MODIS Land team Collection 5.0 and beyond

Kamel Didan on behalf of the Land team
TBRS Lab., The University of Arizona


LP-DAAC UWG Meeting - Sioux Falls, SD
August 22nd-23rd, 2007

Mission of the MODIS Land team

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.

Outline

- Status of Science Team membership
- Planned meetings and workshops
- Collection 5 status & improvements
- Research highlights from Science Team
- Collection 5 reprocessing status
- MODIS related science output
- NASA Senior review, mission extension

MODIS Science Team Status & Membership

MODIS Science Team Leader : Vincent V. Salomonson
MODIS Land Science Team Leader (**MODLAND**) : Chris Justice
MODIS Science Data Support Team (**SDST**) : Ed Masuoka & Mike Teague
MODIS Land Science Data Discipline Team (**SDDT**) : Robert Wolfe
Land Data Operational Product Evaluation (**LDOPE**) : Sadashiva Devadiga & Min Zheng
Land Validation Coordination (**LandVal**) : Jeff Morisette & Jaime Nickeson

Energy Balance Product Suite	**Vegetation Parameters Suite**	**Land Cover/Land Use Suite**	Data Analysis/Application
Vincent Salomonson	Alfredo Huete	Chris Justice	Jeff Morisette
Dorothy Hall	Ranga Myneni	Mark Friedl	Peter Muller
Alexei Lyapustin	Ramakrishna Nemani	John Townshend	Sasan Saatchi
Eric Vermote	Steve Running	Luis Giglio	Jacques Descloitres
Zhengming Wan	Susan Ustin (?)	**Calibration**	Michael Bosilovich
Crystal Schaaf	Forrest Hall (?)	Kurt Thome	Robert E. Dickinson
	Eric Wood (?)	Stuart Bigger	Stith Gower
			Andrew Hansen
			Shunlin Liang
			Tomoaki Miura
			John Kimball
			Xubin Zeng

Future Science Team Meetings & Workshops

- The new MODIS contracts were out on Aug. 6th
  - There are still budget issues
  - Few team members are still in the uncertain category
    - Should know by September (2007)
- No planned meeting as of August 2007
  - A science team meeting may be planned before the end of the year, but most likely early next year, 2008
    - Last Science Team Meeting was on Oct. 2007
  - There may be plans for MODIS products specific workshops in 2008
    - Last global vegetation workshop, Missoula, MT (Aug., 2006)
    - Last MODIS Land C5 workshop, College Park, MD (Jan., 2007)

Collection 5 status & improvements

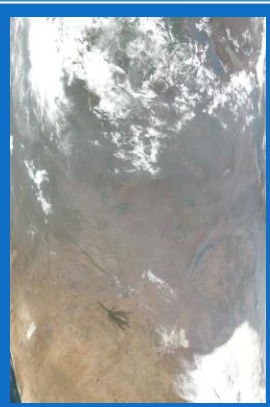
MODIS Land Surface Reflectance

Eric Vermote
Svetlana Kotchenova
Department of Geography, University of Maryland

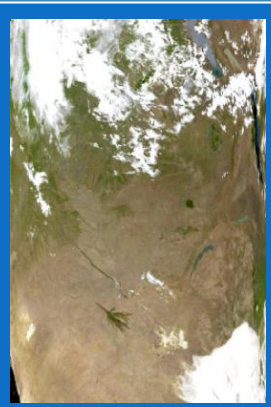
Collection 5 changes

- New look up tables based on 6SV including the latest dynamic aerosol models from AERONET analysis
- Refined inversion of the aerosol based on all the available bands (in particular 412nm and 443nm) and a stronger Red-Blue relationship (in collaboration with the Aerosol group).
- Improved internal (product specific) cloud and snow screening
  - This has been very useful to downstream Land products & LSR applications

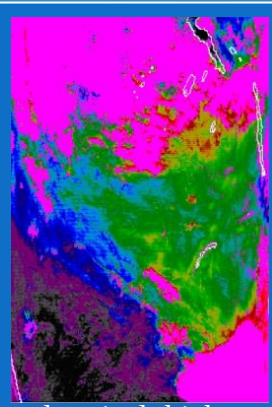
1	620-670
2	841-876
3	459-479
4	545-565
5	1230-1250
6	1628-1652
7	2105-2155



RGB no correction for aerosol effect



RGB surface reflectance (corrected for aerosol)

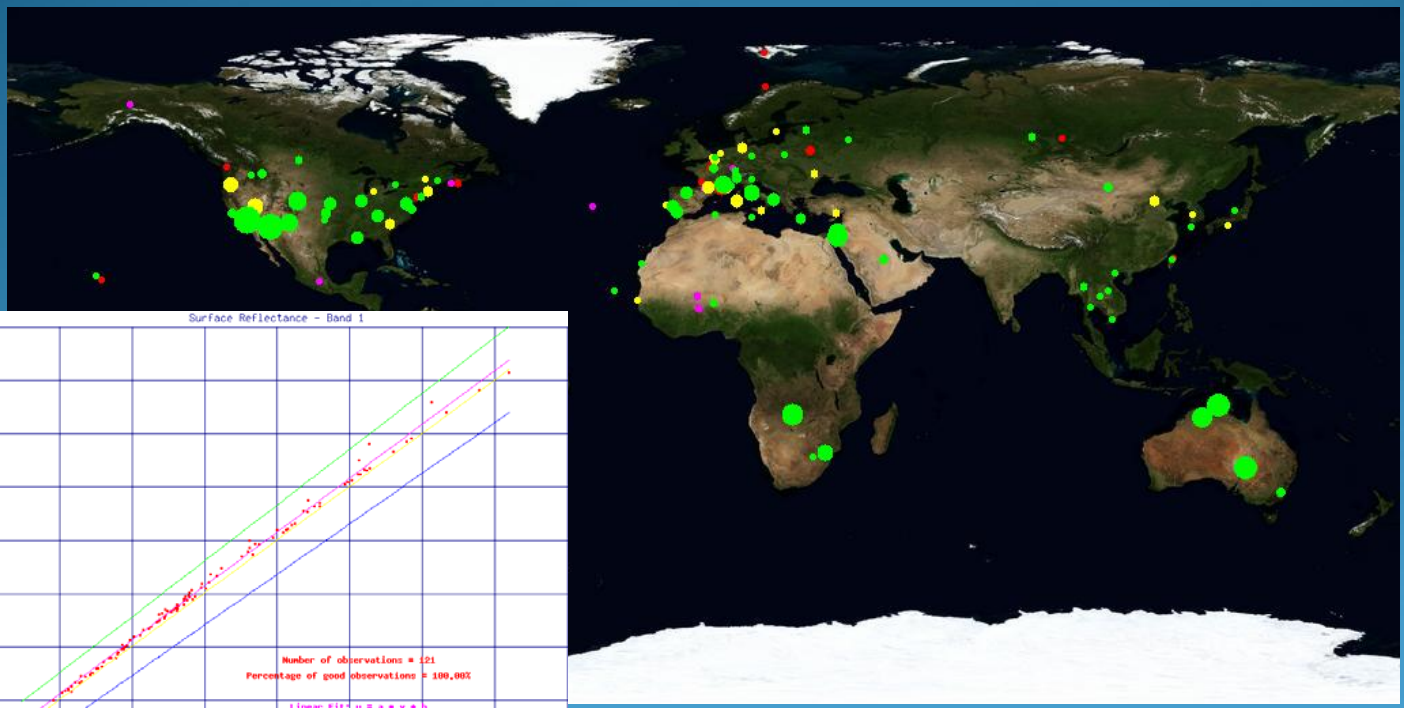


Aerosol optical thickness at 670nm (0 black, 1.0 and above red) linear rainbow scale.

Collection 5 performance

Performance evaluation of the MODIS Collection 5 algorithms over 150 AERONET sites (4988 cases)

band 1



Percentage of good:

band 1 – 86.62%
band 2 – 94.13%
band 3 – 51.30%
band 4 – 75.18%
band 5 – 96.36%
band 6 – 97.69%
band 7 – 98.64%

Theoretical error bar:

±(0.005 + 5%)

green > 80%, 65% < yellow <80%, 55% < magenta < 65%, red <55%

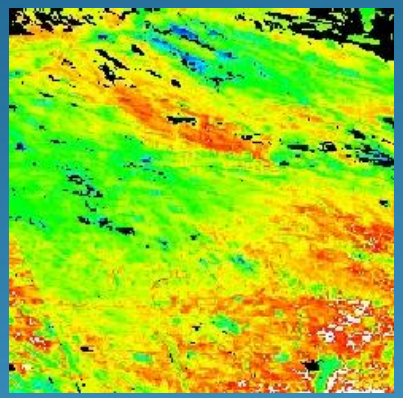
MODIS Land Surface Temperature and Emissivity

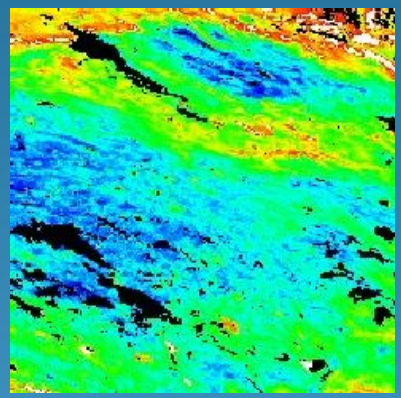
Zhengming Wan

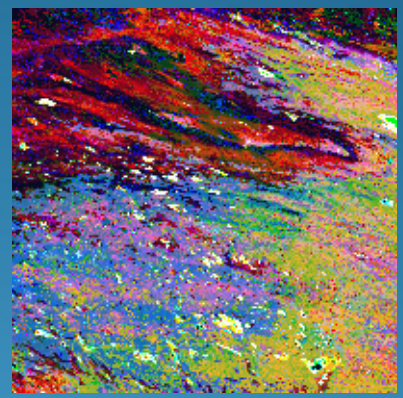
Improvements of the C5 LST Products over C4

Due to using cloud mask combined with surface elevation shown in this example of MOD11B1 (tile h25v05) retrieved from Terra MODIS (21 January 2003).

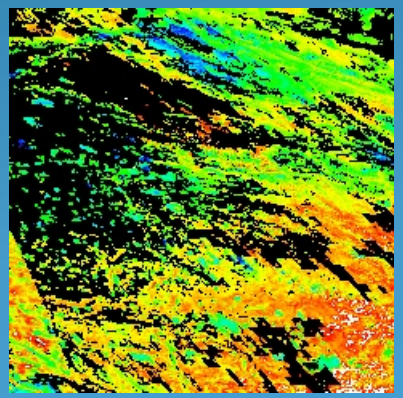
C5

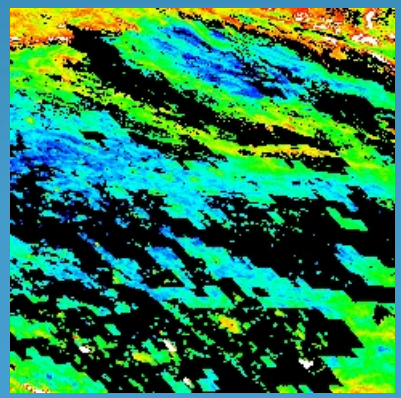


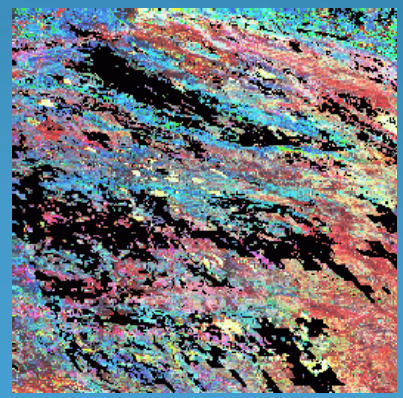




C4







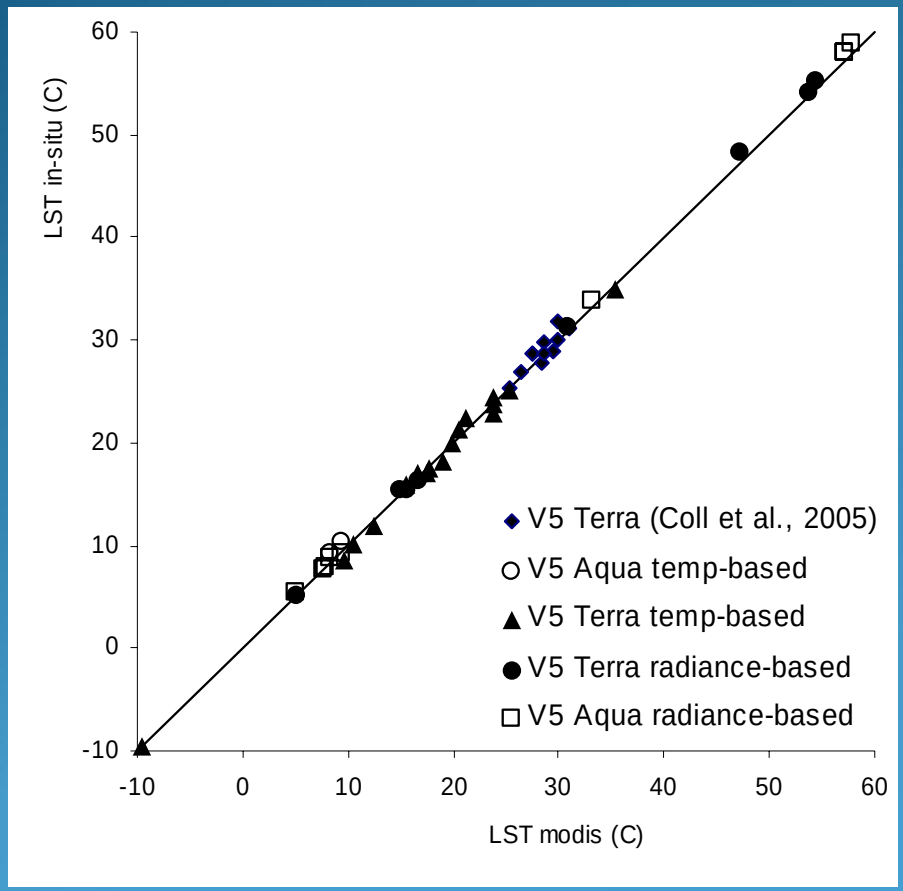
daytime LST

nighttime LST

emissivity RGB

Validation of the C5 LST Products generated in V5 tests

By comparisons of LST values in the C5 MOD11_L2 and MYD11_L2 products with the in-situ values in Wan et al., 2002; Wan et al., 2004; Coll et al., 2005, and radiance-based validation results over Railroad Valley, NV in June 2003 and a grassland in northern TX in April 2005. LST errors < 1K in most cases.



Notes for applications of C4 & C5 LST products:

- In M*D11_L2, if valid LSTs are available in both C4 & C5, their difference is less than 0.2-0.4K in most cases.

- In M*D11A1 within latitude ±28º(MODIS orbits w/o overlapping), if valid LSTs are available in both C4 & C5, their difference is less than 0.2-0.4K in most cases. Outside the latitude region, if valid LSTs are available in both C4 & C5 and at the same view time (indicating temporal average not applied in C4), their difference is less than 0.2-0.4K in most cases. Users should remove cloud-contaminated LSTs in the C4 product before using them in applications.

- LSTs severely contaminated by clouds were removed from level-3 C5 products, but not from all C4 products. It is difficult to remove such LSTs from the 8-day C4 M*D11A2 products because the cloud contamination effect may be reduced in the 8-day averaging.

- There may be larger errors in high LST cases with cwv > 1.5cm because the range of Ts-air ± 16K for the LST values used in the development of the split-window algorithm is not wide enough for some daytime bare soil cases in the summer.

