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

INTRODUCTION TO REMOTE SENSING DATA FOR LAND MANAGEMENT

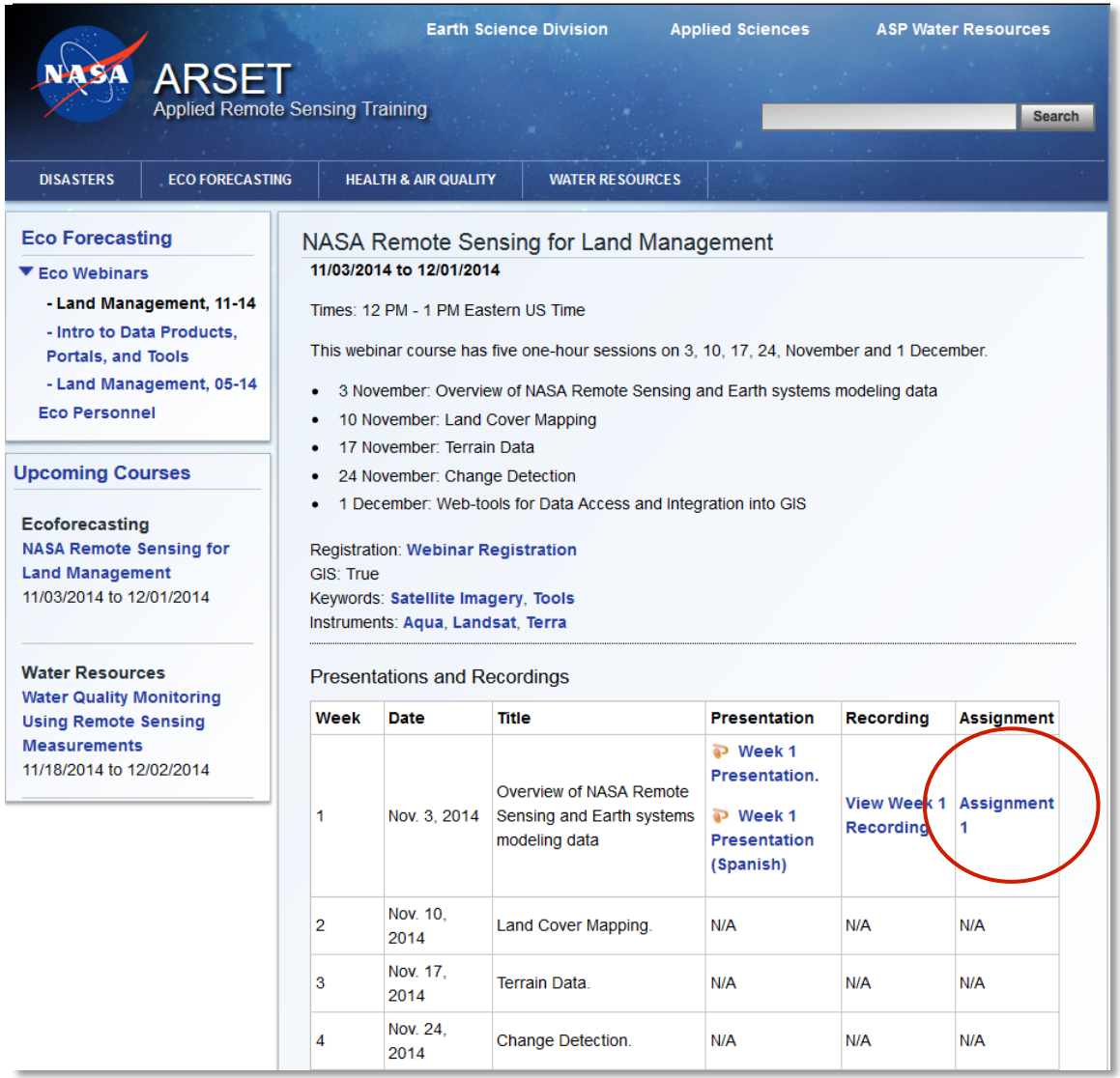
COURSE DATES: EVERY MONDAY, NOVEMBER 3- DECEMBER 1
TIME: 12PM-1PM EDT

Important Information

- Presentations URL:
  - Http://arset.gsfc.nasa.gov/webinars
- 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/

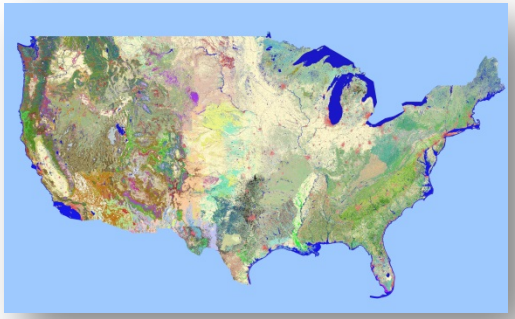


Course Outline

Week 1

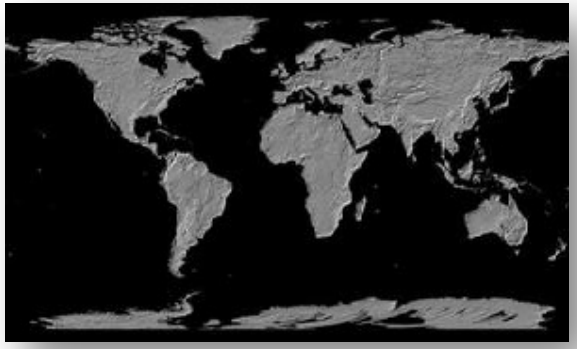
Intro. & Background: Satellite Remote Sensing

Week 2



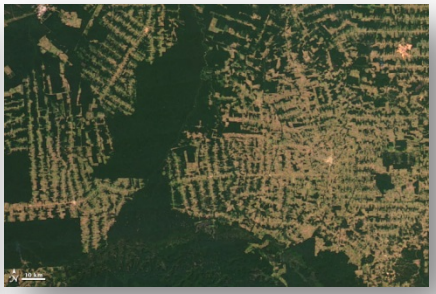
Land Cover Mapping/ Web tools for data access

