

MODIS LAI and FPAR Products: An Update on Status and Validation

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MODIS SCIENCE TEAM MEETING

Greenbelt Marriott, Greenbelt

July 22-24, 2002

MODIS LAI/FPAR HIGHLIGHTS

- Start date: September-27-1996
- End date: June-14-2003
- 5 years 10 months
- 20+ Journal articles
- Graduated: 4 PhDs; 6 MAs
- Current: 4 PhDs; 1 MA
- Developed the MODIS LAI/FPAR algorithm
- Produced 2 yr record of MODIS monthly LAI and FPAR data sets
- Produced 20+ yr record of PAL and GIMMS AVHRR LAI and FPAR data sets

Boston University LAI/FPAR Product (MOD15_BU 1km and MOD15_BU 4km)

Format

Monthly best quality compositing of MOD15A2 product for collection 2 and 3, 1 and 4 km resolutions, binary (separate files for LAI, FPAR, QC and geolocation), MODLAND Integerized Sinusoidal projection

Temporal Coverage

June 2000 to May 2002 (2 years, 24 months)

Distribution

Boston University: <ftp://crsa.bu.edu/pub/rmyneni/myneniproducts/>

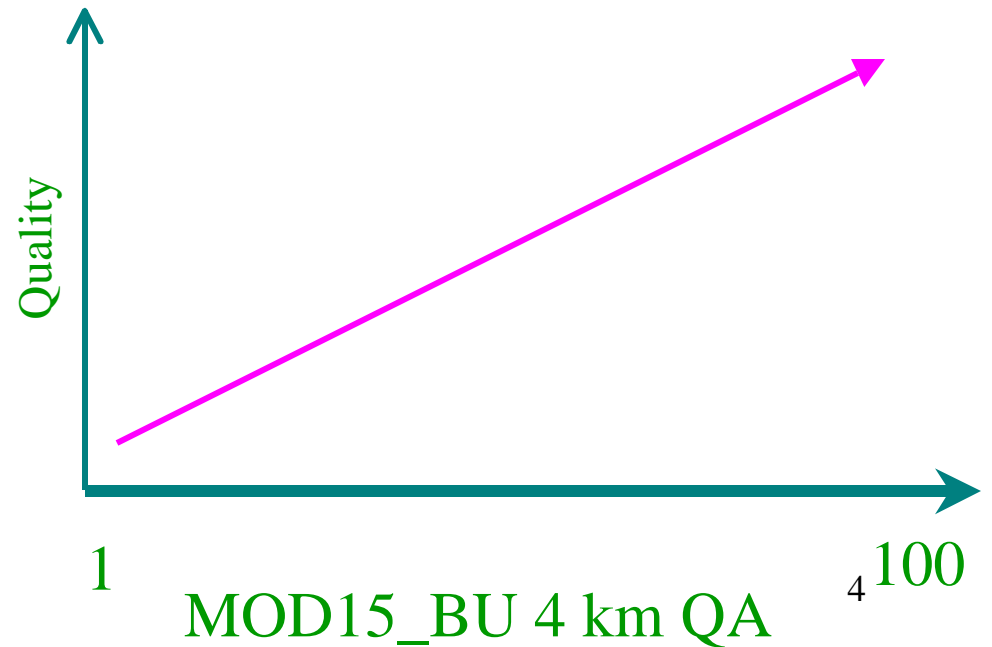
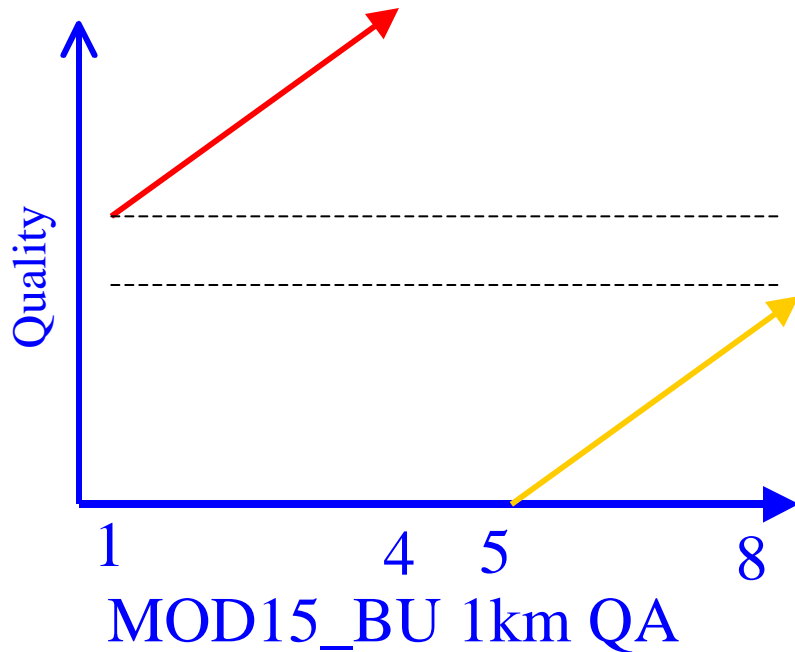
CDROMS

Data Encoding and QA

To convert from DN values to physical values, use the following scaling

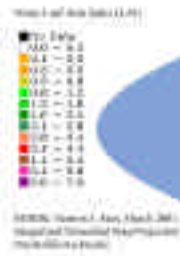
$$\text{LAI} = 0.1 \times \text{DN_LAI}; \quad \text{FPAR} = 0.01 \times \text{DN_FPAR}$$

	LAI	FPAR	outside projection	water	non-computed pixel
Range, value	0-70	0-100	200	254	255

