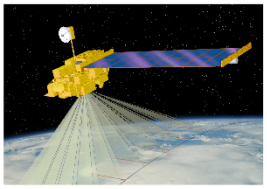
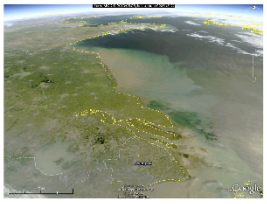
MODIS Direct Broadcast: Products and Software





ECNU IMAPP Workshop
Shanghai, China
June 1-5, 2011

Liam Gumley
Space Science and Engineering Center
University of Wisconsin-Madison

SSEC

Title slide

Outline

1. What is MODIS **Direct Broadcast** (DB)?
2. MODIS DB **Image** Products
3. MODIS DB **Atmosphere** Products
4. MODIS DB **Land** products
5. MODIS DB **Ocean** products
6. Software for **interpreting** MODIS DB products
7. **Downloading** MODIS data from the Web

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What is Direct Broadcast?

- Direct Broadcast is the real-time transmission of earth observation data from the spacecraft to the ground (via X-band on Terra and Aqua)
- On Terra, only MODIS is broadcast
- On Aqua, all data is broadcast
- Data are free and clear with no encryption
- All you need is an antenna and receiver!
- “Terra and Aqua are a great gift to the world” *(Vladimir Gershenzon, ScanEx)*

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Terra

Launched: Dec. 18, 1999

10:30 am descending

ASTER: Hi-res imager

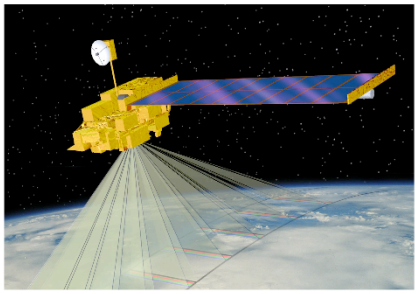
CERES: Broadband scanner

MISR: Multi-angle imager

MODIS: Multispectral imager

MOPITT: Limb sounder

Only MODIS is available by DB



Aqua

Launched: May 4, 2002

1:30 pm ascending

AIRS: Infrared sounder

AMSR-E: Microwave scanner

AMSU: Microwave scanner

CERES: Broadband scanner

HSB: Microwave sounder

MODIS: Multispectral imager

All sensors are available via DB

How do I get Direct Broadcast?

- Direct Broadcast X-band ground stations are available from a number of vendors
- Cost is around $100-300K USD
- ECNU operates an X/L-band ground station, and data is freely available within ECNU network
- There are many other stations in China, but products are usually kept private

There are other ways to get MODIS data…

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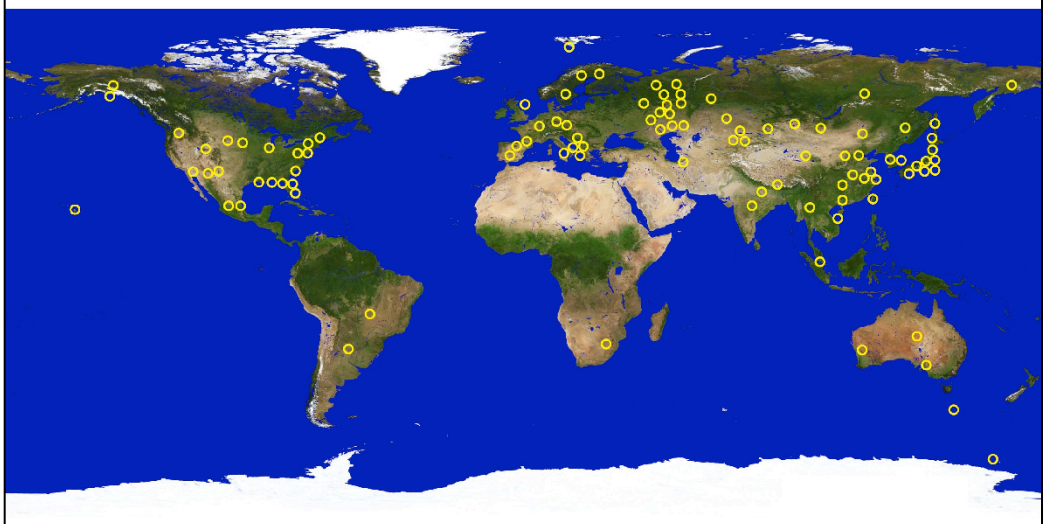
Shanghai, China


Moscow, Russia
27/11/03 12:58


Madison, USA

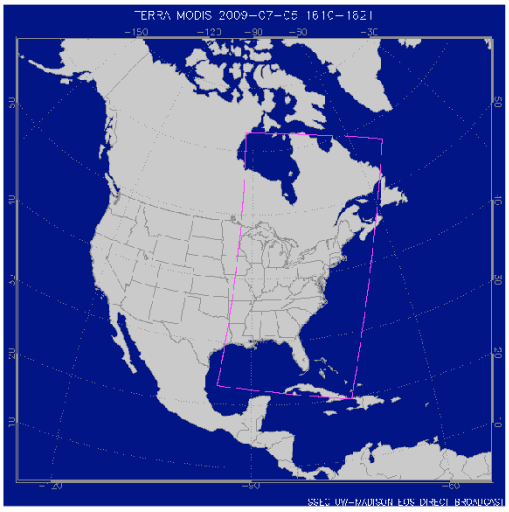

Benevento, Italy

EOS Direct Broadcast Sites Worldwide

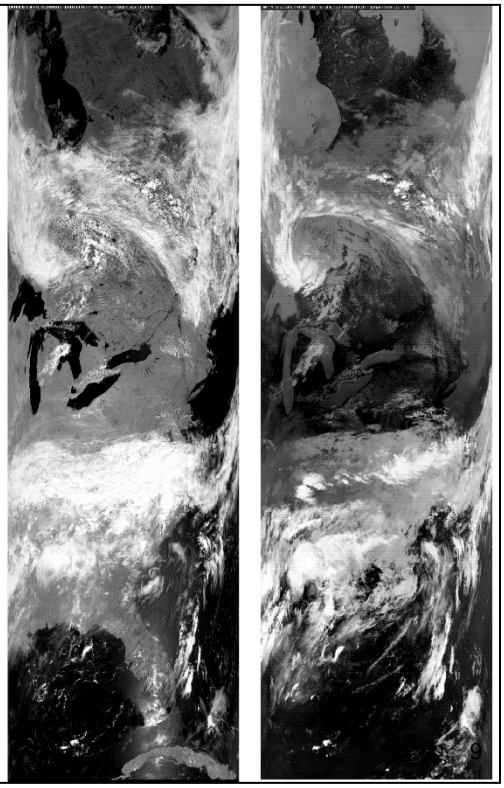


8

DB Coverage from Madison, WI

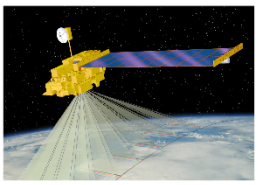


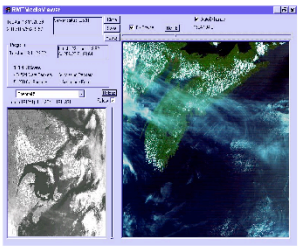
Terra, 2009/07/05



Advantages of DB

Satellite





- Local control gives users the freedom to tailor operations to suit local needs
- Timeliness for responding to natural hazards and providing information for decision makers
- Local researchers are free to develop and refine algorithms tuned for local conditions

Ground Station Processing Software Products and Applications

Terra and Aqua DB Product Suite

MODIS Level 1B Products (MODISL1DB)
Level 0 quicklook images (visible and infrared)
Level 1B 1KM, HKM, and QKM radiances and geolocation
Destriping corrections for Level 1B 1KM infrared radiances

MODIS Atmosphere Level 2 Products (IMAPP)
Cloud Mask
Cloud Top Pressure, Phase, Emissivity, Optical Depth
Aerosol Optical Depth
Temperature and Water Vapor Profiles
Total Column Precipitable Water Vapor
Total Column Ozone
Level 2 browse images for all Atmosphere Products

MODIS Land Products (DRL)
Corrected Reflectance 1KM, HKM, QKM
Fire Detection / Thermal Anomalies
Land Surface Temperature (LST)
Normalized Difference Vegetation Index (NDVI)
Enhanced Vegetation Index (EVI)
Land Surface Reflectance

MODIS Ocean Products (SeaDAS)
Chlorophyll-A Concentration
Sea Surface Temperature (SST)

MODIS Images (HDFLook)
Level 1B browse images (visible, infrared, true color)
Level 2 Land browse images (NDVI, LST)
Level 2 Ocean browse images (Chlorophyll-A, SST)

MODIS Google Earth KML (IMAPP)
MODIS 250 meter resolution true color JPEG images and KML

AIRS Level 1 and Level 2 (IMAPP)
Level 1B data (including AIRS IR, AIRS VIS, and AMSU)
Level 2 retrievals of temperature and moisture

AMSR-E Level 1 and Level 2 (IMAPP)
Geolocated and calibrated antenna temperatures
Rain Rate
Soil Moisture
Snow Water Equivalent

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MODIS DB Level 1 Image Products

Software: **MODISL1DB**

Developers: MODIS Characterization Support Team, MODIS Science Team, NASA Ocean Biology Processing Group

