MODIS Land Product Subsets:

Remote Sensing Products for Field Sites (Collections 4 and 5)

http://daac.ornl.gov/MODIS/modis.html

Bob Cook, Suresh Kumar,
Susan Holladay, and Steve Margle

ORNL DAAC
Oak Ridge National Laboratory
Distributed Active Archive Center
Oak Ridge, Tennessee, USA

Collaborators / Contributors

- Steve Running and Faith Ann Heinsch (*University of Montana*)
- Jeff Morrisette, Carol Davidson, Gary Fu, Gang Ye, and Nazmi El Saleous (*NASA GSFC*)
- Calli Jenkerson, John Dwyer, and Tom Maiersperger *(LP DAAC)*
- Crystal Schaaf, Mark Friedl, and Ranga Myneni (*Boston University*)
- Jim Randerson (*University of California-Irvine*)
- Alfredo Huete and Kamel Didan (*University of Arizona*)
- Tim Wilson and Tilden Meyers *(NOAA-Oak Ridge)*

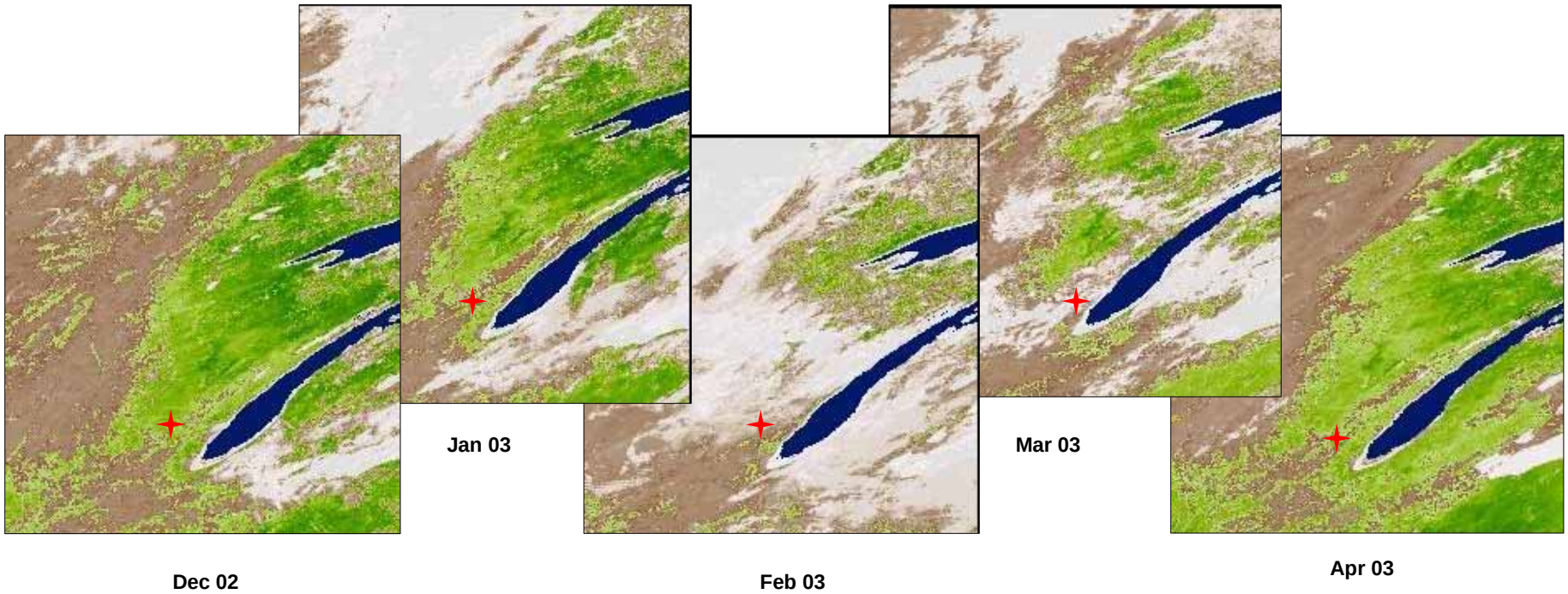
ORNL DAAC User Working Group Member

Background

- ORNL DAAC supports the biogeochemical dynamics and terrestrial ecology (field) research community
  - Field Campaigns, Land Product Validation, Ecosystem Modeling, and Model Archive
- Community requested that we prepare MODIS Land Products in an easy-to-use format and size
  - To validate remote sensing products
  - To characterize field sites
  - For use in modeling studies

- Collection 5 Subsets: in development, beta test version
- Collection 4 Subsets: subsetted products available through Sept. 2008

Preparing time series from remote sensing tiles



NDVI Tiles for cropland site in Wisconsin

✦ Field Site Location

* Images from USGS Global Visualization Viewer http://glovis.usgs.gov/

First tool: MODIS Subsets for Selected Sites

Data Formats Offered (Coll. 5)

- ASCII – 7x7 km subsets
- GeoTIFF – 25x25 km subsets

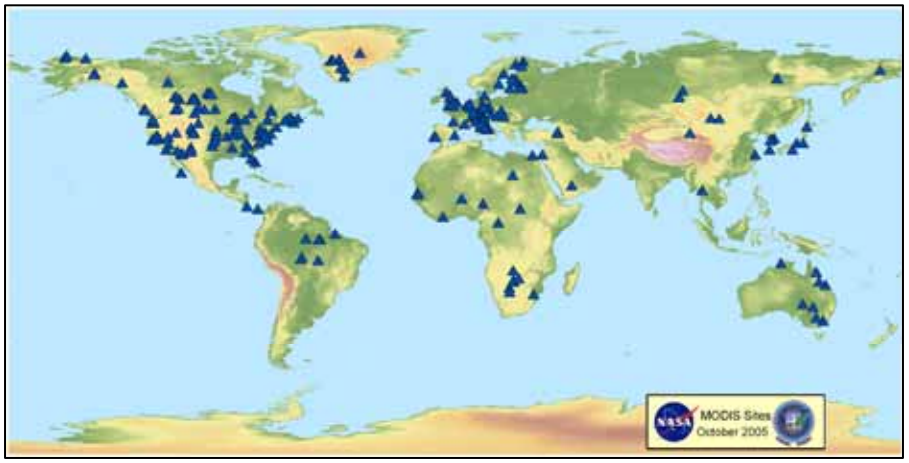
Products are:

8-day, 16-day, or annual composite periods

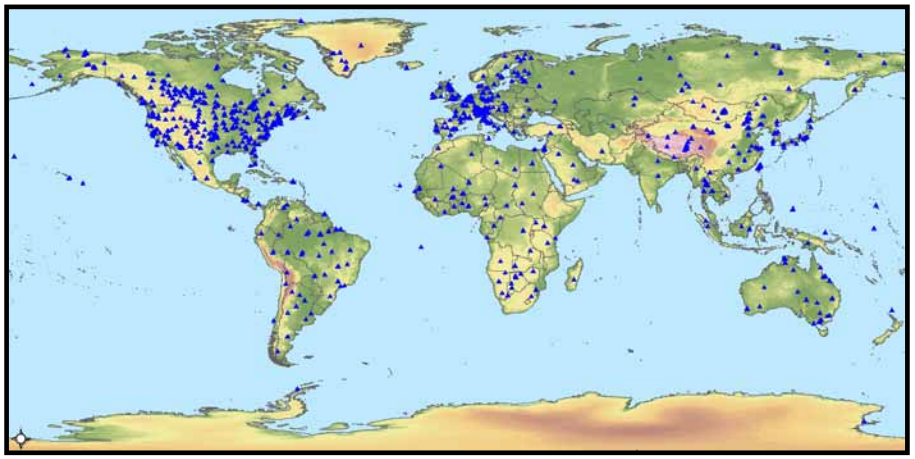
1 km, 500 m, or 250 m resolution

Documentation about subsets and links to detailed documentation of the MODIS products are provided

MODIS Land Products (C5) at ORNL DAAC
Surface Reflectance *(MOD09A1)*
Surface Temperature *(MOD11A2)*
Land Cover *(MOD12Q1)*
Vegetation Phenology *(MOD12Q2)*
NDVI / EVI *(MOD/MYD13Q1)*
LAI / fPAR *(MOD / MYD15A2)*
Net Photosynthesis *(MOD17A2)*
Annual NPP *(MOD17A3)*
Albedo (calc) *(from MCD43A1,2)*
Reflectance – BRDF Adjusted *(MCD43A2,4)*