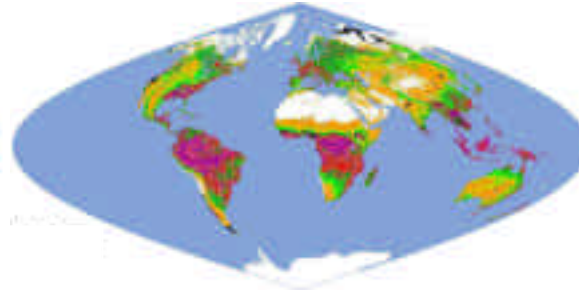


MOD_15 BU 4km, 2001

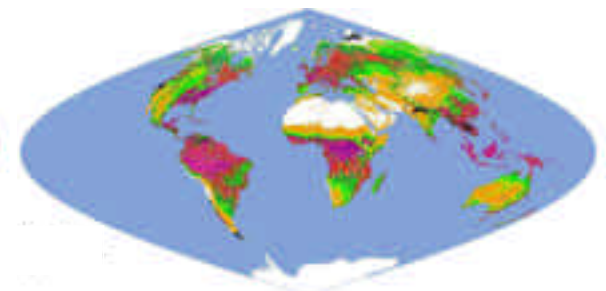
March



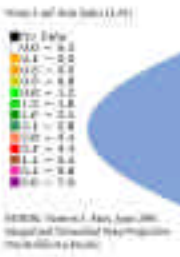
April



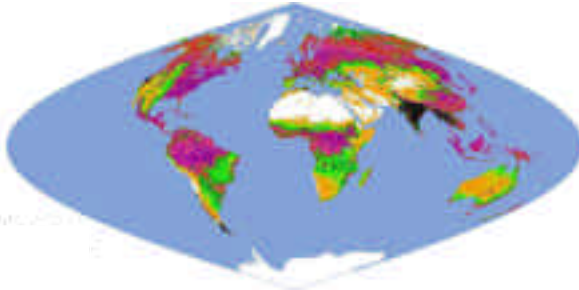
May



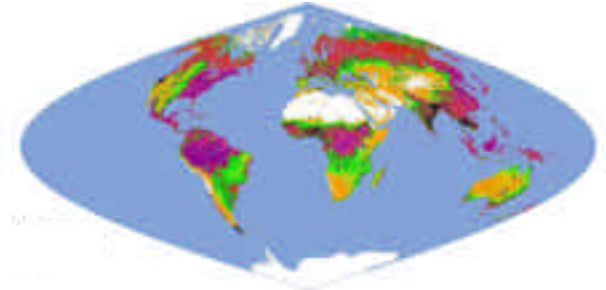
June



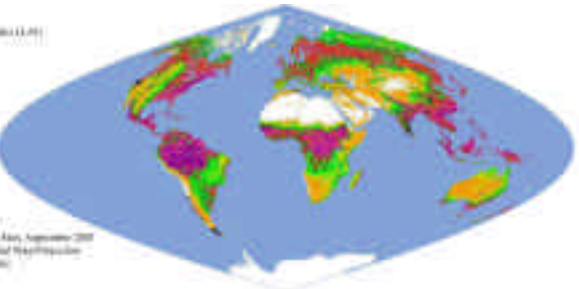
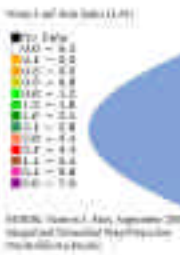
July