Distributor: NASA Ocean Biology Processing Group

Platforms: Linux, OS X, Windows (VM)

http://oceancolor.gsfc.nasa.gov/seadas/modisl1db/

Free Download

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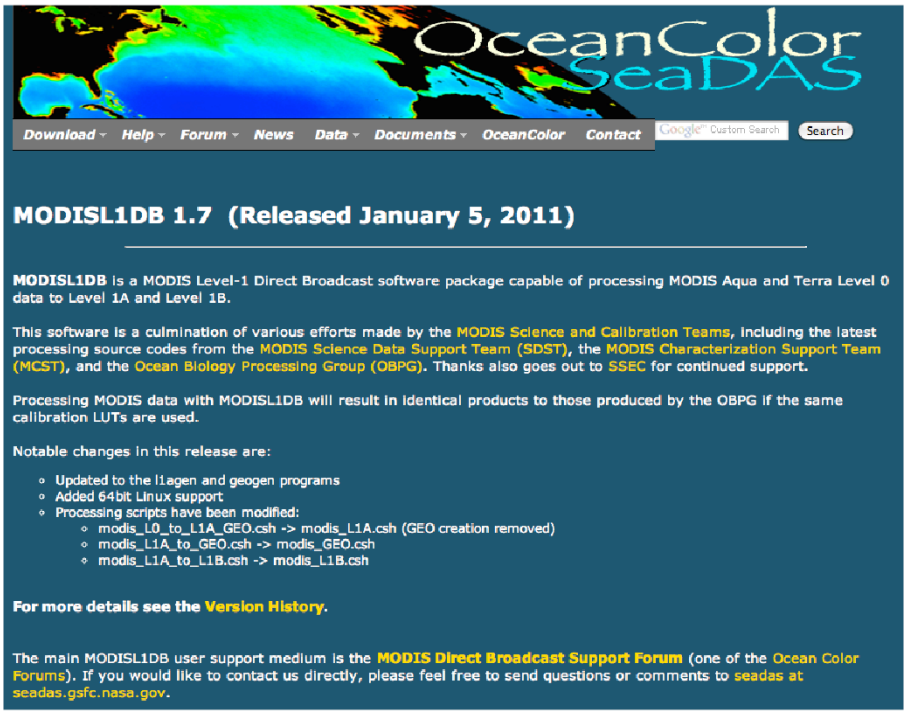
OceanColor
SeaDAS
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Forum
News
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Documents
OceanColor
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Search
MODISL1DB 1.7 (Released January 5, 2011)
MODISL1DB is a MODIS Level-1 Direct Broadcast software package capable of processing MODIS Aqua and Terra Level 0 data to Level 1A and Level 1B.
This software is a culmination of various efforts made by the MODIS Science and Calibration Teams, including the latest processing source codes from the MODIS Science Data Support Team (SDST), the MODIS Characterization Support Team (MCST), and the Ocean Biology Processing Group (OBPG). Thanks also goes out to SSEC for continued support.
Processing MODIS data with MODISL1DB will result in identical products to those produced by the OBPG if the same calibration LUTs are used.
Notable changes in this release are:
Updated to the l1agen and geogen programs
Added 64bit Linux support
Processing scripts have been modified:
modis_L0_to_L1A_GEO.csh -> modis_L1A.csh (GEO creation removed)
modis_L1A_to_GEO.csh -> modis_GEO.csh
modis_L1A_to_L1B.csh -> modis_L1B.csh
For more details see the Version History.
The main MODISL1DB user support medium is the MODIS Direct Broadcast Support Forum (one of the Ocean Color Forums). If you would like to contact us directly, please feel free to send questions or comments to seadas at seadas.gsfc.nasa.gov.

What does MODISL1DB do?

Purpose: **Convert raw MODIS telemetry files to calibrated and geolocated Level 1B image products**

Input Data: **Level 0 CCSDS Packet Files containing APID 64 (MODIS) for Terra and Aqua; and APID 957 (GBAD) for Aqua**

Output Data: **MODIS Level 1B 1KM, HKM, QKM, and Geolocation (HDF4 format)**

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MODIS Level 1B Data

- MODIS Level 1B data contains calibrated and geolocated radiance or reflectance values observed by the instrument (top of atmosphere)
- MYD02 is the Aqua product ID (Terra=MOD02)
- MYD021KM = 1000 meter resolution

  (1354 pixels across track by 2030 pixels along track for a standard 5-minute granule or scene)
- MYD02HKM = 500 meter resolution (2708 x 4060)
- MYD02QKM = 250 meter resolution (5416 x 8120)

DB granules may be larger (up to 14 minutes long)

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MODIS Level 1B Contents

- Format is Hierarchical Data Format v4 (HDF4)
- Image data are stored as scaled integers, with linear slope and intercept to convert to calibrated radiance or reflectance
- Geolocation data at 1000 meter resolution are stored in a separate file (MYD03), along with sensor viewing geometry and solar geometry
- Daytime 1KM granules contain all 36 bands at 1000 meter resolution
- Nighttime 1KM granules contain bands 20-36 only
- HKM and QKM granules are daytime only

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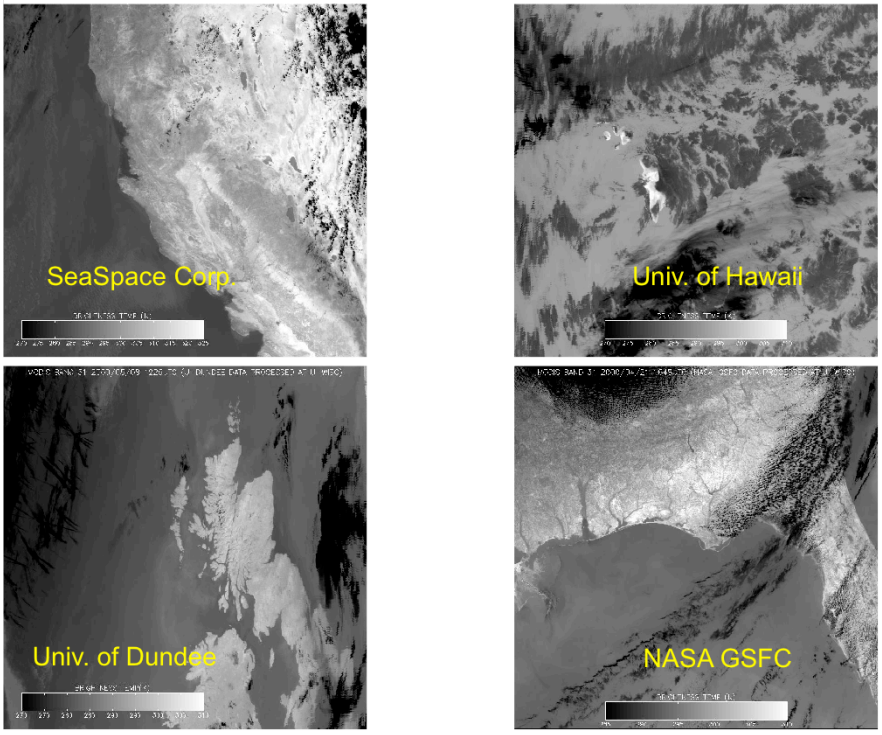
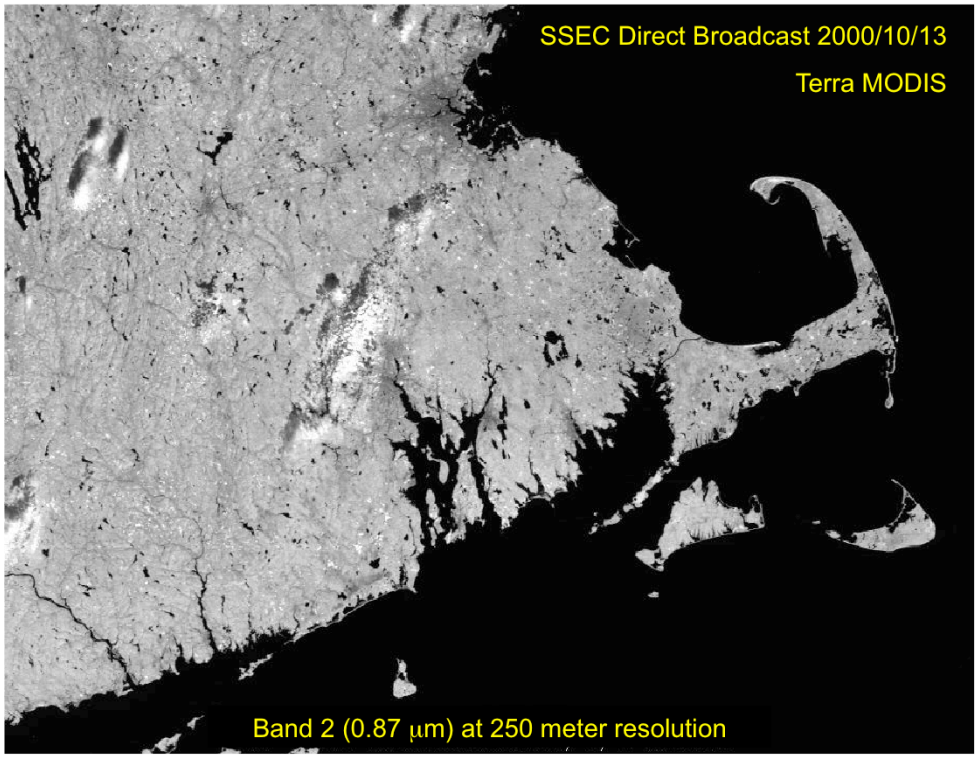
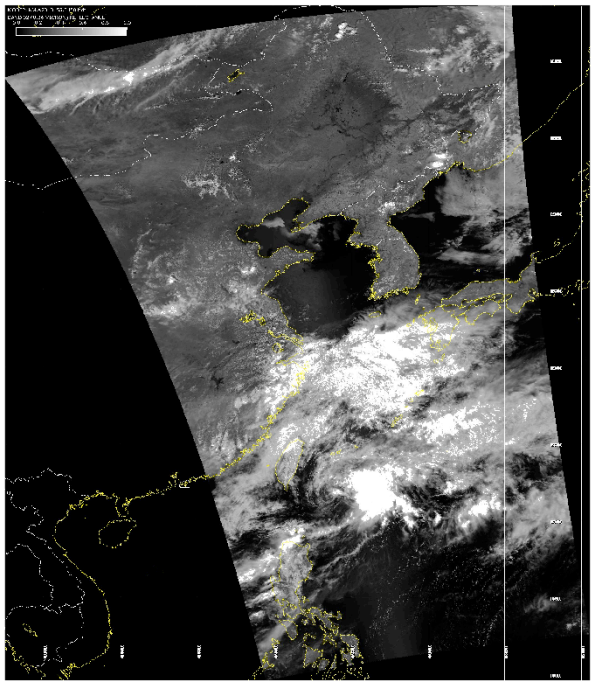
MODIS Band 31, Acquired by four different DB ground stations




