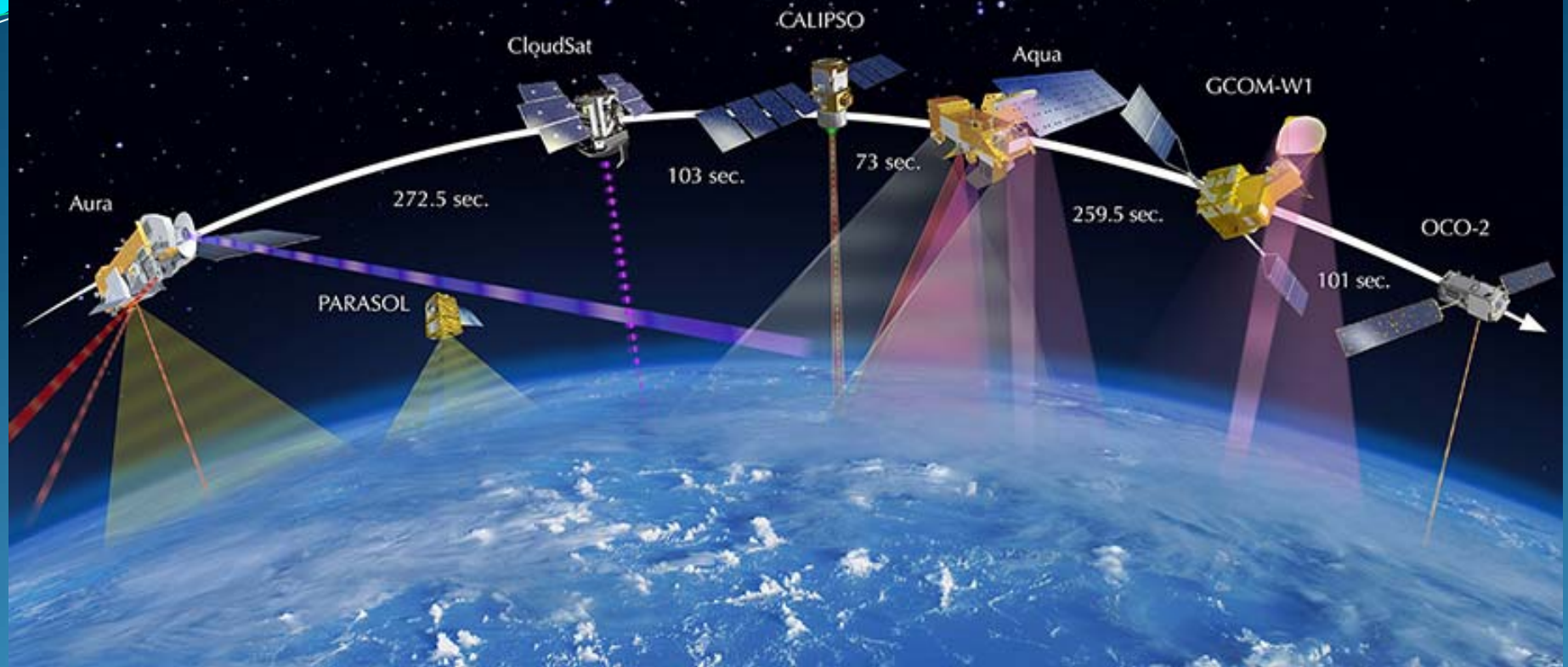


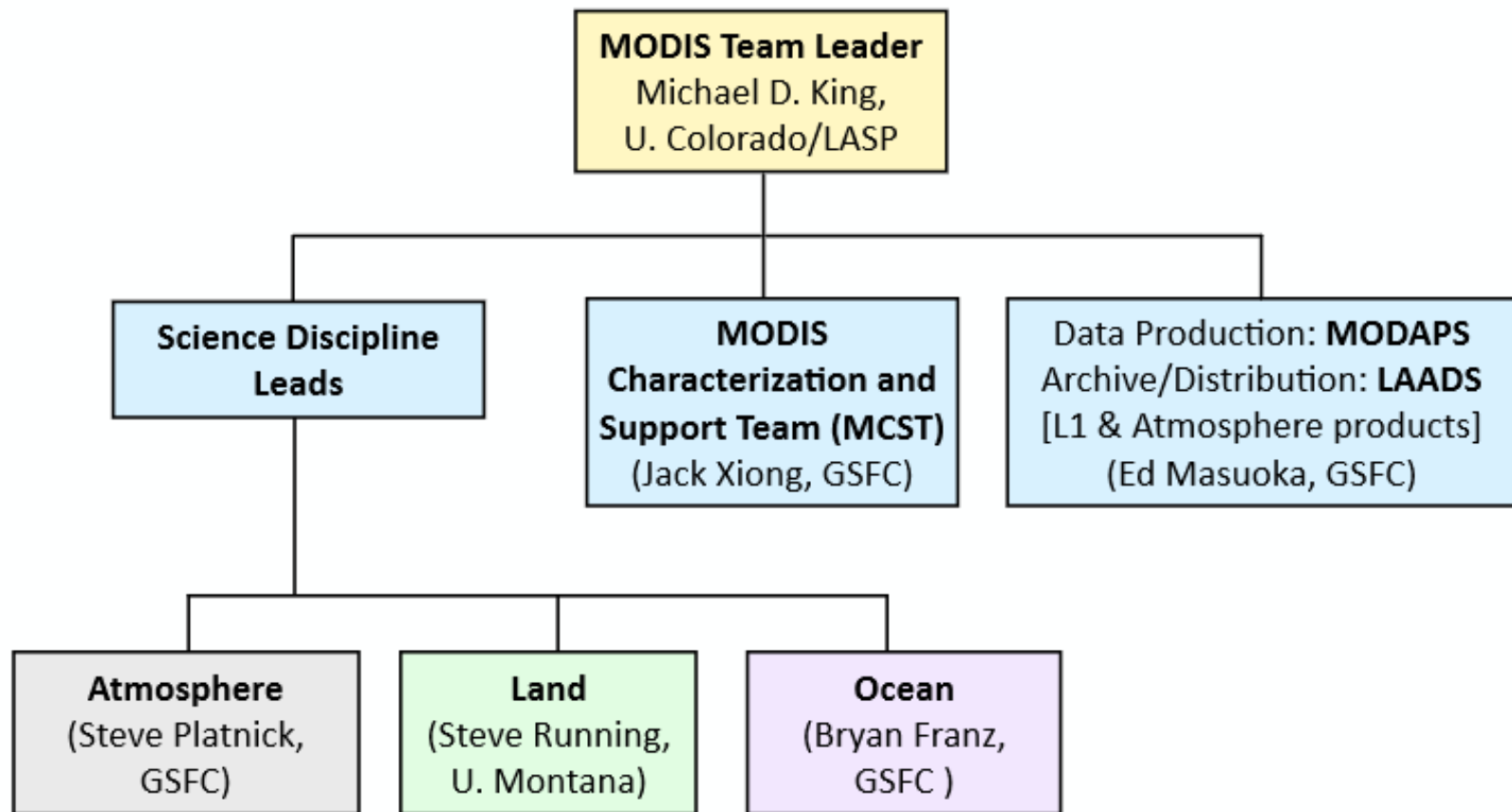
MET 611 – Satellite Data Applications



MODIS Data Access

Jennifer D. S. Griswold

MODIS Organization and People



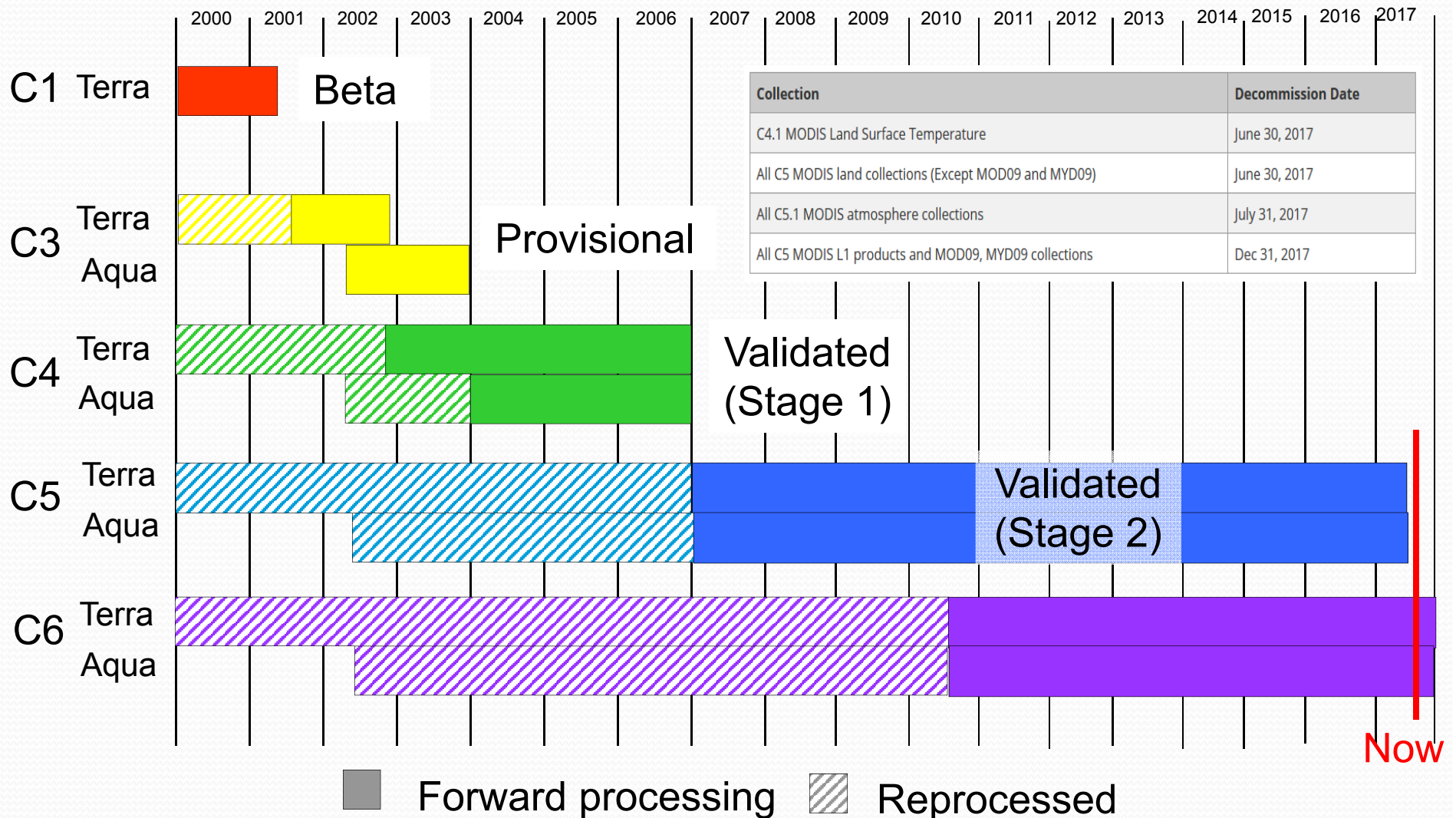
Nomenclature and Acronyms

- **Product “Level” designations**
 - Level-0 (L₀): raw instrument data (digital counts)
 - Level-1B (L_{1B}): calibrated/geolocated instrument data
 - Level-2 (L₂): derived geophysical retrieval data (“pixel” level)
 - Level-3 (L₃): gridded data (spatial and/or temporal aggregation of geophysical products)