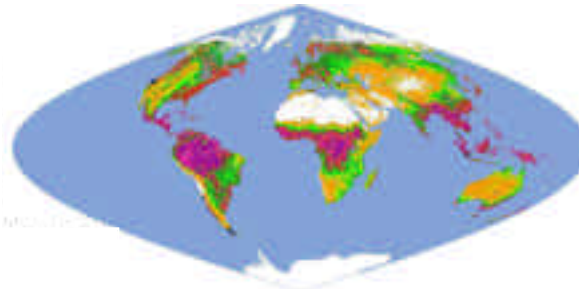
August



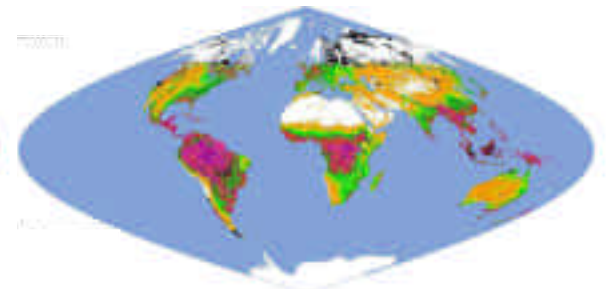
September



October



November



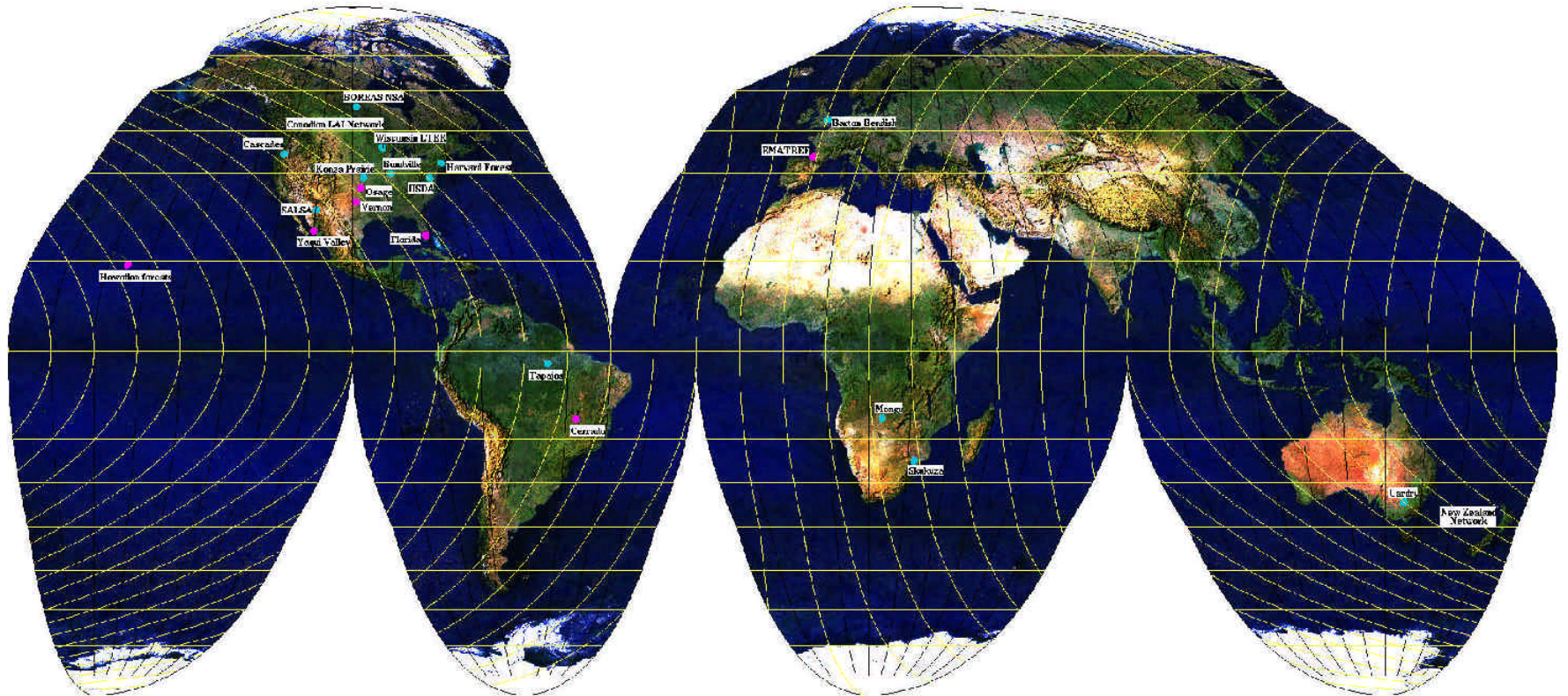
Global MODIS LAI/FPAR

4 km, monthly

CDROM

- /data** contains compressed (.gz) binary data files of the product. Two versions of MOD15A2 data were used to create data set on this CD: (i) Collection 2 (from June to October, 2000); (ii) Collection 3 (from November, 2000 to May, 2002). Within each month, three types of data are generated: FPAR, LAI and QA (quality flag). The dimension of each 4 km resolution data file is 10800x5400.
- /images** contains JPEG images to visualize binary data files of */data* directory
- /utilities** contains (a) reference latitude and longitude binary files (files *lat_4km.bin* and *long_4km.bin*; scale factor is 100); (b) ENVI color tables (density slicing). These are files with extension .dsr; (c) Sample header files (for data in */data* directory, for *lat_4km.bin* and *long_4km.bin* files).
- /tools** contains helper programs to process binary files
- /publications** contains .pdf file of key publications about MODIS LAI/FPAR algorithm and product
- /posters** contains 3 posters illustrating MODIS LAI/FPAR algorithm and product
- readme.txt**

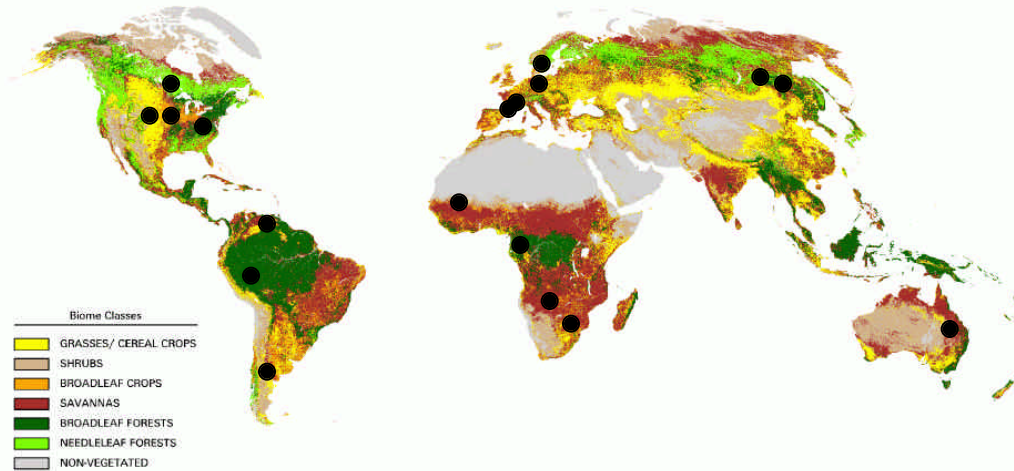
LAI and FPAR Validation Sites



Assessing the uncertainties of satellite derived LAI and FPAR
with respect to *in situ* measurements

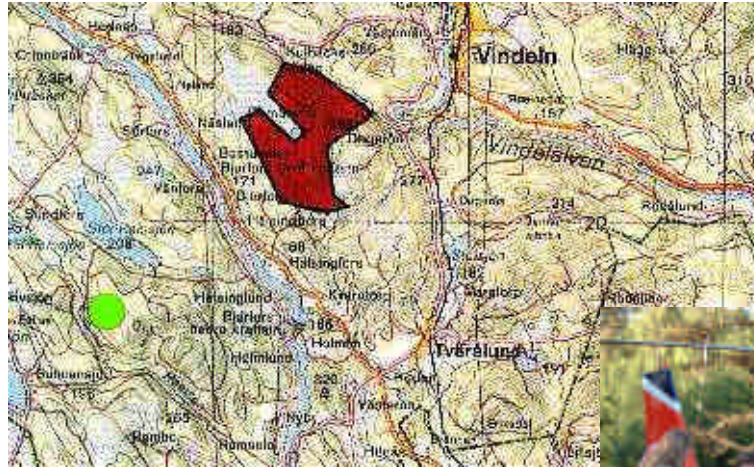
LAI AND FPAR (MOD 15A2): VALIDATION

Biome → Continent → Latitudinal transect



	Biome: validated by July, 2002	Continent: validated by July, 2003	Transect: val by July, 2004
Grasses/ Cereal Crops	Konza, USA: BU and Big Foot SAFARI 2000 wet season campaign	Laprida, Argentina: VALERI	Gourma, Mali: VALERI
Shrubs	Puechabon, France: BU and VALERI	Turco, Bolivia: VALERI	Mongolia (?)
Broadleaf Crops	Bondville, USA: Big Foot	Romille/Seine, France: VALERI	India (?)
Savannas	SAFARI 2000 wet season	Australia	
Broadleaf Forests	Harvard Forest, USA: BU and BigFoot	Counami, FrenchGuyana: VALERI LBA: BU and University of Arizona	Jaervselja, Estonia: VALERI China (?)
Needle Forests	Ruokolahti, Finland: BU Flakaliden, Sweden: BU and Europeans	Manitoba, Canada: Big Foot Siberia	8

Flakaliden Field Campaign, Sweden, June 22 – July 07, 2002 (64° 07'N, 19° 27'E)