Week 3



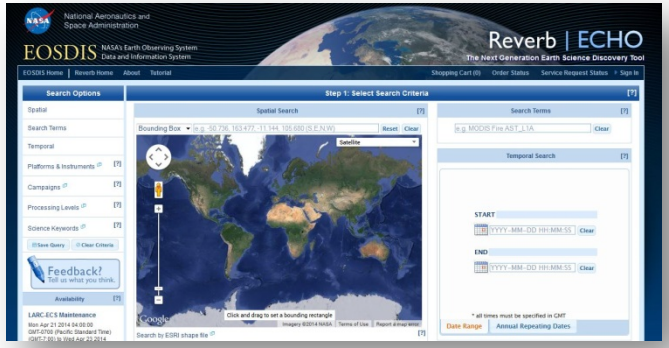
Terrain

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

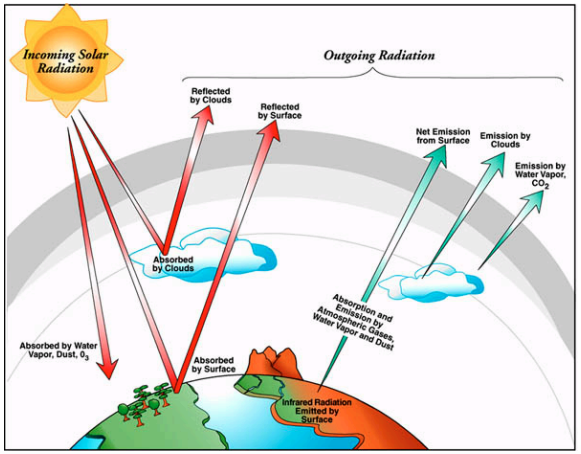
Outline

- 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

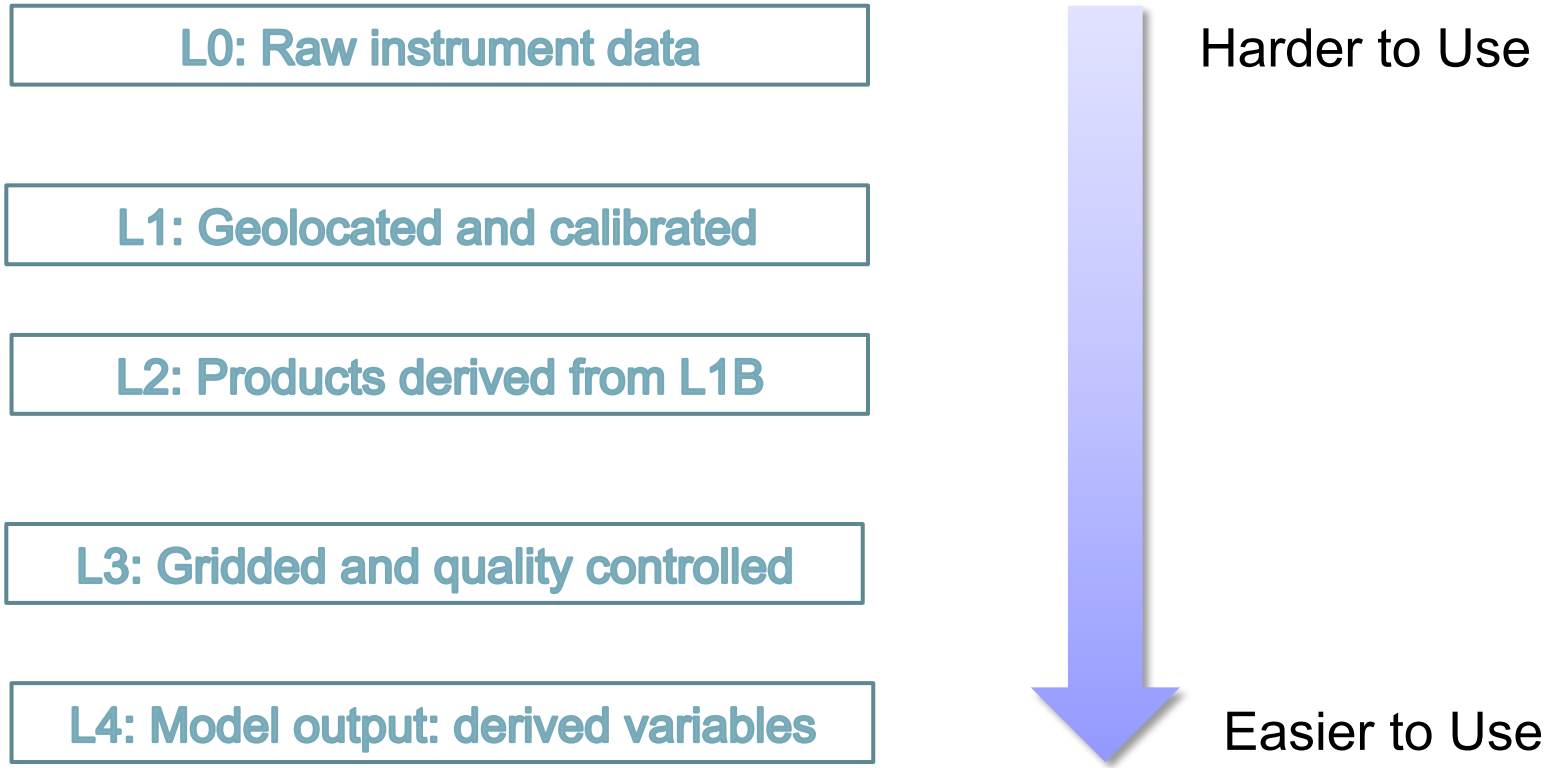
Satellite Data Processing Levels

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



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

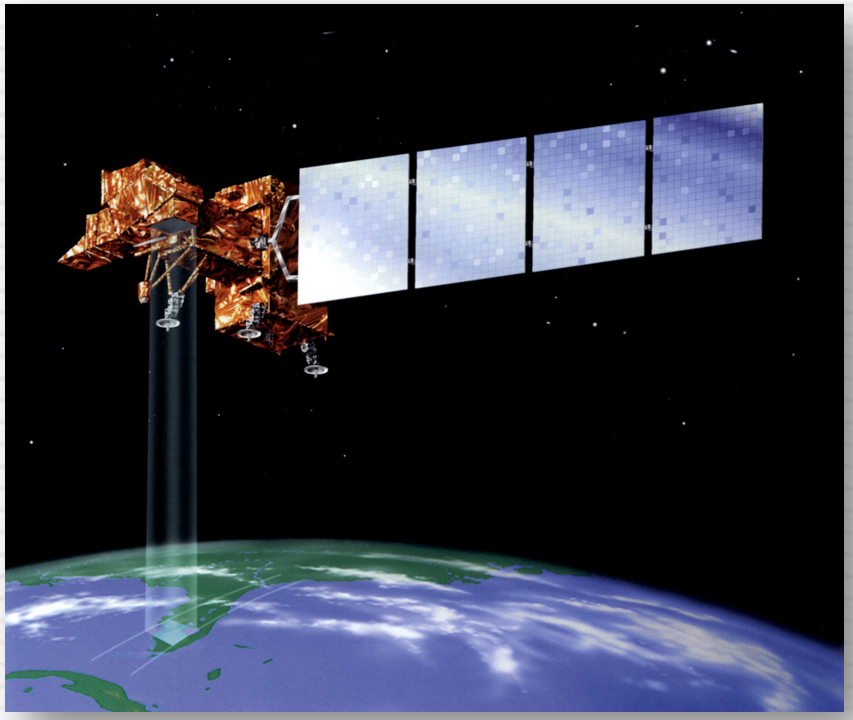
For more information on MODIS Land Products processing levels:
http://lpdaac.usgs.gov/products/modis_products_table/modis_overview

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

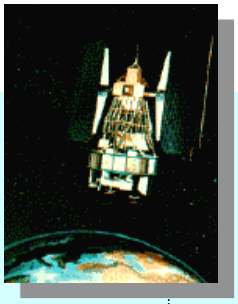
- **MODIS Land Products Overview**
  - Brief overview
  - Characteristics of MODIS data
  - MODIS Land Products and Applications (national and global)
  - Where to Obtain MODIS Products
- Live demonstration: MODIS

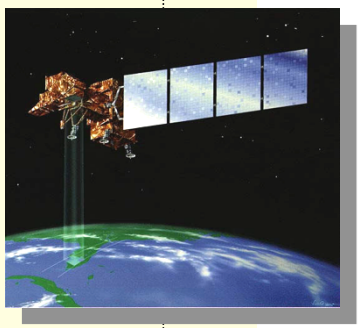
Landsat



Source: landsat.gsfc.nasa.gov

Landsat: 30 years of observations





Landsat-1 (ERTS)

Landsat-2

Landsat-3

Landsat-4

Landsat-5

Landsat-6

Landsat-7

MSS (79 m, 4 band)

TM (30/120 m, 7 band)

ETM+ (15/30/60 m, 8 band)

Landsat 8 (15/30/90 m, 9 band)

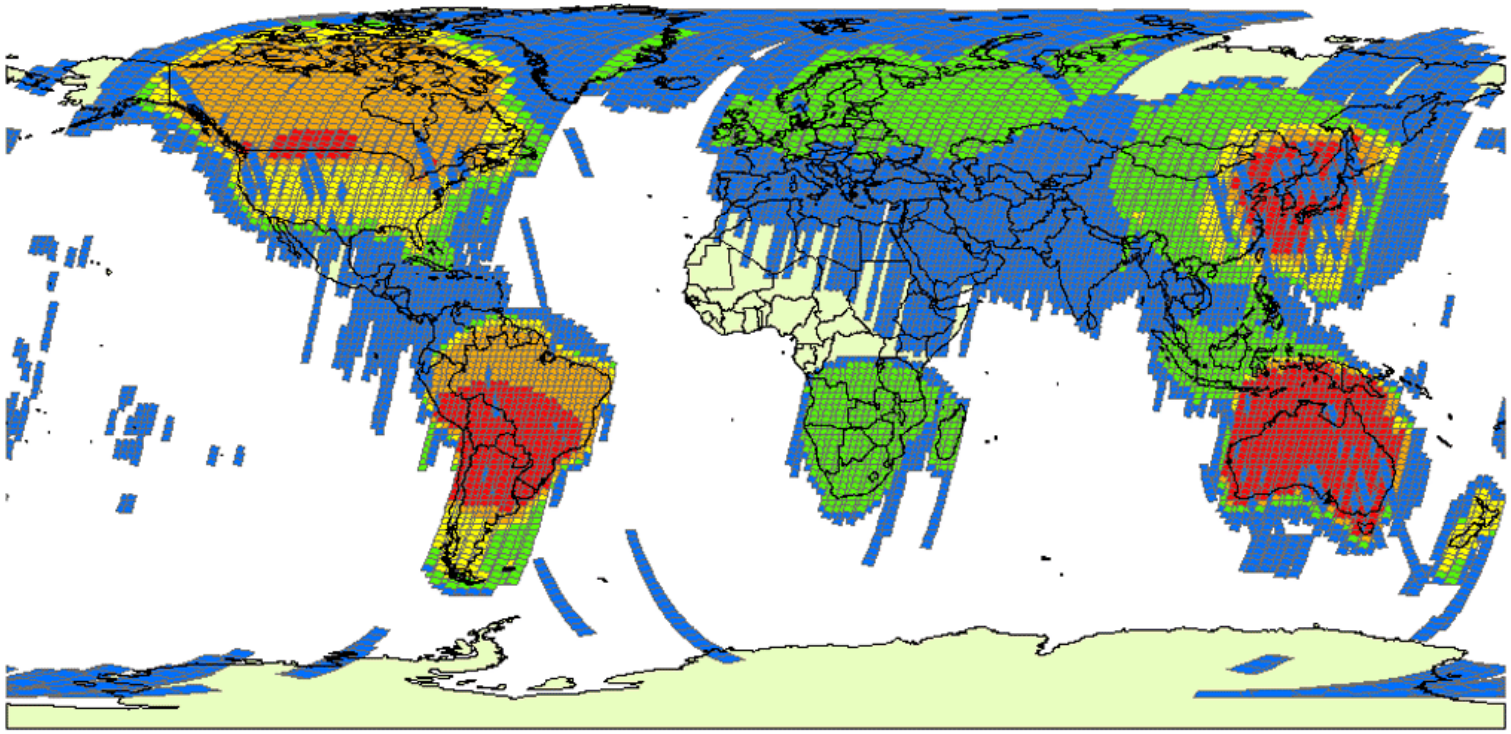
Landsat 8
Launched 11 Feb. 2013

1970 1980 1990 2000 2010

Commercial operations

Government operations

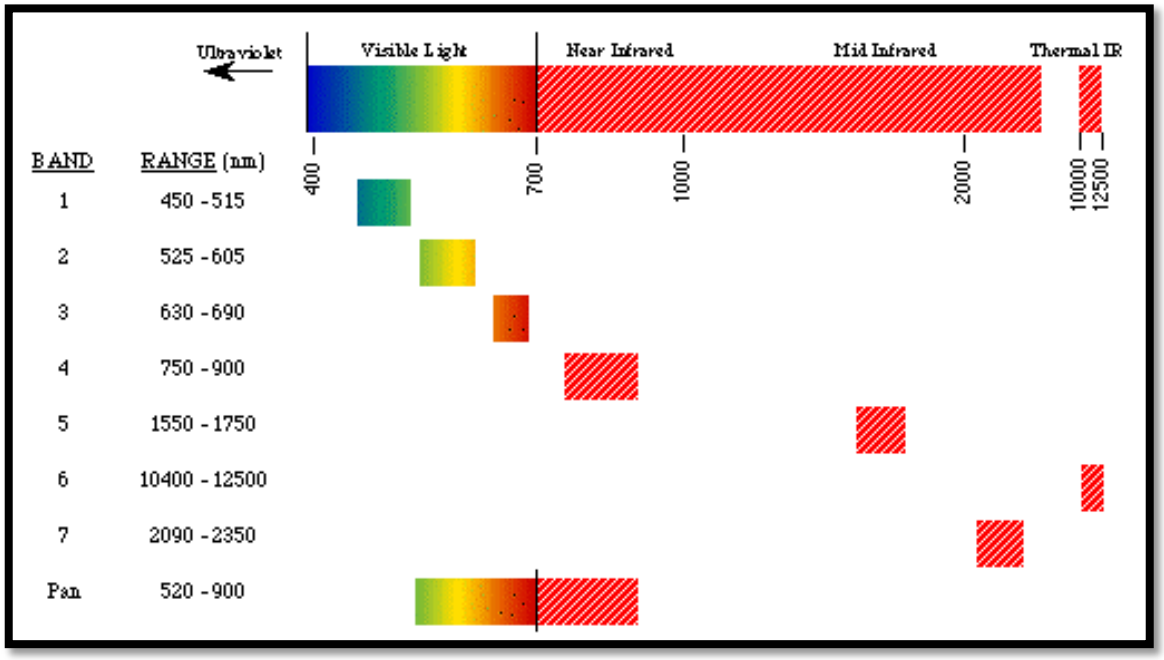
Landsat Global Archive Consolidation (USGS)



