Active fire data from Suomi NPP VIIRS to serve end user applications

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Suomi NPP VIIRS IDPS product status

- The **Suomi NPP Active Fire ARP was declared Operational** by the NESDIS Satellite Products and Services Review Board (SPSRB)
  - Primary use in NOAA'S Hazard Mapping System
- The Suomi NPP Active Fire product has reached **Validated 1 maturity status** with an effectivity date (i.e. IDPS implementation) of **August 13, 2014**.
  - The effectivity date corresponds to the Transition to Operations of IDPS Mx8.5, which includes the implementation SDR changes to address VIIRS Quality Flag and Calibration issues
  - Additional prior SDR changes also improved data quality
  - The team will continue systematic monitoring of product quality and will report any issues found immediately.

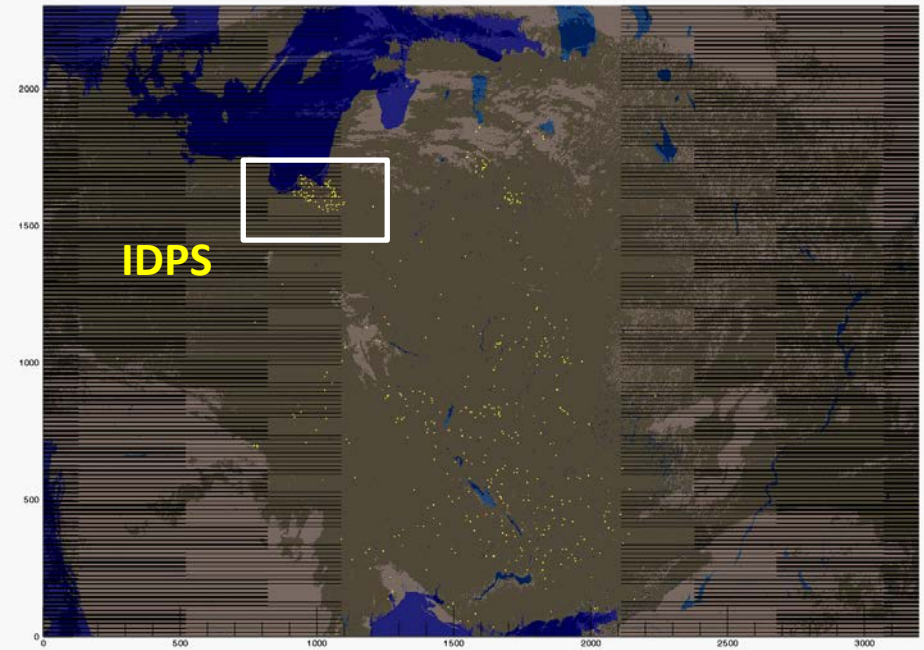
Requirements: L1RD Supplement

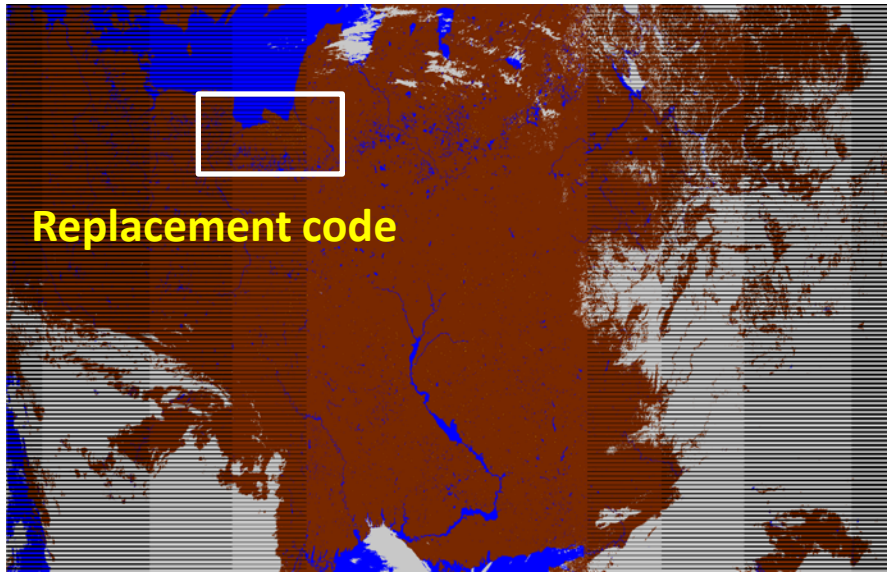
Active Fires		
ATTRIBUTE	**THRESHOLD**	**OBJECTIVE**
a. Horizontal Cell Size		
1. Nadir	0.80 km	0.25 km
2. Worst case	1.6 km	
b. Horizontal Reporting Interval	HCS	
c. Horizontal Coverage	Global	Global
d. Mapping Uncertainty, 3 sigma	1.5 km	0.75 km
e. Measurement Range		
1. Fire Radiative Rower (FRP)	1.0 to 5.0 $(10)^3$ MW	1.0 to 1.0 $(10)^4$ MW
2. Sub-pixel Average Temperature of Active Fire	N/A	N/A
3. Sub-pixel Area of Active Fire	N/A	N/A
f. Measurement Uncertainty		
1. Fire Radiative Rower (FRP)	50%	20%
2. Sub-pixel Average Temperature of Active Fire	N/A	N/A
3. Sub-pixel Area of Active Fire	N/A	N/A
g. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	N/A

: Not required for S-NPP

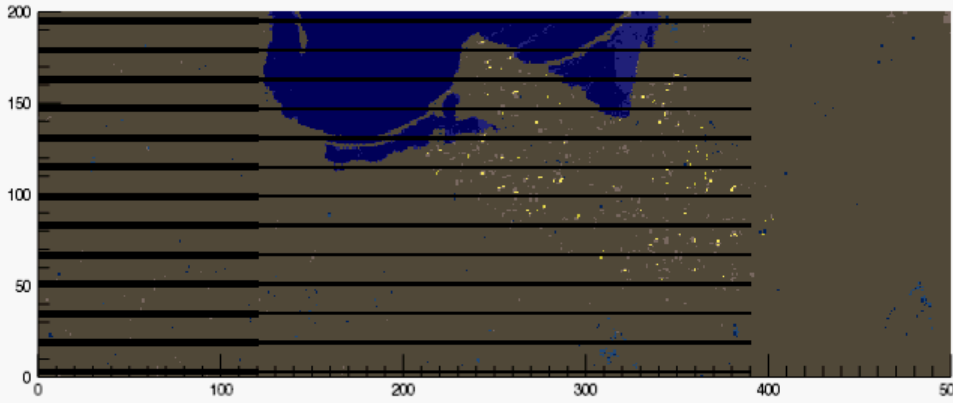
Current IDP product was designed to meet heritage NPOESS requirements., which have been baselined according to L1RDS S-NPP Performance Exclusions (Appendix D). Spatially explicit fire mask and fire characterization are "uppers" in the JPSS L1RD for J1 and beyond.

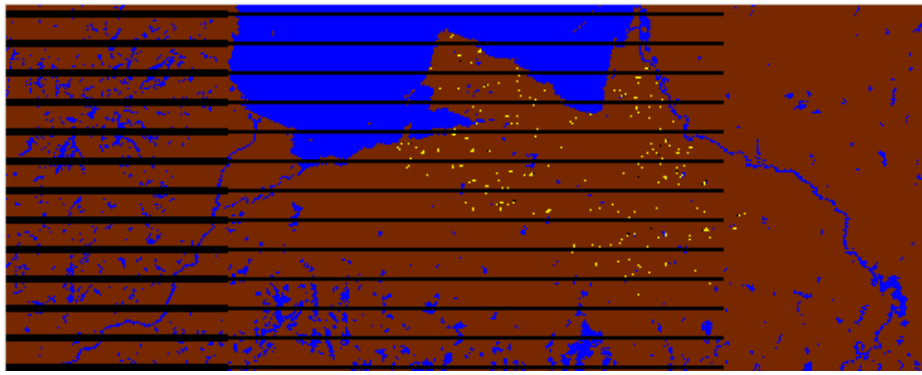
IDPS vs. JPSS “replacement” code





March 10, 2014 10:36-10:40

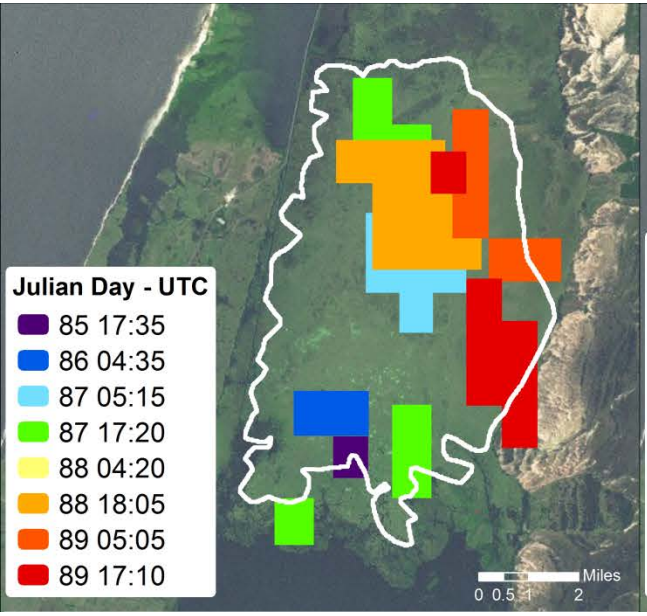




The JPSS 1 “replacement” code has been delivered NOAA STAR Algorithm Implementation Team (AIT) for integration into NOAA operations. A Critical Design Review was held in December 2014.

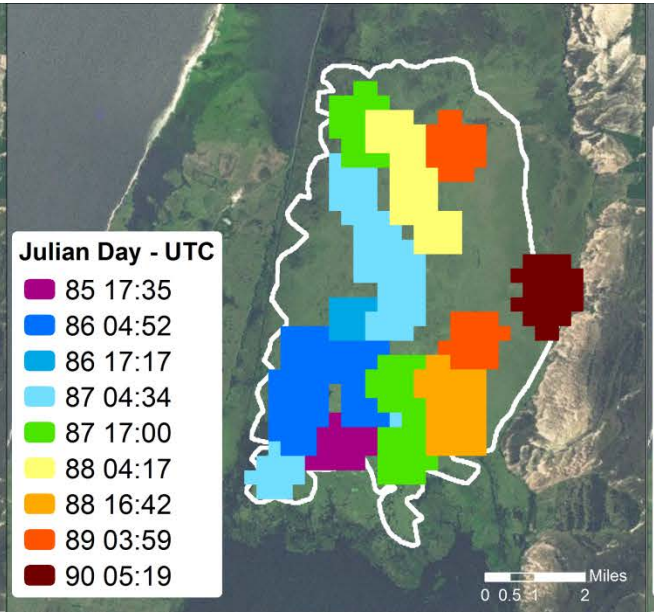
Improved Satellite Mapping of Active Fires Achieved Using VIIRS I-bands