MODIS Anisotropy and Albedo Product

Crystal Schaaf

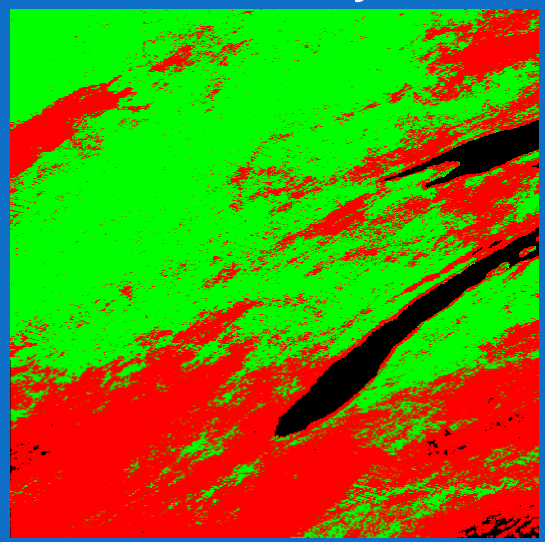
BRDF/Albedo @ BU

Assessment of Surface Albedo Derived from MODIS at ChEAS - Park Falls, WI

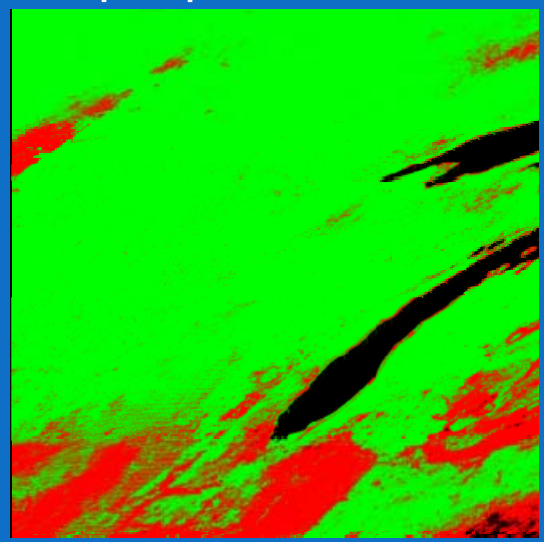
V004 MOD43B3 (1km)

V005 MCD43A3 (500m)

Terra-only



Aqua plus Terra

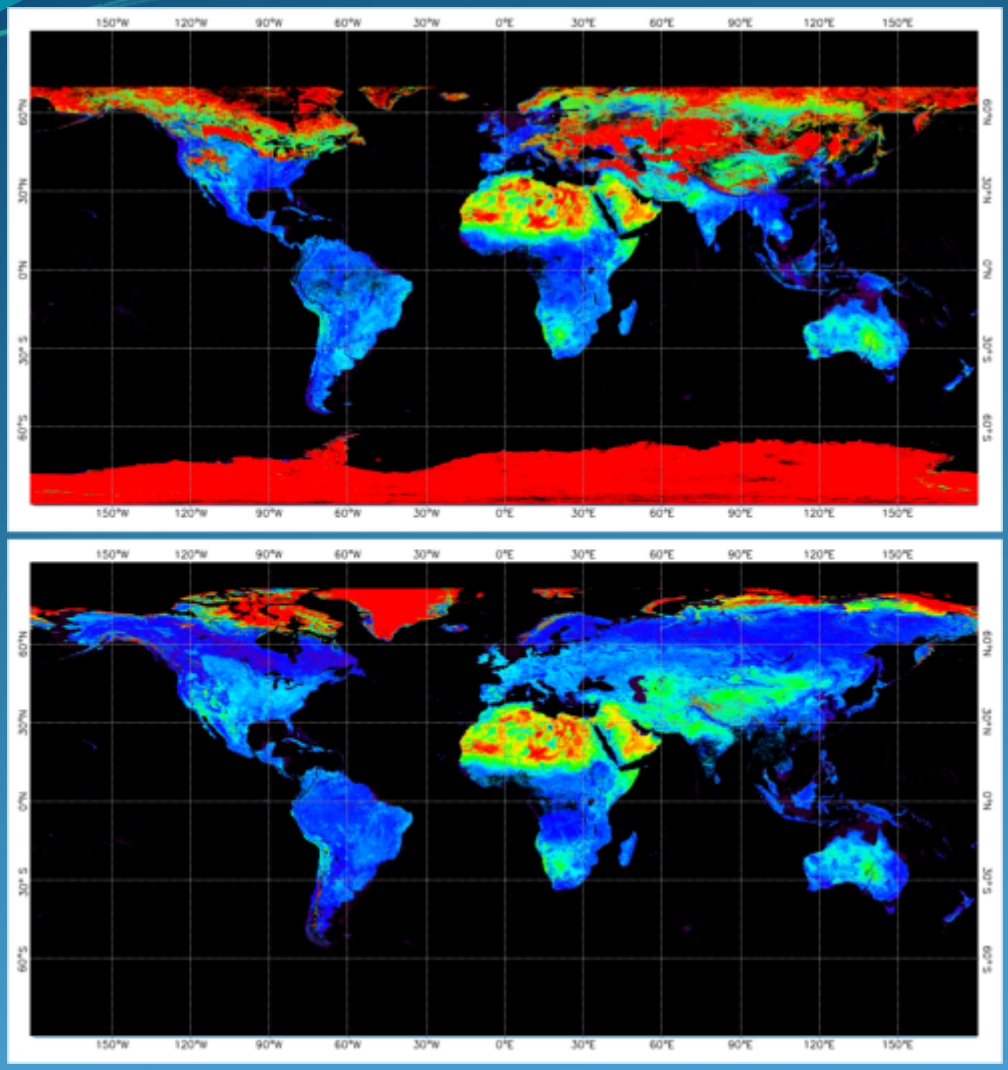


Green	***Best Quality – Full BRDF-Inversions***
Red	***Moderate Quality – Magnitude Inversions***
White	***No Data (Fill Value)***

Mandatory QA (0.3-5.0μm)
August 5th, 2005 (2005210)

White Sky Albedo – True Color (RGB) – August 13th, 2005 (2005225)

Climate Modeling Grid (CMG) Surface Albedo Product



Future plans

- Further improvement of backup algorithm
- Utilization of the BRDF shape information for structural characterization
- Implementation of more frequent anisotropy and albedo measures to serve the Direct Broadcast and eventually NPP/NPOESS communities

This image was produced using 1-km white-sky albedo retrievals (SWIR – 0.3-5.0μm) over a 16-day period for, February 02, 2005 (top) and June 10, 2005 (bottom).

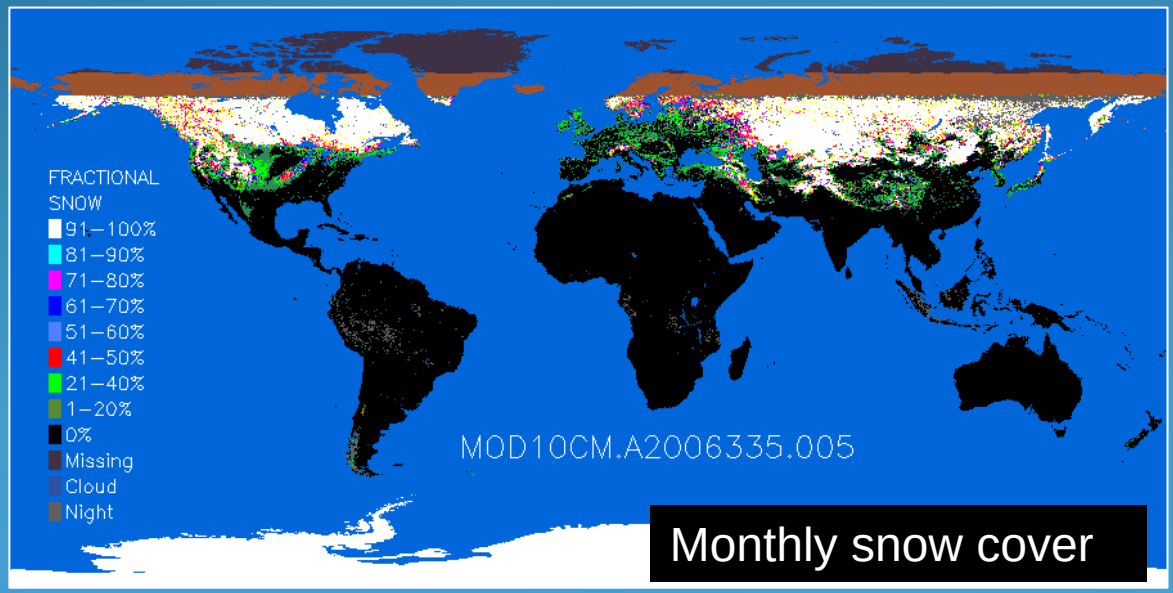
MODIS Snow and Sea Ice Data Products

Dorothy Hall & George Riggs

Cryospheric Sciences Branch,
NASA/GSFC Greenbelt, MD

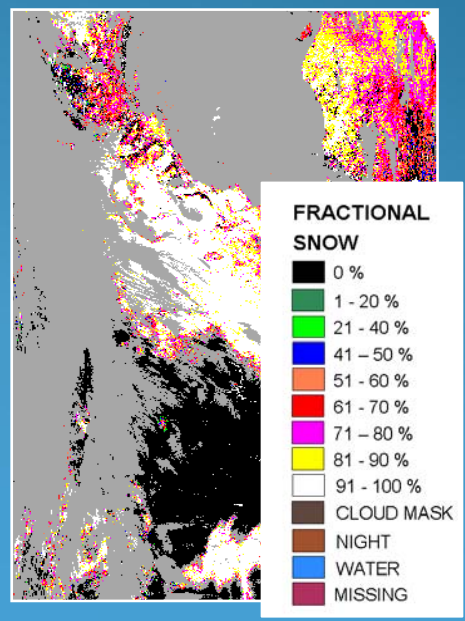
Changes in C5

- Major product additions / changes:
  - Fractional snow cover @ 500m
  - Monthly snow cover
- Daily quarter-degree snow cover
- Only sea-ice-extent-by-reflectance and sea-ice-surface temperature are generated in C5



Monthly snow cover

Snow-cover fraction



Validation Statement

- All snow products are validated with ground measurements, in comparison to higher-resolution remote-sensing data, and to operational snow-cover products
- Overall, MOD10A1 products have an accuracy of 93%
- The accuracy varies with season, location, type of snow and time of day (see "**Accuracy Assessment of the MODIS Snow Products," D.K. Hall and G.A. Riggs, 2007: *Hydrol. Proc.***
- Sea ice surface temperature is accurate to <1.5 deg. C during wintertime conditions

Some Plans for C6

- Improve screening for erroneous snow detection, e.g., improved snow/cloud discrimination
- Improve fractional snow error/uncertainty estimates
- Improve snow albedo algorithm with error/uncertainty estimates (work with C. Schaaf et al./Boston Univ.)
- A daily snow (level 3) product based on surface reflectance and land cover (level 3) product inputs
- Higher resolution CMG products

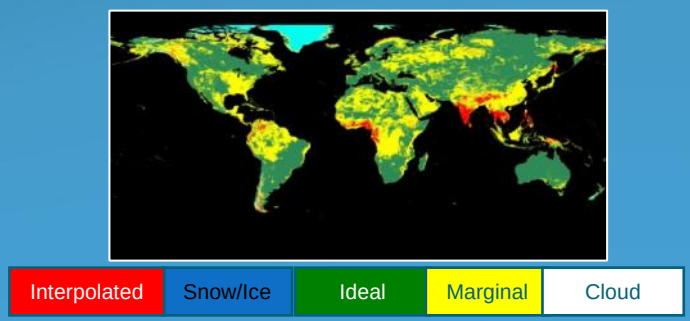
Vegetation Index Products

Kamel Didan & Alfredo Huete

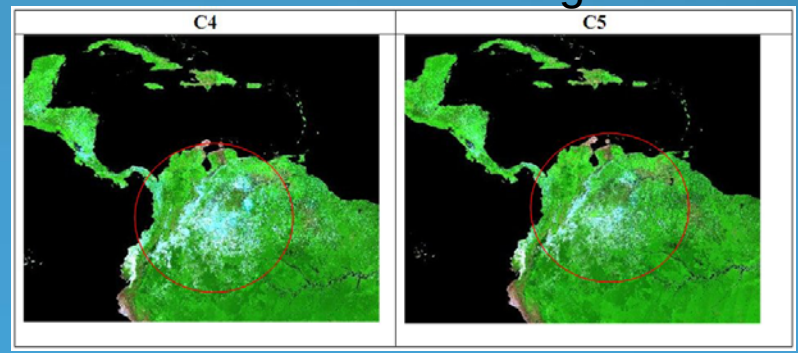
TBRS Lab., The University of Arizona

Collection 5 Changes

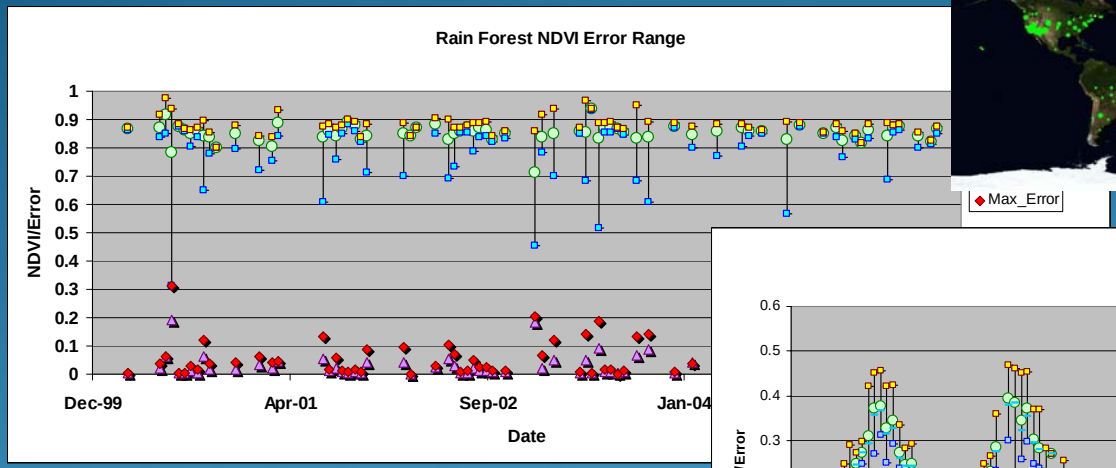
- Added per pixel reliability (Second most important change)
- Added the composite day of the year to the output
- One VI_QA layer (applies to NDVI and EVI)
- Restructured the VI_QA data layer to eliminate redundant information
- Improved input data filtering (& added adjacent cloud filter)
- Modified the compositing approach:
  - To identify mislabeled cloud
  - Modified CV-MVC to favor smaller view angle
- Adopted a phased production for Terra and Aqua to keep the streams separate while increasing the temporal frequency (Most important change)



Cloud screening



Noise related Error budget



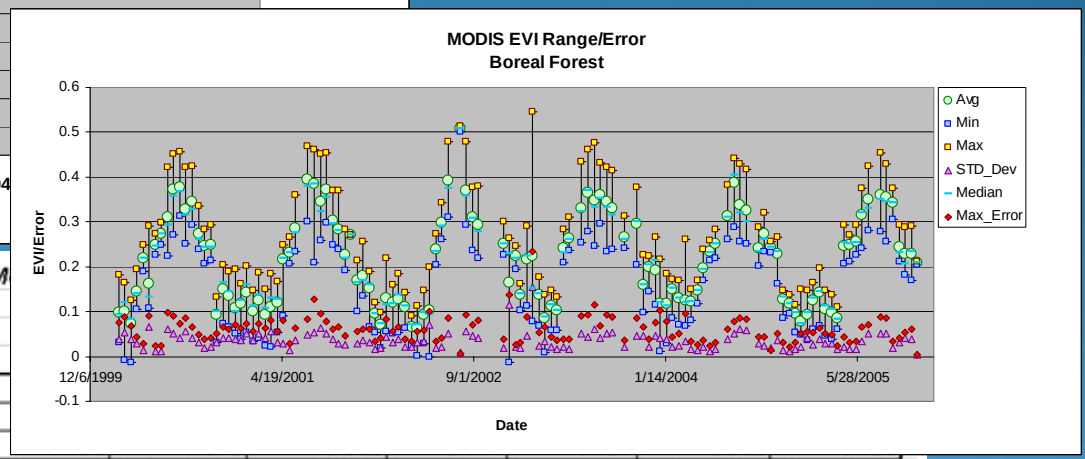
Percentage of good:

NDVI – 97.11%

EVI – 93.64%

Theoretical error bar:

±(0.02 + 2%)



NDVI Statistical Analysis for the MODIS 5+ year record

	Humid RF	Humid RF	Desert	Desert	Moist N L	M						
Avg.	0.880	0.875	0.109	0.158	0.892							
Min	0.869	0.862	0.104	0.152	0.882							
Max.	0.937	0.916	0.116	0.169	0.905							
Error/Rs	0.068	0.054	0.012	0.017	0.022	0.030	0.043	0.032	0.394	0.076	0.055	0.053
Rel Err	7.739	6.200	11.340	10.663	2.515	3.473	5.087	3.655	560.181	-322.204	6.299	5.951
STD_De	0.017	0.014	0.003	0.005	0.007	0.008	0.012	0.008	0.127	0.019	0.015	0.012
Median	0.872	0.872	0.109	0.157	0.892	0.875	0.841	0.879	0.017	-0.026	0.867	0.884

Global Abs Error	0.0715	
Global Rel Error	6.2922	%

Validation statement & C6 plans

Current Maturity= "Validated Stage 2“ [One more stage to go]

C6 Plans

- **MODIS specific**
  - **Completely cloud free & gap filled**
    - **It is pointless to produce/use cloudy observations**
    - **Gaps should be filled with obs. from the historical record (similar to the CMG approach)**
  - **Dynamic composite (First good observation)**
    - **No fixed composite cycle, but VI produced when a good pixel becomes available**
- **General CDR/ESDR**
  - **Validation with in situ Photosynthesis measurement [Last stage]**
  - **EVI2 for continuity**
  - **EVI Backward compatibility (paper in review) and no-Blue band sensors**
  - **BRDF???**

