MODIS Atmosphere
Level-3 Product & Web Site Review

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Presentation Outline:

1. Level-3 (L3) Primer -- High-level algorithm & product description
2. Web Site Review -- Web-based tools and key features
3. Case Studies -- Using web & interactive tools to diagnose algorithm issues
4. L3 Updates -- Collection 005 change summary

Topic 1.

The L3 Algorithm

L3 Daily Algorithm: Characteristics

Important Limitations:

- Limited input - only L2 files
- Fixed grid - equal-angle 1x1 degree
- Subsampling - L2 pixels sampled at geolocation resolution
- No valid range check - inconsistently defined and implemented at L2 - potential to mask L2 algorithm problems

Statistical Computation:

- Aggregation - using L2 QA flags (e.g: ice vs. water cloud phase)
- QA-weighted Statistics - using L2 QA "confidence flags"
- Comparison Statistics - joint histogram and/or regression statistics may be computed of one L2 parameter against another

Sub-sampling

L3 Sub-sampling Impact

Product Family	L2 Data Resolution	L2 Geolocation Resolution	L2 Input Pixels (Max) per 1° L3 Grid (Equator)	Impact
Aerosol 04	10km	10 km	121 out of 121	No
Water Vapor 05	1 km	5 km	484 out of 12,231	Yes
Cirrus Detection 06_CD	1 km	5 km	484 out of 12,231	Yes
Cloud Top Properties 06_CT	5 km	5 km	484 out of 484	No
Cloud Optical Properties 06_OD	1 km	5 km	484 out of 12,321	Yes
Atmosphere Profile 07	5 km	5 km	484 out of 484	No

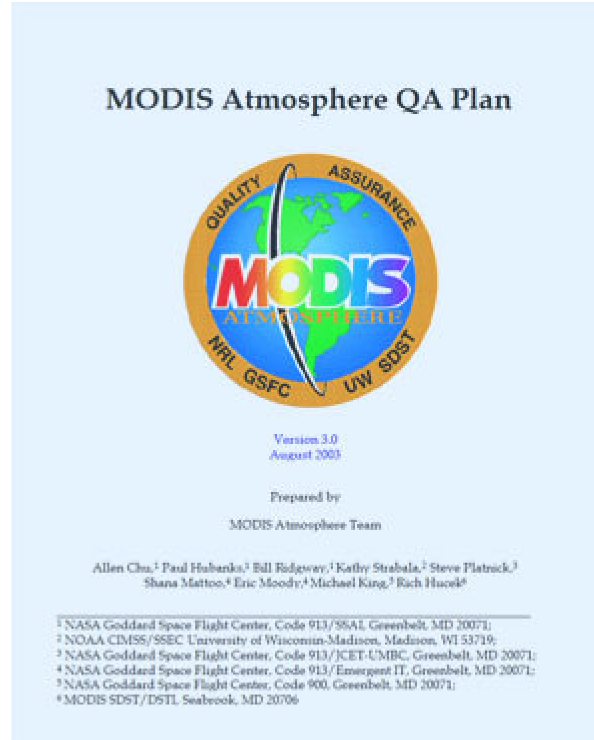
The meaning of “QA”

- QA or Quality Assurance is a loosely defined term that covers a myriad of ancillary information produced along with with many L2 parameters

- QA is described in the QA Plan document (available on the modis-atmos web site -- being updated for Collection 005)

- The "runtime" QA flags produced by Level 2 algorithms are typically stored as packed bit-strings in "Quality Assurance" SDS's. These flags cover many aspects of L2 retrieval parameters including:

  - ✓ Input (ancillary) data sources
  - ✓ Approach (retrieval method)
  - ✓ Various scene attributes
  - ✓ Success or failure of various criteria
  - ✓ Data quality or confidence estimate (*QA confidence flags*)


MODIS Atmosphere QA Plan

Version 3.0
August 2003

Prepared by

MODIS Atmosphere Team

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QA confidence flags, when computed, are set for every L2 pixel. The four categories (for non-fill L2 data) are:

- 0 = No Confidence → 0x weight
- 1 = Questionable or Marginal → 1x weight
- 2 = Good Confidence → 2x weight
- 3 = Very Good Confidence → 3x weight

Who is setting "meaningful" L2 QA?

Product Family	L2 QA Set?	Detail
Aerosol 04	Yes	Differentiate experimental from non-experimental results
Water Vapor 05	Yes	Negligible impact at L3
Cirrus Detection 06_CD	No	No QA bits reserved in QA Plan
Cloud Top Properties 06_CT	No	Dropped in Summer 2002
Cloud Optical Properties 06_OD	Yes	Based on joint distribution of Tau and Re
Atmosphere Profile 07	No	No impact visible at L3

Unique Characteristics of the L3 Multiday (8-Day and Monthly) Algorithm

L3 Multiday Algorithm: Characteristics

1. Only the L3 daily files used as input (highly efficient)

2. Identical Grid, SDS dimensions, and Histogram Bins

3. Three weighting schemes used to compute multiday statistics from daily statistics

- Unweighted
  (time-averaged mean, meaningful for computing temperature averages)

- Pixel count weighted
  (count-averaged mean, ensures computed means match means from histograms)

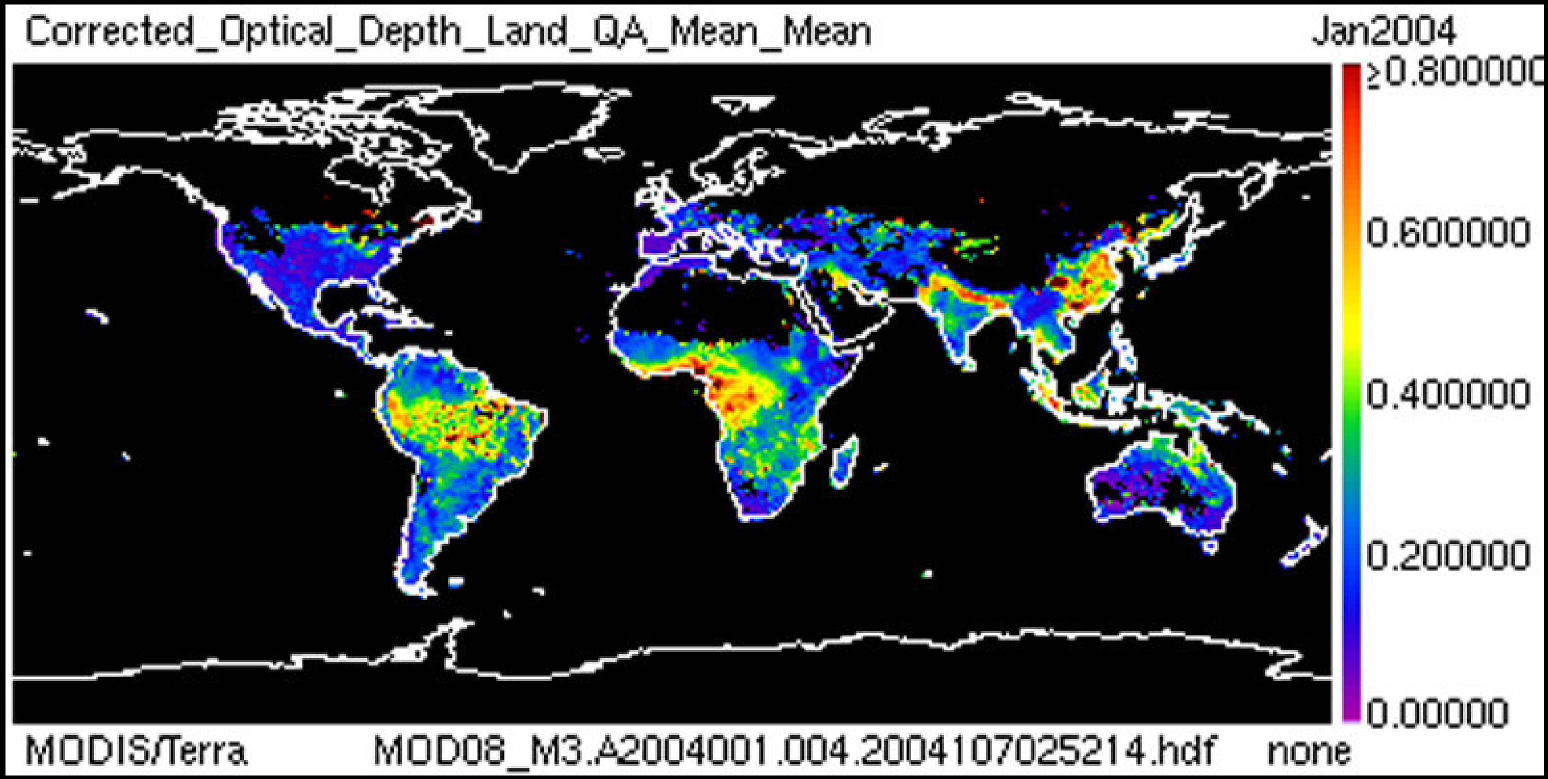
- Pixels count weighted with pixel count screen

L3 Multiday Weighting Scheme Specification

Product Family	Multiday Weighting Scheme *	Detail
Aerosol 04	Pixel Count Weighted with Pixel Count Screen	Each daily grid weighted by the pixel count & daily grids with counts < 6 are excluded
Water Vapor 05	Pixel Count Weighted	Each daily grid weighted by the pixel count
Cirrus Detection 06_CD	Unweighted	Each daily grid given the same weight
Cloud Top Properties 06_CT	Unweighted	Each daily grid given the same weight
Cloud Optical Properties 06_OD	Pixel Count Weighted	Each daily grid weighted by the pixel count (categorical, by phase)
Atmosphere Profile 07	Pixel Count Weighted	Each daily grid weighted by the pixel count

* *Weighting is applied to all non-count based statistics (mean, std); but not applied to histograms*

Example of “Pixel Count Weighted with Pixel Count Screen”
(Multiday Weighting Scheme Update - before and after images)



Implemented in L3 on 1 January 2004

Topic 2.

The MODIS-Atmosphere Web Site

modis-atmos.gsfc.nasa.gov

Introduction

Overview

One of the most important ecological issues concerning our planet is climate change. It is generally agreed that the Earth's climate will modify in response to radiative forcing induced by changes in atmospheric trace gases, cloud cover, cloud type, solar radiation, and tropospheric aerosols (liquid or solid particles suspended in the air). In order to develop conceptual and predictive global climate models, it is vital to monitor these properties. Two MODIS (Moderate Resolution Imaging Spectroradiometer) instruments, the first launched on 18 December 1999 onboard the Terra Platform and the second on 4 May 2002 onboard the Aqua platform, are uniquely designed (wide spectral range, high spatial resolution, and near daily global coverage) to observe and monitor these and other Earth changes. (MORE)

Feature L1B Granule Image

Isabel: Powerful Catagory 5 Hurricane
On September 11th 2003, the Terra-MODIS instrument captured this image of extremely dangerous Hurricane Isabel in the western Atlantic moving slowly but steadily towards the U.S. In this image, the center of Isabel was located about 300 miles east-northeast of the northern Leeward Islands. With maximum sustained winds of 160 mph and gusts to 195 mph, Isabel is a Category 5 hurricane on the Saffir-Simpson hurricane scale. Isabel is the first Category 5 hurricane in the Atlantic Basin since Hurricane Mitch in 1998. Image by Ridgway, Gray, & Hubanks, NASA GSFC. More RGB images of MODIS granules can be found in the L1B Granules section

Spotlight

Introducing the MODIS Online Visualization and Analysis System (MOVAS) - This new and powerful web-based MODIS data analysis tool is designed for visualization and analysis of the Terra / MODIS Level-3 Atmosphere Monthly global product (MOD08_M3). Users can plot area average (area plot) and time series (time plot) or generate ASCII output for selected area and time period. Spatial coverage is 90°S - 90°N, spatial resolution is 1° x 1°, and temporal resolution is monthly. [MORE]

Introducing the MODIS Multiple Data Ordering Page (MDOP) - This new and user-friendly MODIS data ordering system gives the user convenient means to simultaneously order several MODIS Data Sets, including Geolocation. This system also works well for single products. It should be noted that this is a vast improvement over previous ordering interfaces. [TERRA] [AQUA]

Introducing the new L2 Joint Atmosphere Product - A compact L2 product containing the "greatest hits" of MODIS-Atmosphere science parameters began production on October 14th 2003. The first available data days are julian days 285 (10/12/03) for Aqua and 286 (10/13/03) for Terra. [MORE]

Aqua Collection 004 Reprocessing Schedule- The Aqua Collection 004 reprocessing of MODIS Atmosphere data from January 2003 through December 2003 is now complete. A portion of the beginning period of the Aqua dataset (July 2002 through December 2002) will be reprocessed beginning in mid-July 2004 to correct incorrect L2 Cloud parameters (in both MYD06_L2 and all of Aqua L3). Note that the Terra Collection 004 reprocessing of MODIS Atmosphere data from February 2000 through October 2002 was completed in 2003. This means that over four years of continous validated Atmosphere products from Terra/MODIS, and over 18 months of continous validated Atmosphere products from Aqua/MODIS, both processed with the latest updated (version 4) program executables (PGE's) are available. [MORE]

Near Real-time MODIS L1B Images - View near-real time RGB mapped images of all daytime MODIS

New Product Sections

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Introduction

Product Description

The "ATM L2" product is designed so a full day of files fits on a CD

The *post-launch* MODIS Atmosphere Level 2 Joint Product contains a spectrum of key parameters gleaned from the complete set of standard *at-launch* Level 2 products: Aerosol, Water Vapor, Cloud, Profile, and Cloud Mask. The new Joint Atmosphere product was designed to be small enough to minimize data transfer and storage requirements, yet robust enough to be useful to a significant number of MODIS data users. Scientific data sets (SDS's) contained within the Joint Atmosphere product cover a full set of high-interest parameters produced by the MODIS Atmosphere group, and are stored at 5-km and 10-km (at nadir) spatial resolutions. There are two MODIS L2 Joint Atmosphere data product files: MODATML2, containing data collected from the Terra platform; and MYDATML2, containing data collected from the Aqua platform. Both of these products began production on October 14th 2003. The first available data days are julian days 285 (10/12/2003) for Aqua and 286 (10/13/2003) for Terra.

Research and Application

A few limitations were introduced into the Joint Product to reduce the file size. First, some parameters that were stored at 1-km resolution in their original (source) Level 2 product file were subsampled to 5-km in the Joint product. These include the cloud mask, cloud optical thickness, cloud effective radius, cloud quality assurance (includes cloud phase information), cirrus reflectance, and the precipitable water (near IR) parameters. Second, geolocation arrays that were stored as 4-byte floating-point real numbers in the original (source) product file were compressed to 2-byte scaled integers. This sacrifices 0.001 degrees of geolocation accuracy. Finally, only a limited set of QA (quality assurance) arrays were included; and only for parameters where it's absolutely crucial to use and/or interpret the data. These drawbacks were considered acceptable in the context of the overall goal of this project: To create a small and user-friendly Level 2 HDF file of the "greatest hits" of MODIS Atmosphere such that a full day of data files could be stored on a CD (< 700 MB).

Another complexity introduced by this product relates to the geolocation arrays. The Aerosol (04_L2) parameters are computed and stored at a different resolution (10-km) than the rest of the parameters in the Joint Atmosphere product file (5-km). The 5-km resolution geolocation is **copied** from center (3, 3) 1-km cell in the 5x5 1-km region. The 10-km resolution geolocation is **computed** by averaging the four central 1-km cells [(5,5), (5,6), (6,5), (6,6)] in

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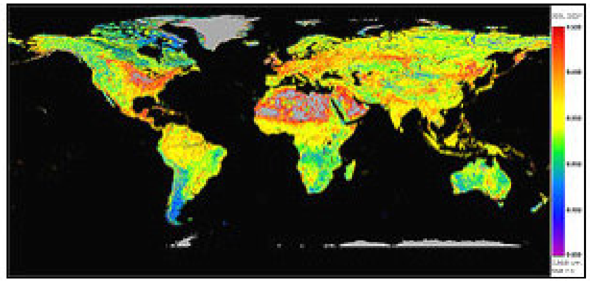

The Filled Land Surface Albedo Product, which is generated from MOD43B3 (the official Terra/MODIS-derived Land Surface Albedo Product), is a global data set of spatially complete albedo maps computed for both "white-sky" and "black-sky" at 10 wavelengths (0.47µm, 0.55µm, 0.67µm, 0.86µm, 1.24µm, 2.1µm, 0.3-0.7µm, 0.3-5.0µm, and 0.7-5.0µm) for 23 sixteen-day periods per year (001, 017, ... 353). There are two types of Filled Land Surface Albedo Products: 1-minute Map Products and coarser resolution Statistical Products.

Map Products, containing spatially complete land surface albedo data, are generated at 1-minute resolution on an equal-angle grid. In addition, Map Products containing run-time processing (as well as source MOD43B3) Quality Assurance (QA) are generated on the same 1-minute resolution grid. The maps are stored in separate HDF files for each albedo type (white- and black-sky), each wavelength, and each 16-day period. This format allows the user to have flexibility to download and store only the data absolutely needed.

Statistical Products, which are generated from the Filled Land Surface Albedo Map Products (outlined above), contain simple statistics (mean, standard deviation, and pixel counts) generated on equal-angle grids at various coarser resolutions (½, 1, 2, 3, 4, 5, and 10°). The statistics are computed with and without an ecosystem classification dependency. Statistics are stored in separate HDF files for each albedo type (white- and black-sky), each 16-day period, and each grid resolution. This format allows the user to have flexibility to download and store only the data absolutely needed.

It should be noted that these products currently exist for year 2001 (Terra) data only. Year 2002 (Terra) data is being prepared for release in early 2004.

Research and Application

The availability of global land surface characteristics and albedo data over a wide range of spectral bands and at high spatial resolution has dramatically improved with the launch of

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The Filled Normalized Difference Vegetative Index (NDVI) Product, which is computed from the (White-Sky) Filled Land Surface Albedo Map Product, is a global data set of spatially complete NDVI maps for 23 sixteen-day periods per year (001, 017, ... 353). There are two types of Filled NDVI Products: 1-minute Map Products and coarser resolution Statistical Products.

Map Products, containing spatially complete NDVI data, are generated at 1-minute resolution on an equal-angle grid.

Statistical Products, computed from the Filled NDVI Map Product (outlined above), contain simple statistics (mean, standard deviation, and pixel counts) generated on equal-angle grids at various coarser resolutions (½, 1, 2, 3, 4, 5, and 10°).