Wildfire in southern Brazil, March/2013



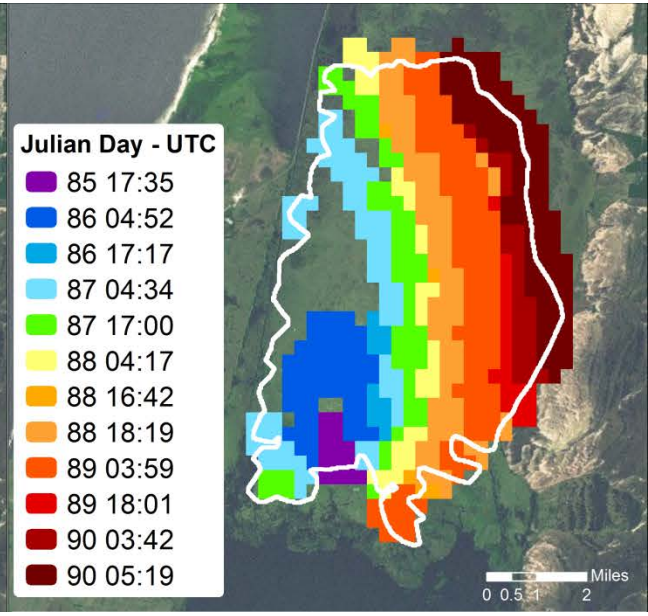
Aqua/MODIS 1 km

Spotty detection pixels and coverage gap at low latitudes



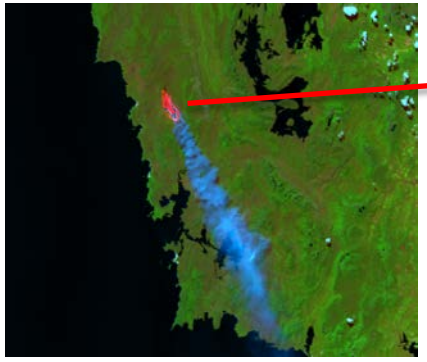
S-NPP/VIIRS 750 m

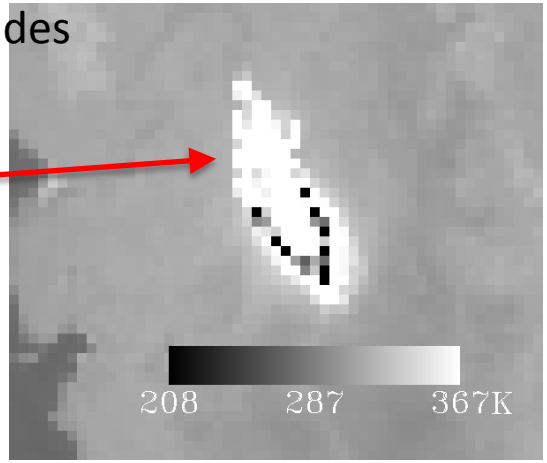
Spotty detection pixels



S-NPP/VIIRS 375 m

Improved fire line mapping



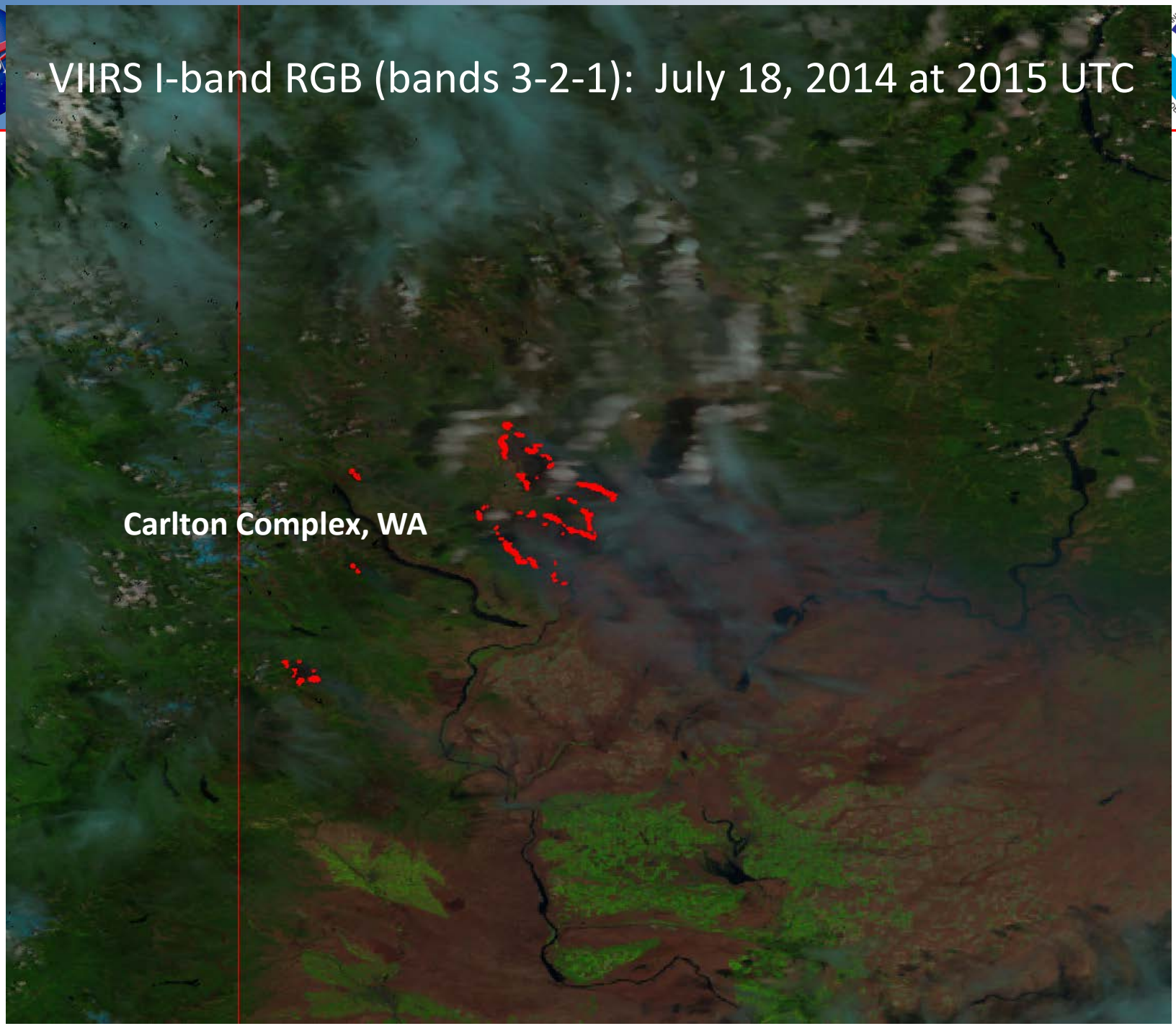


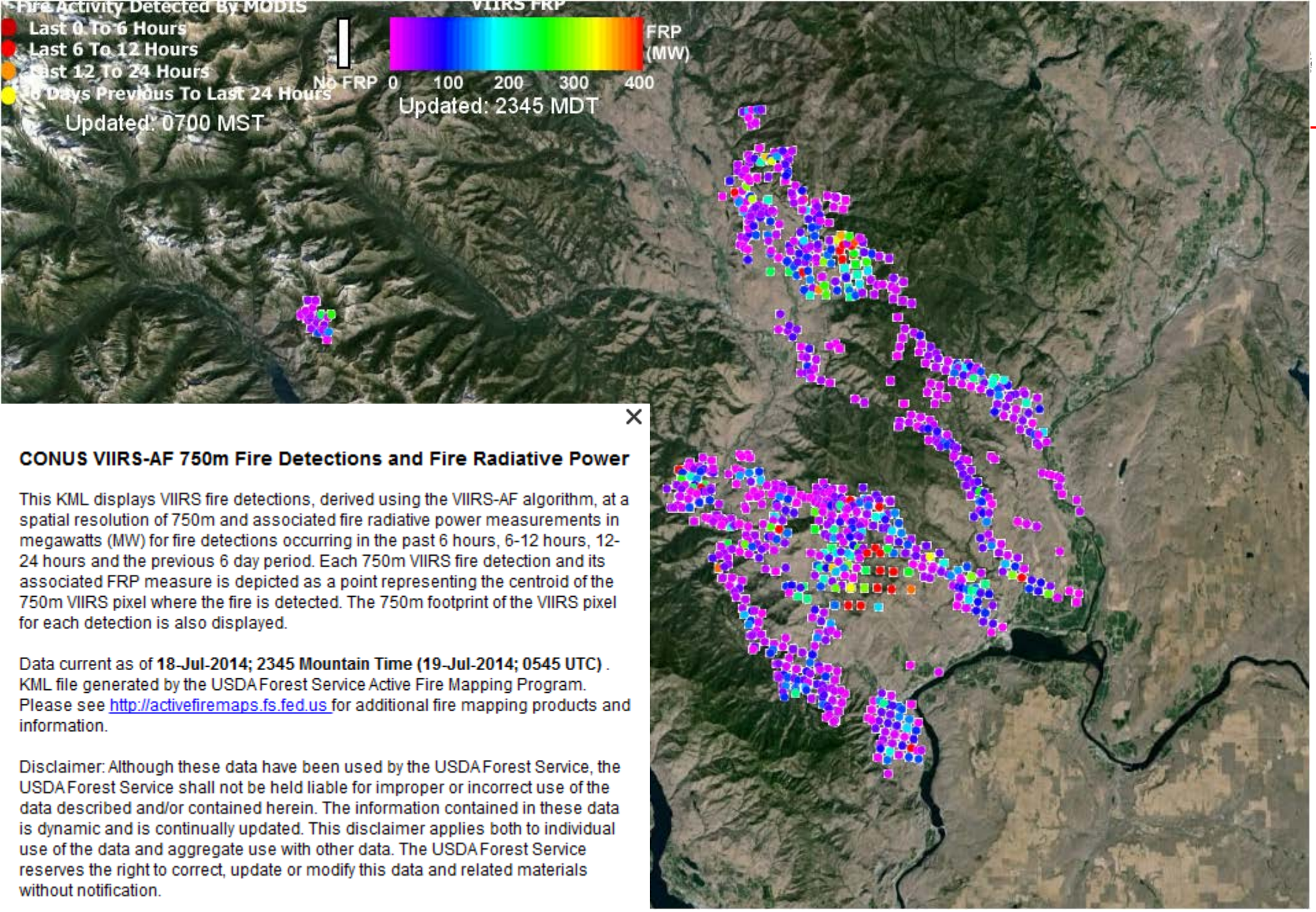
Issues of VIIRS fire detection:

- Anomalous behavior at sensor saturation
- Inconsistent quality flags
- Unknown saturation of native resolution pixels prior to aggregation (single-gain bands)
- South Atlantic Magnetic Anomaly

W. Schroeder, UMD

VIIRS I-band RGB (bands 3-2-1): July 18, 2014 at 2015 UTC





CONUS VIIRS-AF 750m Fire Detections and Fire Radiative Power

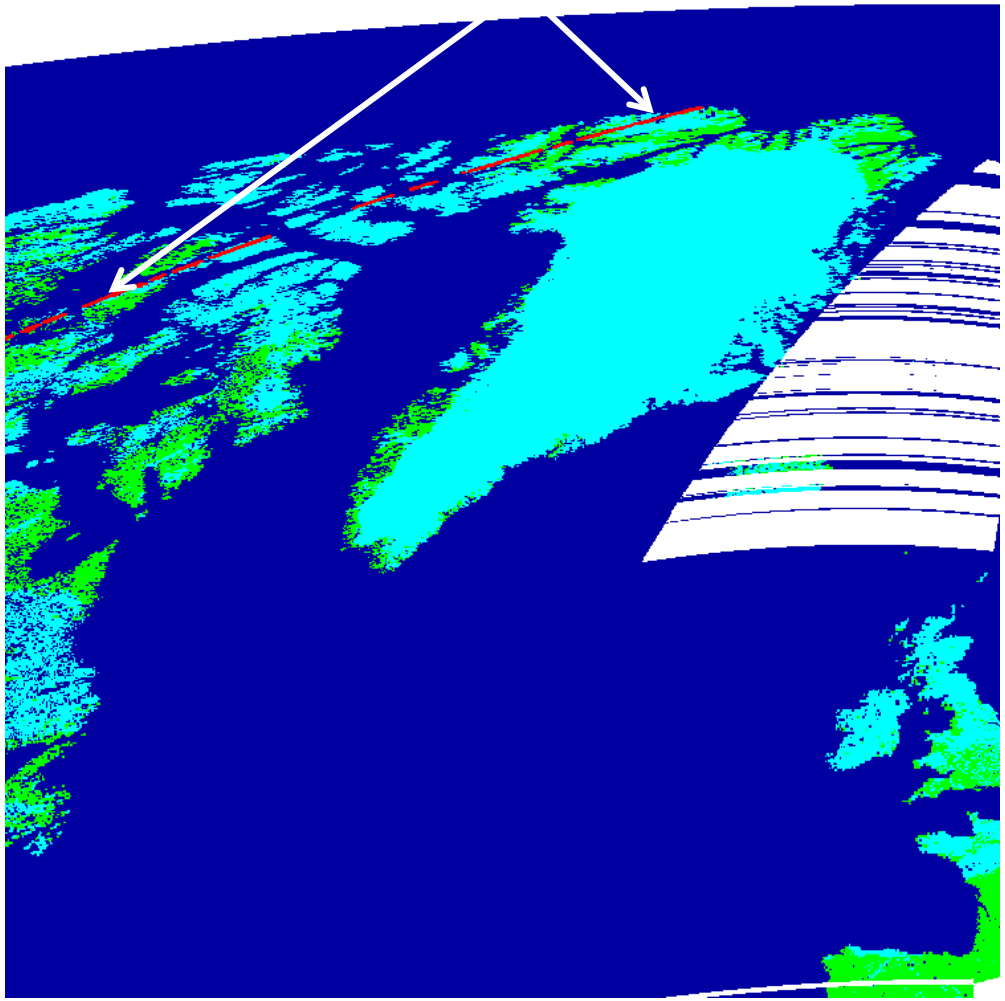
This KML displays VIIRS fire detections, derived using the VIIRS-AF algorithm, at a spatial resolution of 750m and associated fire radiative power measurements in megawatts (MW) for fire detections occurring in the past 6 hours, 6-12 hours, 12-24 hours and the previous 6 day period. Each 750m VIIRS fire detection and its associated FRP measure is depicted as a point representing the centroid of the 750m VIIRS pixel where the fire is detected. The 750m footprint of the VIIRS pixel for each detection is also displayed.

Data current as of **18-Jul-2014; 2345 Mountain Time (19-Jul-2014; 0545 UTC)** .
KML file generated by the USDA Forest Service Active Fire Mapping Program.
Please see http://activefiremaps.fs.fed.us for additional fire mapping products and information.

Disclaimer: Although these data have been used by the USDA Forest Service, the USDA Forest Service shall not be held liable for improper or incorrect use of the data described and/or contained herein. The information contained in these data is dynamic and is continually updated. This disclaimer applies both to individual use of the data and aggregate use with other data. The USDA Forest Service reserves the right to correct, update or modify this data and related materials without notification.

Primary quality issue: bad scan lines

July 15 2014 14:33:19 UTC



*Spurious scanlines are associated with **anomalous calibration** of the dual-gain M13 SDR data and/or **incorrect quality flagging**, typically at the **beginning of data granules or transmission**, of after **missing data packets**.*

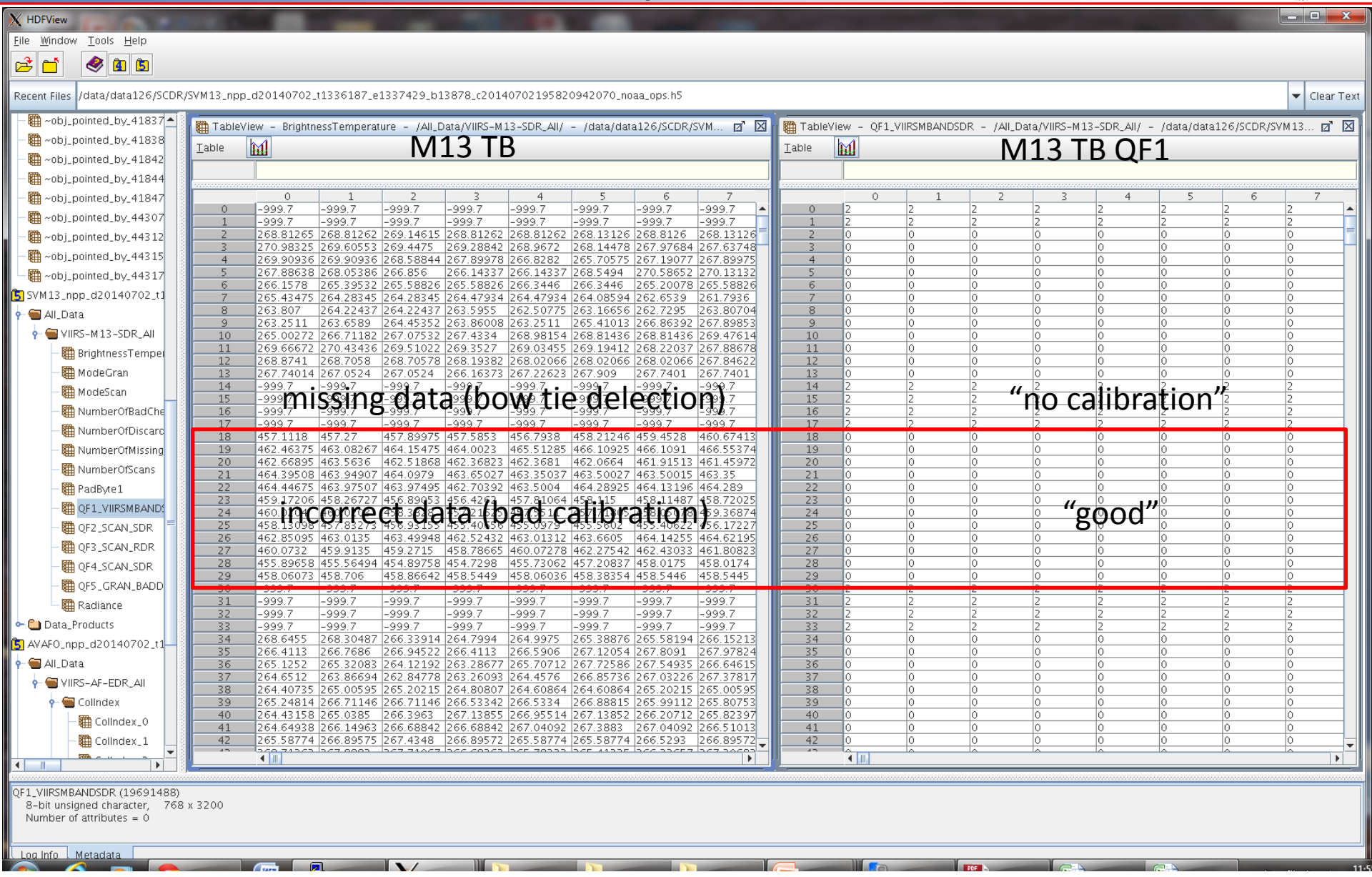
*Over time the **frequency** of spurious scanlines **decreased** as a result of IDPS SDR algorithm changes*