MODIS LAI and fPAR Product

Ranga Myneni & Nikolay Shabanov

Geography Department,

Boston University

C5 improvements

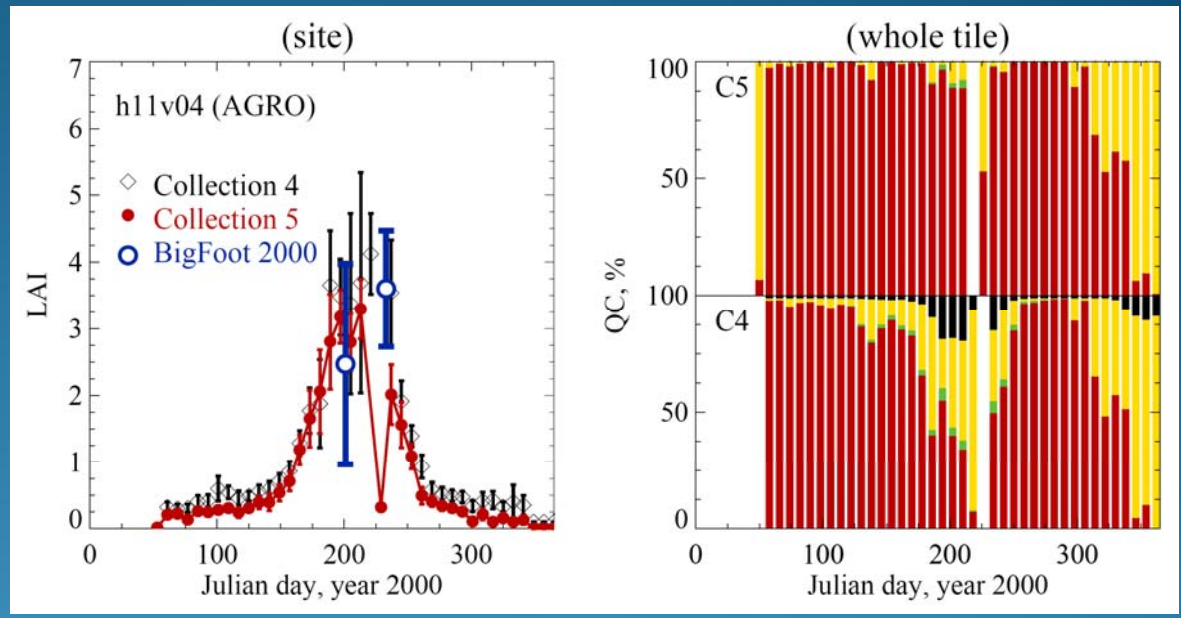
- Introduced two new combined products (4-day and 8-day). The products are generated by compositing daily Aqua and Terra observations with standard compositing scheme. Combined 8-day products improves quality of retrievals (mostly over broadleaf forests, while Combined 4-day products improves temporal resolutions, desirable feature for ecological and climate applications

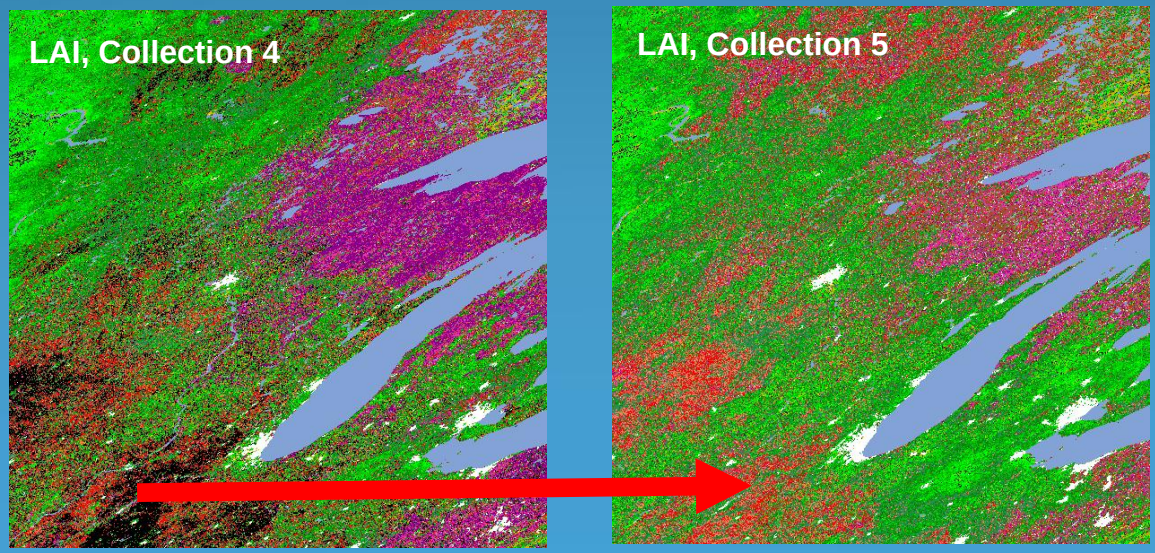
- Introduced new SDSs. In addition to standard SDS (LAI, FPAR, QC, extra_QC), two new layers were added to specify uncertainties of retrievals: standard deviation of LAI and FPAR. The standard deviations are available from the retrieval technique: MODIS main RT algorithm generates LAI/FPAR data not as deterministic values, but as statistical averages over acceptable solutions of the inverse problem

- Minor changes to QA: simplified definition of MODLAND_QC (good quality vs. other quality), and introduced new bit, sensor (Aqua, or Terra based retrievals)

Example Improvement : Broadleaf crops (Biome 3)

- AGRO cropland site in IL, USA
- Retrieved LAI is consistent with field measurements
- Increased rate of best quality retrievals (main algorithm)
- Eliminated fill values





Future Work (Collection 6 Enhancements)

- **Minimize spurious seasonality in needle leaf forests (due to snow, low SZA)**
  - **improved simulations with stochastic RT model with snow patterns as background**
  - **research on impact of low SZA on MODIS surface reflectances at high Northern latitudes**

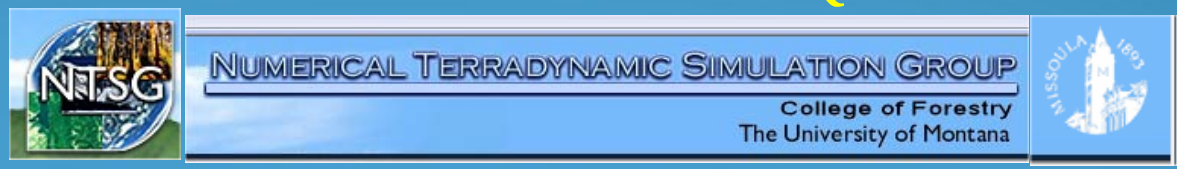
- **Improving retrievals over mixed forests**
  - **reference MODIS continuous fields LC product to evaluate LC mixture**
  - **utilize Stochastic Mixture RT model to perform retrievals over mixed forests**

- **Optimization of retrievals with SWIR data**
  - **analyze MODIS SWIR data for information content/noise**
  - **implement SWIR LUTs with stochastic RT model and test retrievals**
  - **potential areas of improvements: Northern high latitudes evergreen needle leaf forests and broadleaf evergreen forest in Amazonia and Central Africa**

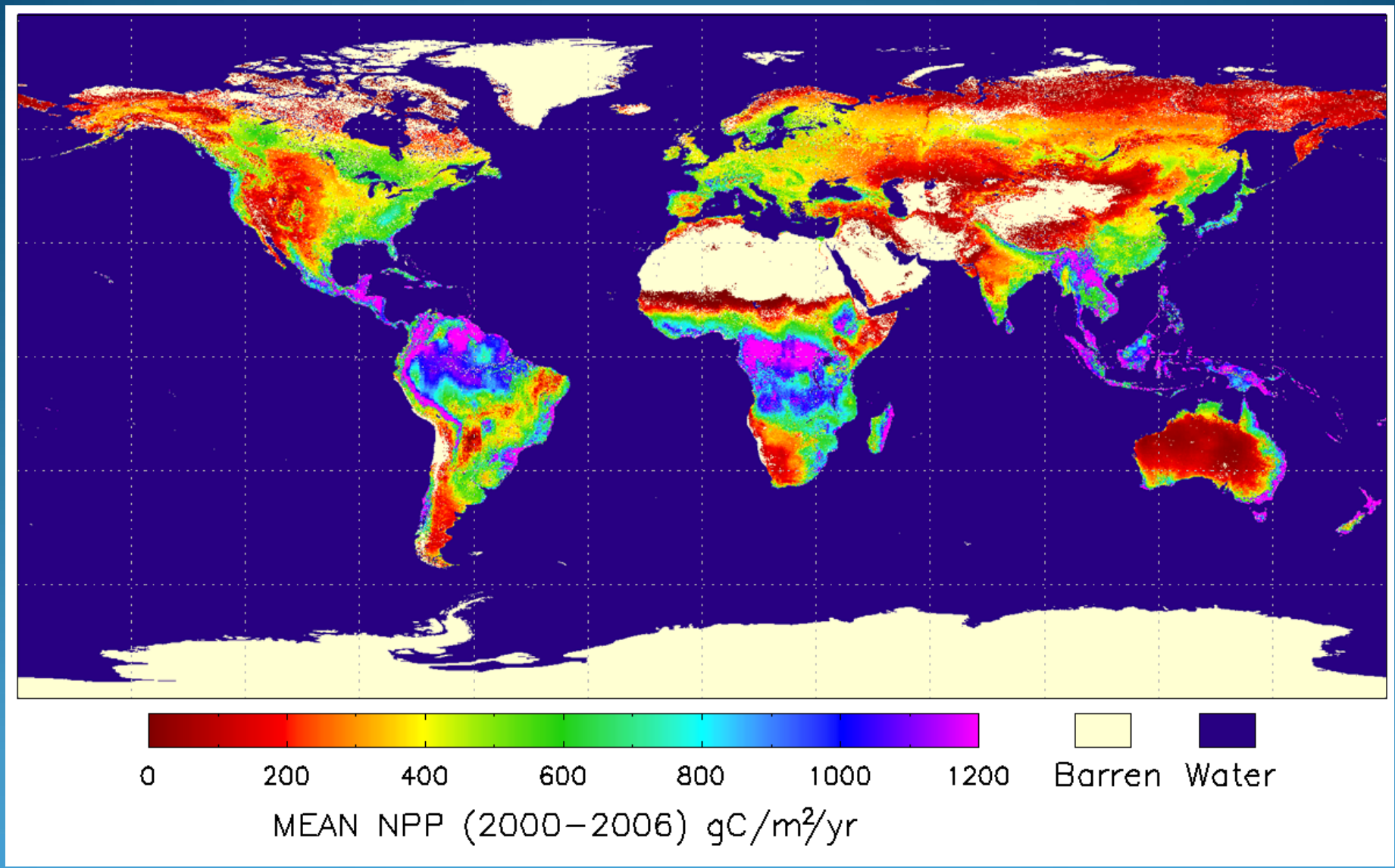
- **Development of high resolution (250-m) LAI/FPAR products**
  - **research on impact of landcover on retrievals (250-m vs 1-km)**
  - **research on consistency of MODIS 250-m and 1-km surface reflectances**
  - **evaluate consistency of 250-m and 1-km LAI/FPAR retrievals**

MODIS Terrestrial GPP, NPP and ET

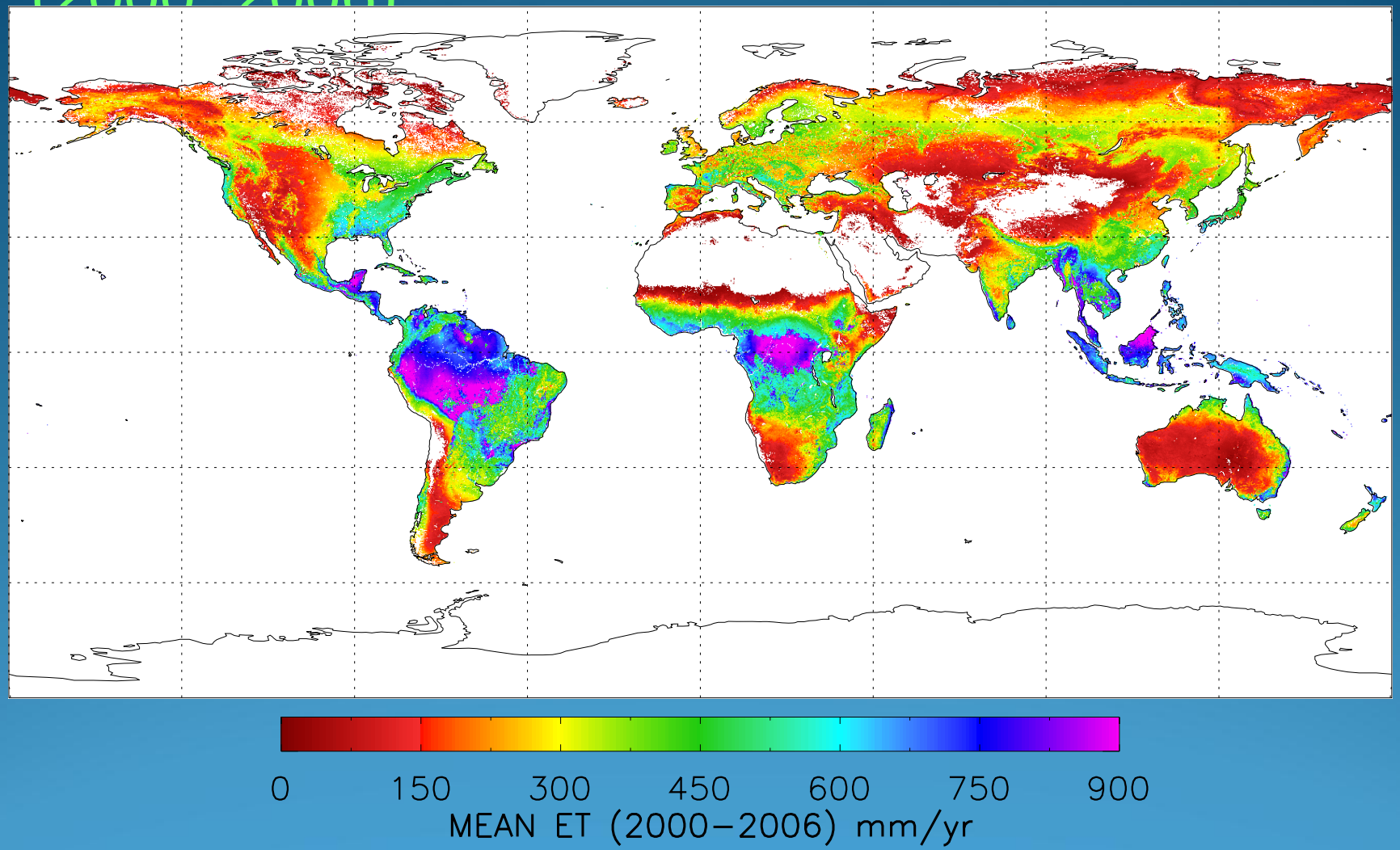
Steven W. Running
Maosheng Zhao
Qiaozhen Mu



Mean Improved MOD17A3 NPP (2000~2006)



MODIS Global Evapotranspiration (2000~2006)



(*Mu et al. 2007, RSE, in press*)

Global Land Cover Type and Land Cover Dynamics

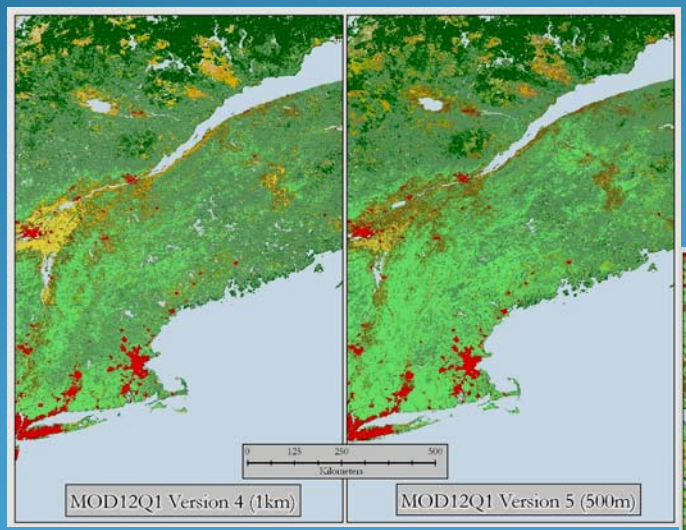
Mark Friedl

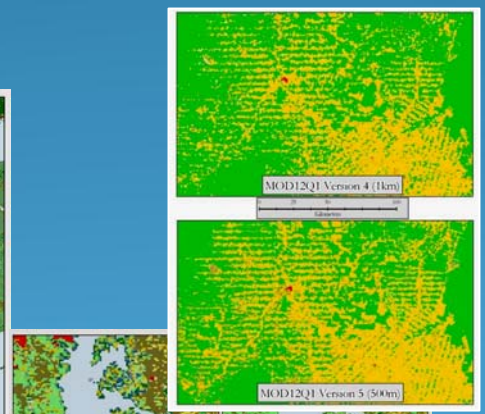
Dept of Geography and Environment

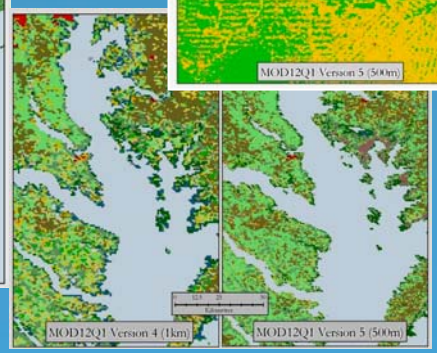
Boston University

Land cover type: Summary of Key Changes

- *Revision of land cover training site database*
  - *Smaller, high quality sites (~1500)*
  - *More recent scenes (post-2000)*
- *Input features*
  - *8-day, 500-m NBAR data*
    - *aggregated to 32-day*
  - *EVI, LST (MOD11)*
  - *Annual Metrics*
- *Updated "priors" layers*
  - *Based on MOD12 C4*
  - *New global agriculture from inventory data*







Extract Exemplars From STEP Database

↓

Estimate Classification (Ensemble Decision Trees)