It should be noted that these products currently exist for year 2001 (Terra) data only. Year 2002 (Terra) data is being prepared for release in early 2004.

Methodology

NDVI can be defined as the following ratio of albedos (α) at different wavelengths:

$$\mathrm{NDVI} = \frac{\alpha_{0.86\mu m} - \alpha_{0.67\mu m}}{\alpha_{0.86\mu m} + \alpha_{0.67\mu m}}$$

The global maps of NDVI are produced by computing this ratio from the specific wavelengths of the spatially complete white-sky albedo maps and statistics are subsequently generated by binning the 1-minute NDVI maps at various resolutions. The binning grid is equal-angle and cell-centered such that for a 1° grid the upper left corner grid

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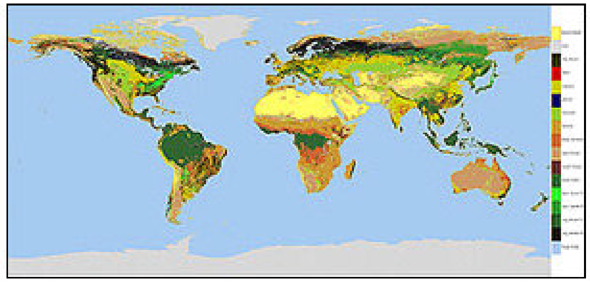

The One-Minute Land Ecosystem Classification Product is a global (static map) data set of the International Geosphere-Biosphere Programme (IGBP) classification scheme stored on an equal-angle rectangular grid at 1-minute resolution. The dataset is generated from the official MODIS land ecosystem classification dataset, MOD12Q1 for year 2000, day 289 data (October 15, 2000).

This dataset is used in generating the spatially complete albedo maps and statistics, but is also a stand-alone product designed for use by the user community.

Methodology

The One-Minute Land Ecosystem Classification Product is generated from the official MODIS Ecosystem product, MOD12Q1, by remapping the IGBP classification scheme from an Integerized Sinusoidal (ISIN) projection to equal-angle rectangular coordinates at 1-minute resolution (2 km at the equator, < 1 km at the pole). The MOD12Q1 Quality Assurance (QA) is then applied to the remapped data.

Additional Information

Coverage: Global

Spatial Characteristics: Equal-angle rectangular oordinates at 1-minute resolution (2 km at equator, < 1 km at pole).

Temporal Characteristics: Static, generated from Julian Day 289, 2001 data.

Key Science Applications: GCM, energy balance, land use and land use change, biophysical, oceanographic, and meteorological studies.

Data Product Processing and Availability Calendar

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Processing and Availability Calendar

= Validated (3) = Validated (2) = Validated (1) = Provisional = Beta = Not Yet Processed = No Instrument Data = Bad Cloud Data 4.0.1 = PGE Version

Last Updated: Monday, 12-July-2004 6:00 AM EDT

			Level 2 Products											Level 3 Products					
DATA DATE			AEROSOL 04_L2		H2O VAPOR 05_L2		CLOUD 06_L2		PROFILE 07_L2		CLD.MASK 35_L2		JOINT ATML2		DAILY 08_D3		EIGHT DAY 08_E3		MONTHLY 08_M3	
Y	M	JulianDays	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua
2004	J	182-212	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	-	-
	J	152-181	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	M	121-151	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	A	092-120	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	M	061-091	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	F	032-060	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	J	001-031	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
2003	D	335-365	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	N	305-334	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	O	274-304	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	S	244-273	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	A	213-243	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	182-212	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	152-181	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	M	121-151	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	A	091-120	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	M	060-090	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	F	032-059	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	J	001-031	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
2002	D	335-365	4.1.1	4.2.2	4.1.1	4.2.2	4.2.2	4.3.0	4.1.0	4.4.0	4.1.0	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	N	305-334	4.1.1	4.2.2	4.1.1	4.2.2	4.2.2	4.3.0	4.1.0	4.4.0	4.1.0	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	O	274-304	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	S	244-273	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	A	213-243	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	182-212	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	152-181	4.1.3	4.0.1	4.1.3	4.0.1	4.2.5	4.0.0	4.1.2	4.0.1	4.1.2	4.0.1	-	-	4.1.1	3.1.0	4.1.0	3.1.0	4.1.0	
	M	121-151	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	A	091-120	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	M	060-090	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	

PRODUCTS
OVERVIEW
AVAILABILITY CALENDAR
PGE03 History
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ACQUISITION
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PGE History

PGE04 Version Detail
Product impact changes only

H = High Impact M = Moderate Impact L = Low Impact
(Dates show approximate starting production date)

Aerosol (04_L2) and Water Vapor (05_L2) HDF products are produced from the Program Executable (PGE) identified as PGE04. One may identify the maturity and quality of an HDF data product by finding the PGE (program executable) version that was used to produce the file. This information can be obtained directly from the HDF file itself by using the HDF utility *ncdump*. The (UNIX) command is ncdump -h *.hdf | awk '/PGEVERSIONCLASS/,/END_GROUP/' . One may also find PGE version information in the ascii text *met* (metadata) file associated with a particular HDF file. Another slightly less reliable way to determine the PGE version is through the "processing date & time" field of the HDF filename (field #5 in L2 HDF files, see HDF Filename convention). Users then match the processing date in the HDF filename with the production start date for various PGE versions in blue in the listing below. If you have any questions about this, contact Paul Hubanks.

PGE04 **v4.2.2** includes: (Terra Forward [004]: ~01.Jan.2004 Aqua Forward & Reprocess [004]: ~01.Jan.2004)

- **Aerosol Properties** (v4.2.2)
  - H **Summary Statement.** This version of the code was promoted to the newly started Aqua Collection 004 (forward and re- processing) as well as the continuing forward processing of Terra Collection 004. This version includes newly implemented changes outlined in PGE v4.2.1 and v4.2.0 (see below).
  - H **Corrected Reflected and Transmitted Flux Computation over Ocean.** The definition of the reflected and transmitted fluxes within the ocean aerosol algorithm are redefined. The previous version interpolated the reflected and transmitted fluxes using an incorrect representation of the optical depth and included a single scattering albedo term. The former was corrected and the later removed from the computation.
  - M **Corrected Missing Data Percentage Computation over Land.** A correction to the counting logic used in the determination of the percent missing data in the land aerosol retrieval is made. The percentage missing data is recorded in the (Aerosol) HDF product inventory metadata under the MEASUREDPARAMETER group.

PGE04 **v4.2.1** includes: (Terra Forward [004]: Changes promoted in v4.2.2 Aqua Forward & Reprocess [004]: Changes promoted in v4.2.2

- **Aerosol Properties** (v4.2.1)
  - L **Longitude Computation Optimization.** The aerosol algorithm longitude computation patch (see v4.2.0) was generalized to work globally.

PGE04 **v4.2.0** includes: (Terra Forward [004]: Changes promoted in v4.2.2 Aqua Forward & Reprocess [004]: Changes promoted in v4.2.2

- **Aerosol Properties** (v4.2.0)
  - H **Summary Statement.** The science algorithm employs a new cloud mask in the land aerosol retrieval, including logic to

= Validated (3) = Validated (2) = Validated (1) = Provisional = Beta = Not Yet Processed = No Instrument Data = Bad Cloud Data 4.0.1 = PGE Version

Last Updated: Monday, 12-July-2004 6:00 AM EDT

DATA DATE			Level 2 Products												Level 3 Products					
			AEROSOL 04_L2		H2O VAPOR 05_L2		CLOUD 06_L2		PROFILE 07_L2		CLD.MASK 35_L2		JOINT ATML2		DAILY 08_D3		EIGHT DAY 08_E3		MONTHLY 08_M3	
Y	M	JulianDays	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua	Terra	Aqua
2004	J	182-212	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	-	-
	J	152-181	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	M	121-151	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	A	092-120	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	M	061-091	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	F	032-060	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
	J	001-031	4.2.2	4.2.2	4.2.2	4.2.2	4.2.6	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.1	4.0.1	4.2.2	4.2.2	4.2.1	4.2.1	4.2.1	4.2.1
2003	D	335-365	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	N	305-334	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	O	274-304	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.3.0	4.4.0	4.3.0	4.4.0	4.0.0	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	S	244-273	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	A	213-243	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	182-212	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	152-181	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	M	121-151	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	A	091-120	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	M	060-090	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	F	032-059	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	J	001-031	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.2	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
2002	D	335-365	4.1.1	4.2.2	4.1.1	4.2.2	4.2.2	4.3.0	4.1.0	4.4.0	4.1.0	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	N	305-334	4.1.1	4.2.2	4.1.1	4.2.2	4.2.2	4.3.0	4.1.0	4.4.0	4.1.0	4.4.0	-	4.0.1	4.0.3	4.2.2	4.0.2	4.2.1	4.0.2	4.2.1
	O	274-304	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	S	244-273	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	A	213-243	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	182-212	4.1.3	4.2.2	4.1.3	4.2.2	4.2.5	4.3.0	4.1.2	4.4.0	4.1.2	4.4.0	-	4.0.1	4.1.1	4.2.2	4.1.0	4.2.1	4.1.0	4.2.1
	J	152-181	4.1.3	4.0.1	4.1.3	4.0.1	4.2.5	4.0.0	4.1.2	4.0.1	4.1.2	4.0.1	-	-	4.1.1	3.1.0	4.1.0	3.1.0	4.1.0	
	M	121-151	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	A	091-120	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	M	060-090	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	F	032-059	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
	J	001-031	4.1.3		4.1.3		4.2.5		4.1.2		4.1.2		-		4.1.1		4.1.0		4.1.0	
2001	D	335-365	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.1.1		4.1.0		4.1.0	
	N	305-334	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.1.1		4.1.0		4.1.0	
	O	274-304	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.1.1		4.1.0		4.1.0	
	S	244-273	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.1.1		4.1.0		4.1.0	
	A	213-243	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	J	182-212	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	J	152-181	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	M	121-151	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	A	091-120	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	M	060-090	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	F	032-059	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	J	001-031	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
2000	D	336-366	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	N	306-335	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	O	275-305	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	S	245-274	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	A	214-244	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	J	183-213	4.1.3		4.1.3		4.2.5		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	J	153-182	4.1.2		4.1.2		4.2.2		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	M	122-152	4.1.2		4.1.2		4.2.2		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	A	092-121	4.1.2		4.1.2		4.2.2		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	M	061-091	4.1.2		4.1.2		4.2.2		4.1.0		4.1.0		-		4.0.3		4.0.2		4.0.2	
	F	032-060	4.1.2		4.1.2		4.2.2		4.1.0		4.1.0		-		4.0.3		4.0.2			
			PGE04 History				PGE06 History		PGE03 History				PGE83 History		PGE56 History		PGE70 History		PGE57 History	

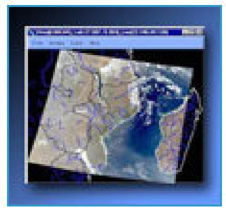
= Validated (3) = Validated (2) = Validated (1) = Provisional = Beta = Not Yet Processed = No Instrument Data = Bad Cloud Data 4.0.1 = PGE Version

New Tools Section

TOOLS
Tool Type
GRAPHICAL INTERFACE
WEB BASED
COMMAND LINE
Documentation
BIT INTERPRETATION
Forum
HDF-EOS USER FORUM

Graphical User Interface Tools

HDFLook



A basic processing and visualization tool for MODIS HDF data within *X-Window* computer environments, HDFLook can visualize structures of an HDF file including: scientific data sets (SDS), vector arrays (Vdatas and Vgroups), and raster images (24 bits or 8 bits with a look-up table). HDFLook can visualize slices of data (up to 6 indexes), display global and local attributes, and automatically detect fill values. HDFLook can also extract SDS ancillary data, export (raw or calibrated) SDS records to binary or HDF files, build reprojected SDS or RGB mosaics, export RGB images to JPEG or HDF files, and print RGB images. For programmers who routinely want jpgs or binary files, HDFLook can be run non-interactively with simple command files to routinely make images or export binary files from hdf (see *HDFLook: How To Examples*). For a more powerful tool, users should consider Msphinx (see below) which incorporates HDFLook as its HDF-EOS reader interface. It should be noted that HDFLook and Msphinx are the only known *graphical user interface* tools that can (correctly and fully) read and visualize the new L2 Joint Atmosphere product. ACQUIRE >>

Cost: Free
Current Version: 4.1
Release Date: January 2004
Requirements: Platform & operating system specific
Rating: ★★★★★
Development Team:
- Laboratoire d'Optique Atmosphérique / U. Lille
- University of Maryland / MODLAND GSFC-923
- Distributed Active Archive Center (DAAC) / GSFC-902

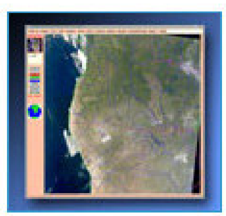
Compatibility:

Macintosh
- OS-X 10.3 Panther
- OS-X 10.2 Jaguar

Linux
- Power PC
- Intel
- Cygwin

Unix
- SUN - Solaris 5.7
- SGI - IRIX 6.5
- IBM - AIX 4.3.2
- HP - HP-UX 10.2
- DEC - OSF/1 v4.0

Msphinx



A more powerful tool than HDFLook (outlined above), Msphinx incorporates HDFLook as its HDF reader interface. Msphinx (Motif Satellite Process Handling Images uNder Xwindow) is a powerful image analysis, data plotting, and format conversion package. Msphinx includes functions to process in the basic data geometry and projection planes, as well as

Cost: Free
Current Version: 9.4
Release Date: January 2004
Requirements: Platform & operating system specific
Rating: ★★★★★
Development Team:
- Laboratoire d'Optique Atmosphérique / U. Lille

Compatibility:

Macintosh
- OS-X 10.3 Panther
- OS-X 10.2 Jaguar

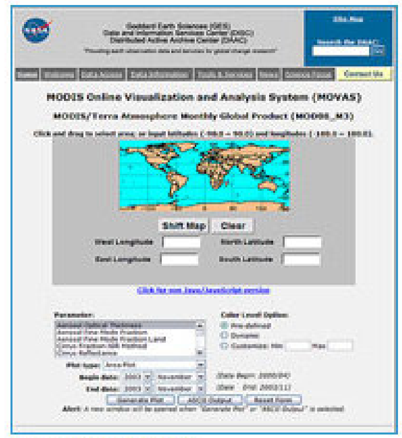
TOOLS
Tool Type
GRAPHICAL INTERFACE
WEB BASED
COMMAND LINE
Documentation
BIT INTERPRETATION
Forum
HDF-EOS USER FORUM

Web Based Tools

MODIS Online Visualization and Analysis System (MOVAS)

A web-based tool designed for visualization and analysis of the Terra / MODIS Atmosphere Level-3 Monthly Product (MOD08_M3). This product has global coverage with 1° degree spatial resolution mapped on an equal angle lat-lon grid. Seventeen (17) high-interest parameters were chosen (out of nearly 80 available) to be included in this online analysis system. Users can plot area average (area plot) and time series (time plot) or generate ASCII output for selected area and time period. To emphasize how easy this tool is to use, a recent monthly global image can be generated by simply clicking on the *"Generate Plot"* button at the bottom of the MOVAS interface page.

ACCESS >>



Development Team:
- Bill Ridgway / Science Systems & Applications, Inc.
- Steve Kempler / DAAC - NASA GSFC
- Zhong Liu / DAAC - NASA GSFC
- Dr. Yorum Kaufman / NASA GSFC

Daily Global Surface Reflectance Images (MODIS-Land)

The MODIS Land Science Team has developed coarse 5km versions of selected products to enable synoptic quality assessment via the internet. The coarse spatial resolution products are projected into a global coordinate system defined with pixel sizes corresponding to 20km in the Hammer-Aitoff projection. These global browse images are generated with fixed contrast stretching and color look-up tables to enable consistent temporal comparison. This web interface has been developed to support interactive selection of browse products and zooming and panning at 5km resolution. The global surface reflectance images (using bands 1/4/3) are useful for monitoring global cloud cover. ACCESS >>

Development Team:

Command Line Programs

Spatial and Dataset Subsetting (for HDF files)

- Subsetting Single Resolution HDF Files

  SnglResSubsetter: This program provides both spatial and data set subsetting for HDF files where all scientific data sets (SDS's) have the same spatial resolution (MOD03, MOD04_L2, and MOD07_L2). Developed by Eric Moody (NASA GSFC). *Fortran 90, PERL Script (HDF-EOS Toolkit Required).* DOWNLOAD >>

- Subsetting Double Resolution HDF Files

  TwoResSubsetter This program provides both spatial and data set subsetting for HDF files where the Lat/Lon data is at one resolution and additional scientific data sets (SDS's) are either at the same or a finer (smaller) spatial resolution (MOD02_1KM, MOD05_L2, MOD06_L2, and MOD35_L2). Developed by Eric Moody (NASA GSFC). *Fortran 90, PERL Script (HDF-EOS Toolkit Required).* DOWNLOAD >>

Visualization & Analysis

- Unmapped Visualizing of Level 1 and Level 2 (Granule) HDF Data

  Unmapped Visualizer: This IDL tool can unpack a MODIS product HDF file and create an unmapped image of a particular scientific data set (SDS). Developed by Eric Moody (NASA GSFC). *IDL, PERL.* DOWNLOAD >>