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

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

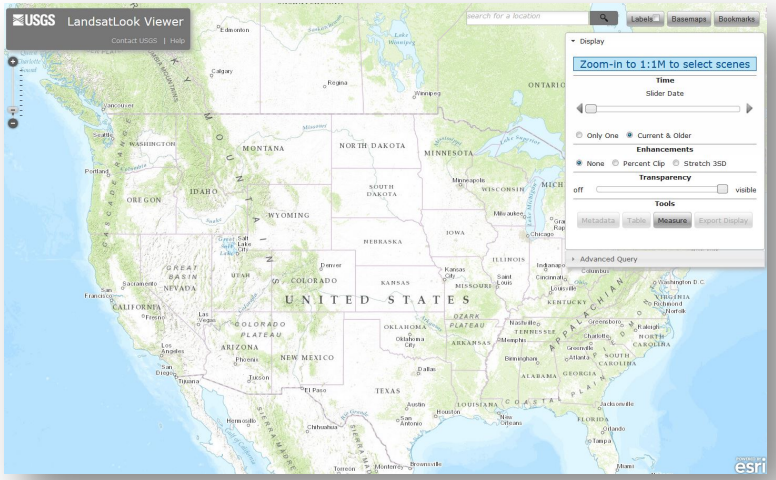
Bands	Wavelength (micrometers)	Resolution (m) Landsat 4-5 (TM)	Resolution (m) Landsat 7 (ETM+)
Band 1-Blue	0.45-0.52	30	30
Band 2 Green	0.52-0.60	30	30
Band 3- Red	0.63-0.69	30	30
Band 4-Near Infrared	0.76-0.90	30	30
Band 5- Shortwave Infrared 1	1.55-1.75	30	30
Band 6- Thermal Infrared	10.40-12.50	120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

Characteristics of Landsat 8

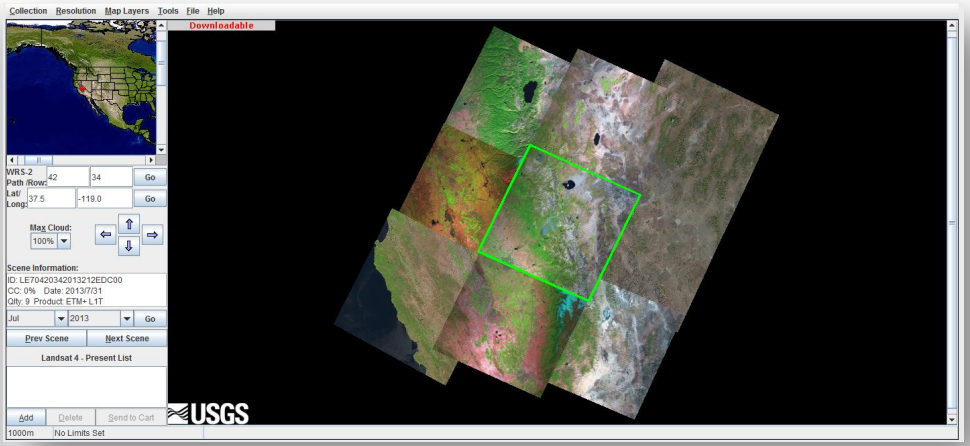
Bands	Wavelength (micrometers)	Spatial Resolution (meters)
Band 1-Coastal aerosol	0.43-0.45	30
Band 2- Blue	0.45-0.51	30
Band 3- Green	0.53-0.59	30
Band 4- Red	0.64-0.67	30
Band 5- Near Infrared	0.85-0.88	30
Band 6- SWIR 1	1.57-1.65	30
Band 7- SWIR 2	2.11-2.29	30
Band 8-Panchromatic	0.50-0.68	15
Band 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

