Recent advances in the development and applications of VIIRS active fire products

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Science issue

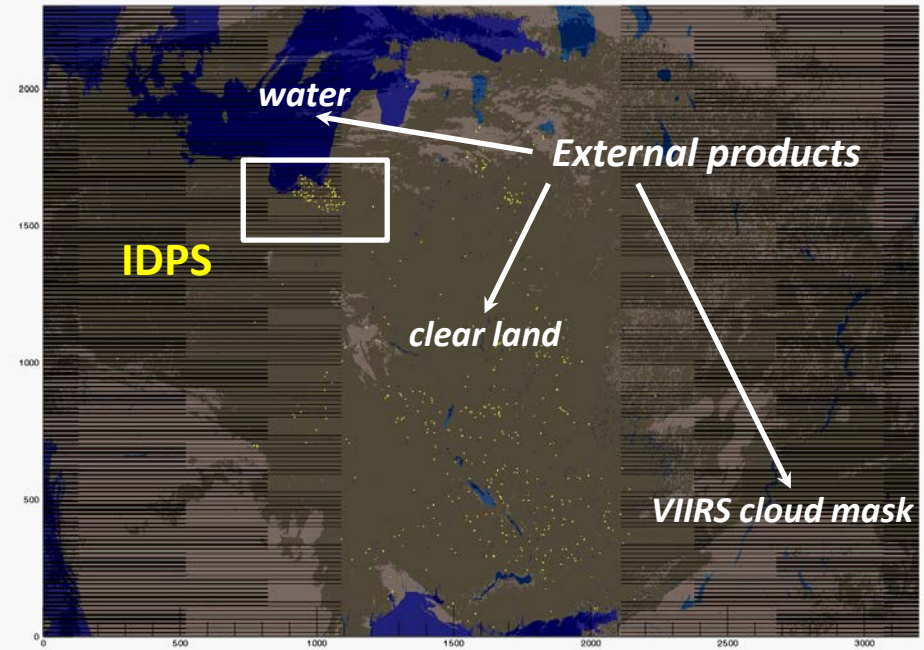
- Best use of radiometric information from the Visible Infrared Imaging Spectroradiometer (VIIRS) on the JPSS series (Suomi NPP, JPSS-1, -2 and beyond)
- Current Suomi NPP operational product provides a list of detections from 750m M-band data
  - The **Suomi NPP Active Fire ARP was declared Operational** 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**.
- Goal: development of enhanced products and transition to NOAA operations
- This talk focuses on mid-wave infrared / infrared based products (i.e. AVHRR / MODIS heritage)
  - Nighttime detection also possible from DNB and shortwave bands (e.g. NightFire etc.)

Ongoing work

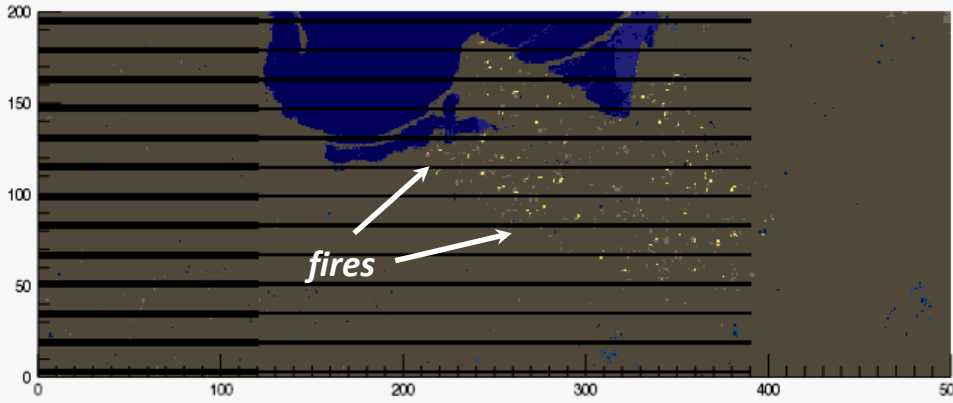
1. Enhanced 750m M-band product, including
   - full spatially explicit fire mask
     - Clear land, water, cloud, fire, detection confidence
   - global detection including water
     - detect off-show gas flares
   - Fire radiative power (FRP)
2. 375m I-band product, including
   - full spatially explicit fire mask
     - Clear land, water, cloud, fire, detection confidence
   - global detection including water
     - detect off-show gas flares
   - limited information on fire radiative power (FRP)
3. Product quality improvements
   - input SDR
   - sensor-specific algorithm tuning
   - product validation
4. User readiness
   - NOAA users
   - domestic and international users
   - proving Ground and Risk Reduction
   - fire and Smoke Initiative

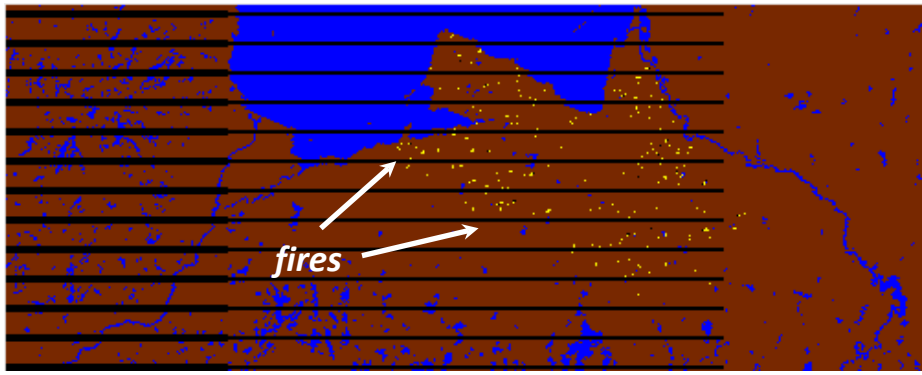
Work is performed as part of NOAA JPSS cal/val, Proving Ground and Risk Reduction and NASA Science Team, Applied Science activities