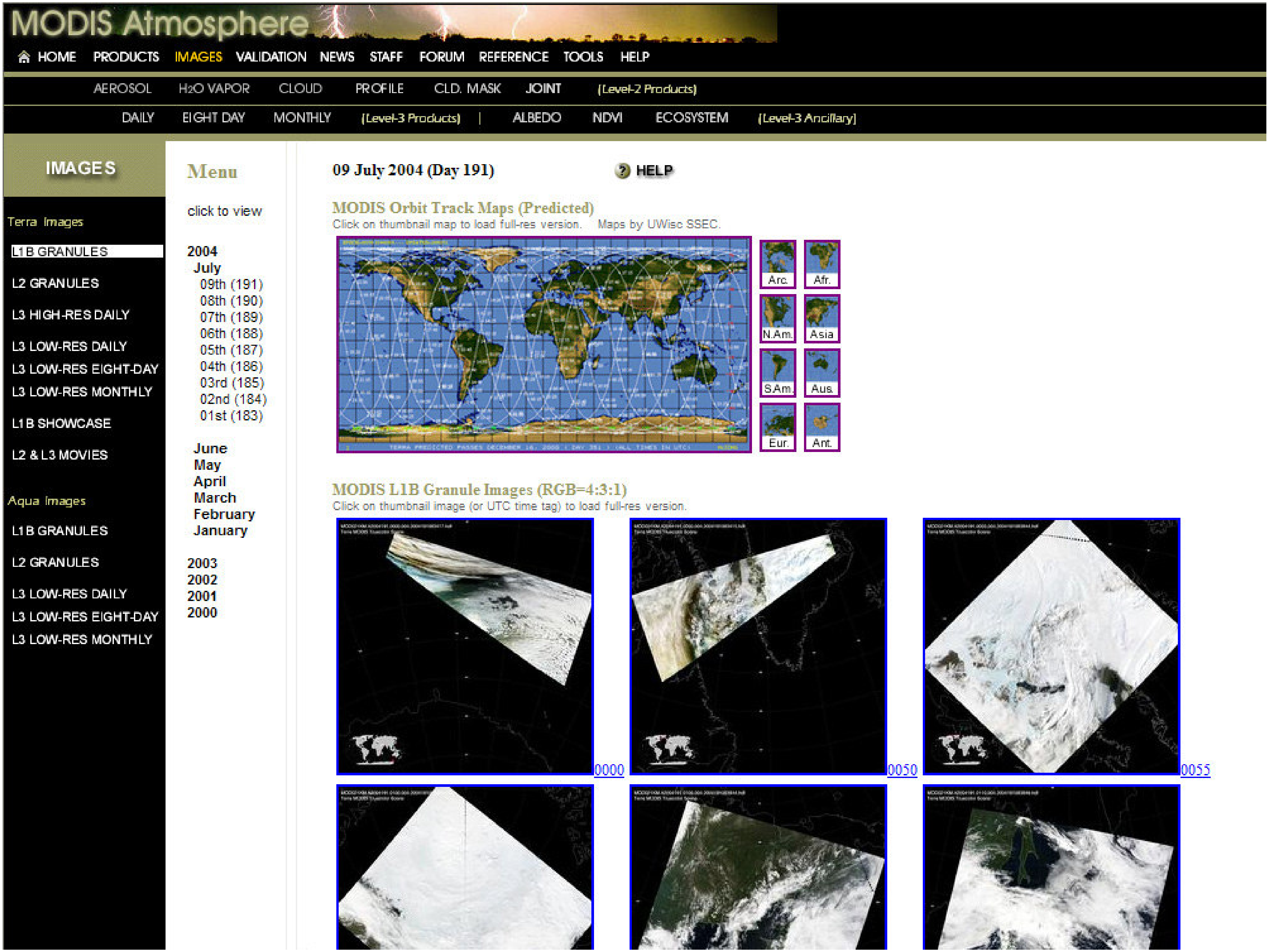
- Mapped Visualizing of Level 1 and 2 (Granule) HDF Data

  Mapped Visualizer: This IDL tool can unpack a MODIS product HDF file and create a mapped image of particular scientific data set (SDS). Developed by Eric Moody (NASA GSFC). *IDL, PERL.* DOWNLOAD >>

- Extracting and Visualizing Bit Flags from Level 2 (Granule) HDF Data

  Bit Mapper: This IDL program extracts bit flags from byte data arrays, and then plots them on a geolocated map with a user-defined color scheme. The specific

The Images Section



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click to view
2004
July
09th (191)
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June
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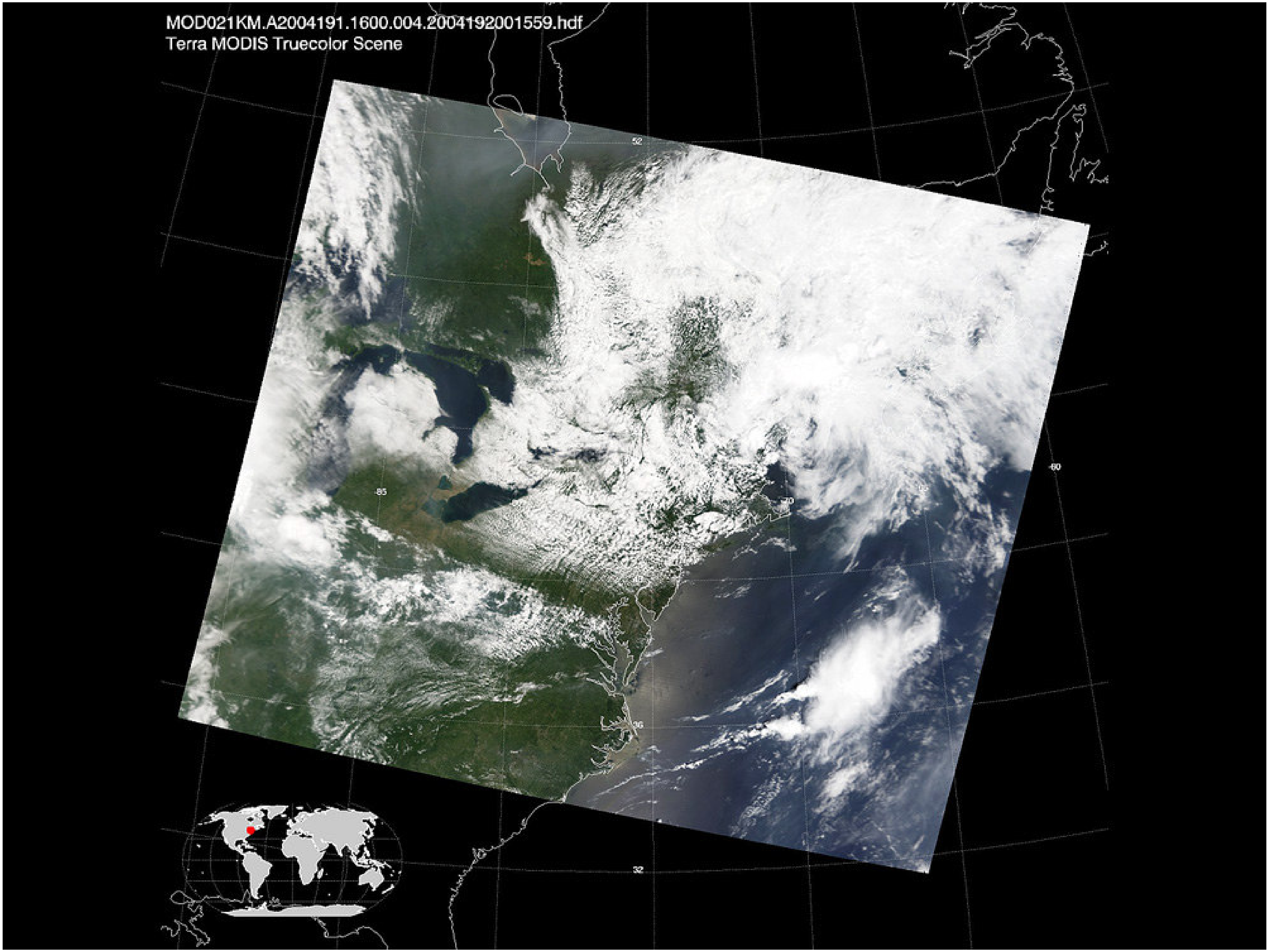
09 July 2004 (Day 191)
HELP
MODIS Orbit Track Maps (Predicted)
Click on thumbnail map to load full-res version. Maps by UWisc SSEC.
Arc.
Afr.
N.Am.
Asia
S.Am.
Aus.
Eur.
Ant.
MODIS L1B Granule Images (RGB=4:3:1)
Click on thumbnail image (or UTC time tag) to load full-res version.
0000
0050
0055


MOD021KM.A2004191.1600.004.2004192001559.hdf
Terra MODIS Truecolor Scene

MODIS Atmosphere

HOME PRODUCTS IMAGES VALIDATION NEWS STAFF FORUM REFERENCE TOOLS HELP

AEROSOL H_2O VAPOR CLOUD PROFILE CLD. MASK JOINT (Level-2 Products)

DAILY EIGHT DAY MONTHLY (Level-3 Products) | ALBEDO NDVI ECOSYSTEM (Level-3 Ancillary)

IMAGES

Terra Images

- L1B GRANULES
- L2 GRANULES
- L3 HIGH-RES DAILY
- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY
- L1B SHOWCASE
- L2 & L3 MOVIES

Aqua Images

- L1B GRANULES
- L2 GRANULES
- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY

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20Nov2002
(Day 324)
Orbit 01
Orbit 02
Orbit 03
Orbit 04
Orbit 05
Orbit 06
Orbit 07
Orbit 08
Orbit 09
Orbit 10
Orbit 11
Orbit 12
Orbit 13
Orbit 14
Orbit 15

10Aug2001
(Day 222)
Orbit 01
Orbit 02
Orbit 03
Orbit 04
Orbit 05
Orbit 06
Orbit 07
Orbit 08
Orbit 09
Orbit 10
Orbit 11
Orbit 12
Orbit 13
Orbit 14
Orbit 15

18Jul2001
(Day 199)
Orbit 01
Orbit 02
Orbit 03
Orbit 04
Orbit 05
Orbit 06
Orbit 07
Orbit 08
Orbit 09
Orbit 10

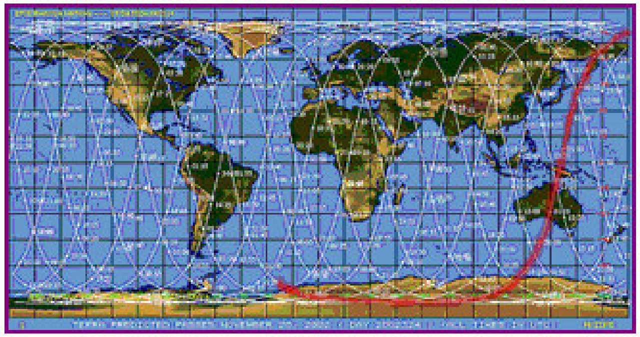
20 November 2002 (Day 324)
Orbit 1 (Daytime) 0045-0135 UTC

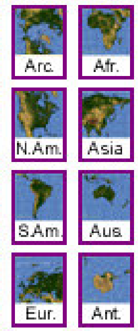
HELP

PRINT FRIENDLY

MODIS Orbit Track Maps (Predicted)

Click on thumbnail map to load full-res version. Maps by UWisc SSEC.





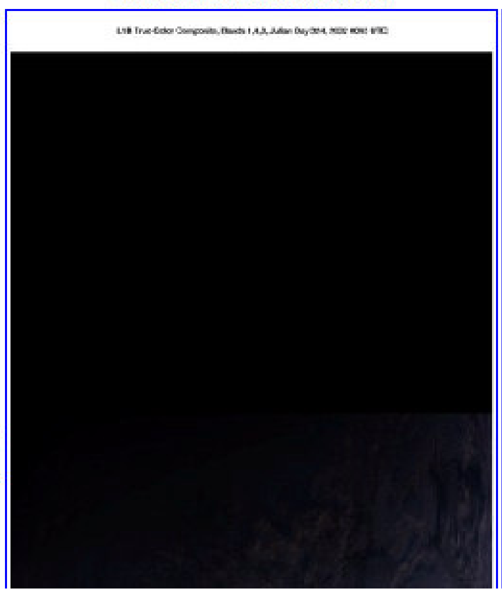
MODIS Granule Images

Click on thumbnail image to load full-res version.

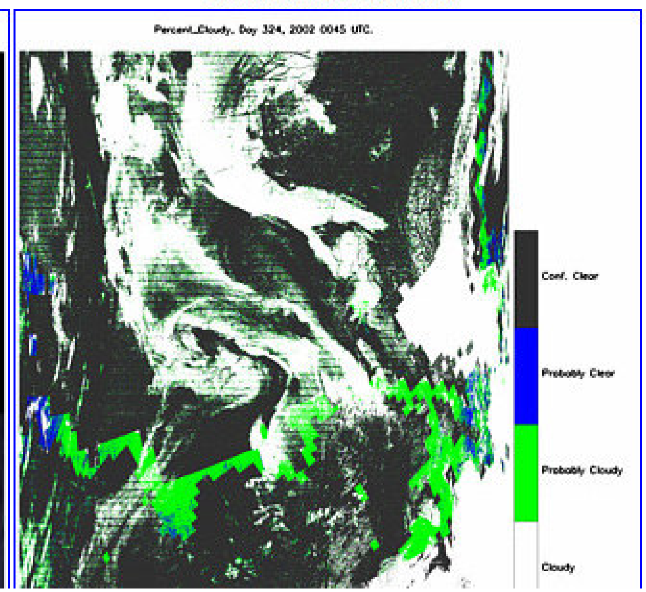
PRODUCTION DATE & VERSION: MOD021KM = 2002.330 (v004) MOD03 = 2001.302 (v003) MOD04 = 2002.330 (v004)

0045 UTC

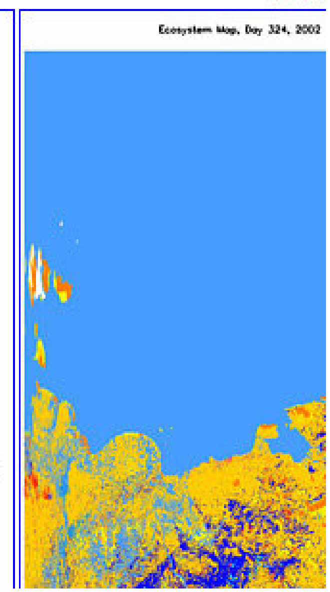
L1B True-Color Composite (1:4:3)

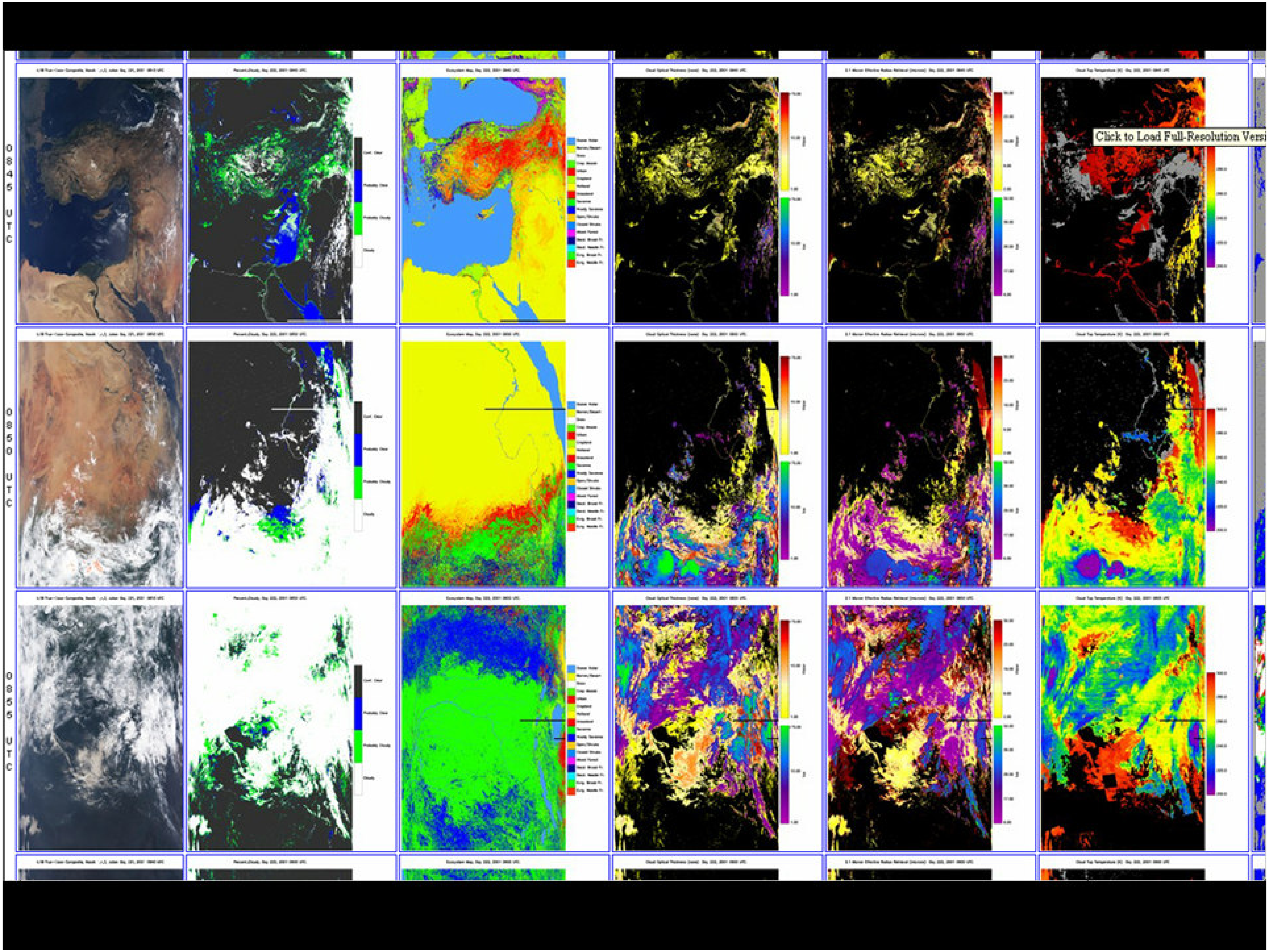


Cloud Mask (Cloud Confidence)



