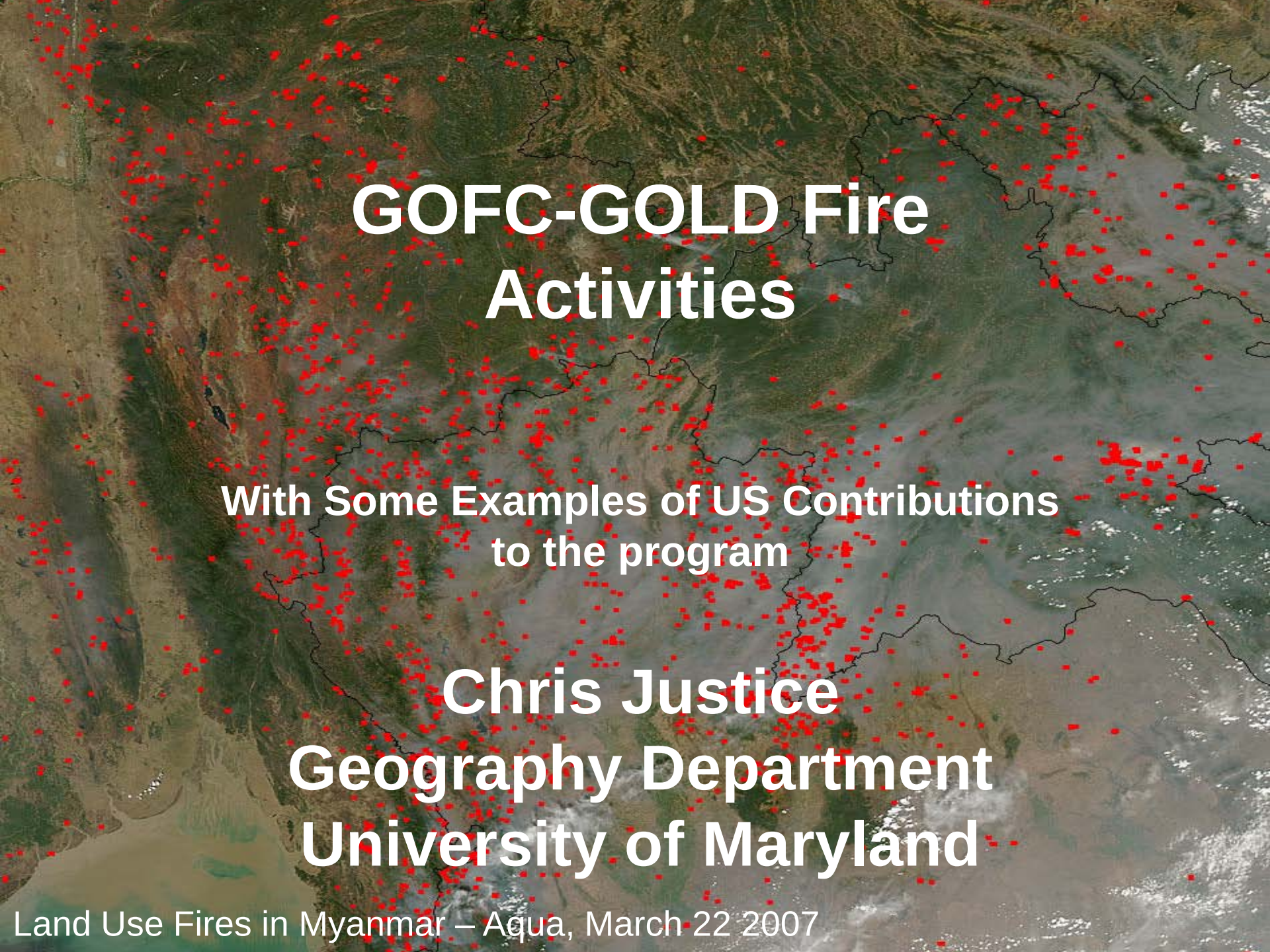


GOFC-GOLD Fire Activities

With Some Examples of US Contributions to the program

Chris Justice
Geography Department
University of Maryland

Land Use Fires in Myanmar – Aqua, March 22 2007

Station Fire Aug 31 09

Burned 200 Sq Miles

95 Miles of fire-lines

2 firemen killed

$102 Million spent since July

Picture from the International Space Station

Los Angeles Skyline

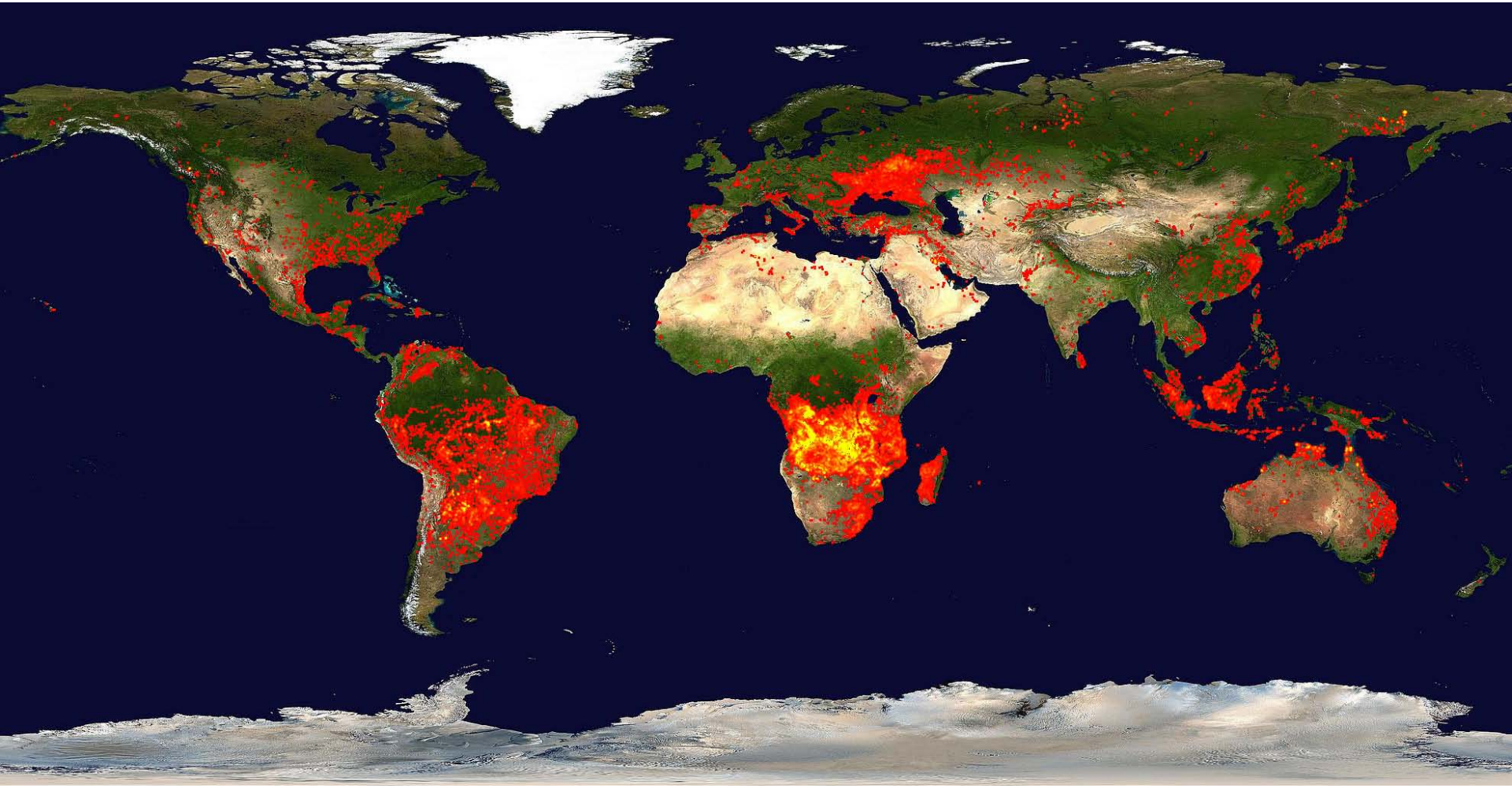
6000 People Evacuated


Athens, Greece
August 22, 2009

Athens Fires 2009

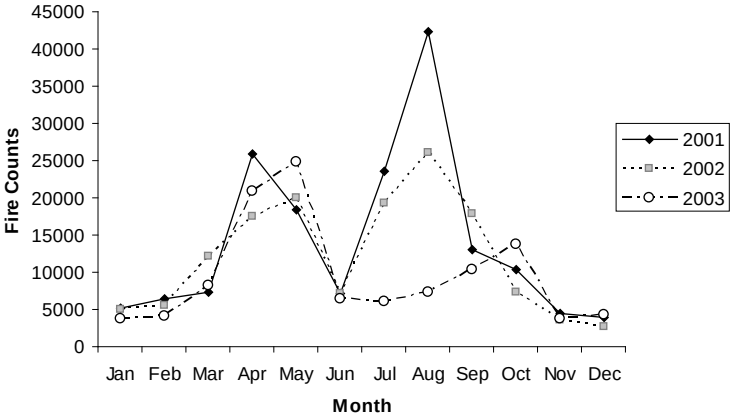
Fires are a Global Phenomenon

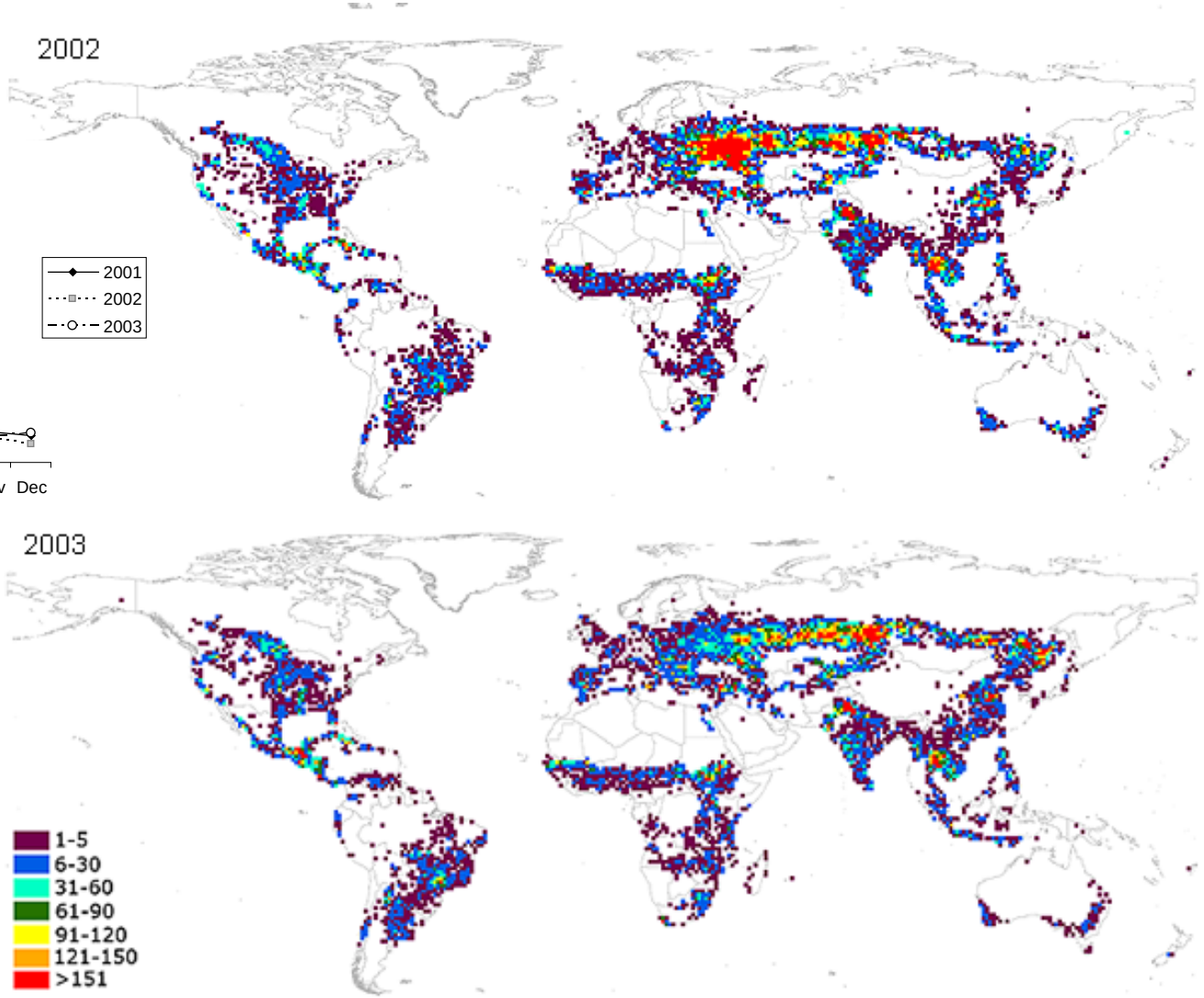
MODIS Active Fire Detections – Rapid Response System



Fires Burning Aug 8 – Aug 19 2009

Global Agricultural Fires





Korontzi et al. 2007

Example Areas of Fire Science

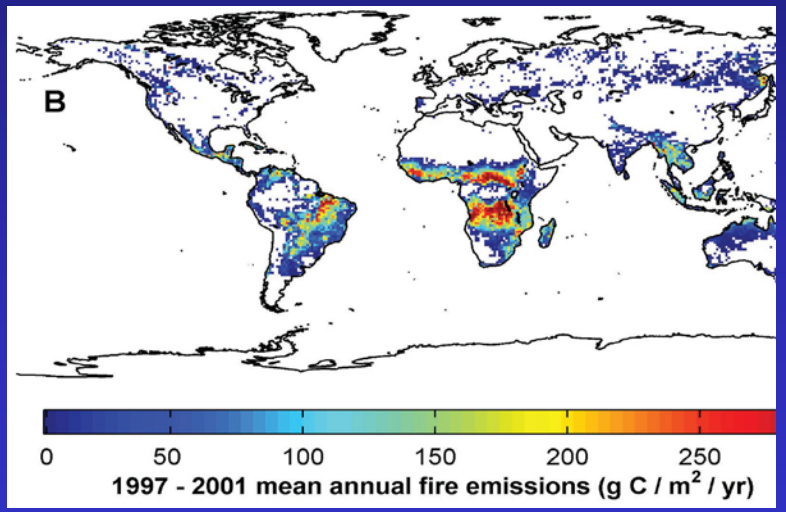
Global to Regional Scales

- 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 ~10^{15} g of carbon (C) to the atmosphere each year. Biomass burning constitutes ~35% of all global C emissions.

Region	Fire emissions 1997-2001 average (10^15g 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

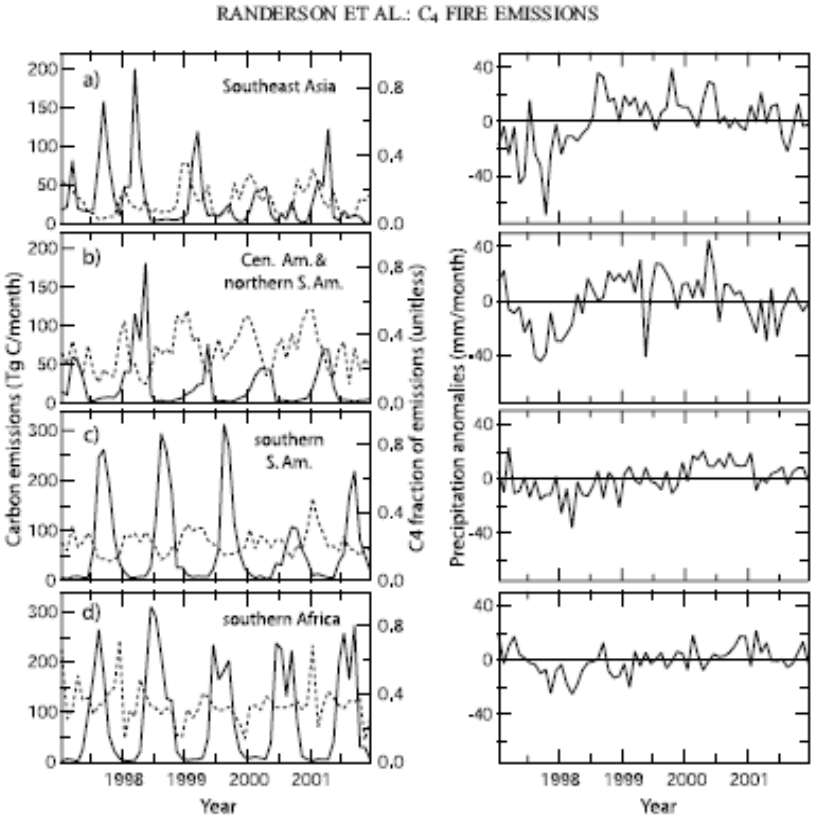
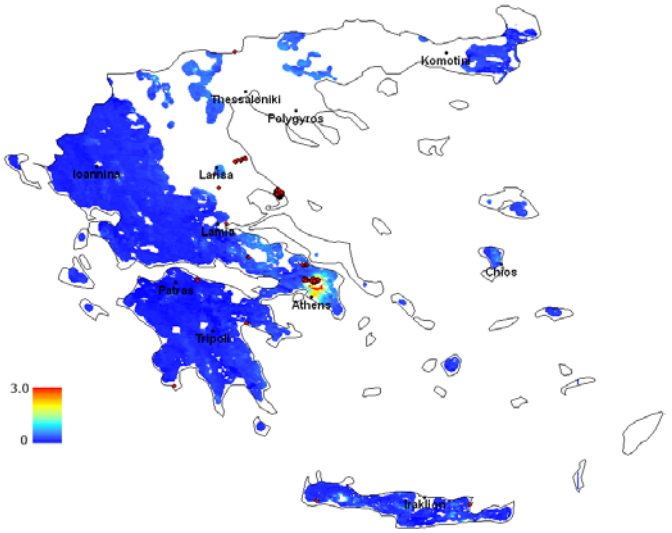
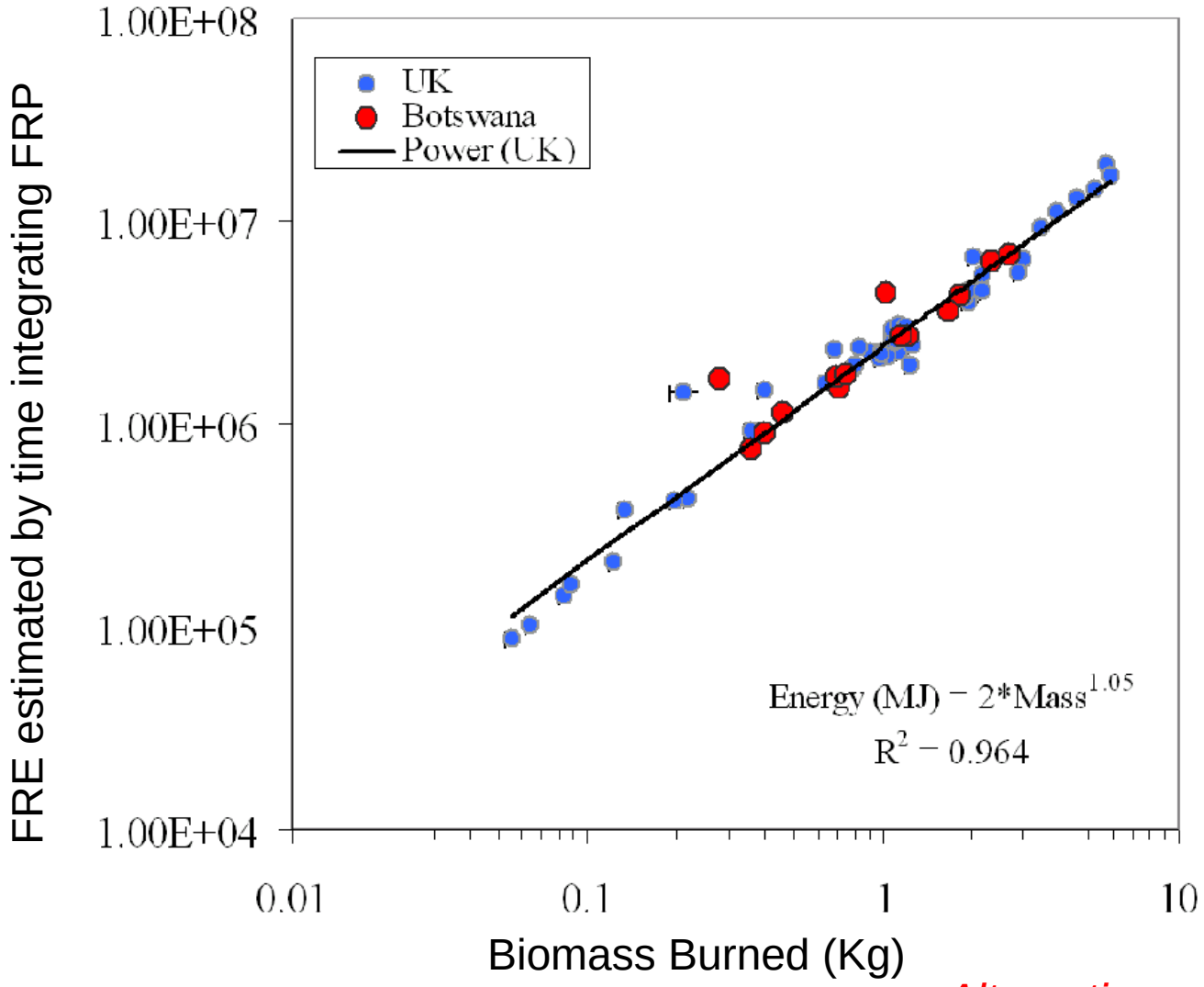


Figure 2. Fire emissions and the C_4 fraction of fire emissions from (a) Southeast Asia, (b) Central and northern South America, (c) southern South America, and (d) southern Africa. Fire emissions (left panel, left axis, solid line) are for total carbon and have units of Tg C/month. The C_4 fraction 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. 6. MODIS CO emissions, southern Africa, September 2000. Light grey = not mapped by MODIS due to insufficient cloud-free observations; dark grey = not considered by MODIS due to sphaerical water or inland water; light blue = water. Lambert Azimuthal Equal Area projection (center longitude 25°, center latitude −15°).



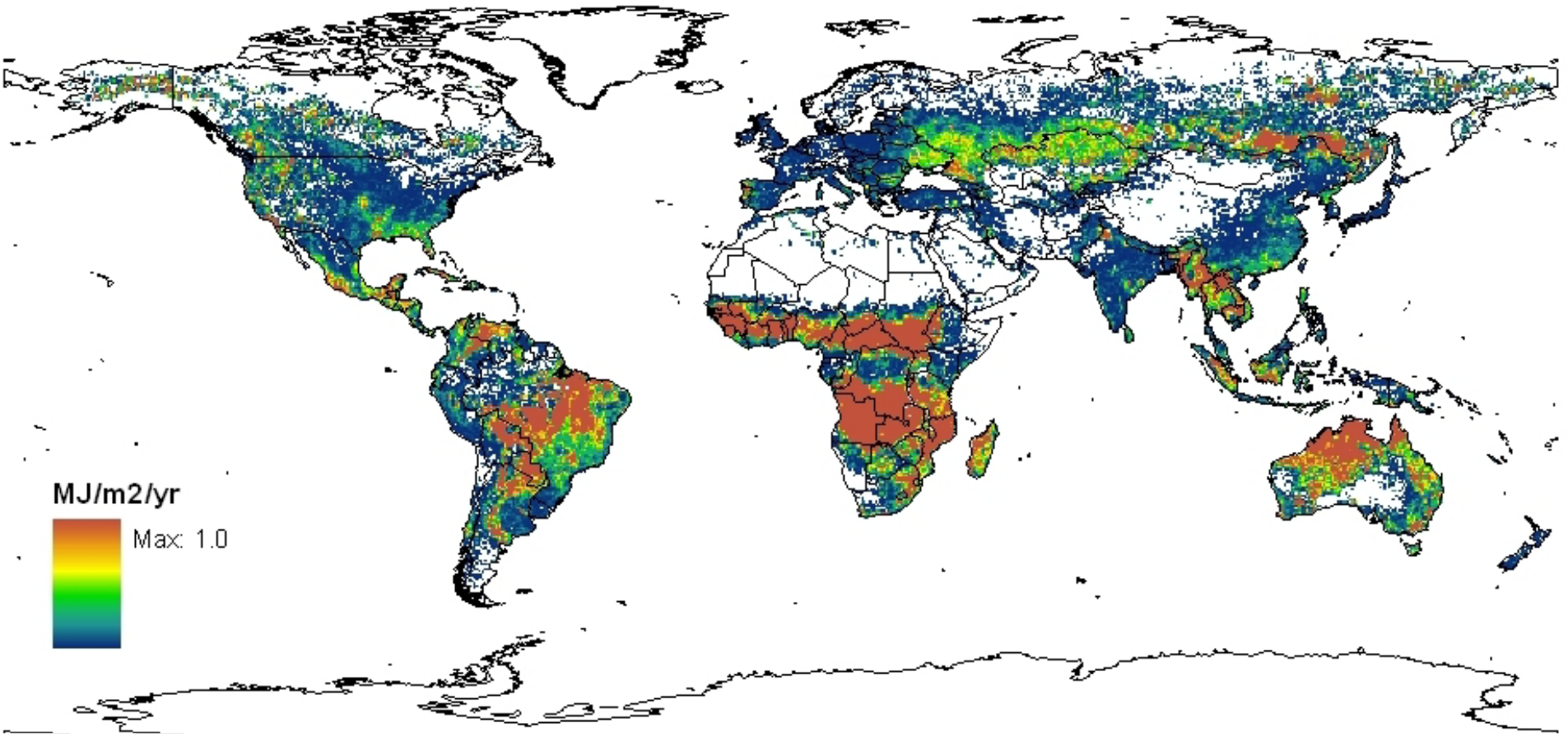
The FRE has been shown to be linearly related to the total biomass burned



M. Wooster et al.

Alternative approach for estimating fire emissions ?

