

A satellite-style map of Myanmar, showing the country's borders and internal regions. The map is overlaid with numerous small red dots, representing fire activities. The dots are distributed across the landmass, with higher concentrations in certain areas. The background shows natural features like rivers, forests, and mountains.

GOFC-GOLD Fire Activities

**With Some Examples of US Contributions
to the program**

**Chris Justice
Geography Department
University of Maryland**



Station Fire Aug 31 09

Burned 200 Sq Miles

95 Miles of fire-lines

2 firemen killed

\$102 Million spent
since July



ISS007E18088

Picture from the International Space Station



Los Angeles Skyline



6000 People Evacuated

Athens, Greece
August 22, 2009

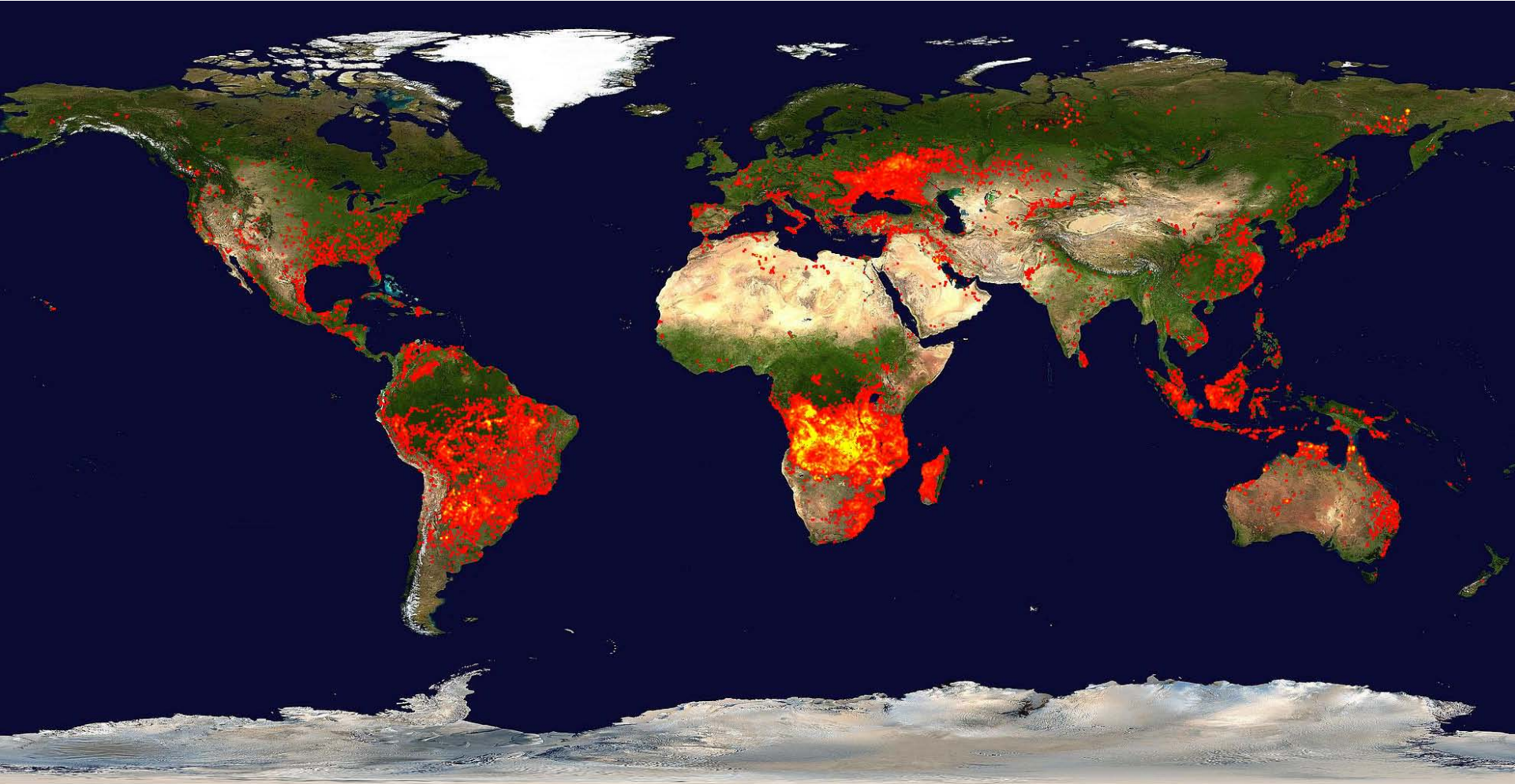


Athens Fires 2009



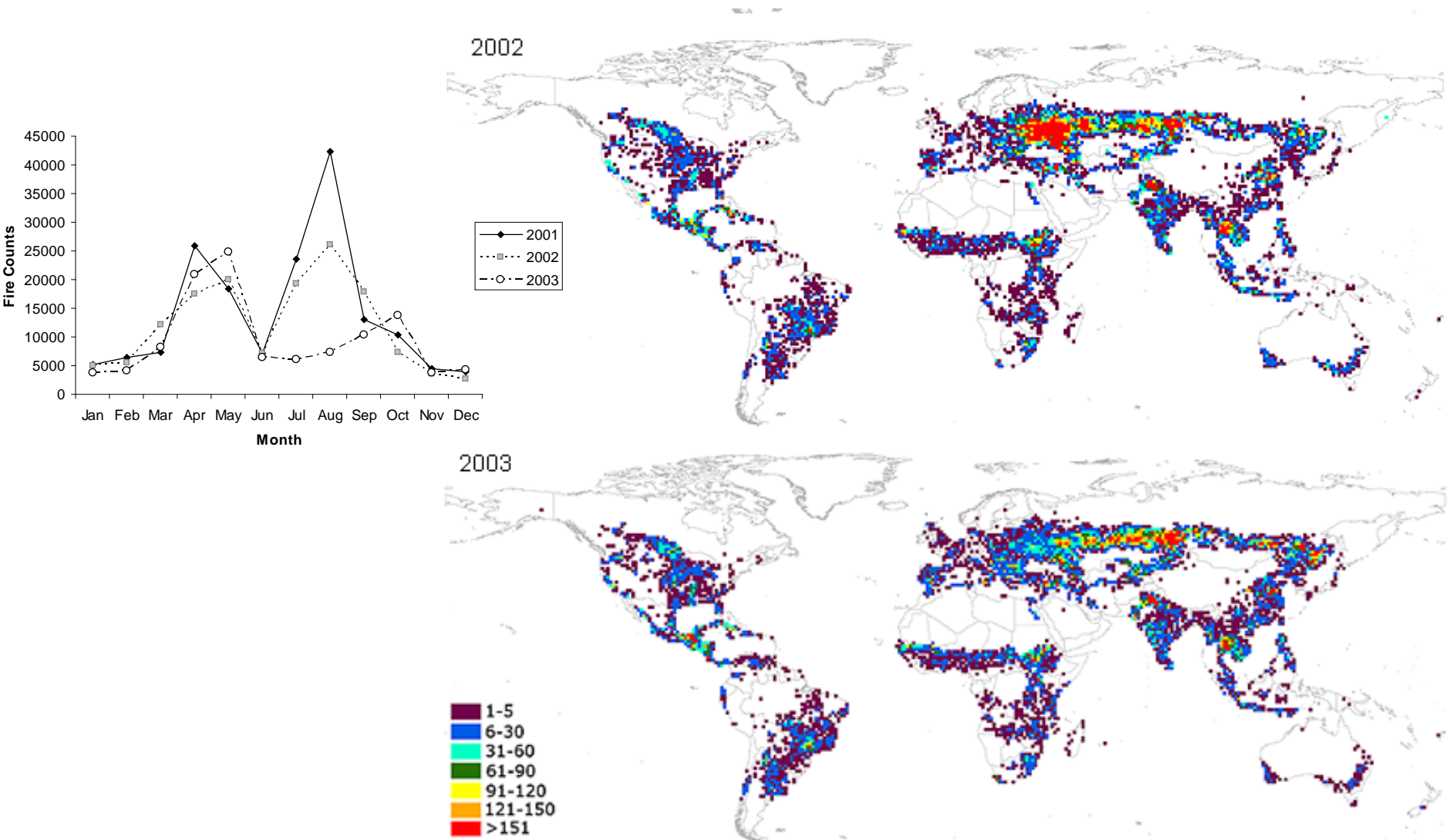
Fires are a Global Phenomenon

MODIS Active Fire Detections – Rapid Response System



Fires Burning Aug 8 – Aug 19 2009

Global Agricultural Fires



Example Areas of Fire Science

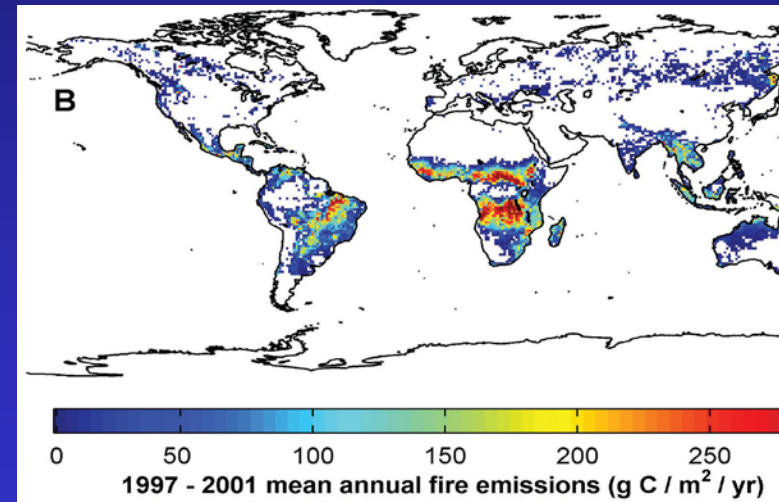
Global to Regional Scales

- Fire, Climate and Land Use
 - Changing Fire Regimes, Monitoring and Modeling
- Fire Ecosystems, Disturbance and Recovery
 - Changing fire succession, Multiple stressors, Insect/fire relationships, Woody encroachment, Nutrient cycling
- Fire related Radiative Forcing
 - Land surface, smoke/cloud interactions
- Fire and Atmospheric Chemistry and Composition
 - Tropospheric ozone precursors
- **Fire Trace Gas and Particulate Emissions**
 - **Biogeochemical cycling, Emissions estimation and budgets, National emission inventories**

Fire and the Atmosphere

Biomass burning and fossil fuel emissions release $\sim 10^{15}$ g of carbon (C) to the atmosphere each year. Biomass burning constitutes $\sim 35\%$ of all global C emissions.

Region	Fire emissions 1997-2001 average (10^{15} g C yr $^{-1}$)
Central and northern South America	0.27
Southern South America	0.80
Northern Africa	0.80
Southern Africa	1.02
Southeast Asia	0.37
Boreal (north of 38°N)	0.14
Other	0.13
Global	3.53



Source: Van der Werf *et al.*, 2004

Regional to Global Scale Emission Estimates

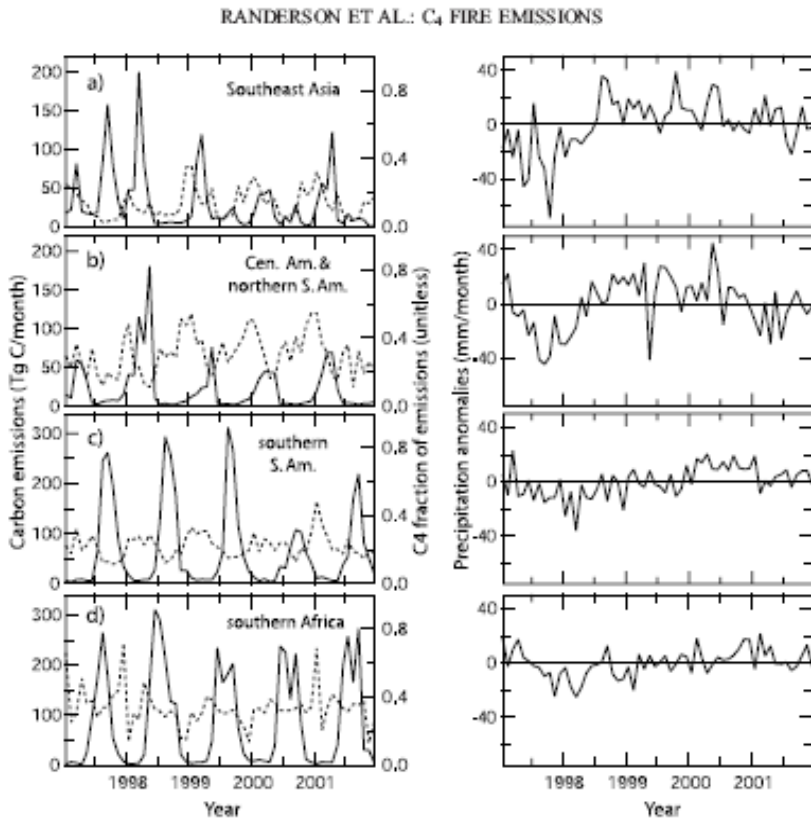


Figure 2. Fire emissions and the C₄ fraction of fire emissions from (a) Southeast Asia, (b) Central and northern South America, (c) southern South America, and (d) southern Africa. Fire emissions (left panel, left axis, solid line) are for total carbon and have units of Tg C/month. The C₄ fraction of fire emissions (left panel, right axis, dashed line) is unitless. Precipitation anomalies for each region (right panel, solid line) have units of mm/month. The precipitation anomalies were constructed by removing a mean seasonal cycle from 1997–2001 from each region.

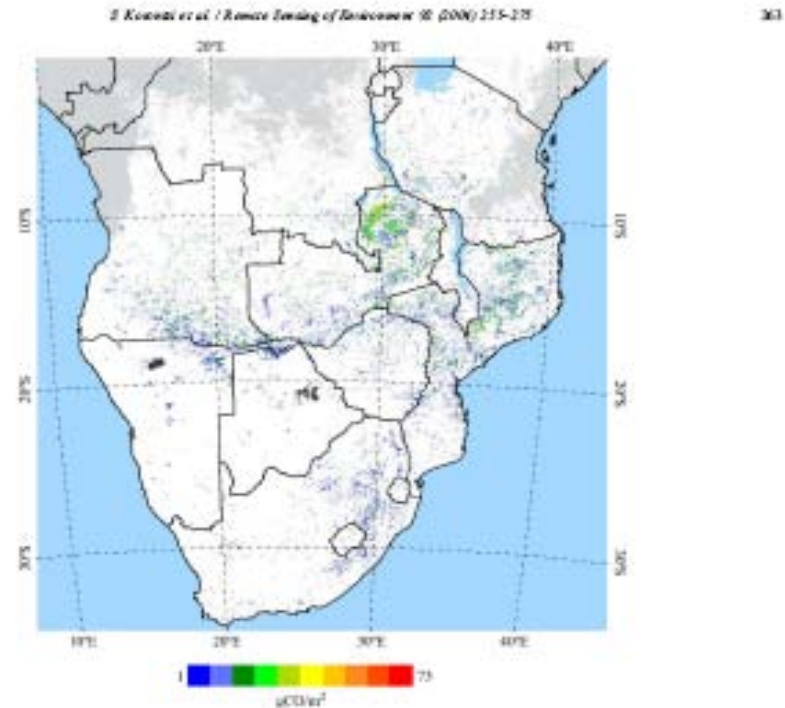
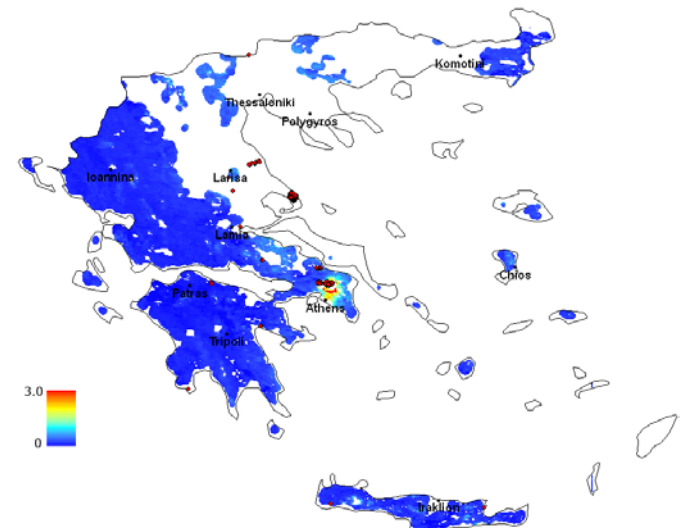
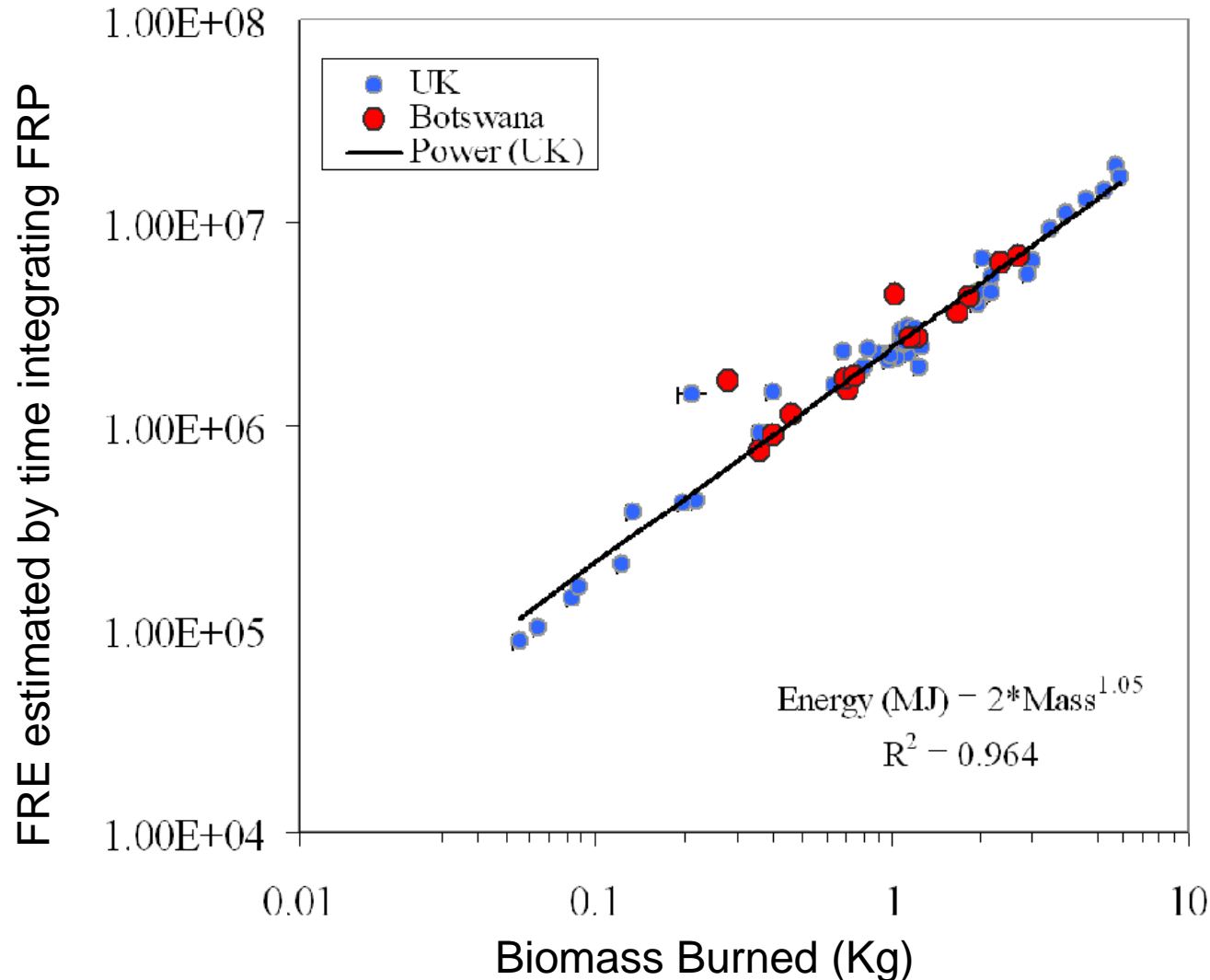


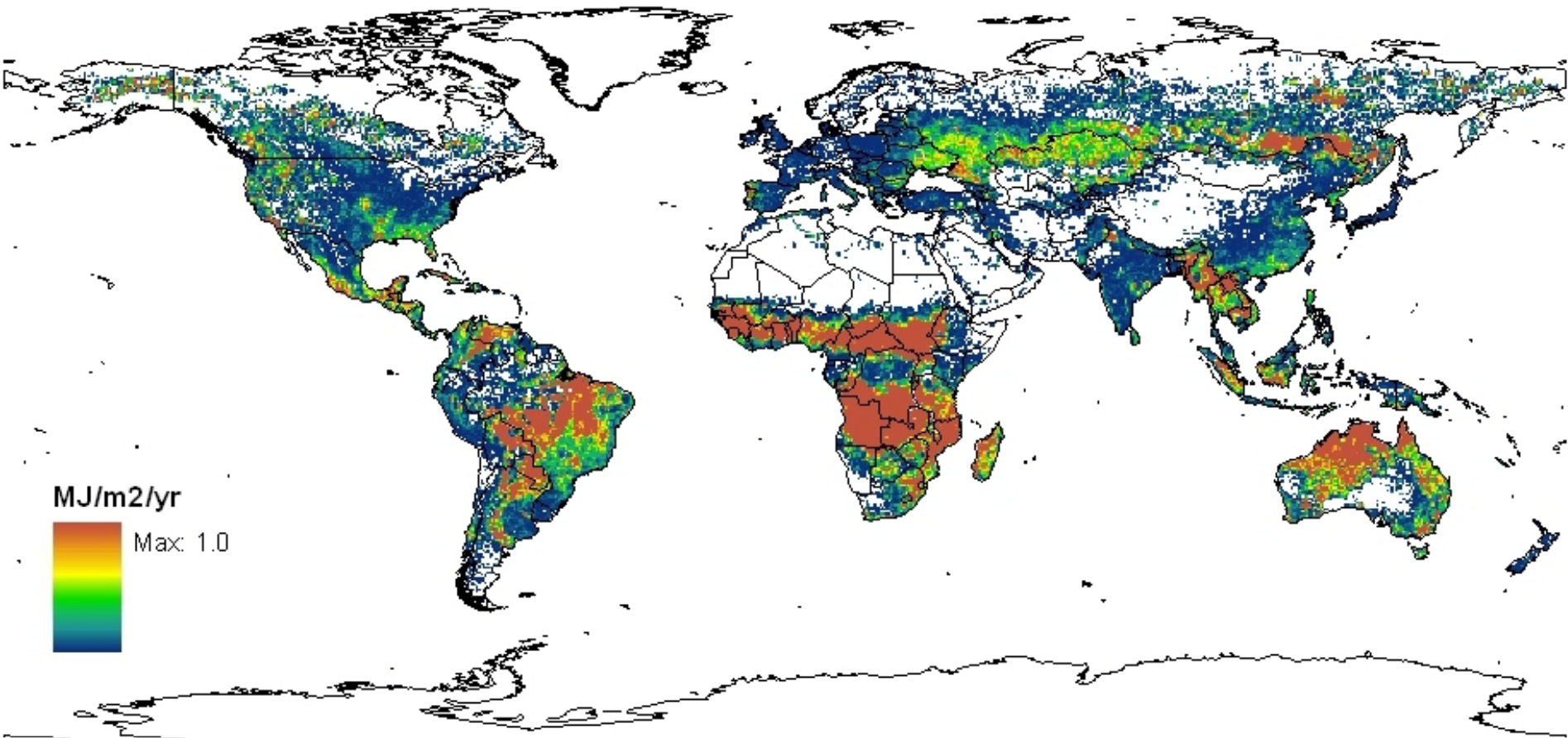
Fig. 4. MODIS CO analysis, southern Africa, September 2000. Light grey = not mapped by MODIS due to insufficient cloud-free observations; dark grey = not considered by MODIS due to open water or inland water; light blue = water. Lambert Azimuthal Equal Area projection (center longitude 25°, outer latitude -8°).