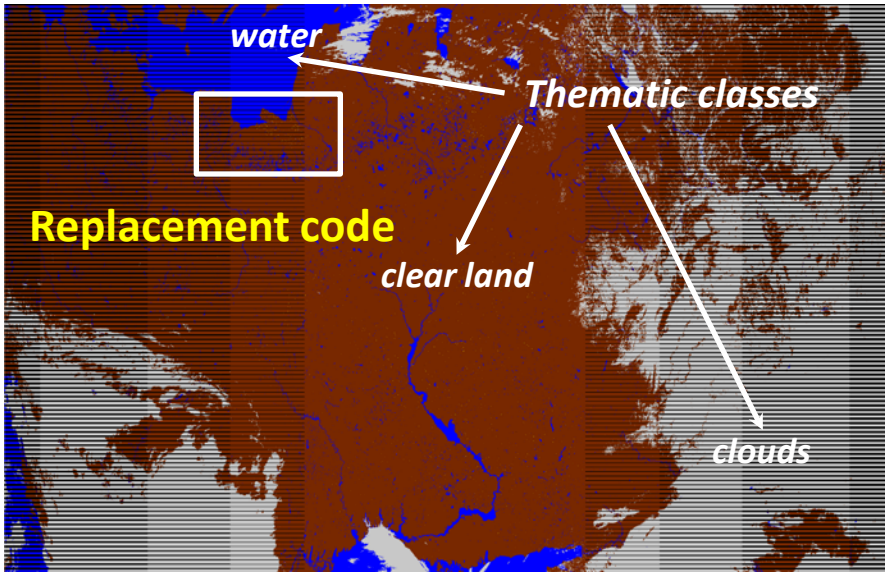
1. Enhanced 750-m M-band product



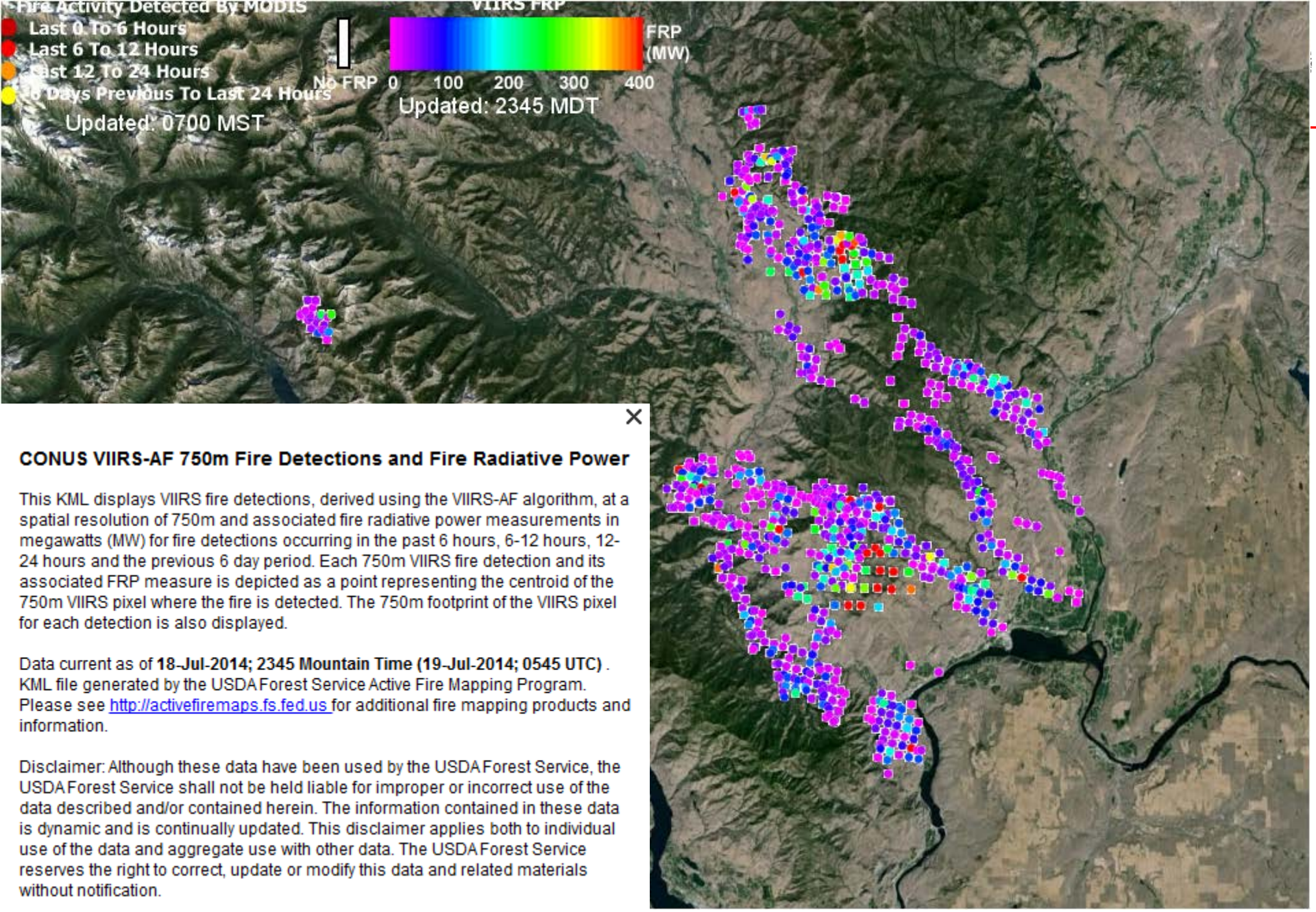
March 10, 2014 10:36-10:40







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.



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

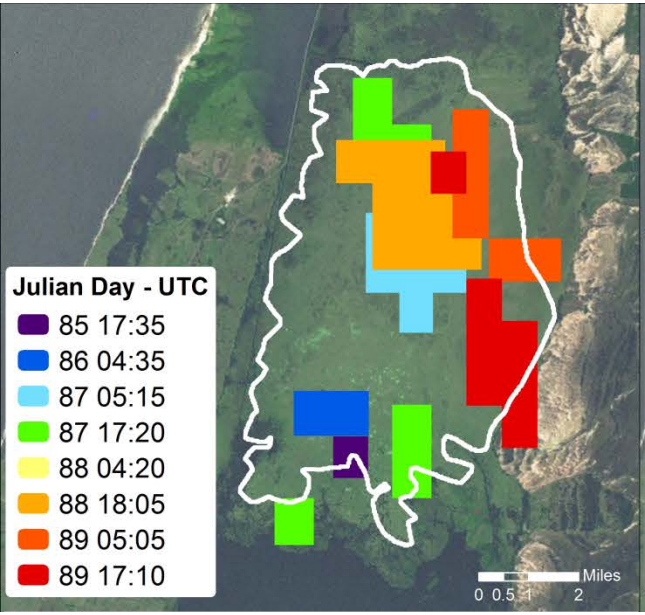
This KML displays VIIRS fire detections, derived using the VIIRS-AF algorithm, at a spatial resolution of 750m and associated fire radiative power measurements in megawatts (MW) for fire detections occurring in the past 6 hours, 6-12 hours, 12-24 hours and the previous 6 day period. Each 750m VIIRS fire 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.

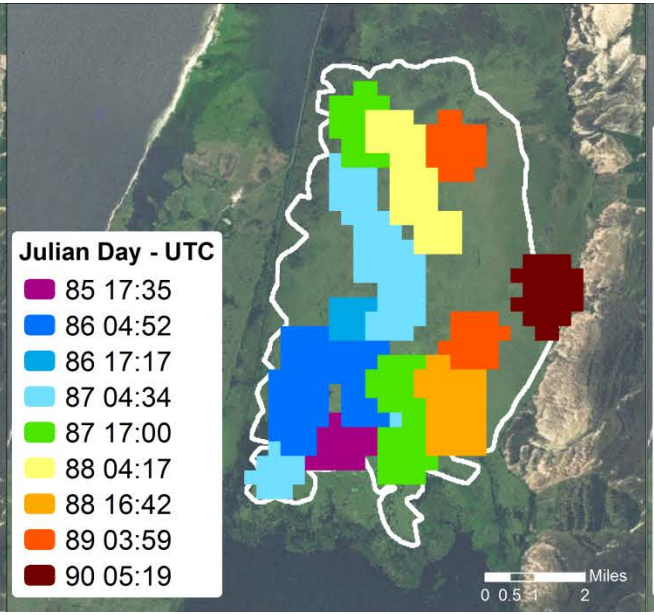
Disclaimer: Although these data have been used by the USDA Forest Service, the USDA Forest Service shall not be held liable for improper or incorrect use of the data described and/or contained herein. The information contained in these data is dynamic and is continually updated. This disclaimer applies 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.

