



WELCOME TO NASA APPLIED REMOTE SENSING TRAINING (ARSET) WEBINAR SERIES

INTRODUCTION TO REMOTE SENSING DATA FOR LAND MANAGEMENT

**COURSE DATES: EVERY MONDAY, NOVEMBER 3- DECEMBER 1
TIME: 12PM-1PM EDT**



Important Information

- ❑ Presentations URL:
 - ❑ [Http://arset.gsfc.nasa.gov/webinars](http://arset.gsfc.nasa.gov/webinars)
- ❑ Contact for requesting recorded link for the webinars:
 - ❑ Marines Martins: marines.martins@ssaihq.com
- ❑ Certificate of Completion
 - ❑ Attend all 5 webinars
 - ❑ Assignment 1 – access from the ARSET land webinar website
 - ❑ Assignment 2- after Week 4

ARSET Land Resource Management

<http://arset.gsfc.nasa.gov/eco/webinars/>



NASA ARSET Applied Remote Sensing Training

Earth Science Division Applied Sciences ASP Water Resources

DISASTERS ECO FORECASTING HEALTH & AIR QUALITY WATER RESOURCES

Eco Forecasting

- Eco Webinars
 - Land Management, 11-14
 - Intro to Data Products, Portals, and Tools
 - Land Management, 05-14
 - Eco Personnel

Upcoming Courses

Ecoforecasting
NASA Remote Sensing for Land Management
11/03/2014 to 12/01/2014

Water Resources
Water Quality Monitoring Using Remote Sensing Measurements
11/18/2014 to 12/02/2014

NASA Remote Sensing for Land Management
11/03/2014 to 12/01/2014

Times: 12 PM - 1 PM Eastern US Time

This webinar course has five one-hour sessions on 3, 10, 17, 24, November and 1 December.

- 3 November: Overview of NASA Remote Sensing and Earth systems modeling data
- 10 November: Land Cover Mapping
- 17 November: Terrain Data
- 24 November: Change Detection
- 1 December: Web-tools for Data Access and Integration into GIS

Registration: [Webinar Registration](#)
GIS: True
Keywords: [Satellite Imagery](#), [Tools](#)
Instruments: [Aqua](#), [Landsat](#), [Terra](#)

Presentations and Recordings

Week	Date	Title	Presentation	Recording	Assignment
1	Nov. 3, 2014	Overview of NASA Remote Sensing and Earth systems modeling data	Week 1 Presentation. Week 1 Presentation (Spanish)	View Week 1 Recording	Assignment 1
2	Nov. 10, 2014	Land Cover Mapping.	N/A	N/A	N/A
3	Nov. 17, 2014	Terrain Data.	N/A	N/A	N/A
4	Nov. 24, 2014	Change Detection.	N/A	N/A	N/A



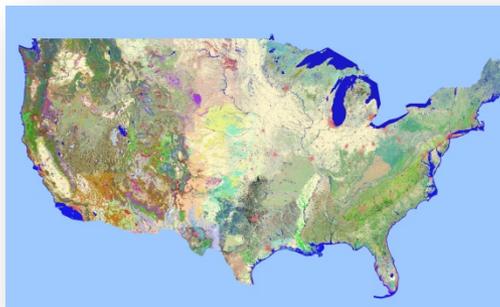
Course Outline

Week 1



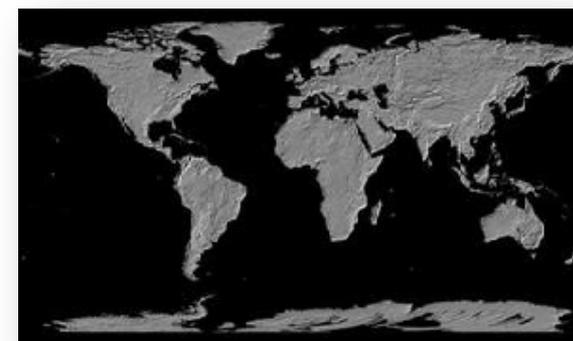
**Intro. & Background:
Satellite Remote Sensing**

Week 2



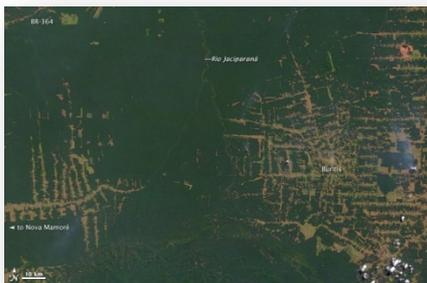
**Land Cover Mapping/
Web tools for data
access**

Week 3



Terrain

Week 4



Change Detection

Week 5



**Web tools for data access/
Integration with GIS**



Your Course Instructors for This Week

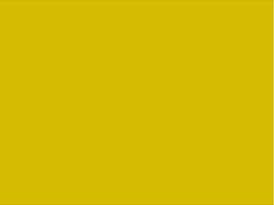
- ❑ Cindy Schmidt (ARSET):
cynthia.l.schmidt@nasa.gov
- ❑ Amber Kuss (ARSET):
amberjean.m.kuss@nasa.gov

General inquiries about ARSET: Ana Prados
(ARSET) aprados@umbc.edu



Outline

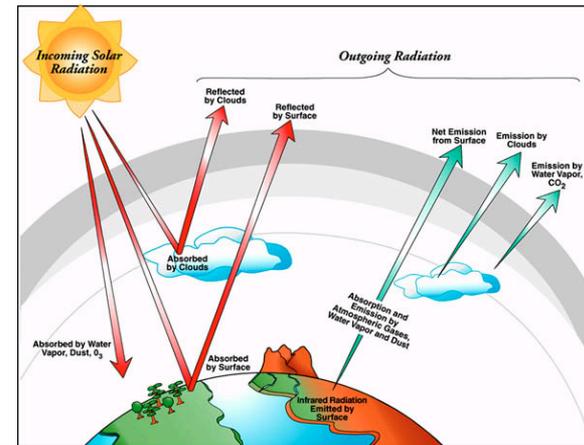
- ❑ Brief review of last week
- ❑ Satellite Data Processing Levels
- ❑ Land Cover Mapping and Web Tools for Data Access
 - ❑ Overview of satellites and sensors (Landsat, MODIS, VIIRS) for land management
 - ❑ Satellite data products for national and global land cover mapping
- ❑ Live Demo:
 - ❑ Using MRTWeb for selecting and downloading MODIS NDVI
 - ❑ Importing MODIS NDVI into GIS



Review of Week 1

Week 1

- ❑ Fundamentals of remote sensing
 - ❑ Electromagnetic spectrum
- ❑ Characteristics of satellite sensors
 - ❑ Passive vs. active
- ❑ NASA satellites for land management



NASA Satellite Instruments for Land Resources Management



Satellite	Sensor(s)	Dates	Spatial Resolution
Landsat 1-3	MSS	1972 - 1983	80 meter
Landsat 4 and 5	Landsat TM	1982 - 2013	30m (120 m thermal band)
Landsat 7	Landsat ETM+	1999 - present	15m panchromatic, 30m multispectral, 60m thermal
Landsat 8 (LDCM)	Operational Land Imager (OLI), Thermal Infrared Sensor (TIRS)	2013 - present	15m panchromatic; 30m multispectral; 100m thermal
Terra, Aqua	MODerate Resolution Imaging Spectroradiometer (MODIS)	2000 - present	250m - 8 km
Terra	ASTER	2000 - present	15-90m
EO-1	Hyperion, Advanced Land Imager (ALI)	2000 - present	10-30m
Suomi NPP	Visible Infrared Imager Radiometer Suite (VIIRS)	2013 - present	375-750m



Satellite Data Processing Levels

Levels of Data Processing and Spatial Resolution



- ❑ **Level 1 and Level 2** data products have the highest spatial and temporal resolution
- ❑ **Level 3 and 4 products** are derived products with equal or lower spatial and temporal resolution than Level 2 products.



Data Processing Levels

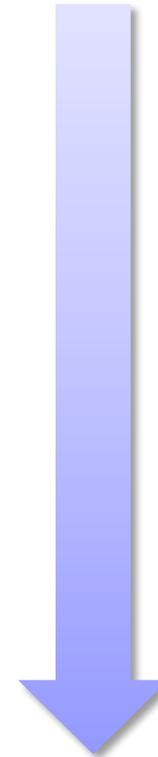
L0: Raw instrument data

L1: Geolocated and calibrated

L2: Products derived from L1B

L3: Gridded and quality controlled

L4: Model output: derived variables



Harder to Use

Easier to Use



Data Processing Levels

Landsat	MODIS
Level 1T – Standard Terrain Corrected	Level 2 – derived geophysical variables
Level 1Gt – Systematic Terrain Correction	Level 2G – level 2 data mapped on a uniform space-time grid scale
Level 1G – Systematic Correction	Level 3 – gridded variables in derived spatial and/or temporal resolutions
	Level 4 – model output or results from analyses of lower level data