The FRE has been shown to be linearly related to the total biomass burned



Estimated annual mean FRE (MJ/m²/yr) MODIS Aqua 2001-2007



Diurnal cycle of hourly FRP was estimated in each climate modeling grid cell, and integrated over time (24 hours) and space (0.5) to estimate FRE

Fire Science: Example Areas

Regional to Local Scales *

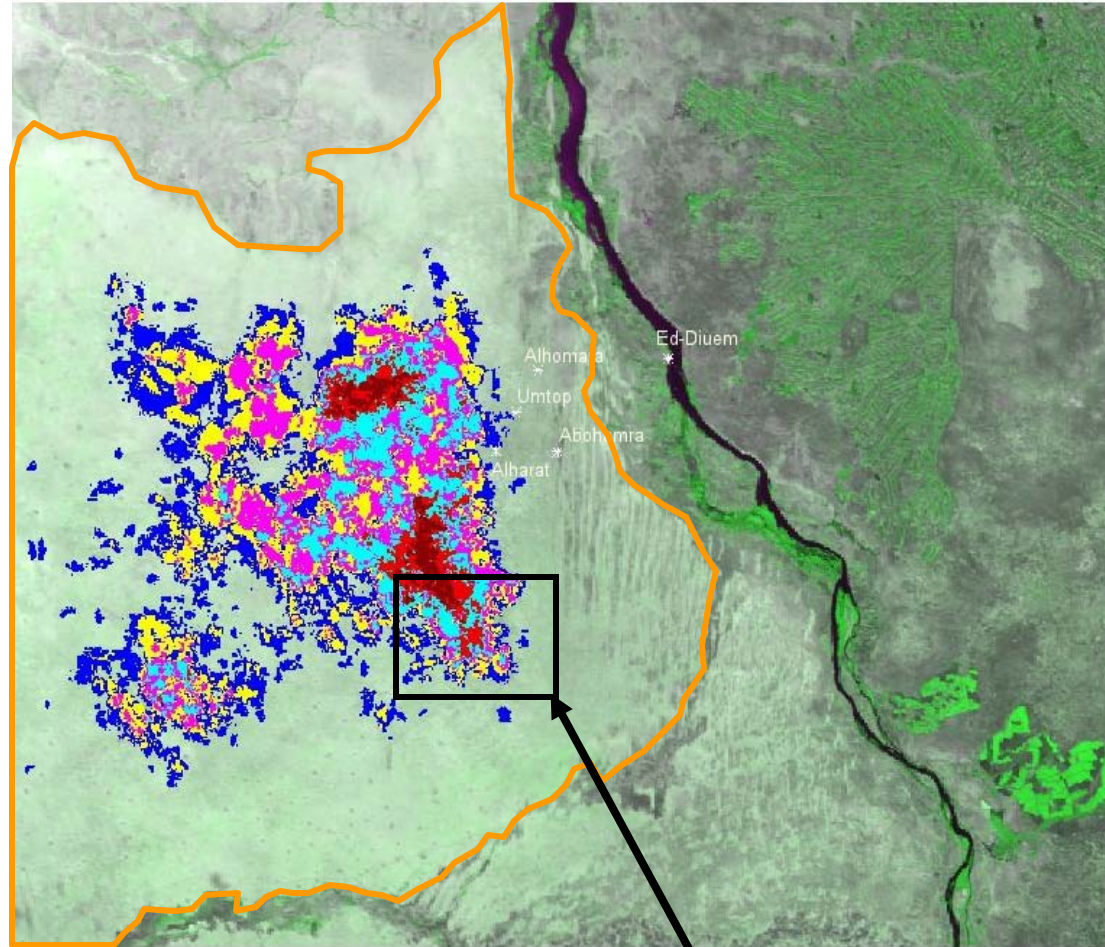
- Fire and Air Quality
 - Wildfires and Land Management Fires (inc. Agriculture)
- Fire and Water Quality
 - Watershed impacts, Nutrient cycling, Erosion
- Fire Danger and Risk Modeling
 - Weather, Fuels and conditions, Fire at the urban interface
- Fire and extreme weather events
 - Monitoring and prediction, Atmospheric processes
- Fire Behavior Modeling
 - Fuels Mapping and Characterization, Fire spread, etc
- Fire Ecology and Biodiversity
 - Fire impacts, species composition, species threats, adaptation
- Impacts of Fire Different Fire Policies
 - Monitoring, modeling and assessment
- **Fire and Land Use**
 - **Indicator of LU change, Slash and Burn, Fuel wood, Sustainability Science, Competing Land Use Conflict, Fire Policy and Management**

** in most cases with linkages to applications*

Land Use Fires and Conflict – Albaja, Sudan



MODIS Fire History, Albaja, '00-05



Number of times burned

- 1
- 2
- 3
- 4
- 5
- 6

Study area

10 0 10 20 30 40 50 60 70 Kilometers

Use ASTER data to look at interface between crop (farmers) / rangeland (nomads)

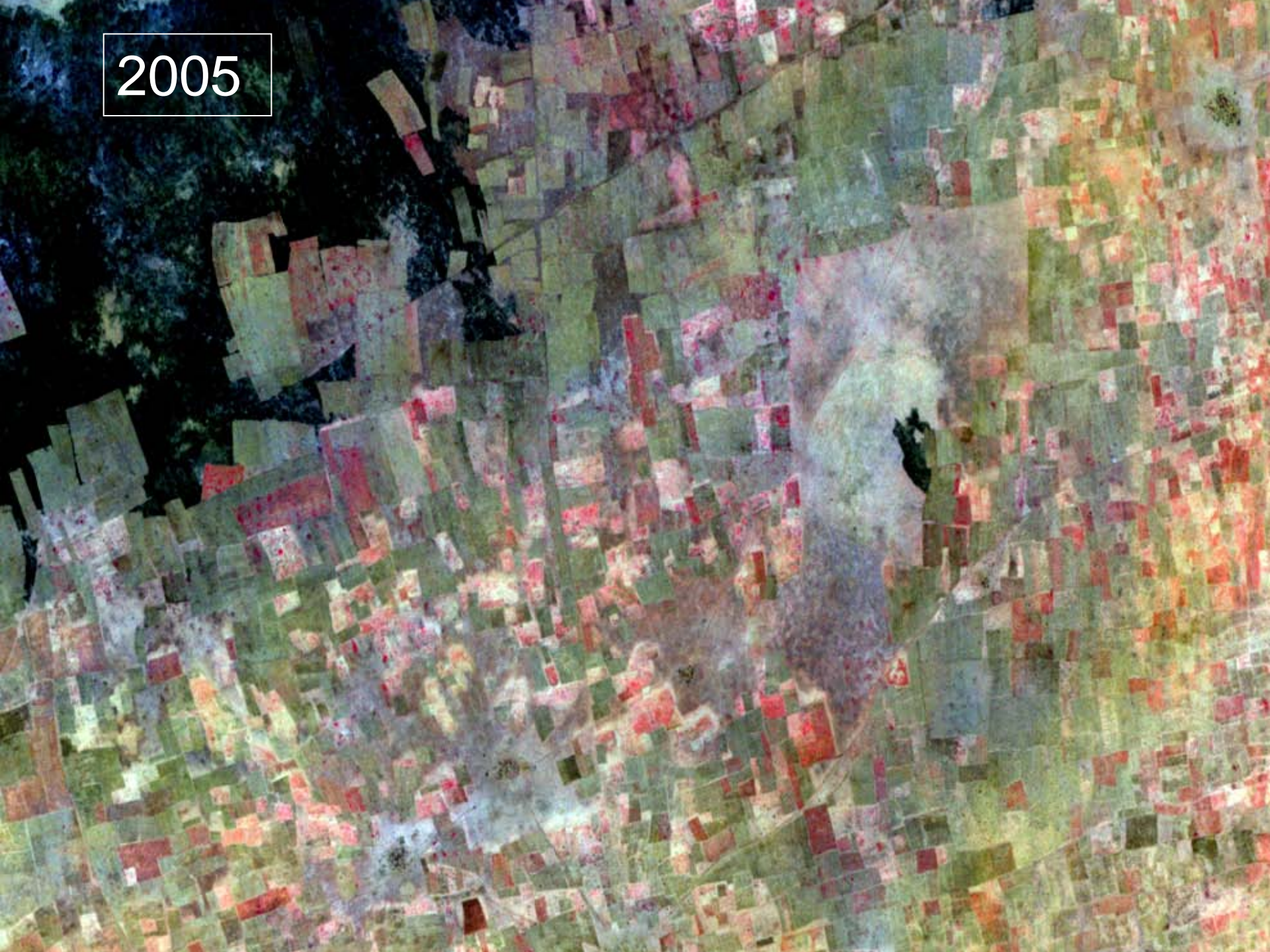
2000

Nomadic rangeland

Burned area



2005



Types of Fire Information Needed

Pre-Fire

Active Phase

Post-Fire

- Fire History
- Fire Danger/Susceptibility (Weather and Satellite data)
 - Fuel type, structure, fuel condition, fire weather
- Fire Behavior related information
 - Weather, topography, fuel load and condition
- Fire Occurrence / Location
 - Tactical (within 15 minutes, local)
 - Strategic (daily briefings, regional coverage)
- Fire Emissions and Related information (NRT and Regional)
 - Fuel load and condition, combustion completeness
 - Distributions of emissions products (trace gases, particulates) – air quality, atmospheric composition
- Fire Characterization (fire intensity)
- Burned Area (near real time, monthly, annual)
- Fire Severity
- Immediate Post Fire Assessment
 - Fire severity > ecosystem damage – remedial actions
 - Fire recovery
- Long-term trends in fire regimes

Fire Related Observations

- **Satellite Sensors**
 - Coarse, Moderate, Fine Resolution
 - Optical, Microwave
 - Polar orbiting, Geostationary
- **Airborne Sensors inc. UAV's**
 - Imaging (active fire, post fire)
 - Lidar (vegetation structure)
 - RT Fire fronts
- **Ground-based (in-situ) Observations**
 - Weather conditions, met stations
 - Atmospheric Profiles (lidar, aeronet)
 - Lightning Detection / Ground Based Fire Detection
- **Field Measurements**
 - Fuel Load, Emission Factors, Post Fire Assessments (area, severity), etc

Satellite Fire Monitoring

- **Current Global Capabilities**

- Vegetation Type and Condition (moisture content)
- Active Fire Detection
- Burned Area Estimation
- Fire Radiative Power
- Direct measurement of fire products (aerosol optical thickness, trace gases)

Examples of Types of Fire Related Modeling

- Model Types
 - Fire Danger
 - Fire Weather
 - Fire Behavior
 - Fire Emissions (NRT, Annual)
 - Projected Fire Regimes and Emissions
 - Dynamic Global Vegetation Models (disturbance)
- **Observations can be used as input and in some cases for model validation**
 - Important to understand product accuracy – requires product validation
 - Can we refine the requirements by model suite?

Examples of Current and Planned Satellite Sensing

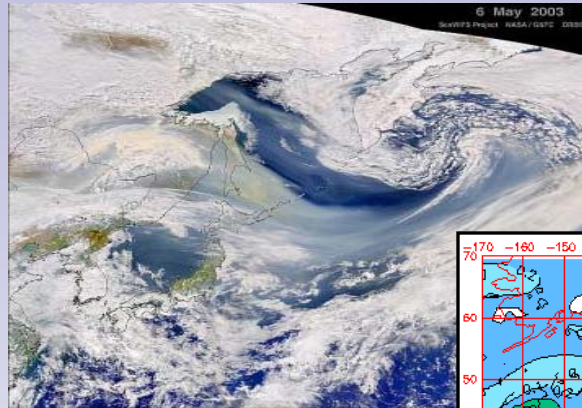
Systems Relevant to Fire Monitoring

- **Active Fire Detection and Characterization (mid IR)**
 - AVHRR, GOES, DMSP, MSG (*operational*)
 - TRMM, MODIS (AM/PM), AATSR, BIRD, ASTER, MERIS (*experimental*)
- **Burned Area, Fire Danger, Post Fire Assessments (VIS, NIR)**
 - Coarse/moderate Resolution
 - AVHRR/METOP, MODIS, SeaWiFS, ATSR, VEGETATION
 - High Resolution
 - Landsat 5/7, SPOT, IRS AWiFs, Formosat, CBERS
 - ASTER – high resolution optical and thermal
 - Radarsat
 - Hyperspectral data – EO1
 - Hyperspatial Resolution – Ikonos, QuickBird, Rapideye, DMC Surrey etc
- **Emission products (optical and sounding)**
 - MODIS, MISR – Aerosol Optical Depth
 - AIRS, MOPITT – CO, etc

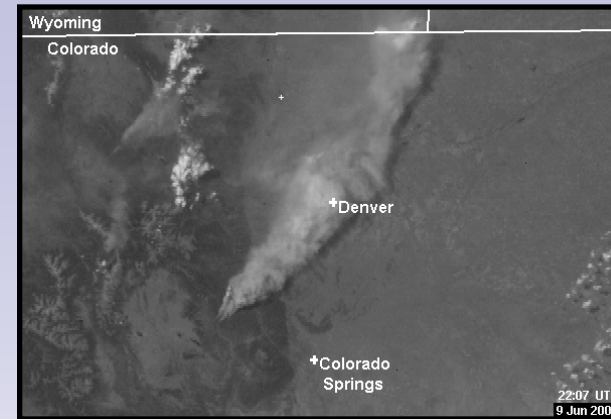
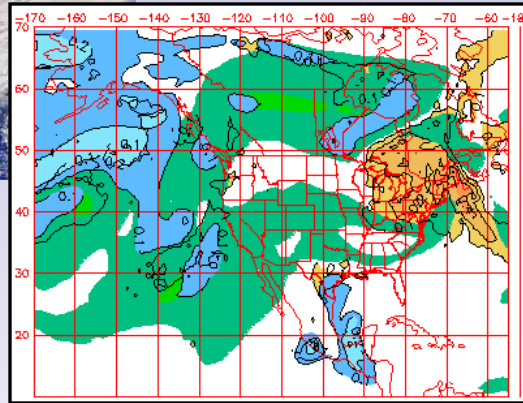
- **Examples of Planned Systems**
 - NPP/NPOESS VIIRS (2011) – active fire and energy - burned area
 - LDCM OLI (2012) and Sentinel 2 (2012) – burned area / severity?
 - HypsIRI (2013) – hyperspectral + multispectral thermal
 - Sentinel 3 (2013) – active fires

GOES Geostationary Monitoring

Monitoring Transport of Biomass Burning Aerosols



Smoke Transport Across Pacific from Siberia
6 May 2003



GOES-11 Rapid Scan Visible Imagery (1 km)
22:07, 9 June 2002 – 00:50, 10 June 2002
Courtesy of CSU - CIRA



Before

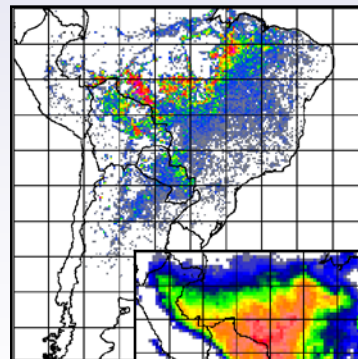


After



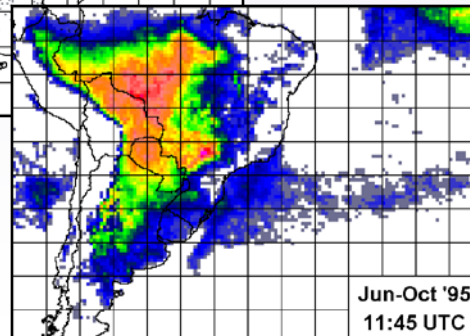
MODIS Rapid fire
9 May 2003

Smoke Transport Across Gulf of Mexico
9 May 2003

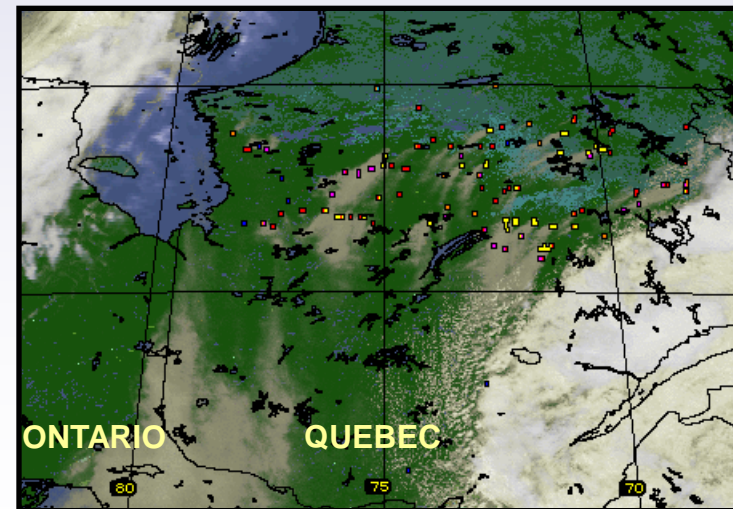


GOES Fire Product
Jun-Oct 1995

GOES Smoke Coverage

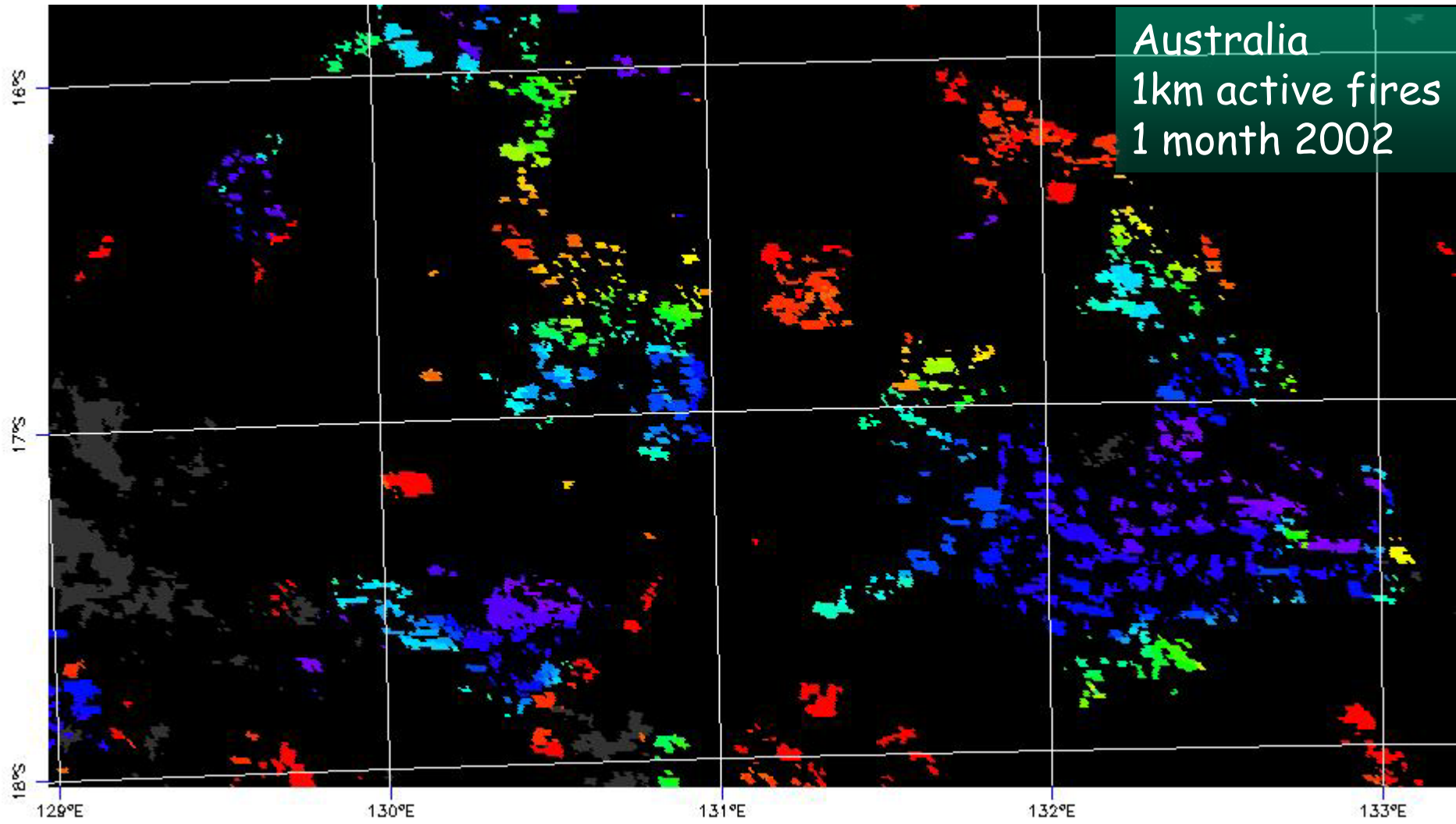


Jun-Oct '95
11:45 UTC



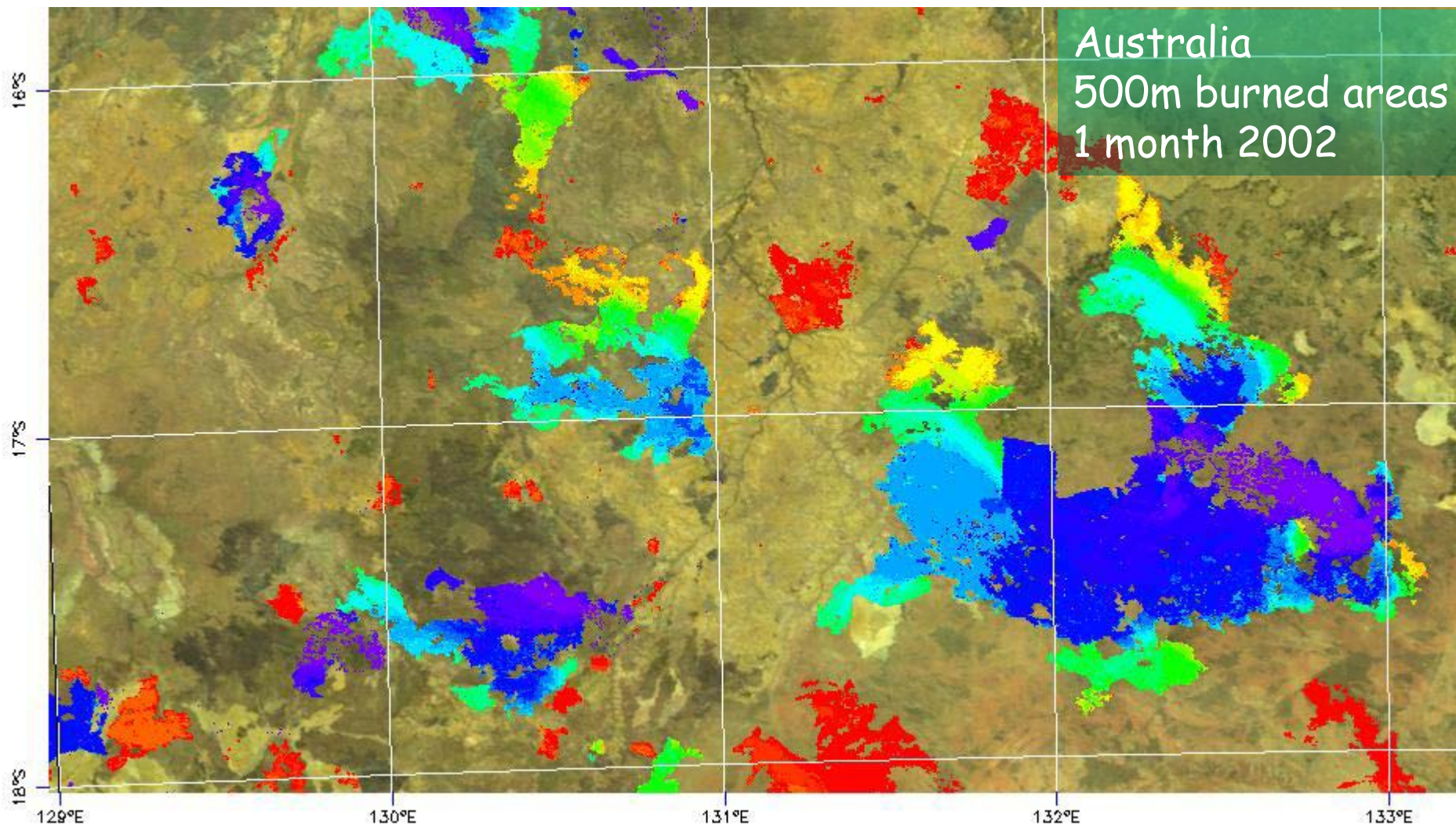
Wildfires in Quebec, Canada
6 July 2003 at 17:45 UTC

(Prins et al)

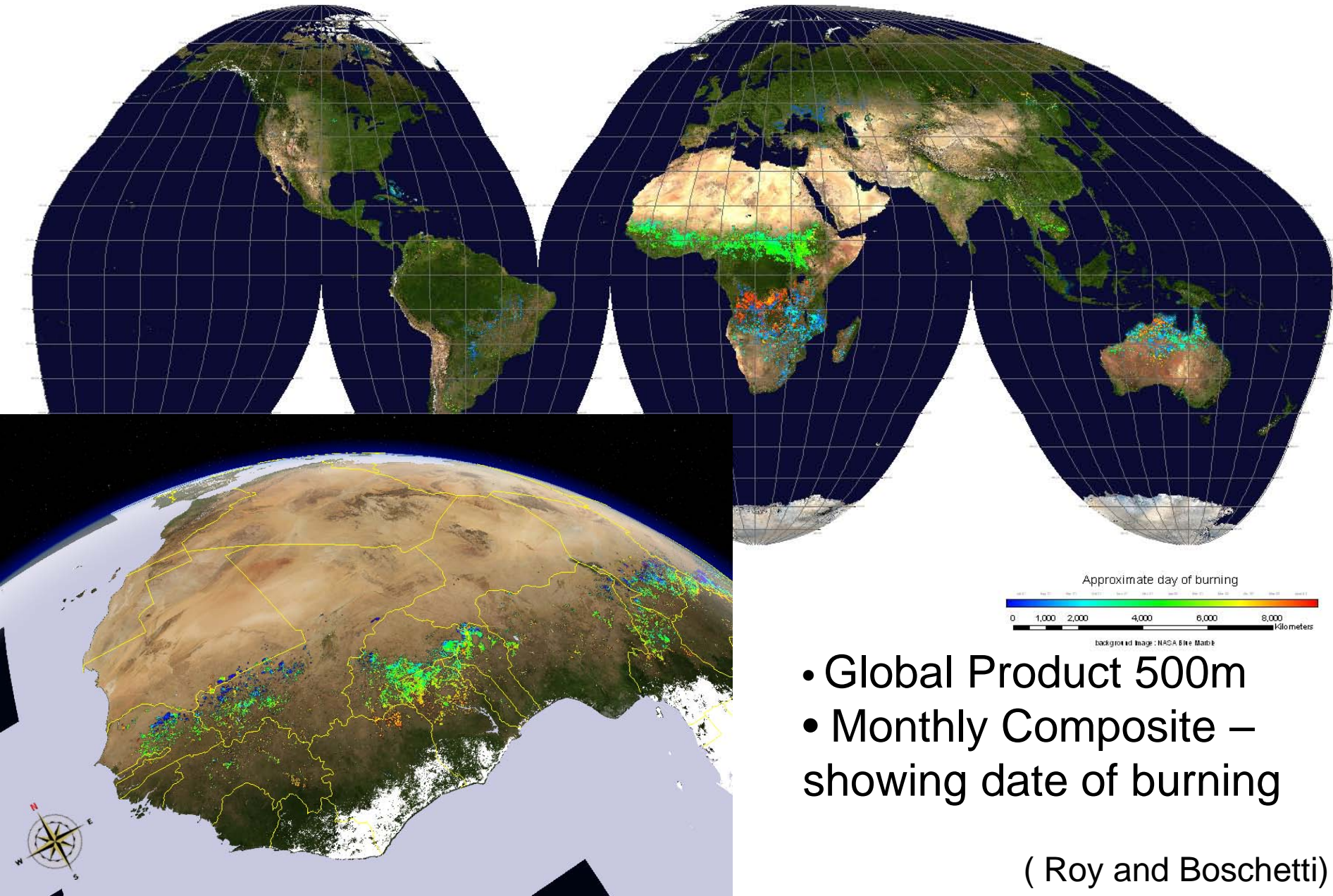


Roy et al.