2. 375m I-band product

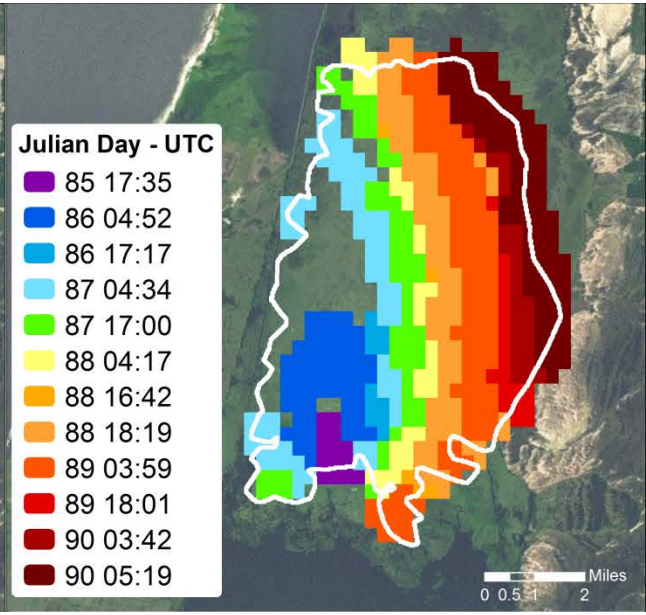
Wildfire in southern Brazil, March 2013



Aqua/MODIS 1 km
Spotty detection pixels and coverage gap at low latitudes



S-NPP/VIIRS 750 m
Spotty detection pixels



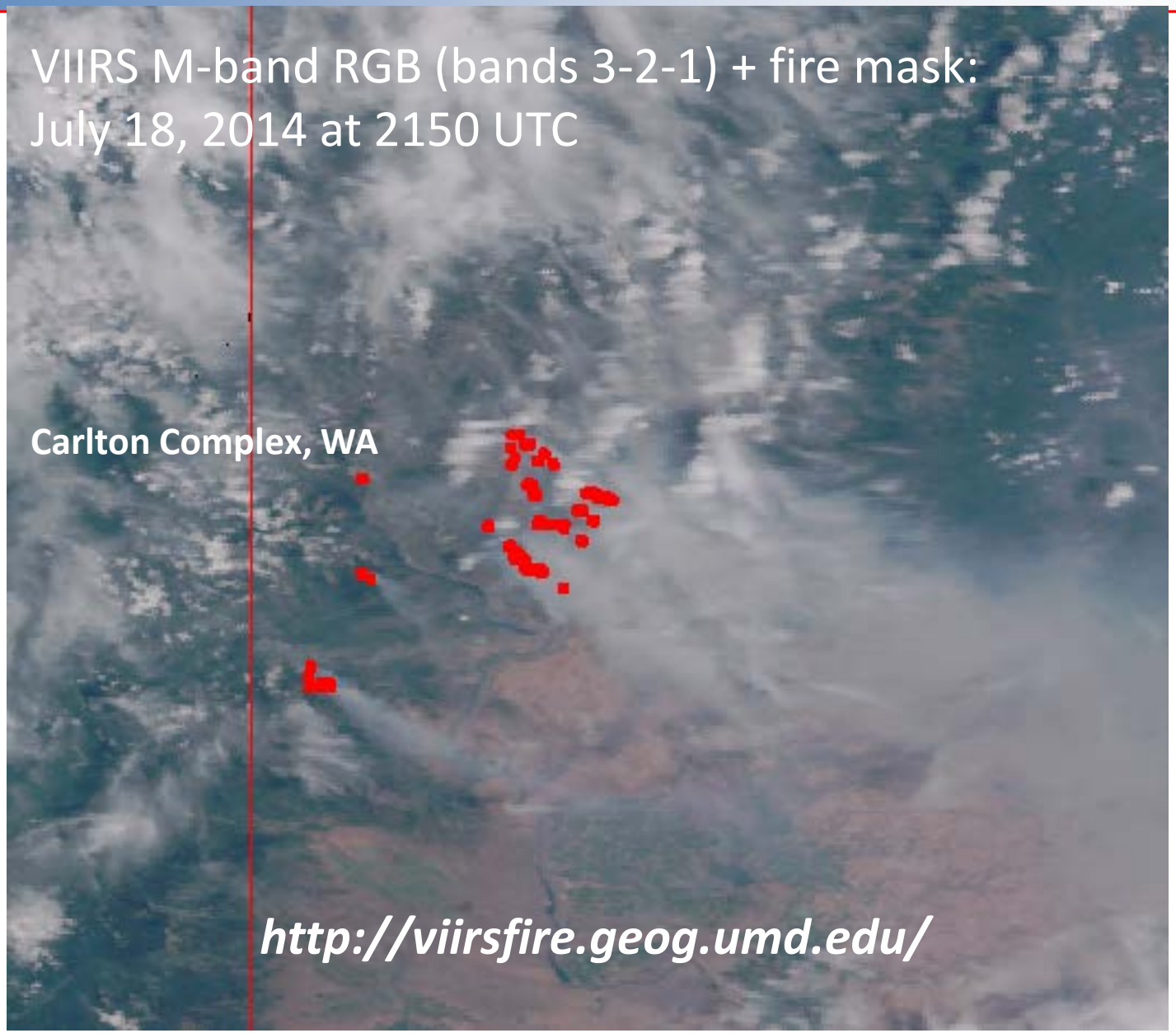
S-NPP/VIIRS 375 m
Improved fire line mapping

<u>Issues of I-band based VIIRS fire detection:</u>

- Suboptimal sensor saturation level due design to serve other primary applications
- South Atlantic Magnetic Anomaly – address by additional algorithm elements
- Remaining SDR quality issues – working with the VIIRS SDR team to diagnose issues and implement improvements