SSEC Direct Broadcast 2000/10/13
Terra MODIS
Band 2 (0.87 μm) at 250 meter resolution

Band 2 (visible)

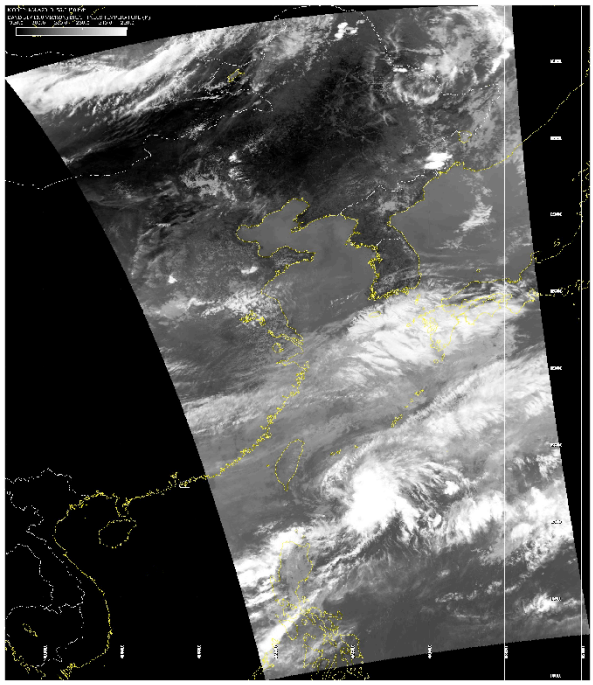
Aqua MODIS
2010/06/04
04:55 UTC



20

Band 31 (infrared)

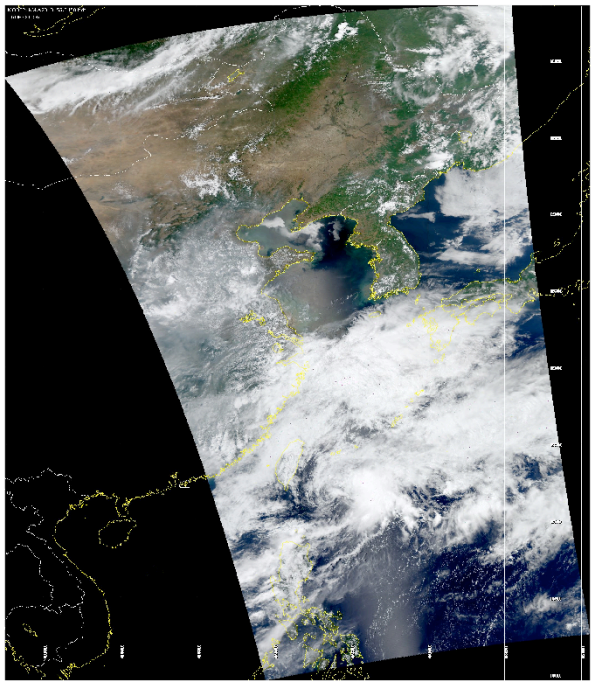
Aqua MODIS
2010/06/04
04:55 UTC



21

True Color

Aqua MODIS
2010/06/04
04:55 UTC



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MODIS DB Atmosphere Products

Software: **International MODIS/AIRS Processing Package (IMAPP)**

Developers: University of Wisconsin-Madison, MODIS Science Team, Remote Sensing Systems, Free University of Berlin

Distributor: University of Wisconsin-Madison

Platforms: Linux, Windows (VM)

Website: http://cimss.ssec.wisc.edu/imapp/

Free Download

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CIMSS » IMAPP
International MODIS/AIRS Processing Package
SSEC
Home
Download
Requirements
Release History
Projects
Related Links
Credits
FAQ
The Direct Broadcast capability of the NASA Terra and Aqua spacecraft provide new remote sensing capabilities for the observation of planet Earth. Both of these platforms have a direct broadcast X-band downlink that allows MODIS (Terra and Aqua) and AIRS/AMSU/HSB and AMSR-E (Aqua) data to be received in real time by sites having the proper reception hardware.
The International MODIS/AIRS Processing Package (IMAPP) allows ground stations capable of receiving EOS direct broadcast to create the following products:
MODIS Level 2 geophysical products (Terra and Aqua)
MODIS cloud mask (MOD35)
MODIS cloud top properties (MOD06CT)
MODIS atmospheric profiles, precipitable water and stability indices (MOD07)
MODIS aerosol product (MOD04)
MODIS Sea Surface Temperatures (IMAPP product)
MODIS Near Infrared Water Vapor product (IMAPP product)
AIRS/AMSU/HSB Level 1 calibrated and geolocated radiances (Aqua)
AIRS/AMSU/HSB Level 2
JPL DAAC Product
Single Field-of-View Product (IMAPP product)
AMSR-E Level 1 calibrated and geolocation radiances (Aqua)
AMSR-E Level 2 geophysical products (Aqua)
AMSR-E Rain Rate
AMSR-E Soil Moisture
AMSR-E Snow Water Equivalent
IMAPP is derived from the operational EOS processing software developed at NASA GSFC and JPL, and has been modified to be compatible with direct broadcast data. The main differences between IMAPP and the operational software are
portability,
wherever possible, the reliance on toolkits has been eliminated,
the IMAPP processing environment is greatly simplified,
overpasses of arbitrary size may be processed.
What's New
AIRS Level 1B HDFEOS to BUFR Utility
AIRS Utility Release: MODIS/AIRS collocation, AIRS Cloud Mask, UWAIRS Single FOV retrieval package
DB Google Earth True Color Imagery Software
DBCRAS Numerical Weather Prediction Forecast Model
Last updated 20-Jan-2009 by IMAPP Webmaster

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IMAPP Product List

MODIS Products:
Cloud Mask (MOD35)
Cloud Top Properties (MOD06CT)
Atmospheric Profiles (MOD09)
Aerosol Optical Depth (MOD04)
Sea Surface Temperature
Near Infrared Water Vapor
Level 1B Destriping
True Color Images for Google Earth
Nadir BRDF Adjusted Reflectance

Other Products:
AIRS/AMSU Level 1B Calibrated And Geolocated Radiances
AIRS/AMSU JPL Atmospheric Profiles
AIRS UW Single FOV Atmospheric Profiles (Clear Sky Only)
AIRS/MODIS Single FOV Atmospheric Profiles (Clear and Cloudy)
AMSR-E Level 2 Geophysical Products
AMSR-E Snow Water Equivalent
DBCRAS Numerical Weather Prediction Model

What does IMAPP do?

