



Production and Distribution of NASA MODIS Remote Sensing Products

ISPMSRS'07

Mar. 14, 2007

Robert Wolfe

NASA GSFC Code 614.5



MODIS Land Products

Energy Balance Product Suite

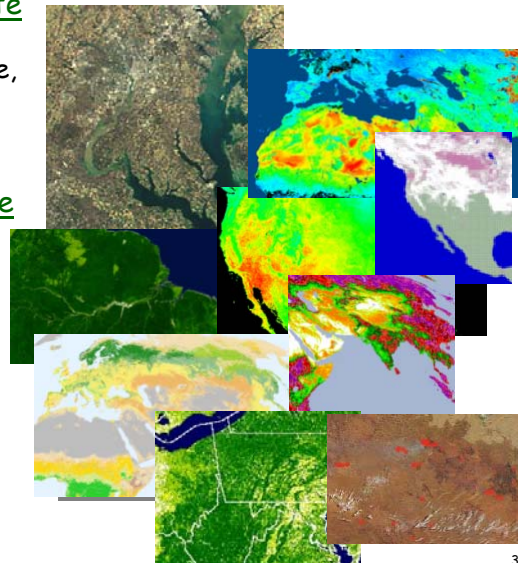
- Surface Reflectance
- Land Surface Temperature, Emmissivity
- BRDF/Albedo
- Snow/Sea-ice Cover

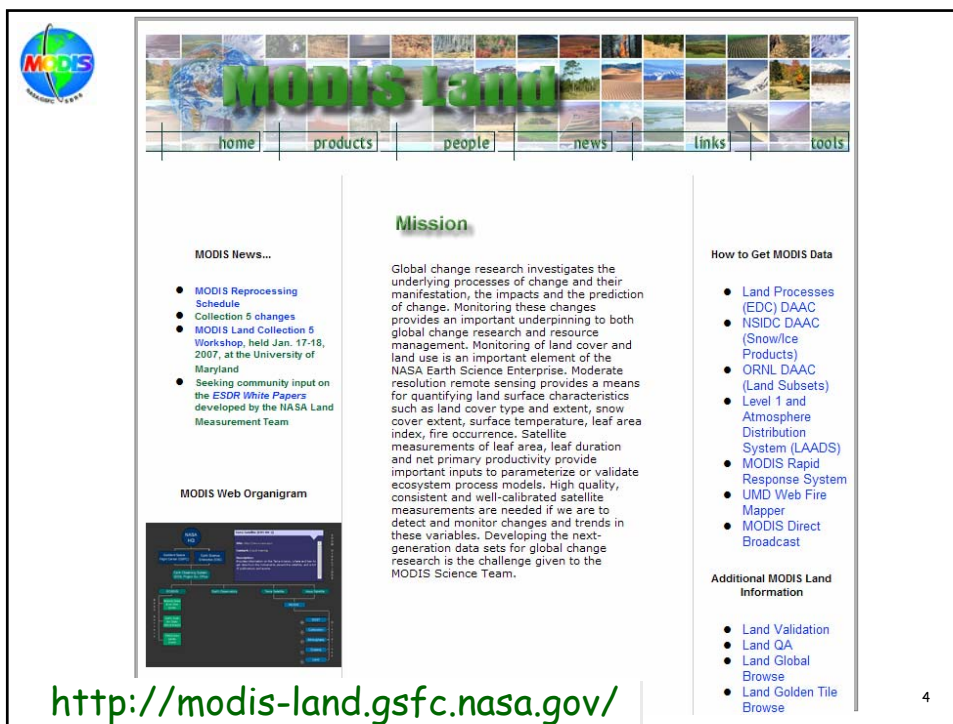
Vegetation Parameters Suite

- Vegetation Indices
- LAI/FPAR
- GPP/NPP

Land Cover/Land Use Suite

- Land Cover/Vegetation Dynamics
- Vegetation Continuous Fields
- Vegetation Cover Change
- Fire and Burned Area



