

Access and Use of Imagery and Data from MODIS, Landsat, and Commercial Satellites

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MODIS Rapid Response image, June 7, 2011

NASA's Earth Observing System

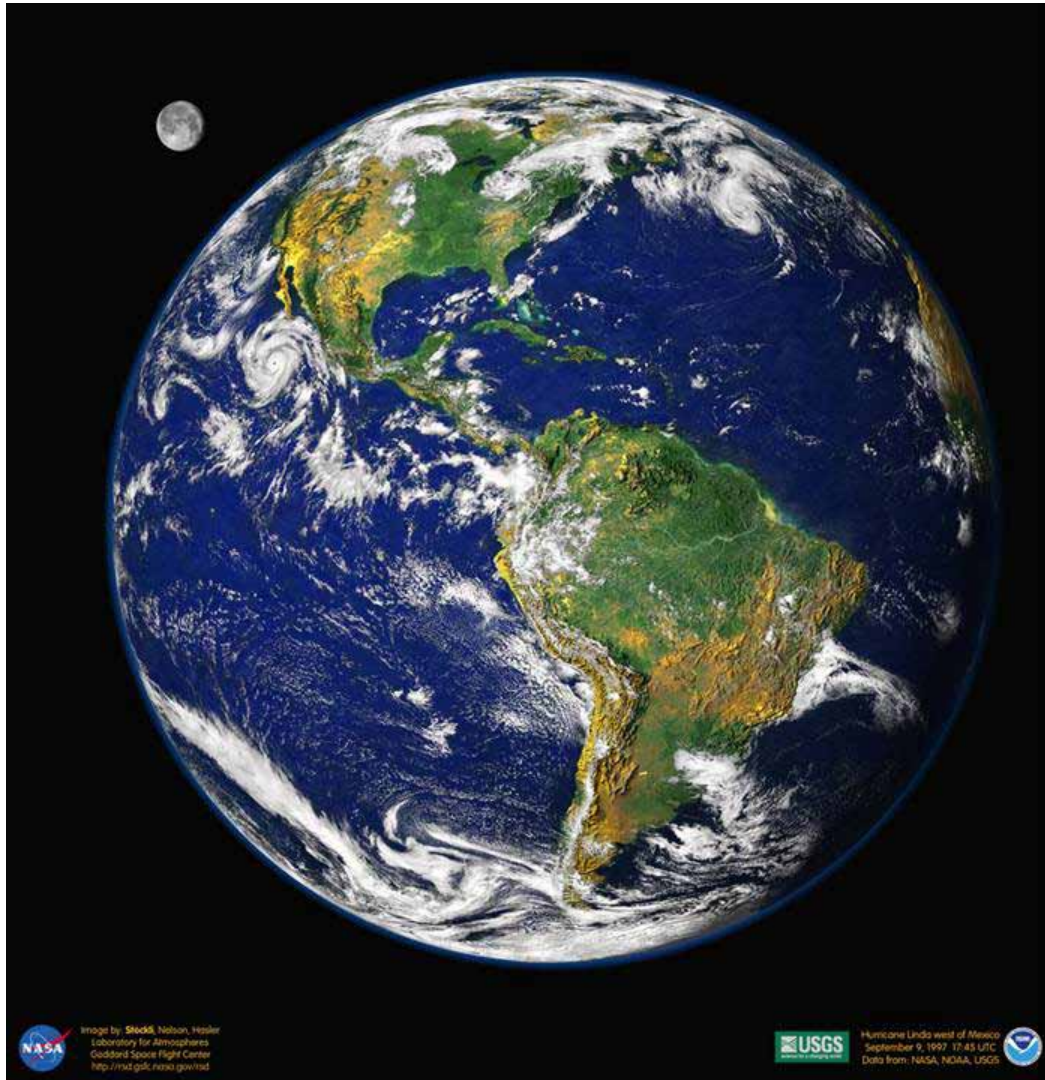


Currently 20 operating satellite missions returning ~1.8 TB of data per day

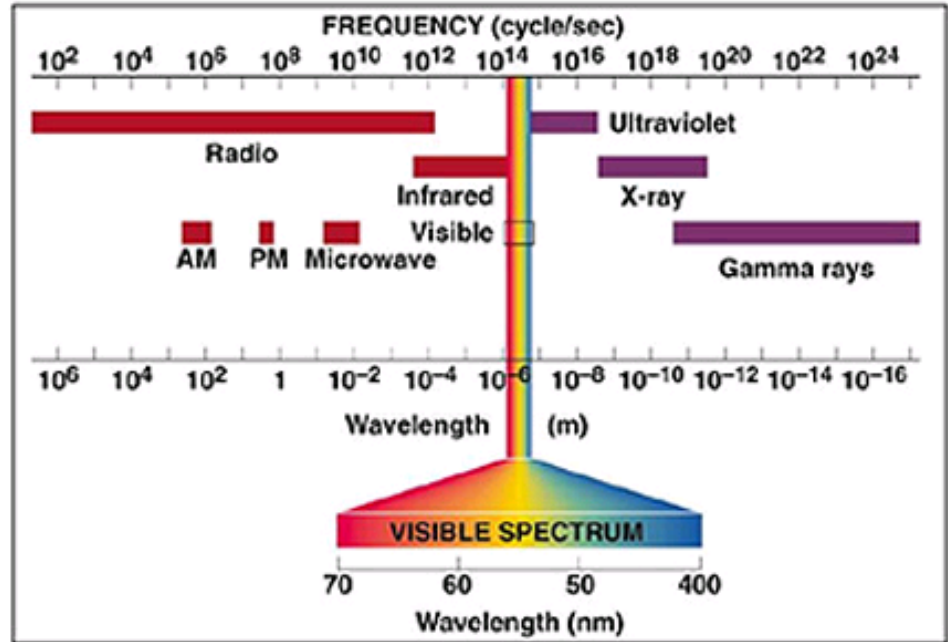
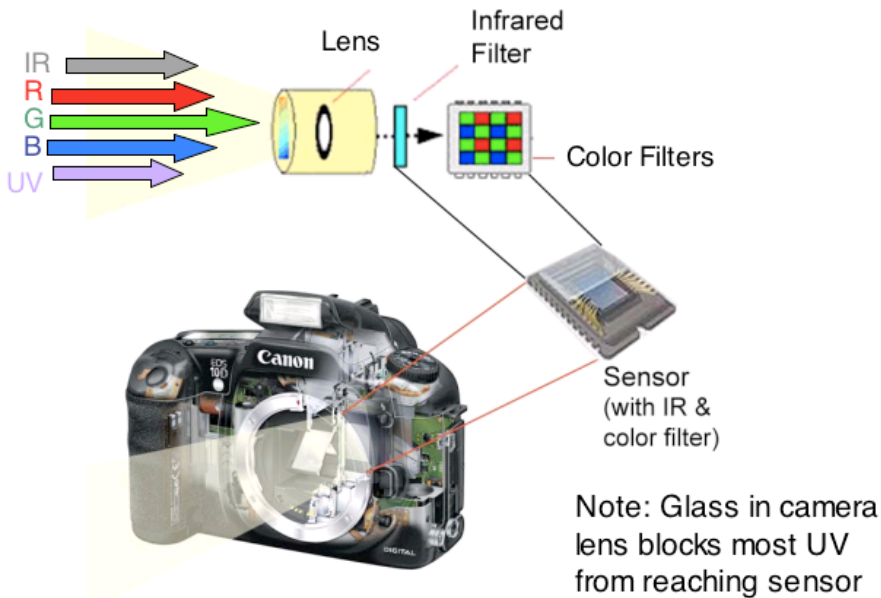
<http://science1.nasa.gov/earth-science/missions/>

Imagery vs Data

Remote sensing imagery is a transformation of digital data collected across the electromagnetic spectrum into the visible spectrum to assist in visualization and analysis.



Introduction to Remote Sensing (abridged version)



Satellite and airborne instruments measure multiple bands across the full electromagnetic spectrum.