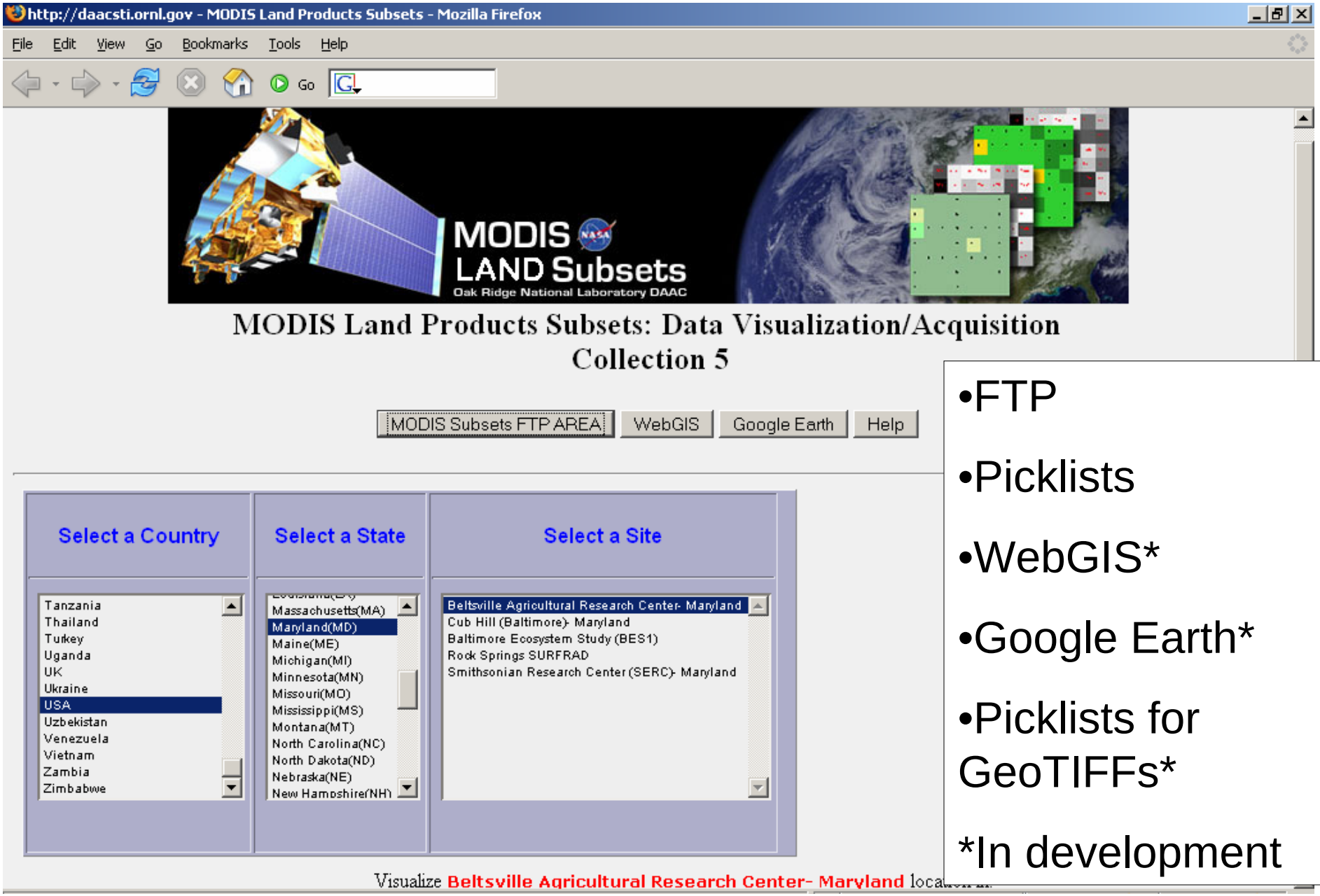


280 field sites for MODIS Collection 4



1,052 field sites for MODIS Collection 5

Multiple paths to access data (Coll.5)



- FTP
- Picklists
- WebGIS*
- Google Earth*
- Picklists for GeoTIFFs*

*In development

SREF MODIS ASCII Subsets Data Visualization-{/cgi-bin/MODIS/GR_col5_1/MOD09A1.time.3.pl} - Mozilla Firefox

http://daacsti.ornl.gov/cgi-bin/MODIS/GR_col5_1/MOD09A1.time.3.pl

MODIS/Terra Surface Reflectance (SREF)

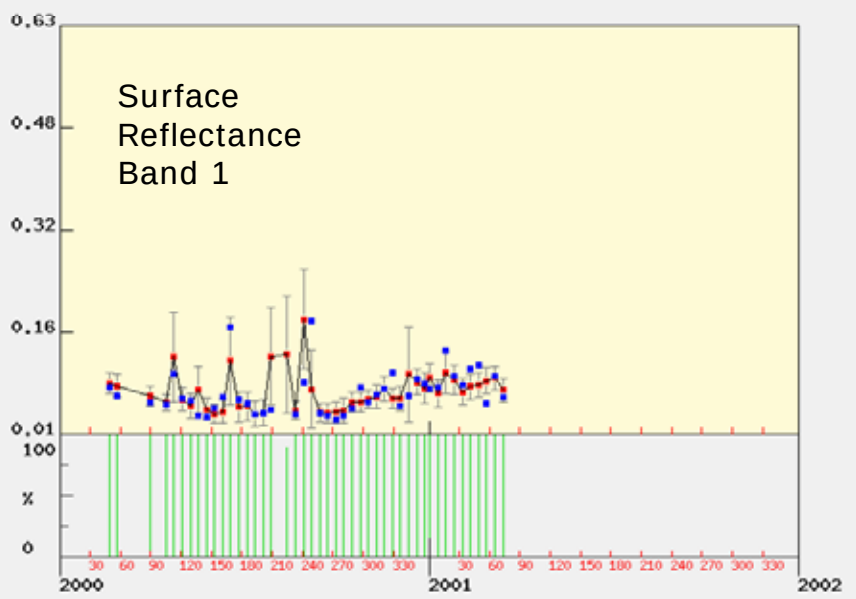
8-Day L3 Global 500m SIN Grid

Product:	MOD09A1
Name:	MODIS/Terra Surface Reflectance (SREF) 8-Day L3 Global 500m SIN Grid
Location:	Site: Beltsville Agricultural Research Center- Maryland [Lat:39.03218,Lon:-76.84475]
Map Links:	Google Map Google Earth Site
Quality Control Conditions:	As Specified by Science Team

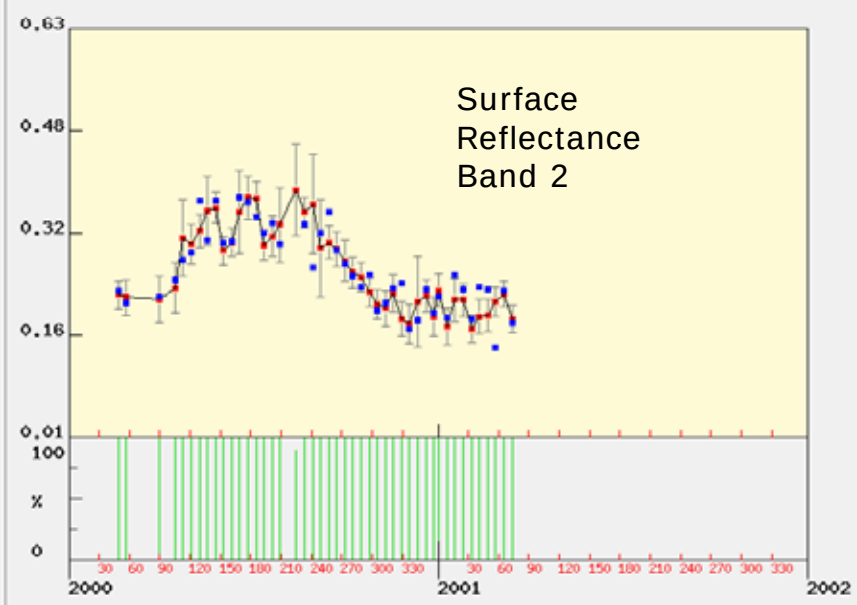
Beltsville Agricultural Research Center

- Center Pixel
- Mean Value of Pixels
- Percent of Pixels that meet QC Criteria

MOD09A1 / sur_refl_b01 Collection 5 [Scale factor=0.0001, units = reflectance]



MOD09A1 / sur_refl_b02 Collection 5 [Scale factor=0.0001, units = reflectance]



MOD09A1 / sur_refl_b03 Collection 5 [Scale factor=0.0001, units = reflectance]

MOD09A1 / sur_refl_b04 Collection 5 [Scale factor=0.0001, units = reflectance]

site.0.pl (PNG Image, 800x500 pixels) - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://daacsti.ornl.gov/cgi-bin/MODIS/GR_col5_1/site.0.pl?site=fn_usbeltsv

Customize Links | Google | Inside ORNL: Home | ORNL DAAC | Pals Web Client | Cook's SAP Home page | DAAC Sharepoint | The North America

ORNL DAAC for Biogeochemical Dynamics | MODIS ASCII Subsets | site.0.pl (PNG Image, 800x500 pixels) | "modis logo" - G

... Presented For Visual Interest Only ...