*Currently most spurious scanlines in the core ground segment data (**Stored Mission Data**) appear in the **Arctic**.*

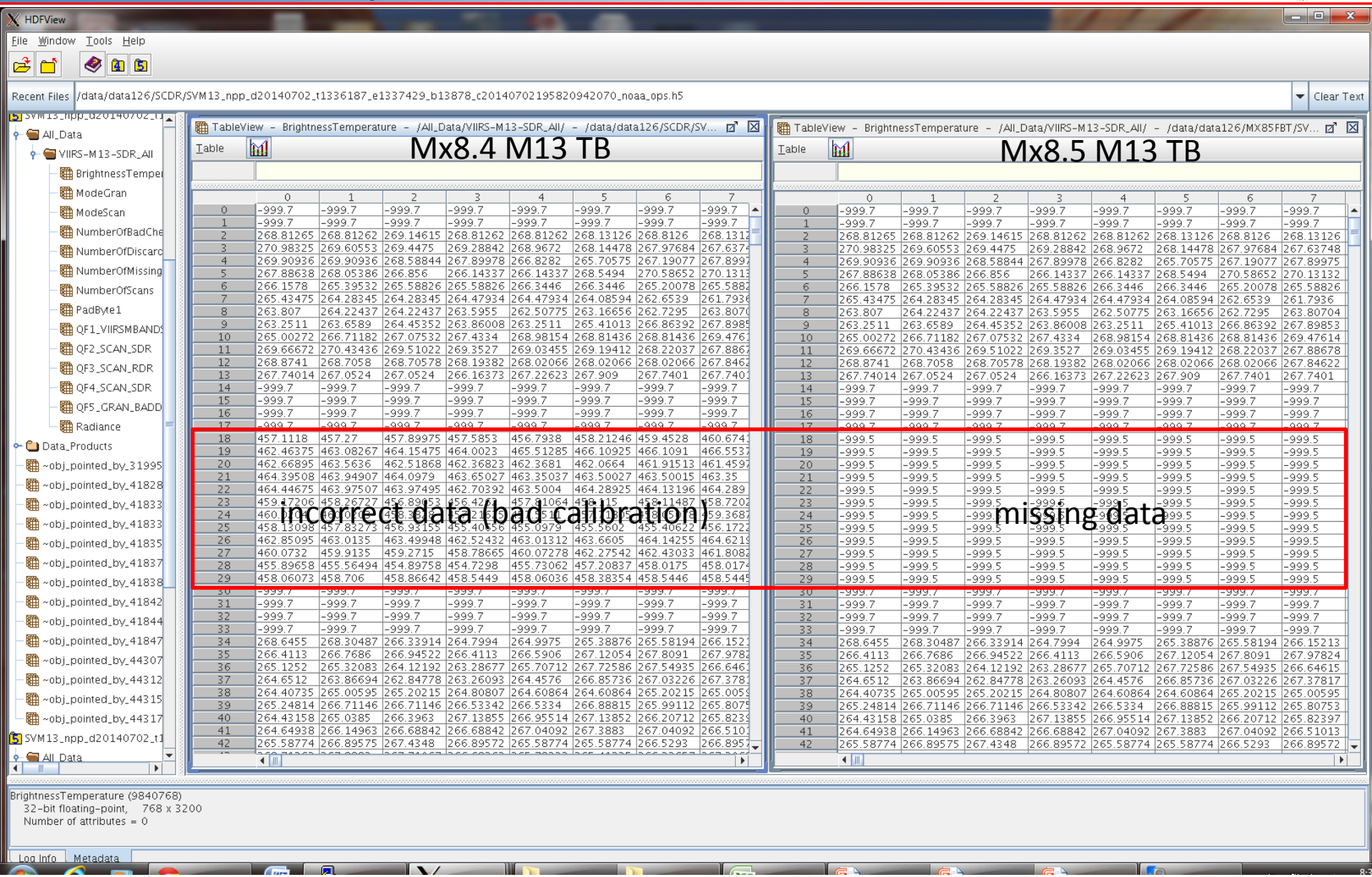
*Anomalies in **direct broadcast** data may occur **anywhere** .*

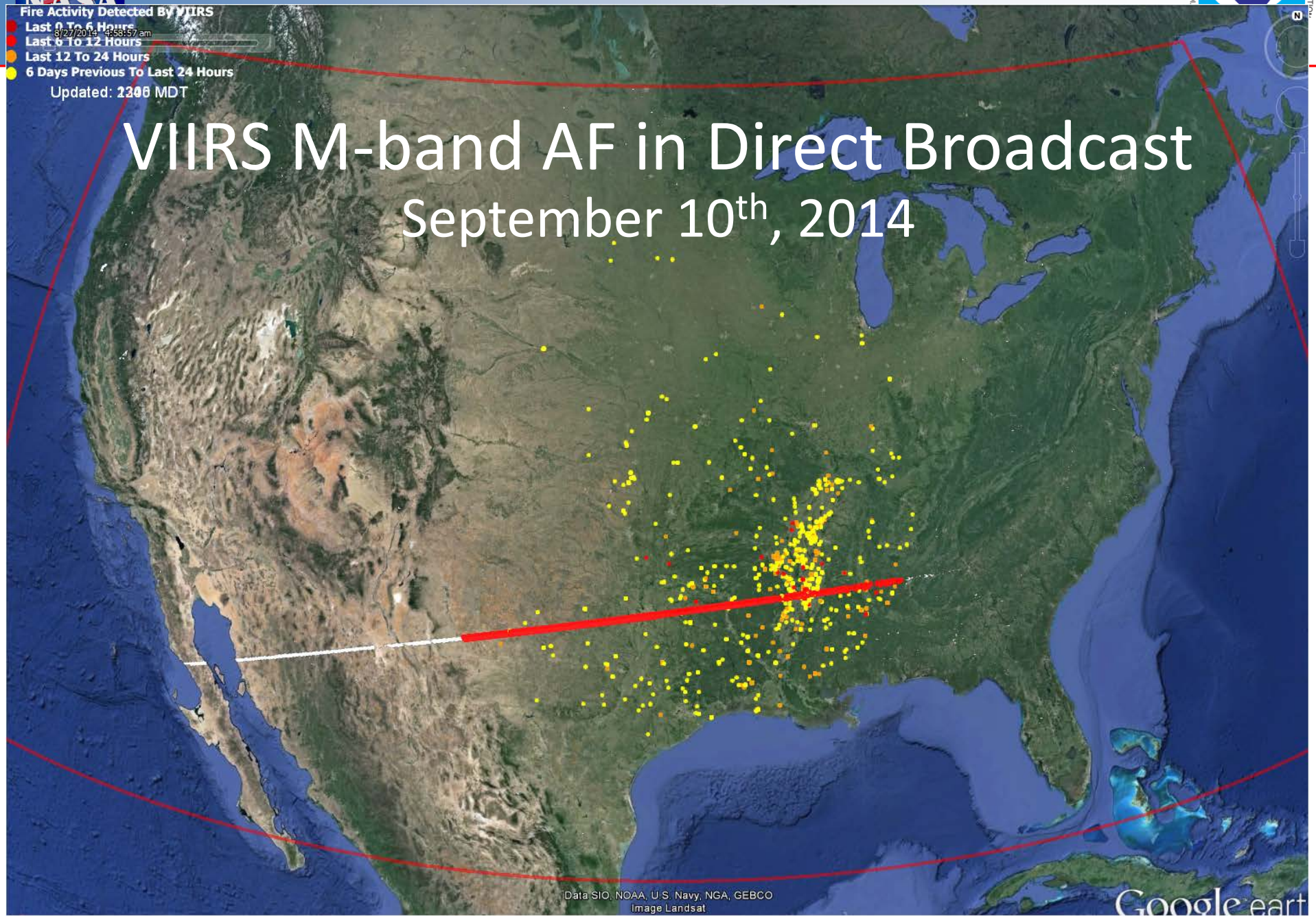
NPP_VAFIP_L2(Active Fire IP) on 2014196, LPEATE (AS3001)

Example of spurious detections: Mx8.4: July 2, 2014 case



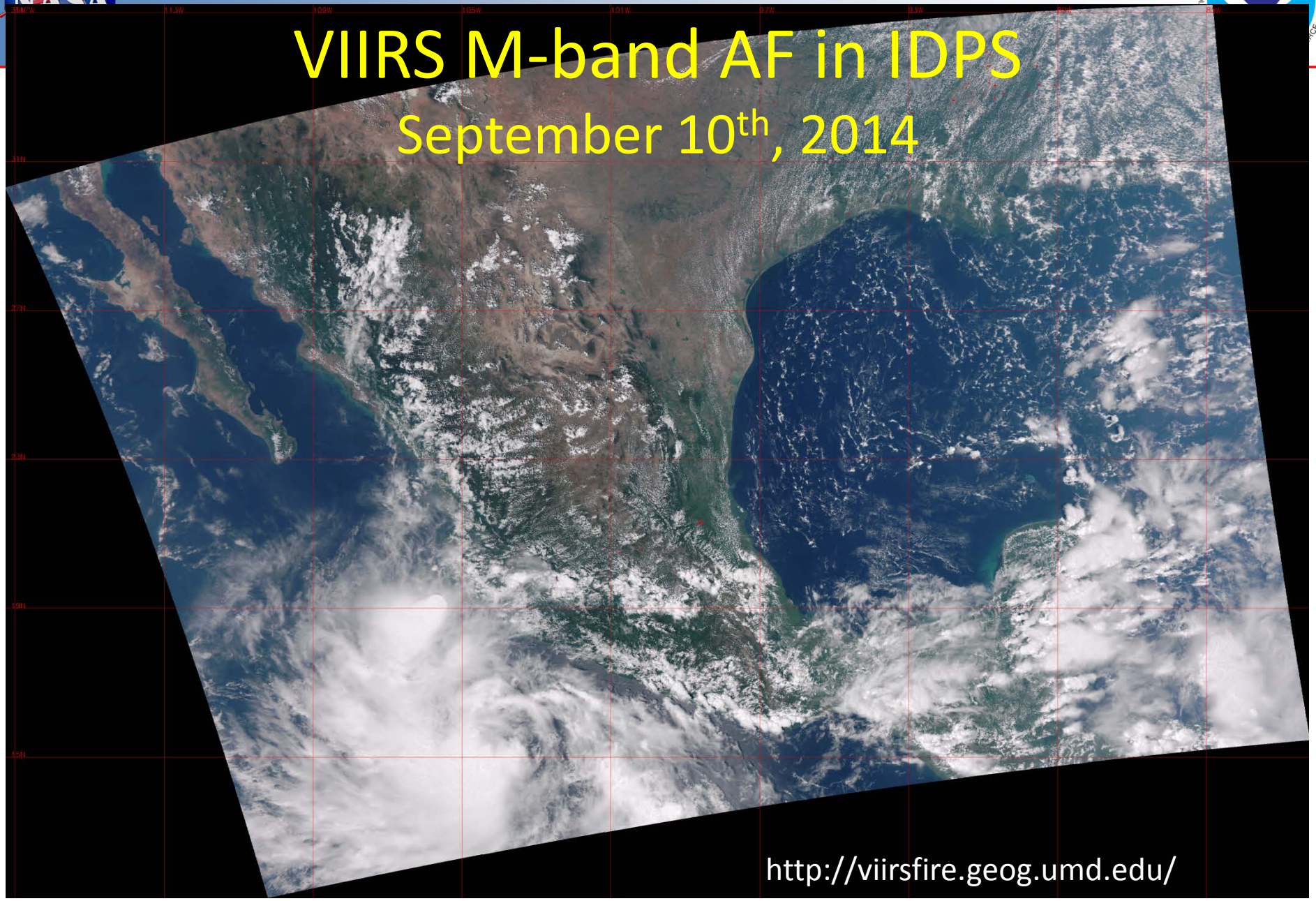
Example of spurious detections: July 2: Mx8.4 vs. Mx8.5 M13 TB