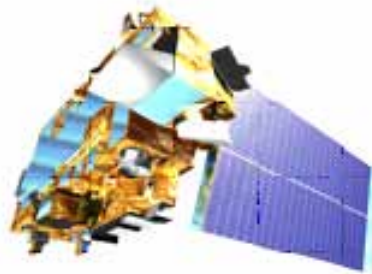
Remote Sensing Tutorial:
<http://rst.gsfc.nasa.gov/>

Satellite Instruments: MODIS

Example: MODIS on Terra & Aqua

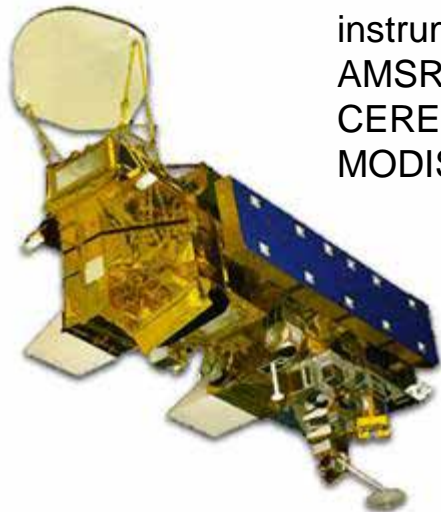
Terra Satellite

Launched Dec. 18, 1999 with five instruments (ASTER, CERES, MISR, MODIS, MOPITT)

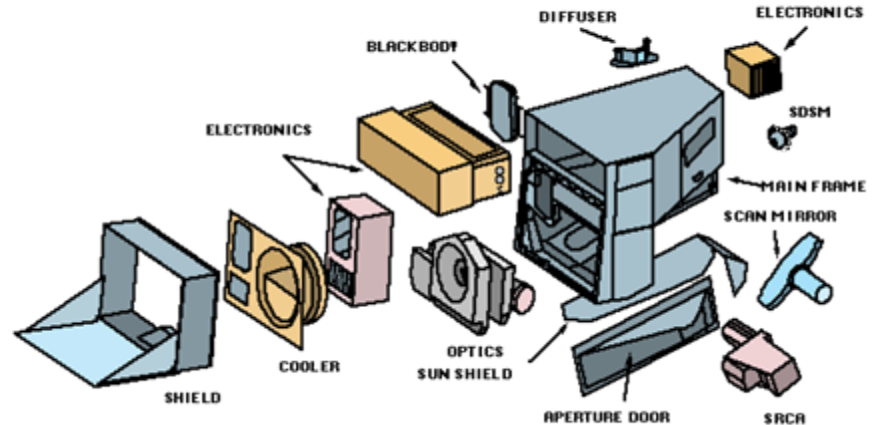


Aqua Satellite

Launched May 4, 2002 with six instruments (AIRS, AMSR-E, AMSU, CERES, HSB, MODIS)



MODIS SUBSYSTEMS



MODerate resolution Imaging Spectroradiometer

Orbit: 705 km, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular

Swath Dimensions: 2330 km (cross track) by 10 km (along track at nadir)

Data Rate: 10.6 Mbps (peak daytime); 6.1 Mbps (orbital average)

Spatial Resolution: 250 m (bands 1-2), 500 m (bands 3-7), 1000 m (bands 8-36)