Purpose: **Creates MODIS atmosphere, utility, and image products (and AIRS, AMSU, AMSR-E)**

Input Data: **MODIS Level 1B 1KM, HKM, QKM, and Geolocation (HDF4 format)**

Output Data: **MODIS Level 2 Cloud Mask, Cloud Top Properties, Atmospheric Temperature and Water Vapor Profiles, Total Ozone, Total Precipitable Water Vapor (HDF4 format)**

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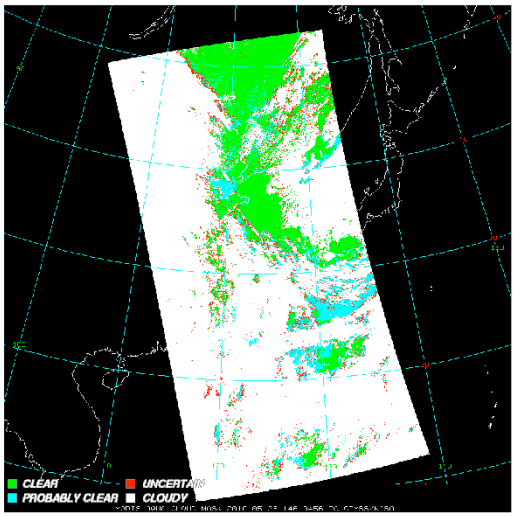
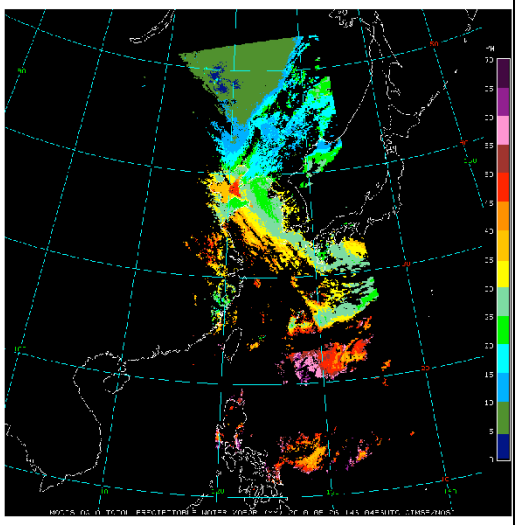
MODIS Atmosphere Products

2010/05/26 04:56

Cloud Mask



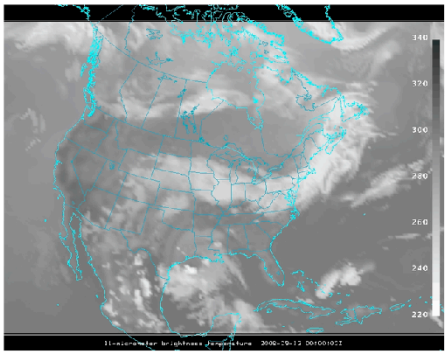
Water Vapor



DBCRAS NWP Model

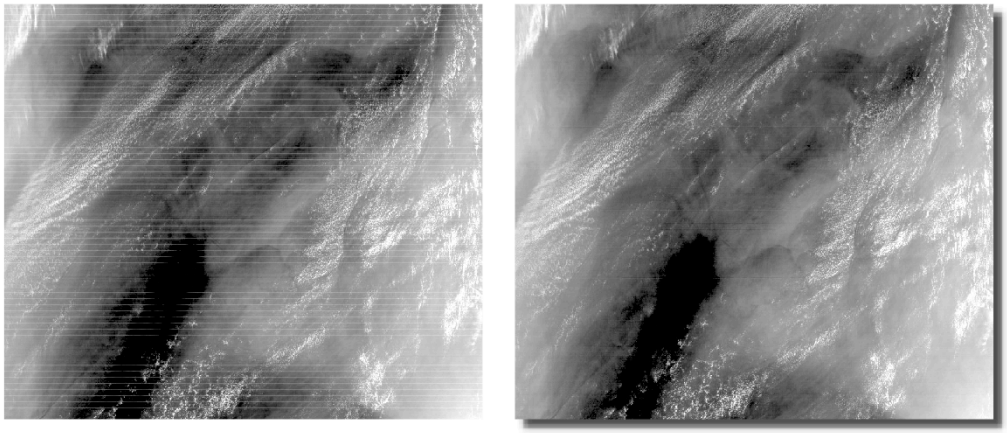
- Easy to install and easy to execute on modest PCs
- NWP domain centered on your DB location
- Assimilates IMAPP MOD07 TPW and MOD06CT Cloud Top Pressure and Cloud Effective Emissivity in order to adjust the cloud and moisture fields in the GFS.
- Output is standard meteorological parameters in GRIB2
- Creates forecast satellite imagery

72 hour forecast of 11 micron brightness temperature (3 hour time step)



Level 1B 1KM Destriping

- Removes stripes from 1KM thermal infrared bands
- Each detector is adjusted to match a reference detector
- Destriping is recommended before creating IMAPP Atmosphere Products (e.g., Cloud Mask)



Terra MODIS L1B 1KM, 2003094 06:05, Band 29

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True Color Images for Google Earth

Images can be ready within 30 minutes of acquisition

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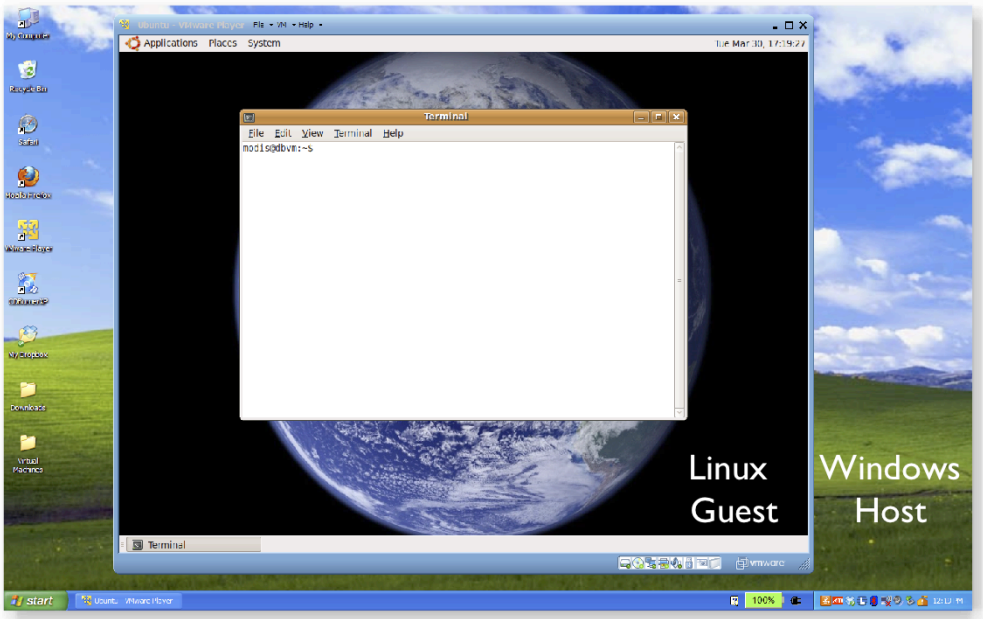
IMAPP Virtual Appliance

The IMAPP VA makes it simple to install and run a DB processing system to create a range of atmosphere, land, and ocean products from the MODIS sensor onboard Terra and Aqua, and the AIRS, AMSU, and AMSR-E sensors onboard Aqua.

- Supports Windows (XP, Vista, 7), Apple OS X, Linux
- Install and run within 10 minutes
- Easy to configure (e.g., turn on MODIS Land, turn off AIRS)
- Easy to maintain (automated lookup table updates)
- Designed for simplicity (no DBMS, no Java, no COTS; just Bash scripts)
- Allow reliable automated processing
- Use only open source software packages (e.g., IMAPP, SeaDAS, etc.)
- Software package downloads are automated as part of the install process
- Easy to add user-created processing software


Linux
Guest
Windows
Host

IMAPP VA Installation (Windows)

1. Download and run IMAPP VA self-extracting archive
2. Download and install VMware Player (free)
3. Start VMware Player and select IMAPP VA

MODIS Level 1 and Atmosphere processing packages are pre-installed.

Other packages can be added by editing a configuration file, and running an installer script.

Version 1.1 is now available on the IMAPP website

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MODIS DB Land Products

Software: **Science Processing Algorithms (SPA)**

Developers: MODIS Science Team
Distributor: NASA Direct Readout Laboratory
Platforms: Linux, Windows (VM)