 - Level-4: combination of model and measured/retrieved data (not generated by atmosphere team)

Nomenclature and Acronyms

- **MODIS “Collection”**
 - refers to a (re)processing production run with consistent algorithms (or nearly consistent)
 - C5 production began in summer 2006, reprocessing completed about a year later.
 - C51 update in late 2008. Collection 6 (C6) Aqua L2 production began in Dec 2013.
- **See next slide for MODIS Production Version Timelines**

MODIS Production Versions



Each collection represents an improvement in science quality

MODIS Standardized Filenaming Convention

NASA Earth Science Data filenames for MODIS

Terra MODIS: **MOD06_L2.AYYYYDDD.HHMM.CCC.YYYYDDDDHHMMSS.hdf**
Aqua MODIS: **MYD06_L2.AYYYYDDD.HHMM.CCC.YYYYDDDDHHMMSS.hdf**

Definition of highlighted text:

MOD06 = Earth Science Data Type name

L2 = Denotes a Level-2 product (or L3 for Level-3, etc.)

A = indicates following date/time information is for the acquisition (observation)

YYYYDDD = acquisition year and day-of-year

HHMM = acquisition hour and minute start time

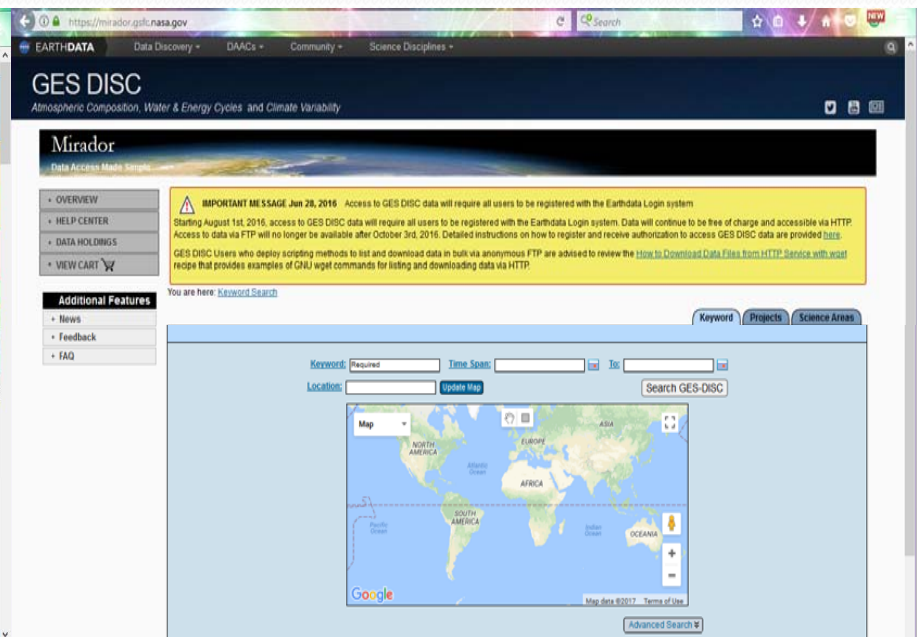
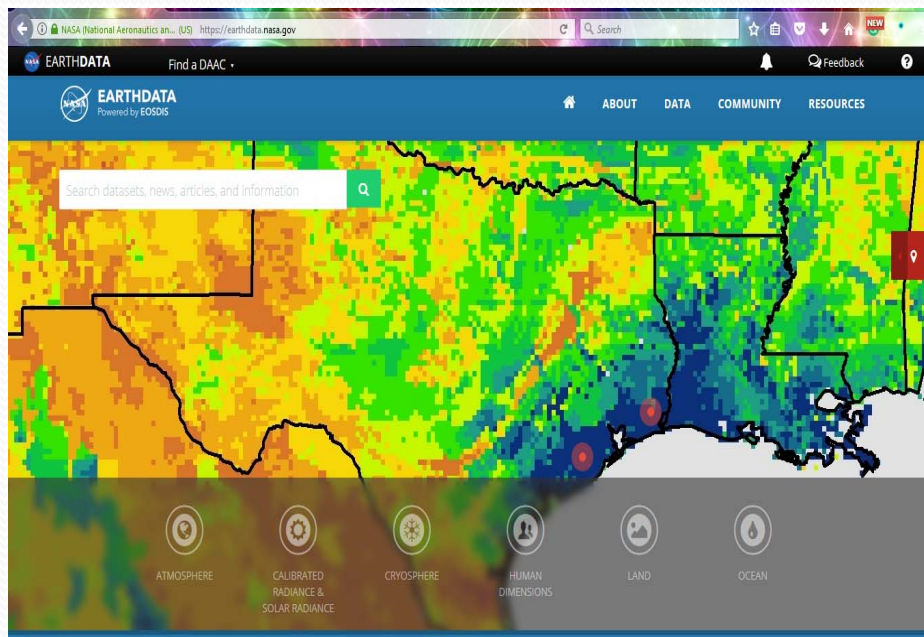
CCC = collection (e.g., '006' for Collection 6)