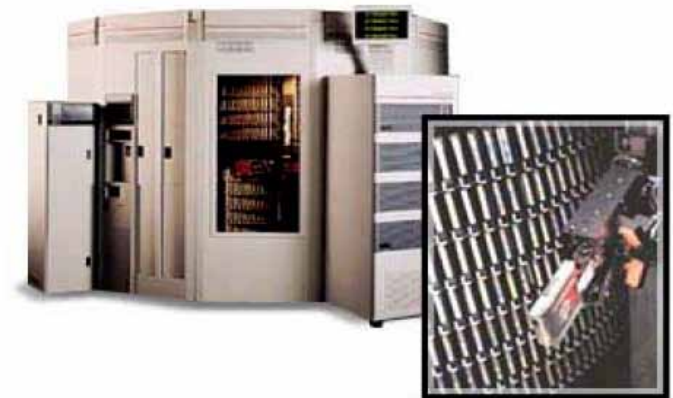
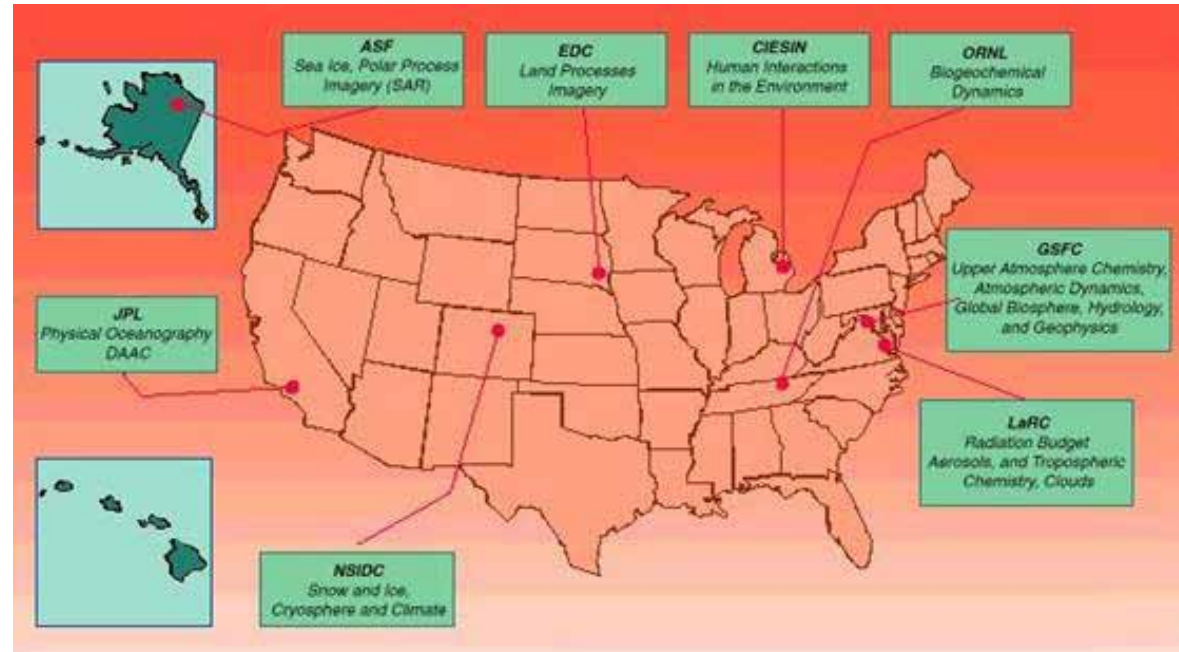
Design Life: 6 years

Multiple Data Products per Instrument: MODIS Measurements

MOD01	Level-1A Radiance Counts	MOD23	Suspended-Solids Conc, Ocean Water
MOD02	Level-1B Calibrated Relocated Radiances	MOD24	Organic Matter Concentration
MOD03	Relocation Data Set	MOD25	Coccolith Concentration
MOD04	Aerosol Product	MOD26	Ocean Water Attenuation Coefficient
MOD05	Total Precipitable Water	MOD27	Ocean Primary Productivity
MOD06	Cloud Product	MOD28	Sea Surface Temperature
MOD07	Atmospheric profiles	MOD29	Sea Ice Cover
MOD08	Gridded Atmospheric Product (Level-3)	MOD31	Phycoerythrin Concentration
MOD09	Atmospherically-corrected Surface Reflectance	MOD32	Processing Framework & Match-up Database
MOD10	Snow Cover	MOD35	Cloud Mask
MOD11	Land Surface Temperature & Emissivity	MOD36	Total Absorption Coefficient
MOD12	Land Cover/Land Cover Change	MOD37	Ocean Aerosol Properties
MOD13	Vegetation Indices	MOD39	Clear Water Epsilon
MOD14	Thermal Anomalies, Fires & Biomass Burning	MOD43	Albedo 16-day L3
MOD15	Leaf Area Index & FPAR	MOD44	Vegetation Cover Conversion
MOD16	Surface Resistance & Evapotranspiration	MODISALB	Snow and Sea Ice Albedo
MOD17	Vegetation Production, Net Primary Productivity		
MOD18	Normalized Water-leaving Radiance		
MOD19	Pigment Concentration		
MOD20	Chlorophyll Fluorescence		
MOD21	Chlorophyll_a Pigment Concentration		
MOD22	Photosynthetically Active Radiation (PAR)		

EOS Data Information System (EOSDIS)

- EOSDIS is the comprehensive ground system for processing, archiving, and distributing data from all the EOS spacecraft
- Data processed, archived and distributed from nine distributed active archive centers, each with its own focus
- Accepts, process, and archives 1.8 TB per day of data from EOS
- > 4.2 petabytes of data archived
- 2.3 TB of user data requests per day fulfilled from 910,000 unique users
- Also provides mission operation systems that perform command and control of the spacecraft and instruments, health and safety monitoring, mission planning and scheduling, initial data capture, and Level 0 processing.



