Overview of the WF_ABBA Global Geostationary Fire Monitoring Program: Current Implementation and Future Plans

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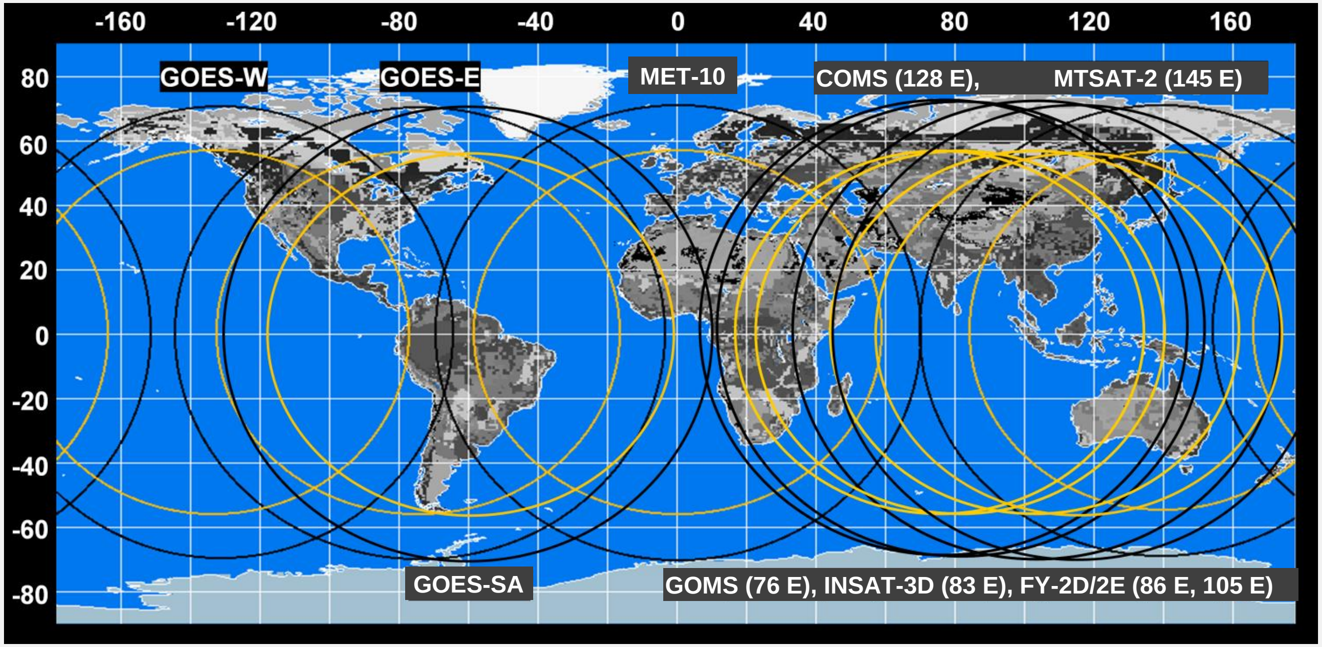
Outline

- Current and future global geostationary fire monitoring sensors and capabilities
- Overview of the global geostationary WF_ABBA and real-time fire products
- GOES-R ABI next generation WF_ABBA
- COMS WF_ABBA fire monitoring
- 2013 Indonesia fires case study



Current Operational Global Geostationary Satellites

Active Fire Monitoring Capabilities

Satellite	Active Fire Spectral Bands	Resolution IGFOV (km)	SSR (km)	Full Disk Coverage	3.9 μm Saturation Temperature (K)
GOES-E(13) /-W (15) Imager (75ºW / 135ºW)	1 visible 3.9 and 10.7 μm	1.0 4.0	0.57 2.3	3 hours (30 min NHE and SHE)	~337-340 K (G-15) ~337-340 K (G-13)
GOES-12 Imager (South America) (60ºW) **(Decomissioned in 2013)**	1 visible 3.9 and 10.7 μm	1.0 4.0	0.57 2.3	3 hours (Full Disk) 15 min (SA)	>337 K (G-12)
Met-10 SEVIRI (0º)	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
FY-2D/2E SVISSR (86ºE / 105ºE)	1 visible, 3.75 and 10.8 μm	1.25 5.0		30 minutes	~330 K
MTSAT-2 Imager (HRIT) (145ºE) Operational (2010)	1 visible 3.7 and 10.8 μm	1.0 4.0		1 hour	~320 K
GOMS Elektro-L N1 MSU-GS (76ºE) (2011) GOMS Elektro-L N2 MSU-GS (76ºE) (≥2014)	3 visible 3.75 and 10.7 μm	1.0 km 4.0 km		30 minutes	TBD
COMS MI (128ºE)	1 visible 3.9 and 10.7 μm	1.0 km 4.0 km		3 hours	~350 K

Near Term and Next Generation
Global Geostationary Active Fire Monitoring Capabilities

Satellite	Launch	Active Fire Spectral Bands	Resolution IGFOV (km)	Full Disk Coverage	3.9 μm Saturation Temperature (K)
India INSAT-3D (82ºE, Prime: 74ºE)	July 2013	1 vis, 1.6 μm 3.9 and 10.8 μm	1.0 4.0	30 minutes	TBD
JMA Himawari-8/-9 AHI (140ºE)	≥2014/2016	1 visible 5 visible/NIR 3.9,10.4,11.2 μm	0.5 1.0 - 2.0 2.0	10 minutes	~400 K (?)
USA GOES-R ABI (75ºW / 137ºW)	≥2015	1 visible 5 visible/NIR 3.9,10.4,11.2 μm	0.5 1.0 – 2.0 2.0	15 minutes	~400 K
CMA FY-4A AGRI (86.5ºE)	≥2015 (2017?)	1 visible 5 visible/NIR 3.9,10.4,11.2 μm	0.5 – 1.0 1.0 – 2.0, 4.0 2.0 & 4.0	15 minutes	?
European MTG-I1 FCI (9.5 ºE, 0º)	≥2018	2 visible (RSS*) 8 visible/NIR 3.8 and 10.5 μm	0.5 1.0 1.0 (RSS-3.8μm) 2.0 for both	10 minutes	~450 K (?)
KMA GEO-KOMPSAT-2A/2BAMI (128.2 or 116.2 ºE)	>2017/2018	1 visible 5 visible/NIR 3.9,10.4,11.2 μm	0.5 1.0 – 2.0 2.0	10 minutes	~400 K (?)
Russia Elektro-M MSU-GSM (76ºE) (considered)	2017	~20 channels from 0.38-14.25 μm (?)	0.5-1.0 km (VNIR/SWIR) 1.0-2.0 km (IR)	10 minutes	TBD

*MTG-I1 RSS- Regional Rapid Scan (2.5 minutes over Europe, .25 full disk)

General Overview of Next Generation Global Geostationary Fire Monitoring

- Over the next 5 years current operational geostationary platforms will be replaced with instruments that are more conducive for diurnal fire monitoring, providing global geostationary fire monitoring capabilities at higher spatial resolution and temporal resolution. Many of these instruments include mandates for fire detection.

- Although these instruments are similar in many ways, pre-processing and saturation limits may not be the same. One of the biggest issues is the lack of information regarding sub-pixel detector saturation.

- Within the next 2-3 years, the operational GOES-R ABI (75ºW / 137ºW), Himawari-8 AHI (140ºE), and CMA FY-4A AGRI (86.5ºE) will offer 2 km spatial resolution in the 3.9 µm band with full disk diurnal observations every 10-15 minutes.

- The European MTG-I1 FCI (9.5 ºE, 0º) (2018) represents a significant step forward in diurnal fire monitoring with the capability for 1 km spatial resolution in the 3.9 µm band in Regional Rapid Scan (RSS) mode every 2.5 minutes over Europe. Full disk observations at a spatial resolution of 2 km will be available every 10 minutes. The saturation temperature in the 3.9 µm band will be ~450 K.

