the feedback of land surface process to climate change has been poorly understood. It is becoming more and more meaningful under the framework of Earth system science to understand systematically the relationships between agricultural phenology dynamic and biophysical process, as well as the feedback on climate. In this paper, we summarized the research progress in this field, including the fact of agricultural phenology change, parameterization of phenology dynamic in land surface progress model, the influence of agricultural phenology dynamic on biophysical process, as well as its feedback on climate. The results showed that the agriculture phenophase, represented by the key phenological phases such as sowing, flowering and maturity, had shifted significantly due to the impacts of climate change and agronomic management. The digital expressions of land surface dynamic process, as well as the biophysical process and atmospheric process, were improved by coupling phenology dynamic in land surface model. The agricultural phenology dynamic had influenced net radiation, latent heat, sensible heat, albedo, temperature, precipitation, circulation, playing an important role in the surface energy partitioning and climate feedback. Considering the importance of agricultural phenology dynamic in land surface biophysical process and climate feedback, the following research priorities should be stressed: (1) the interactions between climate change and land surface phenology dynamic; (2) the relations between agricultural phenology dynamic and land surface reflectivity at different spectrums; (3) the contributions of crop physiology characteristic changes to land surface biophysical process; (4) the regional differences of climate feedbacks from phenology dynamic in different climate zones. This review is helpful to accelerate understanding of the role of agricultural phenology dynamic in land surface process and climate feedback.

Liu, J. Y., et al. (2016). "The climatic impacts of land use and land cover change compared among countries." Journal of Geographical Sciences **26**(7): 889-903.

Land use and land cover change (LULCC) strongly influence regional and global climate by combining both biochemical and biophysical processes. However, the biophysical process was often ignored, which may offset the biogeochemical effects, so measures to address climate change could not reach the target. Thus, the biophysical influence of LULCC is critical for understanding observed climate changes in the past and potential scenarios in the future. Therefore, it is necessary to identify the mechanisms and effects of large-scale LULCC on climate change through changing the underlying surface, and thus the energy balance. The key scientific issues on understanding the impacts of human activities on global climate that must be addressed including: (1) what are the basic scientific facts of spatial and temporal variations of LULCC in China and comparative countries? (2) How to understand the coupling driving mechanisms of human activities and climate change on the LULCC and then to forecasting the future scenarios? (3) What are the scientific mechanisms of LULCC impacts on biophysical processes of land surface, and then the climate? (4) How to estimate the contributions of LULCC to climate change by affecting biophysical processes of land surface? By international comparison, the impacts of LULCC on climate change at the local, regional and global scales were revealed and evaluated. It can provide theoretical basis for the global change, and have great significance to mitigate and adapt to global climate changes.

Liu, Z. H., et al. (2018). "Increases in Land Surface Temperature in Response to Fire in Siberian Boreal Forests and Their Attribution to Biophysical Processes." Geophysical Research Letters **45**(13): 6485-6494.

Wildfire is the most prevalent natural disturbance in boreal forests and impacts climate through biogeochemical (e.g., greenhouse gas emission from biomass burning) and biophysical (e.g., albedo [ET], evapotranspiration [ET], and roughness) processes. We used satellite observations to investigate the immediate (i.e., 1 year after fire) biophysical effects of fire in Siberian boreal forests. We found that boreal forest fires have a net annual warming effect (0.0728 to 0.325K) due to strong summer warming and weak winter cooling. Fires also increased the diurnal temperature range and seasonal amplitude. These effects are strongest in summer and significantly higher in evergreen than in deciduous coniferous forests. Decreases in ET contributed to warming effects in summer, and increases in contributed to cooling in winter. Our results suggest that the increase in observed land surface temperature immediately following fires in boreal ecosystems is most likely due to reduced ET leading to a strong positive feedback on the surface radiative budget. Plain Language Summary When wildfire burns forests, it affects local climate by changing the surface energy budget and distribution because of changes in albedo (alpha) and evapotranspiration (ET). Albedo (alpha) determines the solar energy absorbed by the land surface, with darker surfaces (e.g., forest) absorbing more energy than lighter surfaces (e.g., snow). ET is the energy used to release water from plant leaves and therefore cools the land surface. We used satellite observations to investigate how land surface temperature (LST) changes 1 year after wildfire and how this response relates to and ET in Siberian boreal forests. We found that burned forested areas have a higher annual LST and variability than adjacent unburned forested areas, as a result of strong summer warming and weak winter cooling. A strong decrease in summer ET is the main mechanism for the increase in LST in burned forests. Additionally, the LST response is different between boreal forest types. Our results suggest that boreal forest fires result in increased surface warming primarily due to decreases in evaporative cooling in summer.

Lopez, S., et al. (2017). "A hybrid-epistemological approach to climate change research: Linking scientific and smallholder knowledge systems in the Ecuadorian Andes." Anthropocene **17**: 30-45.

Effective responses to the impacts of climate change require the recognition that people conceptualize and experience environmental changes differently, and require the support of a range of global-to-local interdisciplinary efforts that allow a dialog between the biophysical and social sciences. In this study, we use a hybrid epistemological framework that integrates scientifc and local knowledge systems, methodological approaches, and geographic scopes to: 1) shed light on climate change in the equatorial Andes as reported by scientific and local knowledge systems, and 2) understand the role that climate factors play on land use and agricultural change in natural resource dependent communities in the region. We analyzed weather station (n = 5) data and downscaled climate data using parametric and non-parametric statistical tests, and spatial analysis techniques to detect spatio-temporal climate trends between 1965 and 2013. We also analyzed climate variability in the past four decades using qualitative information derived from a semi-structured survey (n = 36) and life history smallholder interviews (n = 8) collected in three research sites. Our study reveals significant warming trends in the region which is corroborated by local reports. Precipitation records show high inter-annual variability, with no significant decreasing or increasing trends, which contradicts people's views in two of our research sites. Our study shows that although climate change appears to be a factor that influences farmers' agricultural and livestock-production practices, other non-climatic forces play a more important role in determining their intensity and adoption. Despite site-level divergences and convergences, scientific and local knowledge systems can be woven together to expand our understanding of the physical and human manifestations of climate change. (C) 2017 Elsevier Ltd. All rights reserved.

Loran, C., et al. (2017). "Long-term change in drivers of forest cover expansion: an analysis for Switzerland (1850-2000)." Regional Environmental Change **17**(8): 2223-2235.

The spatial distribution of forests in Europe represents the legacy of centuries of human land use decisions. Due to the limited availability of historical data, most studies on forest cover change focus only on analyzing recent decades, thereby overlooking the important long-term context. However, the latter is essential to improve our understanding of present landscape patterns. This study quantifies the spatiotemporal dynamics in drivers of forest gain in Switzerland. Specifically, we model forest gain in a long-term study covering 150 years (1850-2000) split into periods of similar length (30 years). This makes it possible to identify non-linear dynamics and whether drivers have changed over time. The rates of forest change are quantified based on analyzing historical maps and contemporary forest inventory data. Generalized additive models (GAMs) are fitted to examine the variation in the relative importance of socioeconomic and biophysical explanatory variables. Our results suggest that both biophysical and socioeconomic variables co-drive forest gain. Biophysical variables (such as temperature and slope) were identified as the major drivers explaining variations in forest gain. The most important socioeconomic driver was the change in the percentage of people employed per economic sector, although its effect came with a substantial time lag. Changes in employment per sector for the periods 1920-1941 and 1941-1980 were relevant for forest gain between 1980 and 2000. The identified time lag effect emphasizes the added value of long-term studies, since legacies may persist for decades, adding further complexity to contemporary land change processes. These findings are relevant to many temperate ecosystems that are experiencing increases in forest cover. Such insights can improve both future forest change predictions as well as the development of policies for sustainable landscape management.

Lorenz, R., et al. (2016). "Does Amazonian deforestation cause global effects; can we be sure?" Journal of Geophysical Research-Atmospheres **121**(10): 5567-5584.

Does Amazonian deforestation cause global-scale teleconnections in the physical climate system? Some previous studies suggest that complete Amazon deforestation triggers global effects in temperature or precipitation, but other experiments did not find these remote effects. Some all-of-tropics deforestation experiments also found teleconnections, while others did not. Differences between these studies include scale of deforestation, strength of land-atmosphere coupling, and methods used for statistical testing. We examine how apparent teleconnections due to the biophysical impact of Amazonian deforestation vary with the scale of deforestation, how these teleconnections respond to the number of ensemble members, and which statistical methods effectively screen internal climate variability. We show that testing for field significance is crucial; no local statistical test can effectively screen all internal climate variability. The number of statistically significant grid points outside Amazonia does not scale with increased deforestation for most seasons, and we only find field significance for the largest perturbation. Hence, in our simulations we only find statistically significant remote effects from Amazonian deforestation for very large and unrealistic perturbations, but we would have found apparently significant changes for small perturbations had we not used multiple ensembles and field significance testing.

Lu, X. L., et al. (2018). "Potential of solar-induced chlorophyll fluorescence to estimate transpiration in a temperate forest." Agricultural and Forest Meteorology **252**: 75-+.

By utilizing continuous measurements of water fluxes and solar-induced chlorophyll fluorescence (SIF) over the entire growing season, we exploit the potential of broadband SIF in predicting plant transpiration (T) in a temperate forest. After reconstructing the full SIF spectrum from the selected absorption lines and simulations from the SCOPE (Soil Canopy Observation Photochemistry and Energy fluxes) model, linear regression (LR) and Gaussian processes regression (GPR) models are used to analyze the relation between T and combinations of different SIF bands. We find that SIF emissions in the near-infrared spectrum (at 720 nm, 740 nm and 760 nm) are more sensitive to T than SIF emissions in the red spectrum (at 685 nm and 687 nm). While conditions such as light and heat stress decouple the relationship between single-band SIF and T, the combination of different SIF bands allows the retrieval of reliable T estimates even in these conditions. Overall, we find that the use of SIF as a proxy for T yields estimates that are at least as accurate as those from traditional transpiration models such as the Penman-Monteith equation, which are input demanding and complex to apply to in situ and satellite data. Specifically, we find that (1) the SIF-T relationship deteriorates when Photosynthetically Active Radiation (PAR), vapor pressure deficit and air temperature exceed biological optimal thresholds; (2) a high leaf area index exerts a negative impact on the SIF-T correlation due to increasing scattering and (re)absorption of the SIF signal; (3) the SIF-T relationship does not change depending on the observation time during the day; and (4) temporal aggregation to days further enhanced the SIF-T correlations. Altogether, our results provide the first ground based evidence that SIF emission has potential to be a close predictor of plant transpiration, especially when a combination of different SIF bands is considered.

Lutz, D. A., et al. (2013). "Boreal forest sensitivity to increased temperatures at multiple successional stages." Annals of Forest Science **70**(3): 299-308.

Rising temperatures may force boreal forests in central Siberia to transition to alternative ecological states, affecting species composition and carbon storage dynamics. A full understanding of how forests of different ages respond to warming remains elusive, despite being fundamental for proper forest management in the region. To document the sensitivity of Siberian forests of different successional stages to rising temperatures. We use the FAREAST forest gap model to investigate the variation in biophysical response of boreal forests of different stand ages as temperatures rise and question whether there is varying sensitivity at different successional states. Our model predicts that mid-successional forests are more resistant to warming temperatures in low-level warming scenarios and resist biophysical changes more so than forests over 200 years old. This response diminished in more intense warming scenarios. Specifically, forest biomass increased with temperature; however, dieback of Siberian larch and replacement by Siberian Silver birch and by Siberian pine in early-successional stands yielded a net decrease in carbon storage. Mid-succession and old growth forests did not transition to pine forests, however, and may serve as a location for refugia of northern boreal species.

Luyssaert, S., et al. (2014). "Land management and land-cover change have impacts of similar magnitude on surface temperature." Nature Climate Change **4**(5): 389-393.

Anthropogenic changes to land cover (LCC) remain common, but continuing land scarcity promotes the widespread intensification of land management changes (LMC) to better satisfy societal demand for food, fibre, fuel and shelter(1). The biophysical effects of LCC on surface climate are largely understood(2-5), particularly for the boreal(6) and tropical zones(7), but fewer studies have investigated the biophysical consequences of LMC; that is, anthropogenic modification without a change in land cover type. Harmonized analysis of ground measurements and remote sensing observations of both LCC and LMC revealed that, in the temperate zone, potential surface cooling from increased albedo is typically offset by warming from decreased sensible heat fluxes, with the net effect being a warming of the surface. Temperature changes from LMC and LCC were of the same magnitude, and averaged 2 K at the vegetation surface and were estimated at 1.7 K in the planetary boundary layer. Given the spatial extent of land management (42-58% of the land surface) this calls for increasing the efforts to integrate land management in Earth System Science to better take into account the human impact on the climate(8).

Ma, H. Y., et al. (2013). "On the Connection between Continental-Scale Land Surface Processes and the Tropical Climate in a Coupled Ocean-Atmosphere-Land System." Journal of Climate **26**(22): 9006-9025.

An evaluation is presented of the impact on tropical climate of continental-scale perturbations given by different representations of land surface processes (LSPs) in a general circulation model that includes atmosphere-ocean interactions. One representation is a simple land scheme, which specifies climatological albedos and soil moisture availability. The other representation is the more comprehensive Simplified Simple Biosphere Model, which allows for interactive soil moisture and vegetation biophysical processes.The results demonstrate that such perturbations have strong impacts on the seasonal mean states and seasonal cycles of global precipitation, clouds, and surface air temperature. The impact is especially significant over the tropical Pacific Ocean. To explore the mechanisms for such impact, model experiments are performed with different LSP representations confined to selected continental-scale regions where strong interactions of climate-vegetation biophysical processes are present. The largest impact found over the tropical Pacific is mainly from perturbations in the tropical African continent where convective heating anomalies associated with perturbed surface heat fluxes trigger global teleconnections through equatorial wave dynamics. In the equatorial Pacific, the remote impacts of the convection anomalies are further enhanced by strong air-sea coupling between surface wind stress and upwelling, as well as by the effects of ocean memory. LSP perturbations over South America and Asia-Australia have much weaker global impacts. The results further suggest that correct representations of LSP, land use change, and associated changes in the deep convection over tropical Africa are crucial to reducing the uncertainty of future climate projections with global climate models under various climate change scenarios.

Ma, N., et al. (2015). "Environmental and biophysical controls on the evapotranspiration over the highest alpine steppe." Journal of Hydrology **529**: 980-992.

Characterizing the water and energy flux in the alpine steppe ecosystem in Tibetan Plateau (TP) is of particular importance for elucidating hydrological cycle mechanisms in high altitude areas. In the present study, two years of actual evapotranspiration (ET) values from a semi-arid alpine steppe region (4947 m above sea level) and their environmental and biophysical controls were investigated using the energy balance Bowen ratio energy balance (BREB) method. Seasonally, ET was much lower in frozen soil period and transition period mainly because of low soil water availability. However, ample soil water supplied by rainfall during the rainy period substantially increased ET. The available energy played an important role in controlling ET in the rainy period. Also, the leaf-level stomata closure and plant leaf development could impact the ET through changing bulk surface conductance (G(s)) in rainy period. Similarly, the land-atmosphere energy exchange was dominated by latent heat flux (lambda E) in July, but was dominated by sensible heat flux (H) in December and May. Annual ET (plus sublimation) were 362.9 mm and 353.4 mm in the first and second observation year, respectively, which were close to the annual precipitation. On annual scale, the low G(s) (3.30-3.62 mm s(-1)), decoupling factor (Omega, 0.25-0.27) and the ratio of ET to equilibrium evapotranspiration (ET/ETeq, 0.34-0.35) corroborated the overall water-limited conditions for the high-altitude alpine steppe. This research provides not only the ground truth data for future hydrological modeling in the data scarce region of TP but also the insights for elucidating how the environmental and biophysical stress factors control the land surface ET in high-altitude region. (C) 2015 Elsevier B.V. All rights

Ma, S. Y., et al. (2005). "Biophysical controls on soil respiration in the dominant patch types of an old-growth, mixed-conifer forest." Forest Science **51**(3): 221-232.

Little is known about biophysical controls on soil respiration in California's Sierra Nevada old-growth, mixed-conifer forests. Using portable and automated soil respiration sampling units, we measured soil respiration rate (SRR) in three dominant patch types: closed canopy (CC), ceanothus-dominated patches (CECO), and open canopy (OC). SRR varied significantly among the patch types, ranging from 2.0 to 4.5 mu mol m(-2) s(-1) and from 0.9 to 2.9 mu mol m(-2) s(-1) during the 1999 and 2000 measuring periods, respectively, with the maximum in CECO and the minimum in OC. Multiple peaks of seasonal SRR were functions of soil temperature and moisture dynamics. The relationship between SRR and soil temperature switched from a positive to a negative correlation when soil moisture dropped from saturation to drought. Time lag, as a function of soil moisture, was included in an exponential model to assess the effects of soil moisture on SRR in this seasonal water-stressed ecosystem. The total soil C flux summed by an area-weighted average across all three patch types was 660 +/- 163 g C m(-2) from May to Oct. 2000. These results may be applicable to other water-stressed forests in the Mediterranean climate zone, and have implications for the conservation of soil carbon.

Ma, W., et al. (2017). "Multiple satellite-based analysis reveals complex climate effects of temperate forests and related energy budget." Journal of Geophysical Research-Atmospheres **122**(7): 3806-3820.

Forest conversion-driven biophysical processes have been examined in various case studies that largely depend on sensitivity analysis of climate modeling. However, much remains unknown in the real world due to the complicated process and uncertainty in magnitude, especially in the temperate bioclimate regions. This study applied satellite-based observation to investigate the biophysical climate response to potential forest conversion in China, especially on the spatial and temporal patterns and underlying mechanisms. We evaluated the differences of land surface temperature (LST) between adjacent forest and cropland, in terms of the latitudinal and seasonal patterns. Compared to cropland, the temperate forest to the south of 40 degrees N showed the cooling effect of -0.610.02 degrees C (95% confidence interval, and hereafter), and it presented the warming effect of 0.480.06 degrees C to the north of 48 degrees N (the transition zone was between 40 degrees N and 48 degrees N). Seasonal analysis further demonstrated that the cooling effects of temperate forest in China in spring (March, April, May), summer (June, July, August), and autumn (September, October, November) were -0.530.02 degrees C, -0.550.02 degrees C, and -0.30 +/- 0.02 degrees C, respectively, while the forest caused the warming effect of 0.10 +/- 0.04 degrees C in winter (December, January, February). However, the biophysical climate response to forest conversion in temperate regions was complex and showed highly spatial and temporal heterogeneity. We further assessed the role of two major biophysical processes, i.e., albedo and evapotranspiration (ET), in shaping land surface temperature from surface energy budget perspective. Results showed that the latitudinal, seasonal, and spatiotemporal patterns of LST was determined by the net effect of ET-induced latent heat changes and albedo-induced solar radiation absorption changes.

Ma, Y., et al. (2010). "Coupling urbanization analyses for studying urban thermal environment and its interplay with biophysical parameters based on TM/ETM plus imagery." International Journal of Applied Earth Observation and Geoinformation **12**(2): 110-118.

Studies of urbanization and urban thermal environment are now attracting wide interests among scientists all over the world. This study investigated the influences of urbanization on urban thermal environment as well as the relationships of thermal characteristics to other biophysical variables in Guangzhou, China utilizing three dates of Landsat TM/ETM+ images acquired in 1990, 2000, and 2005, respectively. Vegetation abundances and percent impervious surfaces were derived by means of linear spectral mixture model, and a method for effectively enhancing impervious surface has been developed to accurately examine the urban enlargement. As a key parameter for studying urban thermal characteristics, the land surface temperature (LST) was also retrieved from thermal infrared band of each TM/ETM+ dataset. Based on these parameters, the urban expansion, urban heat island effect and the relationships of LSTs to other biophysical parameters were then analyzed. Results indicated that the area ratio of impervious surface in Guangzhou increased significantly, which grew from 20.56% in 1990, to 34.72% in 2000, and further to 41.12% in 2005, however,

the intensity of urban heat island was not always enlarged in observed years. In addition, Geostatistical analyses showed that the mean-centre of the impervious surface was moving towards the northwest during 1990-2005. And correlation analyses revealed that, at the pixel-scale, the association of LSTs to other two variables (vegetation abundance and percent impervious surface) was not straightforward, while LSTs possessed a strong positive correlation with percent impervious surfaces and negative correlation with vegetation abundances at the regional-scale, respectively. This study provided an integrated research scheme and the findings can be very useful for urban ecosystem modeling. (C) 2009 Elsevier B.V. All rights reserved.

Magagi, R. D., et al. (2000). "Results of combining L- and C-band passive microwave airborne data over the sahelian area." Ieee Transactions on Geoscience and Remote Sensing **38**(4): 1997-2008.

This study focuses on an area in the Sahelian zone, Niger, Western Africa, where the HAPEX-Sahel experiment took place in 1992, During the hydrologic atmospheric pilot experiment in the Sahel (HAPEX-Sahel), passive microwave data were acquired with airborne radiometer, the multifrequency (5 to 90 GHz) and dual polarization sensor, PORTOS, and the four-beam sensor push broom microwave radiometer (PBMR), operating at 1.4 GHz in H-polarization, The aim of this investigation is to monitor soil moisture and vegetation parameters by combining Land C-Band passive microwave airborne measurements. Through the relationships between soil moisture measurements from the 2 cm and 0.5 cm top layers, soil moisture; is estimated for PORTOS data using the estimated soil moisture along the transects covered by the PBMR flights. The simplified radiative transfer model is then used to extract the optical thickness and the single scattering albedo of vegetation at C-Band, and to evaluate the vegetation effect on the estimated soil moisture at L-Band, An attempt to relate the estimated optical thickness from PORTOS data to the measured vegetation biophysical parameters water content, biomass, leaf area index (LAI)I is presented.

Mallick, K., et al. (2016). "Canopy-scale biophysical controls of transpiration and evaporation in the Amazon Basin." Hydrology and Earth System Sciences **20**(10): 4237-4264.

Canopy and aerodynamic conductances (g(C) and g(A)) are two of the key land surface biophysical variables that control the land surface response of land surface schemes in climate models. Their representation is crucial for predicting transpiration (lambda E-T) and evaporation (lambda E-E) flux components of the terrestrial latent heat flux (lambda E), which has important implications for global climate change and water resource management. By physical integration of radiometric surface temperature (T-R) into an integrated framework of the Penman-Monteith and Shuttleworth-Wallace models, we present a novel approach to directly quantify the canopy-scale biophysical controls on lambda E-T and lambda E-E over multiple plant functional types (PFTs) in the Amazon Basin. Combining data from six LBA (Large-scale Biosphere-Atmosphere Experiment in Amazonia) eddy covariance tower sites and a T-R-driven physically based modeling approach, we identified the canopy-scale feedback-response mechanism between g(C), lambda E-T, and atmospheric vapor pressure deficit (D-A), without using any leaf-scale empirical parameterizations for the modeling. The T-R-based model shows minor biophysical control on lambda E-T during the wet (rainy) seasons where lambda E-T becomes predominantly radiation driven and net radiation (RN) determines 75 to 80% of the variances of lambda E-T. However, biophysical control on lambda E-T is dramatically increased during the dry seasons, and particularly the 2005 drought year, explaining 50 to 65% of the variances of lambda E-T, and indicates lambda E-T to be substantially soil moisture driven during the rainfall deficit phase. Despite substantial differences in g(A) between forests and pastures, very similar canopy-atmosphere "coupling" was found in these two biomes due to soil moistureinduced decrease in g(C) in the pasture. This revealed the pragmatic aspect of the T-R-driven model behavior that exhibits a high sensitivity of g(C) to per unit change in wetness as opposed to g(A) that is marginally sensitive to surface wetness variability. Our results reveal the occurrence of a significant hysteresis between lambda E-T and g(C) during the dry season for the pasture sites, which is attributed to relatively low soil water availability as compared to the rainforests, likely due to differences in rooting depth between the two systems. Evaporation was significantly influenced by g(A) for all the PFTs and across all wetness conditions. Our analytical framework logically captures the responses of g(C) and g(A) to changes in atmospheric radiation, D-A, and surface radiometric temperature, and thus appears to be promising for the improvement of existing land-surface-atmosphere exchange parameterizations across a range of spatial scales.

Mantel, S., et al. (2000). "Exploring biophysical potential and sustainability of wheat cultivation in Uruguay at the national level." Soil Use and Management **16**(4): 270-278.

A methodology is presented that explores soil survey information at the national level (1:1 M), generating sustainability indicators for wheat cultivation in Uruguay Potential yields were calculated for simplified crop production situations under several constraints, such as limitation of water availability calculated from soil physical properties and climatic conditions, and limitation of nutrient availability calculated from soil fertility and climatic conditions. Land quality sufficiency was examined by comparing these yields with the constraint-free yield conditioned only by solar radiation, temperature and the crop's photosynthetic properties. Crop growth was simulated only for areas suitable for the defined agricultural use. Model runs were repeated with inclusion of a topsoil loss scenario over 20 rears as defined from an erosion risk analysis. Comparison between crop growth simulations for the two situations, gives an indication of the changes in land quality status, which supplies an indicator for agroecological sustainability. On the basis of crop growth simulation it is concluded that wheat production constraints in Uruguay appear to be mainly related to water availability limitations, while nutrient availability is near optimal for the suitable soils. The simulated loss of topsoil impacts most on soil physical properties, expressed in reduced water-limited yields. Soil fertility status, evaluated bq change in nutrient-limited yields,was little affected by the scenario.

Marchesini, V. A., et al. (2015). "Changes in evapotranspiration and phenology as consequences of shrub removal in dry forests of central Argentina." Ecohydrology **8**(7): 1304-1311.

More than half of the dry woodlands (forests and shrublands) of the world are in South America, mainly in Brazil and Argentina, where in the last years intense land use changes have occurred. This study evaluated how the transition from woody-dominated to grass-dominated system affected key ecohydrological variables and biophysical processes over 20000ha of dry forest in central Argentina. We used a simplified surface energy balance model together with moderate-resolution imaging spectroradiometer-normalized difference vegetation index data to analyse changes in above primary productivity, phenology, actual evapotranspiration, albedo and land surface temperature for four complete growing seasons (2004-2009). The removal of woody vegetation decreased aboveground primary productivity by 15-21%, with an effect that lasted at least 4years, shortened the growing season between 1 and 3months and reduced evapotranspiration by as much as 30%. Albedo and land surface temperature increased significantly after the woody to grassland conversion. Our findings highlight the role of woody vegetation in regulating water dynamics and ecosystem phenology and show how changes in vegetative cover can influence regional climatic change. Copyright (c) 2014 John Wiley & Sons, Ltd.

Marcos-Martinez, R., et al. (2017). "Agricultural land-use dynamics: Assessing the relative importance of socioeconomic and biophysical drivers for more targeted policy." Land Use Policy **63**: 53-66.

A detailed understanding of multiple human and environmental factors influencing land allocations among agricultural uses can facilitate more efficient and targeted land policy. To show this, we used a comprehensive dataset of socioeconomic, physiographic, and climatic indicators to investigate potential determinants of land-use in Australia's intensive agricultural region during the period 1992-2010. We applied a seemingly unrelated regressions land-use shares spatial error model with random effects coupled with variance decomposition analysis to identify the statistical significance, direction and magnitude of observed associations between land-use and its drivers. Population: density, rainfall, equity ratio, and access to markets were the most influential policy relevant land-use factors. Land allocations to cereals and livestock production were significantly influenced by spatiotemporal rainfall and temperature variability. Improved pastures, cereals, annual and perennial crops plantations were larger in regions with better access to markets. Increases in equity ratio (i.e., better financial position) were associated with larger land allocations to improved pastures and annual crops and smaller extensive grazing area. Marginal associations were detected between land-use and output prices, and higher population density was associated with lower shares for all high value agricultural land-uses. The results suggest that improved transportation infrastructure, zoning regulations, and mechanisms to reduce farm debt exposure and risks from climate variability could have significant impact on the configuration of the Australian agricultural landscape. Crown Copyright (C) 2017 Published by Elsevier Ltd. All rights reserved.

Marcot, B. G., et al. (2015). "Projected changes in wildlife habitats in Arctic natural areas of northwest Alaska." Climatic

Change **130**(2): 145-154.

We project the effects of transitional changes among 60 vegetation and other land cover types ("ecotypes") in northwest Alaska over the 21st century on habitats of 162 bird and 39 mammal species known or expected to occur regularly in the region. This analysis, encompassing a broad suite of arctic and boreal wildlife species, entailed building wildlife-habitat matrices denoting levels of use of each ecotype by each species, and projecting habitat changes under historic and expected accelerated future rates of change from increasing mean annual air temperature based on the average of 5 global climate models under the A1B emissions scenario, and from potential influence of a set of 23 biophysical drivers. Under historic rates of change, we project that 52 % of the 201 species will experience an increase in medium- and high-use habitats, 3 % no change, and 45 % a decrease, and that a greater proportion of mammal species (62 %) will experience habitat declines than will bird species (50 %). Outcomes become more dire (more species showing habitat loss) under projections made from effects of biophysical drivers and especially from increasing temperature, although species generally associated with increasing shrub and tree ecotypes will likely increase in distribution. Changes in wildlife habitats likely will also affect trophic cascades, ecosystem function, and ecosystem services; of particular significance are the projected declines in habitats of most small mammals that form the prey base for mesocarnivores and raptors, and habitat declines in 25 of the 50 bird and mammal species used for subsistence hunting and trapping.

Martin, J. G., et al. (2012). "High-frequency analysis of the complex linkage between soil CO2 fluxes, photosynthesis and environmental variables." Tree Physiology **32**(1): 49-64.

High-frequency soil CO2 flux data are valuable for providing new insights into the processes of soil CO2 production. A record of hourly soil CO2 fluxes from a semi-arid ponderosa pine stand was spatially and temporally deconstructed in attempts to determine if variation could be explained by logical drivers using (i) CO2 production depths, (ii) relationships and lags between fluxes and soil temperatures, or (iii) the role of canopy assimilation in soil CO2 flux variation. Relationships between temperature and soil fluxes were difficult to establish at the hourly scale because diel cycles of soil fluxes varied seasonally, with the peak of flux rates occurring later in the day as soil water content decreased. Using a simple heat transport/gas diffusion model to estimate the time and depth of CO2 flux production, we determined that the variation in diel soil CO2 flux patterns could not be explained by changes in diffusion rates or production from deeper soil profiles. We tested for the effect of gross ecosystem productivity (GEP) by minimizing soil flux covariance with temperature and moisture using only data from discrete bins of environmental conditions (+/- 1 degrees C soil temperature at multiple depths, precipitation-free periods and stable soil moisture). Gross ecosystem productivity was identified as a possible driver of variability at the hourly scale during the growing season, with multiple lags between similar to 5, 15 and 23 days. Additionally, the chamber-specific lags between GEP and soil CO2 fluxes appeared to relate to combined path length for carbon flow (top of tree to chamber center). In this sparse and heterogeneous forested system, the potential link between CO2 assimilation and soil CO2 flux may be quite variable both temporally and spatially. For model applications, it is important to note that soil CO2 fluxes are influenced by many biophysical factors, which may confound or obscure relationships with logical environmental drivers and act at multiple temporal and spatial scales; therefore, caution is needed when attributing soil CO2 fluxes to covariates like temperature, moisture and GEP.

Martin, K. L., et al. (2017). "Watershed impacts of climate and land use changes depend on magnitude and land use context." Ecohydrology **10**(7).

Human population growth and urban development are affecting climate, land use, and the ecosystem services provided to society, including the supply of freshwater. We investigated the effects of land use and climate change on water resources in the Yadkin-Pee Dee River Basin of North Carolina, United States. Current and projected land uses were modeled at high resolution for three watersheds representing a forested to urban land use gradient by melding the National Land Cover Dataset with data from the U.S. Forest Service Forest Inventory and Analysis. Forecasts for 2051-2060 of regional land use and climate for scenarios of low (B2) and moderately high (A1B) rates of change, coupled with multiple global circulation models (MIROC, CSIRO, and Hadley), were used to inform a distributed ecohydrological model. Our results identified increases in water yields across the study watersheds, primarily due to forecasts of increased precipitation. Climate change was a more dominant factor for future water yield relative to land use change

across all land uses (forested, urban, and mixed). When land use change was high (27% of forested land use was converted to urban development), it amplified the impacts of climate change on both the magnitude and timing of water yield. Our fine-scale (30-m) distributed combined modeling approach of land use and climate change identified changes in watershed hydrology at scales relevant for management, emphasizing the need for modeling efforts that integrate the effects of biophysical (climate) and social economic (land use) changes on the projection of future water resource scenarios.

Martin, R. E. and G. P. Asner (2005). "Regional estimate of nitric oxide emissions following woody encroachment: Linking imaging spectroscopy and field studies." Ecosystems **8**(1): 33-47.

Woody encroachment, a spatially explicit process of land-cover change, is known to affect the biophysical and biogeochemical properties of ecosystems. However, little information is available on the impacts of woody encroachment on N oxide emissions from savanna regions. We combined hyperspectral remote sensing and field measurements to quantify spatial patterns and estimate regional fluxes of soil N oxide emissions as they covary with vegetation cover and soil type across a semiarid rangeland in north Texas. Soil nitric oxide (NO) emissions were highly correlated with Prosopis canopy cover, allowing the extrapolation of NO fluxes from hyperspectral observations of woody cover. NO emissions were highly variable, ranging from 0 to 550 kg NO-N km(-2) y(-1) across the region, with the lowest emissions from shallow clay soils and highest from deeper upland clay loams. An estimate of annual NO emissions based on remotely derived Prosopis cover, temperature, and precipitation was 160 kg NO-N km(-2) y(-1), almost twice that of the value derived from traditional averaging of field measurements. We conclude that relationships between NO emissions and remotely sensed structure and composition are advantageous for quantifying NO emissions at the regional scale. This study also provides new insight into the role of woody encroachment on biogeochemical processes that are highly variable and otherwise difficult to measure at the regional scale.

Martin, R. E., et al. (2003). "Effects of woody vegetation encroachment on soil nitrogen oxide emissions in a temperate savanna." Ecological Applications **13**(4): 897-910.

Woody vegetation has encroached into areas once dominated by herbaceous land cover in and and semiarid regions of the southwestern United States and around the world, resulting in documented changes to the biophysical and biogeochemical structure of these ecosystems during the past century. In North Texas rangelands, encroaching mesquite (Prosopis glandulosa var. glandulosa), a known nitrogen (N)-fixing species, has caused changes in aboveground biomass, which, in turn, have influenced carbon (C) and N storage in surface soils. However, the effect on N oxide (nitric-NO and nitrous-N(2)O oxide) emissions from the soils was unknown. We examined biotic (vegetation type and soil organic and inorganic N dynamics) and abiotic (soil moisture, temperature, and soil texture) controls over soil NO and N(2)O emissions across a gradient of aboveground Prosopis biomass growing on two soil types. Soil N oxide fluxes were dominated by NO emissions produced during nitrification. Aboveground biomass was the best spatial, predictor of NO emissions, with values increasing 20-fold (0.04-0.78 mg NO-N.m(-2).d(-1)) across a 70-fold biomass gradient (5-350 g/m(2)). Emissions also covaried with soil pH and clay content. Microsite position, under or between the mesquite canopies, did not influence NO emission rates. NO fluxes were four times higher from clay loam than from shallow clay soils; however, soil N properties (total organic N and extractable inorganic N) and cycling rates (mineralization and nitrification). did not differ significantly across the sites. Temporally, NO emissions and nitrification potential were positively correlated with temperature, with precipitation events elevating NO emissions fourfold over a 24-h period and producing small amounts of N(2)O, We conclude that mesquite encroachment in these grasslands increases NO emissions in a spatially explicit manner influenced by the Aboveground biomass and soil type, which is then temporally mediated primarily by temperature and secondarily by precipitation.

Marty, C., et al. (2015). "Variation in stocks and distribution of organic C in soils across 21 eastern Canadian temperate and boreal forests." Forest Ecology and Management **345**: 29-38.

Quantifying soil organic carbon (SOC) stocks in forests and identifying the factors that control their size is crucial to predict how they will be affected by climate and land-use changes. Here, we assessed variations in SOC stocks in the forest floor (FF) and the mineral soil of 21 temperate and boreal forest sites in Quebec, and analyzed their relationships with 13 biophysical variables. Across the studied area soil C stocks ranged from 9.2 kg m(-2) to 27.8 kg m(-2) with on average 78% of this C located in the mineral horizons. Carbon stocks in the FF increased with Mean Annual Precipitation (MAP) and the Percentage of Conifers (Pc), and decreased with Mean Annual Air Temperature (MAAT). Total and mineral soil carbon stocks increased with MAP but were poorly correlated with the other variables mainly because of the high variability in C concentration in B-horizons and mineral soil thickness. When the latter was restricted to 50 cm, the explanatory power of the statistical model for total soil C stock shifted from 34% to 49%, illustrating the impact of soil sampling thickness on C stocks estimates and on the ability to predict them. Regression analyses showed that SOC stocks were mainly controlled by MAP. The depth at which 50% of the mineral soil C stock is reached (1350) was used as an index for the distribution of SOC across the soil profile. The 1350 values ranged from similar to 2 cm to similar to 40 cm and increased with altitude and Pc, and conversely decreased with the percentage of hardwoods and MAAT. In light of the recent findings on the origin of C stabilization in soils, these results suggest that these impacts on SOC distribution might also affect the stability of the SOC pool. They also emphasize the importance of sampling depth choice according to site characteristics and the importance of the vegetation not only on FF C stocks but also on C distribution across the soil profile. (C) 2015 Elsevier B.V. All rights reserved.

Matarrese, R., et al. (2004). "COMPARISON BETWEEN REMOTE-SENSED DATA AND IN SITU MEASUREMENTS IN COASTAL WATERS: THE TARANTO SEA CASE." Chemistry and Ecology **20**(3): 225-237.

Monitoring and managing small coastal ecosystems requires a considerable understanding of the temporal dynamics of biophysical factors describing the coastal water systems. For this reason, daily observation from space could be a very efficient tool. The objective of the work described in this paper is to evaluate the contribution of remote sensing to the continuous monitoring of coastal areas. It is well known that in coastal areas, the presence of inorganic suspended sediments and coloured dissolved organic matter can make chlorophyll-concentration measurements from remote sensing difficult. To overcome these difficulties, an alternative approach to the SeaWiFS standard chlorophyll algorithm is presented, based on a semi-analytic model for sea water and on the use of MODIS data as input in a model for atmospheric effects removal. Moreover, land contamination (mixed sea-land pixels) can introduce ambiguities in sea-surface temperature measurements from remote sensing. This paper proposes the use of a hydrodynamic model as a time-space interpolator of in situ campaign data, to extensively validate the temperature values extracted from AVHRR sensor. We validated the proposed approach, using experimental field data collected over a two-year campaign in the Taranto Gulf. The results seem to indicate a good agreement between remote-sensed and in situ data.