Sources of Imagery and Data

Resource	Summary	URL
Warehouse Inventory Search Tool (WIST)	Data search and access interface for EOSDIS	https://wist.echo.nasa.gov/api/
MODIS Rapid Response System	Near real-time RGB and NDVI imagery from MODIS	http://rapidfire.sci.gsfc.nasa.gov/
MODIS Reprojection Tool Web Interface	On-line data access and subsetting and access tool for MODIS	http://mrtweb.cr.usgs.gov/
USGS Earth Resource Observation (EROS) Center	Data search and access interface for land surface satellite data products	http://eros.usgs.gov/
Web Enabled Landsat Data (WELD)	On-line data access and subsetting and access tool for Landsat	http://weld.cr.usgs.gov/region_ds.php

Warehouse Inventory Search Tool (WIST)

- Access to full EOSDIS data archive
- Searchable by keyword, satellite or sensor, location, and date/time range
- Many datasets require specialized software to open and process, though increasing support for scientific data formats by commonly used GIS tools
- WIST includes an extensive tutorial

<https://wist.echo.nasa.gov/api/>

Warehouse Inventory Search Tool (WIST)

The screenshot shows the WIST web application interface. At the top, the browser title is "Primary Data Search - Mozilla Firefox" and the address bar shows the URL "https://wist.echo.nasa.gov/api/". The page has a navigation bar with three radio buttons: "Orthographic" (selected), "Global granules only", and "Orbit Search". Below this is a section titled "Choose a Date/Time Range (not required)" with instructions on date and time formats. It includes input fields for "Start Date", "Time (UTC)", "End Date", and "Time (UTC)", along with a "Clear Time Fields" button. The next section is "Choose Additional Options (not required)", which contains a list of search options: a maximum of 100 data granules per data set, checkboxes for "browse products", a 90-minute search limit, a "Customize" button for metadata, a "Day/Night" dropdown menu, and a query name field. A "Start Search" button is located at the bottom of the form area.

Primary Data Search - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Share Browser WebEx+

Primary Data Search

Orthographic Global granules only Orbit Search

Choose a Date/Time Range (not required)

Date format: YYYY-MM-DD (1967-05-25) or MM/DD/YYYY (05/25/1967)
Time format: HH:MM (14:30) or HH:MM:SS (14:30:01)

You may also enter a date without a time or a start date without an end date.
Use the help link for information on default values.

Start Date: **Time (UTC):**
End Date: **Time (UTC):**

Clear Time Fields

Standard Date Range Julian Date Range Annually Repeating

Choose Additional Options (not required)

- Return a maximum of data granules per data set (Range: 0 - 2000).
- Only return data granules which have browse products.
- Only display collections which have browse products.
- Allow searches to run for a maximum of minute(s)
- Return **DEFAULT** metadata in search results
- Only return data granules which were retrieved during the
- Name this query:
(will be used in creating a file name when saving the query)

Start Search

MODIS Reprojection Tool Web Interface

USGS MODIS Reprojection Tool Web Interface (MRTWeb)

Select a collection, then click on the Global Locator Map to view satellite browse images in that area.

Select Collection: MODIS Aqua
Latitude:
Longitude:

View Images

MYD09A1
MYD09GA
MYD09GQ
MYD09Q1
MYD11A1DAY
MYD11A1NIGHT
MYD11A2DAY
MYD11A2NIGHT
MYD11B1DAY
MYD11B1NIGHT
MYD13A1EVI
MYD13A1NDVI
MYD13A2EVI
MYD13A2NDVI
MYD13A3EVI
MYD13A3NDVI
MYD13A3EVI
MYD13A3NDVI
MYD14A1
MYD14A2

Done

Provides access to geographic and temporal subsets from global MODIS data products.

MODIS Rapid Response System

- Provides access to near real-time RGB / NDVI imagery from the MODerate resolution Imaging Spectroradiometer (MODIS) onboard the NASA Terra and Aqua satellites
- Imagery available in JPEG and GeoTIFF formats, and includes geographic information and KMZ files for viewing in Google Earth
- Excellent source of easily accessible imagery at 250m to 2km resolution



NASA Terra Satellite

MODIS Rapid Response

MODIS Rapid Response System - CAmerica_1_01 Subset - Terra 1km Bands 7-2-1 image for 2011/158 (06/07/11) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://rapidfire.sci.gsfc.nasa.gov/subsets/?subset=CAmerica_1_01.2011158.terra.721.1km