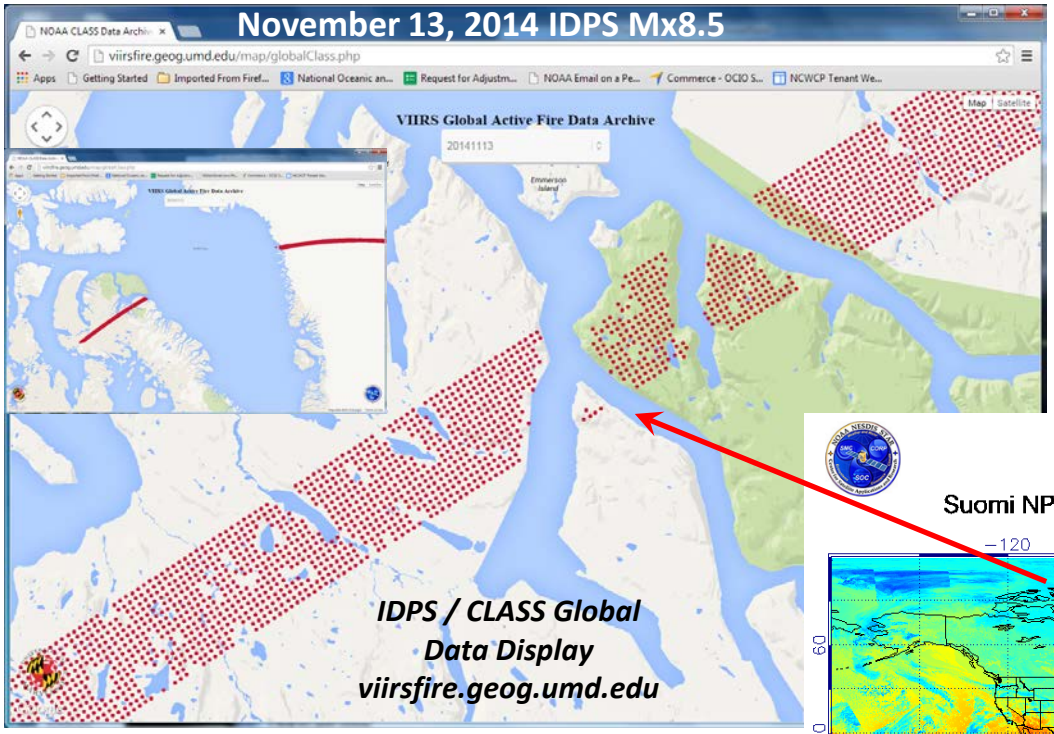
W. Schroeder, UMD

2. 375m I-band product

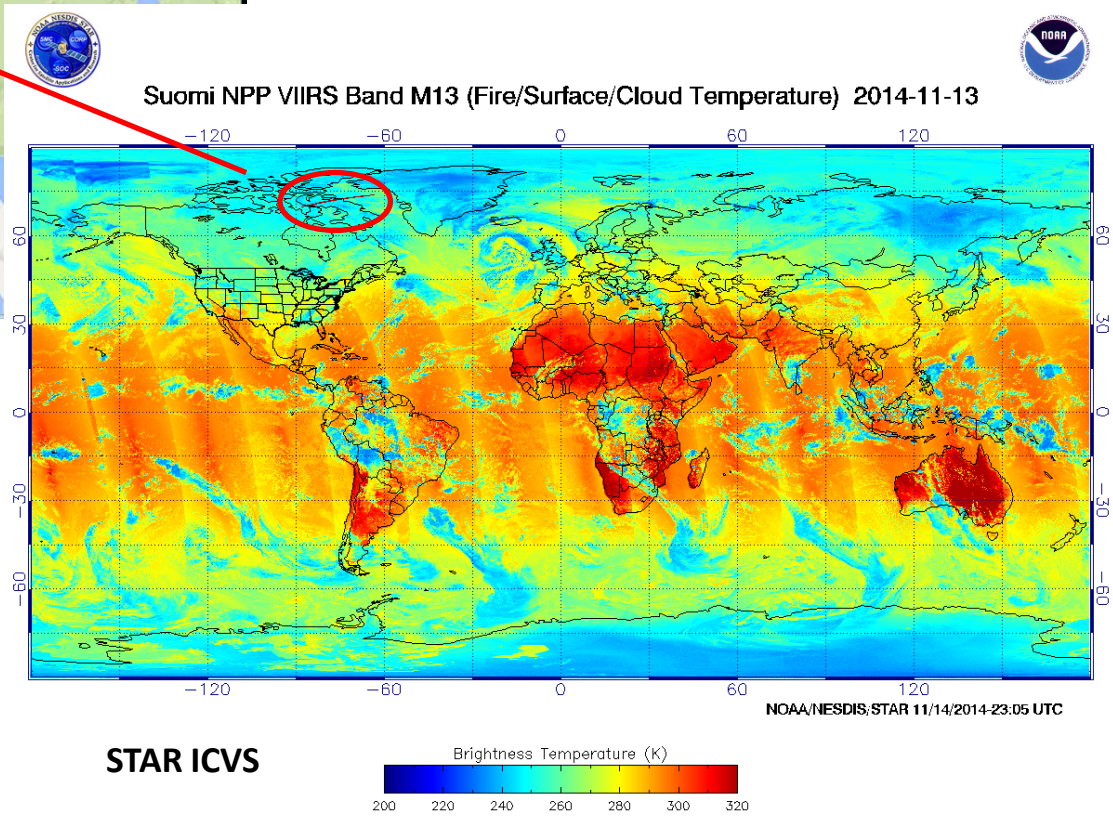


2. 375m I-band product

3. Product quality improvements



*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**.*

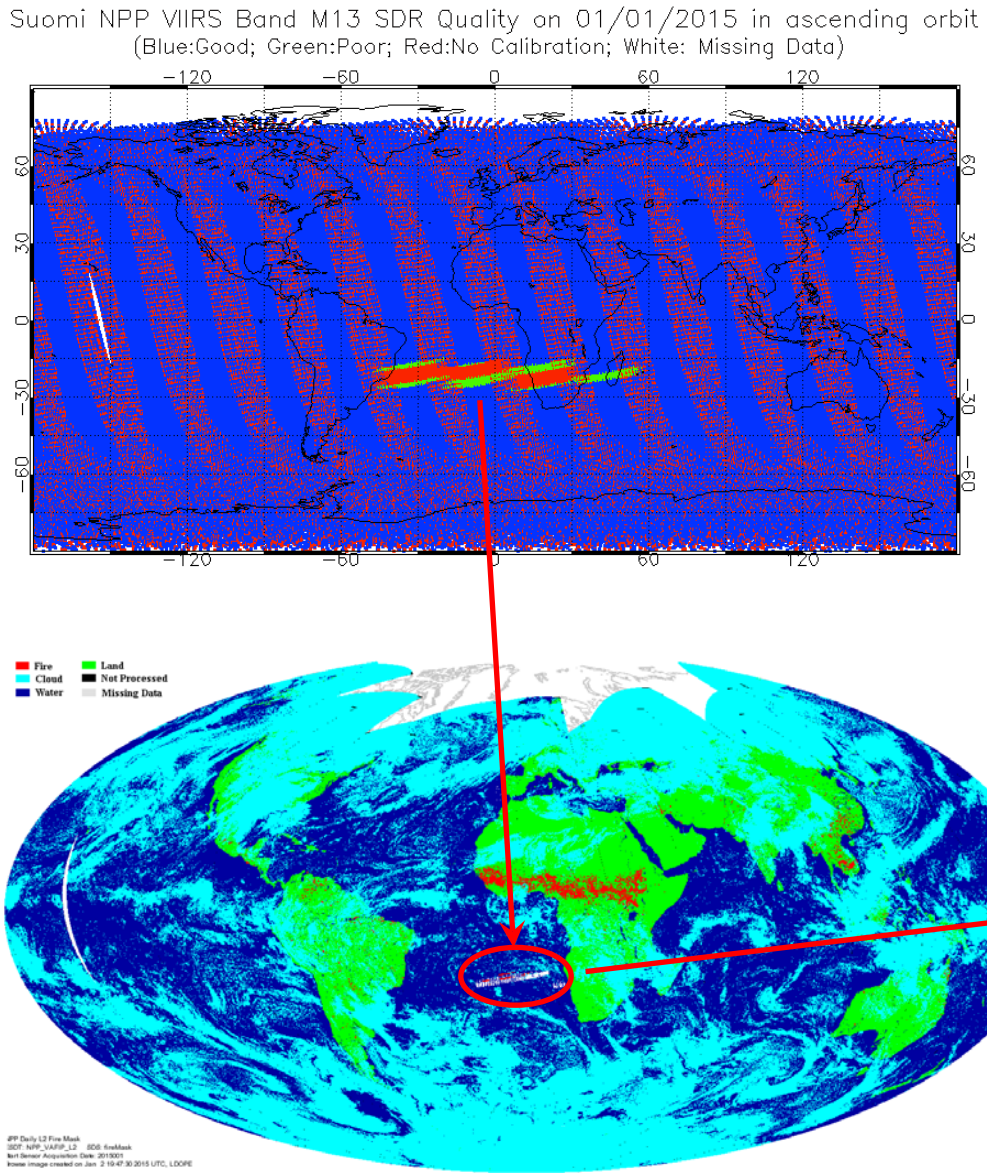


*Over time the **frequency** of spurious scanlines **decreased** as a result of IDPS SDR algorithm changes.*

*Currently most spurious scanlines in the core ground segment data (**Stored Mission Data**) appear in the **Arctic** and during **Lunar Intrusion events**.*

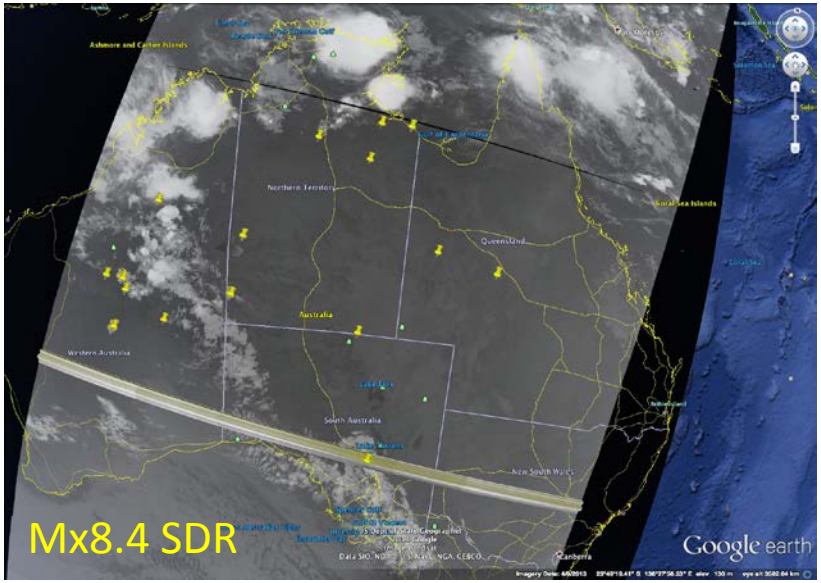
STAR ICVS

3. Product quality improvements



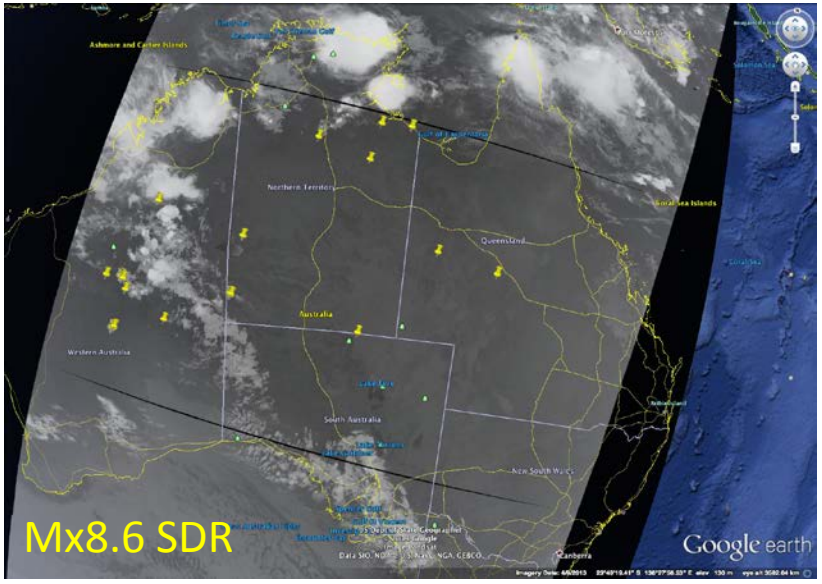
An example of false detections during a lunar intrusion event on January 1, 2015. The Active Fire team has been providing feedback to the VIIRS SDR team to help further improve the quality of the SDR product.