Beltsville Agricultural Research Center- Maryland

Lat 39.03218 Lon -76.84475

Horizontal Tile 12, Vertical Tile 5

Sample 36.41, Line 115.64

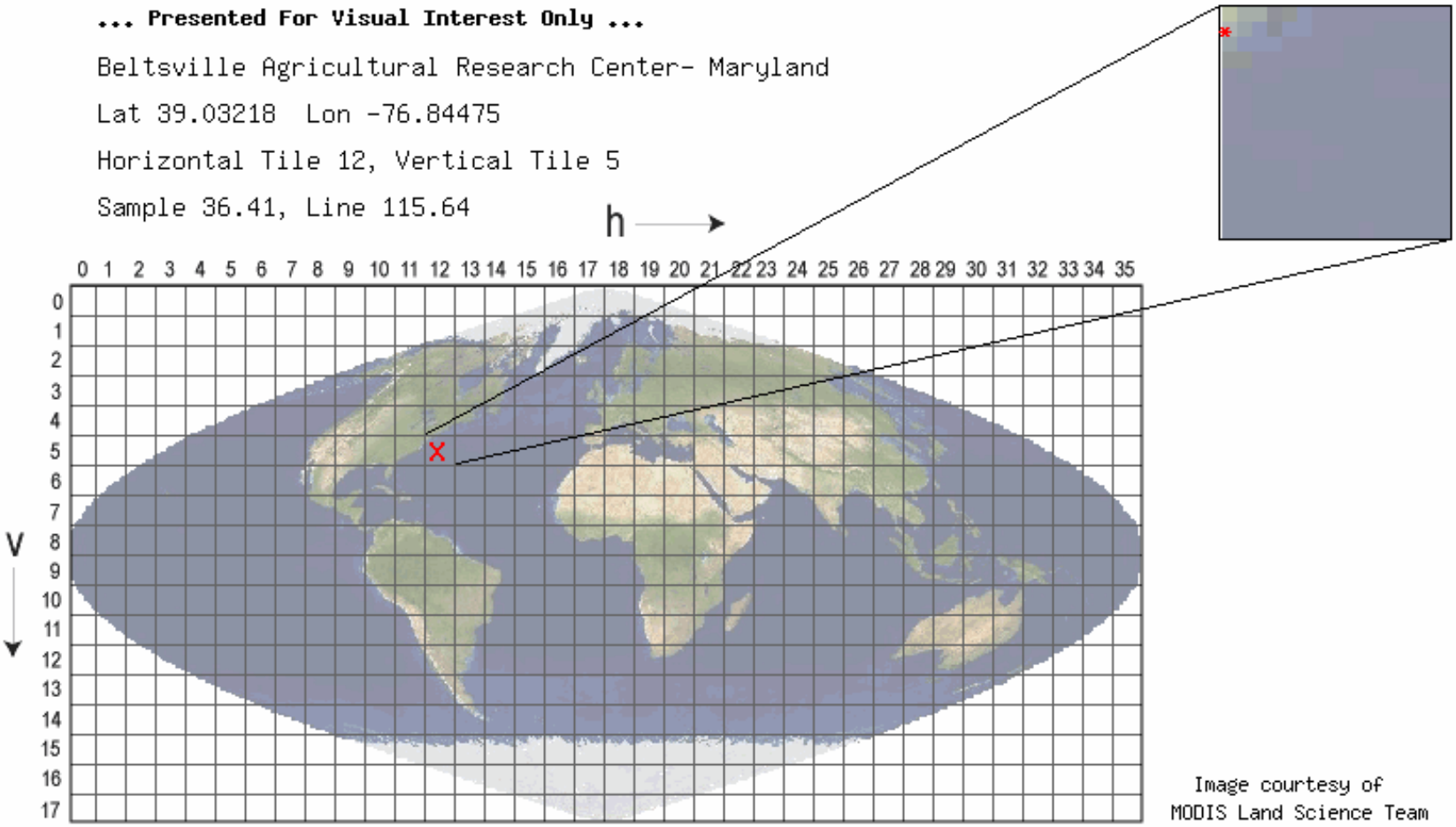
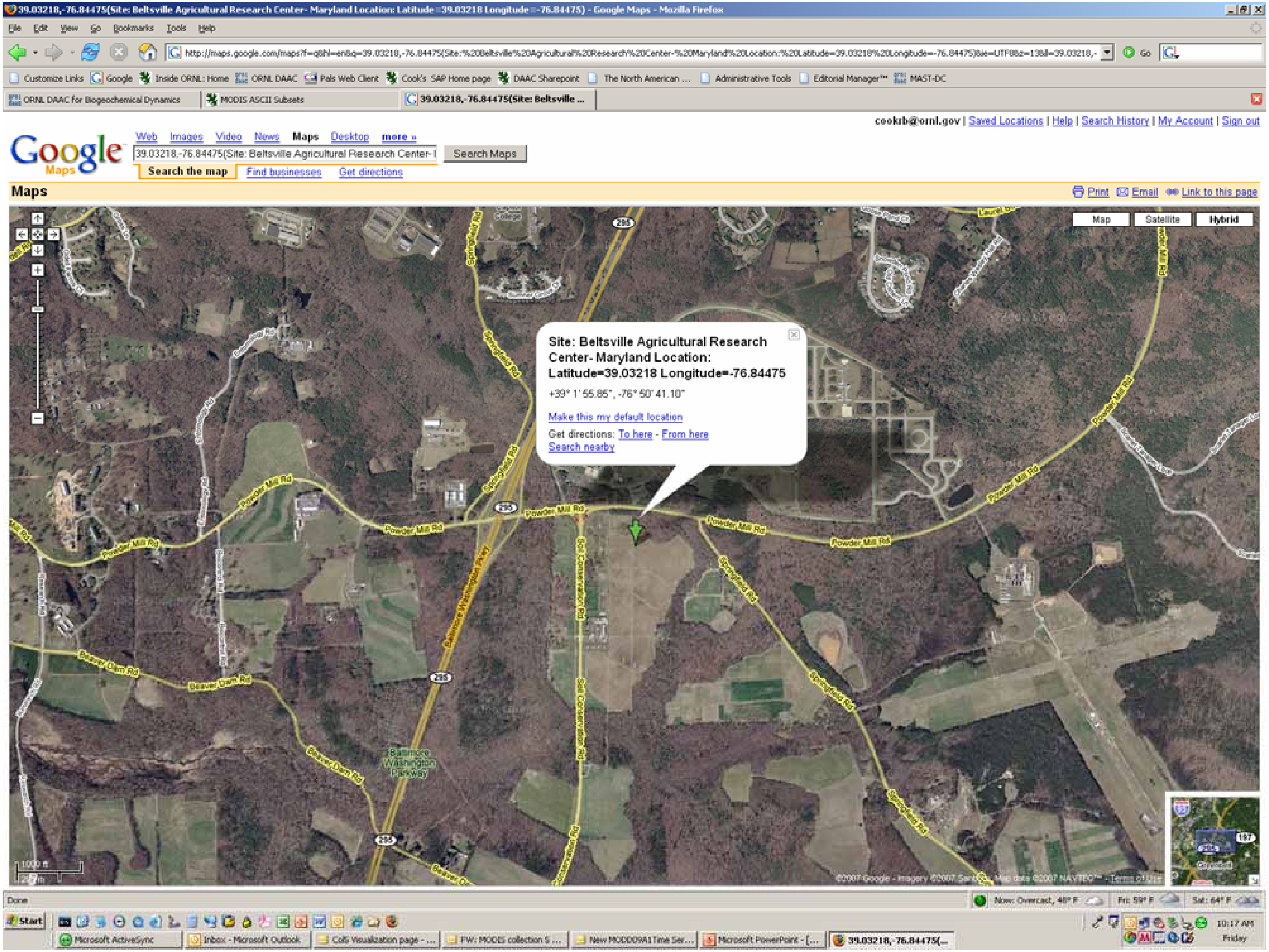


Image courtesy of
MODIS Land Science Team

X - The Tile containing the site - Beltsville Agricultural Research Center- Maryland

* - The Pixel containing the site - Beltsville Agricultural Research Center- Maryland



39.03218,-76.84475(Site: Beltsville Agricultural Research Center- Maryland Location: Latitude =39.03218 Longitude =-76.84475) - Google Maps - Mozilla Firefox

http://maps.google.com/maps?f=q&hl=en&q=39.03218,-76.84475(Site:%20Beltsville%20Agricultural%20Research%20Center-%20Maryland%20Location:%20Latitude=39.03218%20Longitude=-76.84475)&ie=UTF8&z=13&ll=39.03218,-

39.03218,-76.84475(Site: Beltsville Agricultural Research Center- l

Site: Beltsville Agricultural Research Center- Maryland Location: Latitude=39.03218 Longitude=-76.84475

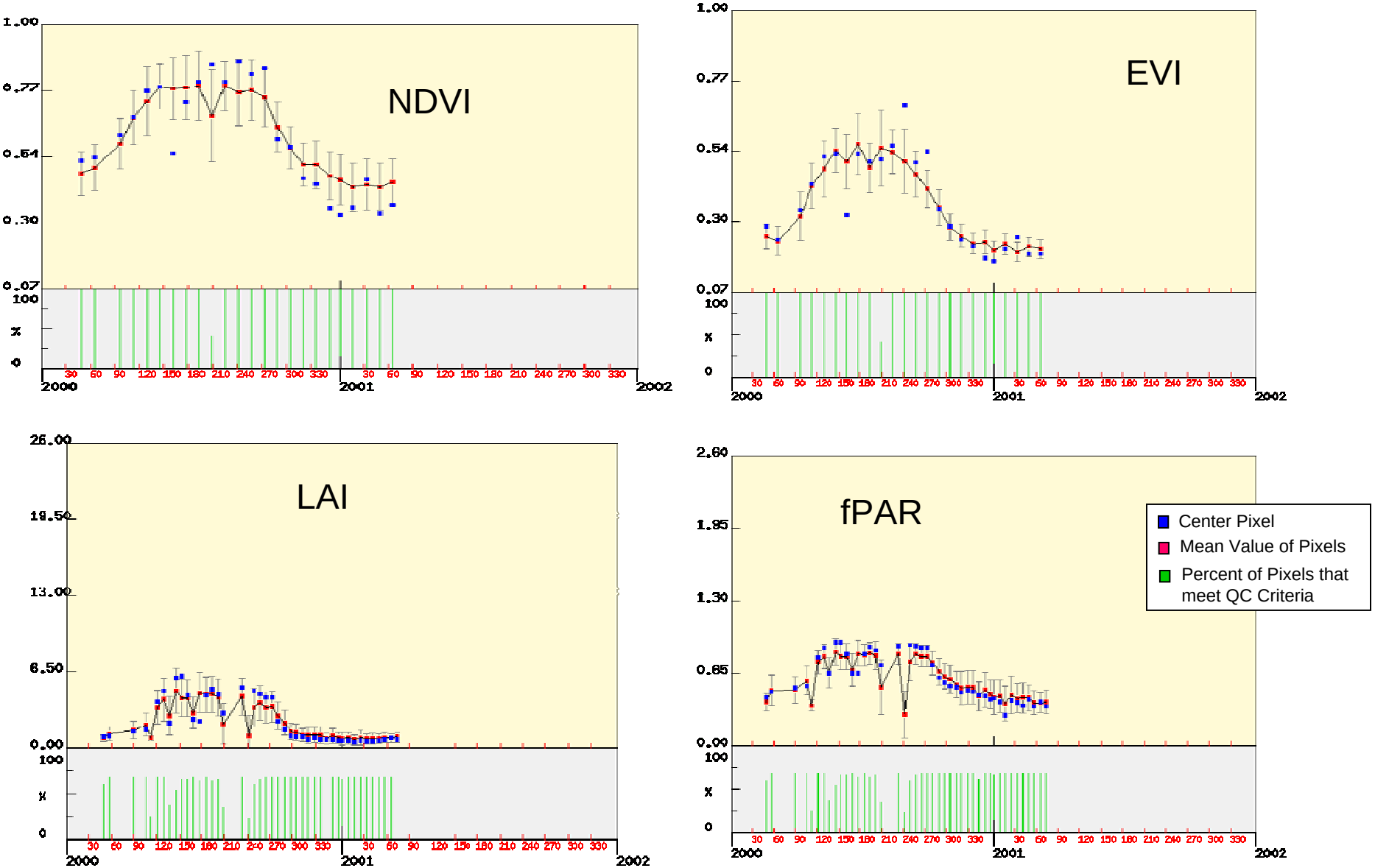
+39° 1' 55.85", -76° 50' 41.10"