Share Browser WebEx+

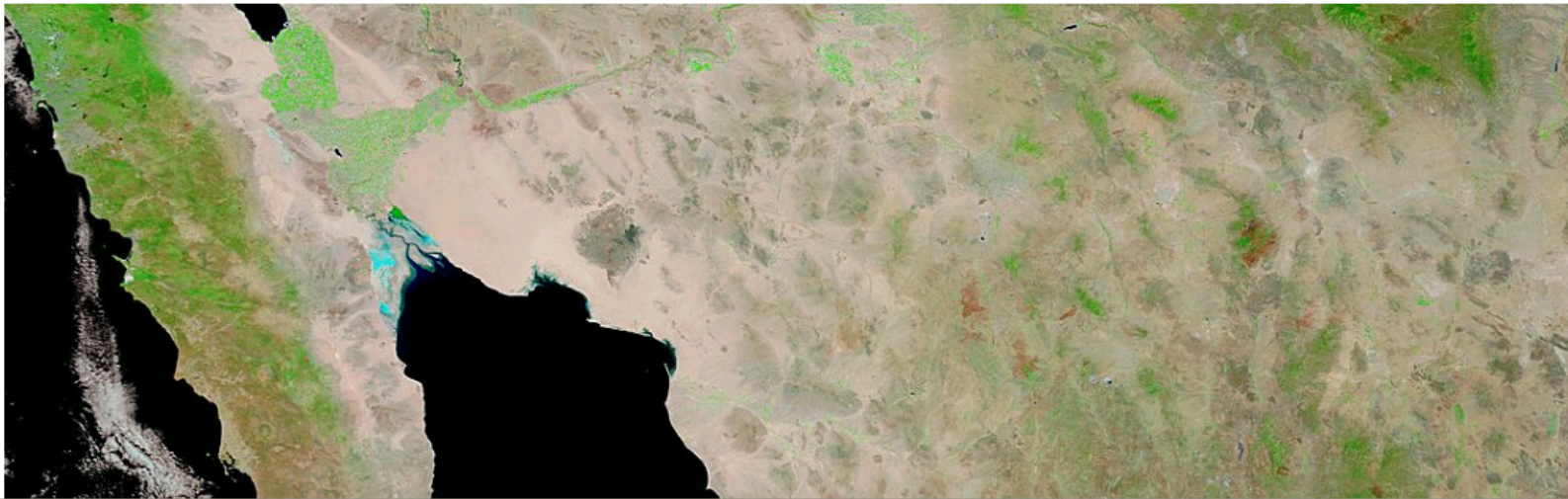
MODIS Rapid Response System - CA...

CAmerica_1_01 Subset - Terra 1km Bands 7-2-1 image for 2011/158 (06/07/11) [← prev](#)

Vectors selected: none
Change vector options:

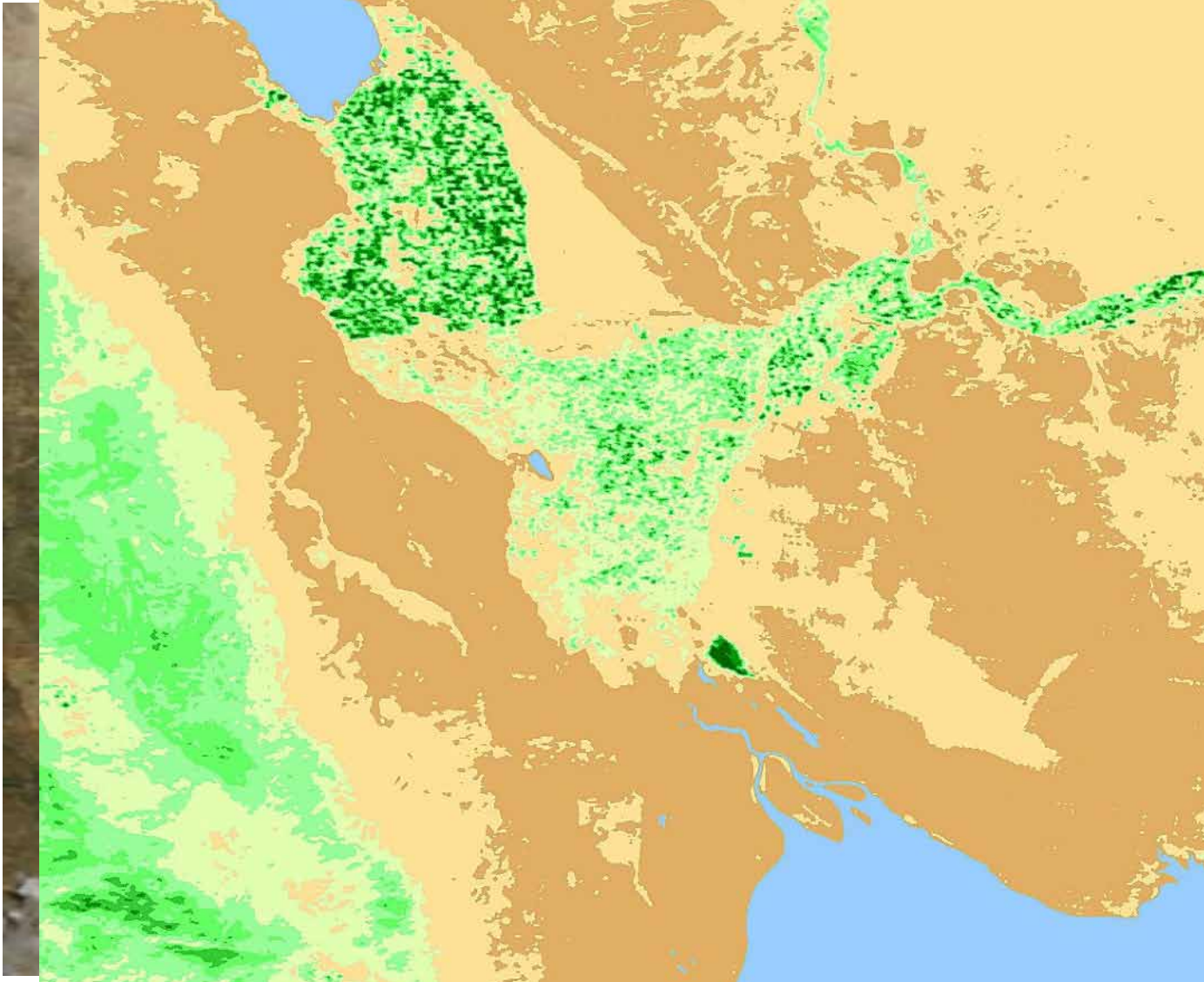
View alternate pixel size: [2km](#) | [500m](#) | [250m](#) |
View alternate band combination: [True Color](#) | [NDVI](#) |
[View Aqua image](#) | [See all images available for this area this day](#) | [Usage Guidelines](#)