3. Product quality improvements

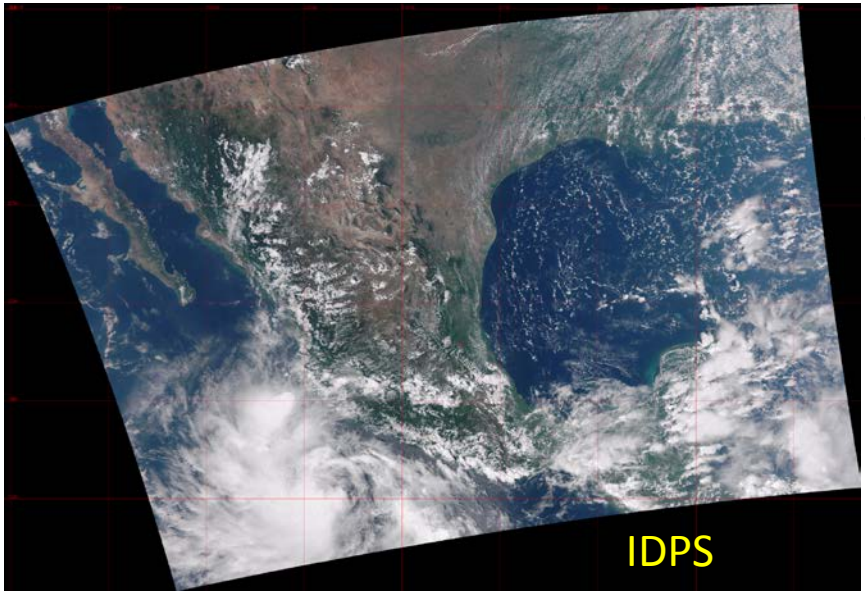


DB CSPP

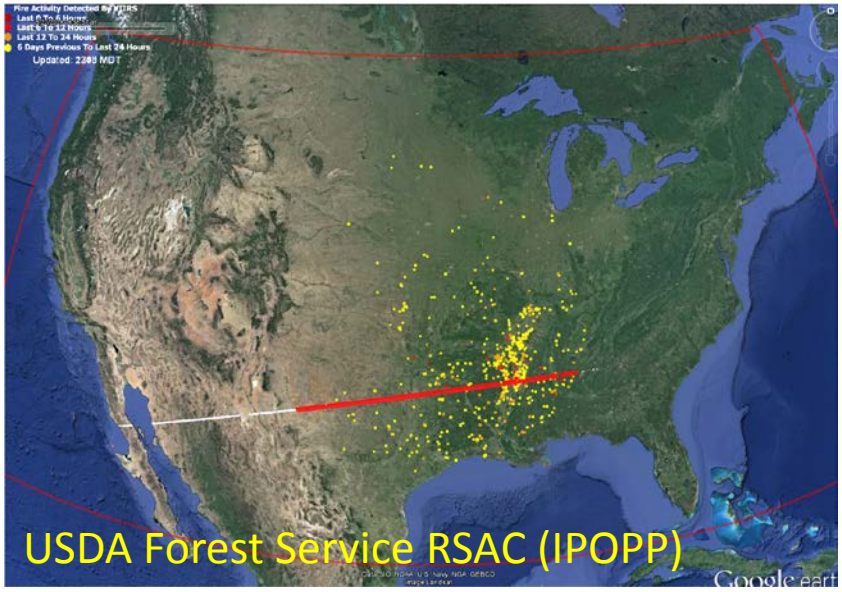
12/13/14
16:10 UTC



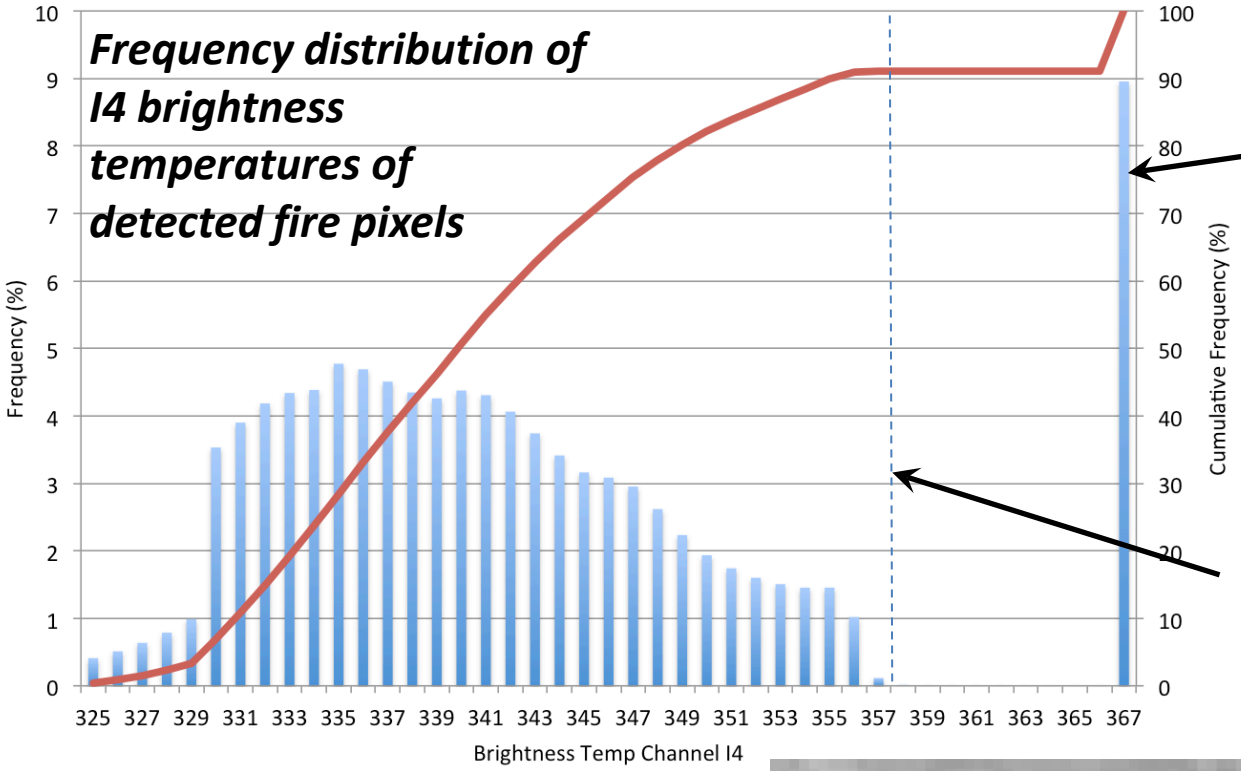
Credit: Lan-Wei Wang (Geoscience Australia) / Kathleen Strabala (University of Wisconsin – Madison)