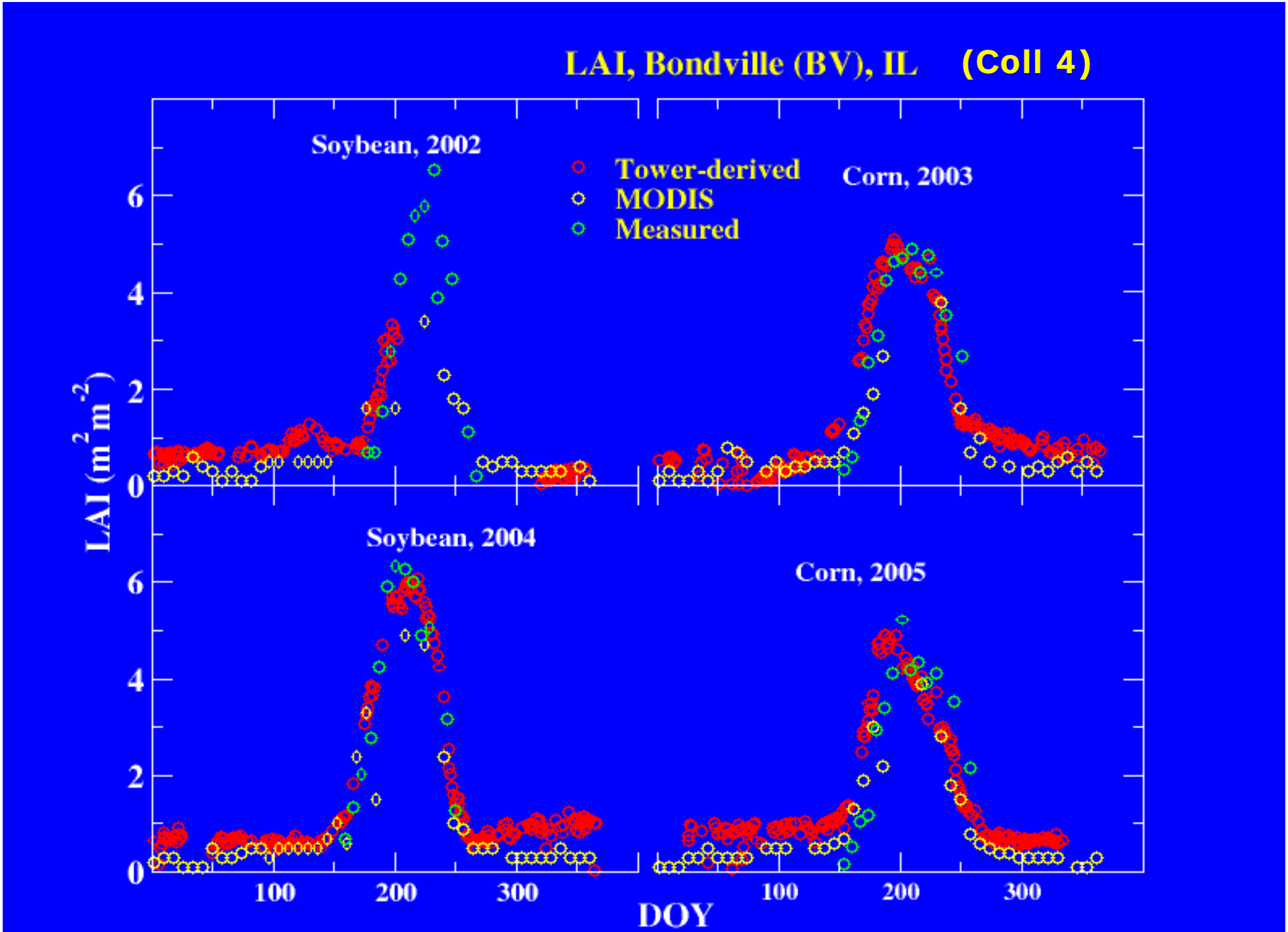
Make this my default location

Get directions: To here - From here

Search nearby

Beltsville Ag Center, MD





Tim Wilson and Tilden Meyers, Ag. For. Met. In press

MODIS ASCII Subsets: *Advanced* Data Visualization

Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR)

8-Day Composite [Collection 5]

Beltsville Agricultural Research Center- Maryland

Select ANY or NONE of EACH Quality Control(QC) measure

Preselected QC defaults will exhibit "Good Quality" Pixel Representations

Note: Those pixels that have the selected QC conditions (e.g., "Main(RT) method failed due to geometry problems, empirical method used" or "Main(RT) method failed due to problems other than geometry, empirical method used" or "Couldn't retrieve pixel") are not displayed

MODLAND_QC

- Best Possible
- OK, but not the best
- Not produced, due to cloud
- Not produced due to other reasons

DEADDECTECOR

- Detectors apparently fine for up to 50% of channnels 1,2
- Dead dectectors caused > 50% adjacent dectector retrieval

CLOUDSTATE

- Significant clouds NOT present (clear)
- Significant clouds WERE present
- Mixed cloud present on pixel
- cloud state not defined, assumed clear

SCF_QC [Science Computing Facility Quality Control]

- Main(RT) method used with the best possible results
- Main(RT) method used with saturation
- Main(RT) method failed due to geometry problems, empirical method used
- Main(RT) method failed due to problems other than geometry, empirical method used
- Couldn't retrieve pixel

User can select and apply QC criteria, then display and download resulting files

Advanced Visualization: Grids of QC Bits

Beltsville Agricultural Research Center, Maryland, LAI / fPAR, Year 2000 Day 113

Site/Tower Pixel highlighted in Yellow :Pixel Number 25

LAI Filtered

Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered
0.8	0.6	Fil-tered	0.9	Fil-tered	Fil-tered	0.7
0.7	1	1.4	Fil-tered	Fil-tered	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	0.7	0.5	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	0.7	Fil-tered	0.7	0.7
Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered

LAI SCF QC

100	100	100	100	011	100	100
100	100	100	011	011	011	011
000	000	100	000	011	011	000
000	000	000	011	011	011	011
100	100	011	000	000	011	011
100	011	011	000	011	000	000
011	011	100	011	100	011	100

LAI Cloudstate

11	11	11	11	10	11	11
11	11	11	10	10	10	10
01	10	11	01	00	00	00
10	10	01	10	00	00	00
11	11	10	10	10	00	00
11	10	10	10	10	01	01
10	10	11	00	11	01	11

LAI Deaddector

1	1	1	1	0	1	1
1	1	1	0	0	0	0
0	0	1	0	0	0	0
0	0	0	0	0	0	0
1	1	0	0	0	0	0
1	0	0	0	0	0	0
0	0	1	0	1	0	1

LAI MODLAND QC

01	01	01	01	01	01	01
01	01	01	01	01	01	01
00	00	01	00	01	01	00
00	00	00	01	01	01	01
01	01	01	00	00	01	01
01	01	01	00	01	00	00
01	01	01	01	01	01	01

fPAR Filtered

Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered
0.4	0.33	Fil-tered	0.37	Fil-tered	Fil-tered	0.33
0.37	0.39	0.48	Fil-tered	Fil-tered	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	0.33	0.3	Fil-tered	Fil-tered
Fil-tered	Fil-tered	Fil-tered	0.34	Fil-tered	0.33	0.3
Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered	Fil-tered

fPAR SCF QC

100	100	100	100	011	100	100
100	100	100	011	011	011	011
000	000	100	000	011	011	000
000	000	000	011	011	011	011
100	100	011	000	000	011	011
100	011	011	000	011	000	000
011	011	100	011	100	011	100

fPAR Cloudstate

11	11	11	11	10	11	11
11	11	11	10	10	10	10
01	10	11	01	00	00	00
10	10	01	10	00	00	00
11	11	10	10	10	00	00
11	10	10	10	10	01	01
10	10	11	00	11	01	11

