

Today
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Remote sensing Introduction
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MODIS Data

Remote Sensing data

Today

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Remote sensing Introduction

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MODIS

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MODIS Data

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Remote sensing Introduction

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MODIS

A horizontal row of 15 small, light gray circles, evenly spaced from left to right.

MODIS Data

A horizontal row of 15 small, light gray circles, evenly spaced from left to right.

Projects

First draft due next week.

- upload .Rmd and .pdf (not HTML!)

Other questions?

Objectives

- Brief introduction to remote sensing
 - Obtaining NASA remote sensing data
 - MODIS
 - MODISTools package

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Remote sensing Introduction

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MODIS

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MODIS Data

A horizontal row of fifteen empty circles, evenly spaced, used as a visual element.

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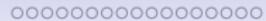
Remote sensing Introduction



MODIS



MODIS Data



Active Earth Observing Satellites (EOS) (as of 8/31/2015)

- Total number of operating satellites: 1,305
 - Total Earth Observing Satellites (EOS): 333
 - United States: 34%
 - China: 21%
 - Japan 6.3%

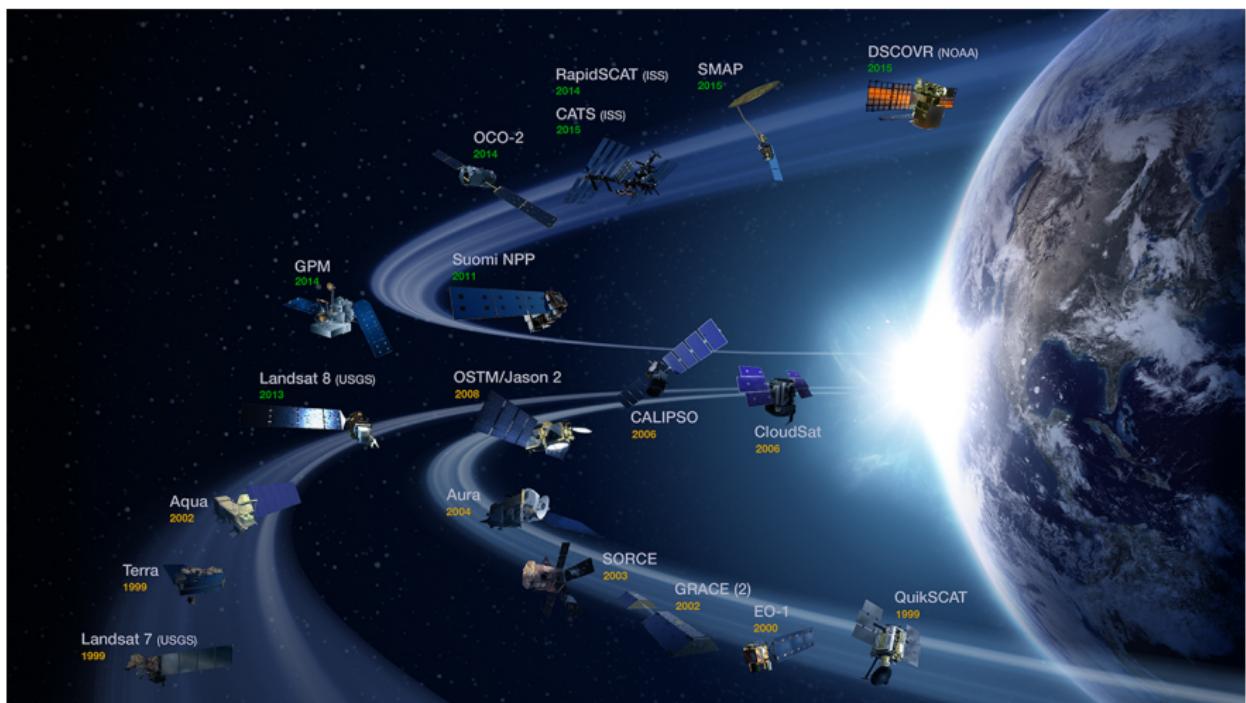
From the Union of Concerned Scientists Satellite Database and Pixalytics
Blog