9/10/14
19:50 UTC

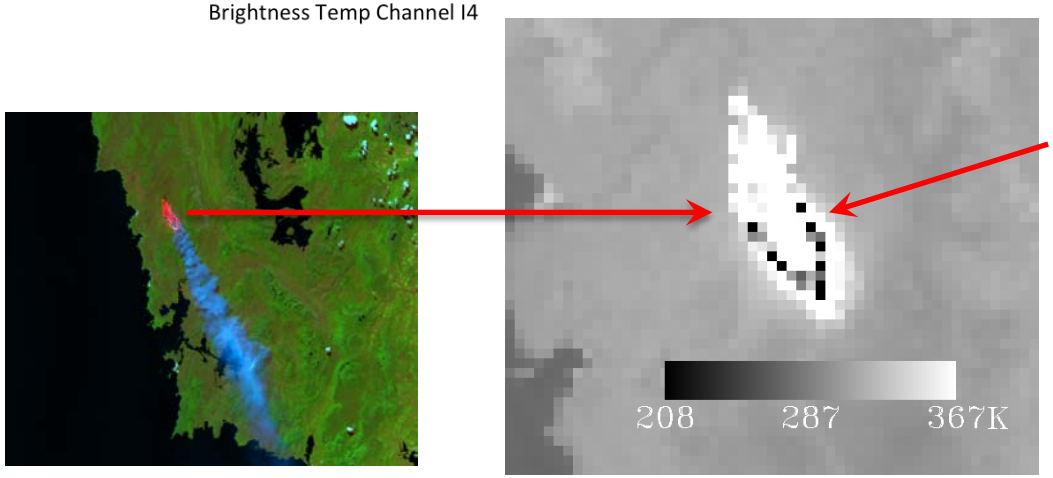


3. Product quality improvements



Saturated pixels with nominal maximum value in calibration LUT

Observed sensor saturation

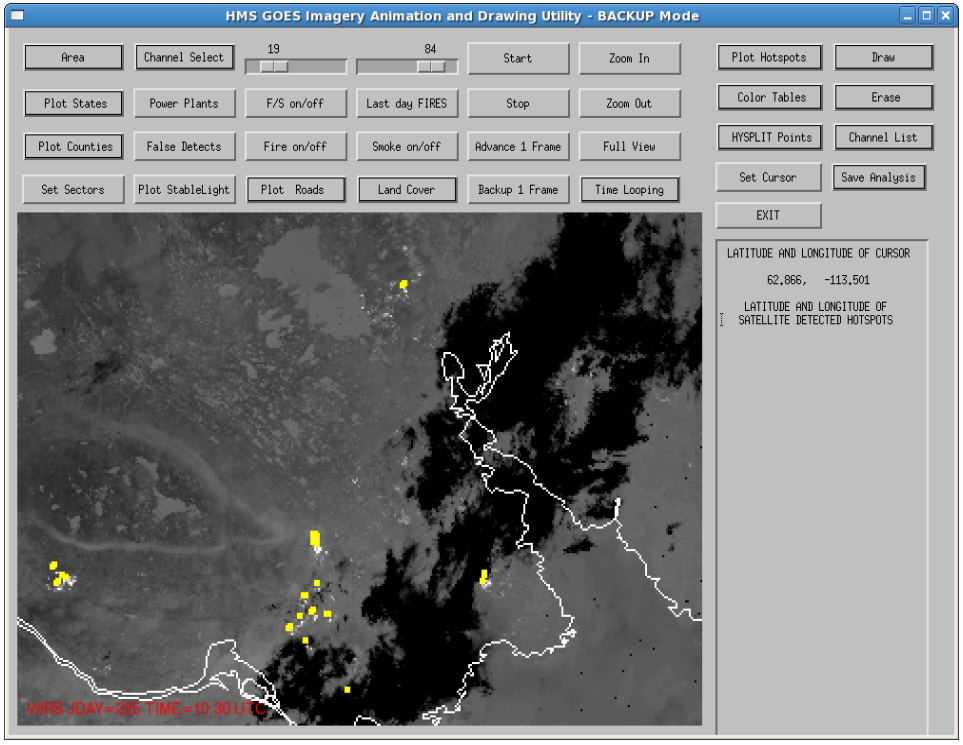


Rollover of sensor output beyond saturation

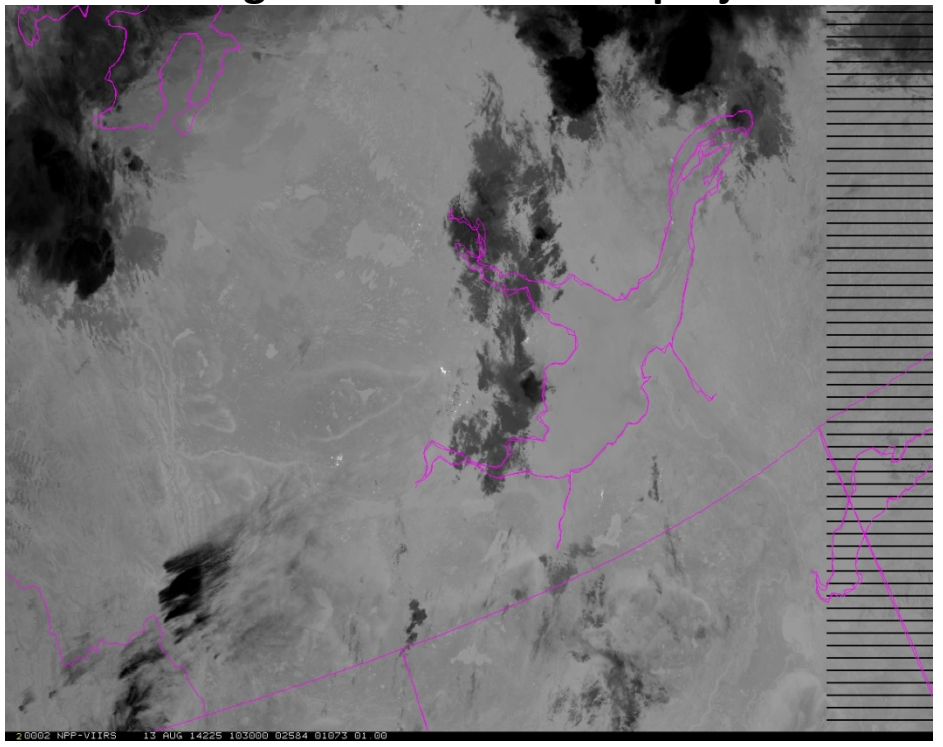
4. User readiness: VIIRS Fire in the NOAA Hazard Mapping System (HMS)

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

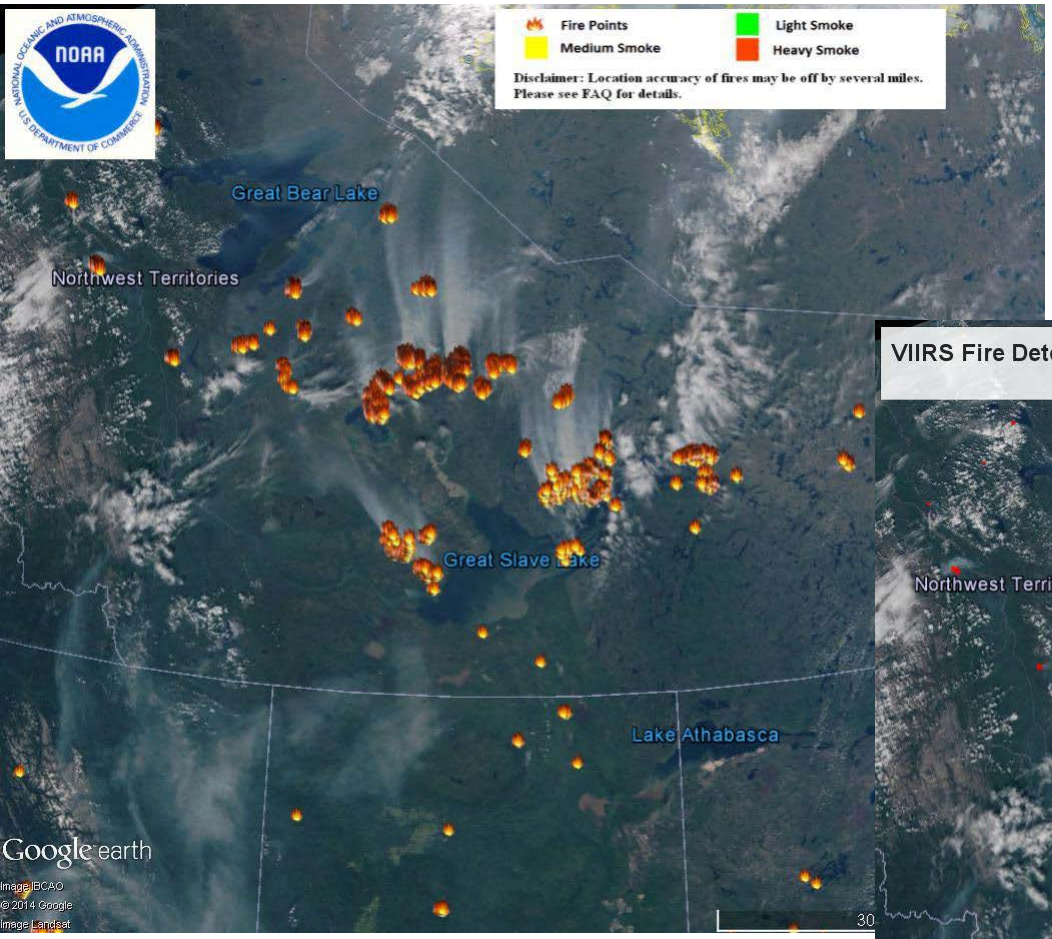
VIIRS AFP from 13 August 0850Z and 1030Z images over VIIRS M13 SDR 1030Z image