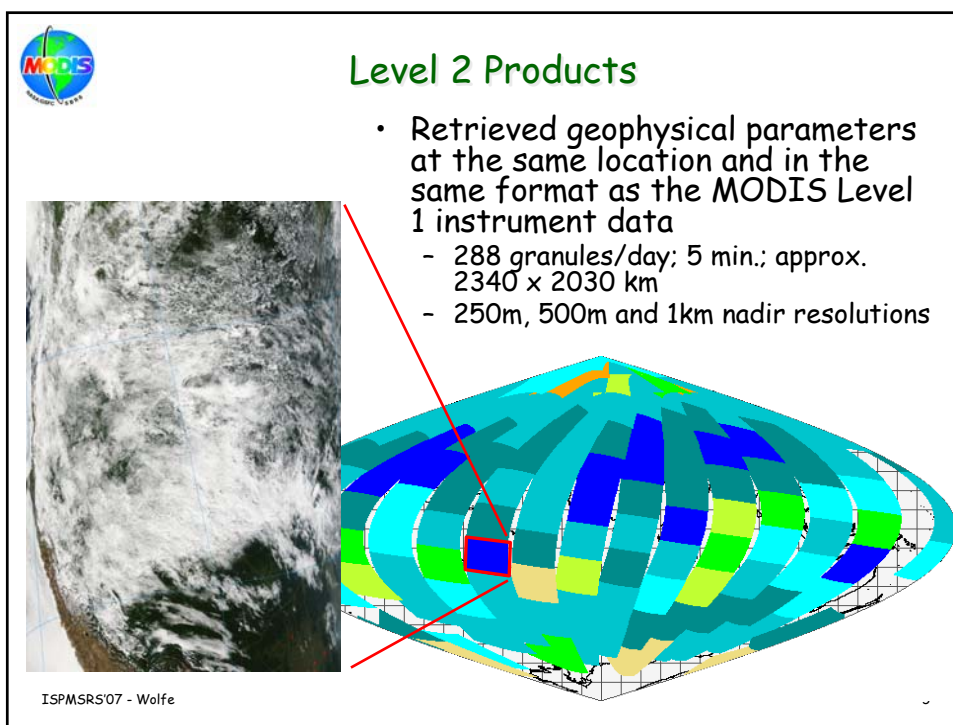


The image shows a screenshot of the MODIS Land website. At the top left is the MODIS logo. The main header features a grid of satellite images with the text "MODIS Land" overlaid. Below the header is a navigation menu with links for "home", "products", "people", "news", "links", and "tools". The main content area is divided into three columns:

- MODIS News...**
 - MODIS Reprocessing Schedule
 - Collection 5 changes
 - MODIS Land Collection 5 Workshop, held Jan. 17-18, 2007, at the University of Maryland
 - Seeking community input on the *ESDR White Papers* developed by the NASA Land Measurement Team
- Mission**

Global change research investigates the underlying processes of change and their manifestation, the impacts and the prediction of change. Monitoring these changes provides an important underpinning to both global change research and resource management. Monitoring of land cover and land use is an important element of the NASA Earth Science Enterprise. Moderate resolution remote sensing provides a means for quantifying land surface characteristics such as land cover type and extent, snow cover extent, surface temperature, leaf area index, fire occurrence. Satellite measurements of leaf area, leaf duration and net primary productivity provide important inputs to parameterize or validate ecosystem process models. High quality, consistent and well-calibrated satellite measurements are needed if we are to detect and monitor changes and trends in these variables. Developing the next-generation data sets for global change research is the challenge given to the MODIS Science Team.
- How to Get MODIS Data**
 - Land Processes (EDC) DAAC
 - NSIDC DAAC (Snow/Ice Products)
 - ORNL DAAC (Land Subsets)
 - Level 1 and Atmosphere Distribution System (LAADS)
 - MODIS Rapid Response System
 - UMD Web Fire Mapper
 - MODIS Direct Broadcast

Below the news section is a "MODIS Web Organigram" with a small screenshot of the website's interface. At the bottom left is the URL <http://modis-land.gsfc.nasa.gov/>. At the bottom right is the number "4".



The image shows a slide titled "Level 2 Products" from a presentation. It features the MODIS logo in the top left corner. The main content is a bulleted list:

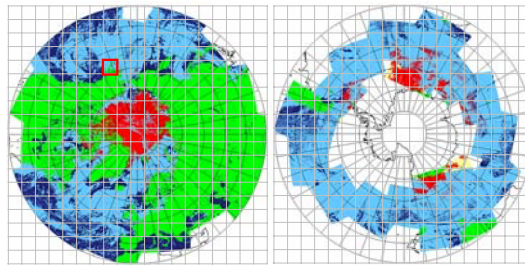
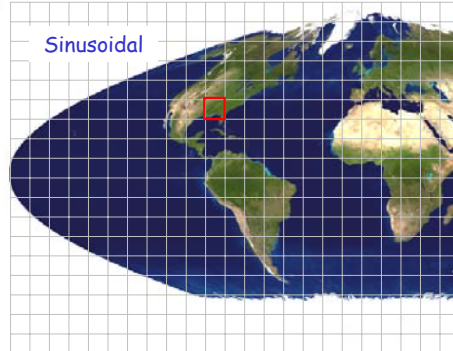
- Retrieved geophysical parameters at the same location and in the same format as the MODIS Level 1 instrument data
 - 288 granules/day; 5 min.; approx. 2340 x 2030 km
 - 250m, 500m and 1km nadir resolutions

On the left side of the slide is a vertical satellite image of Earth. On the right side is a 3D visualization of a satellite's orbital path, showing a grid of colored rectangular areas representing the satellite's footprint. A red line connects a small area on the satellite image to a corresponding area on the 3D model.

At the bottom left of the slide is the text "ISPMRS07 - Wolfe". At the bottom right is a small number "5".



Level 2G, 3 and 4 Products (fine resolution)



- Level 2G/3: earth-gridded geophysical parameters
- Level 4: earth-gridded model outputs
- Daily, 8-day, 16-day, 32-day, monthly and yearly products
- $10^\circ \times 10^\circ$ Tiles (□)
- Sinusoidal (equatorial); 7.5, 15 and 30 arcsec. resolution (roughly 250m, 500m and 1 km)
- LAEA (sea-ice products, polar projection)