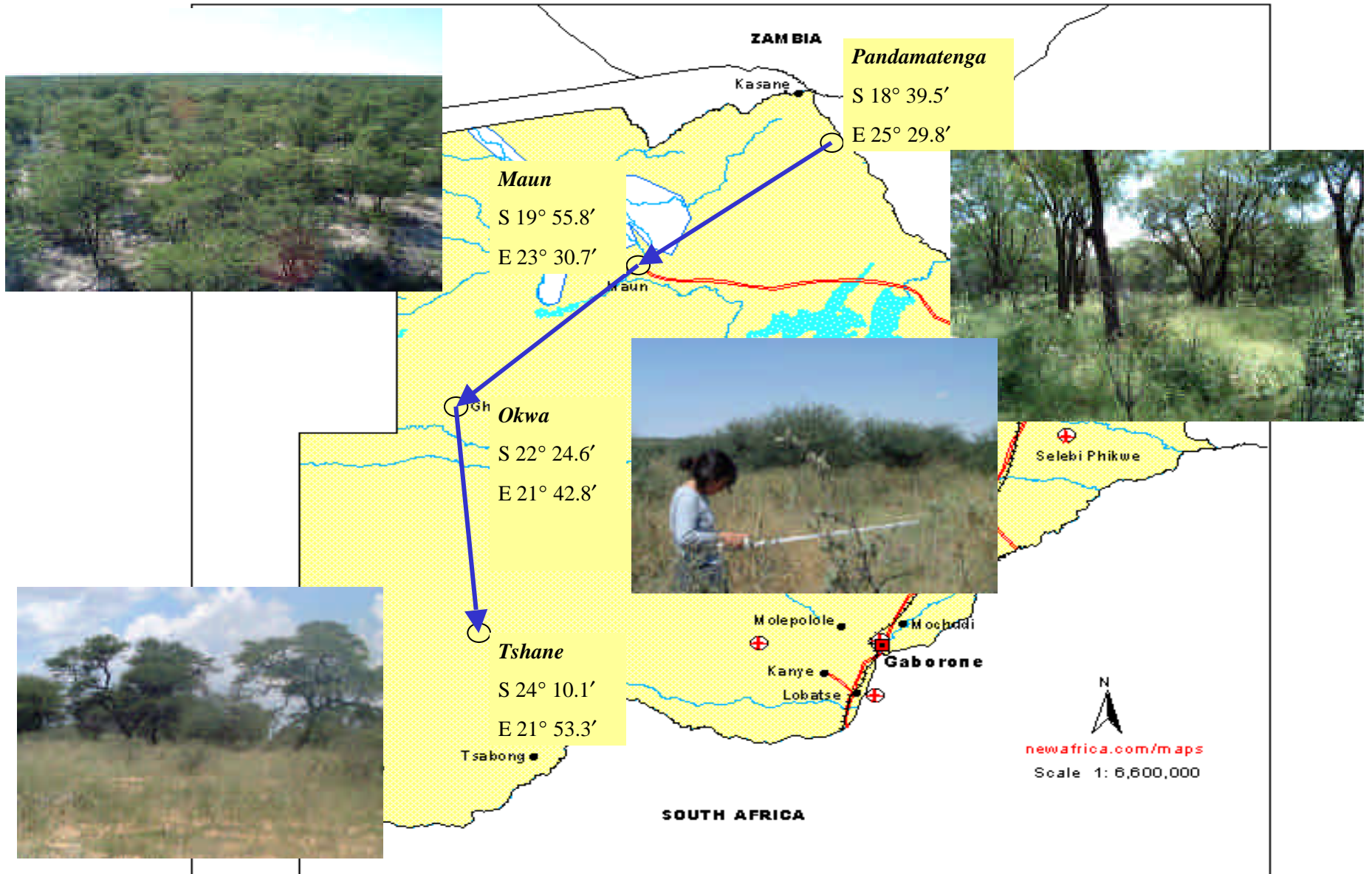


Flakaliden Field Campaign

<u>Participants</u>	<u>Instruments</u>	<u>Measurements</u>
Sweden – 19	Fish eye system	LAI, FPAR
Finland – 7	LAI-2000 – 12	Canopy spectral reflectance
USA – 5	LI-1800 – 2	Canopy spectral transmittance
Italy – 4	LI-1800 with External	Soil/understory spectra
Germany – 2	Integrating Sphere – 1	Leaf optical properties
Estonia – 2	GPS – 5; PAR ceptometer	PAR and SWR above canopy
Iceland – 1	PAR and SWR sensors	Shoot structure

SAFARI 2000 WET SEASON FIELD CAMPAIGN MARCH 3-18, 2000

BOTSWANA OVERVIEW MAP

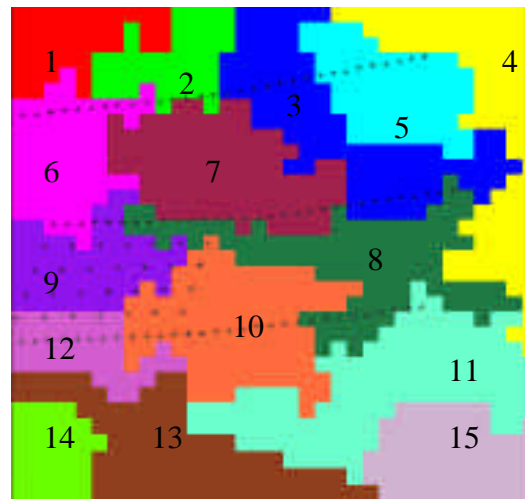


Validation of Moderate Resolution Satellite LAI and FPAR: Patch by Patch Comparison

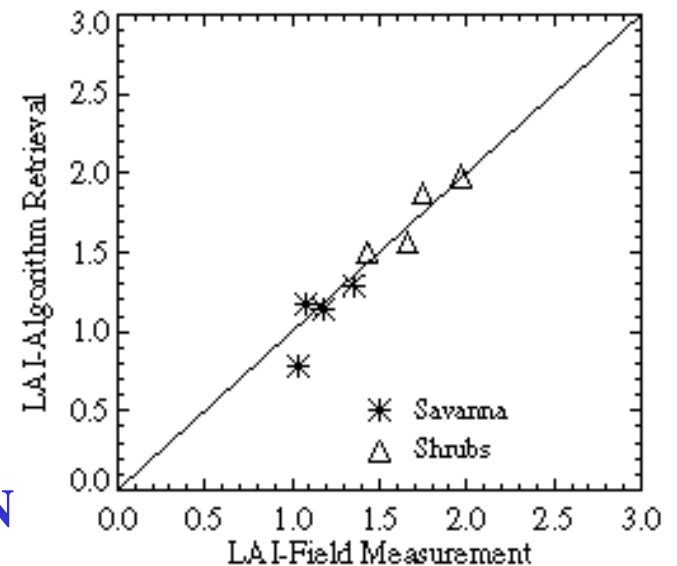
Color RGB image from ETM+ of a
1 km by 1 km region of the Moun site



Map of the same region using a
segmentation procedure which groups
pixels into patches based on their
spectral similarity and adjacency.



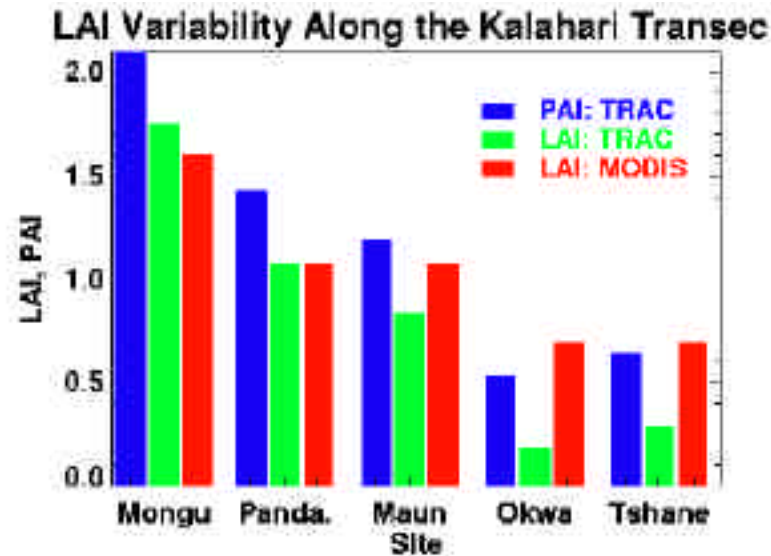
Mean LAI derived from field over
patches derived from field
measurements and ETM data.