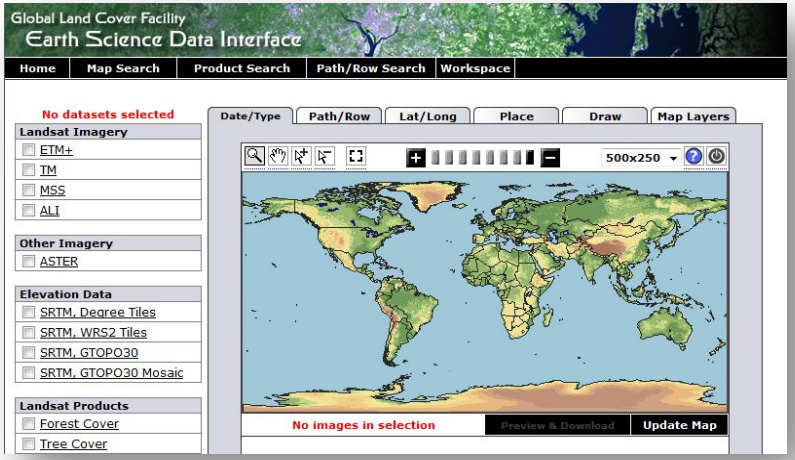
The LandsatLook Viewer



GloVis

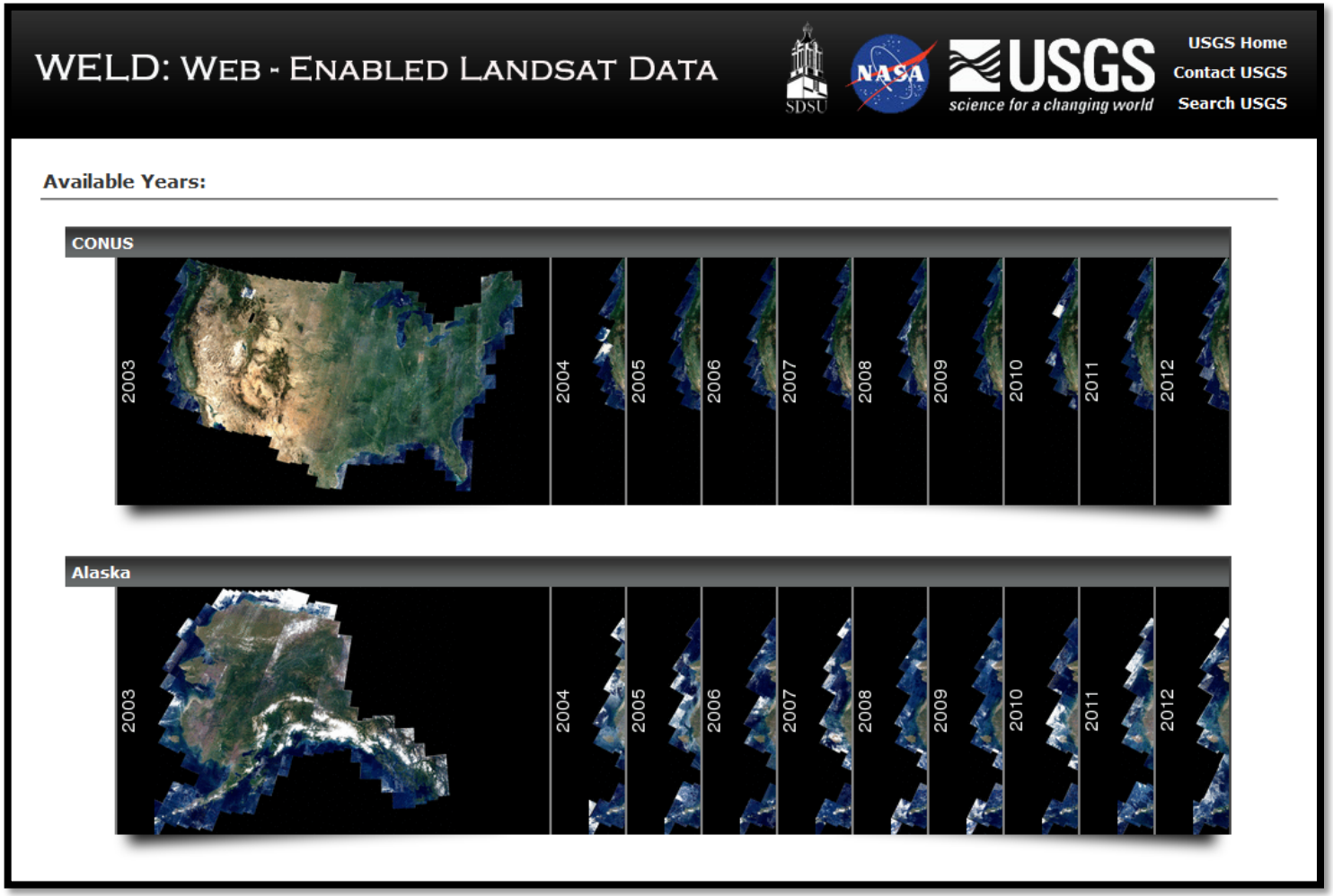


Global Land Cover Facility



Earth Explorer

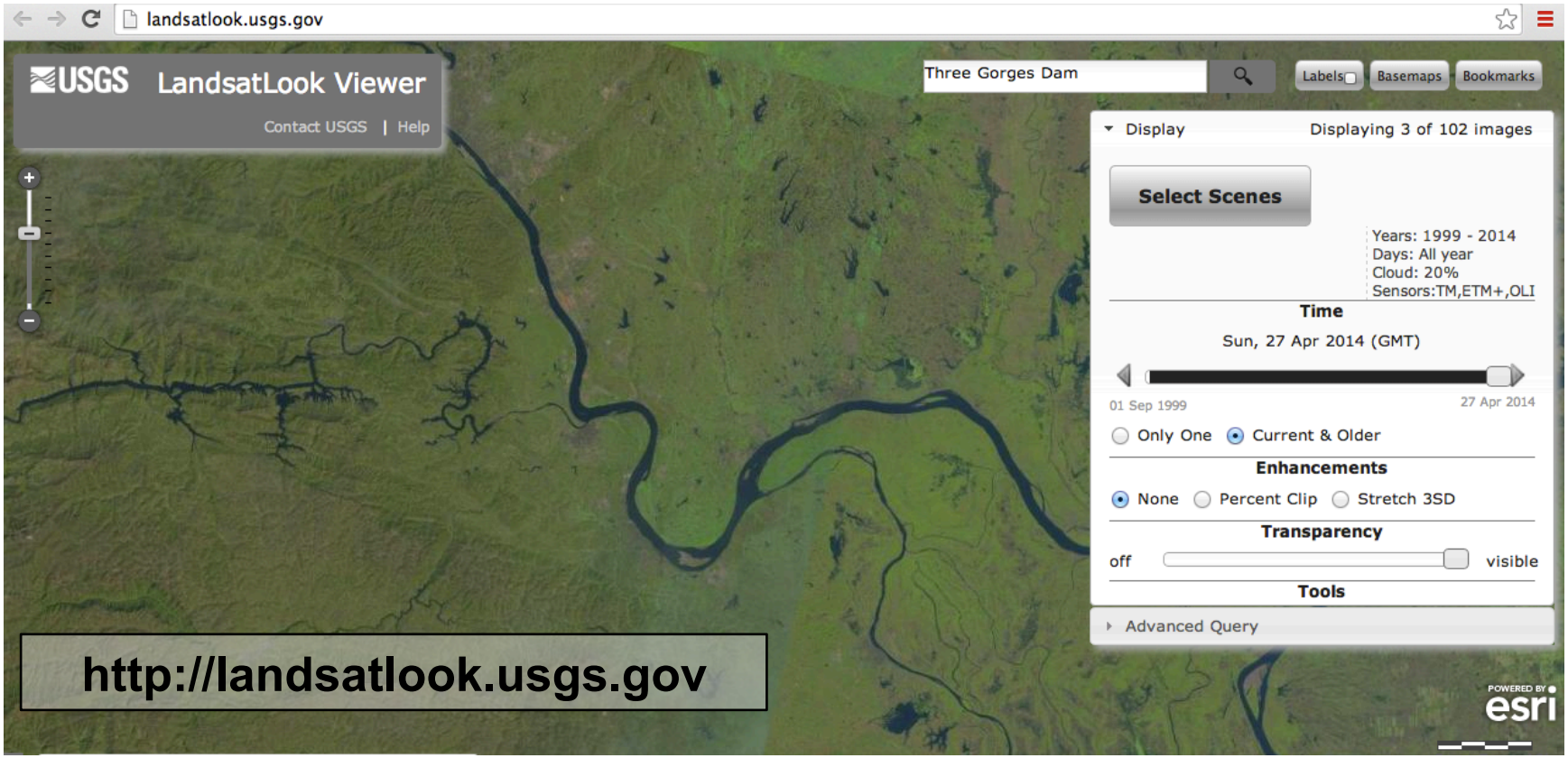
Where to Obtain Landsat Images



http://weld.cr.usgs.gov

http://globalweld.cr.usgs.gov

Acquiring Landsat Images



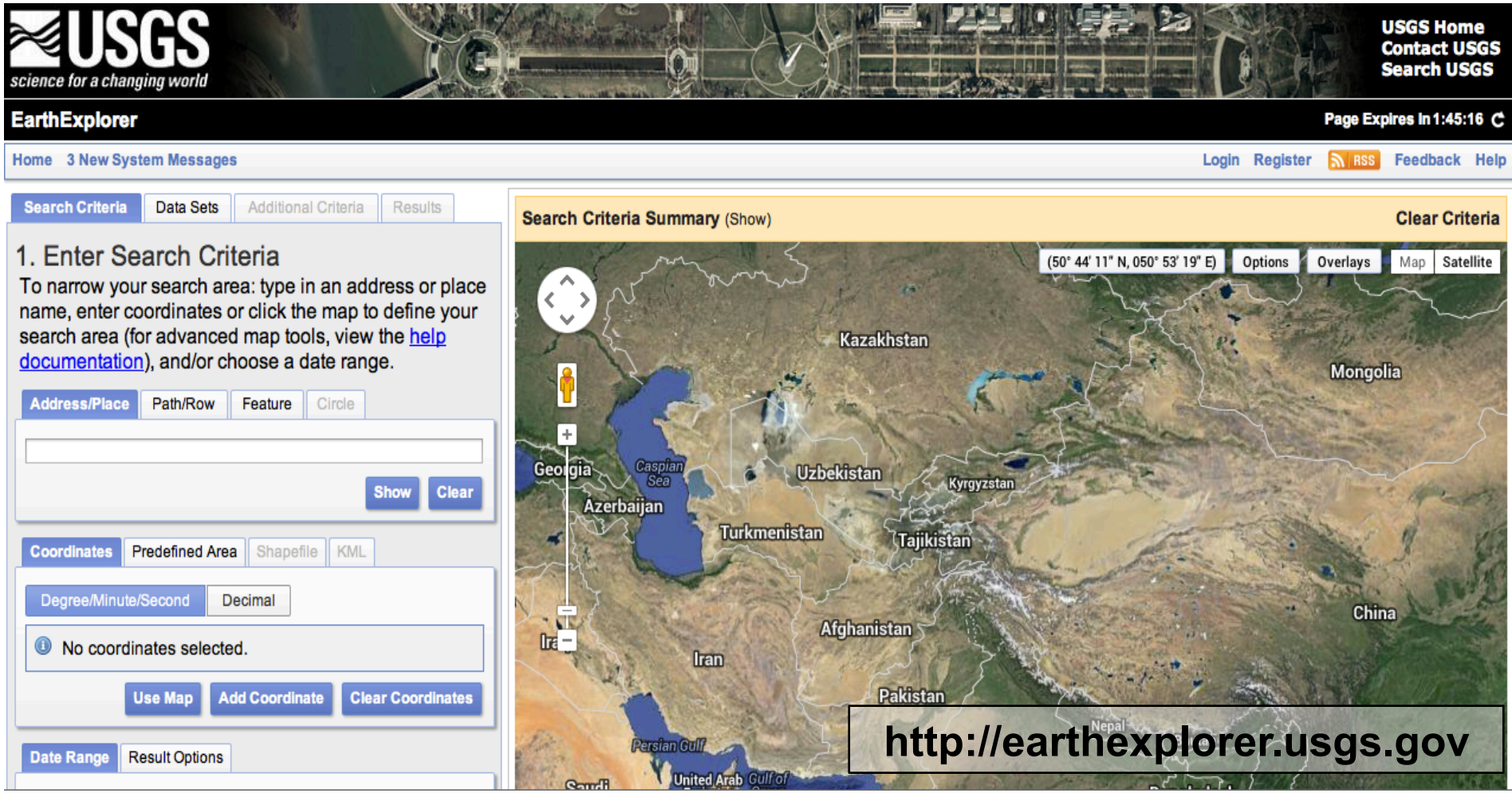
The LandsatLook Viewer

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

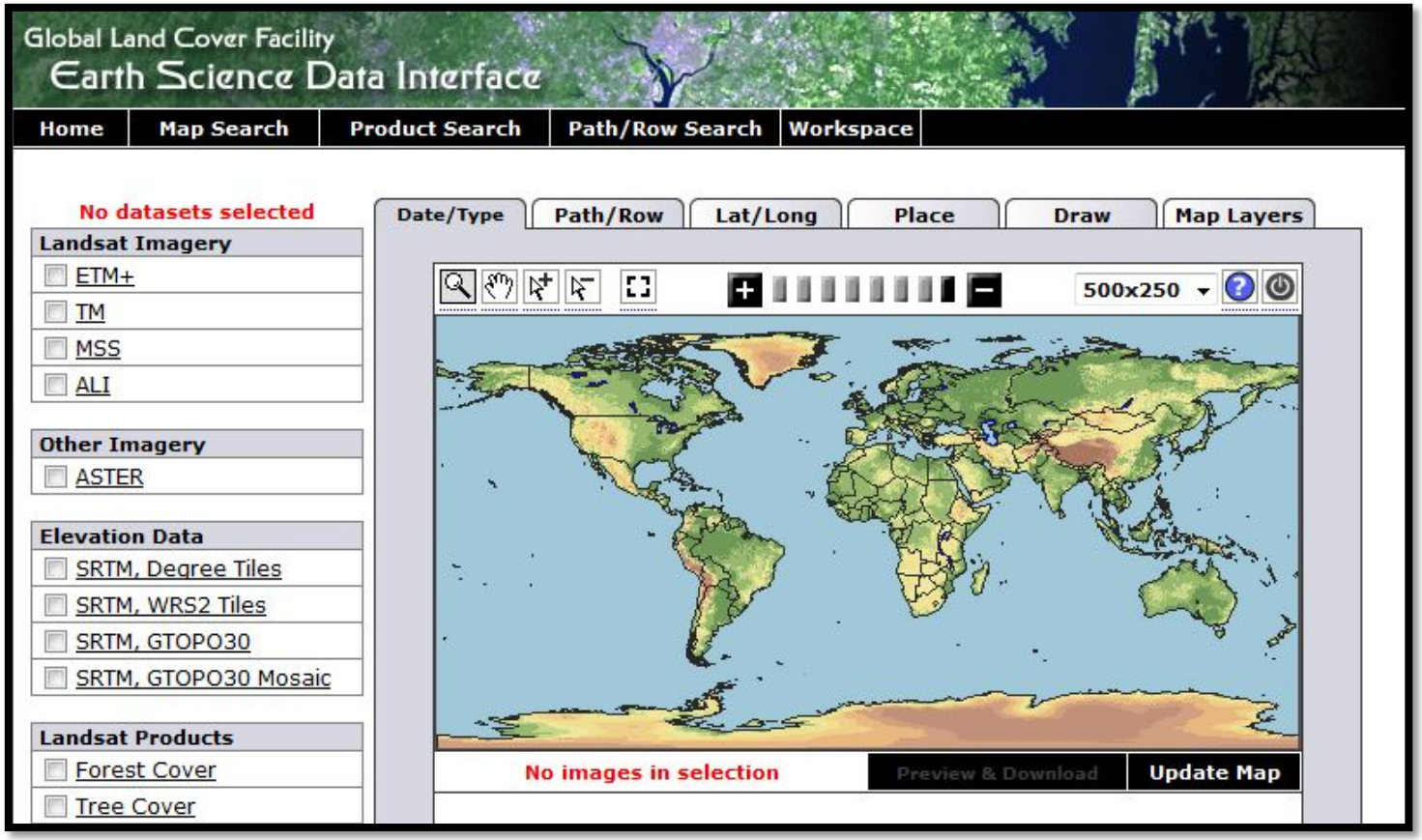
Acquiring Landsat Images

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

Acquiring Landsat Images

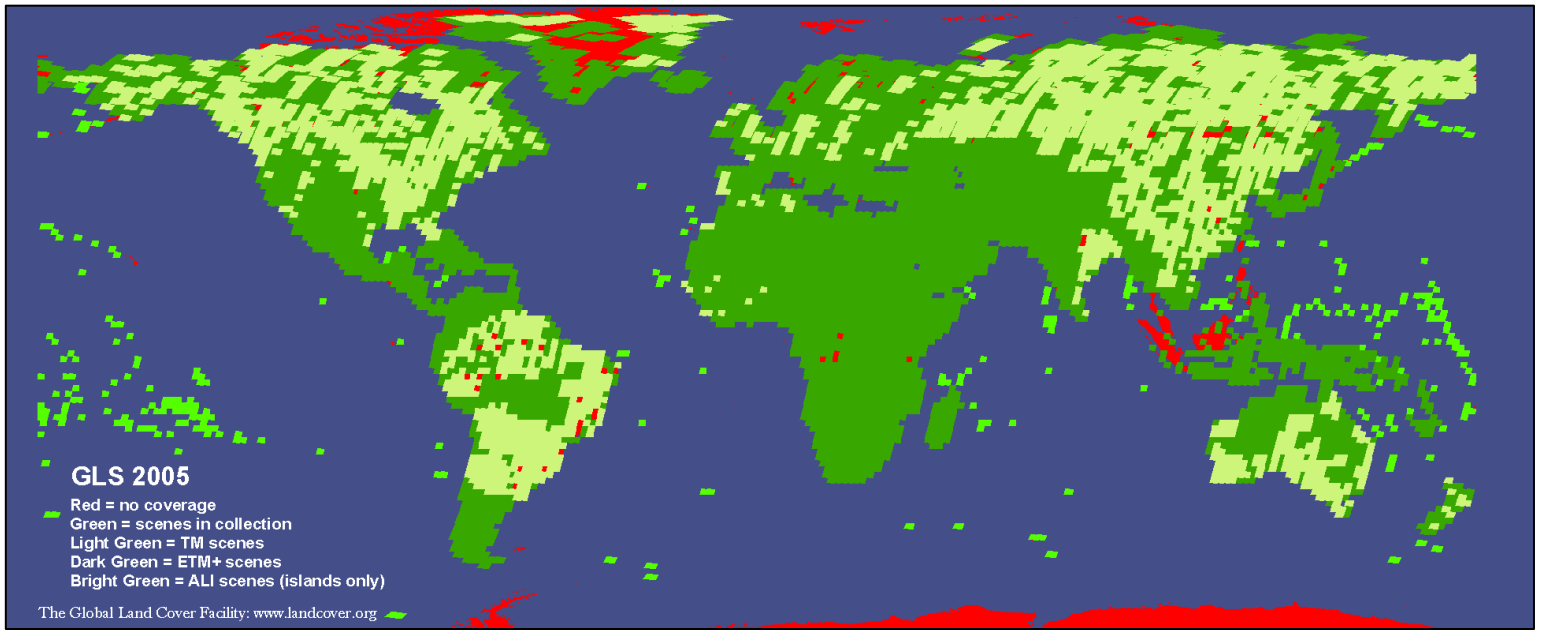


Acquiring Landsat Images



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

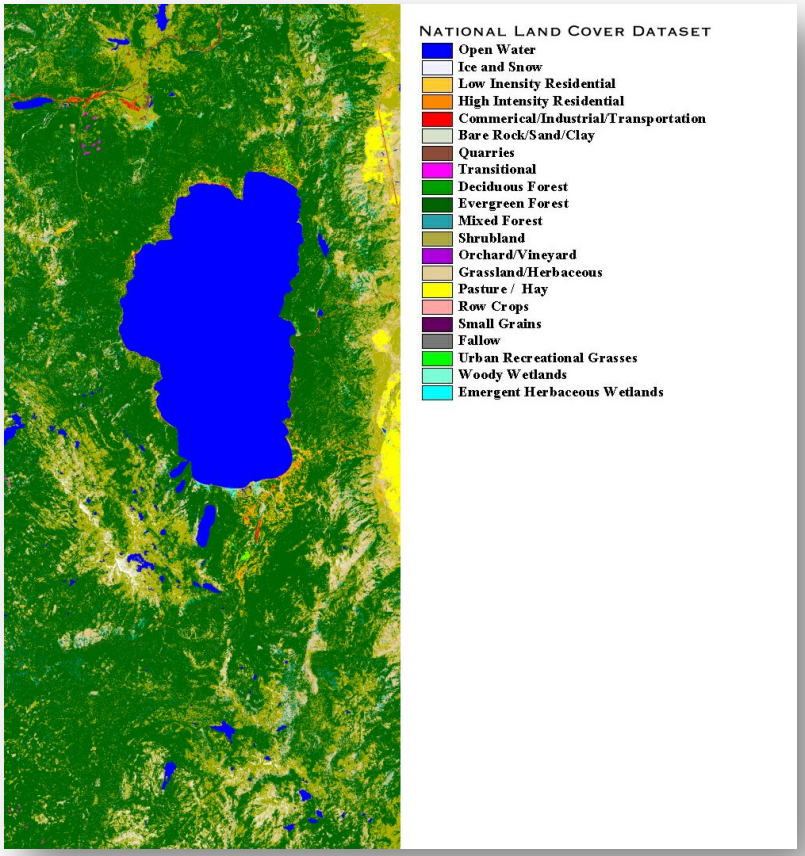