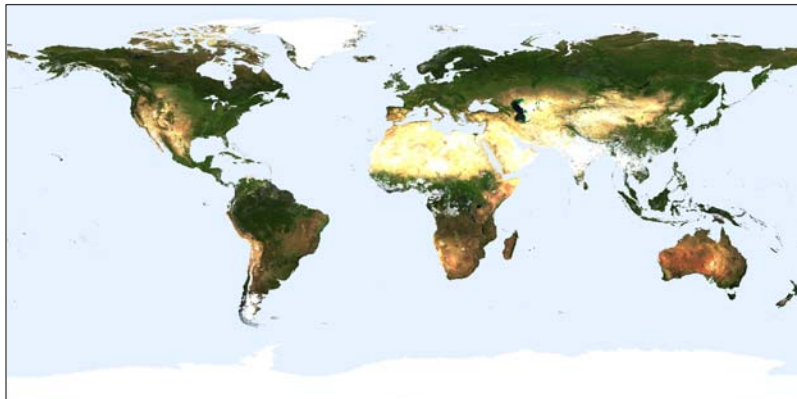
Lambert
Azimuthal
Equal Area
(LAEA)

6



Climate modeling grid products

- Resolution: 0.05° (now) and 0.25° (previous) degrees
- Almost all products are lat/long
 - sea-ice is current exception - in polar grid (snow in C5)



(from BU - NBAR CMG - days 193-208, 2001)

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7



Product Format

- Hierarchical Data Format (HDF) - Self describing file format
- Science Data Sets (SDSs) - 2D, 3D or 4D arrays
 - Bit Fields - unsigned integers broken into groups of bits
 - Discrete values - e.g., Snow, Cloud, etc.
 - Scaled Integers - valid range, scale and offset included
- Attributes - text or other data that annotates the file (global) or arrays (SDSs)
- Metadata - ECS metadata for products (stored as attributes)
 - includes QA information, date/time products acquired/produced, etc.
- .met file also contains the ECS core metadata
 - some additional fields
 - some fields (QA, etc.) may be updated when product distributed
- HDF-EOS Metadata (SWATH or GRID) - geometric information that relates data to specific earth locations

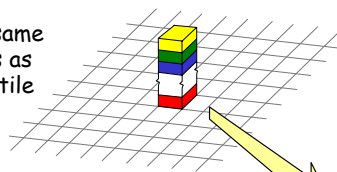
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8



L2G Format

L2G product with same spatial dimensions as corresponding L3 tile



Stack of observations per output grid cell

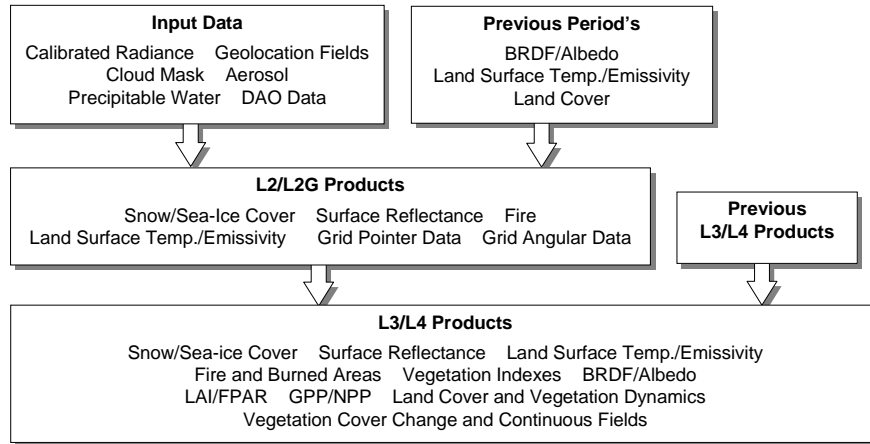
Observation i
Pointer information: <i>granule pointer,</i> <i>line, sample, etc.</i>
Geophysical parameters: <i>e.g., land surf. reflectance,</i> <i>thermal anomalies, etc.</i>
Viewing geometry: <i>view zenith,</i> <i>solar zenith, etc.</i>

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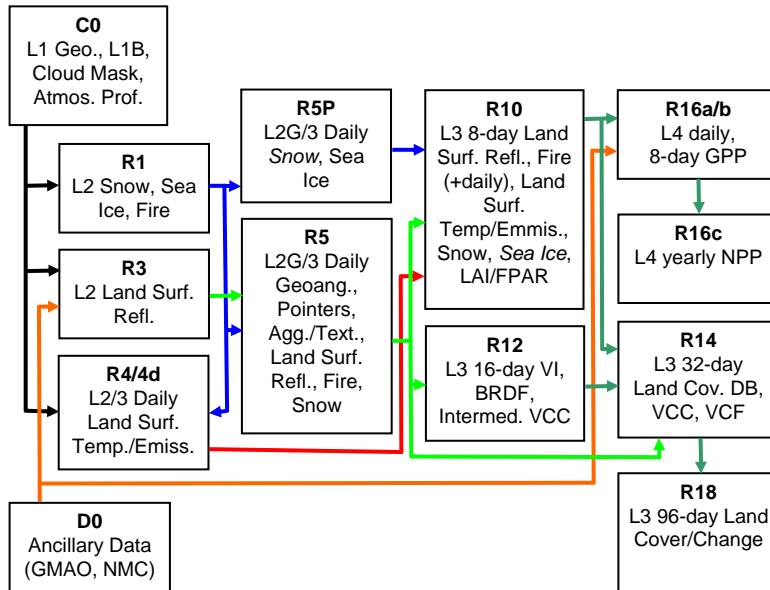
9