Ecosys





0845 UTC
0850 UTC
0855 UTC
Click to Load Full-Resolution Versi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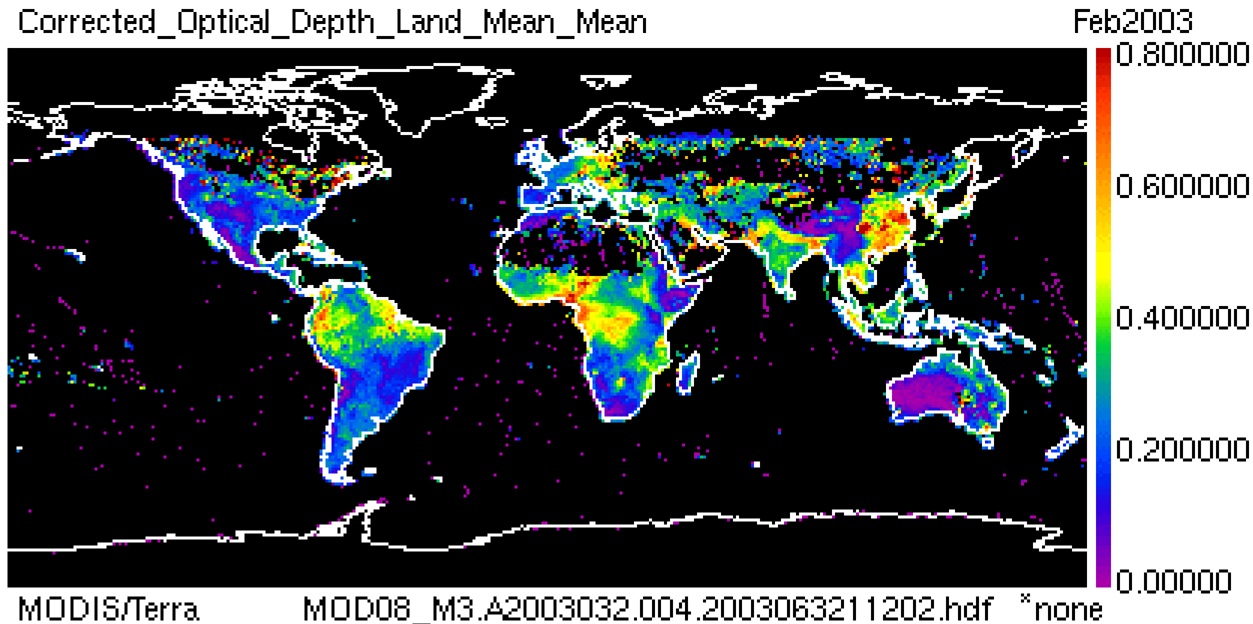
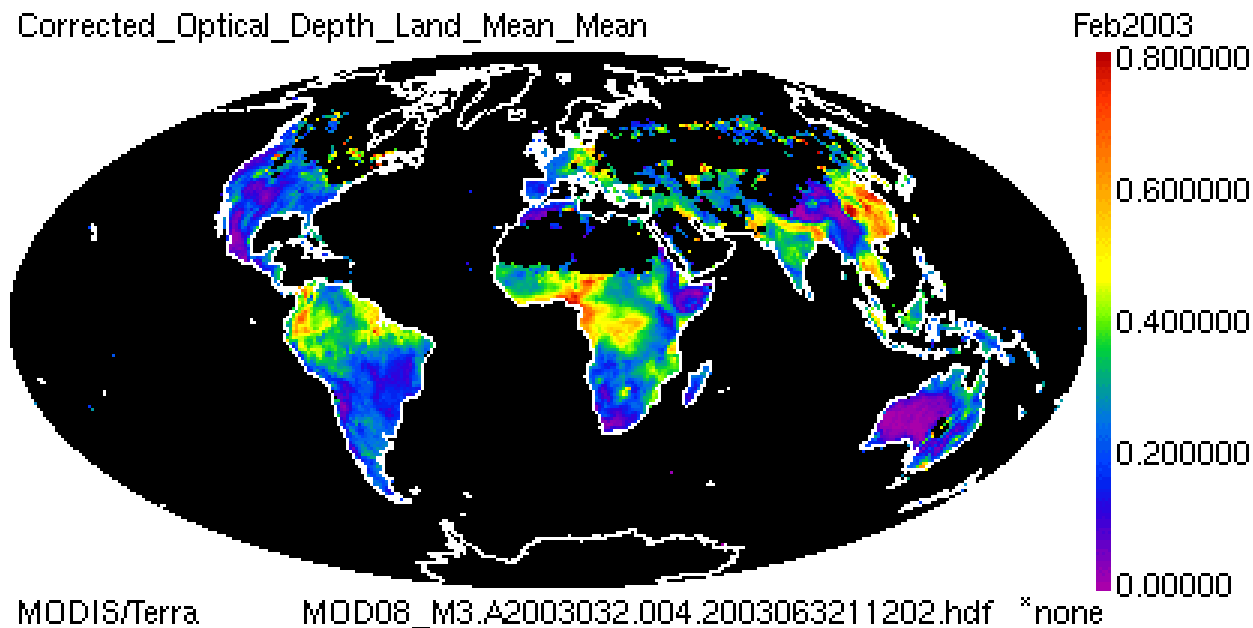
L2 GRANULES
L3 LOW-RES DAILY
L3 LOW-RES EIGHT-DAY
L3 LOW-RES MONTHLY
Terra Browse Imagery
Product Selection
1. Select 'Derived From' Product Group:
Aerosol (MOD04_L2)
Global Only
Land Only
Ocean Only
Place your mouse pointer over the group names to view the parameters in each group
Water Vapor (MOD05_L2)
All
Cloud (MOD06_L2)
Cirrus Detection
Cloud Top Properties
Cloud Optical Properties
Atmosphere Profile (MOD07_L2)
All
2. Select Start Date:
01Jul2004 (183)
3. Select Map Projection:
HAMMER-AITOFF (Equal Area Grid) (for presentations)
LAT-LON (Equal Angle Grid) (for quality assessment)
4. Click Go:
Go!
Browse System Requirements

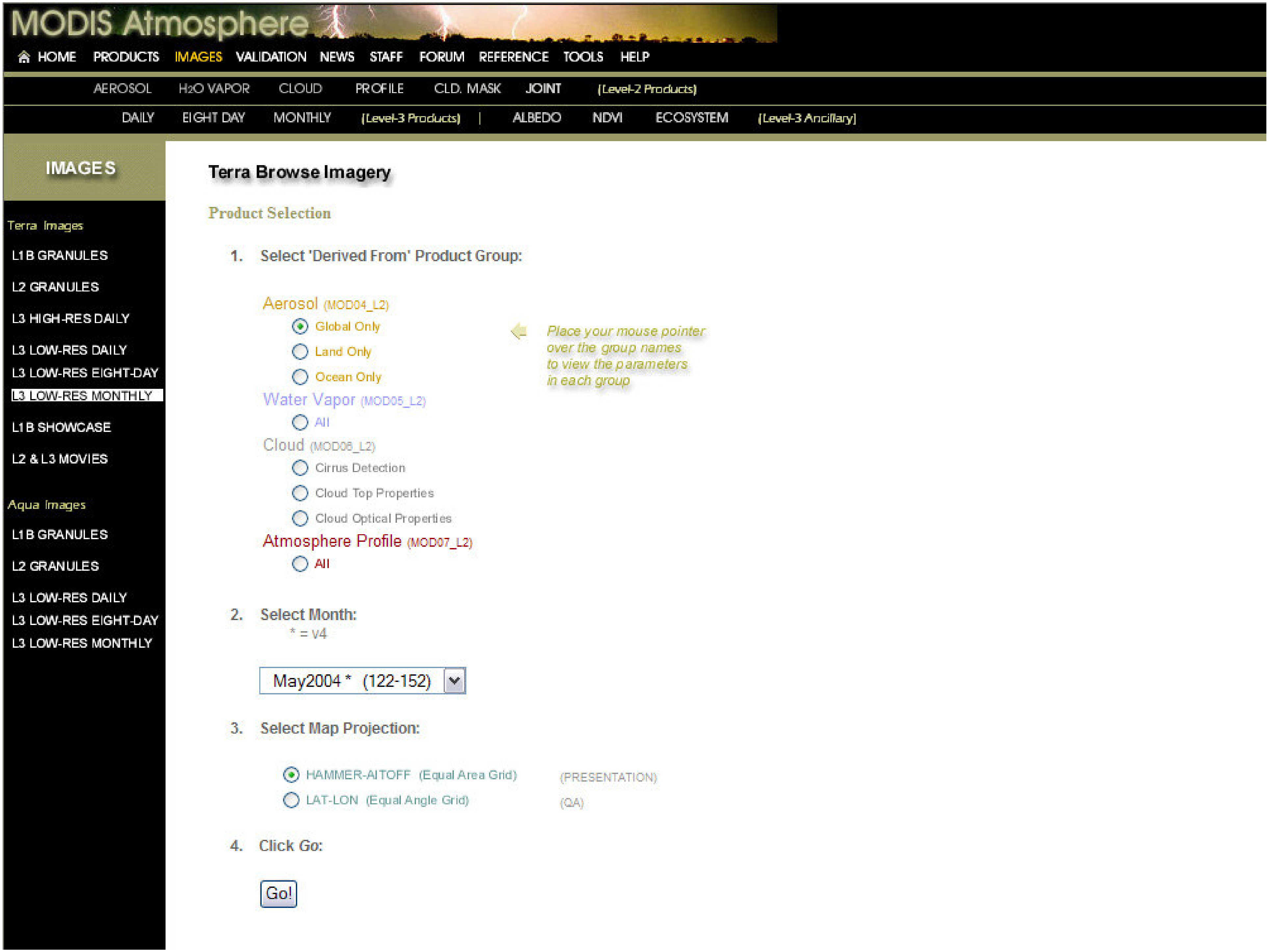
LL vs. HA Images: Data Detail Comparison

- **Equal Angle Grid**
  1x1° Lat-Lon
  Native L3 Grid



- **Equal Area Grid**
  Hammer-Aitoff
  Computed in IDL from Lat-Lon Image

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L3 LOW-RES DAILY
L3 LOW-RES EIGHT-DAY
L3 LOW-RES MONTHLY
Terra Browse Imagery
Product Selection
1. Select 'Derived From' Product Group:
Aerosol (MOD04_L2)
Global Only
Land Only
Ocean Only
Water Vapor (MOD05_L2)
All
Cloud (MOD06_L2)
Cirrus Detection
Cloud Top Properties
Cloud Optical Properties
Atmosphere Profile (MOD07_L2)
All
Place your mouse pointer over the group names to view the parameters in each group
2. Select Month:
* = v4
May2004 * (122-152)
3. Select Map Projection:
HAMMER-AITOFF (Equal Area Grid) (PRESENTATION)
LAT-LON (Equal Angle Grid) (QA)
4. Click Go:
Go!

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- L1B SHOWCASE
- L2 & L3 MOVIES

Aqua Images

- L1B GRANULES
- L2 GRANULES
- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY

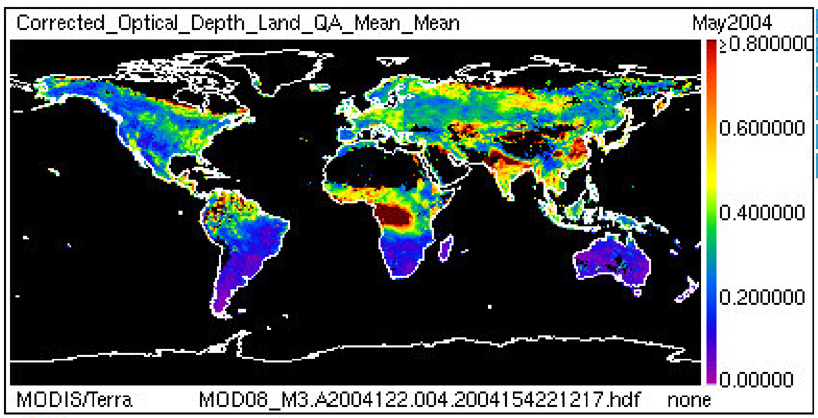
Terra Browse Imagery

NOTE: Lavender denotes data values equal to (or less than) the bottom scale number. Maroon denotes data values equal to (or greater than) the top scale number.

Quick Navigation Links (same day, same projection)

MOD04_L2: Aerosol Global Only	✓ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only	MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection	MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties	MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset	Load Print Friendly Version

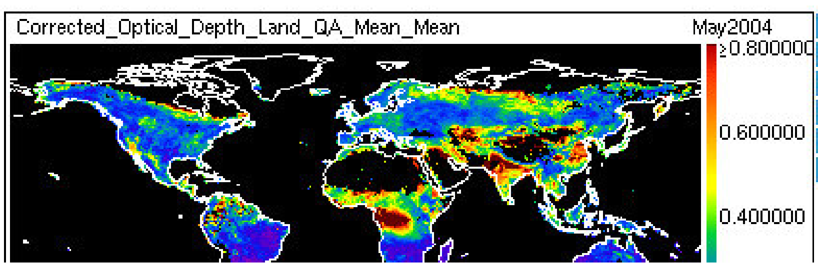
Aerosol (LAND ONLY)



.47 microns

QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars



QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

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Terra Images
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L2 GRANULES
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Aqua Images
L1B GRANULES
L2 GRANULES
L3 LOW-RES DAILY
L3 LOW-RES EIGHT-DAY
L3 LOW-RES MONTHLY

Terra Browse Imagery

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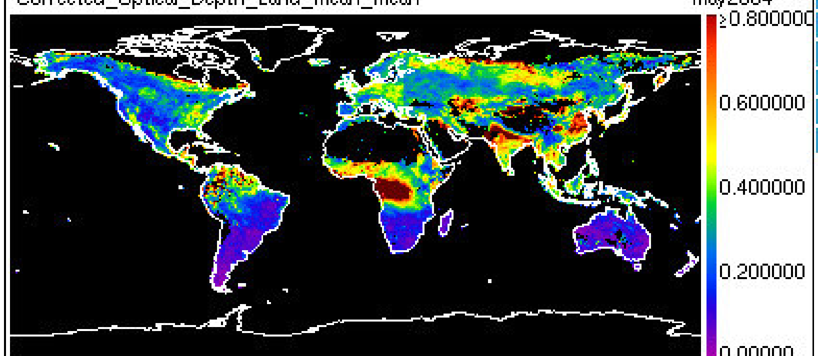
Quick Navigation Links (same day, same projection)

MOD04_L2: Aerosol Global Only	✔ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only	MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection	MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties	MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset	Load Print Friendly Version

Aerosol (LAND ONLY)

Corrected_Optical_Depth_Land_Mean_Mean May2004



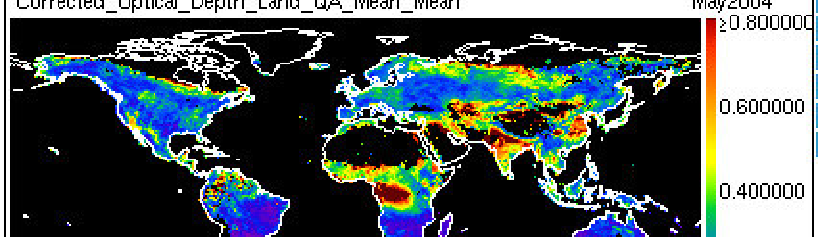
MODIS/Terra MOD08_M3.A2004122.004.2004154221217.hdf none

.47 microns

QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

Corrected_Optical_Depth_Land_QA_Mean_Mean May2004



QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

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L1B GRANULES
L2 GRANULES
L3 LOW-RES DAILY
L3 LOW-RES EIGHT-DAY
L3 LOW-RES MONTHLY

Terra Browse Imagery

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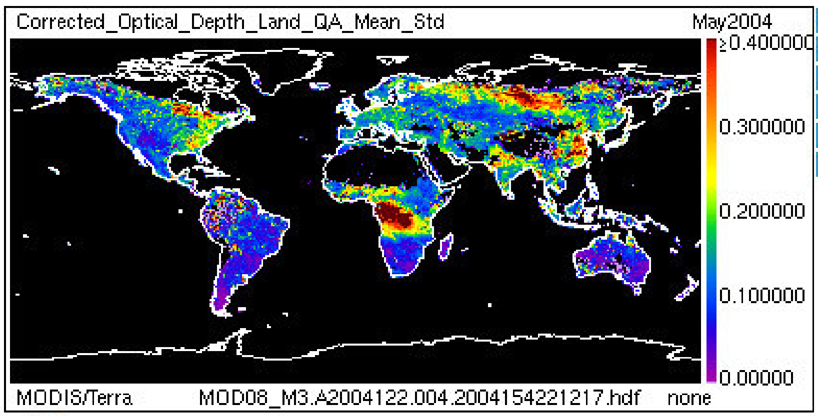
MOD04_L2: Aerosol Global Only
✓ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only
MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection
MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties
MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset
Load Print Friendly Version

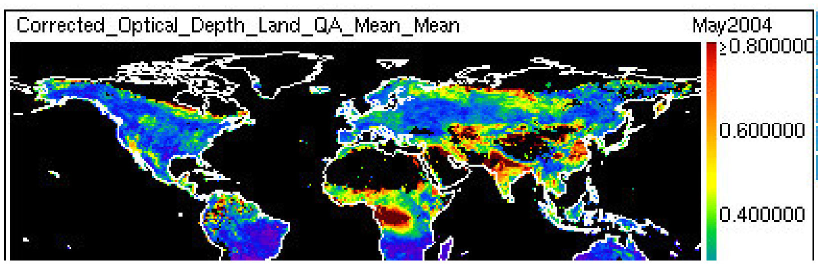
Aerosol (LAND ONLY)



.47 microns

QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars



QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

MODIS Atmosphere

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DAILY | EIGHT DAY | MONTHLY | (Level-3 Products) | ALBEDO | NDVI | ECOSYSTEM | (Level-3 Ancillary)

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- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY
- L1B SHOWCASE
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Aqua Images

- L1B GRANULES
- L2 GRANULES
- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY

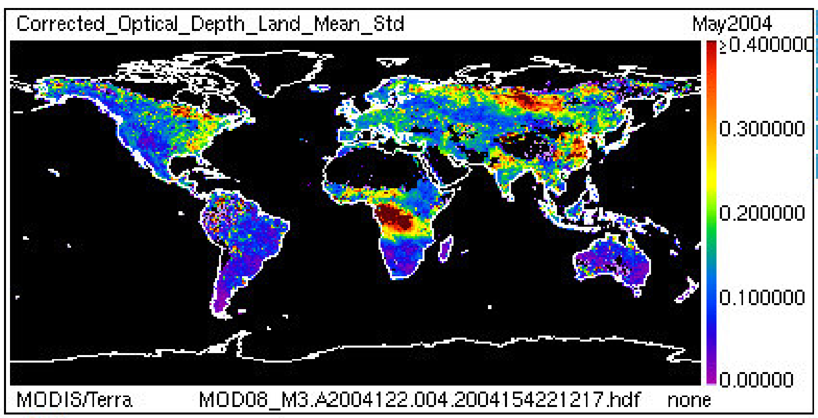
Terra Browse Imagery

NOTE: Lavender denotes data values equal to (or less than) the bottom scale number. Maroon denotes data values equal to (or greater than) the top scale number.