McKenzie, D., et al. (2003). "Modelling conifer species distributions in mountain forests of Washington State, USA." Forestry Chronicle **79**(2): 253-258.

Understanding the effects of climatic change on mountain forests, where snowpacks and short growing seasons limit tree establishment and growth, is a key concern for both ecologists and foresters. We quantified associations between climatic and biophysical variables and individual conifer species distributions in mountain forests with generalized linear models. For the majority of species, a unimodal response to moisture and temperature gradients was evident, suggesting that an environmental niche can be identified. Species known to respond to limiting factors in the abiotic environment showed the strongest associations with predictor variables. The models can improve forecasts of the potential redistribution of species on the landscape in response to climatic change, but disturbance, migration rates. and limits on regeneration are important sources of uncertainty. Nevertheless, by identifying climate-based niches of different species, we can identify effective strategies for reforestation and alert managers to particularly sensitive or vulnerable ecosystems and landscapes.

Mekuria, W. and E. Aynekulu (2013). "EXCLOSURE LAND MANAGEMENT FOR RESTORATION OF THE SOILS IN DEGRADED COMMUNAL GRAZING LANDS IN NORTHERN ETHIOPIA." Land Degradation & Development **24**(6): 528-538.

In the northern highlands of Ethiopia, establishment of exclosures to restore degraded communal grazing lands has been practiced for the past three decades. However, empirical data on the effectiveness of exclosures in restoring degraded soils are lacking. We investigated the influence of exclosure age on degree of restoration of degraded soil and identified easily measurable biophysical and management-related factors that can be used to predict soil nutrient restoration. We selected replicated (n=3) 5-, 10-, 15-, and 20-year-old exclosures and paired each exclosure with samples from adjacent communal grazing lands. All exclosures showed higher total soil nitrogen (N), available phosphorus (P), and cation exchange capacity than the communal grazing lands. The differences varied between 24 (+/- 061) and 69 (+/- 185) Mgha(-1) for the total N stock and from 17 (+/- 3) to 39 (+/- 7) kgha(-1) for the available P stock. The differences in N and P increased with exclosure age. In exclosures, much of the variability in soil N (R-2=064) and P (R-2=071) stocks were explained by a combination of annual average precipitation, woody biomass, and exclosure age. Precipitation and vegetation canopy cover also explained much of the variability in soil N (R-2=074) and P (R-2=052) stocks in communal grazing lands. Converting degraded communal grazing lands into exclosures is a viable option to restore degraded soils. Our results also confirm that the possibility to predict the changes in soil nutrient content after exclosure establishment using regression models is based on field measurements. Copyright (c) 2011 John Wiley & Sons, Ltd.

Michaletz, S. T. and E. A. Johnson (2007). "How forest fires kill trees: A review of the fundamental biophysical processes." Scandinavian Journal of Forest Research **22**(6): 500-515.

Postfire tree mortality is typically characterized using regression approaches that do not consider the causal processes linking fire behavior and tree mortality. Recently, a growing number of studies has used biophysical process approaches that attempt to define and independently validate these causal processes. Nevertheless, some foresters and ecologists are unfamiliar with the approach and it remains a minority in fire ecology research. The purpose of this review is to describe in straightforward terms the fundamental biophysical processes that link fire behavior to tree mortality. The review begins with a brief introduction to heat transfer theory before moving on to combustion processes and forest fire behavior. A discussion follows on how fire behavior is linked to injuries in the tree roots, bole and crown, and finally a biophysical process framework for linking root, bole and crown injuries to tree mortality is outlined. It is hoped that this overview will promote future process approaches and help to produce more predictive and general models of postfire tree mortality.

Mildrexler, D. J., et al. (2011). "A global comparison between station air temperatures and MODIS land surface temperatures reveals the cooling role of forests." Journal of Geophysical Research-Biogeosciences **116**.

Most global temperature analyses are based on station air temperatures. This study presents a global analysis of the relationship between remotely sensed annual maximum LST (LSTmax) from the Aqua/Moderate Resolution Imaging Spectroradiometer (MODIS) sensor and the corresponding site-based maximum air temperature (T-amax) for every World Meteorological Organization station on Earth. The relationship is analyzed for different land cover types. We observed a strong positive correlation between LSTmax and T-amax. As temperature increases, LSTmax increases faster than T-amax and captures additional information on the concentration of thermal energy at the Earth's surface, and biophysical controls on surface temperature, such as surface roughness and transpirational cooling. For hot conditions and in nonforested cover types, LST is more closely coupled to the radiative and thermodynamic characteristics of the Earth than the air temperature (T-air). Barren areas, shrublands, grasslands, savannas, and croplands have LSTmax values between 10 degrees C and 20 degrees C hotter than the corresponding T-amax at higher temperatures. Forest cover types are the exception with a near 1:1 relationship between LSTmax and T-amax across the temperature range and 38 degrees C as the approximate upper limit of LSTmax with the exception of subtropical deciduous forest types where LSTmax occurs after canopy senescence. The study shows a complex interaction between land cover and surface energy balances. This global, semiautomated annual analysis could provide a new, unique, monitoring metric for integrating land cover change and energy balance changes.

Moore, N., et al. (2010). "Adapting MODIS-derived LAI and fractional cover into the RAMS in East Africa." International Journal of Climatology **30**(13): 1954-1969.

Land cover and its associated biophysical parameters govern many land-atmosphere interactions. Several previous studies have demonstrated the utility of incorporating satellite-derived observations of land cover into climate models to improve prediction accuracy. In the developing world where agriculture is a primary livelihood, a better understanding of seasonal variability in precipitation and near-surface temperature is critical to constructing more effective coping strategies for climate changes and food security. However, relatively few studies have been able to assess the impacts of improved surface parameterisation on these variables and their seasonality. Using moderate resolution imaging spectroradiometer (MODIS)-derived products, we sought to address this shortcoming by adapting leaf area index (LAI) and vegetative fractional cover (FC) products, along with an improved representation of the land surface (i.e. land use land cover) into the Regional Atmospheric Modelling System in East Africa to evaluate the effect improved representations would have on simulated precipitation and land surface temperature (LST). In particular, we tested the hypothesis that improved phenological parameterisations could reduce error in precipitation and LST under dramatically different atmospheric conditions. The model was used to simulate dry/normal/wet rainfall years of 2000, 2001, and 2002 (respectively) in order to understand biases in this parameterisation under different boundary conditions. Our results show a dramatic improvement in LST simulation due to the use of the improved representations (spline functions) during most of the year, both spatially and temporally. Annual precipitation, which is dependent upon a much greater variety of surface and atmospheric characteristics, did not improve as much by adopting the spline representations of LAI and FC; the results were more equivocal. However, seasonal timing of precipitation improved in some areas, and this improvement has important consequences for integrated climate-agriculture assessments. Copyright (C) 2009 Royal Meteorological Society

Moreno-de las Heras, M., et al. (2015). "Assessing vegetation structure and ANPP dynamics in a grassland-shrubland Chihuahuan ecotone using NDVI-rainfall relationships." Biogeosciences **12**(10): 2907-2925.

Climate change and the widespread alteration of natural habitats are major drivers of vegetation change in drylands. In the Chihuahuan Desert, large areas of grasslands dominated by perennial grass species have transitioned over the last 150 years to shrublands dominated by woody species, accompanied by accelerated water and wind erosion. Multiple mechanisms drive the shrub-encroachment process, including precipitation variations, land-use change, and soil erosion-vegetation feedbacks. In this study, using a simple ecohydrological modelling framework, we show that herbaceous (grasses and forbs) and shrub vegetation in drylands have different responses to antecedent precipitation due to functional differences in plant-growth and water-use patterns. Therefore, shrub encroachment may be reflected in the analysis of landscape-scale vegetation-rainfall relationships. We analyse the structure and dynamics of vegetation at an 18 km(2) grassland-shrubland ecotone in the northern edge of the Chihuahuan Desert (McKenzie Flats, Sevilleta National Wildlife Refuge, NM, USA) by investigating the relationship between decade-scale (2000-2013) records of remotely sensed vegetation greenness (MODIS NDVI) and antecedent rainfall. NDVI-rainfall relationships show a high sensitivity to spatial variations on dominant vegetation types across the grassland-shrubland ecotone, and provide biophysical criteria to (a) classify landscape types as a function of the spatial distribution of dominant vegetation and to (b) decompose the NDVI signal into partial components of annual net primary production (ANPP) for herbaceous vegetation and shrubs. Analysis of remotely sensed ANPP dynamics across the study site indicates that plant growth for herbaceous vegetation is particularly synchronized with monsoonal summer rainfall. For shrubs, ANPP is better explained by winter plus summer precipitation, overlapping the monsoonal period (June-September) of rain concentration. Our results suggest that shrub encroachment was not particularly active in this Chihuahuan ecotone for the period 2000-2013. However, future changes in the amount and temporal pattern of precipitation (i.e. reductions in monsoonal summer rainfall and/or increases in winter precipitation) may enhance the shrub-encroachment process, particularly in the face of expected upcoming increases in aridity for desert grasslands of the southwestern USA.

Muller, O. V., et al. (2014). "Regional Model Simulations of the 2008 Drought in Southern South America Using a Consistent Set of Land Surface Properties." Journal of Climate **27**(17): 6754-6778.

This work discusses the land surface atmosphere interactions during the severe drought of 2008 in southern South America, which was among the most severe in the last 50 years in terms of both intensity and extent. Once precipitation returned to normal values, it took about two months for the soil moisture content and vegetation to recover. The land surface effects were examined by contrasting long-term simulations using a consistent set of satellite-derived annually varying land surface biophysical properties against simulations using the conventional land-cover types in the Weather Research and Forecasting Model-Noah land surface model (WRF-Noah). The new land-cover dataset is based on ecosystem functional properties that capture changes in vegetation status due to climate anomalies and land-use changes. The results show that the use of realistic information of vegetation states enhances the model performance, reducing the precipitation biases over the drought region and over areas of excessive precipitation. The precipitation bias reductions are attributed to the corresponding changes in greenness fraction, leaf area index, stomatal resistance, and surface roughness. The temperature simulation shows a generalized increase, which is attributable to a lower vegetation greenness and a doubling of the stomatal resistance that reduces the evapotranspiration rate. The increase of temperature has a beneficial effect toward the eastern part of the domain with a notable reduction of the bias, but not over the central region where the bias is increased. The overall results suggest that an improved representation of the surface processes may contribute to improving the predictive skill of the model system.

Munson, S. M., et al. (2015). "Long-term plant responses to climate are moderated by biophysical attributes in a North American desert." Journal of Ecology **103**(3): 657-668.

Recent elevated temperatures and prolonged droughts in many already water-limited regions throughout the world, including the southwestern United States, are likely to intensify according to future climate-model projections. This warming and drying can negatively affect perennial vegetation and lead to the degradation of ecosystem properties. To better understand these detrimental effects, we formulate a conceptual model of dryland ecosystem vulnerability to climate change that integrates hypotheses on how plant species will respond to increases in temperature and drought, including how plant responses to climate are modified by landscape, soil and plant attributes that are integral to water availability and use. We test the model through a synthesis of fifty years of repeat measurements of perennial plant species cover in large permanent plots across the Mojave Desert, one of the most water-limited ecosystems in North America. Plant species ranged in their sensitivity to precipitation in different seasons, capacity to increase in cover with high precipitation and resistance to decrease in cover with low precipitation. Our model successfully explains how plant responses to climate are modified by biophysical attributes in the Mojave Desert. For example, deep-rooted plants were not as vulnerable to drought on soils that allowed for deep-water percolation, whereas shallow-rooted plants were better buffered from drought on soils that promoted water retention near the surface.Synthesis. Our results emphasize the importance of understanding climate-vegetation relationships in the context of biophysical attributes that influence water availability and provide an important forecast of climate-change effects, including plant mortality and land degradation in dryland regions throughout the world.

Murphy, L. N., et al. (2012). "Local and Remote Climate Impacts from Expansion of Woody Biomass for Bioenergy Feedstock in the Southeastern United States." Journal of Climate **25**(21): 7643-7659.

Many efforts have been taken to find energy alternatives to reduce anthropogenic influences on climate. Recent studies have shown that using land for bioenergy plantations may be more cost effective and provide a greater potential for CO2 abatement than using land for carbon sequestration. Native southern U.S. pines (i.e., loblolly) have excellent potential as bioenergy feedstocks. However, the land-cover change due to expansion of biofuels may impact climate through biophysical feedbacks. Here. the authors access the local and remote consequences of greater forest management and biofuel feedstock expansion on climate and hydrology using a global climate model, the NCAR Community Climate System Model, version 4 (CCSM4). The authors examine a plausible U.S. Department of Energy (DOE) biofuel feedstock goal by afforesting 50 million acres of C-4 grasslands in the southeastern United States with an optimized loblolly plant functional type. Changes in sensible and latent heat fluxes are related to increased surface roughness, reduced bare-ground evaporation, and changes in stomatal conductance. In the coupled simulations, these mechanisms lead to a 1 degrees C cooling, higher atmospheric stability, and a more shallow planetary boundary layer over the southeastern United States during the summer; in winter, a cooling of up to 0.25 degrees C between 40 degrees and 60 degrees N, a weakened Aleutian low, and a wetter Australia occurs. A weakened Aleutian low shifts the North Pacific storm track poleward in the future loblolly scenarios. These local and global impacts suggest that biophysical feedbacks need to be considered when evaluating the benefits of bioenergy feedstock production.

Naik, M. and B. J. Abiodun (2016). "Potential impacts of forestation on future climate change in Southern Africa." International Journal of Climatology **36**(14): 4560-4576.

Many studies have projected future climate changes over Southern Africa, but without including the influence of on-going forestation activities in the region. The present study investigates how the forestation activities may alter the projected climate change. For the study, two regional climate models (RegCM and WRF) were applied to simulate the present-day climate (1970-2004) and future climate (2030-2064; IPCC RCP 4.5), with and without forestation. The simulations account for the potential impacts of natural bush encroachment and commercial forestation activities over the eastern part of South Africa. The results agree with previous studies that found that the RCP4.5 emission scenario would induce warming over Southern Africa in the future, but the results further indicate that forestation would enhance the warming over the forested area and induce cooling elsewhere. The additional warming over the forested area is due to the albedo effect of the forestation, while the cooling is due to the dynamic feedback of the local warming induced by the forestation. For similar reasons, the forestation would induce wet and dry conditions over different areas in the sub-continent in the future. As a result of its combined influences on rainfall and temperature, the forestation would enhance summer drought frequency over some areas but reduce it over other areas in Southern Africa. The simulations suggest that using forestation to mitigate the impacts of global warming may produce unintended climate impacts over some areas in Southern Africa. Hence, before embarking on large-scale forestation, the biophysical effects of forestation in Southern Africa should be weighed against the biogeochemical benefits.

Nakalembe, C., et al. (2017). "Agricultural land use change in Karamoja Region, Uganda." Land Use Policy **62**: 2-12.
We examine dramatic cropland expansion in Karamoja, Uganda by investigating the links between biophysical and political historical events leading to the current state of agricultural land use. Our objective was to quantify agricultural expansion, uncover the dominant drivers leading to the current state of agricultural land use and its impacts on livelihoods. Region wide analysis of remotely sensed data, land use policy and history as well as farmer interviews were undertaken. We posit that government programs instituting sedentary agriculture are the most significant drivers of cropland expansion in Karamoja. We show a 299% increase in cropland area between 2000 and 2011 with most expansion occurring in Moroto District (from 706 ha to 23,328 ha). We found no evidence of an increase in overall crop production or food security and food aid continues to be essential due to recurrent crop failures. Due to lack of resources for inputs (e.g., seeds and labor) cultivated fields remain very small in size and over 55% of once cultivated land is left fallow. Our findings bring into question whether continued promotion of rain-fed agriculture in Karamoja serves the best interests of the people. Current cropland expansion is directly competing and compromising pasture areas critical for livestock-based livelihoods. Without strong agricultural extension programs and major investments in climate-smart options, cropland expansion will continue to have a net negative impact, especially in the context of current climate projections which indicate a future decrease in rainfall, increase in temperature and an increase in the frequency and magnitude of extreme events. (C) 2016 Elsevier Ltd. All rights reserved.

Nam, W. H., et al. (2018). "Developing the vegetation drought response index for South Korea (VegDRI-SKorea) to assess the vegetation condition during drought events." International Journal of Remote Sensing **39**(5): 1548-1574.
South Korea has experienced severe droughts and water scarcity problems that have influenced agriculture, food prices, and crop production in recent years. Traditionally, climate-based drought indices using point-based meteorological observations have been used to help quantify drought impacts on the vegetation in South Korea. However, these approaches have a limited spatial precision when mapping detailed vegetation stress caused by drought. For these reasons, the development of a drought index that provides detailed spatial-resolution information on drought-affected vegetation conditions is essential to improve the country's drought monitoring capabilities, which are needed to help develop more effective adaptation and mitigation strategies. The objective of this study was to develop a satellite-based hybrid drought index called the vegetation drought response index for South Korea (VegDRI-SKorea) that could improve the spatial resolution of agricultural drought monitoring on a national scale. The VegDRI-SKorea was developed for South Korea, modifying the original VegDRI methodology (developed for the USA) by tailoring it to the available local data resources. The VegDRI-SKorea utilizes a classification and regression tree (CART) modelling approach that collectively analyses remote-sensing data (e.g. normalized difference vegetation index (NDVI)), climate-based drought indices (e.g. self-calibrated Palmer drought severity index (PDSI) and standardized precipitation index (SPI)), and biophysical variables (e.g. elevation and land cover) that influence the drought-related vegetation stress. This study evaluates the performance of the recently developed VegDRI-SKorea for severe and extreme drought events that occurred in South Korea in 2001,

2008, and 2012. The results demonstrated that the hybrid drought index improved the more spatially detailed drought patterns compared to the station-based drought indices and resulted in a better understanding of drought impacts on the vegetation conditions. The VegDRI-SKorea model is expected to contribute to the monitoring of drought conditions nationally. In addition, it will provide the necessary information on the spatial variations of those conditions to evaluate local and regional drought risk assessment across South Korea and assist local decision-makers in drought risk management.

Natori, Y. and W. P. Porter (2007). "Model of Japanese serow (Capricornis crispus) energetics predicts distribution on Honshu, Japan." Ecological Applications **17**(5): 1441-1459.

Understanding what determines a species' range is a central objective in ecology and evolutionary biology. It has important applications for predicting species distributions and how they might respond to environmental perturbations. This paper describes a mechanistic approach to predict past and present distribution of the Japanese serow (Capricornis crispus) on Honshu, Japan. We applied state-of-the-art microclimate and animal biophysical/ behavioral models coupled with climate and vegetation data to estimate the distribution of potential range expansion under protection. We tested the model results against detailed empirical distribution data from the Ministry of the Environment for a five-prefecture area in central Honshu. We also applied the models to time-series land use/ cover maps to investigate the historical transitions in habitat suitability during 1947-1999 in the Arai-Keinan region. This is the first time to our knowledge that mechanistic models have successfully predicted the landscape scale distribution of a mammal species in the absence of other animal species interactions, such as predators. In this case, animal energetics/ behavior-plant interactions seem to be critical. Forest cover appears to be important in summer and winter for suitable serow habitats. The energetics model results indicate that the serow can overheat in some open environments in midday hours in summer. In winter, simulation results suggested that forest cover provides effective refuge to avoid increased metabolic demands of cold temperatures and strong winds. The model simulations suggested that land use/ cover changes documented during 1947-1999 resulted in increased suitable serow habitat due to expanding forest cover from agricultural marginalization and ecological succession. The models provide a unique tool for estimating species' range expansion under protection or for selecting suitable reintroduction sites.

Neel, L. K. and L. D. McBrayer (2018). "Habitat management alters thermal opportunity." Functional Ecology **32**(8): 2029-2039.

1. Ectotherms engage in behavioral thermoregulation to optimize body temperatures, however, thermoregulatory effort varies across species, over time, and among habitats. Classic cost-benefit models of ectothermic thermoregulation postulate that ectotherms should increase thermoregulatory effort when the benefits of thermoregulatory behavior outweigh the costs (Huey and Slatkin, 1976). However, alteration of habitat via land management may lead to unforeseen shifts in microclimate that change associated costs and benefits. In light of anthropogenic impacts on natural habitats, thermoregulatory effort should be examined in cases where land management results in environmental temperatures that deviate from the preferred temperature range of a given species. 2. We examined how habitat management alters microclimates and influences activity time, thermoregulatory behavior, and thermal physiology in a lizard (Sceloporus woodi) whose range has been significantly reduced due to habitat loss. We compared populations from two ecologically distinct habitats: longleaf pine and sand pine scrub, which have very different management histories. Daily surveys were conducted in each habitat type while environmental temperatures were recorded simultaneously with biophysical models. 3. Thermal performance curves differed between populations such that physiological performance was optimized in each environment. Longleaf pine habitat had greater thermal opportunity because cooler microclimates were available on arboreal perches. In longleaf pine habitat, lizards were able to stay active longer and thermoregulate more effectively. Regardless of habitat, thermoregulatory effort of S. woodi increased when thermal quality of habitat was low. However, when unfavorably high temperatures were experienced, the thermoregulatory effort increased significantly. 4. Our results demonstrate that ectotherms can afford to imprecisely thermoregulate when habitat thermal quality is poor due to cooler environmental temperatures. However under unfavorably hot environmental temperatures, lizards must precisely regulate body temperature in spite of any costs. These results further demonstrate that habitat management has major implications on species-specific thermal opportunity, thermoregulatory behavior, and thermal physiology, such that shifts in

thermoregulatory behavior may lead to higher energetic costs, enhanced predation risk, and constrained activity times.

Nelson, N. G., et al. (2018). "Revealing Biotic and Abiotic Controls of Harmful Algal Blooms in a Shallow Subtropical Lake through Statistical Machine Learning." Environmental Science & Technology **52**(6): 3527-3535.

Harmful algal blooms are a growing human and environmental health hazard globally. Eco-physiological diversity of the cyanobacteria genera that make up these blooms creates challenges for water managers tasked with controlling the intensity and frequency of blooms, particularly of harmful taxa (e.g., toxin producers, N-2 fixers). Compounding these challenges is the ongoing debate over the efficacy of nutrient management strategies (phosphorus-only versus nitrogen and phosphorus), which increases decision-making uncertainty. To improve our understanding of how different cyanobacteria respond to nutrient levels and other biophysical factors, we analyzed a unique 17 year data set comprising monthly observations of cyanobacteria genera and zooplankton abundances, water quality, and flow in a bloom-impacted, subtropical, flow-through lake in Florida (United States). Using the Random Forests machine learning algorithm, an ensemble modeling approach, we characterized and quantified relationships among environmental conditions and five dominant cyanobacteria genera. Results highlighted nonlinear relationships and critical thresholds between cyanobacteria genera and environmental covariates, the potential for hydrology and temperature to limit the efficacy of cyanobacteria bloom management actions, and the importance of a dual nutrient management strategy for reducing bloom risk in the long term.

Newlands, N. K., et al. (2011). "Validation and inter-comparison of three rnethodologies for interpolating daily precipitation and temperature across Canada." Environmetrics **22**(2): 205-223.

The use of daily climate data in agriculture has increased considerably over the past two decades due to the rapid development of information technology and the need to better assess impacts and risks from extreme weather and accelerating climate change. While daily station data is now regularly used as an input to biophysical and biogeochemical models for the study of climate, agriculture, and forestry, questions still remain on the level of uncertainty in using daily data, especially for predictions made by spatial interpolation models. We evaluate the precision of three models (i.e., spline, weighted-truncated Gaussian filter, and hybrid inverse-distance/natural-neighbor) for interpolating daily precipitation and temperature at 10 km across the Canadian landmass south of 60 degrees latitude (encompassing Canada's agricultural region). We compute daily, weekly, and monthly-aggregated bias and root-mean-square (RMSE) validation statistics, examining how error varies with orography and topography, and proximity to large water. Our findings show the best approach for interpolating daily temperature and precipitation across Canada requires a mixed-model/Bayesian approach. Further application of interpolation methods that consider non-stationary spatial covariance, alongside measurement of spatial correlation range would aid considerably in reducing interpolation prediction uncertainty. Copyright (C) 2010 Crown in Right of Canada.

Newton, P. F. (2016). "Simulating the Potential Effects of a Changing Climate on Black Spruce and Jack Pine Plantation Productivity by Site Quality and Locale through Model Adaptation." Forests **7**(10).

Modifying the stand dynamic functional determinates of structural stand density management models (SSDMMs) through the incorporation of site-specific biophysical height-age equations enabled the simulation of the effects of increasing mean temperature and precipitation during the growing season on black spruce (Picea mariana (Mill.) BSP) and jack pine (Pinus banksiana Lamb.) plantation productivity. The analytical approach consisted of calculating future values of growing season mean temperature and precipitation rates under three emissions scenarios (no change (NC); B1; and A2), spanning three continuous commitment periods (2011-2040; 2041-2070; and 2071-2100), for three geographically separated sites throughout the central portion of the Canadian Boreal Forest Region (north-eastern (Kirkland Lake); north-central (Thunder Bay); and north-western (Dryden) Ontario, Canada), using the Canadian Coupled Global Climate Model (CGCM3) in conjunction with a geographic-referencing climatic surface model. These estimates were entered into the embedded biophysical equations in the SSDMMs in order to forecast emission-scenario-specific developmental patterns of plantations managed under a conventional density management regime by species and site quality (poor-to-medium and good-to-excellent) at each locale; from which stand development rates and associated productivity metrics over 75 year-long rotations were estimated and compared (e.g., mean sizes, volumetric, biomass and carbon yields, end-products, economic worth, stand stability, wood quality indices, and operability status). Simulation results indicated that black spruce plantations situated on both site qualities at the north-western location and on the lower site quality at the north-eastern location were negatively affected from the predicted increased warming and rainfall as evidenced from consequential declines in stand development rates and resultant decreases in rotational mean sizes, biomass yields, recoverable end-product volumes, and economic worth (A2 > B1). Conversely, black spruce plantations situated on both site qualities at the north-central location and on the higher site quality at the north-eastern location were minimally and positively affected under the A2 and B1 scenarios, respectively. Jack pine plantations situated on both site qualities at all three locations were negatively affected as evident by the reductions in stand development rates and rotational mean sizes, biomass yields, recoverable end-product volumes, and economic worth (A2 > B1). Collectively, these response patterns suggest that stand-level productivity under a changing climate will vary by species, site quality, geographic locale, and emission scenario, potentially resulting in a landscape-level mosaic of both negative and positive productivity impacts in the case of black spruce, and mostly negative impacts in the case of jack pine. As demonstrated, modelling stand-level responses to projected increases in thermal and moisture regimes through the modification of existing stand-level forecasting models, and accounting for divergent effects due to species, site quality, and geographic locale differences, is a viable and efficient alternative approach for projecting productivity outcomes arising from anthropogenic-induced changes in growing conditions.

Nguy-Robertson, A., et al. (2015). "Modeling gross primary production of maize and soybean croplands using light quality, temperature, water stress, and phenology." Agricultural and Forest Meteorology **213**: 160-172.

Vegetation productivity metrics, such as gross primary production (GPP) may be determined from the efficiency with which light is converted into photosynthates, or light use efficiency (epsilon). Therefore, accurate measurements and modeling of epsilon is important for estimating GPP in each ecosystem. Previous studies have quantified the impacts of biophysical parameters on light use efficiency based GPP models. Here we enhance previous models utilizing four scalars for light quality (i.e., cloudiness), temperature, water stress, and phenology for data collected from both maize and soybean crops at three Nebraska Ameri-Flux sites between 2001 and 2012 (maize: 26 field-years; soybean: 10 field-years). The cloudiness scalar was based on the ratio of incident photosynthetically active radiation (PAR(in)) to potential (i.e., clear sky) PAR(pot). The water stress and phenology scalars were based on vapor pressure deficit and green leaf area index, respectively. Our analysis determined that each parameter significantly improved the estimation of GPP (AIC range: 2503-2740; likelihood ratio test: p-value < 0.0003, df = 5-8). Daily GPP data from 2001 to 2008 calibrated the coefficients for the model with reasonable amount of error and bias (RMSE = 2.2 g Cm-2 d(-1); MNB = 4.7%). Daily GPP data from 2009 to 2012 tested the model with similar accuracy (RMSE = 2.6 g C m(-2) d(-1); MNB = 1.7%). Modeled GPP was generally within 10% of measured growing season totals in each year from 2009 to 2012. Cumulatively, over the same four years, the sum of error and the sum of absolute error between the measured and modeled GPP, which provide measures of long-term bias, was +/- 5% and 2-9%, respectively, among the three sites. (C) 2015 Elsevier B.V. All rights reserved.

Niu, G. Y., et al. (2011). "The community Noah land surface model with multiparameterization options (Noah-MP): 1. Model description and evaluation with local-scale measurements." Journal of Geophysical Research-Atmospheres **116**.

This first paper of the two-part series describes the objectives of the community efforts in improving the Noah land surface model (LSM), documents, through mathematical formulations, the augmented conceptual realism in biophysical and hydrological processes, and introduces a framework for multiple options to parameterize selected processes (Noah-MP). The Noah-MP's performance is evaluated at various local sites using high temporal frequency data sets, and results show the advantages of using multiple optional schemes to interpret the differences in modeling simulations. The second paper focuses on ensemble evaluations with long-term regional (basin) and global scale data sets. The enhanced conceptual realism includes (1) the vegetation canopy energy balance, (2) the layered snowpack, (3) frozen soil and infiltration, (4) soil moisture-groundwater interaction and related runoff production, and (5) vegetation phenology. Sample local-scale validations are conducted over the First International Satellite Land Surface Climatology Project (ISLSCP) Field Experiment (FIFE) site, the W3 catchment of Sleepers River, Vermont, and a French snow observation site. Noah-MP shows apparent improvements in reproducing surface fluxes, skin temperature over dry periods, snow water equivalent (SWE), snow depth, and runoff over Noah LSM version

3.0. Noah-MP improves the SWE simulations due to more accurate simulations of the diurnal variations of the snow skin temperature, which is critical for computing available energy for melting. Noah-MP also improves the simulation of runoff peaks and timing by introducing a more permeable frozen soil and more accurate simulation of snowmelt. We also demonstrate that Noah-MP is an effective research tool by which modeling results for a given process can be interpreted through multiple optional parameterization schemes in the same model framework.

Notaro, M., et al. (2017). "Regional Climate Modeling of Vegetation Feedbacks on the Asian-Australian Monsoon Systems." Journal of Climate **30**(5): 1553-1582.

This study explores the hypothesis that subtropical and tropical monsoon regions exhibit unique responses to vegetation feedbacks. Using the Community Climate System Model (CCSM), M. Notaro et al. concluded that reduced vegetation cover led to an earlier subtropical Chinese monsoon and a delayed, weaker tropical Australian monsoon, yet significant climate and leaf area index (LAI) biases obfuscated the hypothesis's reliability. To address these concerns, the Regional Climate Model, version 4 (RegCM4), likewise coupled to the Community Land Model but with ''observed'' LAI boundary conditions, is applied across China and Australia. The model matches the observed dominance of crops, grass, and evergreen trees in southern China and grass and shrubs in northern Australia. The optimal model configuration is determined and applied in control runs for 1960-2013. Monsoon region LAI is modified in a RegCM4 ensemble, aimed at contrasting vegetation feedbacks between tropical and subtropical regions. Greater LAI supports reductions in albedo, temperature, wind speed, boundary layer height, ascending motion, and midlevel clouds and increases in diurnal temperature range (DTR), wind stress, evapotranspiration (ET), specific humidity, and low clouds. In response to greater LAI, rainfall is enhanced during Australia's pre-to-midmonsoon season but not for China. Modified LAI leads to dramatic changes in the temporal distribution and intensity of Australian rain events. Heterogeneous responses to biophysical feedbacks include amplified impacts (e.g., increased ET and DTR) across China's croplands and Australia's shrublands. Inconsistencies between China's monsoonal responses in the present RegCM4 study and prior CCSM study of M. Notaro et al. are attributed to CCSM's excessive forest cover and LAI, exaggerated roughness mechanism, and deficient ET response.

Nowakowski, A. J., et al. (2017). "Tropical amphibians in shifting thermal landscapes under land-use and climate change." Conservation Biology **31**(1): 96-105.

Land-cover and climate change are both expected to alter species distributions and contribute to future biodiversity loss. However, the combined effects of land-cover and climate change on assemblages, especially at the landscape scale, remain understudied. Lowland tropical amphibians may be particularly susceptible to changes in land cover and climate warming because many species have narrow thermal safety margins resulting from air and body temperatures that are close to their critical thermal maxima (CTmax). We examined how changing thermal landscapes may alter the area of thermally suitable habitat (TSH) for tropical amphibians. We measured microclimates in 6 land-cover types and CTmax of 16 frog species in lowland northeastern Costa Rica. We used a biophysical model to estimate core body temperatures of frogs exposed to habitat-specific microclimates while accounting for evaporative cooling and behavior. Thermally suitable habitat area was estimated as the portion of the landscape where species CTmax exceeded their habitat-specific maximum body temperatures. We projected changes in TSH area 80 years into the future as a function of land-cover change only, climate change only, and combinations of land-cover and climate-change scenarios representing low and moderate rates of change. Projected decreases in TSH area ranged from 16% under low emissions and reduced forest loss to 30% under moderate emissions and business-as-usual land-cover change. Under a moderate emissions scenario (A1B), climate change alone contributed to 1.7- to 4.5-fold greater losses in TSH area than land-cover change only, suggesting that future decreases in TSH from climate change may outpace structural habitat loss. Forest-restricted species had lower mean CTmax than species that occurred in altered habitats, indicating that thermal tolerances will likely shape assemblages in changing thermal landscapes. In the face of ongoing land-cover and climate change, it will be critical to consider changing thermal landscapes in strategies to conserve ectotherm species.

Nunes, A. N. (2012). "Regional variability and driving forces behind forest fires in Portugal an overview of the last three decades (1980-2009)." Applied Geography **34**: 576-586.

The purpose of this paper was to analyze the evolution and regional distribution of both forest fire ignitions and burnt areas in mainland Portugal and to identify the relationship between biophysical and human variables and the incidence of forest fires at the district level over the last 3 decades (1980-2009). A positive trend can be observed in the number of fires and in the areas burnt by forest fires since 1980. An interesting regional distribution of forest fire ignitions and burned areas was detected, highlighting some districts especially vulnerable to the outbreak of fires and others particularly susceptible to the spread of fire. A stepwise multiple regression methodology was applied to determine the relative importance of each variable in explaining the regional distribution of ignitions and burned area fractions and to address hypotheses regarding human and biophysical influences on the drivers of forest fires. Population density was the primary determining variable in the outbreak of fires at the district level (this factor alone explained 65% of the inter-district variation in the density of fire ignitions), whereas burn areas were influenced by the synergistic effects of topography, changes in land use, and vegetation. The topographic roughness index emerged as the most important variable causing the regional variations observed in the percentage of the district area burnt over the last 30 years, explaining 70% of the observed variance. Variables associated with changes in land use and cover during the second half of the last century explained an additional 17% of the variance. Multiple regression analysis also suggested a positive relationship between the total area burnt and the total uncultivated area, explaining 57% of the variance at the district level. In general, the greatest pressures from fire occur in the districts north of the Tejo River, which are more mountainous, have lower annual temperatures and more rainfall, and produce the most biomass under pressure from agriculture and grazing. In these districts, the decline of traditional agriculture has resulted in important transformations to the landscape characterized by the spread of natural vegetation.

O'Connell, C. S., et al. (2018). "Balancing tradeoffs: Reconciling multiple environmental goals when ecosystem services vary regionally." Environmental Research Letters **13**(6).

As the planet's dominant land use, agriculture often competes with the preservation of natural systems that provide globally and regionally important ecosystem services. How agriculture impacts ecosystem service delivery varies regionally, among services being considered, and across spatial scales. Here, we assess the tradeoffs between four ecosystem services-agricultural production, carbon storage, biophysical climate regulation, and biodiversity-using as a case study the Amazon, an active frontier of agricultural expansion. We find that the highest values for each of the ecosystem services are concentrated in different regions. Agricultural production potential and carbon storage are highest in the north and west, biodiversity greatest in the west, and climate regulation services most vulnerable to disruption in the south and east. Using a simple optimization model, we find that under scenarios of agricultural expansion that optimize total production across ecosystem services, small increases in priority for one ecosystem service can lead to reductions in other services by as much as 140%. Our results highlight the difficulty of managing landscapes for multiple environmental goals; the approach presented here can be adapted to guide value-laden conservation decisions and identify potential solutions that balance priorities.

Oikawa, P. Y., et al. (2014). "Unifying soil respiration pulses, inhibition, and temperature hysteresis through dynamics of labile soil carbon and O-2." Journal of Geophysical Research-Biogeosciences **119**(4): 521-536.

Event-driven and diel dynamics of soil respiration (R-s) strongly influence terrestrial carbon (C) emissions and are difficult to predict. Wetting events may cause a large pulse or strong inhibition of R-s. Complex diel dynamics include hysteresis in the relationship between R-s and soil temperature. The mechanistic basis for these dynamics is not well understood, resulting in large discrepancies between predicted and observed R-s. We present a unifying approach for interpreting these phenomena in a hot arid agricultural environment. We performed a whole ecosystem wetting experiment with continuous measurement of R-s to study pulse responses to wetting in a heterotrophic system. We also investigated R-s during cultivation of Sorghum bicolor to evaluate the role of photosynthetic C in the regulation of diel variation in R-s. Finally, we adapted a R-s model with sensitivity to soil O-2 and water content by incorporating two soil C pools differing in lability. We observed a large wetting-induced pulse of R-s from the fallow field and were able to accurately simulate the pulse via release of labile soil C. During the exponential phase of plant growth, R-s was inhibited in response to wetting, which was accurately simulated through depletion of soil O-2. Without plants, hysteresis was not observed; however, with growing plants, an increasingly significant counterclockwise hysteresis developed. Hysteresis was simulated via a dynamic photosynthetic C pool and was not likely controlled by physical processes. These results help characterize the complex regulation of R-s and improve understanding of these phenomena under warmer and more variable conditions.

Onyango, E. A., et al. (2016). "An integrated risk and vulnerability assessment framework for climate change and malaria transmission in East Africa." Malaria Journal **15**.