MODIS Burned Area Product 500m



Global Burned Area (MODIS)



- Global Product 500m
- Monthly Composite – showing date of burning

(Roy and Boschetti)

Hyperspatial Resolution Data: Quickbird

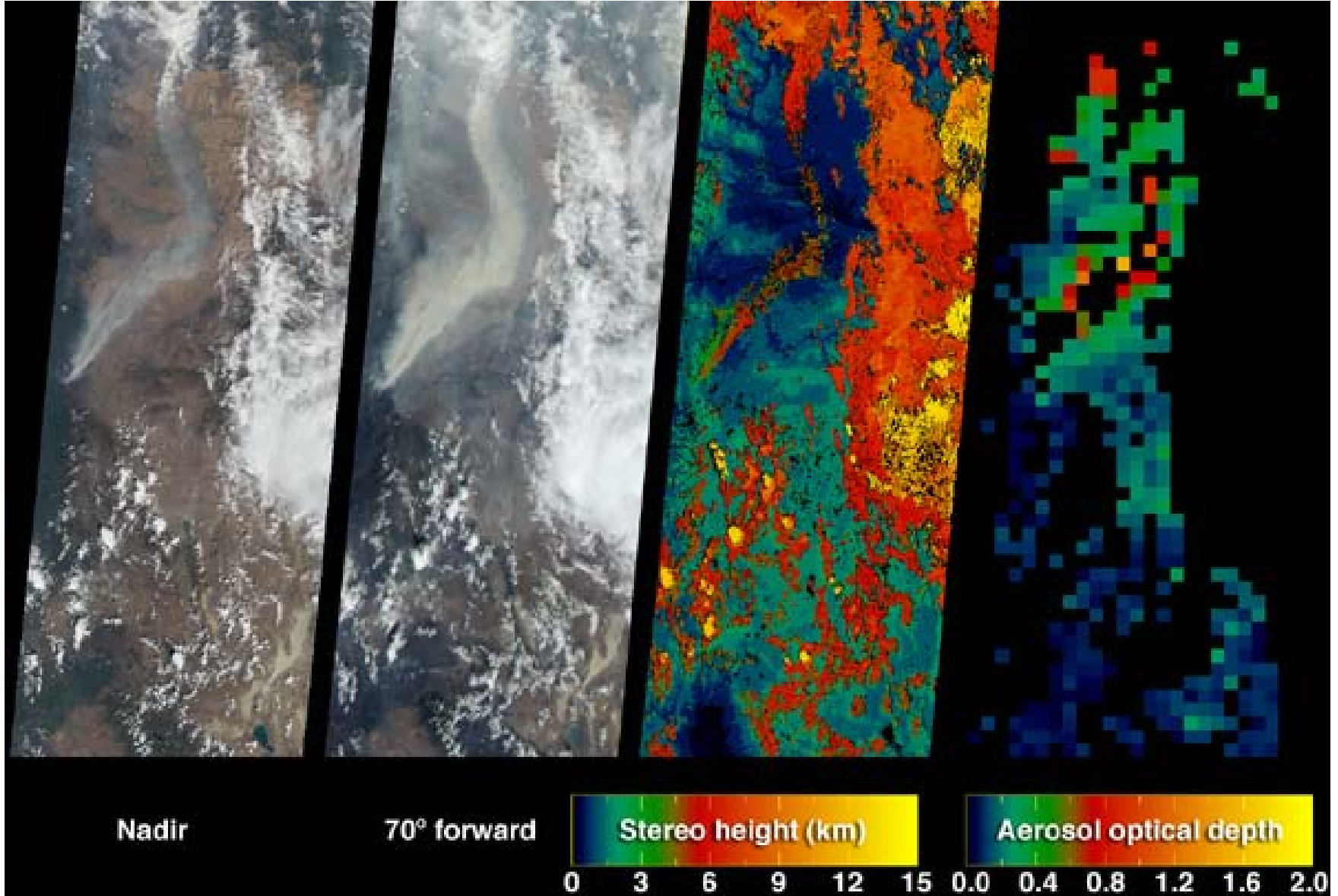


60cm Resolution Imagery of the Esperanza Fire, Twin Pines, Ca

October 2006

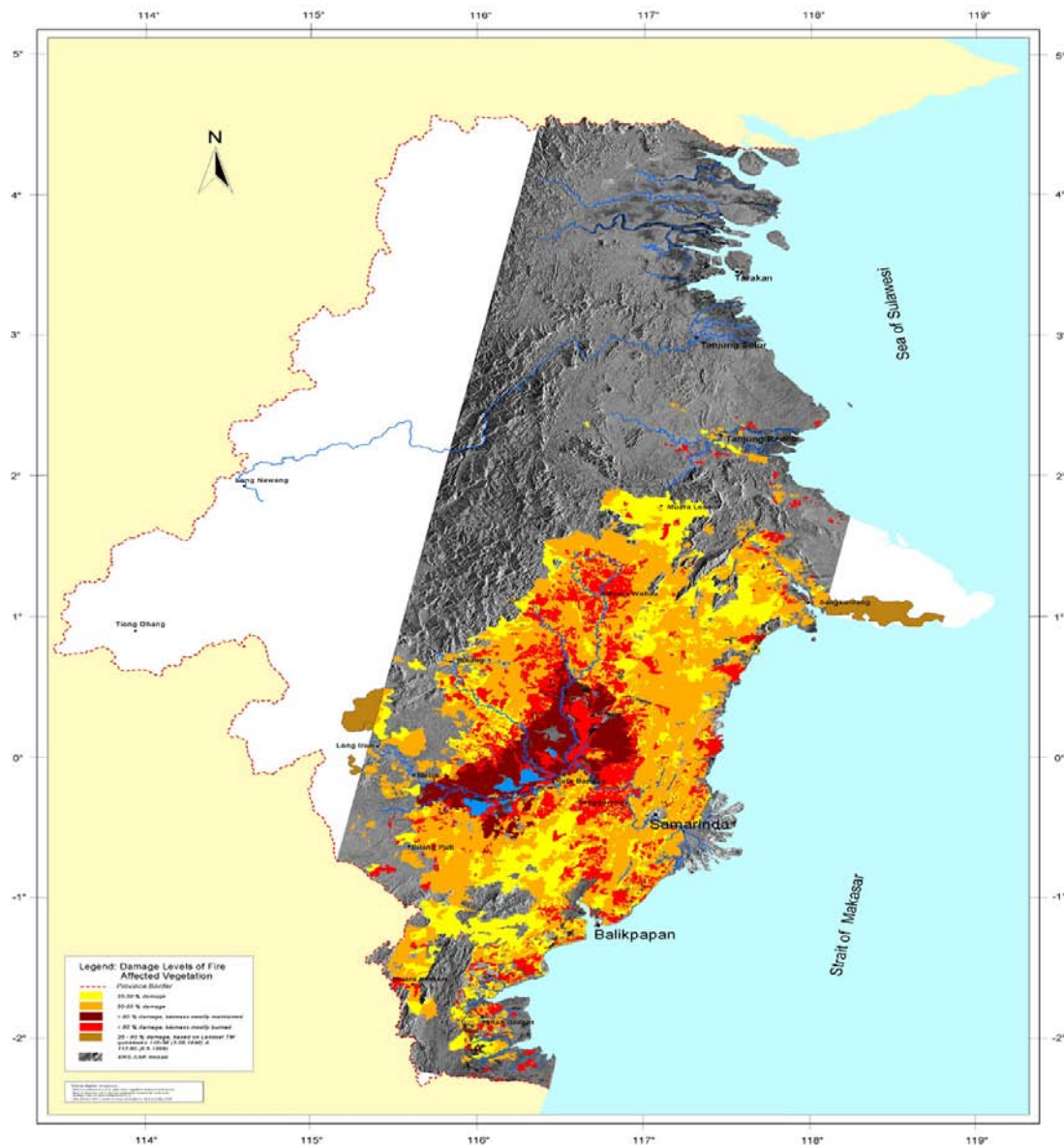
(courtesy Digital Globe)

MISR Imagery and Products



Smoke Plumes, B and B Complex Fire, Oregon 2003

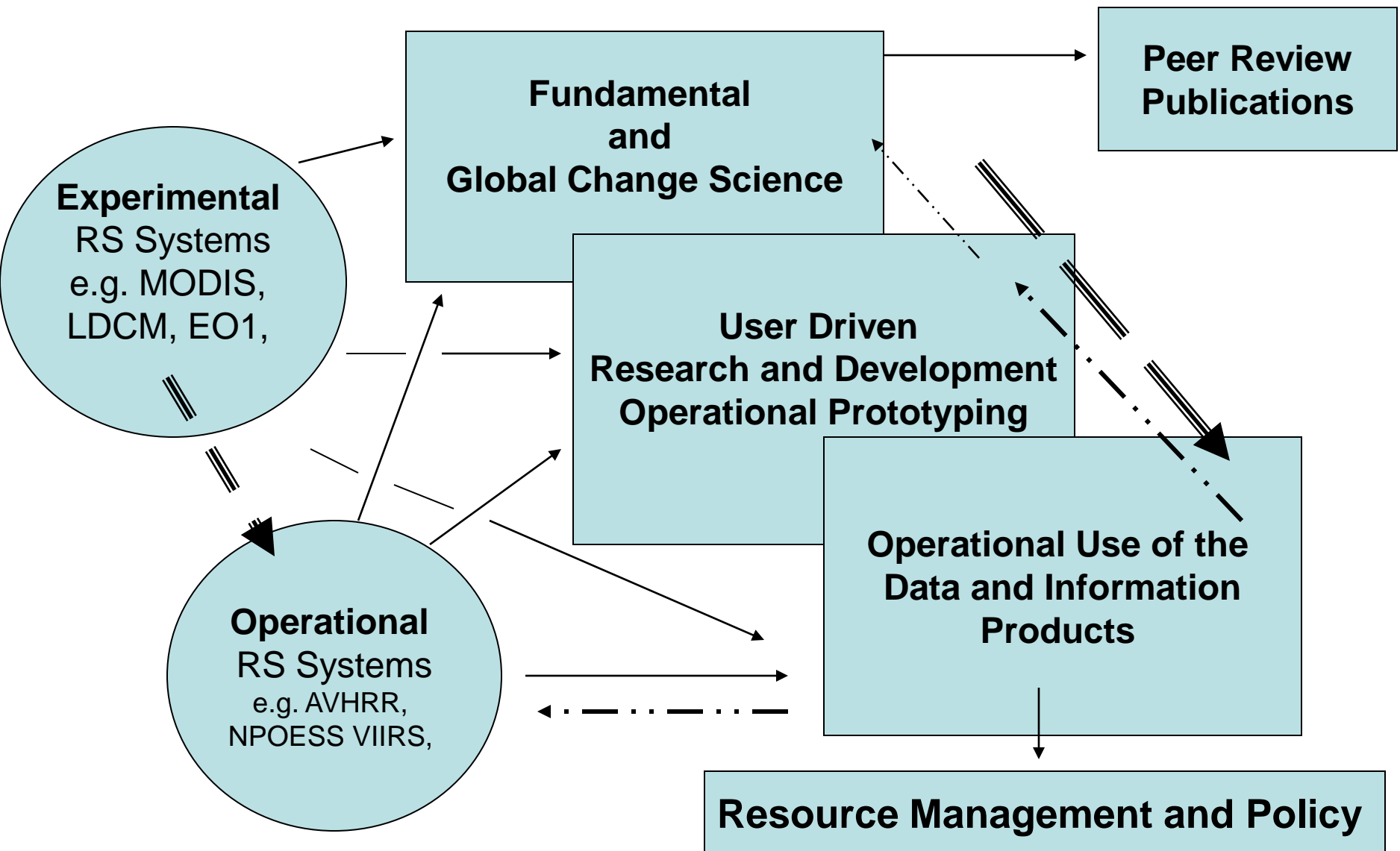
Fire damage classification of the 1997/1998 Fires in East Kalimantan based on ERS-SAR images



ERS- SAR

Fire damage classification of the 1997-98 fires in East Kalimantan, Indonesia

Transitioning Research to Operations



GOFC-GOLD

An International
Program for the
Coordination of
Observations

Land Cover, Fire,
Biomass

A project of GTOS



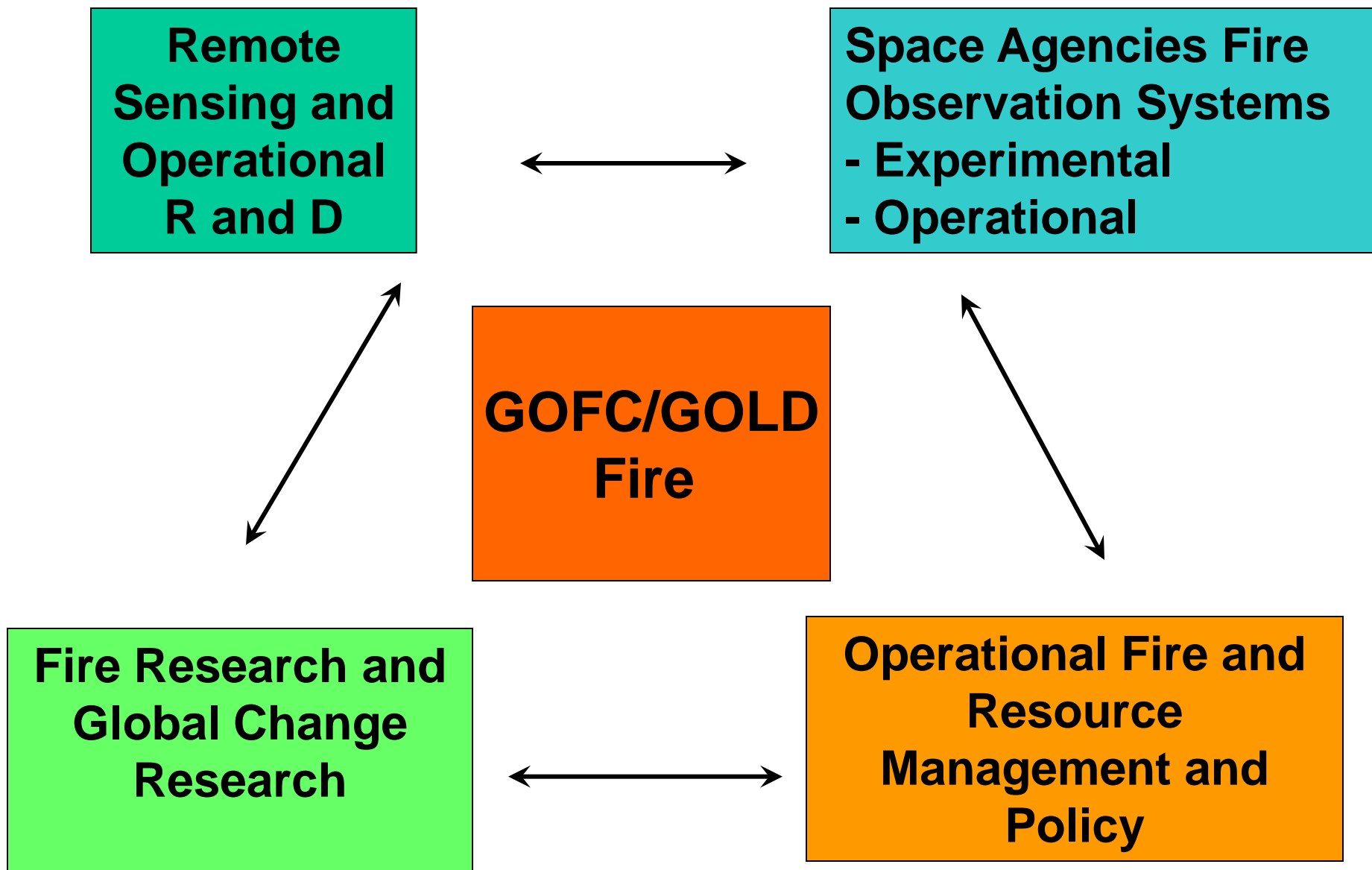
<http://gofc-fire.umd.edu>

Functions of GOFC-GOLD

1. Specifying requirements for products
2. Assessing algorithms and data assimilation procedures
3. Ensuring the availability of observations
4. Harmonization and the development of protocols and standards
5. Ensuring that operational products meet accuracy requirements
6. Capacity building and the role of regional networks
7. Creating GOFC-GOLD products and services
8. Providing information to support international assessments
9. Advocacy role, especially in relation to the continuity of observations and validation



Promote interaction between a number of major communities



UN Conventions, GEO(SS) ...

REQUIREMENTS

STRATEGY

International Sponsors of GTOS:
FAO, UNEP, ICSU, UNESCO, WMO

IGOS Partnership

GCOS
GOOS

Global Terrestrial Observing System (GTOS)

Associates
of CEOS

Committee on Earth Observation Satellites (CEOS) incl. Cal-Val

Collaborative
Projects

GOFC-GOLD

Data "producers"

Scientists

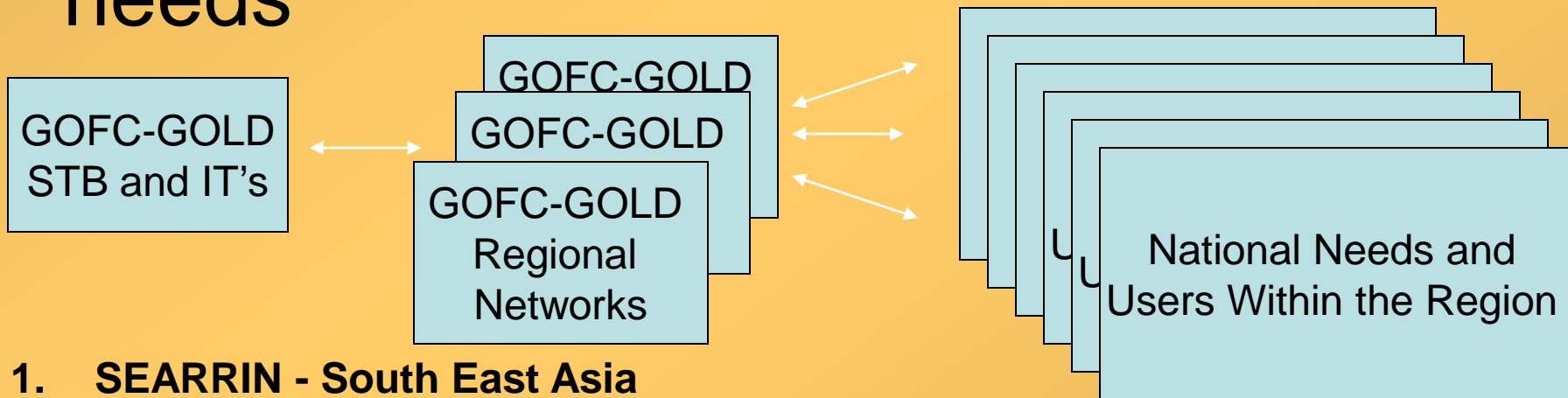
Data "users"

IMPLEMENTATION

Regional Networks

a critical component of the
implementation of **GOFC-GOLD**

Providing the interface between the panel and national level data users and needs



1. **SEARRIN - South East Asia**
2. **OSFAC - Central Africa**
3. **Miombo - Southern Africa**
4. **SAFNET – Southern Africa**
5. **NERIN – Northern Eurasia**
6. **REDLATIF Latin America**

GOFC Fire Community Priority Areas

- **Improved Fire Data and Information Products (of known Accuracy)**
- **Data Continuity and Sensor Improvements**
 - **Operational Spaceborne Assets**
- **Improved Data Policies, Access and Distribution**
- **Improved Capacity Building for Data Utilization**

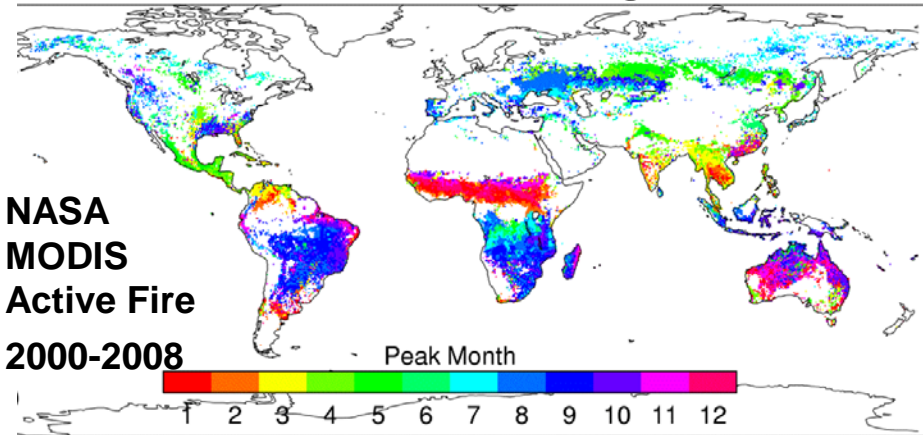
Examples of GOFC/GOLD-Fire Strategic Partnerships

- UN ISDR WG IV on Wildland Fire (Fire Management and Policy, Regional Network Support)
- Global Fire Monitoring Center (Global Fire Outreach)
- CEOS Land Product Validation Working Group (Satellite Product Validation Protocols)
- EARSeL Special Interest Group on Forest Fire (European Research)
- ACRSP (Australian Remote Sensing Research Groups)
- ILDRC (International Land Direct Readout Committee)
- Selected Individual Fire Research and Management Organizations critical to meeting GOFC Fire goals (e.g. USFS, IBAMA, CFS, CSIRO)
- Regional Science Initiatives (e.g. SAFARI, LBA, NEESPI, NACP)

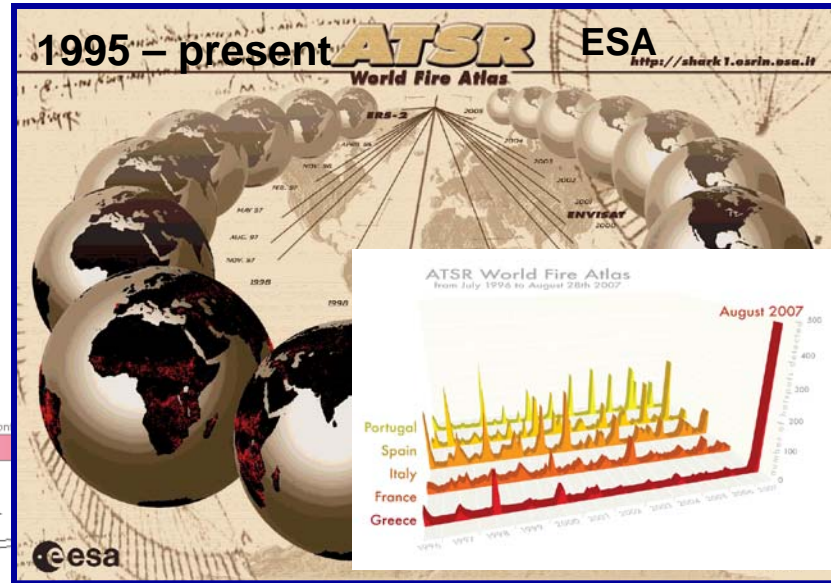
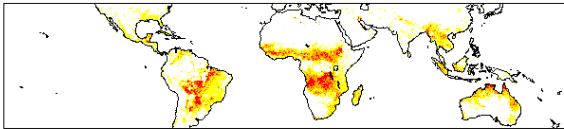
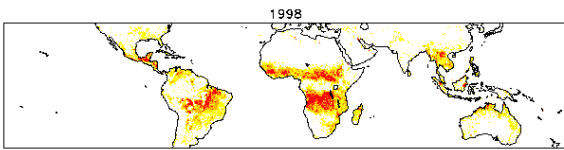
Improved Fire Data and Information Products

- Products to meet International Convention data needs (w. GCOS/GTOS – ECVs)
- Regional / Global (Burned Area) Products with Systematic Product Validation (w. CEOS LPV)
- Global near real-time data (e.g. MODIS Rapid Response)
- Global Fire Danger Rating System (w. UN ISDR)
- Multi-source fire information integration
- Long Term Fire Data Records
- GOFC - Global Fire Assessment 2010

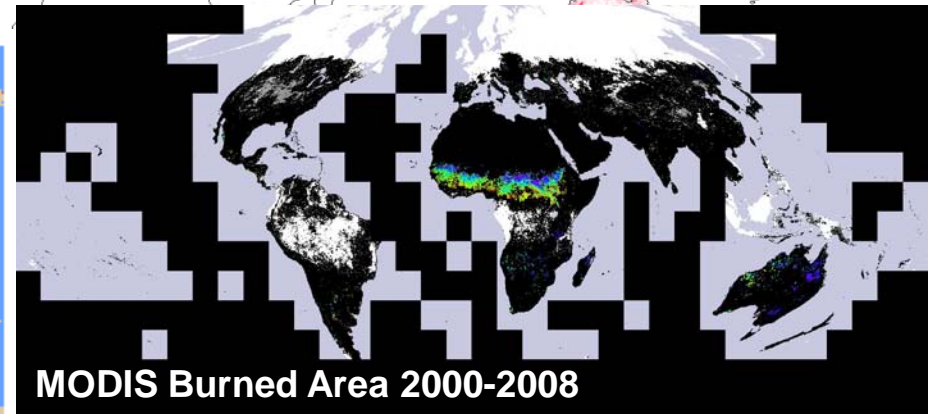
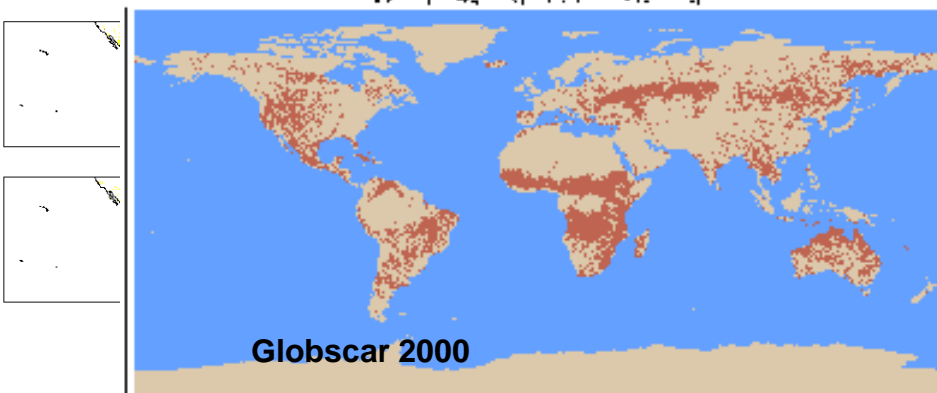
Increasing Satellite Fire Time Series