SAFARI 2000 WET SEASON FIELD CAMPAIGN MARCH 3-18, 2000

Tian, Y., C. E. Woodcock, Y. Wang, J. L. Privette, N. V. Shabanov, L. Zhou, W. Buermann, J. Dong, B. Veikkanen, T. Hame, M. Ozdogan, Y. Knyazikhin, and R. B. Myneni, Multiscale Analysis and Validation of MODIS LAI Product over Maun, Botswana. I. Uncertainty Assessment, *Remote Sens. Environ.*, 2002 (in print).

Tian, Y., C. E. Woodcock, Y. Wang, J. L. Privette, N. V. Shabanov, L. Zhou, W. Buermann, J. Dong, B. Veikkanen, T. Hame, M. Ozdogan, Y. Knyazikhin, and R. B. Myneni, Multiscale Analysis and Validation of MODIS LAI Product over Maun, Botswana. II. Sampling Strategy, *Remote Sens. Environ.*, 2002 (in print).



The first-year MODIS LAI algorithm correctly accommodates structural and phenological variability in semi-arid woodlands and savannas, and is accurate to within the uncertainty of the validation approach used here.

Privette, J.L., Myneni, R.B., Knyazikhin, Y., Mukufute, M., Roberts, G., Tian, Y., Wang, Y., and Leblanc, S.G., Early Spatial and Temporal Validation of MODIS LAI Product in Africa, *Remote Sens. Environ.*, 2002 (in print).

Field Campaign in Ruokolahti, Finland, June 14 – June 21, 2000

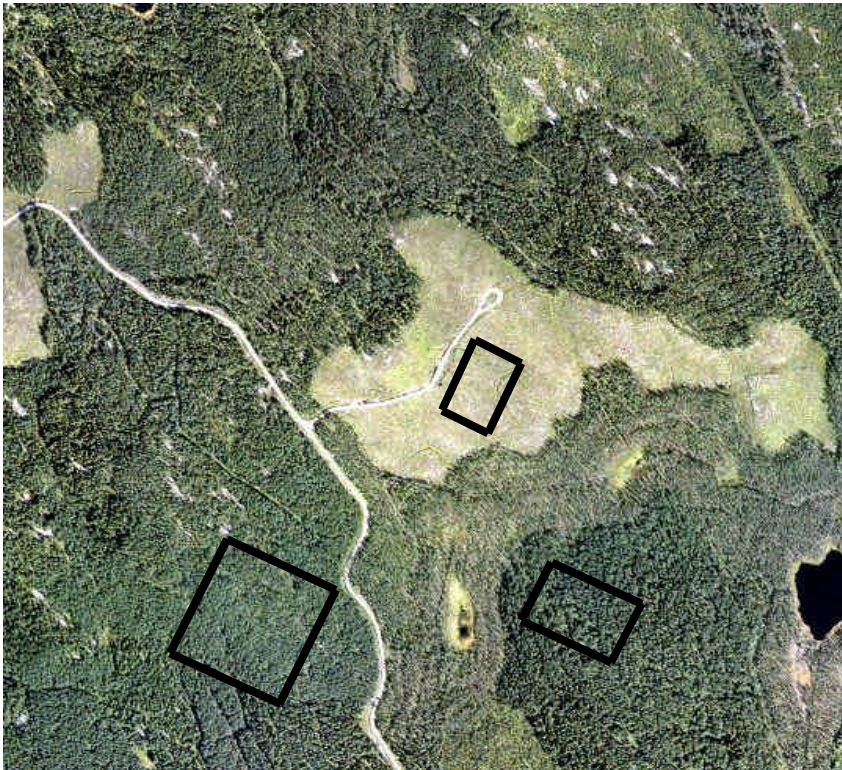
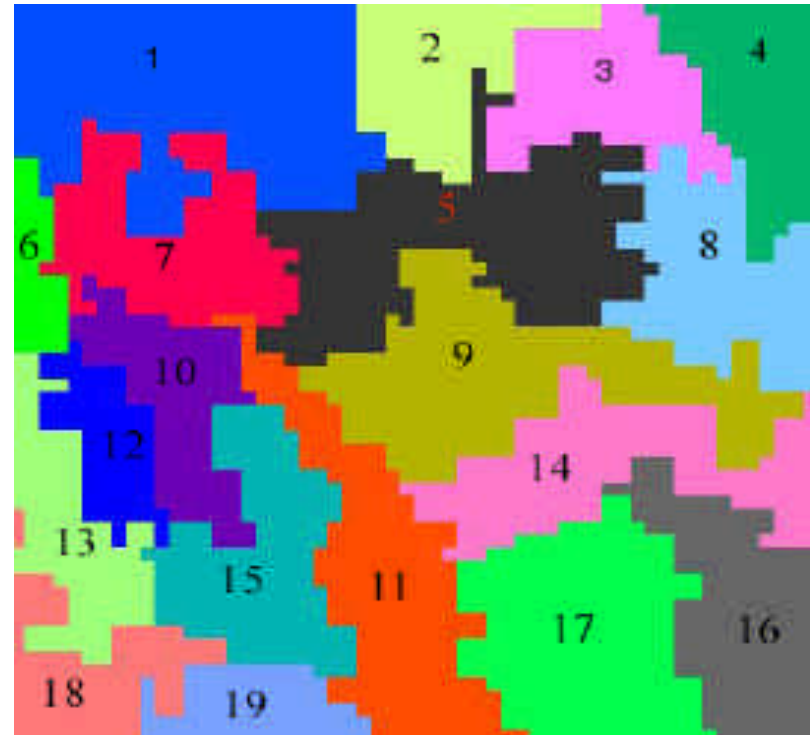