Background: Malaria is one of the key research concerns in climate change-health relationships. Numerous risk assessments and modelling studies provide evidence that the transmission range of malaria will expand with rising temperatures, adversely impacting on vulnerable communities in the East African highlands. While there exist multiple lines of evidence for the influence of climate change on malaria transmission, there is insufficient understanding of the complex and interdependent factors that determine the risk and vulnerability of human populations at the community level. Moreover, existing studies have had limited focus on the nature of the impacts on vulnerable communities or how well they are prepared to cope. In order to address these gaps, a systems approach was used to present an integrated risk and vulnerability assessment framework for studies of community level risk and vulnerability to malaria due to climate change. Results: Drawing upon published literature on existing frameworks, a systems approach was applied to characterize the factors influencing the interactions between climate change and malaria transmission. This involved structural analysis to determine influential, relay, dependent and autonomous variables in order to construct a detailed causal loop conceptual model that illustrates the relationships among key variables. An integrated assessment framework that considers indicators of both biophysical and social vulnerability was proposed based on the conceptual model. Conclusions: A major conclusion was that this integrated assessment framework can be implemented using Bayesian Belief Networks, and applied at a community level using both quantitative and qualitative methods with stakeholder engagement. The approach enables a robust assessment of community level risk and vulnerability to malaria, along with contextually relevant and targeted adaptation strategies for dealing with malaria transmission that incorporate both scientific and community perspectives.

Ouyang, W., et al. (2015). "Soil respiration and carbon loss relationship with temperature and land use conversion in freeze-thaw agricultural area." Science of the Total Environment **533**: 215-222.

Soil respiration (R-s) was hypothesized to have a special response pattern to soil temperature and land use conversion in the freeze-thaw area. The R-s differences of eight types of land use conversions during agricultural development were observed and the impacts of R-s on soil organic carbon (SOC) loss were assessed. The land use conversions during last three decades were categorized into eight types, and the 141 SOC sampling sites were grouped by conversion type. The typical soil sampling sites were subsequently selected for monitoring of soil temperature and R-s of each land use conversion types. The R-s correlations with temperature at difference depths and different conversion types were identified with statistical analysis. The empirical mean error model and the biophysical theoretical model with Arrhenius equation about the R-s sensitivity to temperature were both analyzed and shared the similar patterns. The temperature dependence of soil respiration (Q(10)) analysis further demonstrated that the averaged value of eight types of land use in this freeze-thaw agricultural area ranged from 1.15 to 1.73, which was lower than the other cold areas. The temperature dependence analysis demonstrated that the R-s in the top layer of natural land covers was more sensitive to temperature and experienced a large vertical difference. The natural land covers exhibited smaller R-s and the farmlands had the bigger value due to tillage practices. The positive relationships between SOC loss and R-s were identified, which demonstrated that R-s was the key chain for SOC loss during land use conversion. The spatial-vertical distributions of SOC concentration with the 1.5-km grid sampling showed that the more SOC loss in the farmland, which was coincided with the higher R-s in farmlands. The analysis of R-s dynamics provided an innovative explanation for SOC loss in the freeze-thaw agricultural area. The analysis of R-s dynamics provided an innovative explanation for SOC loss in the freeze-thaw agricultural area. (C) 2015 Elsevier B.V. All rights reserved.

Panagos, P., et al. (2012). "Monthly soil erosion monitoring based on remotely sensed biophysical parameters: a case study in Strymonas river basin towards a functional pan-European service." International Journal of Digital Earth **5**(6): 461-487.

Currently, many soil erosion studies at local, regional, national or continental scale use models based on the USLE-family approaches. Applications of these models pay little attention to seasonal changes, despite evidence in the literature which suggests that erosion risk may change rapidly according to intra-annual rainfall figures and vegetation phenology. This paper emphasises the aspect of seasonality in soil erosion mapping by using month-step rainfall erosivity data and biophysical time series data derived from remote-sensing. The latter, together with other existing pan-European geo-databases sets the basis for a functional pan-European service for soil erosion monitoring at a scale of 1:500,000. This potential service has led to the establishment of a new modelling approach (called the G2 model) based on the inheritance of USLE-family models. The G2 model proposes innovative techniques for the estimation of vegetation and protection factors. The model has been applied in a 14,500 km(2) study area in SE Europe covering a major part of the basin of the cross-border river, Strymonas. Model results were verified with erosion and sedimentation figures from previous research. The study confirmed that monthly erosion mapping would identify the critical months and would allow erosion figures to be linked to specific land uses.

Panda, S., et al. (2016). "REMOTE ESTIMATION OF A MANAGED PINE FOREST EVAPOTRANSPIRATION WITH GEOSPATIAL TECHNOLOGY." Transactions of the Asabe **59**(6): 1695-1705.

Remote sensing has increasingly been used to estimate evapotranspiration (ET) and its supporting parameters in a rapid, accurate, and cost-effective manner. The goal of this study was to develop remote sensing-based models for estimating ET and the biophysical parameters canopy conductance (g(c)), upper-canopy temperature, and soil moisture for a mature loblolly pine forest (Pinus taeda L.) in the Parker Tract in eastern North Carolina. To validate the remote sensing approach, we acquired long-term on-site eddy flux measurements, including micrometeorological variables and water and energy fluxes. Other measured and derived ET-associated parameters include forest g(c), leaf area index, canopy absorbed radiation, canopy temperature, and soil moisture. Multi-temporal cloud-free (<= 10% cloud cover) Landsat 7 ETM+ satellite images from 2006-2012 were acquired. Field data for the 2 h (12: 00 noon to 2: 00 p.m.) means were used in the model, coinciding with the image acquisition time. Individual Landsat bands (1 through 7) and developed image vegetation indices (NDVI, SAVI, and VVI) for the study site were obtained through automated geospatial models and were correlated to measured ET flux and related parameters. An excellent coefficient of determination (R-2 = 0.93, n = 42) was obtained for the upper-canopy temperature versus band 6 (thermal infrared) model. However, a low correlation (R-2 = 0.36, n = 6) was obtained for gc versus band 5 (mid-infrared) model. The correlation for soil moisture versus band 7 was poor (R-2 = 0.05, n = 42), perhaps due to heavy canopy and pine litter ground cover. However, the ET estimation model with multiple image information variables, such as bands 5 and 7, provided a good correlation (R-2 = 0.55, n = 35) with less spatial and temporal variation in the datasets, along with no data mining application in model building. Therefore, this study suggests that the remote sensing approach is promising for estimating ET with good accuracy (average model prediction residual error = 25.46 W m(-2), 6.18% of the average ET values used in the analysis) for a mature homogenous pine forest. Further work is needed to develop robust remote sensing-based ET models by including spatial variability, sound data mining, high-resolution imagery, and advanced image processing to account for potential modeling uncertainties.

Pang, X. Y., et al. (2016). "Effect of thinning-induced gap size on soil CO2 efflux in a reforested spruce forest in the eastern Tibetan Plateau." Agricultural and Forest Meteorology **220**: 1-9.

Understanding the effects of forest management practices (e.g. thinning) on soil respiration (R-s) is crucial for the accurate estimation of forest carbon budget. However, little is known about the response of R-s to forest thinning in the subalpine region and its linkage to changes in environmental factors induced by thinning. We aimed to quantify the response of R-s rate to various gap sizes following thinning treatments, and to explore the relationships between Rs and soil temperature and moisture and other biophysical factors in the different gap sizes. We applied the thinning by simulating gap formation (four gap sizes at 0, 74, 109 and 196 m(2)) in a 26-year old spruce plantation in the eastern Tibetan Plateau. We measured R-s monthly before (July to November 2008) and after (December 2008 to June 2012) thinning, as well as monthly soil temperature and moisture and other biophysical factors. Thinning tended to decrease fine root biomass, litterfall, soil extractable C, and increased soil temperature and soil moisture. The change in soil temperature and moisture depended on the time after thinning and the size of forest gap. We found that R-s showed an immediate decrease in initial stage after thinning, followed by a gradual increase with understory development towards the level at the control plot. Overall, thinning decreased R-s rate by 14.9%, 15.8% and 25.8% in the small, intermediate and large gap, respectively, as compared to the control. We concluded that the decrease in Rs rates by thinning in a spruce plantation was driven by the decline in tree root biomass and

reduction in soil labile C. The positive effect of soil temperature elevation under thinning on Rs was masked by other factors, and the development of understory vegetation after thinning gradually offset the thinning-induced R-s reduction. Our results suggest the need to consider a set of abiotic and biotic factors induced by forest thinning intensity on R-s rates in modeling the response of soil C cycling to forest management practices. (C) 2016 Elsevier B.V. All rights reserved.

Partelow, S., et al. (2015). "Pollution exposure on marine protected areas: A global assessment." Marine Pollution Bulletin **100**(1): 352-358.

Marine protected areas (MPAs) face many challenges in their aim to effectively conserve marine ecosystems. In this study we analyze the extent of pollution exposure on the global fleet of MPAs. This includes indicators for current and future pollution and the implications for regionally clustered groups of MPAs with similar biophysical characteristics. To cluster MPAs into characteristic signature groups, their bathymetry, baseline biodiversity, distance from shore, mean sea surface temperature and mean sea surface salinity were used. We assess the extent at which each signature group is facing exposure from multiple pollution types. MPA groups experience similar pollution exposure on a regional level. We highlight how the challenges that MPAs face can be addressed through governance at the appropriate scale and design considerations for integrated terrestrial and marine management approaches within regional level networks. Furthermore, we present diagnostic social-ecological indicators for addressing the challenges facing unsuccessful MPAs with practical applications. (C) 2015 Elsevier Ltd. All rights reserved.

Paydar, Z., et al. (2011). "AN OVERVIEW OF IRRIGATION MOSAICS." Irrigation and Drainage **60**(4): 454-463.

Irrigation mosaics, involving discrete patches of irrigated land dispersed across the landscape, may offer an alternative to traditional large-scale contiguous irrigation systems. This might be particularly attractive as a means of delivering improved social and economic opportunities for some rural and remote communities as well as better matching land use opportunities with landscape properties. The longer-term environmental impacts of irrigation mosaics that may impair the sustainability of an irrigation project and the surrounding area are still largely unknown. However, there are findings from ecological and hydrological studies of other mosaics that can help with analysis of irrigation mosaics. This paper provides an overview of some biophysical aspects of irrigation mosaics, lessons learnt from other mosaics (e.g. landscape and farming system mosaics) and the potential environmental impacts of irrigation mosaics. Application of some tools for particular groundwater conditions indicates some of these impacts compared to traditional large-scale systems. Irrigation mosaics could have both negative (more evaporation and water use, increased operational losses and costs) and positive (filtering surplus nutrients, enhanced biodiversity, preventing erosion, reduced area of impact around the irrigation area, lower water-table rise) effects on the environment. Copyright (C) 2010 Commonwealth of Australia.

Pearson, R. G., et al. (2015). "Ecology of streams in a biogeographic isolate-the Queensland Wet Tropics, Australia." Freshwater Science **34**(2): 797-819.

Global studies of streams are needed to develop general ecosystem and management models. We reviewed research that tested ecological models in streams of the Queensland Wet Tropics bioregion (QWT), which makes up 0.26% of Australia but supports distinctive and high biodiversity, most of which is of Gondwanan or marine origin. QWT streams have seasonal but perennial flow, high insolation, and higher diversity of riparian vegetation, invertebrates, and fish than temperate streams. Consistent physical conditions sustain biological processes through the year, and predictable wet seasons, but unpredictable floods, have shaped a resilient and opportunistic biota. Stream food webs are dominated by predators, and prey turnover is rapid. Small streams are heterotrophic and become autotrophic as canopies open in larger streams. Predation and competition influence assemblage composition most in the dry season, when habitats contract and densities increase. Riparian clearing, weed invasion, and agricultural contamination affect table lands and floodplains. High temperatures exacerbate weed growth and eutrophication, but contaminants may be diluted by high flows from forested catchments. Climate change probably will cause warming and greater hydrological seasonality, threatening endemic species. The biophysical characteristics of QWT streams are found elsewhere in the tropics, but the species pool is not. QWT streams are important because of their insular and remnant nature. Patterns and processes can differ between QWT and comparable temperate systems because of biogeographic and biophysical characteristics and their interactions with anthropogenic effects, exacerbated by the tropical climate. Research in the QWT both affirms and contradicts theories of stream ecology, underpins conservation and management needs of tropical streams, and provides points of reference for comparative studies in stream ecology, conservation, and management.

Peel, D. R., et al. (2005). "The impact of realistic biophysical parameters for eucalypts on the simulation of the January climate of Australia." Environmental Modelling & Software **20**(5): 595-612.

Climate models use broad definitions of vegetation-based biophysical parameters that may not represent the continentally-specific nature of Australian vegetation well. This paper explores the impact on the January simulation of climate over Australia of this common simplification. First, we map the Australian distribution of vegetation types onto the default classification used in one high-resolution climate model. Second, through a search of the literature we chose replacement values for the biophysical parameters to better reflect the properties of eucalypts. Third, we choose several sets of biophysical parameters and allow these to vary regionally. We assess the impact of these changes on simulated rainfall, temperature and latent heat flux over an ensemble of six different Januaries. We find that the model simulates rainfall and temperature reasonably well over Australia in January and that replacing the default parameter set with a single set of more appropriate values degrades model performance slightly. Allowing the biophysical parameters to vary regionally leads to some small improvements in the simulation of temperature and precipitation. We find large impacts on the simulated latent heat flux. Overall, the model is not substantially improved by careful selection of eucalypt parameters. We comment that given the shortage of observed data on eucalypts and the almost total absence of biophysical parameters for other Australian vegetation types, this lack of sensitivity to the biophysical parameters is reassuring since it implies that the lack of data is not presently seriously limiting to our particular modelling capability. (C) 2004 Elsevier Ltd. All rights reserved.

Peng, D. L., et al. (2012). "Characteristics and drivers of global NDVI-based FPAR from 1982 to 2006." Global Biogeochemical Cycles **26**.

Fraction of Absorbed Photosynthetically Active Radiation (FPAR) is a state parameter in most ecosystem productivity models and is also the key terrestrial product. In this study, Normalized Difference Vegetation Index (NDVI) from Advanced Very High Resolution Radiometer (AVHRR) Global Inventory Modeling and Mapping Studies (GIMMS) was used to estimate FPAR from 1982 to 2006, using an intermediate model. Our research focused on the analysis of long-term global FPAR interannual trend patterns and driving forces involving climate and land cover changes. Results showed that interannual trend and spatial distribution patterns of global FPAR were independent of the changes in AVHRR instruments, and differed by season dynamics and vegetation types. Compared with other seasons, the period during JJA (June-August) exhibited more areas with decreasing FPAR and greater reduction range. For FPAR interannual trend, a wholly different correlation pattern was observed between temperature and precipitation, especially for arid and semi-arid regions. A significant influence of extreme droughts such as those associated with El Nino/Southern Oscillation (ENSO) on FPAR variability was found. The result also revealed the increasing and decreasing interannual trend of FPAR corresponding to the afforestation in the Three North Shelterbelts Program in China and deforestation in tropical forests in Southeast Asia. Driving factor analysis indicated that the climate and land cover changes had an interactive effect on the FPAR annual anomalous variation.

Pereira, M. P. S., et al. (2012). "Predicting land cover changes in the Amazon rainforest: An ocean-atmosphere-biosphere problem." Geophysical Research Letters **39**.

Accurate studies of the impacts of climate change on the distribution of major vegetation types are essential for developing effective conservation and land use policy. Such studies require the development of models that accurately represent the complex and interacting biophysical factors that influence regional patterns of vegetation. Here we investigate the impacts of Sea Surface Temperature (SST) on the vegetation of the Amazon, testing the hypothesis that changes in Amazonian vegetation structure are a consequence of an ocean-atmosphere-biosphere interaction. We design a numerical experiment in which we force a coupled climate-biosphere model by 10 SST patterns produced by different IPCC AR4 models, for the A2 scenario for the period 2000-2050. Simulations for 2011-2050 show that certain patterns of SST are likely to decrease the ensemble for tropical evergreen rainforest and savanna, and that these areas will be occupied mainly by tropical deciduous rainforest, emitting an average of 0.53 Pg-C. yr(-1) during the transition. Citation: Pereira, M. P. S., A. C. M. Malhado, and M. H. Costa (2012), Predicting land cover changes in the Amazon rainforest:

An ocean-atmosphere-biosphere problem, Geophys. Res. Lett., 39, L09713, doi: 10.1029/2012GL051556.

Pitman, A. J., et al. (2011). "Importance of background climate in determining impact of land-cover change on regional climate." Nature Climate Change **1**(9): 472-475.

Humans have modified the Earth's climate through emissions of greenhouse gases and through land-use and land-cover change (LULCC)(1). Increasing concentrations of greenhouse gases in the atmosphere warm the mid-latitudes more than the tropics, in part owing to a reduced snow-albedo feedback as snow cover decreases(2). Higher concentration of carbon dioxide also increases precipitation in many regions(1), as a result of an intensification of the hydrological cycle(2). The biophysical effects of LULCC since pre-industrial times have probably cooled temperate and boreal regions and warmed some tropical regions(3). Here we use a climate model to show that how snow and rainfall change under increased greenhouse gases dominates how LULCC affects regional temperature. Increased greenhouse-gas-driven changes in snow and rainfall affect the snow-albedo feedback and the supply of water, which in turn limits evaporation. These changes largely control the net impact of LULCC on regional climate. Our results show that capturing whether future biophysical changes due to LULCC warm or cool a specific region therefore requires an accurate simulation of changes in snow cover and rainfall geographically coincident with regions of LULCC. This is a challenge to current climate models, but also provides potential for further improving detection and attribution methods.

Poeplau, C., et al. (2017). "Sensitivity of soil carbon fractions and their specific stabilization mechanisms to extreme soil warming in a subarctic grassland." Global Change Biology **23**(3): 1316-1327.

Terrestrial carbon cycle feedbacks to global warming are major uncertainties in climate models. For in-depth understanding of changes in soil organic carbon (SOC) after soil warming, long-term responses of SOC stabilization mechanisms such as aggregation, organo-mineral interactions and chemical recalcitrance need to be addressed. This study investigated the effect of 6 years of geothermal soil warming on different SOC fractions in an unmanaged grassland in Iceland. Along an extreme warming gradient of + 0 to similar to+ 40 degrees C, we isolated five fractions of SOC that varied conceptually in turnover rate from active to passive in the following order: particulate organic matter (POM), dissolved organic carbon (DOC), SOC in sand and stable aggregates (SA), SOC in silt and clay (SC-rSOC) and resistant SOC (rSOC). Soil warming of 0.6 degrees C increased bulk SOC by 22 +/- 43% (0-10 cm soil layer) and 27 +/- 54% (20-30 cm), while further warming led to exponential SOC depletion of up to 79 +/- 14% (0-10 cm) and 74 +/- 8% (20-30) in the most warmed plots (similar to+ 40 degrees C). Only the SA fraction was more sensitive than the bulk soil, with 93 +/- 6% (0-10 cm) and 86 +/- 13% (20-30 cm) SOC losses and the highest relative enrichment in C-13 as an indicator for the degree of decomposition (+ 1.6 +/- 1.5 parts per thousand in 0-10 cm and + 1.3 +/- 0.8 parts per thousand in 20-30 cm). The SA fraction mass also declined along the warming gradient, while the SC fraction mass increased. This was explained by deactivation of aggregate-binding mechanisms. There was no difference between the responses of SC-rSOC (slow-cycling) and rSOC (passive) to warming, and C-13 enrichment in rSOC was equal to that in bulk soil. We concluded that the sensitivity of SOC to warming was not a function of age or chemical recalcitrance, but triggered by changes in biophysical stabilization mechanisms, such as aggregation.

Pongratz, J., et al. (2006). "The impact of land cover change on surface energy and water balance in Mato Grosso, Brazil." Earth Interactions **10**.

The sensitivity of surface energy and water fluxes to recent land cover changes is simulated for a small region in northern Mato Grosso, Brazil. The Simple Biosphere Model (SiB2) is used, driven by biophysical parameters derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) at 250-m resolution, to compare the effects of different land conversion types. The mechanisms through which changes in vegetation alter surface fluxes of energy, momentum, water, and carbon are analyzed for both wet and dry seasons. It is found that morphological changes contribute to warming and drying of the atmosphere while physiological changes, particularly those associated with a plant's photosynthetic pathway, counterbalance or exacerbate the warming depending on the type of conversion and the season. Furthermore, this study's results indicate that initial clearing of evergreen and transition forest to bare ground increases canopy temperature by up to 1.7 degrees C. For subsequent land use such as pasture or cropland, the largest effect is seen for the conversion of evergreen forest to C3 cropland during the wet season, with a 21% decrease of the latent heat flux and 0.4 degrees C increase in canopy temperature. The secondary conversion of pasture to cropland resulted in slight warming and drying during the wet season driven mostly by the change in carbon pathway from C4 to C3. For all conversions types, the daily temperature range is amplified, suggesting that plants replacing forest clearing require more temperature tolerance than the trees they replace. The results illustrate that the effect of deforestation on climate depends not only on the overall extent of clearing but also on the subsequent land use type.

Porfirio, L. L., et al. (2017). "Patterns of crop cover under future climates." Ambio **46**(3): 265-276.

We study changes in crop cover under future climate and socio-economic projections. This study is not only organised around the global and regional adaptation or vulnerability to climate change but also includes the influence of projected changes in socio-economic, technological and biophysical drivers, especially regional gross domestic product. The climatic data are obtained from simulations of RCP4.5 and 8.5 by four global circulation models/earth system models from 2000 to 2100. We use Random Forest, an empirical statistical model, to project the future crop cover. Our results show that, at the global scale, increases and decreases in crop cover cancel each other out. Crop cover in the Northern Hemisphere is projected to be impacted more by future climate than the in Southern Hemisphere because of the disparity in the warming rate and precipitation patterns between the two Hemispheres. We found that crop cover in temperate regions is projected to decrease more than in tropical regions. We identified regions of concern and opportunities for climate change adaptation and investment.

Porter, W. P., et al. (2010). "Modeling Animal Landscapes." Physiological and Biochemical Zoology **83**(5): 705-712.

There is an increasing need to assess the effects of climate and land-use change on habitat quality, ideally from a mechanistic basis. The symposium "Molecules to Migration: Pressures of Life" at the Fourth International Conference in Africa for Comparative Physiology and Biochemistry, Maasai Mara National Reserve, Kenya, 2008, illustrated how the principles of biophysical ecology can capture the mechanistic links between organisms, climate, and other habitat features. These principles provide spatially explicit assessments of habitat quality from a physiological perspective (i.e., "animal landscapes") that can be validated independently of the data used to derive and parameterize them. The contents of this symposium showcased how the modeling of animal landscapes can be used to assess key issues in applied and theoretical ecology. The presentations included applications to amphibians, reptiles, birds, and mammals. The rare Arabian oryx on the Arabian Peninsula is used as an example for energetic calculations and their implications for behavior on the landscape.

Powers, J. S., et al. (2011). "Geographic bias of field observations of soil carbon stocks with tropical land-use changes precludes spatial extrapolation." Proceedings of the National Academy of Sciences of the United States of America **108**(15): 6318-6322.

Accurately quantifying changes in soil carbon (C) stocks with land-use change is important for estimating the anthropogenic fluxes of greenhouse gases to the atmosphere and for implementing policies such as REDD (Reducing Emissions from Deforestation and Degradation) that provide financial incentives to reduce carbon dioxide fluxes from deforestation and land degradation. Despite hundreds of field studies and at least a dozen literature reviews, there is still considerable disagreement on the direction and magnitude of changes in soil C stocks with land-use change. We conducted a meta-analysis of studies that quantified changes in soil C stocks with land use in the tropics. Conversion from one land use to another caused significant increases or decreases in soil C stocks for 8 of the 14 transitions examined. For the three land-use transitions with sufficient observations, both the direction and magnitude of the change in soil C pools depended strongly on biophysical factors of mean annual precipitation and dominant soil clay mineralogy. When we compared the distribution of biophysical conditions of the field observations to the area-weighted distribution of those factors in the tropics as a whole or the tropical lands that have undergone conversion, we found that field observations are highly unrepresentative of most tropical landscapes. Because of this geographic bias we strongly caution against extrapolating average values of land-cover change effects on soil C stocks, such as those generated through meta-analysis and literature reviews, to regions that differ in biophysical conditions.

Pyke, C. R. and S. J. Andelman (2007). "Land use and land cover tools for climate adaptation." Climatic Change **80**(3-4):

239-251.

Land use and land cover interact with atmospheric conditions to determine current climate conditions, as well, as the impact of climate change and environmental variability on ecological systems. Such interactions are ubiquitous, yet changes in LULC are generally made without regard to their biophysical implications. This review considers the potential for LULC to compound, confound, or even contradict changes expected from climate change alone. These properties give LULC the potential to be used as powerful tools capable of modifying local climate and contributing significantly to the net impact of climate change. Management practices based modifications of LULC patterns and processes could be applied strategically to increase the resilience of vulnerable ecological systems and facilitate climate adaptation. These interventions build on the traditional competencies of land management and land protection organizations and suggest that these institutions have a central role in determining the ecological impact of climate change and the development of strategies for adaptation. The practical limits to the use of LULC-based tools also suggest important inflection points between manageable and dangerous levels of climate change.

Pyke, C. R. and J. Marty (2005). "Cattle grazing mediates climate change impacts on ephemeral wetlands." Conservation Biology **19**(5): 1619-1625.

Climate change impacts depend in large part on land-management decisions; interactions between global changes and local resource management, however, rarely have been quantified. We used a combination of experimental manipulations and simulation modeling to investigate the effects of interactions between cattle grazing and regional climate change on vernal pool communities. Data from a grazing exclosure study indicated that 3 years after the removal of grazing, ungrazed vernal pools dried an average of 50 days per year earlier than grazed control pools. Modeling showed that regional climate change could also alter vernal pool hydrology. Increased temperatures and winter precipitation were predicted to increase periods of inundation. We evaluated the ecological implications of interactions between grazing and climate change for branchiopods and the California tiger salamander (Ambystoma californiense) at four sites spanning a latitudinal climate gradient. Grazing played an important role in maintaining the suitability of vernal pool hydrological conditions for fairy shrimp and salamander reproduction. The ecological importance of the interaction varied nonlinearly across the region. Our results show that grazing can confound hydrologic changes driven by climate change and play a critical role in maintaining the hydrologic suitability of vernal pools for endangered aquatic invertebrates and amphibians. These observations suggest an important limitation of impact assessments of climate change based on experiments in unmanaged ecosystems. The biophysical impacts of land management may be critical for understanding the vulnerability of ecological systems to climate change.

Qin, Q., et al. (2008). "Satellite monitoring of spatio-temporal dynamics of China's coastal zone eco-environments: preliminary analysis on the relationship between the environment, climate change and human behavior." Environmental Geology **55**(8): 1687-1698.

In this paper, temporal dynamics of eco-environmental changes in coastal areas of China during 1981-2000 are investigated based on four key surface parameters including normalized difference vegetation index (NDVI), thermal index, moisture index and surface broadband albedo derived from quantitative remote sensing techniques and meteorological data. Firstly, land surface temperature (LST) and land surface broadband albedo are retrieved by the split-window algorithms and high-order polynomial regression method, respectively, using NOAA/AVHRR series images. Then, moisture index and thermal index, indicators of climate and moisture conditions in the study area, are computed from meteorological data and LST using principal component analysis (PCA). Finally, long-term dynamics of these eco-environmental factors and the reasons responsible for these changes are analyzed further. The results show that during the years from 1981 to 2000, the study area experienced a gradual increase in annual NDVI and climate factors and a decrease in surface annual broadband albedo, which indicates that the coastal thermal and moisture conditions and the subsistence conditions of natural vegetation have changed to a considerable extent. According to the results, a warming and wetting tendency over the last two decades is obvious in the China's coastal zone that are mainly due to land use changes as of growing urbanization, exhaust emissions from industries and transportations and, partly global climate change. Uncontrolled rapid development of the study area may be blamed for these negative changes as a major driving force. The positive feedback mechanisms between albedo, NDVI and climate factors also partly explain these changes. This study suggests that the method

integrating biophysical parameters retrieved from remote sensed images and meteorologic data provides a novel and feasible way to monitor large scale eco-environmental changes.

Quesada, B., et al. (2017). "Atmospheric, radiative, and hydrologic effects of future land use and land cover changes: A global and multimodel climate picture." Journal of Geophysical Research-Atmospheres **122**(10): 5113-5131.
Land use and land cover changes (LULCC) modulate land surface energy, heat, moisture, and momentum fluxes. Using simulations performed with and without LULCC for five earth system models, averaged over the 2071-2100 period, we quantify the biophysical effects in response to a future realistic LULCC scenario (Representative Concentration Pathway RCP8.5) on 15 climate variables (i.e., atmospheric, radiative, wind, hydrologic variables, and heat fluxes). We find that climate models are able to simulate some robust and strong climate perturbations in response to LULCC. In tropical regions with substantial LULCC, significantly higher skin temperatures, less precipitation and soil moisture, less evaporation and clouds, more incoming radiation and stronger winds, more anticyclonic conditions and subsidence, are simulated in response to future LULCC. In midlatitude and high latitude, LULCC result in autumn cooling and higher tropospheric pressures, while East Asia is drier, warmer, with higher sensible heat flux and lower evaporation. The tropical wind strengthening and weakening of the hydrological cycle are comparable in magnitude to their future regional changes induced by greenhouse gases under RCP8.5, which make LULCC an indispensable forcing to take into account in future climatic assessments. Finally, our study reveals significant indirect atmospheric processes triggered by LULCC, implying substantial changes in incoming radiation, which dominate climatic responses over the direct effects, particularly in boreal regions. Plain Language Summary Trees affect climate not only by modulating greenhouse gases sequestration but also by regulating the exchange of energy, heat, water, and momentum with the atmosphere. However, few studies quantified, in a consistent way, all the latter perturbations for a realistic deforestation scenario or with several models. Analyzing five earth system models, for a common future business-as-usual land use and land cover changes (LULCC) scenario, we show that significant atmospheric, radiative, and hydrologic changes are robustly simulated. Among others, the weakened hydrological cycle and the wind strengthening due to tropical deforestation are comparable in magnitude to the projected changes induced by greenhouse gases. Our investigation also reveals significant indirect atmospheric processes triggered by LULCC, implying substantial changes in incoming radiation, which dominate climatic responses over the direct effects (albedo, evapotranspiration, or roughness changes), particularly in boreal regions. In consequence, LULCC are a critical forcing that needs to be taken into account for future climatic assessments.

Quesada, B., et al. (2017). "Reduction of monsoon rainfall in response to past and future land use and land cover changes." Geophysical Research Letters **44**(2): 1041-1050.
Land use and land cover changes (LULCC) can have significant biophysical impacts on regional precipitation, including monsoon rainfall. Using global simulations with and without LULCC from five general circulation models, under the Representative Concentration Pathway 8.5 scenario, we find that future LULCC significantly reduce monsoon precipitation in at least four (out of eight) monsoon regions. While monsoon rainfalls are likely to intensify under future global warming, we estimate that biophysical effects of LULCC substantially weaken future projections of monsoons' rainfall by 9% (Indian region), 12% (East Asian), 32% (South African), and 41% (North African), with an average of similar to 30% for projections across the global monsoon region. A similar strong contribution is found for biophysical effects of past LULCC to monsoon rainfall changes since the preindustrial period. Rather than remote effects, local land-atmosphere interactions, implying a decrease in evapotranspiration, soil moisture, and clouds along with more anticyclonic conditions, could explain this reduction in monsoon rainfall.

Rajasekar, U. and Q. H. Weng (2009). "Application of Association Rule Mining for Exploring the Relationship between Urban Land Surface Temperature and Biophysical/Social Parameters." Photogrammetric Engineering and Remote Sensing **75**(4): 385-396.
This paper explores the relationship between remote sensing measurements of land surface temperature and biophysical/socioeconomic data by utilizing the association rule mining technique. The surfaces associated with urban uses typically radiate more heat as compared to its rural counterparts. There is a need to quantitatively analyze this contrast in temperature and the biophysical and social characteristics which influence it. Furthermore, in order to consider the urban heat island (UHI) effect, a parameterization is

required to account for the urban surface characteristics impacts on the magnitude of land surface temperature (LST). The association rule mining model has demonstrated to bring in additional quantitative information concerning the relationship;; among urban parameters. The ASTER data from 2000 was used for the selection of appropriate variables to be used in the model. This information was then used for generating association rules between land-use land-cover (LULC) and LST information from 2000, 2001, and 2004. The results thus obtained quantitatively described the relationships between various urban parameters. It was found that there was little change in the percentage area of the LULC types from 2000 to 2004. This made the comparison of the results possible, In the case of the 2000 data, it was found that forest and impervious surfaces had strong association with temperature and scaled normalized difference vegetation index (SNDVI). Specific zones such as hospitals and universities had negative association with water. The comparison of data from 2000, 2001, and 2004 suggests that impervious surface and the zoning category of airport had a strong association. Nevertheless, the information extracted needs to be analyzed in greater detail in order to arrive at robust decision rules. Overall, the model so developed has demonstrated to be effective in predicting associations between urban EST and pertinent factors. This model could be useful for urban planners and environmental managers in quantifying rules that characterize a particular urban

Ramirez, C. D., et al. (2018). "Identifying Drivers and Spatial Patterns of Deforestation in the Rio Grande Basin, Colombia." Journal of Latin American Geography **17**(1): 108-138.

Identifying the spatial patterns and drivers of deforestation is a critical task in geographic research. In addition to mapping deforestation, it's important to determine the statistical effects of the spatial configuration of tropical landscapes on current deforestation trends. To accurately model drivers of deforestation, it is important to take into account the spatial structure of data (i.e., whether or not observed deforestation is spatially clustered). We calculated deforestation rates at the village level in the Rio Grande Basin, Colombia, using land cover information derived from Landsat TM/ETM satellite imagery (1986-2012). We used econometric models to understand the deforestation patterns using a set of socioeconomic, biophysical, and accessibility variables. Exploratory Spatial Data Analysis showed the existence of globally and locally positive spatial autocorrelation. The Spatial Lag Model, which considers spatial data autocorrelation, explained most of the variability in deforestation patterns. The main drivers of deforestation for the region over a twenty-six-year period were annual average temperature, population density, road density, and distance to main rivers. Results show that observed deforestation is closely related to dairy farming; this is due to the long history of human intervention in the watershed. We found some forest recovery in recent years; however, forest loss continues to be the dominant way land is changing in Andean landscapes, with positive spatial interdependencies. Identifying drivers of deforestation using methods that account for spatial autocorrelation can inform national conservation policies and programs aimed at providing ecosystem services.

Ray, D., et al. (2005). "Micrometeorological and canopy controls of fire susceptibility in a forested Amazon landscape." Ecological Applications **15**(5): 1664-1678.

Fire is playing an increasing role in shaping the structure, composition, and function of vast areas of moist tropical forest. Within the Brazilian Amazon, cattle ranching and swidden agriculture provide abundant sources of ignition to forests that become susceptible to fire through selective logging, severe drought and, perhaps, fragmentation. Our understanding of the biophysical factors that control fire spread through Amazon forests remains largely anecdotal, however, restricting our ability to model the Amazon fire regime, and to simulate the effects of trends in climate and land-use activities on future regimes. We used experimental fires together with measurements of micrometeorology (rainfall, vapor pressure deficit [VPD], wind velocity), canopy attributes (leaf area index [LAI], canopy height), and fuel characteristics (litter moisture content [LMC] and mass) to identify the variables most closely associated with fire susceptibility in the east-central Amazon. Fire spread rates (FSR, m/min) were measured in three common forest types: an 8-yr-old regrowth forest, a recently logged/burned forest, and a mature forest. One hundred fires were set in each study area during the last two months of the 2002 dry season. VPD, recent precipitation history, wind velocity, and LAI explained 57% of the variability in FSR. In combination, LAI, canopy height, and recent precipitation history accounted for similar to 65% of the-variability in VPD, the single most important predictor of FSR, and approximately half of the total observed variability in FSR. Using logistic regression we were able to predict whether a fire would spread or die 72% of the time based on LAI, canopy height, and recent precipitation history. An approximate threshold in fire susceptibility was associated with a LMC of similar to 23%, somewhat higher than previously reported (15%). Fire susceptibility was highest under low, sparse canopies, which permitted greater coupling of relatively hot, dry air above the canopy with the otherwise cool, moist air near the forest floor. Fire susceptibility increased over time after rain events as the forest floor gradually dried. The most important determinants of fire susceptibility can be captured in ecosystem and climate models and through remotely sensed estimates of canopy structure, canopy water content, and microclimatic variables.

Reyer, C. P. O., et al. (2017). "Climate change impacts in Latin America and the Caribbean and their implications for development." Regional Environmental Change **17**(6): 1601-1621.

This paper synthesizes what is known about the physical and biophysical impacts of climate change and their consequences for societies and development under different levels of global warming in Latin America and the Caribbean (LAC). Projections show increasing mean temperatures by up to 4.5 A degrees C compared to pre-industrial by the end of this century across LAC. Associated physical impacts include altered precipitation regimes, a strong increase in heat extremes, higher risks of droughts and increasing aridity. Moreover, the mean intensity of tropical cyclones, as well as the frequency of the most intense storms, is projected to increase while sea levels are expected to rise by similar to 0.2-1.1 mm depending on warming level and region. Tropical glacier volume is found to decrease substantially, with almost complete deglaciation under high warming levels. The much larger glaciers in the southern Andes are less sensitive to warming and shrink on slower timescales. Runoff is projected to be reduced in Central America, the southern Amazon basin and southernmost South America, while river discharge may increase in the western Amazon basin and in the Andes in the wet season. However, in many regions, there is uncertainty in the direction of these changes as a result of uncertain precipitation projections and differences in hydrological models. Climate change will also reduce agricultural yields, livestock and fisheries, although there may be opportunities such as increasing rice yield in several LAC countries or higher fish catch potential in the southernmost South American waters. Species range shifts threaten terrestrial biodiversity, and there is a substantial risk of Amazon rainforest degradation with continuing warming. Coral reefs are at increasing risk of annual bleaching events from 2040 to 2050 onwards irrespective of the climate scenario. These physical and biophysical climate change impacts challenge human livelihoods through, e.g., decreasing income from fisheries, agriculture or tourism. Furthermore, there is evidence that human health, coastal infrastructures and energy systems are also negatively affected. This paper concludes that LAC will be severely affected by climate change, even under lower levels of warming, due to the potential for impacts to occur simultaneously and compound one another.