For more information on Landsat data processing levels:

http://landsat.usgs.gov/Landsat_Processing_details.php

For more information on MODIS Land Products processing levels:

http://lpdaac.usgs.gov/products/modis_products_table/modis_overview



Land Resources Satellites and Sensors

□ **Landsat**

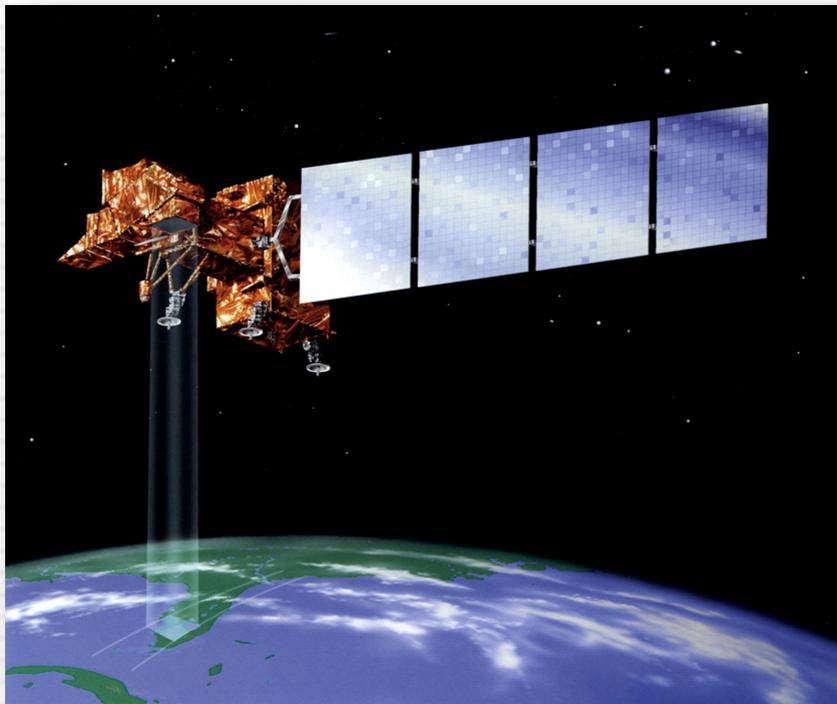
- Brief Overview (History and Current Missions)
- Characteristics of Landsat Data
- Where to Obtain Landsat Images
- Landsat Derived Landcover Products (national and global)
- Where to obtain landcover products

□ **MODIS Land Products Overview**

- Brief overview
- Characteristics of MODIS data
- MODIS Land Products and Applications (national and global)
- Where to Obtain MODIS Products

□ **Live demonstration: MODIS**

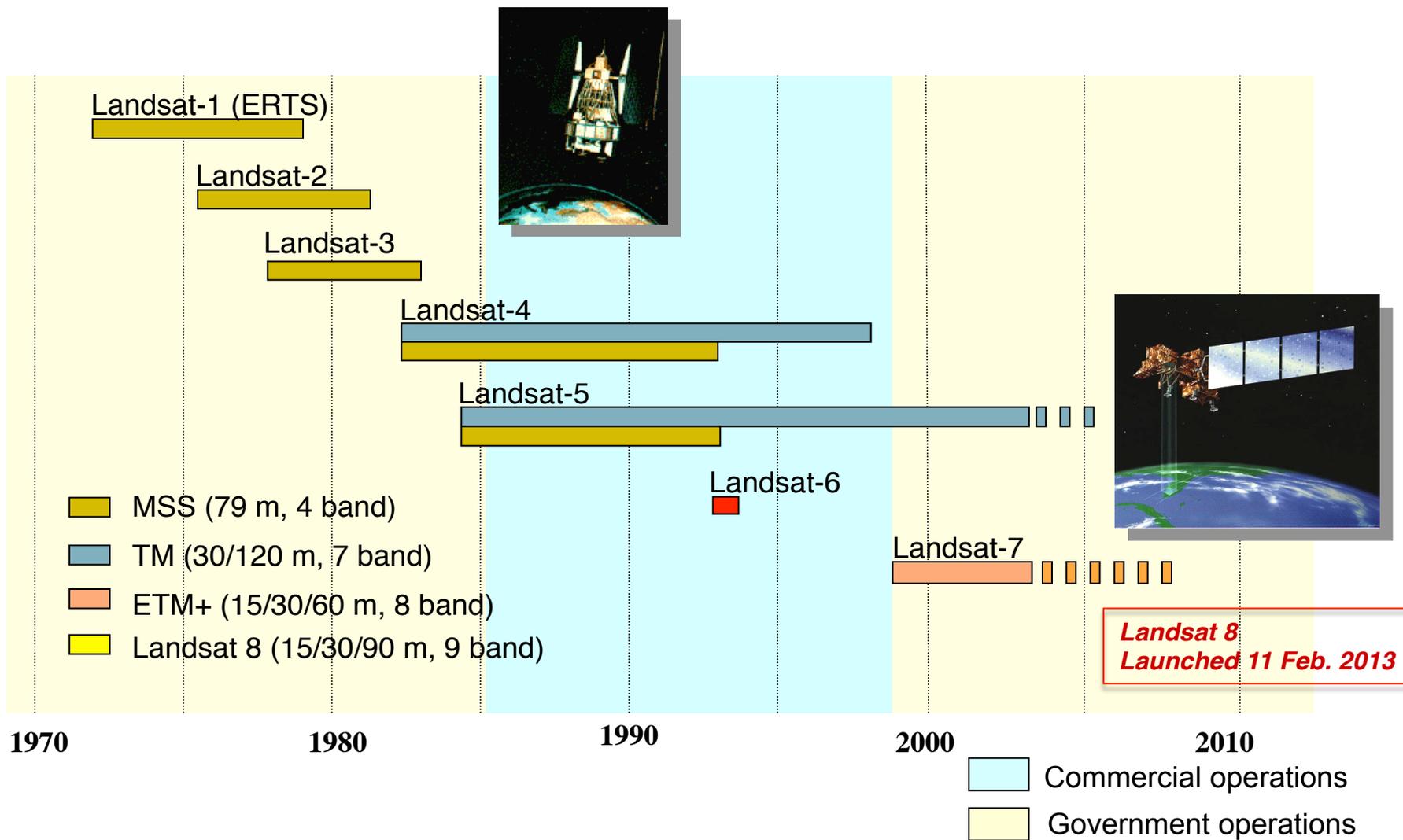
Landsat



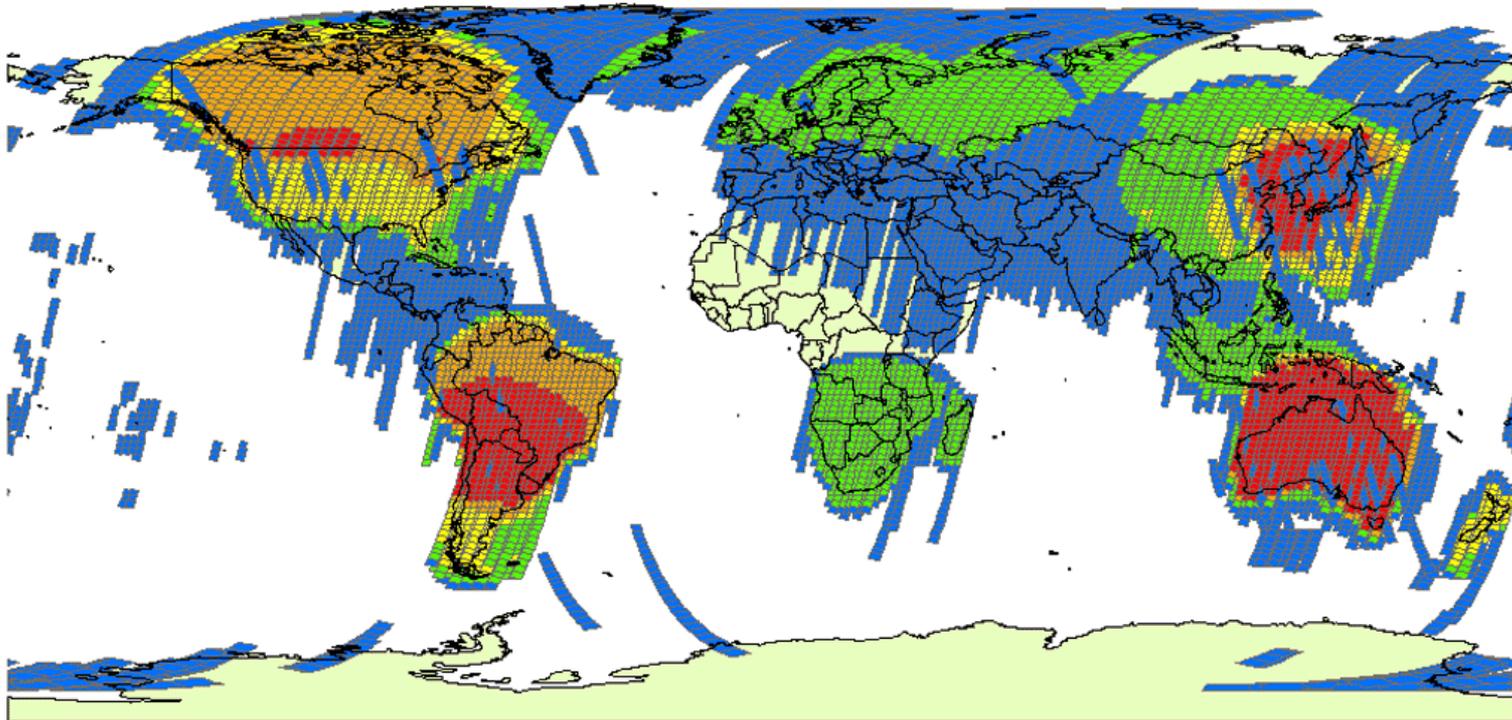
Source: landsat.gsfc.nasa.gov



Landsat: 30 years of observations



Landsat Global Archive Consolidation (USGS)