Image Segmentation

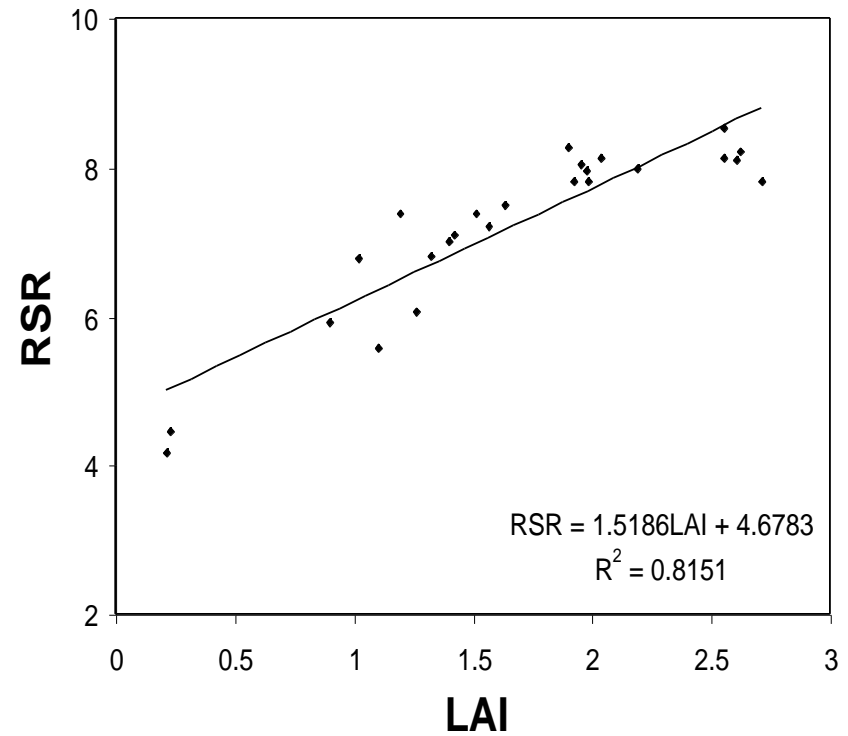
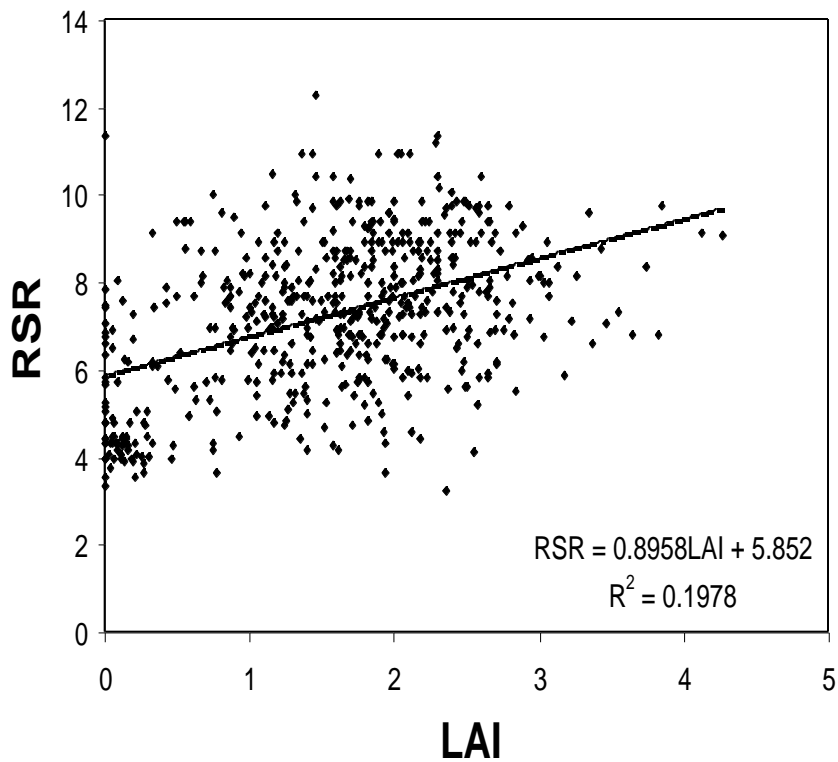


Color RGB image from ETM+ of a 1 km by 1 km region of the field site



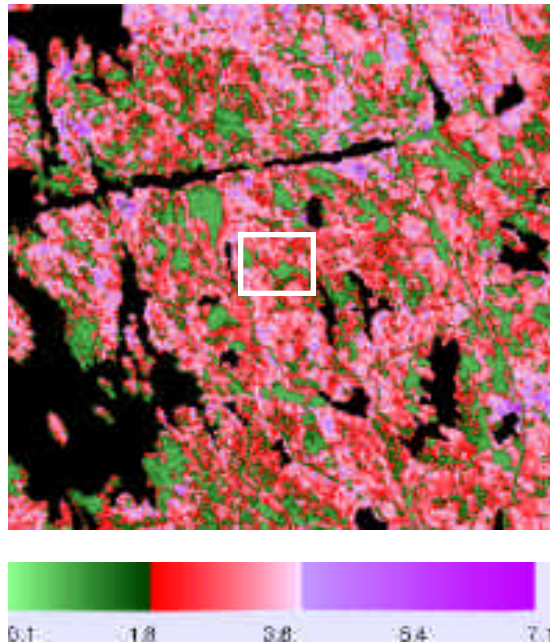
Segmentation result

Patch Level Correlation between Field-measured LAI and Reduced Simple Ratio (RSR)