↓

Apply Classification to Global Data

↓

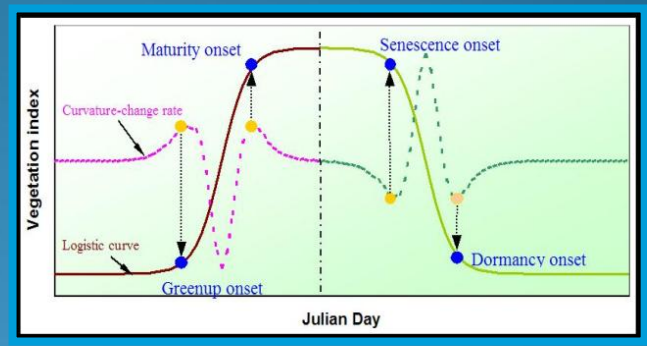
Fuse Results With Ancillary Data (post-processing)

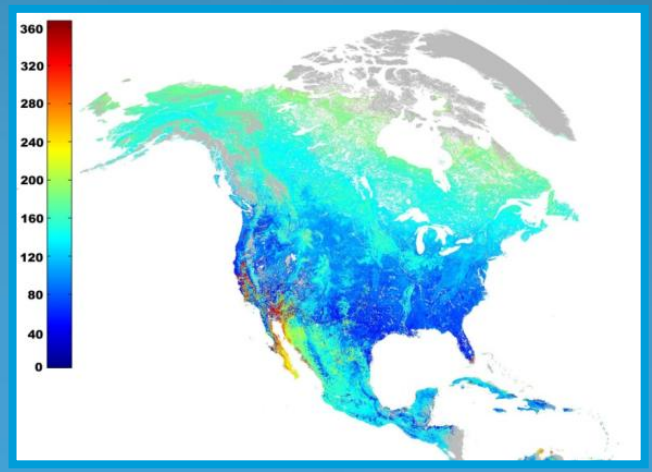
↓

Maps

Land Cover dynamics: Summary of Key Changes

- *Temporal resolution*
  - *Using 8-day EVI*
- *Spatial Resolution*
  - *500-m NBAR inputs*
- *Improved screening for snow*
  - *Using NBAR snow-flag in combination with LST (MOD11)*
- *Identification and correction of several minor bugs in code.*





Summary

- *Key Results from Changes*
  - *Improved spatial resolution (MOD12Q1, Q2)*
  - *Improved temporal resolution (MOD12Q2)*
  - *Fewer missing values (MOD12Q1, Q2)*
- *Most importantly*
  - *Improved thematic quality for MOD12Q1*
  - *Improved accuracy & precision for MOD12Q2*
- *Ongoing and Future Activities (C6)*
  - *Focus on problematic classes; FAO LCCS*
  - *Stabilization across years*
  - *Smoothing and interpolation (clouds) for MOD12Q2*
  - *Validation for C5 versions of both products*
  - *Creation of 1-km and CMG for C5*

MODIS Active Fire Products: Collection 5 Changes

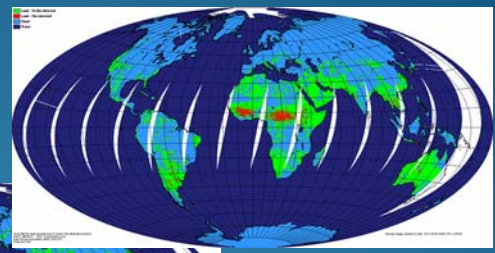
L. Giglio and C. Justice

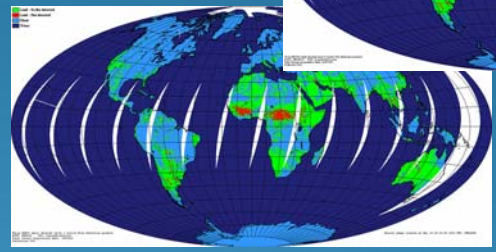
University of Maryland, College Park

Level 2 Collection 5 changes

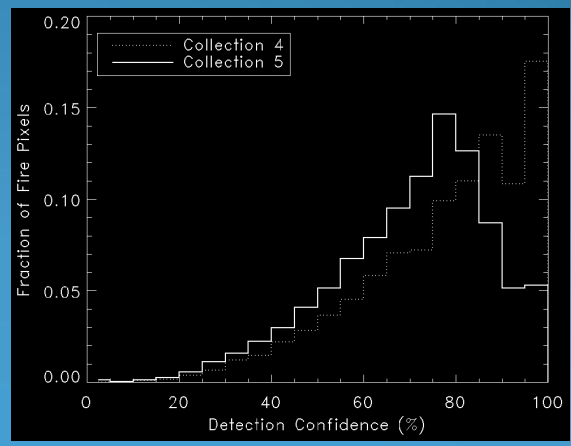
- Level 2: MOD14, MYD14
  - No significant changes to detection algorithm
  - Bug fix
    - Switch between channels 21 & 22 not always performed properly
    - Occasionally missed small/cool fires in C4
  - Change in calculation of detection confidence
    - Better flagging of questionable fire pixels
  - Internal CMG-related changes
- Level 3: MOD14A1, MYD14A1
  - Simplified per-pixel QA
  - Additional data layers
    - FRP, within-swath sample
  - Rationalized SDS names
- 8-day: MOD14A2, MYD14A2
  - Simplified per-pixel QA
  - Rationalized SDS names
- CMG changes
  - MOD14C8H, MYD14C8H, MOD14CMH, MYD14CMH
  - 0.25° spatial resolution (up from 0.5° for Collection 4)
    - MOD14CMQ, etc.
  - Additional data layers

C4





C5



MCD45 Burned Area (500m approximate day of burning)

David Roy, Luigi Boschetti, Chris Justice

South Dakota State University, GIS Center of Excellence

University of Maryland, Department of Geography

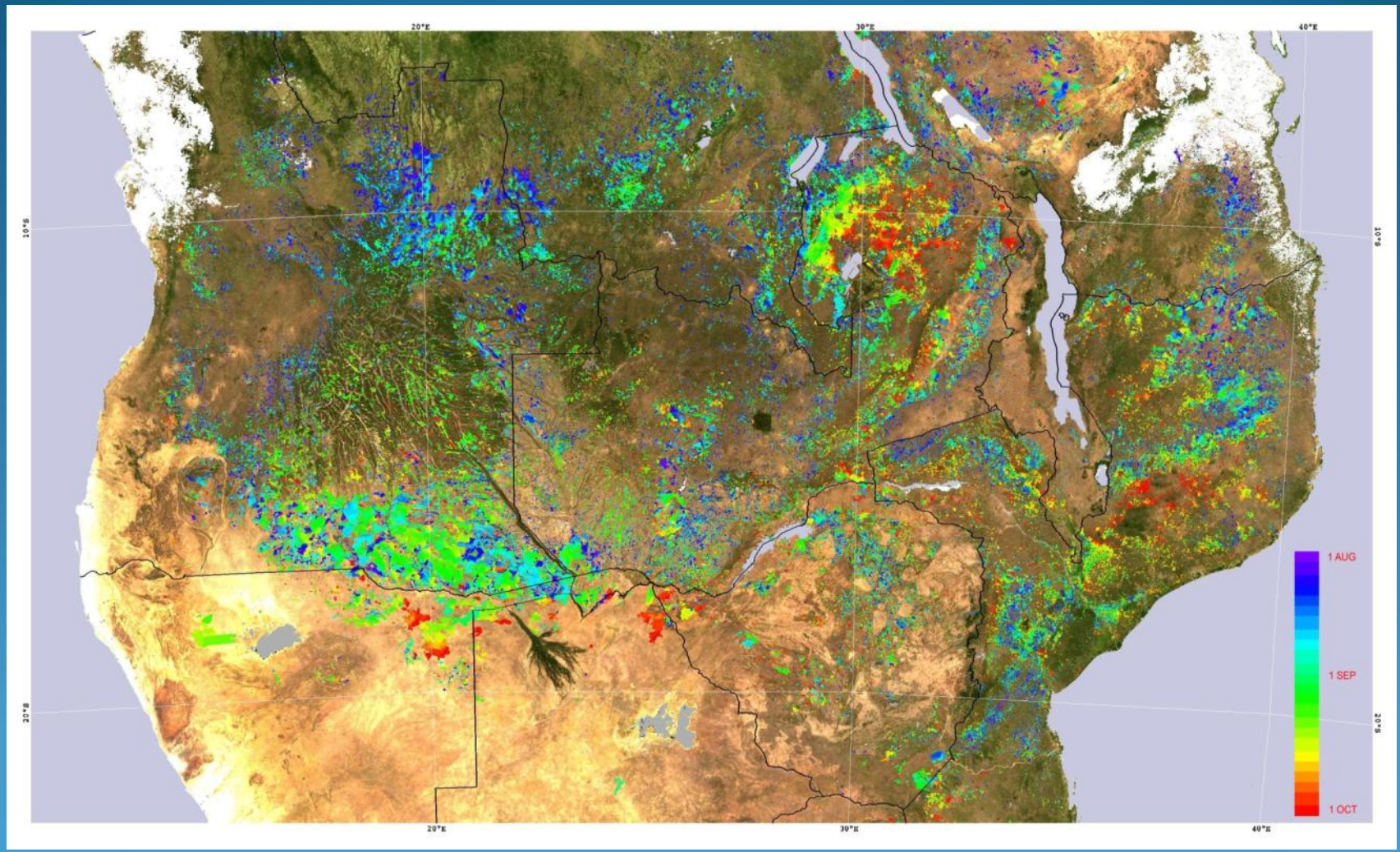
The MCD45 Algorithm and product suite (New product)

- New approach - *Rolling BRDF based expectation change detection*
- Semi-Physically based; less dependent upon imprecise but noise tolerant classification techniques
- Automated, without training data or human intervention
- Applied independently per pixel to daily gridded MODIS 500m land surface reflectance time series

=> **map 500m location and approximate day of burning**

- **Monthly Product (MCD45A1)**
  - 500m approximate day of burning over month +/- 8 days
  - MODLAND 10x10 degree tiles (HDF-EOS format)
  - Extensive QA & metadata
- **Annual Synthesis Product (forthcoming)**
  - As monthly product but for calendar year
- **CMG 0.25 deg product (forthcoming)**
  - Aggregated information for climate modeling community (continental scale, easily accessible format)

Collection 4 prototype (500m burned area)



Collection 5 recommendations

- This is a new product - there is no Collection 4 product
- Product user manual and ATBD are posted on the MODIS Fire website
  http://modis-fire.umd.edu
- Collection 5 production of MCDA1 has started
  - reprocessing of November 2000+
  - forward production of February 2007+
- Note, changes to the Collection 5 algorithm are likely
- Change descriptions will be posted on the MODIS Fire website
- Product version reflected in the product PGEVersion metadata
- Product quality issues posted on the LDOPE QA Web Site

MODIS Vegetation Products

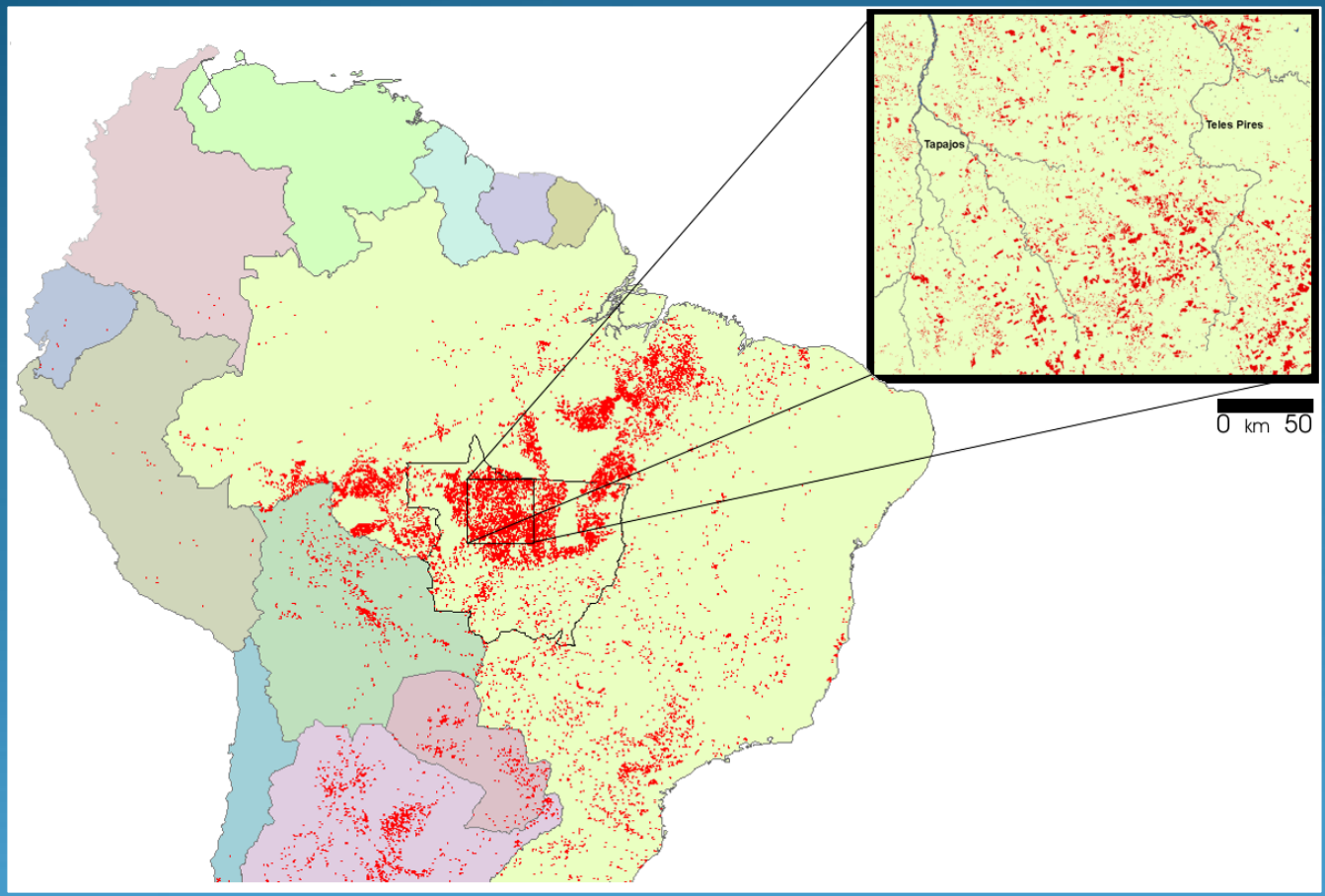
John R.G. Townshend & Mike Carroll

University of Maryland, Geography Department

C4 to C5 changes

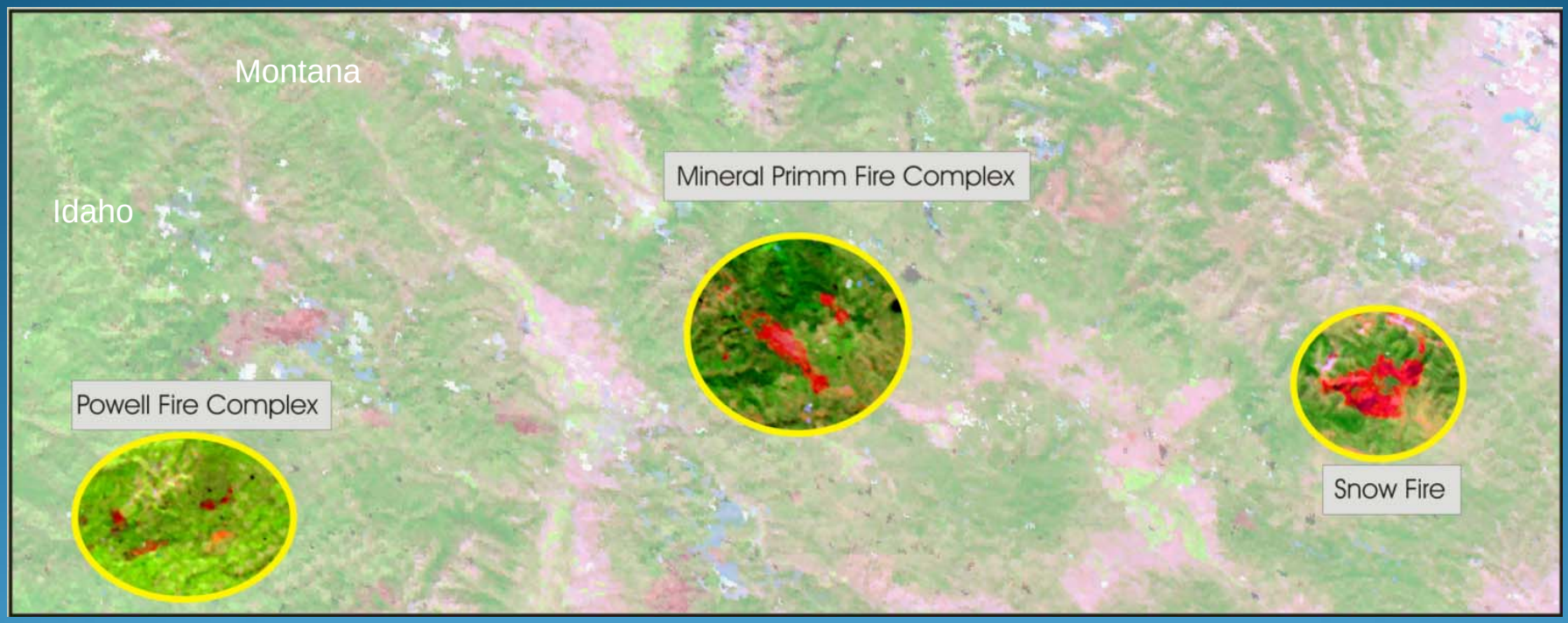
- VCC
  - Addition of inundation identification
  - Expanded record for the change due to burning
  - Deforestation results for temperate and boreal zones
- VCF
  - Change in resolution from 500m to 250m
  - Addition of the following layers
    - Leaf type
    - Leaf longevity
    - Crops
    - Water
  - Regional tuning of percent tree, herbaceous and bare

Five Year Vegetative Cover Conversion Showing Tropical Deforestation



MODIS VCC showing deforestation for South America from 2001 to 2005. The outline box in the large image shows the location of the full resolution data in the upper image from Mato Grosso, Brazil. Change is shown in red.