Riley, W. J. (2005). "A modeling study of the impact of the delta O-18 value of near-surface soil water on the delta O-18 value of the soil-surface CO2 flUX." Geochimica Et Cosmochimica Acta **69**(8): 1939-1946.

Measurements of O-18 in atmospheric CO2 have been used to partition site-level measured net ecosystem CO2 fluxes into gross fluxes and as a constraint on land surface biophysical processes at regional and global scales. However, these approaches require prediction of the delta O-18 value of the net CO2 flux between the soil and atmosphere (delta(F)), a quantity that is difficult to measure and accurately predict. delta(F) depends on the depth-dependent delta O-18 value of soil water (delta(SW)), soil moisture and temperature, soil CO2 production, and the delta O-18 value of above-surface CO2 I applied numerical model manipulations, regression analysis, a simple estimation method, and an analysis of the characteristic times of relevant processes to study the impacts of these parameters on delta(F). The results indicate that ignoring delta(SW) gradients in the near-surface soil can lead to large errors. In particular, in systems where delta(SW) gradients exist, generalizing previous experimental observations to infer that a bulk (e.g., 5-10 cm or 5-15 cm depth) estimate of delta(SW) can be used to estimate 5, is problematic. These results highlight the need for further experiments and argue for the importance of accurately resolving near-surface delta(SW) in the context of partitioning ecosystem CO2 fluxes and CO2 source attribution. Copyright (c) 2005 Elsevier Ltd

Rishmawi, K. and S. D. Prince (2016). "Environmental and Anthropogenic Degradation of Vegetation in the Sahel from 1982 to 2006." Remote Sensing **8**(11).

There is a great deal of debate on the extent, causes, and even the reality of land degradation in the Sahel. Investigations carried out before approximately 2000 using remote sensing data suggest widespread

reductions in biological productivity, while studies extending beyond 2000 consistently reveal a net increase in vegetation production, strongly related to the recovery of rainfall following the extreme droughts of the 1970s and 1980s, and thus challenging the notion of widespread, long-term, subcontinental-scale degradation. Yet, the spatial variations in the rates of vegetation recovery are not fully explained by rainfall trends. It is hypothesized that, in addition to rainfall, other meteorological variables and human land use have contributed to vegetation dynamics. Throughout most of the Sahel, the interannual variability in growing season Sigma NDVIgs (measured from satellites, used as a proxy of vegetation productivity) was strongly related to rainfall, humidity, and temperature (mean r(2) = 0.67), but with rainfall alone was weaker (mean r(2) = 0.41). The mean and upper 95th quantile (UQ) rates of change in Sigma NDVIgs in response to climate were used to predict potential Sigma NDVIgs-that is, the Sigma NDVIgs expected in response to climate variability alone, excluding any anthropogenic effects. The differences between predicted and observed Sigma NDVIgs were regressed against time to detect any long-term (positive or negative) trends in vegetation productivity. Over most of the Sahel, the trends did not significantly depart from what is expected from the trends in meteorological variables. However, substantial and spatially contiguous areas (similar to 8% of the total area of the Sahel) were characterized by negative, and, in some areas, positive trends. To explore whether the negative trends were human-induced, they were compared with the available data of population density, land use, and land biophysical properties that are known to affect the susceptibility of land to degradation. The spatial variations in the trends of the residuals were partly related to soils and tree cover, but also to several anthropogenic pressures.

Rishmawi, K., et al. (2016). "Vegetation Responses to Climate Variability in the Northern Arid to Sub-Humid Zones of Sub-Saharan Africa." Remote Sensing **8**(11).

In water limited environments precipitation is often considered the key factor influencing vegetation growth and rates of development. However; other climate variables including temperature; humidity; the frequency and intensity of precipitation events are also known to affect productivity; either directly by changing photosynthesis and transpiration rates or indirectly by influencing water availability and plant physiology. The aim here is to quantify the spatiotemporal patterns of vegetation responses to precipitation and to additional; relevant; meteorological variables. First; an empirical; statistical analysis of the relationship between precipitation and the additional meteorological variables and a proxy of vegetation productivity (the Normalized Difference Vegetation Index; NDVI) is reported and; second; a process-oriented modeling approach to explore the hydrologic and biophysical mechanisms to which the significant empirical relationships might be attributed. The analysis was conducted in Sub-Saharan Africa; between 5 and 18 degrees N; for a 25-year period 1982-2006; and used a new quasi-daily Advanced Very High Resolution Radiometer (AVHRR) dataset. The results suggest that vegetation; particularly in the wetter areas; does not always respond directly and proportionately to precipitation variation; either because of the non-linearity of soil moisture recharge in response to increases in precipitation; or because variations in temperature and humidity attenuate the vegetation responses to changes in water availability. We also find that productivity; independent of changes in total precipitation; is responsive to intra-annual precipitation variation. A significant consequence is that the degree of correlation of all the meteorological variables with productivity varies geographically; so no one formulation is adequate for the entire region. Put together; these results demonstrate that vegetation responses to meteorological variation are more complex than an equilibrium relationship between precipitation and productivity. In addition to their intrinsic interest; the findings have important implications for detection of anthropogenic dryland degradation (desertification); for which the effects of natural fluctuations in meteorological variables must be controlled in order to reveal non-meteorological; including anthropogenic; degradation.

Rivington, M., et al. (2013). "Climate change impacts and adaptation scope for agriculture indicated by agro-meteorological metrics." Agricultural Systems **114**: 15-31.

Agro-meteorological metrics are indicators of weather determined environmental conditions on which agricultural management decisions are made. Metrics derived from an estimated future climate provide an opportunity to characterise the impacts of climate change on a wide range of agricultural systems, land use practices and ecosystem services. Such indications are vital for determining how changes in the biophysical environment can lead to land management and policy adaptations to achieve multiple objectives of financial viability, food security, biodiversity conservation and environmental sustainability. They provide valuable

links between probable management adaptation responses and capacity for mitigating greenhouse gas emissions. However, there are large uncertainties associated with projected future climates, including the climate models' spatial scale of representation and those at which agro-meteorological metrics are applied. This paper describes the estimation of agro-meteorological metrics derived from observed weather and downscaled Regional Climate Model projection data for 12 sites in Scotland. Results show that projected changes to seasonal rainfall distribution, growing season length, soil moisture deficits and accessibility will be substantially different from the present climate. Fundamentally, the metrics indicate a substantial shift in land management requirements and potential need for substantial changes in agricultural systems and land use that will have implications across a wide range of research disciplines. (C) 2012 Elsevier Ltd. All rights reserved.

Rouse, W. R. (2000). "Progress in hydrological research in the Mackenzie GEWEX study." Hydrological Processes **14**(9): 1667-1685.

This paper reports some of the achievements in hydrological research associated with the Mackenzie GEWEX Study (MAGS). MAGS is a multifaceted study of the energy and water cycle in the Mackenzie River Basin, north-western Canada, and emphasizes cold-region processes and modelling. It pursues methodologies of scaling-up process studies to a large river basin that has few measurement sites. This methodology involves new developments, adapting mid-latitude algorithms to the high latitude setting and promoting the use of remote sensing tools for scaling-up. Intensive hydrological process studies have been concentrated at a number of sites. These have been chosen to represent different biophysical facets of the Mackenzie River Basin. They include northern basins in open tundra and at tree-line, a western basin representing the hilly and mountainous western side of the basin, central basin sites of wetlands, Precambrian Shield terrain and the Mackenzie Basin counterpart of the large Laurentian Great Lakes. The most southerly site represents a mixed-wood boreal forest site that is undergoing land-use change as a result of forest harvesting. Regional community model analysis indicates that processes of lee cyclogenesis result in differential input of precipitation across the basin. Significant results centre on models of snow accumulation featuring the role of blowing snow, intercepted snow and snowmelt. These models emphasize the importance of snow patchiness to speed of melt. Snowmelt infiltration into frozen soils is important in controlling runoff, and tundra microlandforms play a unique role in determining the surface runoff characteristics. On the western margins of the basin, there is a very significant difference in the hydrological behaviour of slopes of different aspects as a result of differences in permafrost and vegetation. In the central basin, a deeper understanding of components of the water budget is being gained through stable isotope analysis of wetland waters. The importance of wetland-controlled spring flow, and its impact on spring breakup characteristics on the Mackenzie River, is being explored. A quite unique influence of Precambrian Shield terrain on the water balance results from the large storage capacity of deep bedrock fissures. They can substantially delay streamflow response to snowmelt. The large lakes of the Mackenzie Basin echo, only in part, the behaviour of the Laurentian Great Lakes. A surprising and rapid response of evaporation to warming during the 1998 El Nino warming episode occurred, which could serve as a surrogate for warming resulting from climate change. In the southern and central forested parts of the basin, vegetation types play a substantial role in the water balance, particularly in influencing interception and subsequent sublimation during winter. The latter is an important component of the water balance and a major cold-region process, the modelling of which is an important achievement of MAGS. Remote sensing provides passive microwave satellite data to help identify snow-water characteristics and calculate the break-up and freeze-up dates of the Mackenzie great lakes, and AVHRR data to help develop algorithms for evapotranspiration modelling, and to use in calculating the surface solar radiation budget on a basin scale. Ongoing research is successfully integrating a GCM model land-surface scheme, regional community climate model and hydrological model to simulate the water balance of sub-basins and of the total Mackenzie River Basin system. Expected achievements at the end of MAGS Phase 1 are outlined and some goals for future MAGS research are discussed. Copyright (C) 2000 John Wiley & Sons, Ltd.

Rowland, J. A., et al. (2017). "Comparing the thermal suitability of nest-boxes and tree-hollows for the conservation-management of arboreal marsupials." Biological Conservation **209**: 341-348.

Hundreds of species rely on tree-hollows for shelter and breeding, however land-clearing has reduced their availability worldwide. While nest-boxes are deployed extensively in hollow-deficient habitats, their thermal value for arboreal marsupials compared to tree-hollows is unclear, particularly in temperate environments. We analysed thermal regimes in nest-box and tree-hollow pairs during summer and winter environmental conditions. Using a biophysical model, we quantified the relative suitability of den-sites for several marsupial species, estimating the impact of microclimates (and ambient conditions) on predicted heat-production and heat-loss. Nest-box temperatures were strongly influenced by ambient temperatures and solar radiation, whereas tree-hollows buffered external temperature fluctuations. On average, nest-boxes reached maximum temperatures 8 degrees C higher than tree-hollows in summer, and 3 degrees C higher in winter, with maximum temperatures of 52 degrees C recorded in nest-boxes, compared to 38 degrees C in tree-hollows. During summer, estimated heat-loss required by marsupials was 1.5-2.4 times higher in nest-boxes than tree-hollows. Conversely, predicted winter heat-production requirements were slightly lower in nest-boxes (0.95-0.97 of hollow requirements). Our study emphasises the importance of retaining tree-hollows as thermal refuges for hollow-dependent marsupials in temperate zones to reduce thermoregulatory costs during heat-events. Current nest-box designs are likely of limited value during high temperatures and solar radiation loads if they consistently reach temperatures exceeding species upper critical temperatures, however may provide suitable microclimates during winter. With increasing and more prolonged heat-events predicted under climate change, future conservation-management programs should focus on improving nest-box thermal properties to enhance suitability for wildlife. (C) 2017 Elsevier Ltd. All rights reserved.

Ruddell, B. L., et al. (2016). "Seasonally varied controls of climate and phenophase on terrestrial carbon dynamics: modeling eco-climate system state using Dynamical Process Networks." Landscape Ecology **31**(1): 165-180.

Prediction of climate impacts on terrestrial ecosystems is limited by the complexity of the couplings between biosphere and atmosphere-what we define here as eco-climate. Critical transitions in ecosystem function and structure must be conceptualized, modeled, and ultimately predicted. Eco-climate system macrostate is a pattern of physical couplings between subsystems; each macrostate must be modeled differently because different physical processes are important. Critical transitions are less likely where the elasticity of macrostate is weak or absent. This motivates a fundamentally new complex systems approach. To model eco-climate macrostate, and its elasticity to seasonal climate forcing (air temperature and precipitation) and ecosystem biophysical state (phenophase). This Dynamical Process Network approach uses information flow to model an eco-climate system structure using timeseries observations from seven eddy-covariance tower sites in the United States. An aggregate power-law model estimates the elasticity of each location's macrostate to seasonal climate and phenophase. Macrostate varies by both season and ecosystem type. Evergreen forests are highly elastic to air temperature and are more likely than agricultural or deciduous systems to experience state changes as the climate warms. Precipitation and phenophase elasticity is stronger in some agricultural, grassland, and deciduous forest systems. Different empirical model structures are needed based on season and location, to simulate ecosystem carbon dynamics and critical state transitions. Phenophase directly controls macrostate in some ecosystems. Flux data co-located with in situ ecological monitoring are essential for eco-climate model development and prediction using complex systems approaches.

Rutherford, W. A., et al. (2017). "Albedo feedbacks to future climate via climate change impacts on dryland biocrusts." Scientific Reports **7**.

Drylands represent the planet's largest terrestrial biome and evidence suggests these landscapes have large potential for creating feedbacks to future climate. Recent studies also indicate that dryland ecosystems are responding markedly to climate change. Biological soil crusts (biocrusts). soil surface communities of lichens, mosses, and/or cyanobacteria. comprise up to 70% of dryland cover and help govern fundamental ecosystem functions, including soil stabilization and carbon uptake. Drylands are expected to experience significant changes in temperature and precipitation regimes, and such alterations may impact biocrust communities by promoting rapid mortality of foundational species. In turn, biocrust community shifts affect land surface cover and roughness-changes that can dramatically alter albedo. We tested this hypothesis in a full-factorial warming (+ 4 degrees C above ambient) and altered precipitation (increased frequency of 1.2 mm monsoon-type watering events) experiment on the Colorado Plateau, USA. We quantified changes in shortwave albedo via multi-angle, solar-reflectance measurements. Warming and watering treatments each led to large increases in albedo (> 30%). This increase was driven by biophysical factors related to treatment effects on cyanobacteria cover and soil surface roughness following treatment-induced moss and lichen mortality. A rise in dryland surface albedo may represent a previously unidentified feedback to future climate.

Ryan, K. C. (2002). "Dynamic interactions between forest structure and fire behavior in boreal ecosystems." Silva Fennica **36**(1): 13-39.

This paper reviews and synthesizes literature on fire as a disturbance factor in boreal forests. Spatial and temporal variation in the biophysical environment, specifically, vegetative structure, terrain, and weather lead to variations in fire behavior. Changes in slope, aspect, elevation, and soil affect site energy and water budgets and the potential plant community. These terrain features also have a major influence on fire-caused disturbance through their role in determining moisture conditions and flammability of fuels on hourly, seasonal, and successional time-scales. On fine time scales (minutes to hours), changes in weather, specifically wind and relative humidity, significantly affect a fire's intensity and aboveground effects. Normal seasonal changes in dryness and periodic drought influence fire intensity and severity principally by affecting the depth of burn and belowground effects. On decades-long time scales changes in vegetative structure affect the mass of fuel available for burning and therefore the potential energy that can be released during a fire. The severity of fire varies in time and space depending not only on the biophysical environment, but also on the location on the fire's perimeter (head vs. flank vs. rear). Spatial and temporal variation in severity within a fire can have long-lasting impacts on the structure and species composition of post-fire communities and the potential for future disturbances. Characteristic temperature histories of ground, surface, and crown fires are used to illustrate variations in fire severity. A soil-heating model is used to illustrate the impact of varying depth of burn on the depth at which various fire effects occur in the soil profile. A conceptual model is presented for the effects of fire severity on fire-plant regeneration interactions. The conceptual model can be used by restoration ecologists to evaluate the differential effects of controlled or prescribed fires and wildfires and to plan and implement fire treatments to conserve biodiversity.

Rydsaa, J. H., et al. (2017). "Effects of shrub and tree cover increase on the near-surface atmosphere in northern Fennoscandia." Biogeosciences **14**(18): 4209-4227.

Increased shrub and tree cover in high latitudes is a widely observed response to climate change that can lead to positive feedbacks to the regional climate. In this study we evaluate the sensitivity of the near-surface atmosphere to a potential increase in shrub and tree cover in the northern Fennoscandia region. We have applied the Weather Research and Forecasting (WRF) model with the Noah-UA land surface module in evaluating biophysical effects of increased shrub cover on the near-surface atmosphere at a fine resolution (5.4 km x 5.4 km). Perturbation experiments are performed in which we prescribe a gradual increase in taller vegetation in the alpine shrub and tree cover according to empirically established bioclimatic zones within the study region. We focus on the spring and summer atmospheric response. To evaluate the sensitivity of the atmospheric response to inter-annual variability in climate, simulations were conducted for two contrasting years, one warm and one cold. We find that shrub and tree cover increase leads to a general increase in near-surface temperatures, with the highest influence seen during the snowmelt season and a more moderate effect during summer. We find that the warming effect is stronger in taller vegetation types, with more complex canopies leading to decreases in the surface albedo. Counteracting effects include increased evapotranspiration, which can lead to increased cloud cover, precipitation, and snow cover. We find that the strength of the atmospheric feedback is sensitive to snow cover variations and to a lesser extent to summer temperatures. Our results show that the positive feedback to high-latitude warming induced by increased shrub and tree cover is a robust feature across inter-annual differences in meteorological conditions and will likely play an important role in land-atmosphere feedback processes in the future.

Sabajo, C. R., et al. (2017). "Expansion of oil palm and other cash crops causes an increase of the land surface temperature in the Jambi province in Indonesia." Biogeosciences **14**(20): 4619-4635.

Indonesia is currently one of the regions with the highest transformation rate of land surface worldwide related to the expansion of oil palm plantations and other cash crops replacing forests on large scales. Land cover changes, which modify land surface properties, have a direct effect on the land surface temperature (LST), a key driver for many ecological functions. Despite the large historic land transformation in Indonesia toward oil palm and other cash crops and governmental plans for future expansion, this is the first study so far to quantify the impacts of land transformation on the LST in Indonesia. We analyze LST from the thermal band of a Landsat image and produce a high-resolution surface temperature map (30 m) for the lowlands of the Jambi province in Sumatra (Indonesia), a region which suffered large land transformation towards oil palm and other cash crops over the past decades. The comparison of LST, albedo, normalized differenced vegetation index (NDVI) and evapotranspiration (ET) between seven different land cover types (forest, urban areas, clear-cut land, young and mature oil palm plantations, acacia and rubber plantations) shows that forests have lower surface temperatures than the other land cover types, indicating a local warming effect after forest conversion. LST differences were up to 10.1 +/- 2.6 degrees C (mean +/- SD) between forest and clear-cut land. The differences in surface temperatures are explained by an evaporative cooling effect, which offsets the albedo warming effect. Our analysis of the LST trend of the past 16 years based on MODIS data shows that the average daytime surface temperature in the Jambi province increased by 1.05 degrees C, which followed the trend of observed land cover changes and exceeded the effects of climate warming. This study provides evidence that the expansion of oil palm plantations and other cash crops leads to changes in biophysical variables, warming the land surface and thus enhancing the increase of the air temperature because of climate change.

Sannigrahi, S., et al. (2018). "Analyzing the role of biophysical compositions in minimizing urban land surface temperature and urban heating." Urban Climate **24**: 803-819.

The alteration of the environment at local and regional scale is often attributed to the rapid urbanization in the developing economies like India, China, etc. The land use and land cover (LULC) modification due to urbanization affect the thermal character and Surface Urban Heat Island Intensity (SUHII) of an urban area. The Greater Hyderabad Municipal Corporation (GHMC) has witnessed the drastic urbanization in the last decade and, is the sixth largest agglomeration of India. In the present study, the temporal dataset from Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) are used to trace the LULC, and land surface temperature (LST) changes during 2002-2015 and demarcate the fluctuation of different biophysical surfaces. Subsequently, four different indices viz. Normalized Difference Vegetation Index (NDVI), Land Surface Water Index (LSWI), Normalized Difference Built-up Index (NDBI), and Normalized Difference Bareness Index (NDBal) are used to document the individual and collective response of the different LULC classes/biophysical surfaces. The simple linear and stepwise multiple linear regression models determined the complex and linear behaviour of the LST with the various biophysical compositions. The GHMC exhibits a rapid urban expansion resulting into increased the LST clusters that corroborate to the changing LULC pattern. The spatio-temporal changes of LULC, LST, and UHI of GHMC from 2002 to 2015 are quantified to evaluate the effects of biophysical indices on moderating or exaggerating LST. The study outlines the urbanization in the GHMC and interaction of changing LULC pattern with the local climate and urban biophysical compositions.

Sannigrahi, S., et al. (2017). "Changing dynamics of urban biophysical composition and its impact on urban heat island intensity and thermal characteristics: the case of Hyderabad City, India." Modeling Earth Systems and Environment **3**(2): 647-667.

The biophysical composition; including the green surface cover and moisture dynamics substantially affects the thermal character and Surface Urban Heat Island intensity (SUHII) of an urban area. Therefore, biophysical indices are highly sensitive to the changing process in land use and land cover. Remote sensing based land surface temperature (LST) plays a significant role in analyzing the thermal behavior of urban areas at multiple scales to moderate the urban heat island. In the present study, Greater Hyderabad Municipal Corporation, is taken as a case study to assess biophysical controls on LST and UHI in an urban ecosystem by implementing biophysical indices. Therefore, the cluster of UHI and the proximity to the hotspots were created from spatial statistics. The areal coverage of urban land was increased from 31.2% in 1973 to 62.87% in 2015 with 5.03 sq km year(-1) expansion rate. The LST hotspot (H-H) in 2002 observed in the central and the southeast portion of the region, ascribe to the presence of higher thermal anomalies, whereas, the mean LST (degrees C) of the neighboring region is below than the average. The highest negative correlation between the estimated LST (degrees C) and the biophysical indices was accounted over aquatic vegetation cover, followed by urban green spaces and built-up urban area, respectively. The simple linear and multiple regression models demonstrated the complex and nonlinear behavior of the UHI and LST with the biophysical components. Therefore, the spatial coherence among the biophysical indices with LST ensembles the necessity of urban greenery and parks within the urban counterpart to mitigate the outdoor thermal discomfort to a reasonable extent.

Sargordi, F., et al. (2013). "Spatio-temporal variation of wheat and silage maize water requirement using CGMS model." International Journal of Plant Production **7**(2): 207-223.

The Crop Growth Monitoring System (CGMS) has been applied for spatial biophysical resource analysis of Borkhar & Meymeh district in Esfahan province, Iran. The potentially suitable area for agriculture in the district has been divided into 128 homogeneous land units in terms of soil (physical characteristics), weather and administrative unit. Crop parameters required in the WOFOST simulation model for winter wheat and silage maize, have been calibrated based on experimental data from the study area. The study area has been classified into three cropping calendar zones based on average annual temperature, altitude and latitude. For each zone, a sowing date has been defined for each crop as the starting point of crop growth simulation. Growth of these crops has been simulated for the potential situation in each land unit for 20 years of historical daily weather data. Daily potential evapotranspiration and irrigation requirements of each crop per land unit have been calculated in a post-simulation, on the basis of model outputs. Outputs of the model are crop yield (marketable yield and total biomass) and irrigation requirements per decade. Spatial and temporal variation in irrigation requirements has been analyzed. The temporal variation in crop water requirements is larger than the spati3al variation.

Sato, H., et al. (2015). "Current status and future of land surface models." Soil Science and Plant Nutrition **61**(1): 34-47.

Although climate conditions primarily determine the distribution and functioning of vegetation, vegetation also influences climate via biophysical and biogeochemical features such as evapotranspiration, albedo, carbon cycling, trace gas emissions and the roughness of the land surface. Forecasts of rapid climate change during the next 100~200years, fueled by an increase in greenhouse gases, have motivated the development of land surface models (LSMs) that predict changes in vegetation functions. Here, we review how these models have been developed and used to simulate interactive processes between climate and the land surface. Current limitations and future perspectives of the LSMs are also presented.

Savage, K., et al. (2013). "Diel patterns of autotrophic and heterotrophic respiration among phenological stages." Global Change Biology **19**(4): 1151-1159.

Improved understanding of the links between aboveground production and allocation of photosynthate to belowground processes and the temporal variation in those links is needed to interpret observations of belowground carbon cycling processes. Here, we show that combining a trenching manipulation with high-frequency soil respiration measurements in a temperate hardwood forest permitted identification of the temporally variable influence of roots on diel and seasonal patterns of soil respiration. The presence of roots in an untrenched plot caused larger daily amplitude and a 23h delay in peak soil CO2 efflux relative to a root-free trenched plot. These effects cannot be explained by differences in soil temperature, and they were significant only when a canopy was present during the growing season. This experiment demonstrated that canopy processes affect soil CO2 efflux rates and patterns at hourly and seasonal time scales, and it provides evidence that root and microbial processes respond differently to environmental factors.

Schaefer, K., et al. (2009). "Improving simulated soil temperatures and soil freeze/thaw at high-latitude regions in the Simple Biosphere/Carnegie-Ames-Stanford Approach model." Journal of Geophysical Research-Earth Surface **114**.

Proper simulation of soil temperature and permafrost at high latitudes in land surface models requires proper simulation of the processes that control snowpack development. The Simple Biosphere/Carnegie-Ames-Stanford Approach (SiBCASA) did not account for depth hoar development and wind compaction, which dominate snow processes at high latitudes. Consequently, SiBCASA had difficulty properly simulating seasonal soil freeze/thaw and permafrost. We improved simulated soil temperatures at high latitudes by (1) incorporating a snow classification scheme that includes depth hoar development and wind compaction, (2) including the effects of organic matter on soil physical properties, and (3) increasing the soil column depth. We ran test simulations at eddy covariance flux tower sites using the North American Regional Reanalysis (NARR) as input meteorology. The NARR captured the observed variability in air temperature, but tended to overestimate precipitation. These changes produced modest improvements in simulated soil temperature at the midlatitude sites because the original snow model already included the weight compaction, thermal aging, and melting processes that dominate snowpack evolution at these locations. We saw significant improvement in simulated soil temperatures and active layer depth at the high-latitude tundra and boreal forest sites. Adding snow classifications had the biggest effect on simulated soil temperatures at the tundra site while the organic soil properties had the biggest effect at the boreal forest site. Implementing snow classes, a deeper soil column, or organic soil properties separately was not sufficient to produce realistic soil temperatures and freeze/thaw processes at high latitudes. Only the combined effects of simultaneously implementing all three changes significantly improved the simulated soil temperatures and active layer depth at the tundra and boreal sites.

Schrag, A. M., et al. (2008). "Influence of bioclimatic variables on tree-line conifer distribution in the Greater Yellowstone Ecosystem: implications for species of conservation concern." Journal of Biogeography **35**(4): 698-710.

Aim Tree-line conifers are believed to be limited by temperature worldwide, and thus may serve as important indicators of climate change. The purpose of this study was to examine the potential shifts in spatial distribution of three tree-line conifer species in the Greater Yellowstone Ecosystem under three future climate-change scenarios and to assess their potential sensitivity to changes in both temperature and precipitation. Location This study was performed using data from 275 sites within the boundaries of Yellowstone and Grand Teton national parks, primarily located in Wyoming, USA. Methods We used data on tree-line conifer presence from the US Forest Service Forest Inventory and Analysis Program. Climatic and edaphic variables were derived from spatially interpolated maps and approximated for each of the sites. We used the random-forest prediction method to build a model of predicted current and future distributions of each of the species under various climate-change scenarios. Results We had good success in predicting the distribution of tree-line conifer species currently and under future climate scenarios. Temperature and temperature-related variables appeared to be most influential in the distribution of whitebark pine (Pinus albicaulis), whereas precipitation and soil variables dominated the models for subalpine fir (Abies lasiocarpa) and Engelmann spruce (Picea engelmannii). The model for whitebark pine substantially overpredicted absences (as compared with the other models), which is probably a result of the importance of biological factors in the distribution of this species. Main conclusions These models demonstrate the complex response of conifer distributions to changing climate scenarios. Whitebark pine is considered a 'keystone' species in the subalpine forests of western North America; however, it is believed to be nearly extinct throughout a substantial portion of its range owing to the combined effects of an introduced pathogen, outbreaks of the native mountain pine beetle (Dendroctonus ponderosae), and changing fire regimes. Given predicted changes in climate, it is reasonable to predict an overall decrease in pine-dominated subalpine forests in the Greater Yellowstone Ecosystem. In order to manage these forests effectively with respect to future climate, it may be important to focus attention on monitoring dry mid- and high-elevation forests as harbingers of long-term change.

Schultz, N. M., et al. (2017). "Global satellite data highlights the diurnal asymmetry of the surface temperature response to deforestation." Journal of Geophysical Research-Biogeosciences **122**(4): 903-917.

Uncertainties remain about the spatial pattern and magnitude of the biophysical effects of deforestation. In particular, a diurnal asymmetry in the magnitude and sign of the surface temperature response to deforestation (T-S) has been observed, but the biophysical processes that contribute to day and nighttime T-S are not fully understood. In this study, we use a space-for-time approach with satellite and reanalysis data to investigate the biophysical processes that control the day and nighttime T-S. Additionally, we incorporate flux-tower data to examine two hypotheses for nighttime forest warming relative to open lands: (1) that forests generate turbulence in the stable nocturnal boundary layer, which brings heat aloft down to the surface, and (2) that forests store more heat during the day and release it at night. Our results confirm a diurnal asymmetry in T-S. Over most regions of the world, deforestation results in daytime warming and nighttime cooling. The strongest daytime warming is in the tropics, where the average T-S is 4.40.07K. The strongest nighttime cooling is observed in the boreal zone, where open lands are cooler than forests by an average of 1.40.04K. Daytime patterns of T-S are explained by differences in the latent heat flux (LE) and absorbed solar radiation (K-a). We find that nighttime T-S is related to the strength of the nocturnal temperature inversion, with stronger temperature inversions at high latitudes and weak inversions in the tropics. Forest turbulence at night combined with stored heat release drives nighttime T-S patterns.

Schwantes, A. M., et al. (2017). "Measuring canopy loss and climatic thresholds from an extreme drought along a

fivefold precipitation gradient across Texas." Global Change Biology **23**(12): 5120-5135.
Globally, trees are increasingly dying from extreme drought, a trend that is expected to increase with climate change. Loss of trees has significant ecological, biophysical, and biogeochemical consequences. In 2011, a record drought caused widespread tree mortality in Texas. Using remotely sensed imagery, we quantified canopy loss during and after the drought across the state at 30-m spatial resolution, from the eastern pine/hardwood forests to the western shrublands, a region that includes the boundaries of many species ranges. Canopy loss observations in similar to 200 multitemporal fine-scale orthophotos (1-m) were used to train coarser Landsat imagery (30-m) to create 30-m binary statewide canopy loss maps. We found that canopy loss occurred across all major ecoregions of Texas, with an average loss of 9.5%. The drought had the highest impact in post oak woodlands, pinyon-juniper shrublands and Ashe juniper woodlands. Focusing on a 100-km by similar to 1,000-km transect spanning the State's fivefold east-west precipitation gradient (similar to 1,500 to similar to 300 mm), we compared spatially explicit 2011 climatic anomalies to our canopy loss maps. Much of the canopy loss occurred in areas that passed specific climatic thresholds: warm season anomalies in mean temperature (+1.6 degrees C) and vapor pressure deficit (VPD, +0.66 kPa), annual percent deviation in precipitation (-38%), and 2011 difference between precipitation and potential evapotranspiration (-1,206 mm). Although similarly low precipitation occurred during the landmark 1950s drought, the VPD and temperature anomalies observed in 2011 were even greater. Furthermore, future climate data under the representative concentration pathway 8.5 trajectory project that average values will surpass the 2011 VPD anomaly during the 2070-2099 period and the temperature anomaly during the 2040-2099 period. Identifying vulnerable ecological systems to drought stress and climate thresholds associated with canopy loss will aid in predicting how forests will respond to a changing climate and how ecological landscapes will change in the near term.

Sekar, I. and T. O. Randhir (2007). "Spatial assessment of conjunctive water harvesting potential in watershed systems." Journal of Hydrology **334**(1-2): 39-52.
Water harvesting can be used to minimize water loss and to augment water supplies in watershed systems. This effort is increasingly being recognized as critical in regions experiencing urbanization and facing uneven water supplies. Water harvesting requires a careful assessment of geographic locations in a watershed and evaluation of surface and groundwater hydrology. In this paper, we develop a spatially expticit method to evaluate costs of harvesting and potential benefits in water harvesting in the Taunton River Watershed in Eastern Massachusetts, USA. A spatial analysis is used to assess surface storage and groundwater recharge potentials in developed and undeveloped regions of the watershed. Distributed parameters used in the analysis include runoff coefficients, land use, soil properties, precipitation, aquifer, and land price. Prioritization maps were developed to characterize conjunctive harvesting potential that is based on benefits and costs. The results demonstrate that a spatially variable harvesting strategy can be used to minimize runoff loss and to augment water supplies. The potential harvest areas were clustered in specific locations that satisfy feasibility and economic criteria. In some subwatersheds, potential harvest locations were dispersed. A spatially variable approach that incorporates economic criteria to hydrologic assessment can be used to enhance efficiency related to water harvest and supply management. Given the increasing demand for clean water, a distributed and conjunctive harvesting strategy could be effective in several urbanizing watersheds. The model has potential for further extension into complex situations of biophysical and socioeconomic conditions at watershed level. (c) 2006 Elsevier B.V. All rights reserved.

Seserman, D. M., et al. (2018). "Simulating Climate Change Impacts on Hybrid-Poplar and Black Locust Short Rotation Coppices." Forests **9**(7).
In Brandenburg, north-eastern Germany, climate change is associated with increasing annual temperatures and decreasing summer precipitation. Appraising short rotation coppices (SRCs), given their long-time planning horizon demands for systematic assessments of woody biomass production under a considerable spectrum of climate change prospects. This paper investigates the prospective growth sensitivity of poplar and black locust SRCs, established in Brandenburg to a variety of weather conditions and long-term climate change, from 2015 to 2054, by a combined experimental and simulation study. The analysis employed (i) a biophysical, process-based model to simulate the daily tree growth and (ii) 100 realisations of the statistical regional climate model STAR 2K. In the last growing period, the simulations showed that the assumed climate change could lead to a decrease in the woody biomass of about 5 Mg ha(-1) (18%) for poplar and a

decrease of about 1.7 Mg ha(-1) (11%) for black locust trees with respect to the median observed in the reference period. The findings corroborate the potential tree growth vulnerability to prospective climatic changes, particularly to changes in water availability and underline the importance of coping management strategies in SRCs for forthcoming risk assessments and adaptation scenarios.

Sharma, M., et al. (2015). "Modeling Climatic Effects on Stand Height/Site Index of Plantation-Grown Jack Pine and Black Spruce Trees." Forest Science **61**(1): 25-34.

Stand height/site index equations that incorporate climate variables were developed for plantation-grown jack pine (Pinus banksiana Lamb.) and black spruce (Picea mariana [Mill.] B.S.P.). Study data came from stem analysis of three dominant or codominant trees sampled from 73 plots for jack pine and 75 plots for black spruce within even-aged monospecific plantations located on 50 sites (25 sites per species) in the Canadian boreal forest region of Northern Ontario. A nonlinear mixed-effects approach was applied to fit the stand height equations. The climate variables that were significant in explaining the variation in heights of dominant and codominant trees were growing season mean temperature and growing season total precipitation. Including climate variables significantly improved the fit statistics of the stand height model for both species. For each species, stand heights were predicted for a randomly selected location for the growth period of 2011 to 2040 under A2 and B2 climate change scenarios. At the end of the growth period, projected heights were reduced by 8 and 2% for jack pine and 28 and 16% for black spruce under A2 and B2 climate change scenarios, respectively, compared with heights projected under a current climate scenario. The site index of a stand can be estimated using the stand height model by calculating height at a given base (index) age. In the absence of climate data, the model fitted to only the height-age pair data can be used as a stand height/site index equation.

Sharma, R., et al. (2015). "Geospatial quantification and analysis of environmental changes in urbanizing city of Kolkata (India)." Environmental Monitoring and Assessment **187**(1).

Over the past five decades, the fragile wetland ecosystem surrounding the city of Kolkata has witnessed extensive changes in the name of urban development. In this study, we elaborate relationships among biophysical parameters and land surface temperature (LST) in Kolkata city and nearby surrounding areas where rapid urbanization has occurred. LST and associated surface physical characteristics were assessed using Landsat images acquired for the years 1989, 2006, and 2010. The satellite data was used to study the spatiotemporal urban footprint and correlation among normalized difference vegetation index (NDVI), normalized difference built-up index (NDBI), normalized difference water index (NDWI) and LST. Land use land cover (LULC) maps prepared using supervised classification had overall accuracy of 90, 88, and 86 % and kappa coefficient of 0.8726, 0.8455, and 0.8212 for 1989, 2006, and 2010, respectively. The spatial expansion as a consequence of increasing urban population is 108.94 km(2) over past two decades. The urban built-up in and around the city extends up to 88.71 km(2) in 1989, 144.64 km(2) in 2006, and 197.65 km(2) in 2010. These changes have attributed in elevating surface temperature in the study region. Analysis of biophysical parameters shows LST and NDBI having a positive correlation, LST and NDVI having negative correlation, while NDBI and NDWI having a perfectly negative correlation. Satellite estimated temperatures of the surface show a warming trend evident from increasing mean surface temperature values from 27.36 degrees C in 1989 to 30.025 degrees C in 2006 and 33.023 degrees C in 2010. The magnitude and extent of the estimates of LST are consistent with the urbanization pattern throughout the city and adjoining areas.

Sharma, R., et al. (2013). "Spatio-temporal footprints of urbanisation in Surat, the Diamond City of India (1990-2009)." Environmental Monitoring and Assessment **185**(4): 3313-3325.

Urbanisation is a ubiquitous phenomenon with greater prominence in developing nations. Urban expansion involves land conversions from vegetated moisture-rich to impervious moisture-deficient land surfaces. The urban land transformations alter biophysical parameters in a mode that promotes development of heat islands and degrades environmental health. This study elaborates relationships among various environmental variables using remote sensing dataset to study spatio-temporal footprint of urbanisation in Surat city. Landsat Thematic Mapper satellite data were used in conjugation with geo-spatial techniques to study urbanisation and correlation among various satellite-derived biophysical parameters, [Normalised Difference Vegetation Index, Normalised Difference Built-up Index, Normalised Difference Water Index, Normalised Difference Bareness Index, Modified NDWI and land surface temperature (LST)]. Land use land cover was prepared using hierarchical decision tree classification with an accuracy of 90.4 % (kappa = 0.88) for 1990 and 85 % (kappa = 0.81) for 2009. It was found that the city has expanded over 42.75 km(2) within a decade, and these changes resulted in elevated surface temperatures. For example, transformation from vegetation to built-up has resulted in 5.5 +/- 2.6 A degrees C increase in land surface temperature, vegetation to fallow 6.7 A +/- 3 A degrees C, fallow to built-up is 3.5 A +/- 2.9 A degrees C and built-up to dense built-up is 5.3 A +/- 2.8 A degrees C. Directional profiling for LST was done to study spatial patterns of LST in and around Surat city. Emergence of two new LST peaks for 2009 was observed in N-S and NE-SW profiles.