Global Land Survey (GLS)



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



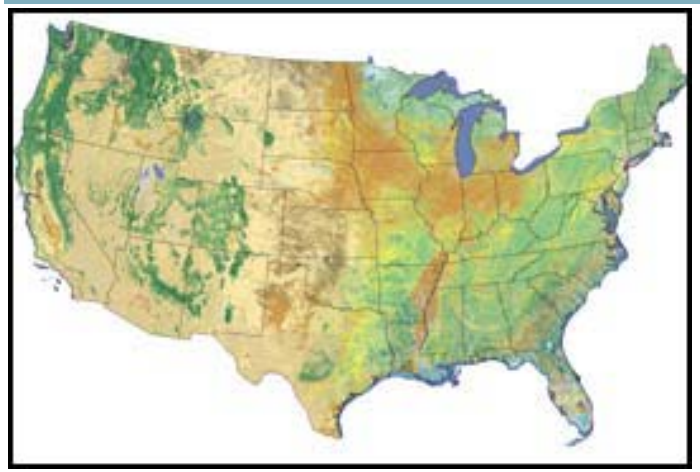
Landsat Image of Lake Tahoe

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

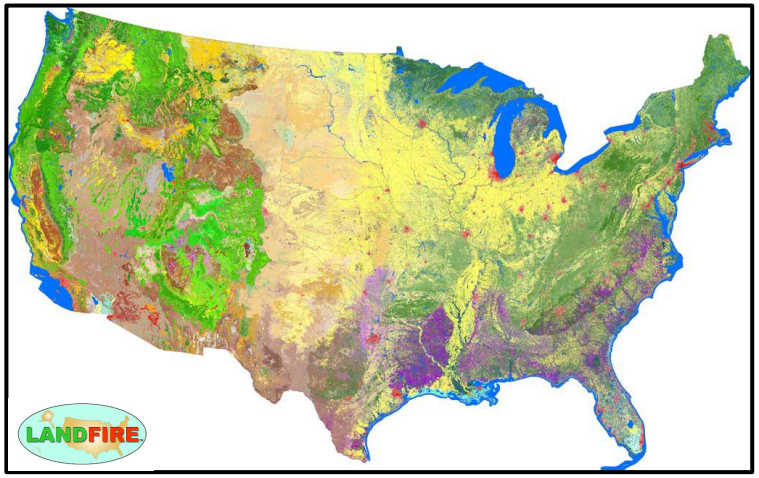
- Supported by the Multi-Resolution Land Characteristic Consortium (MLRC)
- Provides National Land Cover Mapping products at 30m resolution for 1992, 2001, 2006 and 2011.
- 16 class Land Cover classification scheme of the entire U.S. (modified from The Anderson Level 2 Classification System)
- Other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



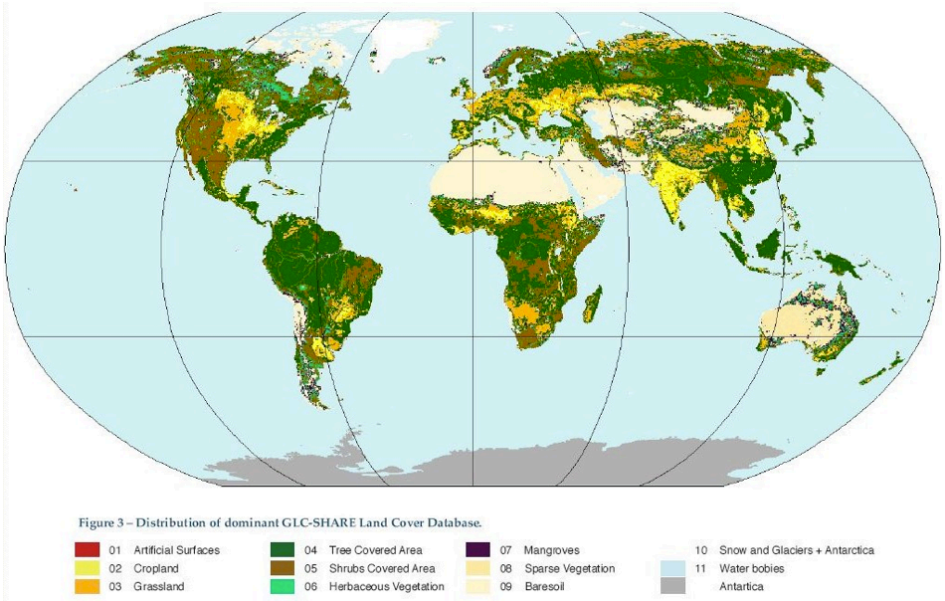
http://www.landfire.gov

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)