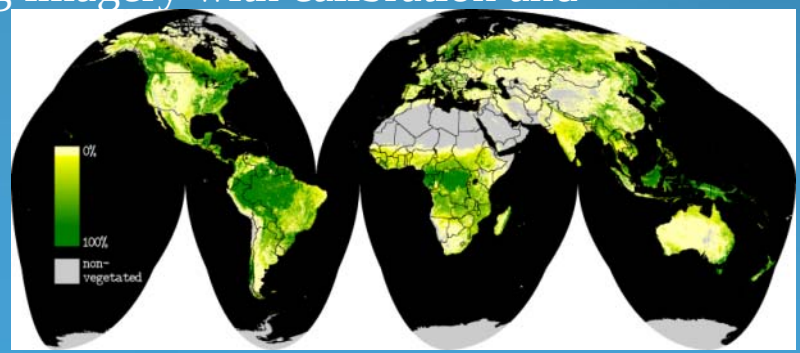
Vegetative Cover Conversion – Change Due to Burning (VCC-CDB)



VCC-Change Due to Burning (VCC-CDB) is generated at 250m resolution using data from the MODIS instrument using Normalized Burn Ratio (NBR) calculated (NIR – SWIR/NIR +SWIR) from 16-day composite.

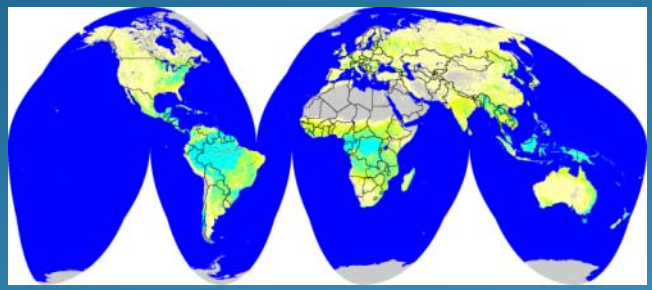
Vegetation Continuous Fields

- Sub-pixel estimate of percent cover
  - Woody, herbaceous and bare
  - Leaf type, leaf longevity, crop cover and water cover
- Employs annual metrics based on reflectance and temperature variations
- Regression tree provides cover estimate in 1% step
- 500m spatial resolution, 250m in Collection 5
- Updated annually
- Can be used to derive changes in forest cover
- Overcome artificial boundaries inherent in classification approaches
- Independent of strict class type definitions
- Possible to apply temporally to identify changes in % cover
- Derived from coarse resolution remote sensing imagery with calibration and validation from high resolution data

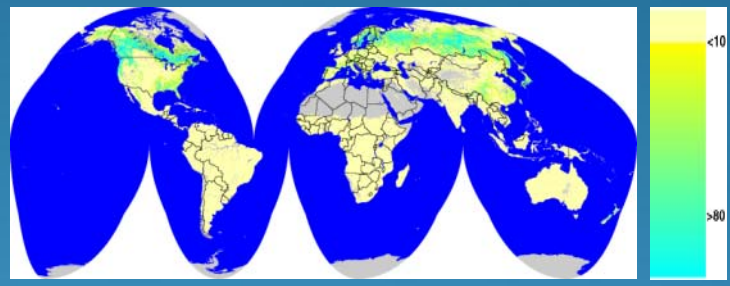


Example product

Leaf type

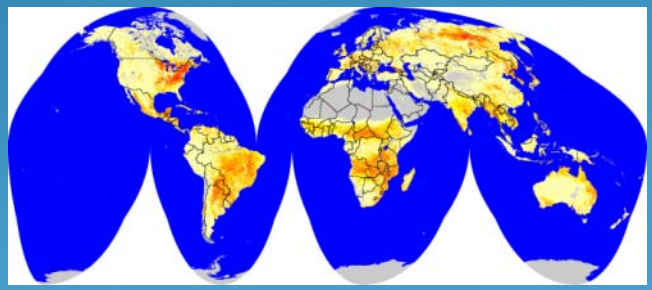


% broadleaf

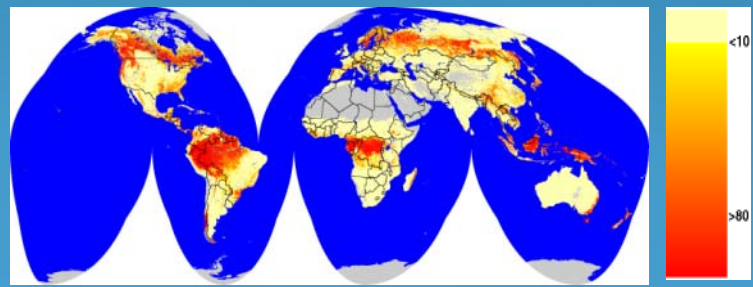


% needleleaf

Leaf longevity



% deciduous



% evergreen

Land wide C5 recommendations

- Use collection 5 whenever available
- It is ‘ok to mix’ Collection 4 and collection 5 for time series, but assess the impact on your specific application
- For ‘subtle’ climate trend studies better to wait for Collection 5 completion – consistent record and documented accuracy

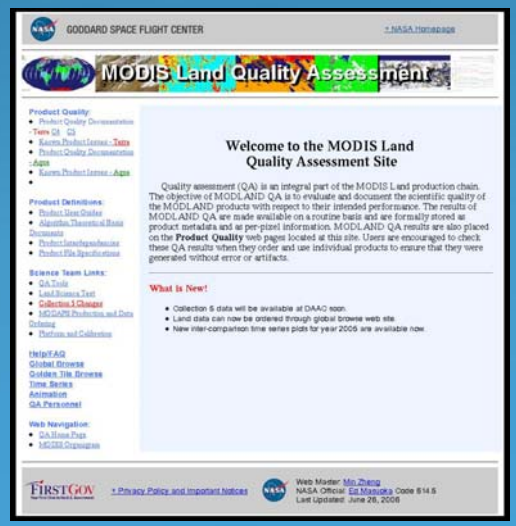
MODIS Land QA

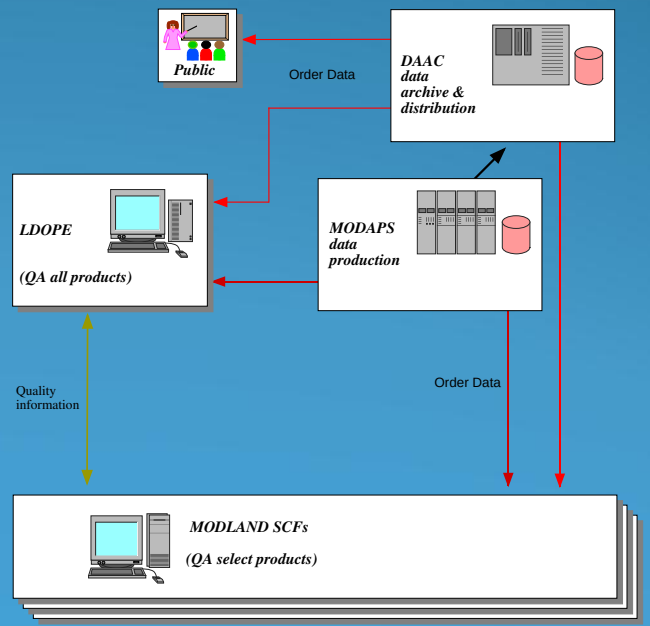
Sadashiva Devadiga & Min Zheng

SSAI

LDOPE Role : MODIS Land Products QA

- **LDOPE -** *is a centralized facility providing a coordination mechanism for MODLAND's QA activities*
  - Performs routine and coordinated QA of all MODIS land products
  - testing & dependencies
  - MODLAND QA services – on LDOPE web site
    - Global & Golden tile Browse, Animations, Time series
    - LDOPE QA Tools
    - Science Quality Flag & Science Quality Flag Explanation
    - Known issues





Known issues documentations

Known issues in MOD09 product (Surface reflectance)

Related PGEs: PGE11 (MOD09_L2), PGE13 (MOD09GQK, MOD09GHK, MOD09GST), PGE21 (MOD09A1)

Product information is also found at the PI website.

Summary

Color Key | Case pending | Case closed | Case reopened | QA note

Case number	Opening Date	Last Update (Sort)	Status	Description
SD_MOD09_06313	10/03/06	10/03/06	Pending	Use of wrong granules in MOD09CMG (CS)
SD_MOD09_06312	10/02/06	10/02/06	Pending	Reflectance values retrived over water area may be incorrect (CS)
SD_MOD09_06005	01/06/05	01/06/05	Pending	Incorrect MODLAND QA bits in MOD09 products
SD_MOD09_04260	09/16/04	08/16/04	Note	Artefact in MOD09 due to high aerosol
SD_MOD09_04105	05/24/04	08/16/04	Note	data corruption due to geolocation problem
SD_MOD09_04104	05/24/04	08/16/04	Note	data corruption due to geolocation problem
SD_MOD09_03289	10/16/03	08/16/04	Note	Striping in MOD09 products associated with noise in band 7.
DR_MOD09_03163	06/12/03	08/16/04	Closed	Production issue corrupted some L2G MOD09 sensed 2003155
SD_MOD09_03148	05/29/03	08/16/04	Note	MOD09A1 made with incomplete set of input L2G
SD_MOD09_03129	03/05/04	08/16/04	Note	Artefact in MOD09 composite product due to high aerosol.
SD_MOD09_03041	02/10/03	08/16/04	Closed	Aerosol retrieval in collection 4 processing
SD_MOD09_02213	08/01/02	08/16/04	Closed	MOD09A1 made with incomplete set of input L2G
JB_MOD09_02070	03/11/02	08/16/04	Closed	Aerosol retrieval artifact over bright surfaces
SD_MOD09_01338	12/24/01	08/16/04	Note	Inaccuracies in MOD03 land water mask propagate into MOD09
JB_MOD09_01332	11/28/01	01/07/02	Closed	Geolocation bug in MOD09
JB_MOD09_01331	11/27/01	08/16/04	Closed	Corrupt geolocation data affect MOD09 and MOD09GHK
JB_MOD09_01317	11/13/01	08/16/04	Note	Overlap between end-of-year and beginning-of-year compositing periods
JB_MOD09_01305	11/01/01	08/16/04	Closed	Probable corrupt band 5 data for day 2001146 in MOD09GHK
JB_MOD09_01304	10/31/01	02/26/02	Closed	Incorrect interpretation of L1B TOA reflectance
JB_MOD09_01302	10/29/01	08/16/04	Note	Aerosol interpolation artifact
SD_MOD09_01295	10/22/01	08/16/04	Closed	Blocky artefacts found in certain cloudy MOD09 L2G products
JB_MOD09_01283	10/10/01	08/16/04	Note	Dropped packet artifact from L1B in aggregated 250m data
JB_MOD09_01282	10/09/01	10/09/01	Note	Odd-even effect in MOD02 affects MOD09
JB_MOD09_01278	10/05/01	08/16/04	Note	Striping in band 5
DR_MOD09_01278	10/05/01	08/17/04	Note	Low amplitude striping in areas with high atmospheric aerosol content
JB_MOD09_01277	10/04/01	08/16/04	Note	Striping in areas with high atmospheric aerosol content
JB_MOD09_01215	08/03/01	08/17/04	Closed	Corrupted data may be present

Detailed Description

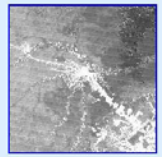
Color Key | Case pending | Case closed | Case reopened | QA note — Large Image

Case #:SD_MOD09_03289 **Opening date:** 10/16/03 **Last update:** 08/16/04
Status: Note

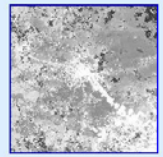
Striping is observed in some of the surface reflectance products associated with noise in band 7. Band 7 is used by the surface reflectance algorithm for aerosol optical depth retrieval. The problem is severe in products made using the Terra MODIS data and is mainly observed over regions with high vegetation cover such as the Amazon. The striping is less evident at the longer wavelength bands (2,5,6) that are not band 7. This problem is not observed in the AQUA surface reflectance (MYD09) products.
The following example shows a spatial subset of an 8-day surface reflectane tile made using Terra (MOD09A1) and Aqua (MYD09A1) MODIS data.

MOD09A1.A2003257.h11v09.004.2003275023809.hdf
SDS: RGB composite of surface reflectance band 1, 3, and 4.

MYD09A1.A2003257.h11v09.003.2003278172916.hdf
SDS: RGB composite of surface reflectance band 1, 3, and 4.



MOD09A1.A2003257.h11v09.004.2003275023809.hdf
SDS: Surface Reflectance Band 7.



MYD09A1.A2003257.h11v09.003.2003278172916.hdf
SDS: Surface Reflectance Band 7.

Note: This striping is propagated into depedent products such as the VI (MOD13) products, LAI/FPAR (MOD15) products, and BRDF/Albedo (MOD43, MCD43) products.

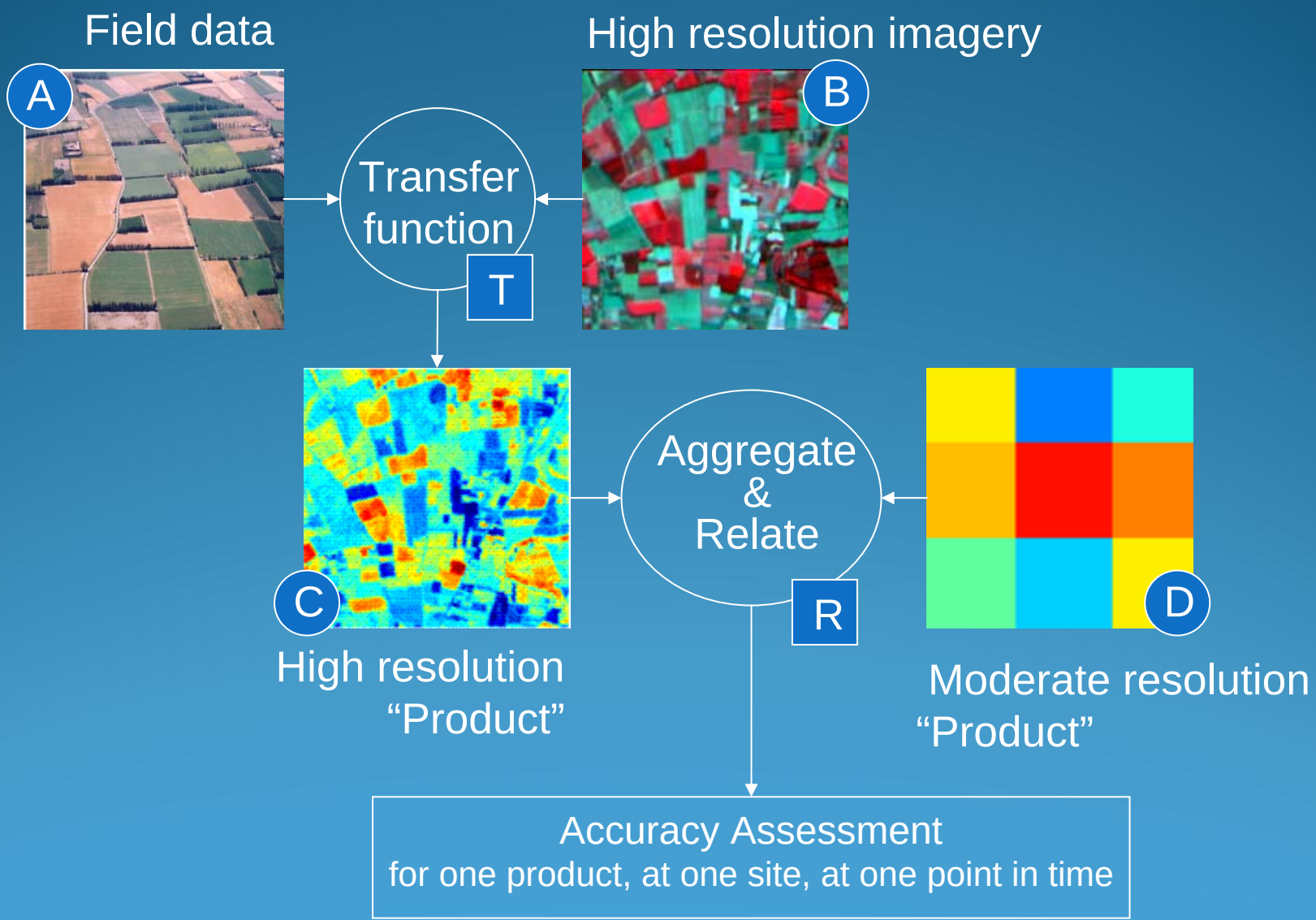
Occurrence: Collection 4 and collection 3 Terra L2, L2G and L3 MOD09 products
PGE:

MODIS Land Product Validation

Jeff Morisette, Jaime Nickeson, Sebastien Garrigues

NASA HQ, GSFC

Validation framework



Validation Hierarchy

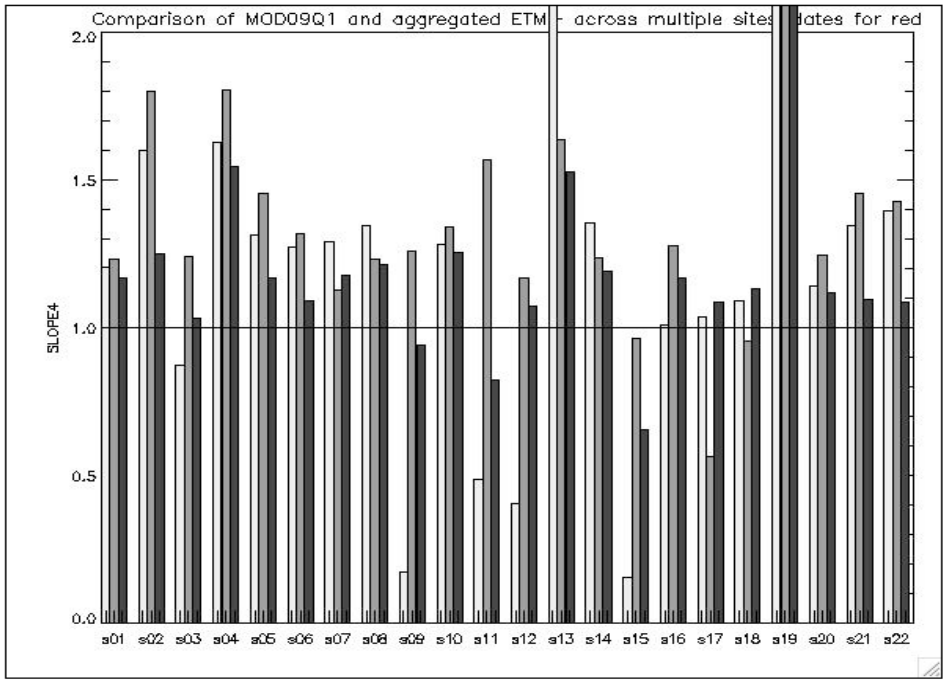
- **Stage 1 Validation**: Product accuracy has been estimated using a small number of independent measurements obtained from selected locations and time periods and ground-truth/field program efforts.
- **Stage 2 Validation:** Product accuracy has been assessed over a widely distributed set of locations and time periods via several ground-truth and validation efforts.
- **Stage 3 Validation**: Product accuracy has been assessed, and the uncertainties in the product well-established via independent measurements made in a systematic and statistically robust way that represents global conditions.