Sieg, A. E., et al. (2015). "Mojave desert tortoise (Gopherus agassizii) thermal ecology and reproductive success along a rainfall cline." Integrative Zoology **10**(3): 282-294.

Desert resource environments (e.g. microclimates, food) are tied to limited, highly localized rainfall regimes which generate microgeographic variation in the life histories of inhabitants. Typically, enhanced growth rates, reproduction and survivorship are observed in response to increased resource availability in a variety of desert plants and short-lived animals. We examined the thermal ecology and reproduction of US federally threatened Mojave desert tortoises (Gopherus agassizii), long-lived and large-bodied ectotherms, at opposite ends of a 250-m elevation-related rainfall cline within Ivanpah Valley in the eastern Mojave Desert, California, USA. Biophysical operative environments in both the upper-elevation, Cima, and the lower-elevation, Pumphouse, plots corresponded with daily and seasonal patterns of incident solar radiation. Cima received 22% more rainfall and contained greater perennial vegetative cover, which conferred 5 degrees C-cooler daytime shaded temperatures. In a monitored average rainfall year, Cima tortoises had longer potential activity periods by up to several hours and greater ephemeral forage. Enhanced resource availability in Cima was associated with larger-bodied females producing larger eggs, while still producing the same number of eggs as Pumphouse females. However, reproductive success was lower in Cima because 90% of eggs were depredated versus 11% in Pumphouse, indicating that predatory interactions produced counter-gradient variation in reproductive success across the rainfall cline. Land-use impacts on deserts (e.g. solar energy generation) are increasing rapidly, and conservation strategies designed to protect and recover threatened desert inhabitants, such as desert tortoises, should incorporate these strong ecosystem-level responses to regional resource variation in assessments of habitat for prospective development and mitigation efforts.

Simmons, C. T. and H. D. Matthews (2016). "Assessing the implications of human land-use change for the transient climate response to cumulative carbon emissions." Environmental Research Letters **11**(3).

Recent research has shown evidence of a linear climate response to cumulative CO2 emissions, which implies that the source, timing, and amount of emissions does not significantly influence the climate response per unit emission. Furthermore, these analyses have generally assumed that the climate response to land-use CO2 emissions is equivalent to that of fossil fuels under the assumption that, once in the atmosphere, the radiative forcing induced by CO2 is not sensitive to the emissions source. However, land-cover change also affects surface albedo and the strength of terrestrial carbon sinks, both of which have an additional climate effect. In this study, we use a coupled climate-carbon cycle model to assess the climate response to historical and future cumulative land-use CO2 emissions, in order to compare it to the response to fossil fuel CO2. We find that when we isolate the CO2-induced (biogeochemical) temperature changes associated with land-use change, then the climate response to cumulative land-use emissions is equivalent to that of fossil fuel CO2. We show further that the globally-averaged albedo-induced biophysical cooling from land-use change is non-negligible and may be of comparable magnitude to the biogeochemical warming, with the result that the net climate response to land-use change is substantially different from a linear response to cumulative emissions. However, our new simulations suggest that the biophysical cooling from land-use change follows its own independent (negative) linear response to cumulative net land-use CO2 emissions, which may provide a useful scaling factor for certain applications when evaluating the full transient climate response to emissions.

Singh, M., et al. (2008). "Biophysical and socioeconomic characterization of a water-stressed area and simulating agri-production estimates and land use planning under normal and extreme climatic events: a case study." Environmental Monitoring and Assessment **142**(1-3): 97-108.

This study aims in linking the biophysical and socioeconomic data base layers with the technical coefficients or simulation models for agri-production estimates and land use planning under normal and extreme climatic events, and exploring the resource and inputs management options in village Shikohpur, Gurgaon district located in the northwest part of India. The socioeconomic profile of Shikohpur is highly skewed with mostly small and marginal farmers. Though the areas under wheat in Shikohpur are increasing, the productivity is declining or remaining stagnant over the years. Most of the area during kharif season (June-September) remains fallow. Pearl millet based cropping systems (pearl millet-mustard and pearl millet-wheat) are predominant. Soils are mostly loamy sand to sandy loam with average of 70-80% sand content. Organic C content in soil is less than 0.3%, due to high prevailing temperature with little rainfall and also intensive agriculture followed in this region. Though the annual average seasonal rainfall in Gurgaon did not have much variation over the years, occurrence of extreme climate events has increased in the last two decades. The crop intensity is low and the water table is declining. Water and nitrogen production functions were developed for the important crops of the region, for their subsequent use in scheduling of the inputs. InfoCrop, WTGROWS and technical coefficients were used for crop planning and resource management under climate change and its variability, extreme events, limited resource availability and crop intensification. These will help in disseminating necessary agro-advisories to the farmers so that they will be able to manipulate the inputs and agronomic management practices for sustained agricultural production under normal as well as extreme climatic conditions.

Smaliychuk, A., et al. (2016). "Recultivation of abandoned agricultural lands in Ukraine: Patterns and drivers." Global Environmental Change-Human and Policy Dimensions **38**: 70-81.

The recent rise in agricultural commodity prices and the expectation that high price will persist have triggered a wave of farmland expansion in regions where land resources are still available. One such region is the former Soviet Union, where the collapse of socialism caused massive agricultural abandonment and where some of these lands are now being brought back into production. Yet, the extent and spatial patterns of recultivation, and what determines these patterns, remains unclear. We examined the extent of recultivation of abandoned agricultural land in Ukraine since 2007 using a new, satellite-based recultivation map and assessed the effect of biophysical and socioeconomic determinants on recultivation patterns using boosted regression trees. We found key predictors of recultivation to be related to the suitability of land for agriculture (i.e., soil quality, temperature). Accessibility to major cities was also important, with most recultivation happening closer to settlements, but this influence varied across Ukraine. Variables related to agricultural management (fertilizer input, mechanization) and demography were negligible in explaining recultivation in our analyses. These factors suggest that recultivation patterns were primarily driven by factors related to land productivity, with recultivation focusing on the most promising areas. Given the remaining large amount of unused agricultural land in Eastern Europe and the former Soviet Union, and considering that much abandonment occurred in areas only marginally suited to agriculture, our findings provide important insights into where recultivation can be expected to happen and thus for assessing the potential socioeconomic and environmental impacts of recultivation. (C) 2016 Elsevier Ltd. All rights reserved.

Small, C. (2006). "Comparative analysis of urban reflectance and surface temperature." Remote Sensing of Environment **104**(2): 168-189.

Urban environmental conditions are strongly dependent on the biophysical properties and radiant thermal field of the land cover elements in the urban mosaic. Observations of urban reflectance and surface temperature provide valuable constraints on the physical properties that are determinants of mass and energy fluxes in the urban environment. Consistencies in the covariation of surface temperature with reflectance properties can be parameterized to represent characteristics of the surface energy flux associated with different land covers and physical conditions. Linear mixture models can accurately represent Landsat ETM+ reflectances as fractions of generic spectral endmembers that correspond to land surface materials with distinct physical properties. Modeling heterogeneous land cover as mixtures of rock and/or soil Substrate, Vegetation and non-reflective Dark surface (SVD) generic endmembers makes it possible to quantify the dependence of aggregate surface temperature on the relative abundance of each physical component of the land cover, thereby distinguishing the effects of vegetation abundance, soil exposure, albedo and shadowing. Comparing these covariations in a wide variety of urban settings and physical environments provides a more robust indication of the global variability in these parameter spaces than could be inferred from a single study area. A comparative analysis of 24 urban areas and their non-urban peripheries illustrates the variability in the urban thermal fields and its dependence on biophysical land surface components. Contrary to expectation, moderate resolution intra-urban variations in surface temperature are generally as large as regional surface heat island signatures in these urban areas. Many of the non-temperate urban areas did Dot have surface heat island signatures at all. However, the multivariate distributions of surface temperature and generic endmember fractions reveal consistent patterns of thermal fraction covariation resulting from land cover characteristics. The Thermal-Vegetation (TV) fraction space illustrates the considerable variability in the well-known inverse correlation between surface temperature and vegetation fraction at moderate (< 100 m) spatial resolutions. The Thermal-Substrate (TS) fraction space reveals energetic thresholds where competing effects of albedo, illumination and soil moisture determine the covariation of maximum and minimum temperature with illuminated substrate fraction. The dark surface endmember fraction represents a fundamental ambiguity in the radiance signal because it can correspond to either absorptive (e.g. low albedo asphalt), transmissive (e.g. deep clear water) or shadowed (e.g. tree canopy shadow) surfaces. However, in areas where dark surface composition can be inferred from spatial context, the different responses of these surfaces may still allow them to be distinguished in the thermal fraction space. (c) 2006 Published by Elsevier Inc.

Smith, N. G., et al. (2017). "Biophysical consequences of photosynthetic temperature acclimation for climate." Journal of Advances in Modeling Earth Systems **9**(1): 536-547.

Photosynthetic temperature acclimation is a commonly observed process that is increasingly being incorporated into Earth System Models (ESMs). While short-term acclimation has been shown to increase carbon storage in the future, it is uncertain whether acclimation will directly influence simulated future climate through biophysical mechanisms. Here, we used coupled atmosphere-biosphere simulations using the Community Earth System Model (CESM) to assess how acclimation-induced changes in photosynthesis influence global climate under present-day and future (RCP 8.5) conditions. We ran four 30 year simulations that differed only in sea surface temperatures and atmospheric CO2 (present or future) and whether a mechanism for photosynthetic temperature acclimation was included (yes or no). Acclimation increased future photosynthesis and, consequently, the proportion of energy returned to the atmosphere as latent heat, resulting in reduced surface air temperatures in areas and seasons where acclimation caused the biggest increase in photosynthesis. However, this was partially offset by temperature increases elsewhere, resulting in a small, but significant, global cooling of 0.05 degrees C in the future, similar to that expected from acclimation-induced increases in future land carbon storage found in previous studies. In the present-day simulations, the photosynthetic response was not as strong and cooling in highly vegetated regions was less than warming elsewhere, leading to a net global increase in temperatures of 0.04 degrees C. Precipitation responses were variable and rates did not change globally in either time period. These results, combined with carbon-cycle effects, suggest that models without acclimation may be overestimating positive feedbacks between climate and the land surface in the future.

Snyder, P. K., et al. (2004). "Evaluating the influence of different vegetation biomes on the global climate." Climate Dynamics **23**(3-4): 279-302.

The participation of different vegetation types within the physical climate system is investigated using a coupled atmosphere-biosphere model, CCM3-IBIS. We analyze the effects that six different vegetation biomes (tropical, boreal, and temperate forests, savanna, grassland and steppe, and shrubland/tundra) have on the climate through their role in modulating the biophysical exchanges of energy, water, and momentum between the land-surface and the atmosphere. Using CCM3-IBIS we completely remove the vegetation cover of a particular biome and compare it to a control simulation where the biome is present, thereby isolating the climatic effects of each biome. Results from the tropical and boreal forest removal simulations are in agreement with previous studies while the other simulations provide new evidence as to their contribution in forcing the climate. Removal of the temperate forest vegetation exhibits behavior characteristic of both the tropical and boreal simulations with cooling during winter and spring due to an increase in the surface albedo and warming during the summer caused by a reduction in latent cooling. Removal of the savanna vegetation exhibits behavior much like the tropical forest simulation while removal of the grassland and steppe vegetation has the largest effect over the central United States with warming and drying of the atmosphere in summer. The largest climatic effect of shrubland and tundra vegetation removal occurs in DJF in Australia and centra Siberia and is due to reduced latent cooling and enhanced cold air advection, respectively. Our results show that removal of the boreal forest yields the largest temperature signal globally when either including or excluding the areas of forest removal. Globally, precipitation is most affected by removal of the savanna vegetation when including the areas of vegetation removal, while removal of the tropical forest most influences the global precipitation excluding the areas of vegetation removal.

Song, Y. and C. S. Wu (2016). "Examining the impact of urban biophysical composition and neighboring environment on surface urban heat island effect." Advances in Space Research **57**(1): 96-109.

Due to atmospheric and surface modifications associated with urbanization, surface urban heat island (SUHI) effects have been considered essential in examining urban ecological environments. With remote sensing technologies, numerous land cover type related variables, including spectral indices and land cover fractions, have been applied to estimate land surface temperature (LST), thereby further examining SUHI. This study begins with the reexamination of the commonly used indicators of LST using Landsat Enhanced Thematic Mapper Plus (ETM+) and Landsat Thematic Mapper (TM) images which cover four counties of Wisconsin, United States. Origin of the large variation of LST found in urban areas is then investigated by discriminating soil and impervious surfaces. Except land cover types, neighboring environment is another key factor which may affect LST in urban areas. Thus, a neighboring effect considered method is proposed at the end of the study to better understand the relationship between impervious surfaces fraction (%ISA) and LST by taking the influence of neighboring environment into account. Results indicate that spectral indices have better performance in predicting LST than land cover fractions do within the study area. However, the result remains arguable due to the complexity and uncertainty of spectral mixture analysis. Impervious surfaces are found responsible for the large variation of LST in urban areas, which indicates that impervious surfaces should not be simply considered as a single land cover type has stable negative correlation with LST. Moreover, a better relationship is found between %ISA and LST when neighboring effect is considered, when compared to the traditional method which ignores the neighboring effect. (C) 2015 COSPAR. Published by Elsevier Ltd. All rights reserved.

Steiner, A. L. and W. L. Chameides (2005). "Aerosol-induced thermal effects increase modelled terrestrial photosynthesis and transpiration." Tellus Series B-Chemical and Physical Meteorology **57**(5): 404-411.

Previous studies suggest that the radiative effects of atmospheric aerosols (reducing total radiation while increasing the diffuse fraction) can enhance terrestrial productivity. Here, simulations using a regional climate/terrestrial biosphere model suggest that atmospheric aerosols could also enhance terrestrial photosynthesis and transpiration through an interaction between solar radiation, leaf temperature and stomatal conductance. During midday, clear-sky conditions, sunlit-leaf temperatures can exceed the optimum for photosynthesis, depressing both photosynthesis and transpiration. Aerosols decrease surface solar radiation, thereby reducing leaf temperatures and enhancing sunlit-leaf photosynthesis and transpiration. This modelling study finds that, under certain conditions, this thermal response of aerosols can have a greater impact on photosynthesis and transpiration than the radiative response. This implies that a full understanding of the impact of aerosols on climate and the global carbon cycle requires consideration of the biophysical responses of terrestrial vegetation as well as atmospheric radiative and thermodynamic effects.

Stockli, R. and P. L. Vidale (2005). "Modeling diurnal to seasonal water and heat exchanges at European Fluxnet sites." Theoretical and Applied Climatology **80**(2-4): 229-243.

The importance of linking measurements, modeling and remote sensing of land surface processes has been increasingly recognized in the past years since on the diurnal to seasonal time scale land surface-atmosphere feedbacks can play a substantial role in determining the state of the near-surface climate. The worldwide Fluxnet project provides long term measurements of land surface variables useful for process-based modeling studies over a wide range of climatic environments. In this study data from six European Fluxnet sites distributed over three latitudinal zones are used to force three generations of LSMs (land surface models): the BUCKET, BATS 1E and SiB 2.5. Processes simulating the exchange of heat and water used in these models range from simple bare soil parameterizations to complex formulations of plant biochemistry and soil physics. Results show that - dependent on the climatic environment - soil storage and plant biophysical processes can determine the yearly course of the land surface heat and water budgets, which need to be included in the modeling system. The Mediterranean sites require a long term soil water storage capability and a biophysical control of evapotranspiration. In northern Europe the seasonal soil temperature evolution can influence the winter energy partitioning and requires a long term soil heat storage scheme. Plant biochemistry and vegetation phenology can drive evapotranspiration where no atmospheric-related limiting environmental conditions are active.

Strack, J. E., et al. (2008). "Sensitivity of June near-surface temperatures and precipitation in the eastern United States to historical land cover changes since European settlement." Water Resources Research **44**(11).

Land cover changes alter the near surface weather and climate. Changes in land surface properties such as albedo, roughness length, stomatal resistance, and leaf area index alter the surface energy balance, leading to differences in near surface temperatures. This study utilized a newly developed land cover data set for the eastern United States to examine the influence of historical land cover change on June temperatures and precipitation. The new data set contains representations of the land cover and associated biophysical parameters for 1650, 1850, 1920, and 1992, capturing the clearing of the forest and the expansion of agriculture over the eastern United States from 1650 to the early twentieth century and the subsequent forest regrowth. The data set also includes the inferred distribution of potentially water-saturated soils at each time slice for use in the sensitivity tests. The Regional Atmospheric Modeling System, equipped with the Land Ecosystem-Atmosphere Feedback (LEAF-2) land surface parameterization, was used to simulate the weather of June 1996 using the 1992, 1920, 1850, and 1650 land cover representations. The results suggest that changes in surface roughness and stomatal resistance have caused present-day maximum and minimum temperatures in the eastern United States to warm by about 0.3 degrees C and 0.4 degrees C, respectively, when compared to values in 1650. In contrast, the maximum temperatures have remained about the same, while the minimums have cooled by about 0.1 degrees C when compared to 1920. Little change in precipitation was found.

Strand, E. K., et al. (2009). "Quantifying successional rates in western aspen woodlands: Current conditions, future predictions." Forest Ecology and Management **257**(8): 1705-1715.

Stands of quaking aspen (Populus tremuloides) rank among the most biologically diverse plant communities across the intermountain region of western North America. Marked declines of aspen have occurred in recent decades, likely due to a combination of effects from changes in fire regimes, herbivory, climate (e.g. drought), and interspecific competition with conifer species. However, it is poorly understood how the effects of these factors are manifested at a landscape scale over decadal time periods. Analysis of field data combined with topographic information collected across the 500,000 ha Owyhee Plateau in southwestern Idaho revealed that aspen in the area occur in three different biophysical settings; First, aspen stands exist at high altitudes on south-facing slopes where local conifer species are not likely to occur because of limiting temperature or precipitation levels under current climate conditions. In these areas aspen is the potential vegetation type rather than conifers. Second, aspen grow on anomalously wet microsites (e.g. near springs), and third, aspen grow within upland mixed aspen/conifer stands, which are experiencing rapid rates of conifer establishment. Based on a paired t-test (alpha = 0.05) we conclude that stands growing on wet microsites show significantly slower successional rates of conifer establishment relative to upland aspen stands. We developed a conceptual state-and-transition model for upland aspen/conifer stands occurring across a range of topographic positions. We then parameterized the model using extensive field data in the vegetation dynamics computer simulation model Vegetation Dynamics Development Tool (VDDT), and examined the current and future aspen distribution under varying fire regimes. Model results indicate that average fire return intervals of 50-70 years are desirable for maintenance of aspen in upland areas where conifers are present. Under the current fire regime in the area many upland aspen/conifer stands will likely be lost within 80-200 years. Thresholds for the effect of conifer encroachment and browsing on aspen regeneration identified through this research are similar to those described by others across the West. We therefore suggest that the results presented for the Owyhee Plateau are likely applicable to semi-arid aspen woodlands across the American West where succession to conifers is a cause of aspen decline. (C) 2009 Elsevier B.V. All rights reserved.

Sulis, M., et al. (2015). "Evaluating the Influence of Plant-Specific Physiological Parameterizations on the Partitioning of Land Surface Energy Fluxes." Journal of Hydrometeorology **16**(2): 517-533.

Plant physiological properties have a significant influence on the partitioning of radiative forcing, the spatial and temporal variability of soil water and soil temperature dynamics, and the rate of carbon fixation. Because of the direct impact on latent heat fluxes, these properties may also influence weather-generating processes, such as the evolution of the atmospheric boundary layer (ABL). In this work, crop-specific physiological characteristics, retrieved from detailed field measurements, are included in the biophysical parameterization of the Terrestrial Systems Modeling Platform (TerrSysMP). The physiological parameters for two typical European midlatitudinal crops (sugar beet and winter wheat) are validated using eddy covariance fluxes over multiple years from three measurement sites located in the North Rhine-Westphalia region of Germany. Comparison with observations and a simulation utilizing the generic crop type shows clear improvements when using the crop-specific physiological characteristics of the plant. In particular, the increase of latent heat fluxes in conjunction with decreased sensible heat fluxes as simulated by the two crops leads to an improved quantification of the diurnal energy partitioning. An independent analysis carried out using estimates of gross primary production reveals that the better agreement between observed and simulated latent heat adopting the plant-specific physiological properties largely stems from an improved simulation of the photosynthesis process. Finally, to evaluate the effects of the crop-specific parameterizations on the ABL dynamics, a series of semi-idealized land-atmosphere coupled simulations is performed by hypothesizing three cropland configurations. These numerical experiments reveal different heat and moisture budgets of the ABL using the crop-specific physiological properties, which clearly impacts the evolution of the boundary layer.

Sun, Y. W., et al. (2018). "Examining urban thermal environment dynamics and relations to biophysical composition and configuration and socio-economic factors: A case study of the Shanghai metropolitan region." Sustainable Cities and Society **40**: 284-295.

Multi-scale assessment of urban thermal environment dynamics and its influencing factors have been considered an essential precondition for mitigation and regulation of urban heat island (UHI) effects. However, the annual cycle behavior of satellite-derived urban land surface temperature (LST) is still unclear due to the limitation of irregular and infrequent satellite LST data. This study investigated annual dynamics of LST and the UHI effects of Shanghai by using an annual temperature cycle (ATC) model to reconstruct the Moderate-resolution imaging spectroradiometer (MODIS) 8-day LST data with 1 km(2) resolution in 2015. Ordinary least squares (OLS) and spatial regression models were further applied to investigate the relationships between day/night LST and urban biophysical composition and configuration and socio-economic characteristics in the metropolitan area of Shanghai, China. The results indicate that ATC model performed well with overall root mean square errors (RMSE) of 2.6 K. The performance of ATC is better in night-time than that in day-time. The thermal gradient analysis showed the urban center was hotter than outskirts by up to 2.0 K in day and 0.8 K in night. Spatial patterns of UHI intensity between day-time and night-time had significant differences in central urban areas. We also observed higher amplitude of the annual temperature cycle in central urban areas than that in rural. Furthermore, our statistical model showed biophysical indicators and land composition had a stronger influence on LST than the other explanatory variables. Nighttime light composite data from the Visible Infrared Imaging Radiometer Suite (VIIRS) on board Suomi National Polar-orbiting partnership (NPP) as a spatial proxy for socioeconomic factors had significant positive relationships with mean LST. Compared with OLS and spatial lag model (SLM), spatial error model (SEM) is more appropriate to predict the urban LST. We conclude that distinct control strategies between day-time and night-time may improve efficiency of attenuating the UHI for a metropolitan region, and the spatial and temporal elements should be considered in landscape and urban planning.

Szczypta, C., et al. (2012). "Impact of precipitation and land biophysical variables on the simulated discharge of European and Mediterranean rivers." Hydrology and Earth System Sciences **16**(9): 3351-3370.

This study investigates the impact on river discharge simulations of errors in the precipitation forcing, together with changes in the representation of vegetation variables and of plant transpiration. The most recent European Centre for Medium-Range Weather Forecasts reanalysis (ERA-Interim) is used to drive the Interactions between Soil, Biosphere, and Atmosphere-Total Runoff Integrating Pathways (ISBA-TRIP) continental hydrological system over Europe and the Mediterranean basin over the 1991-2008 period. As ERA-Interim tends to underestimate precipitation, a number of precipitation corrections are proposed. In particular, the monthly Global Precipitation Climatology Centre (GPCC) precipitation product is used to bias-correct the 3-hourly ERA-Interim estimates. This correction markedly improves the match between the ISBA-TRIP simulations and the river discharge observations from the Global Runoff Data Centre (GRDC), at 150 gauging stations. The impact on TRIP river discharge simulations of various representations of the evapotranspiration in the ISBA land surface model is investigated as well: ISBA is used together with its upgraded carbon flux version (ISBA-A-gs). The latter is either driven by the satellite-derived climatology of the Leaf Area Index (LAI) used by ISBA, or performs prognostic LAI simulations. The ISBA-A-gs model, with or without dynamically simulated LAI, allows a better representation of river discharge at low water levels. On the other hand, ISBA-Ags does not perform as well as the original ISBA model at springtime.

Tang, B. J., et al. (2018). "Local Effects of Forests on Temperatures across Europe." Remote Sensing **10**(4).

Forests affect local climate through biophysical processes in terrestrial ecosystems. Due to the spatial and temporal heterogeneity of ecosystems in Europe, climate responses to forests vary considerably with diverse geographic and seasonal patterns. Few studies have used an empirical analysis to examine the effect of forests on temperature and the role of the background climate in Europe. In this study, we aimed to quantitatively determine the effects of forest on temperature in different seasons with MODIS (MODerate-resolution Imaging Spectroradiometer) land surface temperature (LST) data and in situ air temperature measurements. First, we compared the differences in LSTs between forests and nearby open land. Then, we paired 48 flux sites with nearby weather stations to quantify the effects of forests on surface air temperature. Finally, we explored the role of background temperatures on the above forests effects. The results showed that (1) forest in Europe generally increased LST and air temperature in northeastern Europe and decreased LST and air temperature in other areas; (2) the daytime cooling effect was dominate and produced a net cooling effect from forests in the warm season. In the cold season, daytime and nighttime warming effects drove the net effect of forests; (3) the effects of forests on temperatures were mainly negatively correlated with the background temperatures in Europe. Under extreme climate conditions, the cooling effect of forests will be stronger during heatwaves or weaker during cold spring seasons; (4) the background temperature affects the spatiotemporal distribution of differences in albedo and evapotranspiration (forest minus open land), which determines the spatial, seasonal and interannual effects of forests on temperature. The extrapolation of the results could contribute not only to model validation and development but also to appropriate land use policies for future decades under the background of global warming.

Tang, X. G., et al. (2017). "Remotely Monitoring Ecosystem Water Use Efficiency of Grassland and Cropland in China's Arid and Semi-Arid Regions with MODIS Data." Remote Sensing **9**(6).

Scarce water resources are available in the arid and semi-arid areas of Northwest China, where significant water-related challenges will be faced in the coming decades. Quantitative evaluations of the spatio-temporal dynamics in ecosystem water use efficiency (WUE), as well as the underlying environmental controls, are crucial for predicting future climate change impacts on ecosystem carbon-water interactions and agricultural production. However, these questions remain poorly understood in this typical region. By means of continuous eddy covariance (EC) measurements and time-series MODIS data, this study revealed the distinct seasonal cycles in gross primary productivity (GPP), evapotranspiration (ET), and WUE for both grassland and cropland ecosystems, and the dominant climate factors performed jointly by temperature and precipitation. The MODIS WUE estimates from GPP and ET products can capture the broad trend in WUE variability of grassland, but with large biases for maize cropland, which was mainly ascribed to large uncertainties resulting from both GPP and ET algorithms. Given the excellent biophysical performance of the MODIS-derived enhanced vegetation index (EVI), a new greenness model (GR) was proposed to track the eight-day changes in ecosystem WUE. Seasonal variations and the scatterplots between EC-based WUE and the estimates from time-series EVI data (WUEGR) also certified its prediction accuracy with R-2 and RMSE of both grassland and cropland ecosystems over 0.90 and less than 0.30 g kg(-1), respectively. The application of the GR model to regional scales in the near future will provide accurate WUE information to support water resource management in dry regions around the world.

Tasker, K. A. and E. Y. Arima (2016). "Fire regimes in Amazonia: The relative roles of policy and precipitation." Anthropocene **14**: 46-57.

Reducing carbon emissions from deforestation and forest degradation is now a vital component in climate change mitigation strategies. Global initiatives such as REDD+ are receiving growing investments, and in-country policy makers are under pressure to protect intact forests. In 2008, Brazil met these pressures by making deforestation reduction a central piece of its climate change policy. Although previous research found that this policy led to reduced deforestation, decreases in fire-another significant factor in carbon emissions-were not observed. Here we revisit Amazonia, the target location of Brazil's anti-deforestation policies, to determine how precipitation may be affecting forest fires in the area while controlling for other potential biophysical, economic, and institutional correlates. Using data on precipitation and deforestation alongside MODIS active fire and burned area data, this article examines the general spatial-temporal trends of fire in the region between 2001 and 2013. We then implements statistical models to measure the relative impact of precipitation and anti-deforestation policies on both fire events and burned area over the time period. The analysis shows that while deforestation decreased under policy treatment, forest fires were less responsive to policies. Furthermore, the analysis provides strong evidence for the existence of a precipitation effect on both fire events and burned area. Results indicate that a one standard deviation decrease in precipitation from its normal could increase fire events by 11-15% and burned area by 18-27%. The article concludes by addressing the challenges in controlling fire in Amazonia under drier climatic conditions in the presence of abundant fuel and ignition sources. (C) 2016 Elsevier Ltd. All rights reserved.

Taylor, G., et al. (2001). "Increased leaf area expansion of hybrid poplar in elevated CO2. From controlled environments to open-top chambers and to FACE." Environmental Pollution **115**(3): 463-472.

We examined the response of hybrid poplar to elevated CO2 in contrasting growth environments: controlled environment chamber (CE), open-top chamber (OTC) and poplar free air CO2 enrichment (POPFACE) in order to compare short versus longterm effects and to determine whether generalisations in response are possible for this fast growing tree. Leaf growth, which for poplar is an important determinant of stemwood productivity was followed in all environments, as were the determinants of leaf growth-cell expansion and cell production. Elevated CO2 (550-700 mu mol mol(-1), depending on environment) resulted in an increase in final leaf size for Populus trichocarpa x Populus deltoides (Populus x interamericana) and P. deltoides x Populus nigra (Populus x euramericana), irrespective of whether plants were exposed during a short-term CE glasshouse study (90 days), a longterm OTC experiment (3 years) or during the first year of a POPFACE experiment. An exception was observed in the closed canopy POPFACE experiment, where final leaf size remained unaltered by CO2. Increased leaf extension rate was observed in elevated CO2 in all experiments, at some point during leaf development, as determined by leaf length. Again the exception were the POPFACE experiment, where effects were not statistically significant. Leaf production and specific leaf area (SLA) were increased and decreased, respectively, on five out of six occasions, although both were only statistically significant on two occasions and interestingly for SLA never in the FACE experiment. Although both cell expansion and cell production were sensitive to CO2 concentration, effects appeared highly dependent on growth environment and genotype. However, increased leaf cell expansion in elevated CO2 was often associated with changes in the biophysical properties of the cell wall, usually increased cell wall plasticity. This research has shown that enhanced leaf area development was a consistent response to elevated CO2 but that the magnitude of this response is likely to decline, in long-term exposure to elevated CO2. Effects on SLA and leaf production suggest that CE and OTC experiments may not always provide good predictors of the 'qualitative' effects of elevated CO2 in long-term ecosystem experiments. (C) 2001 Elsevier Science Ltd. All rights reserved.

Teixeira, E. I., et al. (2017). "The interactions between genotype, management and environment in regional crop modelling." European Journal of Agronomy **88**: 106-115.

Biophysical models to simulate crop yield are increasingly applied in regional climate impact assessments. When performing large-area simulations, there is often a paucity of data to spatially represent changes in genotype (G) and management (M) across different environments (E). The importance of this uncertainty source in simulation results is currently unclear. In this study, we used a variance-based sensitivity analysis to quantify the relative contribution of maize hybrid (i.e. G) and sowing date (i.e. M) to the variability in biomass yield (Y-T, total above-ground biomass) and harvest index (HI, fraction of grain in total yield) of irrigated silage maize, across the extent of arable lands in New Zealand (i.e. E). Using a locally calibrated crop model (APSIM-maize), 25 G x M scenarios were simulated at a 5 arc minute resolution (similar to 5 km grid cell) using 30 years of historical weather data. Our results indicate that the impact of limited knowledge on G and M parameters depends on E and differs between model outputs. Specifically, the sensitivity of YT and HI to genotype and sowing date combinations showed different patterns across locations. The absolute impact of G and M factors was consistently greater in the colder southern regions of New Zealand. However, the relative share of total variability explained by each factor, the sensitivity index (S-i), showed distinct spatial patterns for the two output variables. The YT was more sensitive than HI in the warmer northern regions where absolute variability was the smallest. These patterns were characterised by a systematic response of Si to environmental drivers. For example, the sensitivity of YT and HI to hybrid maturity consistently increased with temperature. For the irrigated conditions assumed in our study, inter-annual weather conditions explained a higher share of total variability in the southern colder regions. Our results suggest that the development of methods and datasets to more accurately represent spatio-temporal G and M variability can reduce uncertainty in regional modelling assessments at different degrees, depending on prevailing environmental conditions and the output variable of interest. (C) 2016 Elsevier B.V. All rights reserved.

Thompson, J. R., et al. (2011). "The influence of land use and climate change on forest biomass and composition in Massachusetts, USA." Ecological Applications **21**(7): 2425-2444.

Land use and climate change have complex and interacting effects on naturally dynamic forest landscapes. To anticipate and adapt to these changes, it is necessary to understand their individual and aggregate impacts on forest growth and composition. We conducted a simulation experiment to evaluate regional forest change in Massachusetts, USA over the next 50 years (2010-2060). Our objective was to estimate, assuming a linear continuation of recent trends, the relative and interactive influence of continued growth and succession, climate change, forest conversion to developed uses, and timber harvest on live aboveground biomass (AGB) and tree species composition. We examined 20 years of land use records in relation to social and biophysical explanatory variables and used regression trees to create "probability-of-conversion" and "probability-of-harvest" zones. We incorporated this information into a spatially interactive forest landscape simulator to examine forest dynamics as they were affected by land use and climate change. We conducted simulations in a full-factorial design and found that continued forest growth and succession had the largest effect on AGB, increasing stores from 181.83 Tg to 309.56 Tg over 50 years. The increase varied from 49% to 112% depending on the ecoregion within the state. Compared to simulations with no climate or land use, forest conversion reduced gains in AGB by 23.18 Tg (or 18%) over 50 years. Timber harvests reduced gains in AGB by 5.23 Tg (4%). Climate change (temperature and precipitation) increased gains in AGB by 17.3 Tg (13.5%). Pinus strobus and Acer rubrum were ranked first and second, respectively, in terms of total AGB throughout all simulations. Climate change reinforced the dominance of those two species. Timber harvest reduced Quercus rubra from 10.8% to 9.4% of total AGB, but otherwise had little effect on composition. Forest conversion was generally indiscriminate in terms of species removal. Under the naive assumption that future land use patterns will resemble the recent past, we conclude that continued forest growth and recovery will be the dominant mechanism driving forest dynamics over the next 50 years, and that while climate change may enhance growth rates, this will be more than offset by land use, primarily forest conversion to developed uses.

Tong, X. J., et al. (2014). "Biophysical Controls on Light Response of Net CO2 Exchange in a Winter Wheat Field in the North China Plain." PLoS ONE **9**(2).

To investigate the impacts of biophysical factors on light response of net ecosystem exchange (NEE), CO2 flux was measured using the eddy covariance technique in a winter wheat field in the North China Plain from 2003 to 2006. A rectangular hyperbolic function was used to describe NEE light response. Maximum photosynthetic capacity (P-max) was 46.6 +/- 4.0 mu mol CO2 m(-2) s(-1) and initial light use efficiency (alpha) 0.059 +/- 0.006 mu mol mu mol(-1) in April-May, two or three times as high as those in March. Stepwise multiple linear regressions showed that Pmax increased with the increase in leaf area index (LAI), canopy conductance (g(c)) and air temperature (T-a) but declined with increasing vapor pressure deficit (VPD) (P<0.001). The factors influencing Pmax were sorted as LAI, g(c), T-a and VPD. alpha was proportional to ln(LAI), g(c), T-a and VPD (P<0.001). The effects of LAI, gc and Ta on a were larger than that of VPD. When Ta>25 degrees C or VPD>1.1-1.3 kPa, NEE residual increased with the increase in Ta and VPD (P<0.001), indicating that temperature and water stress occurred. When g(c) was more than 14 mm s(-1) in March and May and 26 mm s(-1) in April, the NEE residuals decline disappeared, or even turned into an increase in g(c) (P<0.01), implying shifts from stomatal limitation to non-stomatal limitation on NEE. Although the differences between sunny and cloudy sky conditions were unremarkable for light response parameters, simulated net CO2 uptake under the same radiation intensity averaged 18% higher in cloudy days than in sunny days during the year 2003-2006. It is necessary to include these effects in relevant carbon cycle models to improve our estimation of carbon balance at regional and global scales.

Toulios, L., et al. (2010). "Satellite-derived normalised difference vegetation index for monitoring climate impacts on European agriculture." Idojaras **114**(3): 169-185.

Some of the climate and biophysical variables essential for understanding and monitoring the climate system and the impact of climate change on agriculture can be efficiently observed from orbital platforms, providing global data sets continuously and consistently. In order to describe the status of satellite-derived data useful for monitoring climate impacts on European agriculture, an initiative was started within the EU COST Action 734, for the registration and analysis of the relevant satellite data records, based on a specific questionnaire. It was noted that among European countries there are great differences concerning the climate and biophysical data derived from satellite measurements in terms of type, collecting period, spatial and spectral characteristics. However, in many countries satellite data have been collected systematically for several years, and these data records have proved to be useful for climate change impact studies in agriculture. The main variables that are collected in an operational or experimental way are land surface temperature and normalized difference vegetation index (NDVI). This paper presents case studies in three European countries, representing the current application stages in the field of the use of NDVI data in impact studies of climatic change on agriculture. Future research will assess the availability and quality of time series of spectral and biophysical data available from current satellite sensors. The main goal of this paper is to demonstrate the common research activity focused on NDVI and carried out in the frame of EU COST Action 734.

Tripathi, P., et al. (2018). "Estimating net primary productivity in tropical forest plantations in India using satellite-driven ecosystem model." Geocarto International **33**(9): 988-999.