[Display metadata \(including time of input data\)](#)
[Display worldfile](#) | [Display projection file](#)
[Download JPG image with ancillary files \(.zip\)](#)
[Download KMZ file for GoogleEarth](#)
[Download GeoTIFF file](#)



Done

MODIS Rapid Response

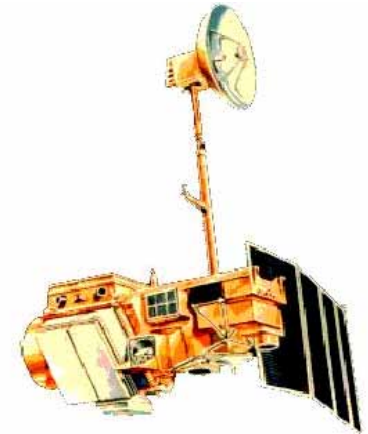


MODIS Rapid Response and Google Earth

The screenshot displays the Google Earth application window. The main map shows a satellite view of a desert landscape with two red dots labeled "Mexicali" and "Yuma". A yellow line connects these two points. The interface includes a search bar at the top left with the text "Fly to e.g., 37 25.818' N, 122 05.36' W". Below the search bar is a "Places" panel with a list of locations, including "Assign_AirPhotoInterp.kmz" and several "LT50390372010223EDC00.tif" files. At the bottom left is a "Layers" panel with a tree view showing "Primary Database", "Borders and Labels", "Places", "Photos", "Roads", "3D Buildings", "Ocean", "Weather", "Gallery", "Global Awareness", and "More". The bottom of the map shows a scale bar for 23.6 miles, a copyright notice for "Image U.S. Geological Survey © 2011 INEGI © 2011 Google Image © 2011 DigitalGlobe", and coordinates "32°35'17.10" N 115°04'09.40" W elev 100 ft" and "Eye alt: 103.06 mi". A NASA logo and the URL "rapidfire.sci.gsfc.nasa.gov" are visible in the top left corner of the map area.

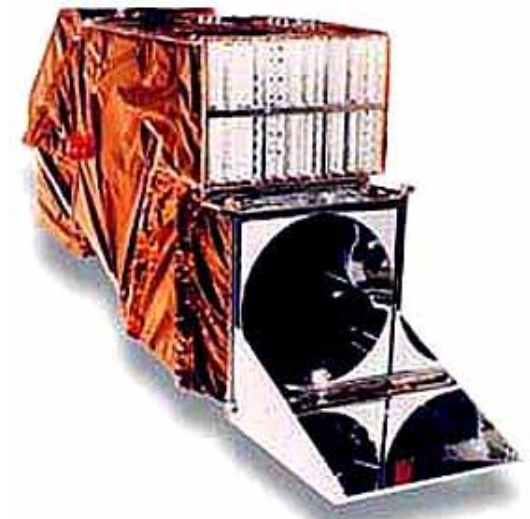
Landsat

- Landsat 5 launched in 1984
- Landsat 7 launched in 1999
- Landsat 8 scheduled for launch in 2012
- 30-120m resolution
- 16 day scene interval



Landsat 5 Satellite

Band No.	Wavelength Interval (μm)	Spectral Response	Resolution (m)
1	0.45 - 0.52	Blue-Green	30
2	0.52 - 0.60	Green	30
3	0.63 - 0.69	Red	30
4	0.76 - 0.90	Near IR	30
5	1.55 - 1.75	Mid-IR	30
6	10.40 - 12.50	Thermal IR	120
7	2.08 - 2.35	Mid-IR	30



Landsat Thematic Mapper (TM) Instrument

WELD: Web-Enabled Landsat Data

WELD Distribution System - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://weld.cr.usgs.gov/WYSIWYG/place_many_orders.php

Share Browser WebEx+

Index of ftp://emodisftp.cr.usgs.gov/... USGS MODIS Reprojection Tool Web I... Weld WELD Distribution System MODIS Rapid Response System - CAM...

Would you like to change the stored password for this login?

You have selected a CONUS region of 10559 x 7871 30m pixels [<< Home](#)

You can order this region for the following WELD products:

- Month07 [2010]
- Annual [December 2009 - November 2010]
- Seasonal [December 2009 - November 2010]
- Monthly [December 2009 - November 2010]
- Monthly [January 2010 - December 2010]
- Weekly [January 2010 - December 2010]

and for the following WELD product bands:

- All
 - Band1_TOA_REF
 - Band2_TOA_REF
 - Band3_TOA_REF
 - Band4_TOA_REF
 - Band5_TOA_REF
 - Band7_TOA_REF
- All
 - Band61_TOA_REF
 - Band62_TOA_REF
- All
 - NDVI_TOA
- All
 - Day_Of_Year
 - Num_Of_Obs
 - Saturation_Flag