Website: http://directreadout.sci.gsfc.nasa.gov/

Free Download

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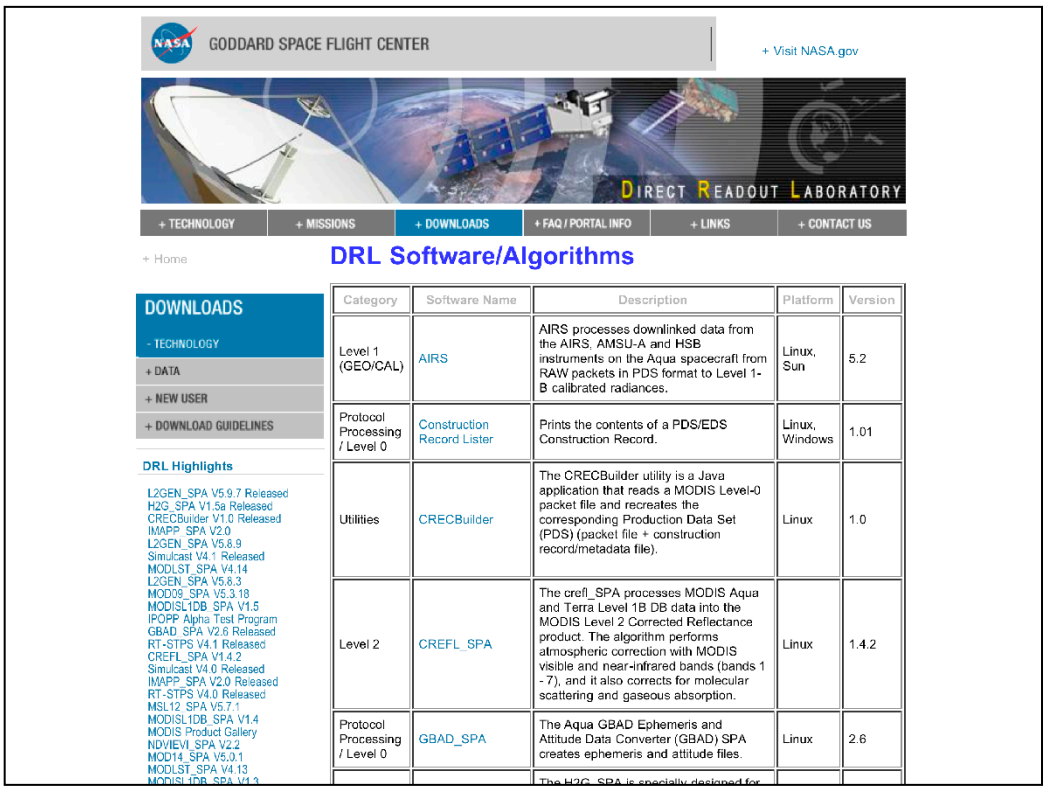
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+ Home
DRL Software/Algorithms
DOWNLOADS
- TECHNOLOGY
+ DATA
+ NEW USER
+ DOWNLOAD GUIDELINES
DRL Highlights
L2GEN_SPA V5.9.7 Released
H2G_SPA V1.5a Released
CRECBuilder V1.0 Released
IMAPP_SPA V2.0
L2GEN_SPA V5.8.8
Simulcast V4.1 Released
MODLST_SPA V4.14
L2GEN_SPA V5.8.3
MOD09_SPA V5.3.18
MODISL1DB_SPA V1.5
IPOPP Alpha Test Program
GBAD_SPA V2.6 Released
RT-STPS V4.1 Released
CREFL_SPA V1.4.2
Simulcast V4.0 Released
IMAPP_SPA V2.0 Released
RT-STPS V4.0 Released
MSL12_SPA V5.7.1
MODISL1DB_SPA V1.4
MODIS Product Gallery
NDVIEVI_SPA V2.2
MOD14_SPA V5.0.1
MODLST_SPA V4.13
Category
Software Name
Description
Platform
Version
Level 1 (GEO/CAL)
AIRS
AIRS processes downlinked data from the AIRS, AMSU-A and HSB instruments on the Aqua spacecraft from RAW packets in PDS format to Level 1-B calibrated radiances.
Linux, Sun
5.2
Protocol Processing / Level 0
Construction Record Lister
Prints the contents of a PDS/EDS Construction Record.
Linux, Windows
1.01
Utilities
CRECBuilder
The CRECBuilder utility is a Java application that reads a MODIS Level-0 packet file and recreates the corresponding Production Data Set (PDS) (packet file + construction record/metadata file).
Linux
1.0
Level 2
CREFL_SPA
The crefl_SPA processes MODIS Aqua and Terra Level 1B DB data into the MODIS Level 2 Corrected Reflectance product. The algorithm performs atmospheric correction with MODIS visible and near-infrared bands (bands 1 - 7), and it also corrects for molecular scattering and gaseous absorption.
Linux
1.4.2
Protocol Processing / Level 0
GBAD_SPA
The Aqua GBAD Ephemeris and Attitude Data Converter (GBAD) SPA creates ephemeris and attitude files.
Linux
2.6

What does SPA do?

Purpose: **Creates DB customized Land products**

Input Data: **MODIS Level 1B 1KM, HKM, QKM, and Geolocation (HDF4 format)**

Output Data: **MODIS Level 2 Active Fires, Corrected Reflectance, NDVI, EVI, Land Surface Temperature, Land Surface Reflectance (HDF4 format)**

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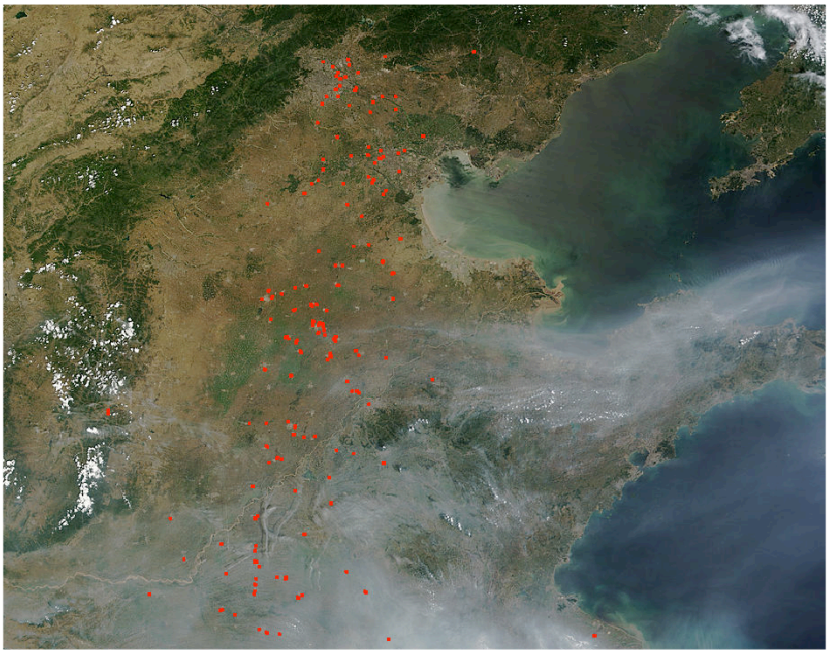
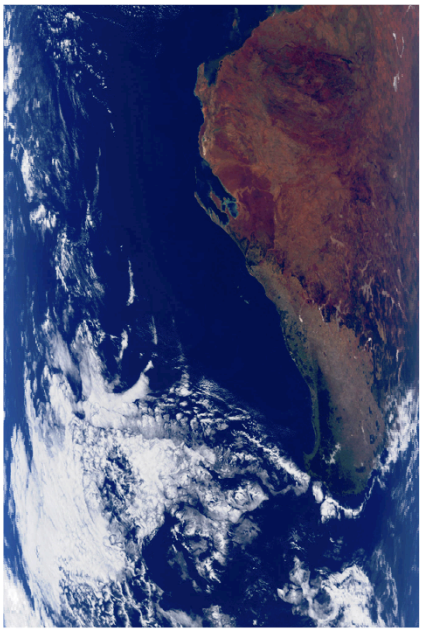
Active Fires



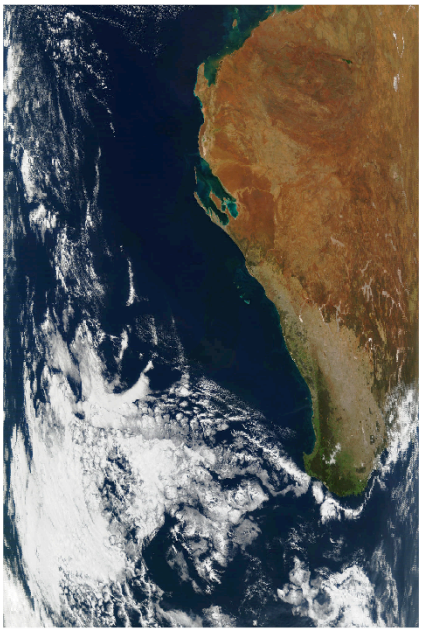
2010/07/06 Terra MODIS

MODIS Corrected Reflectance

Before



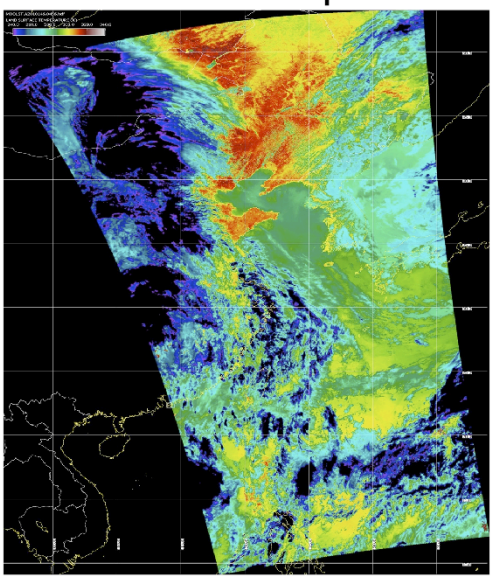
After



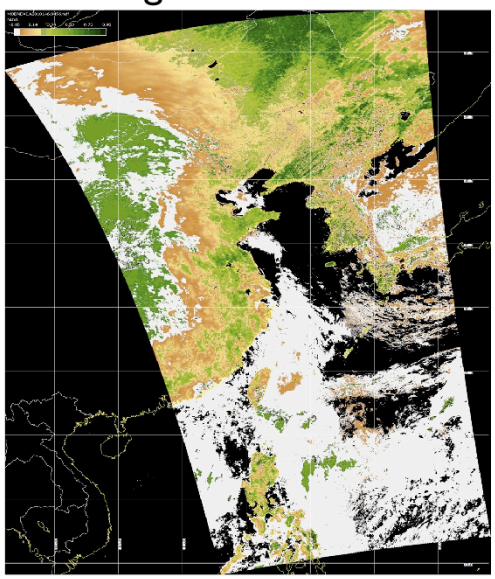
MODIS Land Products

Aqua MODIS 2010/05/26 04:56

Land Surface Temperature



Vegetation Index

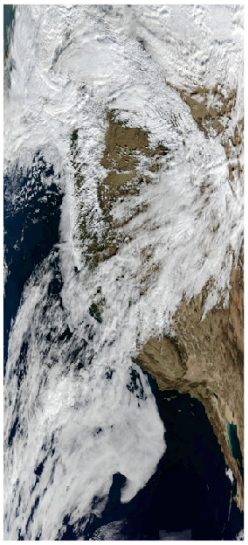


Land Surface Reflectance

MODIS Land Surface Reflectance Algorithm (MOD09) code was adapted for DB by Eric Vermote and Jim Ray. Standard HDF4 format with metadata is created.