Morisette, J.T., F. Baret, S. Liang, 2006. Special issue on Global Land Product Validation, *IEEE TGARS* 44(7) 1695-1697.

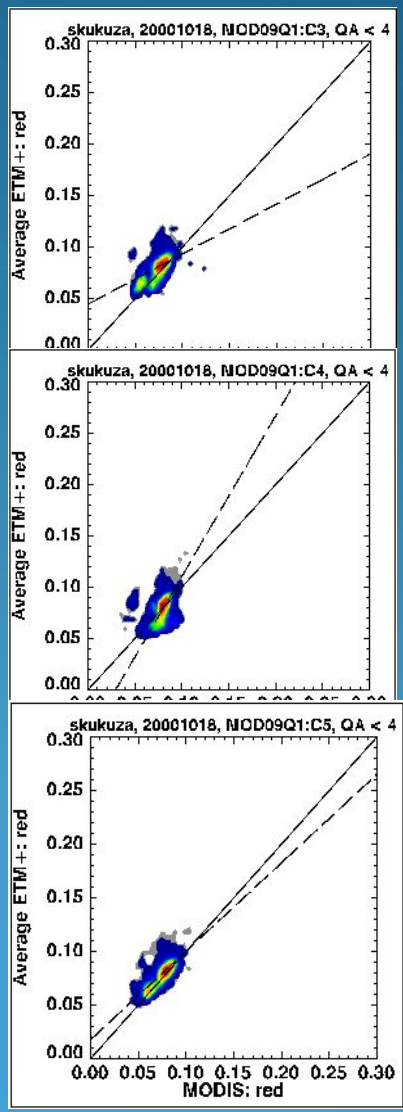
Validation effort

Evaluating MODIS Products from Collections 3, 4 and 5
Comparisons with Coincident ETM+ Data

Product: MOD09Q1_ETM with a QA threshold of 4
Parameter: Fitted slope



s01 - Ji-Parana, 11 Aug 2001
s02 - Bondvill, 15 May 2001
s03 - Harvard, 5 Sep 2001
s04 - Harvard, 28 Jul 2001
s05 - Konza, 9 May 2001
s06 - Konza, 13 Aug 2001
s07 - Mongu, 31 Jul 2000
s08 - Mongu, 1 Sep 2000
s09 - Parkfall, 25 Sep 2001
s10 - Skukuza, 31 Aug 2000
s11 - Skukuza, 18 Oct 2000
s12 - Skukuza, 28 Apr 2001
s13 - Skukuza, 18 Aug 2001
s14 - Skukuza, 3 Sep 2001
s15 - Tapajos, 30 Jul 2001
s16 - Usdaars, 3 Nov 2000
s17 - Usdaars, 22 Jan 2001
s18 - Usdaars, 7 Feb 2001
s19 - Usdaars, 23 Feb 2001
s20 - Usdaars, 28 Apr 2001
s21 - Usdaars, 2 Aug 2001
s22 - Walkerbr, 1 Oct 2001

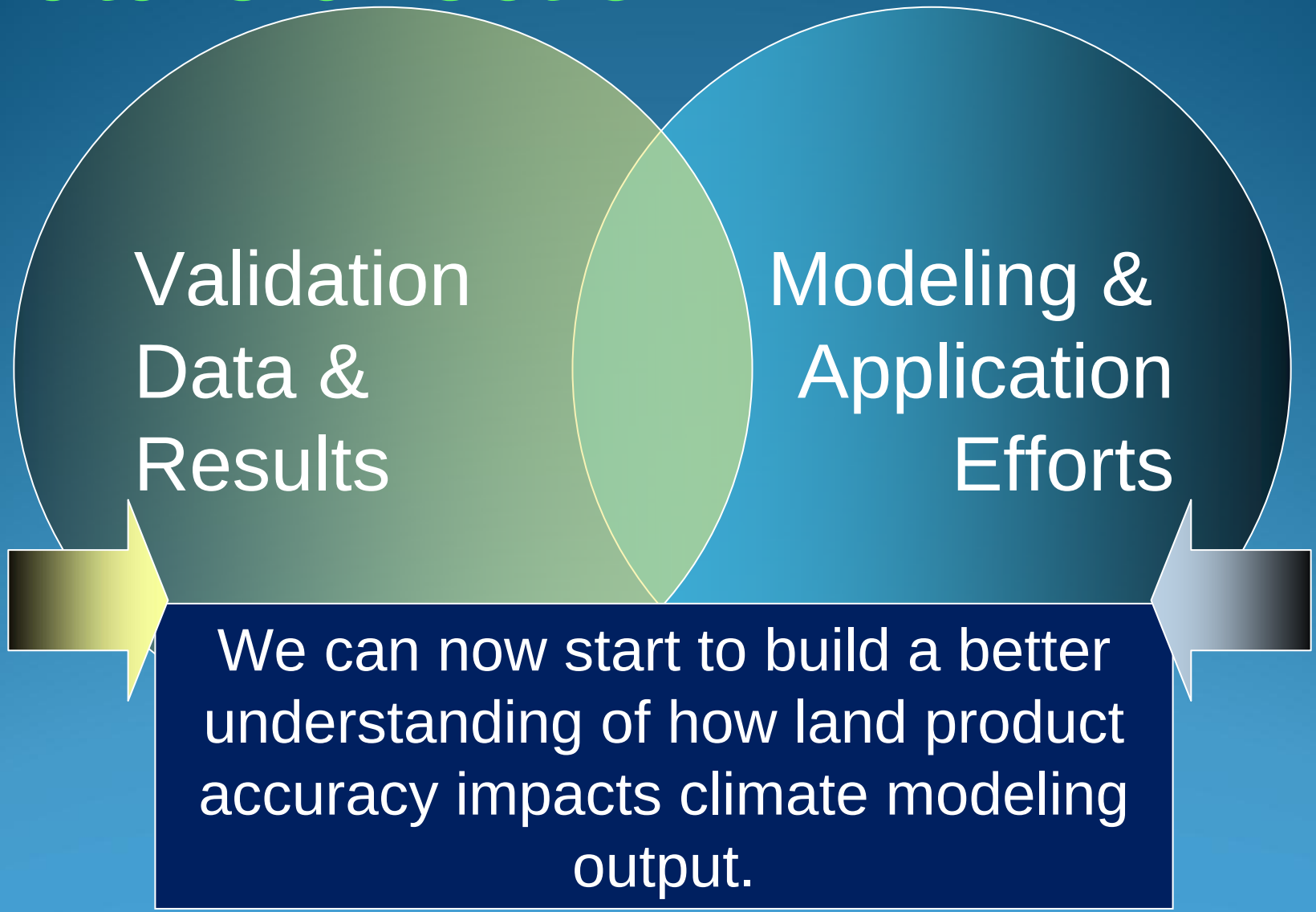


collection 3

collection 4

collection 5

Future direction



MODIS Land Product Subsets: Remote Sensing Products for Field Sites (Collections 4 & 5)

Bob Cook, Suresh Kumar,
Susan Holladay, and Steve Margle

Oak Ridge National Laboratory- DAAC
Oak Ridge, Tennessee, USA

ORNL-DAAC Role

- ORNL DAAC supports the biogeochemical dynamics and terrestrial ecology (field) research community
  - Field Campaigns, Land Product Validation, Ecosystem Modeling, and Model Archive
- Community requested that we prepare MODIS Land Products in an easy-to-use format and size
  - To validate remote sensing products
  - To characterize field sites
  - For use in modeling studies
- Collection 5 Subsets: in development, beta test version
- Collection 4 Subsets: subsetted products available through Sept. 2008(?)

Future direction

- MODIS Collection 5 data for selected sites
  - Beta test now
  - Seeking users' feedback
- Global Subsetting Tool for Collection 5
  - Create subsets of MODIS land products for any location on land anywhere on the globe
  - Quicker turn around time
  - Available Spring 2007 (!?)
- Subsets of MODIS for NACP products
  - Smoothed LAI & fPAR and Vegetation Indices; Land surface water index
- Tools
  - More GIS functionality
  - New visualization features

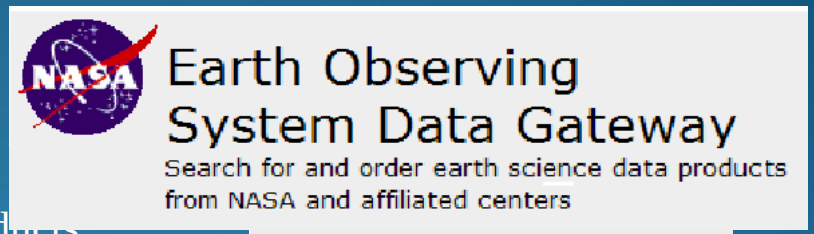
Getting MODIS Data

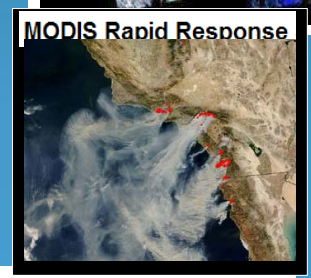
Robert Wolfe

NASA GSFC Code 614.5

Where is the 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.)

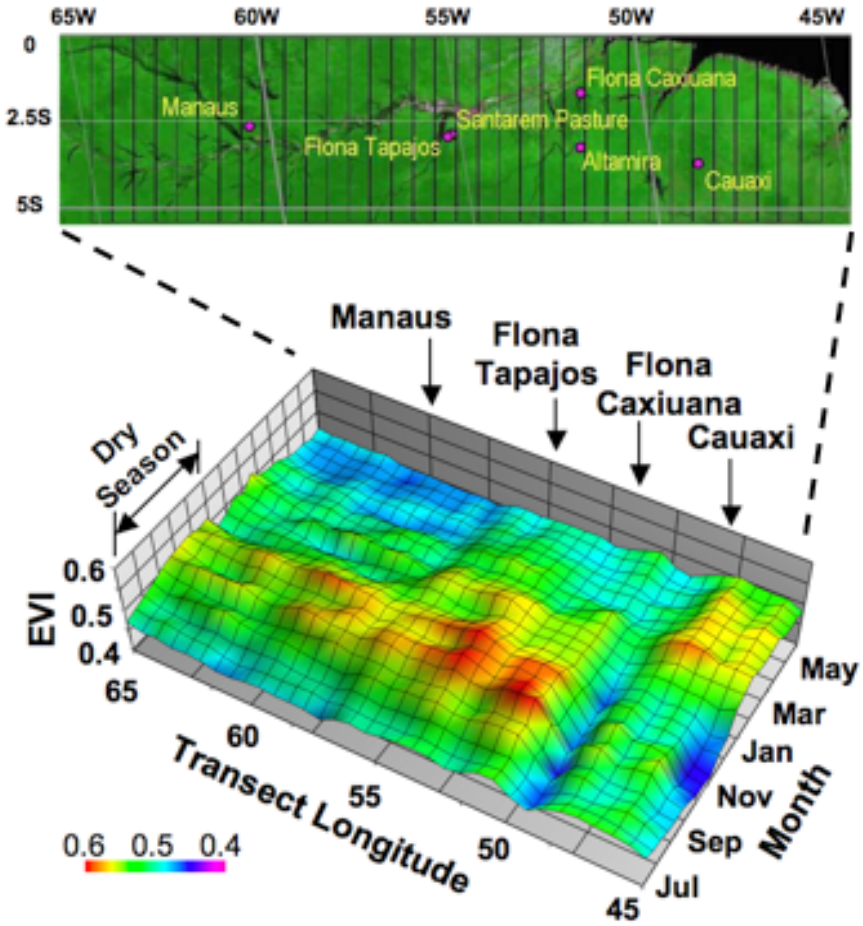


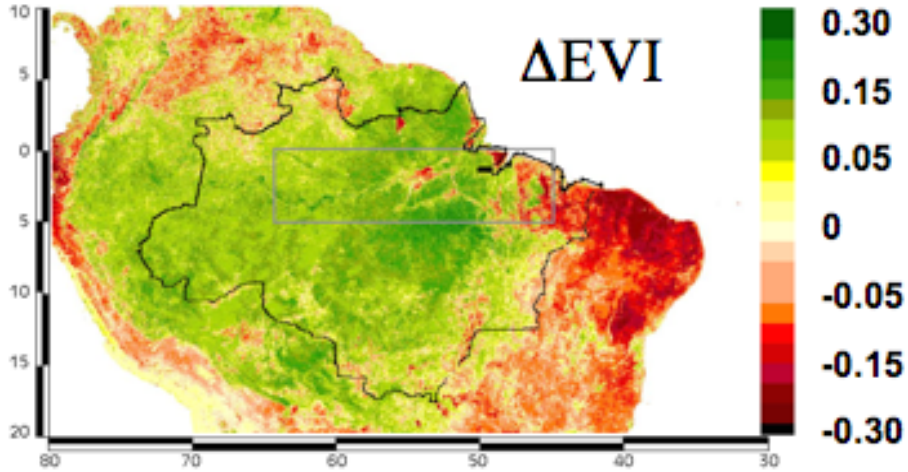


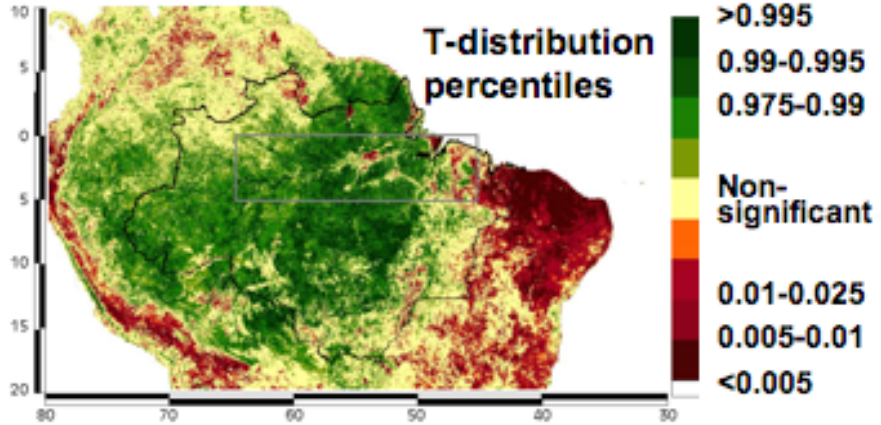
Research highlights from

Science Team

Amazon Rainforests Green-up with Sunlight in Dry Season

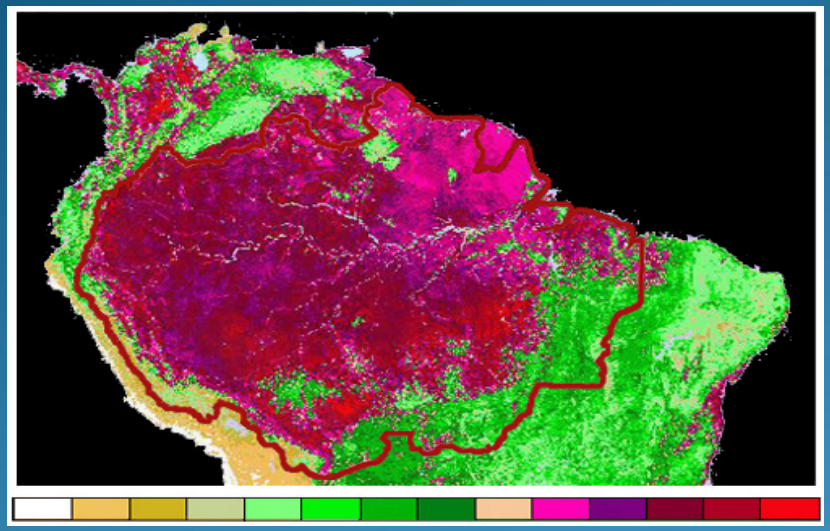






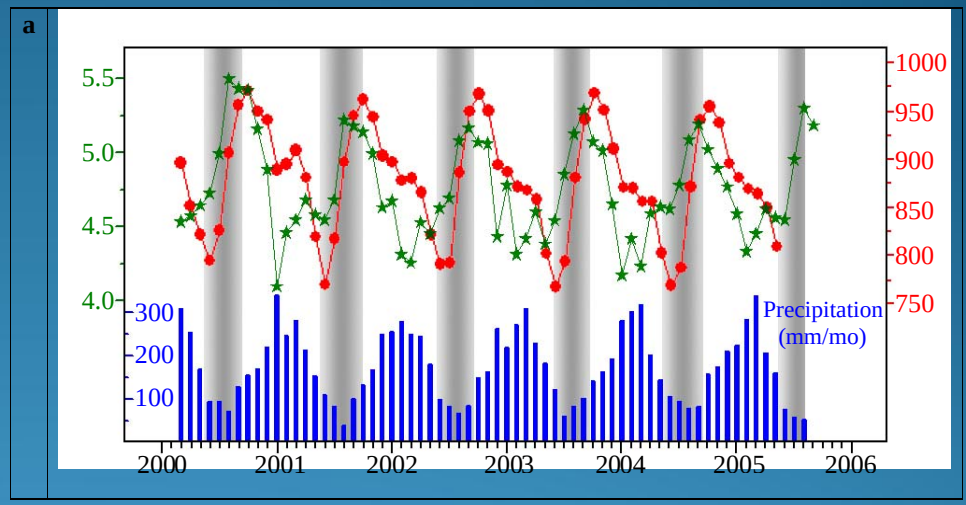
Huete et al. (GRL,. 2006)