Debris & Satellites in low Earth orbit



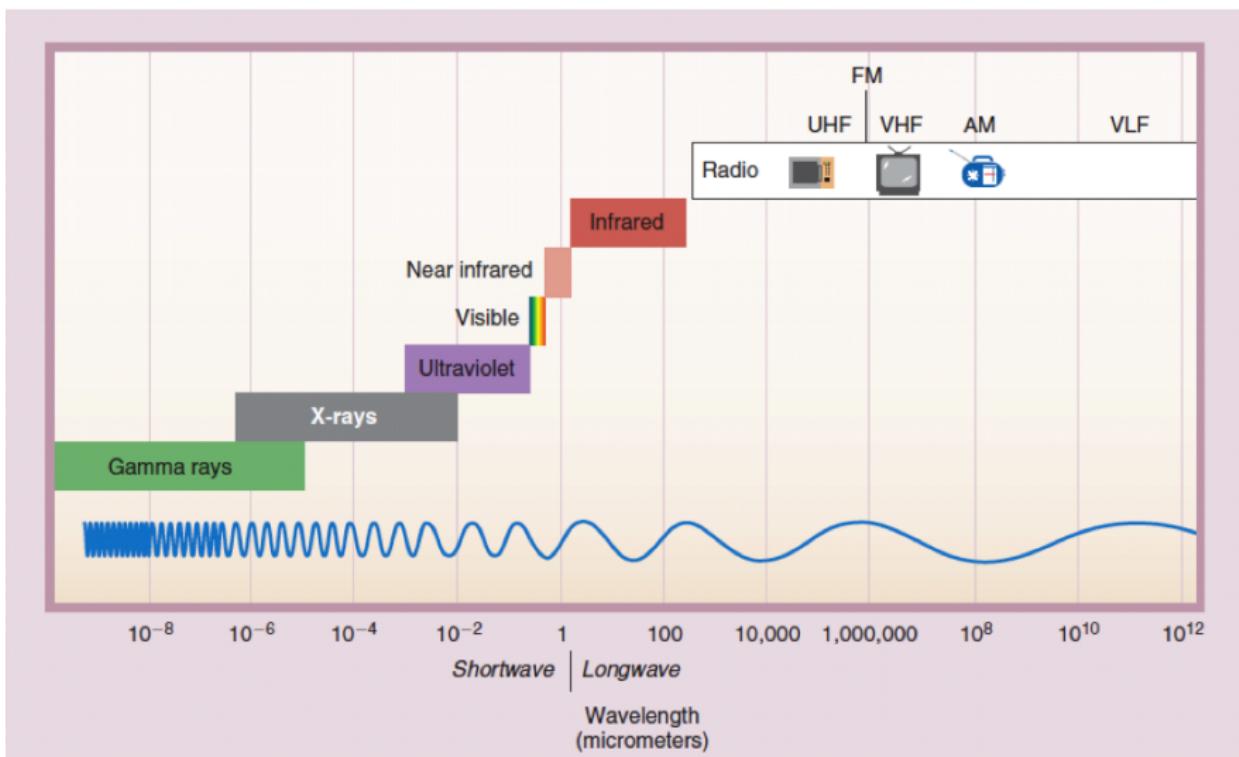
Image courtesy of European Space Agency

NASA's Earth Observing System



Passive Remote Sensing

Electromagnetic Radiation



Today

Remote sensing Introduction

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MODIS

A horizontal row of 15 small circles, evenly spaced, used as a decorative element.

MODIS Data

A horizontal row of 15 small circles, evenly spaced, used as a decorative element.

EarthData.nasa.gov

Datasets, news, articles, information

The screenshot displays the main landing page of the NASA EARTHDATA website. The top navigation bar includes links for Data Discovery, DAACs, Community, and Science Disciplines, along with a search icon. The main content area features a large, colorful map of South America showing atmospheric data with a color gradient from blue to red. A green 'Feedback' button is located on the left side of the map. At the bottom, there are six circular icons representing different science disciplines: Atmosphere, Calibrated Radiance & Solar Radiance, Cryosphere, Human Dimensions, Land, and Ocean.

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MODIS

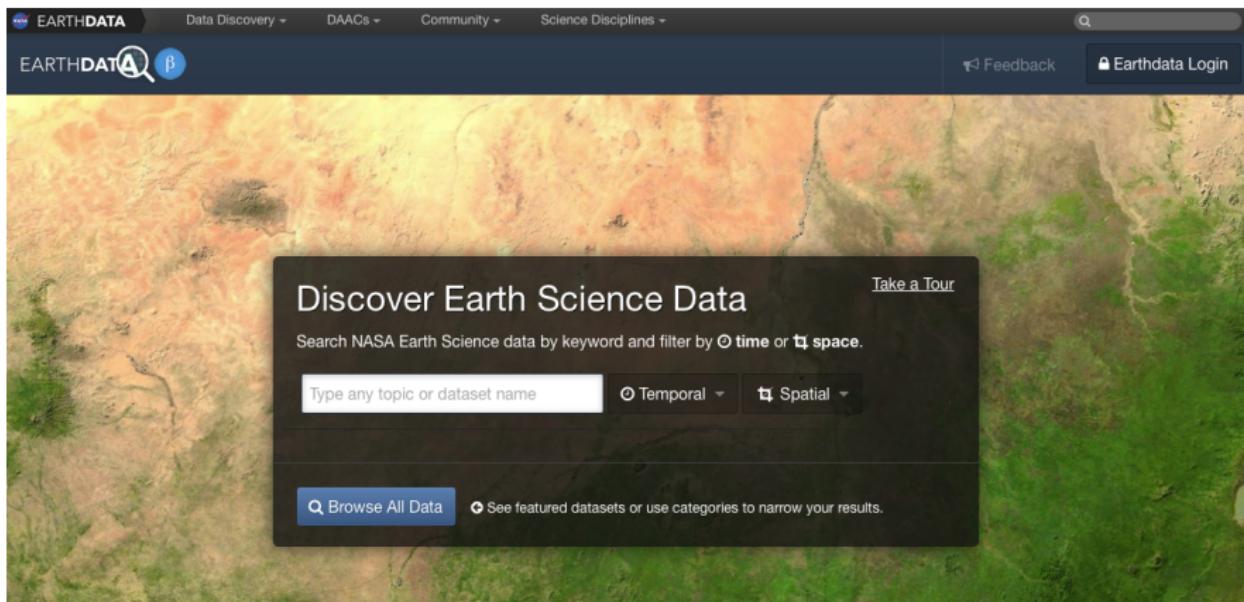
A horizontal row of 15 small circles, evenly spaced, used as a decorative element.

MODIS Data

A horizontal row of 15 small circles, evenly spaced, used as a decorative element.

EarthData.nasa.gov

Datasets, news, articles, information



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Remote sensing Introduction

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MODIS

A horizontal sequence of 15 circles. The first circle is solid black, and the subsequent 14 circles are hollow with a thin black outline.