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



4. User readiness: VIIRS Fire in the NOAA Hazard Mapping System (HMS)



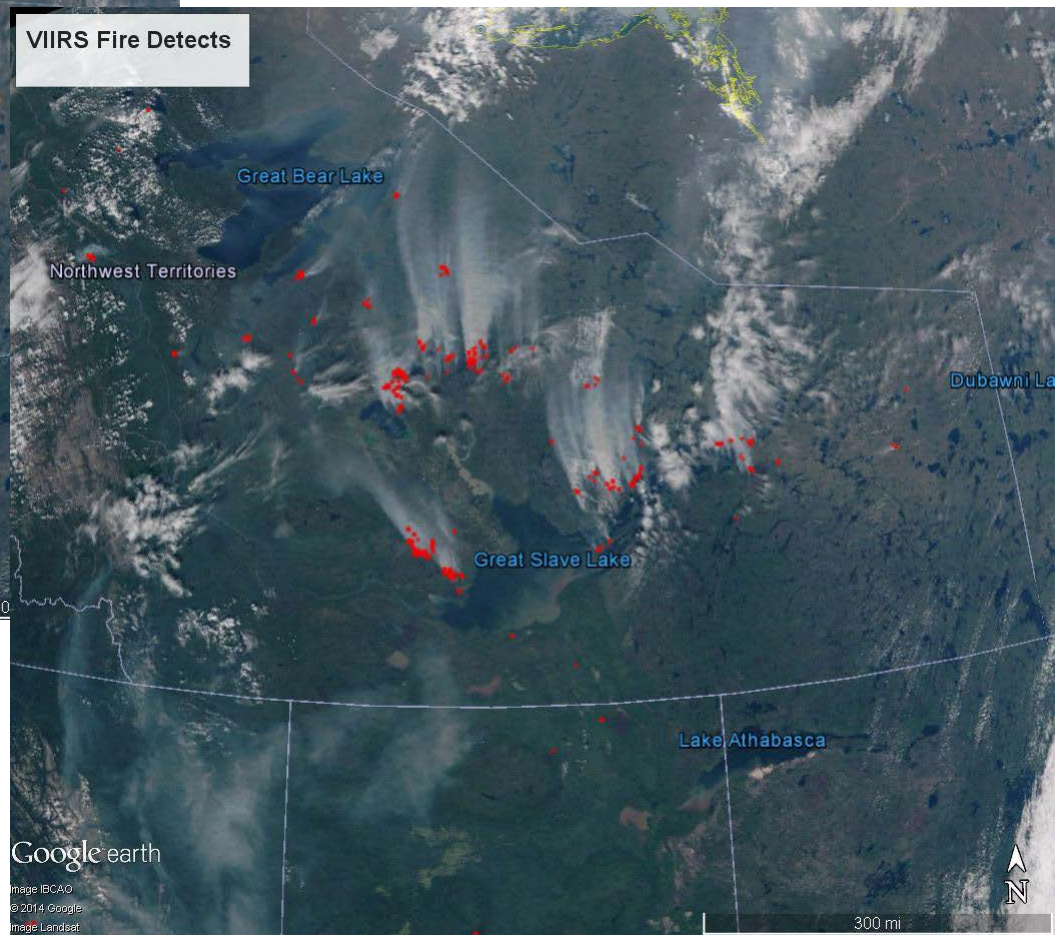
HMS multi-sensor analysis

July 13, 2014, NW Canada

Full operational implementation in 2015.

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

IDPS VIIRS fire product



4. User readiness: 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

4. User readiness: 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

4. User readiness: VIIRS active fire data portal

VIIRS AF Table Data | VIIRS

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

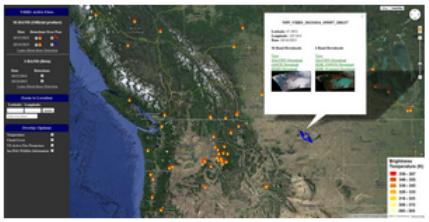
Apps | Getting Started | Imported From Firef... | National Oceanic an... | Request for Adjustm... | NOAA Email on a Pe... | Commerce - OCIO S... | NCWCP Tenant We...