Estimated annual mean FRE ($MJ/m^2/yr$) 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

(Evan Ellicot et al. 2009)

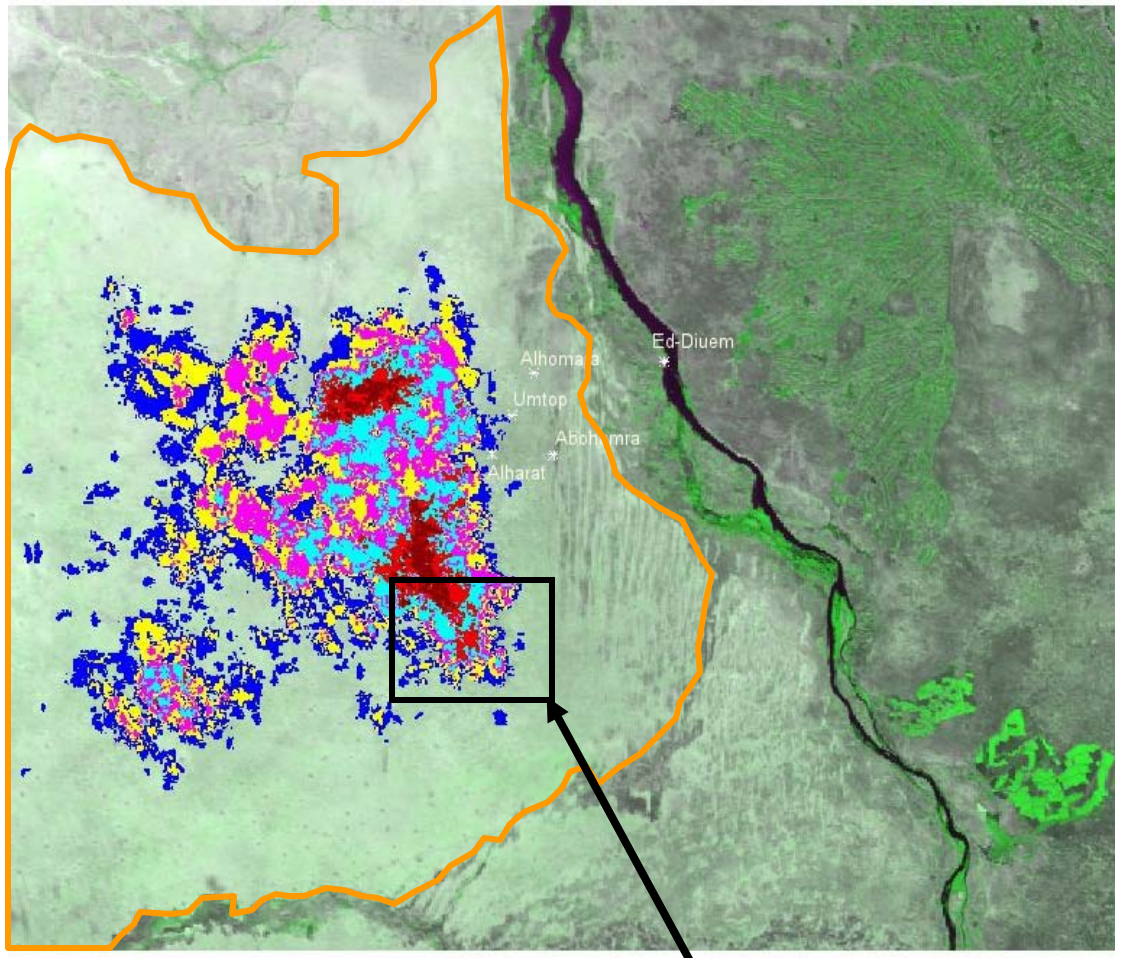
Fire Science: Example Areas
*Regional to Local Scales **

- 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**

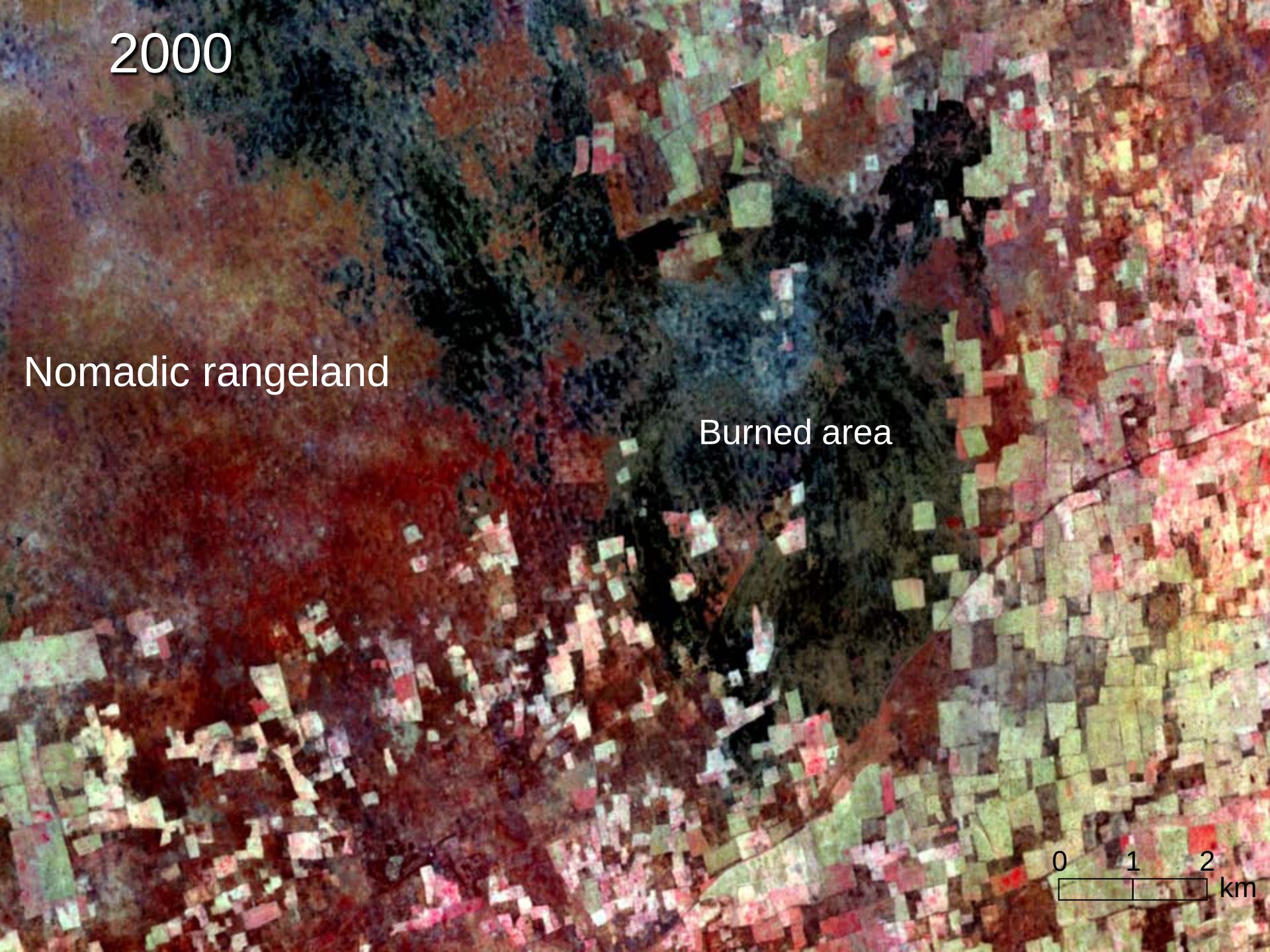
***** *in most cases with linkages to applications*

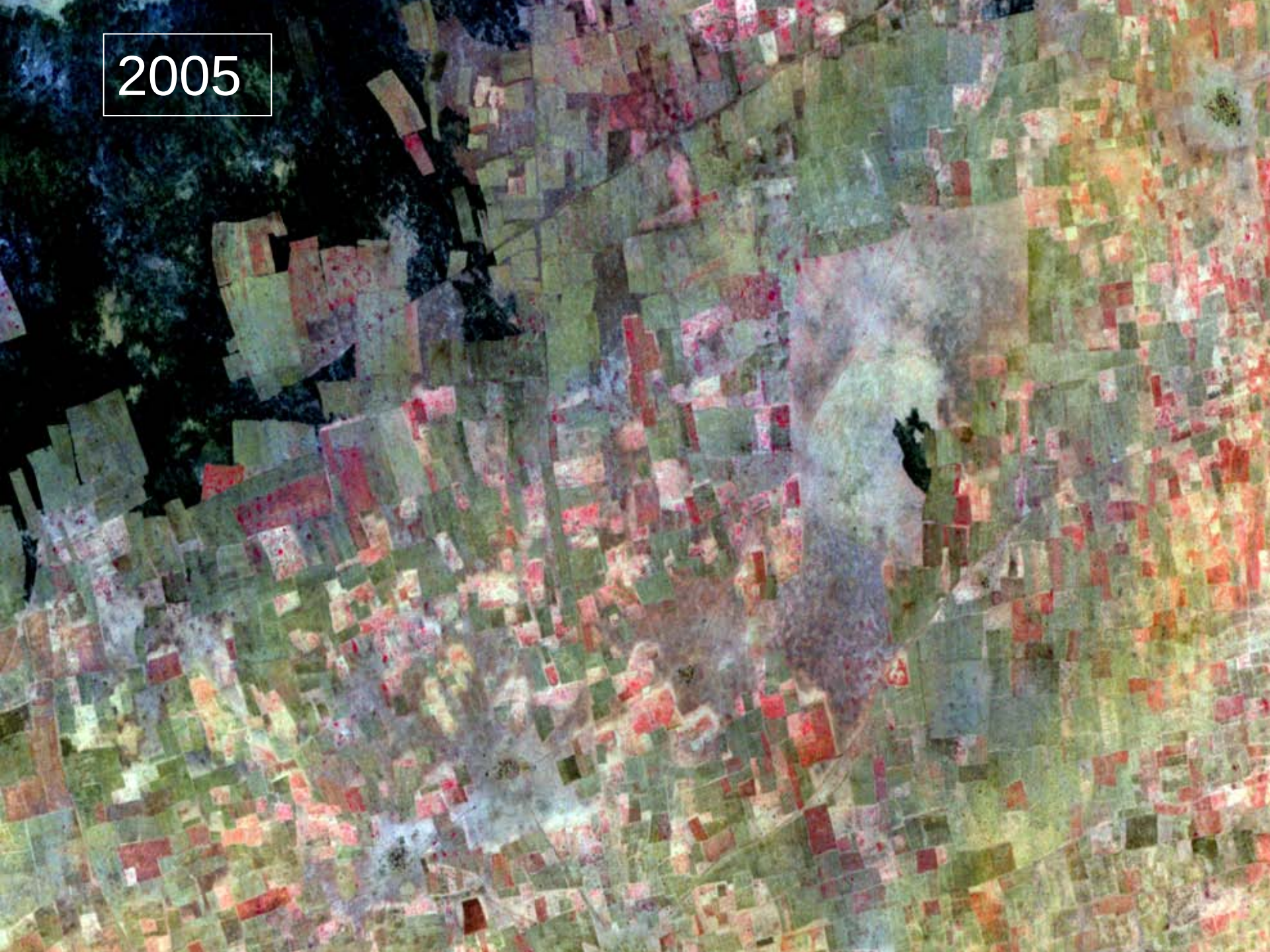
Land Use Fires and Conflict – Albaja, Sudan

MODIS Fire History, Albaja, ’00-05



(M. Elgamri, Sudan Univ, S. Trigg, Cranfield College, Jan Dempenwolf UMD)


2000
Nomadic rangeland
Burned area
0
1
2
km


2005

Types of Fire Information Needed

- 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

Pre-Fire

Active Phase

Post-Fire

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

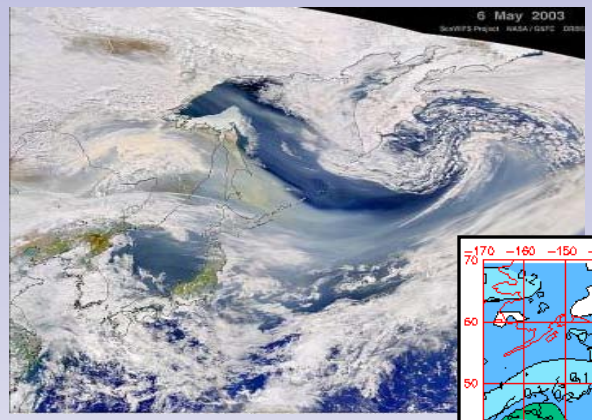
- Model Types
  - Fire Danger
  - Fire Weather
  - Fire Behavior
  - Fire Emissions (NRT, Annual)
  - Projected Fire Regimes and Emissions
  - Dynamic Global Vegetation Models (disturbance)
- **Observations can be used as input and in some cases for model validation**
  - Important to understand product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

Examples of Current and Planned Satellite Sensing Systems Relevant to Fire Monitoring

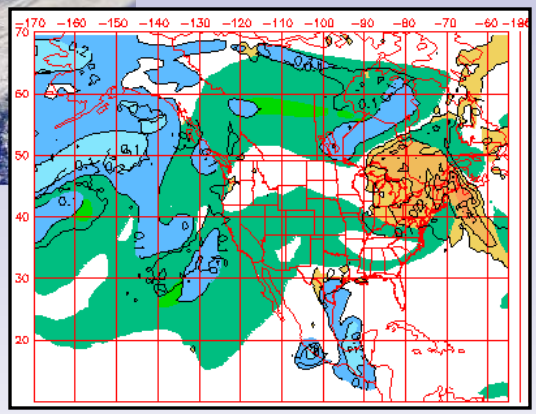
- **Active Fire Detection and Characterization (mid IR)**
  - AVHRR, GOES, DMSP, MSG (operational)
  - TRMM, MODIS (AM/PM), AATSR, BIRD, ASTER, MERIS (experimental)
- **Burned Area, Fire Danger, Post Fire Assessments (VIS, NIR)**
  - Coarse/moderate Resolution
    - AVHRR/METOP, MODIS, SeaWiFS, ATSR, 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

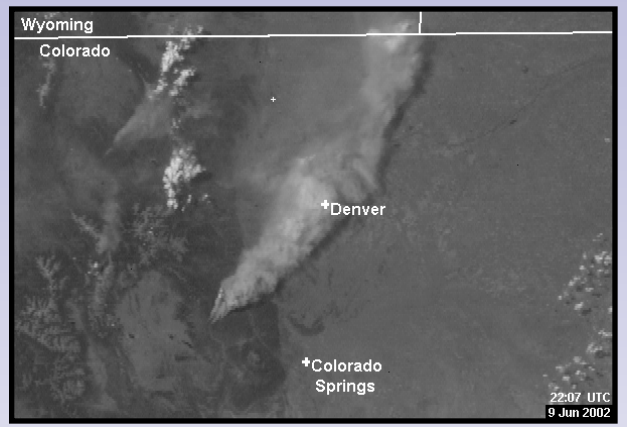
- **Examples of Planned Systems**
  - NPP/NPOESS VIIRS (2011) – active fire and energy - burned area
  - LDCM OLI (2012) and Sentinel 2 (2012) – burned area / severity?
  - HyspIRI (2013) – hyperspectral + multispectral thermal
  - Sentinel 3 (2013) – active fires

Monitoring Transport of Biomass Burning Aerosols



Smoke Transport Across
Pacific from Siberia
6 May 2003

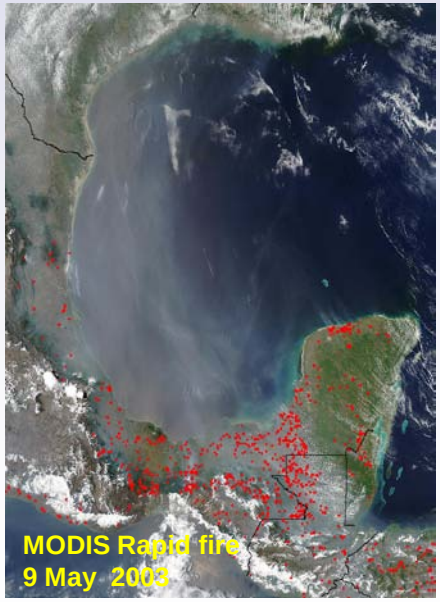




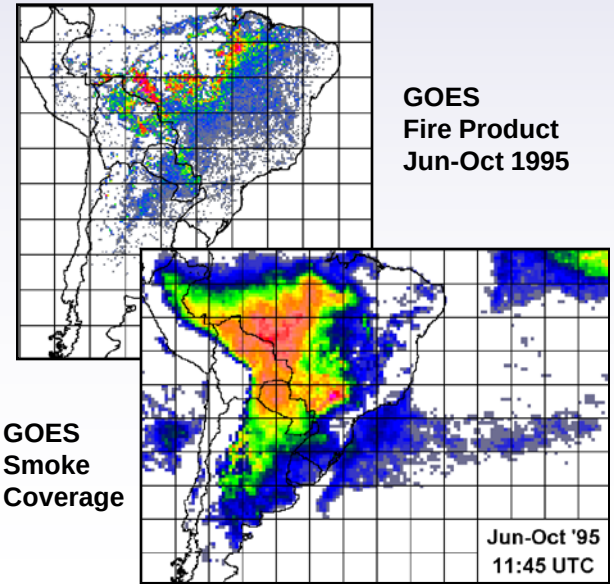
GOES-11 Rapid Scan Visible Imagery (1 km)
22:07, 9 June 2002 – 00:50, 10 June 2002
Courtesy of CSU - CIRA

Before

After

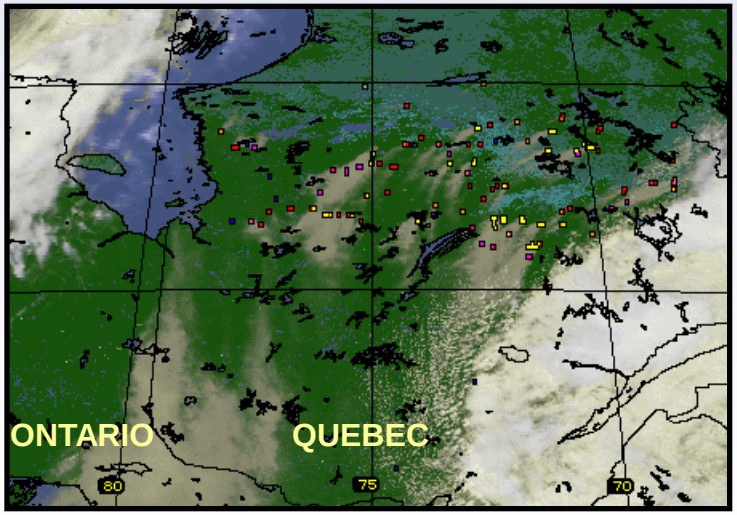


Smoke Transport Across
Gulf of Mexico
9 May 2003



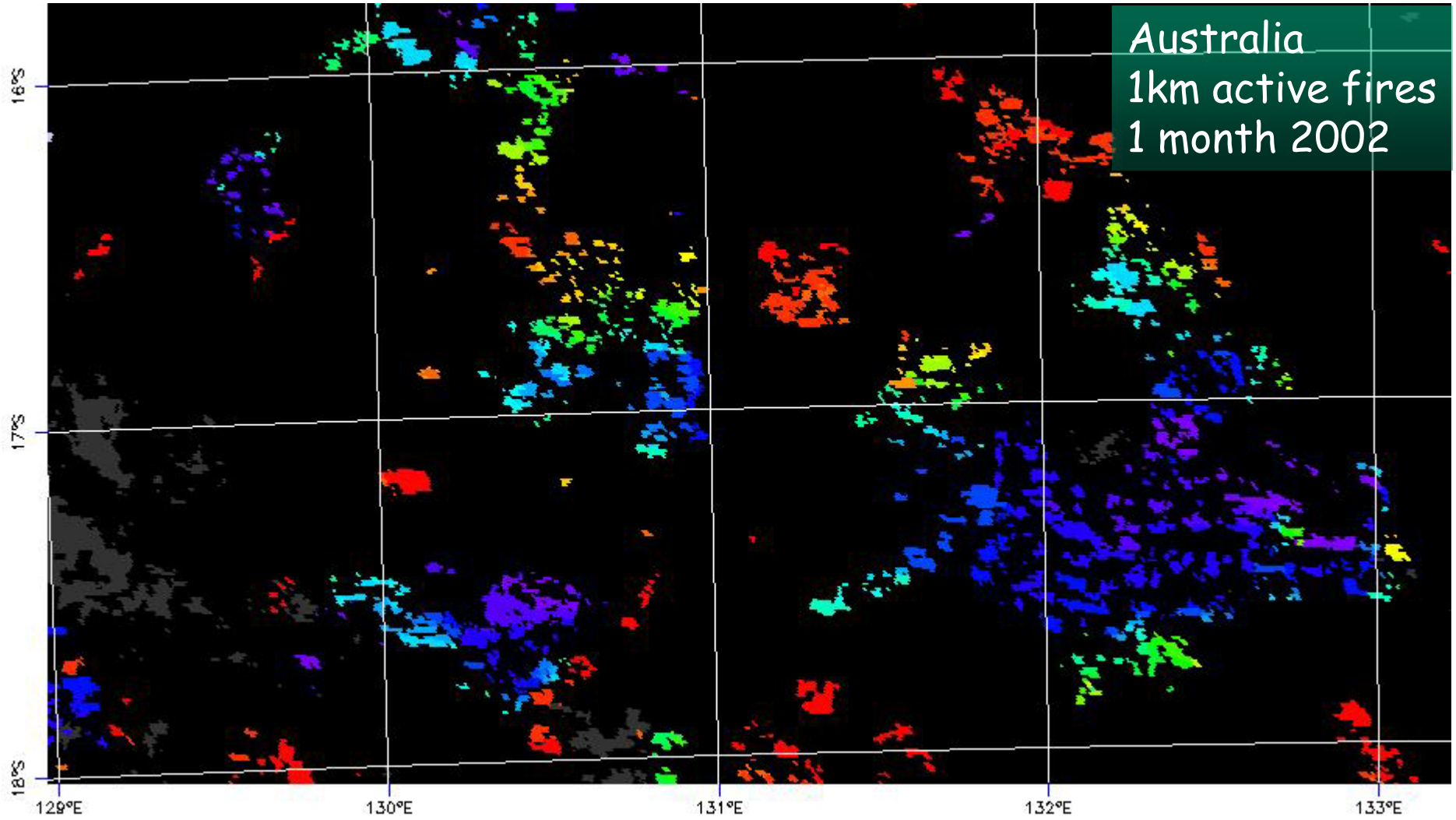
GOES
Fire Product
Jun-Oct 1995

GOES
Smoke
Coverage



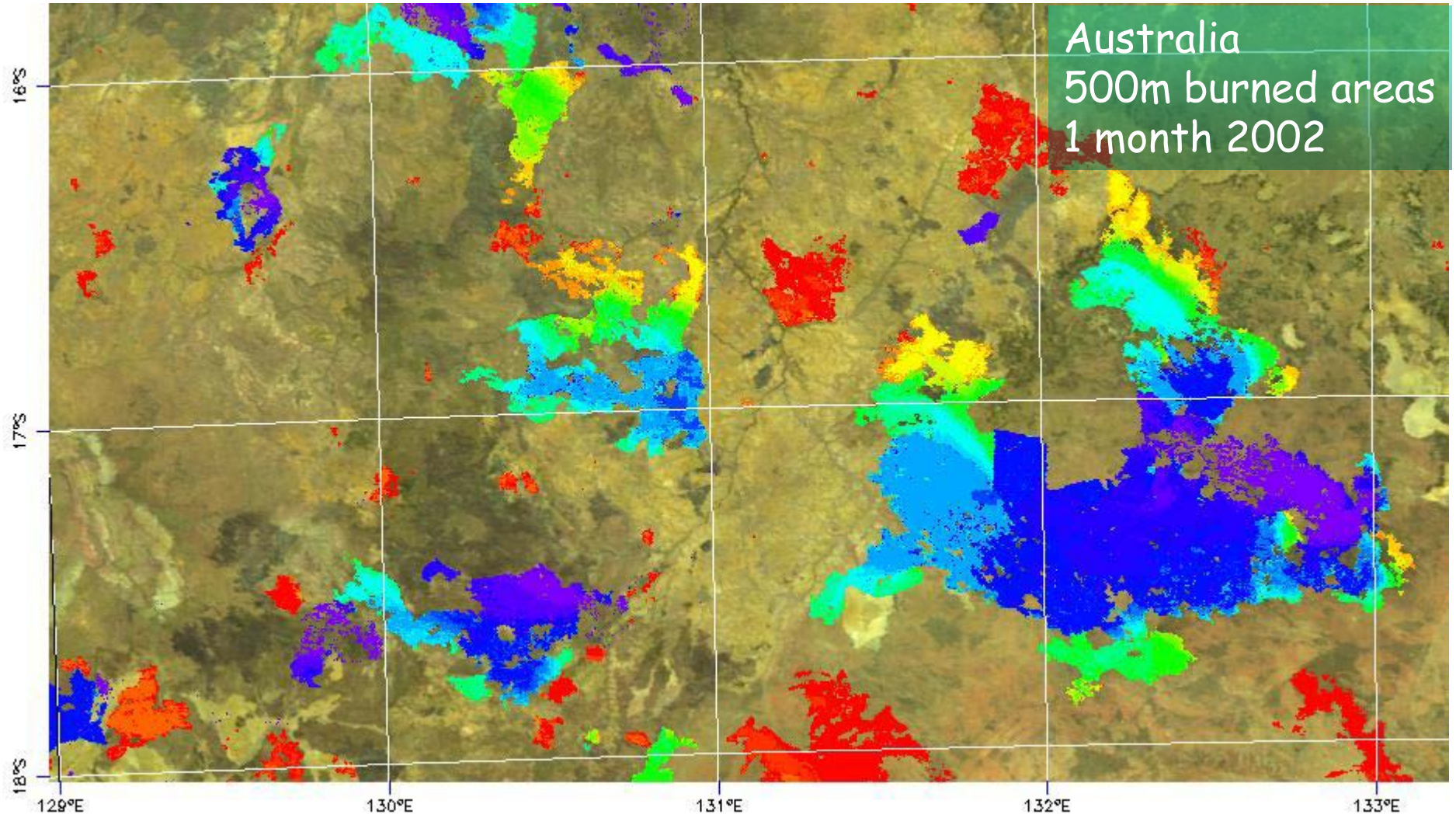
Wildfires in Quebec, Canada
6 July 2003 at 17:45 UTC

(Prins et al)


Australia
1km active fires
1 month 2002
16°S
17°S
18°S
129°E
130°E
131°E
132°E
133°E

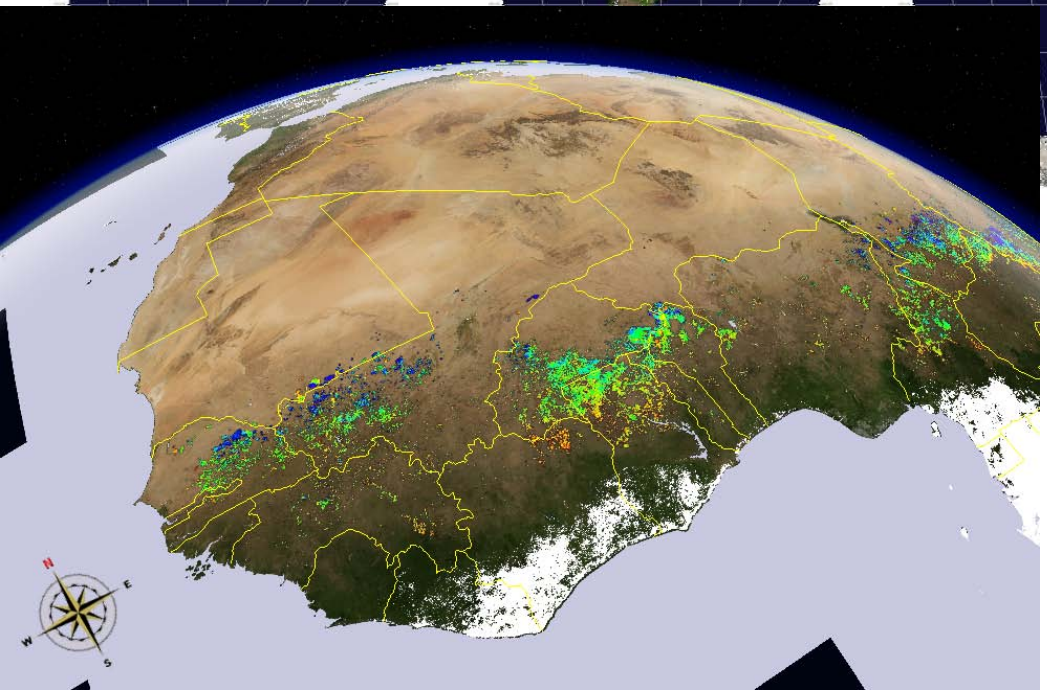
Roy et al.

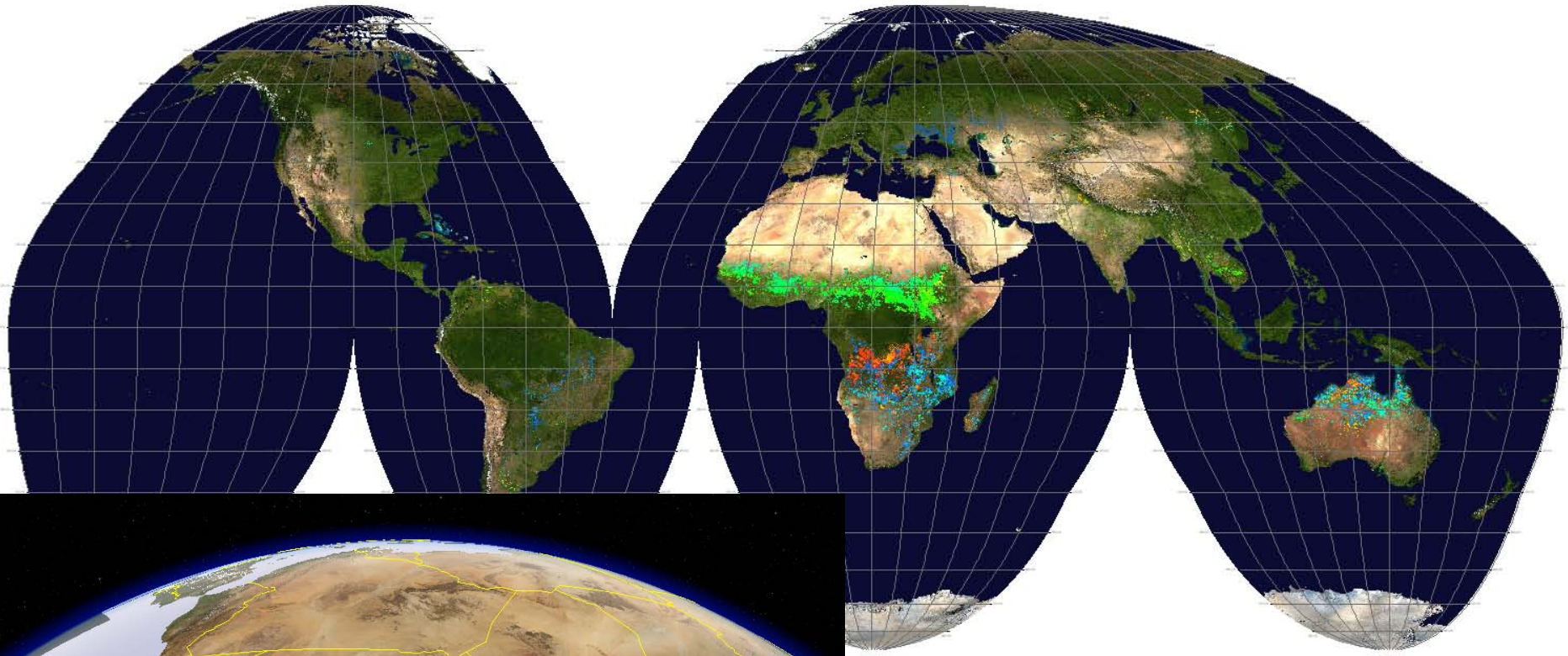
MODIS Burned Area Product 500m

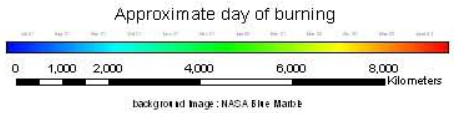


Roy et al

Global Burned Area (MODIS)







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

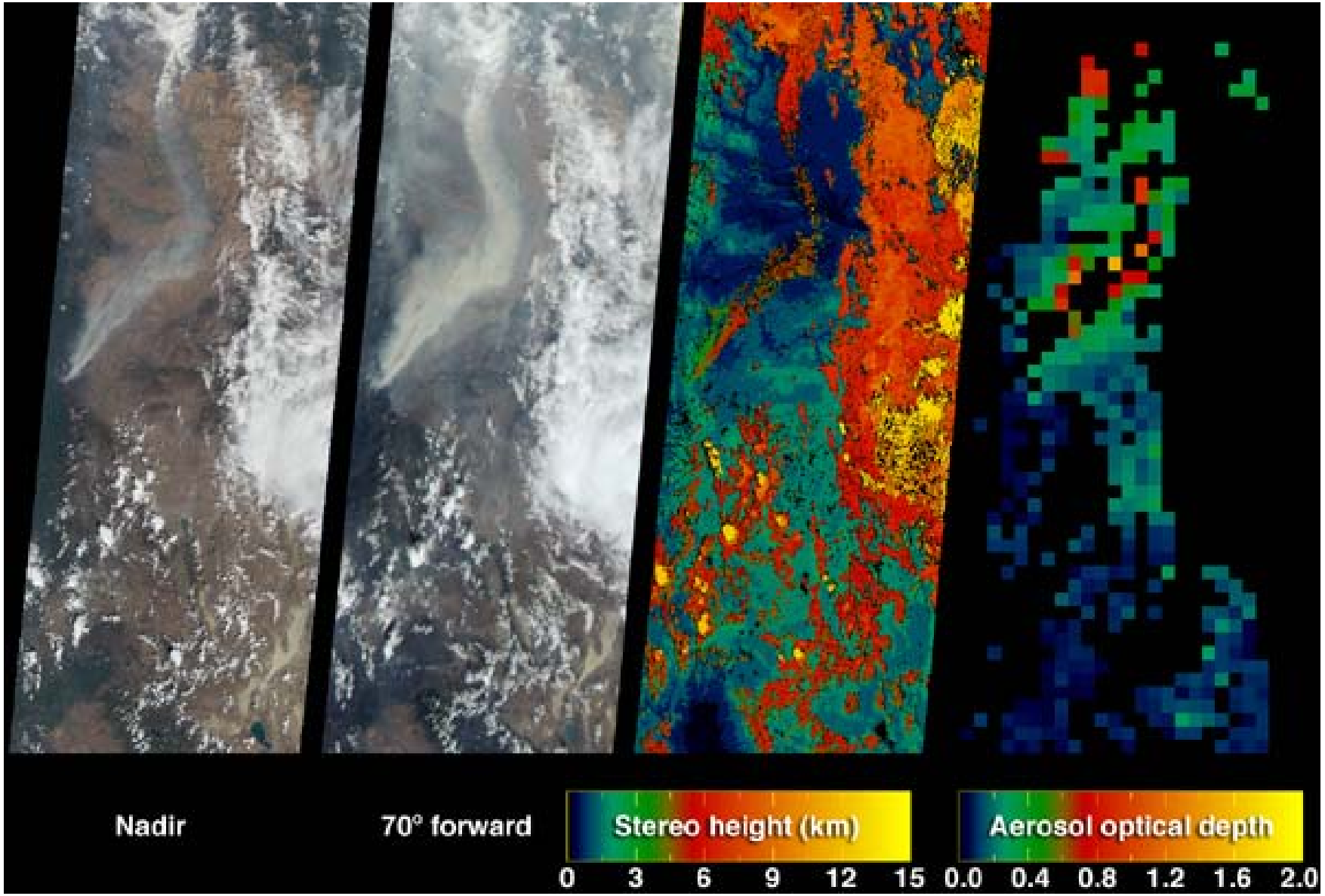
(Roy and Boschetti)

Hyperspatial Resolution Data: Quickbird

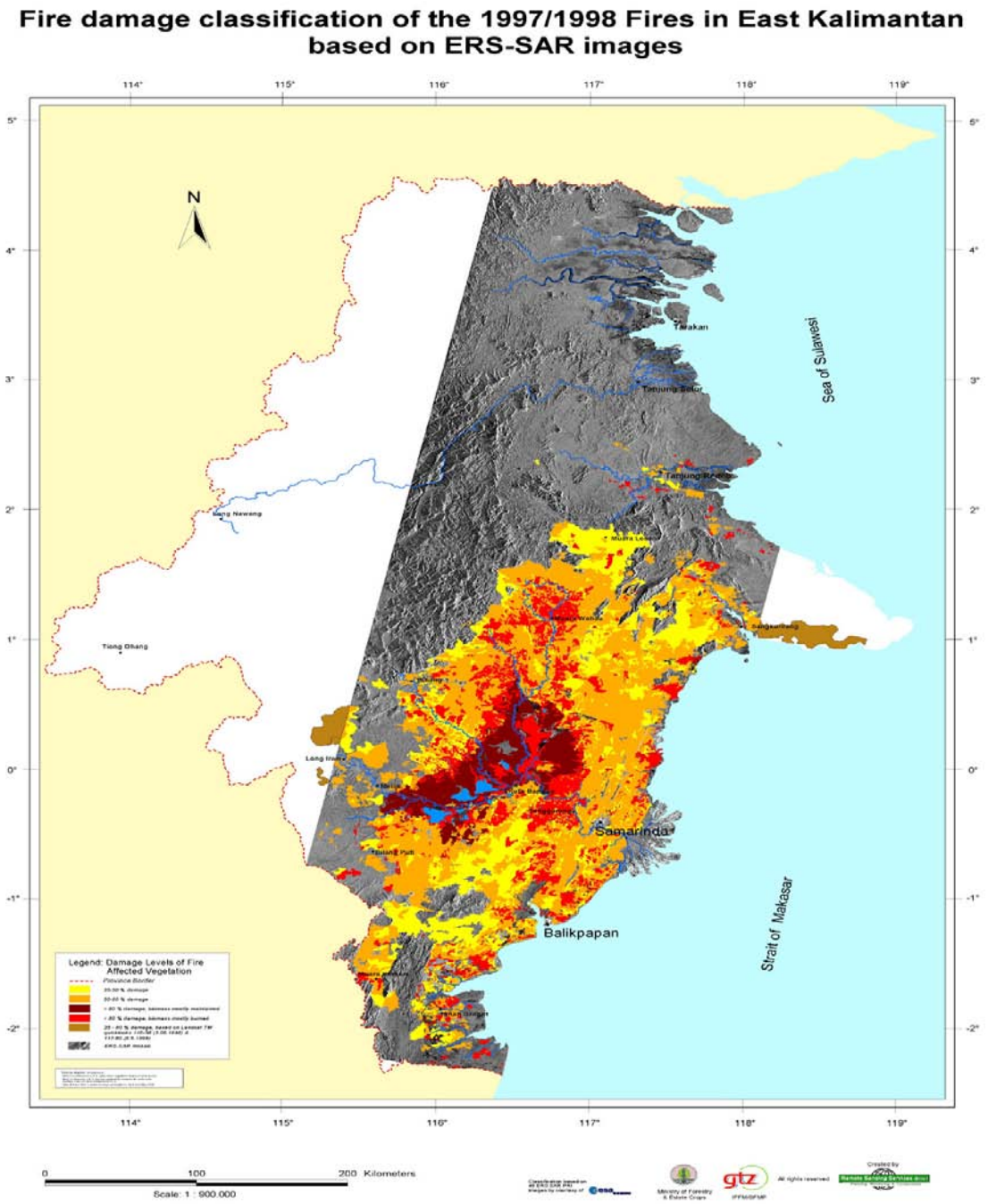
60cm Resolution Imagery of the Esperanza Fire, Twin Pines, Ca
October 2006

(courtesy Digital Globe)

MISR Imagery and Products



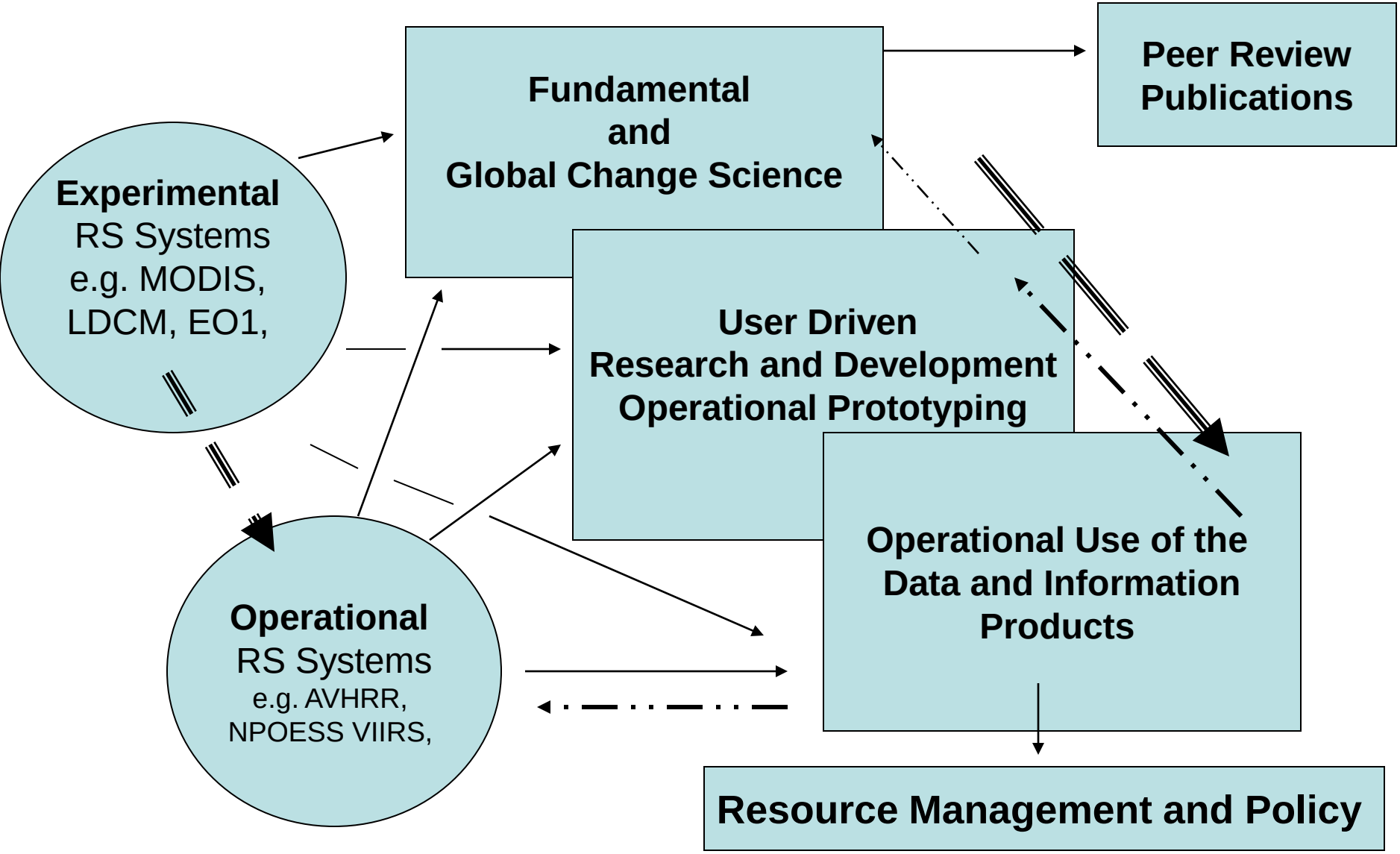
Smoke Plumes, B and B Complex Fire, Oregon 2003



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

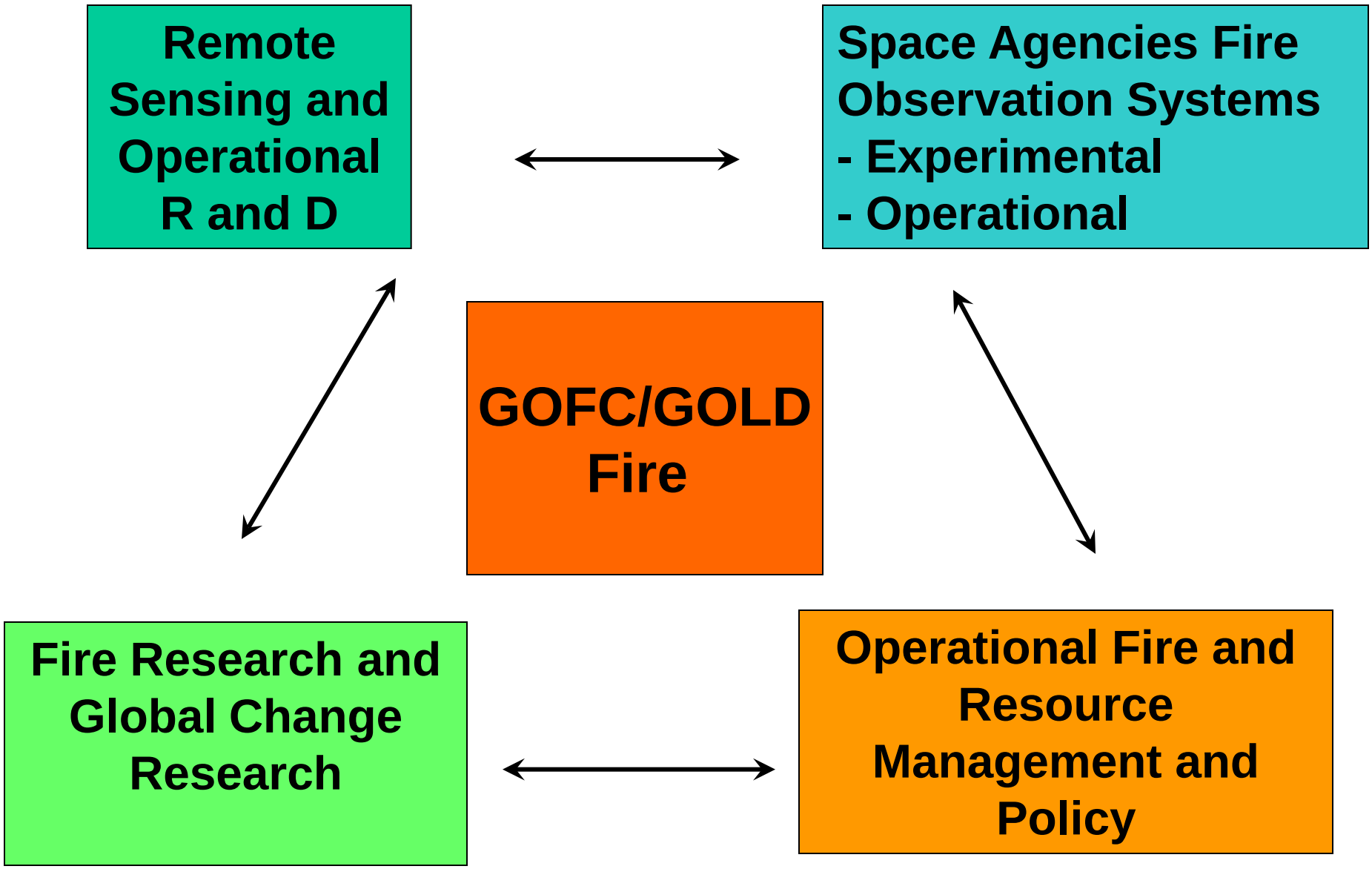
http://gofc-fire.umd.edu

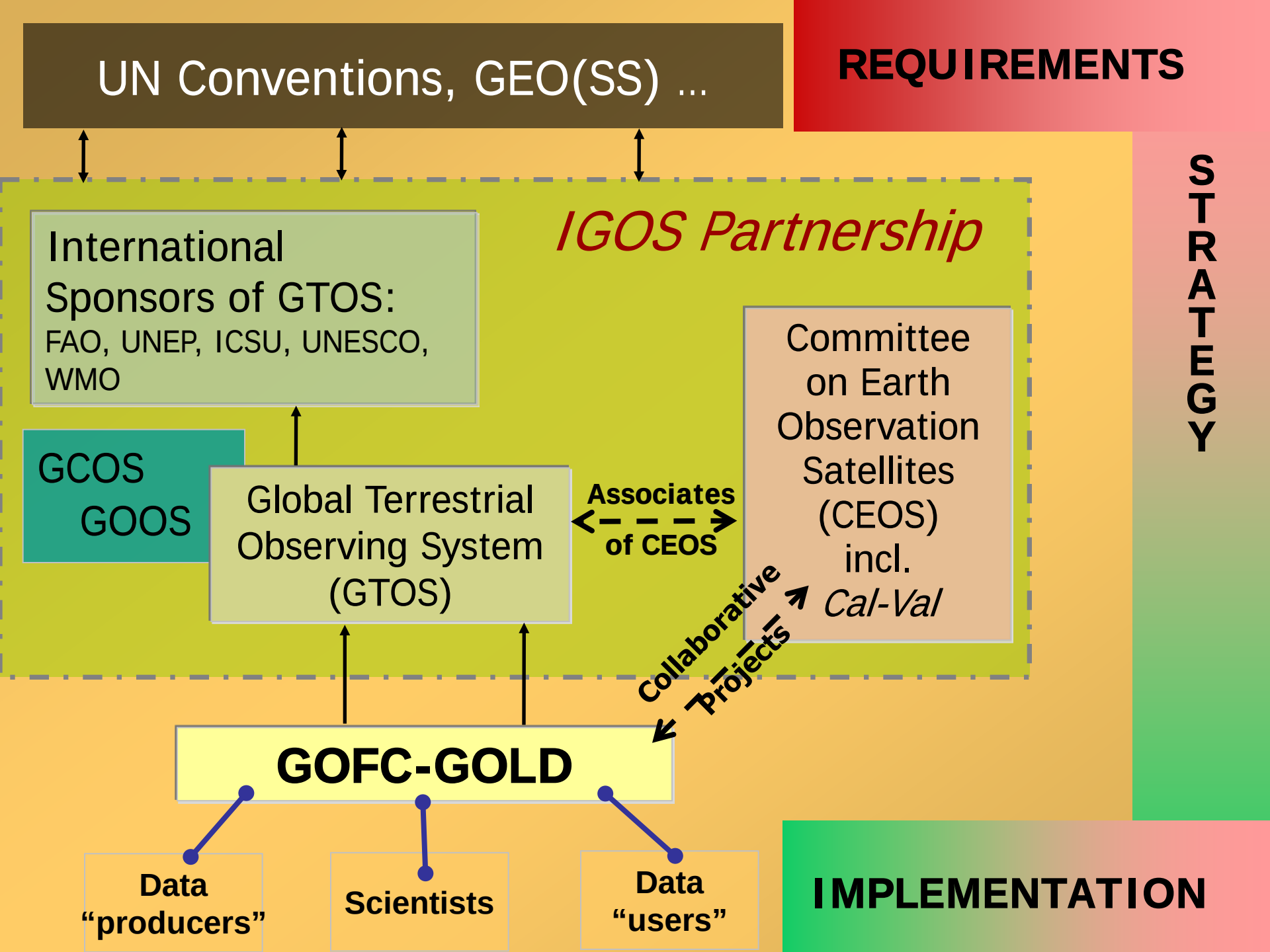
Functions of GOFC-GOLD

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

GOFC-GOLD

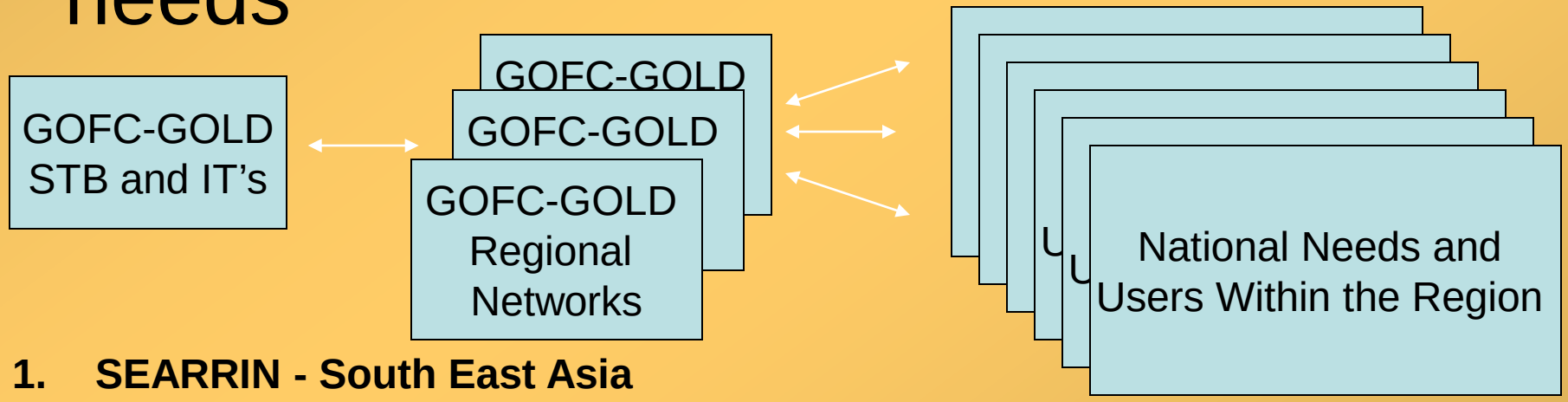
Promote interaction between a number of major communities




UN Conventions, GEO(SS) ...
REQUIREMENTS
IGOS Partnership
International Sponsors of GTOS:
FAO, UNEP, ICSU, UNESCO, WMO
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"
STRATEGY
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**

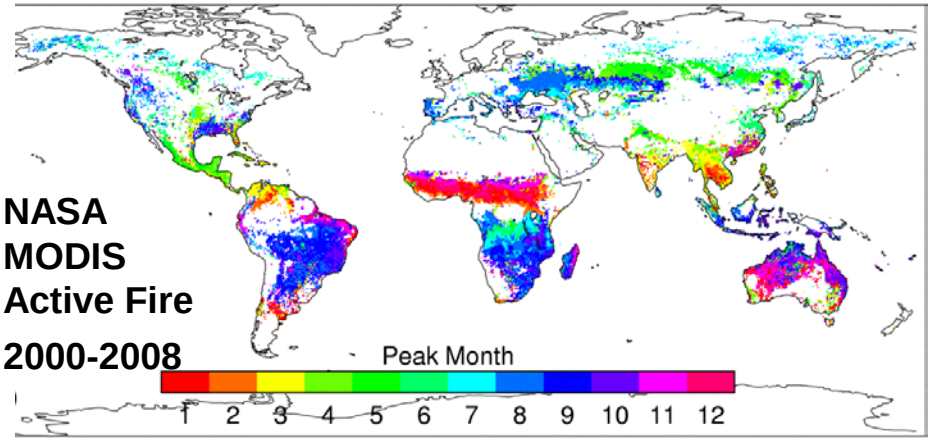
Examples of GOFC/GOLD-Fire Strategic Partnerships

- 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)

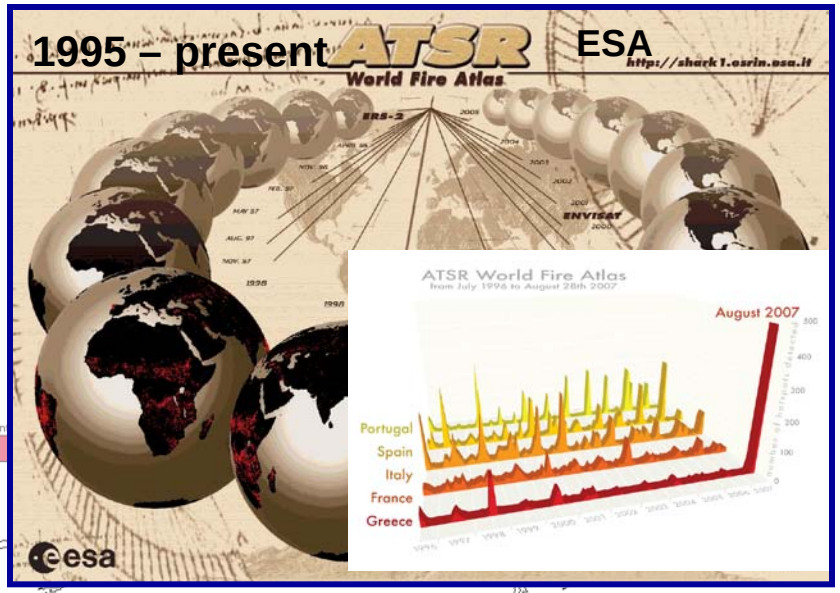
Improved Fire Data and Information Products

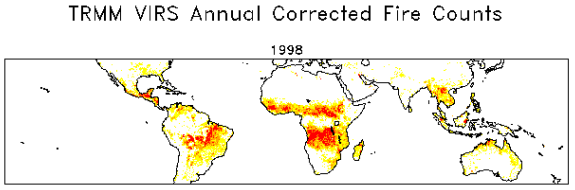
- Products to meet International Convention data needs (w. GCOS/GTOS – ECVs)
- Regional / Global (Burned Area) Products with Systematic Product Validation (w. CEOS LPV)
- Global near real-time data (e.g. MODIS Rapid Response)
- Global Fire Danger Rating System (w. UN ISDR)
- Multi-source fire information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

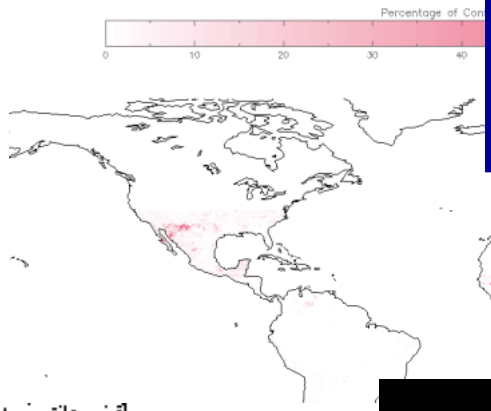
Increasing Satellite Fire Time Series



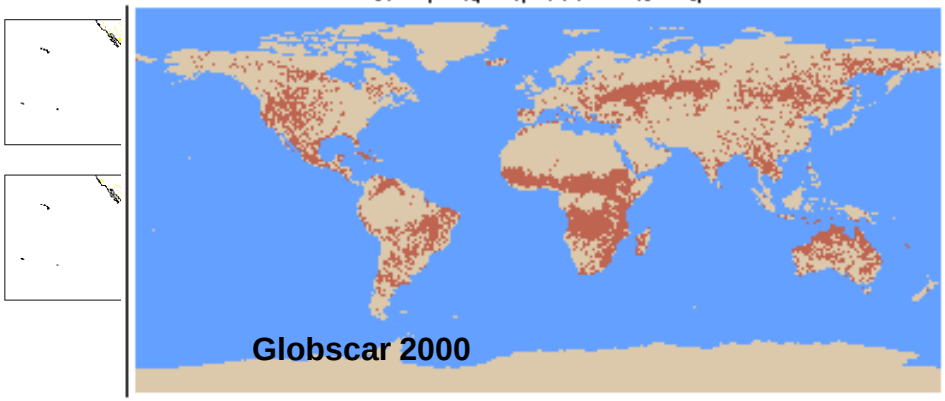
NASA MODIS Active Fire 2000-2008

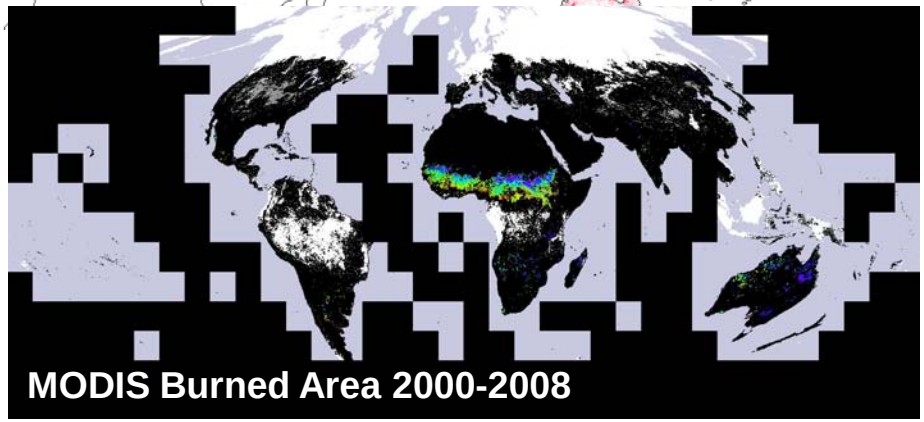


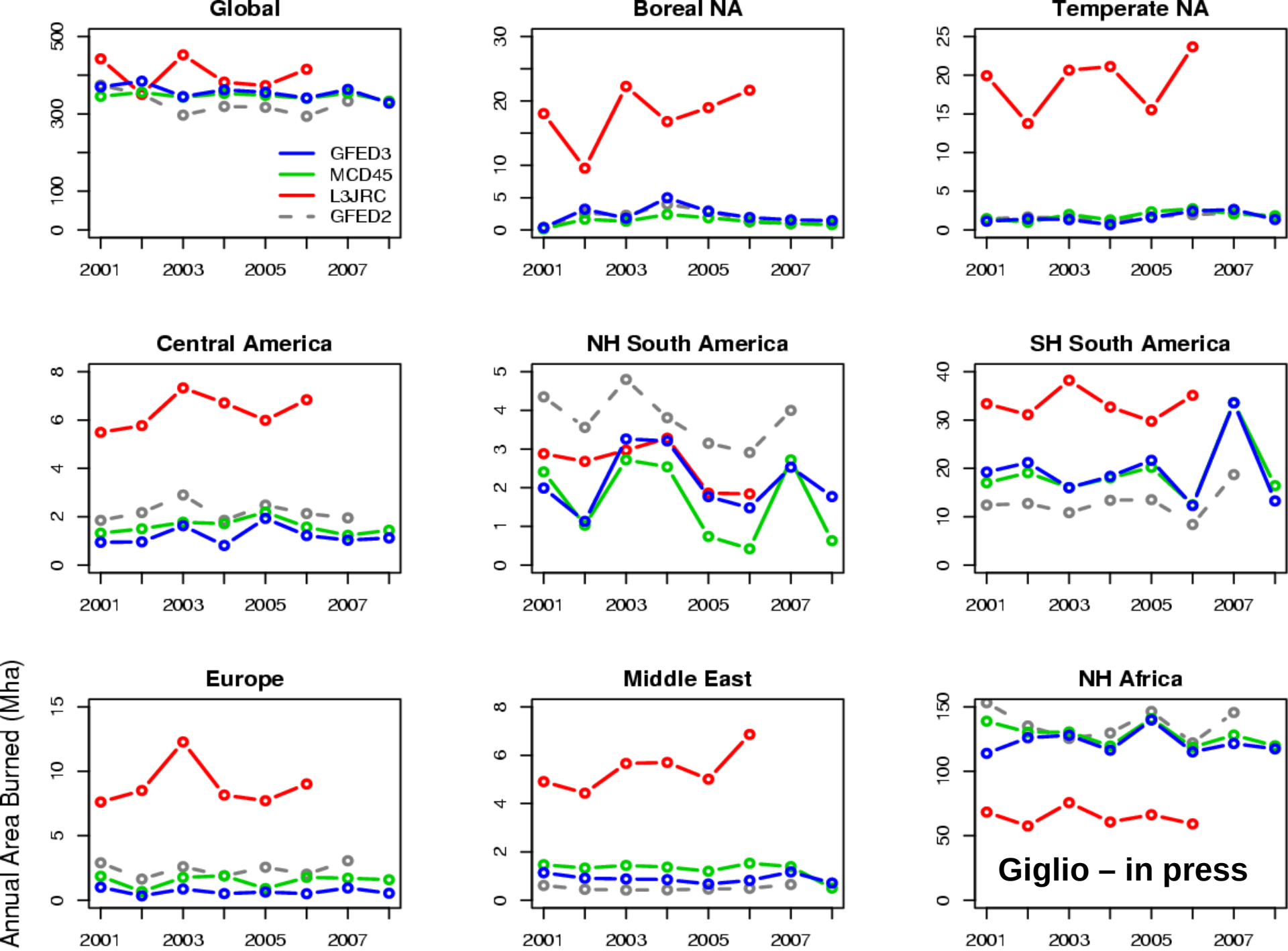


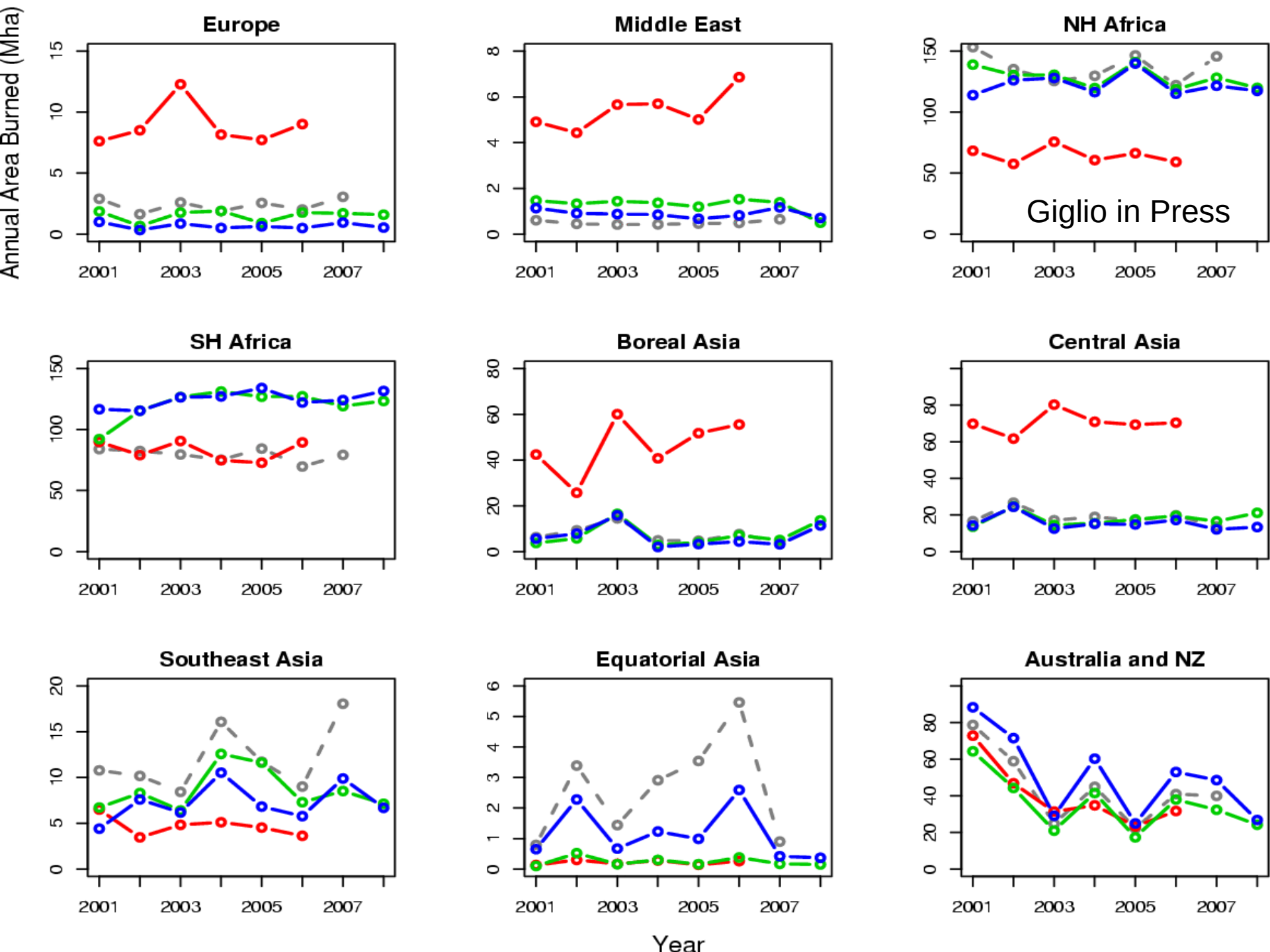


ESA GLOBCARBON 1998-2003






Global
Boreal NA
Temperate NA
Central America
NH South America
SH South America
Europe
Middle East
NH Africa
GFED3
MCD45
L3JRC
GFED2
Annual Area Burned (Mha)
2001
2003
2005
2007
Giglio – in press


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
2001
2003
2005
2007

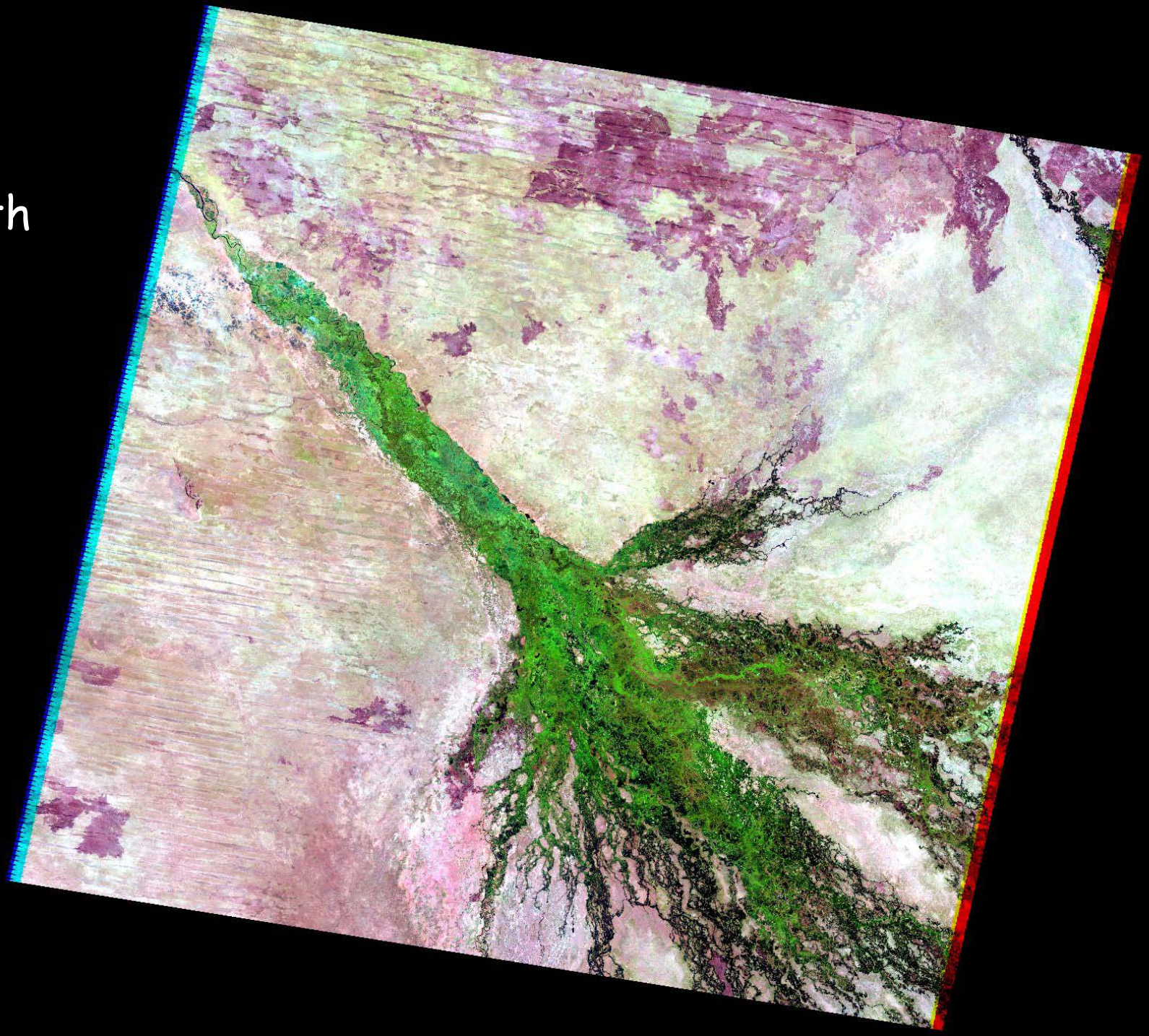
Burned Area Product Validation Protocol

- 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.

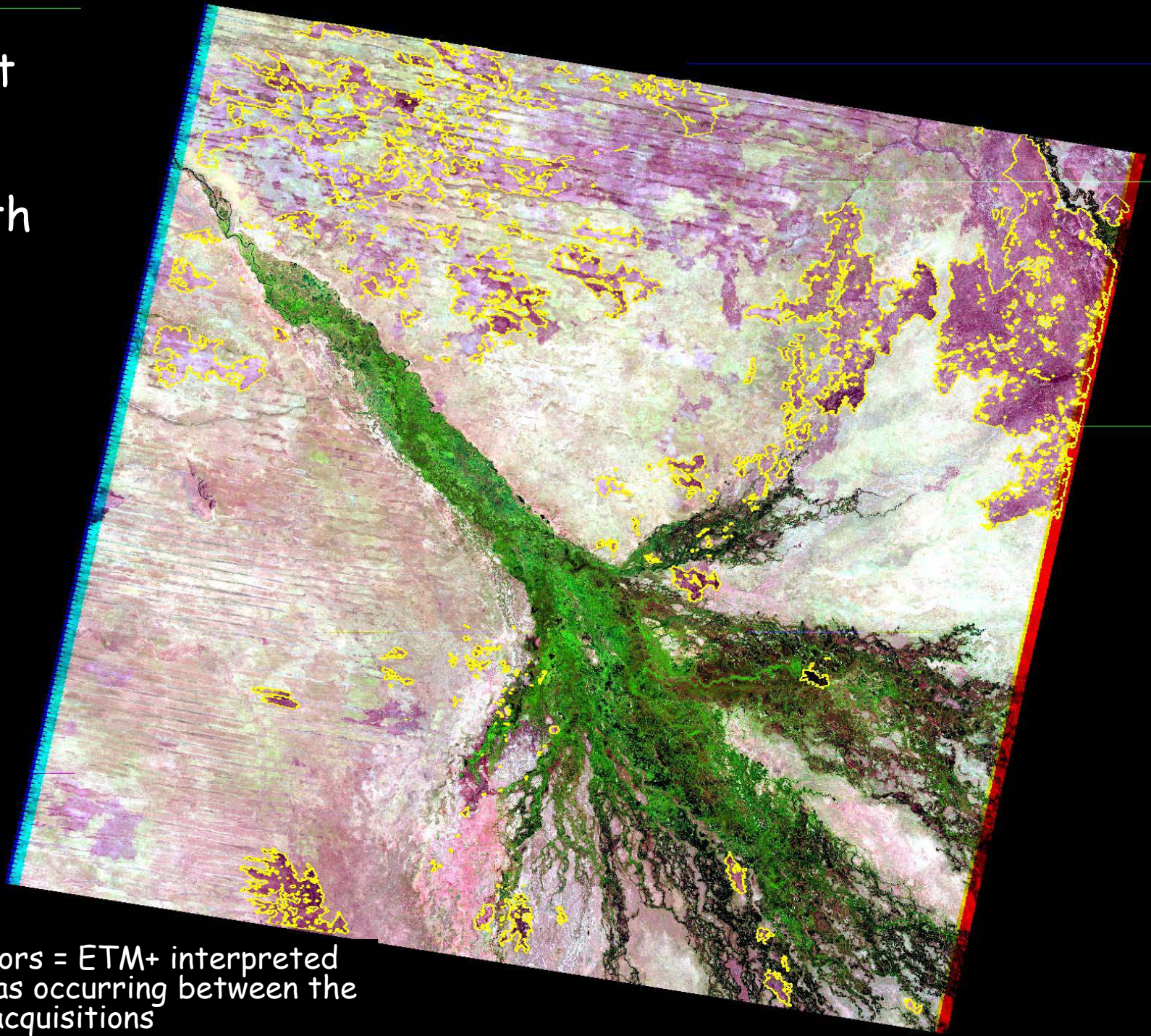
Landsat
ETM+

Sept. 4th

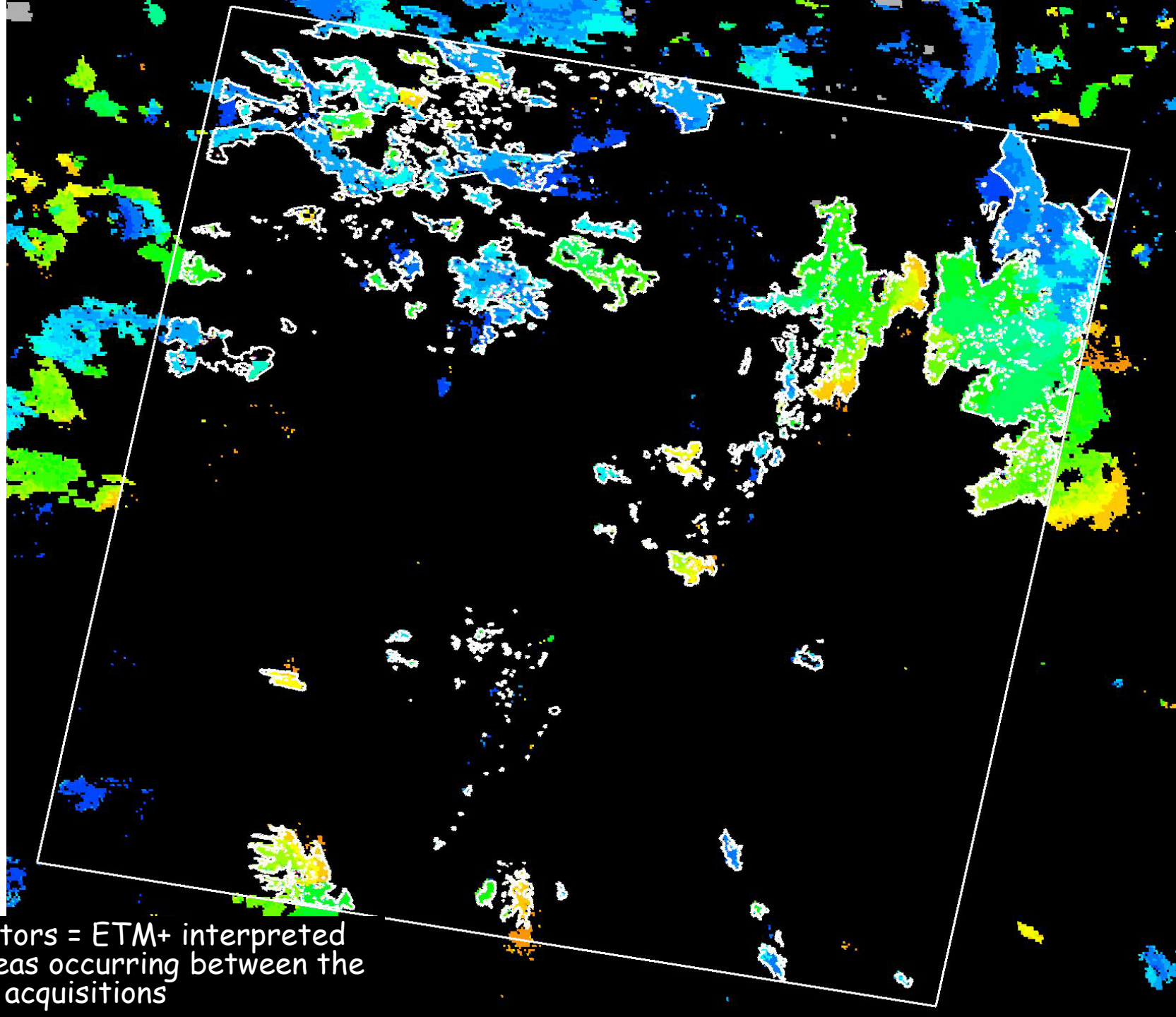


Landsat
ETM+

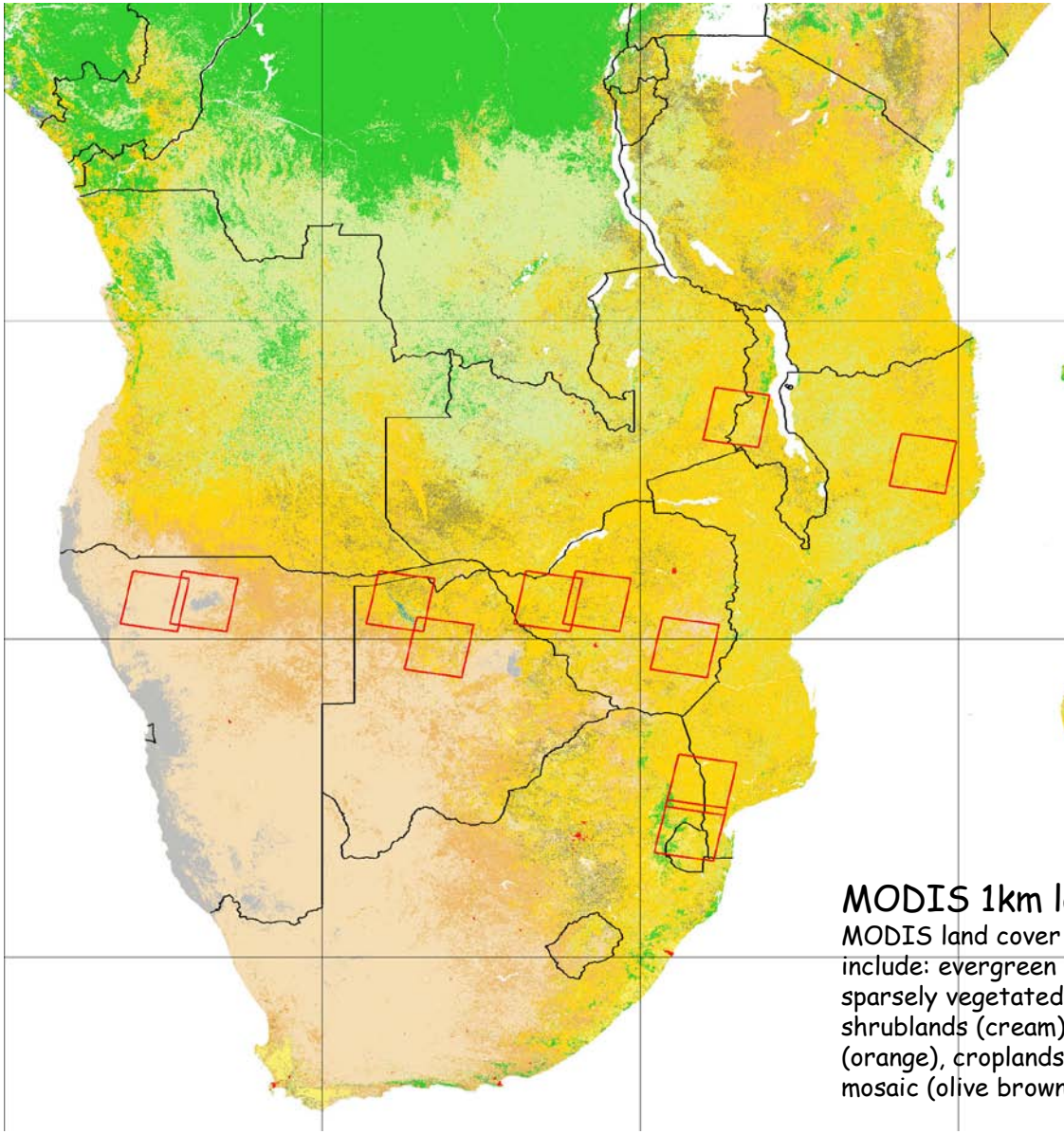
Oct. 6th



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



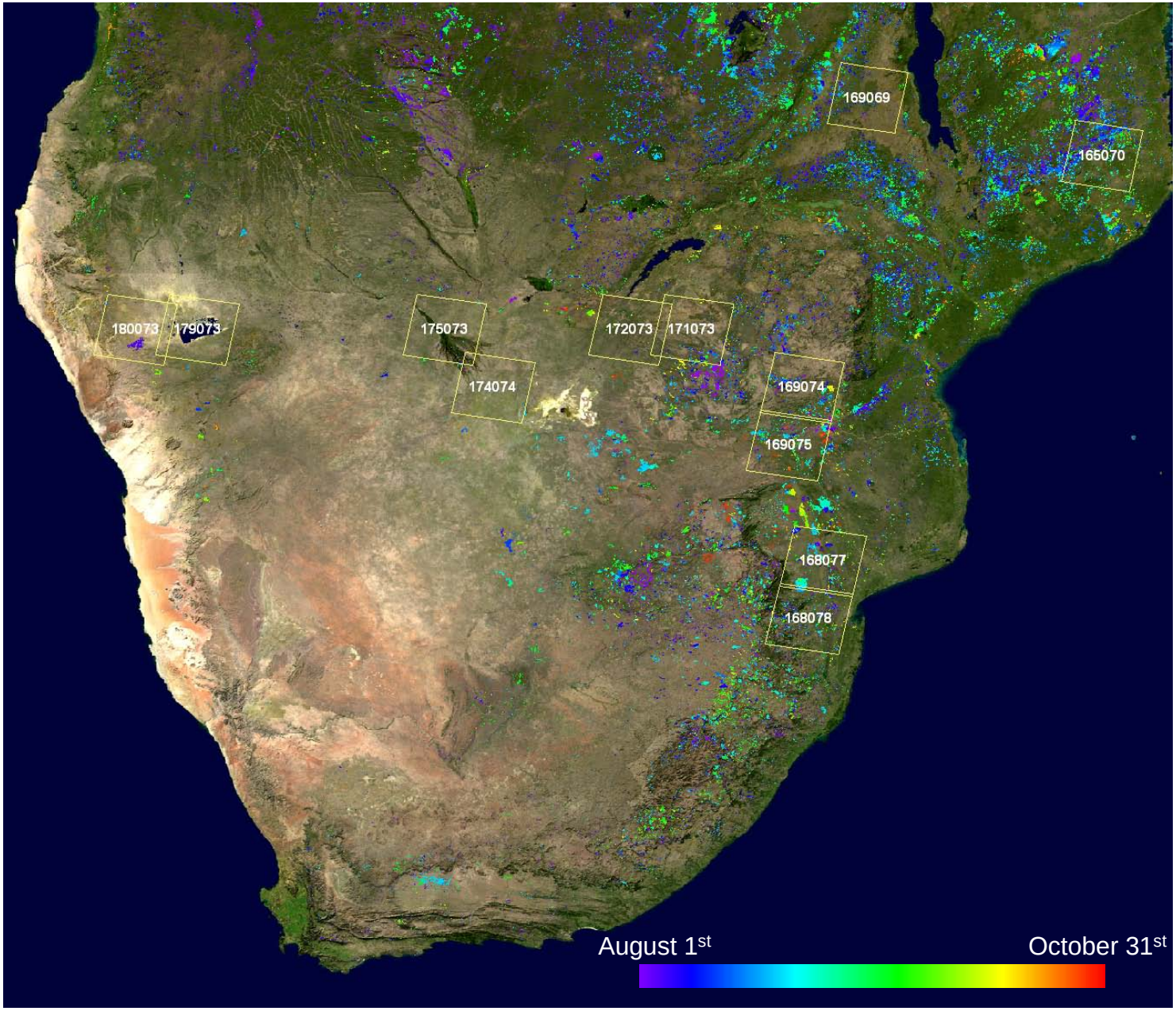
ETM+ scene
~185 * 185 km

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).

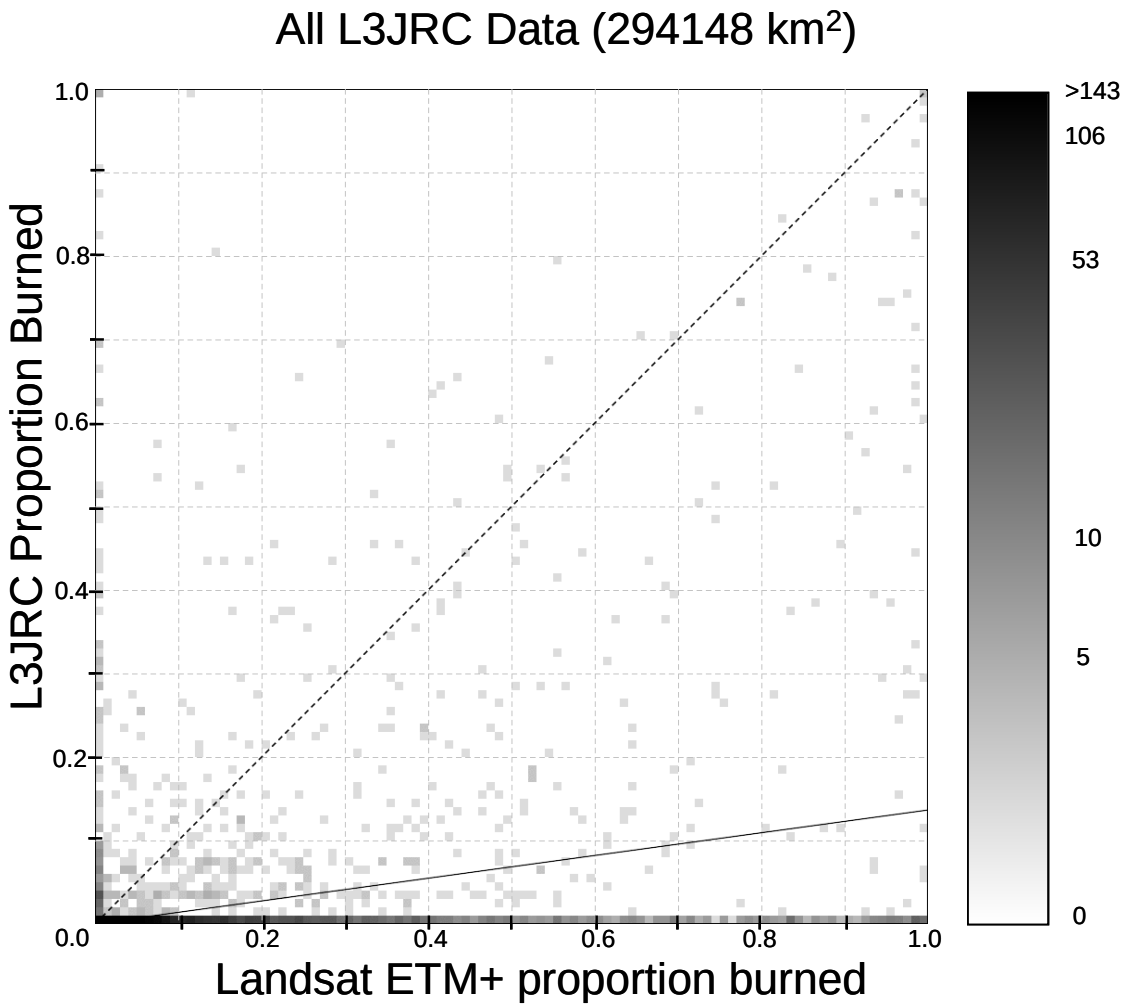
L3JRC – A/S/O 2001



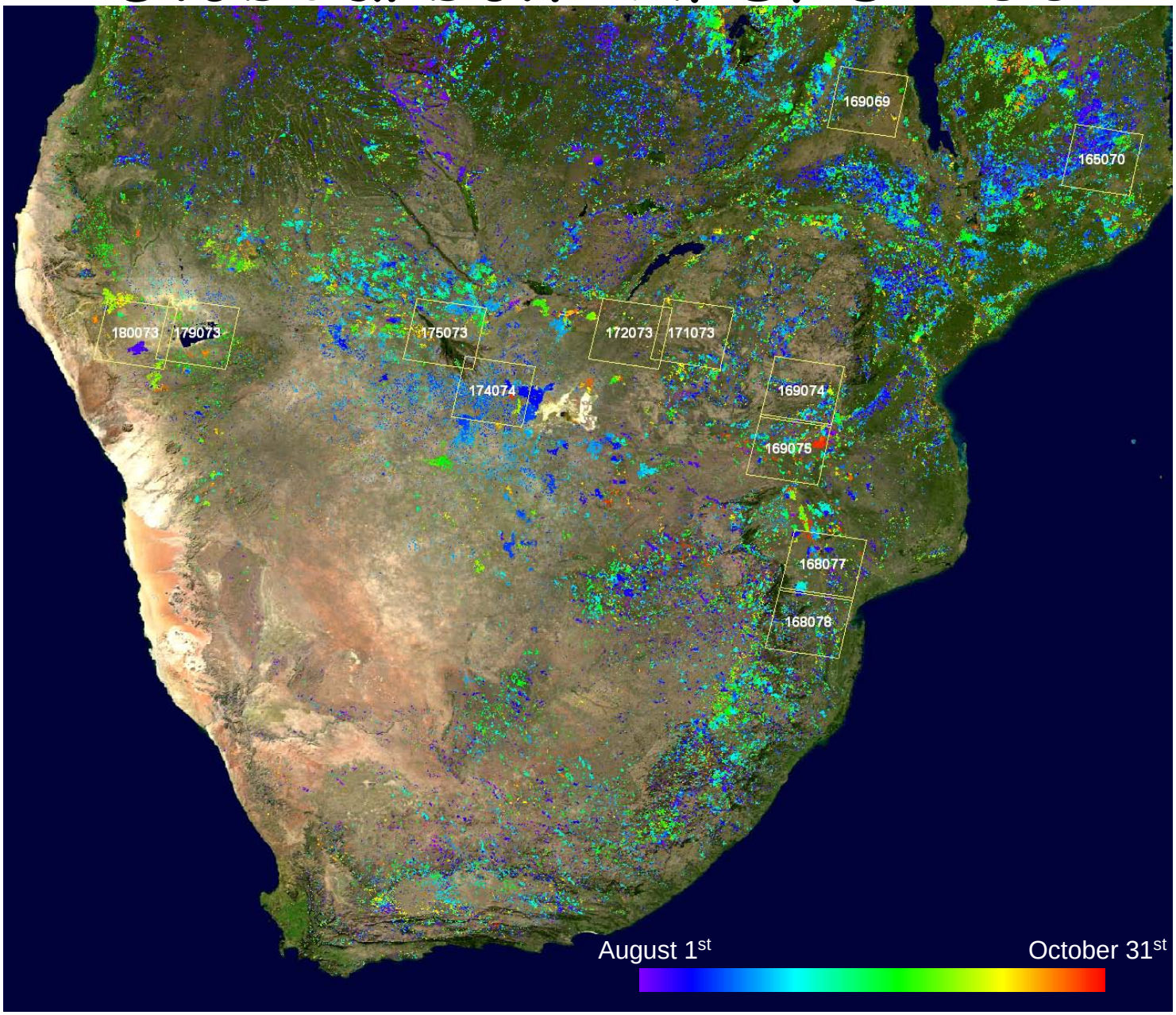
Boschetti et al

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



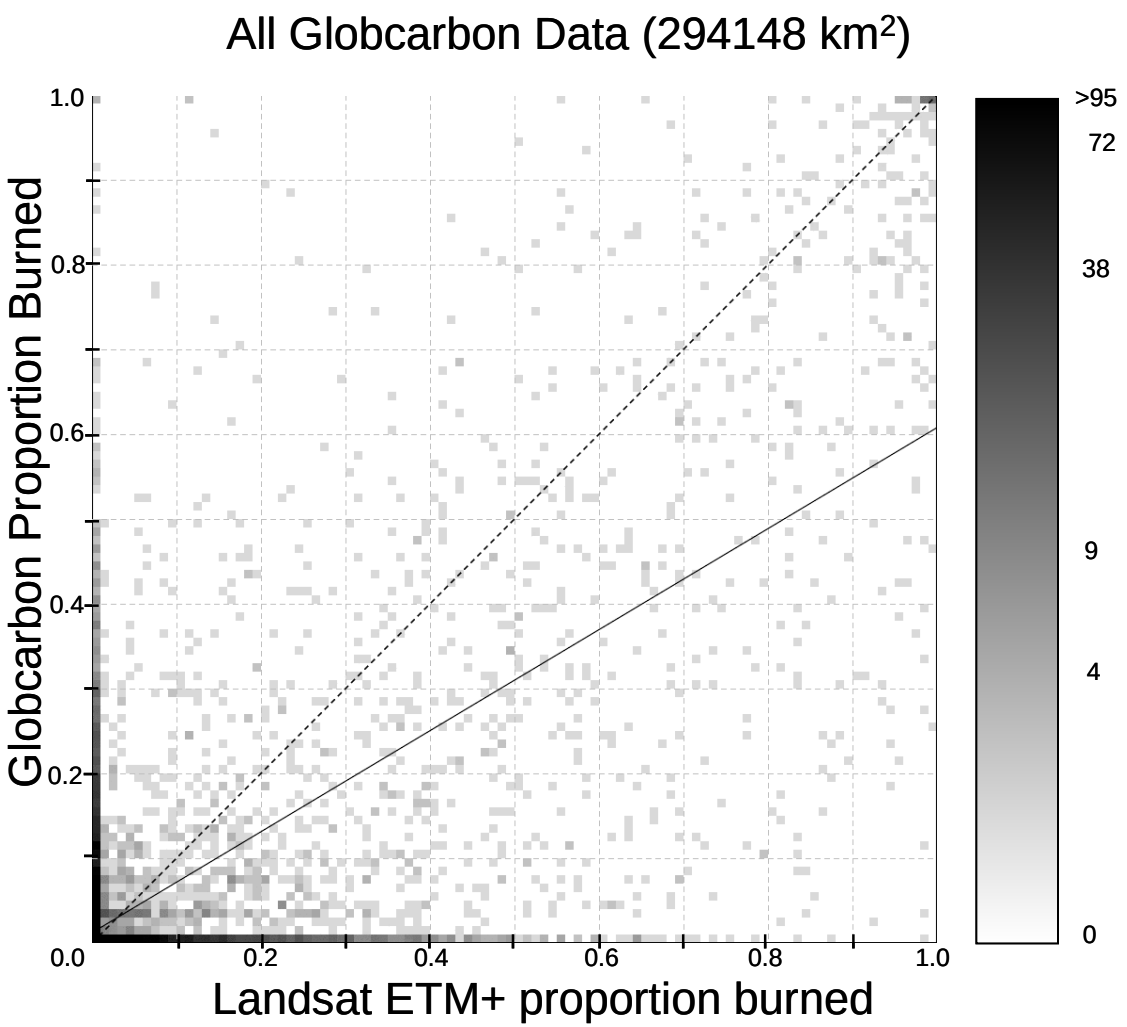
GlobCarbon –A/S/O 2001



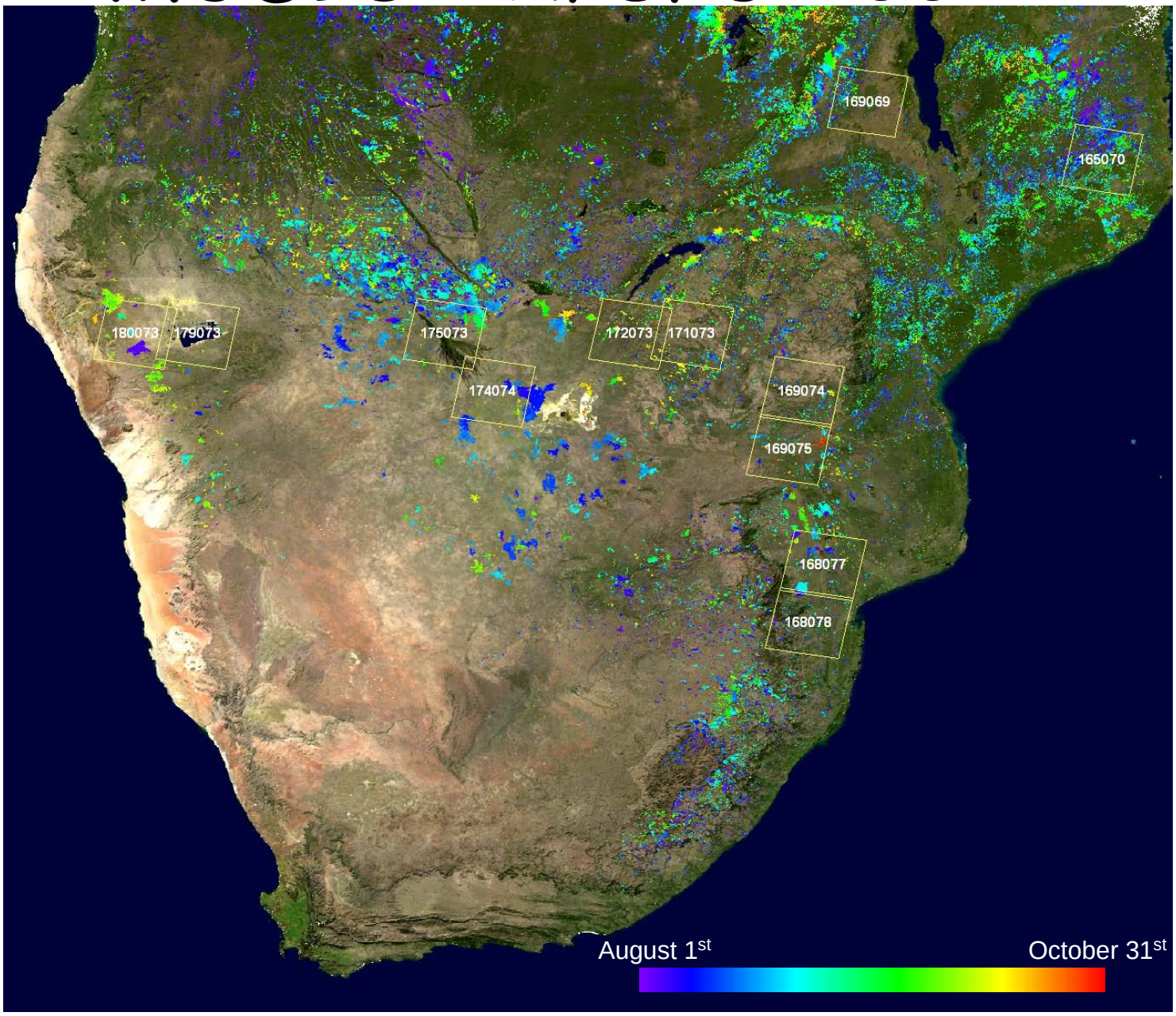
GLOBCARBON Burned Area product Validation.

The slope of the regression line is 0.595,

The intercept is 0.013 and the r2 is 0.509

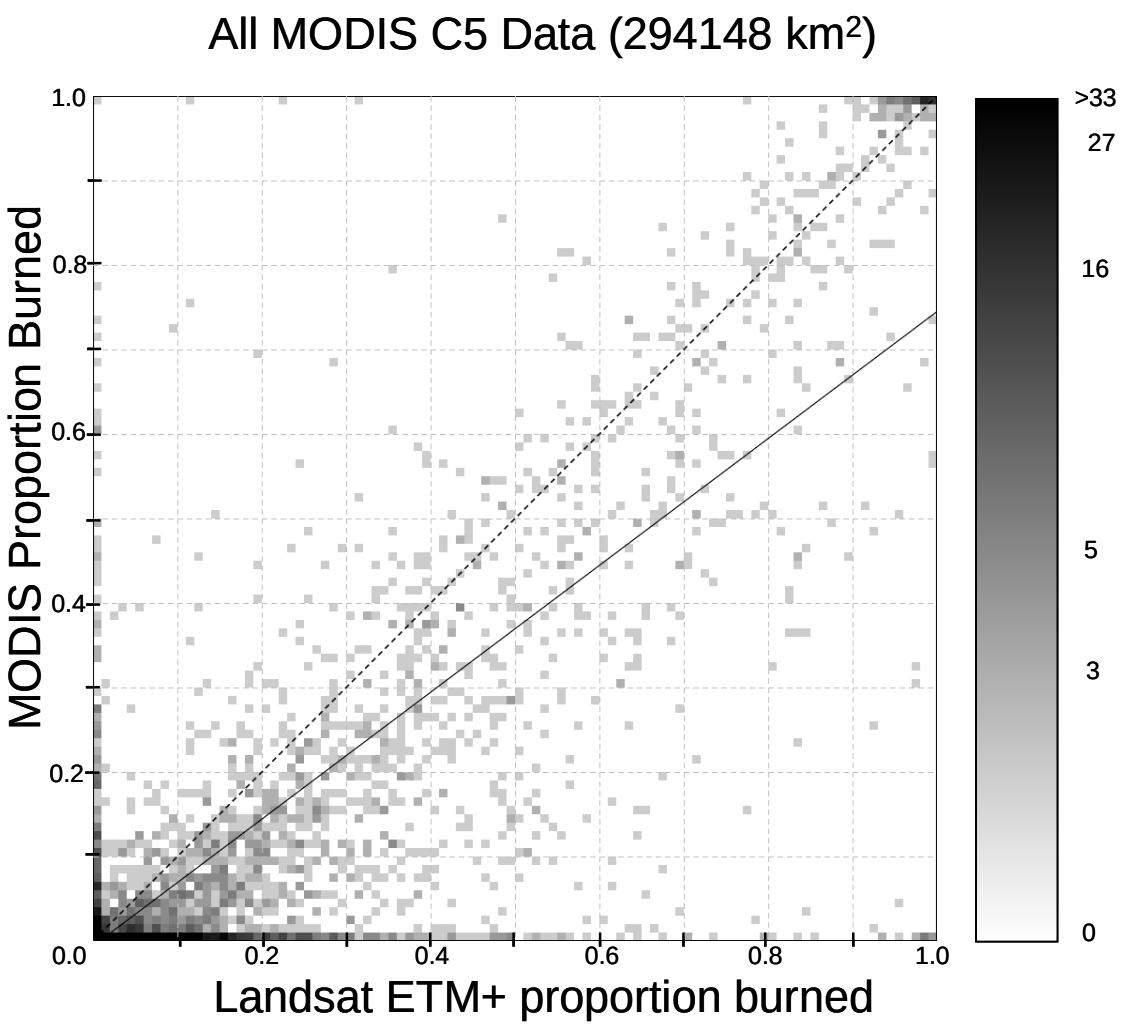


MODIS - A/S/O 2001



MODIS Burned Area product Validation

The slope of the regression line is 0.75,
The intercept is -0.005 and the r2 is 0.746



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

CEOS

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.morisette@nasa.gov

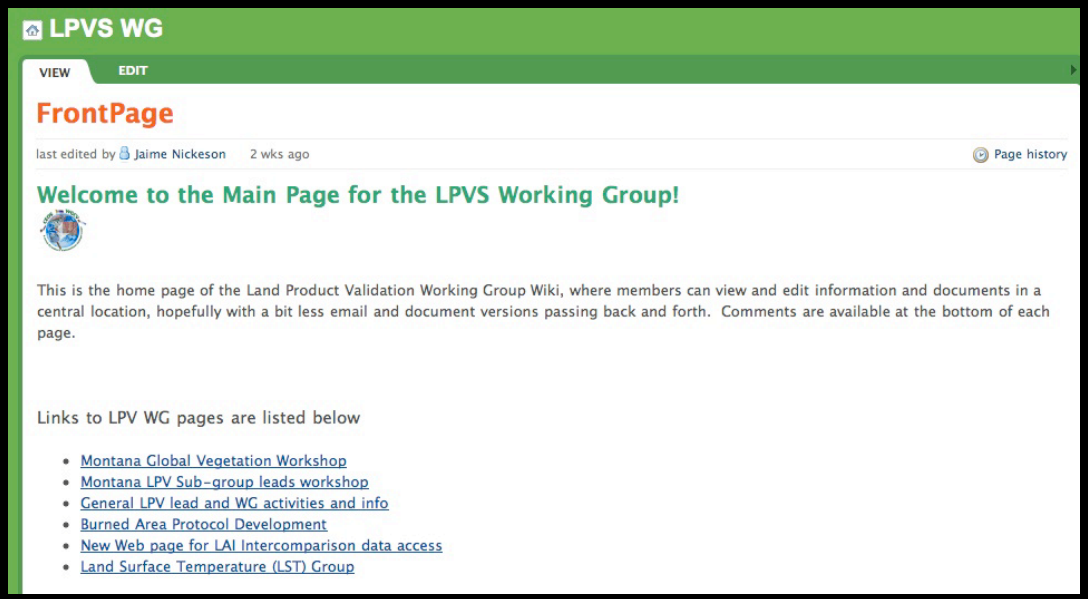
LPV Structure cont.

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



Validation of Satellite Based Fire Products for Central Asia

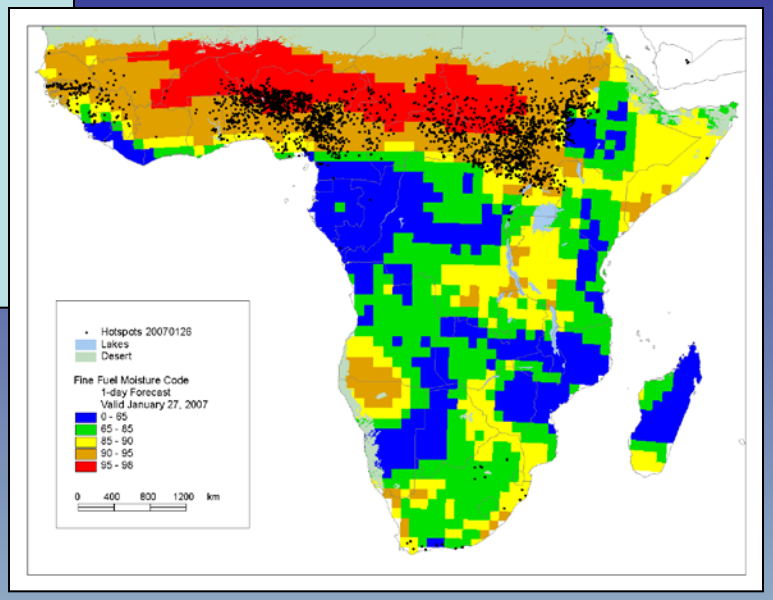
- Is this something of interest to the audience?

Tatiana Laboda's Fire Training Session

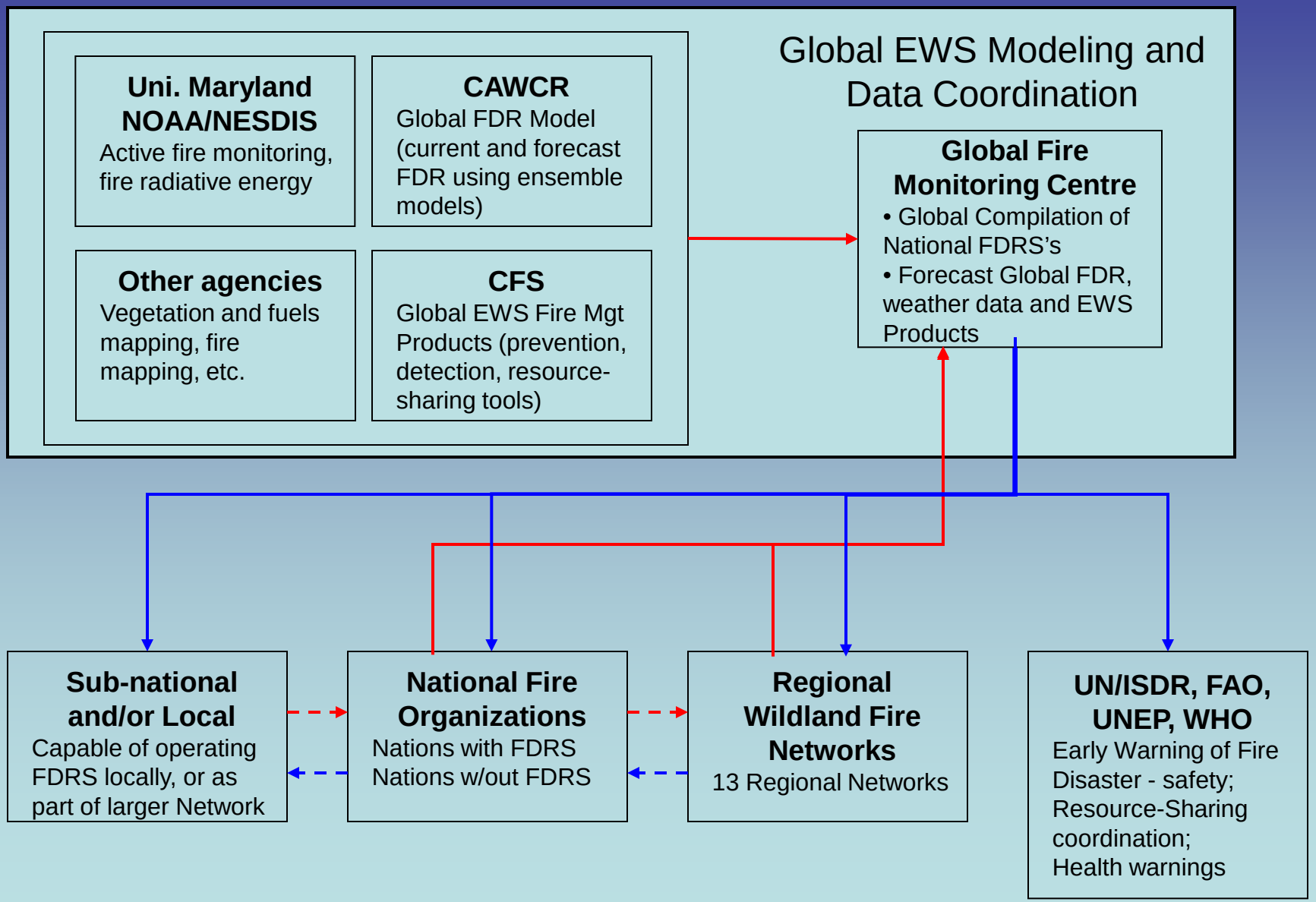
Early warning allows implementation of:

- fire prevention
- fire detection
- resource mobilization

before wildfire disasters occur.



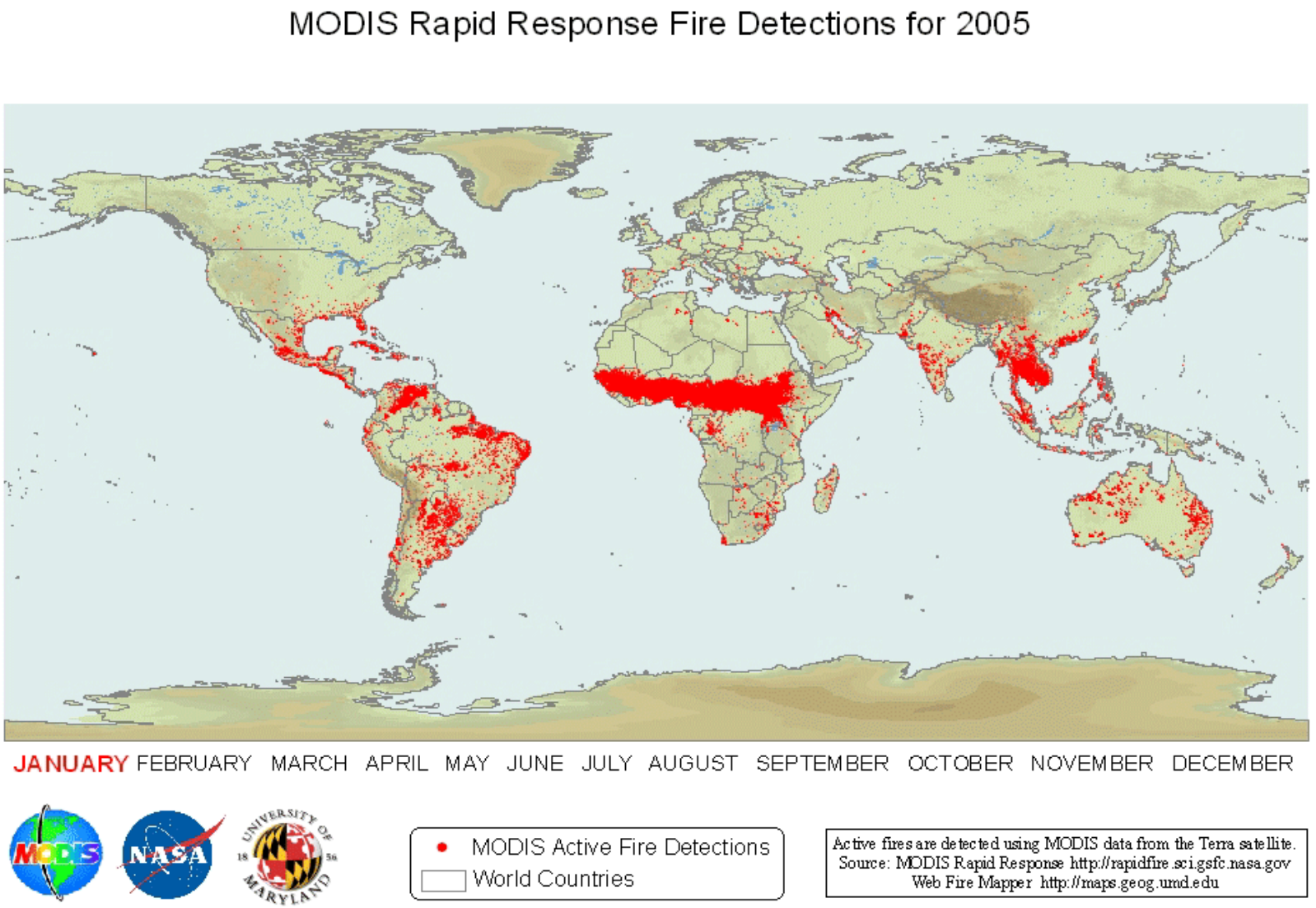
Global EWS – Fire: System Structure



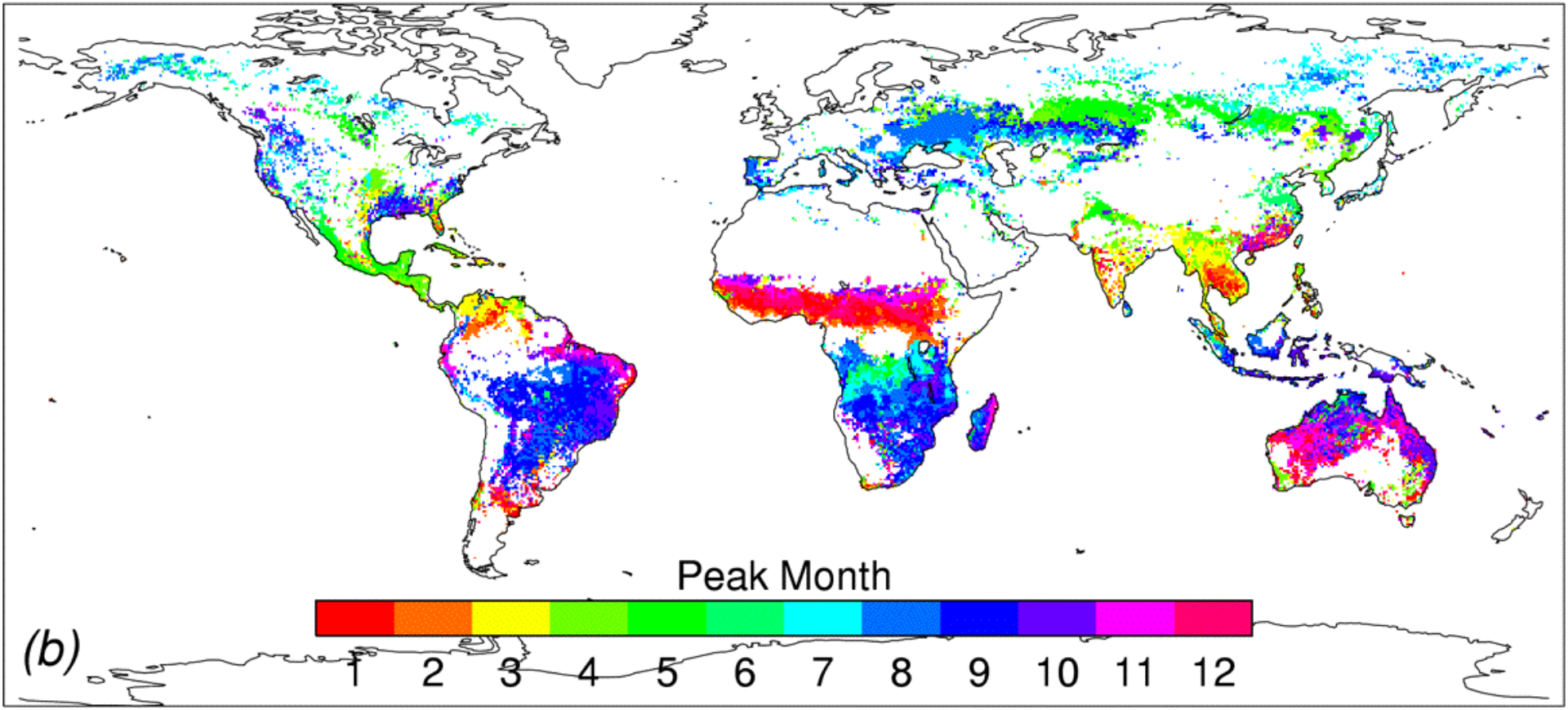
A Satellite-based Global Fire Assessment 2010

- 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)



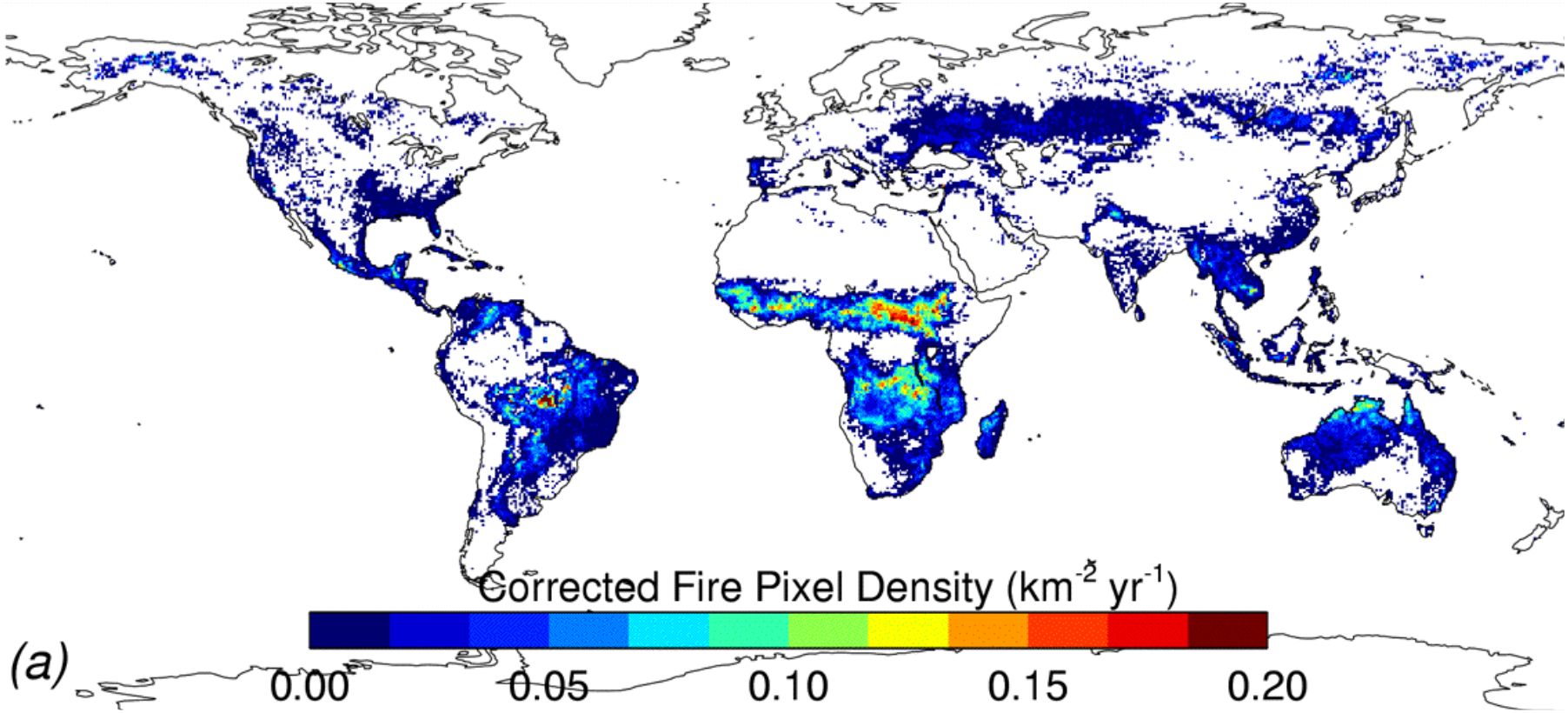
Global Fire Regime Characterization



Mean Peak Fire Month (2000-2005)

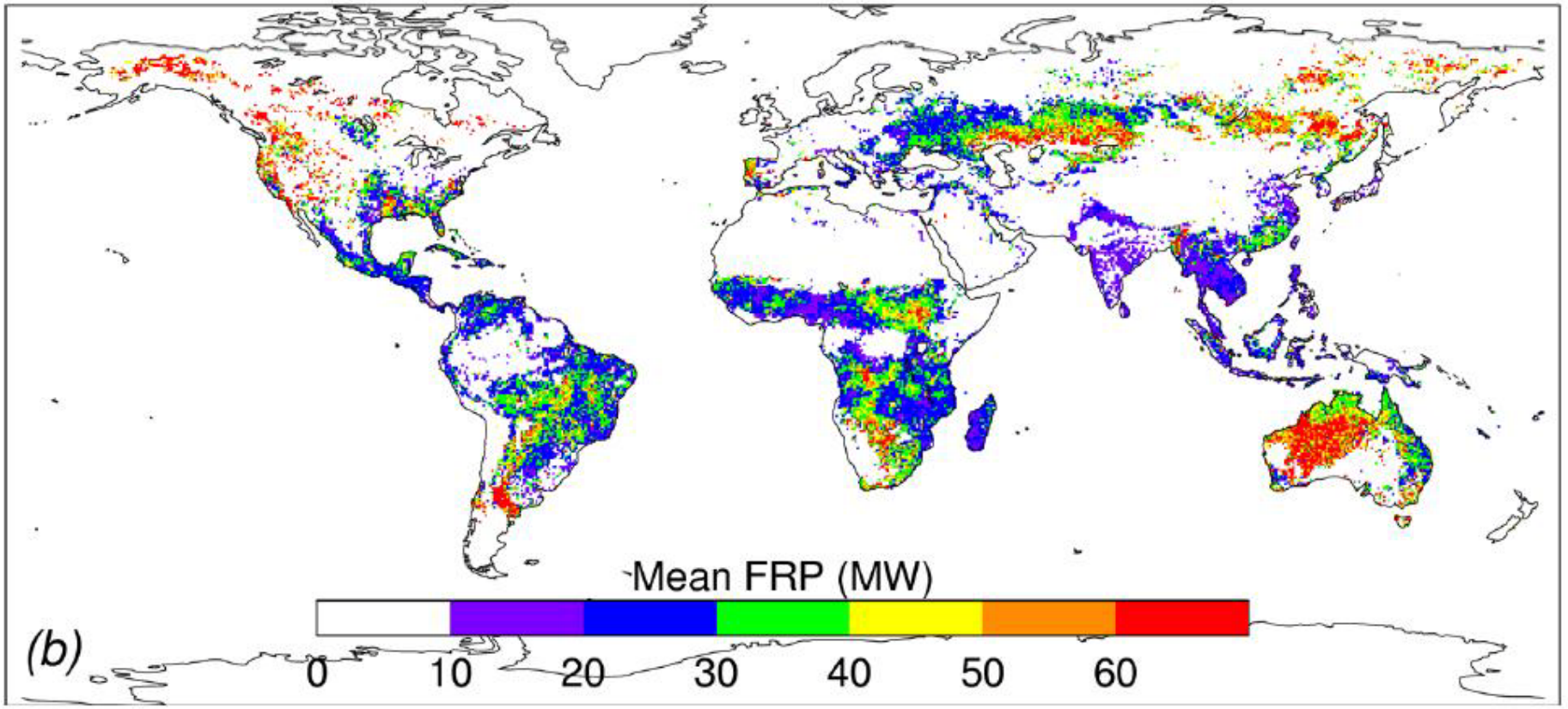
Giglio et al 2007

Global Fire Regime Characterization



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

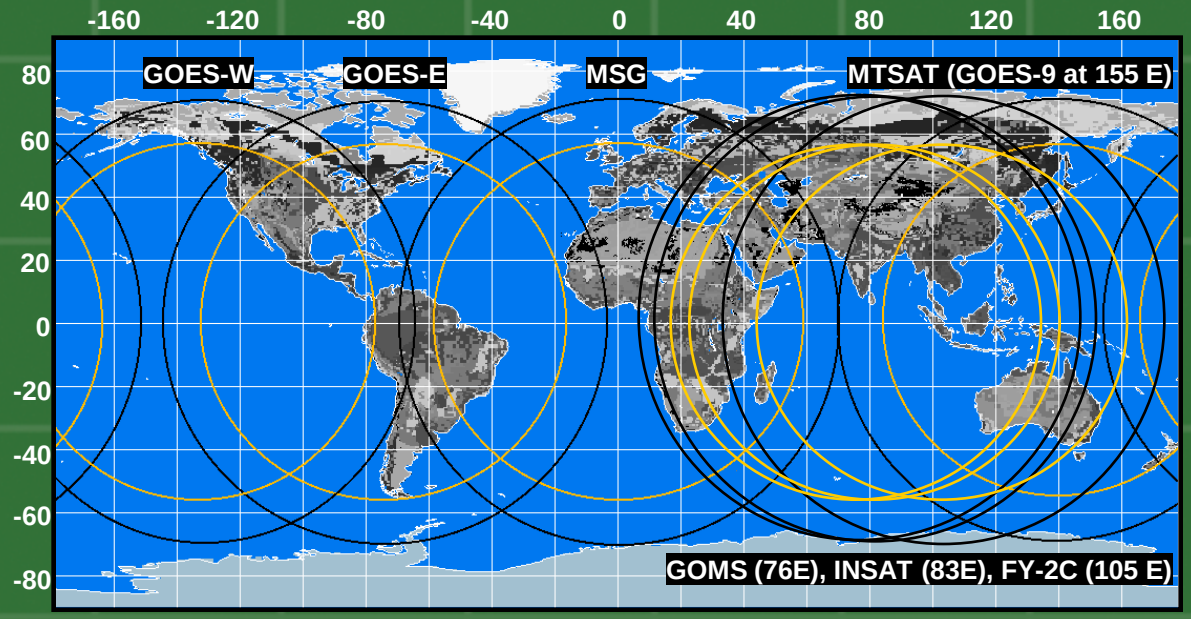
Fire radiative power from MODIS active fires (2000-2005)



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 μm Saturation Temperature (K)	Minimum Fire Size at Equator (at 750 K) (hectares)
GOES-12 Imager	1 visible 3.9 and 10.7 μm	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 μm	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 μm	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 μm	1.25 5.0		30 minutes	~330 K (?)	
MTSAT-1R JAMI (2005)	1 visible 3.7 and 10.8 μm	0.5 2.0		1 hour	~320 K	0.03
INSAT- 3D (2006)	1 vis, 1.6 μm 3.9 and 10.7 μm	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 μm	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

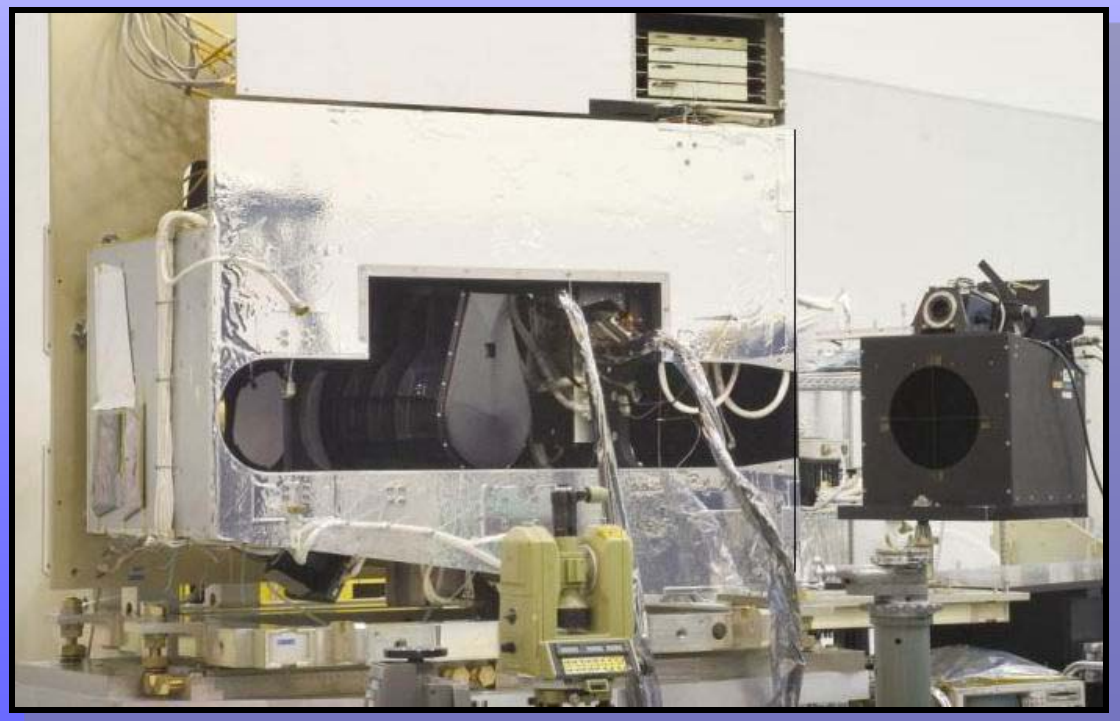
VIIRS

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

THREE AGENCIES • ONE MISSION

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

MODIS		VIIRS	
Band	# λ	λ	Band
1	620 - 670	600 - 680	I-1
2	841 - 876	845 - 885	I-2
3	459 - 479		
4	545 - 565		
5	1230 - 1250	1230 - 1250	M-8
6	1628 - 1652	1580 - 1640	M-10
		1580 - 1640	I-3
7	2105 - 2155	2105 - 2155	
8	405 - 420	402 - 422	M-1
9	438 - 448	436 - 454	M-2
10	483 - 493	478 - 498	M-3
11	526 - 536		
12	546 - 556	545 - 565	M-4
13	662 - 672	662 - 682	M-5
14	673 - 683		
15	743 - 753	733 - 753	M-6
16	862 - 877	846 - 885	M-7
17	890 - 920		
18	931 - 941		
19	915 - 965		

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

MODIS		VIIRS	
Band	# λ	λ	Band
20	3.660 - 3.840	3.610 – 3.810	M-12
		3.550 – 3.930	I-4
21	3.929 - 3.989		
22	3.929 – 3.989	4.001	
23	4.020 - 4.080	3.970 – 4.130	M-13
24	4.433 – 4.498	4.498	
25	4.482 – 4.549	4.549	
26	1.360 - 1.390	1.371 – 1.386	M-9
27	6.535 - 6.895		
28	7.175 - 7.475		
29	8.400 - 8.700	8.400 – 8.700	M-14
30	9.580 - 9.880		
31	10.780 - 11.280	10.263 – 11.263	M-15
		10.050 - 12.450	I-5
32	11.770 - 12.270	11.538 – 12.488	M-16
33	13.185 - 13.485		
34	13.485 - 13.785		
35	13.785 - 14.085		
36	14.085 - 14.385		

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

Imagery & Cloud

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

Ocean

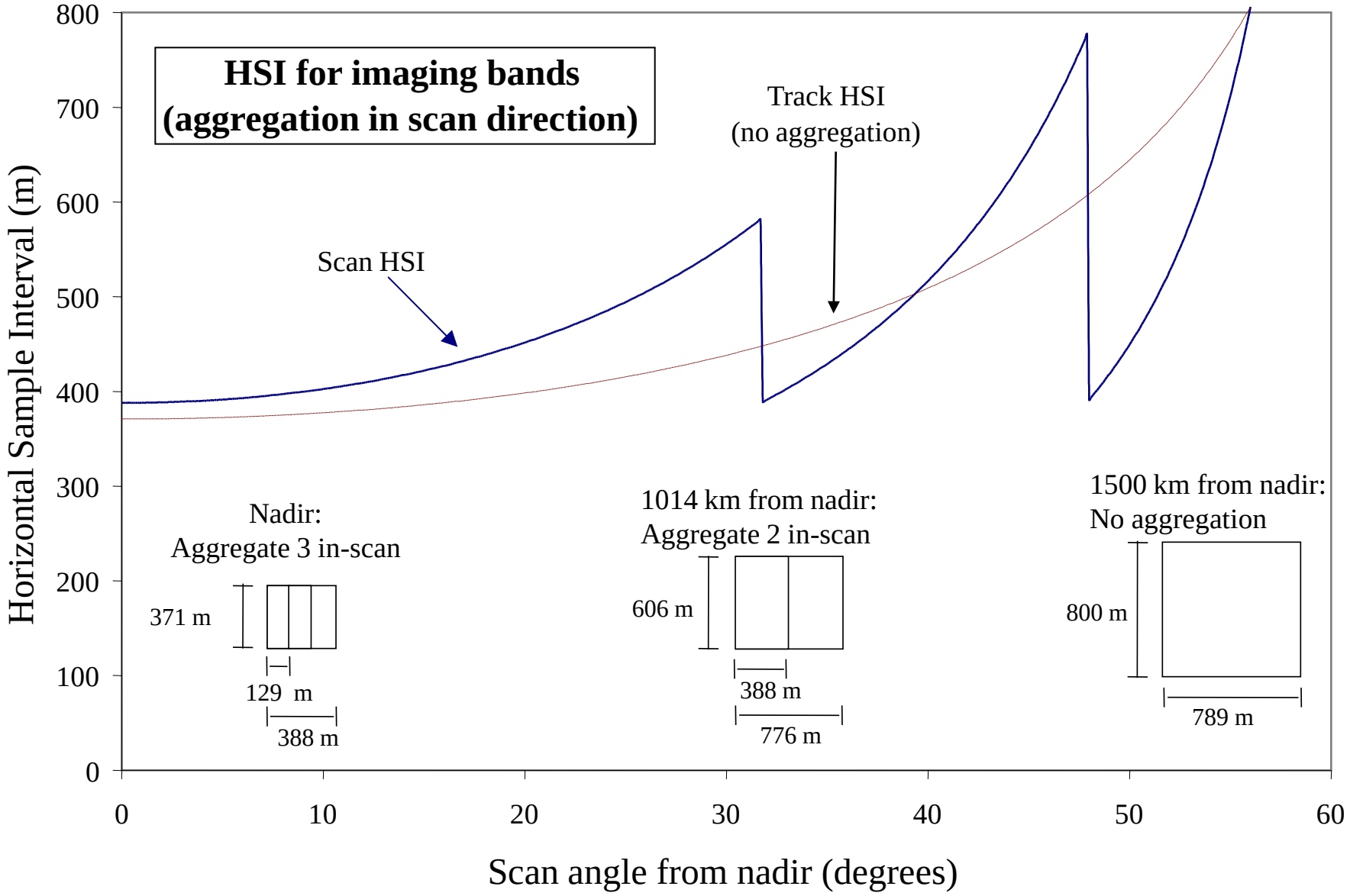
- Sea Surface Temperature
- Ocean Color/Chlorophyll

Aerosol

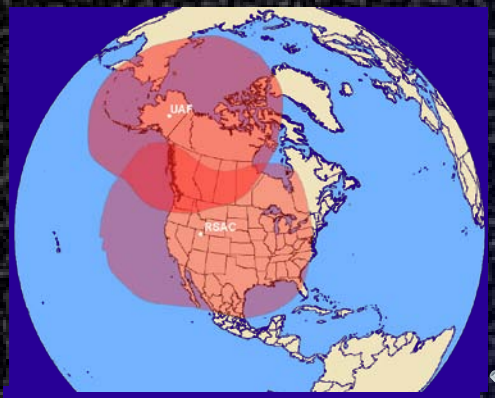
- Aerosol Optical Thickness
- Aerosol Particle Size Parameter
- Suspended Matter

Other Land products in planning phase

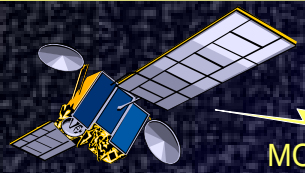
VIIRS Spatial Resolution – requirement for uniform pixel size across scan



DB Station NRT Capability



USFS-RSAC/UAF-GINA
Direct Broadcast Coverage



Terra / Aqua

MODIS
Raw Data

MODIS
Raw Data

USFS-RSAC
Direct Readout

UAF-GINA
Direct Readout

White Sands, NM

RSAC Direct Readout

MODIS L0 Data
(< 1/2 hour)

MODIS L0 Data
(< 1/2 hour)

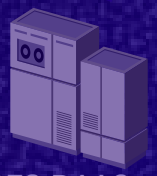
MODIS
L0 Data

USFS-RSAC
Rapid Response System

Image & Active Fire
Detection Processing

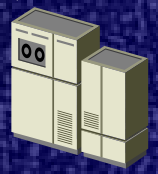
UAF-GINA
Rapid Response System

Image & Active Fire
Detection Processing



GES DAAC
NASA/GSFC

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



NOAA MODIS
Real Time
Processing System

MODIS L0
(~3 hours)

NASA/GSFC
Rapid Response System

Image & Active Fire
Detection Processing

The Landsat Data Continuity Mission

Operational Land Imager

(aka Landsat 8)

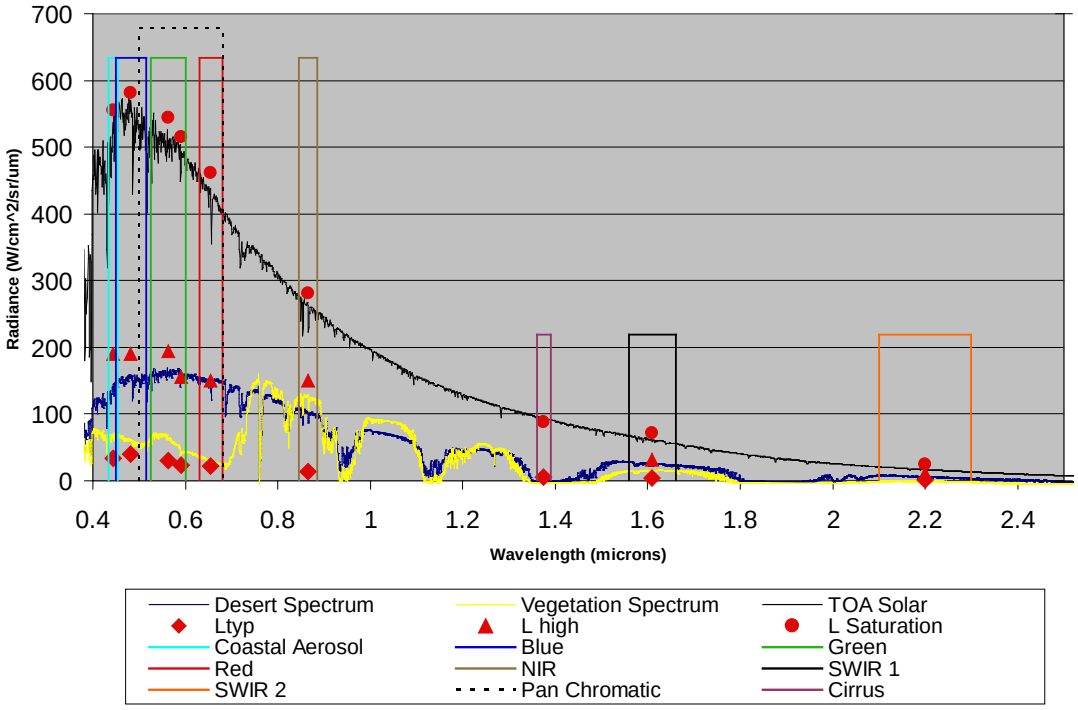
Launch Date Planned for Dec 2012

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



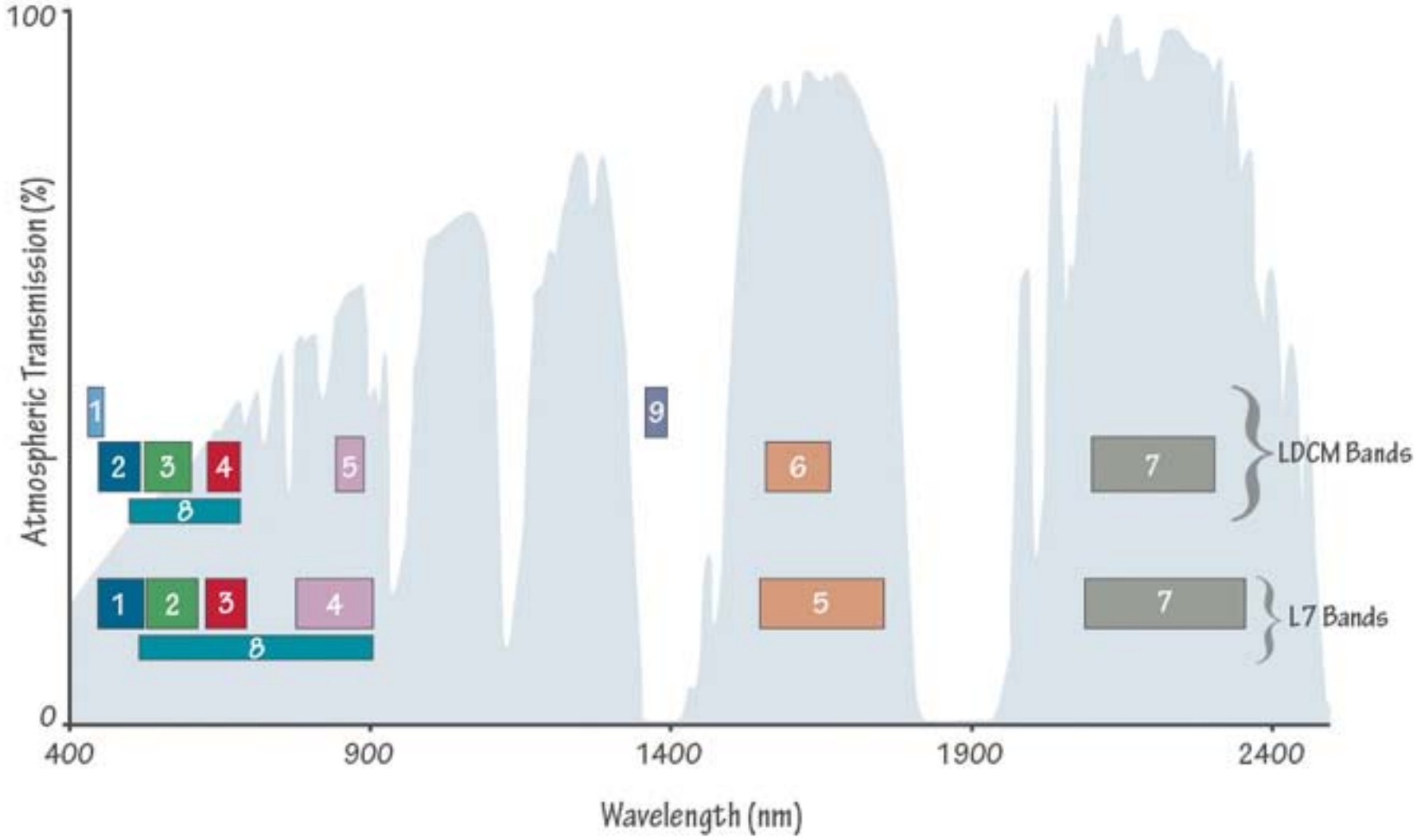
- Key instrument parameters
  - Cross-track FOV 185 km
  - S/C altitude 705 km
  - Geodetic accuracy*
    - Absolute 65 m
    - Relative 25 m
  - Geometric accuracy**
    - Absolute 12 m

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

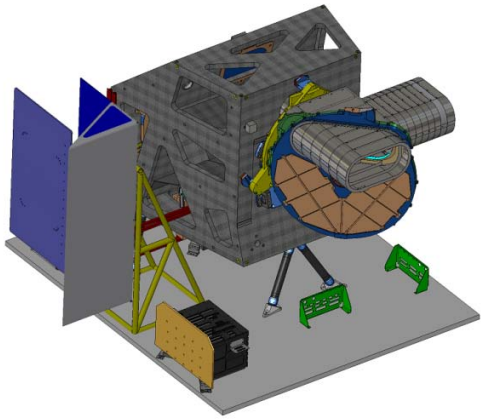
- Radiometric
  - Signal-to-noise radiometric stability (16-day, 60 sec, 5 year)
  - Pixel-to-pixel uniformity
  - Absolute radiometric accuracy
    - Absolute radiance – 5%, absolute reflectance – 3%
- Spectral
  - Spectral band edges and center wavelength tolerance
  - Integrated out-of-band (OOB) response (<2%)
  - Spectral uniformity (FWHM) (± 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

Band	Center Wavelength (micrometers)	Spatial Resolution At Nadir (m)	NEΔT Requirements	
			At $T_{Typical}$	At T_{High}
Thermal 1	10.8	120	0.4 K	0.35 K
Thermal 2	12.0	120	0.4 K	0.35 K

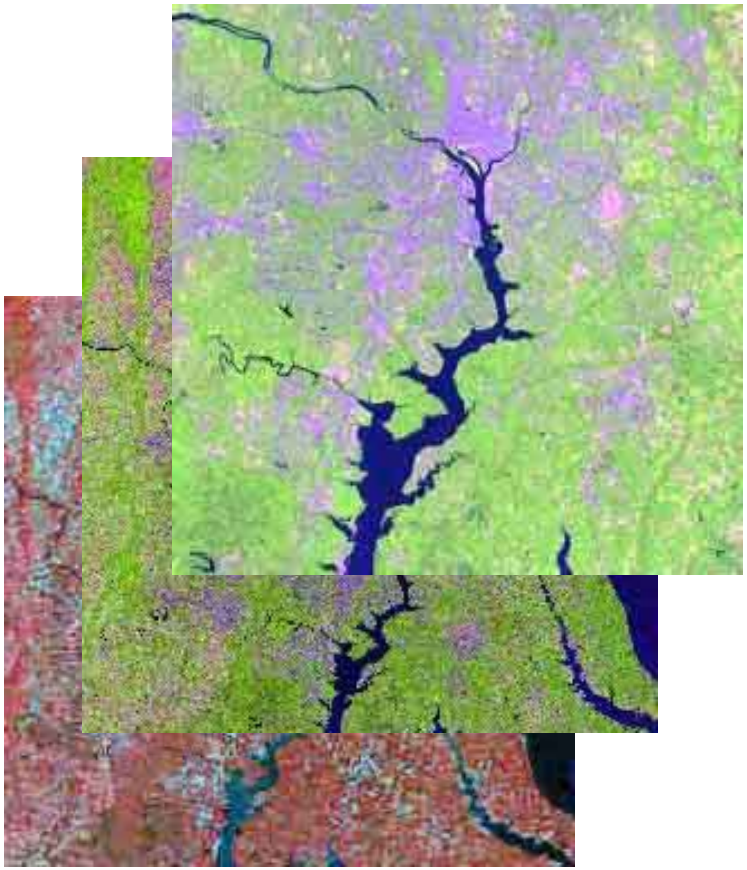
- 120 m resolution was felt to be sufficient to resolve most center-pivot irrigation fields in U.S. West - typically 400 to 800 m in diameter
- Landsat satellites provide 16 day repeat imaging -- sufficient for water consumption estimation
- Landsat 4 & 5 TM's provided 120 m thermal images for a single 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

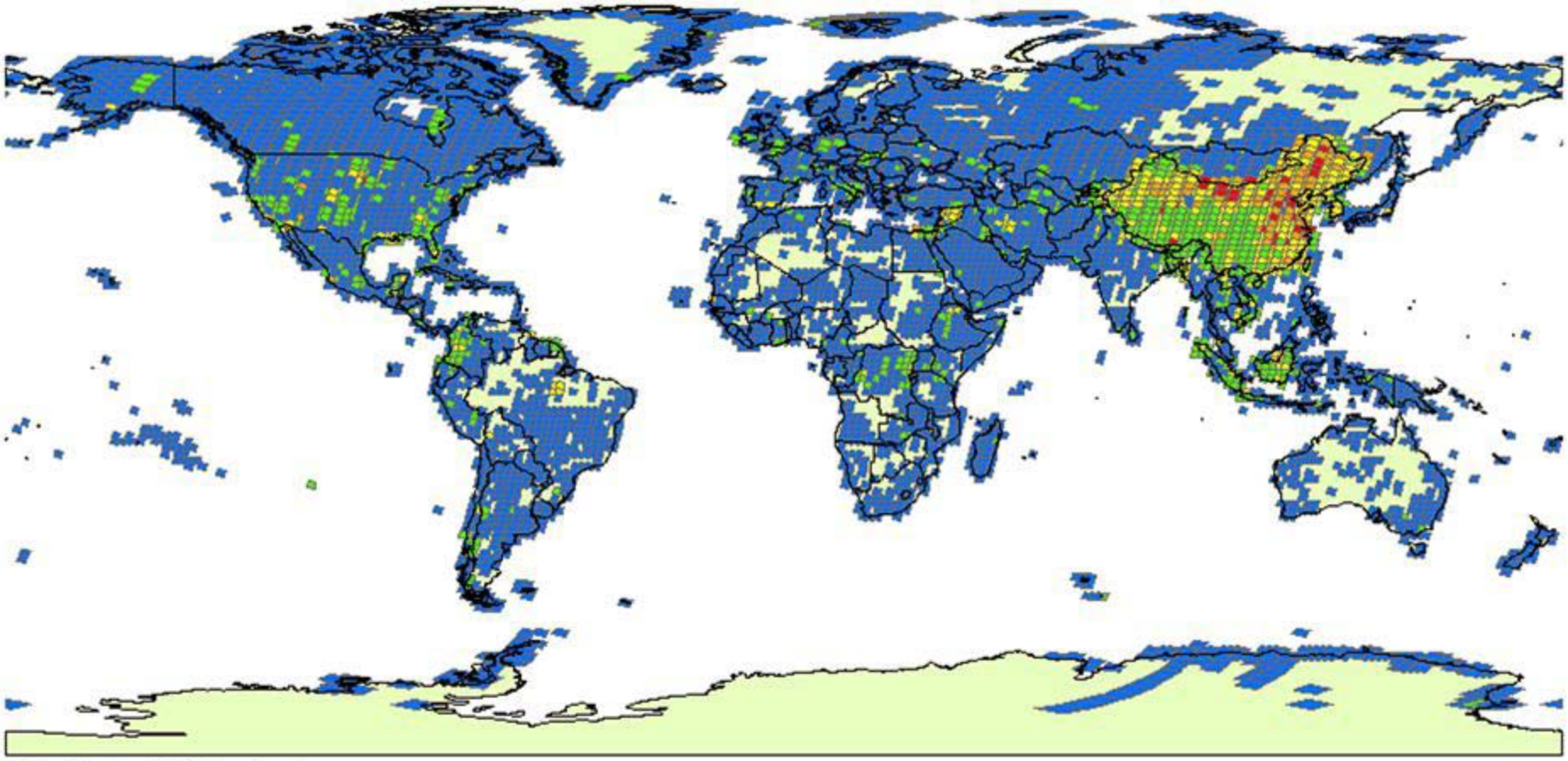
- Free and Open sharing of Data *(Landsat Archive, MODIS Products)*
- User Friendly Products *(GLS 2000-2010)*
- Near Real-Time Global Daily Active Fire Monitoring *(MODIS Rapid Response)*
- Web based Fire and Imagery Distribution Systems *(FIRMS Web GIS)*

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+)

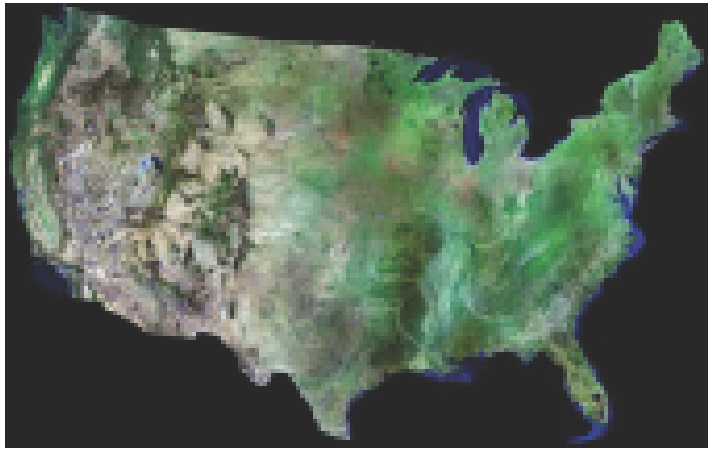


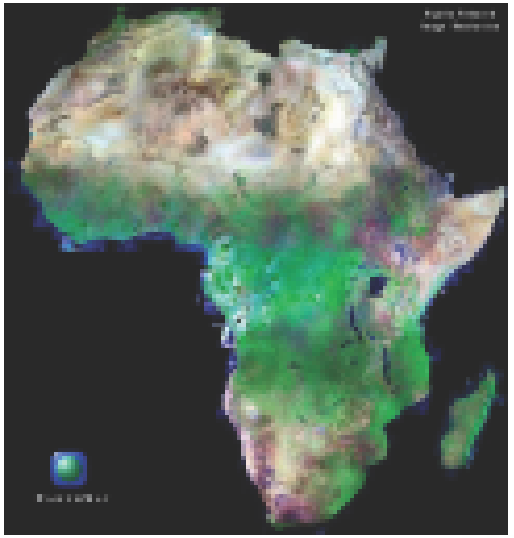
1 Million Scenes Downloaded – Aug 2009

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





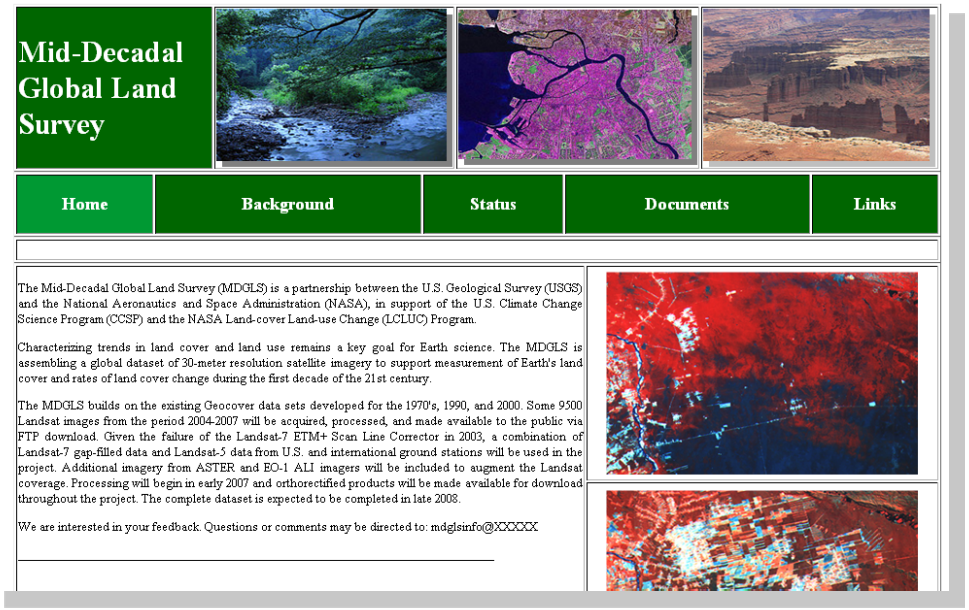
USGS

LANDSAT LDCM

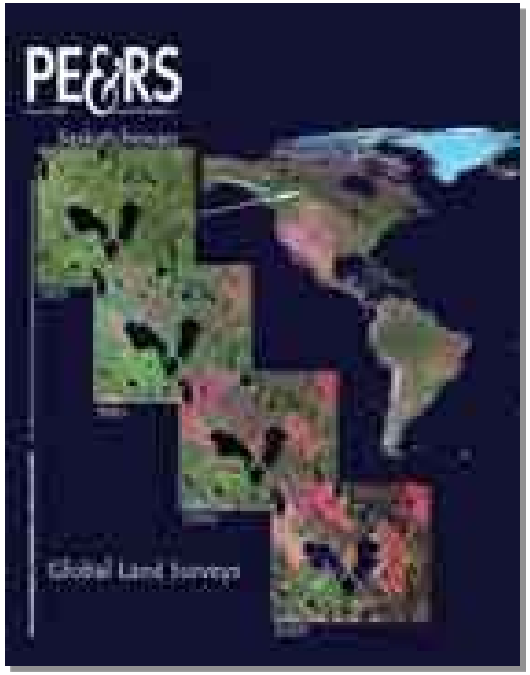
NASA

For More Information

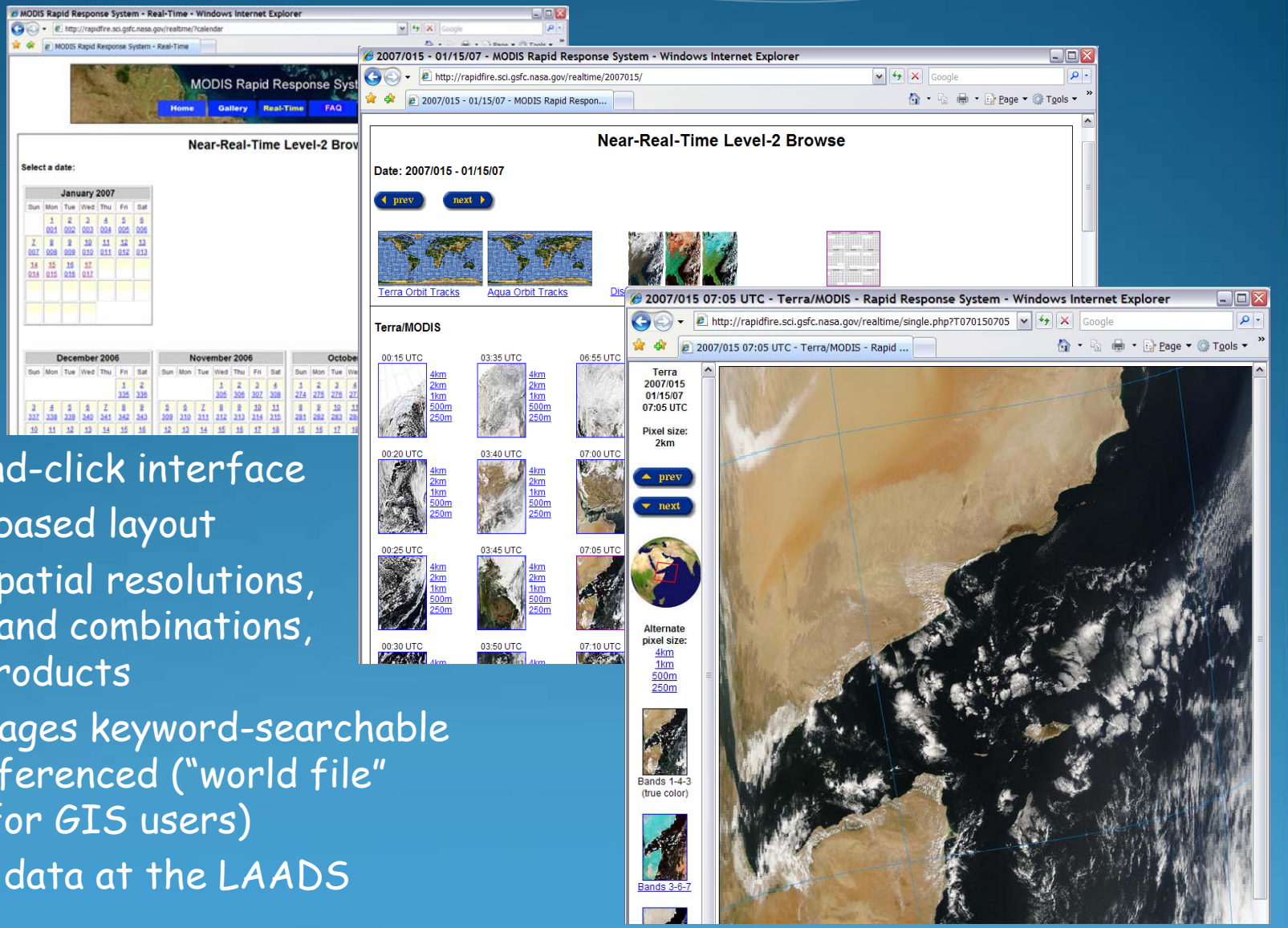
GLS2005 Web Site:
http://mdgls.umd.edu



January 2008
Photogrammetric Engineering & Remote Sensing



MODIS Land Rapid Response



- 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

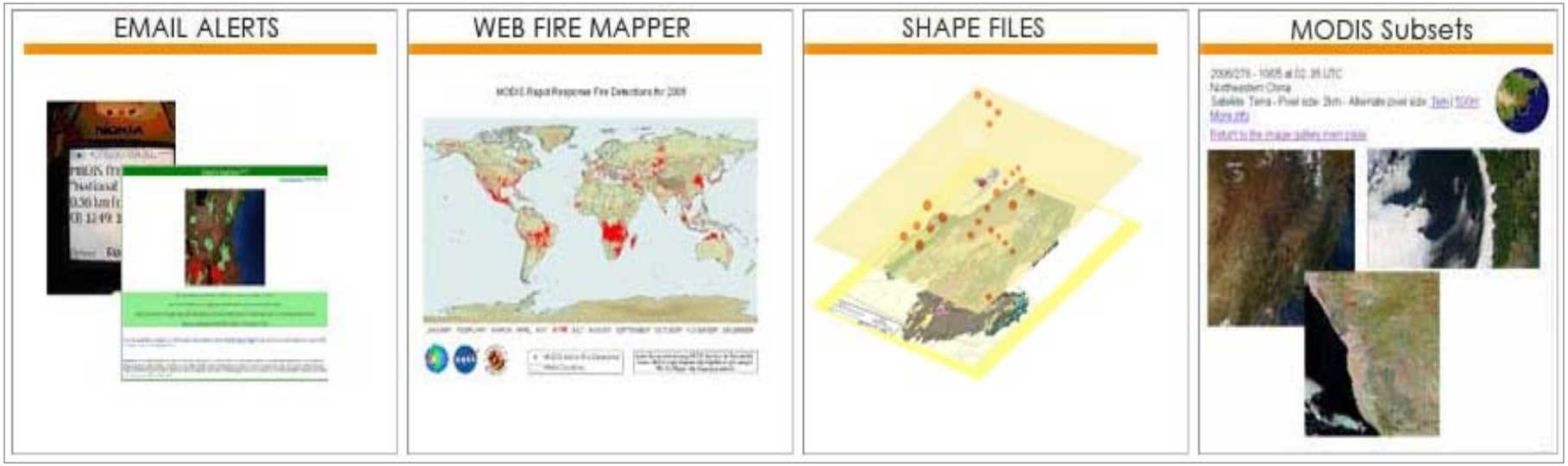
http://ladsweb.nascom.nasa.gov/

FIRMS

FIRE INFORMATION FOR RESOURCE MANAGEMENT SYSTEM

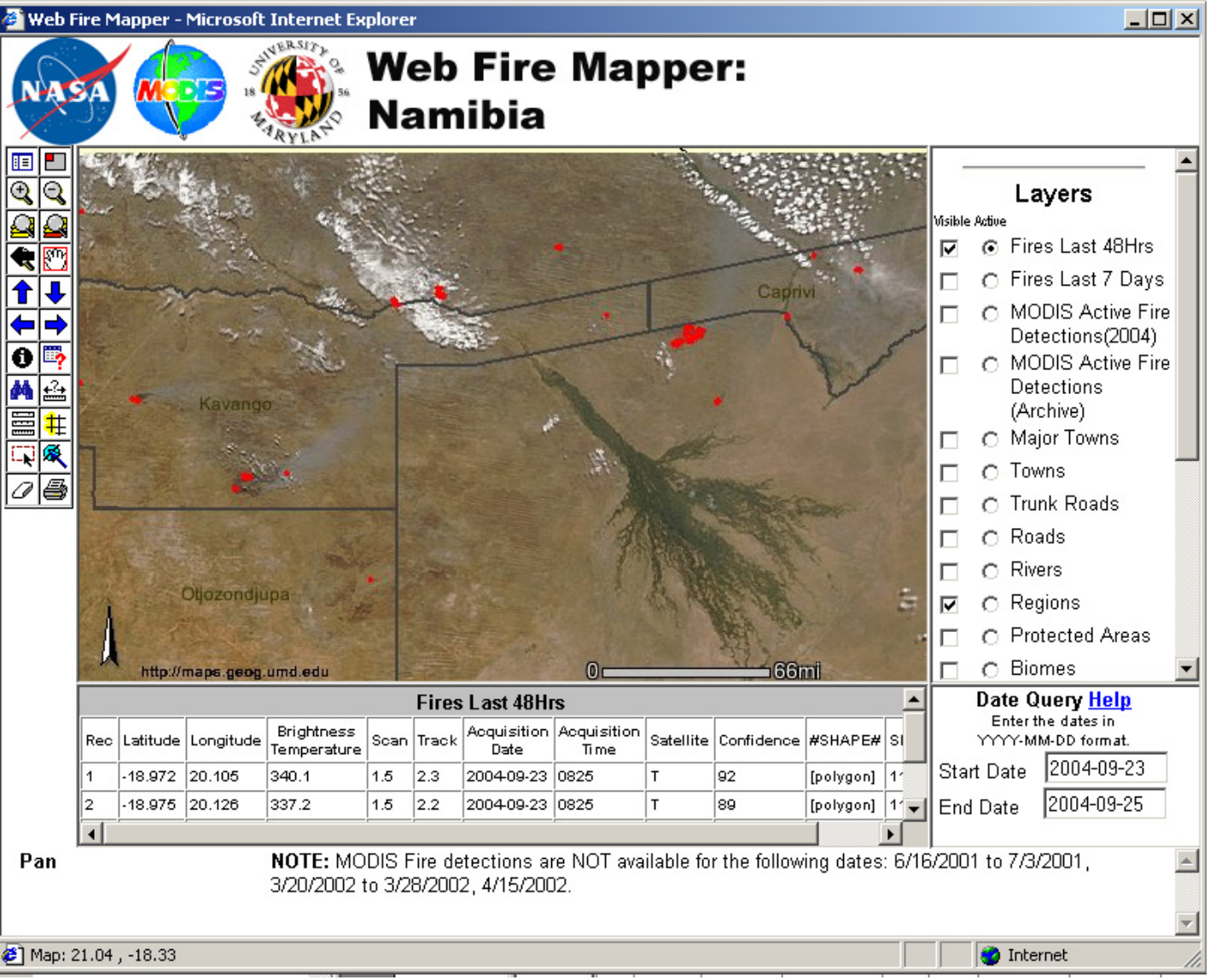
Overview of FIRMS Products

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



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

Diane Davies et al UMD



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

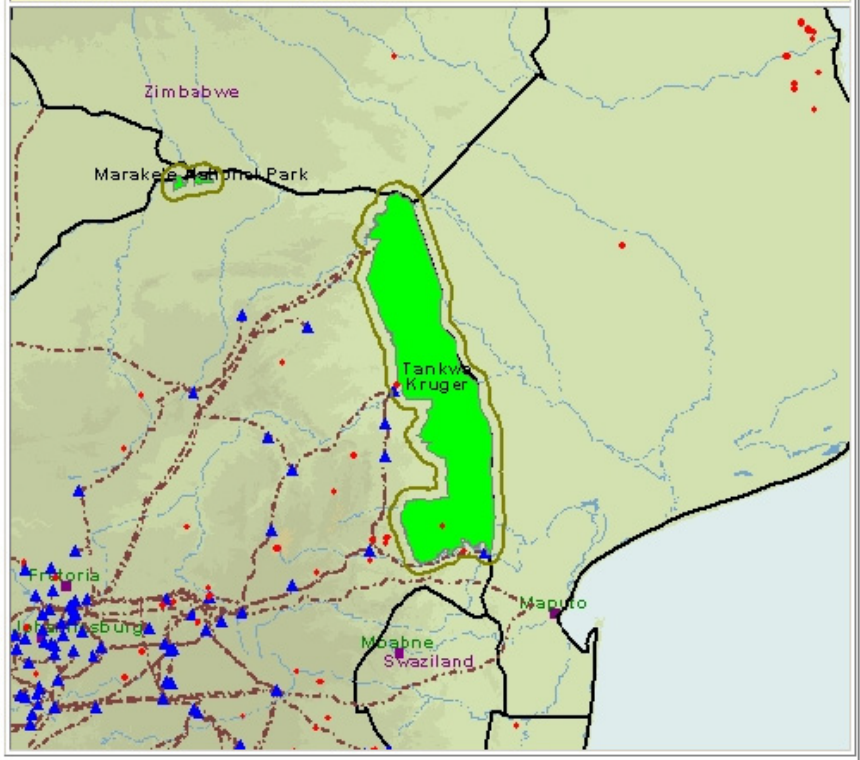
Web Fire Mapper - Namibia service

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

Email alerts with JPEG images

AFIS - WEB FIRE MAPPER

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

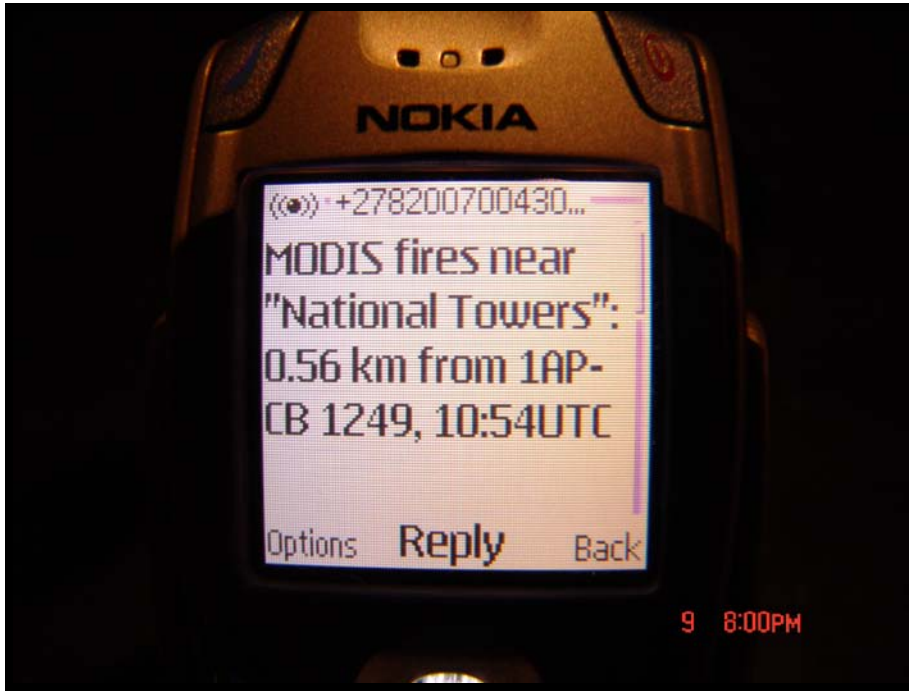


Latitude	Longitude	BT	Scan	Track	Date	Time	Sat	Conf
-25.203	31.564	317.8	1	1.1	2004-07-15	1143	A	76
-23.986	31.155	310.8	1	1	2004-07-16	0806	T	48
-25.412	31.76	312.8	1	1.1	2004-07-16	0806	T	62
-25.414	31.77	313.6	1	1.1	2004-07-16	0806	T	65

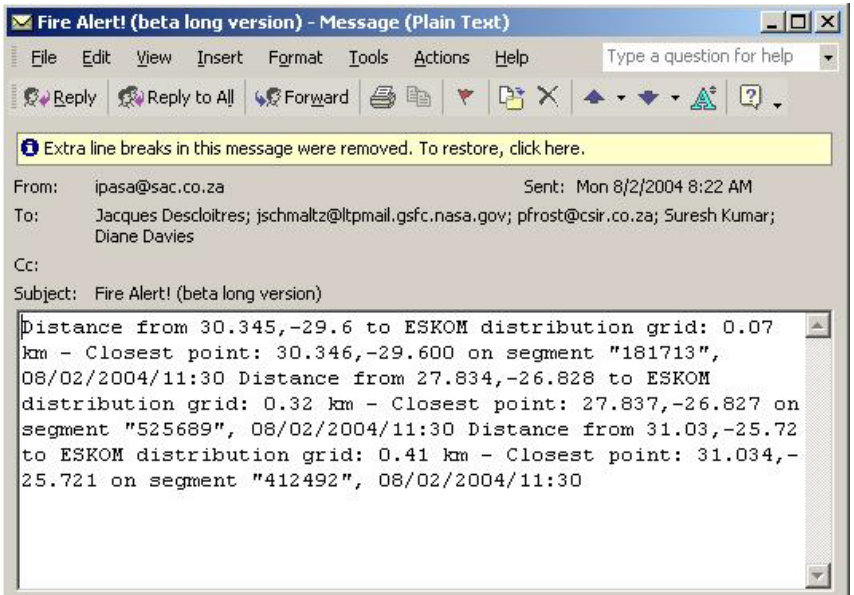
4 Active fire records detected/processed in your region of interest
Region of Interest:
Kruger

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

SMS text messages (cell phones)



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

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

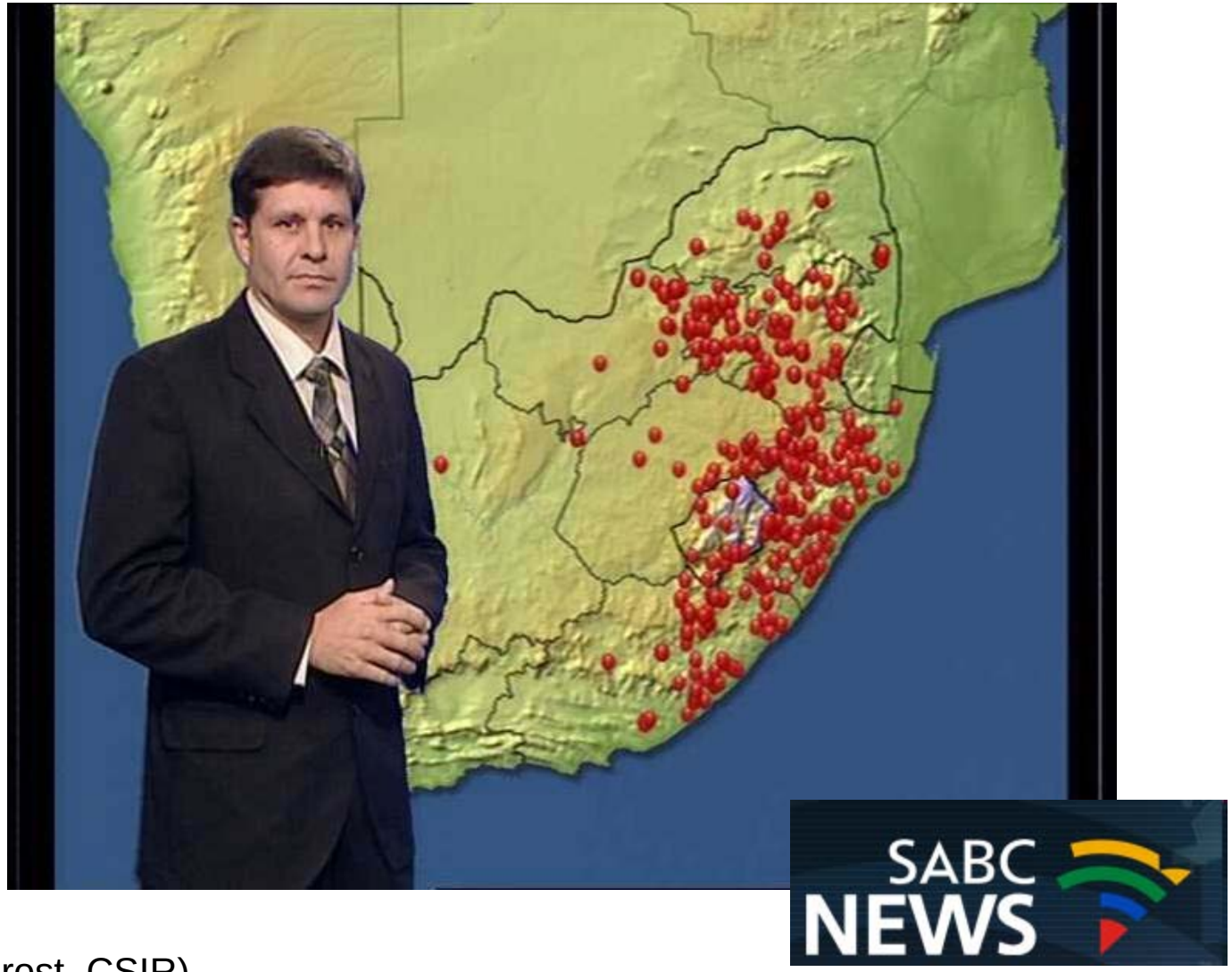
To: Jacques Descloitres; jschmaltz@ltpmail.gsfc.nasa.gov; pfrost@csir.co.za; Suresh Kumar; Diane Davies

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-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

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

*Page under construction

- En español
- По-русски

Acknowledgments

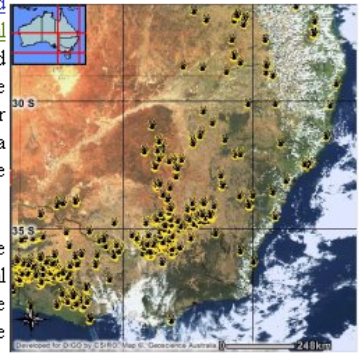
What is GOFC/GOLD-Fire?

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

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