MODIS Data

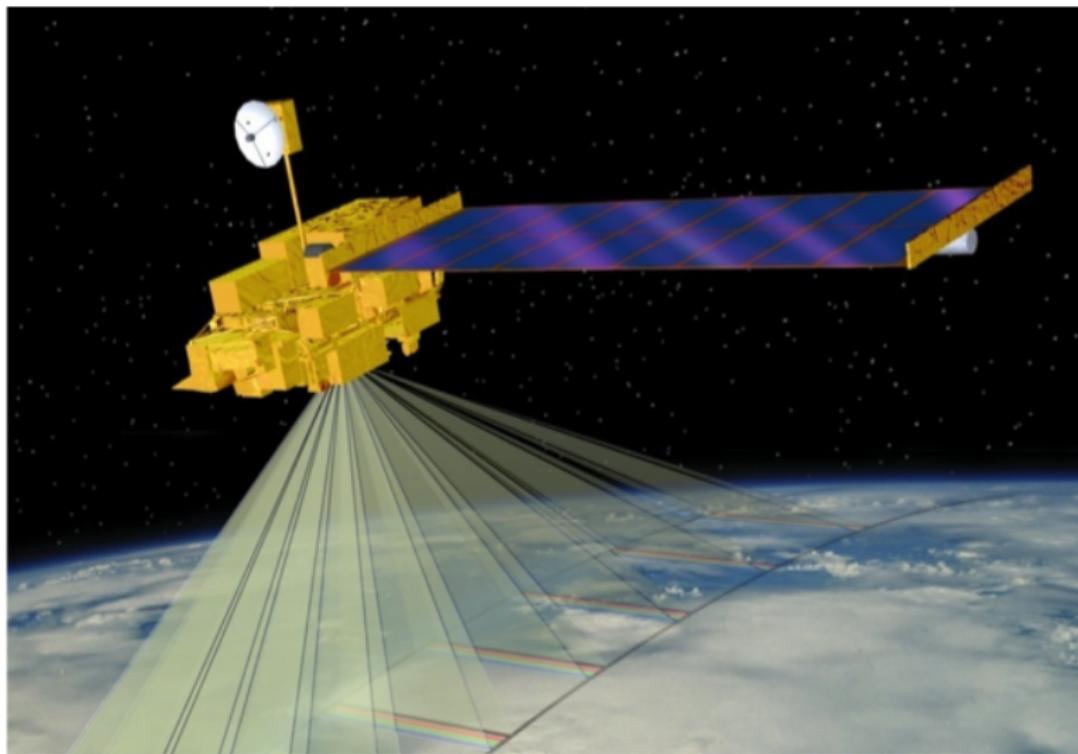
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Moderate Resolution Imaging Spectroradiometer (MODIS)



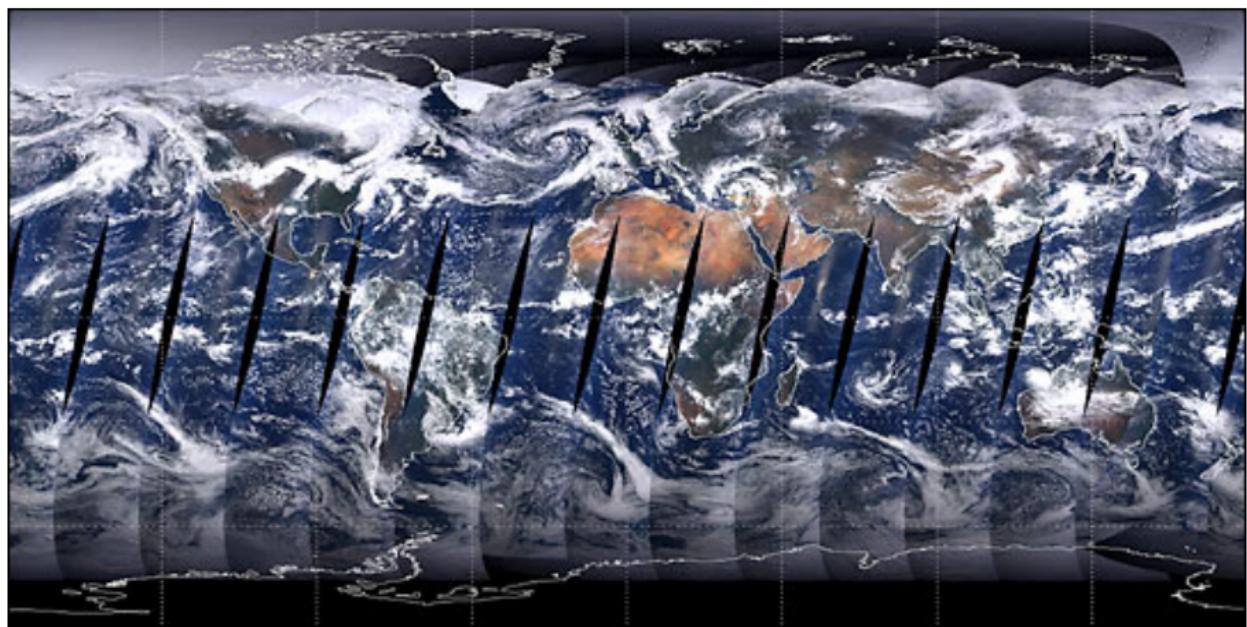
2 Satellites *Terra* launched in 1999, *Aqua* in 2002.