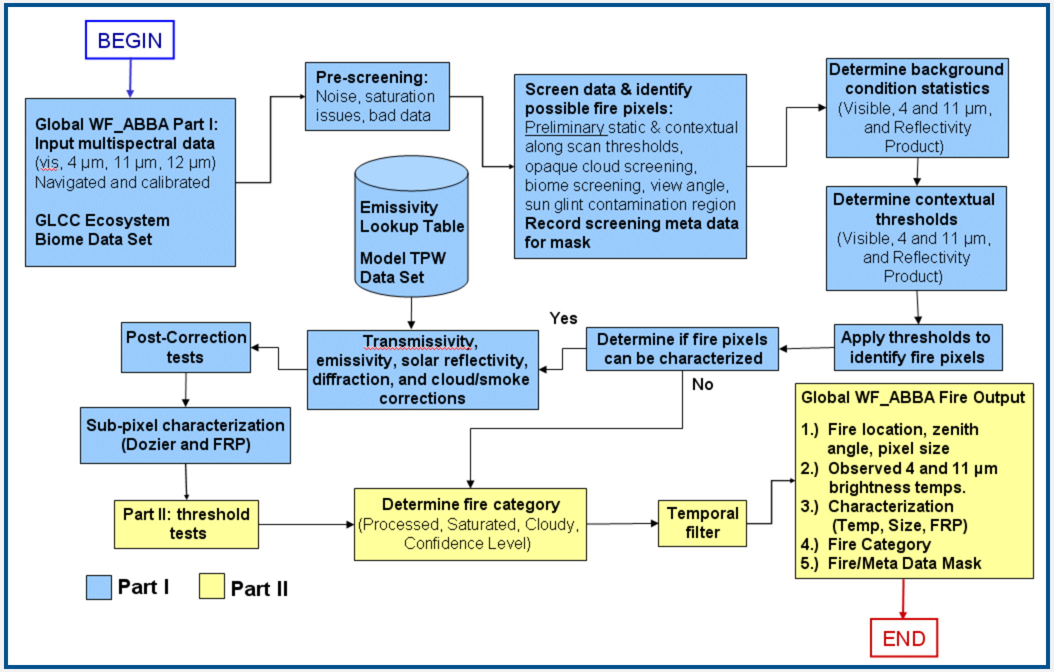
Next Generation Global Geostationary Fire Monitoring Issues and Items of Concern

- Geostationary fire monitoring activities have grown appreciably over the past 5 years. There is a need for increased *coordination* between *operational data producers*, *fire product development and implementation teams*, and the *user community*.

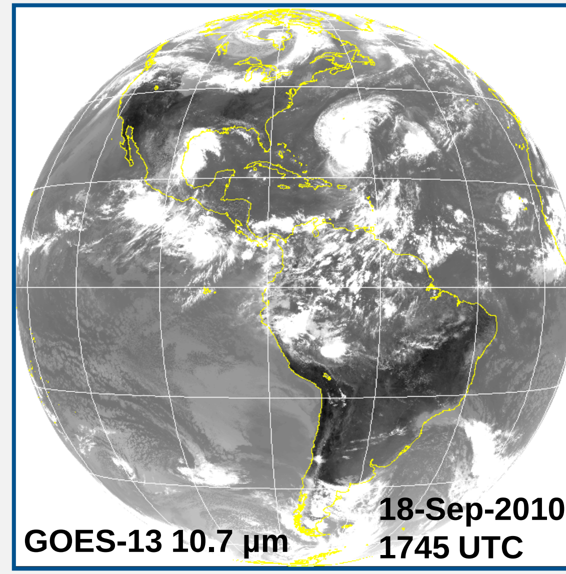
- Although cal/val for fire products is included as part of next generation development and implementation for many of the upcoming platforms, *need systematic validation efforts to understand cross platform differences and coordinated validation activities* with CEOS LPV.

- Success requires *support from operational agencies* to sustain the global geostationary fire monitoring network and produce *standardized long-term data records and fire inventories* of known accuracy.

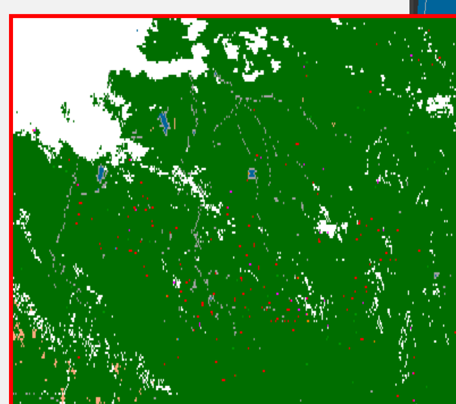
The Global WF_ABBA (Version 6.5.007)



GOES WF_ABBA Version 6.5.007



- Opaque cloud product indicating where fire detection is not possible.
- Fire Radiative Power and Dozier instantaneous estimates of fire size and temperature.
- Meta data on processing regions; opaque cloud coverage; block-out zones due to solar reflectance, clouds, extreme view angles, biome type, etc.
- Fire/meta data mask: view real-time imagery online at **http://wfabba.ssec.wisc.edu**



GOES-13 WF_ABBA Fire Mask
18-Sep-2010 1745 UTC

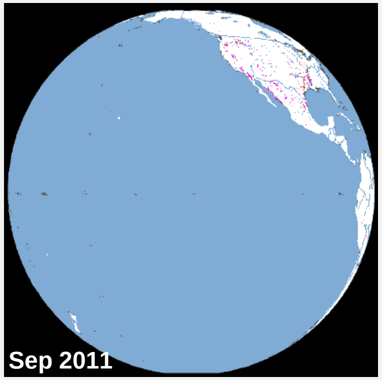
GOAL

The *goal* of the global geostationary WF_ABBA fire monitoring network is to provide *consistent long-term diurnal fire monitoring around the globe* utilizing the capabilities and limitations of unique operational systems and a common fire detection algorithm.

This is not trivial, given the distinctive capabilities of each platform!

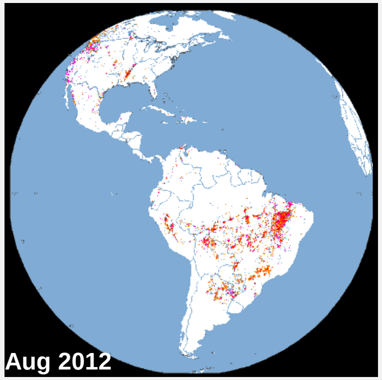
WFABBA Fire Monitoring Around the Globe

GOES-11 (West)



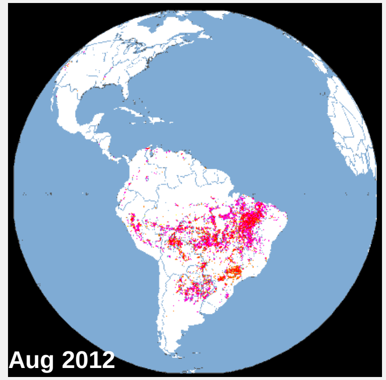
- Schedule:
  Full disk (NHE+SH) - 30 minute
  CONUS - 15 minute
- Western U.S., Alaska, Canada, South America on limb
- Biome block-out limits fire monitoring in arid west
- Saturation minimal

GOES-13 (East)



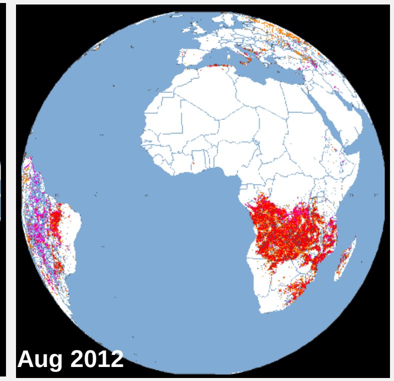
- Schedule:
  Full disk (NHE+SH) - 30 minute
  CONUS - 15 minute
- Good coverage of South America which dominates fire signal
- Although number of detected fires is smaller than GOES-12, year to year variability is similar
- Saturation minimal

GOES-12 (South America)



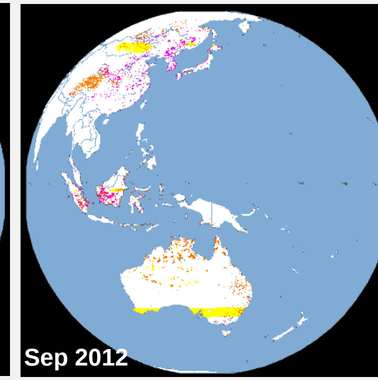
- Schedule:
  Full disk - 3 hour
  South America -15 minute
- Excellent spatial and temporal coverage of South America allows for nearly twice as many fire detects compared with GOES-E
- Higher # of cloud contaminated and low possibility fires
- Saturation minimal

Meteosat-9



- Schedule:
  Full disk- 15 minute
- Excellent spatial and temporal coverage of Africa
- Biome block-out limits fire monitoring in Africa and Middle East
- The number of low possibility fires is high especially over South America
- Saturation slightly higher than GOES series

MTSAT-2



- Schedule:
  Full disk- 1 hour
- Excellent spatial coverage of Indonesia
- Fire monitoring limited by low saturation in the 3.9 μm band
- Low possibility fires dominate the fire signature
- Many saturated fire pixels

The global WFABBA is operational at NOAA/NESDIS with fire product text file download available in near-real time. Fire mask imagery is available online at http://wfabba.ssec.wisc.edu.