Quick Navigation Links (same day, same projection)

MOD04_L2: Aerosol Global Only	✓ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only	MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection	MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties	MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset	Load Print Friendly Version

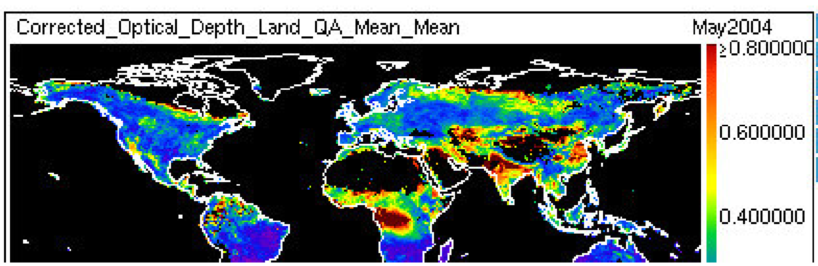
Aerosol (LAND ONLY)



.47 microns

- QA_Mean
- Mean
- QA_Standard_Deviation
- Standard_Deviation
- Minimum
- Maximum

roll mouse over statistic bars



- QA_Mean
- Mean
- QA_Standard_Deviation
- Standard_Deviation
- Minimum
- Maximum

roll mouse over statistic bars

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Terra Images
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- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY
- L1B SHOWCASE
- L2 & L3 MOVIES

Aqua Images
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- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY

Terra Browse Imagery

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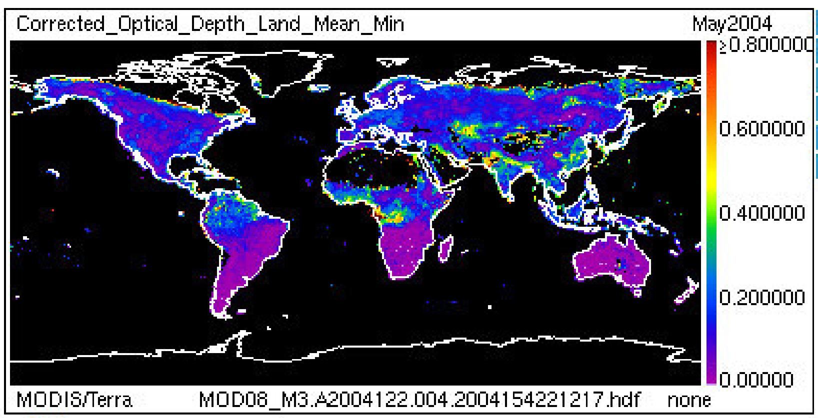
Quick Navigation Links (same day, same projection)

MOD04_L2: Aerosol Global Only	✔ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only	MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection	MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties	MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset	Load Print Friendly Version

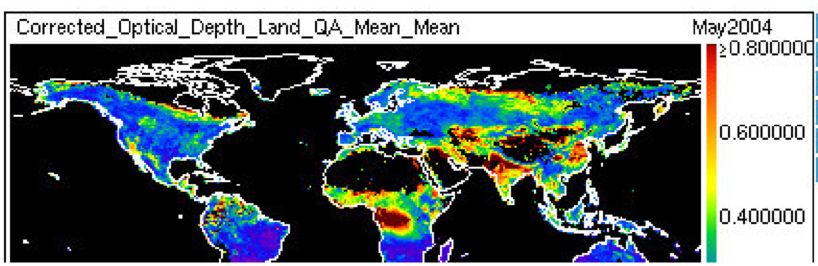
Aerosol (LAND ONLY)



.47 microns

QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars



QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

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- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY
- L1B SHOWCASE
- L2 & L3 MOVIES

Aqua Images
- L1B GRANULES
- L2 GRANULES
- L3 LOW-RES DAILY
- L3 LOW-RES EIGHT-DAY
- L3 LOW-RES MONTHLY

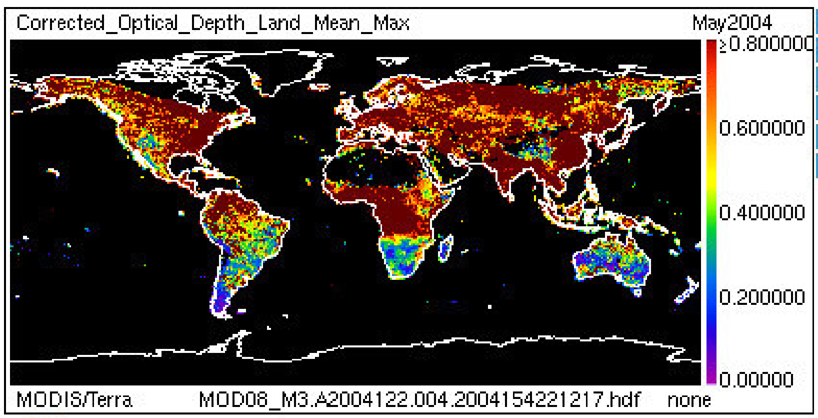
Terra Browse Imagery

NOTE: Lavender denotes data values equal to (or less than) the bottom scale number. Maroon denotes data values equal to (or greater than) the top scale number.

Quick Navigation Links (same day, same projection)

MOD04_L2: Aerosol Global Only	✔ MOD04_L2: Aerosol Land Only
MOD04_L2: Aerosol Ocean Only	MOD05_L2: WaterVapor
MOD06_L2: Cirrus Detection	MOD06_L2: Cloud Top Properties
MOD06_L2: Cloud Optical Properties	MOD07_L2: Atmosphere Profile
Return to Browse Menu Frameset	Load Print Friendly Version

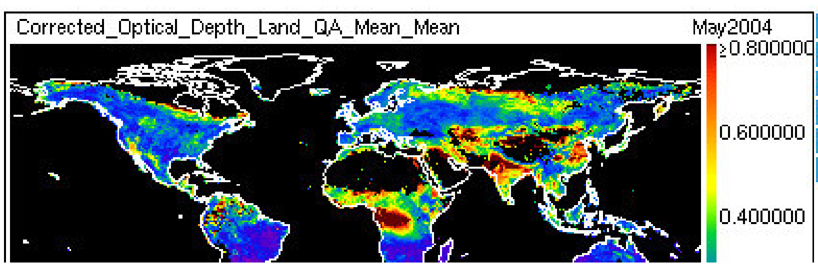
Aerosol (LAND ONLY)



.47 microns

QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars



QA_Mean
Mean
QA_Standard_Deviation
Standard_Deviation
Minimum
Maximum

roll mouse over statistic bars

Web Site Usage Statistics

Usage Statistics – Comparisons from 1 year ago

March 2002 – March 2003

- **Unique visitors = 63,000**
- **Total downloads = 137 Terrabytes**

July 2003 – July 2004

- **Unique visitors = 148,000**
- **Total downloads = 742 Terrabytes**

Topic 3.

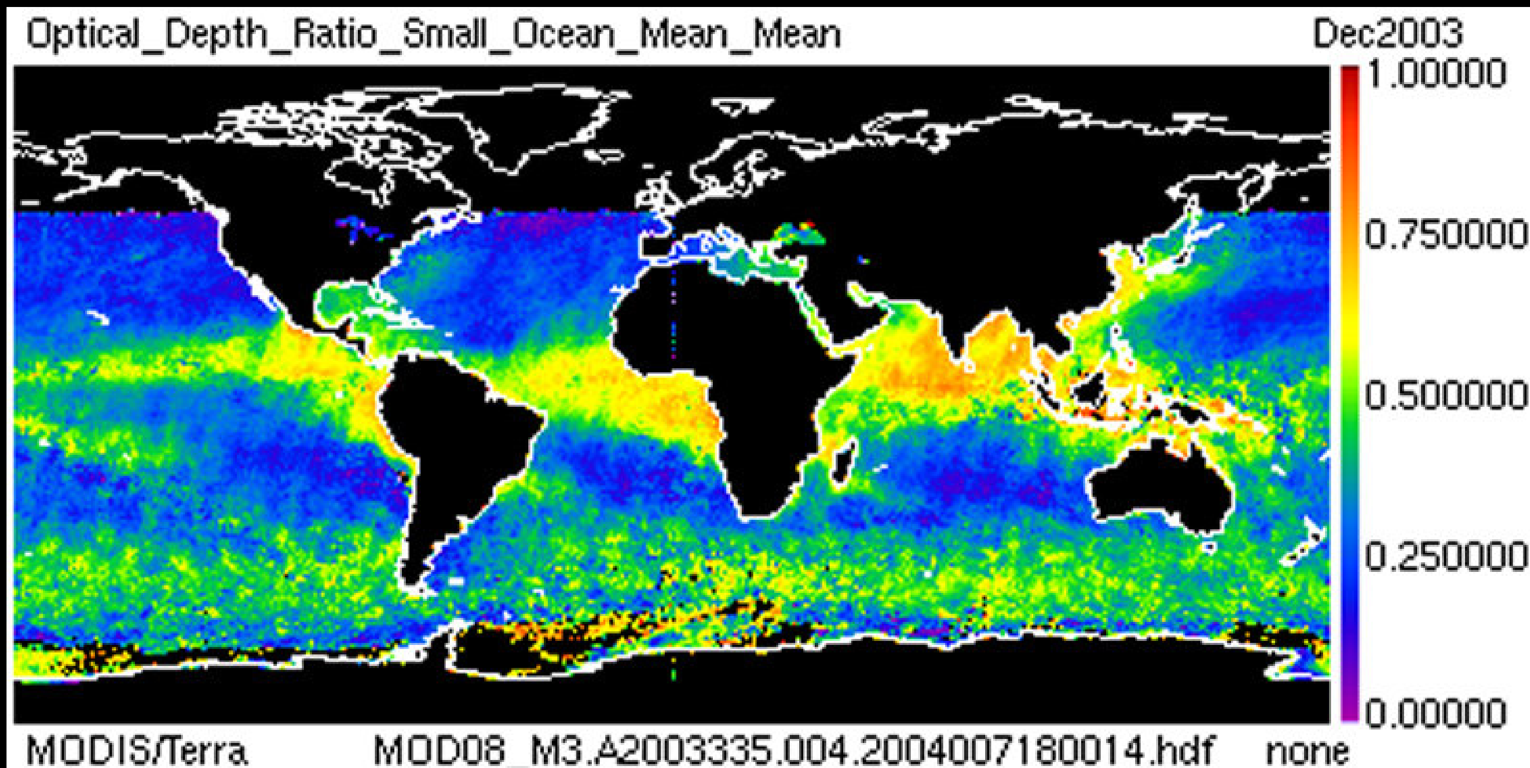
Using web & interactive tools to diagnose L2 algorithm issues

3 Case Studies

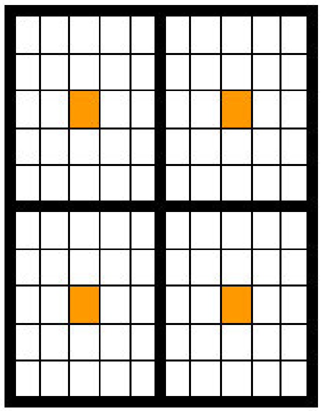
Case 1.

The “Sahara Streak”

(Aerosol)

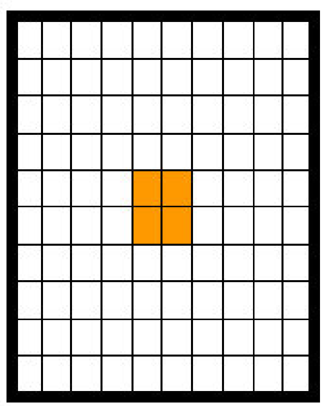

Optical_Depth_Ratio_Small_Ocean_Mean_Mean
Dec2003
1.00000
0.750000
0.500000
0.250000
0.00000
MODIS/Terra
MOD08_M3.A2003335.004.2004007180014.hdf
none

Computation of Geolocation in L2 Atmosphere Products



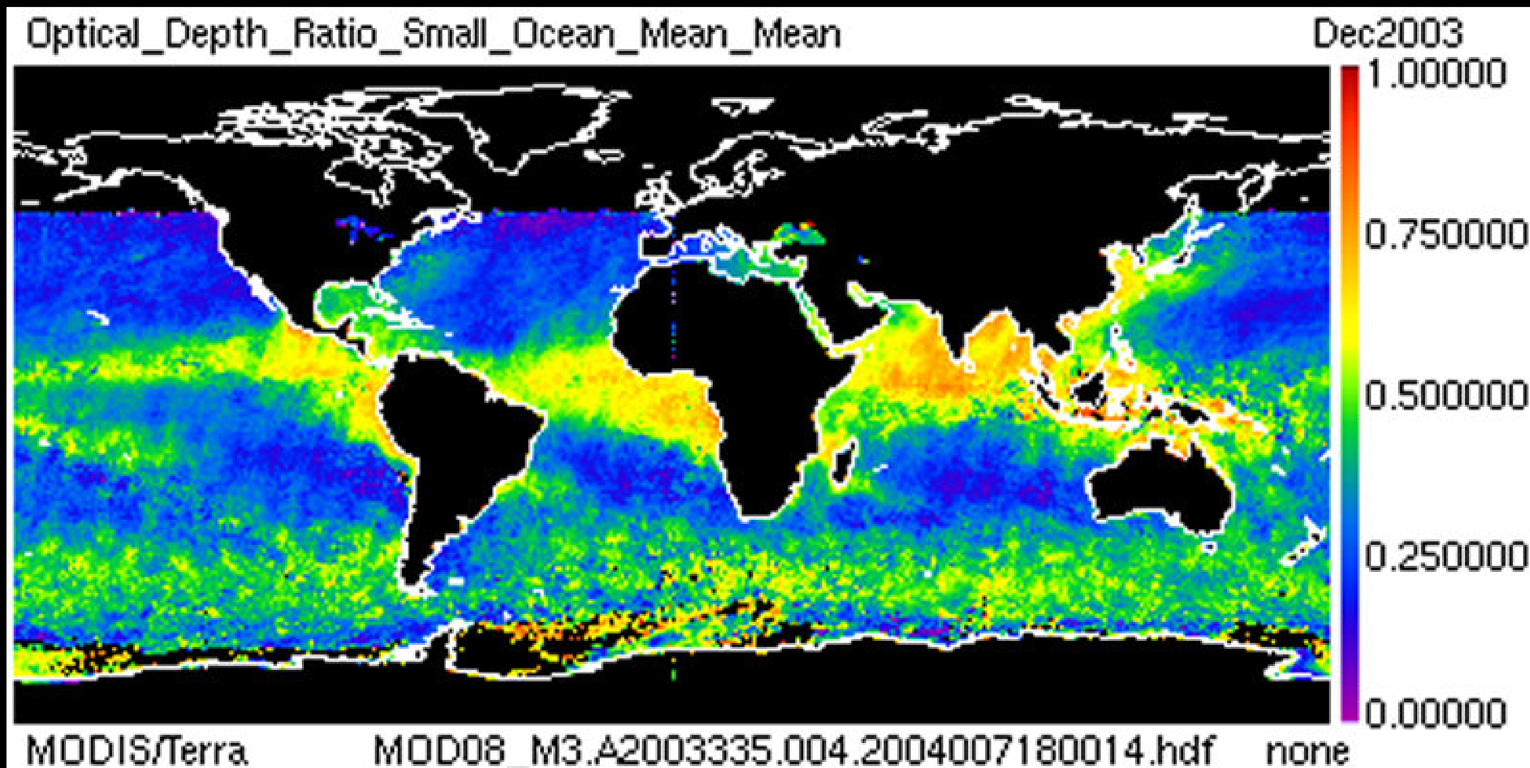
5-km resolution

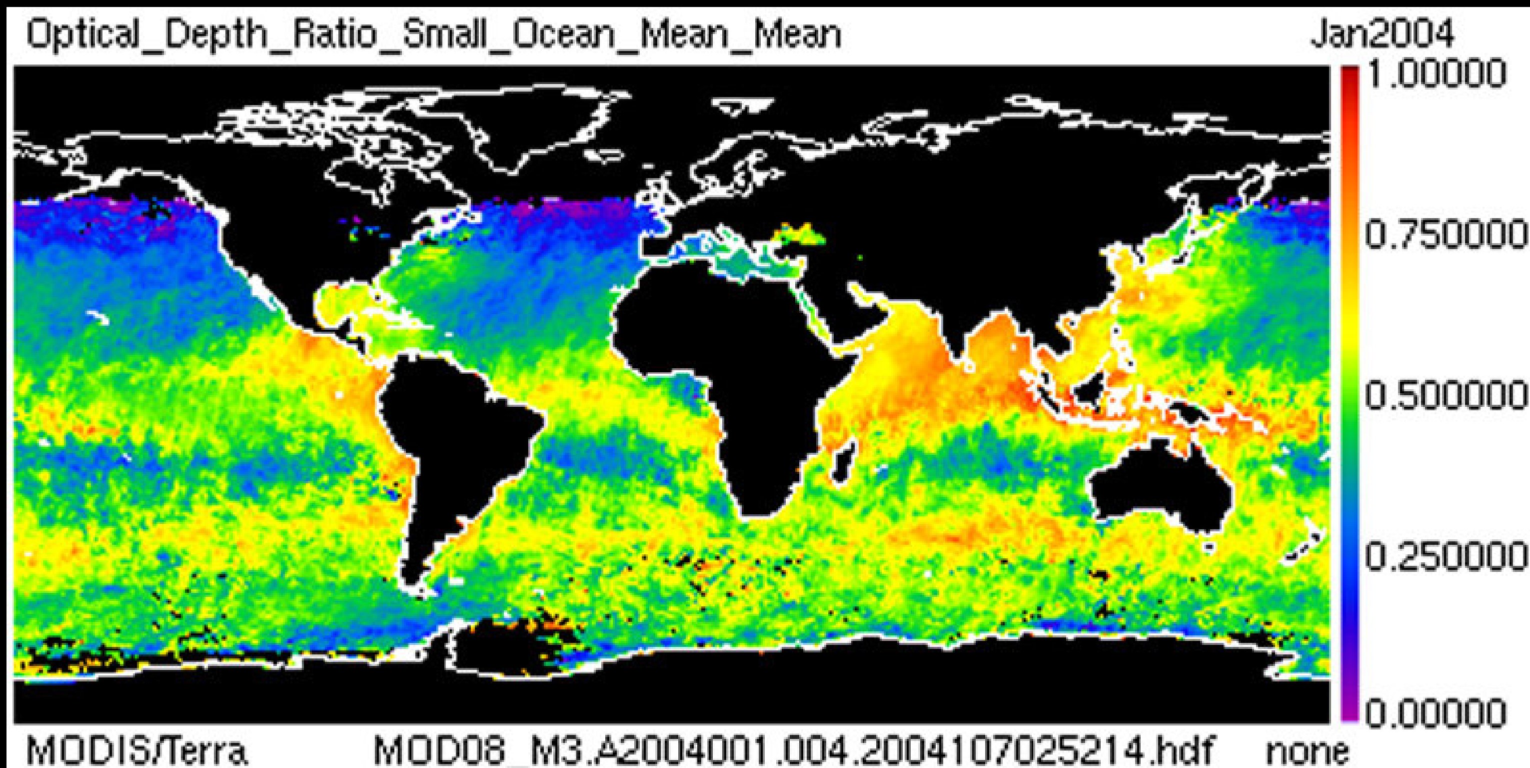
- 5-km geolocation is **copied** from center (3,3) 1-km L1B input pixel in each 5x5-km area



10-km resolution

- 10-km geolocation is **computed** by averaging the 4 central (5,5), (5,6), (6,5), (6,6) 1-km L1B input pixels in each 10x10-km area


Optical_Depth_Ratio_Small_Ocean_Mean_Mean
Dec2003
1.00000
0.750000
0.500000
0.250000
0.00000
MODIS/Terra
MOD08_M3.A2003335.004.2004007180014.hdf
none


Optical_Depth_Ratio_Small_Ocean_Mean_Mean
Jan2004
1.00000
0.750000
0.500000
0.250000
0.00000
MODIS/Terra
MOD08_M3.A2004001.004.2004107025214.hdf
none

Case 2.