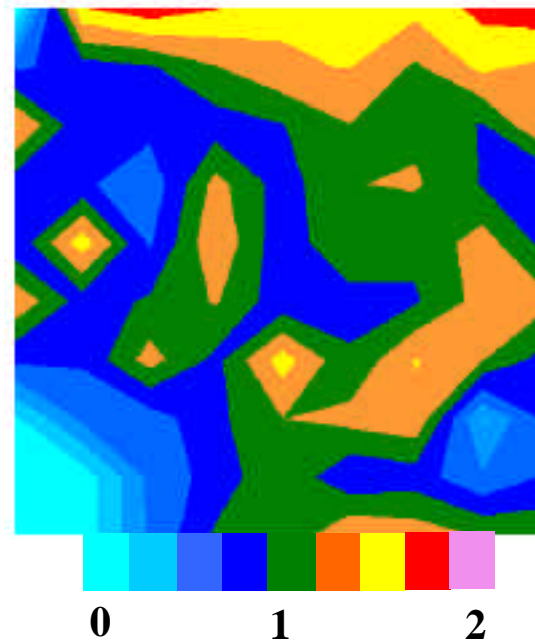


Field Campaign in Ruokolahti, Finland, June 14 – June 21, 2000

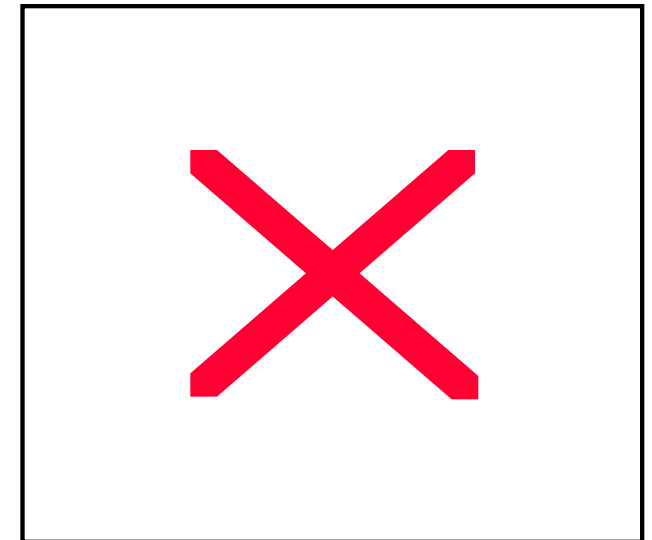
A 30 m resolution LAI map of a 10x10 region derived from ETM+ image



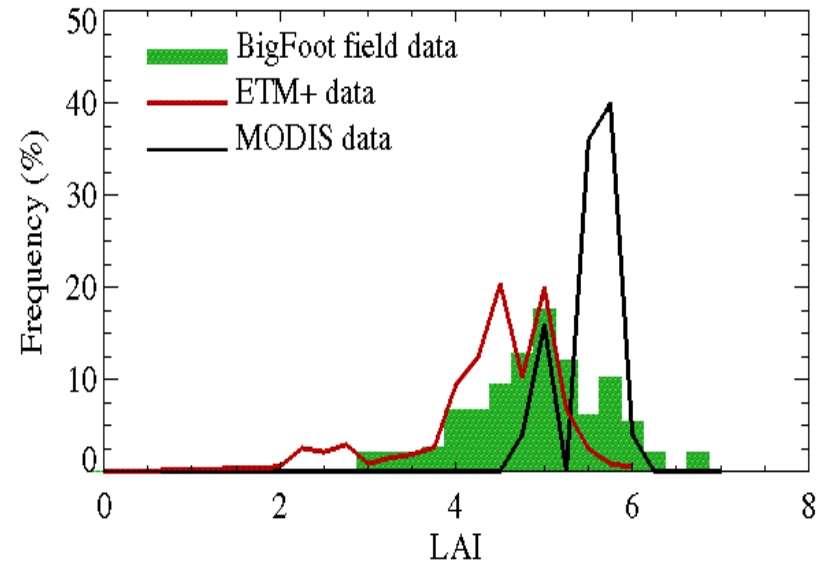
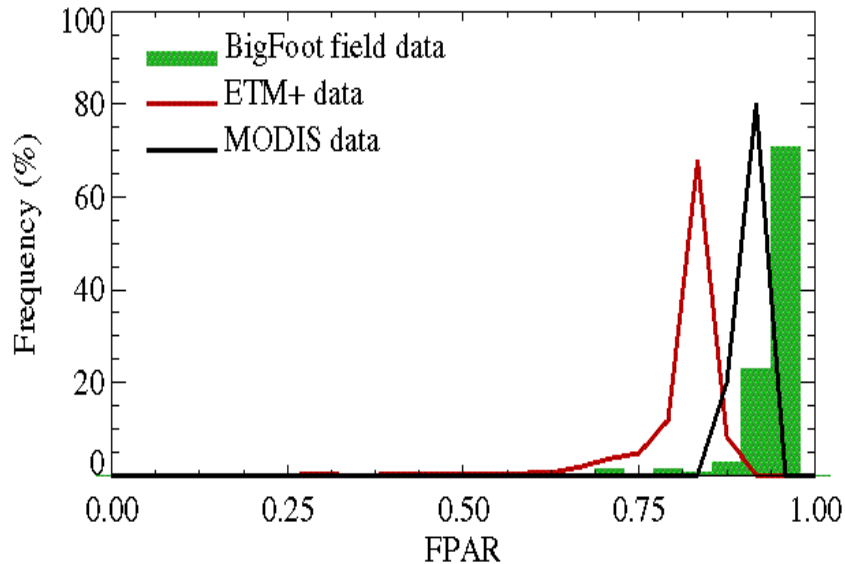
Aggregate the 30 m ETM+ LAI map to 1 km LAI map



Compare statistical properties of the MODIS and aggregated LAI fields



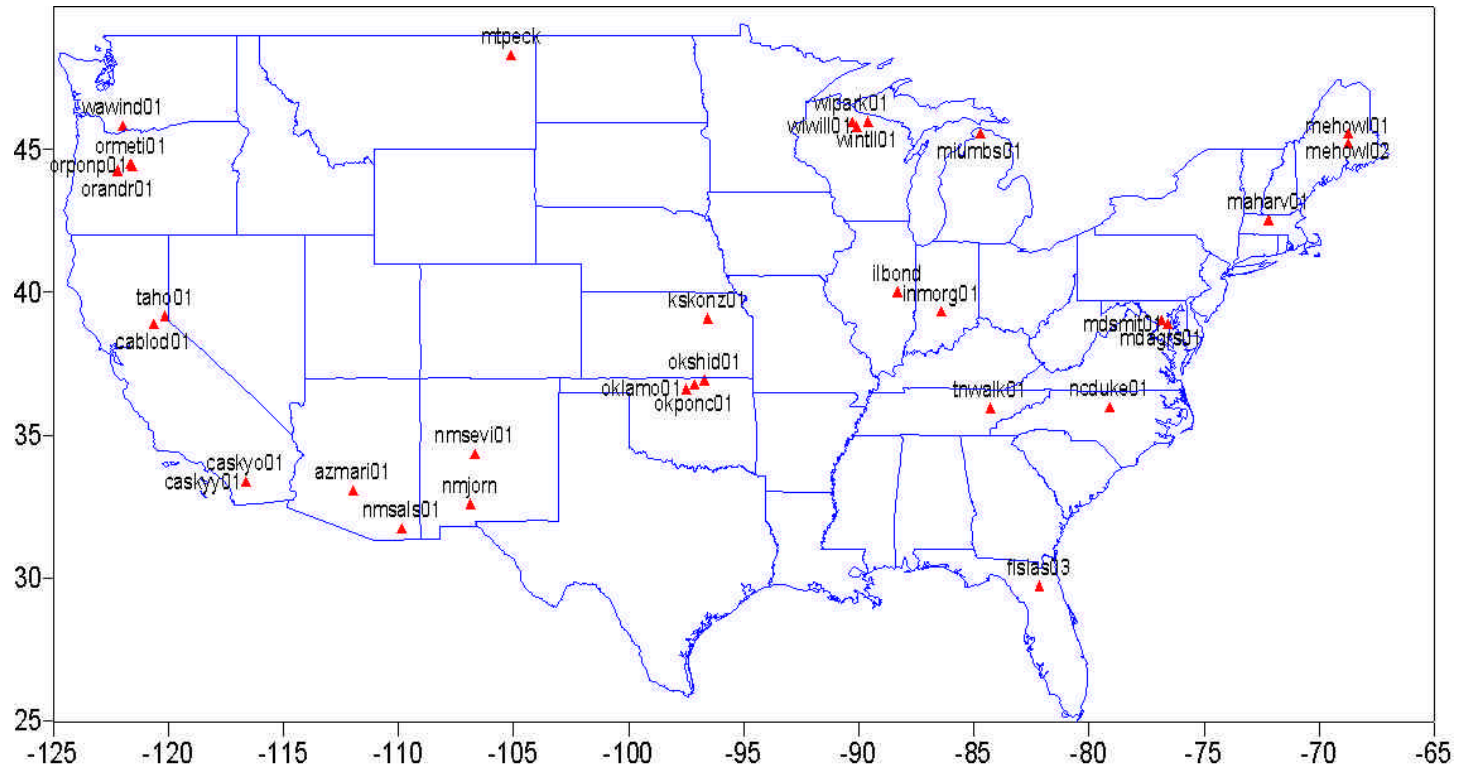
Field Campaign at Harvard Forest: Saturation