Current Geostationary WF_ABBA Fire Products

- **Fire mask imagery and Google Earth based composite maps available on-line at http://wfabba.ssec.wisc.edu/ for GOES-E, GOES-W, MET-10, MTSAT-1R/-2 (COMS in the near future).**

- **Global WF_ABBA ASCII text files and cloud/fire masks are available in near real time within ~30-40 minutes of image start time. Approximately 2 weeks of global geostationary fire products are retained for each platform. NetCDF is a possibility.**

  ftp.ssec.wisc.edu/pub/abba/v65

- **GOES-East satellite and cloud coverage corrected binned fire products for 1995-2012. (.25 ˚ resolution binary files)**

- **Specific data sets not available online can be obtained upon request.**

Geostationary WF_ABBA Fire Product Developments

- **Developing a merged WF_ABBA ASCII output file with additional metadata fields including fire age, the number of fire detections from a given time window, as well as the number and type of observations (clear, partially clear, or not clear - where "not clear" could be a cloud, water, blockout zone, etc.)**
- **Online searchable archive of Global WF_ABBA fire products (1995-current for GOES, Met-9/-10, MTSAT-1R/-2, COMS)**
- **Possibility of a locally-deployable WFABBA using Geocat**

All Things GOES-R

GOES-R ABI (≥2015)
TRANSITION TO FUTURE GEOSTATIONARY FIRE DETECTION

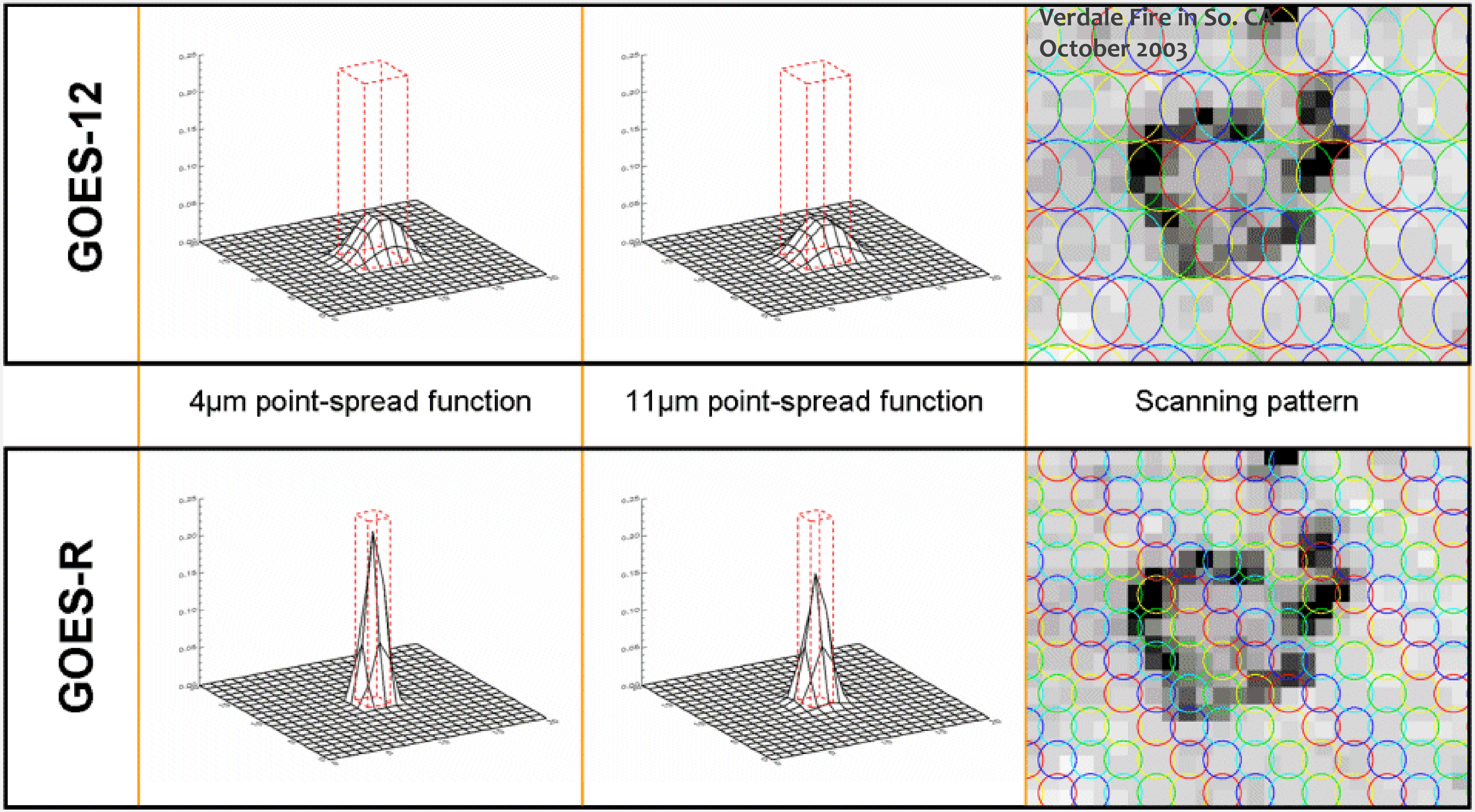
Future GOES Imager (ABI) Band	Nominal Wavelength Range (µm)	Nominal Central Wavelength (µm)	Nominal Central Wavenumber (cm-1)	Nominal sub-satellite IGFOV (km)	Sample Use
1	0.45-0.49	0.47	21277	1	
2	0.59-0.69	0.64	15625	0.5	Fire
3	0.846-0.885	0.865	11561	1	
4	1.371-1.386	1.378	7257	2	
5	1.58-1.64	1.61	6211	1	
6	2.225 - 2.275	2.25	4444	2	Fire
7	3.80-4.00	3.90	2564	2	Fire
8	5.77-6.6	6.19	1616	2	
9	6.75-7.15	6.95	1439	2	
10	7.24-7.44	7.34	1362	2	
11	8.3-8.7	8.5	1176	2	
12	9.42-9.8	9.61	1041	2	
13	10.1-10.6	10.35	966	2	Fire
14	10.8-11.6	11.2	893	2	Fire
15	11.8-12.8	12.3	813	2	Fire
16	13.0-13.6	13.3	752	2	

Current Input

Expected Added Input

Possible Added Input

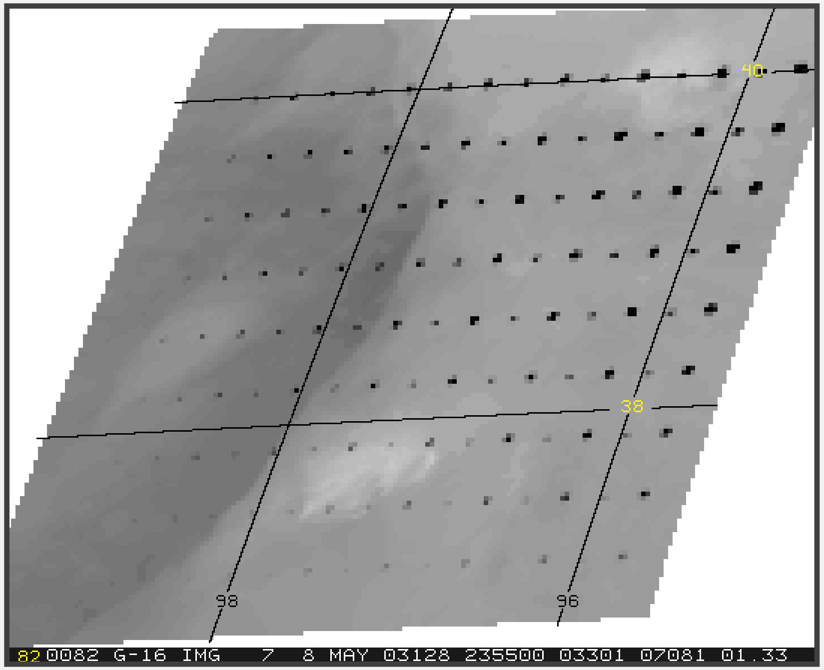
Comparison of GOES-12 and GOES-R ABI Point Spread Functions And Scanning Patterns



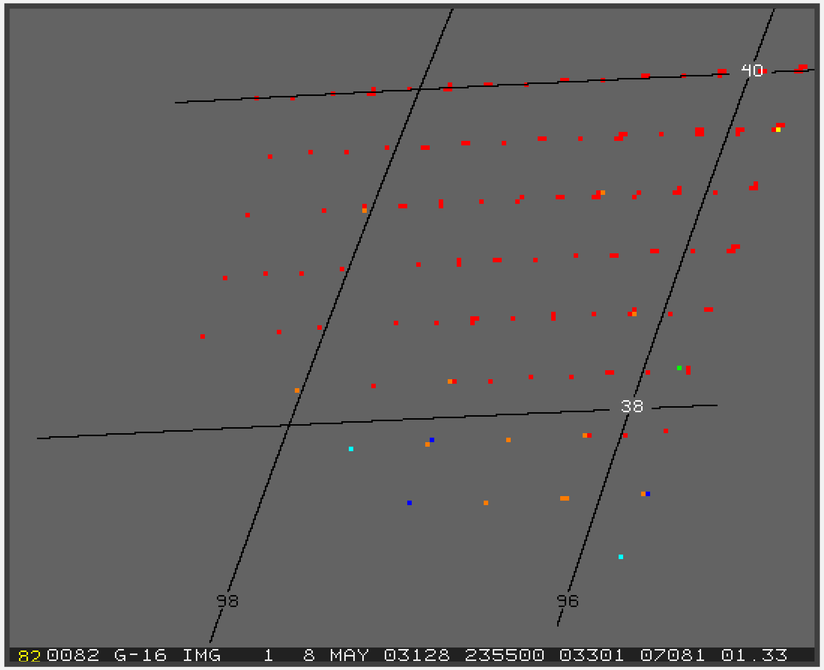
The point spread function and proposed sampling on GOES-R result in improved characterization of sub-pixel fire characteristics.

Great Plains Case Study: Variable Fire - No Cloud

Date: 8 May 2003 **Times: 18:00 – 23:55 UTC**



CIRA Model Simulated ABI 3.9 µm band



CIMSS ABI WF_ABBA Fire Mask Product

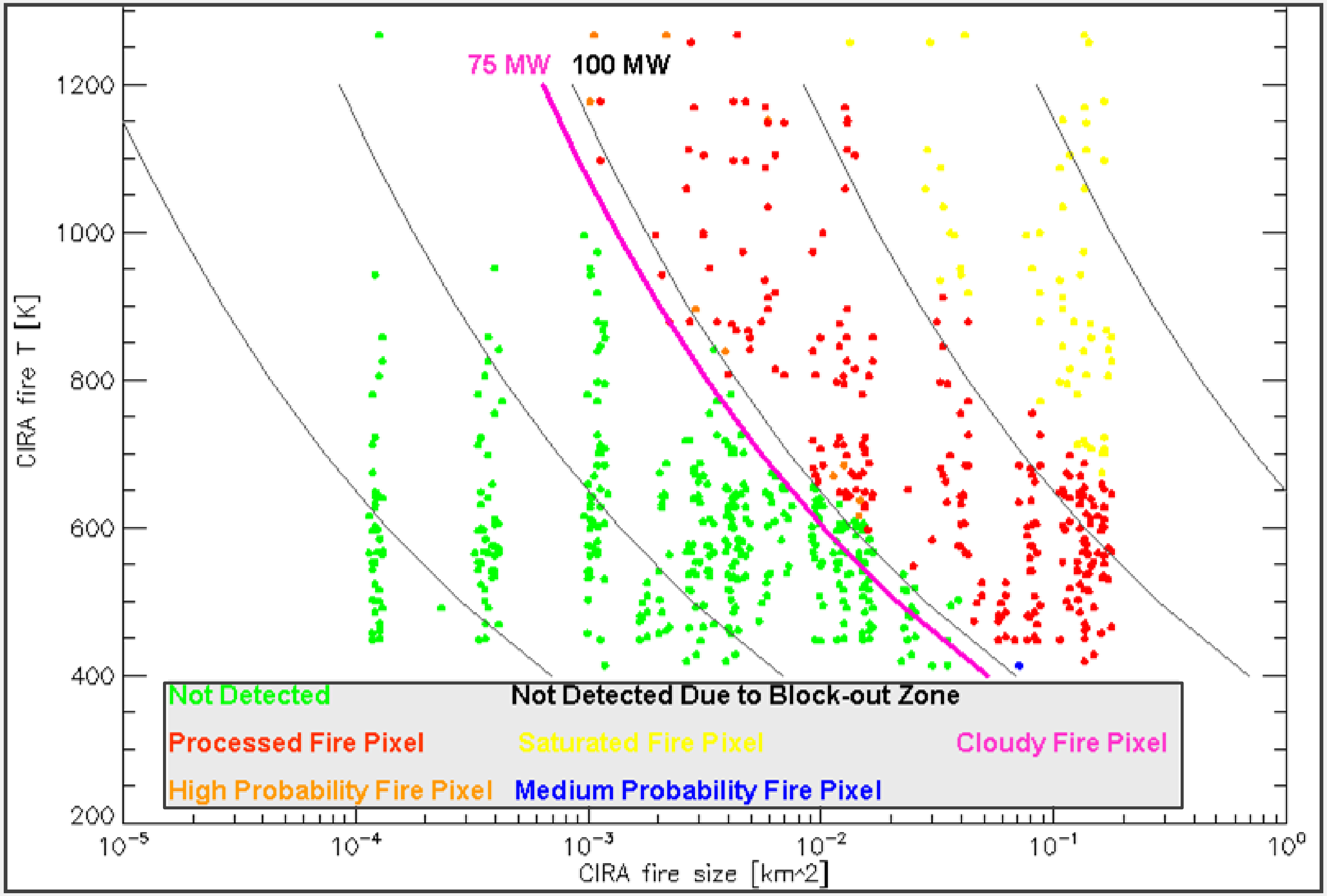
Biome Block-Out Zone

Experimental ABI WF_ABBA Fire Legend

Processed Fire	Saturated Pixel	Cloudy Fire
High Possibility Fire	Medium Possibility Fire	Low Possibility Fire

GOES-R ABI Simulated Case Studies (CIRA)	Simulated Conditions		WF_ABBA Performance			
	Fire Clusters	Fire Pixels	% of fire clusters detected	% of fire pixels detected	% of fire area detected	% of FRP detected
May 8, 2003 Kansas constant fires without clouds	9720	52234	99.3%	90.9%	98.8%	91%
May 8, 2003 Kansas variable fires without clouds	5723	26600	99.5%	80.6%	77.4%	66%
May 8, 2003 Kansas constant fires with clouds	9140	46446	95.9%	84.8%	81.6%	25%
Apr 23, 2004 Cent. Amer. variable fires with clouds	849	1669	95.2%	85.3%	56.3%	69%
Oct 23, 2007 California variable fires with clouds	990	2388	99.9%	87.5%	125.9%.	105%
Oct 26, 2007 California variable fires with clouds	120	252	100%	83.7%	57.1%	100%
Nov 5, 2008 Arkansas variable fires with clouds	282	520	93.3%	78.1%	69.0%	84%

GOES-R WF_ABBA Fire Algorithm: Minimum Detectability



The above chart illustrates WF_ABBA fire detection and classification as a function of the CIRA model simulated ABI fire size and fire temperature. This example is from the Oct 23, 2007 California case. Notice that WF_ABBA is quite successful detecting fires with fire radiative power (FRP) > 75 MW.

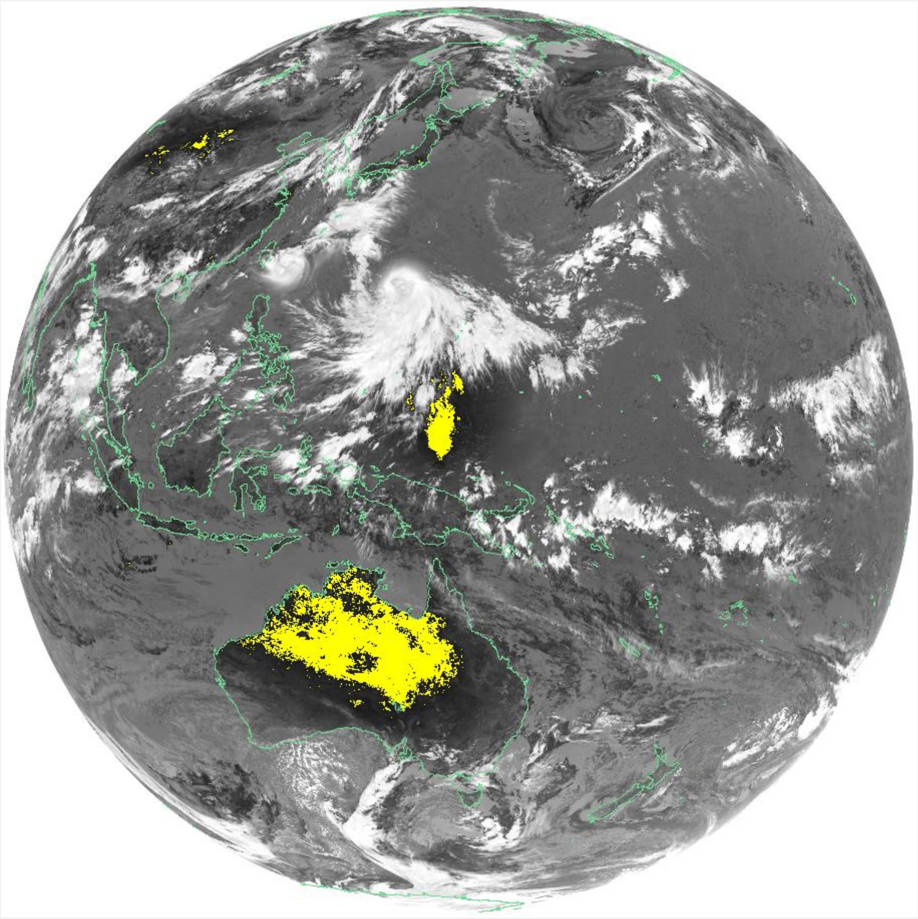
Example of Improved Geostationary Fire Monitoring in SE Asia With the Korean COMS

- **COMS centrally located to observe fires in Australia, Eastern Asia and the Maritime Continent (SE Asia)**
- **High saturation temperature (>350K) in the short-wave IR window allows for unique and improved diurnal fire monitoring with COMS**
- **Initial observations indicate that pre-processing of COMS data results in less smearing of the fire signal along the scan line which may allow for improved geostationary fire detection and characterization in SE Asia and Australia.**
- **COMS high temporal monitoring over Indonesia (15 minutes) allows for monitoring short-lived agricultural fires.**
- **Initial adaptation of the WF_ABBA for COMS is complete.**

MTSAT-2 and COMS

Saturation in the short-wave IR window

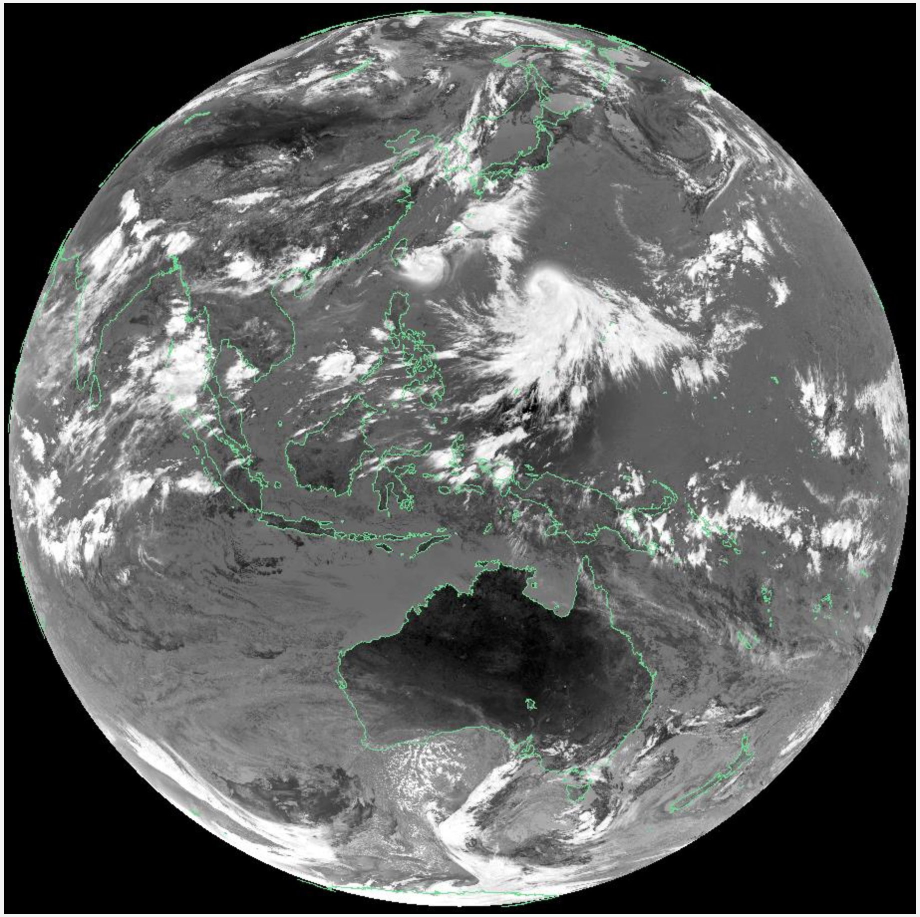
MTSAT-2



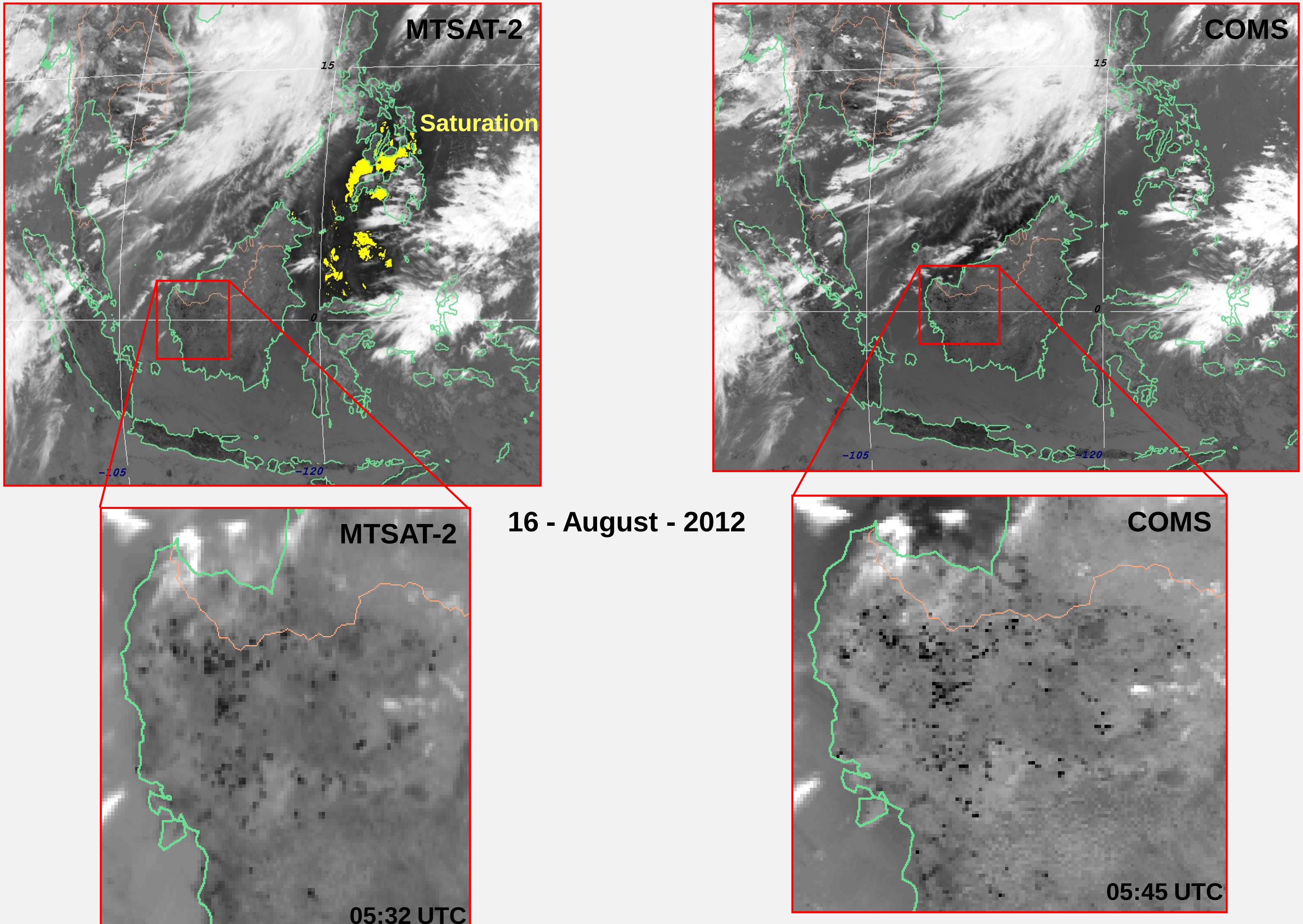
4 micron data *Saturation: ~320K*
Date: 22 August 2012 *Time: 02:32 UTC*

Saturated Values

COMS



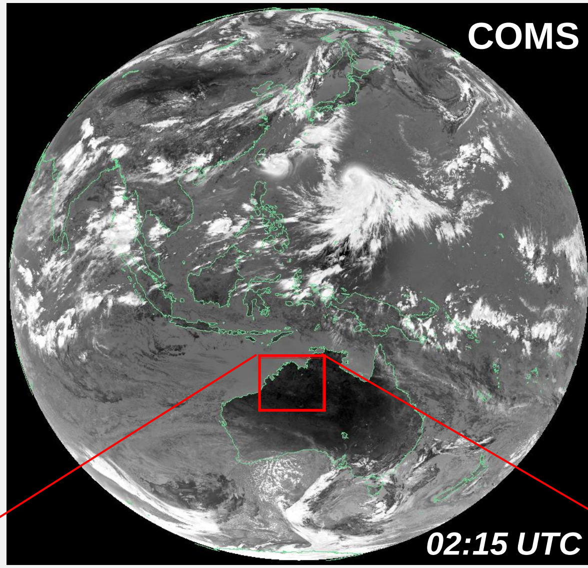
4 micron data *Saturation: >350K*
Date: 22 August 2012 *Time: 02:15 UTC*



