USE OF VIIRS FIRE PRODUCTS TO SUPPORT FIRE MANAGEMENT

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How do we support fire management?

- Improve the quality of the VIIRS fire products
- Facilitate access to the products
- Interact with operational fire management
- Provide improved data for modeling applications

VIIRS active fire product development

NOAA: real-time NOAA operational applications

- Current operational M-band product generated by IDPS[1]
- Part of integrated processing chain
- Low latency; detections only
- Locations only (no fire mask)
- New operational product within NDE[2]; consistent with NASA product

VIIRS Fire Team

Algorithm updates

Upstream processing updates

NASA: science, long-term continuity + added value NRT

- M-band MODIS continuity product at Land SIPS[3]
- Detections, Fire Mask and Fire Radiative Power, CMG
- Spatially explicit fire mask
- Spatial and temporal aggregates – heritage delivery systems (RR, FIRMS)
- Experimental I-band product

NOAA Proving Ground
NASA Applied Science
algorithm synchronization, end user feedback

DIRECT READOUT (CSPP, IPOPP)

- Can run IDPS, NASA or locally developed code
- Stand-alone

[1]Interface Data Processing Segment; [2]Suomi NPP Data Exploitation; [3]Science Investigator-led Processing System

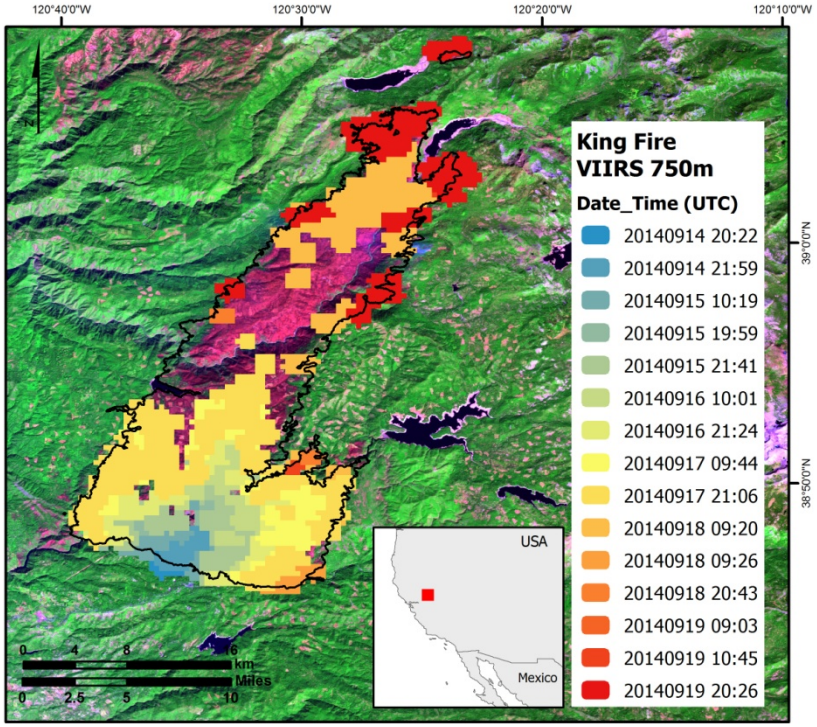
NOAA VIIRS product status

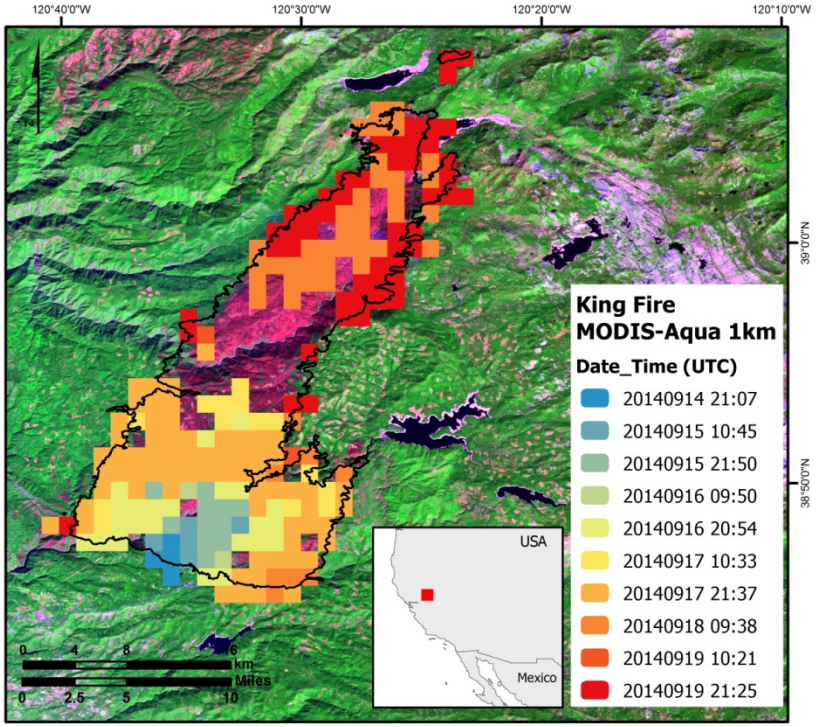
- The **current Suomi NPP 750m Active Fire product** in IDPS is stable and operational
  - provides fire locations over land
  - product monitoring and maintenance is ongoing
- A **new 750m VIIRS fire algorithm** is transitioning into NOAA operations
  - global mask of thematic classes including water, cloud, non-fire clear land and fire at three confidence levels
  - fire radiative power for each fire-affected pixel
  - new algorithm elements to improve detection performance
  - the product is **tailored subset of the NASA science product** for real-time NOAA operations
  - **continuity with** the **MODIS** MOD14/MYD14 product
  - support NWS integration into **AWIFS-II**