Anomalous Water Vapor scans*

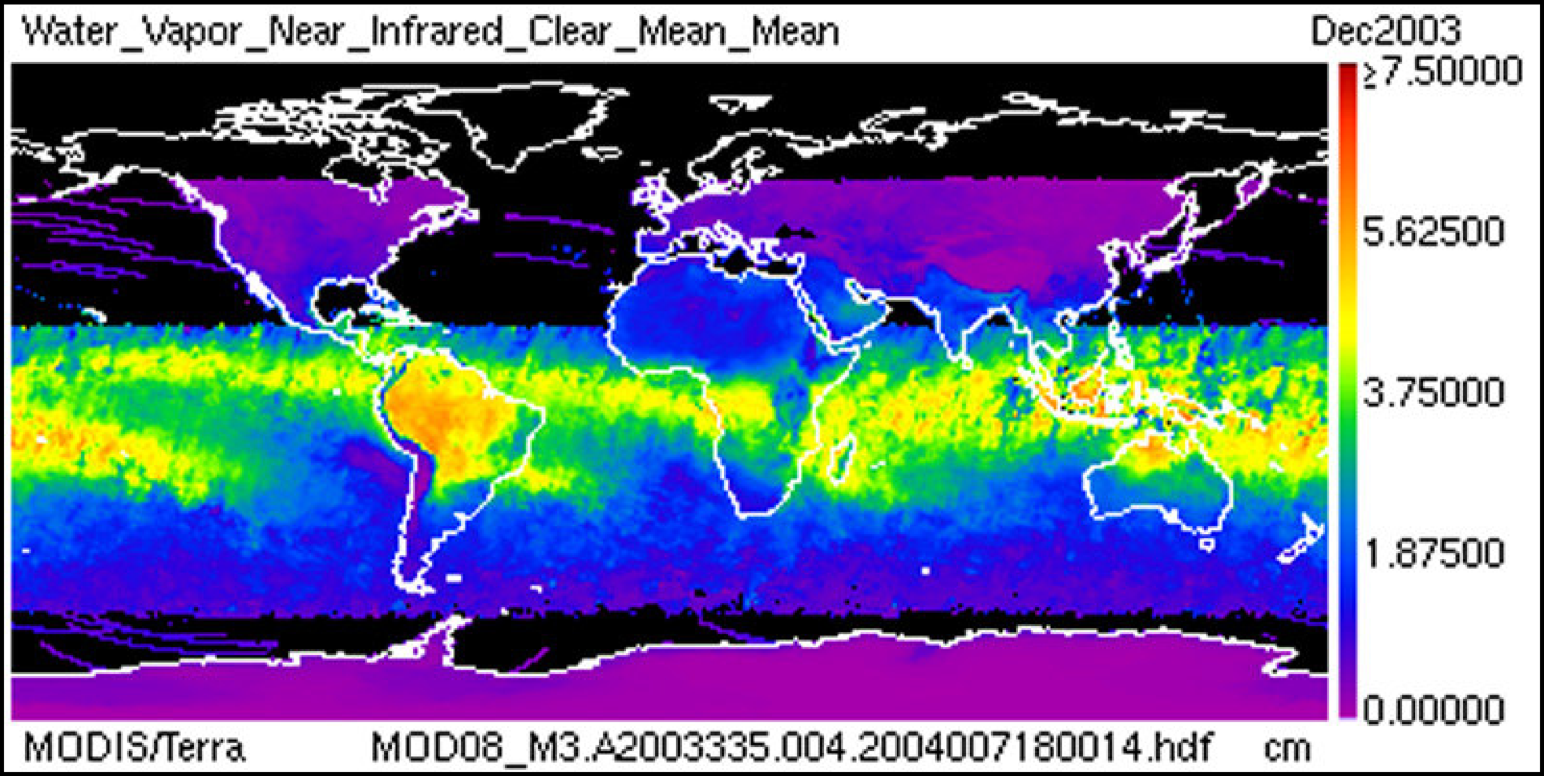
(Water Vapor Near Infrared Clear)

Clear = bright land and ocean sunglint

*** Similar anomalous property found in Cirrus Detection Parameters**

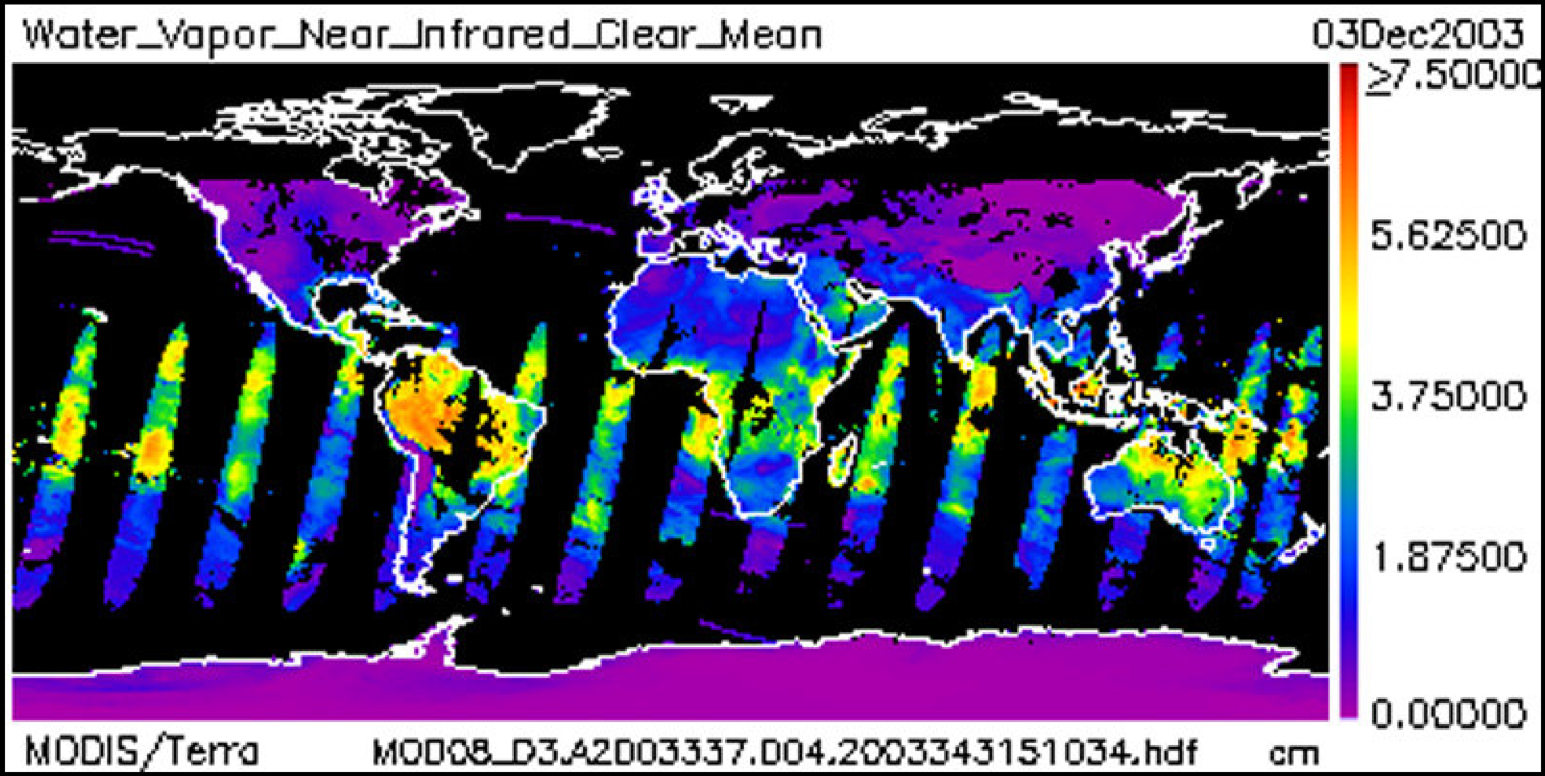
Dec03 Monthly L3 - Water Vapor (NIR) Image

("Clear" = bright land and ocean sunglint only)



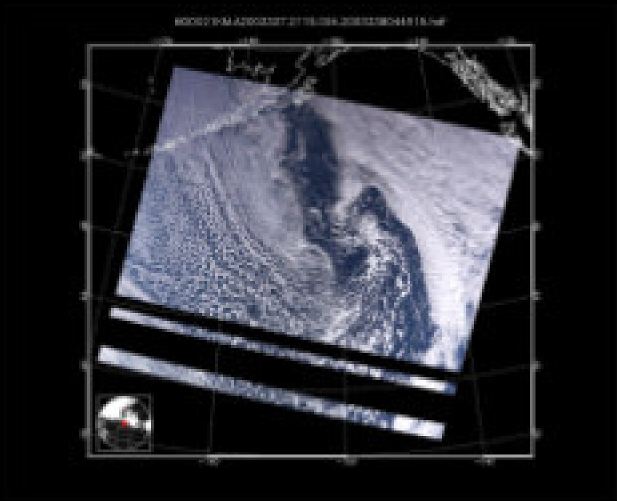
03Dec03 Daily L3 - Water Vapor (NIR) Image

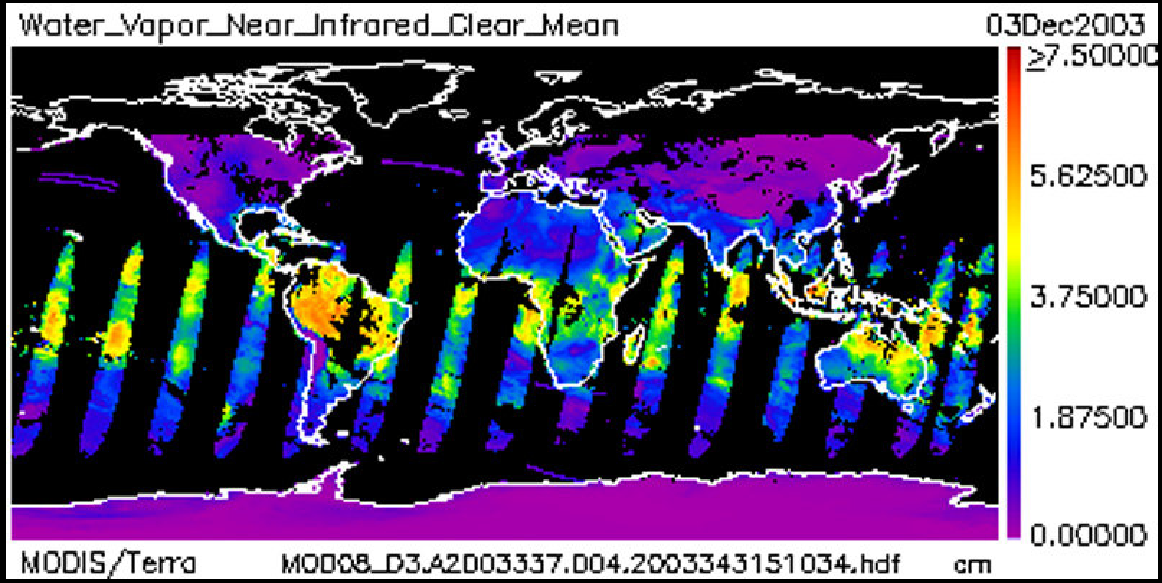
("Clear" = bright land and ocean sunglint only)



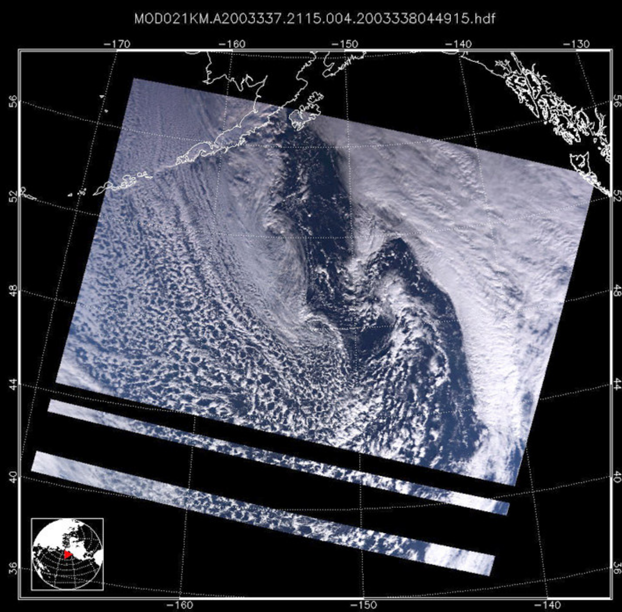
L1B (Alaska) vs. Daily Water Vapor (NIR)

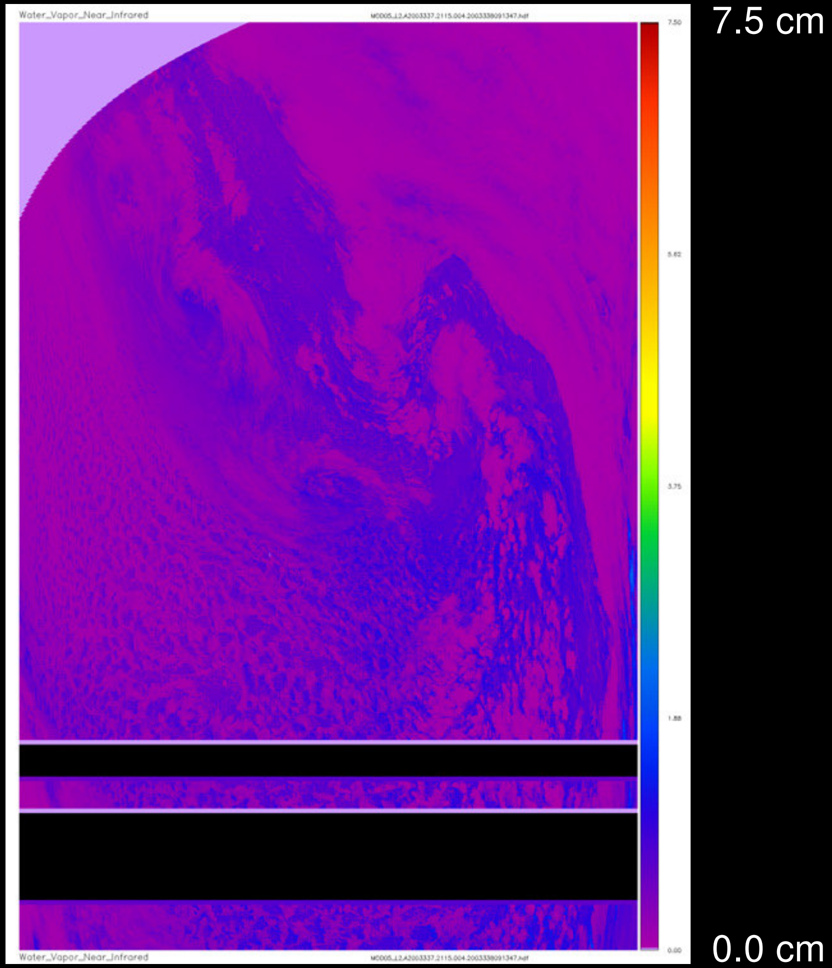
03 Dec 03



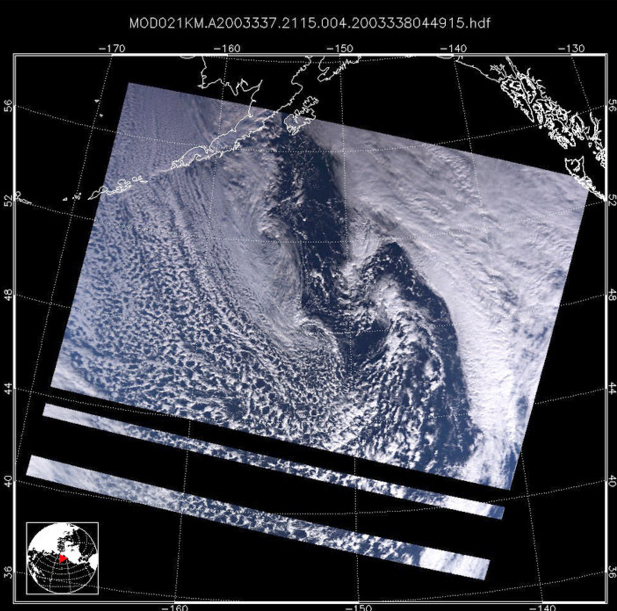


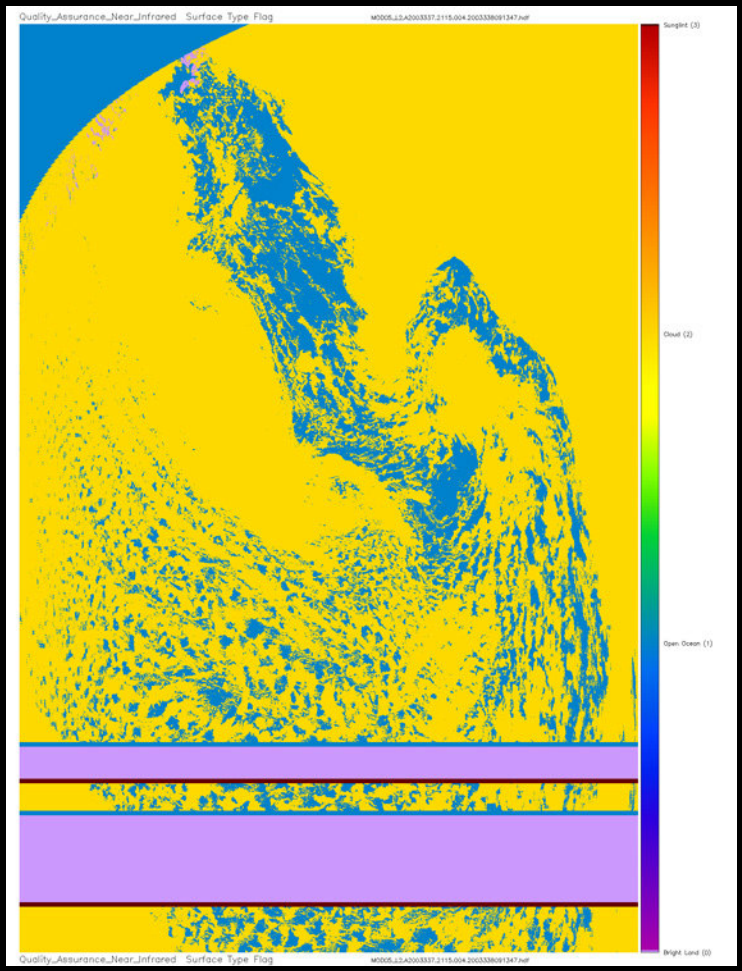
L1B image vs. L2 Water Vapor (NIR)