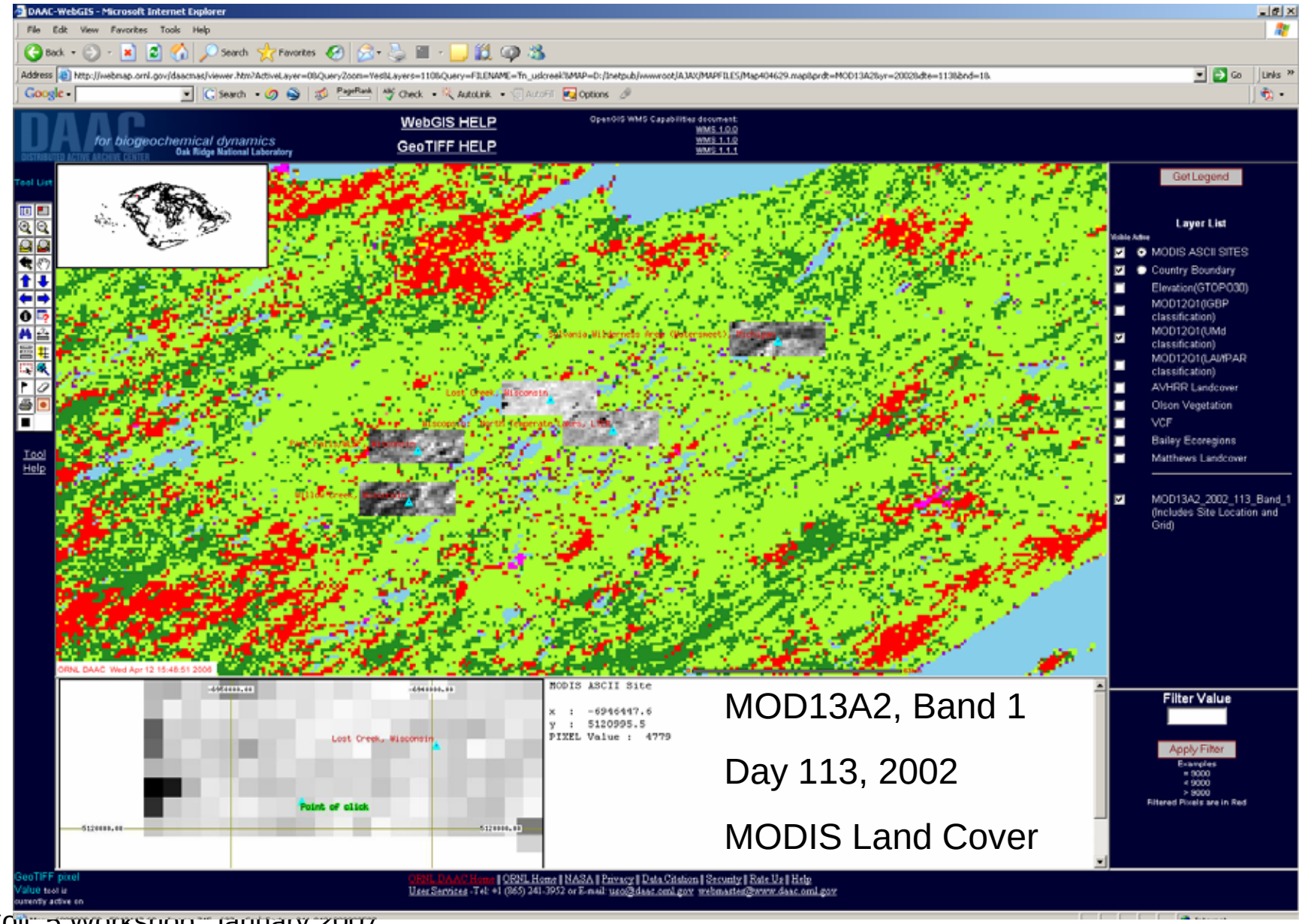
fPAR Deaddector

1	1	1	1	0	1	1
1	1	1	0	0	0	0
0	0	1	0	0	0	0
0	0	0	0	0	0	0
1	1	0	0	0	0	0
1	0	0	0	0	0	0
0	0	1	0	1	0	1

fPAR MODLAND QC

01	01	01	01	01	01	01
01	01	01	01	01	01	01
00	00	01	00	01	01	00
00	00	00	01	01	01	01
01	01	01	00	00	01	01
01	01	01	00	01	00	00
01	01	01	01	01	01	01

Subsets in GeoTIFF / WebGIS (Coll 4)