LGAC WRS2 Scenes

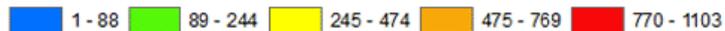
Status as of August 31, 2014

Acquisition Date Range: August 22, 1982 through August 31, 2014

3,058,685 Cumulative Scenes Delivered

2,893,809 Total WRS2 Scenes Acquired

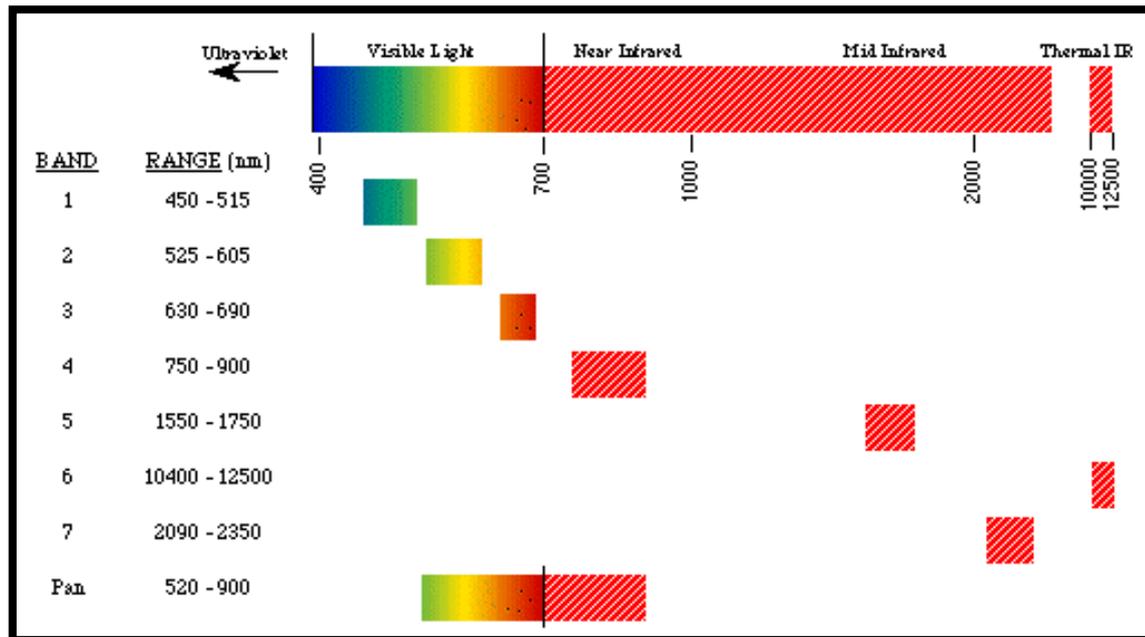
13,061 Unique WRS2 Path/Rows





Characteristics of Landsat: Spectral

- ❑ Landsat instruments measure primarily light that is reflected from Earth's surface (with one exception)
- ❑ Landsat instruments are designed to detect visible and infrared (near and mid) wavelengths.



Landsat bands of ETM+ (Landsat 7)

Source: NASA Goddard Space Flight Center



Characteristics of Landsat 4, 5 and 7

Bands	Wavelength (micrometers)	Resolution (m) Landsat 4-5 (TM)	Resolution (m) Landsat 7 (ETM+)
Band 1-Blue	0.45-0.52	30	30
Band 2 Green	0.52-0.60	30	30
Band 3- Red	0.63-0.69	30	30
Band 4-Near Infrared	0.76-0.90	30	30
Band 5- Shortwave Infrared 1	1.55-1.75	30	30
Band 6- Thermal Infrared	10.40-12.50	120	60
Band 7- Shortwave Infrared 2	2.08-2.35	30	30
Band 8-Pan	0.52-0.90	--	15



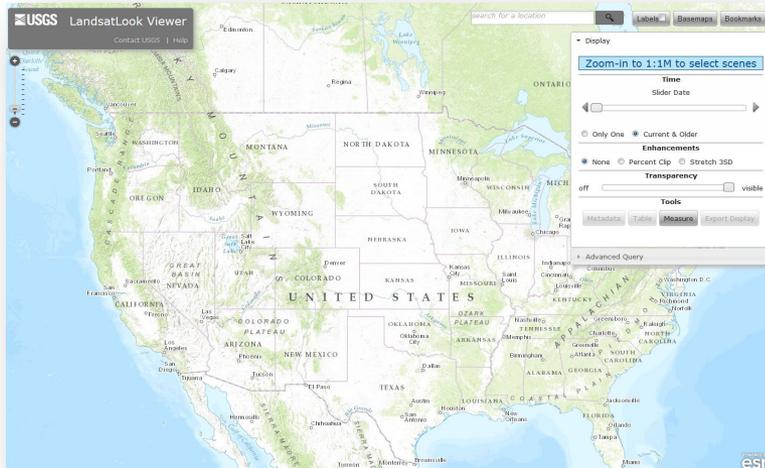
Characteristics of Landsat 8

Bands	Wavelength (micrometers)	Spatial Resolution (meters)
Band 1-Coastal aerosol	0.43-0.45	30
Band 2- Blue	0.45-0.51	30
Band 3- Green	0.53-0.59	30
Band 4- Red	0.64-0.67	30
Band 5- Near Infrared	0.85-0.88	30
Band 6- SWIR 1	1.57-1.65	30
Band 7- SWIR 2	2.11-2.29	30
Band 8-Panchromatic	0.50-0.68	15
Band 9-Cirrus	1.36-1.38	30
Band 10- Thermal Infrared 1	10.60-11.19	100
Band 11- Thermal Infrared 2	11.50-12.51	100

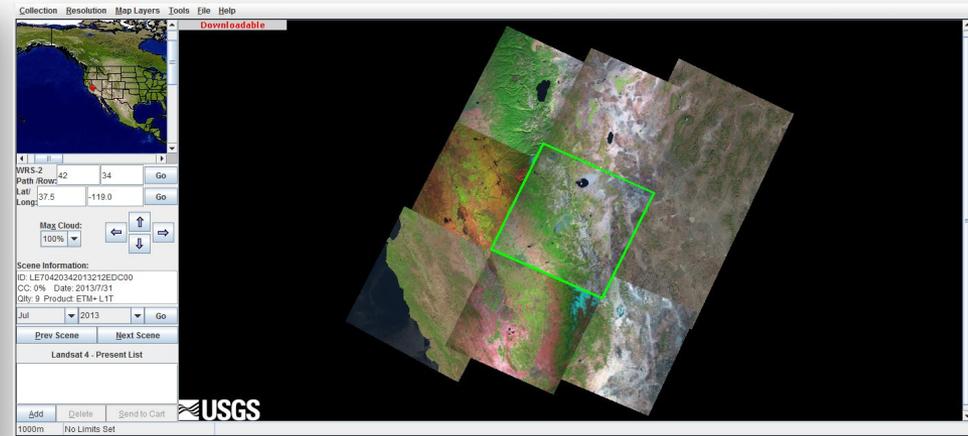


Where to Obtain Landsat Images

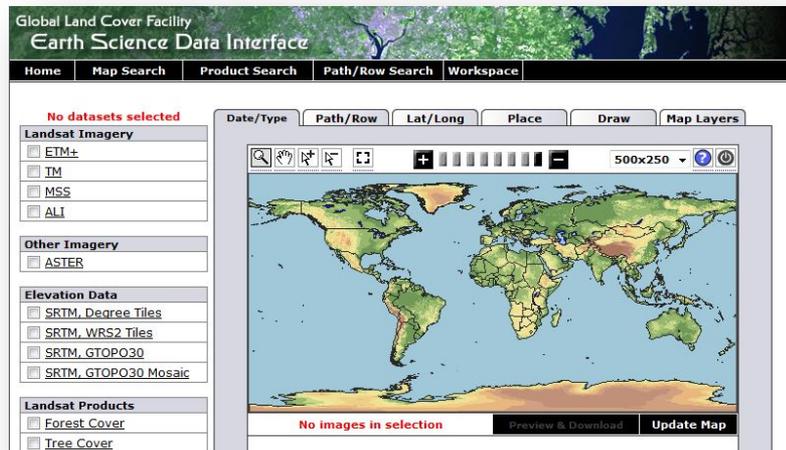
The LandsatLook Viewer



GloVis



Global Land Cover Facility



Earth Explorer





Where to Obtain Landsat Images

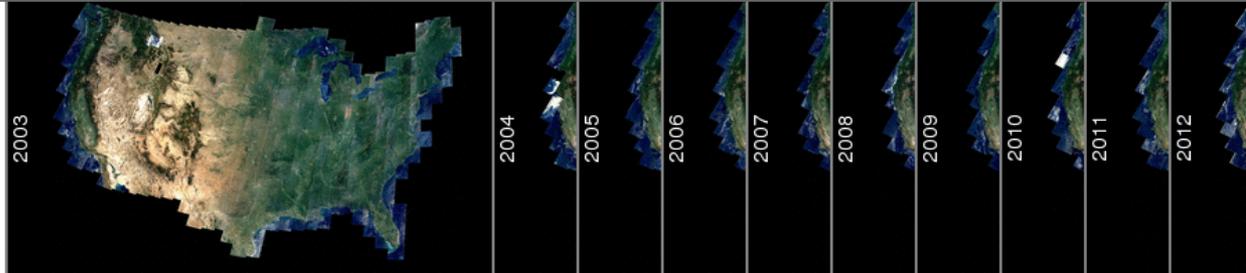
WELD: WEB - ENABLED LANDSAT DATA



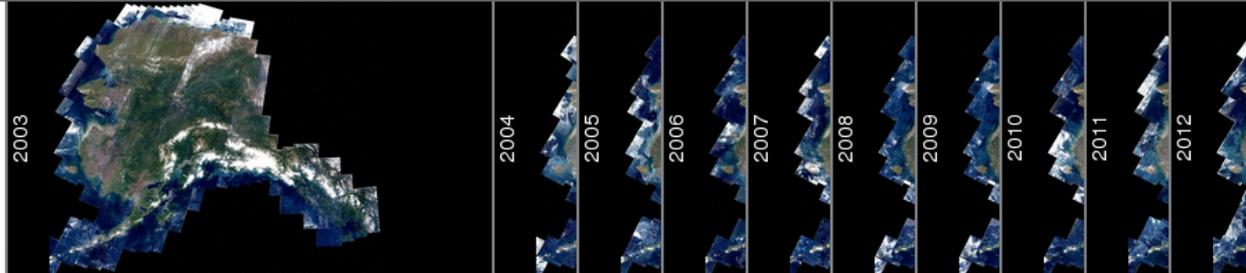
USGS Home
Contact USGS
Search USGS

Available Years:

CONUS



Alaska



<http://weld.cr.usgs.gov>

<http://globalweld.cr.usgs.gov>



Acquiring Landsat Images

<http://landsatlook.usgs.gov>

The LandsatLook Viewer

- Access to all full resolution natural color Landsat imagery and Level 1 Data products



Acquiring Landsat Images

The screenshot displays the USGS Global Visualization Viewer (GloVis) interface. At the top left is the USGS logo with the tagline "science for a changing world" and the text "Earth Resources Observation and Science Center (EROS)". At the top right are links for "USGS Home", "Contact USGS", and "Search USGS". Below the header is a navigation bar with "USGS Global Visualization Viewer" and "System Notices (3), 2 New, 3 Critical". A menu includes "Collection", "Resolution", "Map Layers", "Tools", "File", and "Help". The main area shows a satellite image of a river valley with a yellow bounding box. A "Downloadable" label is visible above the image. On the left, there are search parameters: "WRS-2 Path / Row: 169 51", "Lat / Long: 13.0 38.6", and "Max Cloud: 100%". Below these are "Scene Information" fields: "ID: LC81690512014089LGN00", "CC: 0% Date: 2014/3/30", and "Qty: 9 Product: OLI_TIRS_L1T". At the bottom left are "Prev Scene", "Next Scene", and "Landsat 8 OLI Scene List" buttons. A URL box at the bottom right contains "http://glovis.usgs.gov".

- **GloVis** is a quick and easy online search and download tool for satellite data



Acquiring Landsat Images



USGS Home
Contact USGS
Search USGS

EarthExplorer

Page Expires In 1:45:16

Home 3 New System Messages

Login Register RSS Feedback Help

Search Criteria Data Sets Additional Criteria Results

1. Enter Search Criteria

To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range.

Address/Place Path/Row Feature Circle

Coordinates Predefined Area Shapefile KML

Degree/Minute/Second Decimal

No coordinates selected.

Date Range Result Options

Search Criteria Summary (Show)

Clear Criteria





Acquiring Landsat Images

Global Land Cover Facility
Earth Science Data Interface

Home | Map Search | Product Search | Path/Row Search | Workspace

No datasets selected

Landsat Imagery

- ETM+
- TM
- MSS
- ALI

Other Imagery

- ASTER

Elevation Data

- SRTM, Degree Tiles
- SRTM, WRS2 Tiles
- SRTM, GTOPO30
- SRTM, GTOPO30 Mosaic

Landsat Products

- Forest Cover
- Tree Cover

Date/Type | Path/Row | Lat/Long | Place | Draw | Map Layers

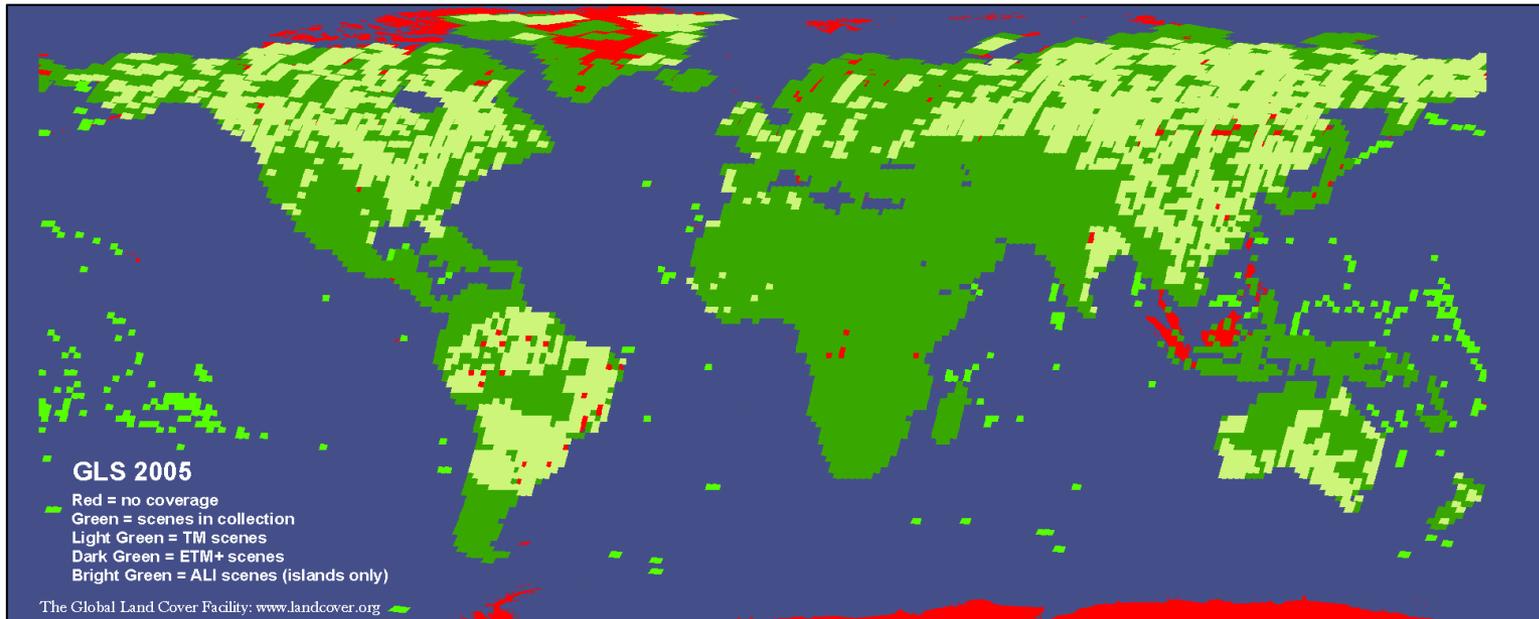
500x250

No images in selection | Preview & Download | Update Map

<http://glcf.umd.edu/data/landsat>



Global Land Survey (GLS)



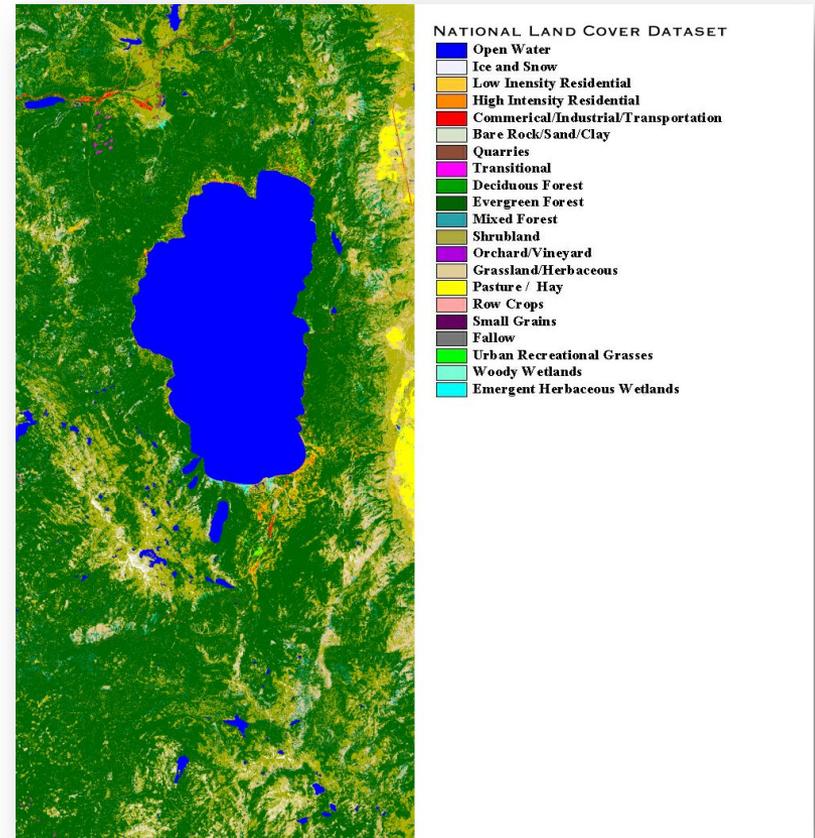
source: glcf.umd.edu

- Collaboration between USGS and NASA
- Global land survey datasets (uses a global collection of cloud free Landsat images from 1975-2008)
- Time series include (GLS 1975, GLS 1990, GLS 2000, GLS 2005, GLS 2010)
- **Acquire GLS datasets through Earth Explorer, GloVis, and GLCF**

Turning Data into Information: Land Cover Maps



Landsat Image of Lake Tahoe



Landcover map of Lake Tahoe



Landsat Derived Land Cover Products

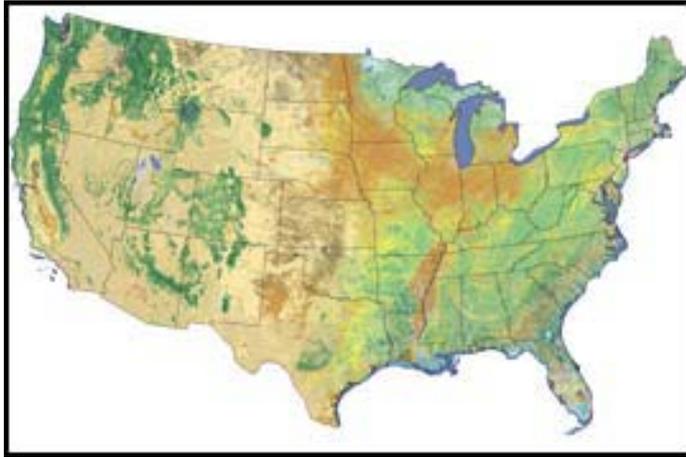
□ **United States**

- National Land Cover Database (NLCD)
- GAP Analysis
- LANDFIRE

□ **Global**

- Global Land Cover Network (FAO)
- Forest Change Products (Amazon Basin, Central Africa, Paraguay) and Landsat Tree Cover (GLCF)