Net Primary Productivity (NPP) is a significant biophysical vegetation variable to understand the spatio-temporal distribution of carbon and source-sink nature of the ecosystem. This study was carried out in a forest plantation area and aimed to (i) estimate the spatio-temporal patterns of NPP during 2009 and 2010 using Carnegie-Ames-Stanford Approach [CASA] model and (ii) study the effects of climate variables on the NPP using generalized linear modelling (GLM) approach. The total annual NPP varied from 157.21 to 1030.89 gC m(-2) yr(-1) for the year 2009 and from 154.36 to 1124.85 g C m(-2) yr(-1) for the year 2010. The annual NPP was assessed across four major plantation types, where maximum NPP gain (106 and 139 g C m(-2) yr(-1)) in October was noticed in teak (Tectona grandis) and minimum (77 and 109 g C m(-2) yr(-1)) in eucalyptus (Eucalyptus hybrid) during 2009 and 2010.The validation, using field-estimated NPP, showed under-estimation of modelled NPP, with maximum MAPE of 34% for eucalyptus and minimum of 13% for teak. The dominant influence of precipitation on the NPP was revealed by GLM explaining more than 20% of variation. CASA model efficiently estimated the annual NPP of plantations. The accuracy could be improved further with inclusion of higher resolution data.

Trotter, L., et al. (2017). "Effects of rapid urbanisation on the urban thermal environment between 1990 and 2011 in Dhaka Megacity, Bangladesh." Aims Environmental Science **4**(1): 145-167.

This study investigates the influence of land-use/land-cover (LULC) change on land surface temperature (LST) in Dhaka Megacity, Bangladesh during a period of rapid urbanisation. LST was derived from Landsat 5 TM scenes captured in 1990, 2000 and 2011 and compared to contemporaneous LULC maps. We compared index-based and linear spectral mixture analysis (LSMA) techniques for modelling LST. LSMA derived biophysical parameters corresponded more strongly to LST than those produced using index-based parameters. Results indicated that vegetation and water surfaces had relatively stable LST but it increased by around 2 degrees C when these surfaces were converted to built-up areas with extensive impervious surfaces. Knowledge of the expected change in LST when one land-cover is converted to another can inform land planners of the potential impact of future changes and urges the development of better management strategies.

Tucker, C. M., et al. (2008). "An Approach to Assess Relative Degradation in Dissimilar Forests: Toward a Comparative Assessment of Institutional Outcomes." Ecology and Society **13**(1).

A significant challenge in the assessment of forest management outcomes is the limited ability to compare forest conditions quantitatively across ecological zones. We propose an approach for comparing different forest types through the use of reference forests. We tested our idea by drawing a sample of 42 forests from the Midwest USA, Mexico, Guatemala, Honduras, Brazil, Bolivia, Uganda, and Nepal. We grouped these forests by shared characteristics and selected a reference forest to serve as a baseline for each forest type. We developed an index of disturbances using ratios of several forest measurements to assess differences between each study forest and its reference forest. None of the study forests was known to have been impacted by major natural disturbances during the past 50 years. Therefore, the disturbances in these forests appear to be largely related to human activities. The forests most similar to their reference forests have had limited human interventions. Our results indicate the potential of this approach to compare different forest conditions across biomes. We argue that development of this approach could facilitate analyses of forest management institutions, promote reliable indicators to compare management outcomes, and contribute to improved policies for conservation.

Tudoroiu, M., et al. (2018). "Solar dimming above temperate forests and its impact on local climate." Environmental Research Letters **13**(6).

Vegetation has a substantial impact on the local climate. Land cover changes through afforestation or deforestation can amplify or mitigate climate warming by changes in biophysical and biogeochemical mechanisms. In the montane to subalpine area of the Eastern Alps in Europe, where forests have constantly expanded in the last four decades, data of meteorological stations show a consistent reduction in incoming global radiation for the period 2000-2015. To assess the potential role of forests in contributing to such a reduction, three site pairs in Central Europe with neighbouring forest and non-forest sites were analysed. In all the pairs, a lower amount of incoming radiation was recorded at the forest site. When biophysical mechanisms such as albedo, surface roughness and Bowen ratio changes were modelled together with changes in global radiation, the total radiative forcing accounted for a rate of change in air temperature was equal to 0.032 degrees C +/- 0.01 degrees C perWm(-2). These results suggest that local climate is influenced by land cover change through afforestation both via albedo and radiation feedbacks but also by means of indirect biophysical and species-dependent mechanisms. The data obtained for the site pairs in Central Europe are finally discussed to infer the occurrence of similar forest-driven effects in the Eastern Alps which may explain part of the solar dimming observed in high elevation weather stations.

Uddling, J. and G. Wallin (2012). "Interacting effects of elevated CO2 and weather variability on photosynthesis of mature boreal Norway spruce agree with biochemical model predictions." Tree Physiology **32**(12): 1509-1521.

According to well-known biochemical and biophysical mechanisms, the stimulation of C-3 photosynthesis by elevated atmospheric CO2 concentration ([CO2]) is strongly modified by changes in temperature and radiation. In order to investigate whether a static parameterization of the commonly used Farquhar et al. model of photosynthesis (i.e., without CO2-induced seasonal or thermal acclimation of photosynthetic capacity) can accurately predict these interactions in mature boreal Norway spruce (Picea abies (L.) Karst.) during the frost-free part of the growing season, shoot gas exchange was continuously measured on trees during their second/third year of exposure to ambient or doubled [CO2] inside whole-tree chambers. The relative CO2-induced enhancement of net photosynthesis (A(n)) at a given temperature remained stable over the study period, but increased strongly with temperature and radiation, in agreement with predictions by the model. Light-saturated A(n) (+67% at 20 degrees C), dark respiration (+36%) and intercellular to ambient [CO2] ratio (c(i)/c(a); +27%) were significantly increased by CO2 treatment. Stomatal conductance (g(s)) was not significantly affected. Our results demonstrate that the Farquhar et al. model of photosynthesis has the capability to predict interactions between [CO2] and seasonal weather variability on A(n) in Norway spruce during the non-frost growing season without accounting for CO2-induced seasonal and/or thermal photosynthetic acclimation. However, stomatal model assumptions of reduced g(s) and constant c(i)/c(a) under rising atmospheric [CO2] did not hold.

Uejio, C. K., et al. (2012). "Inland lake indicator bacteria: Long-term impervious surface and weather influences and a predictive Bayesian model." Lake and Reservoir Management **28**(3): 232-244.

Uejio CK, Peters TW, Patz JA. 2012. Inland lake indicator bacteria: Long-term impervious surface and weather influences and a predictive Bayesian model. Lake Reserv Manage. 28:232-244. Indicator bacteria (IB) that tend to occur with human pathogens provide surveillance of waterborne disease risk. This study analyzes a long-term IB surveillance record at Geneva Lake, Wisconsin, United States. The first research objective examined the influence of urbanization on fecal coliform (FC) variability and change from 1975 to 2000. Over this period, impervious surface expansion mirrored escalating fecal coliform in 2 of the 3 urbanized subwatersheds; however, impervious surface construction in less-developed subwatersheds did not impact FC levels. Average FC levels were highest at the only municipality (Linn Hillside Road Creek) with beaches around the lake using septic systems. The second research objective developed a predictive model to forecast human health risk in periods without surveillance. A Bayesian framework communicated uncertainty surrounding beach management decisions. Existing water quality surveillance is limited by infrequent and relatively slow sample processing; thus, beach managers often do not have reliable water quality information. The predictive statistical model determined associations between biophysical conditions and E. coli levels from 2001 to 2008. More moisture (precipitation, lake discharge) increased E. coli levels at almost every sampling site. Statistical models may accurately forecast risk at some beaches and hydrologic conditions. In particular, statistical models for Lake Geneva and Williams Bay beaches exhibit high overall accuracy, good specificity, and modest sensitivity levels. [Supplementary materials are available for this article. Go to the publisher's online edition of Lake and Reservoir Management to view the supplemental file.]

Uysal, M. and N. Polat (2015). "AN INVESTIGATION OF THE RELATIONSHIP BETWEEN LAND SURFACE TEMPERATURES AND BIOPHYSICAL INDICES RETRIEVED FROM LANDSAT TM IN AFYONKARAHISAR (TURKEY)." Tehnicki Vjesnik-Technical Gazette **22**(1): 177-181.

This study investigates the land surface heat formation in Afyonkarahisar based on the relationship between LST and surface biophysical parameters (NDVI, NDBI and NDWI) for Afyonkarahisar provinces for the years 1987 and 2011. Landsat 5 TM satellite images are used to retrieve NDVI, NDBI and NDWI and surface temperature. While the calculated mean surface temperature for the year 1987 is 27,75 degrees C for the city and 27,04 degrees C for the urban area, the calculated mean surface temperature of the year 2011 is 25,98 degrees C for the city and 24,81 degrees C for the urban area. Based on the analysis of these indices, a slight urban heat sink (UHS) was observed in Afyonkarahisar due to the small size of the city. This study shows that the main causes of the urban heat sink (UHS) in the study area are the natural occurrence including the three very high volcanic rocky hills in the city and geothermal water springs around the city.

Vadrevu, K. P., et al. (2006). "Spatial distribution of forest fires and controlling factors in Andhra Pradesh, India using spot satellite datasets." Environmental Monitoring and Assessment **123**(1-3): 75-96.

Fires are one of the major causes of forest disturbance and destruction in several dry deciduous forests of southern India. In this study, we use remote sensing data sets in conjunction with topographic, vegetation, climate and socioeconomic factors for determining the potential causes of forest fires in Andhra Pradesh, India. Spatial patterns in fire characteristics were analyzed using SPOT satellite remote sensing datasets. We then used nineteen different metrics in concurrence with fire count datasets in a robust statistical framework to arrive at a predictive model that best explained the variation in fire counts across diverse geographical and climatic gradients. Results suggested that, of all the states in India, fires in Andhra Pradesh constituted nearly 13.53% of total fires. District wise estimates of fire counts for Andhra Pradesh suggested that, Adilabad, Cuddapah, Kurnool, Prakasham and Mehbubnagar had relatively highest number of fires compared to others. Results from statistical analysis suggested that of the nineteen parameters, population density, demand of metabolic energy (DME), compound topographic index, slope, aspect, average temperature of the warmest quarter (ATWQ) along with literacy rate explained 61.1% of total variation in fire datasets. Among these, DME and literacy rate were found to be negative predictors of forest fires. In overall, this study represents the first statewide effort that evaluated the causative factors of fire at district level using biophysical and socioeconomic datasets. Results from this study identify important biophysical and socioeconomic factors for assessing 'forest fire danger' in the study area. Our results also identify potential 'hotspots' of fire risk, where fire protection measures can be taken in advance. Further this study also demonstrate the usefulness of best-subset regression approach integrated with GIS, as an effective method to assess 'where and when' forest fires will most likely occur.

Wagle, P., et al. (2015). "Biophysical controls on carbon and water vapor fluxes across a grassland climatic gradient in

the United States." Agricultural and Forest Meteorology **214**: 293-305.
Understanding of the underlying causes of spatial variation in exchange of carbon and water vapor fluxes between grasslands and the atmosphere is crucial for accurate estimates of regional and global carbon and water budgets, and for predicting the impact of climate change on biosphere-atmosphere feedbacks of grasslands. We used ground-based eddy flux and meteorological data, and the Moderate Resolution Imaging Spectroradiometer (MODIS) enhanced vegetation index (EVI) from 12 grasslands across the United States to examine the spatial variability in carbon and water vapor fluxes and to evaluate the biophysical controls on the spatial patterns of fluxes. Precipitation was strongly associated with spatial and temporal variability in carbon and water vapor fluxes and vegetation productivity. Grasslands with annual average precipitation <600 mm generally had neutral annual carbon balance or emitted small amount of carbon to the atmosphere. Despite strong coupling between gross primary production (GPP) and evapotranspiration (ET) across study sites, GPP showed larger spatial variation than ET, and EVI had a greater effect on GPP than on ET. Consequently, large spatial variation in ecosystem water use efficiency (EWUE = annual GPP/ET; varying from 0.67 +/- 0.55 to 2.52 +/- 0.52 g C mm(-1) ET) was observed. Greater reduction in GPP than ET at high air temperature and vapor pressure deficit caused a reduction in EWUE in dry years, indicating a response which is opposite than what has been reported for forests. Our results show that spatial and temporal variations in ecosystem carbon uptake, ET, and water use efficiency of grasslands were strongly associated with canopy greenness and coverage, as indicated by EVI. (C) 2015 Elsevier B.V. All rights reserved.

Walko, R. L., et al. (2000). "Coupled atmosphere-biophysics-hydrology models for environmental modeling." Journal of Applied Meteorology **39**(6): 931-944.
The formulation and implementation of LEAF-2, the Land Ecosystem-Atmosphere Feedback model, which comprises the representation of land-surface processes in the Regional Atmospheric Modeling System (RAMS), is described. LEAF-2 is a prognostic model for the temperature and water content of soil, snow cover, vegetation, and canopy air, and includes turbulent and radiative exchanges between these components and with the atmosphere. Subdivision of a RAMS surface grid cell into multiple areas of distinct land-use types is allowed, with each subgrid area, or patch, containing its own LEAF-2 model, and each patch interacts with the overlying atmospheric column with a weight proportional to its fractional area in the grid cell. A description is also given of TOPMODEL, a land hydrology model that represents surface and subsurface downslope lateral transport of groundwater. Details of the incorporation of a modified form of TOPMODEL into LEAF-2 are presented. Sensitivity tests of the coupled system are presented that demonstrate the potential importance of the patch representation and of lateral water transport in idealized model simulations. Independent studies that have applied LEAF-2 and verified its performance against observational data are cited. Linkage of RAMS and TOPMODEL through LEAF-2 creates a modeling system that can be used to explore the coupled atmosphere-biophysical-hydrologic response to altered climate forcing at local watershed and regional basin scales.

van der Ent, R. J., et al. (2014). "Contrasting roles of interception and transpiration in the hydrological cycle - Part 2: Moisture recycling." Earth System Dynamics **5**(2): 471-489.
The contribution of land evaporation to local and remote precipitation (i.e. moisture recycling) is of significant importance to sustain water resources and ecosystems. But how important are different evaporation components in sustaining precipitation? This is the first paper to present moisture recycling metrics for partitioned evaporation. In the companion paper Wang-Erlandsson et al. (2014) (hereafter Part 1), evaporation was partitioned into vegetation interception, floor interception, soil moisture evaporation and open-water evaporation (constituting the direct, purely physical fluxes, largely dominated by interception), and transpiration (delayed, biophysical flux). Here, we track these components forward as well as backward in time. We also include age tracers to study the atmospheric residence times of these evaporation components. We present a new image of the global hydrological cycle that includes quantification of partitioned evaporation and moisture recycling as well as the atmospheric residence times of all fluxes. We demonstrate that evaporated interception is more likely to return as precipitation on land than transpired water. On average, direct evaporation (essentially interception) is found to have an atmospheric residence time of 8 days, while transpiration typically resides for 9 days in the atmosphere. The process scale over which evaporation recycles is more local for interception compared to transpiration; thus interception

generally precipitates closer to its evaporative source than transpiration, which is particularly pronounced outside the tropics. We conclude that interception mainly works as an intensifier of the local hydrological cycle during wet spells and wet seasons. On the other hand, transpiration remains active during dry spells and dry seasons and is transported over much larger distances downwind, where it can act as a significant source of moisture. Thus, as various land-use types can differ considerably in their partitioning between interception and transpiration, our results stress that land-use changes (e.g. forest-to-cropland conversion) do not only affect the magnitude of moisture recycling, but could also influence the moisture recycling patterns and lead to a redistribution of water resources. As such, this research highlights that land-use changes can have complex effects on the atmospheric branch of the hydrological cycle.

Wang, C., et al. (2013). "Seasonality of soil CO2 efflux in a temperate forest: Biophysical effects of snowpack and spring freeze-thaw cycles." Agricultural and Forest Meteorology **177**: 83-92.

Changes in characteristics of snowfall and spring freeze-thaw-cycle (FTC) events under the warming climate make it critical to understand biophysical controls on soil CO2 efflux (R-S) in seasonally snow-covered ecosystems. We conducted a snow removal experiment and took year-round continuous automated measurements of R-S, soil temperature (T-5) and soil volumetric water content at the 5 cm depth (W-5) with a half-hour interval in a Chinese temperate forest in 2010-2011. Our objectives were to: (1) develop statistical models to describe the seasonality of R-S in this forest; (2) quantify the contribution of seasonal R-S to the annual budget; (3) examine biophysical effects of snowpack on R-S; and (4) test the hypothesis that an FTC-induced enhancement of R-S is jointly driven by biological and physical processes. Empirical R-S-T-5-W-5 models explained 65.3-94.1% of the variability in the R-S data, but the number of the regression terms and their coefficients varied with season. This indicates that the model should be fitted to the seasonal data sets separately to explicitly describe the seasonality of R-S. The R-S during the winter, spring FTC period, and growing season contributed 5.7%, 3.5%, and 91.1%, respectively, to the total annual R-S. The relative enhancement of R-S due to snowpack and FTCs averaged 3.4 and 2.5, respectively. The snowpack-induced enhancement of R-S exponentially increased with T-5 (R-2 = 0.83) and snow depth (R-2 = 0.16), while the FTC-induced enhancement of R-S exponentially decreased with T-5 (R-2 = 0.45) and W-5 (R-2 = 0.67). These results suggest that the snowpack-induced enhancement mainly results from the snow-depth-dependent insulation of soil from low air temperatures, while the FTC-induced enhancement is dominantly driven by biological processes. Accumulatively, the snowpack and spring FTCs made a minor net contribution (2.3% and 1.2%, respectively) to the annual R-S budget. (C) 2013 Elsevier B.V. All rights reserved.

Wang, H., et al. (2014). "Biophsyical constraints on gross primary production by the terrestrial biosphere." Biogeosciences **11**(20): 5987-6001.

Persistent divergences among the predictions of complex carbon-cycle models include differences in the sign as well as the magnitude of the response of global terrestrial primary production to climate change. Such problems with current models indicate an urgent need to reassess the principles underlying the environmental controls of primary production. The global patterns of annual and maximum monthly terrestrial gross primary production (GPP) by C-3 plants are explored here using a simple first-principles model based on the light-use efficiency formalism and the Farquhar model for C-3 photosynthesis. The model is driven by incident photosynthetically active radiation (PAR) and remotely sensed green-vegetation cover, with additional constraints imposed by low-temperature inhibition and CO2 limitation. The ratio of leaf-internal to ambient CO2 concentration in the model responds to growing-season mean temperature, atmospheric dryness (indexed by the cumulative water deficit, Delta E) and elevation, based on an optimality theory. The greatest annual GPP is predicted for tropical moist forests, but the maximum (summer) monthly GPP can be as high, or higher, in boreal or temperate forests. These findings are supported by a new analysis of CO2 flux measurements. The explanation is simply based on the seasonal and latitudinal distribution of PAR combined with the physiology of photosynthesis. By successively imposing biophysical constraints, it is shown that partial vegetation cover - driven primarily by water shortage - represents the largest constraint on global GPP.

Wang, L. M., et al. (2018). "Response of Surface Temperature to Afforestation in the Kubuqi Desert, Inner Mongolia." Journal of Geophysical Research-Atmospheres **123**(2): 948-964.

In this study, micrometeorological observations in a shrub ecosystem and an adjacent poplar plantation forest ecosystem in the Kubuqi Desert, Inner Mongolia, China, are used to evaluate the theory of intrinsic biophysical mechanism (IBPM) and to investigate the biophysical effects of afforestation. Results indicate that after forcing energy balance closure to the observed fluxes, the IBPM theory agrees very well with the observed temporal variations in the surface temperature and with the observed temperature difference between the paired sites at the half-hourly time scale. Afforestation activity in this dryland landscape has a cooling effect (-0.50.2K) in the daytime in all the seasons and a warming effect (0.20.1K) in the nighttime during the winter, spring and, autumn but a cooling effect (-1.00.3K) in the summer at night. These temperature changes are decomposed into contributions from changes in surface albedo, surface roughness, Bowen ratio, and ground heat flux. Comparison is made between the IBPM theory and the theory of the decomposed temperature metric.

Wang, M., et al. (2017). "On the Long-Term Hydroclimatic Sustainability of Perennial Bioenergy Crop Expansion over the United States." Journal of Climate **30**(7): 2535-2557.

Large-scale cultivation of perennial bioenergy crops (e.g., miscanthus and switchgrass) offers unique opportunities to mitigate climate change through avoided fossil fuel use and associated greenhouse gas reduction. Although conversion of existing agriculturally intensive lands (e.g., maize and soy) to perennial bioenergy cropping systems has been shown to reduce near-surface temperatures, unintended consequences on natural water resources via depletion of soil moisture may offset these benefits. The hydroclimatic impacts associated with perennial bioenergy crop expansion over the contiguous United States are quantified using the Weather Research and Forecasting Model dynamically coupled to a land surface model (LSM). A suite of continuous (2000-09) medium-range resolution (20-km grid spacing) ensemble-based simulations is conducted using seasonally evolving biophysical representation of perennial bioenergy cropping systems within the LSM based on observational data. Deployment is carried out only over suitable abandoned and degraded farmlands to avoid competition with existing food cropping systems. Results show that near-surface cooling (locally, up to 5 degrees C) is greatest during the growing season over portions of the central United States. For some regions, principal impacts are restricted to a reduction in near-surface temperature (e.g., eastern portions of the United States), whereas for other regions deployment leads to soil moisture reduction in excess of 0.15-0.2 m(3) m(-3) during the simulated 10-yr period (e.g., western Great Plains). This reduction (similar to 25%-30% of available soil moisture) manifests as a progressively decreasing trend over time. The large-scale focus of this research demonstrates the long-term hydroclimatic sustainability of large-scale deployment of perennial bioenergy crops across the continental United States, revealing potential hot spots of suitable deployment and regions to avoid.

Wang, S., et al. (2018). "Incorporating diffuse radiation into a light use efficiency and evapotranspiration model: An 11-year study in a high latitude deciduous forest." Agricultural and Forest Meteorology **248**: 479-493.

The fraction of diffuse photosynthetic active radiation (PAR) reaching the land surface is one of the biophysical factors regulating carbon and water exchange between terrestrial ecosystems and the atmosphere. This is especially relevant for high latitude ecosystems, where cloudy days are prevalent. Without considering impacts of diffuse PAR, traditional 'top-down' models of ecosystem gross primary productivity (GPP) and evapo-transpiration (ET), which use satellite remote sensing observations, are biased towards clear sky conditions. This study incorporated a cloudiness index (CI), an index for the fraction of diffuse PAR, into a Joint 'top-down' model that uses the same set of biophysical constraints to simulate GPP and ET for a high latitude temperate deciduous forest. To quantify the diffuse PAR effects, CI along with other environmental variables derived from an eleven year eddy covariance data set were used to statistically explore the independent and joint effects of diffuse PAR on GPP, ET, incident light use efficiency (LUE), evaporative fraction (EF) and ecosystem water use efficiency (WUE). The independent and joint effects of CI were compared from global sensitivity analysis of the 'top-down' models. Results indicate that for independent effects, CI increased GPP, LUE, ET, EF and WUE. Analysis of joint effects shows that CI mainly interacted with the radiation intercepted in the canopy (PAR, net radiation and leaf area index) to influence GPP, ET and WUE. Moreover, Ta and vapor pressure saturation deficit played a major role for the joint influence of CI on LUE and EF. In the growing season from May to October, variation in CI accounts for 11.9%, 3.0% and 7.8% of the total variation of GPP, ET and transpiration, respectively. As the influence of CI on GPP is larger than that on ET, this leads to an increase in WUE with CI. Joint GPP and ET model results showed that when including CI, the root mean square errors (RMSE) of daily GPP decreased from 1.64 to

1.45 g C m(-2) d(-1) (11.7% reduction) and ET from 15.79 to 14.50 W m(-2) (8.2% reduction). Due to the interaction of diffuse PAR with plant canopies, the largest model improvements using CI for GPP and ET occurred during the growing season and for the transpiration component, as suggested by comparisons to sap flow measurements. Furthermore, our study suggests a potential biophysical mechanism, not considered in other studies: under high diffuse PAR conditions, due to the increased longwave emission from clouds, canopy temperature gets higher and enhances GPP and transpiration in this temperature-limited high latitude ecosystem.

Wang, Y., et al. (2014). "The biogeophysical effects of extreme afforestation in modeling future climate." Theoretical and Applied Climatology **118**(3): 511-521.

Afforestation has been deployed as a mitigation strategy for global warming due to its substantial carbon sequestration, which is partly counterbalanced with its biogeophysical effects through modifying the fluxes of energy, water, and momentum at the land surface. To assess the potential biophysical effects of afforestation, a set of extreme experiments in an Earth system model of intermediate complexity, the McGill Paleoclimate Model-2 (MPM-2), is designed. Model results show that latitudinal afforestation not only has a local warming effect but also induces global and remote warming over regions beyond the forcing originating areas. Precipitation increases in the northern hemisphere and decreases in southern hemisphere in response to afforestation. The local surface warming over the forcing originating areas in northern hemisphere is driven by decreases in surface albedo and increases in precipitation. The remote surface warming in southern hemisphere is induced by decreases in surface albedo and precipitation. The results suggest that the potential impact of afforestation on regional and global climate depended critically on the location of the forest expansion. That is, afforestation in 0 degrees-15 degrees N leaves a relatively minor impact on global and regional temperature; afforestation in 45 degrees-60 degrees N results in a significant global warming, while afforestation in 30 degrees-45 degrees N results in a prominent regional warming. In addition, the afforestation leads to a decrease in annual mean meridional oceanic heat transport with a maximum decrease in forest expansion of 30 degrees-45 degrees N. These results can help to compare afforestation effects and find areas where afforestation mitigates climate change most effectively combined with its carbon drawdown effects.

Wang, Y. K., et al. (2014). "Non-additive effects of litter-mixing on soil carbon dioxide efflux from poplar-based agroforestry systems in the warm temperate region of China." Agroforestry Systems **88**(2): 193-203.

Poplar-based agroforestry systems are one of the most important farming systems on the temperate plains of China, but soil respiration in those systems has seldom been reported. In this study, poplar leaf litter and residues of the two main crops (wheat and peanut) grown in the agroforestry system were amended to form different litter mixing treatments in field experiments at two sites located in Jiangsu Province, China. We measured soil respiration and environmental factors in the different treatments. Soil respiration rates were increased by the addition of plant residues but were strongly influenced by residue quality. During the growing season, soil respiration was negatively related with C/N ratio, while positively related with the initial P concentration of residues ($P < 0.05$). Poplar leaf litter and crop residues showed non-additive effects on soil respiration when they were mixed. Both air and soil temperature at 10 cm depth explained more than 85 % of the variation of soil respiration at both sites with an exponential model. A significant linear relationship between soil respiration and soil water content at 10 cm depth (W-S) was also observed. The percent of variation in soil respiration explained by a model based on air temperature and soil water content was greater than that explained by a model based on temperature alone. Thus, soil respiration in the studied poplar-based agroforestry systems was driven by both temperature and soil water content. Soil respiration was significantly different between the two sites that had different clay content and C/N ratios. Results from this study are important for us to understand how soil respiration responds to litter mixing or is influenced by biophysical factors in poplar-based agroforestry systems.

Vargas, R. and M. F. Allen (2008). "Dynamics of fine root, fungal rhizomorphs, and soil respiration in a mixed temperate forest: Integrating sensors and observations." Vadose Zone Journal **7**(3): 1055-1064.

Fine roots and rhizomorphs have important implications for the global carbon balance, but the processes underlying these carbon sinks are not well understood. In this study, we coupled continuous minirhizotron observations with an array of solid-state CO(2) sensors. We calculated soil respiration using a gradient flux method. Using a Kaplan-Maier survival analysis, we determined a median longevity of 347 d for fine roots and of 400 d for rhizomorphs. Radiocarbon ((14)C) analysis suggested an age of 7 yr for fine roots < 1 mm and 17 yr for roots of 1 mm in diameter. We found rapid changes in root length (maximum of 38.1 cm m(-2) d(-1)) and rhizomorph length (maximum of 105.4 cm m(-2) d(-1)) during sampling of four consecutive days. Changes in rhizomorph length were more variable than root length, and rhizomorphs were negatively correlated with daily changes in soil moisture. The variation in root length may be associated to prior environmental conditions. Fine root length was correlated with daily CO(2) production, and variation in daily fine root length could contribute up to 4680 g C ha(-1) d(-1). We observed a clockwise diurnal hysteresis effect in soil respiration with soil temperature that changed in amplitude and shape along the year. Our results show the importance of shorter intervals of minirhizotron measurements to understand rapid fine roots and rhizomorphs variation. Furthermore, continuous minirhizotron measurements should be couple with continuous measurements of multiple sensor arrays to explain biophysical factors that regulate belowground carbon dynamics.

Vargas, R., et al. (2011). "On the multi-temporal correlation between photosynthesis and soil CO_2 efflux: reconciling lags and observations." New Phytologist **191**(4): 1006-1017.

Although there is increasing evidence of the temporal correlation between photosynthesis and soil CO_2 efflux, no study has so far tested its generality across the growing season at multiple study sites and across several time scales. Here, we used continuous (hourly) data and applied time series analysis (wavelet coherence analysis) to identify temporal correlations and time lags between photosynthesis and soil CO_2 efflux for three forests from different climates and a grassland. Results showed the existence of multi-temporal correlations at time periods that varied between 1 and 16 d during the growing seasons at all study sites. Temporal correlations were strongest at the 1 d time period, with longer time lags for forests relative to the grassland. The multi-temporal correlations were not continuous throughout the growing season, and were weakened when the effect of variations in soil temperature and CO_2 diffusivity on soil CO_2 efflux was taken into account. Multi-temporal correlations between photosynthesis and soil CO_2 efflux exist, and suggest that multiple biophysical drivers (i.e. photosynthesis, soil CO_2 diffusion, temperature) are likely to coexist for the regulation of allocation and transport speed of carbon during a growing season. Future studies should consider the multi-temporal influence of these biophysical drivers to investigate their effect on the transport of carbon through the soil-plant-atmosphere continuum.

Waring, R. H., et al. (2010). "Improving predictions of forest growth using the 3-PGS model with observations made by remote sensing." Forest Ecology and Management **259**(9): 1722-1729.

Measurements made by remote sensing can characterize the leaf area density and nitrogen/chlorophyll content of forest canopies, as well as maximum photosynthetic capacity and above-ground structure and biomass. Combining these with climate data estimated from relationships based on temperature measurements and using an appropriate process-based model, it is possible to calculate, with useful accuracy, carbon sequestration and wood production by different forest types covering large land areas. To broaden its application and reduce the need for detailed information on stand characteristics, a satellite-driven version of the model 3-PG, was developed. The 3-PGS model incorporates the major first-order physiological processes that determine forest growth, and the biophysical factors that affect and govern those processes. It incorporates remotely sensed estimates of seasonal variation in canopy light interception (fPAR) and includes physiological variables (stomatal conductance and canopy quantum efficiency) that can be estimated by remote-sensing measurements of factors that influence those variables. 3-PGS therefore provides a useful framework within which to evaluate how data from the array of airborne and satellite-borne sensors now available might be used to initialize, drive, and test process-based growth models across regions with diverse soils and climates. We address the question: to what extent might additional remote-sensing techniques improve 3-PGS predictions? Sensitivity analyses indicate that model accuracy would be most improved through better estimates of seasonal changes in canopy photosynthetic capacity (a) and canopy conductance (G(c)). Canopy photosynthetic capacity depends on the amount of light absorbed by the canopy, estimated as a fraction of photosynthetically active radiation (PAR), and on foliage nitrogen or chlorophyll content, which can be estimated using multi-spectral imagery. G, depends on canopy leaf area index (L) and stomatal conductance of the foliage (g,), which is affected by the vapor pressure deficit of the air and soil water content. The onset and effects of drought can be determined from changes in canopy reflectance and fPAR identified from sequential measurements; the same measurements, coupled with calculations of evapotranspiration using climatic data and standard formulae, provide estimates of total available water in forest root zones. Periodic surveys with Light Detection and Ranging (LiDAR) and interferometric RADAR may serve to validate model predictions of above-ground growth (NPPA), while progressive reduction in light-use efficiency (NPPA/APAR) may identify forests with declining vigor that are likely to succumb to attack from insects and pathogens. (C) 2009 Elsevier B.V. All rights reserved.

Veeck, G., et al. (2017). "Contemporary changes to herding systems in China and effects on pasture quality: a case study in Gansu Province, 2000-2012." Environmental Monitoring and Assessment **189**(11).

Post-2000 efforts to protect China's pastoral areas are distinct from earlier efforts in that funding for the most recent round of policies and programs is commensurate with the task. Even with appropriate funding, however, effective methods of mitigating pasture degradation are widely disputed. The most controversial of the current policies include herding family resettlement, pasture fallow programs (herding "bans"), and the promotion of confined animal feeding operations (CAFOs). Ideally, the policies are intended to protect grassland ecological systems while assuring acceptable revenues to affected families and regions. This article presents a case study of 49 townships in three counties in central Gansu investigating the interactions among changes in mean interpolated annual precipitation and livestock density and pasture quality. Pasture quality is assessed using mean township values of the enhanced vegetation index (EVI) from 2000 to 2012 obtained by the MODerate-resolution Imaging Spectroradiometer (MODIS) sensor of the Terra satellite. The research joins remotely sensed environmental data, interpolated annual precipitation estimates, and livestock counts at the township scale for the years from 2000 to 2012 but is also informed by in-depth interviews with herding families and husbandry officials. Joining biophysical analyses of changes in pasture with archived data and indepth interviews, we adopt a synthetic approach to determine changes to pasture quality under post-2000 policy interventions and possible reasons for these changes. Pasture quality has improved as CAFO livestock have increased; however, herders and local officials report that some of the new policies and programs may have important unanticipated negative impacts related to pasture ecology and water consumption.

Weng, Q. H., et al. (2006). "Urban surface biophysical descriptors and land surface temperature variations." Photogrammetric Engineering and Remote Sensing **72**(11): 1275-1286.

In remote sensing studies of land surface temperatures (LST), thematic land-use and land-cover (LULC) data are frequently employed for simple correlation analyses between LULC types and their thermal signatures. Development of quantitative surface descriptors could improve our capabilities for modeling urban thermal landscapes and advance urban climate research. This study developed an analytical procedure based upon a spectral unmixing model for characterizing and quantifying the urban landscape in Indianapolis, Indiana. A Landsat Enhanced Thematic Mapper Plus image of the study area, acquired on 22 June 2002, was spectrally unmixed into four fraction endmembers, namely, green vegetation, soil, high and low albedo. Impervious surface was then computed from the high and low albedo images. A hybrid classification procedure was developed to classify the fraction images into seven land-use and land-cover classes. Next, pixel-based LST measurements were related to urban surface biophysical descriptors derived from spectral mixture analysis (SMA). Correlation analyses were conducted to investigate land-cover based relationships between LST and impervious surface and green vegetation fractions for an analysis of the causes of LST variations. Results indicate that fraction images derived from SMA were effective for quantifying the urban morphology and for providing reliable measurements of biophysical variables such as vegetation abundance, soil, and impervious surface. An examination of LST variations within census block groups and their relationships with the compositions of LULC types, biophysical descriptors, and other relevant spatial data shows that LST possessed a weaker relation with the LULC compositions than with other variables (including urban biophysical descriptors, remote sensing biophysical variables, GIS-based impervious surface variables, and population density). Further research should be directed to refine spectral mixture modeling. The use of multi-temporal remote sensing data for urban time-space modeling and comparison of urban morphology in different geographical settings are also feasible.

Wenkel, K. O., et al. (2013). "LandCaRe DSS - An interactive decision support system for climate change impact assessment and the analysis of potential agricultural land use adaptation strategies." Journal of Environmental

Management **127**: S168-S183.

Decision support to develop viable climate change adaptation strategies for agriculture and regional land use management encompasses a wide range of options and issues. Up to now, only a few suitable tools and methods have existed for farmers and regional stakeholders that support the process of decision-making in this field. The interactive model-based spatial information and decision support system LandCaRe DSS attempts to close the existing methodical gap. This system supports interactive spatial scenario simulations, multi-ensemble and multi-model simulations at the regional scale, as well as the complex impact assessment of potential land use adaptation strategies at the local scale. The system is connected to a local geo-database and via the Internet to a climate data server. LandCaRe DSS uses a multitude of scale-specific ecological impact models, which are linked in various ways. At the local scale (farm scale), biophysical models are directly coupled with a farm economy calculator. New or alternative simulation models can easily be added, thanks to the innovative architecture and design of the DSS. Scenario simulations can be conducted with a reasonable amount of effort. The interactive LandCaRe DSS prototype also offers a variety of data analysis and visualisation tools, a help system for users and a farmer information system for climate adaptation in agriculture. This paper presents the theoretical background, the conceptual framework, and the structure and methodology behind LandCaRe DSS. Scenario studies at the regional and local scale for the two Eastern German regions of Uckermark (dry lowlands, 2600 km(2)) and Weisseritz (humid mountain area, 400 km(2)) were conducted in close cooperation with stakeholders to test the functionality of the DSS prototype. The system is gradually being transformed into a web version (http://www.landcare-dss.de) to ensure the broadest possible distribution of LandCaRe DSS to the public. The system will be continuously developed, updated and used in different research projects and as a learning and knowledge-sharing tool for students. The main objective of LandCaRe DSS is to provide information on the complex long-term impacts of climate change and on potential management options for adaptation by answering "what-if" type questions. (C) 2013 Elsevier Ltd. All rights reserved.

Verhoef, W., et al. (2018). "Hyperspectral radiative transfer modeling to explore the combined retrieval of biophysical parameters and canopy fluorescence from FLEX - Sentinel-3 tandem mission multi-sensor data." Remote Sensing of Environment **204**: 942-963.