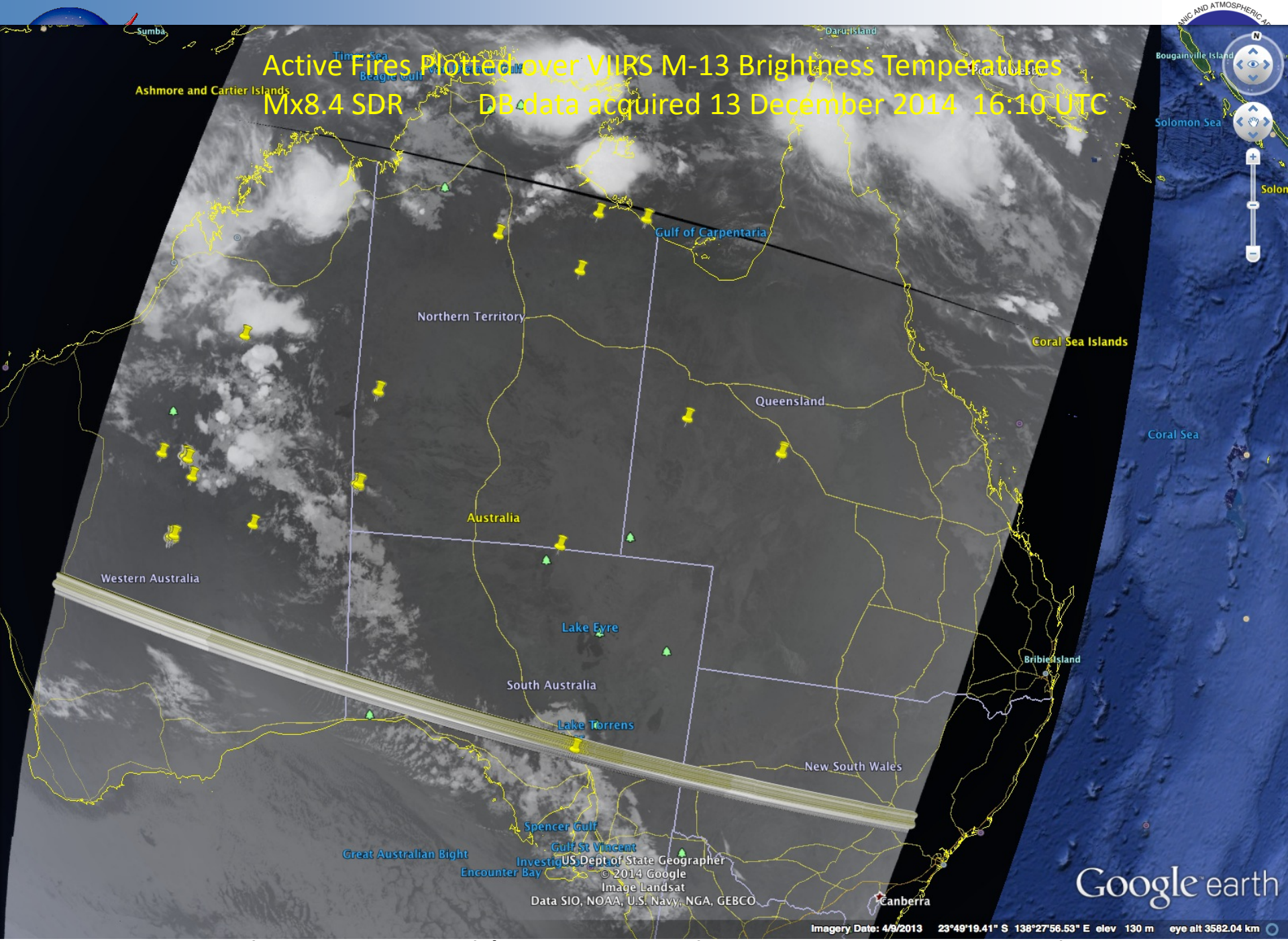

Fire Activity Detected By VIIRS
Last 0 To 6 Hours
Last 6 To 12 Hours
Last 12 To 24 Hours
6 Days Previous To Last 24 Hours
Updated: 1206 MDT
VIIRS M-band AF in Direct Broadcast
September 10th, 2014
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Google earth

VIIRS M-band AF in IDPS

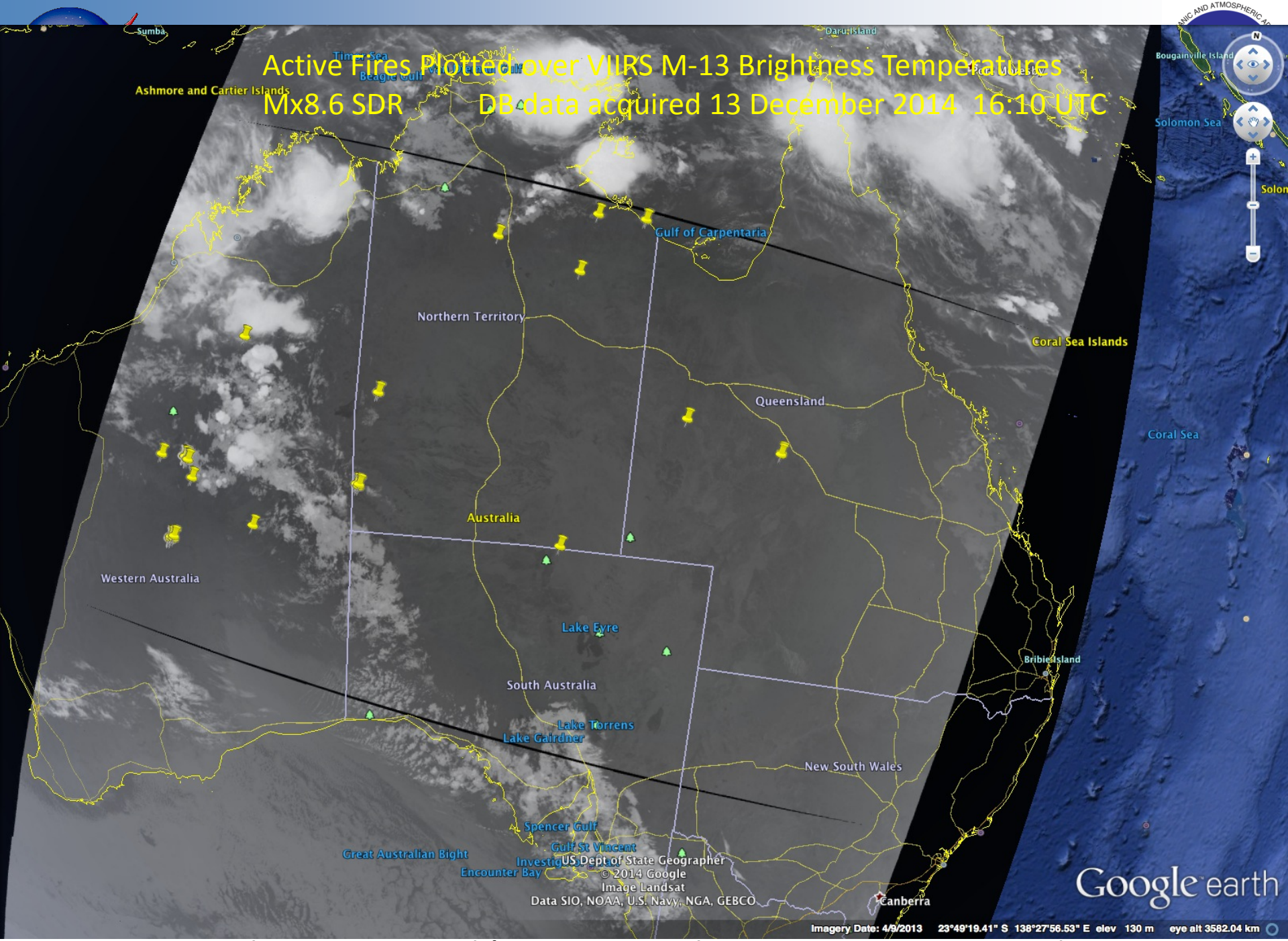
September 10th, 2014



http://viirsfire.geog.umd.edu/

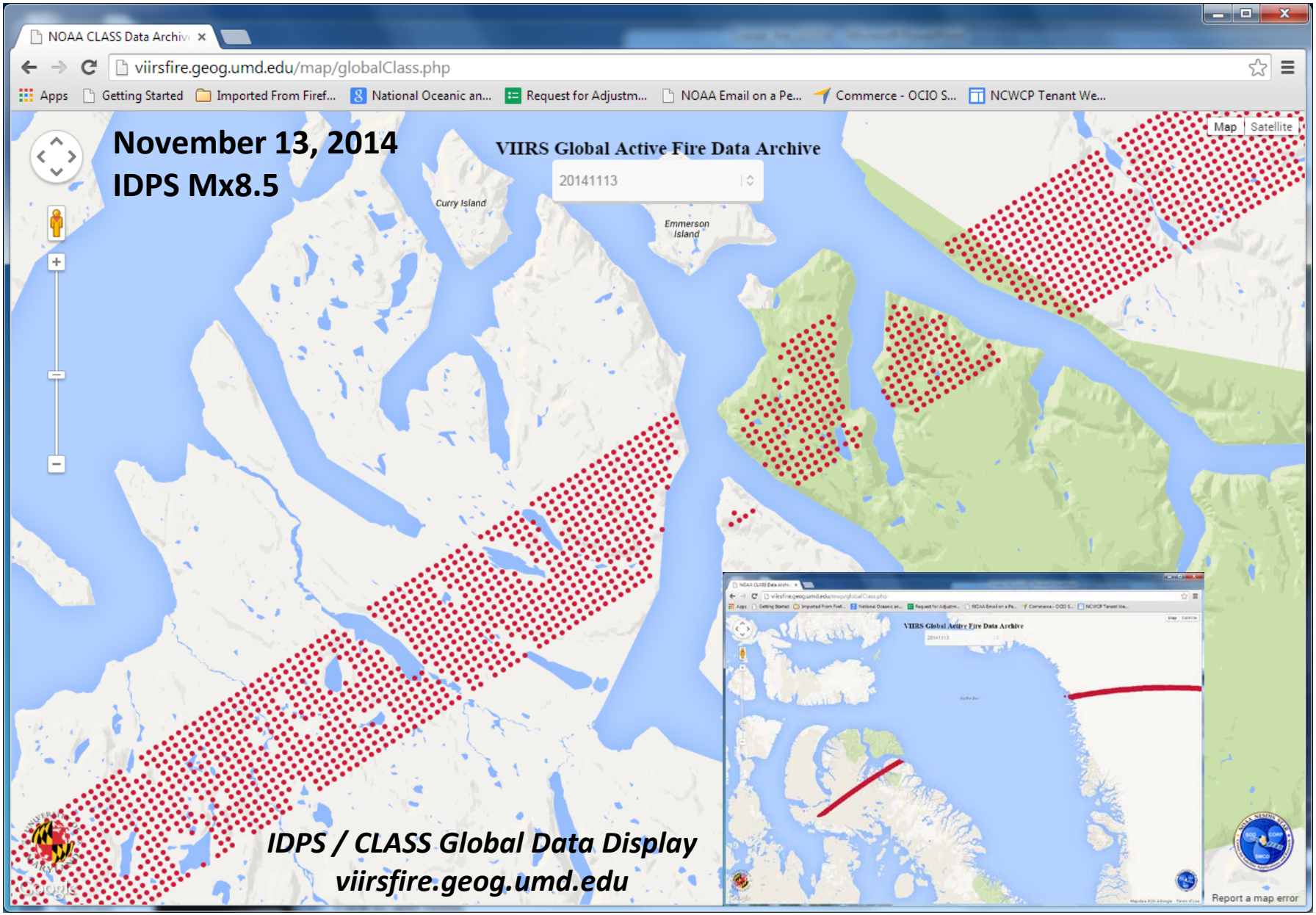


Credit: Lan-Wei Wang (Geoscience Australia) / Kathleen Strabala (University of Wisconsin – Madison)



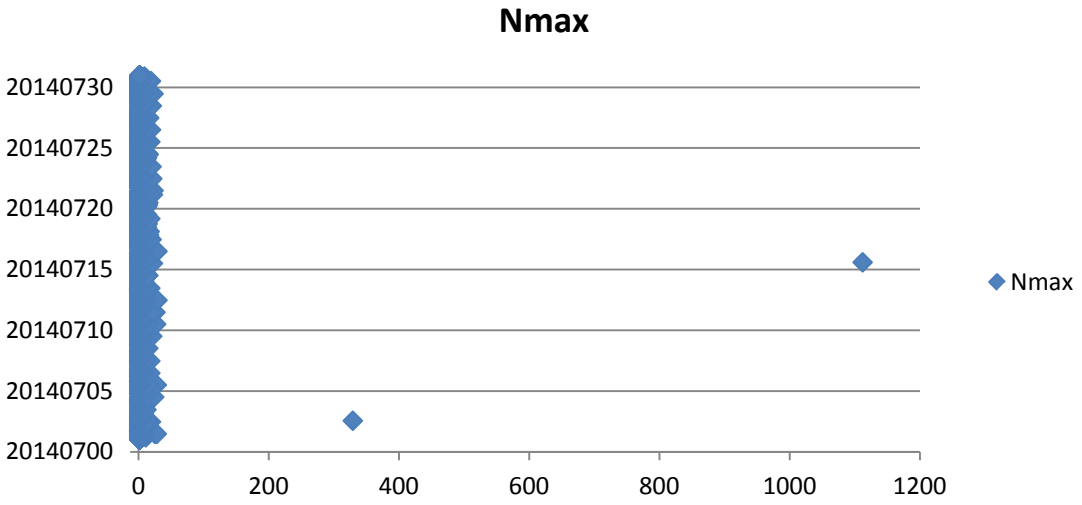
Credit: Lan-Wei Wang (Geoscience Australia) / Kathleen Strabala (University of Wisconsin – Madison)

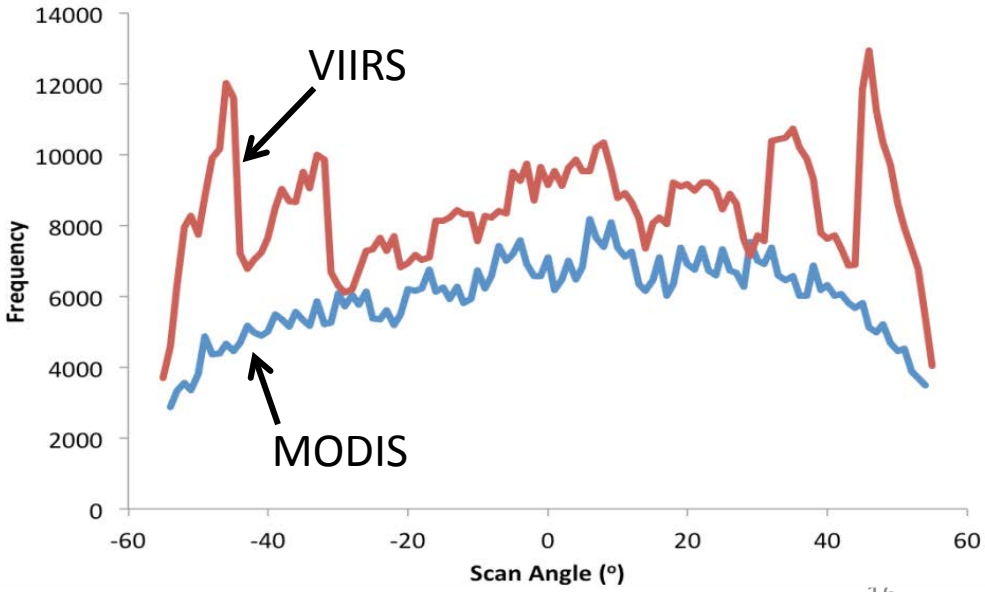
Remaining data anomalies in IDPS



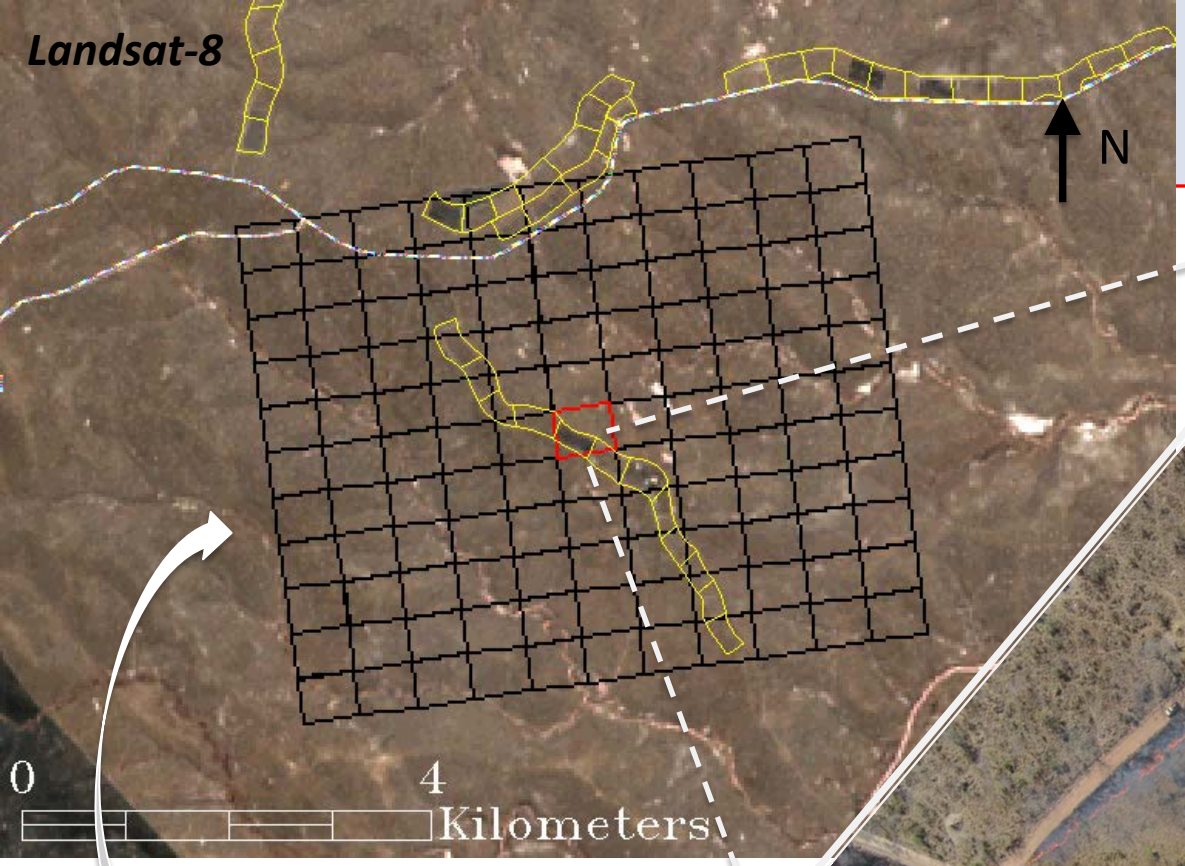
Monitoring Methods/Strategies

- Identification of data anomalies: spurious fire detections
  - Typically long segments of scan lines
- Monitoring key QFs
  - Input SDR quality
  - Detection confidence statistics
- Comparison with Aqua MODIS
  - Consistency; close match not expected due to differences in detection capabilities
- No in-situ data are available for systematic monitoring

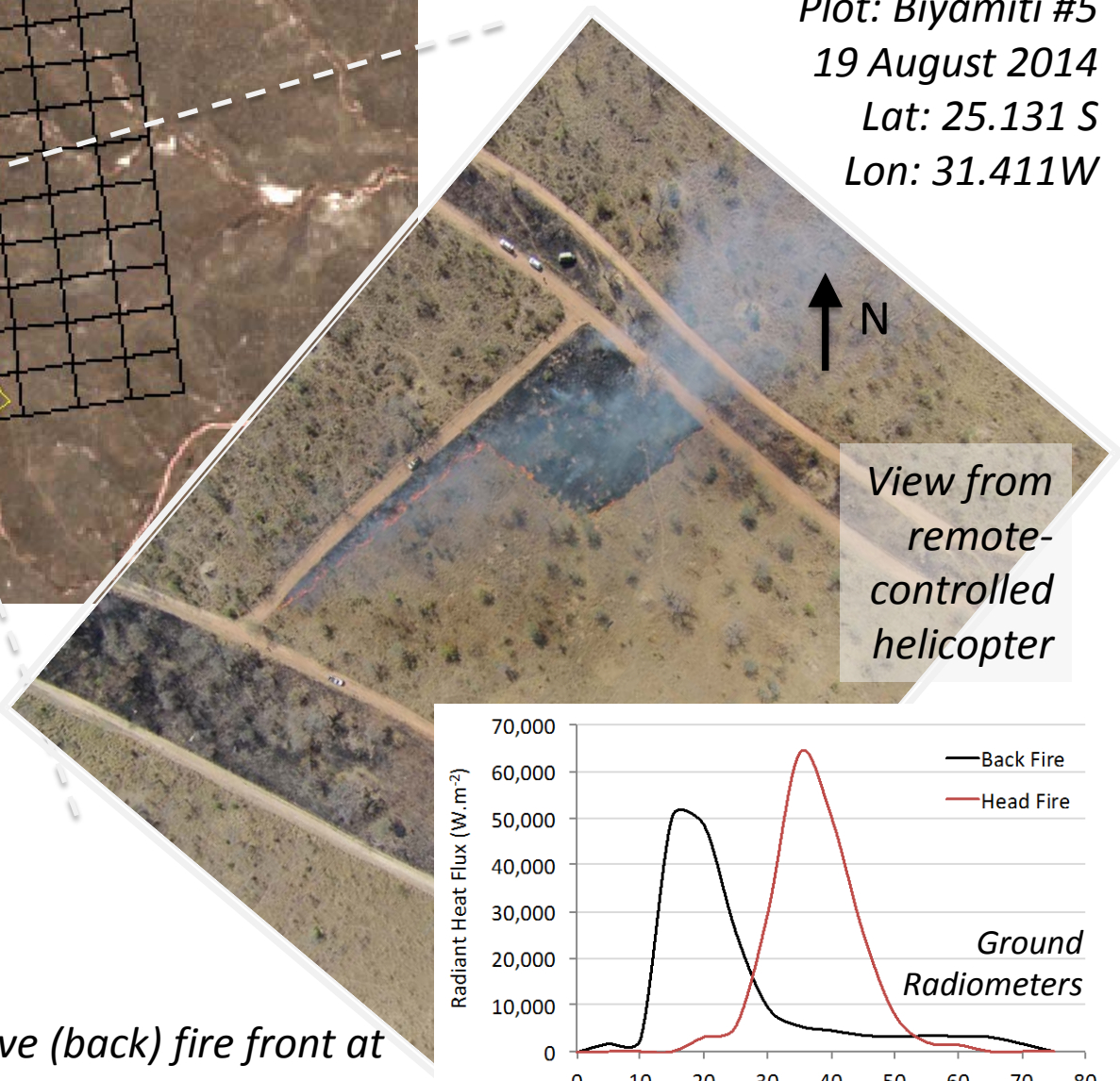




Feb - Jun 2013



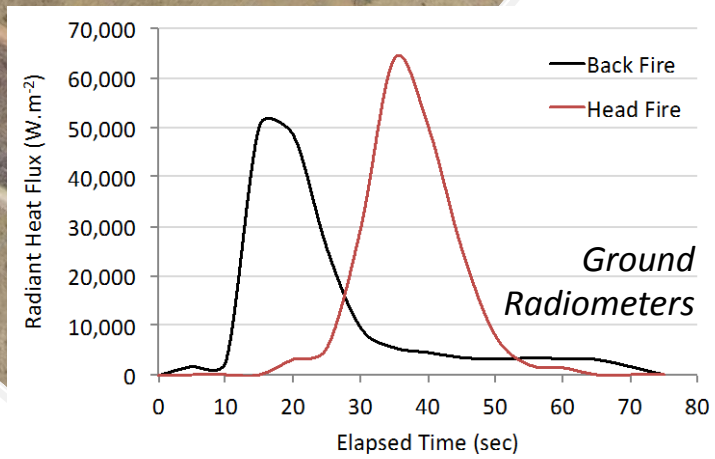
Plot: Biyamiti #5
19 August 2014
Lat: 25.131 S
Lon: 31.411W



View from remote-controlled helicopter

Subset of VIIRS 375 m pixel grid (fire detection in red)

Surface-leaving FRP (VIIRS): 4.4±0.2MW @ 13:24:26 h local time

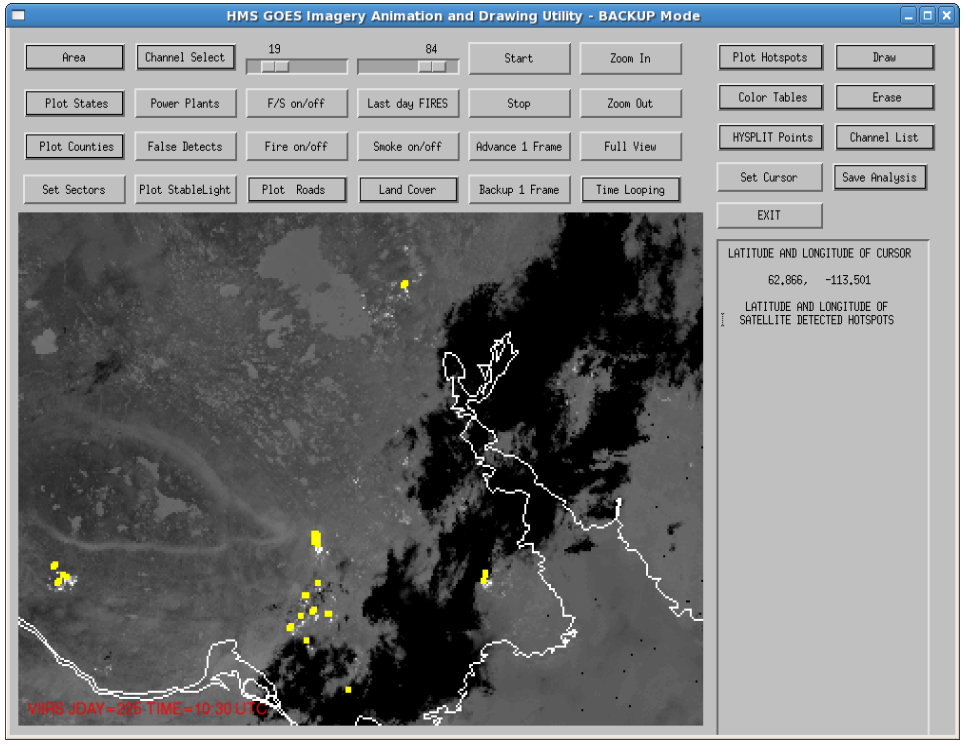


Length of active (back) fire front at time of VIIRS overpass: 200 m

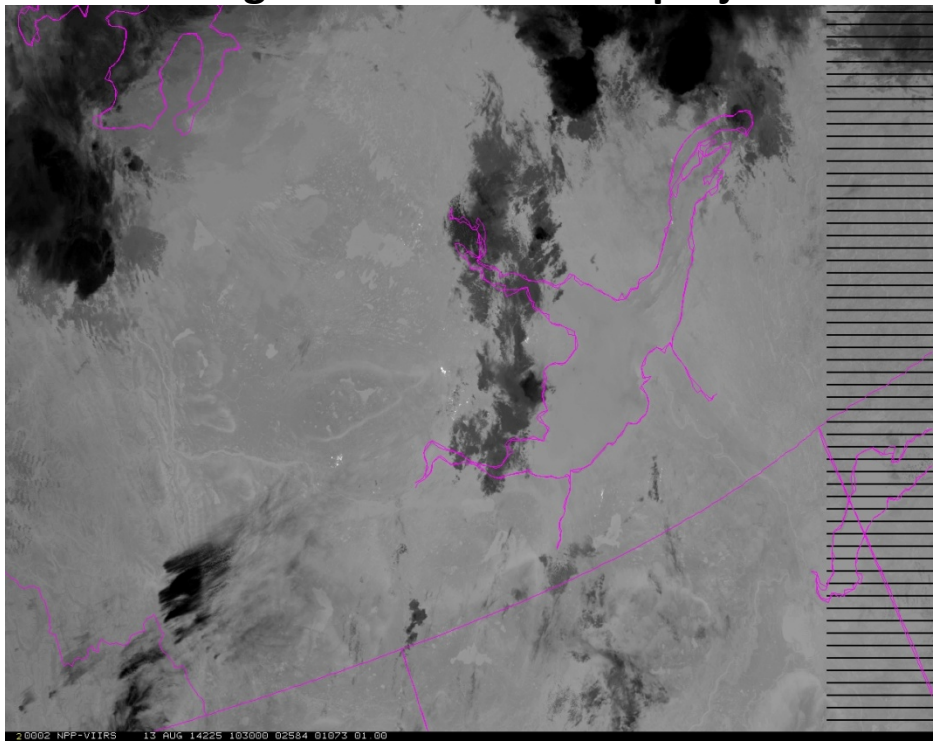
VIIRS Fire in the NOAA Hazard Mapping System (HMS)

- **VIIRS Active Fire is incorporated** with detected fires from numerous other satellite sources (GOES, POES and MODIS) and undergoes **additional manual quality control** before being merged into a unified daily fire analysis product for North America.
- The AFP also provides an additional **data source as input for initializing the daily National Weather Service Air Quality smoke forecast**.

