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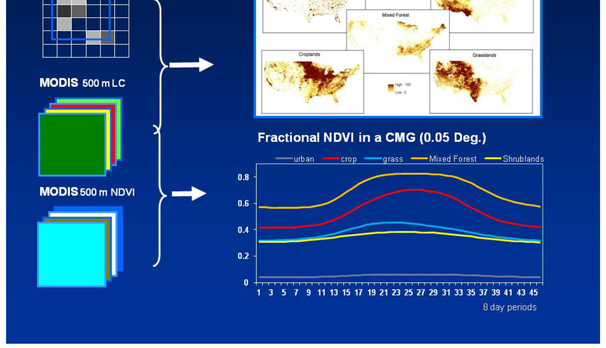
Combining Satellite Data and Models to Assess the Impacts of Urbanization on the Continental US Surface Climate

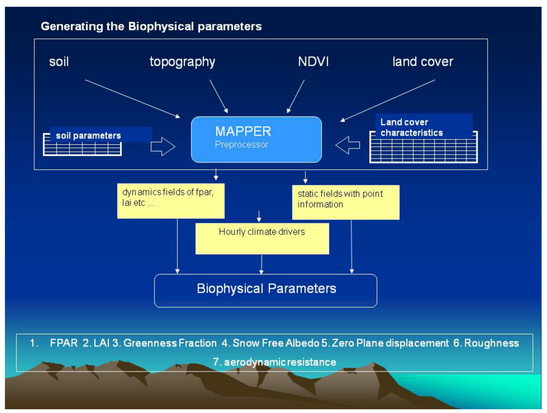
L. Bounoua[1], P. Zhang[2,1], M. Imhoff[3], J. Santanello[4], S. Kumar[5,4], M. Shepherd[6], D. Quattrochi[7], J. Silva[8], C. Rosenzweigh[9], S. Gaffin[10] and G. Mostovoy[2,1]

Urbanization is one of the most important and long lasting forms of land transformation. Urbanization affects the surface climate in different ways: 1) by reduction of the vegetation fraction causing subsequent reduction in photosynthesis and plant's water transpiration, 2) by alteration of surface runoff and infiltration and their impacts on soil moisture and the water table, 3) by change in the surface albedo and surface energy partitioning, and 4) by transformation of the surface roughness length and modification of surface fluxes. Land cover and land use change maps including urban areas have been developed and will be used in a suite of land surface models of different complexity to assess the impacts of urbanization on the continental US surface climate. These maps and datasets based on a full range of available satellite data and ground observations will be used to characterize distant-past (*pre-urban*), recent-past (*2001*), present (*2010*), and near future (*2020*) land cover and land use changes. The main objective of the project is to assess the impacts of these land transformation on past, current and near-future climate and the potential feedbacks from these changes on the atmospheric, hydrologic, biological, and socio-economic properties beyond the immediate metropolitan regions of cities and their near suburbs. The WRF modeling system will be used to explore the nature and the magnitude of the two-way interactions between urban lands and the atmosphere and assess the overall regional dynamic effect of urban expansion on the northeastern US weather and climate.

Generating Land Cover Maps and Biophysical Parameters

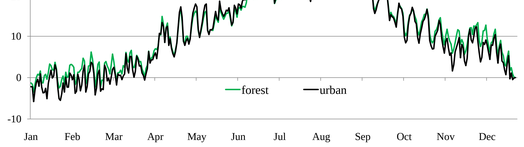
Land Cover Land Use

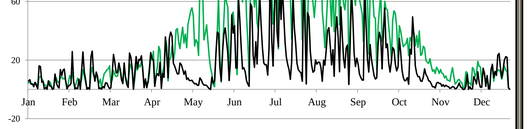


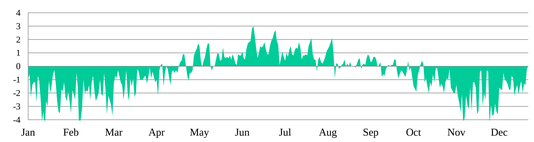


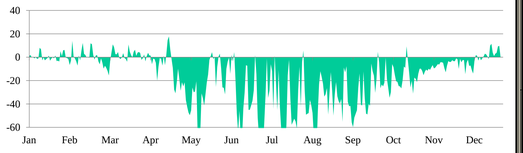
Offline Continental Scale Simulations

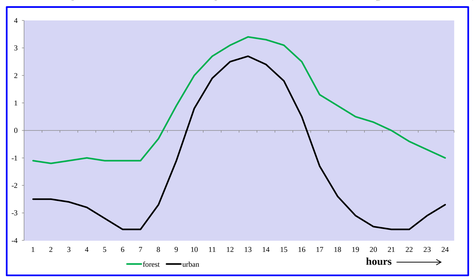
SiB2 runs were performed over the CONUS area at 5x5 km spatial resolution to assess the impact of urbanization on surface climate during 2001 (recent past scenario). Plots show preliminary results of surface temperature and evaporation fluxes between forested and urban fraction occupying the same pixel at 5x5 km located at 38.975 North and 76.350 West [west of Baltimore city].

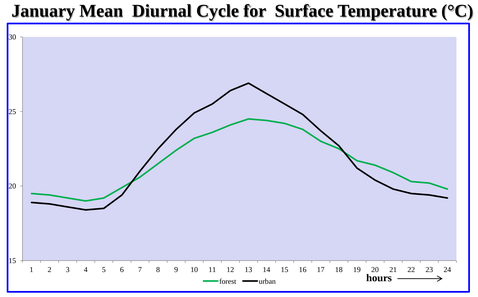






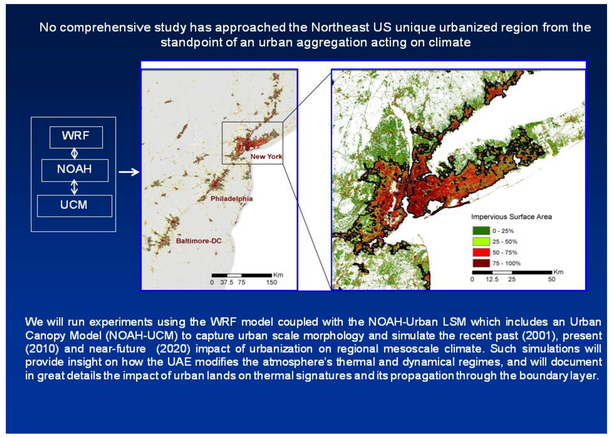






Regional Scale Simulations

Regional Analysis



Social-Economic Impact

Socio-economic datasets including population and incomes for 2000 and 2010 (for areas with more than 65,000 people for which income data are available) will be linked with environmental and surface climate variables (e.g., extreme temperatures, heat-stress index). In order to assess differences across major US urban areas we will add spatial indicator variables including census region codes to the dataset. Using the linked socio-economic-climate database we will explore and search answers to the following questions:

- What are the driving forces behind cities' growth?
- Why do some cities grow faster than others?
- How is the influence of climate manifested in urban growth?

Expected Outcomes

- Multidimensional continental scale land cover maps at 5x5km for 4 four periods containing fractions of 14 land cover types as well as an internally consistent, spatially and temporally continuous, georeferenced biophysical dataset representing the annual cycle of each existing land cover fraction in the CMG at 8-day time interval.
- Full grid and sub-grid contributions to fluxes and states variables for each annual cycle hourly for major metropolitan regions and at 8-day time-interval for the continental US.
- Comprehensive analysis of the impact of urbanization on the biological, hydrological and energy cycles at local, regional and continental scales.
- Continental scale assessment of the overall impact of urbanization on the temperature, carbon and water cycles since the pre-urban era.
- Detailed analysis of the urban heat island effect in major US cities and comparison of this effect between urban areas as a function of urban size, shape and ISA density.
- Study of the urban archipelagos effects along the northeastern US on climate.
- Socio-economic analysis will be performed to assess the impact urban modification of surface climate on human population's behavior, energy consumption and plausible mechanisms for alleviating the urban heat island effect.

[1]Biospheric Sciences Laboratory, Code 618, NASA GSFC, [2]Earth Resource Technology Inc., [3]Joint Global Change Research Institute, PNNL, [4]Hydrological Sciences Laboratory, Code 617, NASA GSFC, [5]Science Applications International Corporation, [6]University of Georgia, [7]Earth Science Office, NASA MSFC, [8]Univeristy of Maryland, Dpt. Geography' [9]Goddard Institute for Space Studies, NASA, [10] Columbia University