Changes for DB included:

- Code pre-compiled for 32-bit Intel Linux; source code is also available
- Handles arbitrary granule sizes
- Able to use NCEP GFS forecast data instead of NCEP GDAS analysis data
- Automatically discovers and downloads required ancillary data at runtime
- Handles bad geolocation data
- Night granules are handled gracefully in wrapper script

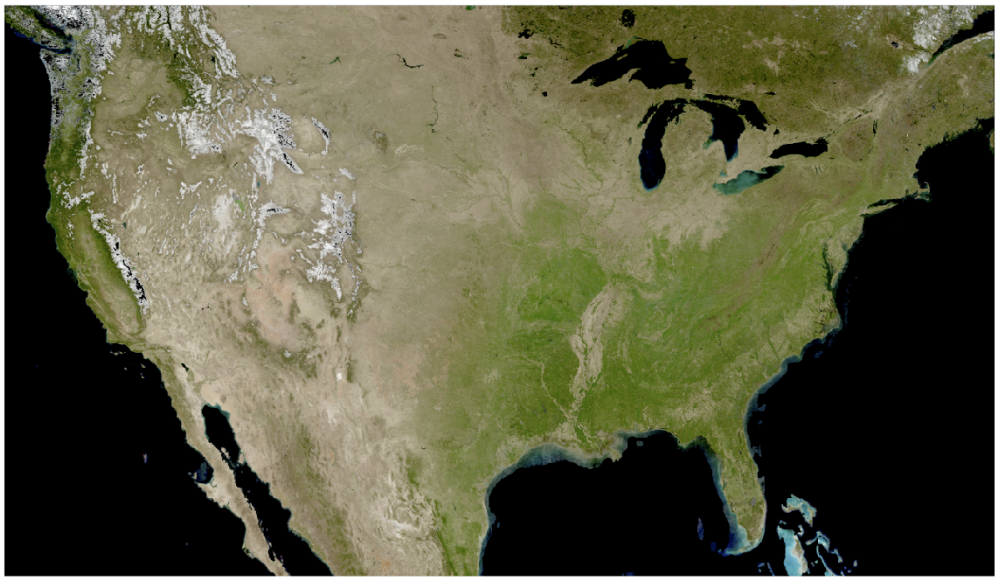


MOD09 True Color
Aqua DB

MODIS NBAR

- MOD43B4 Nadir BRDF-Adjusted Reflectance (NBAR) Product is computed for MODIS spectral bands (1-7) at the mean solar zenith angle of each 16 day period.
- View angle effects are removed from the directional reflectances.
- Applications include vegetation indices, land cover change, and burned area mapping.

16-day Composite from DB NBAR Algorithm (True Color)
visualized by HDFLook



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Outline

1. What is MODIS **Direct Broadcast** (DB)?
2. MODIS DB **Image** Products
3. MODIS DB **Atmosphere** Products
4. MODIS DB **Land** products
5. MODIS DB **Ocean** products
6. Software for **interpreting** MODIS DB products
7. **Downloading** MODIS data from the Web

MODIS DB Ocean Products

Software: **SeaDAS**

Developers: NASA Ocean Biology Processing Group, MODIS Science Team

Distributor: NASA Ocean Biology Processing Group

Platforms: Linux, OS X, Windows (VM)

Website: http://oceancolor.gsfc.nasa.gov/seadas/

Free Download

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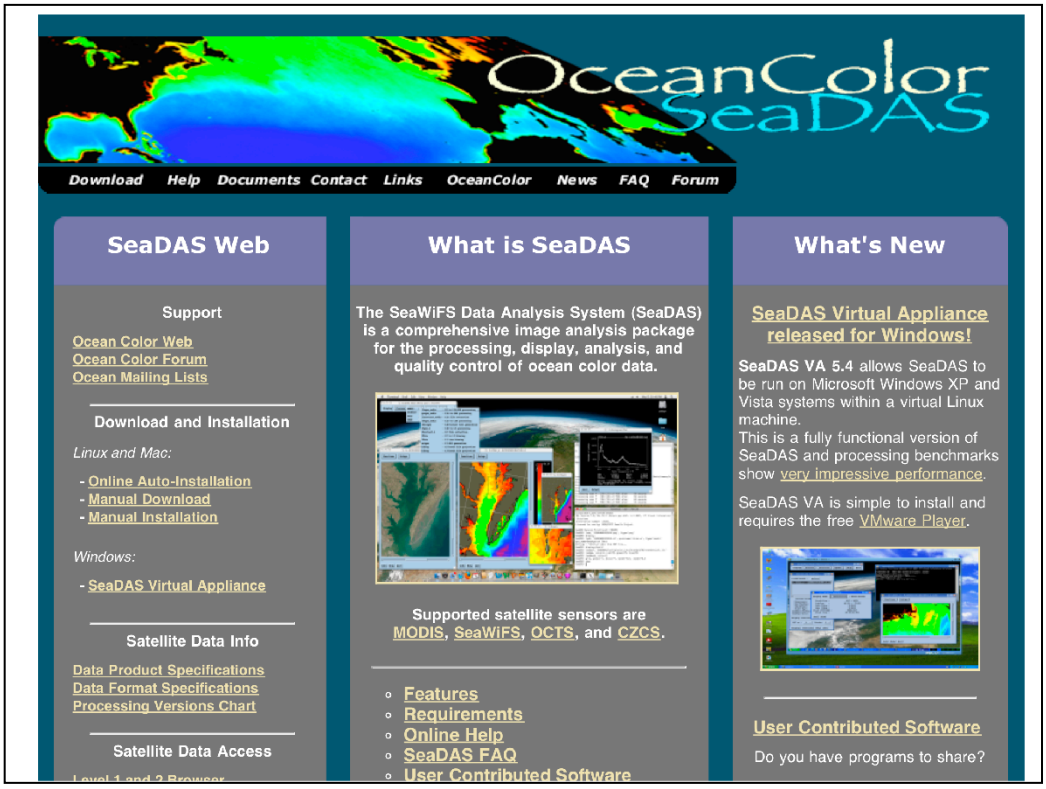
OceanColor
SeaDAS
Download Help Documents Contact Links OceanColor News FAQ Forum
SeaDAS Web
Support
Ocean Color Web
Ocean Color Forum
Ocean Mailing Lists
Download and Installation
Linux and Mac:
- Online Auto-Installation
- Manual Download
- Manual Installation
Windows:
- SeaDAS Virtual Appliance
Satellite Data Info
Data Product Specifications
Data Format Specifications
Processing Versions Chart
Satellite Data Access
What is SeaDAS
The SeaWiFS Data Analysis System (SeaDAS) is a comprehensive image analysis package for the processing, display, analysis, and quality control of ocean color data.
Supported satellite sensors are MODIS, SeaWiFS, OCTS, and CZCS.
Features
Requirements
Online Help
SeaDAS FAQ
User Contributed Software
What's New
SeaDAS Virtual Appliance released for Windows!
SeaDAS VA 5.4 allows SeaDAS to be run on Microsoft Windows XP and Vista systems within a virtual Linux machine.
This is a fully functional version of SeaDAS and processing benchmarks show very impressive performance.
SeaDAS VA is simple to install and requires the free VMware Player.
User Contributed Software
Do you have programs to share?

What does SeaDAS do?

Purpose: **Creates standard ocean color and ocean temperature products. Allows interactive display and analysis of ocean products.**

Input Data: **MODIS Level 1B 1KM, HKM, QKM, and Geolocation (HDF4 format)**

Output Data: **MODIS Level 2 Water Leaving Radiance, Chlorophyll concentration, Sea Surface Temperature (HDF4 format)**

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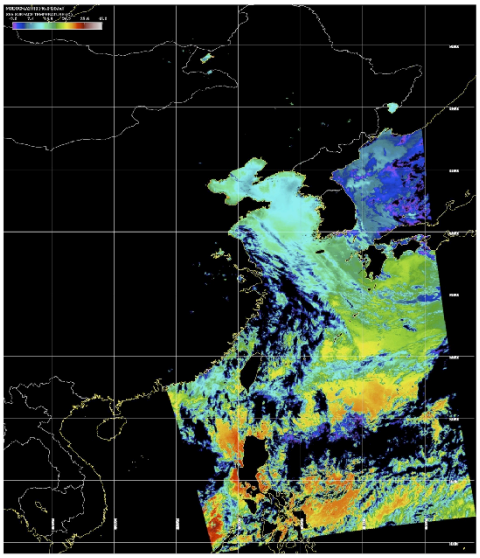
SeaDAS Standard Products

Geophysical Parameter Name	Description
nLw_412	Normalized water-leaving radiance at 412 nm
nLw 443	Normalized water-leaving radiance at 443 nm
nLw_488	Normalized water-leaving radiance at 488 nm
nLw_531	Normalized water-leaving radiance at 531 nm
nLw_551	Normalized water-leaving radiance at 551 nm
nLw_667	Normalized water-leaving radiance at 667 nm
Tau_869	Aerosol optical thickness at 869 nm
Eps_78	Epsilon of aerosol correction at 748 and 869 nm
Chlor_a	OC3 Chlorophyll a concentration
K490	Diffuse attenuation coefficient at 490nm
Angstrom_531	Angstrom coefficient, 531-869 nm
SST	Sea Surface Temperature: 11 micron
SST4	Sea Surface Temperature: 4 micron (night only)