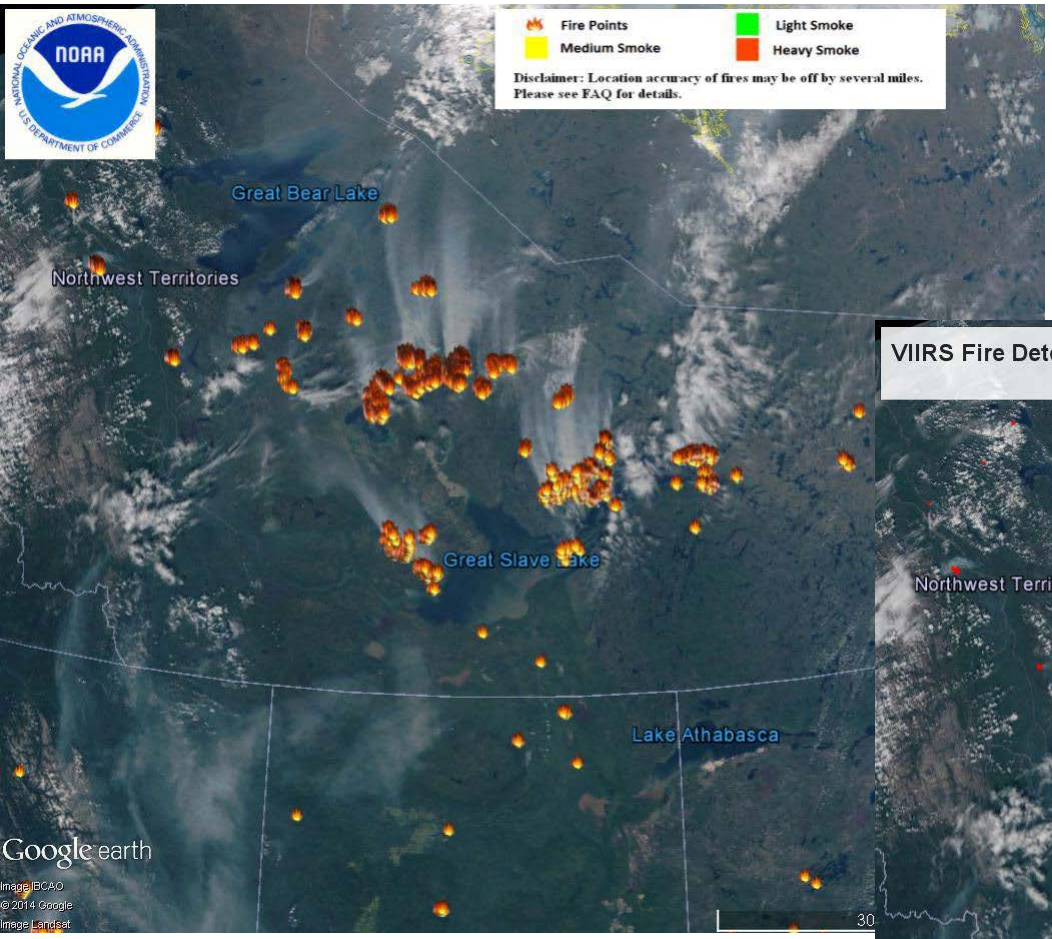
VIIRS AFP from 13 August 0850Z and 1030Z images over VIIRS M13 SDR 1030Z image



McIDAS display of 13 August 1030Z M13 SDR image in native satellite projection



VIIRS Fire in the NOAA Hazard Mapping System (HMS)



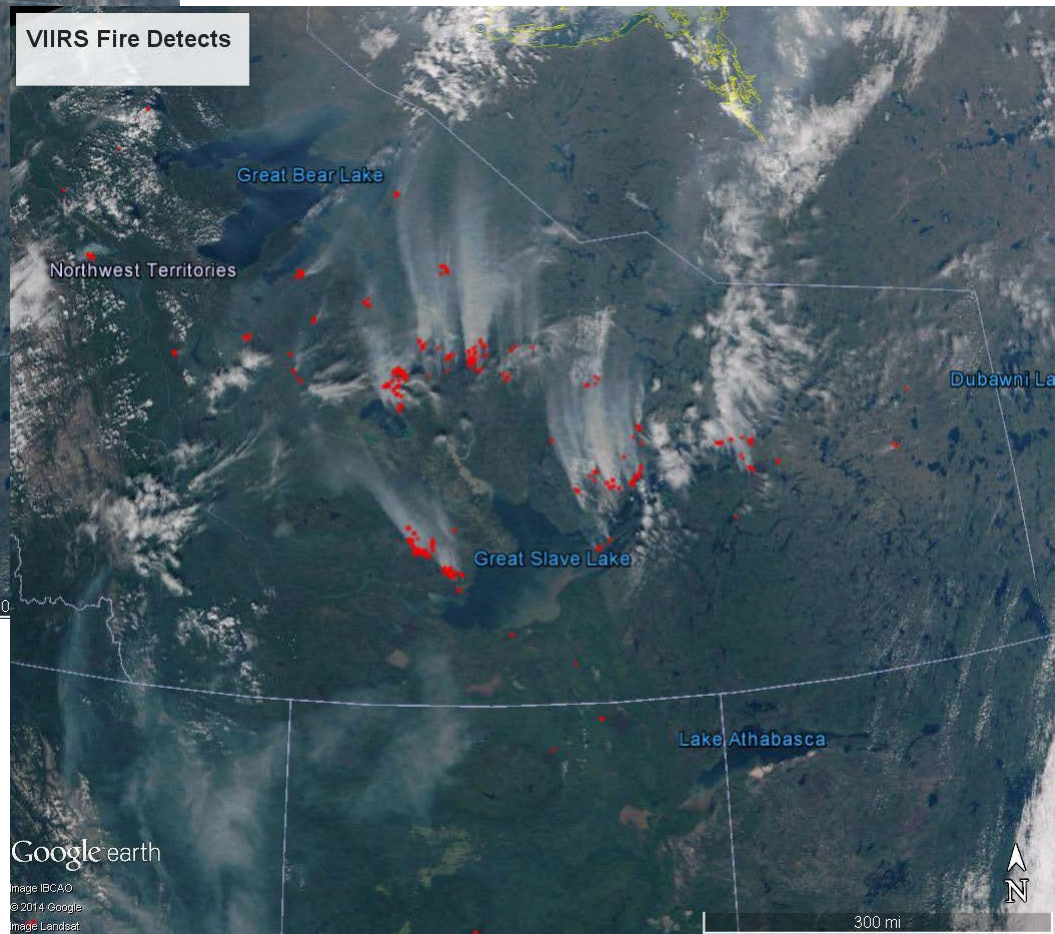
HMS multi-sensor analysis

July 13, 2014, NW Canada

Full operational implementation in early 2015.

The relative contribution of VIIRS data is being evaluated, including needs for operational redundancy.

IDPS VIIRS fire product



Fire and Smoke Initiative Objectives

- Organize a forum to allow stakeholder supporting Fire and Smoke detection and forecasting to interact
- Encourage participation of the stakeholder organizations with current responsibilities in Fire and Smoke detection and forecasting.
- Understand the current use of geostationary and polar orbiting satellite capabilities in support of Fire and Smoke detection and forecasting mission
- Identify current SNPP/JPSS and new GOES-R data and capabilities with the potential to improve support to this mission
- Establish methodologies and procedures for the operational demonstrations of these capabilities
- Following these operational demonstrations, identify the satellite capabilities whose operational impacts are sufficient to warrant transition from research to operations
- Determine required actions for an effective transition of these capabilities to operations

VIIRS active fire data portal

VIIRS AF Table Data | VIIRS

viirsfire.geog.umd.edu/viirs-af-table-data

Apps | Getting Started | Imported From Firef... | National Oceanic an... | Request for Adjustm... | NOAA Email on a Pe... | Commerce - OCIO S... | NCWCP Tenant We...

VIIRS Active Fire | Home | About | FAQ | VIIRS AF Products | VIIRS vs MODIS | Maps & Data | Contact Us

VIIRS AF Table Data

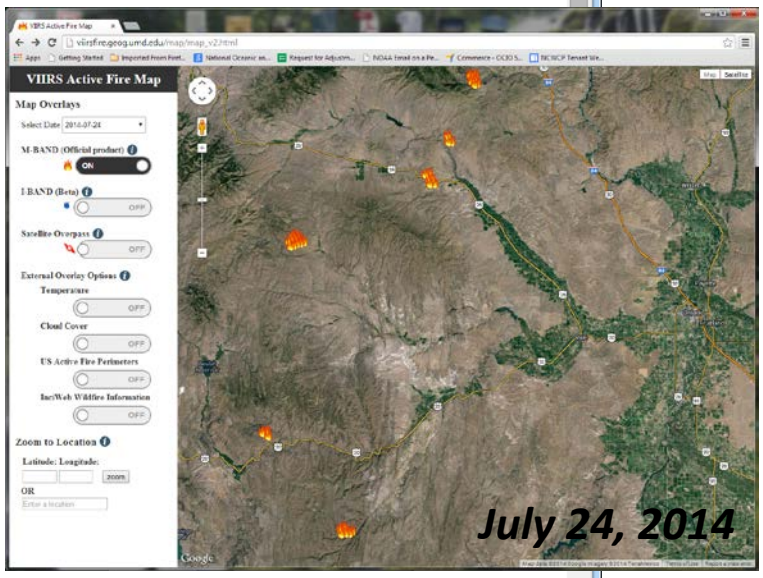
http://viirsfire.geog.umd.edu/

View CONUS Active Fire Map

View active fire detections. The map also provides an icon to represent the center of each VIIRS granule, weather information (temperature and cloud cover), and RSS feeds for US active fire perimeters and Incident Information. RSS feeds provided by GEOMAC and InciWeb, respectively.

View Global Active Fire Map

VIIRS daily global active fire detections



Data Archive

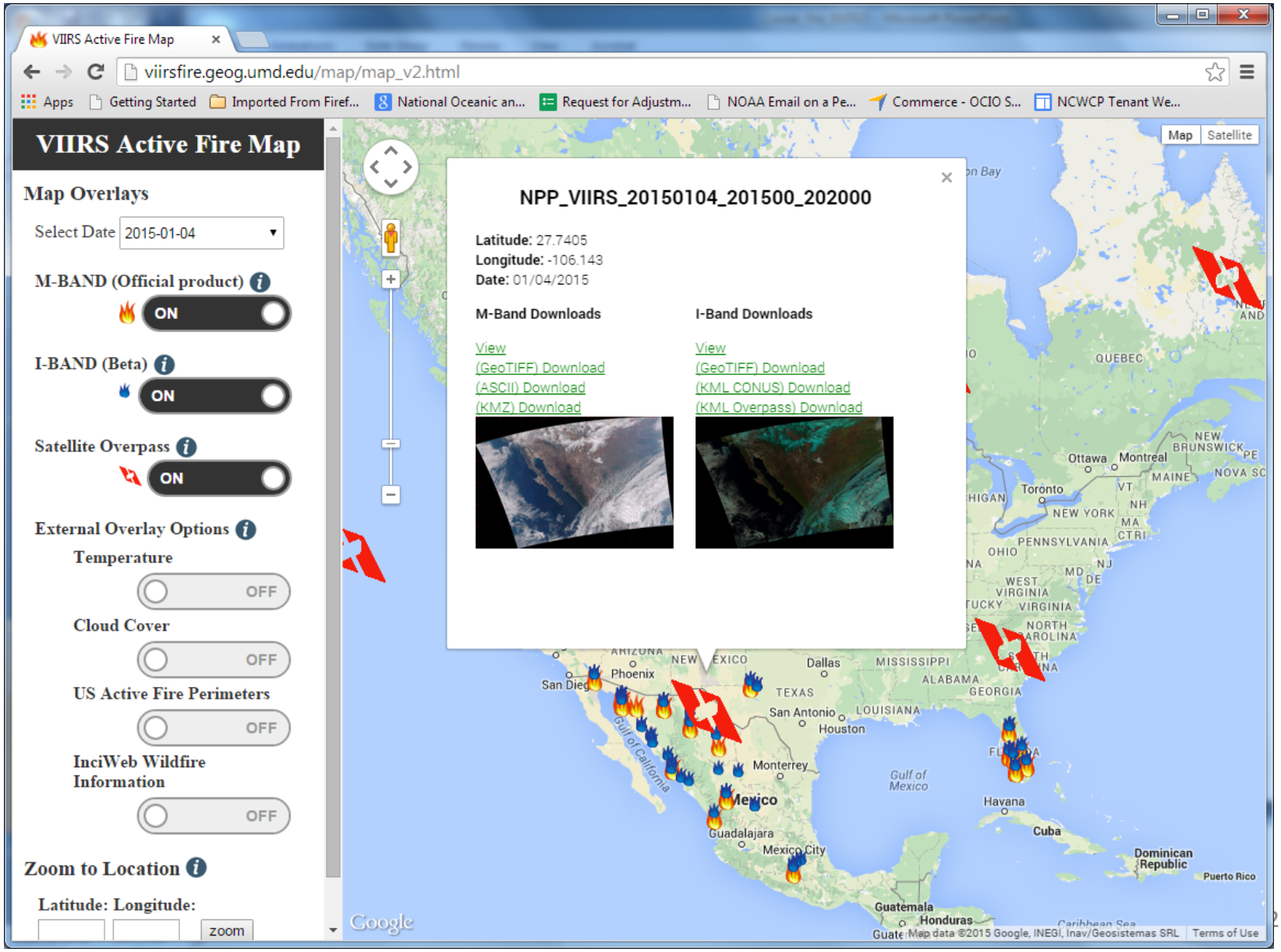
Displaying 1 - 20 of 6395

Date

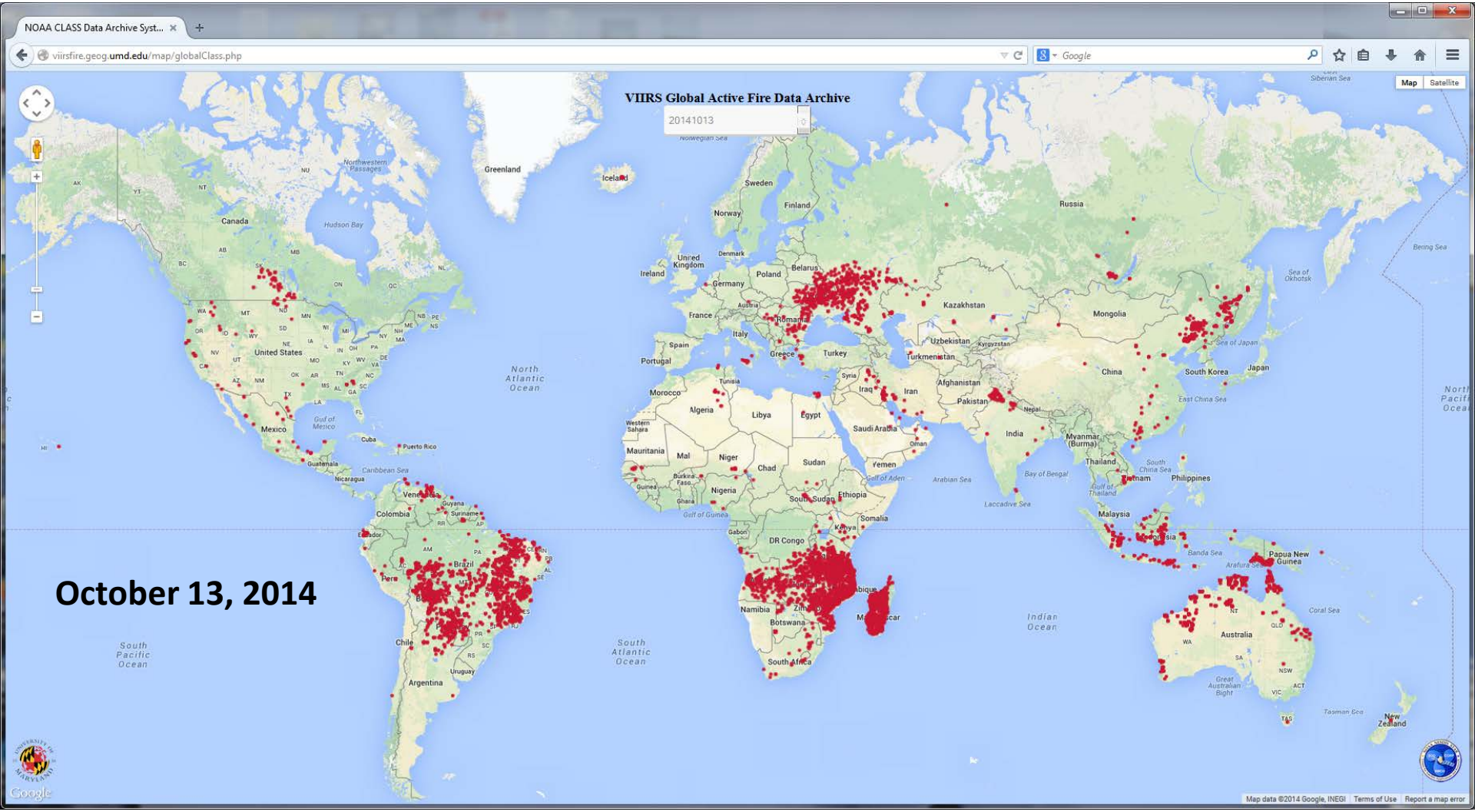
Apply

Date	Timestamp	ASCII	KMZ	TIFF	IBAND(png)	IBAND(GeoTIFF)	IBAND(kml)

