MODIS Land Product Subsets:
Remote Sensing Products for Field Sites
(Collections 4 and 5)

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

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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*)
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- 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
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

<table>
<thead>
<tr>
<th>Product</th>
<th>MODIS Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Reflectance</td>
<td>MOD09A1</td>
</tr>
<tr>
<td>Surface Temperature</td>
<td>MOD11A2</td>
</tr>
<tr>
<td>Land Cover</td>
<td>MOD12Q1</td>
</tr>
<tr>
<td>Vegetation Phenology</td>
<td>MOD12Q2</td>
</tr>
<tr>
<td>NDVI / EVI</td>
<td>MOD/MYD13Q1</td>
</tr>
<tr>
<td>LAI / fPAR</td>
<td>MOD / MYD15A2</td>
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<tr>
<td>Net Photosynthesis</td>
<td>MOD17A2</td>
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<tr>
<td>Annual NPP</td>
<td>MOD17A3</td>
</tr>
<tr>
<td>Albedo (calc) (from MCD43A1,2)</td>
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<tr>
<td>Reflectance – BRDF Adjusted</td>
<td>MCD43A2,4</td>
</tr>
</tbody>
</table>

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
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, Long: 76.54475]

Map Links: Google Map, Google Earth, Site

Quality Control Conditions: As Specified by Science Team

Beltsville Agricultural Research Center
... 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

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

Image courtesy of MODIS Land Science Team
MODIS ASCII Subsets: *Advanced Data Visualization*

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

8-Day Composite [Collection 5]

Beltzville 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

<table>
<thead>
<tr>
<th>MODLAND_QC</th>
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<tbody>
<tr>
<td>Best Possible</td>
</tr>
<tr>
<td>OK, but not the best</td>
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<tr>
<td>Not produced, due to cloud</td>
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<tr>
<td>Not produced due to other reasons</td>
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<th>DEADDETECTCOR</th>
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<tr>
<td>Detectors apparently fine for up to 50% of channels</td>
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<td>Dead detectors caused &gt; 50% adjacent detector retrieval</td>
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<tr>
<th>CLOUDSTATE</th>
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<tr>
<td>Significant clouds NOT present (clear)</td>
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<tr>
<td>Significant clouds WERE present</td>
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<tr>
<td>Mixed cloud present on pixel</td>
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<tr>
<td>Cloud state not defined, assumed clear</td>
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<tr>
<th>SCF_QC [Science Computing Facility Quality Control]</th>
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<tr>
<td>Main(RT) method used with the best possible results</td>
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<td>Main(RT) method used with saturation</td>
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<td>Main(RT) method failed due to geometry problems, empirical method used</td>
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<td>Main(RT) method failed due to problems other than geometry, empirical method used</td>
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<td>Couldn't retrieve pixel</td>
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User can select and apply QC criteria, then display and download resulting files
Beltsville Agricultural Research Center, Maryland, LAI / fPAR, Year 2000 Day 113

<table>
<thead>
<tr>
<th>LAI Filtered</th>
<th>LAI SCF QC</th>
<th>LAI Cloudstate</th>
<th>LAI Deaddector</th>
<th>LAI MODLAND QC</th>
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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.
### MODIS Land Cover Classification (Collection 4 IGBP Type_1)

- **User Selected Area 7 km Wide x 7 km High**
- **Shannon Diversity Components:** 
  - **Richness = 4**
  - **Evenness = 0.9135**

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### MODIS Land Cover Classification (Collection 4 IGBP Type_1)

- **201 km x 201 km with User Selected 7 km x 7 km Area Marked**

### MODIS Land Cover Visualization

- **(0) Water**
- **(1) Evergreen Needle**
- **(2) Evergreen Broadle**
- **(3) Deciduous Needle**
- **(4) Deciduous Broadle**
- **(5) Mixed Forests**
- **(6) Closed Shrublands**
- **(7) Open Shrublands**
- **(8) Woody Savannas**
- **(9) Savannas**
- **(10) Grasslands**
- **(11) Permanent Wetlan**
- **(12) Croplands**
- **(13) Urban and Built-**
- **(14) Cropland/Natural**
- **(15) Snow and Ice**
- **(16) Barren or Sparse**

**IGBP Water Bodies / U**
Time Series Example

EVI
Southern California

Center Pixel
Mean Value of Pixels
Percent of Pixels that meet QC Criteria
Time Series Example