Done

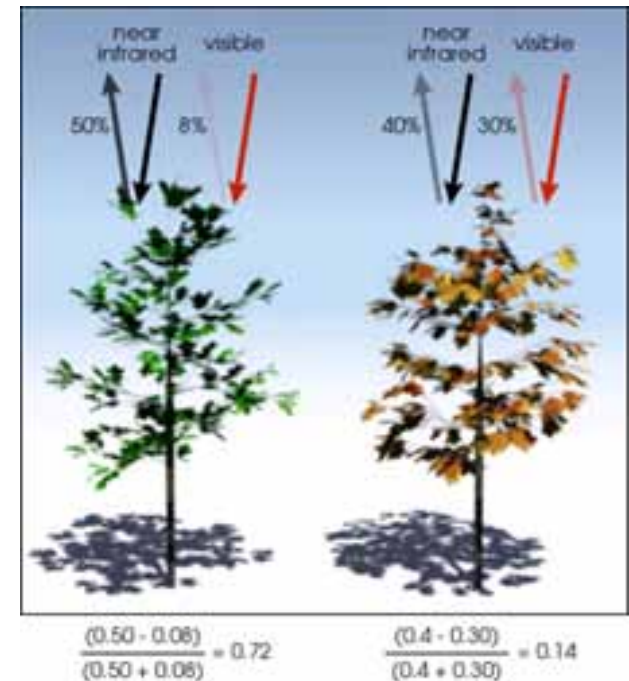
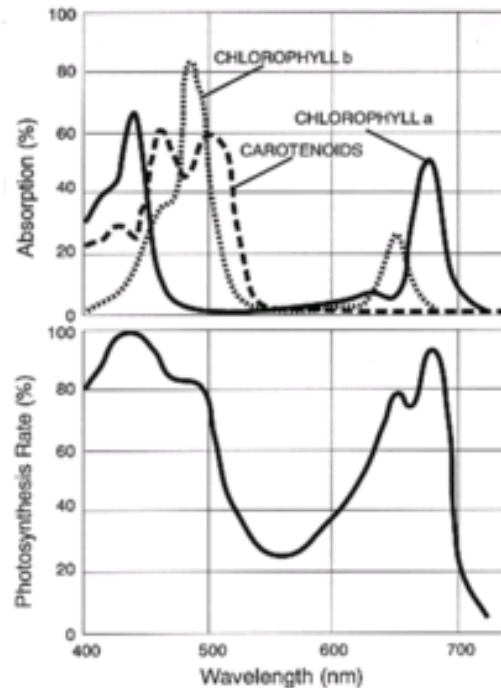
WELD: Web-Enabled Landsat Data

- Available data includes NDVI in TIF format (viewable in many image processing tools)
- WELD derived from Landsat 7 ETM+ data, and WELD composites address many of the issues with L7 data
- Some residual striping due to scan line correction hardware failure on satellite



Normalized Difference Vegetation Index (NDVI)

- NDVI is an index that ranges from -1 to 1, and provides a measure of the differential reflectance of light in the visible and near-infrared wavelengths
- Commonly used of as an index of photosynthetic activity or “vegetation greenness”



$$\text{NDVI} = \frac{(\text{NIR} - \text{VIS})}{(\text{NIR} + \text{VIS})}$$

USGS: GLOVIS

EarthExplorer - Mozilla Firefox

File Edit View History Bookmarks Tools Help

EE http://edcsns17.cr.usgs.gov/NewEarthExplorer/order

Share Browser WebEx

USGS Global Visualization Viewer EE EarthExplorer

USGS
science for a changing world

USGS Home
Contact USGS
Search USGS

EarthExplorer

Home Profile

Orders

You have no orders in your basket.

Downloads

1/1 10

Download Options

Please select from the following download options:

- LandsatLook "Natural Color" Image (4.3 Mb JPEG)
- LandsatLook Thermal Image (3.9 Mb JPEG)
- LandsatLook Images with Geographic Reference (8.2 Mb JPEG)
- Level 1 Product (184.2 Mb Geotiff)

Select Download Option Cancel

Entity ID	Item Description	Data Set	Operations
LT50390372010223EDC00	Acquisition Date: 11-AUG-10 Path: 39 Row: 37	L4-5 TM	

Entity ID Item Description Data Set Operations

Accessibility FOIA Privacy Policies and Notices Google Maps API Disclaimer

U.S. Department of the Interior U.S. Geological Survey

URL:
Page Contact Information: custserv@usgs.gov
Page Last Modified: 02/15/2011

USA.gov
TAKE PRIDE IN AMERICA

Done

Quick Start Guide User Guide What's New!

Done

One active download (17 minutes remaining)

Working with Data and Imagery in ArcGIS

The screenshot displays the ArcGIS interface with the Raster Calculator dialog box open. The dialog box contains the following information:

Raster Calculator

Map Algebra expression

Layers and variables

- L5038038_03820110519_B50.TIF
- bands743
- L5038038_03820110519_B70.TIF
- L5038038_03820110519_B40.TIF
- L5038038_03820110519_B30.TIF

Conditional

- Con
- Pick
- SetNull

Math

- Abs
- Exp
- Exp10

Map Algebra expression:

$$\frac{("L5038038_03820110519_B40.TIF" - "L5038038_03820110519_B30.TIF")}{("L5038038_03820110519_B40.TIF" + "L5038038_03820110519_B30.TIF")}$$

Output raster:

C:\Users\fmelton\Desktop\Data\L5_3838_2011_139\ndvi_20110519

Buttons: OK, Cancel, Environments..., Show Help >>

The ArcToolbox on the right side of the interface shows the following categories:

- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Parcel Fabric Tools
- Schematics Tools
- Server Tools
- Spatial Analyst Tools
 - Conditional
 - Density
 - Distance
 - Extraction
 - Generalization
 - Groundwater
 - Hydrology
 - Interpolation
 - Local
 - Map Algebra
 - Raster Calculator
 - Math
 - Multivariate
 - Neighborhood
 - Overlay
 - Raster Creation
 - Reclass
 - Solar Radiation
 - Surface
 - Zonal
- Spatial Statistics Tools
- Tracking Analyst Tools