VIIRS active fire data portal



VIIRS active fire data portal

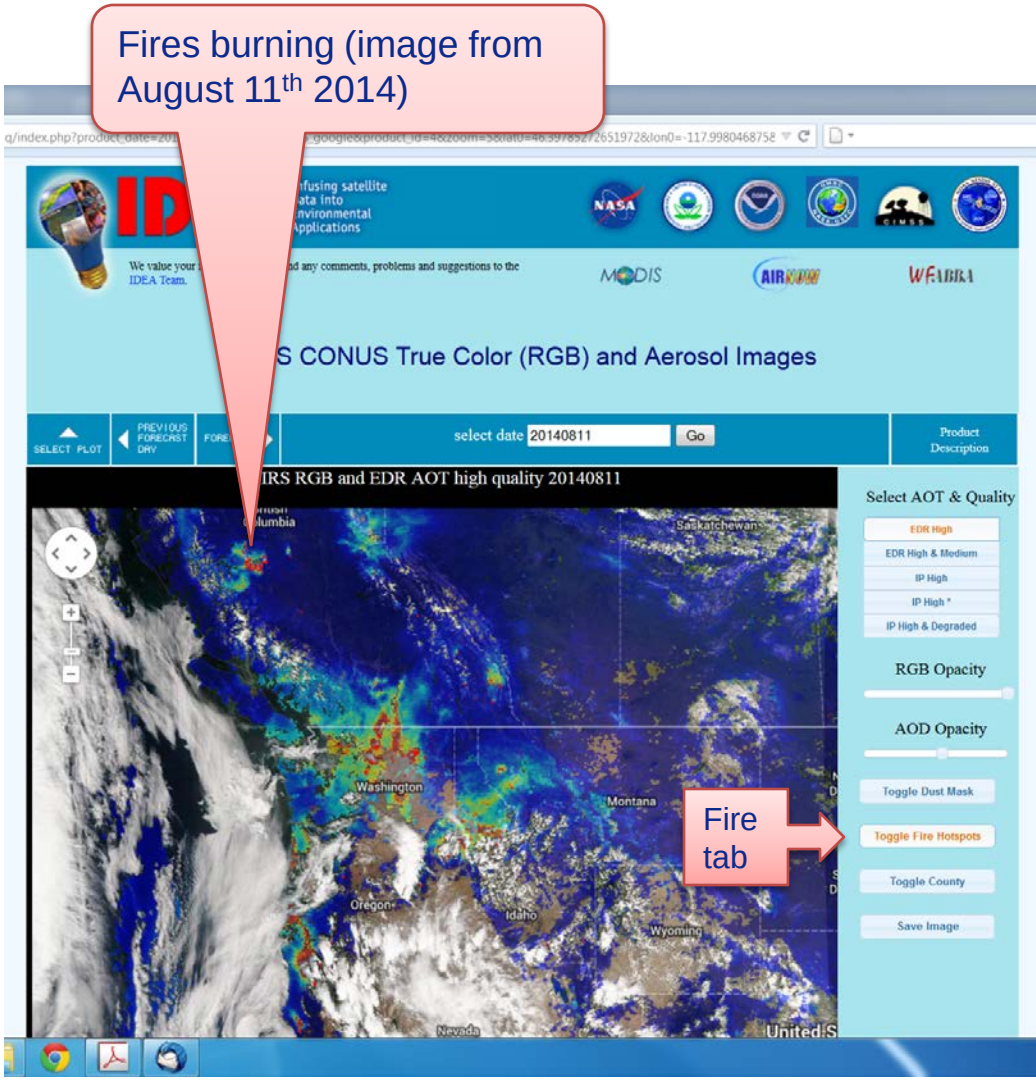


http://viirsfire.geog.umd.edu/

Data from NOAA CLASS: http://www.nsof.class.noaa.gov/

VIIRS Fire in STAR Smoke Analysis system (IDEA)

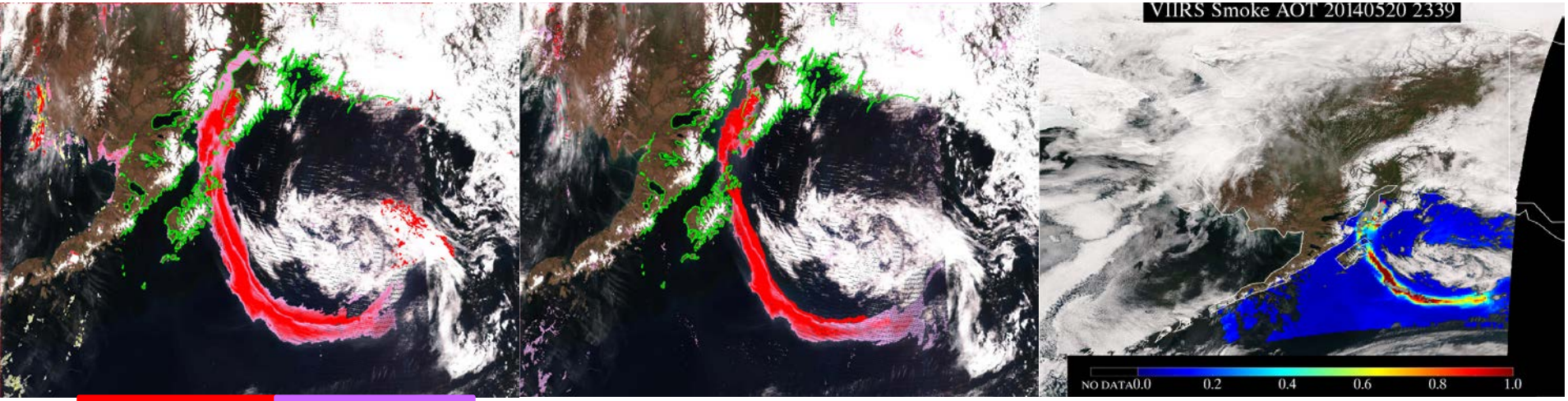
- IDEA (Infusing satellite Data into Environmental Applications) system and ASDA (Automated Smoke Detection and tracking Algorithm) have been using **VIIRS hot spots** generated from DB data since March 2013. NDE products will also be used when available operationally.
- GBBEPx (Global Biomass Burning Emissions Product – Extended) will also use the product when **FRP** becomes available along with fire detection
- Air quality forecasters use the IDEA system in their daily forecasting. *This website gets more than one million hits each year.*
- NWS Alaska and Western regions will use ASDA smoke plumes for incident monitoring and containment activities. *Through new fire and smoke initiative*
- GBBEPx using fire detection and FRP will generate emissions that will be used by **NCEP's global aerosol model**



http://www.star.nesdis.noaa.gov/smcd/spb/aq/

Testing of Different Smoke Detection Algorithms on VIIRS Data

JPSS RR Algorithm | GOES-R ABI algorithm | ASDA Algorithm



Thick Smoke | Thin Smoke

Funny River Fire Southern Alaska on 05/20/2014

- Smoke event nicely captured by VIIRS
  - Qualitative smoke detection has some data artifacts: false dust detection, false smoke detection in between clouds. But this smoke was mixed in with clouds quite a bit so hard to tell if smoke near clouds is true or not. Need to evaluate further.
  - ASDA "smoke AOD" product is quantitative but has a higher latency due to run time of the ASDA algorithm
- Question to users: which product do you prefer? A qualitative product generated with lower latency or a quantitative product with higher latency

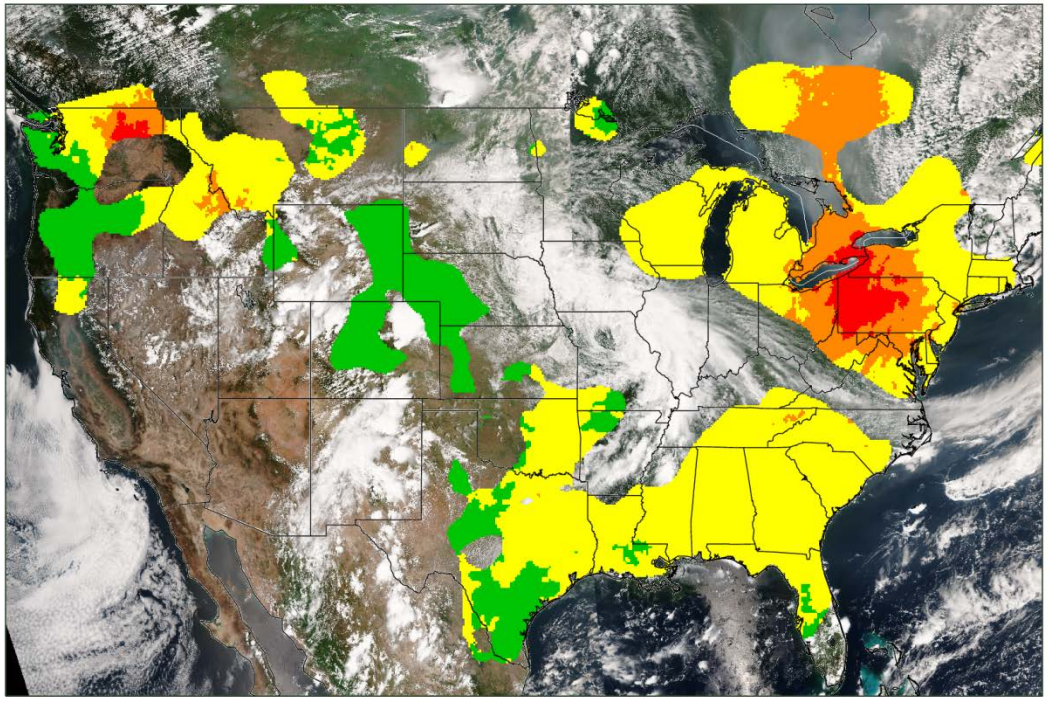
Air Quality and Public Health

Air Quality Index (AQI) for August 7, 2014 from SNPP VIIRS

Aerosols from natural (fires, volcanic eruptions, dust storms) and man-made (cars, industry) sources are harmful to human health. **More than 3 million premature deaths globally per year*.**

EPA ground monitors not dense enough to provide monitoring and warnings for 40 million people living in rural areas in the US.

Satellite data help fill the spatial gaps



AQI AIR QUALITY INDEX 50 100 150 200

NESDIS satellite-derived air quality products used in Environmental Protection Agency (EPA) Air Quality Index (AQI) forecasts. Currently using Aqua/Terra MODIS with plans to transition to SNPP VIIRS. *AQI derived for August 7, 2014 using **SNPP VIIRS** aerosol optical thickness is shown above as an example.*

Courtesy of S. Kondragunta (STAR) and H. Zhang (IMSG)

Global Disease Burden project by Lim et al., The Lancet, 2012

Global Observation of Forest and Land Cover Dynamics Fire Implementation Team Meeting

Primary forum for international outreach and coordination

NOAA Center for Weather and Climate Prediction, College Park, MD, July 29-31 2014

Summary and conclusions

- The **IDPS Suomi NPP product** is stable
  - Validated Stage 1 science maturity and NOAA Operational status
- Some **data anomalies** in Direct Broadcast and high latitudes remain
- A processing code is available to generate a product that meets the **JPSS 1 requirements** is available
  - Developed as part of a NASA Science Team effort
  - Implemented at STAR
- An automated **long-term monitoring system** is being set up at STAR for quality monitoring and reactive maintenance of the Suomi NPP Active Fire product
- Continuing efforts towards rigorous **validation** using **independent reference data**
- Domestic and international **partnerships and user outreach** are ongoing as part of Proving Ground / Fire and Smoke and GOFC-GOLD initiatives

For more information

- **NOAA JPSS**

  www.jpss.noaa.gov
- **NOAA STAR JPSS**

  www.star.nesdis.noaa.gov/jpss
- **VIIRS Fire Evaluation and Data Portal**

  viirsfire.geog.umd.edu
- **STAR JPSS 2014 Annual Science Team Meeting**

  www.star.nesdis.noaa.gov/star/meeting_2014JPSSAnnual_agenda.php

- Csiszar, I., W. Schroeder, L. Giglio, E. Ellicott, K. P. Vadrevu, C. O. Justice, B. Wind, 2014: **Active fires from the Suomi NPP Visible Infrared Imaging Radiometer Suite: Product status and first evaluation results**, *J Geophys Res Atmos*, 119, doi:10.1002/2013JD020453.
- Schroeder, W., P. Oliva, L. Giglio, I. A. Csiszar, **The New VIIRS 375 m active fire detection data product: Algorithm description and initial assessment**, Remote Sensing of Environment, Volume 143, 5 March 2014, Pages 85-96, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2013.12.008

Backup slides

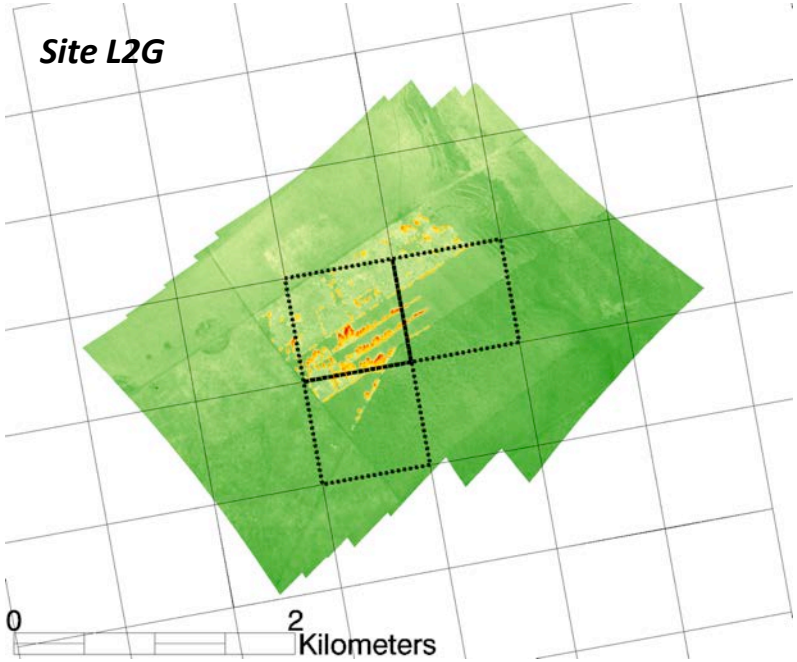
National Weather Service: Information Gaps

- Limited observations and measurements near fires
- Real-time detection of fires
- Improved high-res model forecast guidance
- Fine-scale coupled model (sub 1-km, hourly)
- Improved Red Flag ID, lead time, indexing
- No coupled smoke behavior prediction less than 4 km res
- Intra-seasonal prediction of fires
- IMET capability improvements (training, customer interface)
- Tool for debris flow prediction
- Social science evaluation

Eli Jacks, Supervisory Meteorologist, Fire and Public Weather Services
Peter Roohr, Meteorologist, Science Plans Branch
Heath Hockenberry, Meteorologist, Fire and Public Weather Services

VIIRS Fire Product Validation: Preliminary Results

Prescribed Fire Combustion and Atmospheric Dynamics Research (RxCadre) experiment in Eglin Air Force Base, FL Nov 2012.