YYYYDDDDHHMMSS = production data and time

hdf = denotes HDF file format

Ordering MODIS and other Satellite Products

- EarthData - <https://earthdata.nasa.gov/>
- Mirador - <https://mirador.gsfc.nasa.gov/>
- **LAADS** - <https://ladsweb.modaps.eosdis.nasa.gov/>



LAADS DAAC

Level-1 and Atmosphere Archive and Distribution System (LAADS)
Distributed Active Archive Center (DAAC)

<https://ladsweb.modaps.eosdis.nasa.gov/>

LAADS is the DAAC that archives and distributes Atmosphere products from MODIS Terra, Aqua, VIIRS, and more.

The screenshot shows the LAADS DAAC website interface. At the top, there is a navigation bar with the NASA EarthData logo and the text "LAADS DAAC". To the right of the logo, there are several icons for navigation: "About LAADS", "Find Data", "Data Discovery", "Quality", "Help", and "Profile". Below the navigation bar is a large image of a satellite view of a hurricane, labeled "Hurricane Jose". Below the image are three main content blocks, each with a title and a list of links:

- ABOUT LAADS** (What we do)
 - Purpose & Mission
 - About our Atmosphere
 - News
- DATA DISCOVERY** (Information, products, and services)
 - Missions & Measurements
 - Find Data** (highlighted with a yellow border)
 - Tools & Services
- QUALITY** (Evaluation and validation)
 - Product Quality Assessment
 - MODIS Atmosphere Product Validation
 - MODIS Land Product Validation

At the bottom of the page, there is a section titled "LAADS ALERTS".

LAADS DAAC

Level-1 and Atmosphere Archive and Distribution System (LAADS) Distributed Active Archive Center (DAAC)

1. Select Sensor
2. Select Collection
3. Select Product
4. Select Time
 1. Single Day or a Range of Days
5. Select Location
 1. Can scroll map to choose a box or type in lat and lon values, choose a country, or the whole globe!
6. View Files
 1. You can sneak a peek at the figures.
 2. Click on “Search by Product” to go back to the list
 3. To order the files you have to “select them”
7. Review and Order Data
 1. You need to make an account

The screenshot displays the LAADS DAAC web interface. The top navigation bar includes the NASA logo, the text 'LAADS DAAC', and several menu items: 'About LAADS', 'Find Data', 'Data Discovery', 'Quality', 'Help', and 'Profile'. Below the navigation bar is a progress indicator with five steps: 1. PRODUCTS, 2. TIME, 3. LOCATION, 4. FILES, and 5. REVIEW & ORDER. The current step, 'REVIEW & ORDER', is highlighted. The main content area shows a search result for 'MYD06_L2 (6)' with a time range of '2017-09-11 ... 2017-09-12' and location coordinates 'W: 199°, N: 24.5°, E: 207.5°, S: 16.8°'. It indicates that 4 files are selected. A 'Files Summary' box shows 'MYD06_L2 (Collection 6)' with a total of 4 files. A yellow box highlights the 'Apply Post-Processing' and 'Select Delivery Method' dropdown menus, along with the 'Add another search' and 'Submit Order' buttons. The footer includes the NASA logo, the Goddard Space Flight Center logo, and the text 'Level-1 and Atmosphere Archive & Distribution System' and 'Privacy Policy and Important Notices'.

Your order notification

LAADS Web Order Notification

Inbox x



apache user for nonntp servers <apache@modx.nascom.nasa.gov>

2:37 PM (2 minutes ago) ☆



to me ▾

Your Order ID is: 501173010

The data you ordered will be staged (in about 10 minutes), and you can retrieve the data through anonymous FTP using:

ftp [ladsweb.modaps.eosdis.nasa.gov](ftp://ladsweb.modaps.eosdis.nasa.gov)

username: anonymous

password: smalljen@hawaii.edu

```
cd /orders/501173010
```

```
binary
```

```
prompt
```

```
mget *
```

Order 501173010 contains 4 file

- if your submission required additional post-processing you will be notified when these files become available

*NOTE: The files will be deleted after 5 days, please download the files before they get deleted.