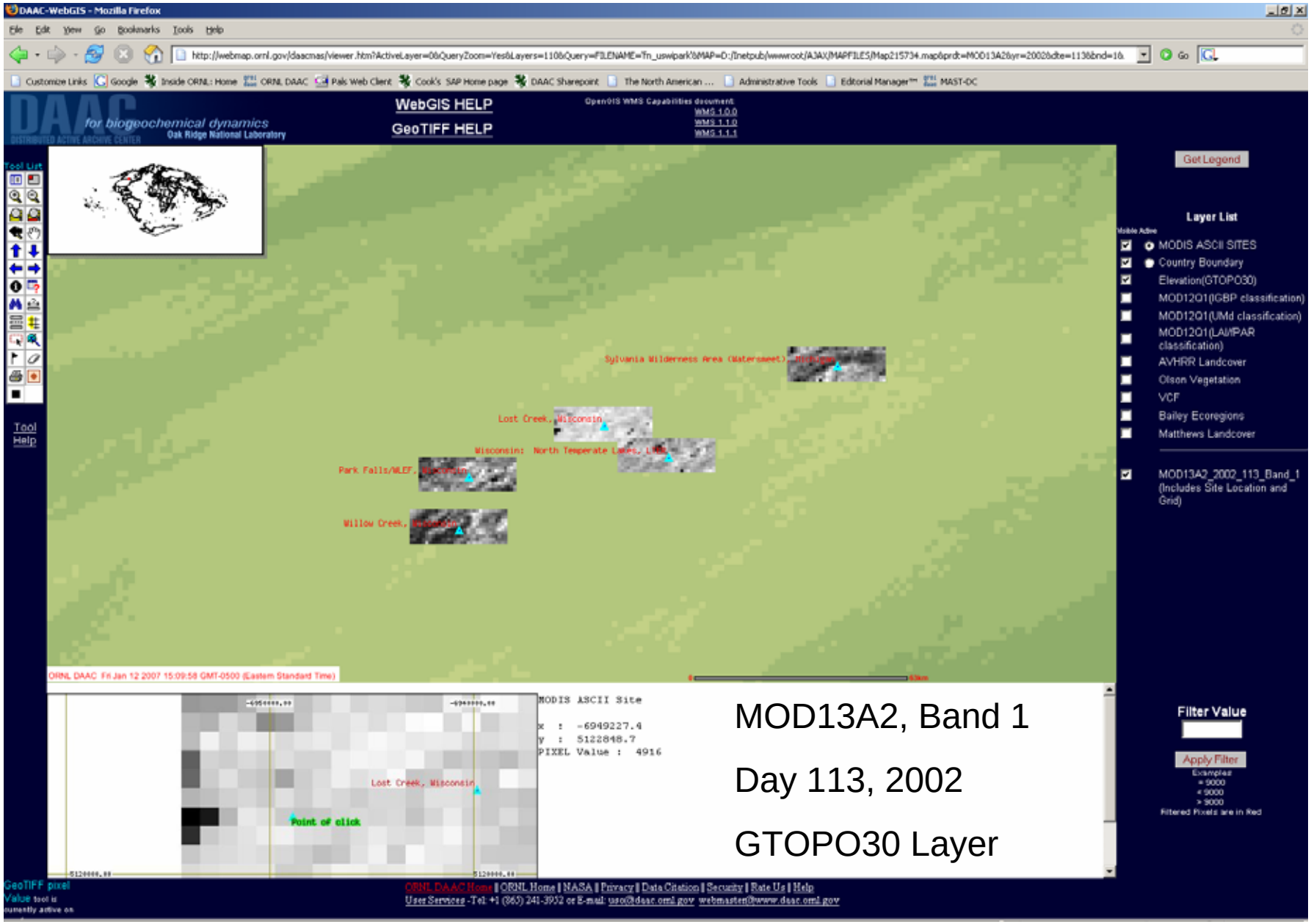


MOD13A2, Band 1

Day 113, 2002

MODIS Land Cover

Subsets in GeoTIFF / WebGIS



MOD13A2, Band 1

Day 113, 2002

GTOPO30 Layer

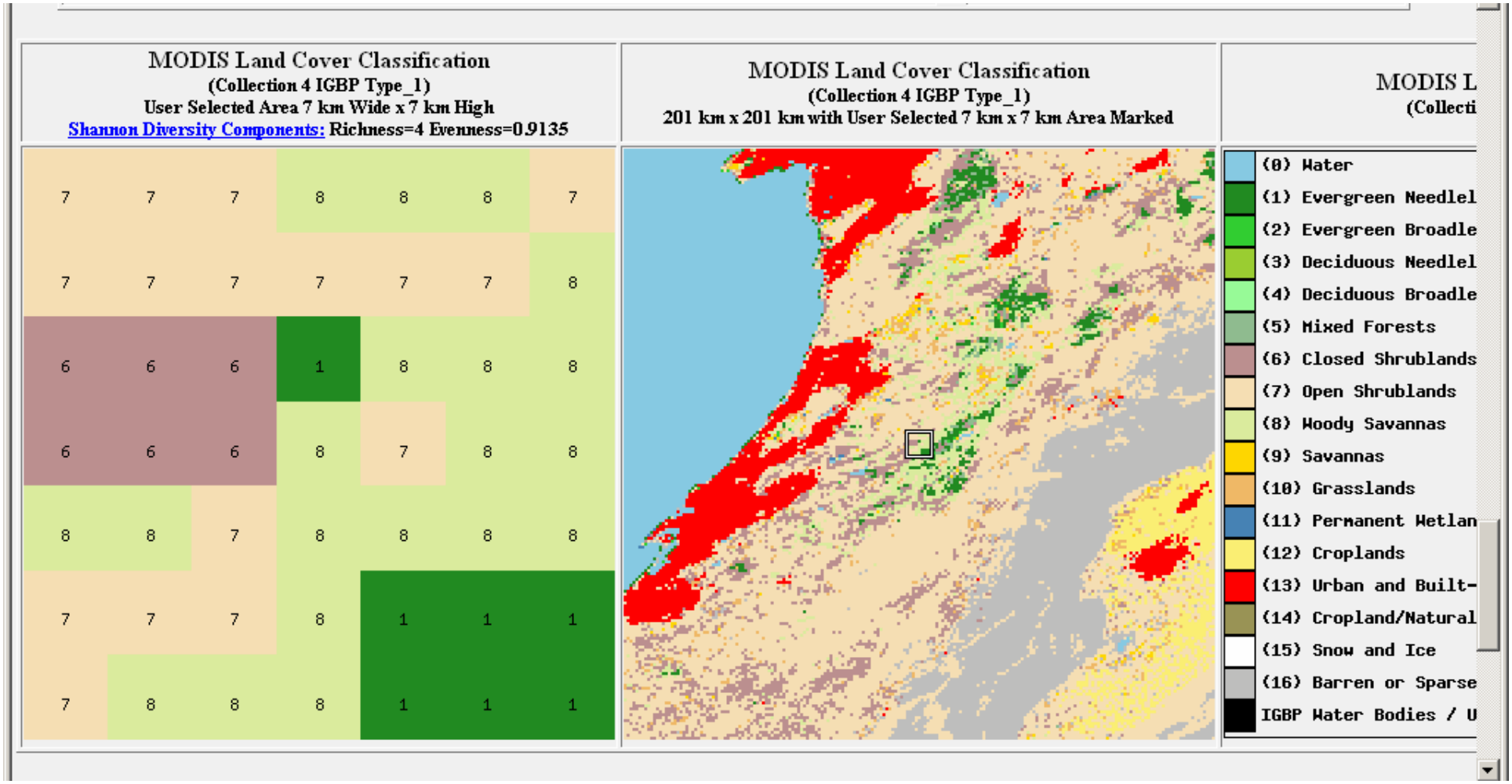
Second Tool: Custom Subsets for North America

- User Working Group requested that we expand our subsetting to allow users to select
  - Site – not limited to pre-selected sites
  - Area – 7 x 7 km too small
  - Time period – instead of entire MODIS record

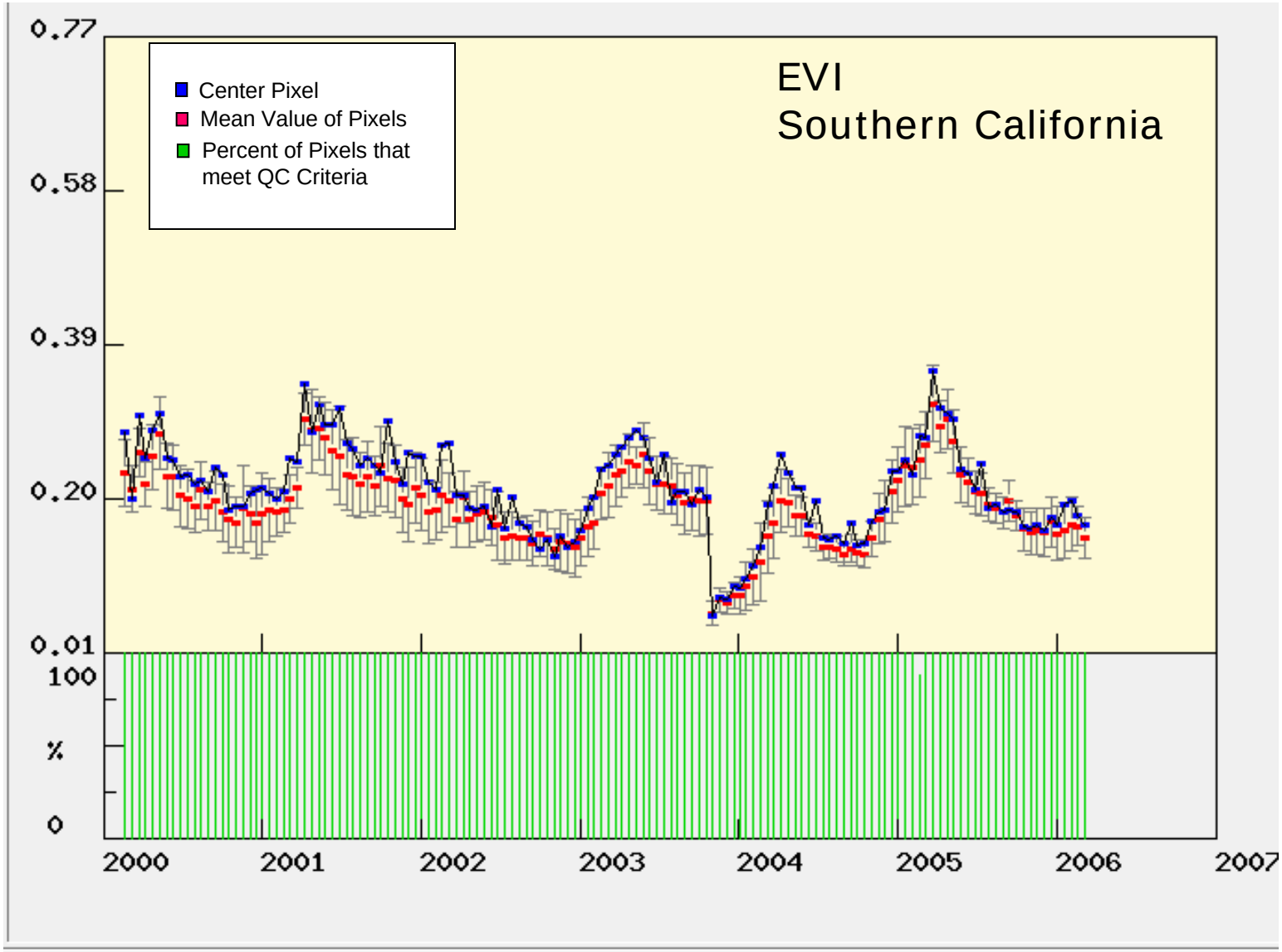
Second Tool (Coll. 4)

- User selects center coordinates or site in North America, areal extent (up to 201 x 201 km), and period of interest
- Processing of time series (selection of tiles, mosaicking, generating time series data file and graphs) takes 10 to 60 minutes for most products (depends on area, time period, and product)
- URL with graphs and pointers to data files is emailed to user