The FLuorescence EXplorer (FLEX) satellite mission, selected as ESA's 8th Earth Explorer, has been designed for the measurement of sun-induced fluorescence (F) spectra emitted by plants. This will be accomplished through a multi-sensor approach by placing it in a common orbit in tandem with the Sentinel-3 (S3) mission, which will have two optical sensors on board, OLCI (Ocean and Land Colour Instrument) and SLSTR (Sea and Land Surface Temperature Radiometer) to complement FLEX. These S3 instruments will be used in combination with the imaging spectrometers on board FLEX to provide data useful for atmospheric correction of FLEX data. However, a fully synergetic approach, i.e. by exploiting the spectral and directional information from all tandem mission instruments together, is an attractive alternative which is explored in this paper. By employing all combined top of-atmosphere (TOA) spectral radiance data, one can (i) characterize the relevant optical properties of the atmosphere, (ii) retrieve biophysical canopy properties including the associated reflectance anisotropy, and (iii) retrieve a more accurate and consistent canopy F. Regarding retrieval methods, Fraunhofer Line Depth (FLD) and Spectral Fitting (SF) are well-known techniques applied to hyperspectral data. Both methods depend on a high spectral resolution and assume a Lambertian (isotropic) canopy reflectance. However, most vegetation canopies are non-Lambertian. This implies that, in particular when ignoring the anisotropic surface reflection, substantial retrieval errors can occur due to the interaction between atmospheric absorption bands and surface reflectance anisotropy. In this paper, a novel method based on spectral radiative transfer (RT) modeling is proposed, in which coupled RT models are used to simulate TOA radiance spectra. These are then matched with `measured' spectra in order to retrieve surface fluorescence, along with a suite of biophysical parameters, by model inversion through optimization. By applying coupled RT models of the soil-leaf-canopy and the surface-atmosphere systems, TOA radiance spectra can be simulated for all optical sensors of this tandem mission. In this way, complex effects due to surface reflectance anisotropy and the spectral sampling by the various instruments, which are difficult to compensate for in the end products, are properly taken into account by their incorporation in the forward modeling. Next, by model inversion of TOA radiance data via optimization, the most accurate F retrievals can be achieved in a consistent manner, along with important canopy level biophysical parameters that may help interpret the F spectrum, such as chlorophyll content and leaf area

index (LAI). The potential of this approach has been explored in a numerical experiment, and the results are presented in this paper. We find that, with the assumed well-characterized and plausible FLEX/S3 instrument performances, the simultaneous retrieval of biophysical canopy parameters and F spectra would be possible with a remarkable accuracy, provided the correct atmospheric characterization is available.

Wethey, D. S., et al. (2011). "Predicting intertidal organism temperatures with modified land surface models." Ecological Modelling **222**(19): 3568-3576.

Animals and plants in the marine intertidal zone live at the interface between terrestrial and marine environments. This zone is likely to be a sensitive indicator of the effects of climate change in coastal ecosystems, because of several key characteristics including steep environmental gradients, rapid temperature changes during tide transitions, fierce competition for limited space, and a community of mostly sessile organisms. Here we describe a modular modeling approach using modifications to a meteorological land surface model to determine body temperatures of the ecologically dominant rocky intertidal mussel Mytilus californianus, as a tool that can be used as a proxy for ecological performance. We validate model results against in situ measurements made with biomimetic body temperature sensors. Model predictions lie within the range of variability of biomimetic measurements, based on observations over a 4-year period at sites along 1700 km of the US west coast from southern California (34.5 degrees N) to northern Washington (48.4 degrees N). Our modular approach can be easily applied to many situations in the intertidal zone, including bare rock, mussel, barnacle, and algal beds, salt-marsh grasses, and sand- and mud-flats, by modifying the "vegetation layer" in a standard meteorological land surface model. Biophysical models such as these, which link ecological processes to changing climates through predictions of body temperature, are essential for understanding biogeographic patterns of physiological stress and mortality risk. (C) 2011 Elsevier B.V. All rights reserved.

White, A., et al. (2000). "The high-latitude terrestrial carbon sink: a model analysis." Global Change Biology **6**(2): 227-245.

A dynamic, global vegetation model, hybrid v4.1 (Friend et al. 1997), was driven by transient climate output from the UK Hadley Centre GCM (HadCM2) with the IS92a scenario of increasing atmospheric CO2 equivalent, sulphate aerosols and predicted patterns of atmospheric N deposition. Changes in areas of vegetation types and carbon storage in biomass and soils were predicted for areas north of 50 degrees N from 1860 to 2100. Hybrid is a combined biogeochemical, biophysical and biogeographical model of natural, potential ecosystems. The effect of periodic boreal forest fires was assessed by adding a simple stochastic fire model. Hybrid represents plant physiological and soil processes regulating the carbon, water and N cycles and competition between individuals of parameterized generalized plant types. The latter were combined to represent tundra, temperate grassland, temperate/mixed forest and coniferous forest. The model simulated the current areas and estimated carbon stocks in the four vegetation types. It was predicted that land areas above 50 degrees N (about 23% of the vegetated global land area) are currently accumulating about 0.4 PgC y(-1) (about 30% of the estimated global terrestrial sink) and that this sink could grow to 0.8-1.0 PgC y(-1) by the second half of the next century and persist undiminished until 2100. This sink was due mainly to an increase in forest productivity and biomass in response to increasing atmospheric CO2, temperature and N deposition, and includes an estimate of the effect of boreal forest fire, which was estimated to diminish the sink approximately by the amount of carbon emitted to the atmosphere during fires. Averaged over the region, N deposition contributed about 18% to the sink by the 2080 s. As expected, climate change (temperature, precipitation, solar radiation and saturation pressure deficit) and N deposition without increasing atmospheric CO2 produced a carbon source. Forest areas expanded both south and north, halving the current tundra area by 2100. This expansion contributed about 30% to the sink by the 2090 s. Tundra areas which were not invaded by forest fluctuated from sink to source. It was concluded that a high latitude carbon sink exists at present and, even assuming little effect of N deposition, no forest expansion and continued boreal forest fires, the sink is likely to persist at its current level for a century.

Wickham, J., et al. (2014). "An isoline separating relatively warm from relatively cool wintertime forest surface temperatures for the southeastern United States." Global and Planetary Change **120**: 46-53.

Forest-oriented climate mitigation policies promote forestation as a means to increase uptake of atmospheric carbon to counteract global warming. Some have pointed out that a carbon-centric forest

policy may be overstated because it discounts biophysical aspects of the influence of forests on climate. In extra-tropical regions, many climate models have shown that forests tend to be warmer than grasslands and croplands because forest albedos tend to be lower than non-forest albedos. A lower forest albedo results in higher absorption of solar radiation and increased sensible warming that is not offset by the cooling effects of carbon uptake in extra-tropical regions. However, comparison of forest warming potential in the context of climate models is based on a coarse classification system of tropical, temperate, and boreal. There is considerable variation in climate within the broad latitudinal zonation of tropical, temperate, and boreal, and the relationship between biophysical (albedo) and biogeochemical (carbon uptake) mechanisms may not be constant within these broad zones. We compared wintertime forest and non-forest surface temperatures for the southeastern United States and found that forest surface temperatures shifted from being warmer than non-forest surface temperatures north of approximately 36 degrees N to cooler south of 36 degrees N. Our results suggest that the biophysical aspects of forests' influence on climate reinforce the biogeochemical aspects of forests' influence on climate south of 36 degrees N. South of 36 degrees N, both biophysical and biogeochemical properties of forests appear to support forestation as a climate mitigation policy. We also provide some quantitative evidence that evergreen forests tend to have cooler wintertime surface temperatures than deciduous forests that may be attributable to greater evapotranspiration rates. Published by Elsevier B.V.

Wickham, J. D., et al. (2013). "Empirical analysis of the influence of forest extent on annual and seasonal surface temperatures for the continental United States." Global Ecology and Biogeography **22**(5): 620-629.

Aim Because of the low albedo of forests and other biophysical factors, most scenario-based climate modelling studies indicate that removal of temperate forest will promote cooling, indicating that temperate forests are a source of heat relative to other classes of land cover. Our objective was to test the hypothesis that US temperate forests reduce surface temperatures. Location The continental United States. Methods Ordinary least squares regression was used to develop relationships between forest extent and surface temperature. Forest extent was derived from the 900m2 2001 National Land Cover Database (NLCD 2001) and surface temperature data were from the MODIS 1 km2 8-day composite (MYD11A2). Forestsurface temperature relationships were developed for winter, spring, summer, autumn and annually using 5 years of MODIS land surface temperature data (200711) across six spatial scales (1, 4, 9, 16, 25 and 36 km2). Regression models controlled for the effects of elevation, aspect and latitude (by constraining the regressions within a 1 degrees range). Results We did not find any significant positive slopes in regressions of average annual surface temperatures versus the proportion of forest, indicating that forests are not a source of heat relative to other types of land cover. We found that surface temperatures declined as the proportion of forest increased for spring, summer, autumn and annually. The forestsurface temperature relationship was also scale dependent in that spatially extensive forests produced cooler surface temperatures than forests that were dominant only locally. Main conclusions Our results are not consistent with most scenario-based climate modelling studies. Because of their warming potential, the value of temperate afforestation as a potential climate change mitigation strategy is unclear. Our results indicate that temperate afforestation is a climate change mitigation strategy that should be implemented to promote spatially extensive forests.

Villalobos-Vega, R., et al. (2011). "Leaf litter manipulations alter soil physicochemical properties and tree growth in a Neotropical savanna." Plant and Soil **346**(1-2): 385-397.

This study was aimed to assess the role that leaf litter play in nutrient cycling, nutrient soil availability and ecosystem processes in an oligotrophic tropical savanna. A four year experiment was performed in a Neotropical savanna from the Brazilian plateau (cerrado), in which litter levels were modified, and the resulting changes in biophysical and chemical soil properties were studied. Changes in organic matter decomposition, soil respiration and stem growth of the six most common tree species were also monitored. Compared to litter removal plots, double litter plots had lower maximum soil temperature and higher soil water content, and litter decomposition rates in one of three species studied, consistent with higher soil respiration rates observed in this treatment. With the exception of Ca, there were no significant differences in nutrients between the removal, natural and double litter plots, even though most nutrients tended to increase in the double litter plots by the end of the experimental period, while in the control plots nutrient levels remained relatively constant. Of the six tree species used for growth analysis, only one, Sclerolobium paniculatum, a fast growing species with shallow roots, had a significant increase in stem growth due to litter addition. Preliminary results over four years indicate that litter removal and addition resulted in some significant changes and tendencies that indicate that litter is effectively altering ecosystem processes. The information obtained also suggest that nutrient cycling in plots with natural litter levels (control plots) was in a closed loop; most nutrients released by litter decomposition and mineralization were absorbed and reutilized immediately by the plants, thus minimizing nutrient leakage outside the system.

Williams, C. A. and N. P. Hanan (2011). "ENSO and IOD teleconnections for African ecosystems: evidence of destructive interference between climate oscillations." Biogeosciences **8**(1): 27-40.

Rainfall and vegetation across Africa are known to resonate with the coupled ocean-atmosphere phenomena of El Nino Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). However, the regional-scale implications of sea surface temperature variability for Africa's photosyntheis have received little focused attention, particularly in the case of IOD. Furthermore, studies exploring the interactive effects of ENSO and IOD when coincident are lacking. This analysis uses remotely sensed vegetation change plus a land surface model driven with observed meteorology to investigate how rainfall, vegetation, and photosynthesis across Africa respond to these climate oscillations. In addition to the relatively well-known ENSO forcing, the IOD induces large departures of photosynthesis across much of Africa associated with anomalies in rainfall and vegetation greenness. More importantly, sizeable independent effects can be suppressed or even reversed by destructive interferences during periods of simultaneous ENSO and IOD activity. For example, effects of positive IOD on southeastern Africa tended to dominate those of El Nino during their coincidence spanning 1997-1998, with sign reversal of El Nino's typically strong suppression of photosynthesis in this region. These findings call into question past analyses examining teleconnections to ENSO or IOD in isolation, and indicate the need to consider their simultaneous states when examining influences on hydroclimatic and ecological conditions across Africa.

Williams, C. A., et al. (2008). "Interannual variability of photosynthesis across Africa and its attribution." Journal of Geophysical Research-Biogeosciences **113**(G4).

Africa is thought to be a large source of interannual variability in the global carbon cycle, only vaguely attributed to climate fluctuations. This study uses a biophysical model, Simple Biosphere, to examine in detail what specific factors, physiological (acute stress from low soil water, temperature, or low humidity) and biophysical (low vegetation radiation use), are responsible for spatiotemporal patterns of photosynthesis across the African continent during the period 1982-2003. Acute soil water stress emerges as the primary factor driving interannual variability of photosynthesis for most of Africa. Southern savannas and woodlands are a particular hot spot of interannual variability in photosynthesis, owing to high rainfall variability and photosynthetic potential but intermediate annual rainfall. Surprisingly low interannual variability of photosynthesis in much of the Sudano-Sahelian zone derives from relatively low vegetation cover, pronounced humidity stress, and somewhat lower rainfall variability, whereas perennially wet conditions diminish interannual variability in photosynthesis across much of the Congo Basin and coastal West Africa. Though not of focus here, the coefficient of variation in photosynthesis is notably high in drylands and desert margins (i.e., Sahel, Greater Horn, Namib, and Kalahari) having implications for supply of food and fiber. These findings emphasize that when considering impacts of climate change and land surface feedbacks to the atmosphere, it is important to recognize how vegetation, climate, and soil characteristics may conspire to filter or dampen ecosystem responses to hydroclimatic variability.

Wohlgemuth, T., et al. (2008). "Diversity of forest plant species at the community and landscape scales in Switzerland." Plant Biosystems **142**(3): 604-613.

Conservation strategies increasingly refer to indicators derived from large biological data. However, such data are often unique with respect to scale and species groups considered. To compare richness patterns emerging from different inventories, we analysed forest species richness at both the landscape and the community scales in Switzerland. Numbers of forest species were displayed using nationwide distributional species data and referring to three different definitions of forest species. The best regression models on a level of four predictor variables ranged between adj. R2=0.50 and 0.66 and revealed environmental heterogeneity/energy, substrate (rocky outcrops) and precipitation as best explanatory variables of forest species richness at the landscape scale. A systematic sample of community data (n=729; 30m2, 200m2,

500m2) was examined with respect to nationwide community diversity and plot species richness. More than 50% of all plots were assigned to beech forests (Eu-Fagion, Cephalanthero-Fagion, Luzulo-Fagion and Abieti-Fagion), 14% to Norway spruce forests (Vaccinio-Piceion) and 13% to silver fir forests (Piceo-Abietion). Explanatory variables were derived from averaged indicator values per plot, and from biophysical and disturbance factors. The best models for plot species richness using four predictor variables ranged between adj. R2=0.31 and 0.34. Light (averaged L-indicator, tree canopy) and substrate (averaged R-indicator and pH) had the highest explanatory power at all community scales. By contrast, the influence of disturbance variables was very small, as only a small portion of plots were affected by this factor. The effects of disturbances caused by extreme events or by management would reduce the tree canopies and lead to an increase in plant species richness at the community scale. Nevertheless, such community scale processes will not change the species richness at the landscape scale. Instead, the variety of different results derived from different biological data confirms the diversity of aspects to consider. Therefore, conservation strategies should refer to value systems.

Wolken, J. M., et al. (2011). "Evidence and implications of recent and projected climate change in Alaska's forest ecosystems." Ecosphere **2**(11).

The structure and function of Alaska's forests have changed significantly in response to a changing climate, including alterations in species composition and climate feedbacks (e. g., carbon, radiation budgets) that have important regional societal consequences and human feedbacks to forest ecosystems. In this paper we present the first comprehensive synthesis of climate-change impacts on all forested ecosystems of Alaska, highlighting changes in the most critical biophysical factors of each region. We developed a conceptual framework describing climate drivers, biophysical factors and types of change to illustrate how the biophysical and social subsystems of Alaskan forests interact and respond directly and indirectly to a changing climate. We then identify the regional and global implications to the climate system and associated socio-economic impacts, as presented in the current literature. Projections of temperature and precipitation suggest wildfire will continue to be the dominant biophysical factor in the Interior-boreal forest, leading to shifts from conifer-to deciduous-dominated forests. Based on existing research, projected increases in temperature in the Southcentral- and Kenai-boreal forests will likely increase the frequency and severity of insect outbreaks and associated wildfires, and increase the probability of establishment by invasive plant species. In the Coastal-temperate forest region snow and ice is regarded as the dominant biophysical factor. With continued warming, hydrologic changes related to more rapidly melting glaciers and rising elevation of the winter snowline will alter discharge in many rivers, which will have important consequences for terrestrial and marine ecosystem productivity. These climate-related changes will affect plant species distribution and wildlife habitat, which have regional societal consequences, and trace-gas emissions and radiation budgets, which are globally important. Our conceptual framework facilitates assessment of current and future consequences of a changing climate, emphasizes regional differences in biophysical factors, and points to linkages that may exist but that currently lack supporting research. The framework also serves as a visual tool for resource managers and policy makers to develop regional and global management strategies and to inform policies related to climate mitigation and adaptation.

Vourlitis, G. L., et al. (2011). "Temporal patterns of net CO2 exchange for a tropical semideciduous forest of the southern Amazon Basin." Journal of Geophysical Research-Biogeosciences **116**.

The carbon cycling of tropical ecosystems has received considerable attention over the last 1-2 decades; however, interactions between climate variation and tropical forest net ecosystem CO2 exchange (NEE) are still uncertain. To reduce this uncertainty, and assess the biophysical controls on NEE, we used the eddy covariance method over a 3 year period (2005-2008) to measure the CO2 flux and energy balance for a 25-28 m tall, mature tropical semideciduous forest located near Sinop Mato Grosso, Brazil. The study period encompassed warm-dry, cool-wet, and cool-dry climate conditions, and based on previous research, we hypothesized that the net CO2 accumulation of the semideciduous forest would be lower during periods of drought. Using time series of the enhanced vegetation index (EVI), a NEE-light-use model, and path analysis, we found that the estimated quantum yield (a', mu mol CO2 mmol photons(-1)) was directly affected by temporal variations in the EVI, precipitation, and photosynthetically active radiation (PAR), while the optimal rate of gross primary production (F-GPP,F-opt, mu mol m(-2) s(-1)) was directly affected by the EVI and PAR. However, indirect effects of precipitation on the a' and F-GPP,F-opt were stronger than direct effects

because variations in precipitation also lead to variations in the EVI and the atmospheric vapor pressure deficit (VPD). Daytime ecosystem respiration (F-RE,F-day, mu mol m(-2) s(-1)) was directly affected by temporal variations in temperature and VPD and indirect effects of other variables were of lesser importance. Net ecosystem CO2 uptake was often higher in the dry season than the wet season, not because of a dry season "green-up" but because rates of ecosystem respiration declined relatively more than rates of canopy photosynthesis. Over interannual timescales, average daily NEE increased over the 3 year study period and was highest in 2007-2008, which was also the driest year in terms of rainfall. However, 2007-2008 was also the coolest year during the 3 year study period, and the low temperature appeared to compensate for the low rainfall. Overall, our data suggest that the NEE of tropical semideciduous forests is sensitive to temporal variations in surface water availability but that indirect effects of other variables, such as temperature and VPD, are important in controlling CO2 gain and loss. Such interactions will be important for the future NEE under warmer and drier conditions that are anticipated with anthropogenic climate change.

Wright, K. K., et al. (2005). "Restricted hyporheic exchange in an alluvial river system: implications for theory and management." Journal of the North American Benthological Society **24**(3): 447-460.

Large-scale patterns of hyporheic exchange are predictable within some river systems, but our understanding of the factors driving hyporheic processes and the magnitude of hyporheic exchange needed to influence biophysical patterns at larger scales remains limited. We investigated the patterns, magnitude, and potential effects on biota of reach-scale hyporheic exchange in an alluvial river of the Pacific Northwest. The river was topographically similar to and in the same geographic region as other systems where large-scale hyporheic exchange and associated biological responses have been observed. We hypothesized that predictable reach-scale patterns of hyporheic exchange would occur in alluvial valley segments of the river and that hyporheic upwelling would be associated with reach-scale patterns of physical and biological characteristics. We used in-channel piezometers and synoptic stream flow measurements to quantify hyporheic exchange. We measured temperature, dissolved O-2, pH, specific conductivity, chlorophyll a biomass, primary production, and benthic macroinvertebrates as indicators of physical and biological responses. Contrary to our expectations, we found no evidence, physical or biological, of reach-scale hyporheic exchange. Hyporheic connectivity in this river system probably is constrained by geologic and geomorphic characters as well as the legacy of human land use in the basin. Thus, our results illustrate the variability of hyporheic processes that can occur among alluvial river systems and may have implications for watershed management.

Wu, M. C., et al. (2016). "Vegetation-climate feedbacks modulate rainfall patterns in Africa under future climate change." Earth System Dynamics **7**(3): 627-647.

Africa has been undergoing significant changes in climate and vegetation in recent decades, and continued changes may be expected over this century. Vegetation cover and composition impose important influences on the regional climate in Africa. Climate-driven changes in vegetation structure and the distribution of forests versus savannah and grassland may feed back to climate via shifts in the surface energy balance, hydrological cycle and resultant effects on surface pressure and larger-scale atmospheric circulation. We used a regional Earth system model incorporating interactive vegetation-atmosphere coupling to investigate the potential role of vegetation-mediated biophysical feedbacks on climate dynamics in Africa in an RCP8.5-based future climate scenario. The model was applied at high resolution (0.44 x 0.44 degrees) for the CORDEX-Africa domain with boundary conditions from the CanESM2 general circulation model. We found that increased tree cover and leafarea index (LAI) associated with a CO2 and climate-driven increase in net primary productivity, particularly over subtropical savannah areas, not only imposed important local effect on the regional climate by altering surface energy fluxes but also resulted in remote effects over central Africa by modulating the land-ocean temperature contrast, Atlantic Walker circulation and moisture inflow feeding the central African tropical rainforest region with precipitation. The vegetation-mediated feedbacks were in general negative with respect to temperature, dampening the warming trend simulated in the absence of feedbacks, and positive with respect to precipitation, enhancing rainfall reduction over the rainforest areas. Our results highlight the importance of accounting for vegetation-atmosphere interactions in climate projections for tropical and subtropical Africa.

Wu, W. X., et al. (2008). "Modeling gross primary production of a temperate grassland ecosystem in Inner Mongolia,

China, using MODIS imagery and climate data." Science in China Series D-Earth Sciences **51**(10): 1501-1512.

Carbon fluxes in temperate grassland ecosystems are characterized by large inter-annual variations due to fluctuations in precipitation and land water availability. Since an eddy flux tower has been in operation in the Xilin Gol grassland, which belongs to typical temperate grassland in North China, in this study, observed eddy covariance flux data were used to critically evaluate the biophysical performance of different remote sensing vegetation indices in relation to carbon fluxes. Furthermore, vegetation photosynthesis model (VPM) was introduced to estimate gross primary production (GPP) of the grassland ecosystem for assessing its dependability. As defined by the input variables of VPM, Moderate Resolution Imaging Spectroradimeter (MODIS) and standard data product MOD09A1 were downloaded for calculating enhanced vegetation index (EVI) and land surface water index (LSWI). Measured air temperature (Ta) and photosynthetically active radiation (PAR) data were also included for model simulating. Field CO_2 flux data, during the period from May, 2003 to September, 2005, were used to estimate the "observed" GPP (GPP(obs)) for validation. The seasonal dynamics of GPP predicted from VPM (GPP(VPM)) was compared quite well (R-2=0.903, N=111, p<0.0001) with the observed GPP. The aggregate GPP(VPM) for the study period was 641.5 g C.m(-2), representing a similar to 6% over-estimation, compared with GPP(obs). Additionally, GPP predicted from other two typical production efficiency model (PEM) represents either higher overestimation or lower underestimation to GPP(obs). Results of this study demonstrate that VPM has potential for estimating site-level or regional grassland GPP, and might be an effective tool for scaling-up carbon fluxes.

Xiao, R. B., et al. (2008). "Land surface temperature variation and major factors in Beijing, China." Photogrammetric Engineering and Remote Sensing **74**(4): 451-461.

Land surface temperature (LST) is a significant parameter in urban environmental analysis. Current research mainly focuses on the impact of land-use and land-cover (LULC) on LST. Seldom has research examined LST variations based on the integration of biophysical and demographic variables, especially for a rapidly developing city such as Beijing, China. This study combines the techniques of remote sensing and geographic information system (GIS) to detect the spatial variation of LST and determine its quantitative relationship with several biophysical and demographic variables based on statistical modeling for the central area of Beijing. LST and LULC data were retrieved from a Landsat Thematic Mapper (TM) image. Building heights were delimited from the shadows identified on a panchromatic SPOT image. The integration of LULC and census data was further applied to retrieve grid-based population density. Results indicate that the LST pattern was non-symmetrical and non-concentric with high temperature zones clustered towards the south of the central axis and within the fourth ring road. The percentage of forest, farmland, and water per grid cell were found to be most significant factors, which can explain 71.3 percent Of LST variance, Principal component regression analysis shows that LST Was positively correlated with the percentage of low density built-up, high density built-up, extremely-high buildings, low buildings per grid cell, and population density, but was negatively correlated with the percentage of forest, farmland, and water bodies per grid cell. The findings of this study can be applied as the theoretical basis for improving urban planning for mitigating the effects of urban heat islands.

Xie, J., et al. (2016). "Ten-year variability in ecosystem water use efficiency in an oak-dominated temperate forest under a warming climate." Agricultural and Forest Meteorology **218**: 209-217.

The impacts of extreme weather events on water-carbon (C) coupling and ecosystem-scale water use efficiency (WUE) over a long term are poorly understood. We analyzed the changes in ecosystem water use efficiency (WUE) from 10 years of eddy-covariance measurements (2004-2013) over an oak-dominated temperate forest in Ohio, USA. The aim was to investigate the long-term response of ecosystem WUE to measured changes in site-biophysical conditions and ecosystem attributes. The oak forest produced new plant biomass of 2.5 +/- 0.2 gC kg(-1) of water loss annually. Monthly evapotranspiration (ET) and gross ecosystem production (GEP) were tightly coupled over the 10-year study period (R-2=0.94). Daily WUE had a linear relationship with air temperature (T-a) in low-temperature months and a unimodal relationship with T-a in high-temperature months during the growing season. On average, daily WUE ceased to increase when T-a exceeded 22 degrees C in warm months for both wet and dry years. Monthly WUE had a strong positive linear relationship with leaf area index (LAI), net radiation (R-n), and T-a and weak logarithmic relationship with water vapor pressure deficit (VPD) and precipitation (P) on a growing-season basis. When exploring the regulatory mechanisms on WUE within each season, spring LAI and P, summer R-n and T-a, and autumnal

VPD and R-n were found to be the main explanatory variables for seasonal variation in WUE. The model developed in this study was able to capture 78% of growing-season variation in WUE on a monthly basis. The negative correlation between WUE and A in spring was mainly due to the high precipitation amounts in spring, decreasing GEP and WUE when LAI was still small, adding ET being observed to increase with high levels of evaporation as a result of high SWC in spring. Summer WUE had a significant decreasing trend across the 10 years mainly due to the combined effect of seasonal drought and increasing potential and available energy increasing ET, but decreasing GEP in summer. We concluded that seasonal dynamics of the interchange between precipitation and drought status of the system was an important variable in controlling seasonal WUE in wet years. In contrast, despite the negative impacts of unfavorable warming, available groundwater and an early start of the growing season were important contributing variables in high seasonal GEP, and thus, high seasonal WUE in dry years. (C) 2015 Elsevier B.V. All rights reserved.

Xie, J., et al. (2014). "Long-term variability in the water budget and its controls in an oak-dominated temperate forest." Hydrological Processes **28**(25): 6054-6066.

Water availability is one of the key environmental factors that control ecosystem functions in temperate forests. Changing climate is likely to alter the ecohydrology and other ecosystem processes, which affect forest structures and functions. We constructed a multi-year water budget (2004-2010) and quantified environmental controls on an evapotranspiration (ET) in a 70-year-old mixed-oak woodland forest in northwest Ohio, USA. ET was measured using the eddy-covariance technique along with precipitation (P), soil volumetric water content (VWC), and shallow groundwater table fluctuation. Three biophysical models were constructed and validated to calculate potential ET (PET) for developing predictive monthly ET models. We found that the annual variability in ET was relatively stable and ranged from 578mm in 2009 to 670mm in 2010. In contrast, ET/P was more variable and ranged from 0.60 in 2006 to 0.96 in 2010. Mean annual ET/PET_FAO was 0.64, whereas the mean annual PET_FAO/P was 1.15. Annual ET/PET_FAO was relatively stable and ranged from 0.60 in 2005 to 0.72 in 2004. Soil water storage and shallow groundwater recharge during the non-growing season were essential in supplying ET during the growing season when ET exceeded P. Spring leaf area index (LAI), summer photosynthetically active radiation, and autumn and winter air temperatures (T-a) were the most significant controls of monthly ET. Moreover, LAI regulated ET during the whole growing season and higher temperatures increased ET even during dry periods. Our empirical modelling showed that the interaction of LAI and PET explained >90% of the variability in measured ET. Altogether, we found that increases in T-a and shifts in P distribution are likely to impact forest hydrology by altering shallow groundwater fluctuations, soil water storage, and ET and, consequently, alter the ecosystem functions of temperate forests. Copyright (C) 2013 John Wiley & Sons, Ltd.

Xie, M. M., et al. (2013). "Assessment of landscape patterns affecting land surface temperature in different biophysical gradients in Shenzhen, China." Urban Ecosystems **16**(4): 871-886.

The urban heat island (UHI) effect is one of the important ecological effects of urbanization. This study focuses on the different effects of landscape patterns on LST within different land covers. The land cover was measured by surface biophysical components, including vegetation fraction (VF) and impervious surface area (ISA), acquired by a linear spectral mixture model (LSMM). LST was derived from Landsat-5 TM thermal infrared (TIR) data using the generalized single-channel method. Landscape patterns were measured by landscape metrics, including the Shannon diversity index (SHDI), the aggregation index (AI), patch density (PD), and fractal dimension area-weighted mean index (FRAC_AM). Shenzhen, a rapidly urbanizing city in China, was taken as the case study area. Results showed that VF and ISA are more important than spatial patterns in determining LST. However, these effects change in densely covered areas. VF and LST are negatively correlated, with the inflection of the regression curves being 45 %. In areas with VF lower than 45 %, the correlation between LST and VF is monotonically linear. In areas with VF higher than 45 %, landscape patterns can act to decrease LST. The aggregation index (AI) and the largest patch index (LPI) can contribute to decreasing LST significantly. Impervious surfaces contribute to high temperature, and the inflection point of the regression curves is 70 %. In areas with ISA higher than 70 %, a fragmented pattern of impervious surfaces can lower LST. These findings provide insights for planners into how the strategic use of landscape to mitigate UHI effects may vary for different land covers.

Xu, J. Y., et al. (2011). "Influence of Timber Harvesting Alternatives on Forest Soil Respiration and Its Biophysical

Regulatory Factors over a 5-year Period in the Missouri Ozarks." Ecosystems **14**(8): 1310-1327.

We investigated the variability of soil respiration and several potential regulatory factors and modeled their interrelationships from May to August over a 5-year period in oak forests subjected to alternative harvesting treatments as part of the Missouri Ozark Forest Ecosystem Project (MOFEP). Treatments included even-aged management (EAM), uneven-aged management (UAM), and no-harvest management (NHM) and were implemented 7-8 years prior to this study. Summer mean soil respiration did not differ among the treatments, possibly because of changes in treatment differences in the separate months and years that tended to cancel each other out when averaged. Summer mean soil respiration and soil moisture tended to be higher in wet years (2004, 2006, and 2008) and lower in dry years (2005 and 2007) in EAM and UAM than in NHM. Summer precipitation was assumed to be the primary driver of variability in summer mean soil respiration through its control on soil moisture and the normalized difference vegetation index (NDVI) in the harvested forests. Nonlinear models using soil temperature, soil moisture and day-of-the-year (DOY) were used to predict within-summer soil respiration for all the treatments. A sensitivity analysis of the model using 30 min interval data suggested that soil respiration was more sensitive to soil moisture in the EAM and UAM treatments than in NHM. We also found a change in the soil respiration-soil temperature relationship in the summer for all the treatments. Simulated data sets that removed the covariance structure between soil temperature and moisture suggested that the change in the respiration-temperature relationship resulted from the combined effect of moisture stress and low temperature sensitivity at high temperatures during July and August. Simulations also showed the effect of moisture stress to be more limiting to soil respiration in the harvested forests than in the control at high temperatures, even resulting in a negative relationship at high temperatures.

Xu, W., et al. (2008). "Modelling of urban sensible heat flux at multiple spatial scales: A demonstration using airborne hyperspectral imagery of Shanghai and a temperature-emissivity separation approach." Remote Sensing of Environment **112**(9): 3493-3510.

Urbanization related alterations to the surface energy balance impact urban warming ('heat islands'), the growth of the boundary layer, and many other biophysical processes. Traditionally, in situ heat flux measures have been used to quantify Such processes, but these typically represent only a small local-scale area within the heterogeneous urban environment. For this reason, remote sensing approaches are very attractive for elucidating more spatially representative information. Here we use hyperspectral imagery from a new airborne sensor, the Operative Modular Imaging Spectrometer (OMIS), along with a survey map and meteorological data, to derive the land cover information and surface parameters required to map spatial variations in turbulent sensible heat flux (Q(H)). The results from two spatially-explicit flux retrieval methods which use contrasting approaches and, to a large degree, different input data are compared for a central urban area of Shanghai, China: (1) the Local-scale Urban Meteorological Parameterization Scheme (LUMPS) and (2) an Aerodynamic Resistance Method (ARM). Sensible heat fluxes are determined at the full 6 m spatial resolution of the OMIS sensor, and at lower resolutions via pixel exceeds that of roads, water and vegetated areas, with values peaking at similar to 350 W m(-2), whilst the storage heat flux is greatest for road dominated pixels (peaking at around 420 W m(-2)). We investigate the use of both OMIS-derived land surface temperatures made using a Temperature-Emissivity Separation (TES) approach, and land surface temperatures estimated from air temperature measures. Sensible heat flux differences from the two approaches over the entire 2 x 2 km study area are less than 30 W m(-2), suggesting that methods employing either strategy maybe practical when operate using low spatial resolution (e.g. 1 km) data. Due to the differing methodologies, direct comparisons between results obtained with the LUMPS and ARM methods are most sensibly made at reduced spatial scales. At 30 m spatial resolution, both approaches produce similar results, with the smallest difference being less than 15 W m(-2) in mean Q(H) averaged over the entire study area. This is encouraging given the differing architecture and data requirements of the LUMPS and ARM methods. Furthermore, in terms of mean study Q(H,) the results obtained by averaging the original 6 m spatial resolution LUMPS-derived Q(H) values to 30 and 90 m spatial resolution are within similar to 5 W m(-2) of those derived from averaging the original surface parameter maps prior to input into LUMPS, suggesting that that use of much lower spatial resolution spaceborne imagery data, for example fro Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is likely to be a practical solution for heat flux determination in urban areas. Crown Copyright (C) 2008 Published by Elsevier Inc. All rights reserved.

Xue, Y., et al. (2006). "Role of land surface processes in South American monsoon development." Journal of Climate **19**(5): 741-762.

This study explores the role of vegetation biophysical processes (VBPs) in the structure and evolution of the South American monsoon system (SAMS) with an emphasis on the precipitation field. T e approach is based on comparing ensemble simulations by the National Centers for Environmental Prediction general circulation model (GCM) in which the land surface parameterization in one ensemble includes an explicit representation of vegetation processes in the calculation of surface fluxes while the other does not [GCM/Simplified Simple Biosphere Model (SSiB) and GCM/Soil, respectively], but with similar monthly mean surface albedo and initial soil moisture. The ensembles consist of five pairs of 1-yr integrations differing in the initial conditions for the atmosphere. The results show that, during the austral summer, consideration of explicit vegetation processes does not alter the monthly mean precipitation at the planetary scale. However, at continental scales, GCM/SSiB produces a more successful simulation of SAMS than GCM/Soil. The improvement is particularly clear in reference to the seasonal southward displacement of precipitation during the onset of the SAMS and its northward merging with the intertropical convergence zone during the monsoon mature stage, as well as better monthly mean austral summer precipitation over the South American continent. The changes in surface water and energy balances and circulation in October (monsoon onset) and December (the start of the monsoon mature stage) were analyzed for a better understanding of the results and mechanisms involved. It was found that the major difference between the simulations is in the partitioning of latent heat and sensible heat fluxes (i.e., different Bowen ratio), which produced different latitudinal and longitudinal thermal gradients at the surface. A stronger sensible heat flux gradient between continent and ocean in the GCM/SSiB simulation helped generate an enhanced ventilation effect, which lowered moist static energy (MSE) over the northeast coast of South America leading to stronger counterclockwise turning of the low-level wind from the Atlantic Ocean toward the continent during the premonsoon and early monsoon stages, modifying moisture flux convergence (MFC). It was further identified that the seasonality of savanna and shrublands to the south and east of the Amazon rain forest contributed to the variability of heating gradients and influenced the SAMS onset and, its northward merge with the ITCZ at the early monsoon mature stage. The comparison of the differences between precipitation, evaporation, advection of MSE, and MFC based on simulations using two different land parameterizations suggested that the VBP modulated the surface water budget, but its impact on precipitation was determined by the changes in circulation via changes in heat gradient and MSE.

Yan, K., et al. (2016). "Evaluation of MODIS LAI/FPAR Product Collection 6. Part 2: Validation and Intercomparison." Remote Sensing **8**(6).

The aim of this paper is to assess the latest version of the MODIS LAI/FPAR product (MOD15A2H), namely Collection 6 (C6). We comprehensively evaluate this product through three approaches: validation with field measurements, intercomparison with other LAI/FPAR products and comparison with climate variables. Comparisons between ground measurements and C6, as well as C5 LAI/FPAR indicate: (1) MODIS LAI is closer to true LAI than effective LAI; (2) the C6 product is considerably better than C5 with RMSE decreasing from 0.80 down to 0.66; (3) both C5 and C6 products overestimate FPAR over sparsely-vegetated areas. Intercomparisons with three existing global LAI/FPAR products (GLASS, CYCLOPES and GEOV1) are carried out at site, continental and global scales. MODIS and GLASS (CYCLOPES and GEOV1) agree better with each other. This is expected because the surface reflectances, from which these products were derived, were obtained from the same instrument. Considering all biome types, the RMSE of LAI (FPAR) derived from any two products ranges between 0.36 (0.05) and 0.56 (0.09). Temporal comparisons over seven sites for the 2001-2004 period indicate that all products properly capture the seasonality in different biomes, except evergreen broadleaf forests, where infrequent observations due to cloud contamination induce unrealistic variations. Thirteen years of C6 LAI, temperature and precipitation time series data are used to assess the degree of correspondence between their variations. The statistically-significant associations between C6 LAI and climate variables indicate that C6 LAI has the potential to provide reliable biophysical information about the land surface when diagnosing climate-driven vegetation responses.

Yang, X. H., et al. (2013). "Biophysical and spectral responses to various burn treatments in the northern mixed-grass prairie." Canadian Journal of Remote Sensing **39**(2): 175-184.