For help, please contact us at modapsuso@lists.nasa.gov

Thank you,

The LAADS Support Team

MODIS Product Hierarchy

Level 1 Products

Granules

Used to produce



Level 2 Products

Granules

Used to produce



Level 3 Products

Global composites
of level 2 granules

Less Processing

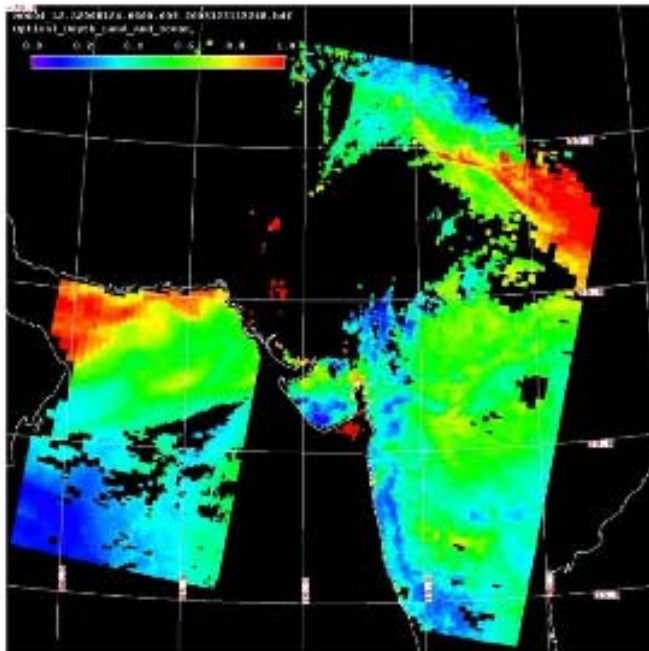
Granule - A 5 minute piece of an orbit



More Processing

MOD - Terra product

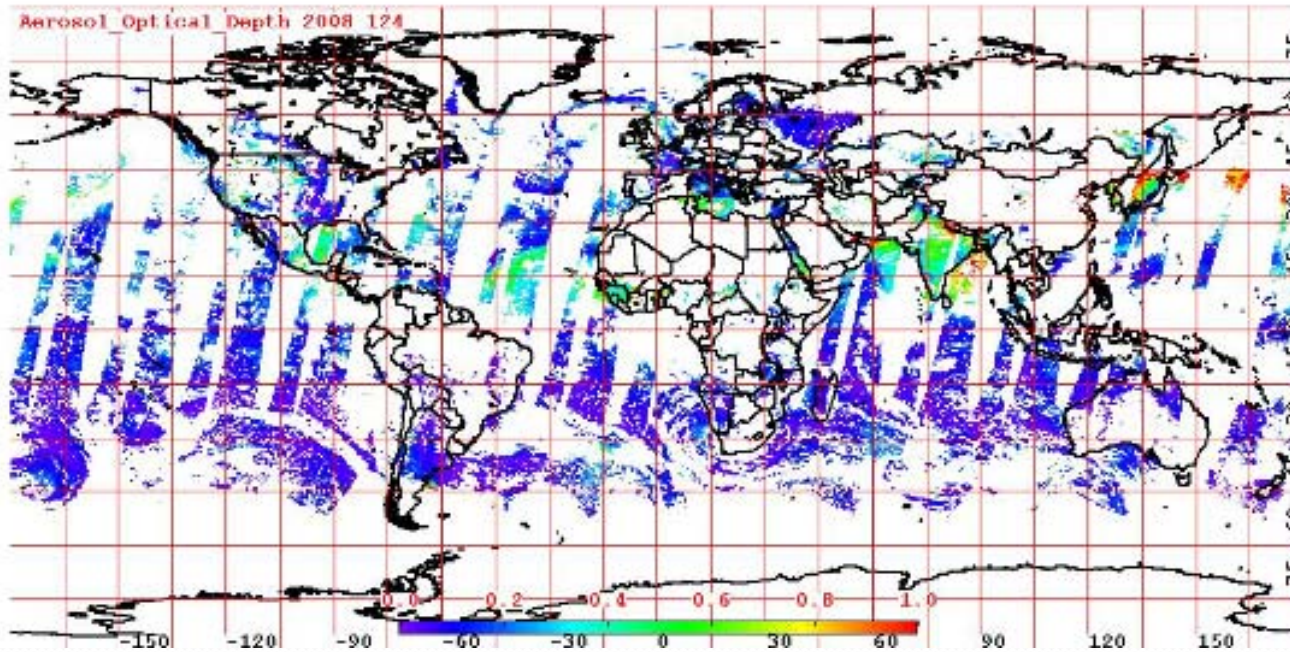
MYD - Aqua product



←
Level 2
Aerosol
Product
(AOD)