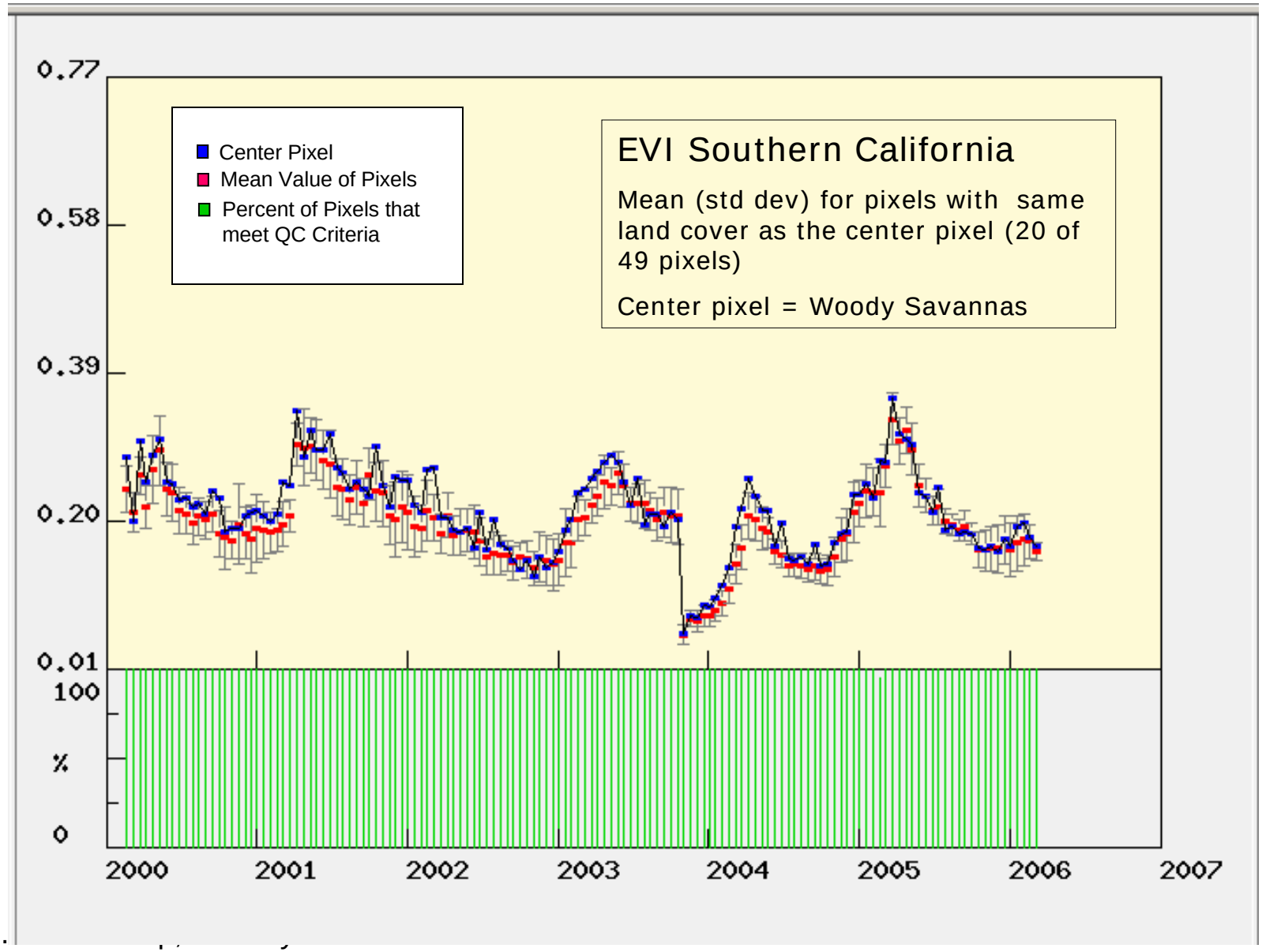
Land Cover Visualization



Time Series Example



Time Series Example

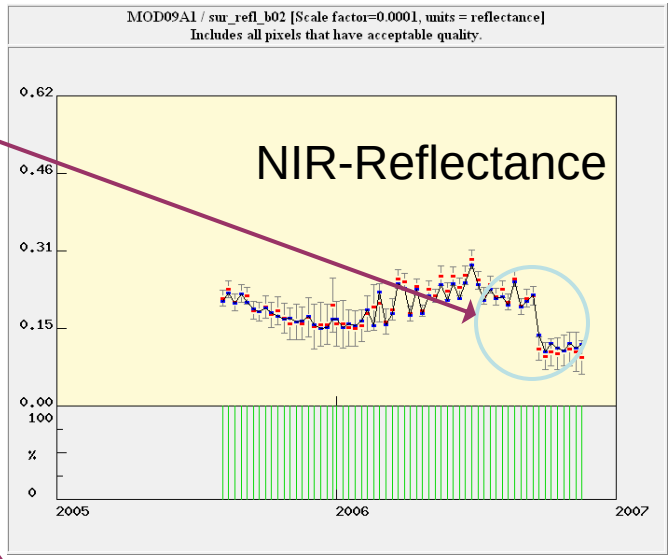


Coll.

California Wildfire in September 2006

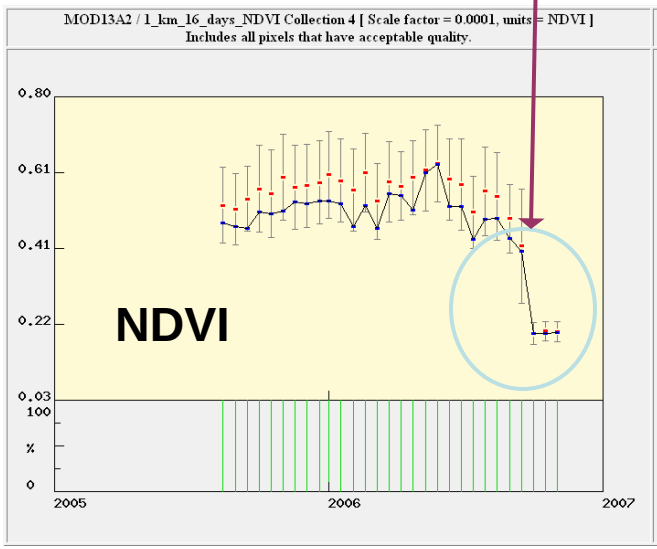
Latitude [34.58] Longitude [-118.99]
MODIS Horizontal Tile [8] Vertical Tile [5]
August 2006 to October 2006
3km x 3km subset

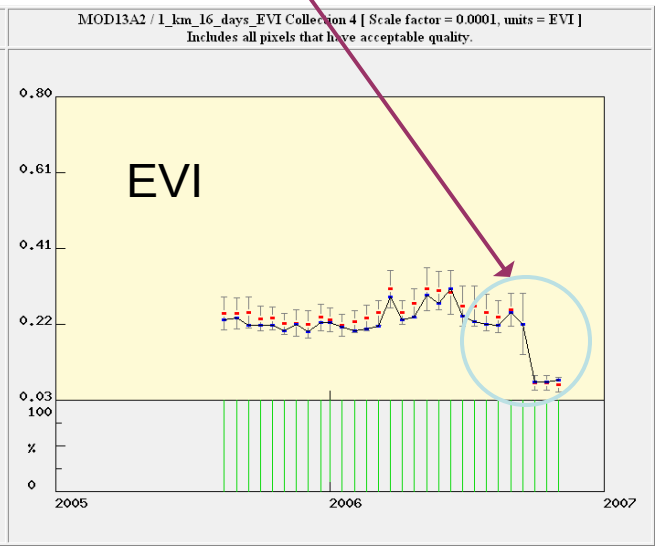
http://rapidfire.sci.gsfc.nasa.gov/



NIR reflectance
Terra-MOD09A1

August 2005-November 2006





Fire on September 17th 2006 caused

1. Reduction in NDVI,EVI
2. Reduction in NIR reflectance
3. Increase in SWIR reflectance etc

August 2005-November 2006 NDVI and EVI – Terra–MOD13A2

Data Download Options

- ASCII formatted file
- Image data files in ASCII Grid format
- QC-filtered data and statistics
- Land cover data in ASCII Grid Format
- Summary statistics for MODIS Land Products (ASCII)

- Tool used in Undergrad / graduate classes
  - Alfred Huete, University of Arizona
  - Jim Randerson, UC – Irvine
  - David Roy, South Dakota State
    - "….extremely useful for scientists, students, lecture's and also for PR."

What's coming?

- MODIS Collection 5 data for selected sites
  - Beta test now
  - Send us your comments
- Global Subsetting Tool for Collection 5
  - Create subsets of MODIS land products for any location on land anywhere on the globe
  - Quicker turn around time
  - Available Spring 2007
- Subsets of MODIS 4 NACP products
  - Smoothed LAI & fPAR and Vegetation Indices; Land surface water index
- Tools
  - More GIS functionality
  - New visualization features

Questions?

MODIS Subsets at ORNL DAAC

- http://daac.ornl.gov/MODIS/modis.html

Suresh Kumar: santhanavans@ornl.gov

Bob Cook: cookrb@ornl.gov

Extra Slides

MODIS Land Product Subsets
(Collection 4)

MODIS ASCII Subsets

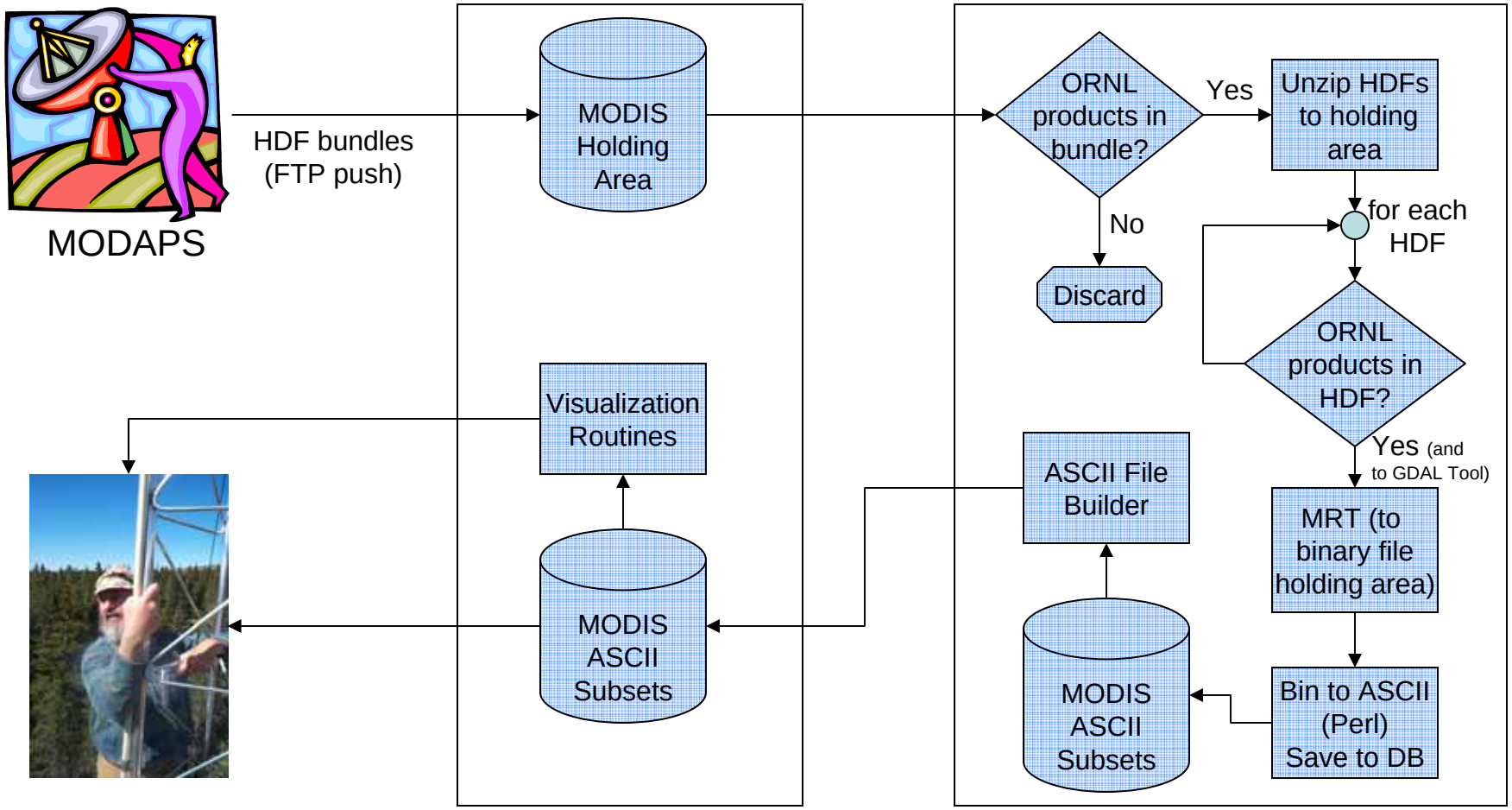
- 18 Land Products from MODIS (Terra and Aqua)
- Pre-selected time period (2000 – present) and sites (n = 280 worldwide)
- Area of 7 x 7 km (ASCII)
- Area of 31 x 11 km (GeoTIFF)
- Data files stored on FTP
- One file per product-site
  - File contains all dates and SDS*
- Upon-request visualization of single composite period grid or time series
- User can select and apply QC criteria, then display and download resulting files (Advanced Visualization)