Over the past century, environmental managers have worked to suppress fire throughout various biomes. Today, burning is generally considered beneficial to many ecosystems, though the precise effects are not entirely understood. This research aims to further our understanding of the biophysical effects of fire in C3 dominated mixed-grass prairies and to find an effective remote sensing approach for differentiating between burn treatments in late spring. Biophysical properties including vegetation cover, biomass, soil properties, canopy height, Leaf Area Index (LAI), and individual wavebands of the SPOT-5 sensor as well as two vegetation indices (Normalized Difference Vegetation Index and Normalized Burn Ratio Index) derived from SPOT-5 images were compared among unburned sites and sites with various burning treatments in Grasslands National Park, Canada. Results showed that significantly higher soil temperature and lower LAI were found in burned sites. Dead material biomass, total biomass, and percentage of standing dead cover were significantly lower in burned and grazed sites. The percentage of bare ground cover was the only biophysical variable to show significant changes in all burning treatments. Burned and unburned sites could not be distinguished based on assessing the changes of individual wavebands of the SPOT-5 sensor and the two vegetation indices. Models based on linear combinations of spectral indices were developed for biophysical properties that show significant changes in burned sites. The agreement between model simulated biophysical properties and field measured values suggest the feasibility of remote sensing to assess or monitor post-fire effects in mixed grasslands.

Yeom, J. M., et al. (2015). "Evapotranspiration in Korea estimated by application of a neural network to satellite images." Remote Sensing Letters **6**(6): 429-438.

Previous biophysical and empirical models of evapotranspiration retrieval are difficult to parameterize because of the effects of the nonlinear biophysics of plants, terrestrial and solar radiation and soils, despite attempts made using various satellite products. In this study, the multilayer feed-forward neural network approach with Levenberg-Marquardt back propagation (LM-BP) was used to successfully estimate evapotranspiration using the input of various satellite-based products. When applying neural network training, value-added satellite-based products such as normalized difference vegetation index (NDVI), normalized difference water index (NDWI), land surface temperature (LST), air temperature and insolation are used instead of only spectral information from satellite sensors to reflect the spatial representativeness of the neural network. The evapotranspiration estimated from the neural network with input parameters showed better statistical accuracy than the MODIS products (MOD16) and Priestley-Taylor methods when compared with ground station eddy flux measurements, which were considered as reference data. Additionally, the temporal variation in neural network evapotranspiration well reflected seasonal patterns of eddy flux evapotranspiration, especially for the high cloudiness in the summer season.

Zeng, J. Y., et al. (2014). "A simplified physically-based algorithm for surface soil moisture retrieval using AMSR-E data." Frontiers of Earth Science **8**(3): 427-438.

A simplified physically-based algorithm for surface soil moisture inversion from satellite microwave radiometer data is presented. The algorithm is based on a radiative transfer model, and the assumption that the optical depth of the vegetation is polarization independent. The algorithm combines the effects of vegetation and roughness into a single parameter. Then the microwave polarization difference index (MPDI) is used to eliminate the effects of surface temperature, and to obtain soil moisture, through a nonlinear iterative procedure. To verify the present algorithm, the 6.9 GHz dual-polarized brightness temperature data from the Advanced Microwave Scanning Radiometer (AMSR-E) were used. Then the soil moisture values retrieved by the present algorithm were validated by in-situ data from 20 sites in the Tibetan Plateau, and compared with both the NASA AMSR-E soil moisture products, and Soil Moisture and Ocean Salinity (SMOS) soil moisture products. The results show that the soil moisture retrieved by the present algorithm agrees better with ground measurements than the two satellite products. The advantage of the algorithm is that it doesn't require field observations of soil moisture, surface roughness, or canopy biophysical data as calibration parameters, and needs only single-frequency brightness temperature observations during the whole retrieval process.

Zeng, X. D., et al. (2005). "Ecological dynamic model of grassland and its practical verification." Science in China Series C-Life Sciences **48**(1): 41-48.

Based on the physico-biophysical considerations, mathematical analysis and some approximate formulations generally adopted in meteorology and ecology, an ecological dynamic model of grassland is developed. The model consists of three interactive variables, i.e. the biomass of living grass, the biomass of wilted grass, and the soil wetness. The major biophysical processes are represented in parameterization formulas, and the model parameters can be determined inversely by using the observational climatological and ecological data. Some major parameters are adjusted by this method to fit the data (although incomplete) in the Inner Mongolia grassland, and other secondary parameters are estimated through sensitivity studies. The model results are well agreed with reality, e.g., (i) the maintenance of grassland requires a minimum amount of annual precipitation (approximately 300 mm); (ii) there is a significant relationship between the annual precipitation and the biomass of living grass; and (iii) the overgrazing will eventually result in desertification. A specific emphasis is put on the shading effect of the wilted grass accumulated on the soil surface. It effectively reduces the soil surface temperature and the evaporation, hence benefits the maintenance of grassland and the reduction of water loss in the soil.

Zeng, Y. L., et al. (2016). "A Radiative Transfer Model for Heterogeneous Agro-Forestry Scenarios." Ieee Transactions on Geoscience and Remote Sensing **54**(8): 4613-4628.

Landscape heterogeneity is a common natural phenomenon but is seldom considered in current radiative transfer (RT) models for predicting the surface reflectance. This paper developed an analytical RT model for heterogeneous Agro-Forestry scenarios (RTAF) by dividing the scenario into nonboundary regions (NRs) and boundary regions (BRs). The scattering contribution of the NRs can be estimated from the scattering-by-arbitrarily-inclined-leaves-with-the-hot-spot-effect model as homogeneous canopies, whereas that of the BRs is calculated based on the bidirectional gap probability by considering the interactions and mutual shadowing effects among different patches. The multiangular airborne observations and discrete-anisotropic-RT model simulations were used to validate and evaluate the RTAF model over an agro-forestry scenario in the Heihe River Basin, China. The results suggest that the RTAF model can accurately simulate the hemispherical-directional reflectance factors (HDRFs) of the heterogeneous scenarios in the red and near-infrared (NIR) bands. The boundary effect can significantly influence the angular distribution of the HDRFs and consequently enlarge the HDRF variations between the backward and forward directions. Compared with the widely used dominant cover type (DCT) and spectral linear mixture (SLM) models, the RTAF model reduced the maximum relative error from 25.7% (SLM) and 23.0% (DCT) to 9.8% in the red band and from 19.6% (DCT) and 13.7% (SLM) to 8.7% in the NIR band. The RTAF model provides a promising way to improve the retrieval of biophysical parameters (e.g., leaf area index) from remote sensing data over heterogeneous agro-forestry scenarios.

Zeng, Z. Z., et al. (2017). "Climate mitigation from vegetation biophysical feedbacks during the past three decades." Nature Climate Change **7**(6): 432-+.

The surface air temperature response to vegetation changes has been studied for the extreme case of land-cover change(1-5); yet, it has never been quantified for the slow but persistent increase in leaf area index (LAI) observed over the past 30 years (Earth greening)(6,7). Here we isolate the fingerprint of increasing LAI on surface air temperature using a coupled land-atmosphere global climate model prescribed with satellite LAI observations. We find that the global greening has slowed down the rise in global land-surface air temperature by 0.09 +/- 0.02 degrees C since 1982. This net cooling effect is the sum of cooling from increased evapotranspiration (70%), changed atmospheric circulation (44%), decreased shortwave transmissivity (21%), and warming from increased longwave air emissivity (29%) and decreased albedo (6%). The global cooling originated from the regions where LAI has increased, including boreal Eurasia, Europe, India, northwest Amazonia, and the Sahel. Increasing LAI did not, however, significantly change surface air temperature in eastern North America and East Asia, where the effects of large-scale atmospheric circulation changes mask local vegetation feedbacks. Overall, the sum of biophysical feedbacks related to the greening of the Earth mitigated 12% of global land-surface warming for the past 30 years.

Zha, T. S., et al. (2017). "Soil moisture control of sap-flow response to biophysical factors in a desert-shrub species, Artemisia ordosica." Biogeosciences **14**(19): 4533-4544.

The current understanding of acclimation processes in desert-shrub species to drought stress in dryland ecosystems is still incomplete. In this study, we measured sap flow in Artemisia ordosica and associated environmental variables throughout the growing seasons of 2013 and 2014 (May-September period of each

year) to better understand the environmental controls on the temporal dynamics of sap flow. We found that the occurrence of drought in the dry year of 2013 during the leaf-expansion and leaf-expanded periods caused sap flow per leaf area (J(s)) to decline significantly, resulting in transpiration being 34% lower in 2013 than in 2014. Sap flow per leaf area correlated positively with radiation (R-s), air temperature (T), and water vapor pressure deficit (VPD) when volumetric soil water content (VWC) was greater than 0.10m(3)m(-3). Diurnal J(s) was generally ahead of Rs by as much as 6 hours. This time lag, however, decreased with increasing VWC. The relative response of Js to the environmental variables (i.e., Rs, T, and VPD) varied with VWC, Js being more strongly controlled by plant-physiological processes during periods of dryness indicated by a low decoupling coefficient and low sensitivity to the environmental variables. According to this study, soil moisture is shown to control sap-flow (and, therefore, plant-transpiration) response in Artemisia ordosica to diurnal variations in biophysical factors. This species escaped (acclimated to) water limitations by invoking a water-conservation strategy with the regulation of stomatal conductance and advancement of Js peaking time, manifesting in a hysteresis effect. The findings of this study add to the knowledge of acclimation processes in desert-shrub species under drought-associated stress. This knowledge is essential in modeling desert-shrub-ecosystem functioning under changing climatic conditions.

Zhai, J., et al. (2014). "Radiative forcing over China due to albedo change caused by land cover change during 1990-2010." Journal of Geographical Sciences **24**(5): 789-801.

Land cover change affects surface radiation budget and energy balance by changing surface albedo and further impacts the regional and global climate. In this article, high spatial and temporal resolution satellite products. were used to analyze the driving mechanism for surface albedo change caused by land cover change during 1990-2010. In addition, the annual-scale radiative forcing caused by surface albedo changes in China's 50 ecological regions were calculated to reveal the biophysical mechanisms of land cover change affecting climate change at regional scale. Our results showed that the national land cover changes were mainly caused by land reclamation, grassland desertification and urbanization in past 20 years, which were almost induced by anthropogenic activities. Grassland and forest area decreased by 0.60% and 0.11%, respectively. The area of urban and farmland increased by 0.60% and 0.19%, respectively. The mean radiative forcing caused by land cover changes during 1990-2010 was 0.062 W/m(2) in China, indicating a warming climate effect. However, spatial heterogeneity of radiative forcing was huge among different ecological regions. Farmland conversing to urban construction land, the main type of land cover change for the urban and suburban agricultural ecological region in Beijing-Tianjin-Tangshan region, caused an albedo reduction by 0.00456 and a maximum positive radiative forcing of 0.863 W/m(2), which was presented as warming climate effects. Grassland and forest conversing to farmland, the main type of land cover change for the temperate humid agricultural and wetland ecological region in Sanjiang Plain, caused an albedo increase by 0.001.52 and a maximum negative radiative forcing of 0.184 W/m(2), implying cooling climate effects.

Zhang, H. and Z. Y. Zhou (2018). "Recalcitrant carbon controls the magnitude of soil organic matter mineralization in temperate forests of northern China." Forest Ecosystems **5**.

Background: The large potential of the soil organic carbon (SOC) pool to sequester CO_2 from the atmosphere could greatly ameliorate the effect of future climate change. However, the quantity of carbon stored in terrestrial soils largely depends upon the magnitude of SOC mineralization. SOC mineralization constitutes an important part of the carbon cycle, and is driven by many biophysical variables, such as temperature and moisture. Methods: Soil samples of a pine forest, an oak forest, and a pine and oak mixed forest were incubated for 387 days under conditions with six temperature settings (5 degrees C, 10 degrees C, 15 degrees C, 20 degrees C, 25 degrees C, 30 degrees C) and three levels of soil moisture content (SMC, 30%, 60%, 90%). The instantaneous rate of mineralized SOC was periodically and automatically measured using a Li-Cor CO_2 analyzer. Based on the measured amount of mineralized SOC, carbon fractions were estimated separately via first-order kinetic one-and two-compartment models. Results: During the 387 day incubation experiment, accumulative mineralized carbon ranged from 22.89 mg carbon (C).g(-1) SOC at 30 degrees C and 30% SMC for the mixed forest to 109.20 mg C.g(-1) SOC at 15 degrees C and 90% SMC for the oak forest. Mineralized recalcitrant carbon varied from 18.48 mg C.g(-1) SOC at 30 degrees C and 30% SMC for the mixed forest to 104.98 mg C.g(-1) SOC at 15 degrees C and 90% SMC for the oak forest, and contributed at least 80% to total mineralized carbon. Conclusions: Based on the results of this experiment, the soil organic matter of the pure broadleaved forest is more vulnerable to soil microbial degradation in

northern China; most of the amount of the mineralized SOC derived from the recalcitrant carbon pool. Labile carbon fraction constitutes on average 0.4% of SOC across the three forest types and was rapidly digested by soil microbes in the early incubation stage. SOC mineralization markedly increased with soil moisture content, and correlated parabolically to temperature with the highest value at 15 degrees C. No significant interaction was detected among these variables in the present study.

Zhang, H. Y., et al. (2018). "Changes in multiple ecosystem services between 2000 and 2013 and their driving factors in the Grazing Withdrawal Program, China." Ecological Engineering **116**: 67-79.

Quantitative assessment of ecosystem services in the Grazing Withdrawal Program (GWP) of China is required to understand the effectiveness of environmental protection programs and the sustainability of grassland ecosystems. This study focused on quantitative assessment of changes of key ecosystem services and their driving factors in the GWP from 2000 to 2013. Based on widely used biophysical models, including the GLOPEM-CEVSA model, the precipitation storage method, Integrated Valuation of Ecosystem Services and Trade-Offs (InVEST), Revised Wind Erosion Equation (RWEQ) and Underground Productivity Model (UPM), this study integrated multi-source data to analyze dynamic changes of regulating services, including carbon sequestration, water regulation, sand fixation and soil retention, and the provisioning service of grassland yield. For the GWP area during 2000-2013, the ecosystem pattern remained relatively stable and multiple ecosystem services showed overall improvement but there were local deteriorations. For the 14 years net primary productivity (NPP) and grassland yield (GY) increased substantially. Water regulation in forest, grassland and wetland/water body ecosystems improved slightly. The soil conservation function of the entire ecosystem was slightly enhanced with soil retention showing an increasing spatial homogenization and wind erosion having a decreasing tendency. Ecological restoration and reconstruction efforts and climate change helped to improve ecosystem services. Increases in both temperature and precipitation and ecological rehabilitation had a positive effect on vegetation restoration related to a marked increase of vegetation coverage. Increase in annual precipitation increased rainfall related erosion but also assisted water regulation. Reduction in wind speed effectively lowered the occurrence of wind erosion. Vegetation restoration directly increased NPP and GY, and was conducive to water regulation and soil conservation. However, grassland degradation still continued in local areas. Ecological programs applied to the grasslands of China should be continued. Adopting adaptive management approaches that facilitate the synergy of multiple ecosystem services are required to maximize their benefit to the people of China.

Zhang, M., et al. (2014). "Response of surface air temperature to small-scale land clearing across latitudes." Environmental Research Letters **9**(3).

Climate models simulating continental scale deforestation suggest a warming effect of land clearing on the surface air temperature in the tropical zone and a cooling effect in the boreal zone due to different control of biogeochemical and biophysical processes. Ongoing land-use/cover changes mostly occur at local scales (hectares), and it is not clear whether the local-scale deforestation will generate temperature patterns consistent with the climate model results. Here we paired 40 and 12 flux sites with nearby weather stations in North and South America and in Eastern Asia, respectively, and quantified the temperature difference between these paired sites. Our goal was to investigate the response of the surface air temperature to local-scale (hectares) land clearing across latitudes using the surface weather stations as proxies for localized land clearing. The results show that north of 10 degrees N, the annual mean temperature difference (open land minus forest) decreases with increasing latitude, but the temperature difference shrinks with latitude at a faster rate in the Americas [-0.079 (+/- 0.010) degrees C per degree] than in Asia [-0.046 (+/- 0.011) degrees C per degree]. Regression of the combined data suggests a transitional latitude of about 35.5 degrees N that demarks deforestation warming to the south and cooling to the north. The warming in latitudes south of 35 degrees N is associated with increase in the daily maximum temperature, with little change in the daily minimum temperature while the reverse is true in the boreal latitudes.

Zhang, P., et al. (2012). "Biophysical regulations of NEE light response in a steppe and a cropland in Inner Mongolia." Journal of Plant Ecology **5**(2): 238-248.

Ecosystem carbon models often require accurate net ecosystem exchange of CO2 (NEE) light-response parameters, which can be derived from the Michaelis-Menten equation. These parameters include maximum net ecosystem exchange (NEEmax), apparent quantum use efficiency (alpha) and daytime ecosystem respiration rate (R-e). However, little is known about the effects of land conversion between steppe and cropland on these parameters, especially in semi-arid regions. To understand how these parameters vary in responses to biotic and abiotic factors under land conversions, seasonal variation of light-response parameters were evaluated for a steppe and a cropland of Inner Mongolia, China, during three consecutive years (2006-08) with different precipitation amounts. NEE was measured over a steppe and a cropland in Duolun, Inner Mongolia, China, using the eddy covariance technique, and NEE light-response parameters (NEEmax, alpha and R-e) were derived using the Michaelis-Menten model. Biophysical regulations of these parameters were evaluated using a stepwise regression analysis. The maximum absolute values of NEEmax occurred in the meteorological regimes of 15 degrees C < T-a < 25 degrees C, vapor pressure deficit (VPD) < 1 KPa and 0.21 m(3) m(-3) < volumetric soil water content at 10 cm (SWC) < 0.28 m(3) m(-3) for both the steppe and the cropland ecosystems. The variations of alpha and R-e showed no regular variation pattern in different T-air, VPD and SWC regimes. Under the same regime of T-air, VPD and SWC, the cropland had higher absolute values of NEEmax than the steppe. Canopy conductance and leaf area index (LAI) were dominant drivers for variations in NEE light-response parameters of the steppe and the cropland. The seasonal variation of NEE light-response parameters followed the variation of LAI for two ecosystems. The peak values of all light-response parameters for the steppe and the cropland occurred from July to August. The values of NEE light-response parameters (NEEmax, alpha and R-e) were lower in the driest year (2007). Seasonally averaged NEE light-response parameters for the cropland surpassed those for the steppe. Land conversion from steppe to cropland enhanced NEE light-response parameters during the plant growing period. These results will have significant implications for improving the models on regional NEE variation under climate change and land-use change scenarios.

Zhang, Y. L., et al. (2015). "Understanding moisture stress on light use efficiency across terrestrial ecosystems based on global flux and remote-sensing data." Journal of Geophysical Research-Biogeosciences **120**(10): 2053-2066.

Light use efficiency (LUE) is a key biophysical parameter characterizing the ability of plants to convert absorbed light to carbohydrate. However, the environmental regulations on LUE, especially moisture stress, are poorly understood, leading to large uncertainties in primary productivity estimated by LUE models. The objective of this study is to investigate the effects of moisture stress on LUE for a wide range of ecosystems on daily, 8 day, and monthly scales. Using the FLUXNET and Moderate Resolution Imagine Spectroradiometer data, we evaluated moisture stress along the soil-plant-atmosphere continuum, including soil water content (SWC) and soil water saturation (SWS), land surface wetness index (LSWI) and plant evaporative fraction (EF), and precipitation and daytime atmospheric vapor pressure deficit (VPD). We found that LUE was most responsive to plant moisture indicators (EF and LSWI), least responsive to soil moisture (SWC and SWS) variations with the atmospheric indicator (VPD) falling in between. LUE showed higher sensitivity to SWC than VPD only for grassland ecosystems. For evergreen forest, LUE had better association with VPD than LSWI. All moisture indicators (except soil indicators) were generally less effective in affecting LUE on the daily and 8 day scales than on the monthly scale. Our study highlights the complexity of moisture stress on LUE and suggests that a single moisture indicator or function in LUE models is not sufficient to capture the diverse responses of vegetation to moisture stress. LUE models should consider the variability identified in this study to more realistically reflect the environmental controls on ecosystem functions.

Zhang, Y. Q., et al. (2012). "Decadal Trends in Evaporation from Global Energy and Water Balances." Journal of Hydrometeorology **13**(1): 379-391.

Satellite and gridded meteorological data can be used to estimate evaporation (E) from land surfaces using simple diagnostic models. Two satellite datasets indicate a positive trend (first time derivative) in global available energy from 1983 to 2006, suggesting that positive trends in evaporation may occur in "wet" regions where energy supply limits evaporation. However, decadal trends in evaporation estimated from water balances of 110 wet catchments ((E) over bar (wb)) do not match trends in evaporation estimated using three alternative methods: 1) (E) over bar (MTE), a model-tree ensemble approach that uses statistical relationships between E measured across the global network of flux stations, meteorological drivers, and remotely sensed fraction of absorbed photosynthetically active radiation; 2) (E) over bar (Fu), a Budyko-style hydrometeorological model; and 3) (E) over bar (PML), the Penman-Monteith energy-balance equation coupled with a simple biophysical model for surface conductance. Key model inputs for the estimation of (E) over bar (Fu) and (E) over bar (PML) are remotely sensed radiation and gridded meteorological fields and it is concluded that these data are, as yet, not sufficiently accurate to explain trends in E for wet regions. This provides a significant challenge for satellite-based energy-balance methods. Trends in (E) over bar (wb) for 87 "dry" catchments are strongly correlated to trends in precipitation (R-2 = 0.85). These trends were best captured by (E) over bar (Fu), which explicitly includes precipitation and available energy as model inputs.

Zhang, Y. Z. and S. L. Liang (2018). "Impacts of land cover transitions on surface temperature in China based on satellite observations." Environmental Research Letters **13**(2).

China has experienced intense land use and land cover changes during the past several decades, which have exerted significant influences on climate change. Previous studies exploring related climatic effects have focused mainly on one or two specific land use changes, or have considered all land use and land cover change types together without distinguishing their individual impacts, and few have examined the physical processes of the mechanism through which land use changes affect surface temperature. However, in this study, we considered satellite-derived data of multiple land cover changes and transitions in China. The objective was to obtain observational evidence of the climatic effects of land cover transitions in China by exploring how they affect surface temperature and to what degree they influence it through the modification of biophysical processes, with an emphasis on changes in surface albedo and evapotranspiration (ET). To achieve this goal, we quantified the changes in albedo, ET, and surface temperature in the transition areas, examined their correlations with temperature change, and calculated the contributions of different land use transitions to surface temperature change via changes in albedo and ET. Results suggested that land cover transitions from cropland to urban land increased land surface temperature (LST) during both daytime and nighttime by 0.18 and 0.01 K, respectively. Conversely, the transition of forest to cropland tended to decrease surface temperature by 0.53 K during the day and by 0.07 K at night, mainly through changes in surface albedo. Decreases in both daytime and nighttime LST were observed over regions of grassland to forest transition, corresponding to average values of 0.44 and 0.20 K, respectively, predominantly controlled by changes in ET. These results highlight the necessity to consider the individual climatic effects of different land cover transitions or conversions in climate research studies. This short-term analysis of land cover transitions in China means our estimates should represent local temperature effects. Changes in ET and albedo explained <60% of the variation in LST change caused by land cover transitions; thus, additional factors that affect surface climate need consideration in future studies.

Zhang, Z. Q., et al. (2015). "Investigation of North American vegetation variability under recent climate: A study using the SSiB4/TRIFFID biophysical/dynamic vegetation model." Journal of Geophysical Research-Atmospheres **120**(4): 1300-1321.

Recent studies have shown that current dynamic vegetation models have serious weaknesses in reproducing the observed vegetation dynamics and contribute to bias in climate simulations. This study intends to identify the major factors that underlie the connections between vegetation dynamics and climate variability and investigates vegetation spatial distribution and temporal variability at seasonal to decadal scales over North America (NA) to assess a 2-D biophysical model/dynamic vegetation model's (Simplified Simple Biosphere Model version 4, coupled with the Top-down Representation of Interactive Foliage and Flora Including Dynamics Model (SSiB4/TRIFFID)) ability to simulate these characteristics for the past 60 years (1948 through 2008). Satellite data are employed as constraints for the study and to compare the relationships between vegetation and climate from the observational and the simulation data sets. Trends in NA vegetation over this period are examined. The optimum temperature for photosynthesis, leaf drop threshold temperatures, and competition coefficients in the Lotka-Volterra equation, which describes the population dynamics of species competing for some common resource, have been identified as having major impacts on vegetation spatial distribution and obtaining proper initial vegetation conditions in SSiB4/TRIFFID. The finding that vegetation competition coefficients significantly affect vegetation distribution suggests the importance of including biotic effects in dynamical vegetation modeling. The improved SSiB4/TRIFFID can reproduce the main features of the NA distributions of dominant vegetation types, the vegetation fraction, and leaf area index (LAI), including its seasonal, interannual, and decadal variabilities. The simulated NA LAI also shows a general increasing trend after the 1970s in responding to warming. Both simulation and satellite observations reveal that LAI increased substantially in the southeastern U. S. starting from the 1980s. The effects of the severe drought during 1987-1992 and the last decade in the southwestern U. S. on vegetation are also evident from decreases in the simulated and satellite-derived LAIs. Both simulated and satellite-derived LAIs have the strongest correlations with air temperature at northern middle to high latitudes in spring reflecting the effect of these climatic variables on photosynthesis and phenological processes. Meanwhile, in southwestern dry lands, negative correlations appear due to the heat and moisture stress there during the summer. Furthermore, there are also positive correlations between soil wetness and LAI, which increases from spring to summer. The present study shows both the current improvements and remaining weaknesses in dynamical vegetation models. It also highlights large continental-scale variations that have occurred in NA vegetation over the past six decades and their potential relations to climate. With more observational data availability, more studies with different models and focusing on different regions will be possible and are necessary to achieve comprehensive understanding of the vegetation dynamics and climate interactions.

Zhao, C. Y., et al. (2006). "GIS-assisted modelling of the spatial distribution of Qinghai spruce (Picea crassifolia) in the Qilian Mountains, northwestern China based on biophysical parameters." Ecological Modelling **191**(3-4): 487-500.

There has been an increasing use of predictive spatial distribution of main communities or dominant species at the landscape scale for ecological restoration planning, biodiversity conservation planning and regional management decisions in the Qilian Mountains, northwest China. Understanding the spatial distribution of dominant species at the regional scale is also essential for assessing the impacts of environmental change or human effects on vegetation distribution. Based on the spatial distribution of resource variables that correlate with or control plant distribution, this study focused on the prediction of Qinghai spruce (Picea crassifolia) distribution at the regional scale, i.e., where the extent of the prediction was within the biogeographic range of Qinghai spruce in the upper reach of Heihe River. The development of the predictive model in the study required the integration of geographical information system (GIS) with remote sensing (RS), spatial analytic and statistical tools. First, we selected the main resource variables such as mean July temperature, water and solar radiation. These variables were spatialized as functions of elevation and horizontal coordinates or as functions of aspect and slope via a GIS. Second, the niche spaces of Qinghai spruce were determined by incorporating the spatially-distributed resource variables with the current distribution of the species, which came from remote sensing data (Landsat TM image). The niche spaces defined then were extrapolated over the study area. Third, the distribution pattern was validated by field investigations. The study showed that the scope of mean July temperature ranged from 8.5 degrees C to 13.5 degrees C, average annual precipitation from 370 mm to 660 mm, the soil moisture index from 2.3 m(3) m(-1) year(-1) to 4.5 m(3) m(-1) year(-1) and the shortwave radiation for an average July day from 3.8 mm m(-2) day(-1) to 7.8 mm m(-2) day(-1). The elevation range belonging to Qinghai spruce in Qilian Mountains was also determined according to the mean July temperature space occupied by the forest. The elevation occupied by Qinghai spruce was about from 2600 m to 3400 m. We found that the density of the species has higher value from 2650 m to 3100 m based on the field investigation, and from 3 100 m the density decreased with elevation increase. The basal area of Qinghai spruce had the same change as the density. That is, the suitable niche of the species ranged from 2650 m to 3 100 m. (c) 2005 Elsevier B.V. All rights reserved.

Zhao, L., et al. (2018). "Interactions between urban heat islands and heat waves." Environmental Research Letters **13**(3).

Heat waves (HWs) are among the most damaging climate extremes to human society. Climate models consistently project that HWfrequency, severity, and duration will increase markedly over this century. For urban residents, the urban heat island (UHI) effect further exacerbates the heat stress resulting from HWs. Here we use a climate model to investigate the interactions between the UHI and HWs in 50 cities in the United States under current climate and future warming scenarios. We examine UHI2m (defined as urban-rural difference in 2m-height air temperature) and UHIs (defined as urban-rural difference in radiative surface temperature). Our results show significant sensitivity of the interaction between UHI and HWs to local background climate and warming scenarios. Sensitivity also differs between daytime and nighttime. During daytime, cities in the temperate climate region show significant synergistic effects between UHI and HWs in current climate, with an average of 0.4 K higher UHI2m or 2.8 K higher UHIs during HWs than during normal days. These synergistic effects, however, diminish in future warmer climates. In contrast, the daytime synergistic effects for cities in dry regions are insignificant in the current climate, but emerge in future climates. At night, the synergistic effects are similar across climate regions in the current climate, and are stronger in future climate scenarios. We use a biophysical factorization method to disentangle the mechanisms behind the interactions between UHI and HWs that explain the spatial-temporal patterns of the interactions. Results show that the difference in the increase of urban versus rural evaporation and enhanced anthropogenic heat emissions (air conditioning energy use) during HWs are key contributors to the synergistic effects during daytime. The contrast in water availability between urban and rural land plays an important role in determining the contribution of evaporation. At night, the enhanced release of stored and anthropogenic heat during HWs are the primary contributors to the synergistic effects.

Zhao, W., et al. (2017). "Comparison of surface energy budgets and feedbacks to microclimate among different land use types in an agro-pastoral ecotone of northern China." Science of the Total Environment **599**: 891-898.

The biophysical effect of land use conversion plays a significant role in regulating climate change. Owing to albedo and evapotranspiration (ET) change, the effect of energy budget difference on land surface temperature (LST) is important but unclear among contrasting land use types, especially in temperate semi-arid regions. Based on moderate-resolution imaging spectroradiometer (MODIS) data, we compared the differences in albedo, ET, and LST between cropland and grassland (CR-GR), and between planted forest and grassland (PF-GR) in the Horqin Sandy Land of Inner Mongolia, an agro-pastoral ecotone of northern China. Our main objective was to explore the magnitude and direction of albedo and ET change during the growing season and, subsequently, to estimate the biophysical effects on LST as a result of land use and land cover change. Our results indicate no significant difference in mean monthly albedo for CR-GR and PF-GR Cropland lost more water through ET and significantly decreased daytime LST compared with grassland from July to September, but no significant differences in ET and LST were observed for PF-GR in any month. The biophysical climate effects were more pronounced for CR-GR compared with PF-GR. The response of LST to the changes in energy budget confirmed that ET was the critical driving factor relative to albedo. Compared with grassland, cropland and planted forest tended to cool the land surface by 5.15 degrees C and 1.51 degrees C during the growing season, respectively, because of the biophysical effects. Our findings suggest the significance of local-scale biophysical effect on climate variation after land use conversion in semi-arid regions. (C) 2017 Elsevier B.V. All rights reserved.

Zhao, Y. Y., et al. (2017). "Linking wind erosion to ecosystem services in drylands: a landscape ecological approach." Landscape Ecology **32**(12): 2399-2417.

Wind erosion is a widespread environmental problem in the world's arid landscapes, which threatens the sustainability of ecosystem services in these regions. We investigated how wind erosion and key ecosystem services changed concurrently and what major biophysical and socioeconomic factors were responsible for these changes in a dryland area of China. Based on remote sensing data, field measurements, and modeling, we quantified the spatiotemporal patterns of both wind erosion and four key ecosystem services (soil conservation, crop production, meat production, and carbon storage) in the Mu Us Sandy Land in northern China during 2000-2013. Linear regression was used to explore possible relationships between wind erosion and ecosystem services. From 2000 to 2013, wind erosion decreased by as much as 60% and the four ecosystem services all increased substantially. These trends were attributable to vegetation recovery due mainly to government-aided ecological restoration projects and, to a lesser degree, slightly increasing precipitation and decreasing wind speed during the second half of the study period. The maximum soil loss dropped an order of magnitude when vegetation cover increased from 10% to 30%, halved again when vegetation increased from 30 to 40%, and showed little change when vegetation increased beyond 60%. Our study indicates that vegetation cover has nonlinear and threshold effects on wind erosion through constraining the maximum soil loss, which further affects dryland ecosystem services. These findings have important implications for ecological restoration and ecosystem management in dryland landscapes in China and beyond.

Zhou, M. C., et al. (2009). "Evapotranspiration in the Mekong and Yellow river basins." Hydrological Sciences Journal-Journal Des Sciences Hydrologiques **54**(3): 623-638.

Estimates of potential evapotranspiration (PET) and reference evapotranspiration (RET) were compared over the Mekong and Yellow river basins, representing humid and semi-arid Asian monsoon regions. Multiple regression relationships between monthly RET, PET, LAI (leaf area index) and climatic variables were explored for different vegetation types. Over the Mekong River basin, the spatial average of RET is only 1.7%

lower than PET; however, RET is 140% higher than PET over parts of the Tibetan Plateau, due to the short and sparse grassland, and 30% lower than PET in parts of the lower basin due to the tall and well-developed forests. Over the Yellow River basin, RET is estimated to be higher than PET, on average about 50% higher across the whole basin, due to the generally sparse vegetation. A close linear relationship between annual RET and PET allows the establishment of a regional regression to predict monthly PET from monthly RET, climatic variables and/or vegetation LAI. However, the large prediction errors indicate that the Shuttleworth-Wallace (S-W) model, although it is more complex, should be recommended due to its more robust physical basis and because it successfully accounts for the effect of changing land surface conditions on PET. The limited available field data suggest that the S-W estimate may be more realistic. It was also found that vegetation conditions in summer are primarily controlled by the regional antecedent precipitation in the cold and dry seasons over the Loess Plateau in the middle reaches of the Yellow River.

Zhou, S., et al. (2015). "Effects of human activities on the eco-environment in the middle Heihe River Basin based on an extended environmental Kuznets curve model." Ecological Engineering **76**: 14-26.

With rapid socio-economic development over the past three decades in China, adverse effects of human activities on the natural ecosystem are particularly serious in arid regions where landscape ecology is fragile due to limited water resources and considerable interannual climate variability. Data on land use, surface and ground water, climate, gross domestic product (GDP) per capita from the middle Heihe River Basin were used to (i) examine changes in water consumption, land use composition, and vegetation cover; (ii) evaluate the effectiveness of short-term management strategies for environmental protection and improvement, and (iii) apply and extend the environmental Kuznets curve (EKC) framework to describe the relationship between economic development and environmental quality in terms of the normalized difference vegetation index (NDVI). The results showed that with rapid development of agriculture and economy, land use change for the period 1986-2000 was characterized by the expansion of constructed oases, considerable contraction of oasis-desert transitional zone and natural oases. This has led to a decrease in ecosystem stability. Since 2001, effective basin management has brought about improved environment conditions, with a more optimal hierarchical structure of vegetation cover. The original EKC model could not explain most of the observed variation in NDVI (R-2 = 0.37). Including additional climate variables, the extended EKC model to explain the observed NDVI was much improved (R-2 = 0.78), suggesting that inclusion of biophysical factors is a necessary additional dimension in the relationship between economic development and environmental quality for arid regions with great climate variability. The relationship between GDP per capita and NDVI, with the effect of precipitation and temperature taken into consideration, was adequately described by an N-shaped curve, suggesting that the relationship between society and the environment followed a process of promotion, contradiction, and coordination. (C) 2014 The Authors. Published by Elsevier B.V.

Zhu, P., et al. (2017). "Importance of biophysical effects on climate warming mitigation potential of biofuel crops over the conterminous United States." Global Change Biology Bioenergy **9**(3): 577-590.

Current quantification of climate warming mitigation potential (CWMP) of biomass- derived energy has focused primarily on its biogeochemical effects. This study used site-level observations of carbon, water, and energy fluxes of biofuel crops to parameterize and evaluate the community land model (CLM) and estimate CO2 fluxes, surface energy balance, soil carbon dynamics of corn (Zea mays), switchgrass (Panicum virgatum), and miscanthus (Miscanthus 9 giganteus) ecosystems across the conterminous United States considering different agricultural management practices and land-use scenarios. We find that neglecting biophysical effects underestimates the CWMP of transitioning from croplands and marginal lands to energy crops. Biogeochemical effects alone result in changes in carbon storage of -1.9, 49.1, and 69.3 g C m(-2) y (-1) compared to 20.5, 78.5, and 96.2 g C m(-2) y(-1) when considering both biophysical and biogeochemical effects for corn, switchgrass, and miscanthus, respectively. The biophysical contribution to CWMP is dominated by changes in latent heat fluxes. Using the model to optimize growth conditions through fertilization and irrigation increases the CWMP further to 79.6, 98.3, and 118.8 g C m (-2) y(-1), respectively, representing the upper threshold for CWMP. Results also show that the CWMP over marginal lands is lower than that over croplands. This study highlights that neglecting the biophysical effects of altered surface energy and water balance underestimates the CWMP of transitioning to bioenergy crops at regional scales.

Zvereva, E. L. and M. V. Kozlov (2007). "Facilitation of bilberry by mountain birch in habitat severely disturbed by

pollution: Importance of sheltering." Environmental and Experimental Botany **60**(2): 170-176.

Earlier we demonstrated that in heavily polluted industrial barren dwarf shrubs grew and reproduced better under top-canopy plants than in gaps, while in undisturbed forests they performed better in gaps than under tree canopies. During 2002-2004 we used bilberry, Vaccinium myrtillus to experimentally test the hypothesis that positive effects observed in industrial barrens were due to mechanical sheltering of dwarf shrubs by canopies of birch, Betula pubescens subsp. czerepanovii. Sheltering by wooden fence during 2 years improved performance and alleviated stress (as indicated by decrease in FA) in bilberry plants growing in open microsites, compared to both the same plants in pre-treatment year and non-sheltered (control) plants. Performance indices of artificially sheltered V myrtillus reached the level observed in plants naturally sheltered by birch canopies. Removal of natural shelter, i.e. cutting of neighbouring birch, caused steady decline in vegetative biomass production, while changes in shoot mass, leaf mass and leaf FA of bilberry were not significant, and performance of these plants during the two post-treatment years remained higher than performance of bilberry in open microsites. Our data indicate that shelter effects to the great extent explain facilitation of dwarf shrubs by top-canopy plants in industrial barrens. Amelioration of unfavourable environment by both natural and artificial shelters was mostly due to protection from wind and extreme soil temperatures. We suggest that in harsh environmental conditions positive plant-plant interactions are primarily mediated by changes in biophysical environment.