Technical Details: swath



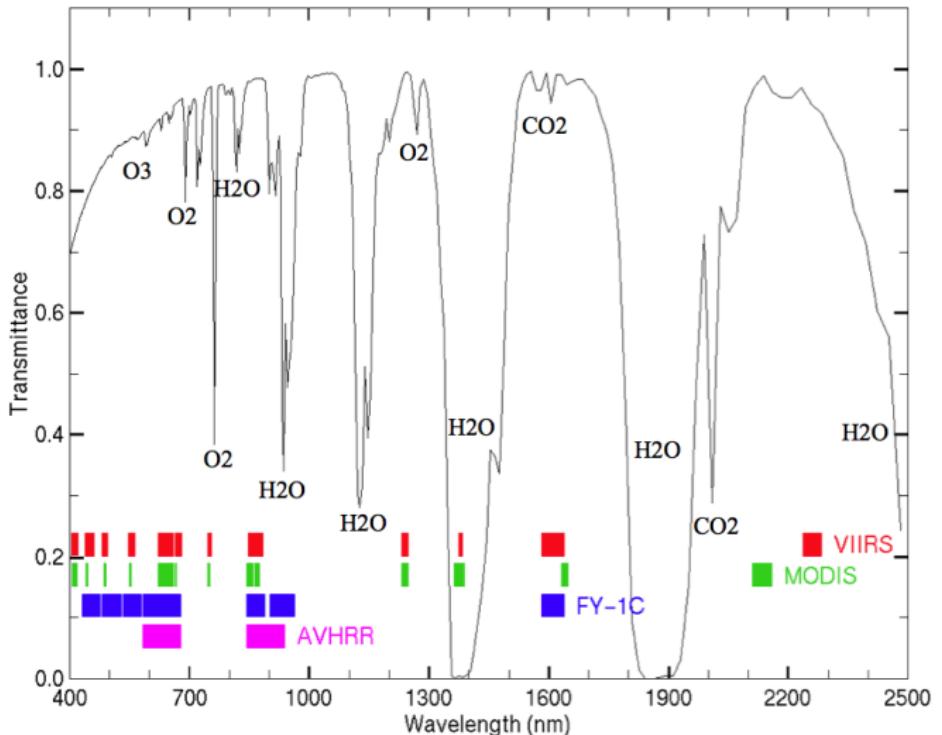
Viewing swath width of 2,330 km

Technical Details: spatial coverage



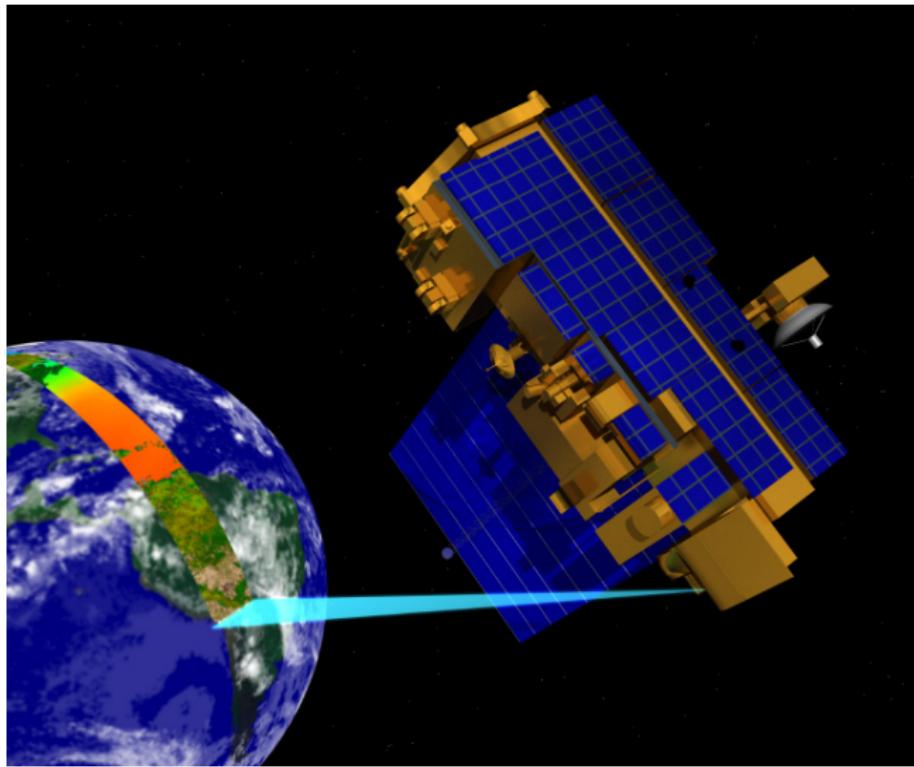
Covers Earth every one to two days

Technical Details: spectral coverage



36 spectral bands between 0.405 and 14.385 μm

Technical Details: spatial resolution



3 spatial resolutions – 250m, 500m, and 1,000m

MODIS Data Processing

- Tracking and Data Relay Satellite System in White Sands, New Mexico
 - EOS Data and Operations System @ Goddard Space Flight Center in Greenbelt, MD
 - MODIS Adaptive Processing System (MODAPS)
 - 3 DAACs for distribution

MODIS products (a subset...)

Atmosphere

- Aerosol & Clouds
 - Total Precipitable Water

Cryosphere Products

- Snow Cover
 - Sea Ice and Ice Surface Temperature

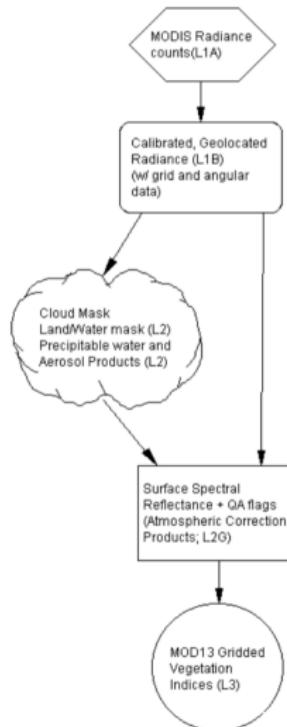
Ocean Products

- Sea Surface Temperature
 - Sub-surface Chlorophyll-a Concentration
 - Particulate Carbon
 - Photosynthetically Available Radiation

Land Products

- Surface Reflectance
 - Land Surface Temperature and Emissivity
 - Land Cover Products
 - Vegetation Index Products (NDVI and EVI)
 - Thermal Anomalies - Active Fires
 - Photosynthetically Active Radiation (FPAR) / Leaf Area Index (LAI)
 - Evapotranspiration
 - Primary Productivity
 - Vegetation Continuous Fields
 - Water Mask
 - Burned Area Product