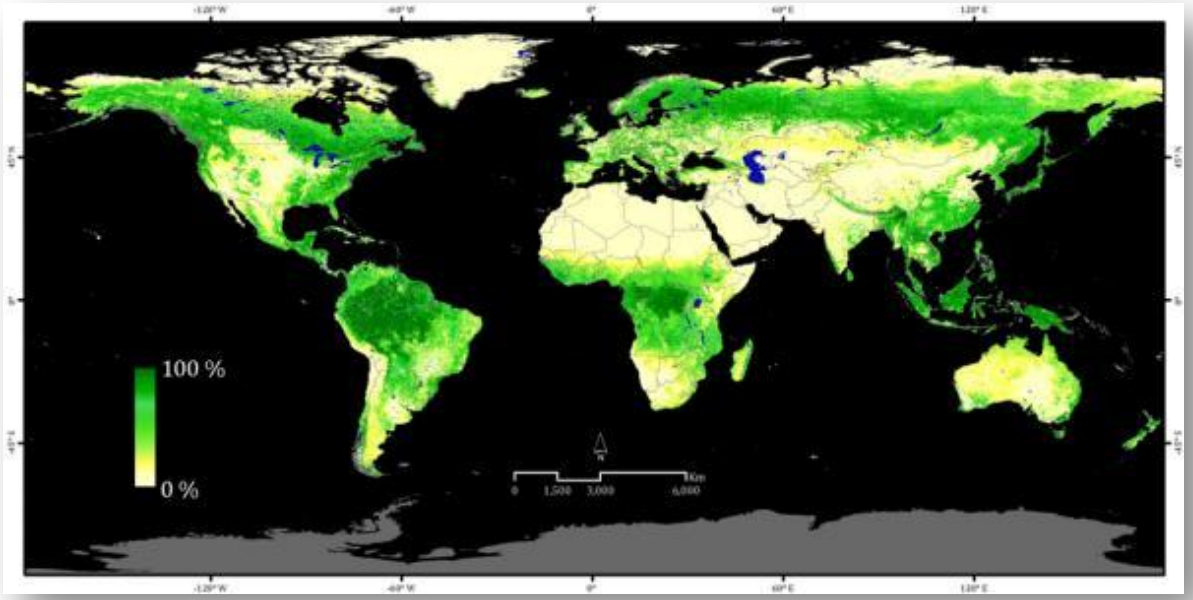
http://www.glcn.org/databases/lc_glcshare_en.jsp



- 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

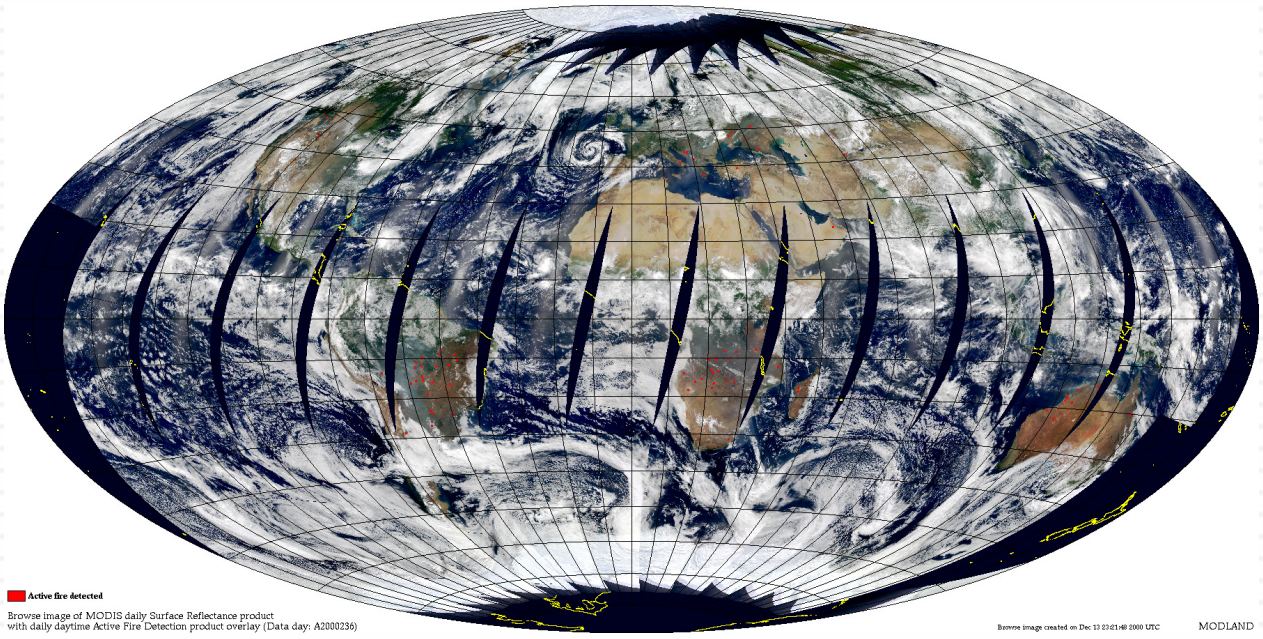
http://glcf.umd.edu/data/landsatTreecover/



source: glcf.umd.edu

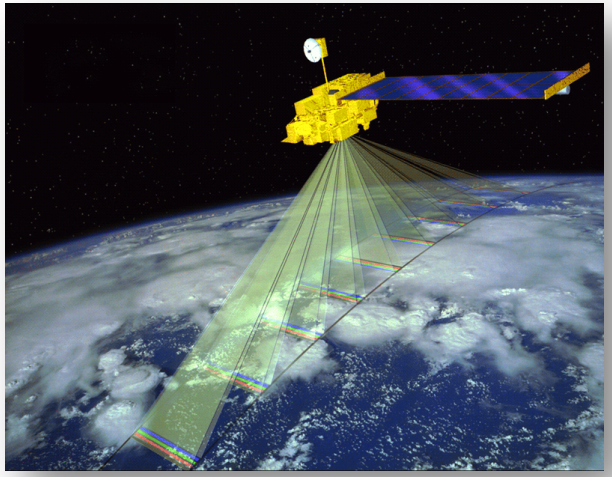
- Landsat Tree Cover layers estimate the percent of tree cover per 30m pixel area (includes stems, branches, leaves greater than 5 meters in height)
- Derived from all seven bands of Landsat 5-TM and Landsat ETM
- Landsat Tree Cover product represents 2000, 2005

MODIS



Source: earthobservatory.nasa.gov

MODIS (Moderate Resolution Imaging Spectroradiometer)