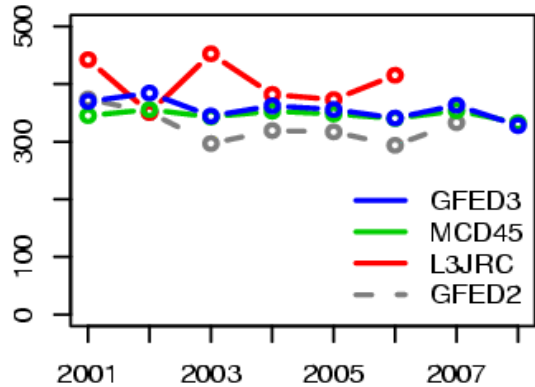
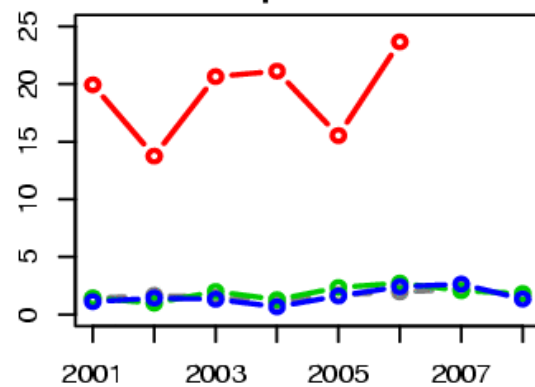
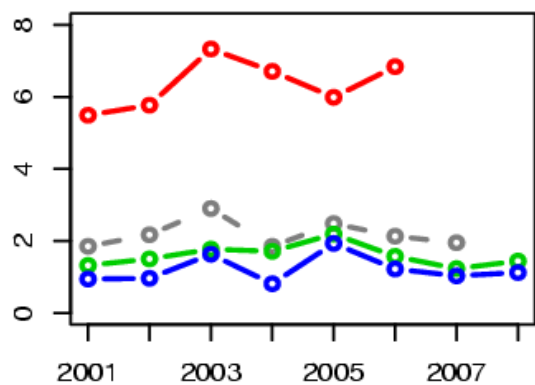
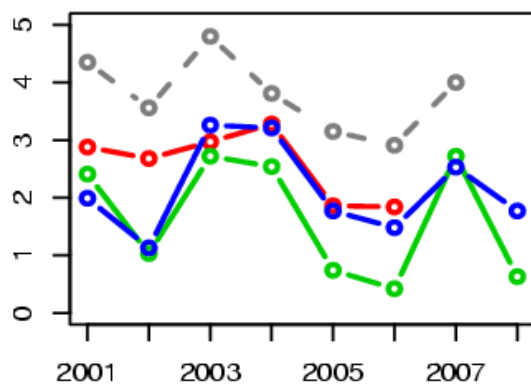
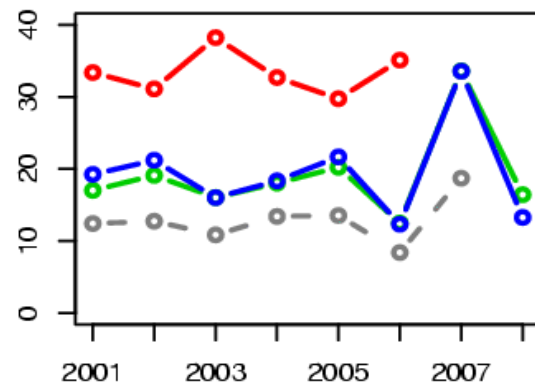
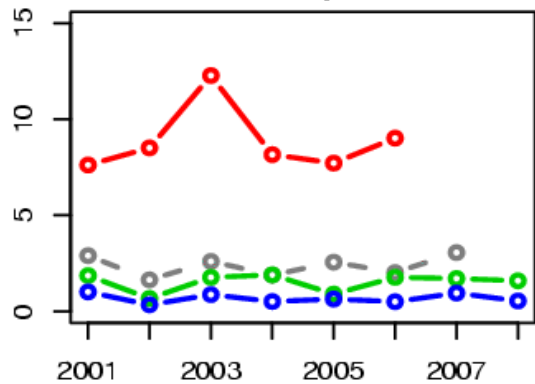
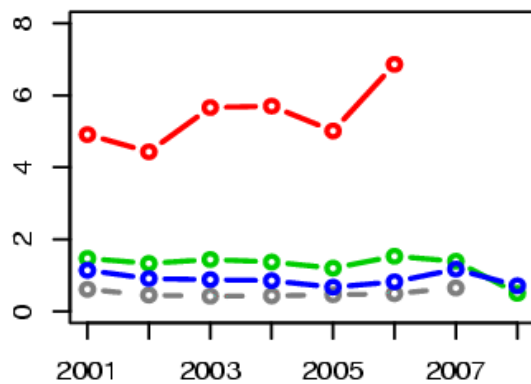
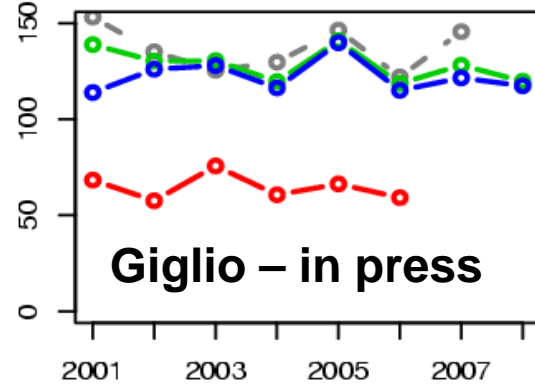


TRMM VIRS Annual Corrected Fire Counts



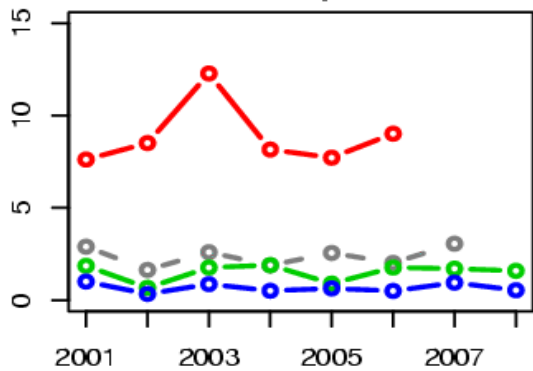
ESA GLOBCARBON 1998-2003



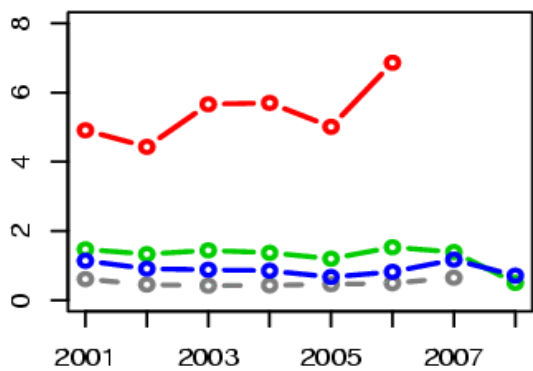
Global**Boreal NA****Temperate NA****Central America****NH South America****SH South America****Europe****Middle East****NH Africa**

Annual Area Burned (Mha)

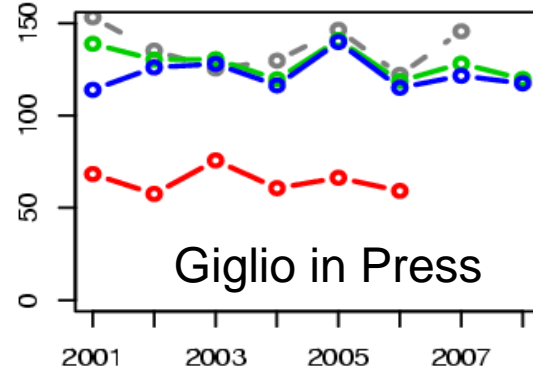
Europe



Middle East

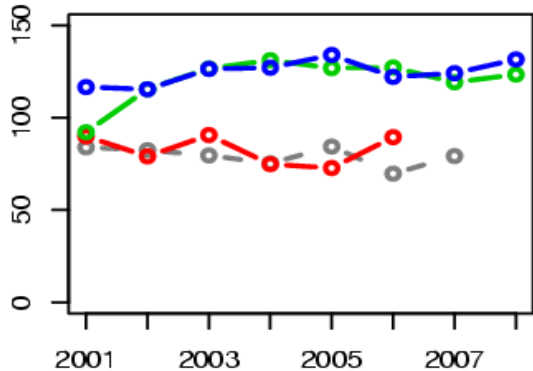


NH Africa

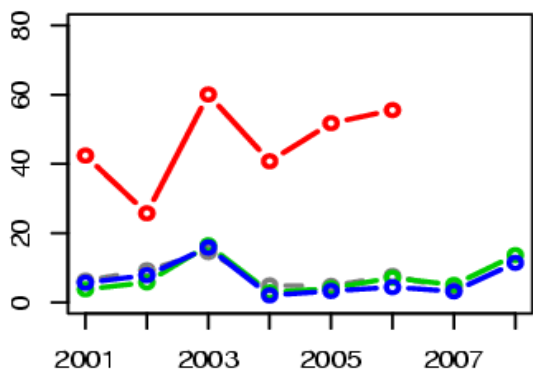


Giglio in Press

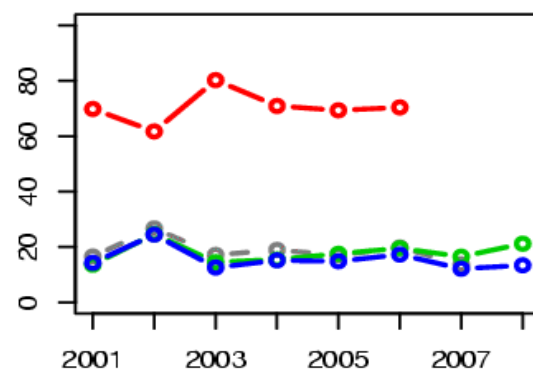
SH Africa



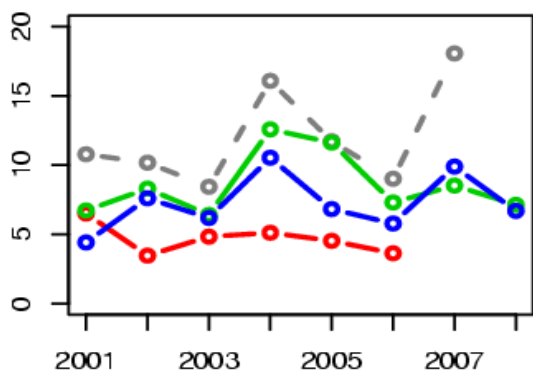
Boreal Asia



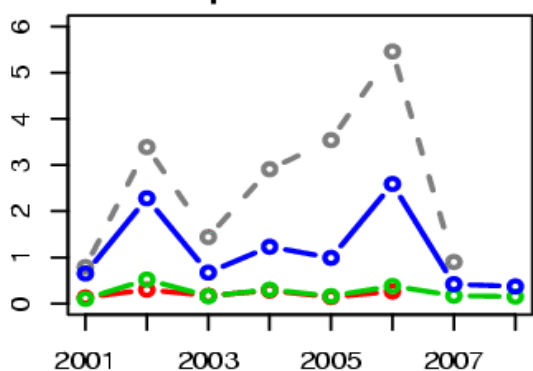
Central Asia



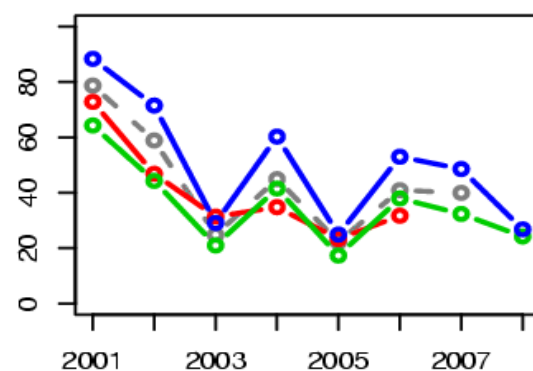
Southeast Asia



Equatorial Asia



Australia and NZ



Year

Burned Area Product Validation Protocol

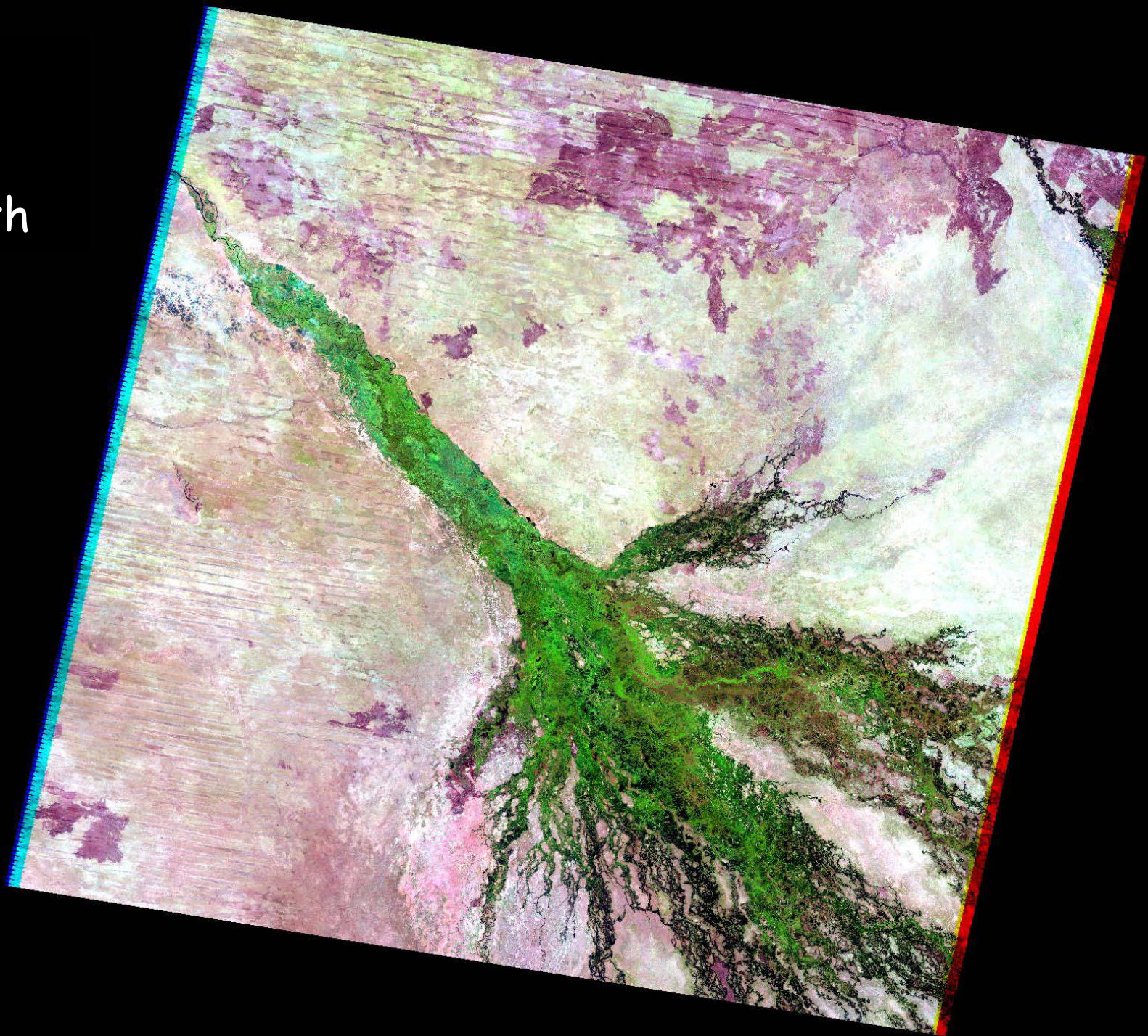
- Compare MODIS burned area product with independent spatially explicit burned area data derived from **multitemporal Landsat ETM+ data**
- SAFNet field trip held to develop the mapping protocol and to discuss southern African fire information needs, Zimbabwe-Zambia, July 2000
- SAFNet members map the areas burned between 2+ Landsat acquisitions, augmented by limited fieldwork
- Consensus mapping protocol to ensure regionally consistent independent validation data
- **protocol followed 2000-2002 at ~11 ETM+ scenes/year**

Roy, D. et al. 2005, The Southern Africa Fire Network (SAFNet) regional burned area product validation protocol, *International Journal of Remote Sensing*, 26:4265-4292.



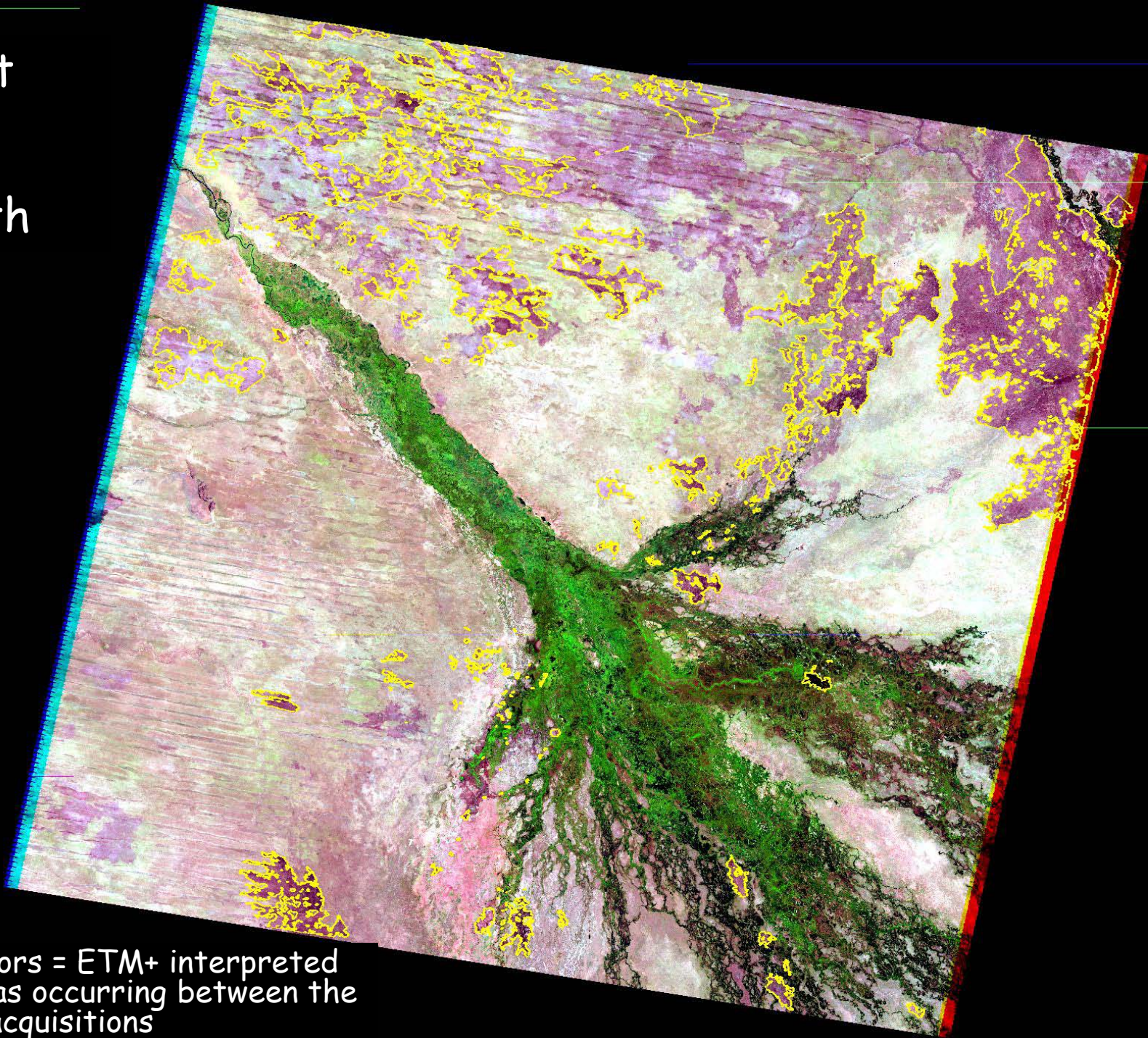
Landsat
ETM+

Sept. 4th



Landsat
ETM+

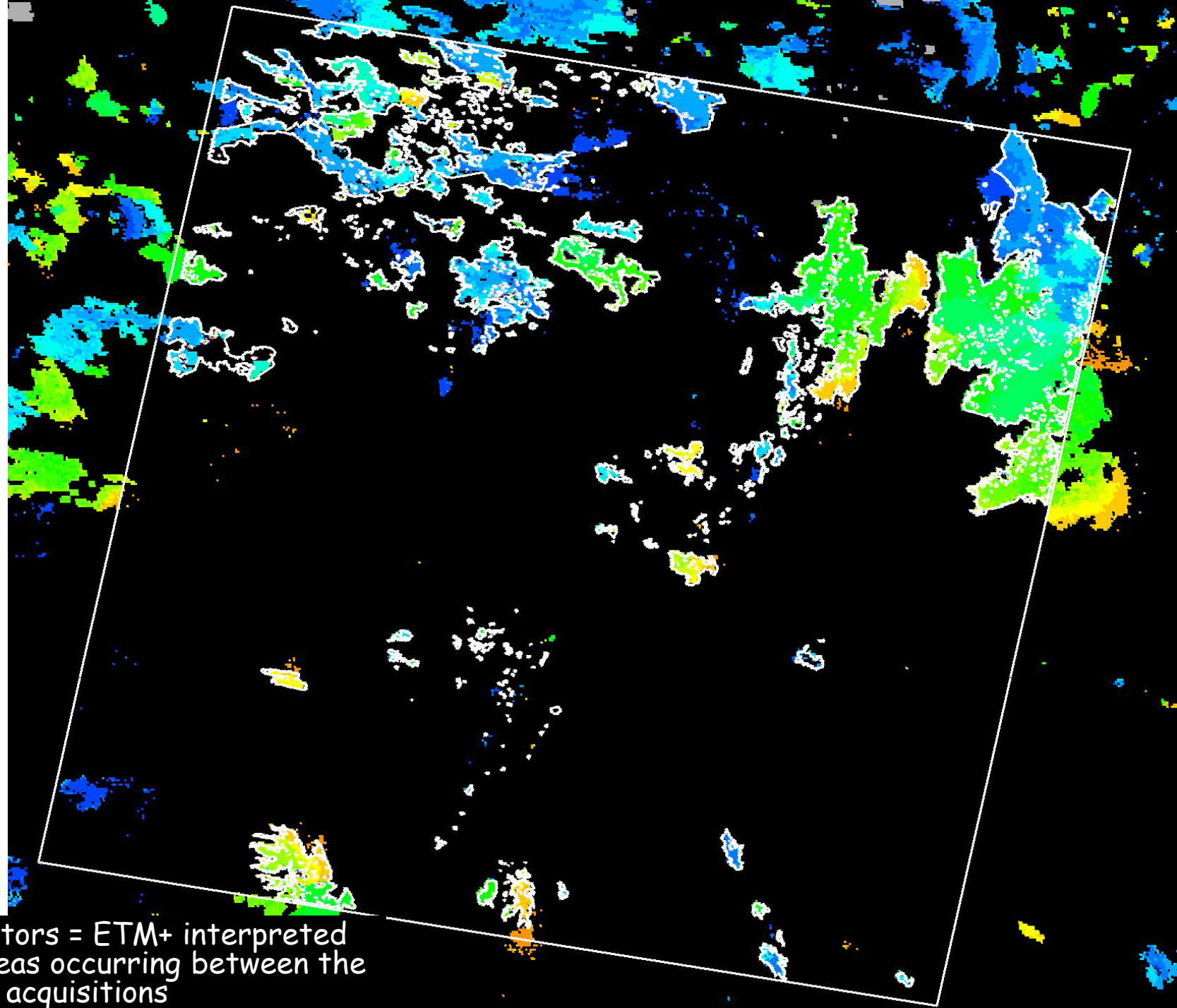
Oct. 6th



Yellow vectors = ETM+ interpreted
burned areas occurring between the
two ETM+ acquisitions

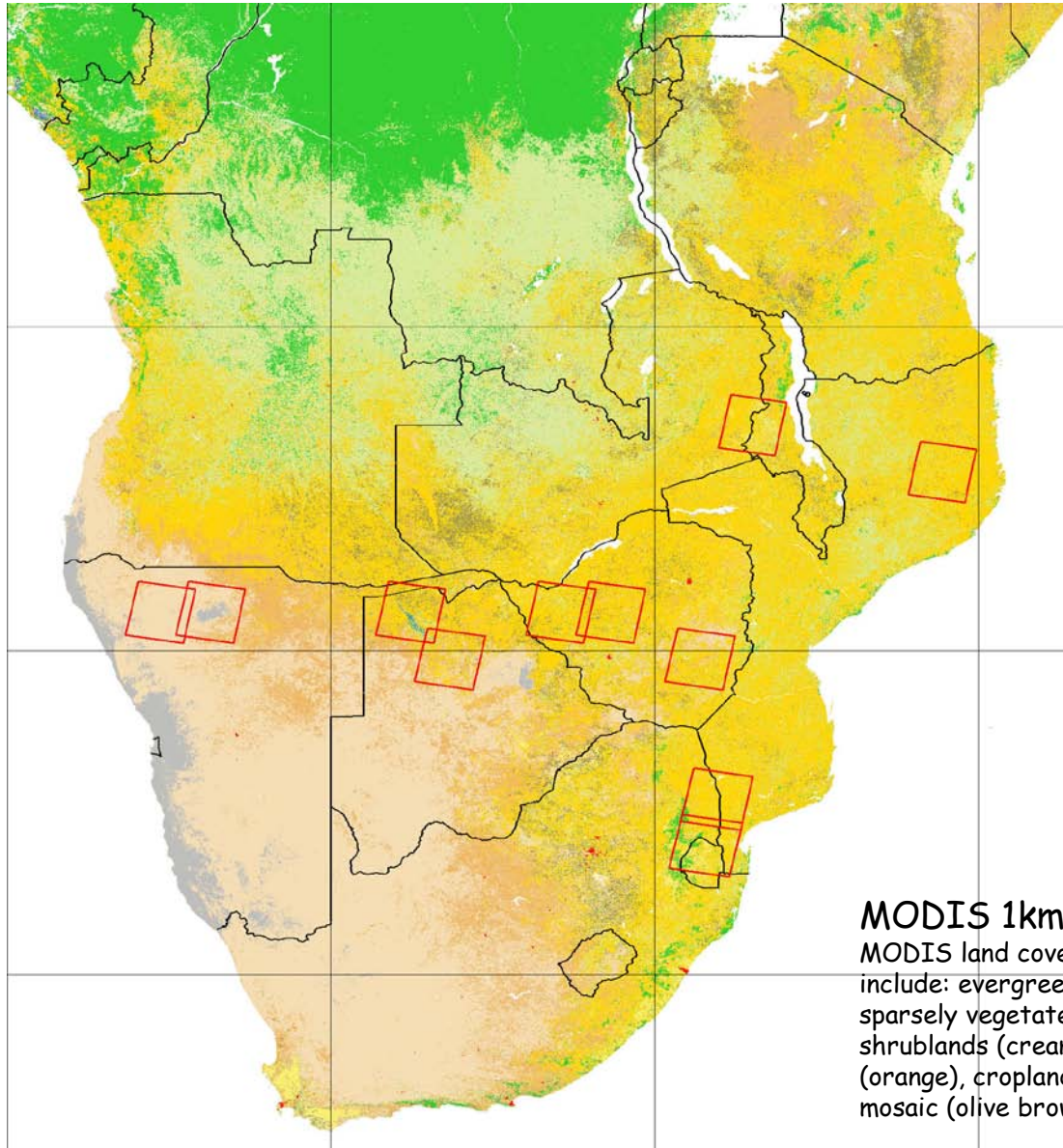
MODIS
500m
Burned
Areas

Sept. 4
to
Oct. 6



White vectors = ETM+ interpreted
burned areas occurring between the
two ETM+ acquisitions