Land Algorithm Dependency

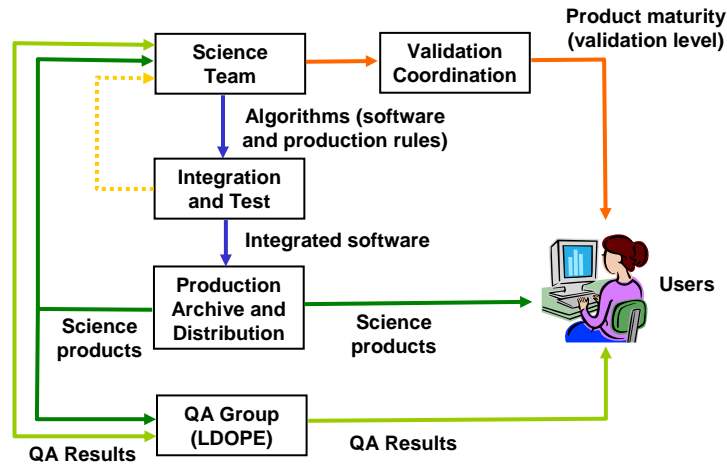


MODLAND Production Details





Science Product Process Flow



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12



MODLAND QA

http://landweb.nascom.nasa.gov/cgi-bin/QA_WWW/newPage.cgi

QA Summaries

Known Issues

Global Browse

Time Series

The screenshot shows the MODIS Land Quality Assessment website. The header includes the NASA logo and the text "GODDARD SPACE FLIGHT CENTER". The main title is "MODIS Land Quality Assessment". Below the title, there is a "Welcome to the MODIS Land Quality Assessment Site" section. The page contains several sections: "Product Quality" with links to "Product Quality", "Documentation", "Known Product Issues", and "Product Quality"; "Product Definitions" with links to "Product User Guides", "Algorithm Theoretical Basis Documents", "Product Interdependencies", and "Product File Specifications"; "Science Team Links" with links to "QA Tools", "Land Science Test", "Collection 2 Changes", "MODAP's Production and Data Ordinance", and "Platform and Calibration"; and "Help/FAQ" with links to "Global Browse", "Golden Tile Browse", "Time Series", and "Animation". There is also a "What is New!" section with bullet points: "Collection 5 data will be available", "Land data can now be ordered the", and "New inter-comparison time series". The bottom of the page features a "Products available for Aug 2003(8):" section with a grid of product thumbnails and a search bar.

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MODLAND Validation

<http://landval.gsfc.nasa.gov/>

- Val Summaries
- EOS Core Sites
- Major Campaigns
- Val Metadata w. ORNL
- MODIS Validation Data sub sets w. EDC

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Announcements:

- View and comment on the EOS White Papers developed by the NASA Land Measurement Team
- MODIS Science Team Meeting, Oct. 31-Nov. 2, 2006, at the University of Maryland.
- Announcing... MODIS Land collection 5 Workshop, Jan. 17-18, 2007, University of Maryland, see Draft Agenda.
- Validation of global vegetation indices and their time series, a one-day workshop, August 7, 2006, Missoula, MT
- Global Vegetation Workshop 2006, August 8-10, Missoula, MT
- TGARS Special Issue on Global Land Product Validation now available