Spatial Resolution

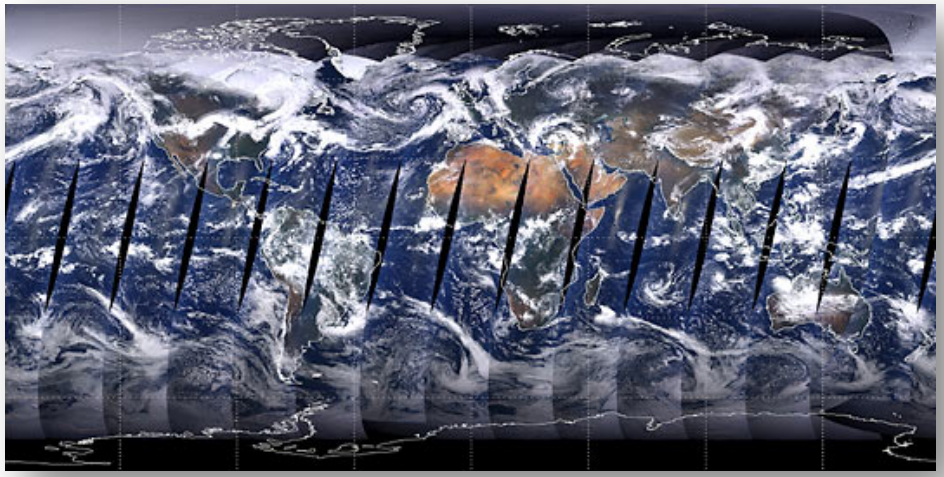
250m, 500m, 1km

Temporal Resolution

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

Data Format

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



Spectral Coverage

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

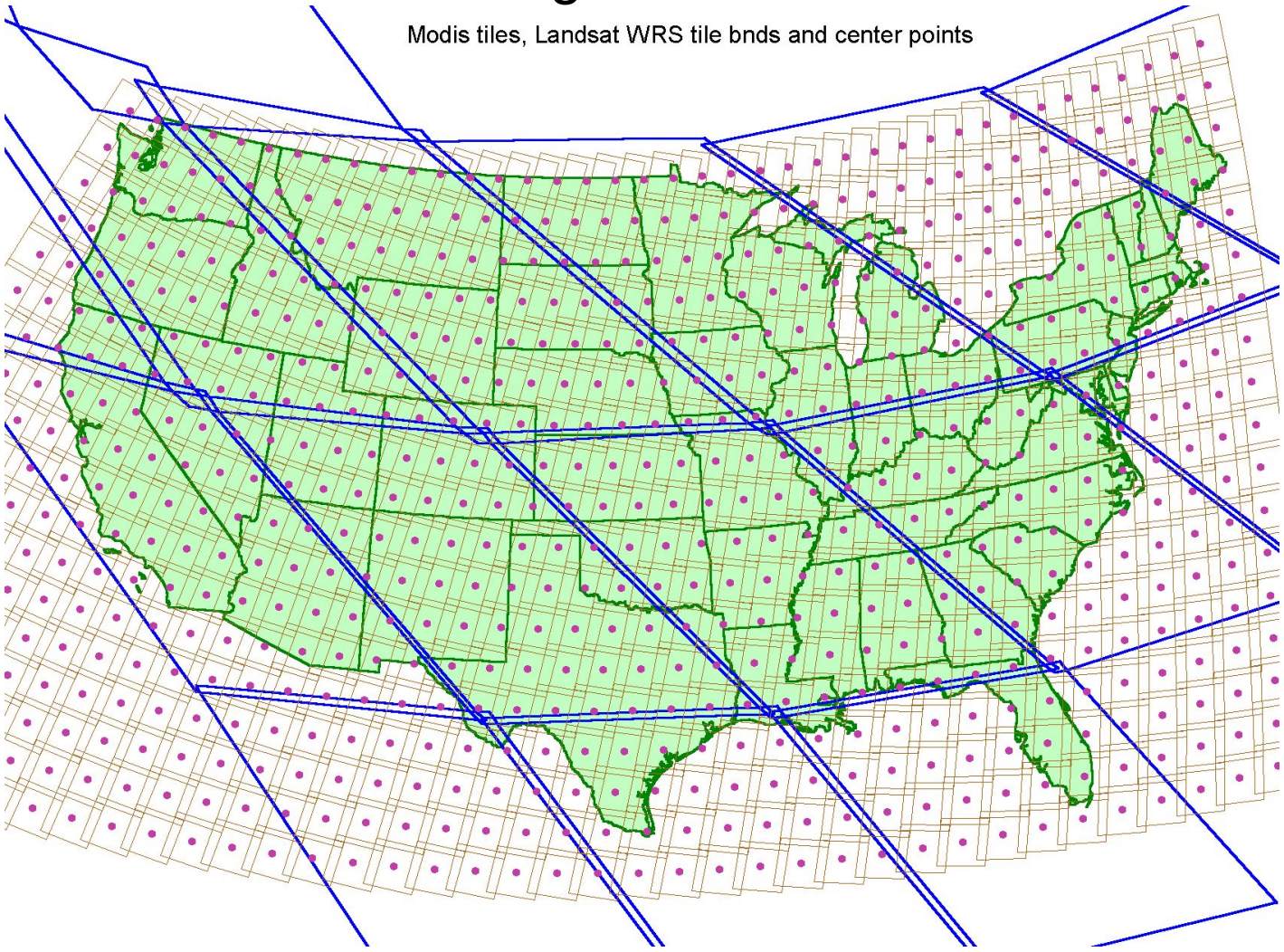
Bands 1-2: 250m

Bands 3-7: 500m

Bands 8-36: 1000m

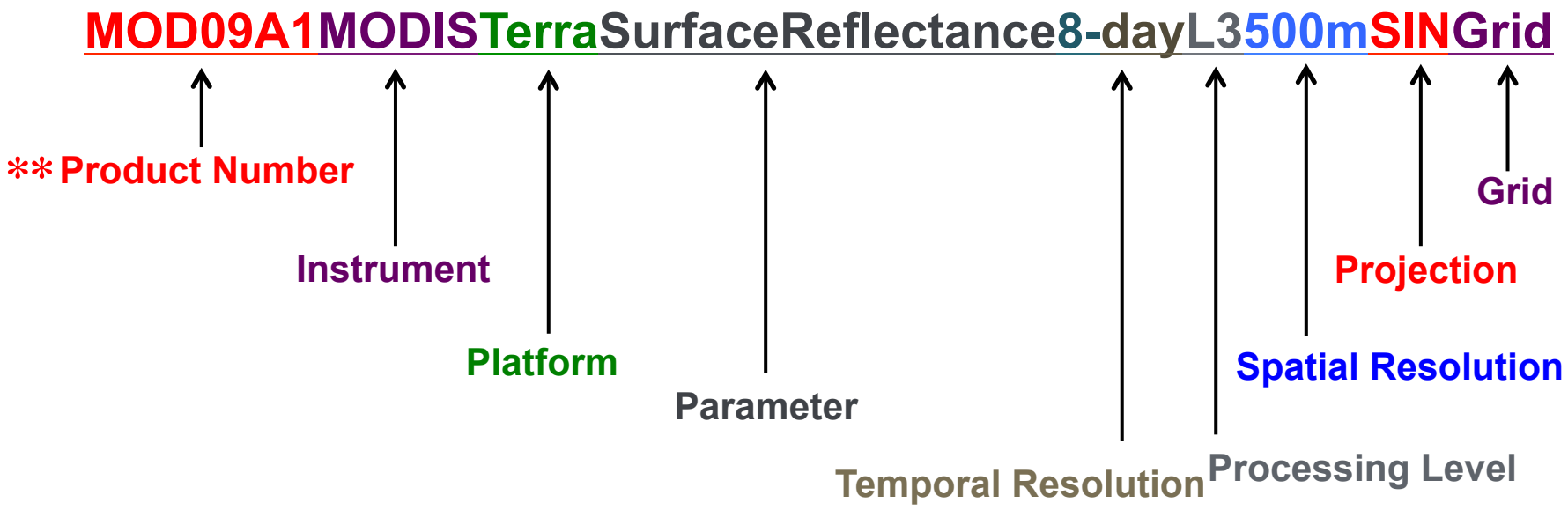
MODIS Tiles vs. Landsat Images

Large swaths!



MODIS 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

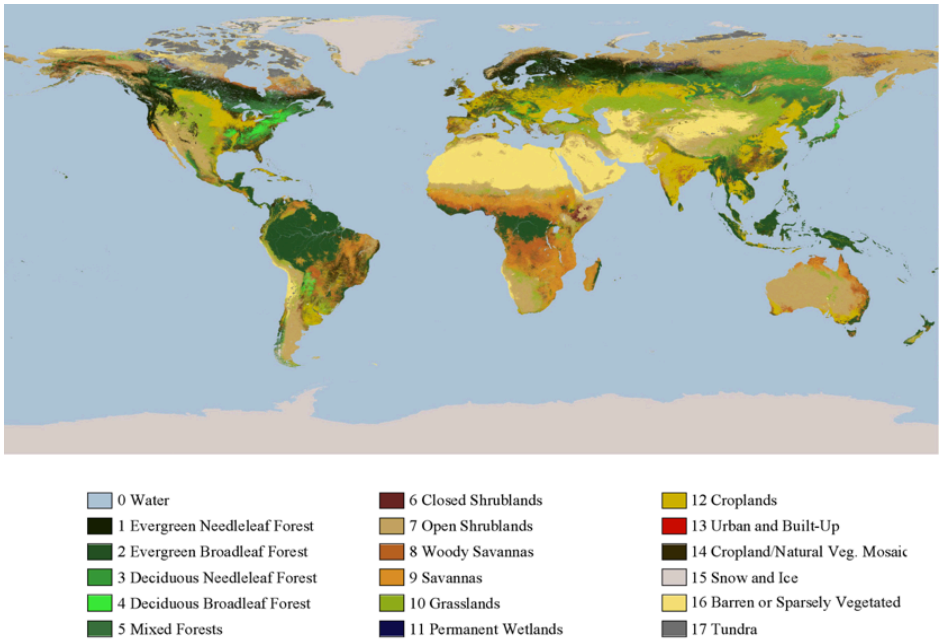
All MODIS Land Products are available at processing Level 3

Short name

MODIS Name	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

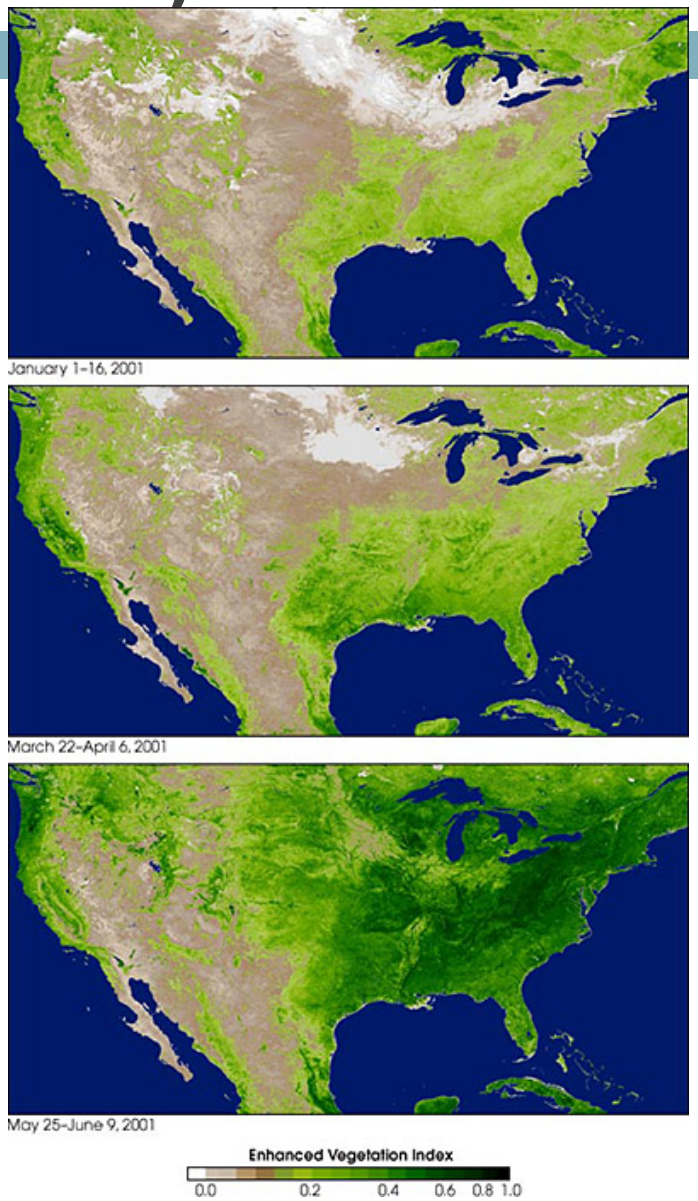
MODIS Land Products: Land Cover (MCD12Q1)

- 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



MODIS Land Products: Vegetation Indices (MOD13Q1/MOD13A1)

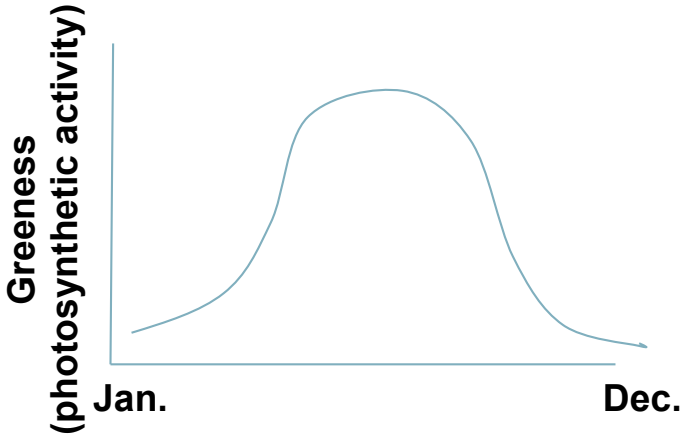
- **NDVI** (Normalized Difference Vegetation Index): Ratio between the red and the Near-Infrared bands
- **EVI** (Enhanced Vegetation Index): Addition of the blue band to account for atmosphere
- Used for: drought monitoring, phenology (timing of vegetation green-up)



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

MODIS Land Products: Land Cover Dynamics (MCD12Q2)