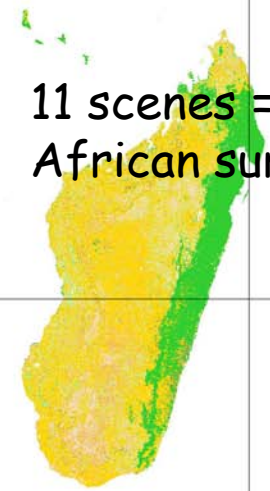
Landsat ETM+ validation scenes distributed from dry savanna to wet miombo woodland to quantify product accuracy over range of representative biomass burning conditions



ETM+ scene
~185 * 185 km

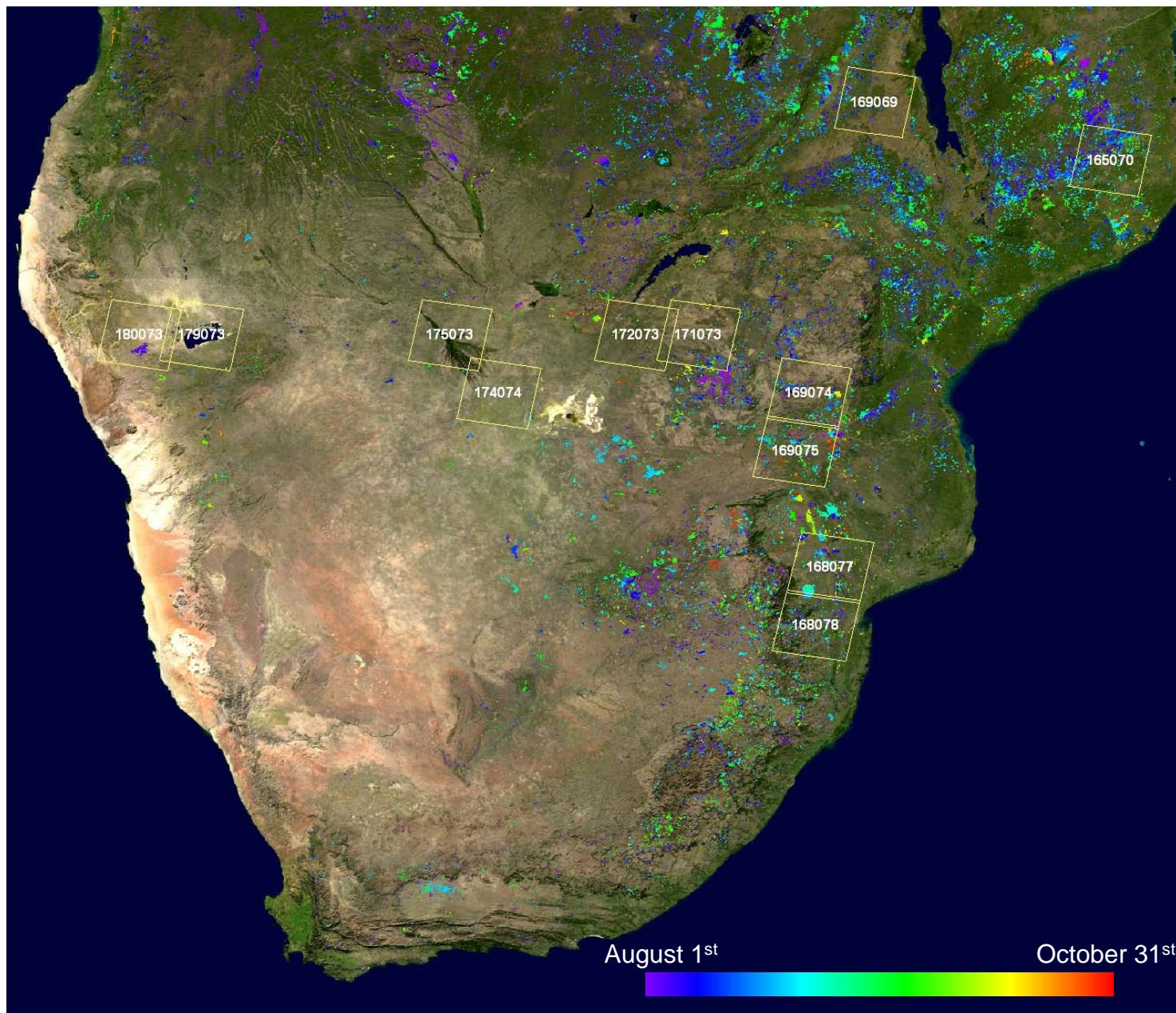
Each ETM+ scene has a local
SAFNet collaborator

11 scenes = ~3% of southern
African surface



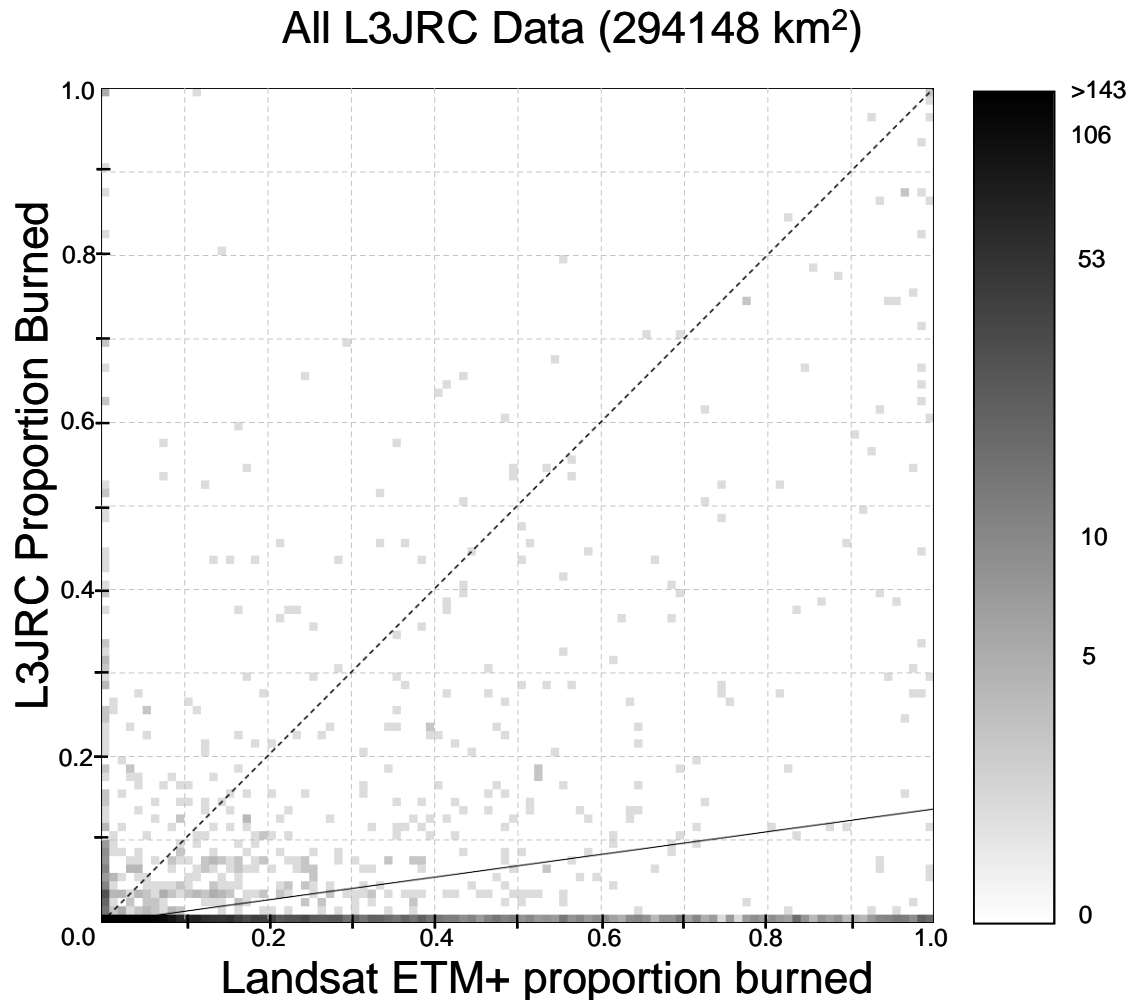
MODIS 1km land cover product: of the 17
MODIS land cover classes, predominant classes illustrated
include: evergreen broadleaf forest (dark green), barren or
sparsely vegetated (gray), woody savannas (light green), open
shrublands (cream), grasslands (light brown), savannas
(orange), croplands (yellow), cropland/natural vegetation
mosaic (olive brown), urban (red).

L3JRC - A/S/O 2001

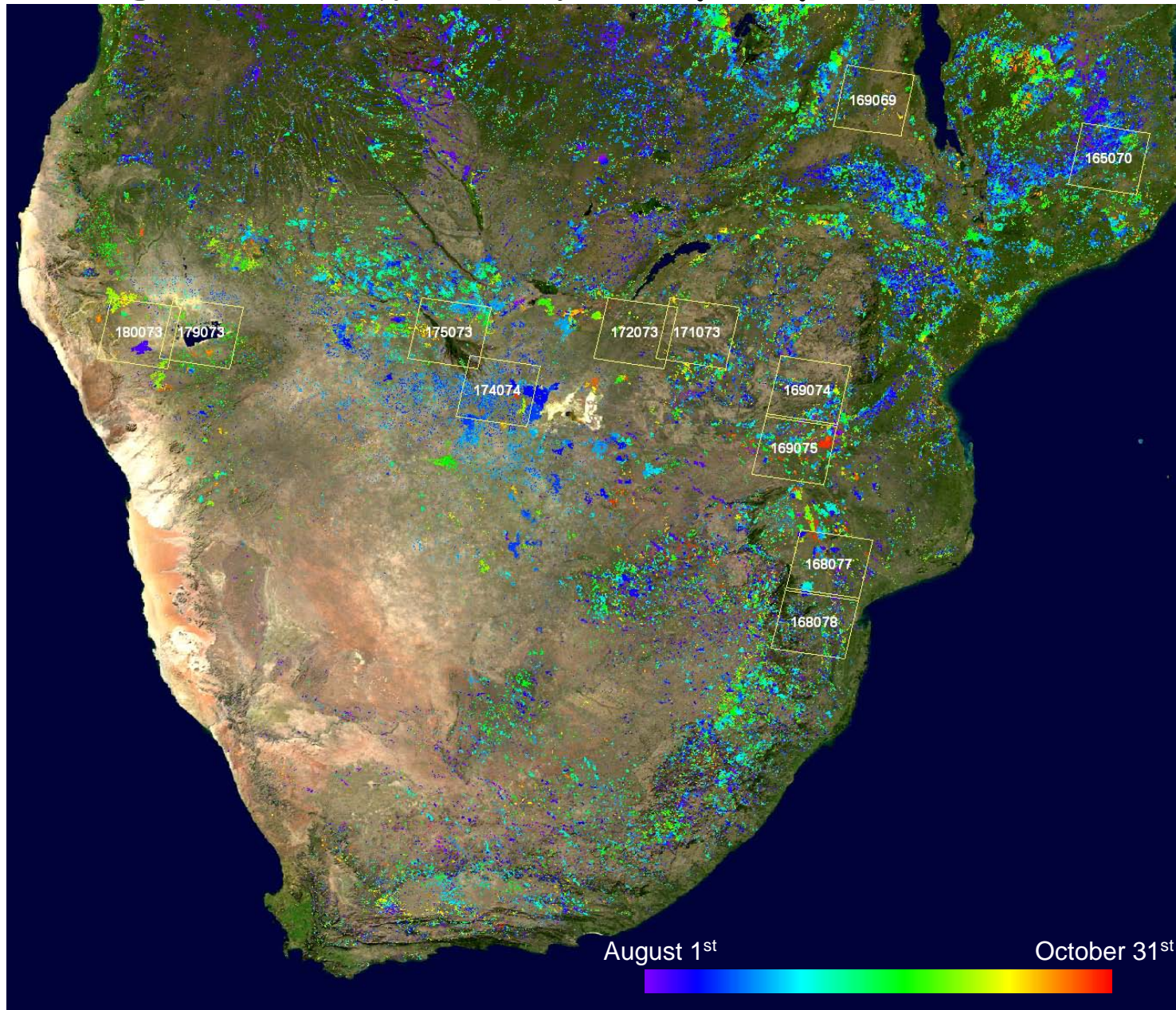


L3JRC Burned Area product Validation

The slope of the regression line is **0.136**,
The intercept is 0.001 and the r2 is **0.128**

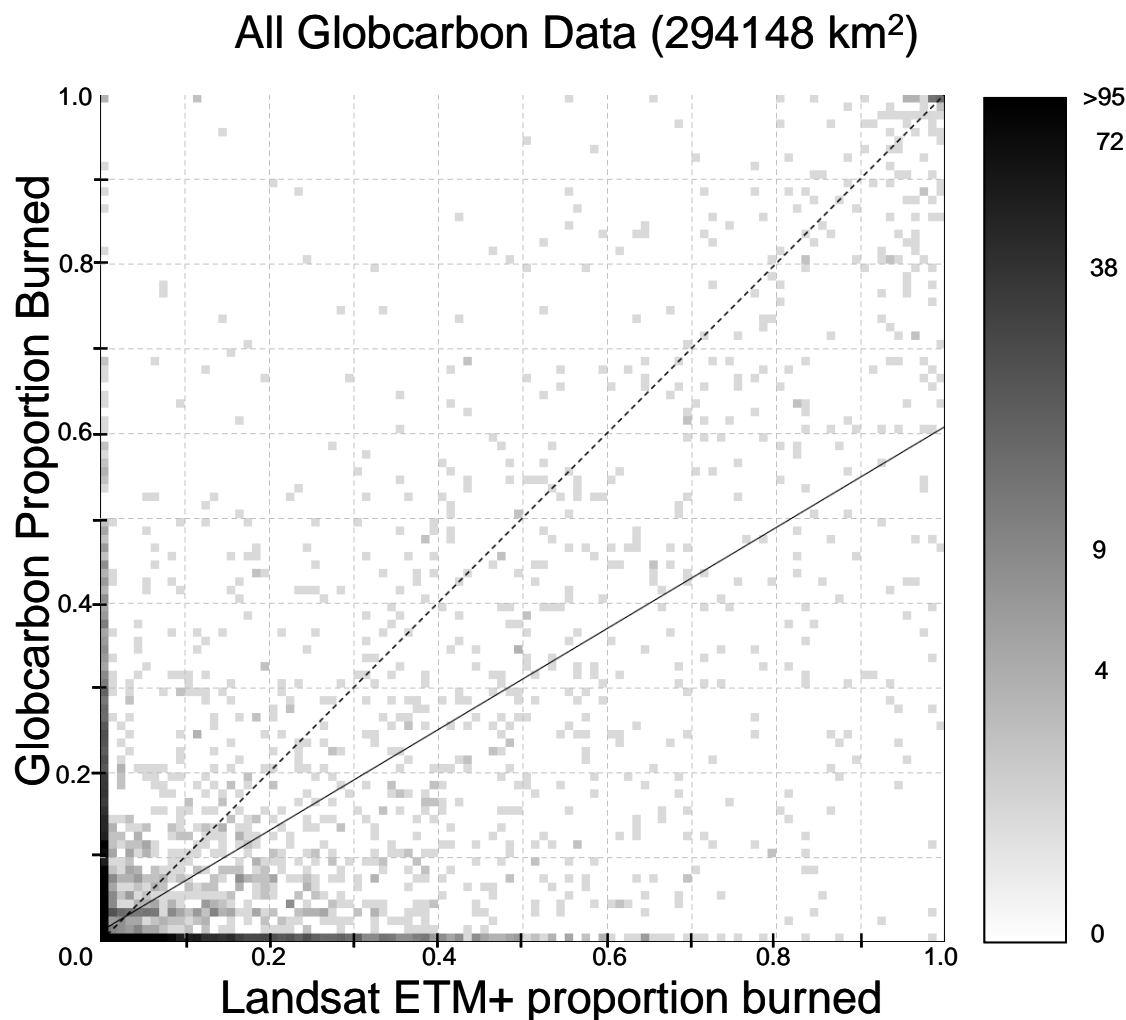


GlobCarbon -A/S/O 2001

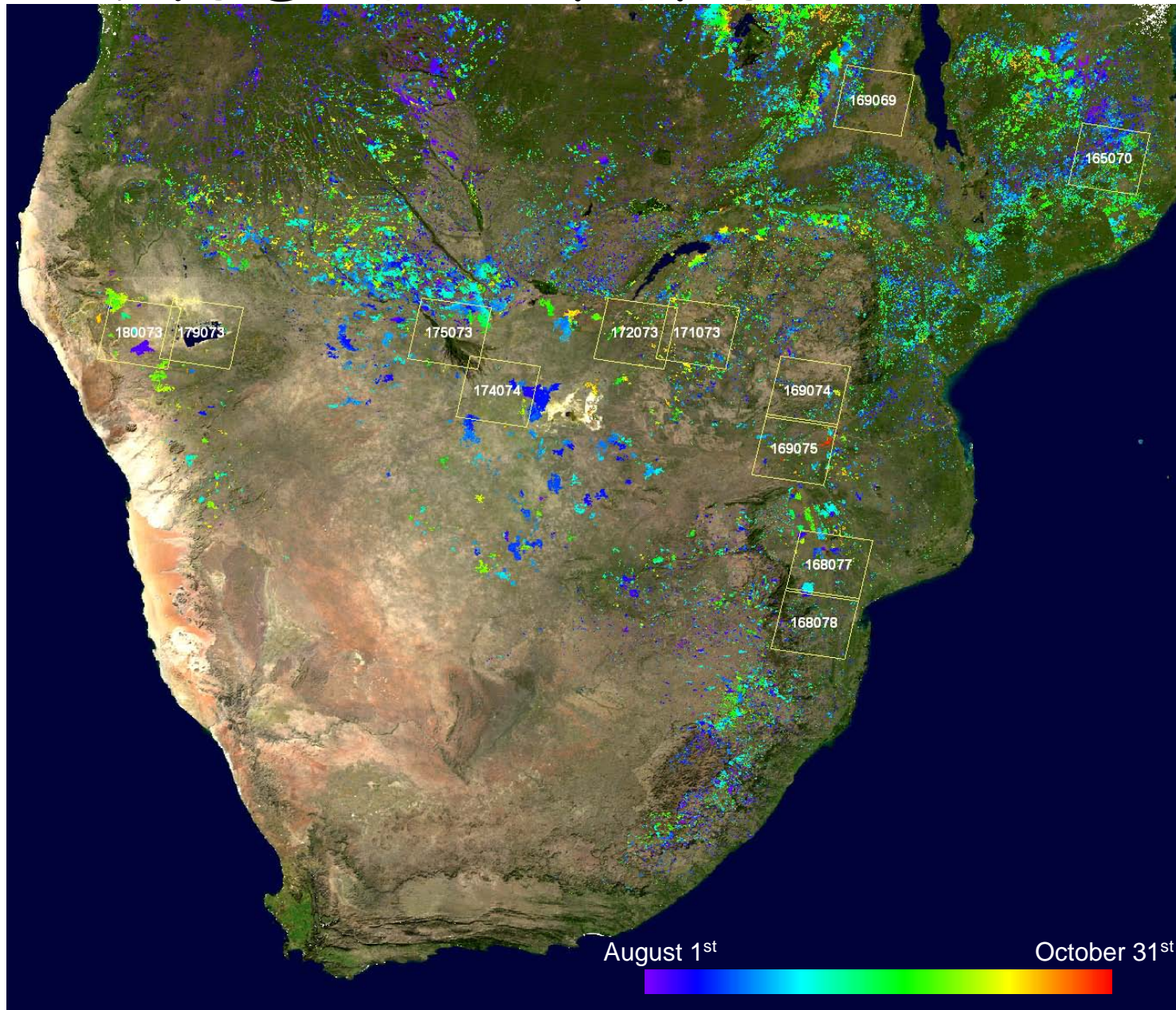


GLOBCARBON Burned Area product Validation.

The slope of the regression line is **0.595**,
The intercept is 0.013 and the r2 is **0.509**



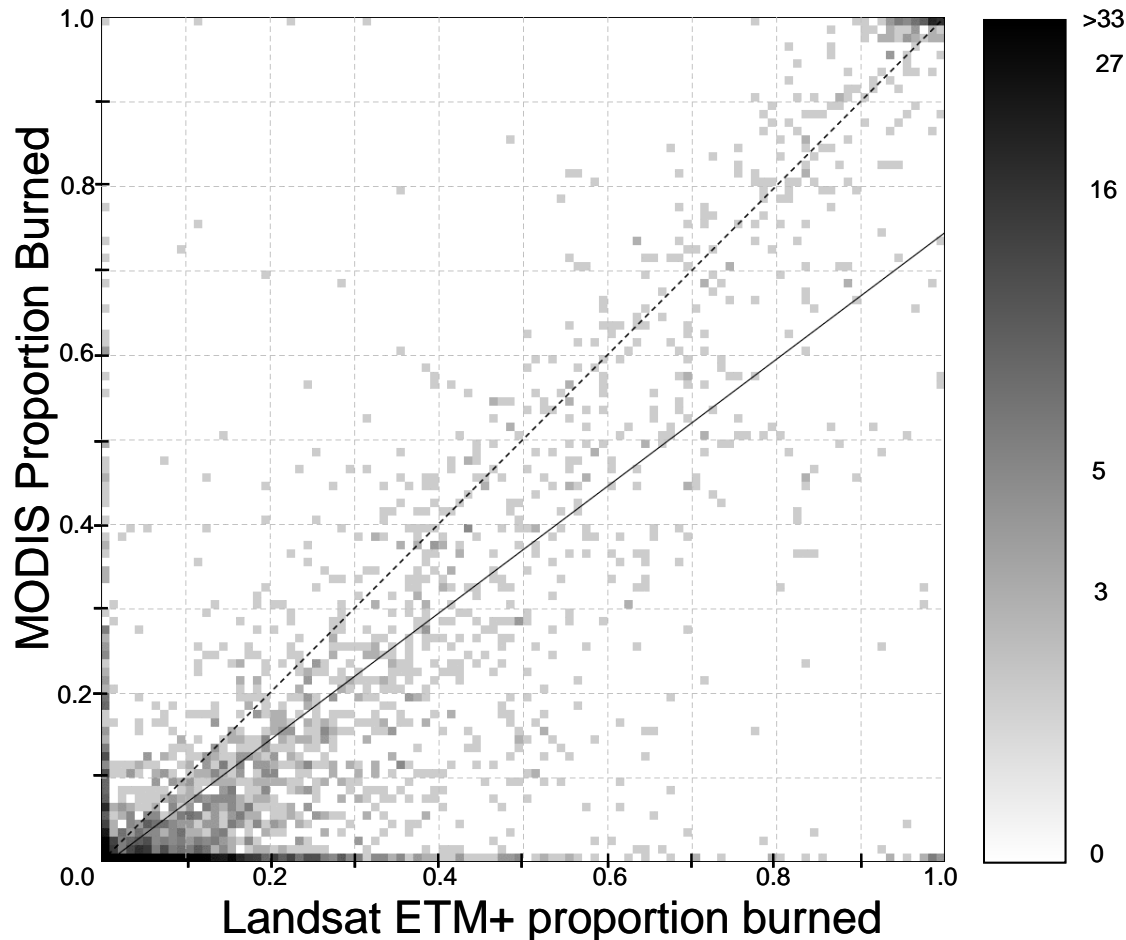
MODIS - A/S/O 2001



MODIS Burned Area product Validation

The slope of the regression line is **0.75**,
The intercept is **-0.005** and the r^2 is **0.746**

All MODIS C5 Data (294148 km²)



Satellite Fire Monitoring

- **Data Product Progression**

- Algorithm Development and Testing (ATBD peer review)
- Data Set Generation
- Product Quality Control (QA metadata)
- Product Validation (independent measurements)
- Product Documentation and Distribution
- Algorithm Refinement and **Reprocessing**

Working Group on
Calibration & Validation



Land Product Validation Subgroup

(Validation = independent Accuracy Assessment)

Established in 2000
as a subgroup of the
Committee on Earth Observing Satellites:
Working Group on Calibration/Validation

Linked through

www.wgcvceos.org

Chair: jeff.morissette@nasa.gov



LPV Structure cont.

Focus Group	North America	Europe (Other)
Land Cover / Dynamics	Mark Friedl (Boston University)	Martin Herold (GOFC/GOLD)
Fire	Luigi Boschetti (University of Maryland)	Kevin Tansey (University of Leicester, UK)
Biophysical	Joanne Nightingale / Richard Fernandes (NR Canada)	Stephen Plummer (ESA/ESRIN, IT)
Surface Radiation	Crystal Schaaf (Boston University)	Gabriela Schaepman (University of Zurich, SW)
Land Surface Temperature	Ana Pinheiro (NOAA)	Jose Sobrino (University of Valencia, SP)
Soil Moisture	Tom Jackson (USDA)	Wolfgang Wagner (Vienna Uni of Technology, AT)

LPV Web Site: <http://lpvs.gsfc.nasa.gov>

Communication:

- Process for data / information collection and sharing
- Mailing lists
- Group communication via LPV wiki
- Information sharing via LPV website

The screenshot shows the 'FrontPage' of the LPVS WG wiki. At the top, it says 'VIEW' and 'EDIT'. Below that, it says 'FrontPage' and 'last edited by Jaime Nickeson 2 wks ago'. The main heading is 'Welcome to the Main Page for the LPVS Working Group!'. Below this, there is a paragraph: 'This is the home page of the Land Product Validation Working Group Wiki, where members can view and edit information and documents in a central location, hopefully with a bit less email and document versions passing back and forth. Comments are available at the bottom of each page.' Below that, it says 'Links to LPV WG pages are listed below' and lists several links: 'Montana Global Vegetation Workshop', 'Montana LPV Sub-group leads workshop', 'General LPV lead and WG activities and info', 'Burned Area Protocol Development', 'New Web page for LAI Intercomparison data access', and 'Land Surface Temperature (LST) Group'.