EVI Southern California
Mean (std dev) for pixels with same land cover as the center pixel (20 of 49 pixels)
Center pixel = Woody Savannas

Center Pixel
Red Mean Value of Pixels
Green Percent of Pixels that meet QC Criteria
California Wildfire in September 2006

Latitude [34.58] Longitude [-118.99]
August 2006 to October 2006
3km x 3km subset

Fire on September 17th 2006 caused
1. Reduction in NDVI, EVI
2. Reduction in NIR reflectance
3. Increase in SWIR reflectance etc

Source: MODIS Rapid Response

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

<table>
<thead>
<tr>
<th>MODIS ASCII Subsets</th>
<th>Tool For North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 18 Land Products from MODIS (Terra and Aqua)</td>
<td>• 18 Land Products from MODIS (Terra and Aqua)</td>
</tr>
<tr>
<td>• Pre-selected time period (2000 – present) and sites (n = 280 worldwide)</td>
<td>• User selected time period and location (center pixel) for North America</td>
</tr>
<tr>
<td>• Area of 7 x 7 km (ASCII)</td>
<td>• User selected area from 1 x 1 km up to 201 x 201 km</td>
</tr>
<tr>
<td>• Area of 31 x 11 km (GeoTIFF)</td>
<td>• Data files generated upon-request for NA</td>
</tr>
<tr>
<td>• Data files stored on FTP</td>
<td>– ASCII file contains all SDS* and dates</td>
</tr>
<tr>
<td>• One file per product-site</td>
<td>• User receives URL via email (within an hour for most products)</td>
</tr>
<tr>
<td>– File contains all dates and SDS*</td>
<td>– Contains data and visualizations</td>
</tr>
<tr>
<td>• Upon-request visualization of single composite period grid or time series</td>
<td>• Use the Science Team’s QC criteria</td>
</tr>
</tbody>
</table>
| • User can select and apply QC criteria, then display and download resulting files (Advanced Visualization) | *SDS = Science Data Set
MODIS ASCII Subsets
Data Flow

1. HDF bundles (FTP push) → MODIS Holding Area
2. MODIS Holding Area → Visualization Routines
3. Visualization Routines → MODIS ASCII Subsets
4. MODIS ASCII Subsets → ASCII File Builder
5. ASCII File Builder → MODIS ASCII Subsets
6. MODIS ASCII Subsets → MRT (to binary file holding area)
7. MRT (to binary file holding area) → Bin to ASCII (Perl) Save to DB
8. MODIS ASCII Subsets → ORNL products in HDF?
   - Yes (and to GDAL Tool)
   - No → Discard
9. ORNL products in HDF?
   - Yes → Unzip HDFs to holding area
   - No → for each HDF
10. Unzip HDFs to holding area → Yes

Coll. 5 Workshop, January 2007
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)

**Coll. 5 Workshop, January 2007**
Comparison of MODIS and Tower NDVI
Missouri Ozark Site

Beginning to compile site data for comparison
Yang Bai and Lianhong Gu (ORNL)

Comparison of MODIS and Tower Albedo
Missouri Ozark Site

Pixel Values
- Mean Value of Pixels
- Percent of Pixels that meet QC Criteria
NDVI / EVI Time series for cropland in Wisconsin

MODIS/Terra Vegetation Indices (NDVI/EVI)

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

Product: MOD13A2
Name: MODIS/Terra Vegetation Indices (NDVI/EVI) 16-Day L3 Global 1km SIN Grid [Collection 4]
Coordinates: Latitude: 42.677777, Longitude: -89.433333
Map Links: Google Maps, Google Earth, MODIS site map

Area Extent: 3 km Wide x 3 km High
Quality Control Conditions: As Specified by Science Team

Location from Google maps

Location, Latitude: 42.677777, Longitude: -89.433333
Google Maps, Google Earth, MODIS site map

MOD13A2 / 1_km_16_days_NDVI Collection 4 | Scale factor = 0.0001, units = NDVI
Includes all pixels that have acceptable quality.

MOD13A2 / 1_km_16_days_EVI Collection 4 | Scale factor = 0.0001, units = EVI
Includes all pixels that have acceptable quality.

NDVI

EVI

Year

Year

Coll. 5 Workshop, January 2007

NDVI / EVI Time series for cropland in Wisconsin

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