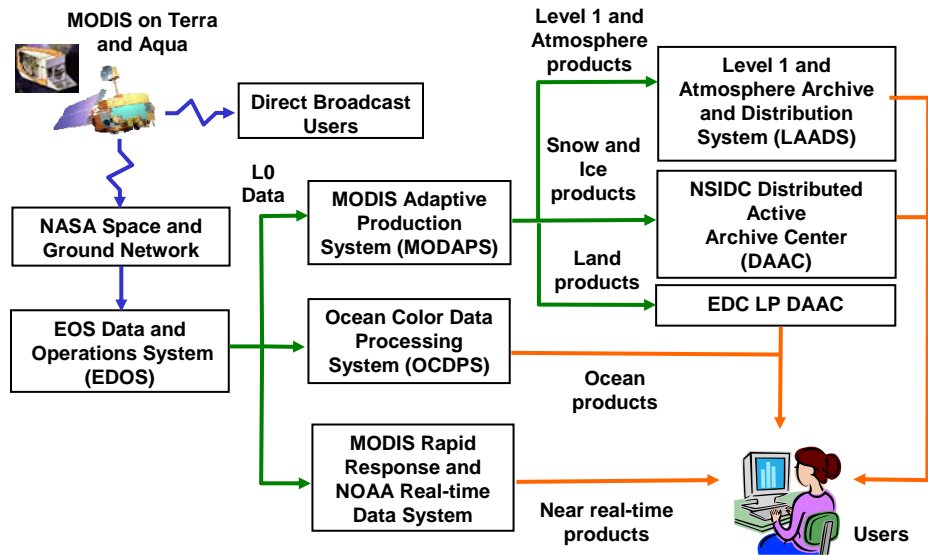
MODIS News

- Terra
- Aqua

14



MODIS Data Flow

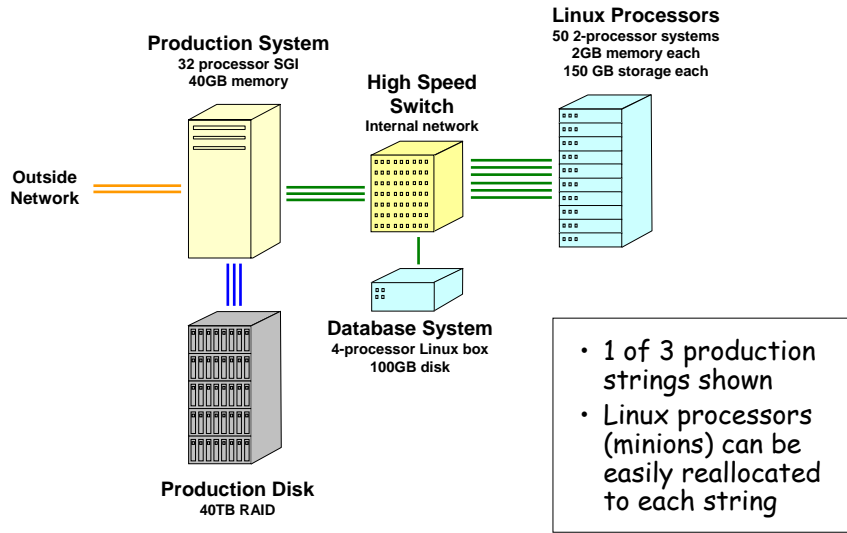


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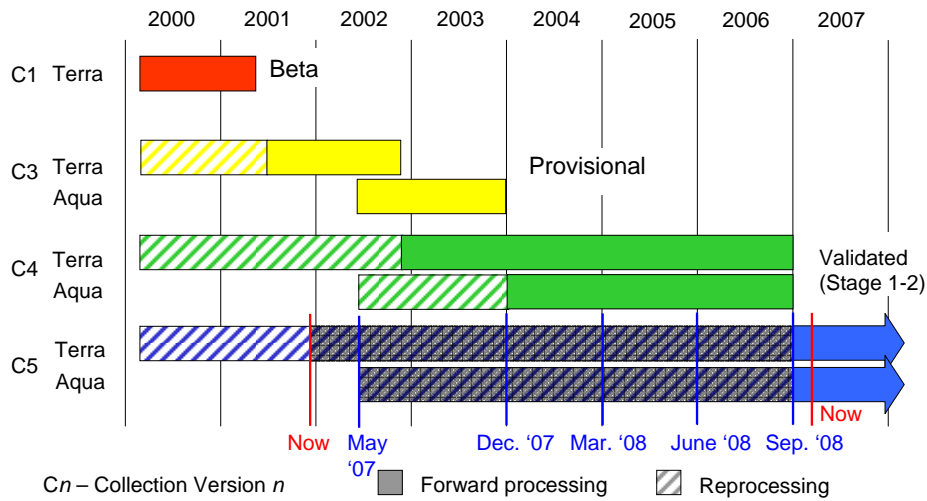
15



MODAPS System



MODIS Land Collections



Each collection represents an improvement in science quality



MODIS Land Collection 5 Changes - Summary

- Used improved Land/Water mask and new Land Cover map based on 3 years of Collection 4 data
- Refined surface reflectance by adopting a dynamic aerosol model in atmospheric correction
- Reduced size and complexity of daily surface reflectance products
- Improved quality of the Land Surface Temperature by revising the day/night algorithm and improving the detection and filtering of cloud contaminated observations
- Increased resolution of BRDF/Albedo products to 500m; 8-day overlapped production
- Refined LAI/FPAR LUTs to improve numerical accuracy of the radiative transfer simulations; 4-day combined product
- Added fractional snow algorithm in the snow product
- Burned area product added
- Improved ancillary data interpolation to remove artifacts in the NPP product
- Reduced size of all Land products through HDF internal compression

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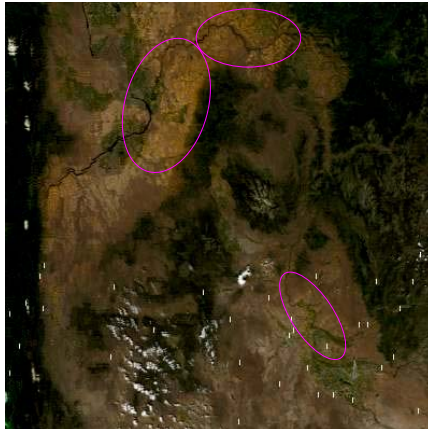
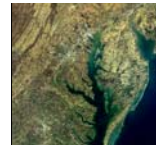
18



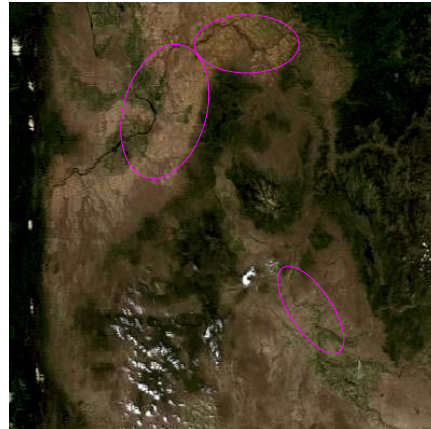
C5 Surface Reflectance

The Collection 5 surface reflectance algorithm retrieves the aerosol model along with the aerosol optical thickness.