The screenshot shows the homepage of the LPV website. At the top, it says 'NASA GODDARD SPACE FLIGHT CENTER' and '+ NASA Homepage'. Below that, it says 'CEOS WORKING GROUP ON CALIBRATION & VALIDATION' and 'Land Product Validation Subgroup'. There are navigation links: 'Home', 'Landcover', 'Biophysical', 'Fire/Burn', and 'Surface Rad'. Below that, there is a section for 'Announcing...' with a list of events: 'The International Conference on Land Surface Radiation and Energy Budgets, Beijing, March 18-20, 2009', 'Mark your calendars!! 4th Global Vegetation Workshop, Missoula, MT, June 16-18, 2009', 'The Globcover product and validation report are now available via the POSTEL web site.', 'The proposed satellite Burned Area Validation Protocol is now available for review.', 'CEOS CaVal Portal. See Newsletter link under Information section.', 'View a summary of current GEO/GEOSS tasks and the LPV contributions here.', 'Reports and presentations from the GEO/GEOSS Workshop on Calibration and Validation Processes - Geneva, 2007', 'TGRS Special Issue on Land Product Validation', 'CEOS Publication - Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment', and 'Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment'. Below that, there is a 'Subscribe!' section with a 'Subscribe:' button and an 'Unsubscribe:' button. Below that, there is a 'Data access' section with links to 'CEOS Validation Core Sites' and 'GEOSS Test Facility (WTF)'. Below that, there is a 'CEOS Calendar' section. Below that, there is an 'Organization:' section. At the bottom, it says 'LPV is a subgroup of the Working Group on Calibration and Validation'. On the right side, there is a 'LPV Mission' section with the text: 'To foster quantitative validation of higher-level global land products derived from remote sensing data and to relay results so they are relevant to users'. Below that, there is a 'Validation is the process of assessing, by independent means, the quality of the data products derived from the system outputs' section. Below that, there is a 'Background' section with the text: 'The subgroup on Land Product Validation (LPV) is one of six subgroups of the Working Group on Calibration and Validation (WGCV), which itself is one of two standing working groups within the Committee on Earth Observation Satellites (CEOS, see also CEOS structure [2]). The six WGCV subgroups are: Infrared and Visible Optical Sensors (IVOS), Atmospheric Chemistry (AC), Microwave Sensors (MS), Synthetic Aperture Radar (SAR), Terrain Mapping (TM), and Land Product Validation (LPV)'. Below that, there is a section for 'Validation' with the text: 'The Land Product Validation subgroup arose out of the recognition in the late nineties that standardized approaches to global product validation were essential for wide acceptance and use of proposed global land products. Several programs at the time were aimed at global monitoring of Earth processes, many with plans to distribute higher level data products. A common approach to validation would encourage widespread use of validation data, and thus help us to move toward standardized approaches to global product validation. With the high cost of in-situ data collection, the potential benefits from international cooperation are considerable and obvious. Previous requests for assistance from the original International Global Observing Strategy (IGOS) pilot projects and two subsequent ad hoc meetings of the WGCV identified a clear need for improved international collaboration concerning the validation of land products derived from Earth observing satellites. A new subgroup within the WGCV was proposed to the CEOS Plenary in Stockholm at the end of 1999, receiving full support. The LPV was officially adopted as a subgroup at the WGCV-17 meeting in October of 2000. A general consensus now exists within the CEOS community to identify the three stages of validation for satellite products. The guidelines for the CEOS Hierarchy of Validation are: 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 effort. 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. The LPV subgroup activities are divided up into four themes that complement the research agenda of the Global Observations of Forest and Land Cover Dynamics'.

Validation of Satellite Based Fire Products for Central Asia

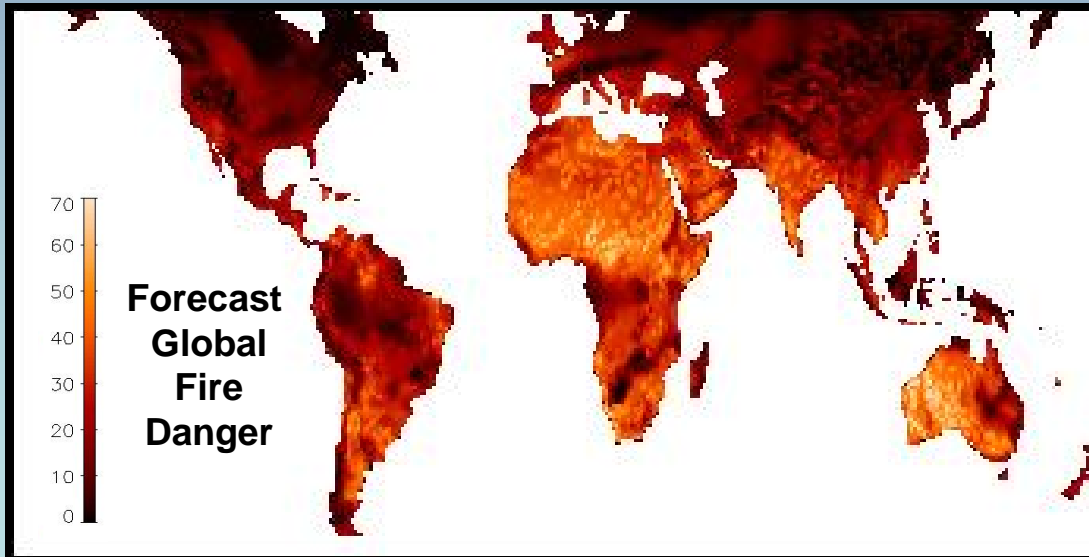
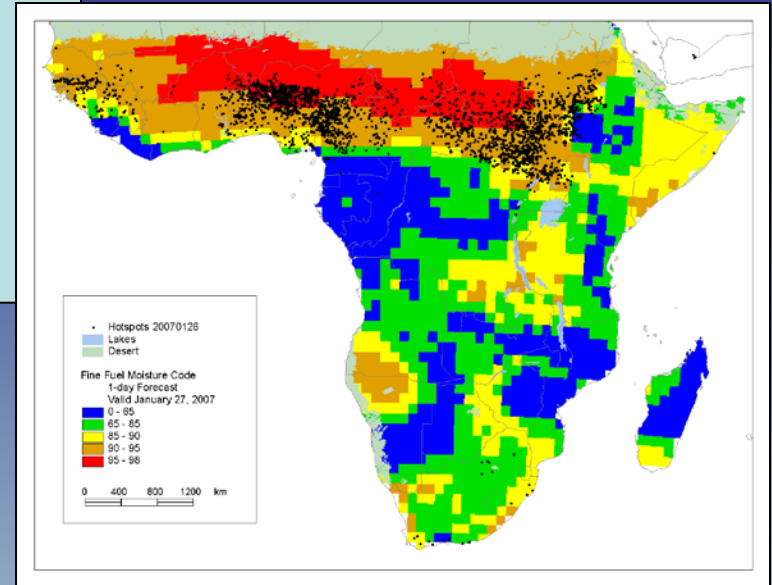
- Is this something of interest to the audience?

Tatiana Laboda's Fire Training Session

Early warning allows implementation of:

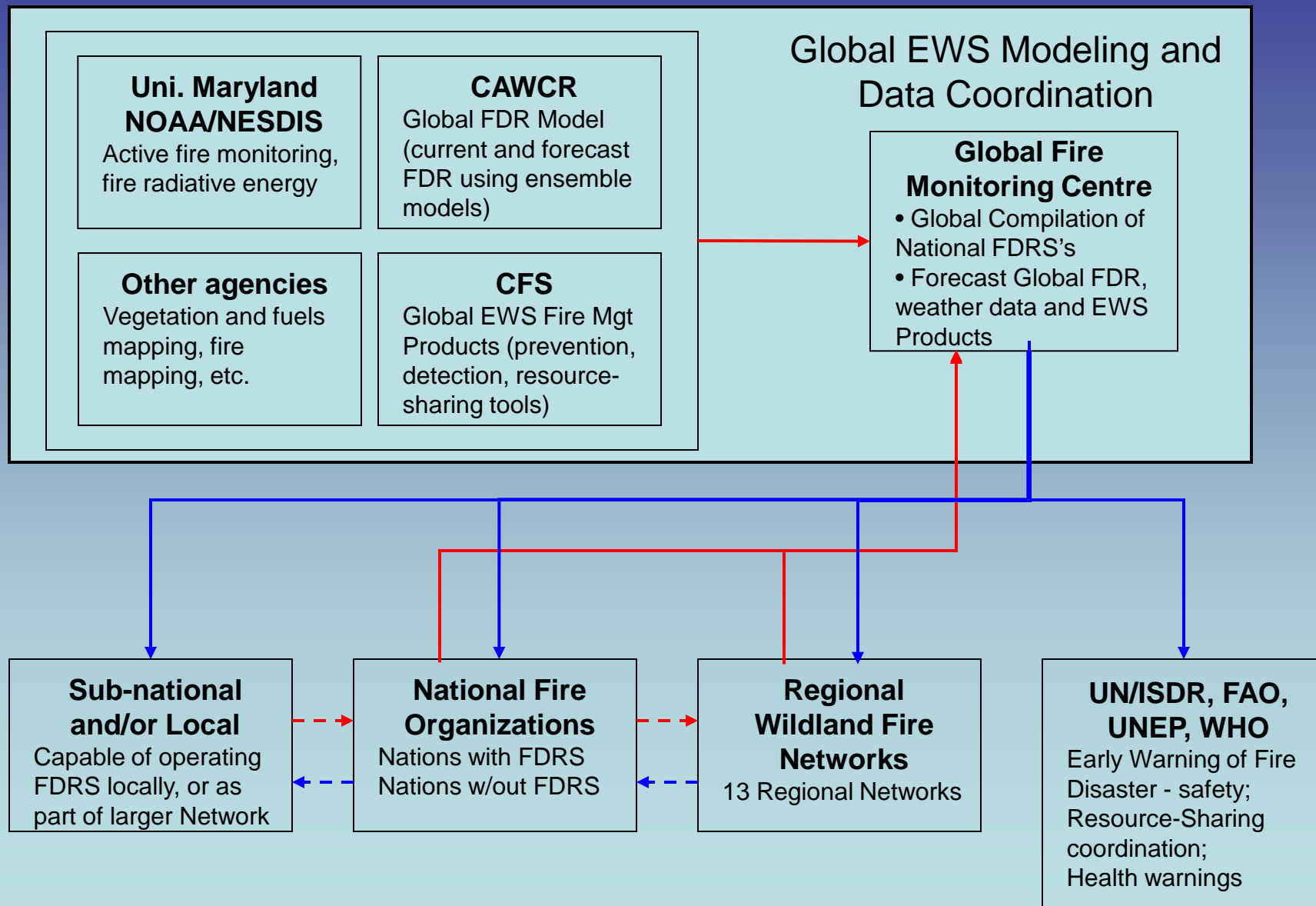
- fire prevention
- fire detection
- resource mobilization

before wildfire disasters occur.



Global EWS – Fire: System Structure

- EWS products (www)
- EWS data inputs
- - - Information links

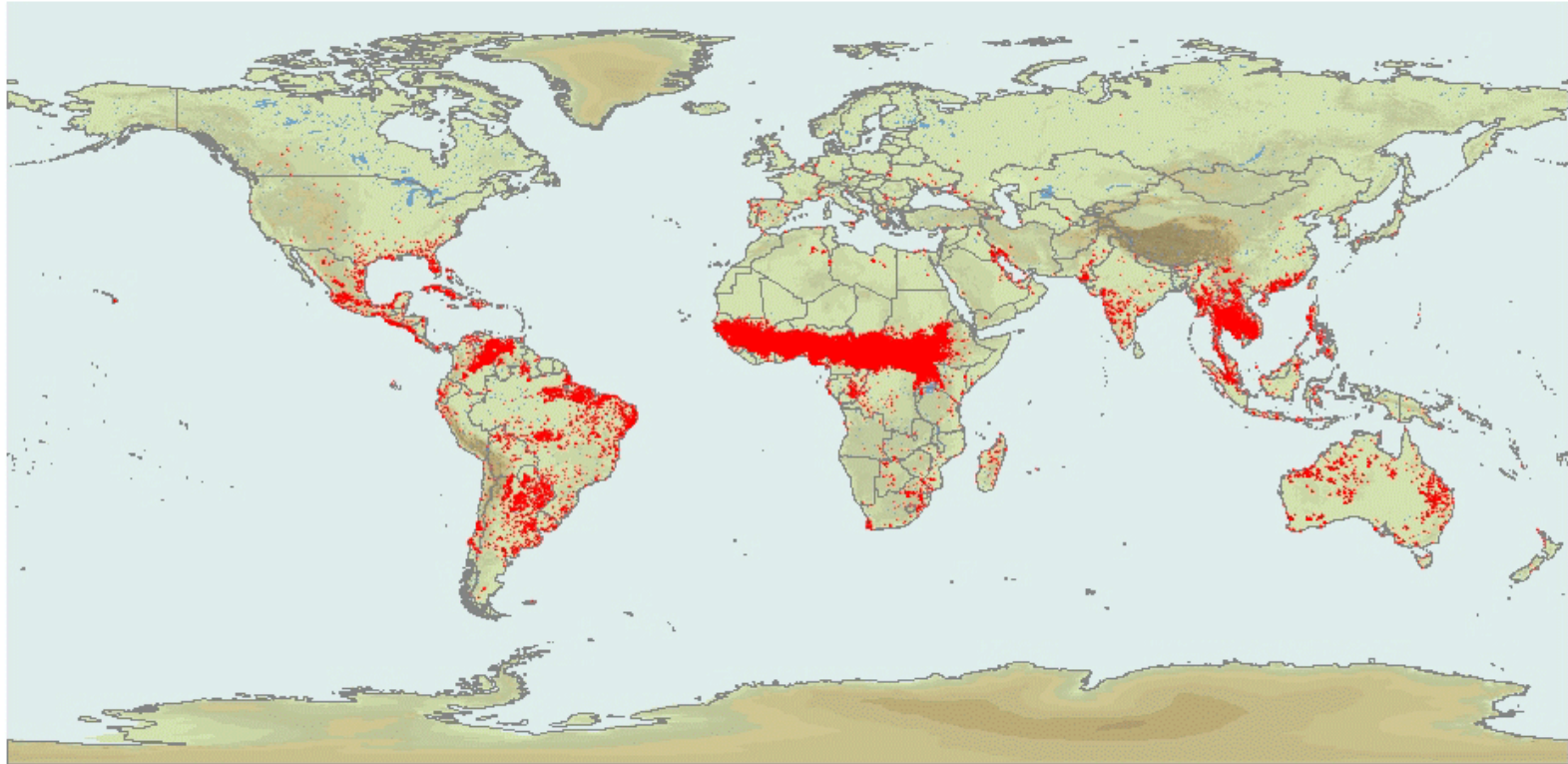


A Satellite-based Global Fire Assessment 2010

- GOFC/GOLD, ISDR and GFMC are initiating a satellite-based global fire assessment using the available validated fire data records
- Global Trends in fire activity (10 year record)
 - Developing the most useful metrics
- The assessment would be undertaken working closely with regional fire scientists and management community to design and evaluate the assessment
 - Recent trends in fire activity, consistent method
 - Complement FAO's compilation of national fire statistics

Seasonal Variability (2005)

MODIS Rapid Response Fire Detections for 2005



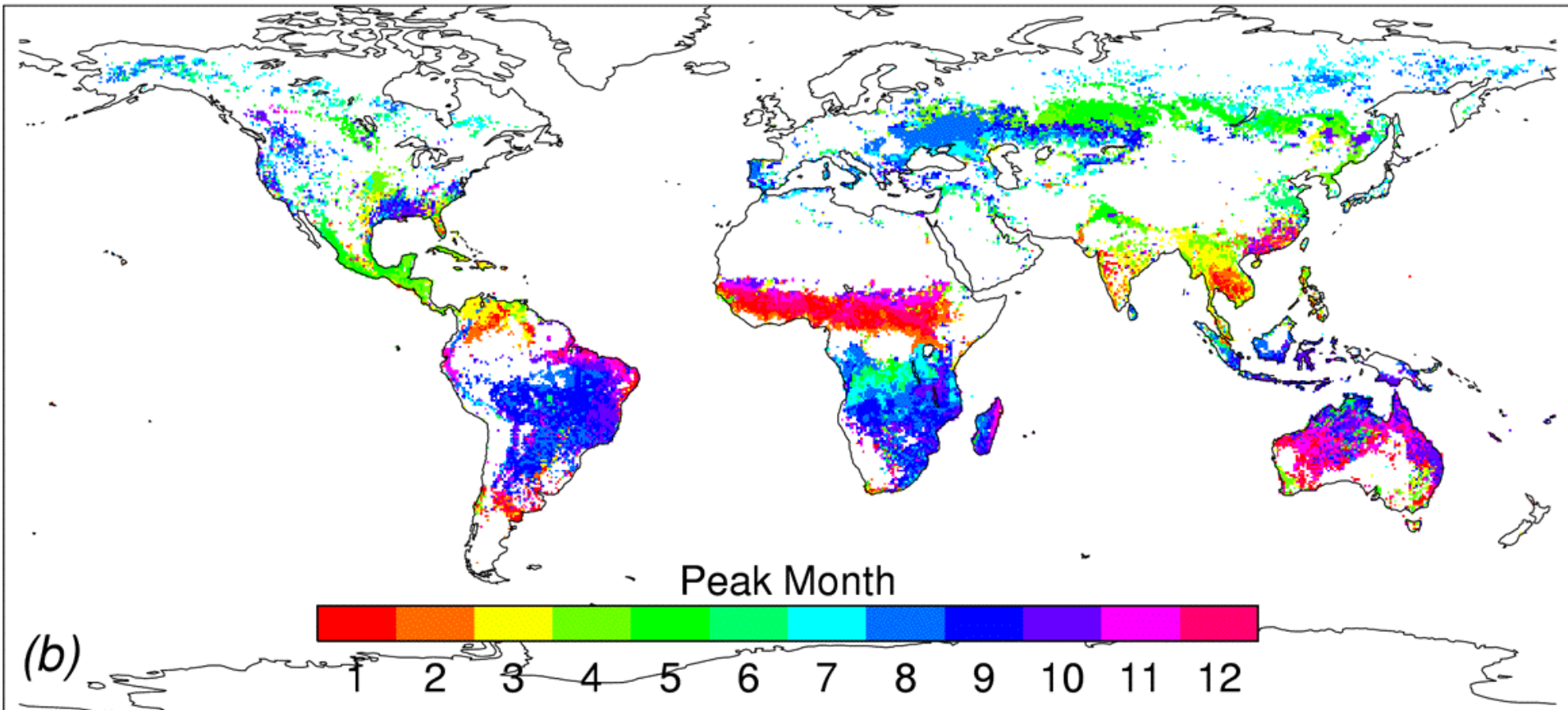
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER



● MODIS Active Fire Detections
□ World Countries

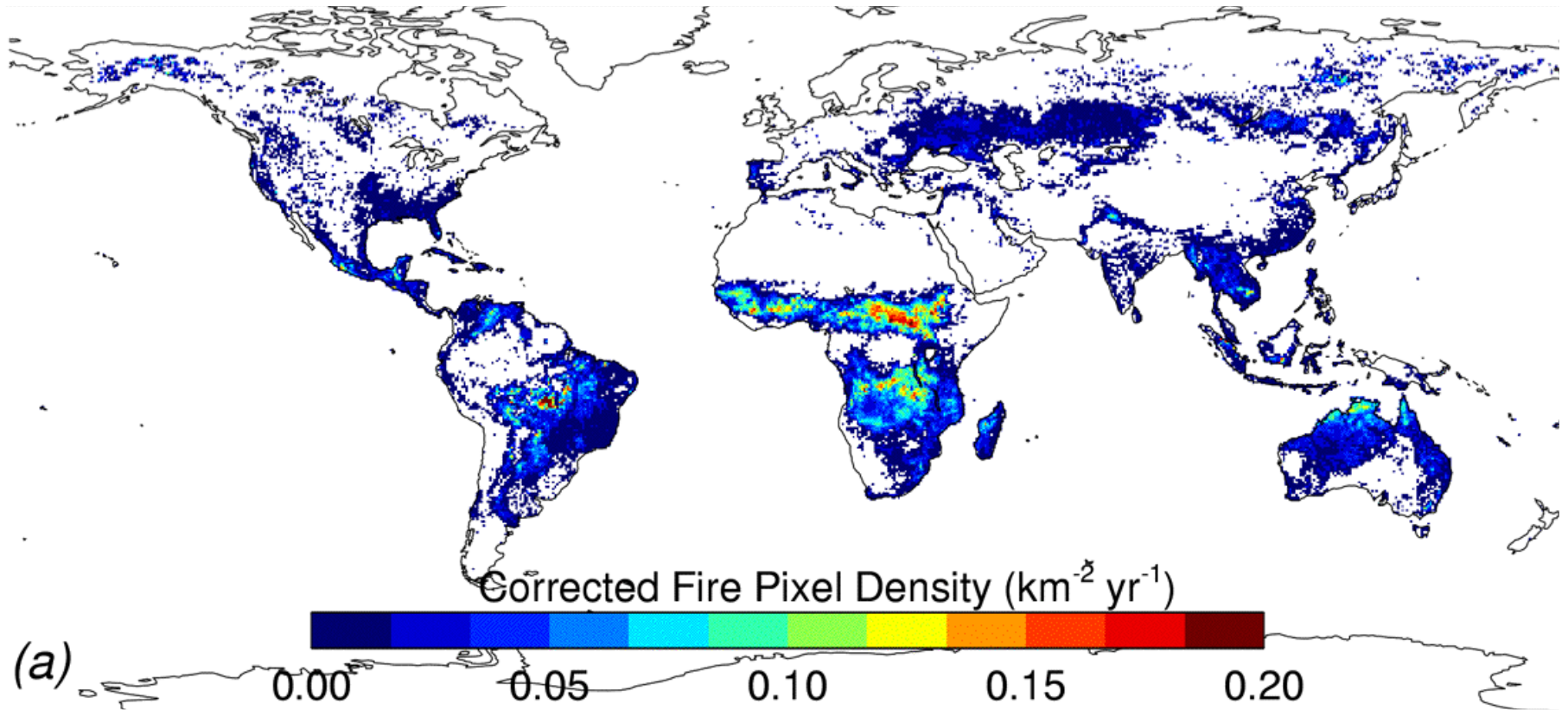
Active fires are detected using MODIS data from the Terra satellite.
Source: MODIS Rapid Response <http://rapidfire.sc.gsfc.nasa.gov>
Web Fire Mapper <http://maps.geog.umd.edu>

Global Fire Regime Characterization



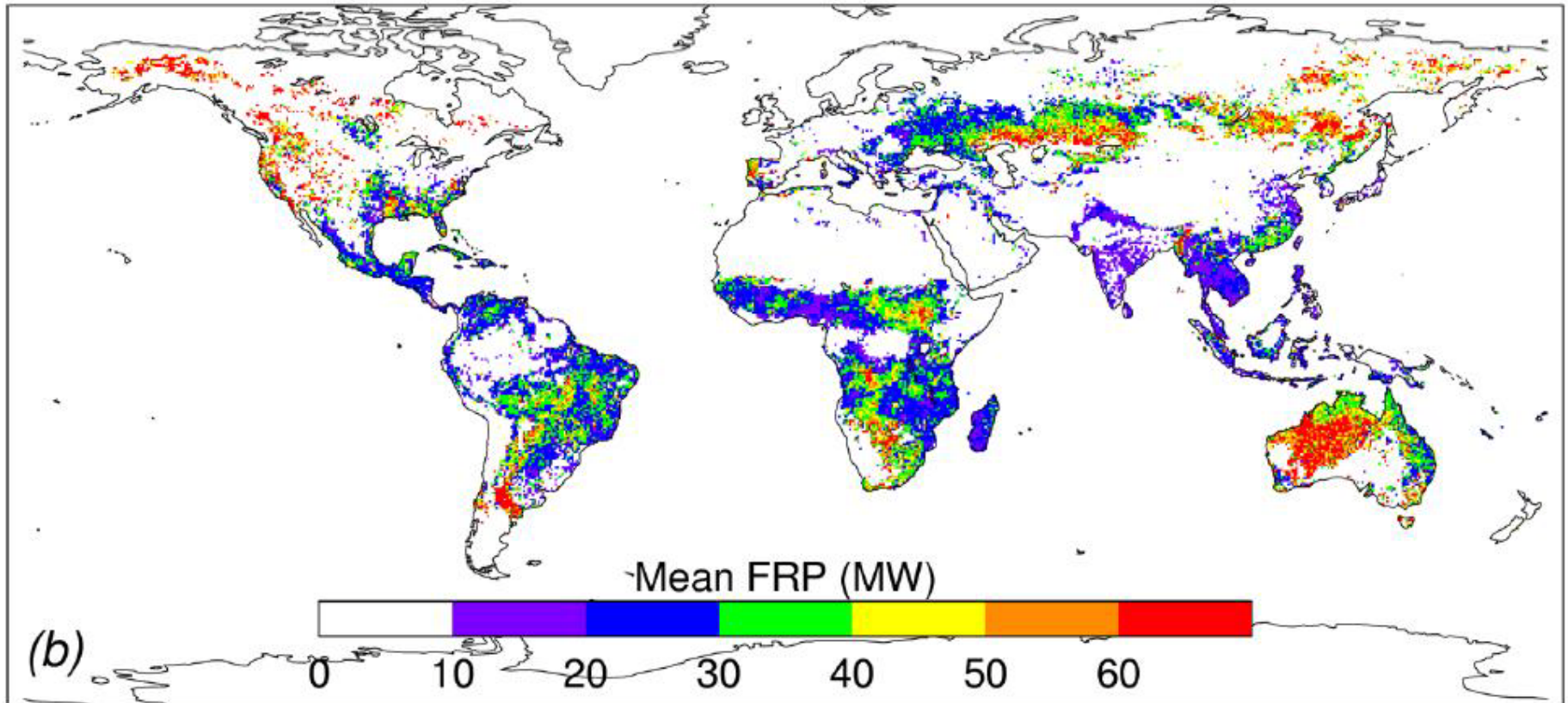
Mean Peak Fire Month (2000-2005)