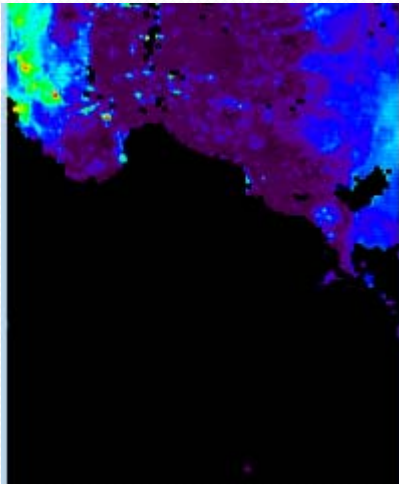
↓
Level 1 (RGB)



Level 3
Aerosol
Product
(AOD)

Data Quality Screening Service

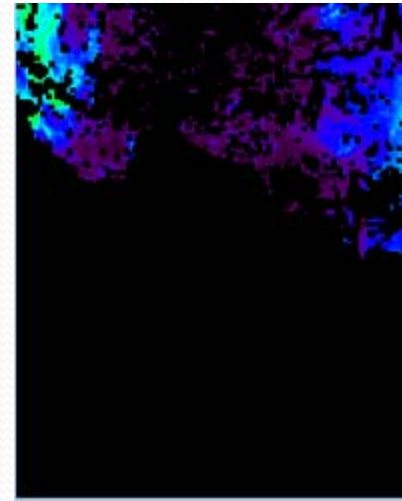
Original Image



Mask



Screened Image



Mask is white (1) where data meet the quality threshold specified (in this example, Good or Very Good) and black (0) where data fall below threshold. Observations that correspond to black (0) elements in the mask are replaced with fill values in the screened product.

Legacy Image Search

https://modis-images.gsfc.nasa.gov/IMAGES/o2_1km_main.html

- Great way to preview L2 granules and help you choose the right file for a specific event!
- You can choose the Year, Month and Day.
- By clicking on the map it'll help you identify the best time (HH:MM) to check

The screenshot displays the NASA Legacy Image Search interface. The browser address bar shows the URL: https://modis-images.gsfc.nasa.gov/IMAGES/MYD02/GRANULE/granule_frameset_new.html. A yellow box highlights the file name: MYD021KM.A2017253.1855.006.2017254151228.hdf Aqua MODIS Truecolor Scene. The main content area shows a satellite image of a tropical storm over the Caribbean Sea, with a map of the region overlaid. A navigation menu on the left side allows users to select the year (2017, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002), the month (September, August, July, June, May, April, March, February, January), and the day (13th, 12th, 11th, 10th, 09th, 08th, 07th, 06th, 05th, 04th, 03rd, 02nd, 01st). A small world map in the bottom right corner shows the location of the image.

MODIS Level 2 Data Summary

- **Key Science Applications:**
 - Aerosol climatology
 - biomass-burning aerosols
 - cloud radiative properties
 - hydrological cycle climatology
 - effect on aerosol and clouds
 - atmospheric correction
 - characterization of the atmosphere
 - cloud parameterization
 - climate modeling & monitoring
 - precipitable water
 - cloud determination and screening.

MODIS Level 2 Data Summary

- **Key Geophysical Parameters:**
 - Atmospheric aerosol optical depth
 - aerosol size distribution over oceans
 - cloud particle phase
 - cloud particle size
 - cloud optical thickness at $0.66\ \mu\text{m}$
 - cirrus reflectance at $0.66\ \mu\text{m}$
 - cloud top temperature
 - cloud top pressure
 - clear-sky total-column precipitable water derived from both infrared and near-infrared algorithms
 - and cloud fraction.

World View

The screenshot displays the NASA WorldView web application interface. The browser address bar shows the URL <https://worldview.earthdata.nasa.gov>. The main interface features a satellite view of Earth with several data layers overlaid. On the left, a sidebar menu includes sections for "OVERLAYS" and "BASE LAYERS".

OVERLAYS:

- Place Labels (OpenStreetMap (license), Natural Earth)
- Coastlines / Borders / Roads (OpenStreetMap (license), Natural Earth)
- Coastlines (OpenStreetMap (license))

BASE LAYERS:

- Corrected Reflectance (True Color) (Suomi NPP / VIIRS)
- Corrected Reflectance (True Color) (Aqua / MODIS)
- Corrected Reflectance (True Color) (Terra / MODIS)

A "+ Add Layers" button is located at the bottom of the sidebar. The main map area includes a search bar at the top right, navigation icons (back, forward, home, refresh), and a scale bar at the bottom right showing 1000 km and 1000 mi. The bottom of the interface features a timeline for the date "2017 SEP 13" and a "DAYS" / "MONTHS" toggle.

World View – Wildfires, Montana

The screenshot displays the NASA WorldView interface. The browser address bar shows the URL: https://worldview.earthdata.nasa.gov/?p=geographic&l=VIIRS_SNPP_CorrectedReflectance_TrueColor. The main map area shows a satellite view of Montana with red dots indicating wildfire events. A red location pin is placed over Missoula. The left sidebar lists several wildfire events:

- Monday, September 4
- Mission Fire, CALIFORNIA, Sunday, September 3
- Wildfire - S of Missoula, Montana - United States, Saturday, September 2 (highlighted)
- Wildfire - W of Salmon, Idaho - United States, Saturday, September 2
- Strychnine Fire, IDAHO, Saturday, September 2
- Wildfire - California, United States, Saturday, September 2
- Finlay Creek Fire, British Columbia, Canada, Saturday, September 2
- Wildfire - SE of Cranbrook, British Columbia - Canada, Friday, September 1
- Caldwell Fire, CALIFORNIA, Friday, September 1
- Helena Fire, CALIFORNIA, Wednesday, August 30

The bottom of the interface features a timeline for August and September 2017, with the date 2017 SEP 03 selected. A scale bar indicates 20 km and 10 mi. A notification box in the top right corner states: "Events may not be visible at all times. Read more..."

World View – Hurricane Jose

The screenshot displays the NASA WorldView web application interface. The browser's address bar shows the URL: https://worldview.earthdata.nasa.gov/?p=geographic&I=VIIRS_SNPP_CorrectedReflectance_Tn. The main map area shows a satellite view of the Caribbean region, with a large hurricane system (Hurricane Jose) visible over the Sargasso Sea. A red location pin is placed on the hurricane's center. The interface includes a left-hand sidebar with a 'Layers' panel, an 'Events' panel listing various weather events, and a 'Data' panel. The 'Events' panel is currently expanded to show details for Hurricane Jose on September 13, 2017, including a link to 'Unisys Weather' and a date range from 2017-09-05 to 2017-09-13. Other events listed include Tropical Storm Dokuri, Pine Tree Fire, Typhoon Talim, Hurricane Katia, Deep Creek Fire, and Fernandina Volcano. The bottom of the interface features a timeline navigation bar for the month of September 2017, with the current date set to 2017 SEP 13. The Windows taskbar at the bottom shows the system clock as 8:50 PM on 9/13/2017.

NASA WORLDVIEW

Layers Events Data

- Tropical Storm Dokuri
Wednesday, September 13
- Pine Tree Fire, COLORADO
Saturday, September 9
- Typhoon Talim
Wednesday, September 13
- Hurricane Katia
Saturday, September 9
- Hurricane Jose
Wednesday, September 13

[Unisys Weather](#)

2017-09-13
2017-09-12
2017-09-11
2017-09-10
2017-09-09
2017-09-08
2017-09-07
2017-09-06
2017-09-05

Deep Creek Fire, COLORADO
Monday, September 4

Fernandina Volcano, Galapagos Islands,
Ecuador
Monday, September 4

2017 SEP 13

JUL 2017 AUG 2017 SEP 2017

500 km
200 mi

DAYS
MONTHS

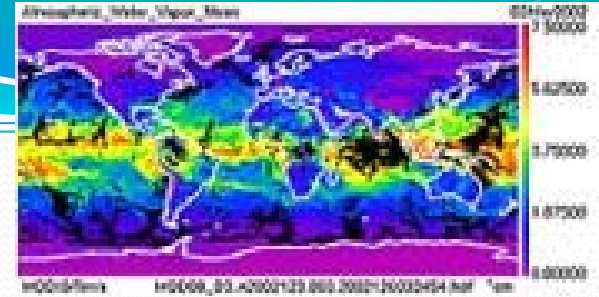
8:50 PM
9/13/2017



Why Level 3 products?

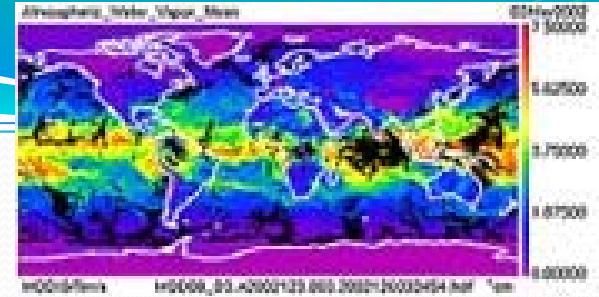
- Level 2 data is difficult to work with because of:
 - Formats
 - Volume
 - Number of files
- Level 3 data are easy to use ... but might lead to wrong conclusions if not being careful
- Level 3 products are mostly used by modelers, application users, climate scientists

MODIS L3 Daily Product Descriptions



- The Level-3 MODIS Atmosphere Daily Global Product contains roughly 600 statistical datasets that are derived from approximately 80 scientific parameters from four Level-2 MODIS Atmosphere Products:
 - Aerosol
 - Water Vapor
 - Cloud
 - Atmosphere Profile.
- There are two MODIS Daily Global data product files:
 - **MOD08_D3**, containing data collected from the Terra platform
 - **MYD08_D3**, containing data collected from the Aqua platform.

