BIOPHYSICAL VARIABLES FROM 250m MODIS DATA TO IMPROVE ECOLOGICAL MONITORING OF URBAN ENVIRONMENTS

CRISTINA MILESI[1], PETR VOTAVA[1], ANDREW MICHAELIS[1], NIKOLAY SHABANOV[2], RANGA MYNENI[2], and RAMAKRISHNA NEMANI[3] [1]FOUNDATION CSUMB [2]BOSTON UNIVERSITY [3]NASA AMES RESEARCH CENTER

Abstract: The MODIS products offer the possibility of weekly global monitoring of fundamental vegetation parameters such as LAI/FPAR and NPP at spatial resolutions down to 1km. While this spatial and temporal resolution represents a big advancement for global and regional ecological monitoring compared to the pre-MODIS era, it leaves out urbanized pixels, which are masked out in the calculation of MODIS LAI/FPAR (MOD15A2) and MODIS NPP (MOD17A2). The high degree of heterogeneity is one of the reasons for exclusion of urban areas, since the spatial resolution of 1km is still too coarse to resolve vegetation process in these fragmented landscapes.

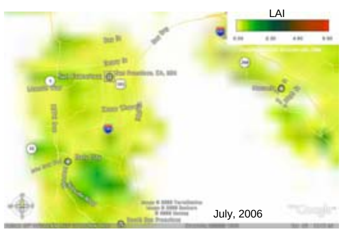
For the purpose of improving the characterization of terrestrial ecosystem processes in highly heterogeneous regions such as metropolitan areas, we are developing MODIS 250m estimates of LAI/FPAR. We expect that these data will prove useful to enhance the ecological monitoring, modeling, and forecasting of these regions. Here we present preliminary results of LAI estimates for the southwestern US and the San Francisco Bay Area.

Berkeley, CA

Menlo Park, CA

Along with impervious surfaces, which subtract land previously covered with crops and forests from the photosynthetic process, the patchy mosaic making up urban and suburban landscapes can maintain substantial vegetation fractions. This is particularly true for urban areas in the United States and in other developed countries where the density of settlements is low.

ASTER 2 October 2005



Urban vegetation is often characterized by intensive management through irrigation, fertilization, and pruning. The combination of large fractions of vegetation and high resource investments results in these urban areas maintaining a significant contributions to the terrestrial carbon cycle, with fluxes generally larger than those of the pre-urban land cover and likely to result in a carbon sink.

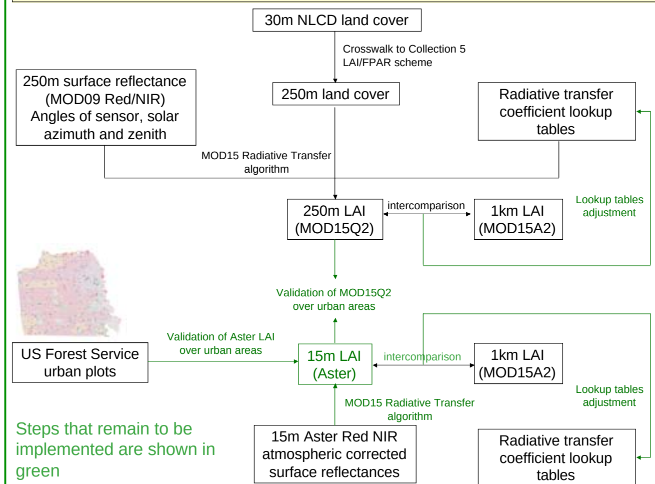
Of course, this carbon sink is still small compared to the fluxes from fossil fuel consumption, for which urban areas are hotspots of emissions. However, monitoring the carbon cycle of the urban vegetation is important as it contributes indirectly to regulating other components of urban biogeochemistry, for example by modulating storm runoff, lowering air temperatures through shading or evapotranspirational cooling, through VOC emissions as a result of landscaping maintenance practices.

Urbanized pixels in the standard 1km MODIS LAI/FPAR (MOD15A2) and MODIS NPP (MOD17A2), however, are masked out, and therefore no consistent continuous biophysical monitoring is available for these ecosystems.

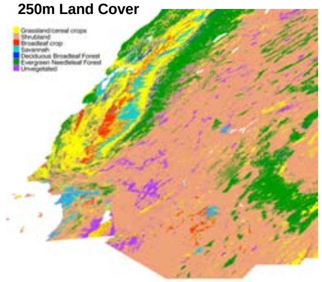
Continuous estimates of LAI/FPAR from MODIS for urban areas are useful for the monitoring, modeling and forecasting of:

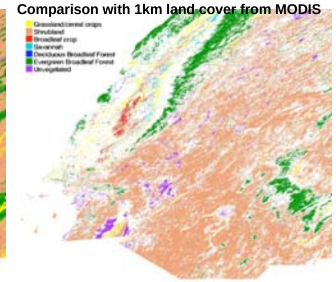
- Urban biogeochemistry
- Air quality and energy demands
- Local and regional climate
- Pollen
- Urban water demand

Methods: To test the retrieval of LAI at 250m, we apply the MOD15 algorithm to all the biomes represented in the US portion of the MODIS tile v08 h05. The steps involve the creation of a 250m land cover to be used as input into the MOD15 Radiative Transfer algorithm together with the 250m surface reflectances and the biome-dependent lookup table. To scale the algorithm to 250m, we compare the 250m LAI retrievals to the standard 1km product (MOD15A2) and perform adjustments to the lookup table. To validate the LAI estimates for urban ecosystems, we use data from US Forest Service plots scaled through an Aster image.

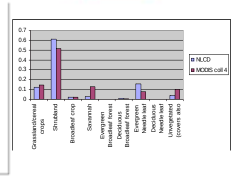


250 m land cover: was obtained by reprojecting and resampling the 1992 National Land Cover Dataset (NLCD), a 30m Landsat-derived land cover. The original 21 classes have been cross-walked to the Collection 5 MODIS LAI/FPAR land cover class scheme. The urban residential classes from NLCD has been assigned to the savanna biome. Below, the image on the right compares the 250m land cover with the MODIS one, showing only the pixels assigned to the same class in both maps.

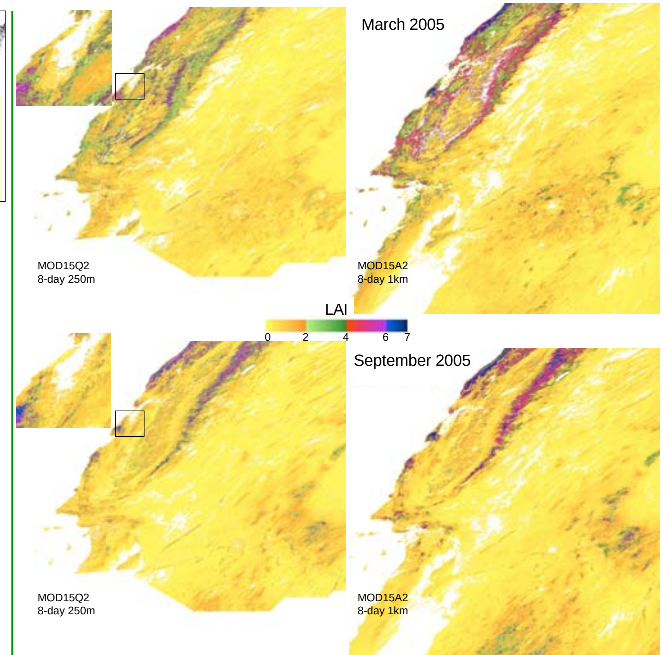




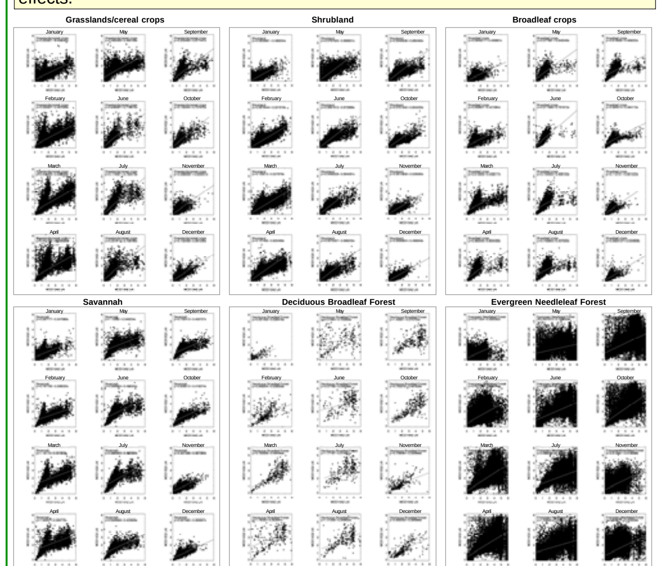
NLCD		MODIS LAI/FPAR	
11	Open water	0	Water
12	Perennial Ice/Snow	9	Unvegetated
21	Low Intensity Residential	4	Savannah
22	High Intensity Residential	4	Savannah
23	Commercial/Industrial/Transportation	9	Unvegetated
31	Bare Rock/Sand/Clay	9	Unvegetated
32	Quarries/Strip Mines/Gravel Pits	9	Unvegetated
33	Transitional	9	Unvegetated
41	Deciduous Forest	6	Deciduous Broadleaf forest
42	Evergreen Forest	7	Evergreen Needleleaf forest
43	Mixed Forest	6	Deciduous Broadleaf forest
51	Shrubland	2	Shrubland
61	Orchards/Vineyards/Other	4	Savannah
71	Grasslands/Herbaceous	1	Grassland/cereal crops
81	Pasture/Hay	1	Grassland/cereal crops
82	Row Crops	3	Broadleaf crop
83	Small Grains	1	Grassland/cereal crops
84	Fallow	9	Unvegetated
85	Urban/Recreational grasses	1	Grassland/cereal crops
91	Woody Wetlands	6	Deciduous Broadleaf forest
92	Emergent Herbaceous Wetlands	1	Grassland/cereal crops



The main differences in land cover distribution from the two sources has to be attributed to inability to accurately cross-walk the NLCD classes to the LAI/FPAR classes and to differences in resolution . For example, 1992 NLCD does not have a savannah class. Although many evergreen needleleaf forest pixels can be at a density low enough to support an understory of grasses, and therefore be considered a savannah in the LAI/FPAR classification scheme, this distinction between forest and savannah is not made in the 1992 land cover, thus leading to a possible underestimation of savannah and an overestimation of evergreen needleleaf forest in the NLCD-derived 250 m land cover.



Preliminary results: A first comparison of the 8-day 250m MODIS LAI with the standard 1km composites indicates a good agreement for most biomes. No lookup table adjustment has been yet been implemented. Observed differences in LAI estimation can be explained by differences in land cover assignment and scaling effects.



Conclusions and future work: Initial results from the implementation of the MOD15 algorithm on 250m MODIS surface reflectance are encouraging. Next steps include lookup table adjustments and validation of the LAI estimates over urbanized pixels. This step will be implemented by scaling plot level measurements to 250m LAI estimates through Aster data.