Working with Data and Imagery in ArcGIS

Untitled - ArcMap - ArcInfo

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:208,012

Bands 7,4,3 False-color

Table Of Contents

- Layers
 - ndwi_20110519
 - ndvi_20110519
 - Value
 - High : 1
 - Low : -1
 - L5038038_03820110519
 - Value
 - High : 255
 - Low : 0
 - bands743_composite
 - RGB
 - Red: bands721c1
 - Green: bands721c2
 - Blue: bands721c3
 - L5038038_03820110519
 - Value
 - High : 255
 - Low : 0
 - L5038038_03820110519
 - Value
 - High : 255
 - Low : 0
 - L5038038_03820110519
 - Value
 - High : 255
 - Low : 0

708049.067 3549094.602 Meters

Viewing and Analyzing Data

Multiple commercial tools for viewing and analyzing commercial data:

Application	Description	
RSI ENVI/IDL	Geospatial Image Processing	http://www.rsinc.com/
ERDAS Imagine	Geospatial Image Processing	http://gis.leica-geosystems.com/
PCI Geomatics (eCognition)	Geospatial Image Processing	http://www.pcigeomatics.com/
Idrisi	Geospatial Image Processing	http://www.clarklabs.org/
ERMapper	Geospatial Image Processing	http://www.ermapper.com/
Matlab	Technical Computing & Image Processing	http://www.mathworks.com/
HDF Explorer Pro	Data Visualization	http://www.space-research.org/
ArcGIS 9.x, 10	Geographic Information System	http://www.esri.com/

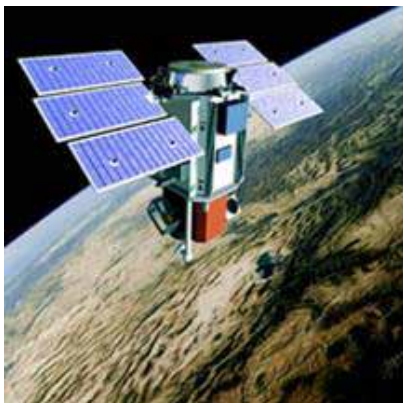
Viewing and Analyzing Data

Open Source Remote Sensing Applications

- RemoteSensing.org, <http://remotesensing.org/Home.html>

Application	Description	
MultiSpec	Multispectral Image Data Analysis	http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/
MSPHINX	Satellite Process Handling Images uNder Xwindow	http://www-loa.univ-lille1.fr/Msphinx/Msphinx_gb.html
LDOPE Tools	MODLAND Quality Assessment	http://lpdaac.usgs.gov/landdaac/tools/ldope/index.asp
MODIS Swath-to-Grid	IDL-Based Conversion	http://nsidc.org/data/modis/ms2gt/
Cube Visualization (CV)	Data Visualization	http://isis.astrogeology.usgs.gov/Isis2/isis-bin/isis.cgi/
WebWinds	Data Visualization/Processing	http://www.openchannelsoftware.com/projects/WebWinds/
WinVicar	Windows-Based Image Processing	http://www.openchannelsoftware.com/projects/WINVICAR/
HEW	Web-based HDF-EOS Subsetter	http://subset.itsc.uah.edu/hew2k/
NCSA HDF Tools	HDF Utilities	http://hdf.ncsa.uiuc.edu/hdfutils.html

Commercial Satellite Data



Quickbird (2)



Ikonos



GeoEye

	Pan	Blue	Green	Red	Near-IR
Quickbird	450–900 nm / 0.6m	450-520 nm / 2.4m	520-600 nm / 2.4m	630 – 690nm / 2.4m	760 – 900 nm / 2.4m
Ikonos	526-929 nm / 0.8m	445-516nm / 3.2m	506-595 nm / 3.2	632-698nm / 3.2m	757-893nm / 3.2m
GeoEye	450-800nm / 0.4m	450-510nm / 1.65m	510-580 nm / 1.65	655-690nm / 1.65m	780-920nm /1.65m

- Pan-sharpened multispec data with 0.4 - 0.8m spatial resolution
- Data cost of ~\$25/km² ; \$500-\$2500 minimum order

Commercial Satellite Data: Disaster Monitoring



Country : USA
State : Illinois
City : Cairo
Area : Mississippi River Flooding
Sensor : Worldview-2 (Natural Color)
Acquisition Date : May 5, 2011
Resolution (GSD): 0.5 Meter



Resources for More Information

NASA Earth Science Reference Handbook

http://eosps0.gsfc.nasa.gov/eos_homepage/for_scientists/data_products/refbook2006.php

Finding Data

WIST: <http://wist.echo.nasa.gov/api/>
MODIS Rapid Response: <http://rapidfire.sci.gsfc.nasa.gov>
MRT Web: <http://mrtweb.cr.usgs.gov/>
USGS EROS: <http://eros.usgs.gov/>
USGS GLOVIS <http://glovis.usgs.gov/>
WELD: <http://weld.cr.usgs.gov/>

EOS Missions

Mission Overviews: <http://science.hq.nasa.gov/missions/earth.html>
Missions Profiles: http://eosps0.gsfc.nasa.gov/eos_homepage/mission_profiles/index.php

NASA Decadal Survey Missions

<http://science.nasa.gov/earth-science/decadal-surveys/>

Further Resources

NASA Remote Sensing Tutorial: <http://rst.gsfc.nasa.gov/>
GIS Cafe Forums: <http://www10.giscale.com/wwwthreads-5.3/wwwthreads.php>