L1B image vs. L2 Surface Type Flag (NIR)





Sunglint

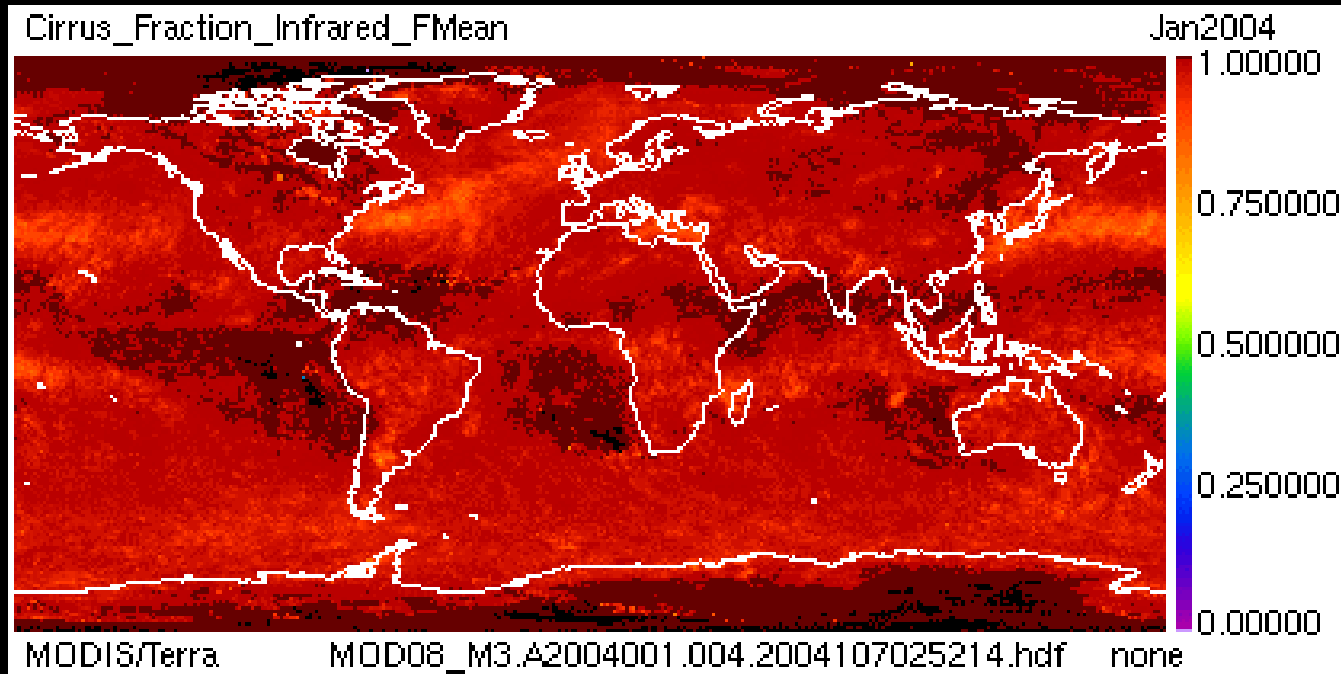
Cloudy

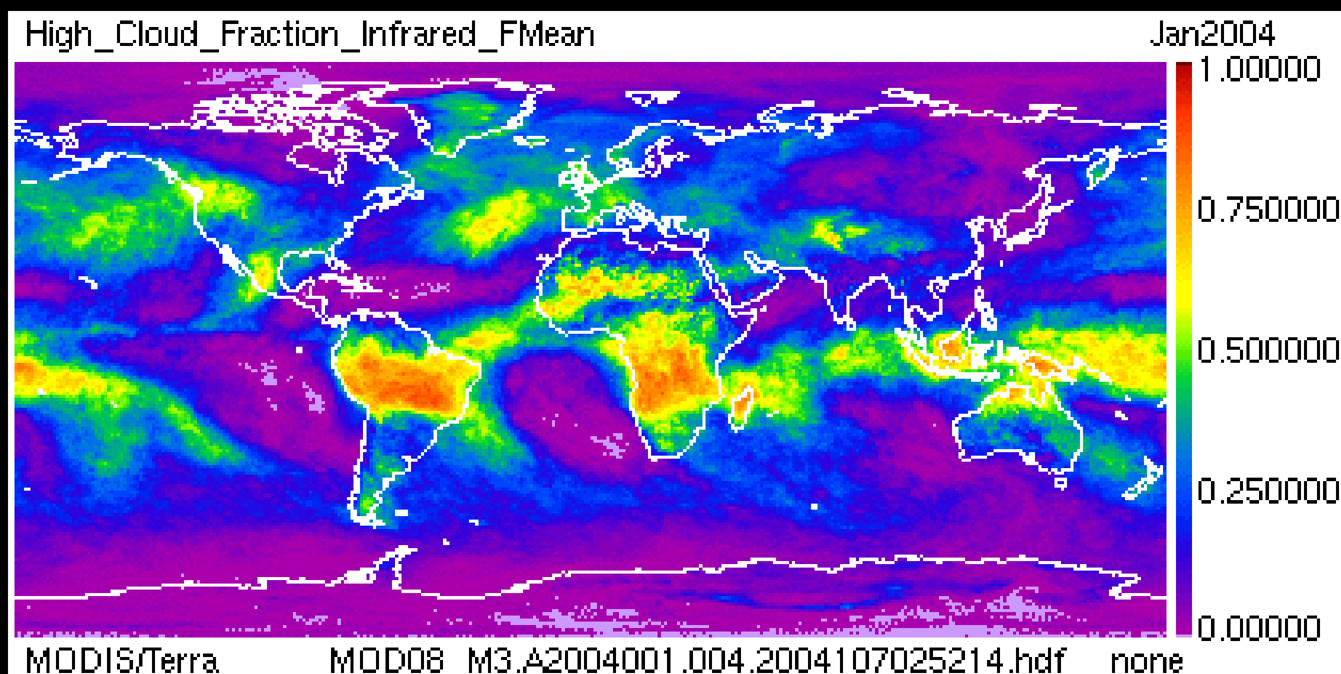
Ocean

Bright Land

Case 3.
Unphysical results from Cirrus Fraction (IR)

(Cloud Top Properties)


Cirrus_Fraction_Infrared_FMean
Jan2004
1.00000
0.750000
0.500000
0.250000
0.00000
MODIS/Terra
MOD08_M3.A2004001.004.2004107025214.hdf
none


High_Cloud_Fraction_Infrared_FMean
Jan2004
1.00000
0.750000
0.500000
0.250000
0.00000
MODIS/Terra
MOD08_M3.A2004001.004.2004107025214.hdf
none

Two “CO_2 Slicing Algorithm” Cloud Flags set in 06_L2 *Quality_Assurance_5km* array

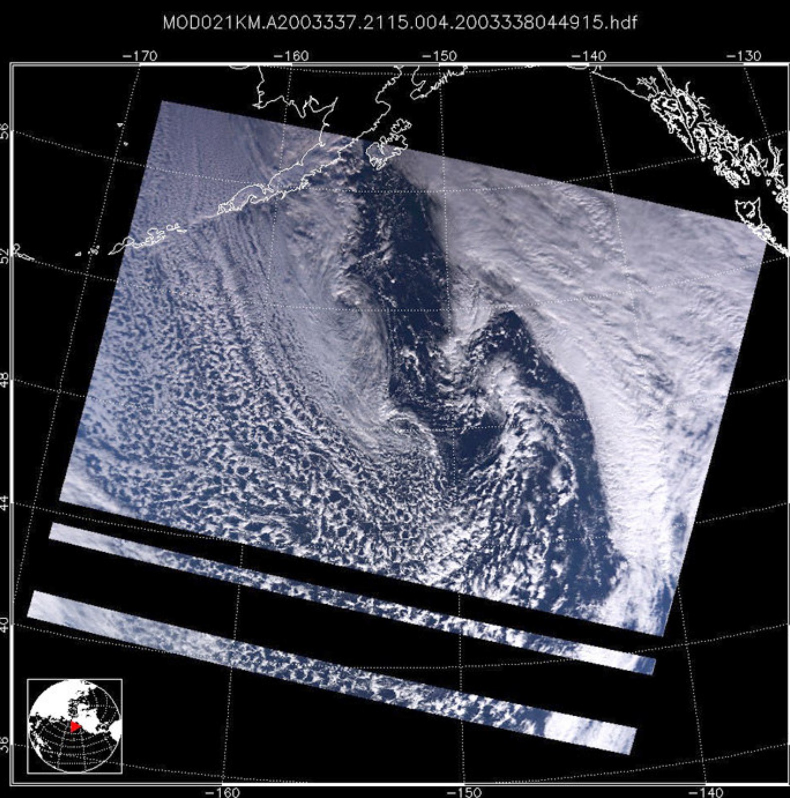
Parameter Definitions:

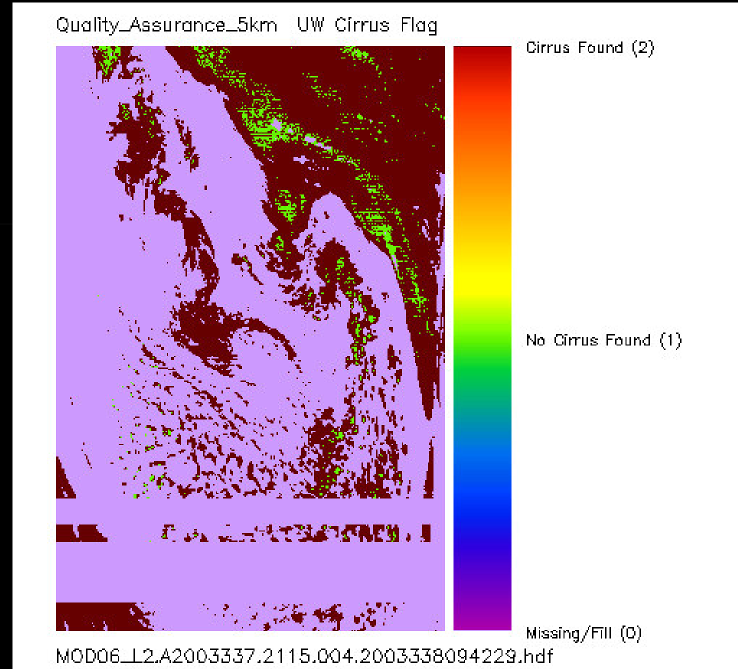
Cirrus Cloud:
CTP ≤ 700mb and CEE ≤ 0.95

High Cloud:
CTP < 400mb

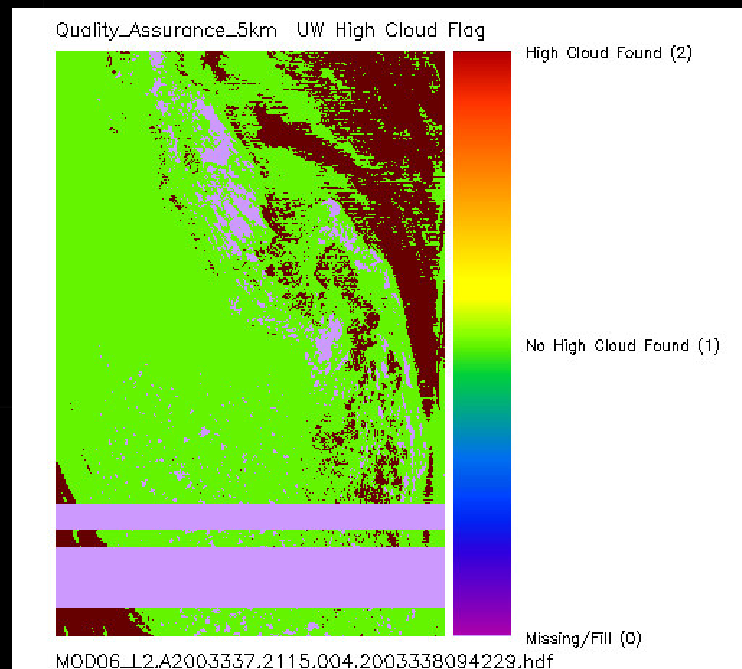
Cloud Fraction QA	1	0 1	Not useful Useful
Cloud Fraction Confidence QA	3	0-7	8 confidence levels*
Cloud Effective Emissivity QA	1	0 1	Not useful Useful
Cloud Effective Emissivity Confidence QA	3	0-7	8 confidence levels*
Cloud Phase Infrared QA	1	0 1	Not useful Useful
Cloud Phase Infrared Confidence QA	3	0-7	8 confidence levels*
Retrieval processing QA flags - processing path flags			
Cirrus Level 3 flag	2	0 1 2	0 - missing 1 - no cirrus found 2 - cirrus found
High cloud Level 3 flag	2	0 1 2	0 - missing 1 - no high cloud found 2 - high cloud found
Number of Cloudy Pixels within 5x5 km box	Int 8	0-25	
Number of Clear Pixels within 5x5 km box	Int 8	0-25	
Number of Missing Pixels within 5x5 km box	Int 8	0-25	
Maximum Likelihood Estimator	1	0 1	Not used Invoked
Cluster analysis	1	0 1	Not used Invoked
Goodness of Fit	1	0 1	0 = < 1 0 = 1
χ^2	1	0 1	< npts used in MLE > npts used in MLE

Cirrus Cloud: CTP ≤ 700mb and CEE ≤ 0.95 →





High Cloud: CTP < 400mb →



CO_2 Slicing Algorithm

Old Cloud Top Properties CO_2 slicing subroutine:

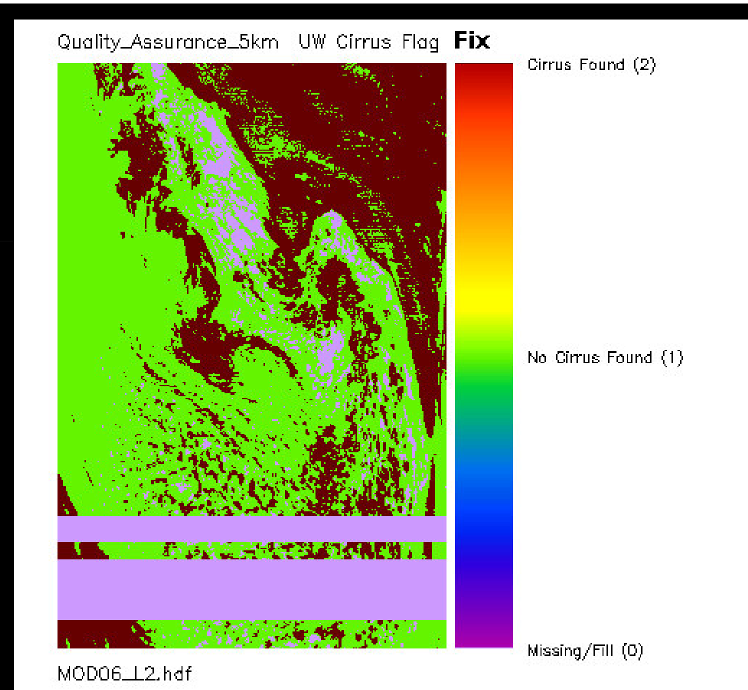
- High Cloud Flags initialized using “window retrieval” CTP’s.
  High Cloud Flags overwritten with valid “CO_2 retrieval” CTP’s.

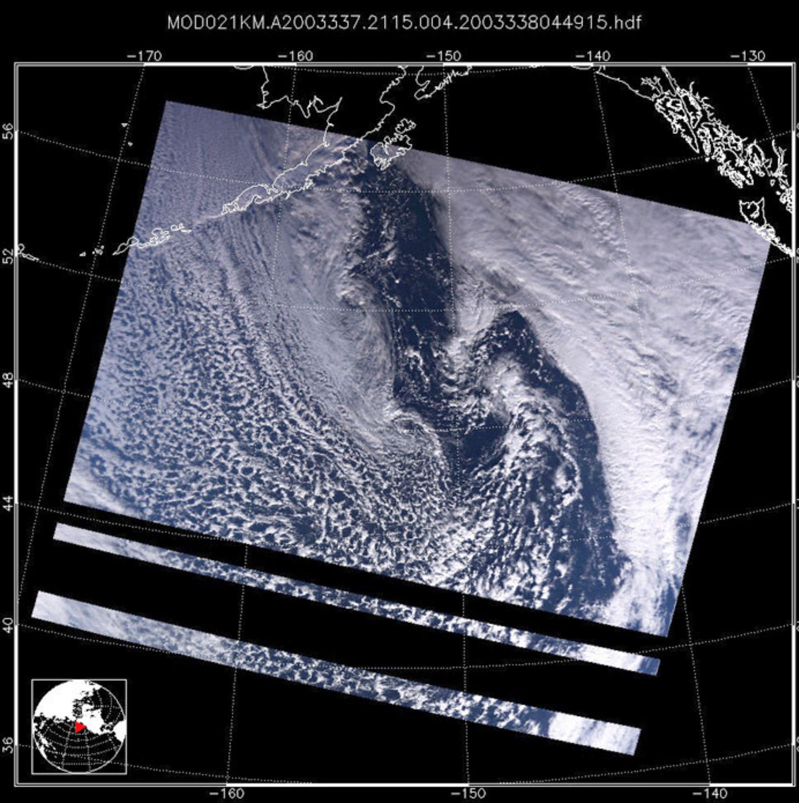
- Cirrus Flags were *not* initialized.
  Cirrus Flags overwritten with valid “CO_2 retrieval” CTP’s and CEE’s.