National Land Cover Database (NLCD)



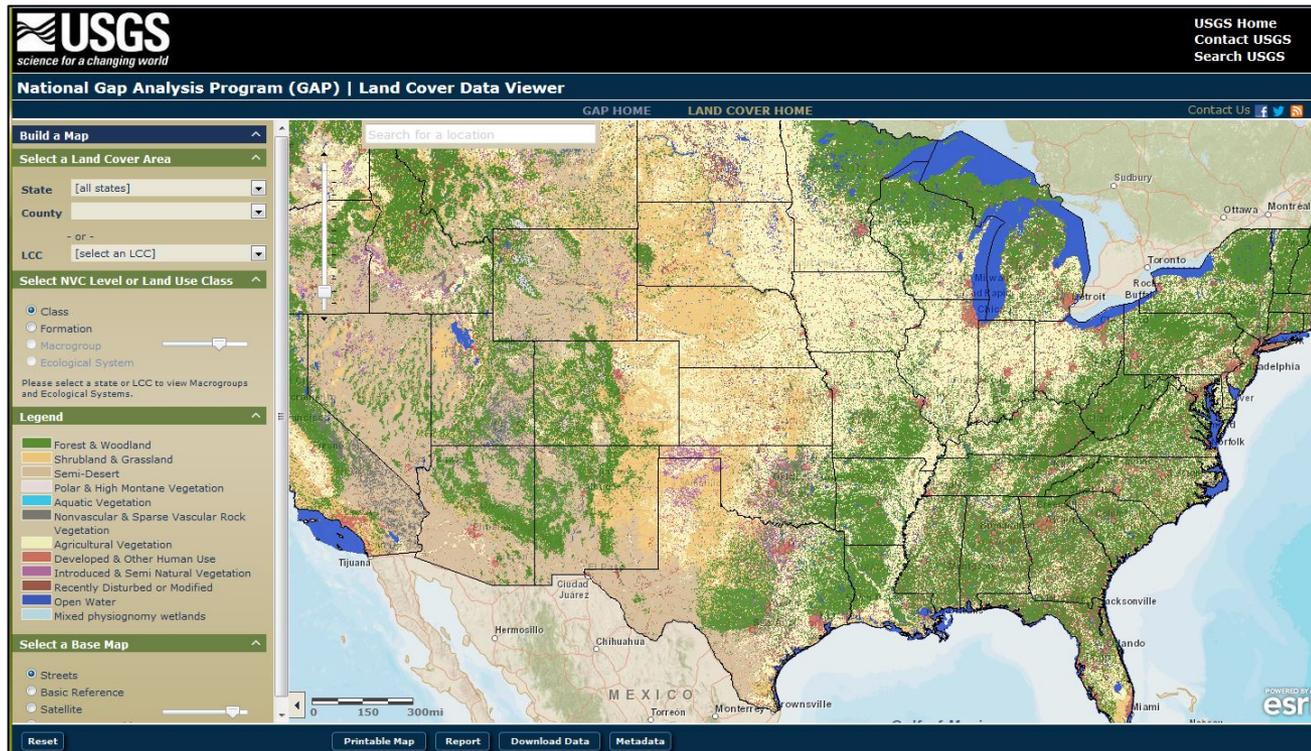
http://www.mrlc.gov/nlcd11_data.php

- ❑ Supported by the Multi-Resolution Land Characteristic Consortium (MLRC)
- ❑ Provides National Land Cover Mapping products at 30m resolution for 1992, 2001, 2006 and 2011.
- ❑ 16 class Land Cover classification scheme of the entire U.S. (modified from The Anderson Level 2 Classification System)
- ❑ Other NLCD Mapping products include: Land Cover Change, Percent Tree Canopy, and Percent Developed Imperviousness (1992, 2001, 2006)



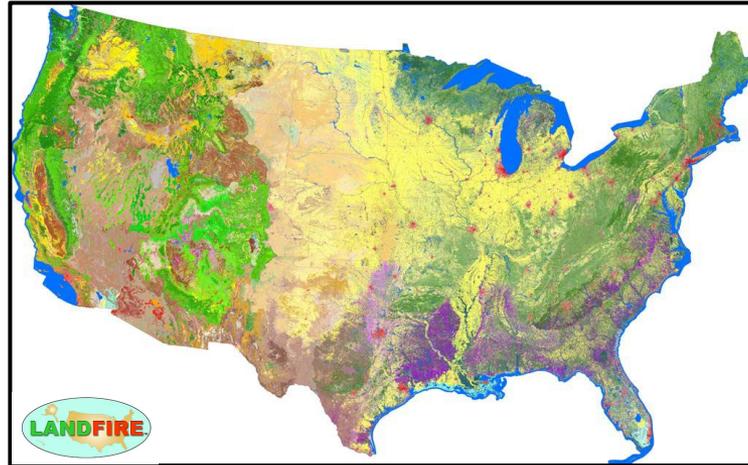
National Gap Analysis Program

<http://gapanalysis.usgs.gov>



- ❑ Land cover maps
- ❑ Species distribution maps
- ❑ Land stewardship/protected areas

LANDFIRE (Interagency partnership between USFS and USGS)



<http://www.landfire.gov>

Products: Delivered at 30 m spatial resolution

- **Vegetation data layers** using Landsat imagery from 1999 - present
 - Current and historic vegetation composition and structure of the entire U.S.
- **Fuel and Fire Regime data layers**
 - Fire behavior and fuel loading models for entire U.S. 1999 -present
- **Disturbance data**
 - Fuel, vegetation, natural, and prescribed disturbance by type and year 1999-present



FAO Global Land Cover-SHARE (GLC-SHARE)

http://www.glcn.org/databases/lc_glcshare_en.jsp

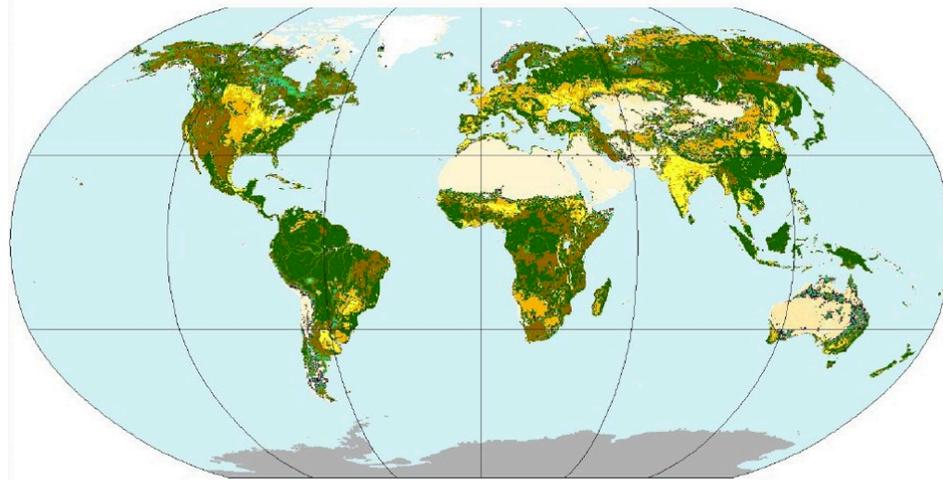


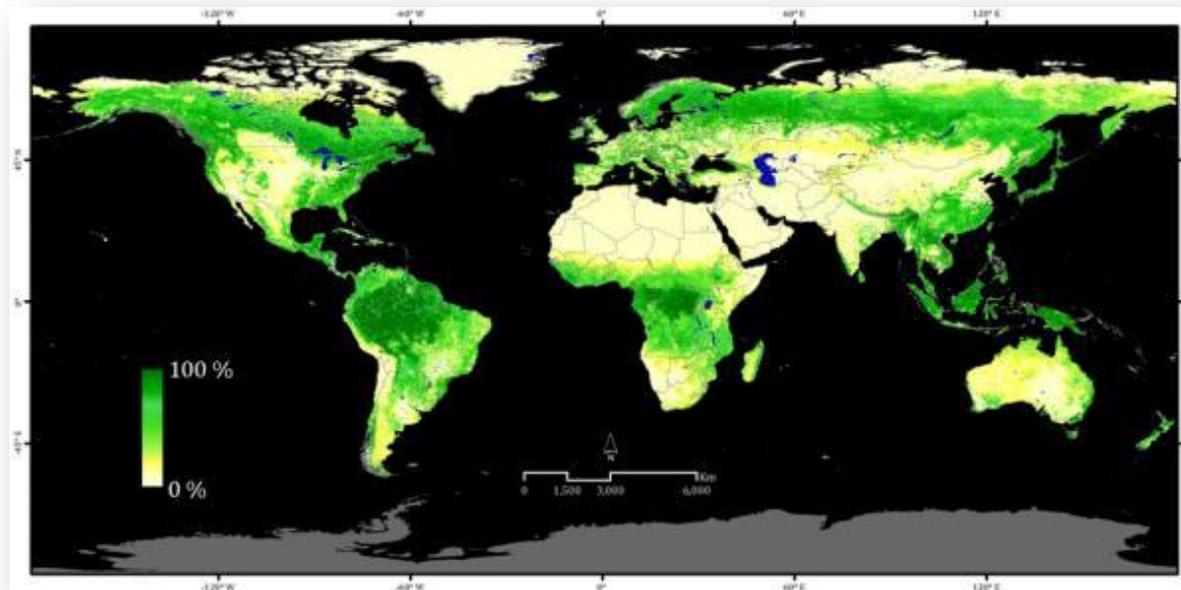
Figure 3 – Distribution of dominant GLC-SHARE Land Cover Database.