Global Fire Regime Characterization



Peak Fire Month Mean Fire Pixel Density
(Terra MODIS mean ; Nov. 2001 - Oct. 2005)

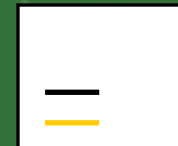
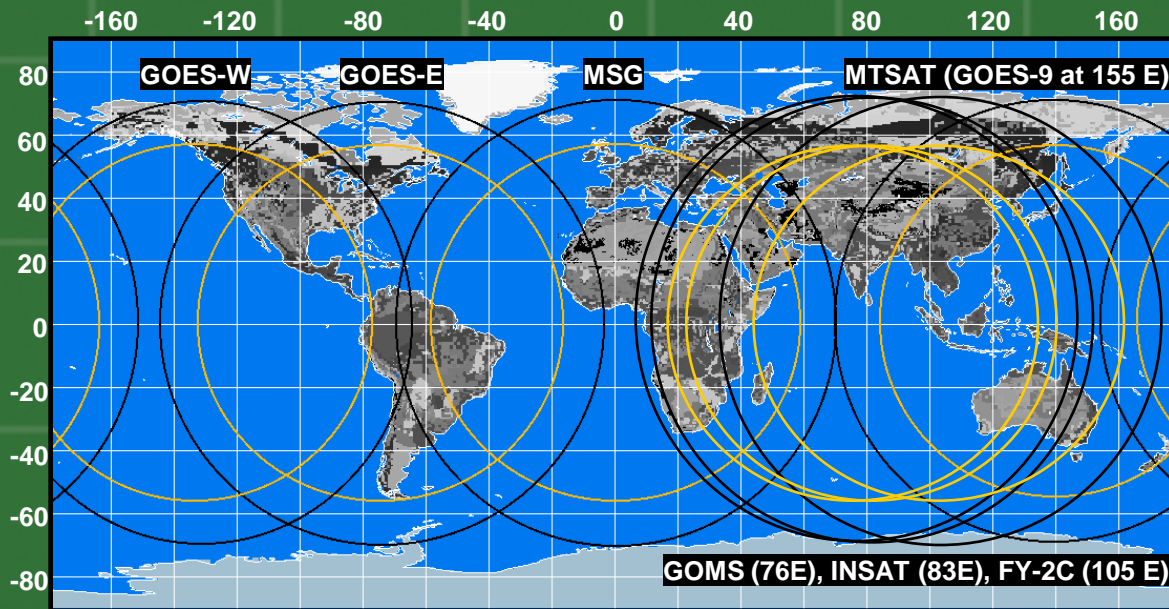
Fire radiative power from MODIS active fires (2000-2005)



Giglio et al., 2006, JGR

Data Continuity and Improved Observations for Fire Monitoring

- Geostationary Global Fire Network (*GOES-R*)
- Fire Monitoring with next generation Operational Polar Orbiters (*NPP VIIRS*)
- High/Mod Resolution Data Continuity (*NASA/USGS LDCM OLI and TIRS (Landsat 8)*)
- New Technology Development (*UAV Fire, NASA Sensor Web, New Decadal Survey Missions*)



Global Geostationary Active Fire Monitoring Capabilities

Satellite	Active Fire Spectral Bands	Resolution IGFOV (km)	SSR (km)	Full Disk Coverage	3.9 μ m Saturation Temperature (K)	Minimum Fire Size at Equator (at 750 K) (hectares)
GOES-12 Imager	1 visible 3.9 and 10.7 μ m	1.0 4.0 (8.0)	0.57 2.3	3 hours	~335 K	0.15
GOES-9 & GOES-10 Imager	1 visible 3.9 and 10.7 μ m	1.0 4.0 (8.0)	0.57 2.3	1 hour (G-9) 3 hours (G-10)	~324 K (G-9) ~322 K (G-10)	0.15
MSG SEVIRI	1 HRV 2 visible 1.6, 3.9 and 10.8 μ m	1.6 4.8 4.8	1.0 3.0 3.0	15 minutes	~335 K	0.22
FY-2C SVISSR (Fall 2004)	1 visible, 3.75 and 10.8 μ m	1.25 5.0		30 minutes	~330 K (?)	
MTSAT-1R JAMI (2005)	1 visible 3.7 and 10.8 μ m	0.5 2.0		1 hour	~320 K	0.03
INSAT- 3D (2006)	1 vis, 1.6 μ m 3.9 and 10.7 μ m	1.0 4.0	0.57 ? 2.3 ?	30 minutes		
GOMS Electro N2 MSU-G (2006)	3 visible 1.6, 3.75 and 10.7 μ m	1.0 km 4.0 km		30 minutes		



GOFC-GOLD



What Happens After MODIS ?



NPOESS Preparatory Project (NPP) Status

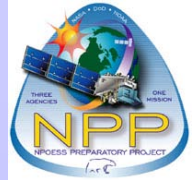
**A CONVERGED SYSTEM
NASA / NOAA / DOD**

National Polar-orbiting Operational Earth Satellite Suite
Preparatory
Project

NPP

Visible
Infrared
Imaging
Radiometer
Suite

VIIRS



Visible Infrared Imaging Radiometer Suite IPO /NGST/ Raytheon Santa Barbara Remote Sensing



Description

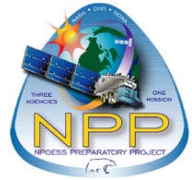
- Purpose: Global observations of land, ocean, & atmosphere parameters at high temporal resolution (~ daily)
- Predecessor Instruments: AVHRR, OLS, MODIS, SeaWiFS
- Approach: Multi-spectral scanning radiometer (22 bands between 0.4 μm and 12 μm) 12-bit quantization
- Swath width: 3000 km

Status

- EDU Finished T/Vac testing
- Flight Unit #1 Development continues

Launch early 2011





Comparison of MODIS & VIIRS Bands

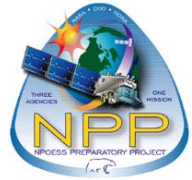


M O D I S		V I I R S	
B a n d	#λ	λ	B a n d
1	6 2 0 -	6 760 0 -	6 8 0-1
2	8 4 1 -	8 780 5 -	8 8 5-2
3	4 5 9 -	4 7 9	
4	5 4 5 -	5 6 5	
5	1 2 3 0 -	1 1250 0 -	1 2 5-3
6	1 6 2 8 -	1 5 8 0 -	1 6 7-0
		1 5 8 0 -	1 6 1 30
7	2 1 0 5 -	2 2 5 5 S	2 2 7 15
8	4 0 5 -	4 2400 2 -	4 2 2 M - 1
9	4 3 8 -	4 4483 6 -	4 5 4 M - 2
1 0	4 8 3 -	4 9437 8 -	4 9 8 M - 3
1 1	5 2 6 -	5 3 6	
1 2	5 4 6 -	5 5564 5 -	5 6 5 M - 4
1 3	6 6 2 -	6 7626 2 -	6 8 2 M - 5
1 4	6 7 3 -	6 8 3	
1 5	7 4 3 -	7 5733 9 -	7 5 4 M - 6
1 6	8 6 2 -	8 7874 6 -	8 8 5 M - 7
1 7	8 9 0 -	9 2 0	
1 8	9 3 1 -	9 4 1	
1 9	9 1 5 -	9 6 5	

MODIS Bands 1-2 are 250 m at Nadir
 MODIS Bands 3-7 are 500 m at Nadir
 MODIS Bands 8-36 are 1,000 m at Nadir

M O D I S		V I I R S	
B a n d	# λ	λ	B a n d
2 0	3 . 6 6 0 - 3	3 . 6 1 0 S	3 . 7 9 0 2
		3 . 5 5 0 S	3 . 9 1 3 4 0
2 1	3 . 9 2 9 - 3	3 . 9 8 9	
2 2	3 . 9 4 0 S	4 . 0 0 1	
2 3	4 . 0 2 0 - 4	4 . 0 8 9 0 7 S	4 . 1 2 8 3
2 4	4 . 4 3 3 S	4 . 4 9 8	
2 5	4 . 4 8 2 S	4 . 5 4 9	
2 6	1 . 3 6 0 - 1	1 . 3 1 9 0 1 S	1 . 3 8 6 M - 9
2 7	6 . 5 3 5 - 6	6 . 8 9 5	
2 8	7 . 1 7 5 - 7	7 . 4 7 5	
2 9	8 . 4 0 0 - 8	8 . 0 4 0 S	8 . 1 0 0 4
3 0	9 . 5 8 0 - 9	9 . 8 8 0	
3 1	1 0 . 7 8 0 - 1	1 0 . 2 3 S	1 0 . 2 1 6 5
		1 0 . 0 5 0 - 1	1 0 . 1 4 5 0
3 2	1 1 . 7 7 0 - 1	1 1 . 2 5 7 8 S	1 1 . 4 1 8 6
3 3	1 3 . 1 8 5 - 1	1 3 . 4 8 5	
3 4	1 3 . 4 8 5 - 1	1 3 . 7 8 5	
3 5	1 3 . 7 8 5 - 1	1 4 . 0 8 5	
3 6	1 4 . 0 8 5 - 1	1 4 . 3 8 5	

VIIRS Bands I1-I5 are 371 m at Nadir
 VIIRS Bands M-1-M-16 are 742 m at Nadir



VIIRS EDRs, IPs, and ARPs



EDR-Environmental Data Record | IP-Intermediate Product | ARP-Application Related Product

Land

- Active Fire [ARP]
- Land Surface Albedo
- Land Surface Temperature Ice Surface Temperature
- Sea Ice Characterization
- Snow Cover/Depth
- Vegetation Index
- Surface Type

Ocean

- Sea Surface Temperature
- Ocean Color/Chlorophyll

Imagery & Cloud

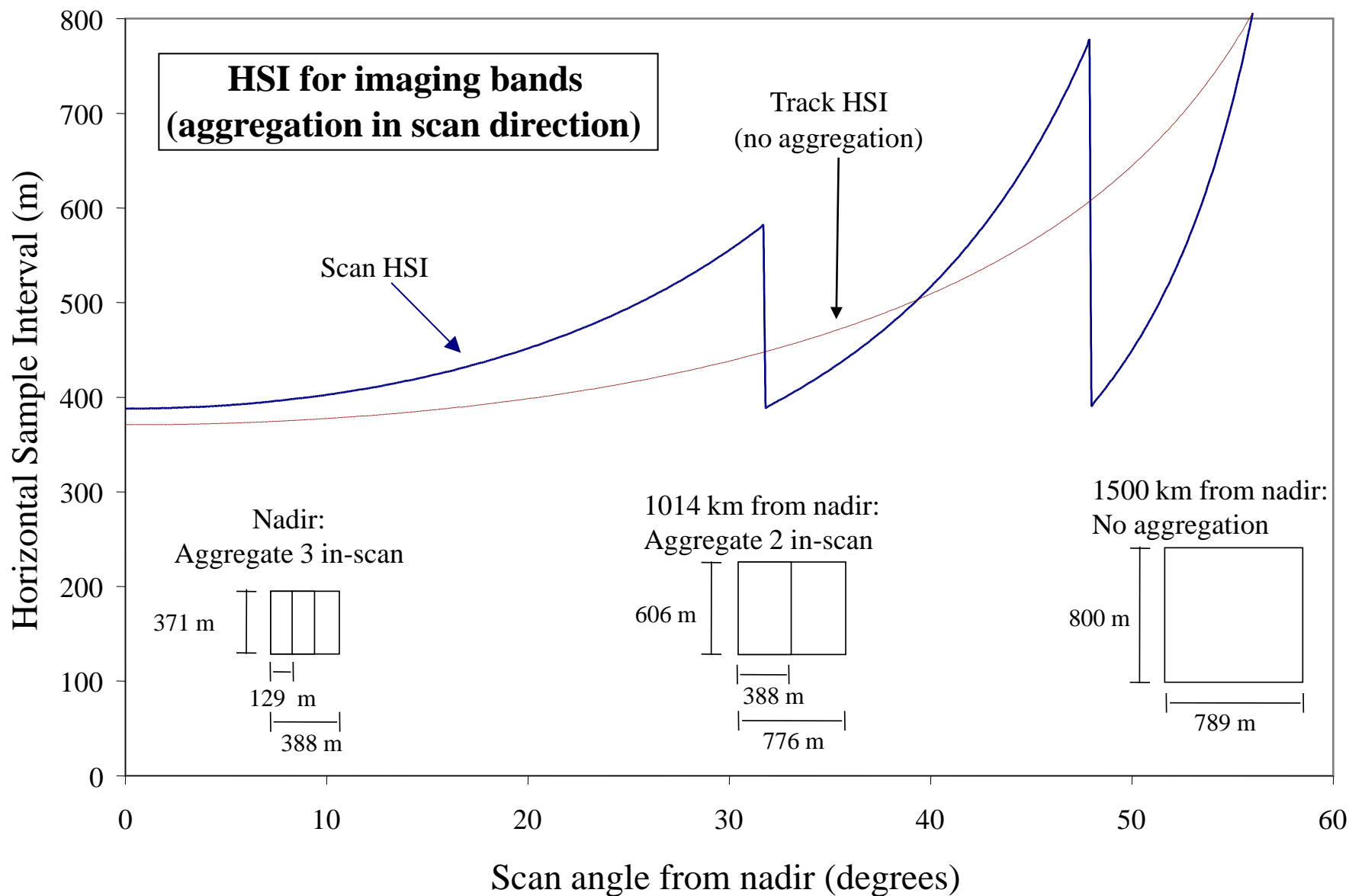
- Imagery
- Cloud Mask [IP]
- Cloud Optical Thickness
- Cloud Effective Particle Size Parameter
- Cloud Top Parameters
- Cloud Base Height
- Cloud Cover/Layers

Aerosol

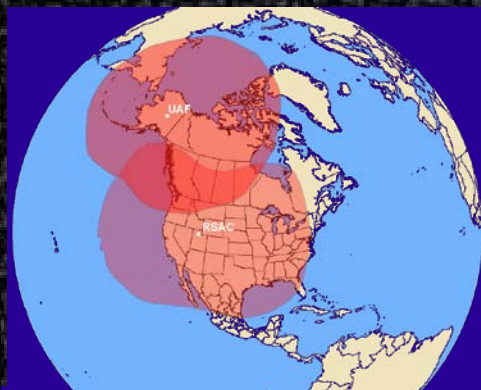
- Aerosol Optical Thickness
- Aerosol Particle Size Parameter
- Suspended Matter

Other Land products in planning phase

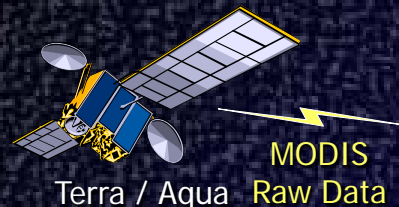
VIIRS Spatial Resolution – requirement for uniform pixel size across scan



DB Station NRT Capability



USFS-RSAC/UAF-GINA
Direct Broadcast Coverage



Terra / Aqua
MODIS Raw Data



TDRSS

MODIS Raw Data



USFS-RSAC
Direct Readout



UAF-GINA
Direct Readout

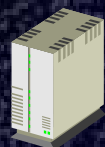


White Sands, NM



RSAC Direct Readout

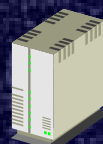
MODIS L0 Data
($< 1/2$ hour)



USFS-RSAC
Rapid Response System

Image & Active Fire
Detection Processing

MODIS L0 Data
($< 1/2$ hour)



UAF-GINA
Rapid Response System

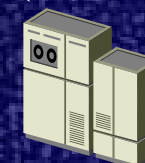
Image & Active Fire
Detection Processing

MODIS L0 Data



GES DAAC
NASA/GSFC

MODIS Land
Product
Distribution @
LP DAAC
(~ 1 Week)



NOAA MODIS
Real Time
Processing System

MODIS L0
(~3 hours)

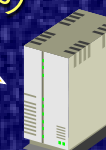


Image & Active Fire
Detection Processing

The Landsat Data Continuity Mission

Operational Land Imager

(aka Landsat 8)

Launch Date Planned for Dec 2012



**Ball Aerospace
& Technologies Corp.**

**Agility to innovate,
Strength to deliver**



OLI Maintains Landsat Legacy

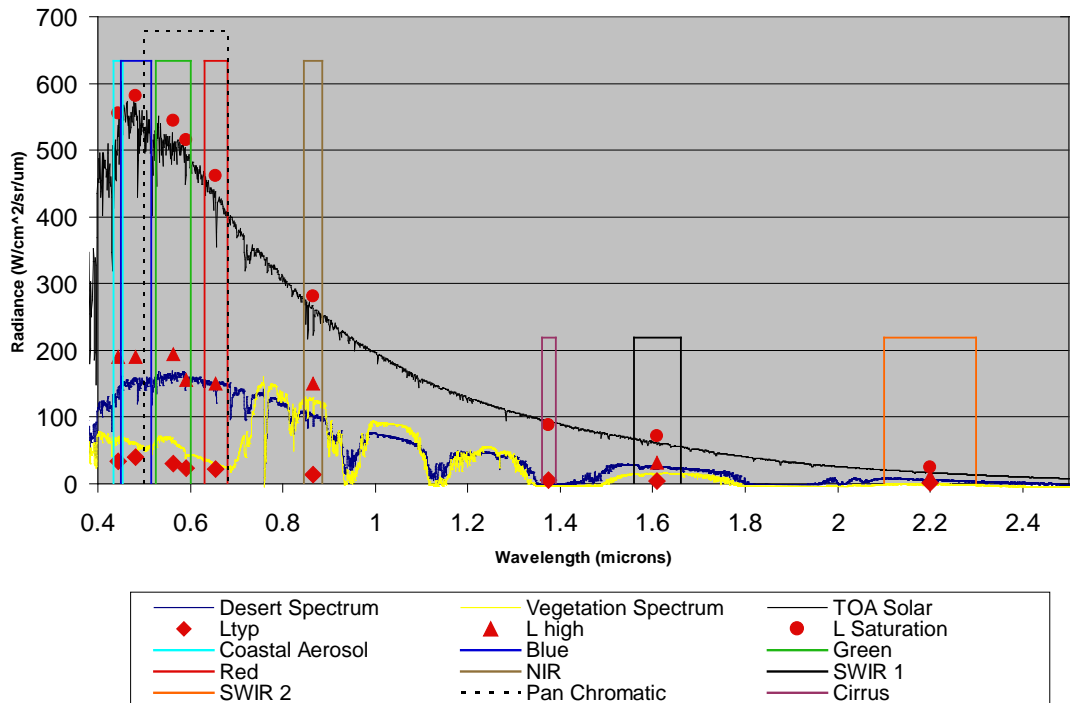


■ Landsat Continuity Mission demands

- Accurate spectral and spatial information
- Frequent synoptic earth views
- NIST calibrated over time
- Precise geo-referenced data

■ Key instrument parameters

- Cross-track FOV 185 km
- S/C altitude 705 km
- Geodetic accuracy*
 - ❖ Absolute 65 m
 - ❖ Relative 25 m
- Geometric accuracy**
 - ❖ Absolute 12 m

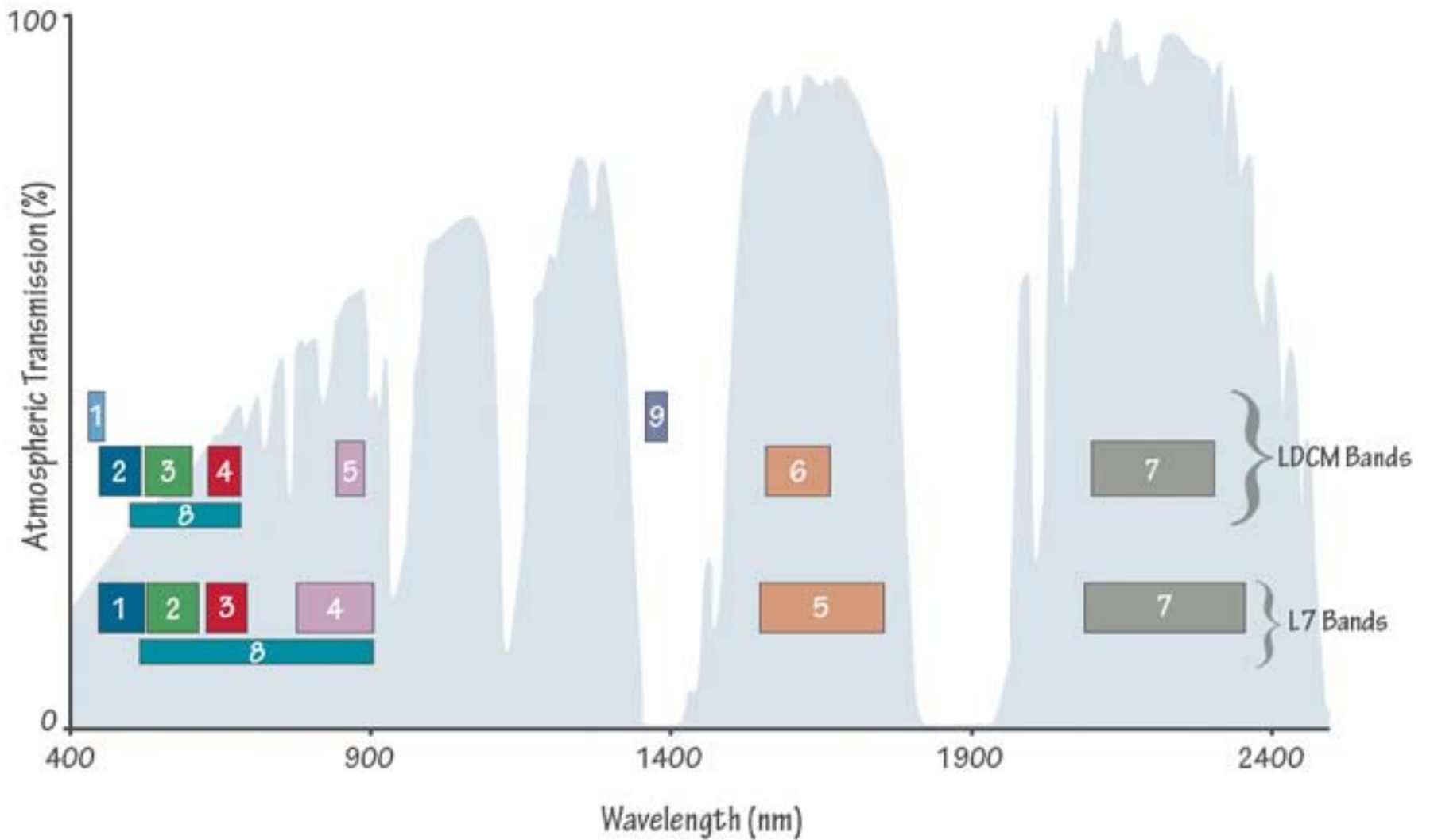


Band Name	Band (nm)	Bandwidth (nm)	GSD (m)	SNR
Coastal/Aerosol	443	20	30	130
Blue	482	65	30	130
Green	562	75	30	100
Red	655	50	30	90
NIR	865	40	30	90
SWIR 1	1610	100	30	100
SWIR 2	2200	200	30	100
PAN	590	180	15	80
Cirrus	1375	30	30	50

Visible/NIR SWIR

*No terrain compensation
**w/ terrain compensation

OLI Spectral Bands





Driving Performance Requirements



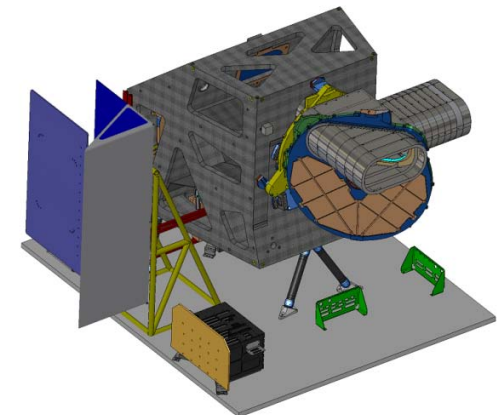
- Radiometric
 - Signal-to-noise radiometric stability (16-day, 60 sec, 5 year)
 - Pixel-to-pixel uniformity
 - Absolute radiometric accuracy
 - ❖ Absolute radiance – 5%, absolute reflectance – 3%
- Spectral
 - Spectral band edges and center wavelength tolerance
 - Integrated out-of-band (OOB) response (<2%)
 - Spectral uniformity (FWHM) ($\pm 3\%$)
- Spatial – Pushbroom
 - Edge response
 - Aliasing
 - Light rejection and internal scattering
 - Ghosting
- Geometric
 - Band-to-band co-registration (4.5 m)
 - Absolute geodetic accuracy (65 m)

OLI Band and SNR Specs

#	Minimum Lower Band Edge (nm)	Maximum Upper Band Edge (nm)	SNR at LTypical	SNR at LHigh
1	433	453	130	290
2	450	515	130	360
3	525	600	100	390
4	630	680	90	340
5	845	885	90	460
6	1560	1660	100	540
7	2100	2300	100	510
8	500	680	80	230
9	1360	1390	50	N/A

Global Acquisition Strategy

Free Data Download



LDCM Thermal – TIRS Instrument

B a n d	C e n t e r W a v e l e n g t h (m i c r o m e t e r s)	S p a t i a l R e s o l u t i o n A t N o r m a l (m)	N o i s e R e q u i r e m e n t s	
			A t T _{T y p i c a l}	A t T _{H i g h}
Th e r m a l 1	1 0 8	1 2 0	0.4 K	0.3 5 K
Th e r m a l 2	1 2 0	1 2 0	0.4 K	0.3 5 K

- 120 m resolution was felt to be sufficient to resolve most center-pivot irrigation fields in U.S. West - typically 400 to 800 m in diameter
- Landsat satellites provide 16 day repeat imaging -- sufficient for water consumption estimation
- Landsat 4 & 5 TM's provided 120 m thermal images for a single thermal band
- Landsat 7 ETM+ provided 60 m thermal images for a single thermal band
- A two band instrument will enable atmospheric correction so that more accurate surface temperatures can be derived.