Tool For North America

- 18 Land Products from MODIS (Terra and Aqua)
- User selected time period and location (center pixel) for North America
- User selected area from 1 x 1 km up to 201 x 201 km
- Data files generated upon-request for NA
  - ASCII file contains all SDS* and dates
- User receives URL via email (within an hour for most products)
  - Contains data and visualizations
- Use the Science Team's QC criteria

*SDS = Science Data Set

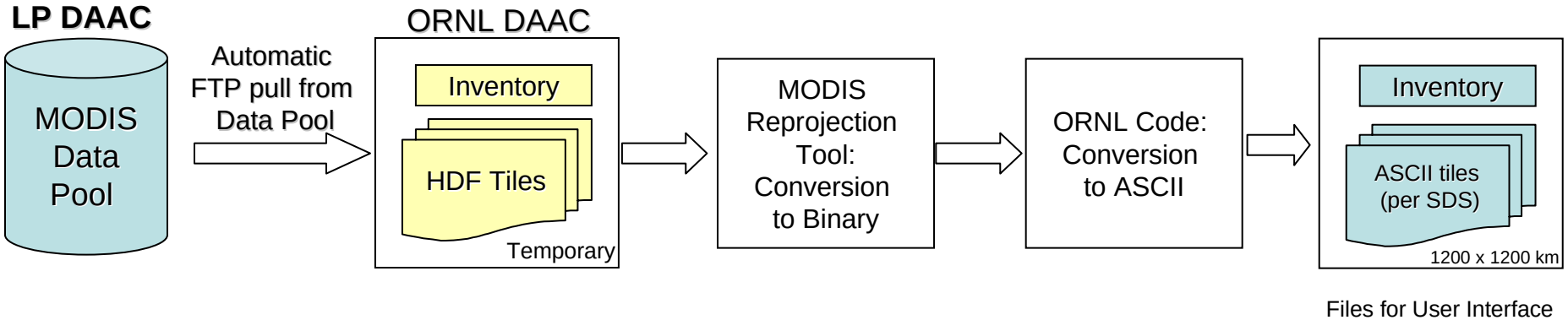
MODIS ASCII Subsets Data Flow



MODIS Subsets in GeoTIFF

- GeoTIFF image files
- ORNL receives 31 x 11 km HDF-EOS files from the MODIS Processing Stream
  - Optimum size: can be reprojected from SIN to UTM to yield a 7 x 7 km subset anywhere on earth
- ORNL uses GDAL Open Library tools to convert to GeoTIFF
- Developed picklists to select sites / products / dates
  - Can be viewed in WebGIS

Acquisition and Processing of MODIS Tiles:
Tool for North America



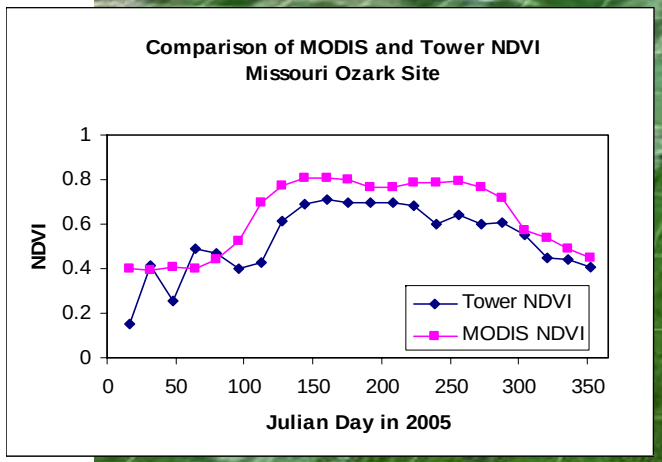
Computer Resources

Dedicated Server

10 TB RAID storage

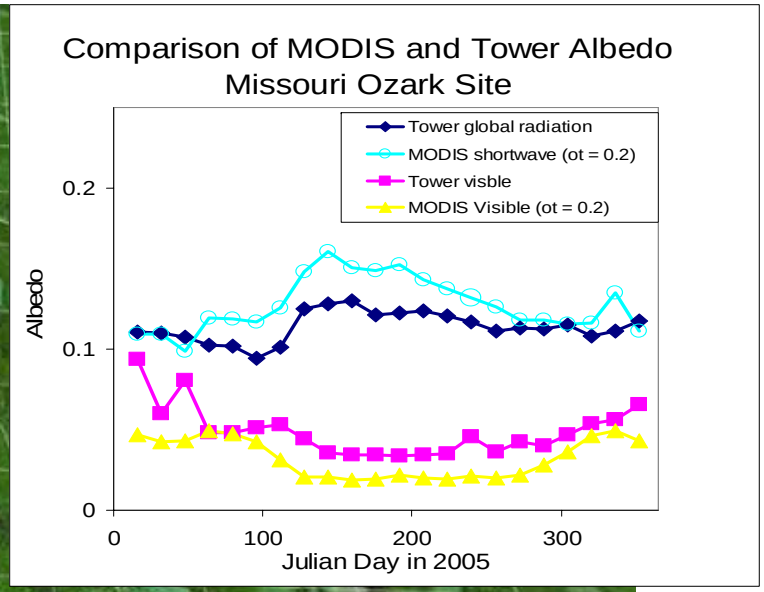
(capacity through 2009 for 1.5 TB/y)

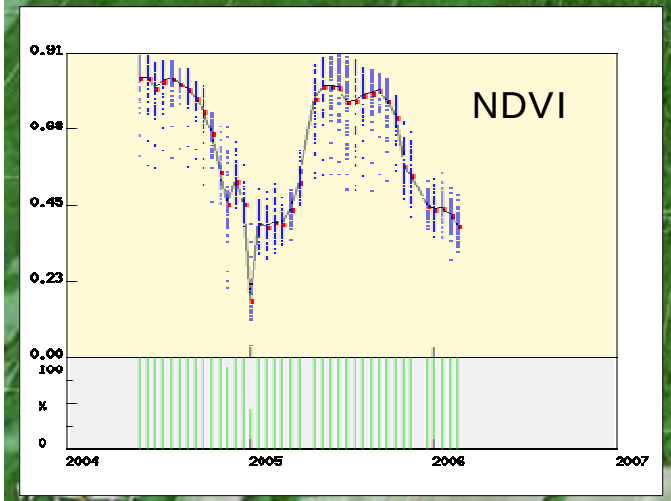
SDS = Science Data Set

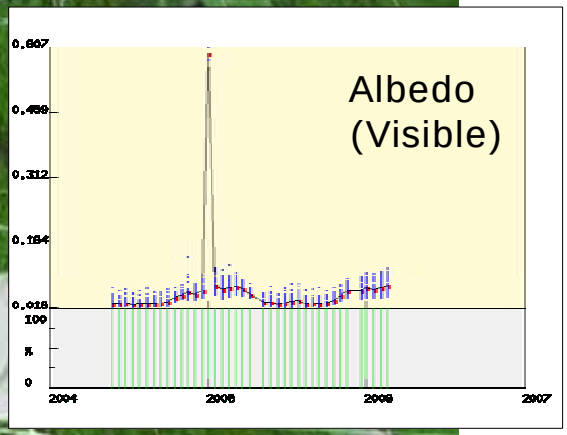


Beginning to compile site data for comparison

Yang Bai and Lianhong Gu (ORNL)







- Pixel Values
- Mean Value of Pixels
- Percent of Pixels that meet QC Criteria

NDVI / EVI Time series for cropland in Wisconsin

Dec 02 | Jan 03 | Feb 03 | Mar 03 | Apr 03

* Images from
USGS Global Visualization Viewer

http://glovis.usgs.gov/

Location

- Center Pixel
- Mean Value of Pixels
- Percent of Pixels that meet QC Criteria

MODIS/Terra Vegetation Indices (NDVI/EVI)

16-Day L3 Global 1km SIN Grid [Collection 4]

Latitude [42.667777] Longitude [-88.433333]
1km Horizontal Tile [11] Vertical Tile [4] Sample [597] Line [879]
February 2000 to September 2006

Product:	MOD13A2
Name:	MODIS/Terra Vegetation Indices (NDVI/EVI) 16-Day L3 Global 1km SIN Grid [Collection 4]
Coordinates:	Latitude: 42.667777, Longitude: -88.433333
Map Links:	Google Maps Google Earth MODIS tile map
Areal Extent:	3 km Wide x 3 km High
Quality Control Conditions:	As Specified by Science Team

Location from Google maps