Large Seasonal Swings in Leaf Area of Amazon Rainforests



0.0 0.3 0.8 1.6 2.8 4.2 5.0 7.0

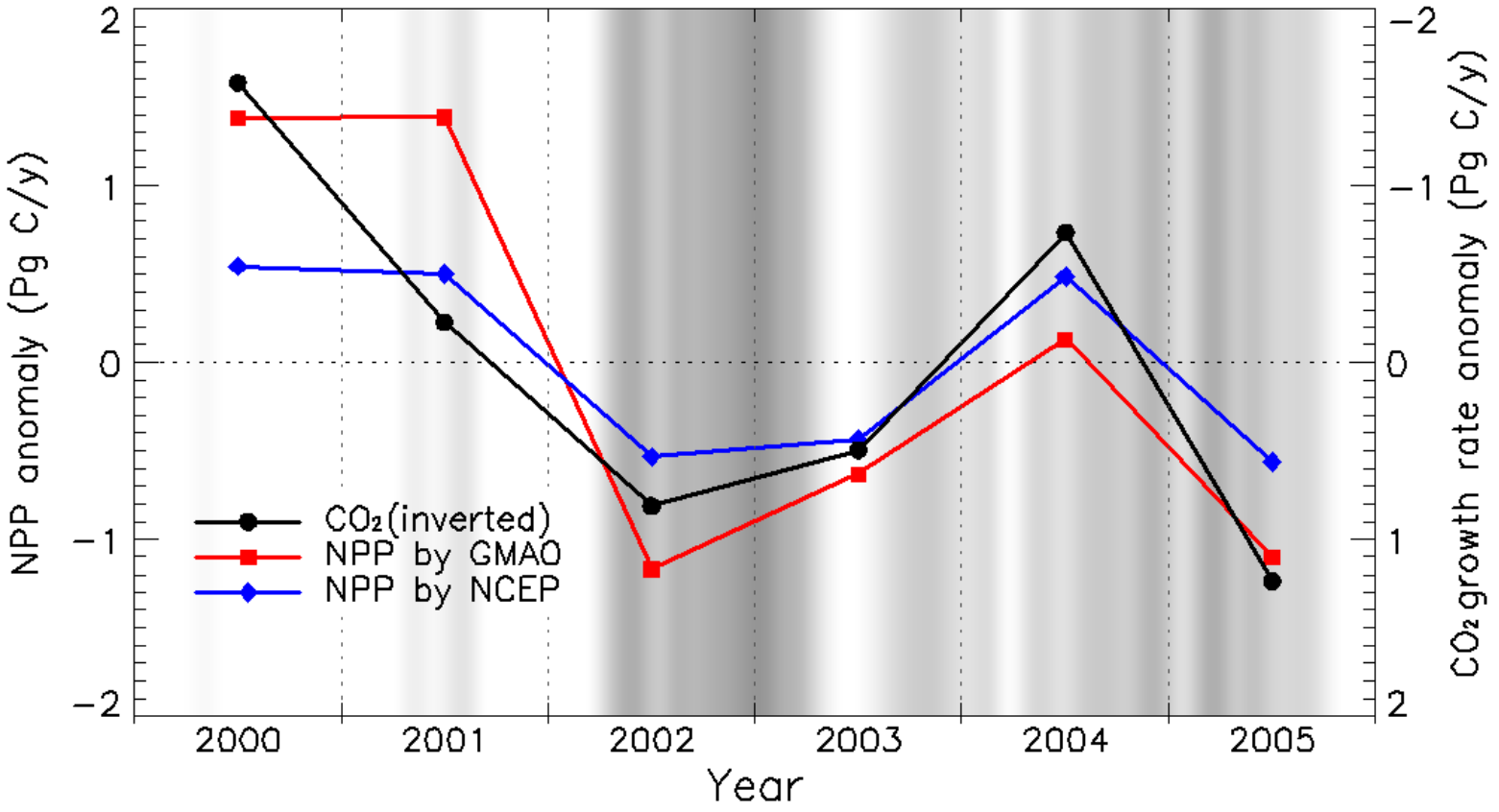
Annual Average Leaf Area Index



Leaf area data of the Amazon rainforests exhibit *notable seasonality*, with an amplitude (peak to trough difference) that is about 25% of the average annual LAI of 4.7, over the entire course of the data record.

Myneni et al. (PNAS, 2007)

Inter-annual Anomalies of MODIS Global NPP



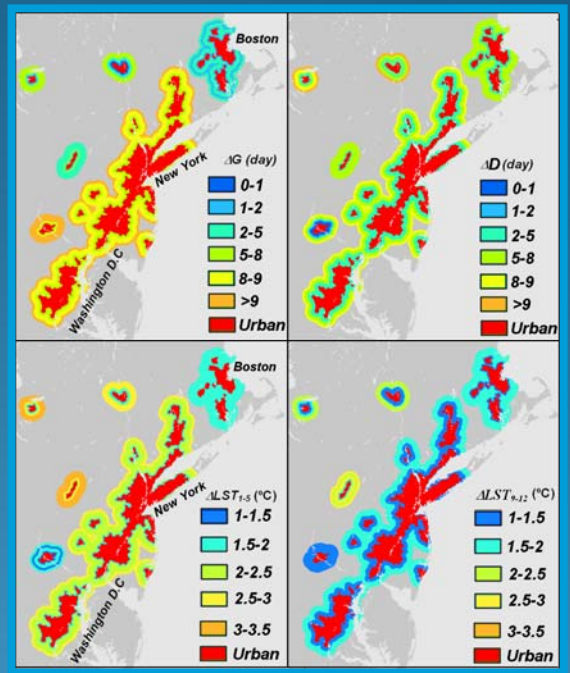
Correlation between NPP and inverted CO_2 growth rate

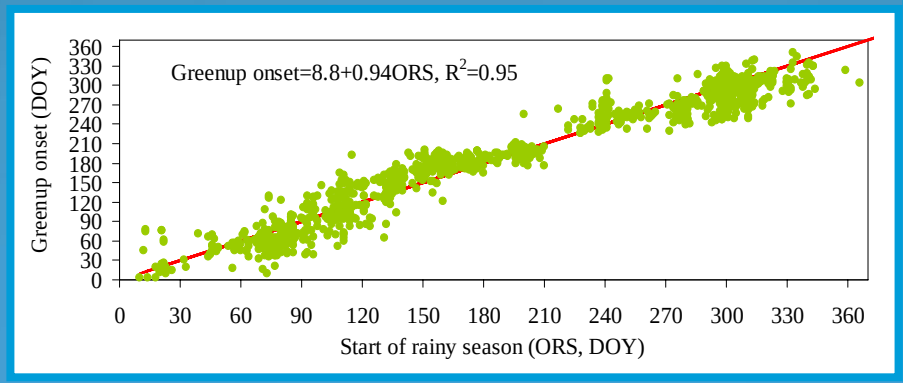
NPP by GMAO R = 0.85 2000~2005 $p < 0.016$

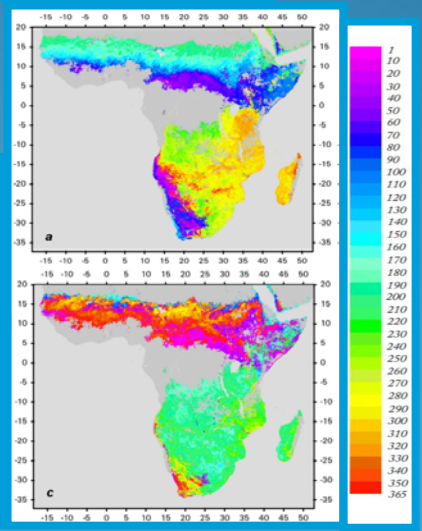
NPP by NCEP R = 0.91 2000~2005 $p < 0.006$

Global Vegetation Phenology, Mark Friedl, Boston Univ

- Footprint of Urban Climates on Phenology:
  - Phenological signature extends well beyond urban periphery
    - Exponential decay
  - Footprint
    - 2.4 x urban area
    - Longer growing season
- Compare Onset of rainy season (TRMM) onset of greenup (MODIS)
  - Linear model explains 93-95% of variance in timing of greenup onset

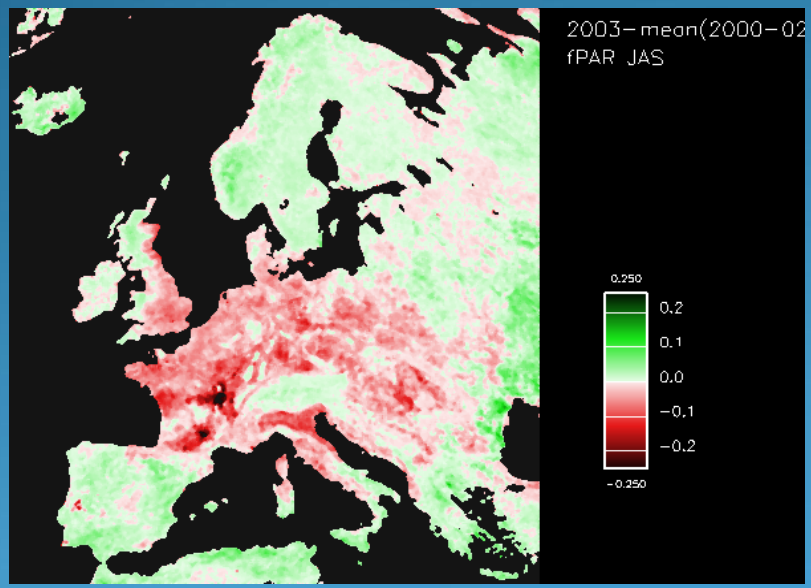




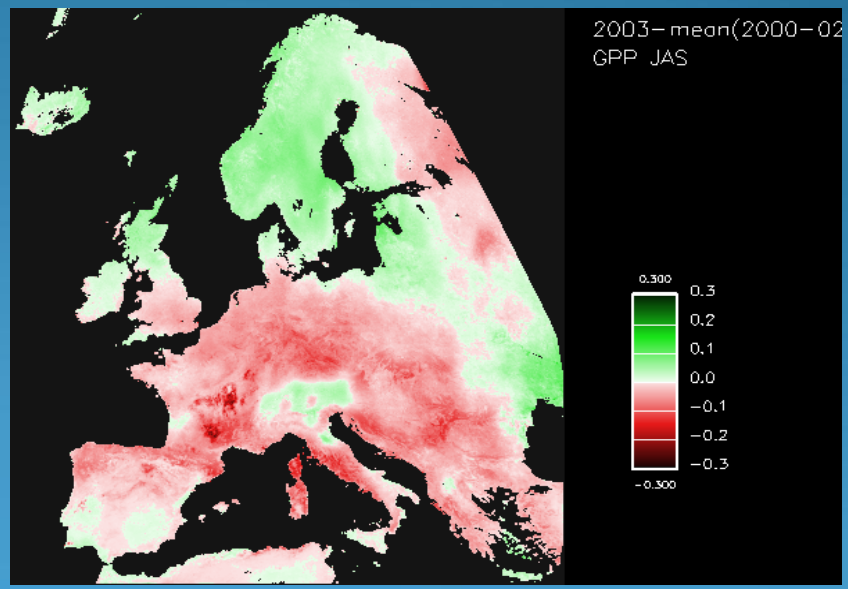


Europe Summer 2003 fPAR 'anomaly‘ according to MOD15+/MOD17+

FPAR 'anomaly‘
Jul./Aug./Sept.
2003-mean(2000-2002)
Unit: fraction



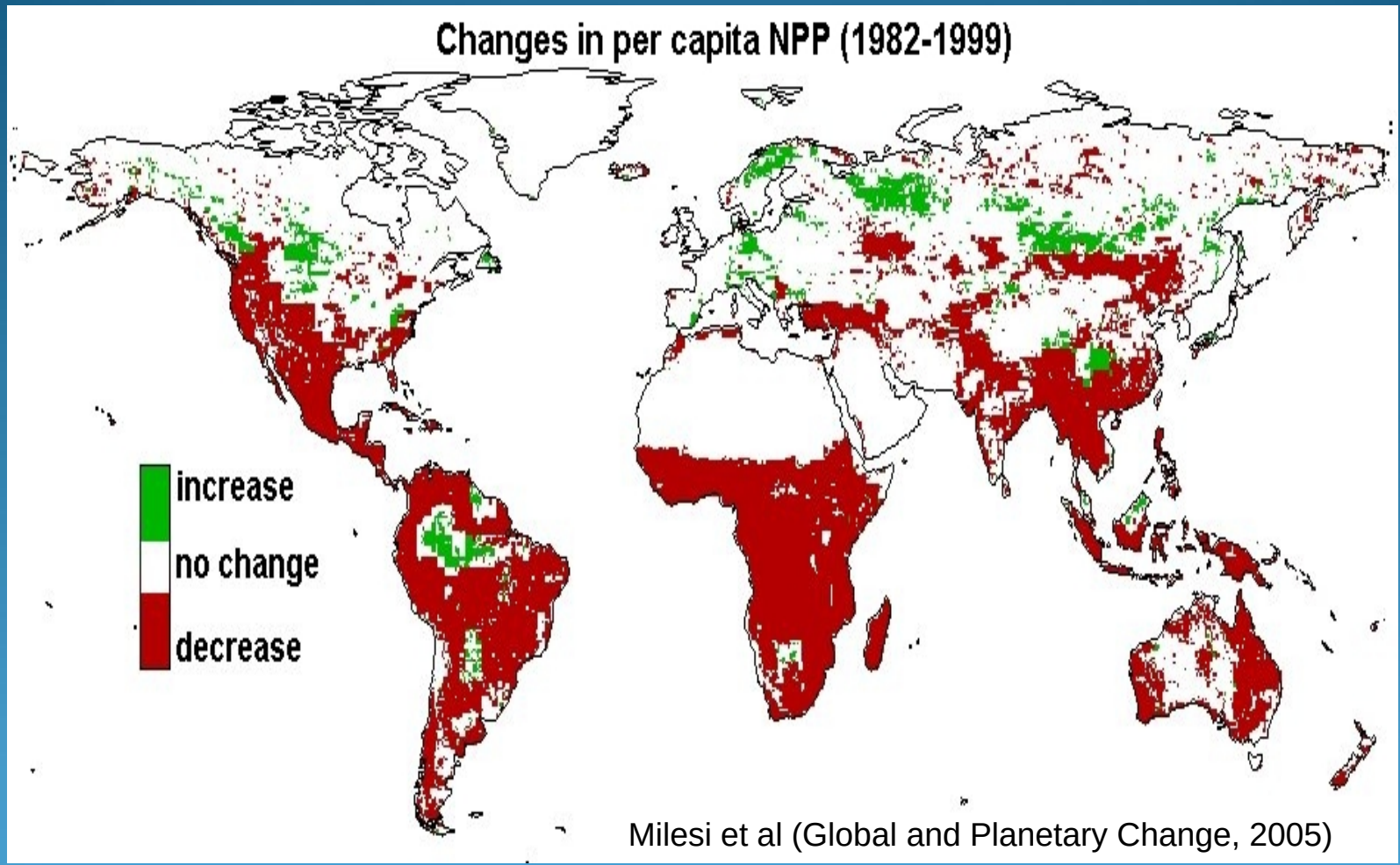
GPP 'anomaly‘
Jul./Aug./Sept.
2003-mean(2000-2002)
Unit: kg m^{-2}