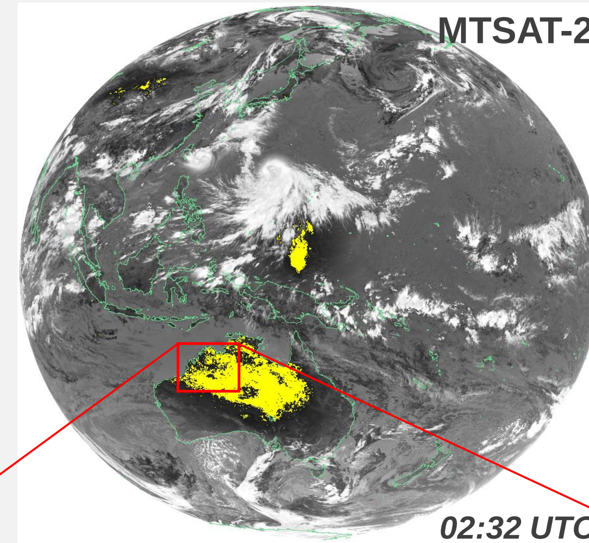
16 - August - 2012

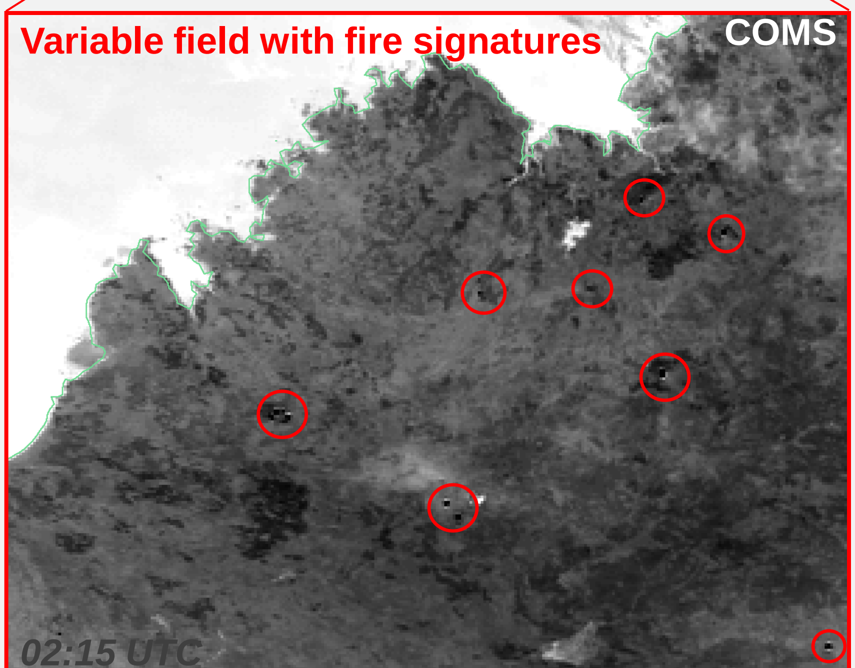
Dark hot spots indicate active fires in COMS and MTSAT-2 4-micron imagery. Fire signatures in the COMS data are more readily distinguished from the background conditions allowing for enhanced detection/characterization.

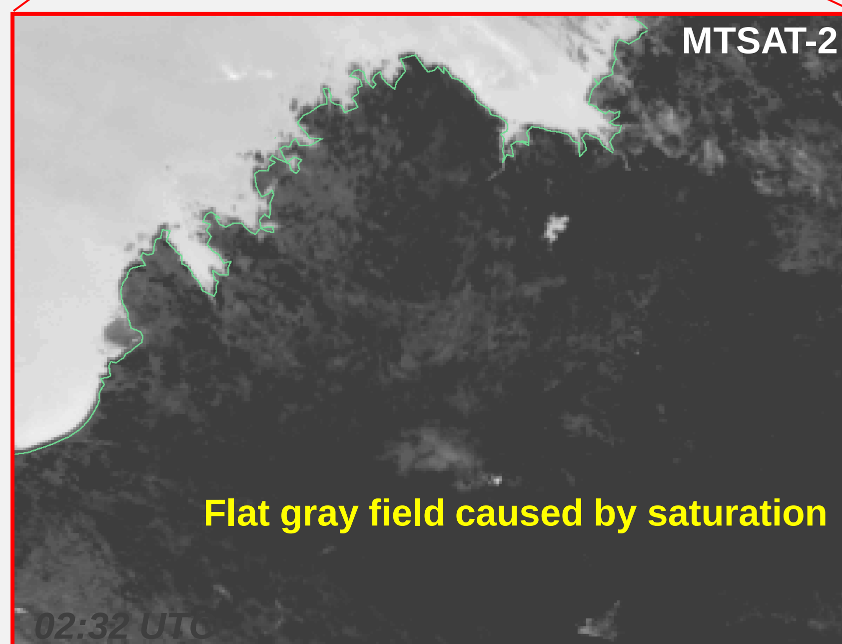
COMS and MTSAT-2: Example of short-wave IR band over Northern Australia



Date:
22 August 2012

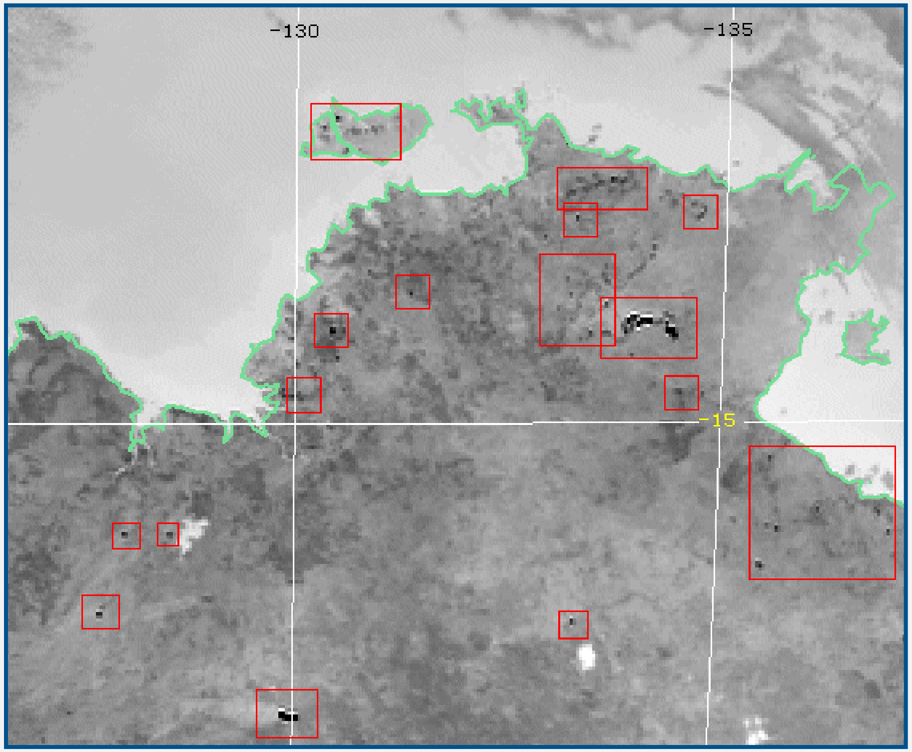




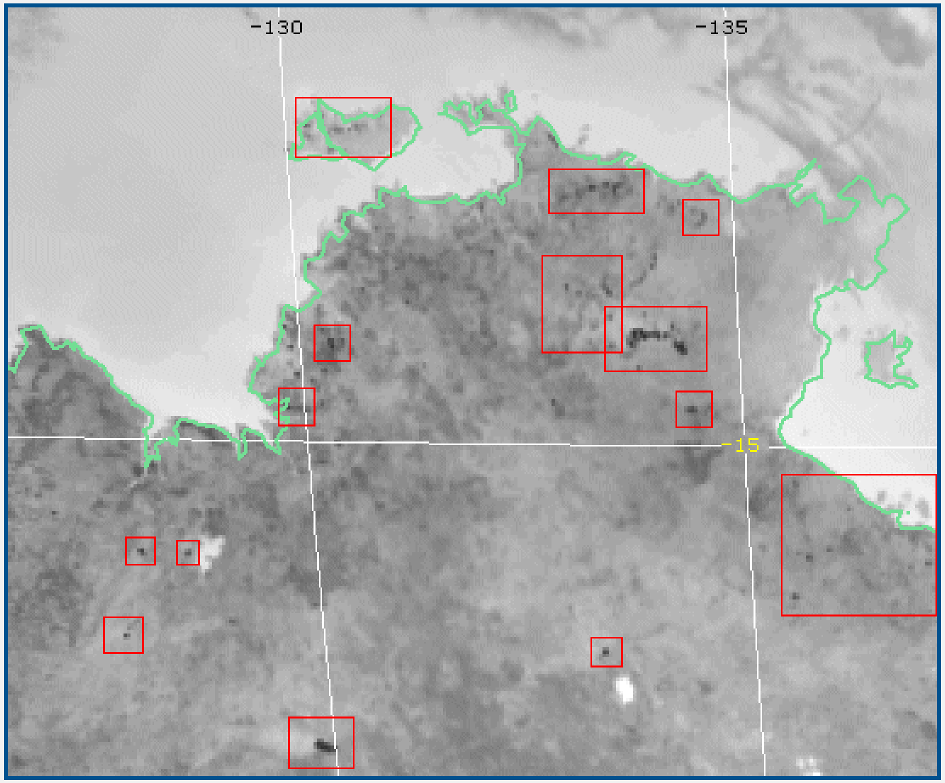


Observations of Fires in Northern Australia Using COMS and MTSAT-2

COMS: 4 micron: Sub-satellite point: 0º, 128º E
Date: 25-Jun-2012 Time: 05:15 UTC