FPAR and LAI histograms for a 5x5 km area (25 pixels) derived from the BigFoot data (shaded contour) and MODIS retrieval (black line). Values produced by the main algorithm were used. To maximize number of unsaturated pixels the composite for days 241-248 (August 28-September 4, 2000) was selected, where 5 of the 25 pixels were unsaturated. Histograms of LAI and FPAR values derived from ETM+ data are shown as a red line.

Shabanov, N.V., Y. Wang, W. Buerman, J. Dong, S. Hoffman, G.R. Smith, Y. Tian, Y. Knyazikhin, and R.B. Myneni, Validation of the radiative transfer principles of the MODIS LAI/FPAR algorithm with field data from the Harvard Forest, *Remote Sens. Environ.*, 2001 (submitted for publication).

Flux tower sites

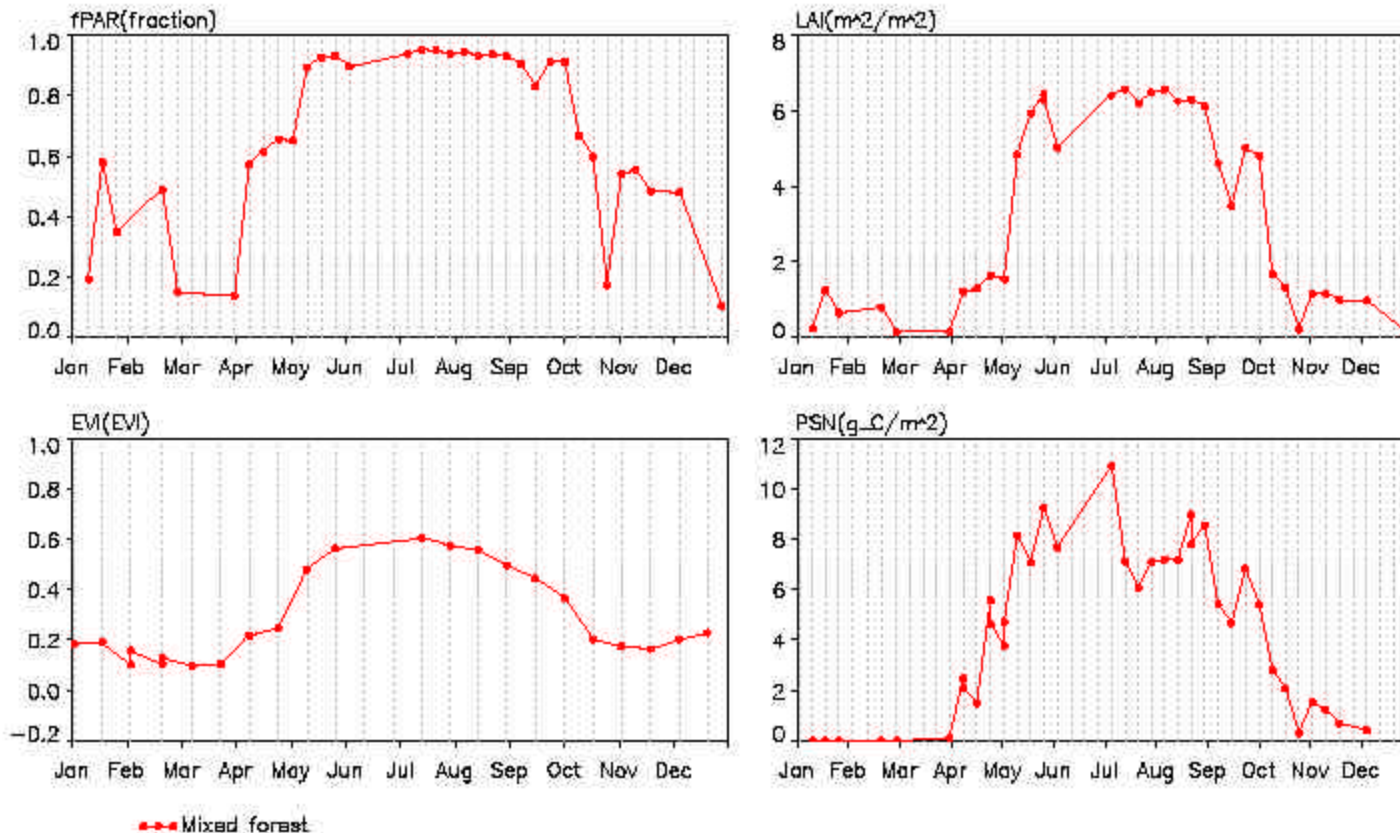


A number of ecological variables (leaf area index, biomass and NPP) besides carbon/water and energy fluxes are measured at these sites. MODIS data are being extracted regularly over these sites. 2001 MODIS data extracted over these sites were used to verify the magnitudes and seasonality of a number of MODIS products.

Credit: ORNL DAAC

Willow Creek, Wisconsin

MODIS Vegetation Variables, 5x5km area: fPAR,LAI,EVI,PSN 2001 (uswiwill.01)



Mean, Pixels are 1x1km, I-SIN Projection, based on QC_1km flags (Best Only, QC = 4)