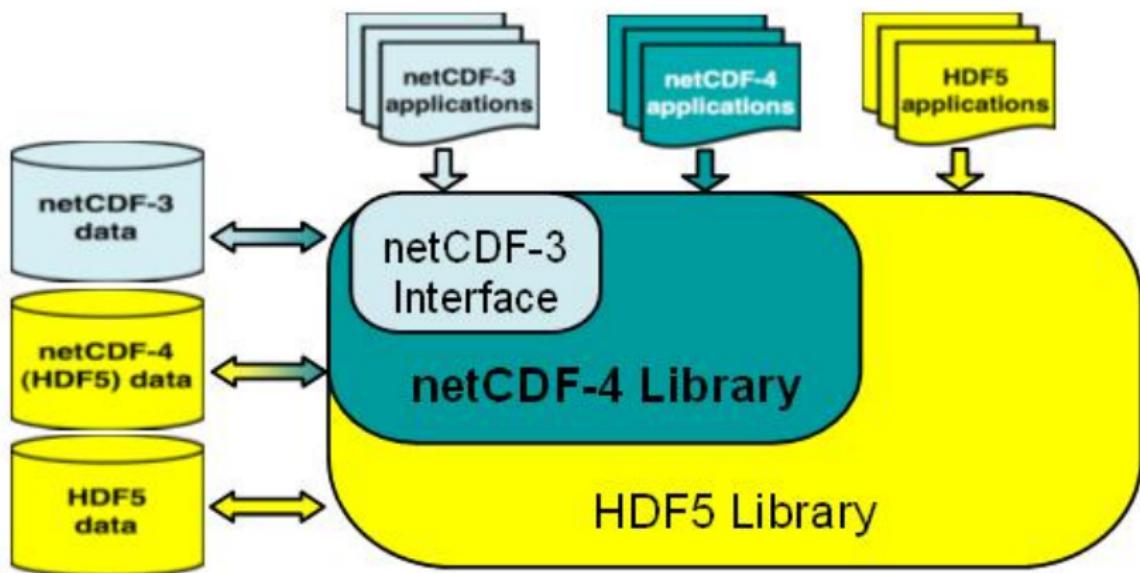
Example product workflow



MODIS Products used to generate vegetation indices. From the MOD13 Algorithm Theoretical Basis Document.

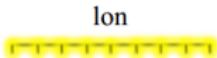
Data formats

Most NASA EOS data distributed as HDF files, which are very similar to netCDF.

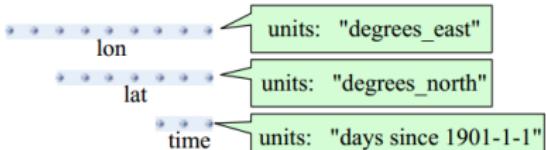


NetCDF / HDF

Dimensions

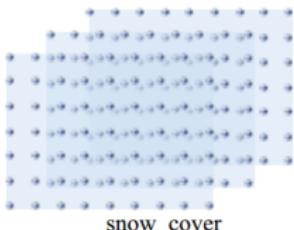
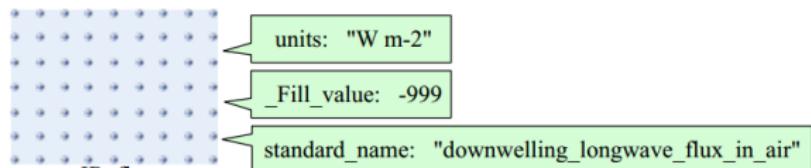
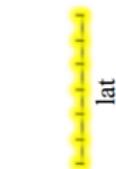


Variables



Attributes

title: "Global monthly surface averages"

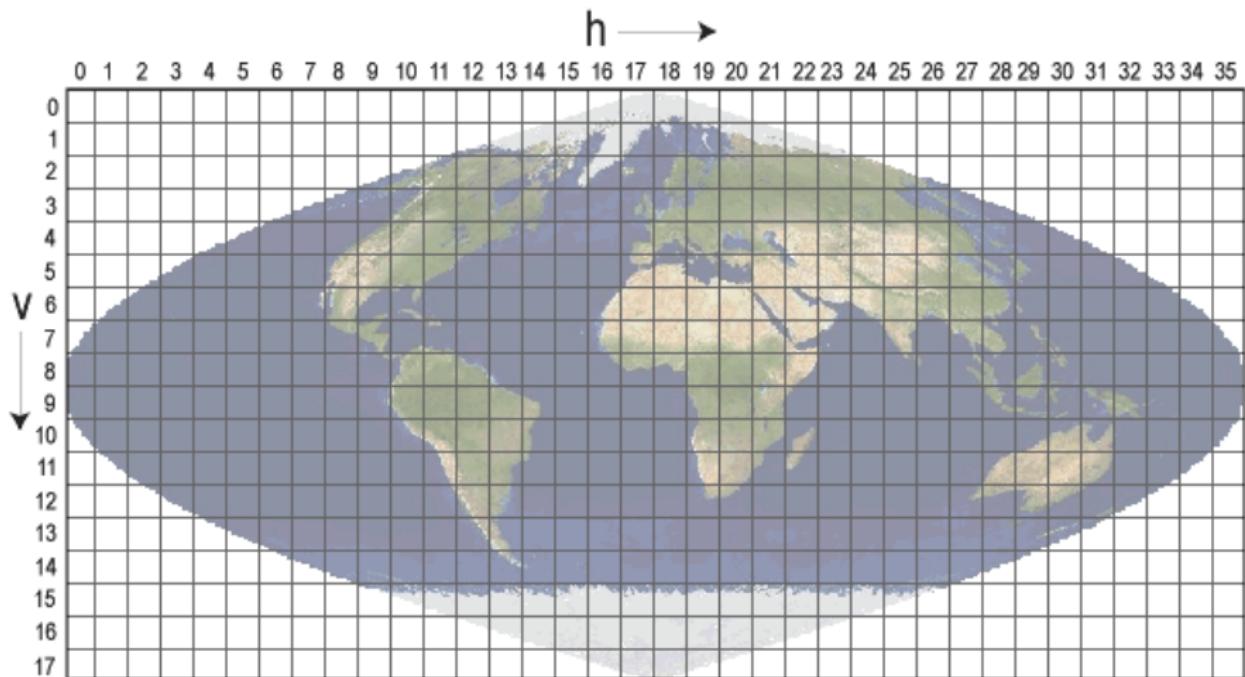


Collection-Level Naming Conventions

MODIS/Terra Surface Reflectance 8-Day L3 Global 500m SIN Grid V005

- MODIS/Terra - Instrument/Sensor
- Surface Reflectance - Geophysical Parameter
- 8-Day - Temporal Resolution
- L3 - Processing Level
- Global - Global or Swath
- 500m - Spatial Resolution
- SIN Grid - Gridded or Not
- V005 - Collection Version

MODIS Gridding system



Filename Conventions

MOD09A1.A2006001.h08v05.005.2006012234657.hdf

- MOD09A1 - Product Short Name
 - .A2006001 - Julian Date of Acquisition (A-YYYYDDD)
 - .h08v05 - Tile Identifier (horizontalXXverticalYY)
 - .005 - Collection Version
 - .2006012234567 - Julian Date of Production
(YYYYDDDHHMMSS)
 - .hdf - Data Format (HDF-EOS)