- GLC-SHARE combines “best available” high resolution national, regional and/or subnational land cover databases
- Produced with a resolution of 30 arc-second (~ 1 sq. km.)
- 11 land cover classes
- Beta-release 1.0

Landsat Tree Cover

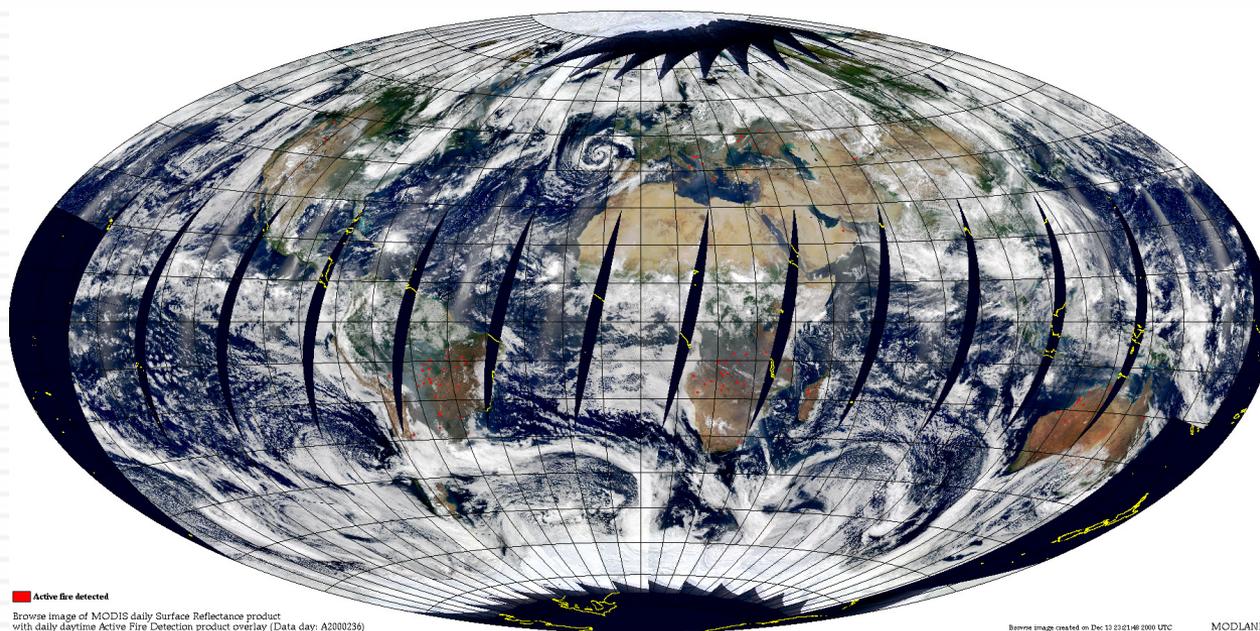
<http://glcf.umd.edu/data/landsatTreecover/>



source: glcf.umd.edu

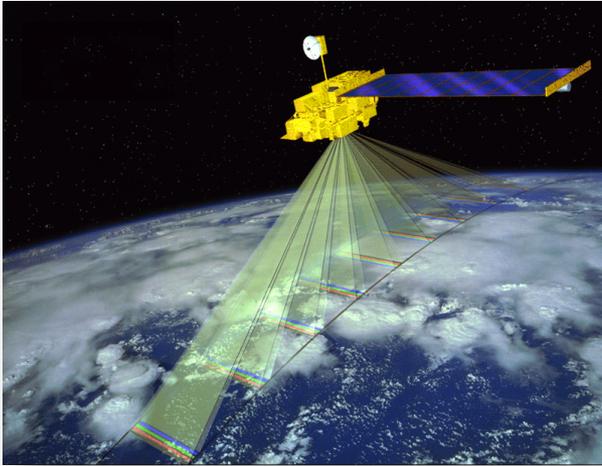
- ❑ Landsat Tree Cover layers estimate the percent of tree cover per 30m pixel area (includes stems, branches, leaves greater than 5 meters in height)
- ❑ Derived from all seven bands of Landsat 5-TM and Landsat ETM
- ❑ Landsat Tree Cover product represents 2000, 2005

MODIS



Source: earthobservatory.nasa.gov

MODIS (Moderate Resolution Imaging Spectroradiometer)



Spatial Resolution

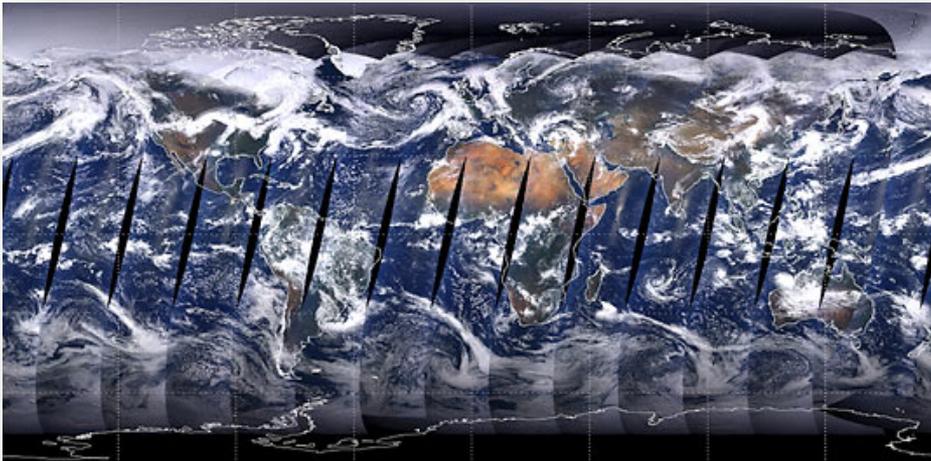
250m, 500m, 1km

Temporal Resolution

Daily, 8-day, 16-day, monthly, quarterly, yearly
(2000-present)

Data Format

Hierarchical Data Format - Earth Observing System
Format (HDF-EOS)



Spectral Coverage

36 bands (major bands include
Red, Blue, IR, NIR, MIR)

Bands 1-2: 250m

Bands 3-7: 500m

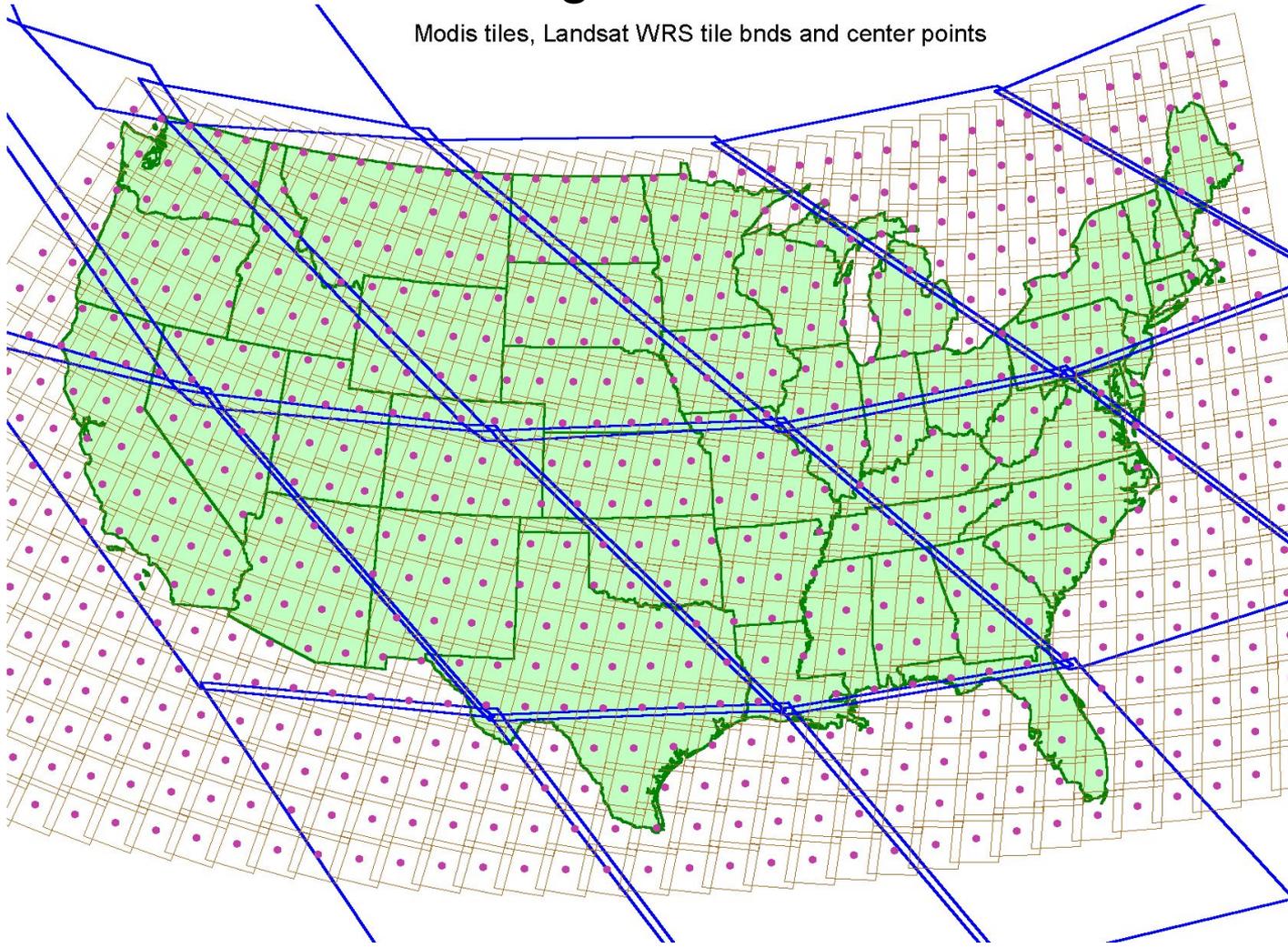
Bands 8-36: 1000m



MODIS Tiles vs. Landsat Images

Large swaths!