This means less overcorrection in the surface reflectance product



C004



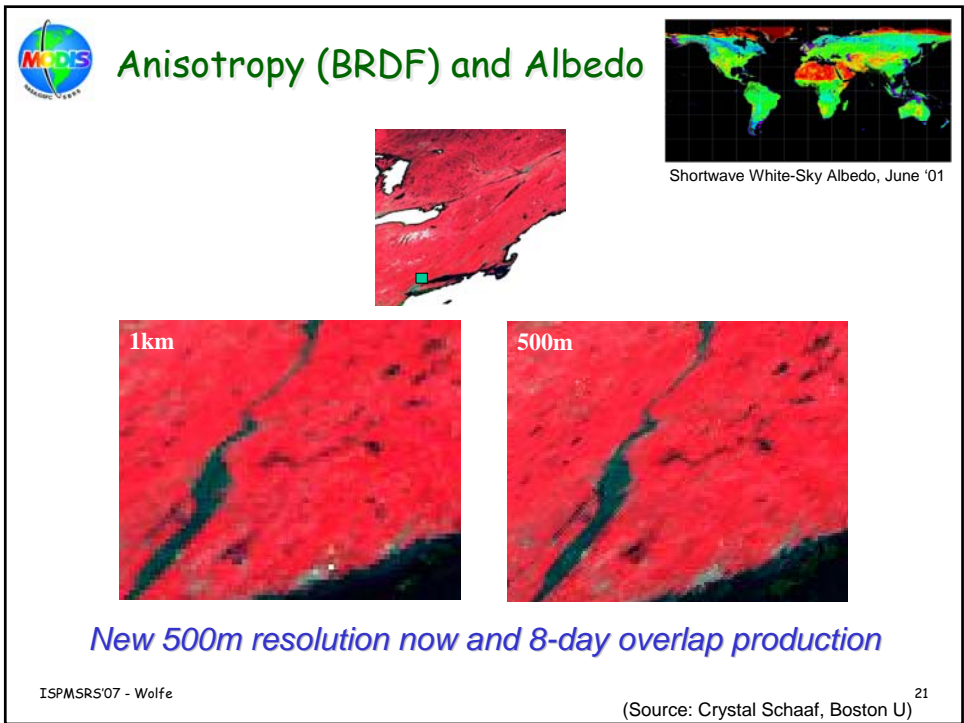
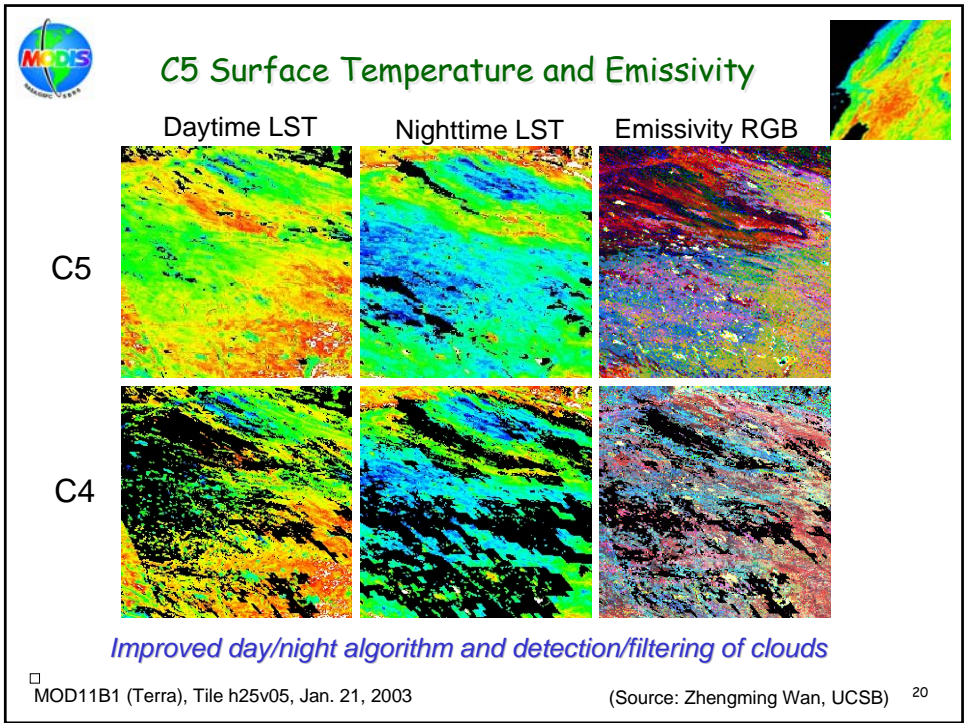
C005

New dynamic aerosol model

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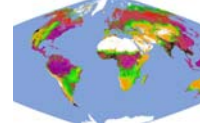
(Source: Eric Vermote, UMD)

19

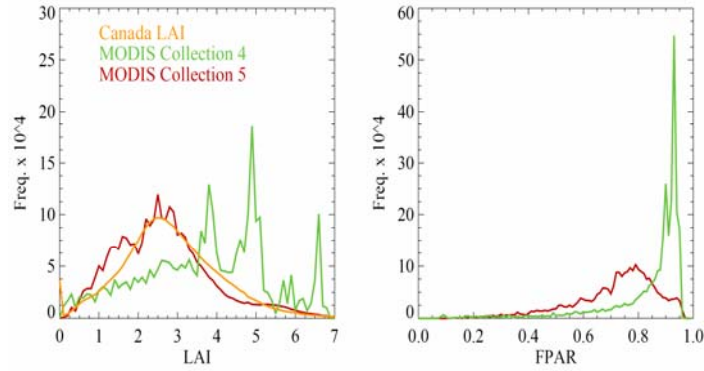




LAI/FPAR



Example: Reduction in over-stimulation of LAI and FPAR for needle leaf forest (below) and an increase in the rate of best quality retrievals.



MODIS and CCRS (Canadian Center of Remote Sensing) LAI and FPAR over Canada (MODIS data-days 201-208, 2003)

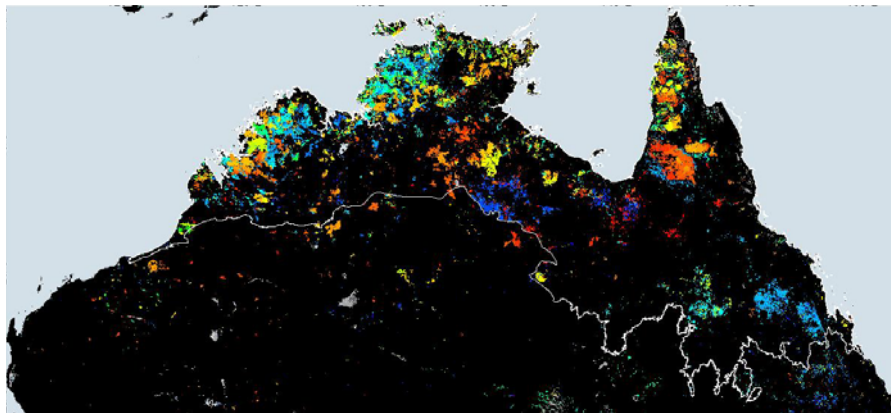
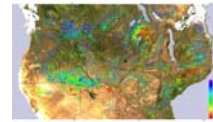
Improved numerical accuracy of radiative transfer simulations

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(Source: Nikolay Shabanov, Boston U) ²²



New Burned Area Product



Burned Area 2003 dry season in Australia (March-November)

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(Source: David Roy, SDSU) ²³



Land C5 Reduced Product Volume

	MODAPS Production (GB/day)		Export Volume (GB/day)			
			LP DAAC		NSIDC DAAC	
	C4	C5	C4	C5	C4	C5
L2 - L3 Daily	456	140	265	31	7	<1
Level 3 8-day +	23	26	70	19	1	<1
Total	479	166	335	50	8	1

Reduced size of all Land products through HDF internal compression



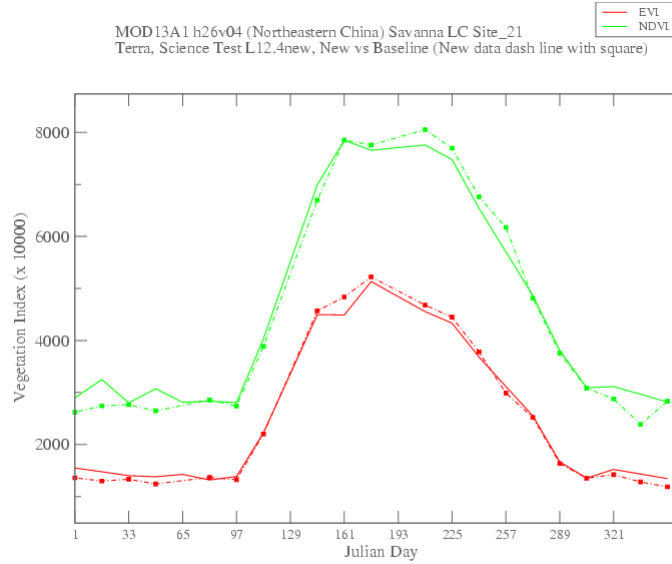
C4 to C5 Transition

- C5 data products are produced using the latest available versions of the science algorithms developed by the MODIS Land Science Team
 - changes to fix known problems
 - C5 science improvements
- C5 product format may have changed from the C4
- C5 product quality both at the pixel level and the granule level may differ from the C4
- It take $1\frac{3}{4}$ years to complete the remaining C5 reprocessing
 - until that time, the full data record will not have been processed into either C4 or C5
- So - caution should be used if combining C5 and C4 products
 - science team members have made specific recommendations



C4 vs. C5 Example - VI

MOD13A1 h26v04 (Northeastern China) Savanna LC Site_21
Terra, Science Test L12.4new, New vs Baseline (New data dash line with square)



Mon Feb 6 17:29:00 2006

26



MODIS C5 Processing Schedule

Processing of the newest MODIS Land collection (also known as Collection 5 or C5) commenced in September of 2006 starting with the first Terra data collected in February of 2000. Collection 5 processing of current MODIS data, or forward processing, began at the beginning of 2007. The full reprocessing is expected to be completed in September of 2008.

The plan for completing each year of either Terra-only, Terra + Aqua (combined), and Aqua-only data is indicated below. Aqua launch was in May of 2002.

Expected Completion Date by Data-Year

- 2000 - completed
- 2001 - March 2007
- 2002 - August 2007
- 2003 - December 2007
- 2004 - March 2008
- 2005 - June 2008
- 2006 - September 2008

Additional Information on C5 Reprocessing

- Collection 5 changes
- Use of C4 data with C5 data
- Land Quality Assessment

MODIS News...

- MODIS Reprocessing Schedule
- Collection 5 Strategies
- MODIS Land Collection 5 Workshop, held Jan. 17-18, 2007, at the University of Maryland
- Seeking community input on the ESDR White Papers developed by the NASA Land Measurement Team

MODIS Web Organigram

<http://modis-land.gsfc.nasa.gov/>

• browse Land Golden Tile Browse

27



Collection 6?

- We may not need to reprocess all products for C6
- A C6 reprocessing could incorporate
 - improvements in calibration and geolocation accuracy
 - essential improvements to science products
 - changes to product format
 - recent and new MODIS science products (e.g., Burned Area, MODIS water product)
 - new merged products from multiple instrument (e.g., MODIS & MISR)
- C6 would most likely not start until
 - after C5 reprocessing completes (after Sept. '08)
 - until a recompeted science team (round 3) develops and tests any improvements - C5 took more than 2 years



Getting MODIS Data

- Order from DAAC through EOS Data Gateway
 - response is a few hours
 - services (e.g. subsetting) available for some products
- Get data from DAAC data pools
 - most recently produced data are on-line and available via FTP
- Get data from other sources (LAADS, Science team sites, MODIS Rapid Response, direct broadcast, etc.)



DAAC Data Pool





MODLAND Website

<http://modis-land.gsfc.nasa.gov/>

The screenshot shows the MODLAND website interface. At the top, it features the NASA logo and 'GODDARD SPACE FLIGHT CENTER' with a link to '+ NASA Homepage'. Below this is a large banner with 'MODIS Land' and a grid of satellite images. A navigation menu includes 'home', 'products', 'people', 'news', 'links', and 'tools'. The 'products' menu is highlighted with a red circle, listing items such as 'Surface Reflectance', 'Snow Cover/Sea Ice', 'Land Surface Temperature', 'Land Cover/Dynamics', 'Vegetation Indices', 'Thermal Anomalies/Fire', 'LAI/Pear', 'Net Primary Productivity', 'BRDF/Albedo', and 'Vegetation Cover Conversion'. Below the menu is a 'MODIS News' section with several bullet points and a 'MODIS Web Organigram' diagram. A second screenshot of the website is overlaid on the right, showing the 'Land Cover, Change, and Conversion' section. This section includes a sub-section for 'Vegetation Cover Conversion' with a red box around the text 'Product ID: 300a, Transformed, PE, maintained, product, web, page'. Below this is a table with columns for 'Product Name', 'Terra Product ID', and 'Aqua Product ID'.

Product Name	Terra Product ID	Aqua Product ID
Vegetation Cover Conversion 30-Day L3 Global 250m	MOD44A	none
Vegetation Cover Conversion Yearly L4 Global 500m	MOD44B	none

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30



LAADS Web

The screenshot shows the LAADS Web website interface. At the top, it features the NASA logo and 'GODDARD SPACE FLIGHT CENTER' with a link to '+ Visit NASA.gov'. Below this is a banner with 'LAADS Web' and 'Level 1 and Atmosphere Archive and Distribution System'. A navigation menu includes '+ HOME', '- DATA', '+ IMAGES', '+ TOOLS', and '+ HELP'. Below the menu is a 'Data' section with links for 'Search', 'Shopping Cart', 'Data Availability', 'FTP Site', and 'Track Orders'. At the bottom, there is a footer with the 'FIRSTGOV' logo, a link to '+ Privacy Policy and Important Notices', the NASA logo, and contact information for the webmaster: 'Webmaster: Karen Horrocks, NASA Official: Ed Masuoka, + Send Us Your Comments'.

<http://ladsweb.nascom.nasa.gov/>

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31



Browsing the Image Archive

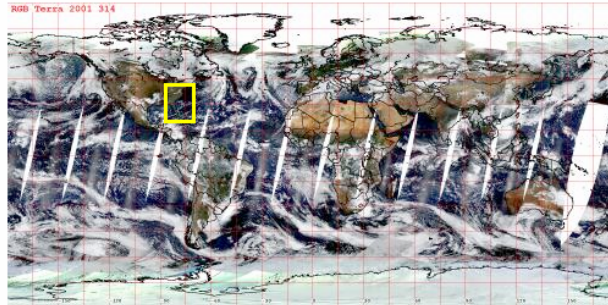
Level 2 Browse

Satellite: Terra
Date: November 10, 2001
Parameter: RGB
Collection: 5

Satellite:
Aqua: Terra:
Month: Nov Day: 10 Year: 2001
Parameter: RGB

[+ Previous](#)

[+ View Help](#)



North:

West: East:
South:

[+ View high resolution image of Terra MODIS Level 2 RGB Global Composite for November 10, 2001](#)

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32



Summary

- MODIS production and distribution systems
 - are being continuously improved
 - enabled extensive end-to-end testing
 - achieving (relatively) fast processing rates
 - maintaining high distribution volumes and quality user services
- MODIS team has continued to carefully improve the science products
 - large reduction in product volume has been reduced
 - some product formats have been reworked to enable usability
 - C5 reprocessing is underway and will finish in Sept. 2008

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33



<http://modis-land.gsfc.nasa.gov/>



Questions?

34