MODIS Temporal Resolution

- Daily
 - 8-Day
 - 16-Day
 - Monthly
 - Quarterly
 - Yearly

MODIS Spatial Resolution

- **Bands 1–2** 250-meter
 - **Bands 3–7** 500-meter
 - **Bands 8–36** 1000-meter

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MODIS Data

Distributed Active Archive Centers (DAACs)

- **Level 1 data:** geolocation, cloud mask, and atmosphere products
ladsweb.nascom.nasa.gov
 - **Land products:** lpdaac.usgs.gov
 - **Cryosphere (snow/ice) products:** nsidc.org/daac/modis
 - **Ocean color and sea surface temperature:**
oceancolor.gsfc.nasa.gov

Accessing data

The Land Processes Distributed Active Archive Center has a nice “Data Discovery” Tool:

LP DAAC
LAND PROCESSES DISTRIBUTED ACTIVE ARCHIVE CENTER

NASA USGS

Home About ▾ Dataset Discovery ▾ Citing Our Data Tools ▾ User Resources ▾ User Services ▾ Site Search Login with URS

[Home](#) > [Dataset Discovery](#)

Enter terms

form text

Product

- Bidirectional Reflectance Distribution Function and Albedo (88)
- Temperature and Emissivity (47)
- Reflectance (35)
- Vegetation Indices (28)
- Elevation (13)
- Thermal Anomalies and Fire (13)
- Radiance (8)
- Leaf Area Index and Fractional Photosynthetically Active Radiation (8)
- Land Cover (6)
- Gross Primary Productivity (4)
- Net Primary Productivity (3)
- Vegetation Continuous Cover/Fields (2)
- Unprocessed (2)

Search results

MOD09A1



Name: MODIS/Terra Surface Reflectance 8-Day L3 Global
500m SIN Grid
Product: Reflectance
Dataset: Terra MODIS
Dataset Version: 6
Temporal Granularity: Composites
Pixel Size: 500
Spatial Extent: Global
Data Access: [Data Pool](#), [EarthExplorer](#), [GloVis](#), [Reverb](#), [DAAC2Disk](#), [Earthdata Search](#)

MOD09CMG



Name: MODIS/Terra Surface Reflectance Daily L3 Global
0.05Deg CMG
Product: Reflectance
Dataset: Terra MODIS
Dataset Version: 6
Temporal Granularity: Daily
Pixel Size: 5600
Spatial Extent: Global
Data Access: [Data Pool](#), [EarthExplorer](#), [DAAC2Disk](#), [Earthdata Search](#)

MODIS Products Table

Lists all available MODIS land products



LP DAAC

LAND PROCESSES DISTRIBUTED ACTIVE ARCHIVE CENTER



NASA USGS

MODIS Products Table

These links will direct you to specific information and access points for each of the MODIS Land Products distributed from LP DAAC.

- + Radiation Budget Variables
 - + Ecosystem Variables
 - + Land Cover Characteristics

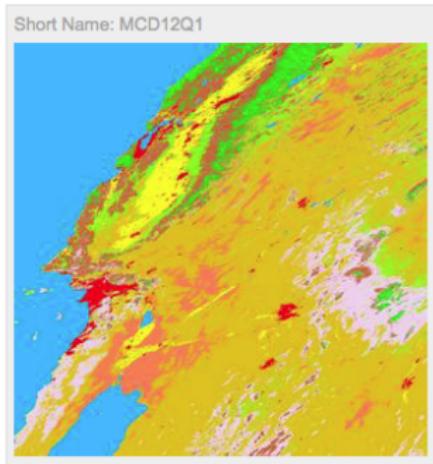
Annual Land Cover Type Description

[Home](#) > MODIS > MODIS Products Table > MCD12Q1

Land Cover Type Yearly L3 Global 500 m SIN Grid

MCD12Q1

The MODIS Land Cover Type product (Short Name: MCD12Q1) provides data characterizing five global land cover classification systems. In addition, it provides a land-cover type assessment, and quality-control information.



Detailed layer information



Version 051

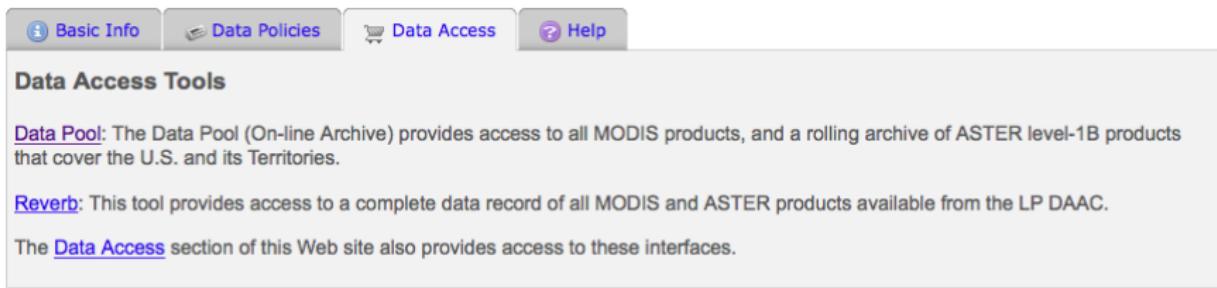
+ Overview

= Layers

V051 MODIS Land Cover Type HDF Science Data Set Layers

Science Data Set	Units	Data-Type	Fill Value	Valid Range
Land Cover Type 1 (IGBP)*	Class #	8-bit unsigned	255	0 – 254
Land Cover Type 2 (UMD)*	Class #	8-bit unsigned	255	0 – 254
Land Cover Type 3 (LAI/fPAR)*	Class #	8-bit unsigned	255	0 – 254
Land Cover Type 4 (NPP/BGC)*	Class #	8-bit unsigned	255	0 – 254

Data access links



Downloading: http/ftp access

U.S. GOVERNMENT COMPUTER

This US Government computer is for authorized users only. By accessing this system you are consenting to complete monitoring with no expectation of privacy. Unauthorized access or use may subject you to disciplinary action and criminal prosecution.