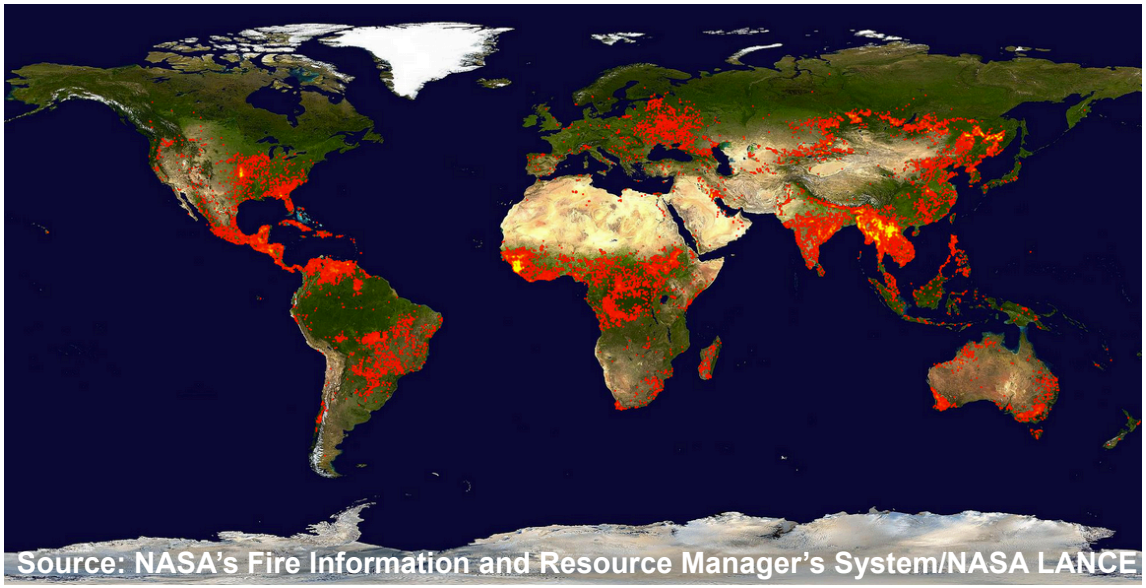
- Informally called the MODIS Global Vegetation Phenology product
- Provides estimates of the timing of vegetation phenology
- Primarily uses MODIS EVI
- Layers correspond to timing of vegetation greenup, maturity, senescence and dormancy:
  - Onset_greeness_increase
  - Onset_greeness_maximum
  - Onset_greeness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



MODIS Land Products: Thermal Anomalies (MYD14A1)

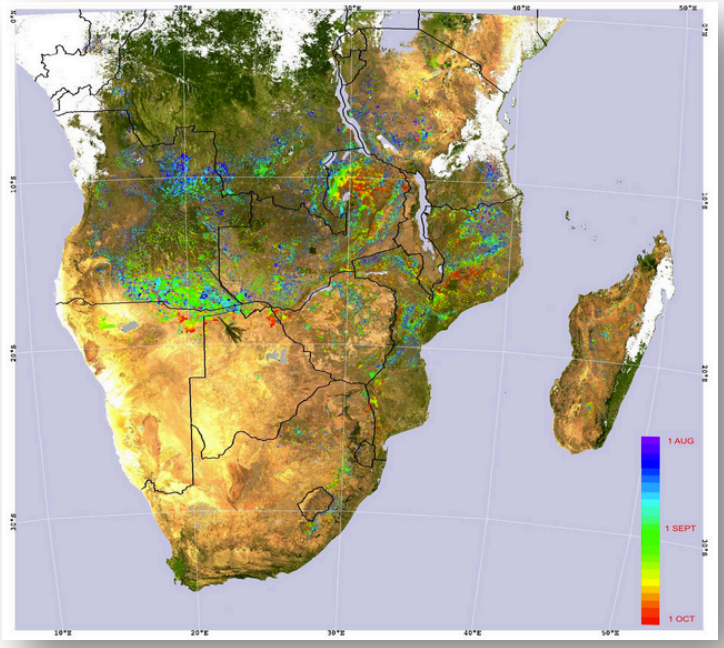
- Provides snapshots of active burning fires and burned areas
- The Active Fire product delivers actively burning locations on a daily basis at 1km resolution (additional 8 day and monthly products)
- Fire product includes multiple attributes such as fire mask, fire pixel table, and maximum fire radiative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

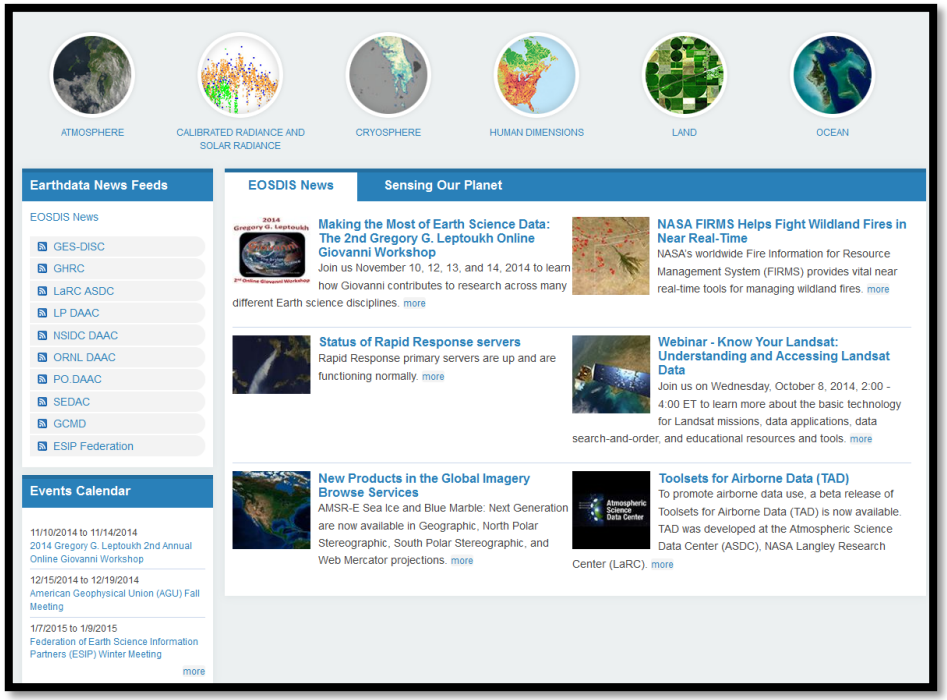


Example of the MODIS 500 m burned area product for sub equatorial Africa. The different colors indicate the approximate day of the burning detected between August and October in 2000.

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



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

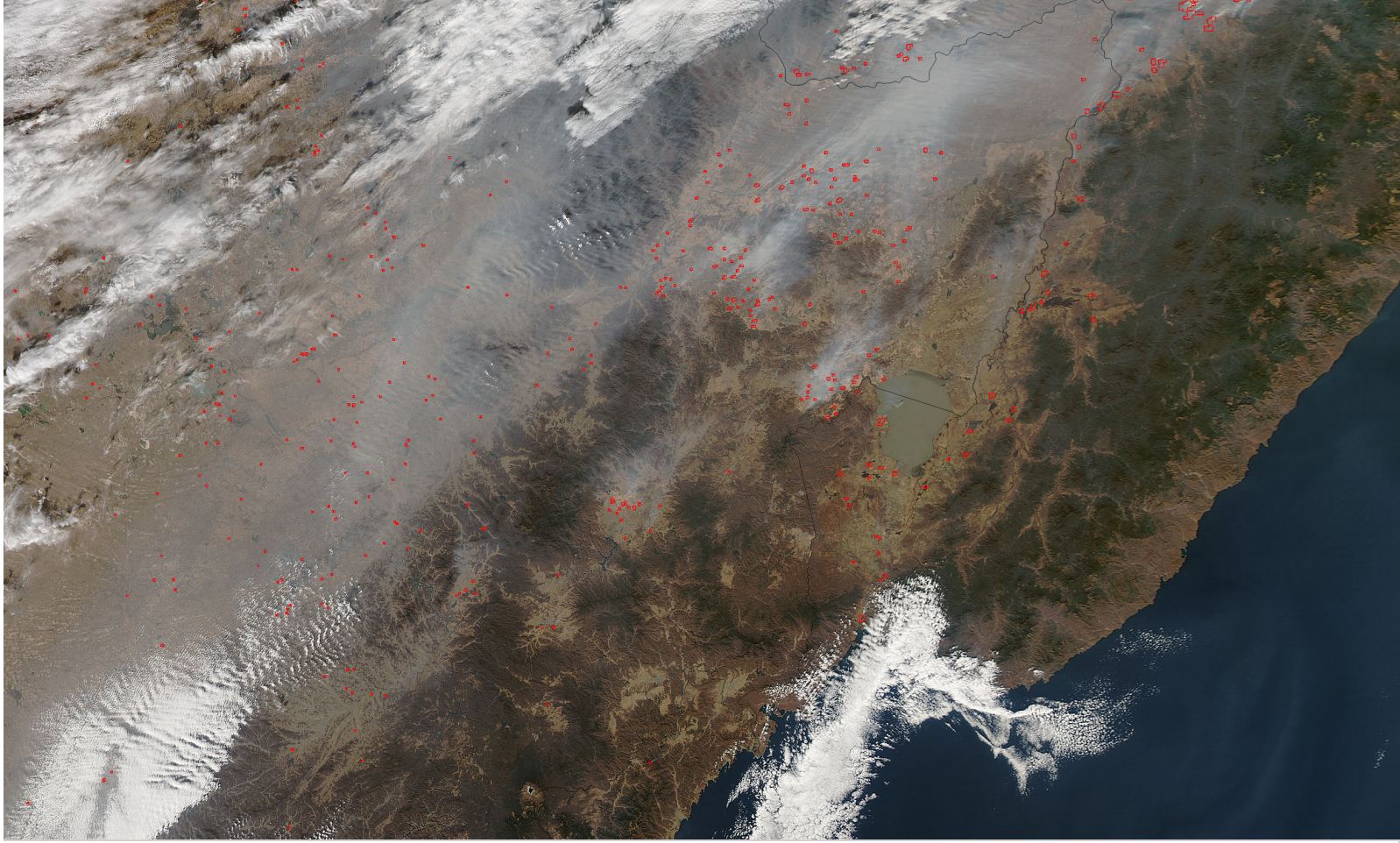
MRTWeb Demo

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.

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Thank You!!

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