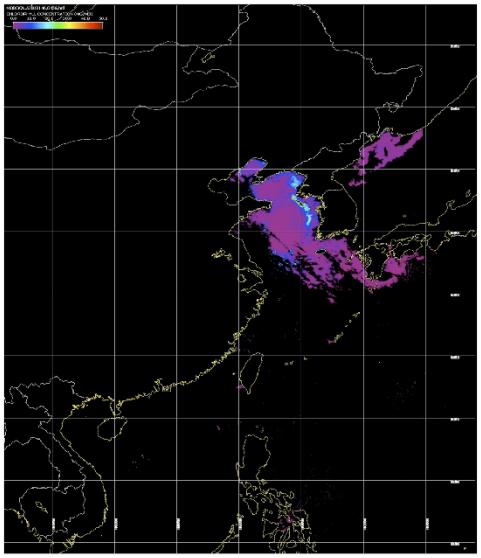
SeaDAS MODIS Products

Aqua MODIS 2010/05/26 04:56

Sea Surface Temperature



Chlorophyll-A



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Software for Interpreting DB Products

- MODIS products are stored in a specialized format named Hierarchical Data Format (HDF) version 4.
- Some of the MODIS products (e.g., Level 1B) have complex internal structures
- Specialized software is required to read and interpret the HDF4 format correctly
- Software is designed for (a) Interactive Display, (b) Quantitative Analysis, or (c) Both
- Software is either (a) Free; or (b) Expensive

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Software from Univ. of Wisconsin

- **Hydra** is a free application for MODIS, AIRS, and SEVIRI data exploration in classroom settings
- **Mc-LITE** is a free application for automated generation of MODIS image products (available as an add-on to IMAPP)
- **McIDAS-V** is a free application for interactively exploring MODIS and many other satellite and meteorological data products

http://www.ssec.wisc.edu/

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Free Software

- **MRTSwath** is a Linux application for reprojecting MODIS Level 1B and Level 2 products to a map grid (removes bowtie artifacts)
- **HDFLook** is a Linux application for interactive and automated display and reprojection of MODIS Level 1B and Level 2 products
- **MS2GT** is a Linux application for reprojecting MODIS Level 1B data and any other satellite imager data (AVHRR, MERSI, VIIRS)

Just Google the names…

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Commercial Software

- **ENVI** is a Windows/Linux/OSX application interactive display and analysis of many satellite products, including MODIS Level 1B and Level 2
- **IDL and Matlab** are Windows/Linux/OSX interactive programming environments for quantitative analysis, and they can read MODIS Level 1B and Level 2 products in HDF4 format

Just Google the names…

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HDF4 Application Programming Interface (API)

- The HDF4 API is available for C, C++, FORTRAN-90, Java, and Python
- Documentation, binaries, and source code are available

http://www.hdfgroup.org/

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Terra and Aqua DB Products from ECNU

ECNU provides real-time MODIS, AIRS, AMSU, and AMSR-E products (Level 0 through Level 2) at

http://dbps.ecnu.edu.cn/data/terra/

http://dbps.ecnu.edu.cn/data/aqua/

All data collected at ECNU is available on this site!

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MODIS Products from NASA

NASA provides MODIS Level 0, Level 1B, Land, Ocean and Atmosphere Products at no cost

Global near real-time products (about 90-120 minutes delay) are available from LANCE

Best for obtaining products in real-time; regional subscriptions are available.

Global long-term archive products (about 24 hours delay) are available from LAADS

Best for obtaining long-term historical data.

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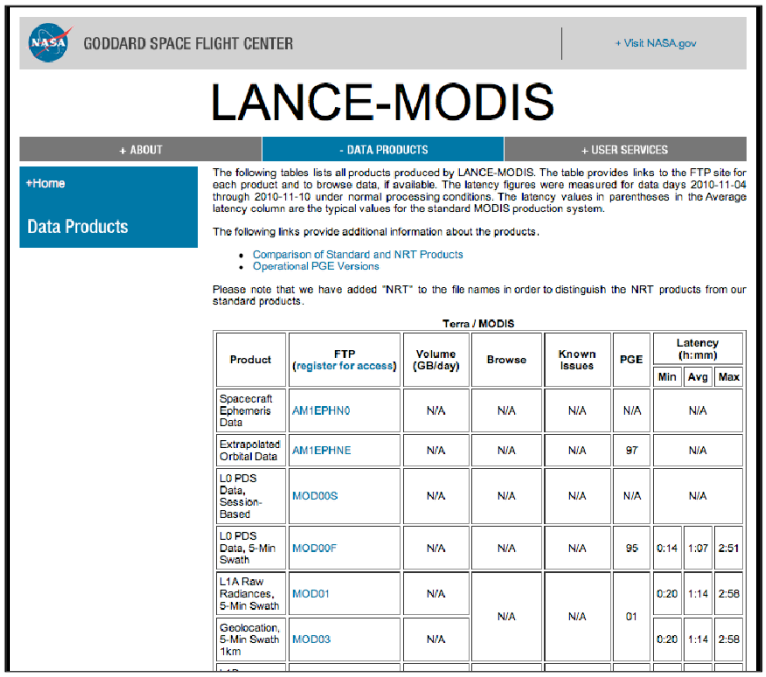

GODDARD SPACE FLIGHT CENTER

+ Visit NASA.gov

LANCE-MODIS

+ ABOUT | - DATA PRODUCTS | + USER SERVICES

+Home

Data Products

The following tables lists all products produced by LANCE-MODIS. The table provides links to the FTP site for each product and to browse data, if available. The latency figures were measured for data days 2010-11-04 through 2010-11-10 under normal processing conditions. The latency values in parentheses in the Average latency column are the typical values for the standard MODIS production system.

The following links provide additional information about the products.

- Comparison of Standard and NRT Products
- Operational PGE Versions

Please note that we have added "NRT" to the file names in order to distinguish the NRT products from our standard products.

Terra / MODIS

Product	FTP (register for access)	Volume (GB/day)	Browse	Known Issues	PGE	Latency (h:mm)		
						Min	Avg	Max
Spacecraft Ephemeris Data	AM1EPHN0	N/A	N/A	N/A	N/A	N/A		
Extrapolated Orbital Data	AM1EPHNE	N/A	N/A	N/A	97	N/A		
L0 PDS Data, Session-Based	MOD00S	N/A	N/A	N/A	N/A	N/A		
L0 PDS Data, 5-Min Swath	MOD00F	N/A	N/A	N/A	95	0:14	1:07	2:51
L1A Raw Radiances, 5-Min Swath	MOD01	N/A	N/A	N/A	01	0:20	1:14	2:58
Geolocation, 5-Min Swath 1km	MOD03	N/A				0:20	1:14	2:58

http://lance-modis.eosdis.nasa.gov/data_products/

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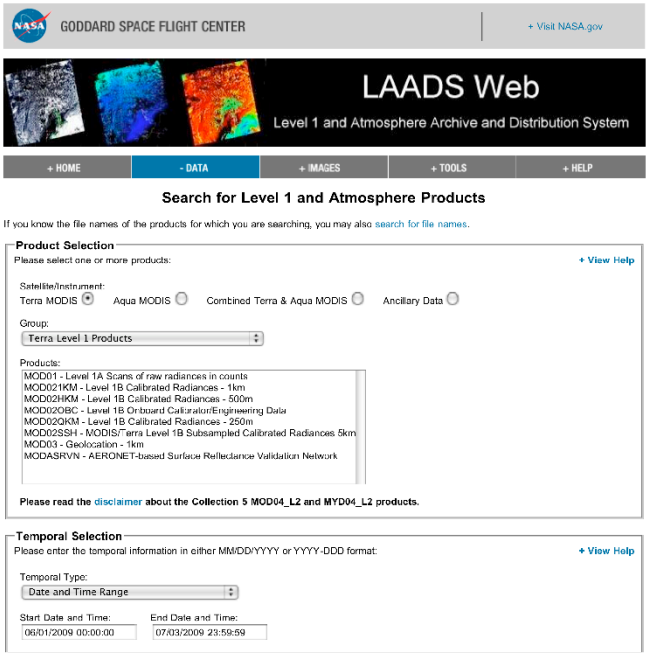

http://ladsweb.nascom.nasa.gov/data/search.html

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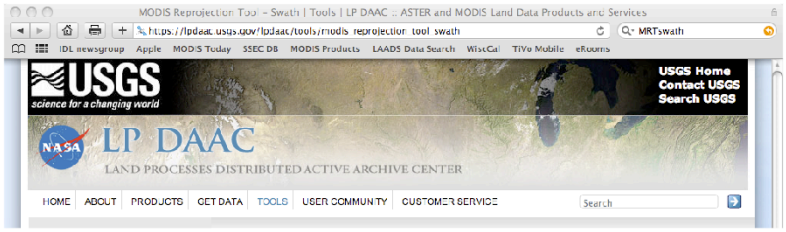
MODIS Ocean Level 2 Products are available from

http://oceancolor.gsfc.nasa.gov/

MODIS Land Level 2/3 Products are available from

http://lpdaac.usgs.gov/



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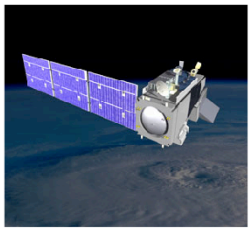
What Does the Future Hold?

Based on spacecraft fuel reserves, Terra and Aqua are expected to last until at least 2015.



NPOESS Preparatory Project (NPP) is a NASA mission scheduled to launch in October 2011 (afternoon orbit).

Joint Polar Satellite System (JPSS) is the successor to the canceled NPOESS program, and JPSS-1 (a clone of NPP) is planned to launch in 2014.

Space Science and Engineering Center
University of Wisconsin-Madison

NPP Sensors

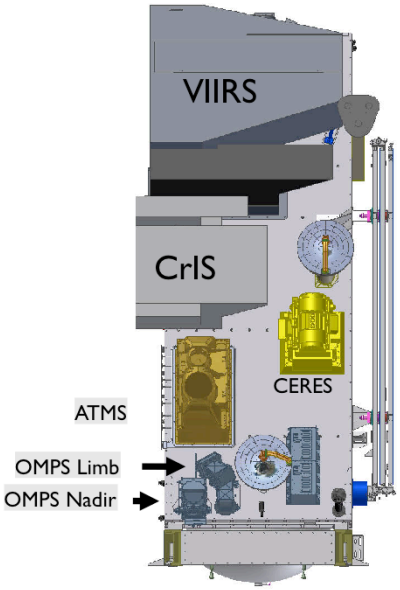
VIIRS – Medium Resolution Visible & Infra-red Imager

CrIS – Fourier Transform Spectrometer for IR Temperature and Moisture sounding

ATMS – Microwave sounding radiometer

OMPS – Total Ozone Mapping and Ozone Profile measurements

CERES - Earth Radiation Budget



Space Science and Engineering Center
University of Wisconsin-Madison

NPP at Ball Aerospace
July 2010

SSEC

VIIRS Spectral Bands

		Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs	Radi-ance Range	Ltyp or Ttyp	Signal to Noise Ratio (dimensionless) or NE$^{\Delta}$T (Kelvins)		
				Nadir	End of Scan				Required	Predicted	Margin
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	44.9	352	441	25%
						Aerosols	High	155	316	807	155%
		M2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	40	380	524	38%
						Aerosols	High	146	409	926	126%
		M3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	32	416	542	30%
						Aerosols	High	123	414	730	76%
		M4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	21	362	455	26%
						Aerosols	High	90	315	638	102%
		I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery	Single	22	119	146	23%
		M5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	10	242	298	23%
						Aerosols	High	68	360	522	45%
		M6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n	Single	9.6	199	239	20%
		I2	0.865	0.371 x 0.387	0.80 x 0.789	NDVI	Single	25	150	225	50%
		M7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	6.4	215	388	81%
						Aerosols	High	33.4	340	494	45%
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery	Var.	6.70E-05	6	5.7	-5%
SI/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size	Single	5.4	74	98	32%
		M9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover	Single	6	83	155	88%
		I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map	Single	7.3	6.0	97	1523%
		M10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction	Single	7.3	342	439	28%
		M11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds	Single	0.12	10	17	66%
		I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds	Single	270 K	2.500	0.486	415%
		M12	3.70	0.742 x 0.776	1.60 x 1.58	SST	Single	270 K	0.396	0.218	82%
		M13	4.05	0.742 x 0.259	1.60 x 1.58	SST	Low	300 K	0.107	0.063	69%
						Fires	High	380 K	0.423	0.334	27%
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties	Single	270 K	0.091	0.075	22%
		M15	10.763	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.070	0.038	85%
		I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery	Single	210 K	1.500	0.789	90%
		M16	12.013	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.072	0.051	42%

MODIS vs. VIIRS

Similarities

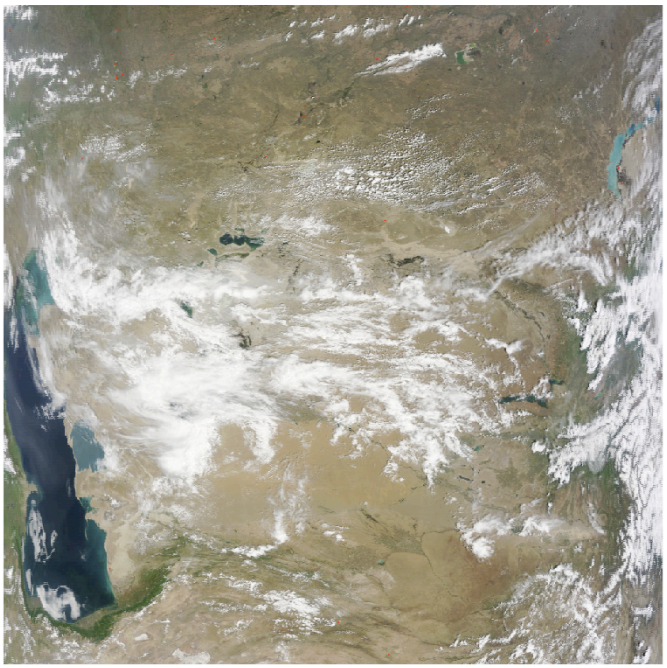
- VIIRS supports all land surface imaging applications of MODIS (NDVI, LST, Burned Area, Snow/Ice, True Color, etc.).
- NPP and JPSS-1 will transmit all data to the ground in real-time via X-band direct broadcast (but not L-band).
- Software for real-time processing will be available (SSEC is funded from JPSS Project).

MODIS vs. VIIRS

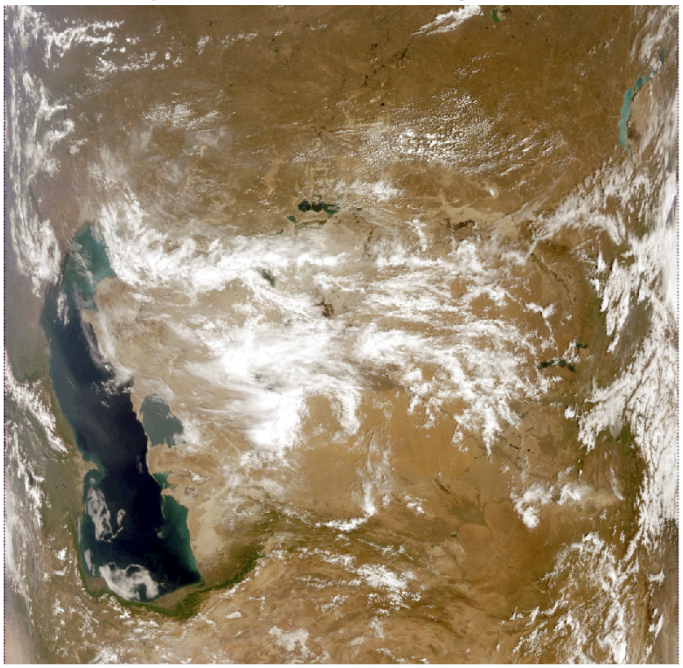
Differences

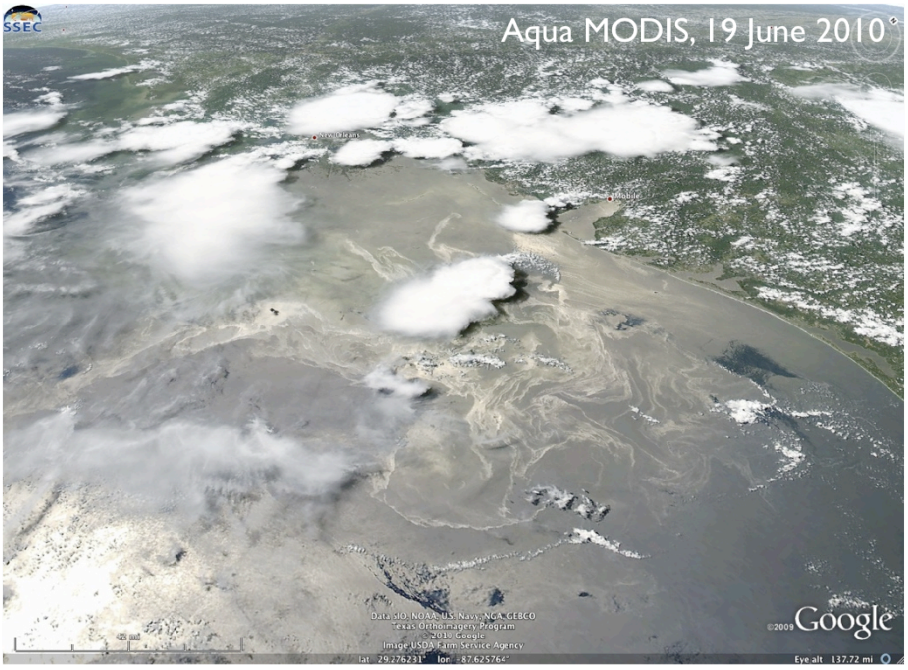
- VIIRS native resolution is 375 and 750 meters (vs. 250 and 1000 meters for MODIS).
- VIIRS has 22 bands while MODIS has 36 bands.
- VIIRS has constant pixel size across the scan.
- VIIRS data format is HDF5.
- Redundant "bow-tie" pixels on VIIRS are not transmitted to the ground.

Terra MODIS, 8 May 2010 06:50
Enhanced Image without Atmospheric Correction



FY-3 MERSI, 8 May 2010 06:50
Enhanced Image without Atmospheric Correction





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