Name	Last modified	Size	Description
 Parent Directory		-	
 MCD12Q1.A2001001.h00v08.051.2014287161513.hdf	04-Nov-2014 14:10	88M	
 MCD12Q1.A2001001.h00v08.051.2014287161513.hdf.xml	04-Nov-2014 14:10	6.8K	
 MCD12Q1.A2001001.h00v09.051.2014287161511.hdf	04-Nov-2014 14:09	88M	
 MCD12Q1.A2001001.h00v09.051.2014287161511.hdf.xml	04-Nov-2014 14:09	6.8K	
 MCD12Q1.A2001001.h00v10.051.2014287161527.hdf	04-Nov-2014 14:10	88M	

or the LP DAAC2Disk Download Manager which builds a download script.

MODIS Reprojection Tool

Available at lpdaac.usgs.gov/tools/modis_reprojection_tool.



LP DAAC
LAND PROCESSES DISTRIBUTED ACTIVE ARCHIVE CENTER



NASA USGS

MODIS Reprojection Tool

The MODIS tiled Land products are generated by the MODIS Adaptive Processing System (MODAPS), located at the NASA Goddard Space Flight Center, as gridded output in the Sinusoidal (SIN) projection. These data products are then sent to the LP DAAC for archive and distribution.

MRT enables users to read data files in HDF-EOS format (MODIS Level-2G, Level-3, and Level-4 land data products), specify a geographic subset or specific science data sets as input to processing, perform geographic transformation to a different coordinate system/cartographic projection, and write the output to file formats other than HDF-EOS.

The MODIS Reprojection Tool is available for use by all registered users. The MODIS Tool will undergo further development to correct problems as they are detected, incorporate additional functionality, and be modified to enhance computational performance. The funding support for this work comes from the NASA Earth Science Data and Information Systems (ESDIS) Project.

Download

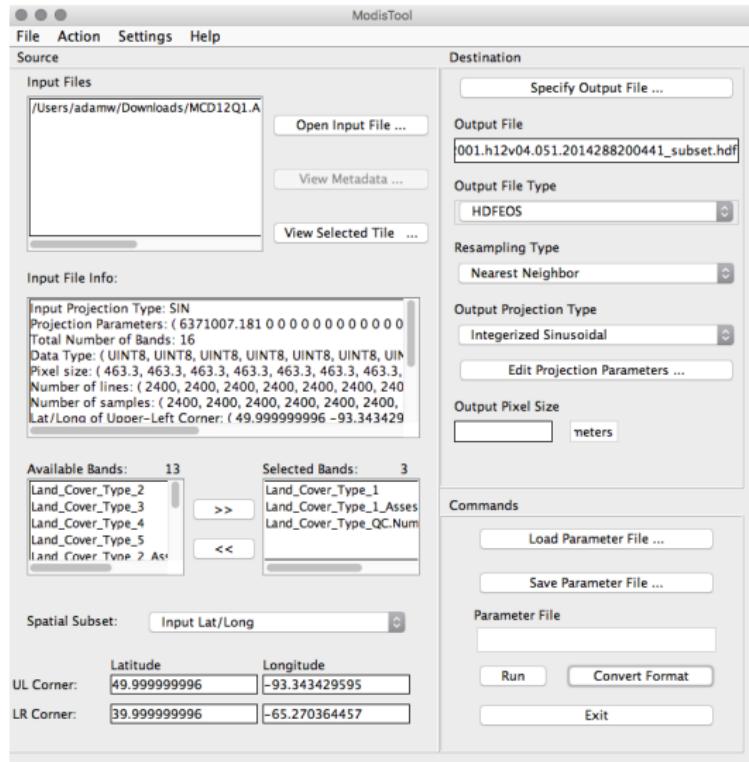
Please log in to download files.

-  Windows NT+32-bit
 -  Macintosh OS X (Intel)
 -  Linux 32-bit
 -  Linux 64-bit

Manuals

-  [MRT User Manual](#)
 -  [MRT Release Notes](#)

MODIS Reprojection Tool: Subset & Reproject



MCD12Q1.A2012001.h12v04.051.2014288200441.hdf

MODIS Web Services



daacmodis.ornl.gov/cgi-bin/MODIS/GLBVIZ_1_Glb/modis_subset_order_global_col5.pl

- Provide access to regional subsets (<100x100km)
 - Merge across tiles
 - Download full time series

MODIS Subset: Spatial

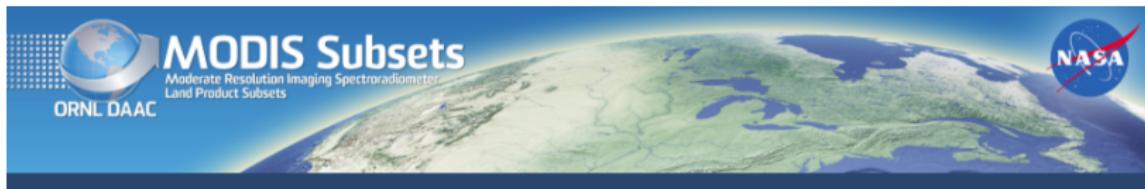


Global Subsetting Tool: MODIS Land Products

Specify the Coordinates for the Center of Area of Interest



MODIS Subset: Variables



Global Subsetting Tool: MODIS Land Products

Select Product and Subset size then Continue



Latitude [43.00168] Longitude [-78.78618]:Horizontal Tile [12] Vertical Tile [4] Sample [285] Line [839]

- [MCD43A1] MODIS/Terra+Aqua BRDF and Calculated Albedo
[MCD43A4] MODIS/Terra+Aqua Nadir BRDF-Adjusted Reflectance 16-Day L3 Global 500m SIN Grid
[MOD09A1] Surface Reflectance
[MOD11A2] Land Surface Temperature and Emissivity
[MOD13Q1] Vegetation Indices (NDVI, EVI)
[MOD15A2] Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR) 8 Day Composite
[MOD15A2GFS] Terra Gap-Filled,Smoothed Leaf Area Index (LAI) 8 Day Composite [Collection 4]
[MOD16A2] Evapotranspiration
[MOD17A2_51] Gross primary production (GPP) [Collection 5.1]
[MOD17A3] Primary Productivity (NPP)
[MYD09A1] Surface Reflectance
[MYD11A2] Land Surface Temperature/Emissivity
[MYD13Q1] Vegetation Indices (NDVI, EVI)
[MYD15A2] Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR) 8 Day Composite