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/

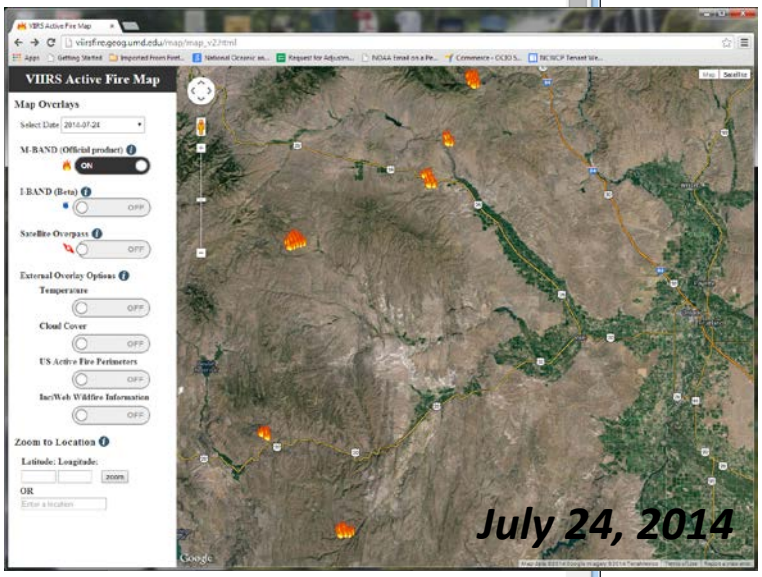
View CONUS Active Fire Map



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

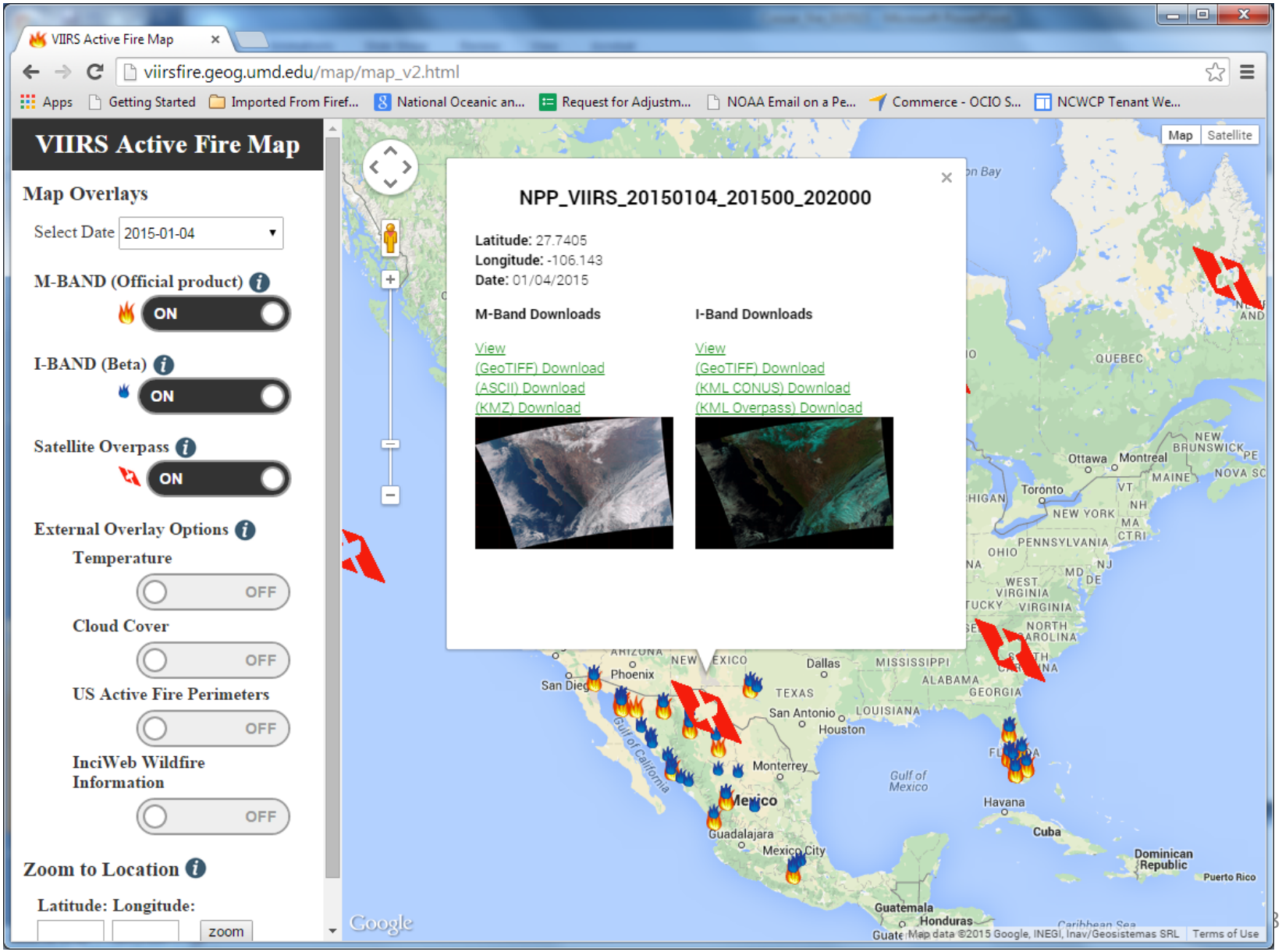
Displaying 1 - 20 of 6395

Date

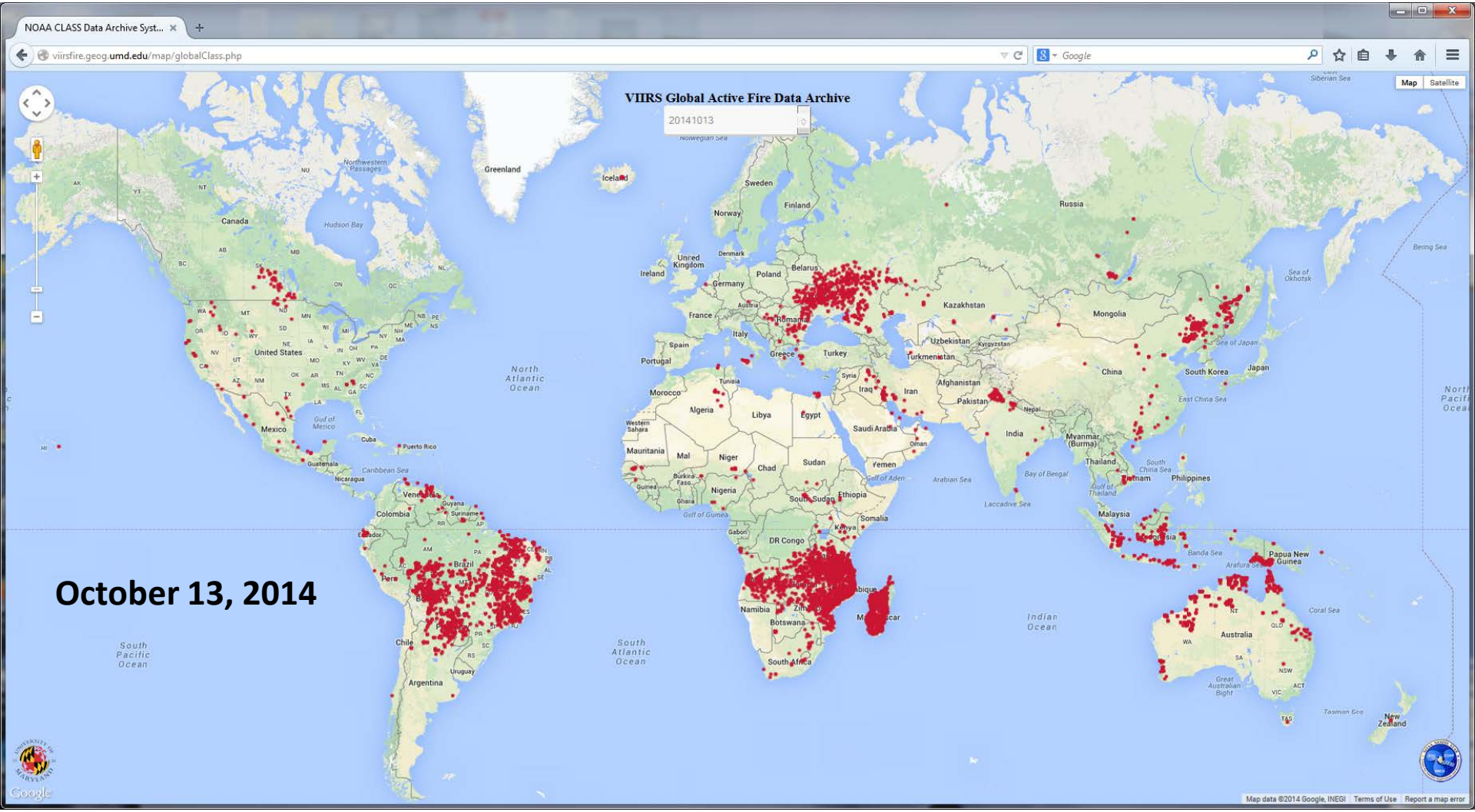
Apply

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

4. User readiness: VIIRS active fire data portal



4. User readiness: VIIRS active fire data portal



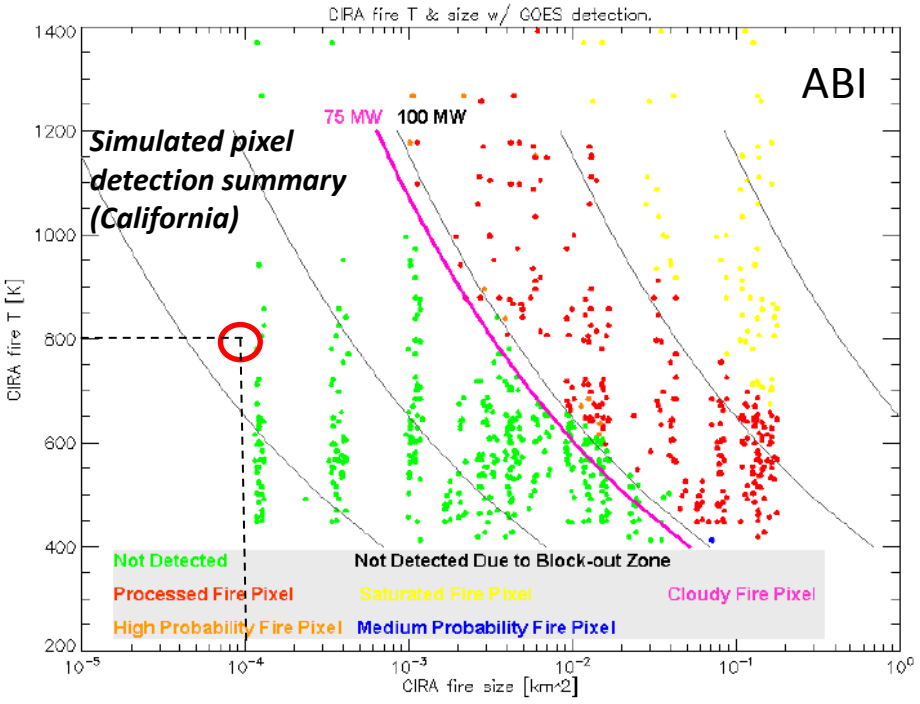
http://viirsfire.geog.umd.edu/

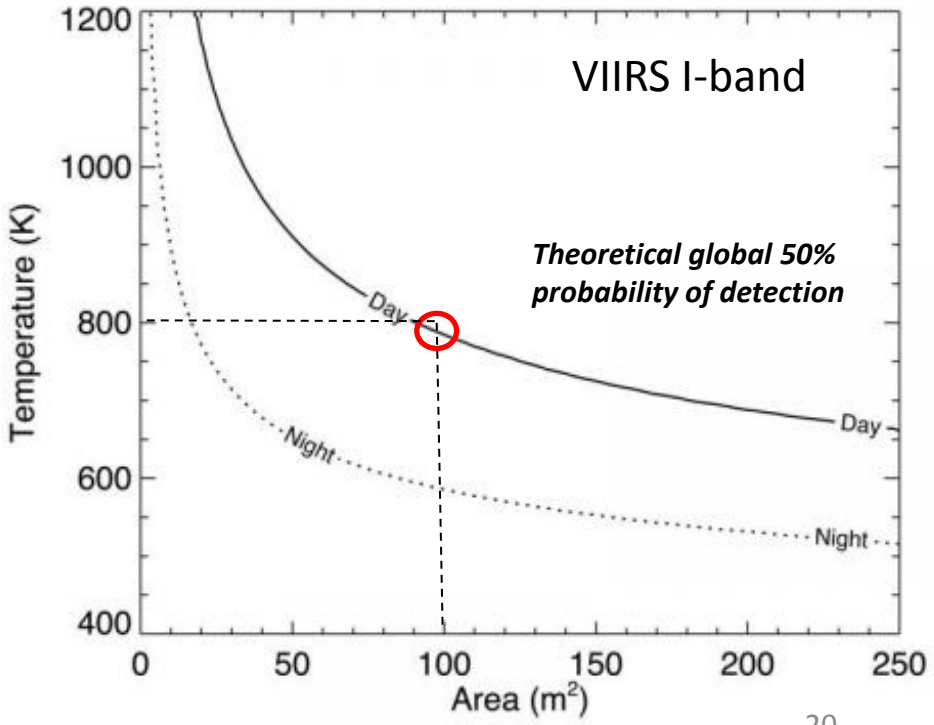
Data from NOAA CLASS: http://www.nsof.class.noaa.gov/

4. User readiness: VIIRS fire products in the new generation of NOAA polar/geo fire product suite

- VIIRS: higher spatial resolution, lower temporal frequency, varying viewing geometry
- ABI: lower spatial resolution, higher temporal frequency, fixed viewing geometry
- High geo frequency offsets some of the low spatial resolution effects
- For the same fire VIIRS provides higher detection confidence than ABI -> VIIRS can confirm low-confidence ABI detections and reduce need for temporal filtering

Detection envelopes





http://www.star.nesdis.noaa.gov/goesr/docs/ATBD/Fire.pdf

Schroeder et al., 2014

Summary and conclusions

- 750m M-band prodouct
  - the **IDPS Suomi NPP product** is stable
    - Validated Stage 1 science maturity and NOAA Operational status
  - new product that meets the **JPSS 1 requirements** is transitioning to NOAA operations
- 375m I-band product
  - experimental with **encouraging results**; higher sensitivity to **sensor issues**
- Product quality
  - some **data anomalies** in Direct Broadcast and high latitudes remain
  - **long-term monitoring system** is being set up at STAR
  - efforts towards rigorous **validation** using **independent reference data**
- User readiness
  - coordinated efforts through **Proving Ground / Fire and Smoke Initiative**
  - **Product evaluation portal** with various products and formats
  - domestic and international **partnerships and user outreach** are ongoing as part of Proving Ground / Fire and Smoke and GOFC-GOLD initiatives

For more information on VIIRS fire

- **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