M. Reichstein et al., (2005)

The increase in NPP is very modest compared to population growth

- Δ NPP per capita = Δ NPP / Δ Population

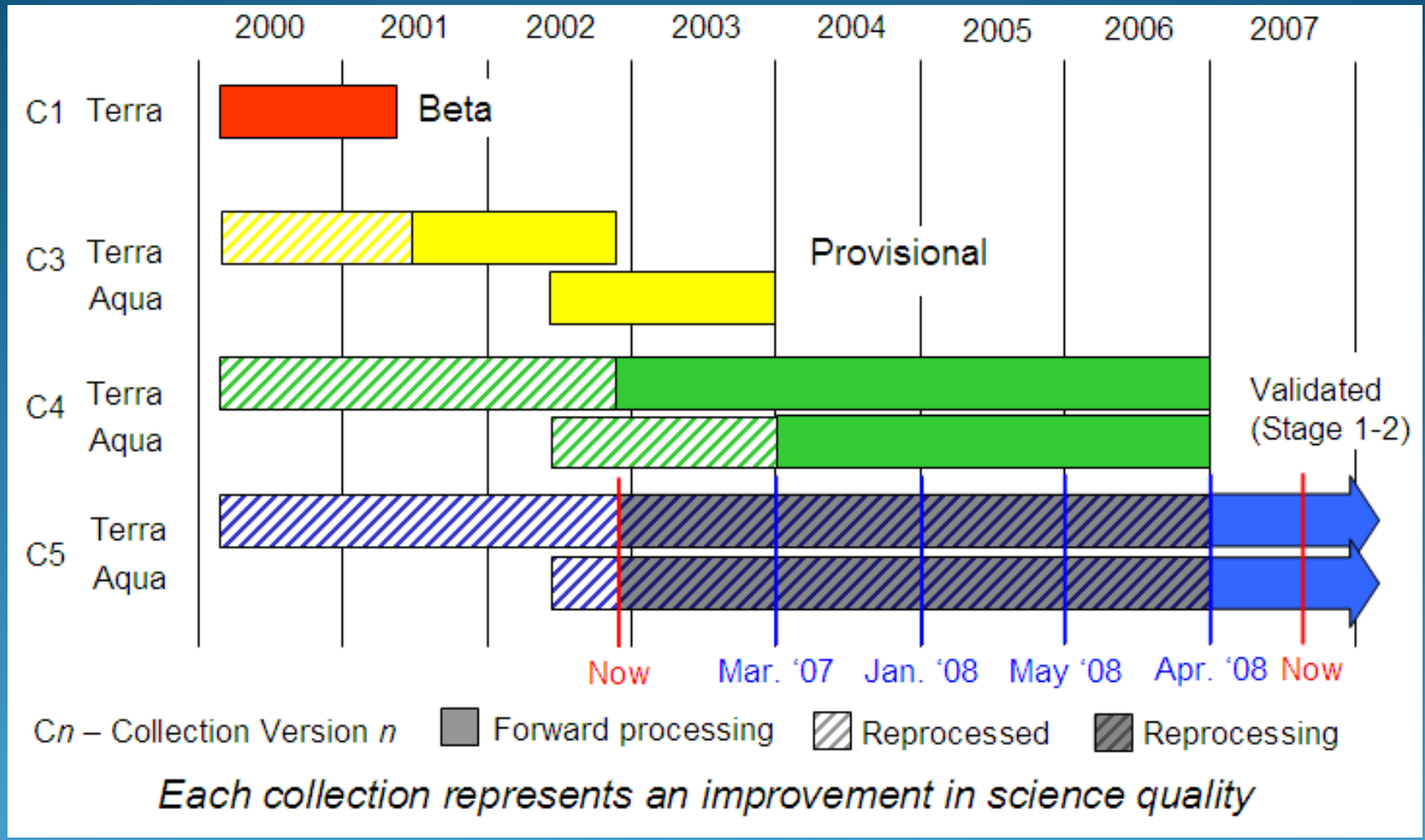


Over 80% of the populated land areas NPP per capita declined

Collection 5 Processing Status

Robert Wolfe, Mike Teague & Ed Masuoka

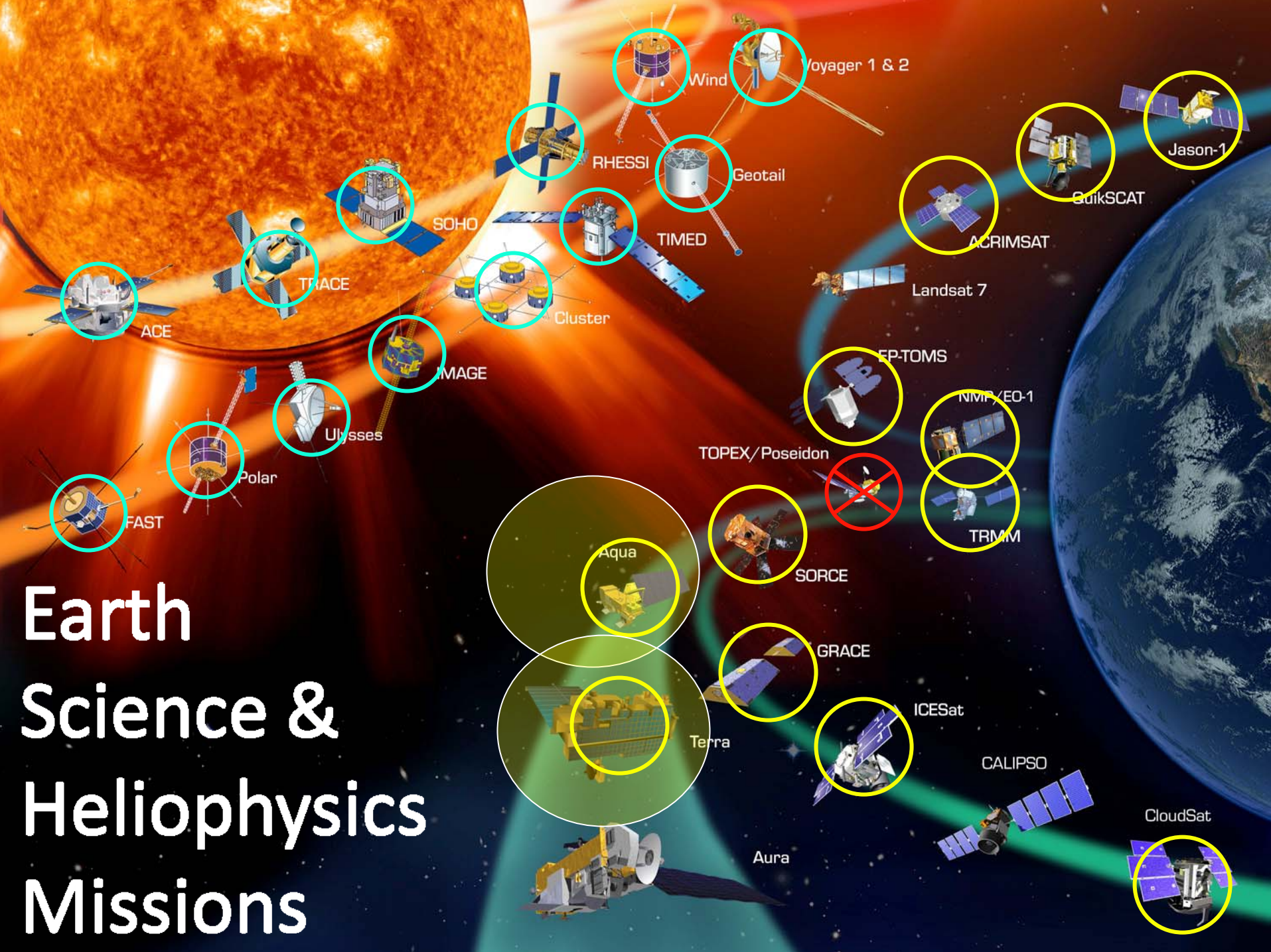
MODIS Land Collections



Assuming the production proceeds at 4x/machine, the land reprocessing will be completed by late-May, 2008

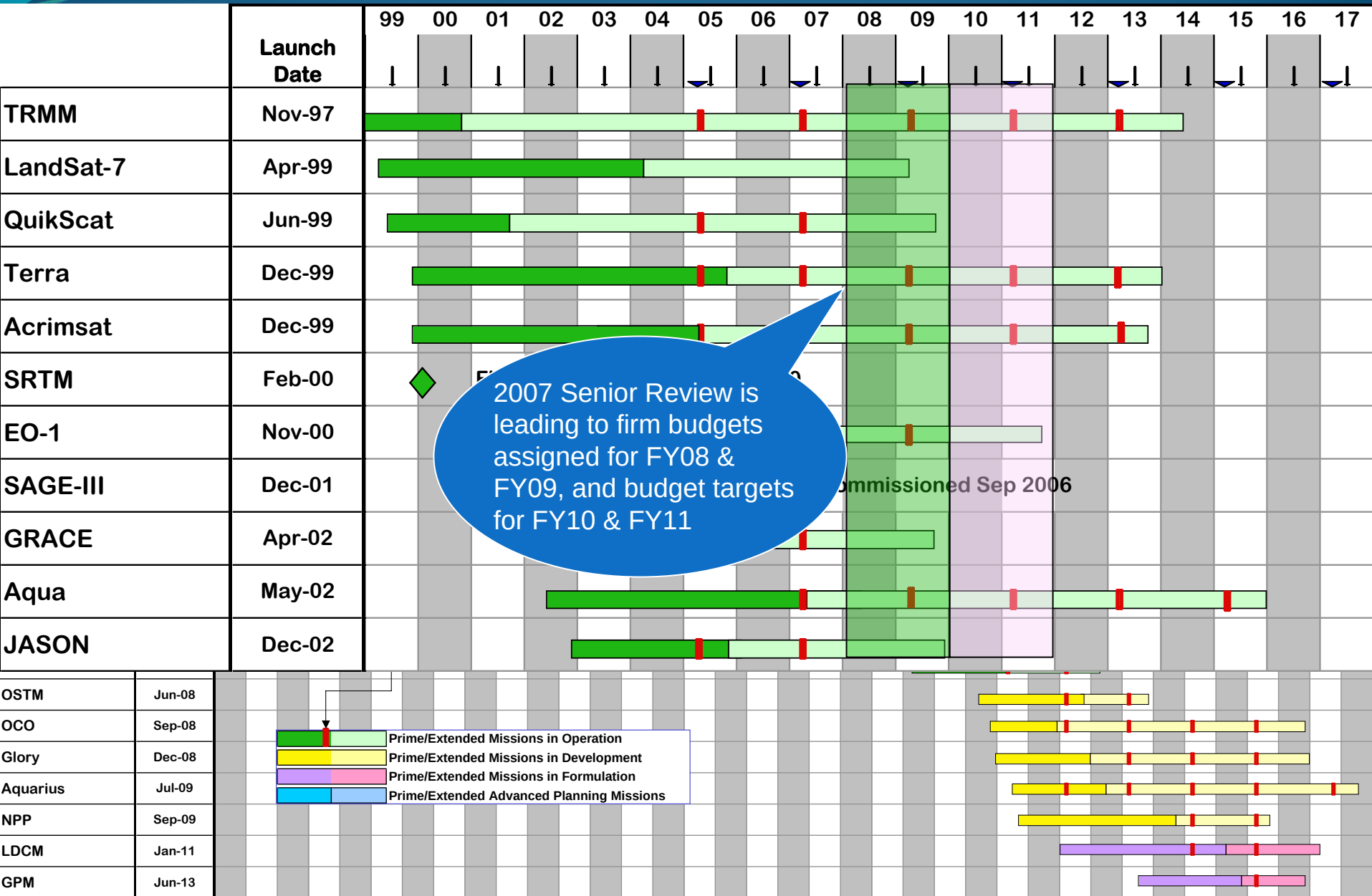
NASA Senior Review and Mission Extension

NASA Review



Earth Science & Heliophysics Missions

Earth Science Missions



Review Overview

- Primarily: Scientific relevance of the mission/measurement to NASA Science Strategic Plan
- Secondary but still important criteria include:
  - Efficiency and cost effectiveness of the mission operations
    - Could be cost reductions with extended missions, but not necessarily so. Older missions may need more “care and feeding” than younger.
  - Multiple instrument and satellite utility of the data products
    - Looking for multiple satellite data fusion
  - Quality and timeliness of the baseline data products
    - Including processing, archiving, and dissemination of the data products to the broader scientific and general community (operational users)
  - Education & Public Outreach section will also be included

Review Panels

- **NASA EARTH SCIENCE SENIOR REVIEW**

Gregory Asner (chair), Steve Ackerman, Anthony Busalacchi, Janet Campbell, Tsing-Chang Chen, Dennis Hartmann, Thomas Herring, Ian Joughin, Michael Prather, William Rossow, Azadeh Tabazadeh, Xubin Zeng

- **Education and Public Outreach**

Ann Benbow, Larry Cooper, Jennifer Grier, Jean May-Brett, Theresa Schwerin

- **Core Mission Review Panel**

Robert Arnone, Tom Cecere, Michael Clancy, Jeffrey Hawkins, Brian Kennedy, David Kunkee, Bruce Quirk, Kevin Schrab, Dale Schulz, Stephen Volz, Shannon Walker, Cara Wilson

Review results

Science review

TERRA

Instruments: ASTER, CERES, MISR, MODIS, MOPITT
Data Products: Many
Maturity of Data Products: High (except for a few MISR core products)
Relevance to NASA Science Goals: **HIGH**
Maturity of Data Products: **HIGH**

AQUA

Instrument(s): AIRS/AMSU/HSB, MODIS, CERES, AMSR-E
Research Activities: EOS platform #2 in the A-train
Data Product Names: numerous
Science Strengths/Weaknesses: (below)
Relevance to NASA Science Goals: **HIGH**
Maturity of Data Products: **LOW to HIGH**

Education and Public outreach

Mission	E/PO Budget (FY07 SK)	% of Mission Costs	Score*	Recommendation
Terra **Terra "Plus"**	566 2,556	0.77% 3.25%	3.8	Acceptable
Aqua	905.0	0.74%	2.6	Acceptable with revisions

- 2008-2009 : Firm funding approved
- 2010-2011 : Highly fundable with further budget reviews

- Lack of synergy (important theme during the review)
- Why cost stays the same (No ramping down)

Core Mission Review Panel

	CoMRP Ranking	NOAA	USGS	Navy	Other DOD
Aqua	**Very High**	Very High	Very High	Very High	Very High
MODIS	*Very High*	*Very High*	*Very High*	*Very High*	*Very High*
AIRS	*Very High*	*Very High*	*NA*	*Very High*	*Very High*
AMSR-E	*Very High*	*High*	*NA*	*Very High*	*Very High*
CERES	*NA*	*NA*	*NA*	*NA*	*NA*
Terra	**Very High**	Very High	Very High	Very High	Very High
MODIS	*Very High*	*High*	*Very High*	*Very High*	*Very High*
ASTER	*High*	*NA*	*High*	*NA*	*High*
CERES	*NA*	*NA*	*NA*	*NA*	*NA*
MISR	*NA*	*NA*	*NA*	*NA*	*NA*
MOPITT	*NA*	*NA*	*NA*	*NA*	*NA*
TRMM	**Very High**	High	Some Utility	Very High	Very High
QuikSCAT	**Very High**	Very High	NA	Very High	Very High
Jason	**Very High**	Very High	NA	Very High	High
CloudSat	**High**	Some Utility	NA	High	Very High
SORCE	**High**	High	NA	NA	High
GRACE	**High**	NA	NA	NA	High
ICESat	**Some Utility**	NA	Some Utility	NA	High
EO-1	**Some Utility**	NA	NA	NA	Very High
ACRIMSAT	**NA**	NA	NA	NA	NA

Table 2: Detailed Mission and Product Assessment Breakout

anel developed a projection of the expected health of the missions for two two-year windows of FY08 – FY09 and of FY10 – FY11. The panel conclusions are shown below in Table 3.

	Risk of failure within 2 years	Risk of failure within 4 years	Primary Risk Factor	Age (years) in 2011
TRMM	Low	Low	Age	15
ACRIMSAT	Low	Low	Age	13
QuikSCAT	Medium	High	Spacecraft	13
Terra	Low	Medium	SSR	13
EO-1	Medium	High	Spacecraft	11
GRACE	Low	Low	Age	10
Jason	Medium	High	Spacecraft	10
Aqua	Low	Medium	Spacecraft	9
ICESat	Medium	High	Laser	8
SORCE	Low	Medium	XPS/SOLSTICE	8
CloudSat	Low	Medium	Klystron	5

Table 3: Technical Panel estimation of the risk of significant mission failure over the period of FY08 – FY11.

Where are we going (Land community)?

- **NASA developing Earth Science Data Records (Science Quality Data) in support of its science programs**
- **MODIS on its 4th reprocessing (Collection 5)**
  - Collection 6 now being discussed for 2009 timeframe - will be seeking community input on necessary changes ?
  - Resources exist for a faster reprocessing (Ed Masuoka & Mike Teague)
- **NASA Moving from Missions to Measurements**
  - Creating Land Measurement Teams (slowly)
  - ESDR White Papers drafted - initial step in defining some of the land measurement suites (download via the NASA LCLUC Web Site) – community feedback is being sought