Bug Fix Implemented for Collection 005

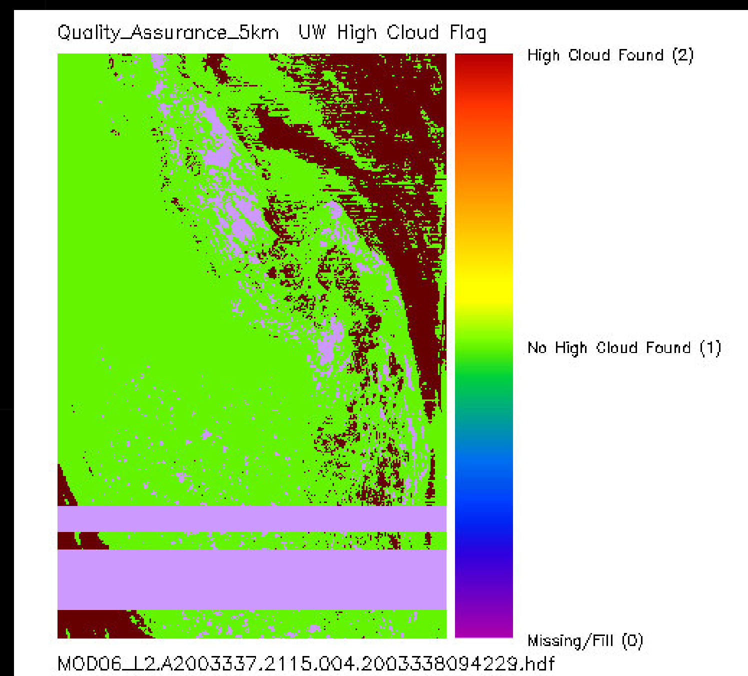
- <u>Cirrus Flags initialized using “window retrieval” values.</u>

Cirrus Cloud: CTP ≤ 700mb and CEE ≤ 0.95 →





High Cloud: CTP < 400mb →



Topic 4.

Level-3 Collection 005
Change Summary

Daily Global (08_D3) statistics
derived from

Aerosol (04_L2)

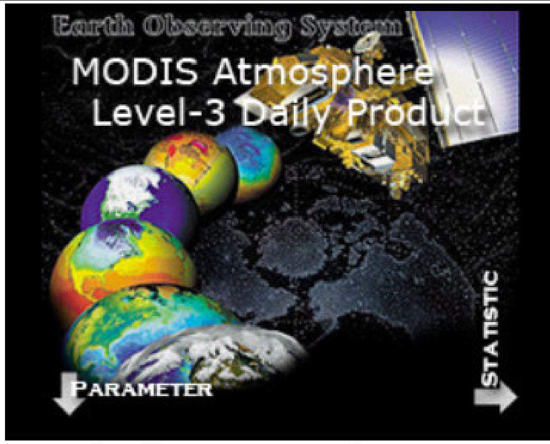
- Combined Land & Ocean
- Land only

Collection 005 Updates

- = Added
- = Corrected
- = Improved L2 algorithm
- = Deleted
- = Future Enhancement

L2 Aerosol algorithm improvements:

- reduced snow contamination in land retrievals at the snow/ice edge



Derived from L2 Aerosol (04_L2)

Parameter	Mean	Standard_Deviation	Minimum	Maximum	Mode or Median ?	QA_Mean	QA_Standard_Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Log_Mean	Log_Standard_Deviation	QA_Log_Mean	QA_Log_Standard_Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean_Square_Error	Joint_Histogram_vs_Effect_Radius (nxn)	Joint_Histogram_vs_Temperature (nxn)	Joint_Histogram_vs_Emissivity (nxn)	Joint_Histogram_vs_Pressure (nxn)
Combined Land & Ocean																							
01. Optical_Depth_Land_And_Ocean	•	•	•	•							•												
02. Optical_Depth_Ratio_Small_Land_And_Ocean	•	•	•	•							•												
03. Reflected_Flux_Land_And_Ocean	•	•	•	•							•												
04. Scattering_Angle	•	•	•	•							•												
05. Solar_Zenith	•	•	•	•							•												
06. Solar_Azimuth	•	•	•	•							•												
07. Sensor_Zenith	•	•	•	•							•												
08. Sensor_Azimuth	•	•	•	•							•												
Land Only																							
09. Corrected_Optical_Depth_Land (3)	•	•	•	•		•	•	•	•														
10. Optical_Depth_Ratio_Small_Land	•	•	•	•		•	•	•	•														
11. Mass_Concentration_Land	•	•	•	•		•	•	•	•														
12. Transmitted_Flux_Land (2)	•	•	•	•		•	•	•	•														
13. Reflected_Flux_Land (3)	•	•	•	•		•	•	•	•														
14. Angstrom_Exponent_Land [1]	•	•	•	•		•	•	•	•							•	•	•	•				
15. Mean_Reflectance_Land_All_QA47 (3)	•	•	•	•		•	•	•	•														
16. Mean_Reflectance_Land_All_QA66 (3)	•	•	•	•		•	•	•	•														
17. Path_Radiance_Land_QA47 (2)	•	•	•	•		•	•	•	•														
18. Path_Radiance_Land_QA66 (2)	•	•	•	•		•	•	•	•														
19. Critical_Reflectance_Land_QA47 (2)	•	•	•	•		•	•	•	•														
20. Critical_Reflectance_Land_QA66 (2)	•	•	•	•		•	•	•	•														
21. Aerosol_Cloud_Mask_Cloud_Fraction_Land	•	•	•	•							•												
22. Number_Pixels_Used_Land	•	•	•	•							•												

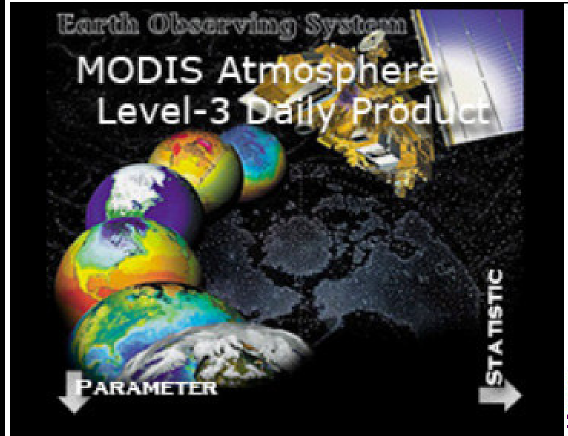
Daily Global (08_D3) statistics
derived from

Aerosol (04_L2)

- **Ocean only**

Collection 005 Updates

- = Added
- = Corrected
- = Improved L2 algorithm
- = Deleted
- = Future Enhancement



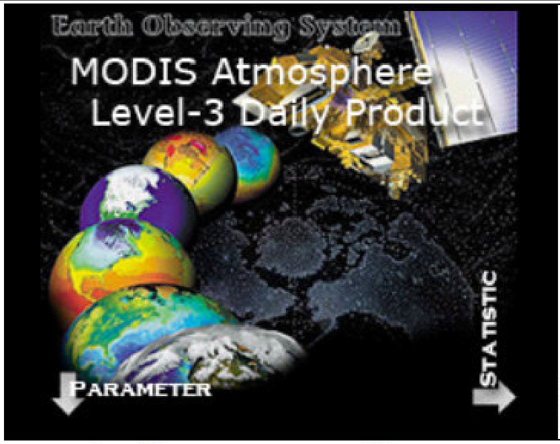
Derived from L2 Aerosol (04_L2)

Ocean Only

Parameter	Mean	Standard_Deviation	Minimum	Maximum	Mode or Median ?	QA_Mean	QA_Standard_Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Log_Mean	Log_Standard_Deviation	QA_Log_Mean	QA_Log_Standard_Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean_Square_Error	Joint_Histogram_vs_Effect_Radius (nxn)	Joint_Histogram_vs_Temperature (nxn)	Joint_Histogram_vs_Emissivity (nxn)	Joint_Histogram_vs_Pressure (nxn)
23. Effective_Optical_Depth_Average_Ocean (7)	•	•	•	•		•	•	•	•														
24. Optical_Depth_Ratio_Small_Ocean	•	•	•	•		•	•	•	•														
25. Effective_Radius_Ocean	•	•	•	•		•	•	•	•														
26. Mass_Concentration_Ocean	•	•	•	•		•	•	•	•														
27. Cloud_Condensation_Nuclei_Ocean	•	•	•	•		•	•	•	•														
28. Angstrom_Exponent_1_Ocean [2]	•	•	•	•		•	•	•	•							•	•	•	•				
29. Angstrom_Exponent_2_Ocean [3]	•	•	•	•		•	•	•	•							•	•	•	•				
30. Asymmetry_Factor_Average_Ocean (7)	•	•	•	•		•	•	•	•														
31. Backscattering_Ratio_Average_Ocean (7)	•	•	•	•		•	•	•	•														
32. Transmitted_Flux_Average_Ocean (7)	•	•	•	•		•	•	•	•														
33. Reflected_Flux_Average_Ocean (7)	•	•	•	•		•	•	•	•														
34. Optical_Depth_by_models_Ocean (9)	•	•	•	•		•	•		•														
35. Aerosol_Cloud_Mask_Cloud_Fraction_Ocean	•	•	•	•							•												
36. Number_Pixels_Used_Ocean	•	•	•	•							•												

Daily Global (08_D3) statistics
derived from

Atm. Profile (07_L2)



Derived from L2 Atm Profile (07_L2)

	Mean	Standard_Deviation	Minimum	Maximum	Mode or Median ?	QA_Mean	QA_Standard_Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Log_Mean	Log_Standard_Deviation	QA_Log_Mean	QA_Log_Standard_Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean_Square_Error	Joint_Histogram_vs_Effect_Radius (nxn)	Joint_Histogram_vs_Temperature (nxn)	Joint_Histogram_vs_Emissivity (nxn)	Joint_Histogram_vs_Pressure (nxn)
90. Total_Ozone	•	•	•	•		•	•	•	•														
91. Total_Totals	•	•	•	•		•	•	•	•														
92. Lifted_Index	•	•	•	•		•	•	•	•														
93. Atmospheric_Water_Vapor	•	•	•	•		•	•	•	•														
94. Atmospheric_Water_Vapor_Low	•	•	•	•		•	•	•	•														
95. Atmospheric_Water_Vapor_High	•	•	•	•		•	•	•	•														
96. Retrieved_Temperature_Profile	•	•	•	•							•												

Collection 005 Updates

- = Added
- = Corrected
- = Improved L2 algorithm
- = Deleted
- = Future Enhancement

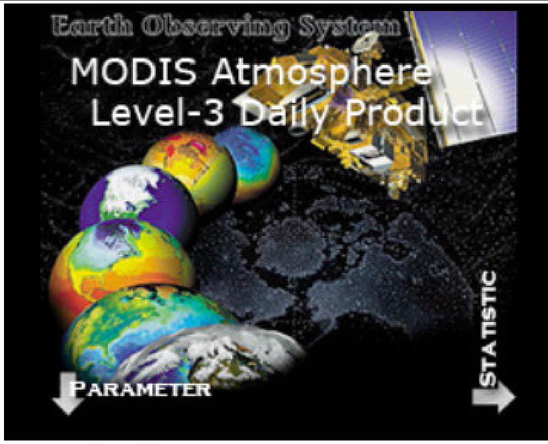
Daily Global (08_D3) statistics
derived from

Water Vapor (05_L2)

&

Cloud (06_L2)

- Cirrus detection
- Cloud Top properties



Parameter	Mean	Standard_Deviation	Minimum	Maximum	Mode or Median ?	QA_Mean	QA_Standard_Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Log_Mean	Log_Standard_Deviation	QA_Log_Mean	QA_Log_Standard_Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean_Square_Error	Joint_Histogram_vs_Effect_Radius (nxn)	Joint_Histogram_vs_Temperature (nxn)	Joint_Histogram_vs_Emissivity (nxn)	Joint_Histogram_vs_Pressure (nxn)
Derived from L2 Water Vapor (05_L2)																							
37. Water_Vapor_Near_Infrared_Clear	•	•	•	•		•	•	•	•														
38. Water_Vapor_Near_Infrared_Cloud	•	•	•	•		•	•	•	•														
Derived from L2 Cloud (06_L2)																							
Cirrus Detection																							
39. Cirrus_Reflectance	•	•	•	•		•	•	•															
40. Cirrus_Fraction_SWIR										•	•												
Cloud Top Properties																							
41. Cloud_Top_Pressure	•	•	•	•				•			•											•	
42. Cloud_Top_Pressure_Day	•	•	•	•				•			•											•	
43. Cloud_Top_Pressure_Night	•	•	•	•				•			•											•	
44. Cloud_Top_Temperature	•	•	•	•				•			•												
45. Cloud_Top_Temperature_Day	•	•	•	•				•			•												
46. Cloud_Top_Temperature_Night	•	•	•	•				•			•												
47. Cloud_Effective_Emissivity	•	•	•	•				•			•												
48. Cloud_Effective_Emissivity_Day	•	•	•	•				•			•												
49. Cloud_Effective_Emissivity_Night	•	•	•	•				•			•												
50. Cloud_Fraction	•	•	•	•				•			•												
51. Cloud_Fraction_Day	•	•	•	•				•			•												
52. Cloud_Fraction_Night	•	•	•	•				•			•												
53. Cirrus_Fraction_Infrared										•	•												
54. High_Cloud_Fraction_Infrared										•	•												
55. Cloud_Phase_Infrared								•															
56. Cloud_Phase_Infrared_Day								•															
57. Cloud_Phase_Infrared_Night								•															

Collection 005 Updates

- = Added
- = Corrected
- = Improved L2 algorithm
- = Deleted
- = Future Enhancement

Daily Global (08_D3) statistics
derived from

Cloud (06_L2)

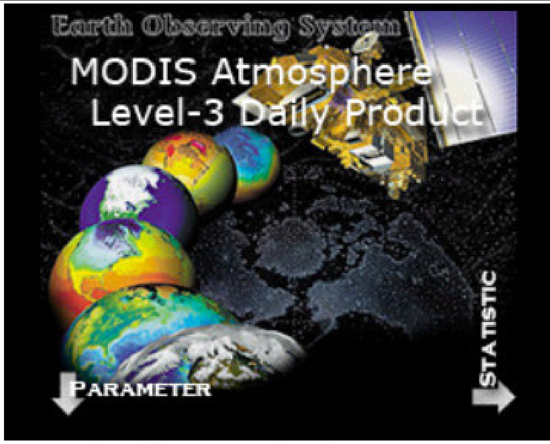
- **Cloud Optical properties**

Collection 005 Updates

- = Added
- = Corrected
- = Improved L2 algorithm
- = Deleted
- = Future Enhancement

File Size Change Est.

C004 D3 = 440 mb
C005 D3 = 550 mb



Derived from L2 Cloud (06_L2)

Cloud Optical Properties

Parameter	Mean	Standard_Deviation	Minimum	Maximum	Mode or Median ?	QA_Mean	QA_Standard_Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Log_Mean	Log_Standard_Deviation	QA_Log_Mean	QA_Log_Standard_Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean_Square_Error	Joint_Histogram_vs_Effect_Radius (nxn)	Joint_Histogram_vs_Temperature (nxn)	Joint_Histogram_vs_Emissivity (nxn)	Joint_Histogram_vs_Pressure (nxn)
58. Cloud_Optical_Thickness_Water	●	●	●	●	●	●	●	●	●			●	●	●	●					●	●	●	●
59. Cloud_Optical_Thickness_Ice	●	●	●	●	●	●	●	●	●			●	●	●	●					●	●	●	●
60. Cloud_Optical_Thickness_Undetermined	●	●	●	●		●	●					●	●	●	●								
61. Cloud_Optical_Thickness_Combined	●	●	●	●		●	●					●	●	●	●								
62. Cloud_Effective_Radius_Water	●	●	●	●	●	●	●	●	●												●	●	●
63. Cloud_Effective_Radius_Ice	●	●	●	●	●	●	●	●	●												●	●	●
64. Cloud_Effective_Radius_Undetermined	●	●	●	●		●	●																
65. Cloud_Effective_Radius_Combined	●	●	●	●		●	●																
66. Successful_Water_Cloud_Retrieval_Fraction										●	●												
67. Successful_Ice_Cloud_Retrieval_Fraction										●	●												
68. Successful_Undetermined_Cloud_Retrieval_Fraction										●	●												
69. Successful_Total_Cloud_Retrieval_Fraction										●	●												
70. Water_Path_Liquid	●	●	●	●	●	●	●	●	●														
71. Water_Path_Ice	●	●	●	●	●	●	●	●	●														
72. Water_Path_Undetermined	●	●	●	●		●	●																
73. Water_Path_Combined	●	●	●	●		●	●																
74. Cloud_Optical_Thickness_1L_Water[4]	●	●	●	●	●			●												●			
75. Cloud_Optical_Thickness_1L_Ice[5]	●	●	●	●	●			●												●			
76. Cloud_Effective_Radius_1L_Water	●	●	●	●	●			●															
77. Cloud_Effective_Radius_1L_Ice	●	●	●	●	●			●															
78. Water_Path_1L_Liquid	●	●	●	●	●			●															
79. Water_Path_1L_Ice	●	●	●	●	●			●															
80. Multilayer_Water_Cloud_Fraction										●	●												
81. Multilayer_Ice_Cloud_Fraction										●	●												
82. Multilayer_Undetermined_Cloud_Fraction										●	●												
83. Multilayer_Total_Cloud_Fraction										●	●												
84. MLWater_To_Water_Cloud_Fraction										●	●												
85. MLIce_To_Ice_Cloud_Fraction										●	●												
86. MLUndetermined_To_Undetermined_Cloud_Fraction										●	●												
87. MLTotal_To_Total_Cloud_Fraction										●	●												
88. Cloud_Optical_Thickness_1621_Water[6]	●	●	●	●	●			●												●			
89. Cloud_Effective_Radius_1621_Water	●	●	●	●	●			●															