Improved Data Access and Distribution

- Free and Open sharing of Data (*Landsat Archive, MODIS Products*)
- User Friendly Products (*GLS 2000-2010*)
- Near Real-Time Global Daily Active Fire Monitoring (*MODIS Rapid Response*)
- Web based Fire and Imagery Distribution Systems (*FIRMS Web GIS*)

U.S. Landsat Archive Overview

(Useable Scenes through December 31, 2008)

- **ETM+: Landsat 7**

- ◆ 892,051 scenes
- ◆ 828 TB RCC and L0Ra Data
- ◆ Archive grows by 260 GB Daily

- **TM: Landsat 4 & Landsat 5**

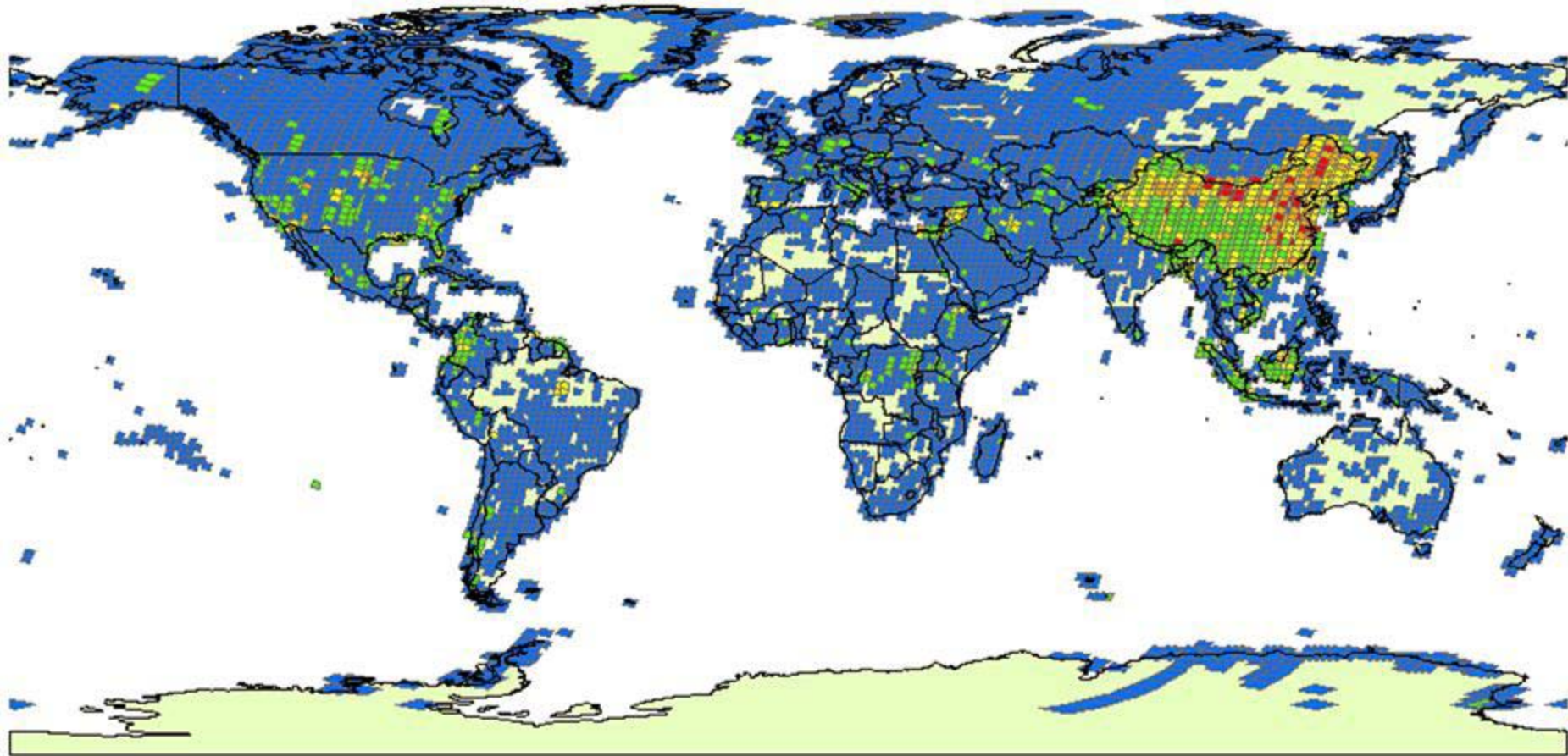
- ◆ 780,191 scenes
- ◆ 391 TB of RCC and L0Ra Data
- ◆ Archive Grows by 40 GB Daily

- **MSS: Landsat 1 through 5**

- ◆ 652,173 scenes
- ◆ 20 TB of Data



Downloads through EE/Glovis (ETM+)



ETM+ Standard L1T Downloads
via User Interface
October 1, 2008 through December 31, 2008
185,307 Total Scenes
6,659 Unique Locations

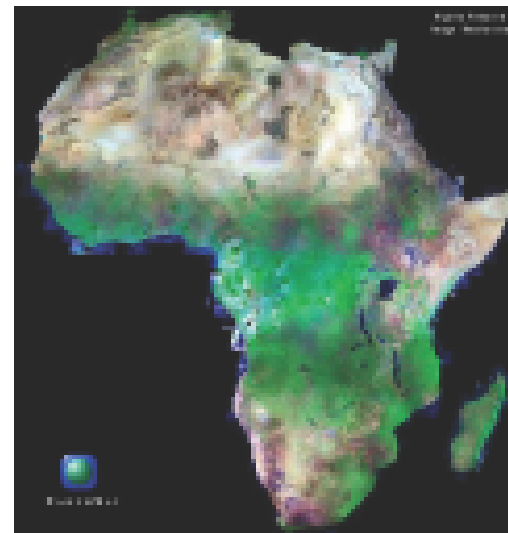
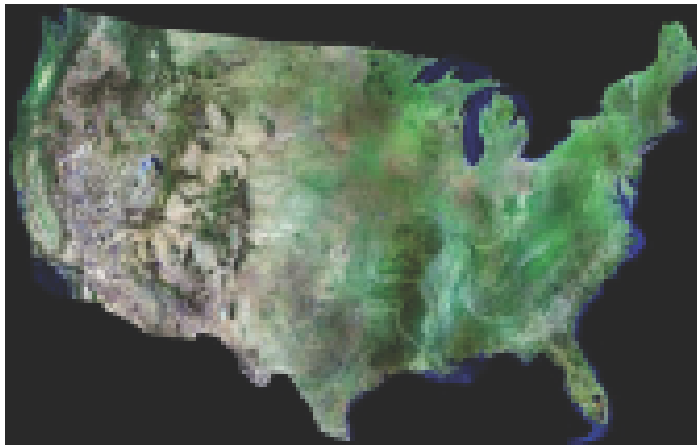
1 Million Scenes Downloaded – Aug 2009

1 - 35 36 - 106 107 - 208 209 - 375 376 - 839

Global Land Survey Data Sets

Global cloud-free, orthorectified Landsat data sets centered on 1975, 1990, 2000, 2005, and 2010

- Partnership between USGS and NASA, in support of CCSP
- Support global assessments of land-cover, land-cover change, and ecosystem dynamics (disturbance, vegetation health, etc)
- Pilot project for routine global monitoring in LDCM era



For More Information

GLS2005 Web Site:
<http://mdgls.umd.edu>

January 2008
*Photogrammetric
Engineering &
Remote Sensing*

Mid-Decadal Global Land Survey

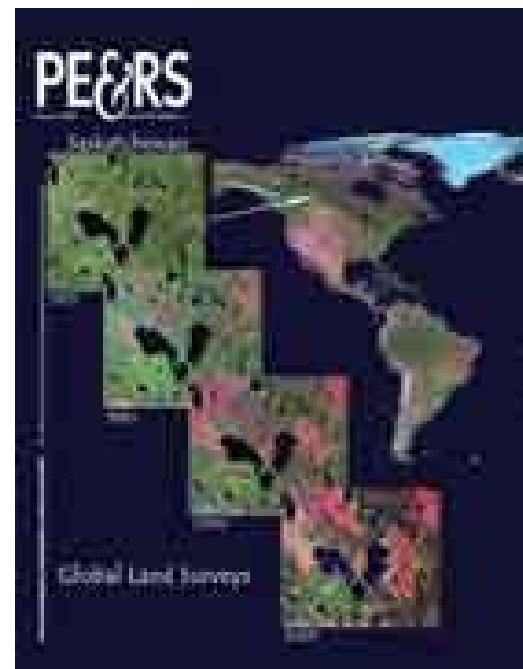
Home **Background** **Status** **Documents** **Links**

The Mid-Decadal Global Land Survey (MDGLS) is a partnership between the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA), in support of the U.S. Climate Change Science Program (CCSP) and the NASA Land-cover Land-use Change (LCLUC) Program.

Characterizing trends in land cover and land use remains a key goal for Earth science. The MDGLS is assembling a global dataset of 30-meter resolution satellite imagery to support measurement of Earth's land cover and rates of land cover change during the first decade of the 21st century.

The MDGLS builds on the existing Geocover data sets developed for the 1970's, 1990, and 2000. Some 9500 Landsat images from the period 2004-2007 will be acquired, processed, and made available to the public via FTP download. Given the failure of the Landsat-7 ETM+ Scan Line Corrector in 2003, a combination of Landsat-7 gap-filled data and Landsat-5 data from U.S. and international ground stations will be used in the project. Additional imagery from ASTER and EO-1 ALI imagers will be included to augment the Landsat coverage. Processing will begin in early 2007 and orthorectified products will be made available for download throughout the project. The complete dataset is expected to be completed in late 2008.

We are interested in your feedback. Questions or comments may be directed to: mdglsinfo@xxxxxx



MODIS Land Rapid Response

MODIS Rapid Response System - Real-Time - Windows Internet Explorer

http://rapidfire.sci.gsfc.nasa.gov/realtime/calendar

MODIS Rapid Response System - Real-Time

Near-Real-Time Level-2 Browse

Select a date:

January 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

December 2006

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

November 2006

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

October

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

2007/015 - 01/15/07 - MODIS Rapid Response System - Windows Internet Explorer

http://rapidfire.sci.gsfc.nasa.gov/realtime/2007015/

2007/015 - 01/15/07 - MODIS Rapid Respon...

Near-Real-Time Level-2 Browse

Date: 2007/015 - 01/15/07

prev next

Terra Orbit Tracks Aqua Orbit Tracks

2007/015 07:05 UTC - Terra/MODIS - Rapid Response System - Windows Internet Explorer

http://rapidfire.sci.gsfc.nasa.gov/realtime/single.php?T070150705

2007/015 07:05 UTC - Terra/MODIS - Rapid ...

Terra/MODIS

00:15 UTC 4km 2km 1km 500m 250m

00:20 UTC 4km 2km 1km 500m 250m

00:25 UTC 4km 2km 1km 500m 250m

00:30 UTC 4km 2km 1km 500m 250m

03:35 UTC 4km 2km 1km 500m 250m

03:40 UTC 4km 2km 1km 500m 250m

03:45 UTC 4km 2km 1km 500m 250m

03:50 UTC 4km 2km 1km 500m 250m

06:55 UTC 4km 2km 1km 500m 250m

07:00 UTC 4km 2km 1km 500m 250m

07:05 UTC 4km 2km 1km 500m 250m

07:10 UTC 4km 2km 1km 500m 250m

Terra 2007/015 01/15/07 07:05 UTC

Pixel size: 2km

prev next

Alternate pixel size: 4km 1km 500m 250m

Bands 1-4-3 (true color)

Bands 3-6-7


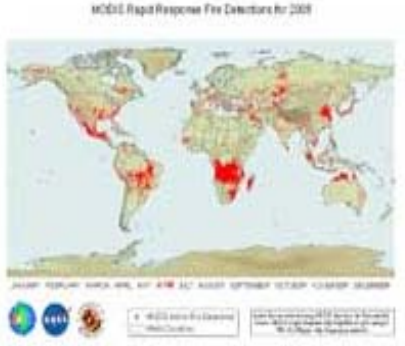
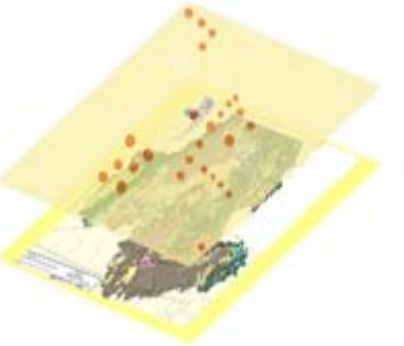

- Browse-and-click interface
- Calendar-based layout
- Multiple spatial resolutions, multiple band combinations, multiple products
- Gallery images keyword-searchable and georeferenced ("world file" available for GIS users)
- Link to L1 data at the LAADS

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






Overview of FIRMS Products

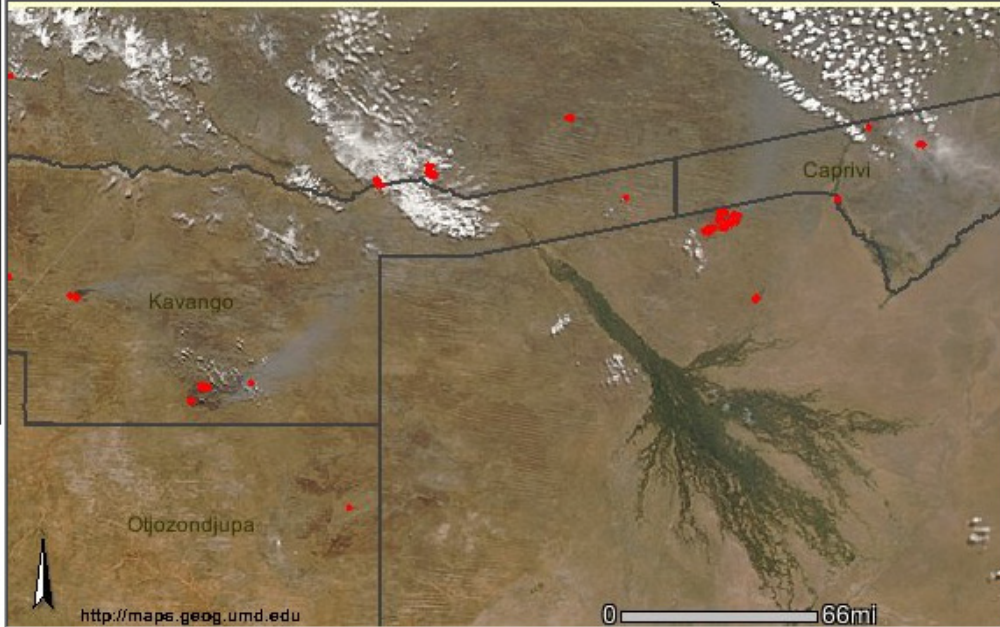
FIRMS delivers MODIS hotspots/active fire locations in 4 ways:

EMAIL ALERTS	WEB FIRE MAPPER	SHAPE FILES	MODIS Subsets
			

All of which are delivered in near real time (approx 2 hours after satellite overpass), with relatively small file sizes and in easily accessible formats

Web Fire Mapper - Microsoft Internet Explorer

   **Web Fire Mapper:
Namibia**



Layers

Visible Active

- Fires Last 48Hrs
- Fires Last 7 Days
- MODIS Active Fire Detections(2004)
- MODIS Active Fire Detections (Archive)
- Major Towns
- Towns
- Trunk Roads
- Roads
- Rivers
- Regions
- Protected Areas
- Biomes

Fires Last 48Hrs

Rec	Latitude	Longitude	Brightness Temperature	Scan	Track	Acquisition Date	Acquisition Time	Satellite	Confidence	#SHAPE#	SI
1	-18.972	20.105	340.1	1.5	2.3	2004-09-23	0825	T	92	[polygon]	1
2	-18.975	20.126	337.2	1.5	2.2	2004-09-23	0825	T	89	[polygon]	1

Date Query [Help](#)
Enter the dates in YYYY-MM-DD format.

Start Date

End Date

NOTE: MODIS Fire detections are NOT available for the following dates: 6/16/2001 to 7/3/2001, 3/20/2002 to 3/28/2002, 4/15/2002.

Pan

Map: 21.04 , -18.33

Internet

Web Fire Mapper

An internet mapping tool (WEB GIS) that displays near-real time active fires using data from the MODIS Rapid Response System

-customized interactive maps can be viewed and queried for the world or selected regions and countries

Web Fire Mapper - Namibia service

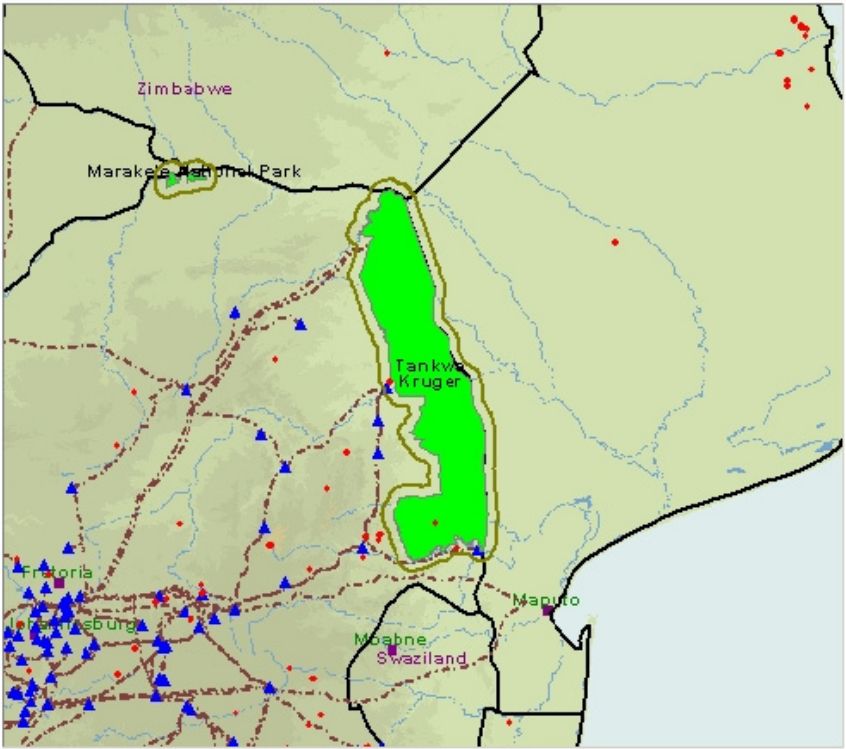
Fires are shown in red on the most recent MODIS background image

Email alerts with JPEG images

SMS text messages (cell phones)

AFIS - WEB FIRE MAPPER

Email Generated 8/23/2004 4:15:10 PM



Latitude	Longitude	BT	Scan	Track	Date	Time	Sat	Conf
-25.203	31.564	317.8	1	1.1	2004-07-15	1143	A	76
-23.986	31.155	310.8	1	1	2004-07-16	0806	T	48
-25.412	31.76	312.8	1	1.1	2004-07-16	0806	T	62
-25.414	31.77	313.6	1	1.1	2004-07-16	0806	T	65

4 Active fire records detected/processed in your region of interest

Region of Interest:
Kruger

BT= Brightness Temperature (Kelvin)
 Date= Date of MODIS acquisition
 Sat=Satellite (A=Aqua,T=Terra)
 Conf=Confidence



Short text messages (email)

Fire Alert! (beta long version) - Message (Plain Text)

File Edit View Insert Format Tools Actions Help Type a question for help

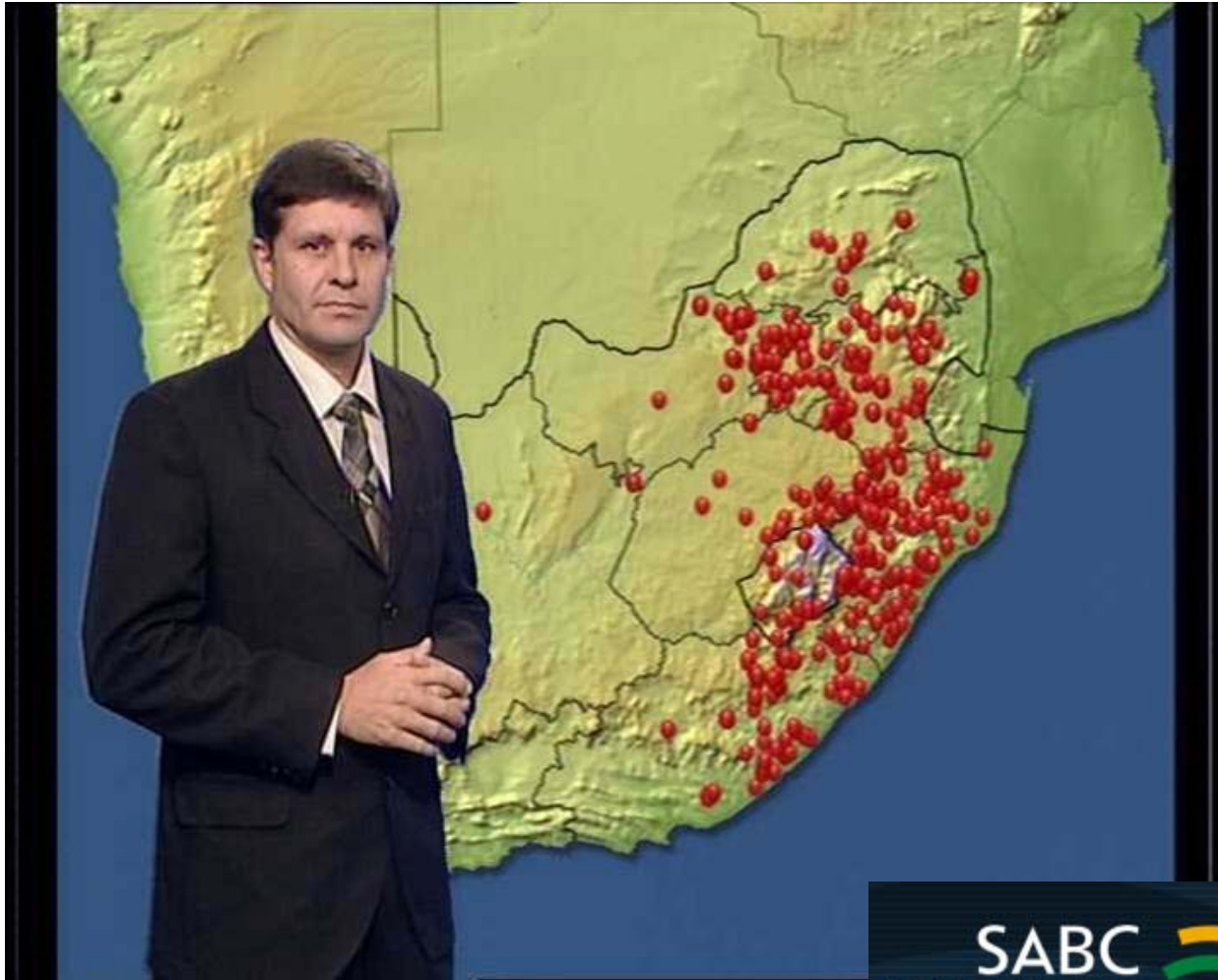
Reply Reply to All Forward Print Attachments

Extra line breaks in this message were removed. To restore, click here.

From: ipasa@sac.co.za Sent: Mon 8/2/2004 8:22 AM
 To: Jacques Descloitres; jschmaltz@ltpmail.gsfc.nasa.gov; pfrost@csir.co.za; Suresh Kumar; Diane Davies
 Cc:
 Subject: Fire Alert! (beta long version)

Distance from 30.345,-29.6 to ESKOM distribution grid: 0.07 km - Closest point: 30.346,-29.600 on segment "181713", 08/02/2004/11:30 Distance from 27.834,-26.828 to ESKOM distribution grid: 0.32 km - Closest point: 27.837,-26.827 on segment "525689", 08/02/2004/11:30 Distance from 31.03,-25.72 to ESKOM distribution grid: 0.41 km - Closest point: 31.034,-25.721 on segment "412492", 08/02/2004/11:30

Satellite Active Fire Product is appearing like Weather Data



(Philip Frost, CSIR)

GOFC-GOLD Fire website gofc-fire.umd.edu

GOFC-Fire Web Page - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://gofc-fire.umd.edu/ Redlatif

GOFC-GOLD GLOBAL OBSERVATION FOR FOREST AND LAND COVER DYNAMICS

GOFC/GOLD-FIRE

GOFC/GOLD Fire Monitoring and Mapping Implementation Team

Site Index

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- Objectives
- Participants
- Regional Networks
- Implementation
- Projects
- Meetings
- Resources
- Site Map
- Search*

*Page under construction

- En español
- По-русски

[Acknowledgments](#)

What is GOFC/GOLD-Fire?

[GOFC/GOLD \(Global Observations of Forest and Land Cover Dynamics\)](#) is a project of the [Global Terrestrial Observing System \(GTOS\)](#) program, which is sponsored by the [Integrated Global Observing Strategy \(IGOS\)](#). The main goal of GOFC/GOLD is to provide a forum for international information exchange, observation and data coordination, and a framework for establishing the necessary long-term monitoring systems.

The GOFC/GOLD-Fire Mapping and Monitoring Theme is aimed at refining and articulating the international observation requirements and making the best possible use of fire products from the existing and future satellite observing systems, for fire management, policy decision-making and global change research.

Featured contributory project

Sentinel Fire Mapping



Click on the image for summary and link to project website.
[Refresh](#) this page for more projects, or go to the [full list of projects](#).

GOFC/GOLD is promoting self-organized regional networks of data users, data brokers and providers, where closer linkages and collaborations are established with emphasis on an improved understanding of user requirements and product quality. GOFC/GOLD-Fire is pursuing, in a joint effort with the [Committee on Earth Observing Satellites \(CEOS\) Working Group on Calibration and Validation \(WGCV\) Land Product Validation \(LPV\)](#) subgroup, the coordinated validation of fire products by standardized protocols.

GOFC/GOLD-Fire is partnering with the [Global Fire Monitoring Center \(GFMC\)](#), and the [United Nations International Strategy for Disaster Reduction \(UNISDR\) Wildland Fire Advisory Group / Global Wildland Fire Network](#)

Latest [meeting](#) information. Click [here](#) for latest news.

- [International EOS/NPP Direct Readout Meeting](#)
3/31/2008 - 4/4/2008 (Bangkok, Thailand)
- [Wildfire sessions at EGU 2008](#)
4/13/2008 - 4/18/2008 (Vienna, Austria)
- [International Conference on Modelling, Monitoring and Management of Forest Fires](#)
9/17/2008 - 9/19/2008 (Toledo, Spain)
- [14 Australasian Remote Sensing and Photogrammetry Conference](#)
9/29/2008 - 10/3/2008 (Darwin, Australia)

Done