Specify the Number of Kilometers Encompassing the Center Location

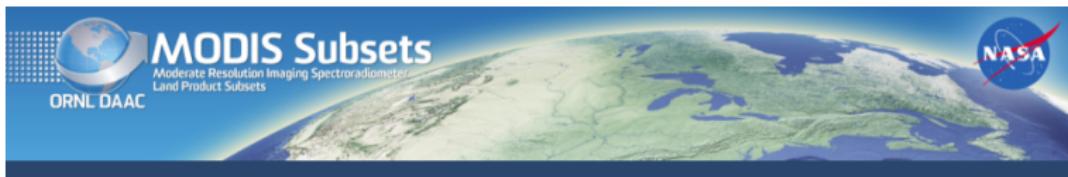
Above and Below Left and Right

(0–100) (0–100)

3

3

MODIS Subset: Temporal



Global Subsetting Tool: MODIS Land Products

Select Date and Provide Email then Place Order



MODIS/Terra Vegetation Indices (NDVI/EVI) 16-Day L3 Global 250m SIN Grid [Collection 5]

Latitude [43.00168] Longitude [-78.78618] Horizontal Tile [12] Vertical Tile [4] Sample [285] Line [839]

The Requested Data Area is Approximately 6.25 Kilometers Wide and 6.25 Kilometers High

Select Starting Date

Day 049 of the Year 2000 [Feb. 18,2000]
Day 065 of the Year 2000 [Mar. 05,2000]
Day 081 of the Year 2000 [Mar. 21,2000]
Day 097 of the Year 2000 [Apr. 06,2000]
Day 113 of the Year 2000 [Apr. 22,2000]
Day 129 of the Year 2000 [May. 08,2000]
Day 145 of the Year 2000 [May. 24,2000]
Day 161 of the Year 2000 [Jun. 09,2000]
Day 177 of the Year 2000 [Jun. 25,2000]
Day 193 of the Year 2000 [Jul. 11,2000]
Day 209 of the Year 2000 [Jul. 27,2000]
Day 225 of the Year 2000 [Aug. 12,2000]

Select Ending Date

- Day 097 of the Year 2015 [Apr. 07, 2015]
- Day 113 of the Year 2015 [Apr. 23, 2015]
- Day 129 of the Year 2015 [May. 09, 2015]
- Day 145 of the Year 2015 [May. 25, 2015]
- Day 161 of the Year 2015 [Jun. 10, 2015]
- Day 177 of the Year 2015 [Jun. 26, 2015]
- Day 193 of the Year 2015 [Jul. 12, 2015]
- Day 209 of the Year 2015 [Jul. 28, 2015]
- Day 225 of the Year 2015 [Aug. 13, 2015]
- Day 241 of the Year 2015 [Aug. 29, 2015]
- Day 257 of the Year 2015 [Sep. 14, 2015]
- Day 273 of the Year 2015 [Sep. 30, 2015]

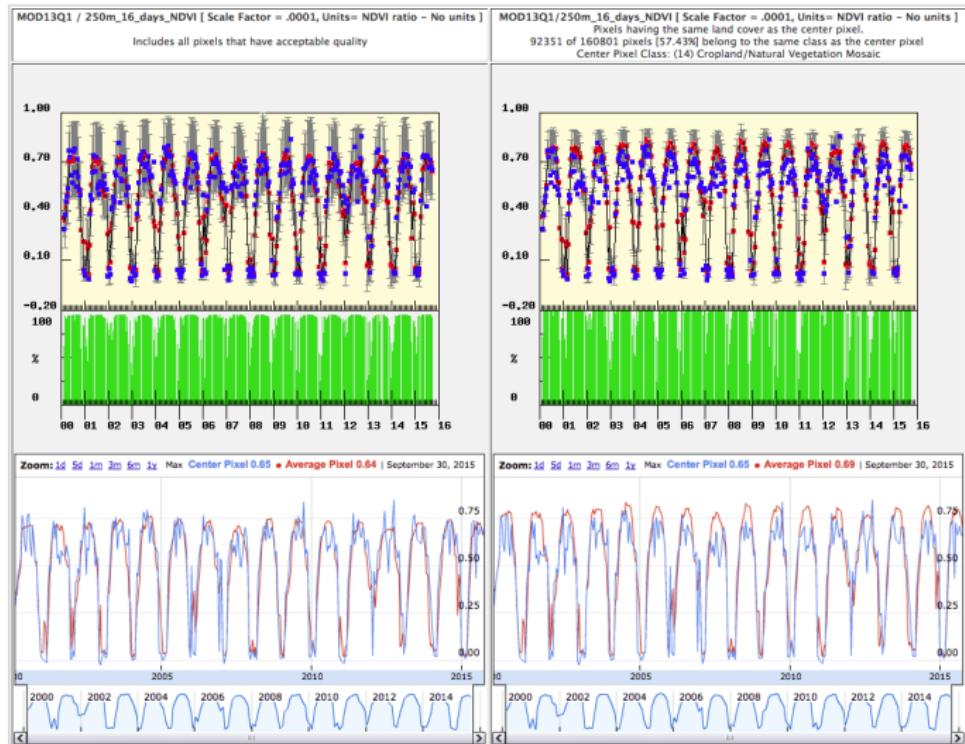
Pre-selected Dates Reflect ALL Available Dates for the Selected Product/Location

GeoTIFF Options

- Generate GeoTIFF in MODIS Sinusoidal Projection
 - Generate GeoTIFF and Reproject to Geographic Lat/long

Submit email and wait for results...

[MODIS Subset: Results & Download](#)



MODIS Subsets: API

Subsets of MODIS Land Products through **Simple Object Access Protocol** (SOAP).

MODISTools R package.

Presentation Credits

- Images: NASA
 - Some contents from Steve Ackerman stevea@ssec.wisc.edu, Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison