Global Geostationary Network

Ivan Csiszar, Martin Wooster

Recommendations from 2nd workshop

- *Research and Product Development*
  - Continue data fusion efforts and characterization
  - Encourage products based on a multi-sensor approach
  - Evaluate the Dozier technique and comparison of FRP and Dozier products
- *Data Sharing*
  - Develop a coordinated depository to share data sets with each other and the general user community
  - Provide ancillary data sets for algorithm development (e.g. improved land/water data sets, known locations of false alarms, emissivity, etc.).
- *Validation and Calibration Activities*
  - Encourage joint validation efforts regarding global fire detection and characterization products within the geostationary network (GOES, Met-8/-9, MTSAT, FY-2C/2D, etc.)
  - Provide access to ground truth including location, size and temperature, and higher resolution imagery (Landsat, ASTER). Regional validation should also be encouraged
  - Utilize aircraft validation campaigns/experiments (e.g. NASA-Ames)
  - Encourage investigators working with similar instruments to intercompare products
  - Improve characterization of the 3.9 micron band on existing geostationary sensors

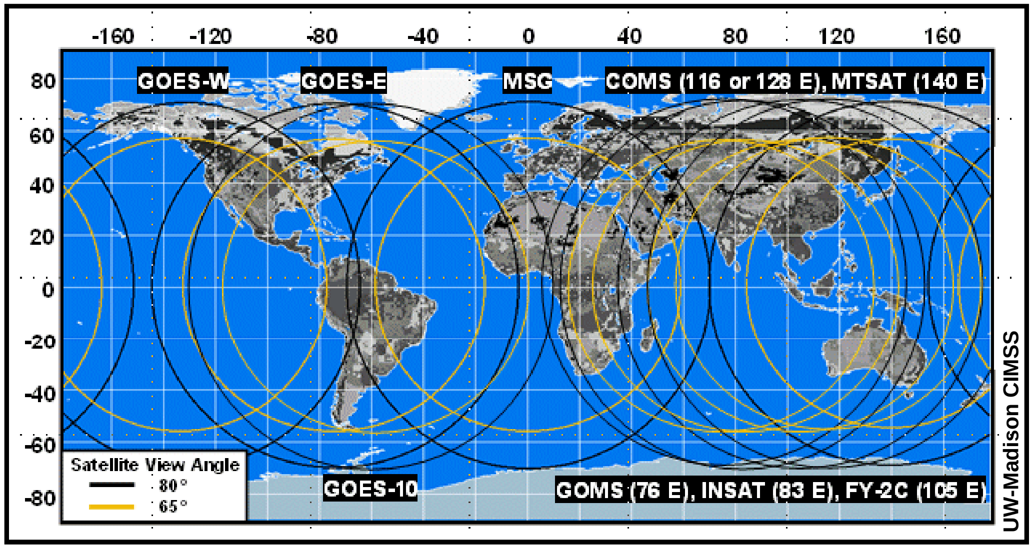
Recommendations from 2nd workshop

- *Future Sensors*
  - Encourage active involvement of the fire monitoring community in evaluating specifications for next generation operational geostationary satellites and provide feedback to operational agencies (e.g. calibration on hot end, pre-processing, flagging of saturated raw data, etc.).

- *International Coordination*
  - Increase involvement of climate community and gain a better understanding of their needs
  - Encourage greater involvement from agencies with new sensor capabilities in Asia. (Korea, Japan, India, Russia). Collaborate with surrounding countries and dialogue on user needs/requirements.
  - Continue active participation in GEOSS/GEO tasks and planning
  - Establish link with CGMS and operational agencies
  - Adapt elements of the CEOS constellation process and maintain a strong relationship with the CEOS WGCV LPV to ensure ongoing cal/val activities in the community
  - Convene follow-on meeting to address progress on global geostationary products, applications, and validation

Some major US activities

I Csiszar, C. Schmidt, W. Shroeder,
E. Prins, S. Kondragunta, X. Zhang



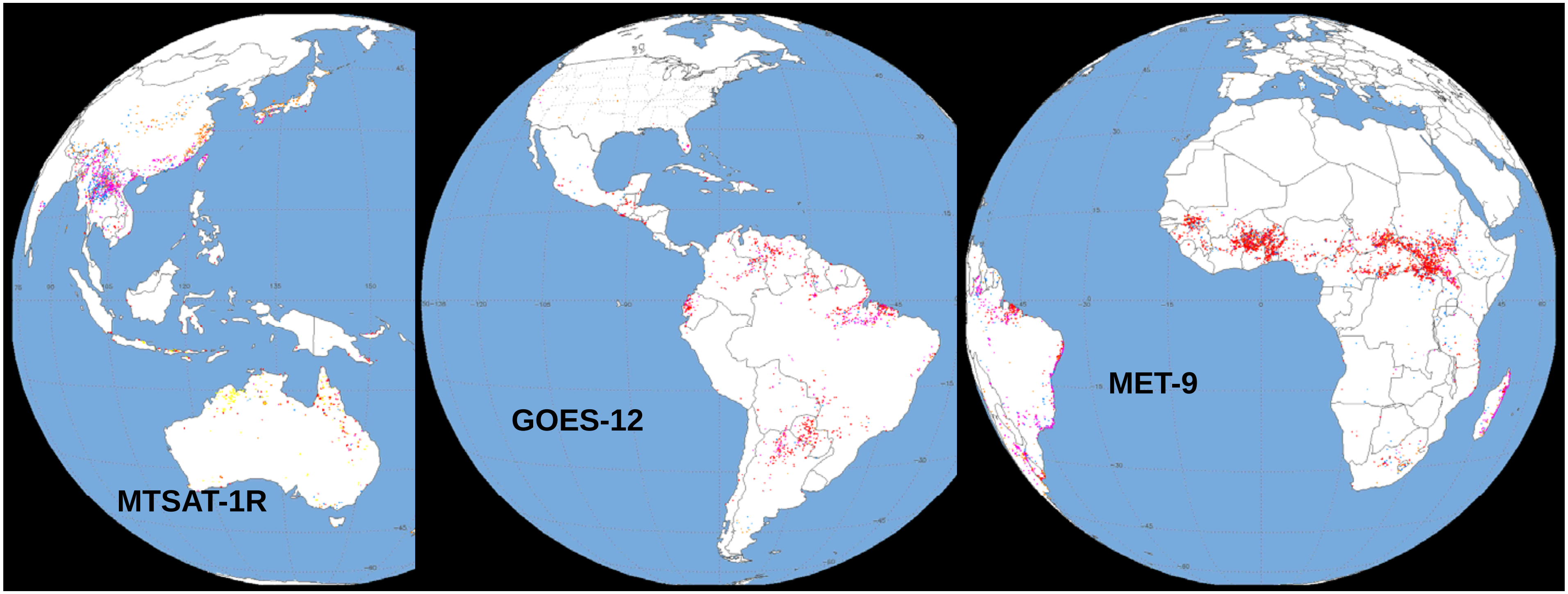
Global Geostationary Active Fire Monitoring Capabilities

Satellite View Angle
80°
65°

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-E/-W Imager (75°W / 135°W)	1 visible 3.9 and 10.7 µm	1.0 4.0	0.57 2.3	3 hours (30 min NHE and SHE)	>335 K (G-11) >335 K (G-12)	0.15
GOES-10 Imager (60°W) (Ceased operation December 2009, replaced with GOES-12 in May 2010)	1 visible 3.9 and 10.7 µm	1.0 4.0	0.57 2.3	3 hours (Full Disk) 15 min (SA)	~322 K (G-10) >335 K (G-12)	0.15
Met-8/-9 SEVIRI (9.5 °E, 0°)	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/2D SVISSR (105 °E / 86.5°E)	1 visible, 3.75 and 10.8 µm	1.25 5.0		30 minutes	~330 K	
MTSAT-1R JAMI (140°E) MTSAT-2 (HRIT) (145°E) Operational 2010	1 visible 3.7 and 10.8 µm	1.0 4.0		1 hour	~320 K (MTSAT-1R) 330 K (MTSAT-2)	0.15
INSAT-3D (83 °E ?, TBD) (Launch 2010)	1 vis, 1.6 µm 3.9 and 10.7 µm	1.0 4.0	0.57 2.3	30 minutes	?	
GOMS Elektro-L N1 (76 °E) (2010) GOMS Elektro-L N2 (14.5 °E) (2011?)	3 visible 1.6, 3.75 and 10.7 µm	1.0 km 4.0 km		30 minutes	?	
COMS (128 °E) (Launch 2010)	1 visible 3.9 and 10.7 µm	1.0 km 4.0 km		30 minutes	~350 K	

NOAA/NESDIS Operational Product

WF_ABBA v65 Fires: 2009336



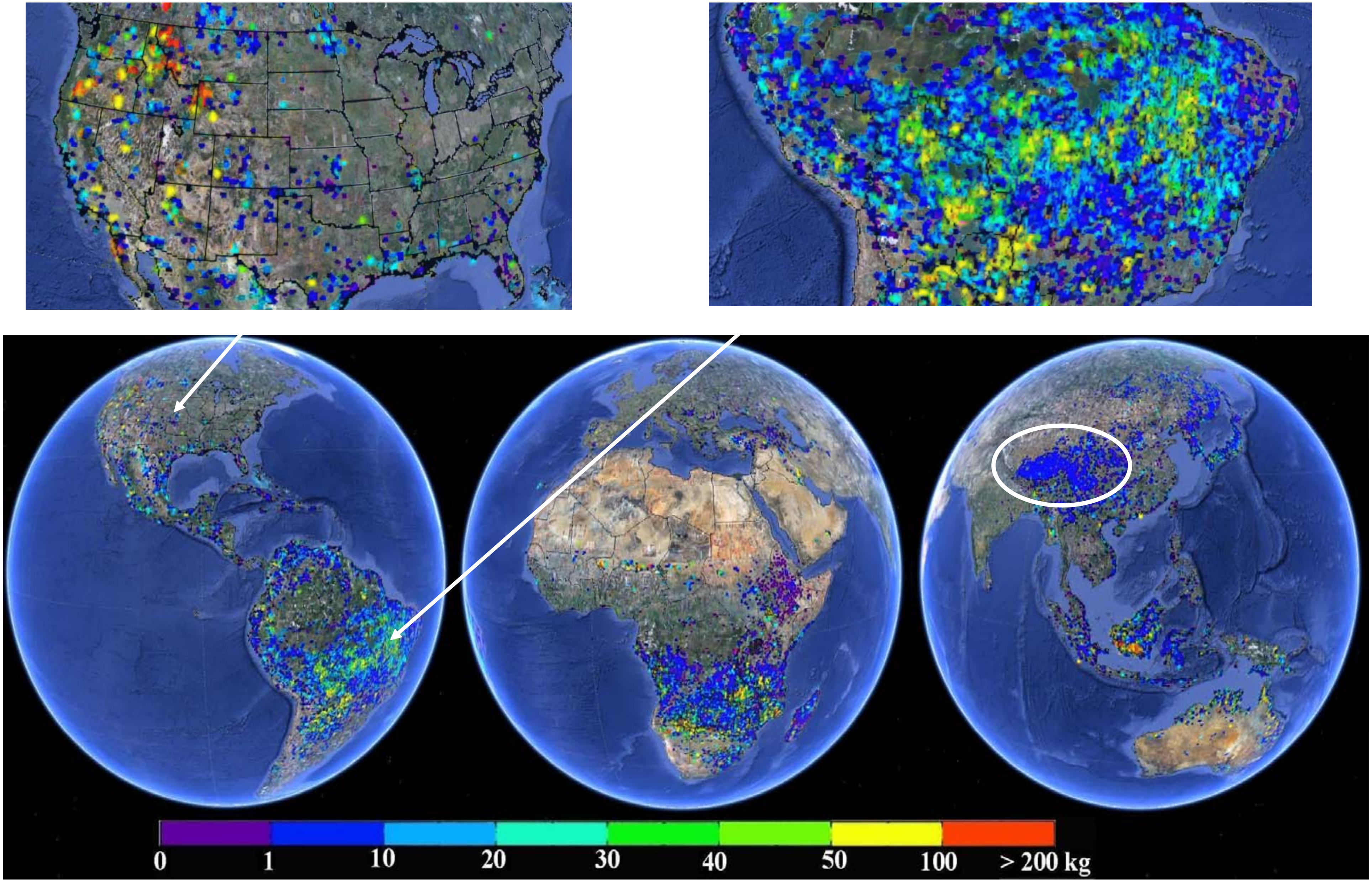
Red represents characterized fires and blue is low possibility fires.

Schmidt et al.

NOAA/NESDIS operational Product

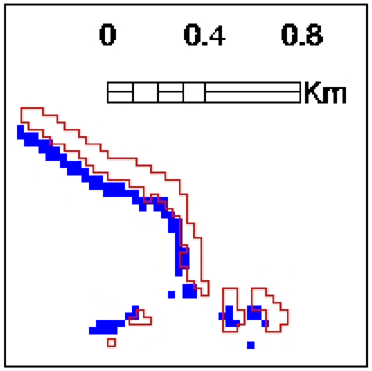
- Fire detections available in text file format at
  - ftp://140.90.213.161/FIRE/ABBA/
    - GOES 11 and 12
  - ftp://140.90.213.161/FIRE/forPo/
    - METEOSAT-9 and MTSAT-1
- Satellites to be included in the near future
  - MTSAT-2
  - COMS
  - INSAT-3D

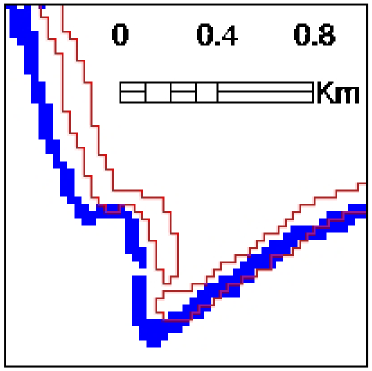
Biomass Burning Emissions of Aerosols Sept. 15-30, 2009

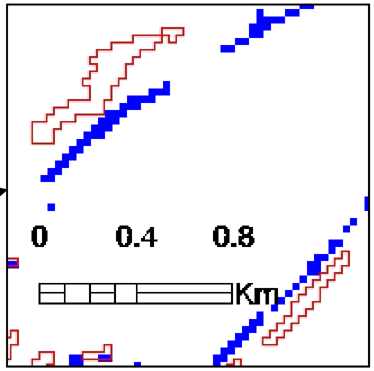


Same-day ETM+ and ASTER

Location on map	Date	WRS-2 path/row	ASTER time (UTC)	Vegetation type
1	8/13/2001	229/067	14:27:35	forest interface
			14:27:43	forest interface
			14:27:52	forest interface
2	8/29/2002	224/064	13:49:16	forest interface
			13:49:25	forest interface
			13:49:34	forest interface
3	8/29/2002	224/067	13:50:27	forest interface
			13:50:36	forest interface
			13:50:45	forest interface
4	8/29/2002	224/071	13:51:55	cerrado
			13:52:04	cerrado
			13:52:13	cerrado
5	8/31/2002	222/066	13:37:36	cerrado
			13:37:45	cerrado
			13:37:54	cerrado
6	10/5/2002	227/068	14:08:52	forest interface
			14:09:01	forest interface
			14:09:10	forest interface
			14:09:19	forest interface
7	10/17/2002	231/067	14:33:18	forest interface
			14:33:27	forest interface
			14:33:36	forest interface
8	1/28/2003	232/058	14:35:59	grassland
			14:36:08	grassland



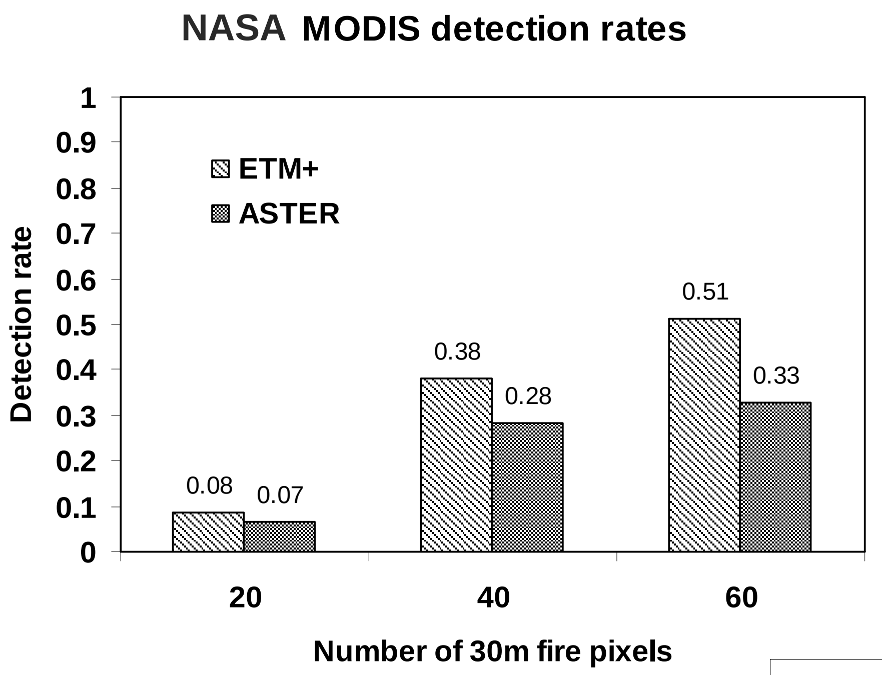




Red: ASTER

Blue: TM+

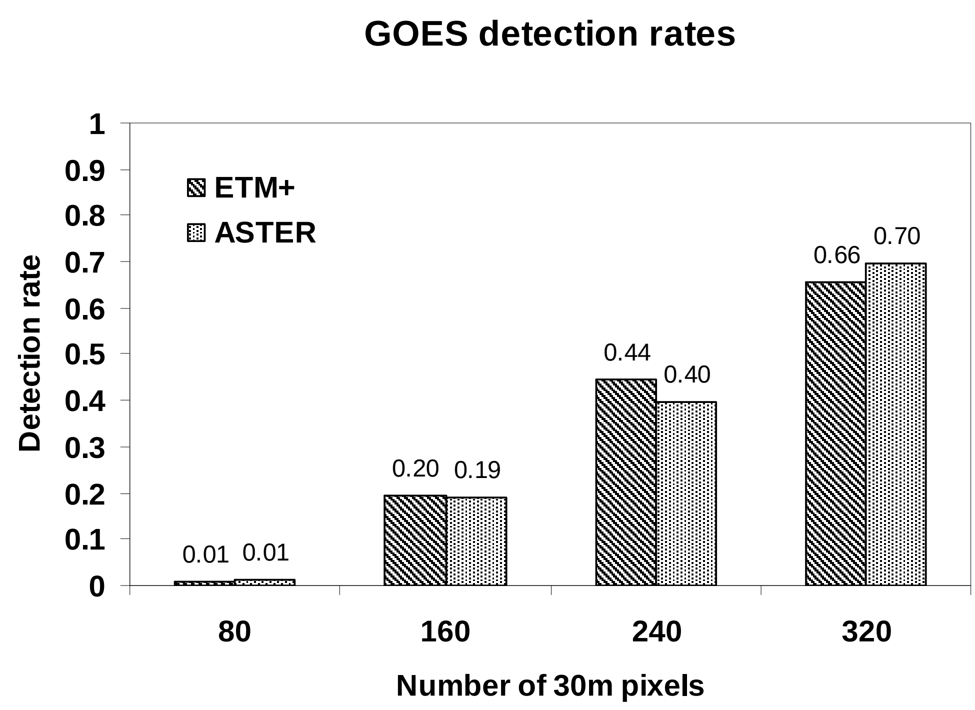
Validation: impact of non-simultaneous reference data

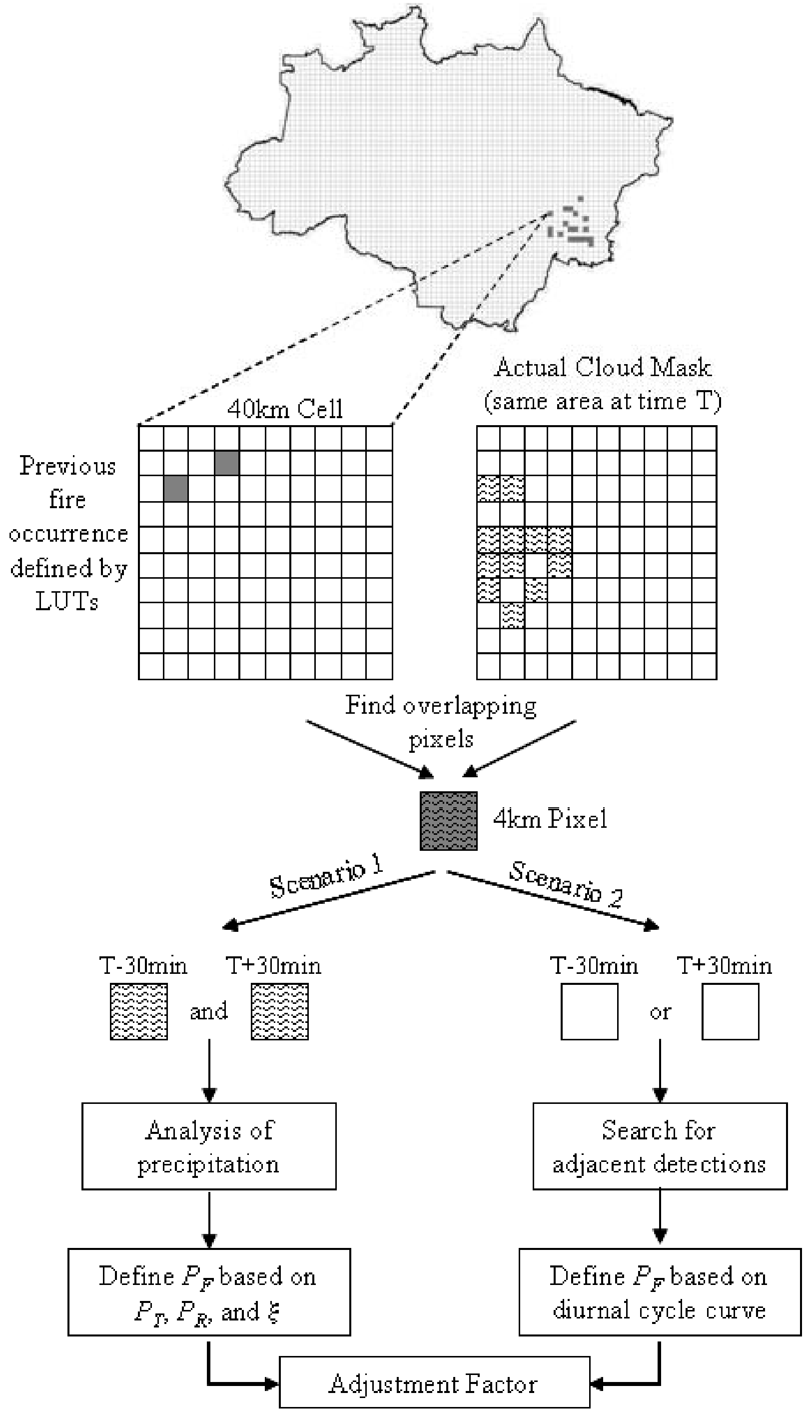


ETM+: temporally biased
ASTER: simultaneous

Detection rates as a function of the number of 30m pixels within the pixel footprint

Temporally unbiased





Correction for Omission Errors from Cloud Obscuration

- **Simple approach:**

probability of fire under cloud cover

=

probability of fire over cloud-free areas

- Correction based on cloud fraction

↓

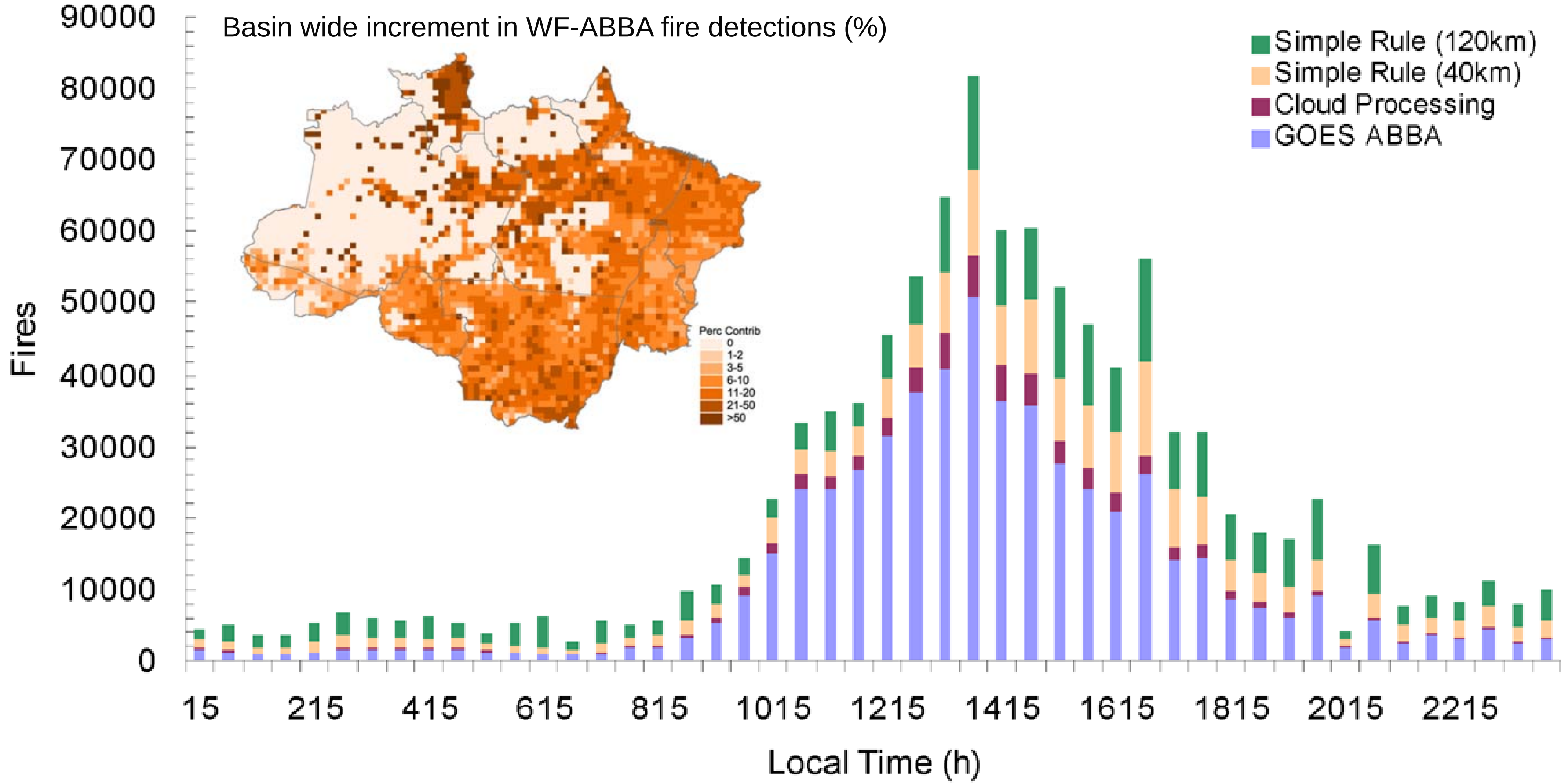
- **Probabilistic estimation:**
  - Fire climatology
  - Precipitation
  - Diurnal fire cycle

Correction for Omission Errors from Cloud Obscuration

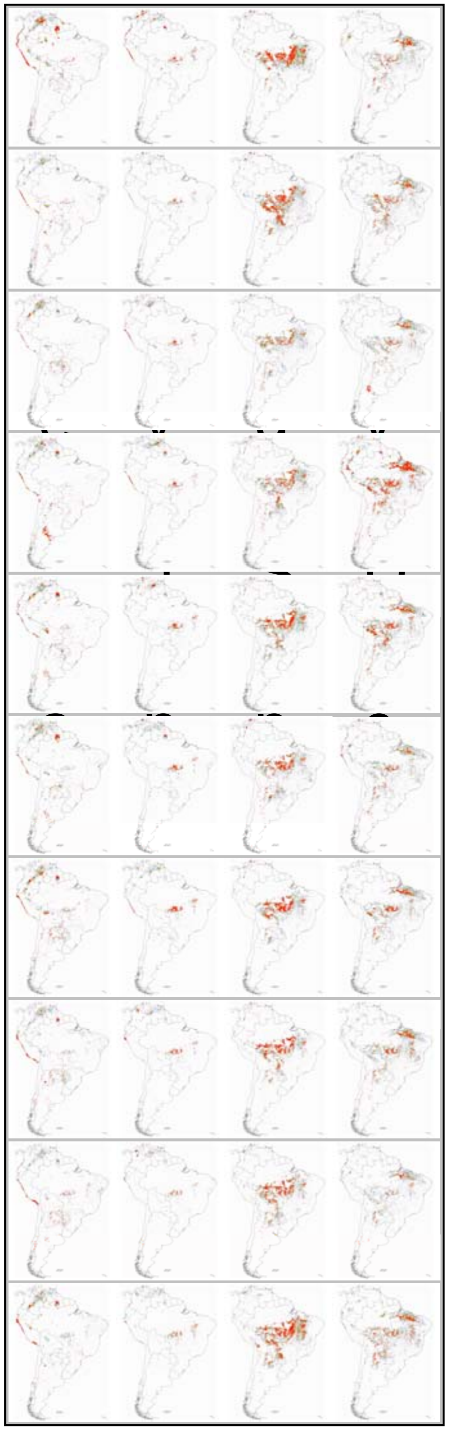
Results for WF-ABBA 2005

-Cloud processing analysis 11% increment

- Simple rule approach: 33% / 40% increments for 40 /120km sampling areas

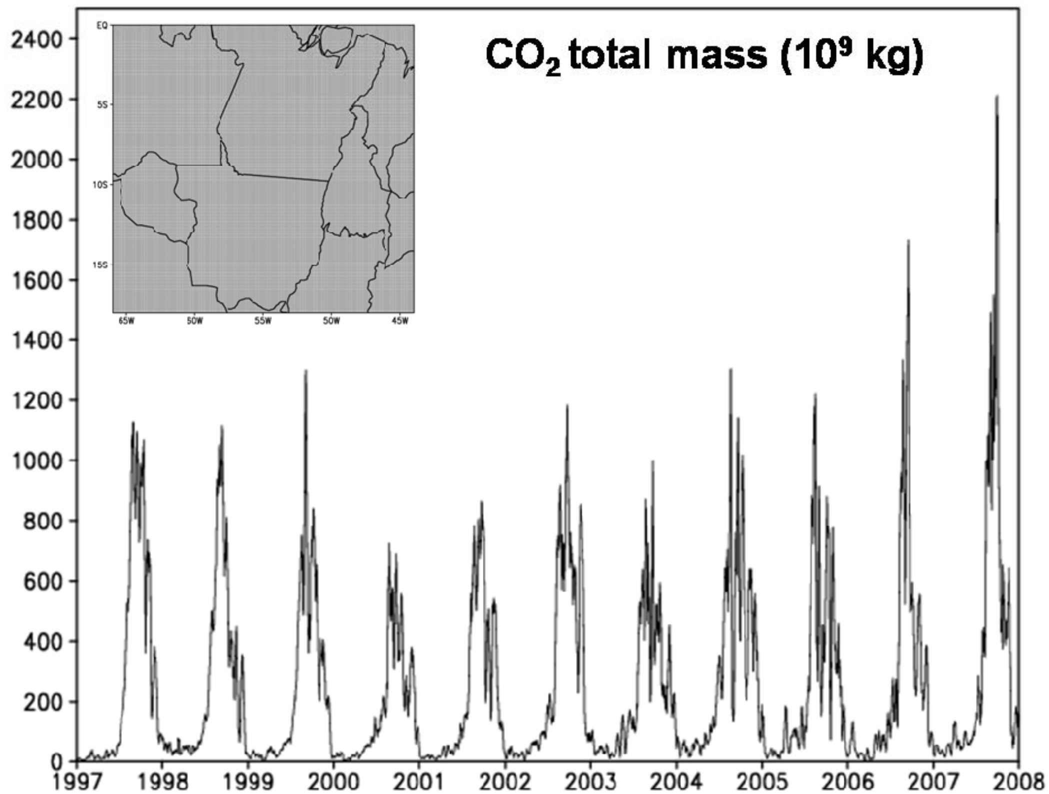


(Schroeder et al., 2008)



Long-term processing

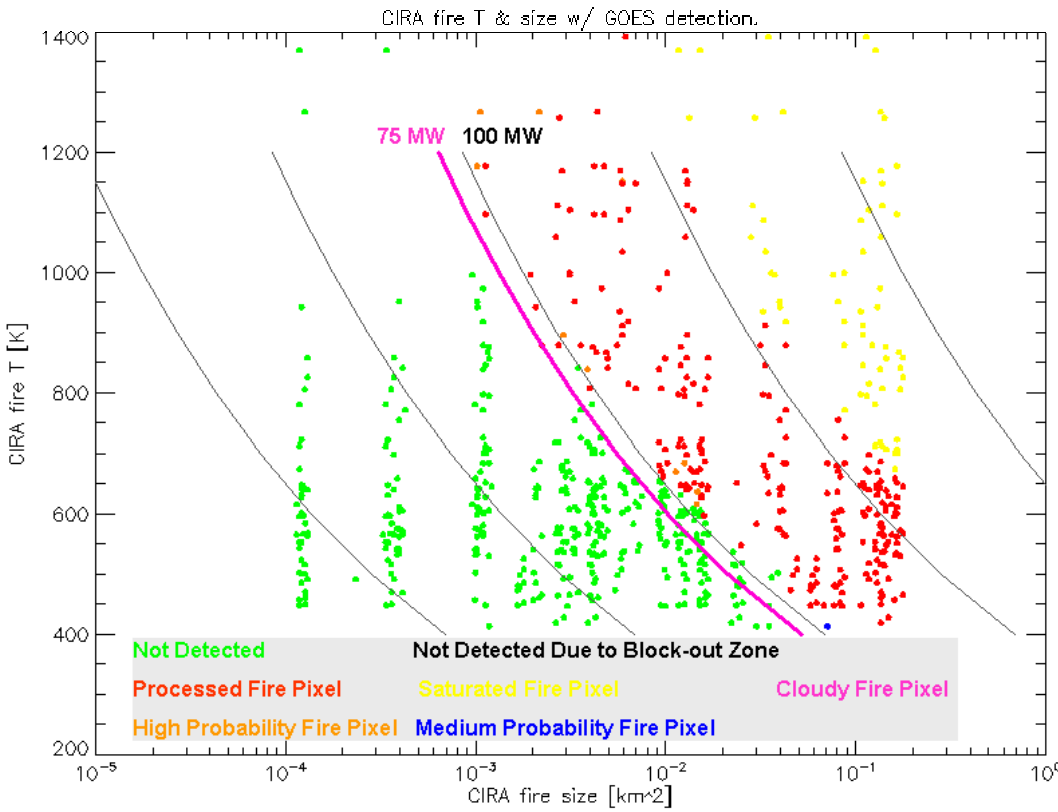
Analysis of Long-Term Fire Dynamics and Impacts on the Amazon Using Integrated Multi-Source Fire Observations: NASA LBA-ECO Phase III LC-35 (I. Csiszar, C. Schmidt, W. Schroeder, E. Prins, A. Setzer, K. Longo, S. Freitas)



CO_2 mass emission derived from GOES WF-ABBA v6.5 active fire data for 0-18ºS 44-66ºW.

GOES-R Advanced Baseline Imager

- Builds on heritage WF-ABBA algorithm for current GOES, Met-8/-9, and MTSAT-1R
- Uses simulated ABI data created from models by CIRA and MODIS data remapped to ABI from CIMSS as proxies
- Product includes detection and characterization
  - Instantaneous fire area and temperature
  - Fire Radiative Power
- Fire detection threshold roughly 75 MW in terms of Fire Radiative Power



National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

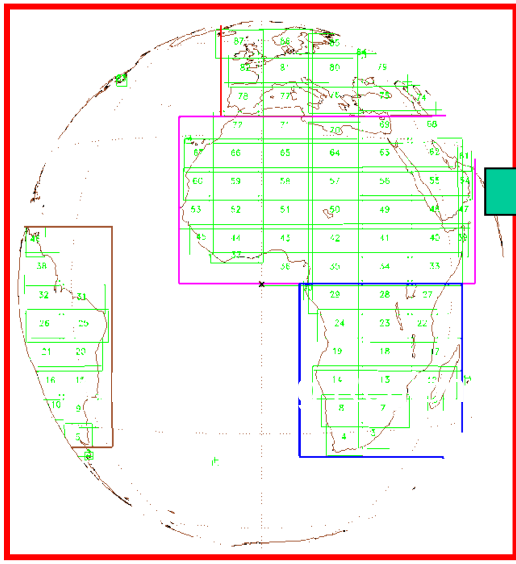
Environmental Monitoring & Modelling Research Group

"European & African Contributions Towards a Global Geostationary Network"

Presented by Martin Wooster,
Environmental Monitoring and Modelling Research Group
Dept of Geography, King's College London, Strand, London, WC2R 2LS

Contributions from W. Xu (KCL), G. Roberts (KCL), T. Smith (KCL),
J. Kaiser (ECMWF) and G. Van der Werf (VUA)

LSA SAF Operational Meteosat Active Fire Radiative Power Product



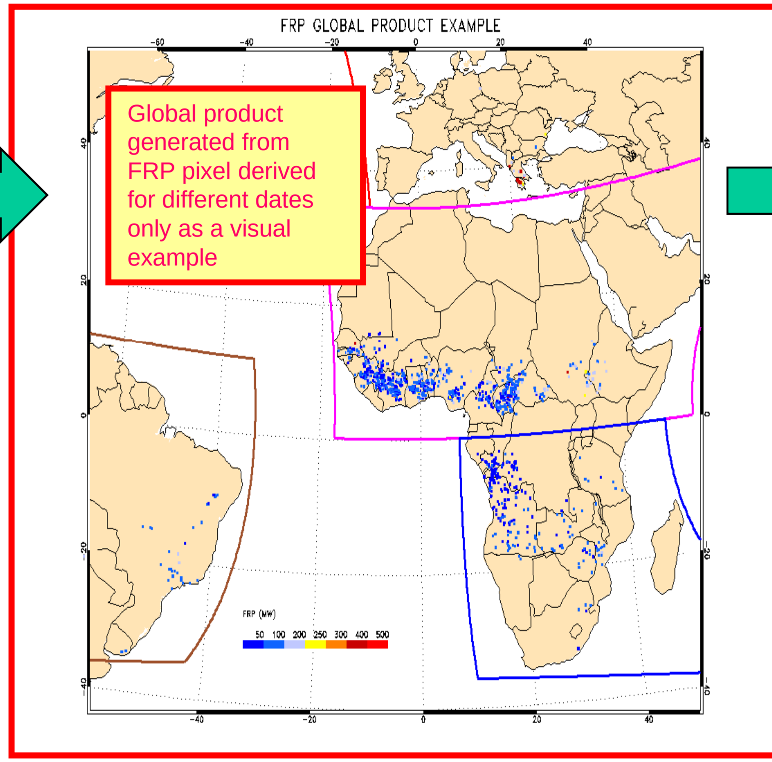
FRP Pixel product is generated for four Regions of SEVIRI disk

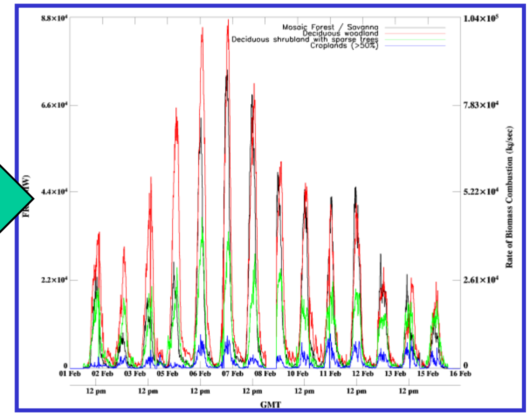
Euro (Europe)

NAfr (Northern Africa)

SAfr (Southern Africa)

SAme (Southern America)



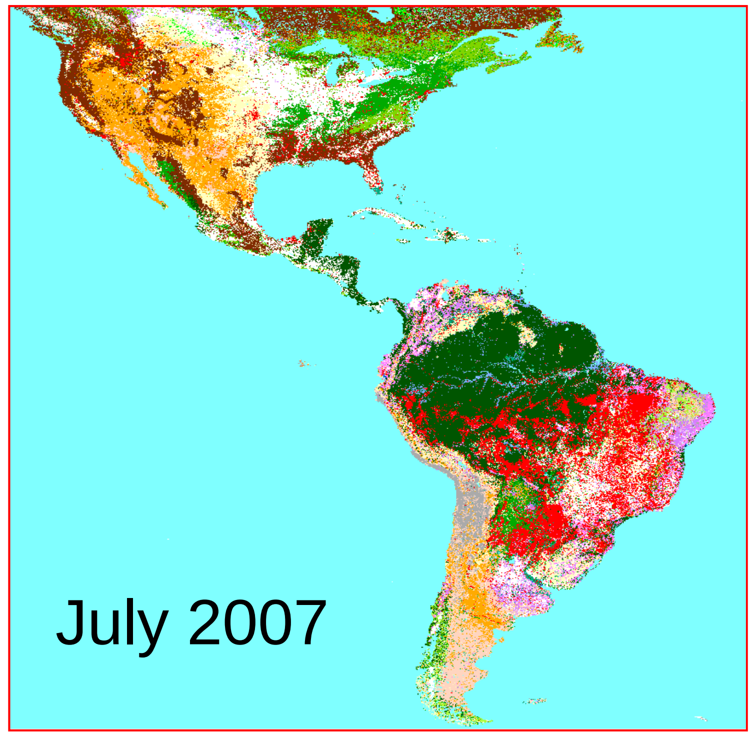


Available via FTP/EUMETCast

http://landsaf.meteo.pt/

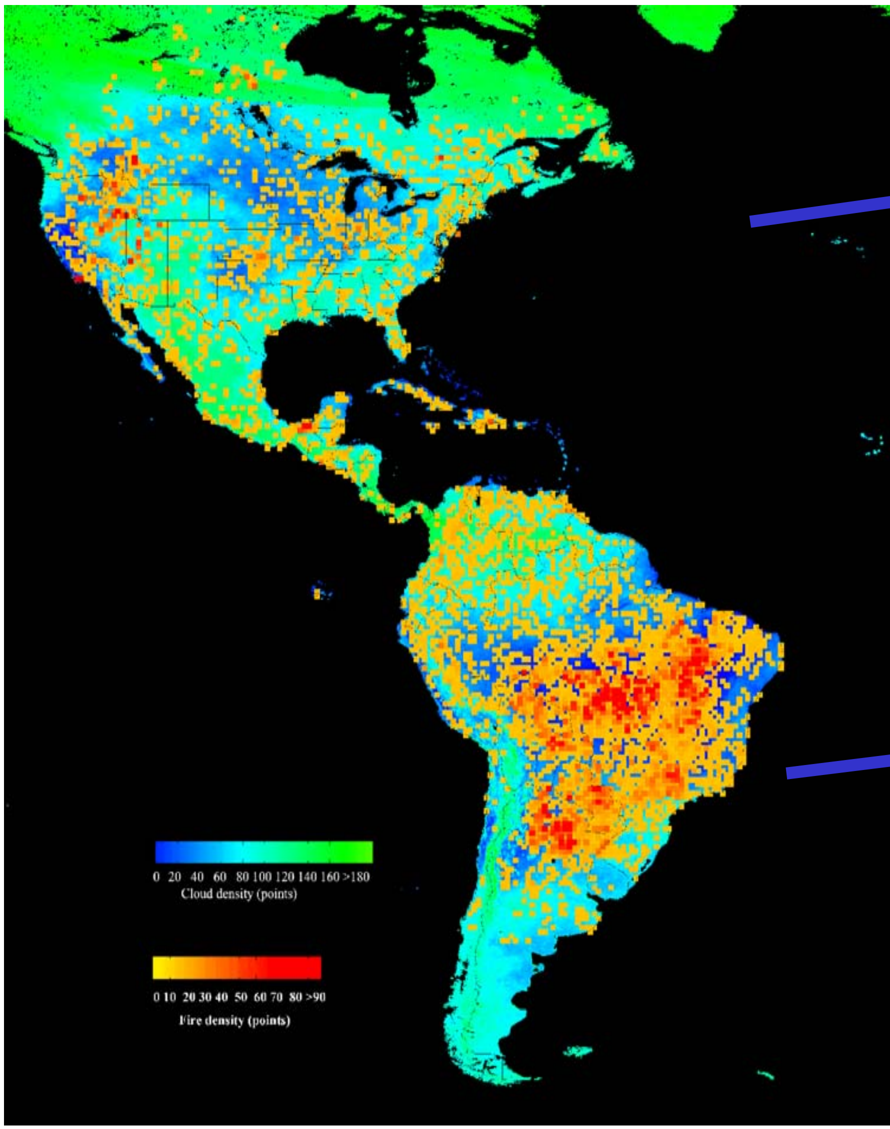
- FRP_Pixel Product (native spatial/temporal resolution) – available within 30 mins
- Gridded product - inc. adjustments for “small fires” and “clouds” also available.

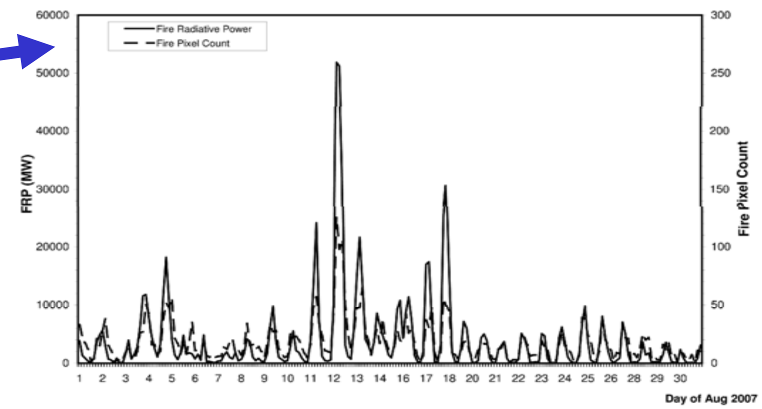
Prototyped: GOES Active Fire/FRP

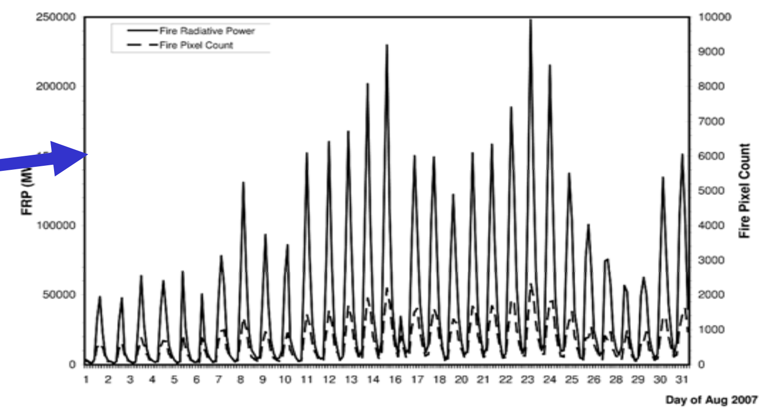


GOES-detected fires (red)
Superimposed on GLC2000

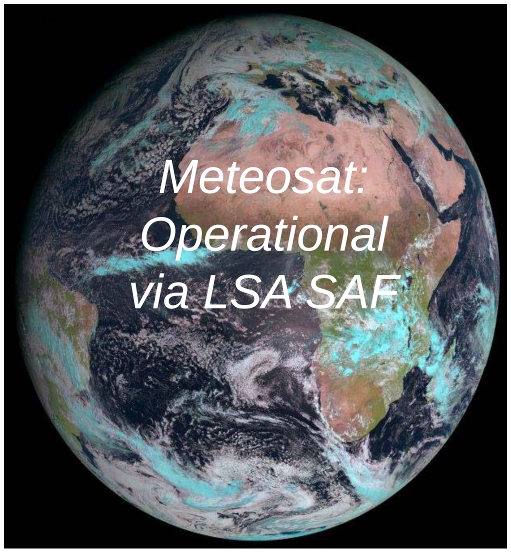
GOES: Fire Diurnal Cycle in Americas







Expected Global Geostationary System



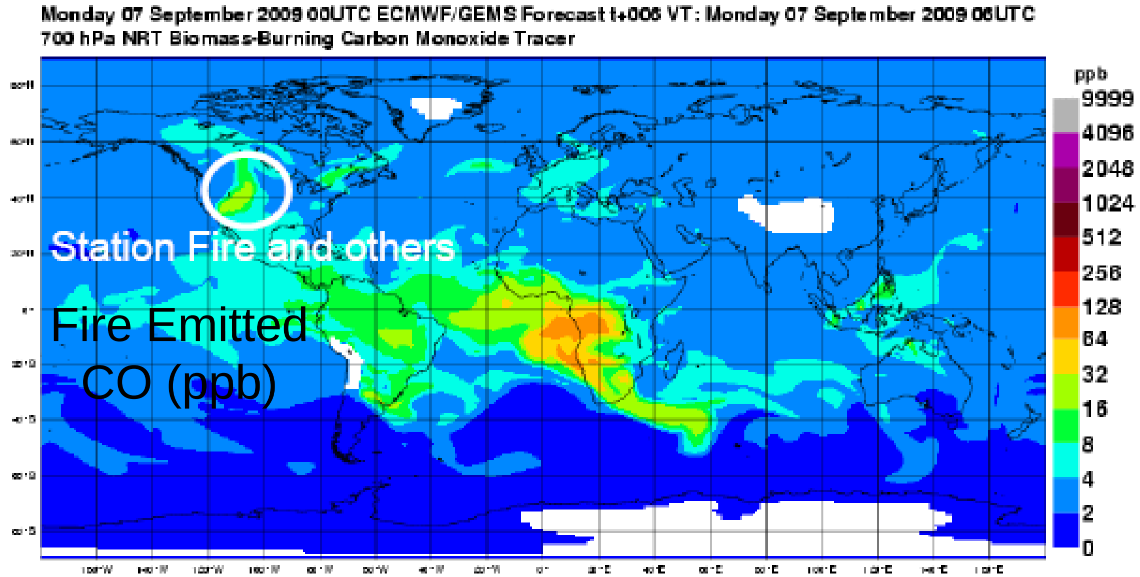
Non-Optimum 3.9 µm channel data quality

Non-Optimum 3.9 µm channel dynamic range

+ Future Meteosat Third Generation (2015+) will have improved temporal resolution, 2 km spatial resolution (SSP) and extended dynamic range 3.9 µm band.

GMES MACC D-FIRE System

- ✓ FRP-based
- ✓ real time, 6 hrs lag
- ✓ global
- × 125 km spatial res.
- × 1 day temporal res.
- × cloud cover affecte
  - → needs assimilation
    - ✓ measure of observation density
    - ✓ FRP=0 observations included



www.gmes-atmosphere.eu/fire

- merged by
  - averaging FRP density [W m^{-2}] in each grid cell
  - weighting according to representativeness error (observed area)
  - correction for small fires below the SEVIRI detection threshold

Other Meteosat Active Fire Detection Algorithms & Systems

Algorithms

- Active Fire Monitoring (FIR) algorithm (EUMETSAT MPEF) - *operational* - available by FTP/Eumetcast (2007 – present)

- Fire Detection Algorithm (FiDAlgo) (Amraou et al., 2009, RSE)

- Active Fire Monitoring Algorithm (AFMA) (Hassini et al., 2009)

- MSG Data Manager fire detection algorithm (David Taylor) – commercial software available for use with EUMETCast

Related "Novel" Research

- Kalman Filter multi-temporal MSG fire detects (van den Bergh & Frost, 2005)

- Effect of SEVIRI PSF on fire detection/characterisation (Calle et al., 2009)

Systems using Active Fire Observations from European Sensors / Agencies

1) Advanced Fire Information System (AFIS) (http://afis.meraka.org.za/afis/)
An NRT operational fire alert and mapping system of fire activity in Africa
Uses : SEVIRI and MODIS active fire products

2) African Monitoring of the Environment for Sustainable Development (AMESD)
(http://www.amesd.org/index.php)
A continental wide, pan-African project to improve decision making-processes in environmental resource and risk management. Based on AFIS SEVIRI active fires.

3) Integrated System for Fire Risk Management (SIGRA)
(http://www.incendi.sardegna.it/)
NRT detection of wildfire in the Mediterranean area using Meteosat SEVIRI.

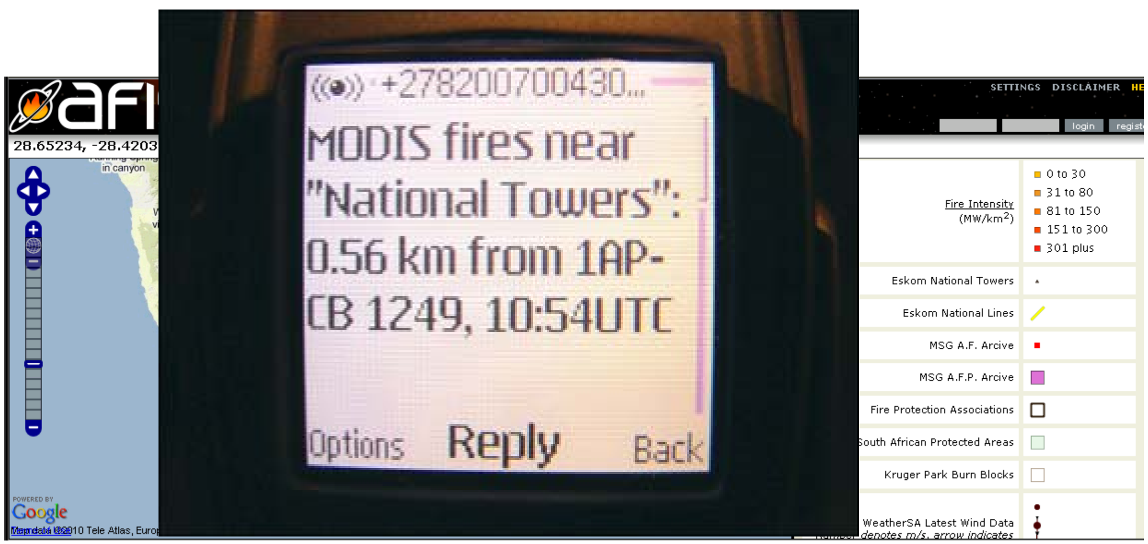
4) *European Forest Fire Information System (EFFIS)*
http://effis.jrc.ec.europa.eu/about/technical-background/active-fire-detection
Provides a synoptic view of fires in Europe on a daily basis (based on MODIS)

5) ***Multi source data integration for fire management*** (http://www.cse.sn/)
A prototype data assimilation system that uses a Kalman filter to integrate data from AATSR, MERIS and SEVIRI for fire detection and distribute the results to the user community (Diagne et al., 2010, IEEE GRSL)

Advanced Fire Information System

An NRT operational fire alert and mapping system of fire activity in Africa

Instruments : MSG SEVIRI and MODIS active fire products
Reference : Frost & Vosloo (2006)
Purpose: Reduction of fire flashovers on South African transmission lines
Method: AFIS scans a 2.5 km buffer along all transmission lines, identifying
fires within buffer zones every 15 minutes.
Provides: Email and text message system to provide rapid alert to fires.
By-products: Frequency and distribution of fires in areas of interest to researchers can be reported by an automated daily email.
Results: 60% detection of flashover fires using AFIS (compared with 44%
and 46% for just using MODIS or MSG, respectively)



Screen grab from AFIS website:
Web product provides fire location, intensity, location of electricity infrastructure and latest meteorological data.

(http://afis.meraka.org.za/afis/)

SIGRA

Satellite real-time monitoring of forest fires in Sardinia

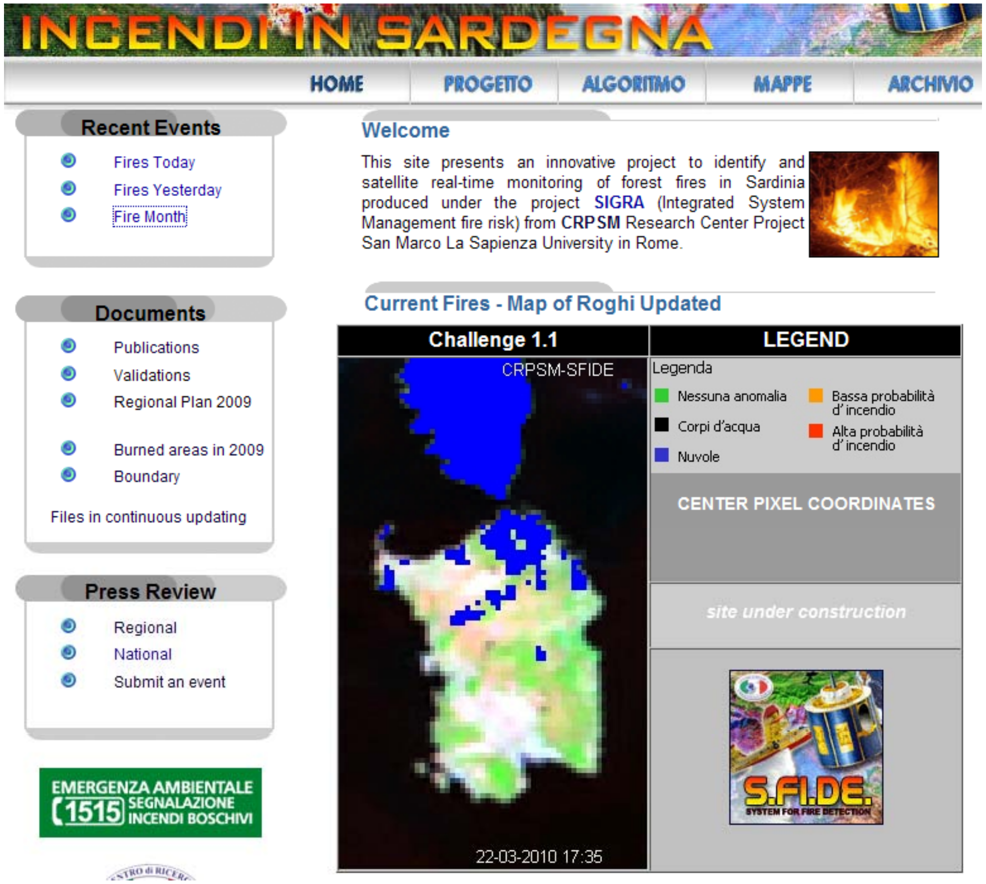
Instruments : MSG SEVIRI

Reference : _G. Laneve, et al., (2009) Estimation of burned biomass based on the quasi-continuous MSG/SEVIRI EO System, IGARSS 2009.

Purpose: Detection of fires in Sardina

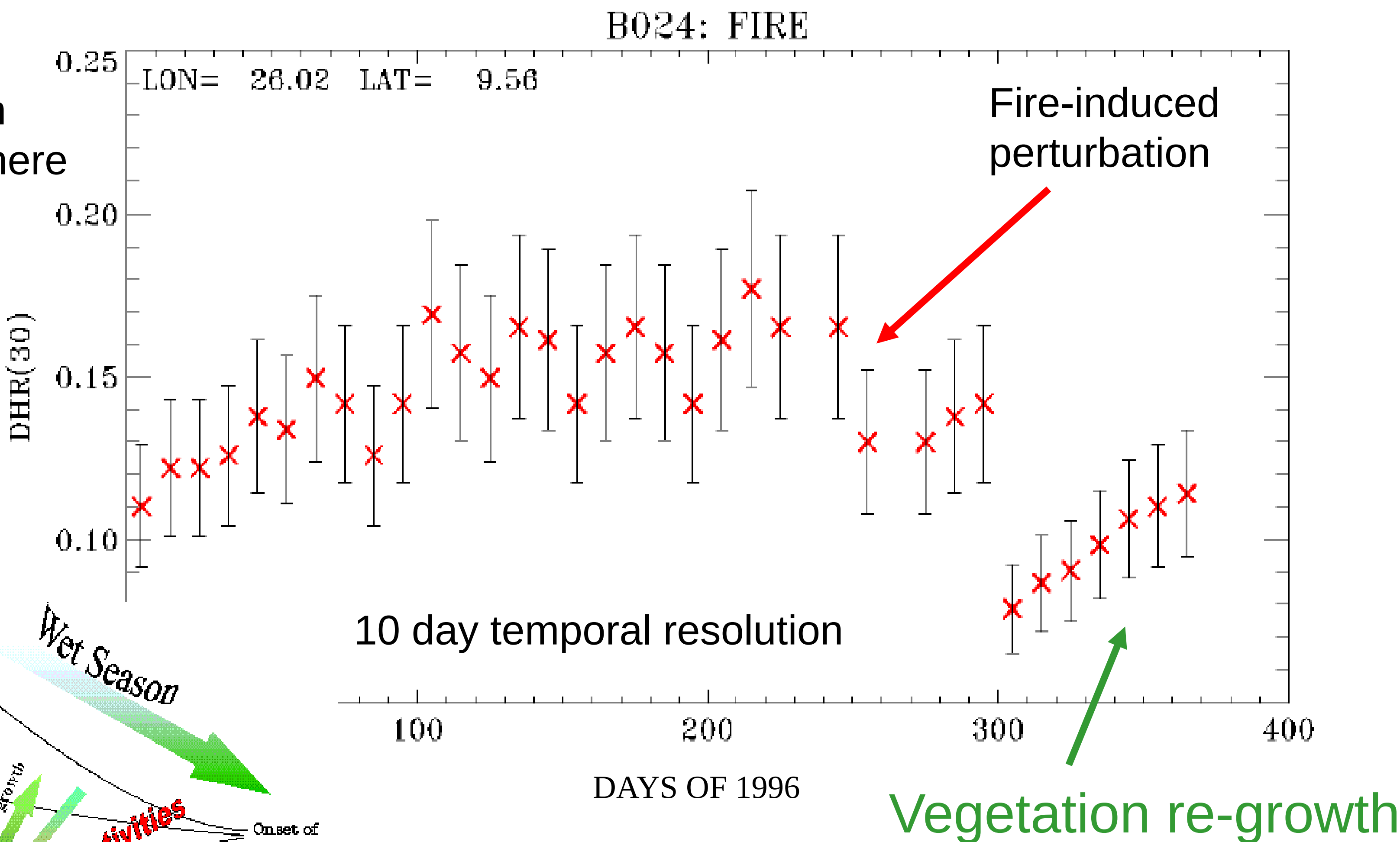
Method: Detection of thermal anomalies seen in MSG SEVIRI data.

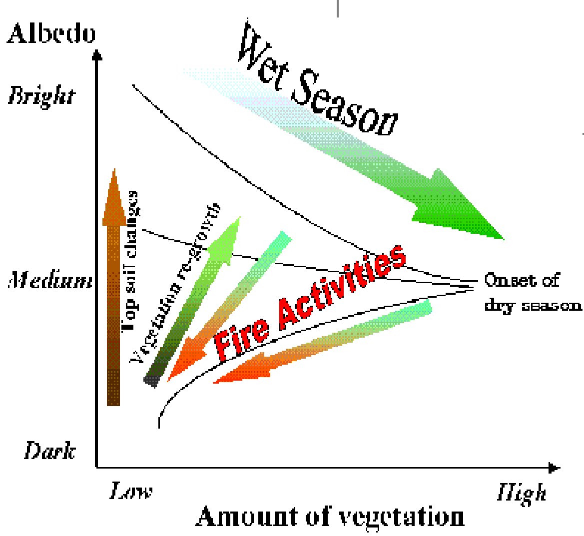
Provides: Online detected hotspots.



(http://www.incendi.sardegna.it/)

Meteosat Surface Albedo & Fire Effects





Pinty, B., Verstraete, M.M., Gobron, N., Govaerts, Y., and Roveda, F. (2000) Do Human-induced Fires Affect the Earth Surface reflectance at Continental Scales?, *EOS Transactions*,81, 381-389.

International coordination for geostationary fire network within CGMS

CGMS

CGMS-36, NOAA-WP-21
Prepared by E. Prins
Agenda Item: II/7
Discussed in WG II

CGMS requirements —(CGMS plenary)→ *agency response*

CHARACTERIZATION OF FUTURE CHANNELS AND SENSORS FOR FIRE MONITORING

In Response to Recommendation 35.14: Future satellite sensors are expected to be used for fire monitoring; relevant channels and sensors should be adequately characterised for this application. The matter should be part of the pertinent work under GSICS.

NOAA WP-21 reports that a geostationary fire monitoring network is technically feasible but must be supported by operational agencies to sustain the activity and produce standardized long-term data records and derived fire inventories of known accuracy. This requires commitment from operational agencies for ongoing support of global geostationary fire monitoring through appropriate sensor design and application and subsequent ongoing characterization.

In order to ensure that future geostationary sensors are capable of active fire detection and characterization, the fire monitoring community should be involved in evaluating specifications for next generaton operational geostationary satellites and provide feedback to operational agencies on issues relating to data access and pre-processing chains, pixel saturation in the middle and long-wave IR window bands, characterization of sensor behaviour at high temperatures, navigation, band-to-band co-registration, PSF implications, and cal/val.

CGMS

CGMS-37 EUM-WP-29
v1, 23 September 2009
Prepared by EUMETSAT
Agenda Item: WGII/7 ?
Discussed in WGII

ASSESSMENT OF THE SPECIFICATION OF RELEVANT MTG CHANNELS FOR FIRE MONITORING

In response to CGMS action 36.03:
CGMS agencies with current and/or future geostationary programmes to review CGMS-36 NOAA-WP-21, and to complete an assessment on the level of compliance to the recommendations in the Working Paper.

This document provides an analysis of the imager end-user requirements onboard Meteosat Third Generation (MTG) satellite in response to CGMS action 36.03. The compliance of these requirements with working paper CGMS-36 NOAA-WP-21 recommendations are analysed.

User requirements concerning wild fire detection and characterisation have been explicitly taken into account for FCI onboard MTG. The dynamic range of the 3.8 µm channel has been expanded to support user requirements on fire detection and characterisation. This translates into a 450K saturation value of the FDHSI mission for a sampling distance of 2km at the sub-satellite point.

CGMS requirements

- Data access and pre-processing protocols
- Spatial resolution
- Pixel saturation and characterization of sensor behavior at high temperatures
- Data navigation
- Band-to-band co-registration
- Impact of Point Spread Function on fire detection and characterization
- Calibration and Validation Activities

Progress and next steps

- Progress has been steady, but moderate
- Comprehensive validation of all products
  - Landsat-class imagery
- Research quality products
  - fire masks etc.
- Improved data distribution system
- Identify fire POCs for all satellites/agencies
- Continued advocacy for future sensors
  - GOES-R, MTG, etc.
- Better intergrate geostationary data into fire ECV
- Third workshop needed