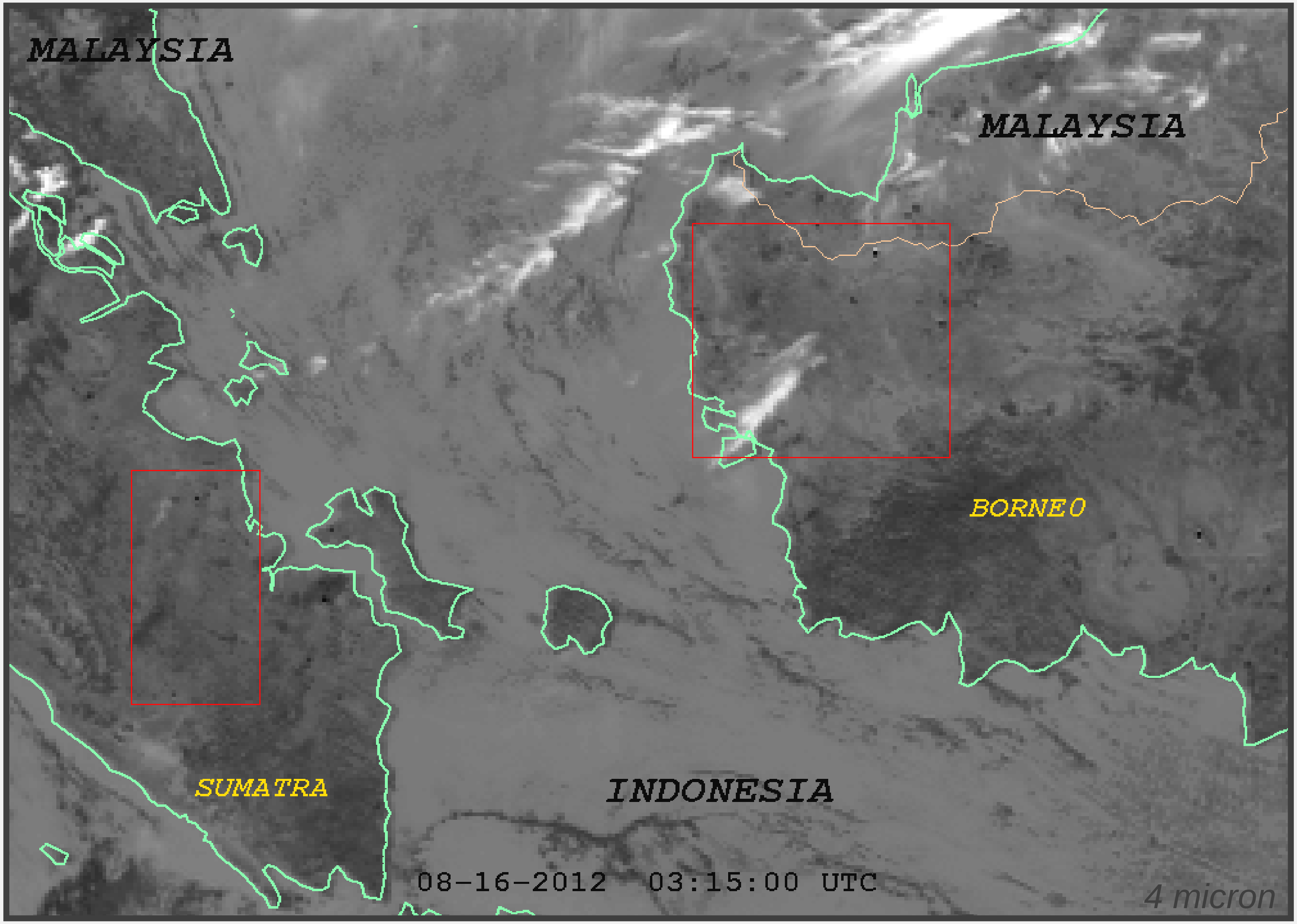
MTSAT-2: 4 micron Sub-satellite point: 0º, 145º E
Date: 25-Jun-2012 Time: 05:32 UTC



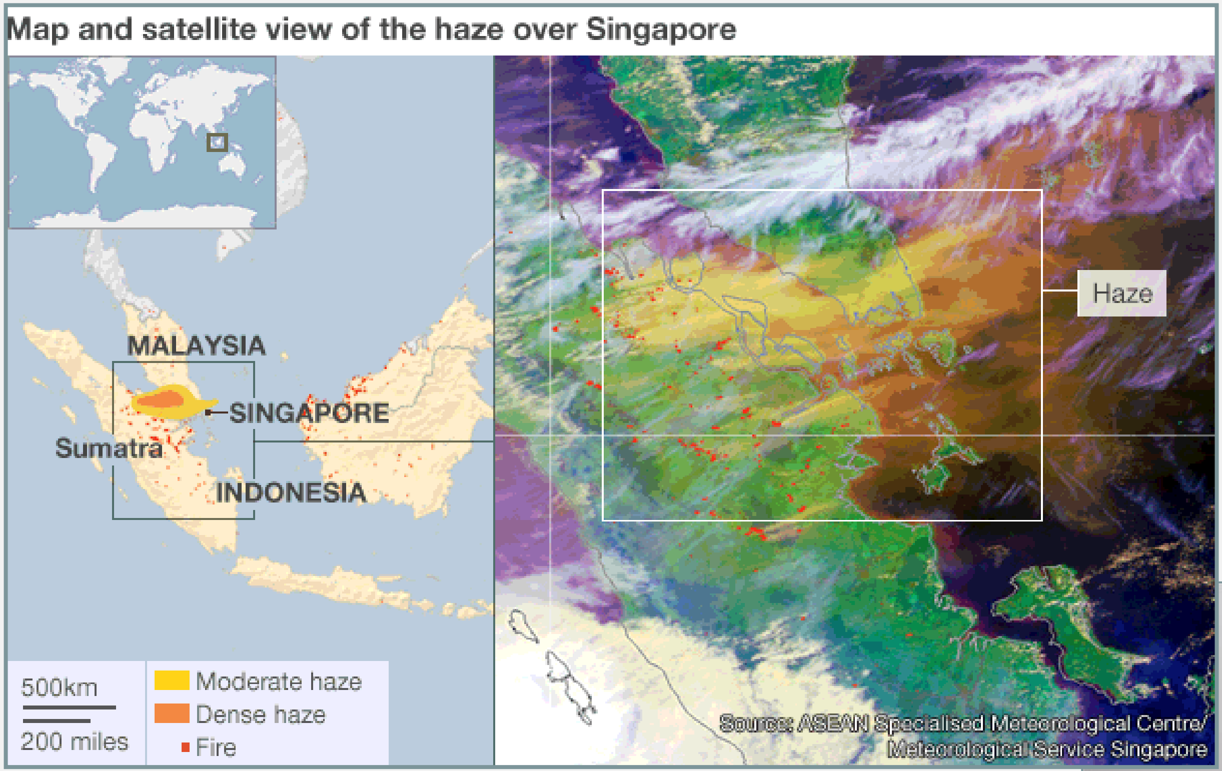
The view angle for COMS and MTSAT-2 is similar for this region (slightly larger for MTSAT-2) in Northern Australia. Pre-processing of COMS data results in reduced smearing of the fire signal along the scan line allowing for improved fire detection and characterization.