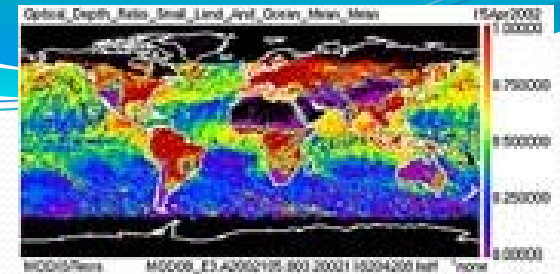
MODIS L3 Daily Product Descriptions



- A range of statistical summaries are computed, depending on the parameter being considered. Statistics for a given measurement might include:
 - Simple (mean, minimum, maximum, standard deviation) statistics
 - Parameters of normal and log-normal distributions
 - Fraction of pixels that satisfy some condition (e.g. cloudy, clear)
 - Histograms of the quantity within each grid box
 - Histograms of the confidence placed in each measurement
 - Histograms and/or regressions derived from comparing one science parameter to another, statistics may be computed for a subset that satisfies some condition
- Statistics are sorted into 1 by 1 degree cells on an equal-angle grid that spans a 24-hour (0000 to 2400 Greenwich Mean Time) interval and then summarized over the globe.
- It should be noted that browse images are available in both the native equal-angle (lat-lon) grid as well as an equal-area (hammer-aitoff) grid.



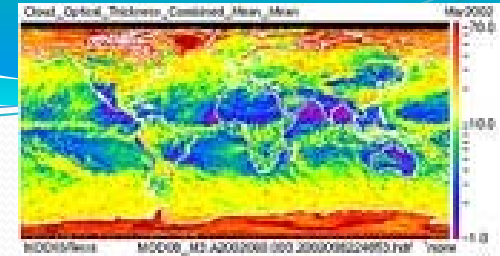
MODIS L3 8-Day Product Descriptions



- **Computed Statistics**

- Statistics are sorted into 1x1 degree cells on an equal-angle grid that spans an 8-day interval and then summarized over the globe. It should be noted that the eight-day interval start date is reset to January 1st at the beginning of every new year.
- A range of statistical summaries are computed, depending on the parameter being considered. Statistics for a given measurement might include:
 - Simple (mean, minimum, maximum, standard deviation) statistics
 - Parameters of normal and log-normal distributions
 - Fraction of pixels that satisfy some condition (e.g. cloudy, clear)
 - Histograms of the quantity within each grid box
 - Histograms of the confidence placed in each measurement
 - Histograms and/or regressions derived from comparing one science parameter to another, statistics may be computed for a subset that satisfies some condition

MODIS L3 Monthly Computed Statistics

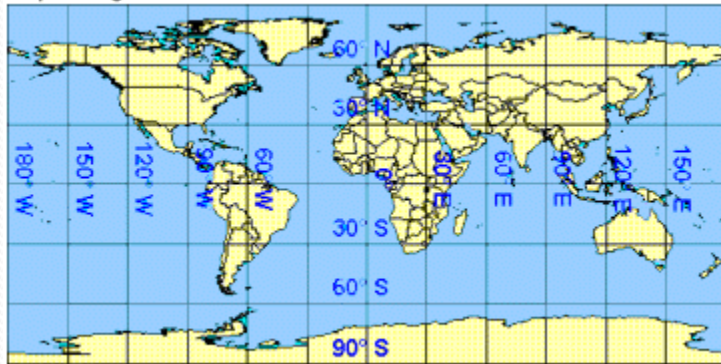


- **Computed Statistics**

- Statistics are sorted into **1x1 degree cells** on an equal-angle grid that spans a (calendar) monthly interval and then summarized over the globe.
- A range of statistical summaries are computed, depending on the parameter being considered. Statistics for a given measurement might include:
 - Simple (mean, minimum, maximum, standard deviation) statistics
- Parameters of normal and log-normal distributions
 - Fraction of pixels that satisfy some condition (e.g. cloudy, clear)
 - Histograms of the quantity within each grid box
 - Histograms of the confidence placed in each measurement
 - Histograms and/or regressions derived from comparing one science parameter to another, statistics may be computed for a subset that satisfies some condition

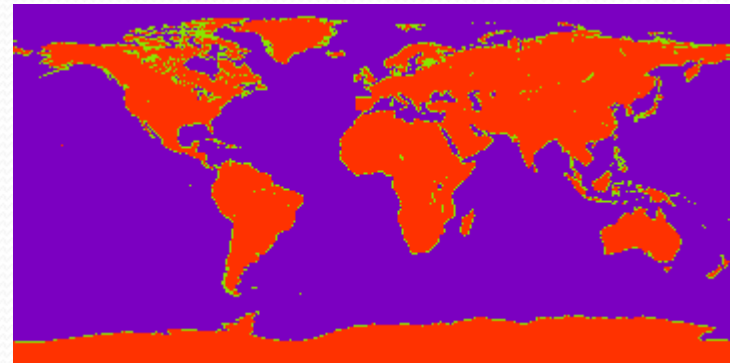
L3 Grids and Mapping

Equal Angle Lat-Lon Grid



The MODIS Atmosphere Daily Global Product is stored on an equal angle lat-lon grid. The grid cells are 1 degree by 1 degree, which means the output grid is always 360 pixels in width and 180 pixels in height.

Hammer-Aitoff Projection



A Land/Ocean Mask for L3 products is provided below. The PNG image is 360 pixels in width and 180 pixels in height. Each image pixel corresponds to one L3 1x1 degree grid cell. Values of 200 represent land grid cells, values of 100 represent mixed grid cells, and values of 0 represent ocean grid cells. This image can be use with analysis programs, such as those written in IDL, to screen L3 results for ocean or land only.