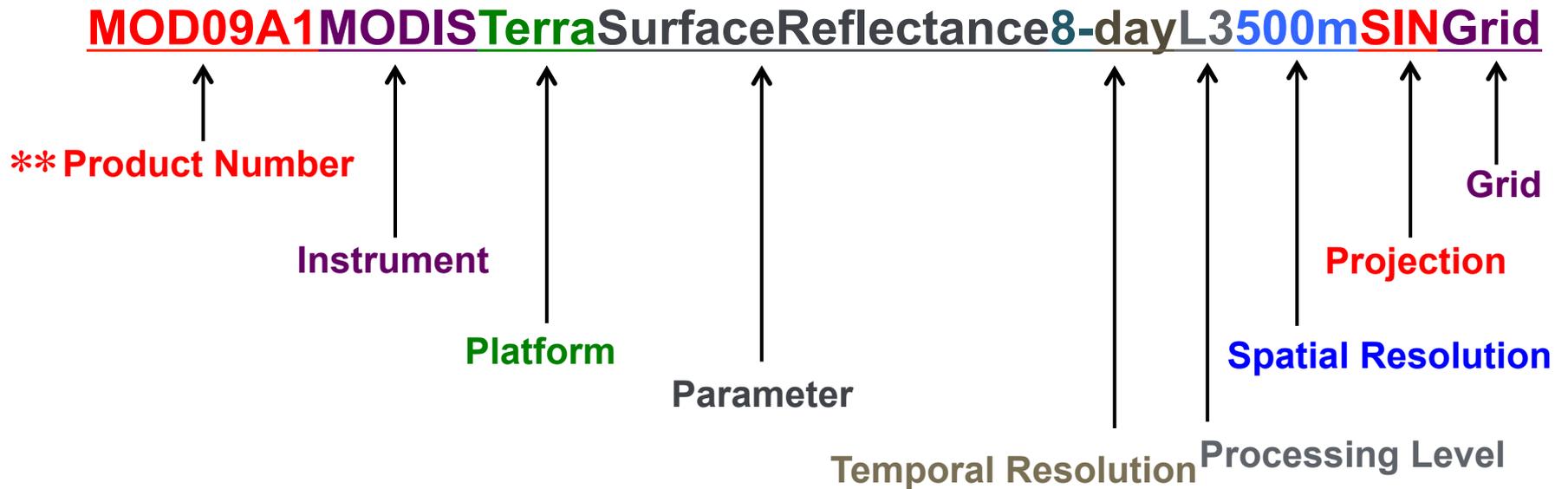
Modis tiles, Landsat WRS tile bnds and center points





MODIS Naming Convention

MODIS filenames follow a naming convention which gives useful information regarding the specific product. For Example:



****NOTE: MOD – Terra; MYD – Aqua; MCD - Combined**



MODIS Land Products

All MODIS Land Products are available at processing Level 3

Short name

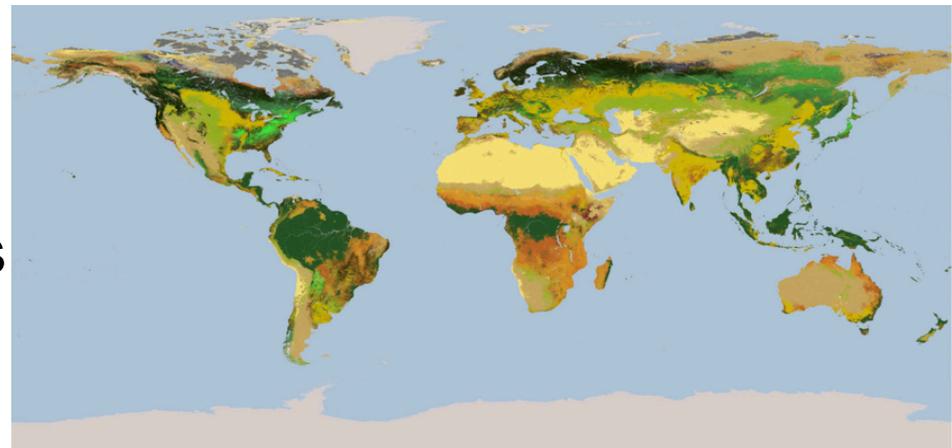
MODIS Name

MODIS Name	Product Name	Spatial Resolution (m)	Temporal
MOD 09	Surface Reflectance	500	8-day
MOD 11	Land Surface Temperature	1000	Daily, 8-day
MOD 12	Land Cover/Change	500	8-day, Yearly
MOD 13	Vegetation Indices	250-1000	16 day, monthly
MOD 14	Thermal Anomalies/Fire	1000	Daily, 8-day
MOD 15	Leaf Area Index/Fraction of Absorbed Photosynthetically Active Radiation (FPAR)	1000	4-day, 8-day
MOD 16	Evapotranspiration		
MOD 17	Primary Production	1000	8-day, yearly
MOD 43	Bidirectional reflectance distribution function (BRDF)/Albedo	500-1000	16-day
MOD 44	Vegetation Continuous Fields	250	yearly
MOD 45	Burned Area	500	monthly



MODIS Land Products: Land Cover (MCD12Q1)

- Yearly 500 meter product
- Primary Land Cover Type Scheme: International Geosphere Biosphere Program (IGBP) global vegetation classification scheme
 - 11 vegetation classes
 - 3 developed classes
 - 3 non-vegetated classes



0 Water	6 Closed Shrublands	12 Croplands
1 Evergreen Needleleaf Forest	7 Open Shrublands	13 Urban and Built-Up
2 Evergreen Broadleaf Forest	8 Woody Savannas	14 Cropland/Natural Veg. Mosaic
3 Deciduous Needleleaf Forest	9 Savannas	15 Snow and Ice
4 Deciduous Broadleaf Forest	10 Grasslands	16 Barren or Sparsely Vegetated
5 Mixed Forests	11 Permanent Wetlands	17 Tundra



MODIS Land Products: Vegetation Indices (MOD13Q1/MOD13A1)

- **NDVI** (Normalized Difference Vegetation Index): Ratio between the red and the Near-Infrared bands
- **EVI** (Enhanced Vegetation Index): Addition of the blue band to account for atmosphere
- Used for: drought monitoring, phenology (timing of vegetation green-up)

Vegetation index data demonstrates part of the seasonal cycle in the contiguous US during the first half of 2001

Credit: NASA/GSFC/University of Arizona



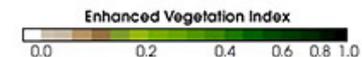
January 1-16, 2001



March 22-April 6, 2001



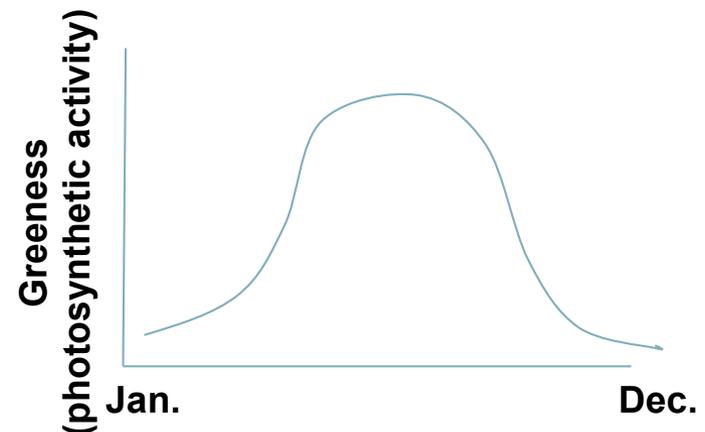
May 25-June 9, 2001



MODIS Land Products: Land Cover Dynamics (MCD12Q2)



- ❑ Informally called the MODIS Global Vegetation Phenology product
- ❑ Provides estimates of the timing of vegetation phenology
- ❑ Primarily uses MODIS EVI
- ❑ Layers correspond to timing of vegetation greenup, maturity, senescence and dormancy:
 - ❑ Onset_greeness_increase
 - ❑ Onset_greeness_maximum
 - ❑ Onset_greeness decrease
 - ❑ Onset_greeness_minimum

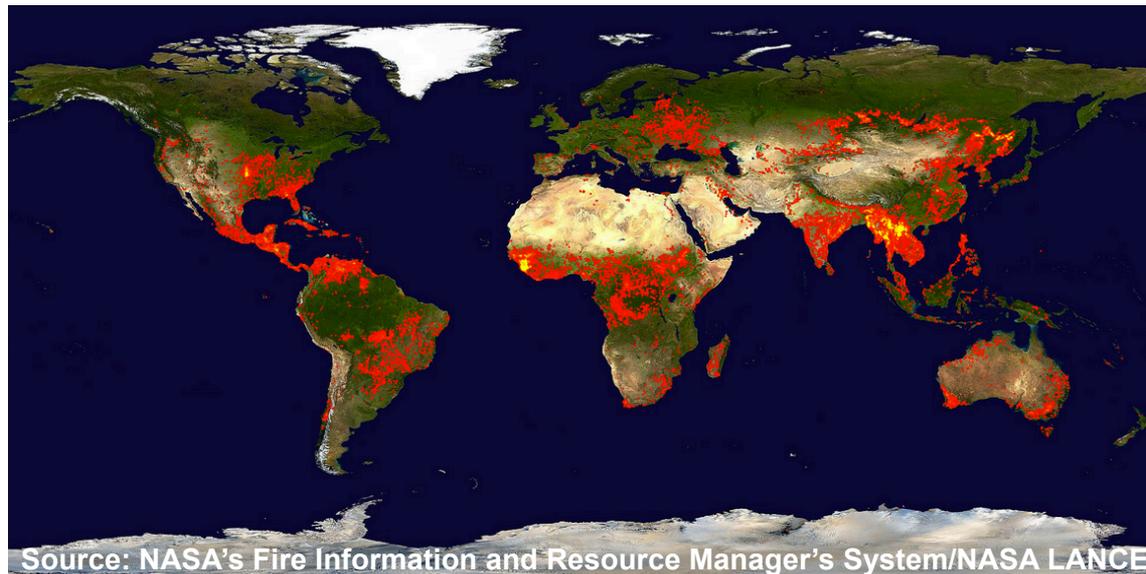




MODIS Land Products: Thermal Anomalies (MYD14A1)

- ❑ Provides snapshots of active burning fires and burned areas
- ❑ The Active Fire product delivers actively burning locations on a daily basis at 1km resolution (additional 8 day and monthly products)
- ❑ Fire product includes multiple attributes such as fire mask, fire pixel table, and maximum fire radiative power
- ❑ The Thermal Anomalies product detects other thermal anomalies such as volcanic signatures

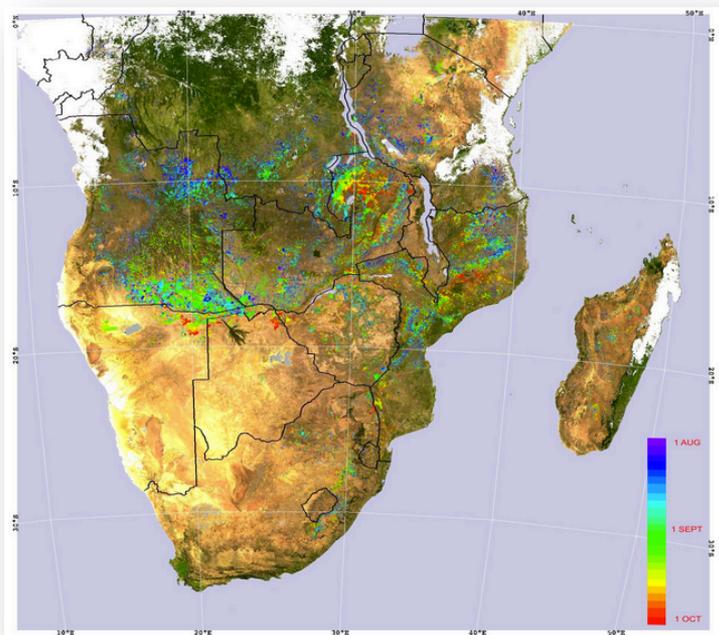
Global Fire Map (April 1- April 10, 2014)



MODIS Land Products: Burned Area (MCD45A1)



- The combined Terra & Aqua MODIS Burned Area Product is a monthly gridded 500m product
- MODIS detects the approximate date of burning at 500m resolution
- For more information: <http://modis-fire.umd.edu>



Example of the MODIS 500 m burned area product for sub equatorial Africa. The different colors indicate the approximate day of the burning detected between August and October in 2000.

Image courtesy of MODIS Fire Team

Where to Obtain Information on MODIS (and other) NASA Products



- Land Processes Distributed Active Archive (LP DAAC)
 - https://lpdaac.usgs.gov/products/modis_products_table
- Earth Observing System Data and Information System (EOSDIS):
 - <http://Earthdata.nasa.gov>

The screenshot displays the Earthdata.nasa.gov website interface. At the top, there are six circular icons representing different Earth system components: Atmosphere, Calibrated Radiance and Solar Radiance, Cryosphere, Human Dimensions, Land, and Ocean. Below these icons is a navigation bar with tabs for 'Earthdata News Feeds', 'EOSDIS News', and 'Sensing Our Planet'. The 'Earthdata News Feeds' section lists various data centers: GES-DISC, GHRC, LaRC ASDC, LP DAAC, NSIDC DAAC, ORNL DAAC, PO DAAC, SEDAC, GCMD, and ESIIP Federation. The 'EOSDIS News' section features several news items with accompanying images and links to more information. The 'Sensing Our Planet' section includes news about the 2014 Gregory G. Leptoukh 2nd Annual Online Giovanni Workshop, the status of rapid response servers, a webinar on Landsat data, and toolsets for airborne data (TAD). An 'Events Calendar' section at the bottom lists upcoming events such as the 2014 Gregory G. Leptoukh 2nd Annual Online Giovanni Workshop, the American Geophysical Union (AGU) Fall Meeting, and the Federation of Earth Science Information Partners (ESIIP) Winter Meeting.



Where to Obtain MODIS Images

- ❑ ECHO Reverb
 - ❑ <http://reverb.echo.nasa.gov>
- ❑ Data Subsetting and Visualization: Oakridge National Lab DAAC (ORNL DAAC)
 - ❑ <http://daac.ornl.gov>
- ❑ GLCF
 - ❑ <http://www.landcover.org/data/lc>
- ❑ GLOVIS
 - ❑ <http://glovis.usgs.gov>
- ❑ Fire Information for Resource Management System (FIRMS)
 - ❑ <https://earthdata.nasa.gov/data/near-real-time-data/firms>



Where to Obtain MODIS Images

- ❑ Worldview (Fires, Land Surface Temperature and Snow Cover)
 - ❑ <https://earthdata.nasa.gov/labs/worldview/>
- ❑ Visualization: SERVIR
 - ❑ <https://www.servirglobal.net/Global/MapsData/InteractiveMapper.aspx>
- ❑ MRTWeb
 - ❑ <http://mrtweb.cr.usgs.gov>



MRTWeb Demo



Helpful MODIS Websites

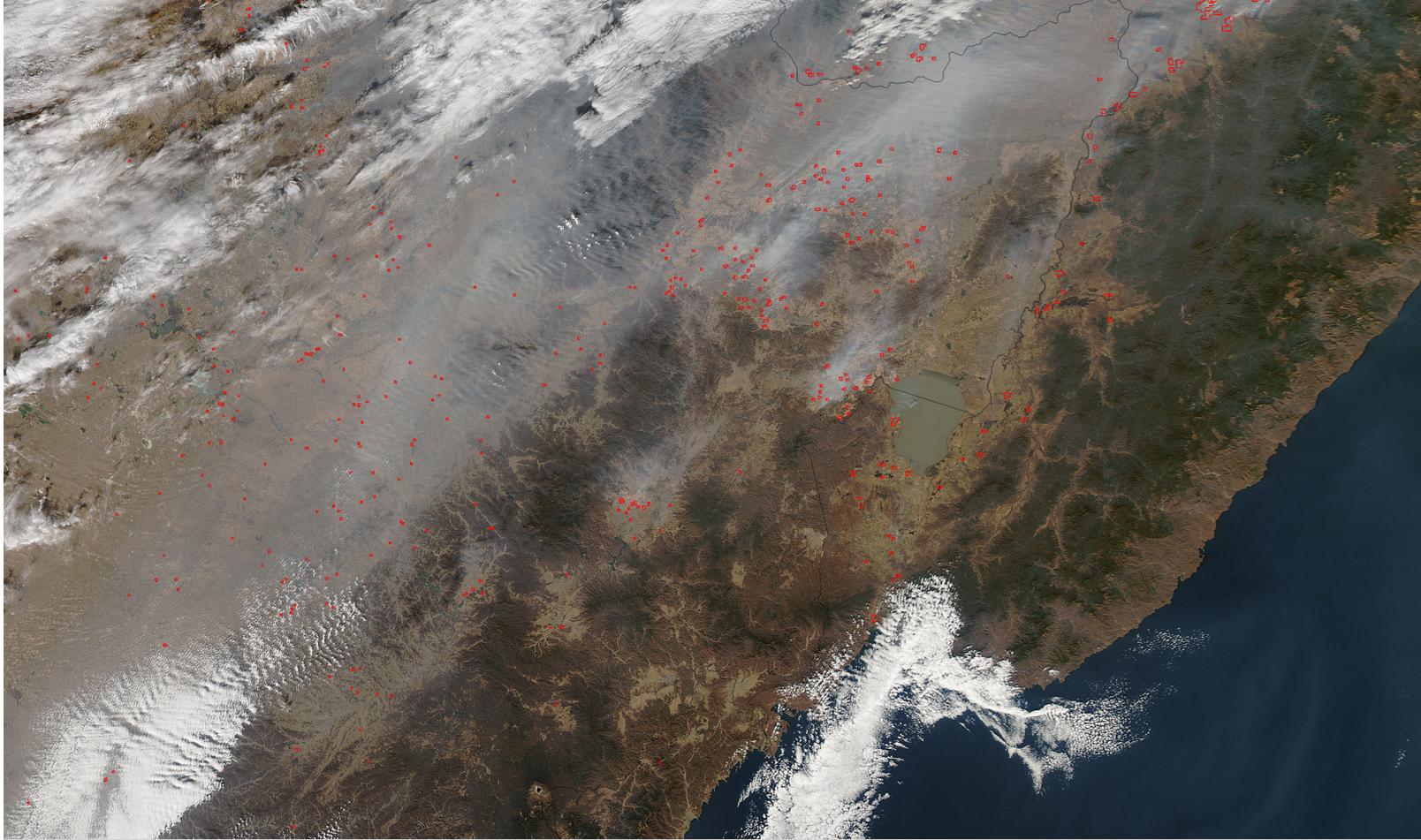
- ❑ Measuring NDVI and EVI:
 - ❑ <http://earthobservatory.nasa.gov/Features/MeasuringVegetation/>
- ❑ MODIS Data Overview
 - ❑ <http://earthobservatory.nasa.gov/Features/MeasuringVegetation/>
- ❑ MODIS MOD13A1 16 day NDVI Data Overview
 - ❑ <http://mrtweb.cr.usgs.gov>

Coming up next week!

**Terrain Products from the Land
Processes DAAC**

MODIS
image of
small fires,
smoke and
haze in
eastern
China.

November
3, 2014



Thank You!!

Cindy Schmidt
Cynthia.L.Schmidt@nasa.gov