COMS Captures Diurnal Variability in Fire Activity in Borneo and Sumatra

August 16, 2012 03:15 – 07:15 UTC



June 2013 Indonesian Fires



Plume extended across Singapore, Malaysia, and the South China Sea

ASEAN Specialized Meteorological Centre: Meteorological Service Singapore

Hazy skyline of Singapore

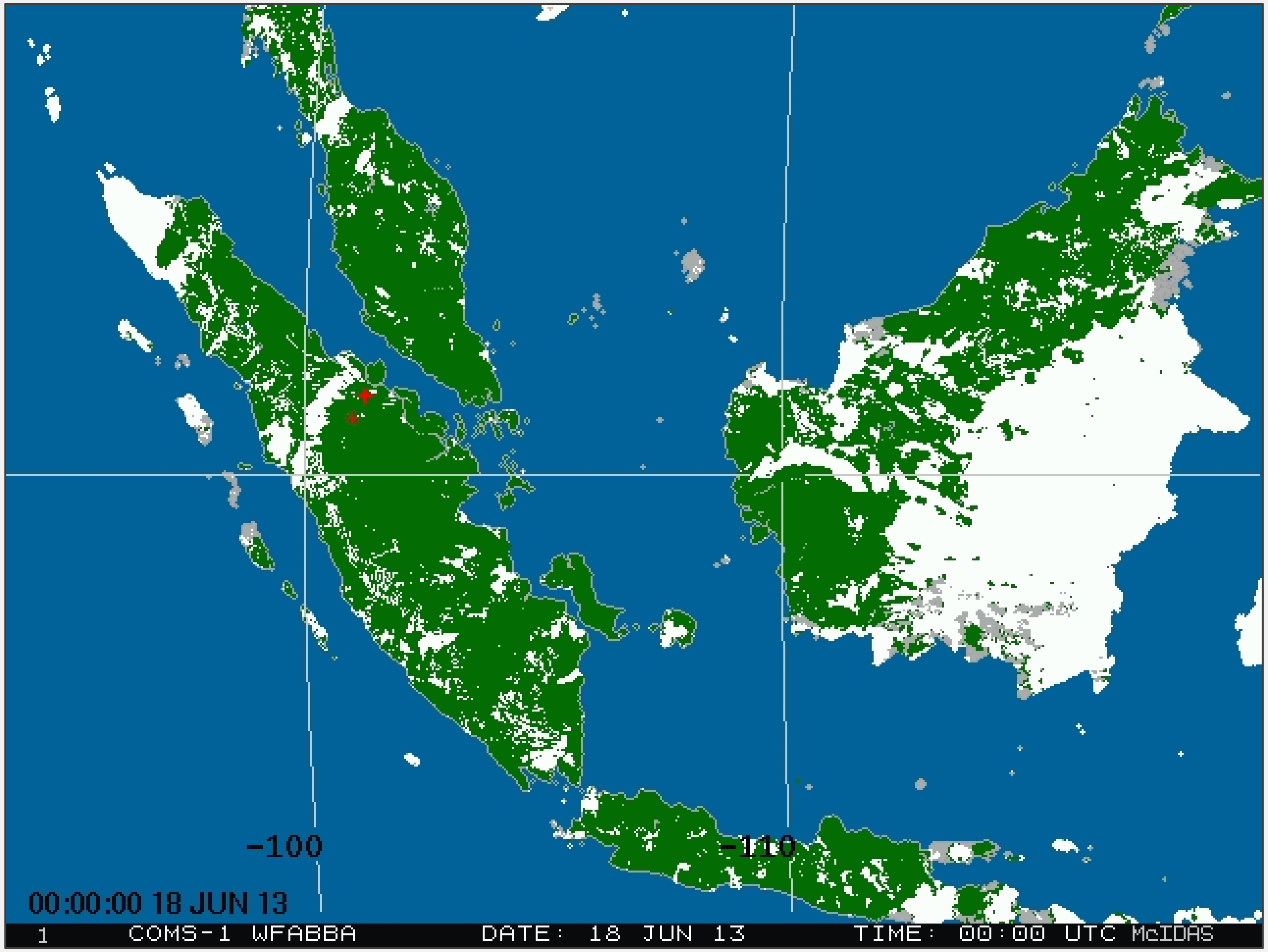
http://arabia.msn.com/news-gallery/news-gallery-detail/

The 2013 Indonesian Fires Impact Regional Air Quality

- During the last week of June 2013, smoke from biomass burning on the island of Sumatra impacted Singapore and Malaysia. It was the worst smoke air quality crisis since 1997.
- The Malaysian government's index for air pollution reached a measurement of 746 in the southern district of Muar. It was far above the threshold of 300 for hazardous air quality.
- Singapore and Malaysia closed schools and airports. Over 200 schools closed in southern Malaysia.
- The cost of the haze episode for Singapore alone was estimated at hundreds of millions of dollars.
- Many fires were set deliberately on palm oil plantations and in logging regions.
- As a result Indonesia has agreed to sign the ASEAN Agreement on Transboundary Haze Pollution which was established in 2002 between ASEAN nations to reduce haze pollution n Southeast Asia.
- On October 9, 2013, the 10 member countries of the Association of Southeast Asian Nations, agreed to adopt a system to jointly monitor haze.

COMS Visible Observations of the June 2013 Indonesian Smoke Plumes
18 – 22 June 2013

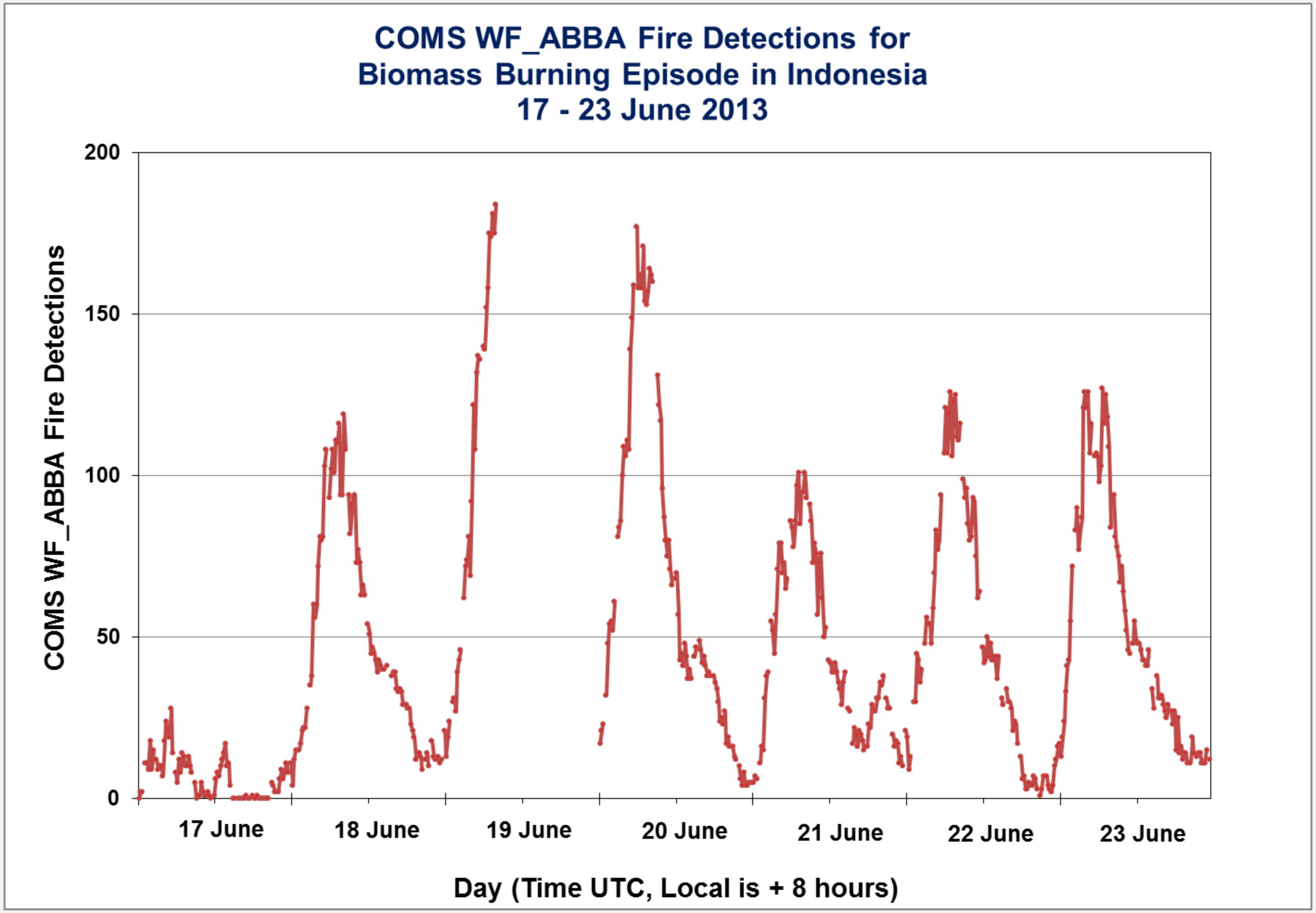
COMS WF_ABBA Diurnal Fire Mask Product for the 2013 Indonesia Fires
18 – 22 June 2013



WF_ABBA Fire Legend

Processed Fire	Saturated Pixel	Cloudy Fire
High Possibility Fire	Medium Possibility Fire	Low Possibility Fire

COMS WF_ABBA Diurnal Fire Detections for the 2013 Indonesia Fires 17 – 23 June 2013



Final Thoughts

- **We are entering a new era of global geostationary fire monitoring capabilities.**
- **Current and future global geostationary fire monitoring sensors provide unique opportunities to capture diurnal emissions and augment higher resolution polar products.**
- **More coordination is needed between the fire product data developers, modelers, and operational centers to sustain consistent long-term fire products.**
- **Validation activities are underfunded and hinder future product improvements and user confidence.**

Thank You!