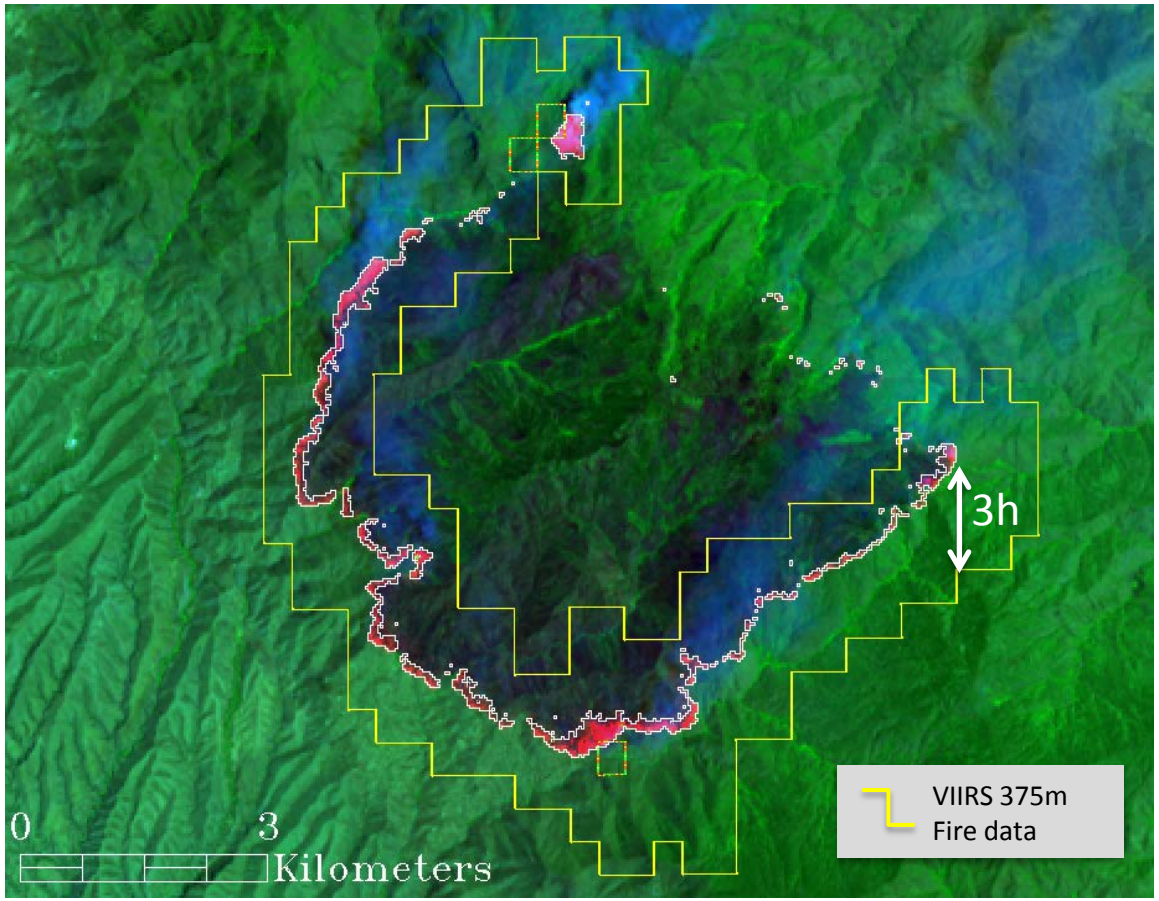
VIIRS (750 m) mapping of 2012 prescribed fire in Florida using airborne reference data (WASP sensor)

		FRP (MW)				Time (UTC)		
Satellite	Fire	WASP	MODIS	Diff	Cloud	WASP	MODIS	Diff (s)
MODIS	L1G	148	143	5	Yes	19:19:47	19:18:58	49
	L2G	111	167	-55	No	18:42:26	18:42:01	25
	L2F	119	199	-79	No	19:25:56	19:25:05	51
			Mean (SD)	-43 (44)				
VIIRS	L1G	414	158	256	Yes	18:59:24	18:59:54	30
	L2G	152	151	1	No	18:49:08	18:47:22	106
	L2F	487	237	250	Yes	18:29:47	18:28:34	73
			Mean (SD)	169 (146)				

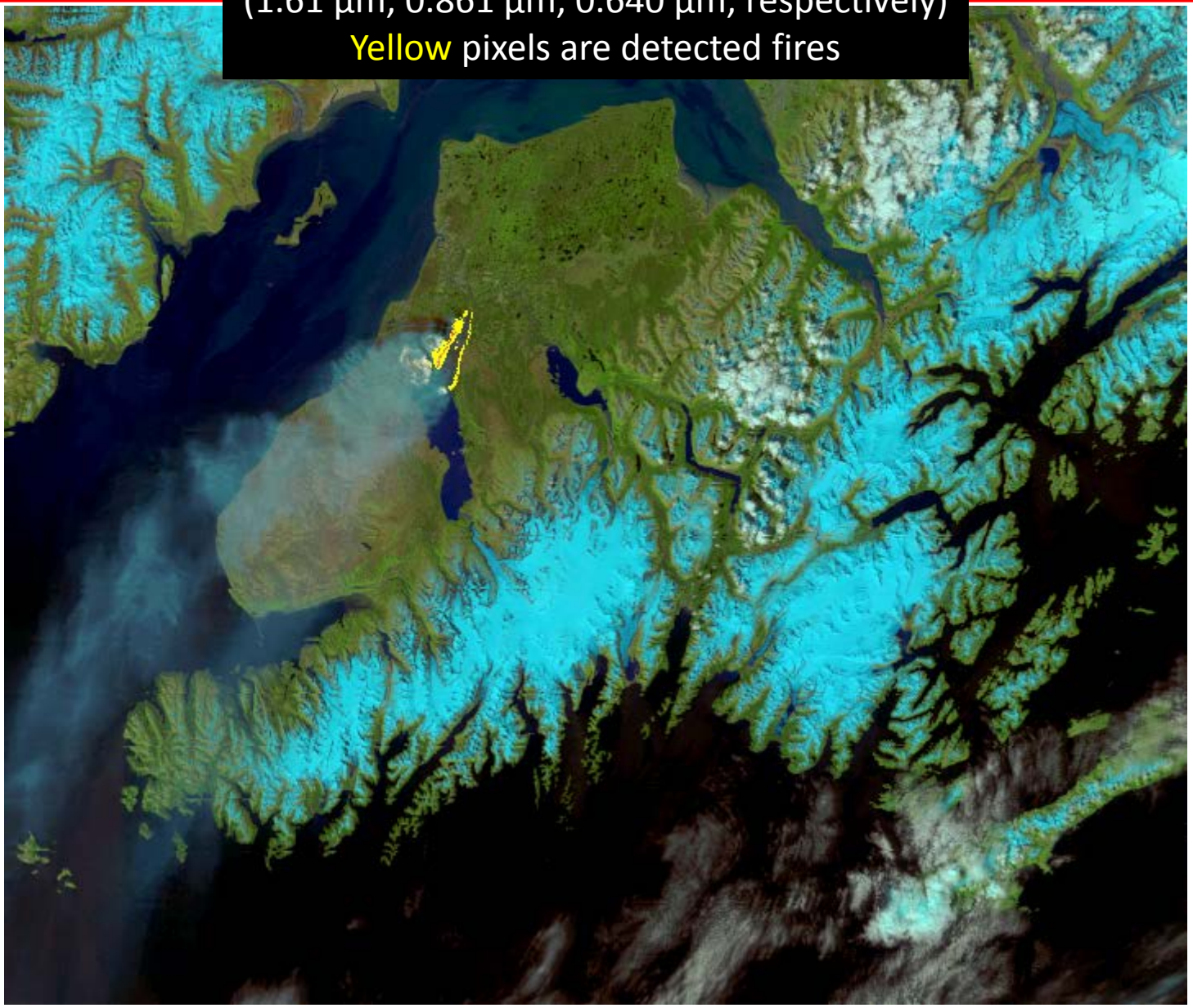
Dickinson et al. [2014]

Landsat-8 30 m Active Fire Data

Built on proven ASTER/Landsat (5&7) fire algorithms [Giglio *et al.*, 2008; Schroeder *et al.*, 2008]
Day & nighttime detections 16/8-day revisit (day/&night)
Spatial resolution providing detailed fire perimeter information (plus area estimate)



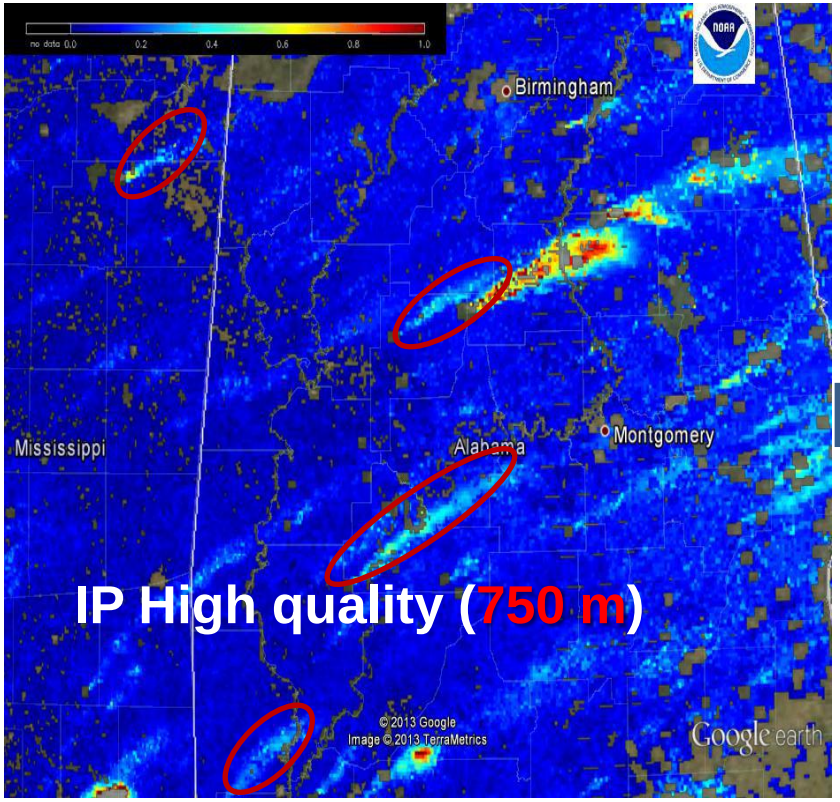
I-band false color “RGB” using bands 3-2-1
(1.61 µm, 0.861 µm, 0.640 µm, respectively)
Yellow pixels are detected fires

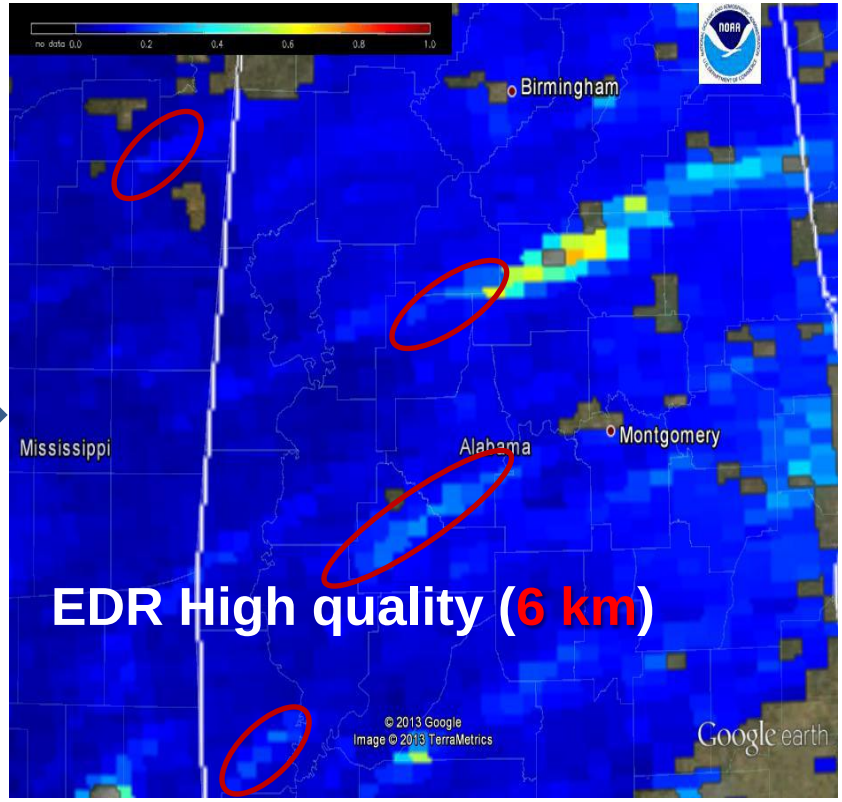


High Resolution Aerosol Optical Thickness (AOT) product from SNPP VIIRS provides forecast guidance to operational air quality forecasters

Pixel level AOT clearly shows smoke plumes from different fires including the small ones.

The smoke plumes in the EDR AOT are pixelated and not very obvious





Courtesy of S. Kondragunta (STAR) and H. Zhang (IMSG)