NASA VIIRS Active Fire Status

- **Baseline 750 m product** builds on MODIS C6 *Fire and Thermal Anomalies* (MOD14/MYD14) algorithm
  - Provides fire mask, fire radiative power retrievals, plus additional metadata
    - Mimics MOD14/MYD14 science data format & nomenclature
  - Currently implemented/maintained at Land SIPS (**NPP_VAFIRE_L2D**)
  - Currently implemented/maintained in IPOPP serving the DB community
  - Latest algorithm being ported to NESDIS in order to replace operational version in IDPS (based on outdated Collection 4 version)
- **New 375 m product** based on similar MOD14/MYD14 architecture
  - Provides fire mask, limited fire retrievals (frequent saturation), plus additional metadata
    - Resembles MOD14/MYD14 science data format & nomenclature
  - Currently running at the USDA Remote Sensing Applications Center (RSAC), and in fire monitoring systems in South Africa and Brazil
  - Being ported to IPOPP
  - To be ported to Land SIPS
  - Long-term plan is to implement in NOAA operations

VIIRS vs. MODIS active fire

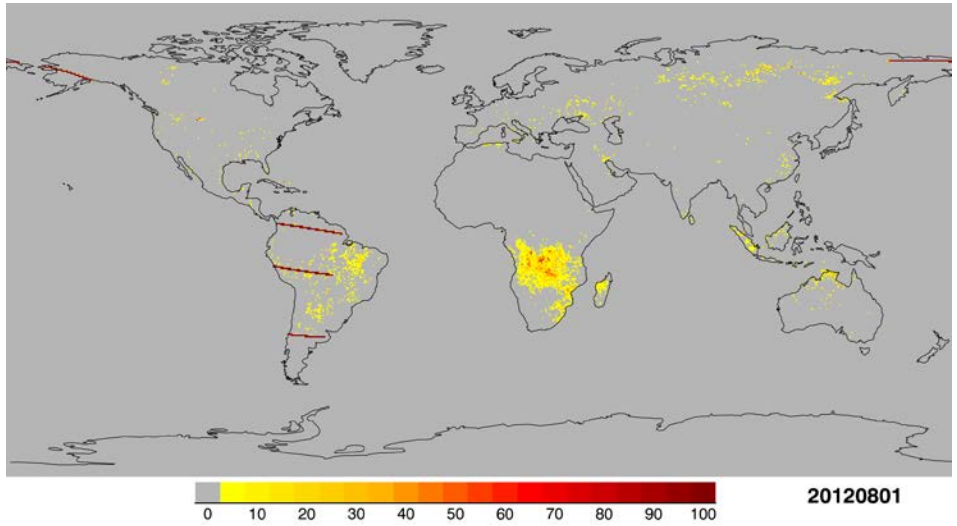


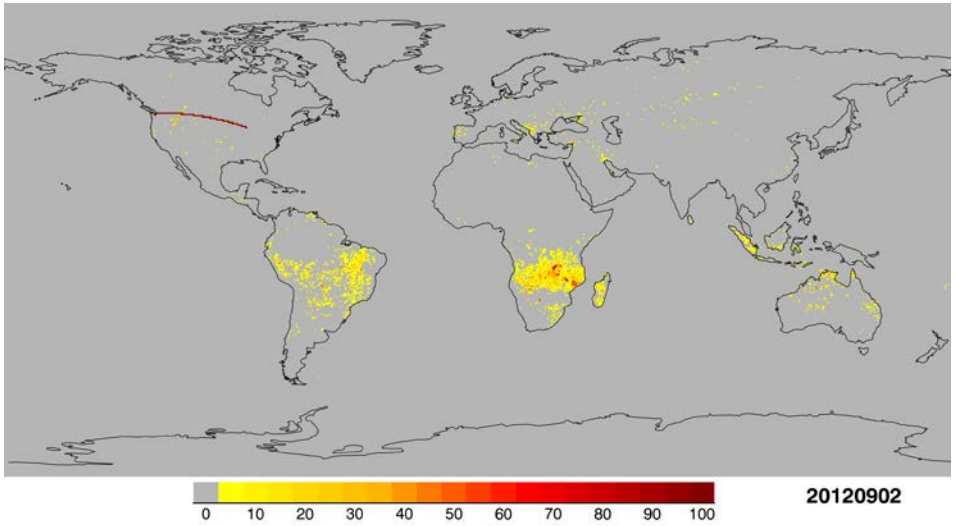


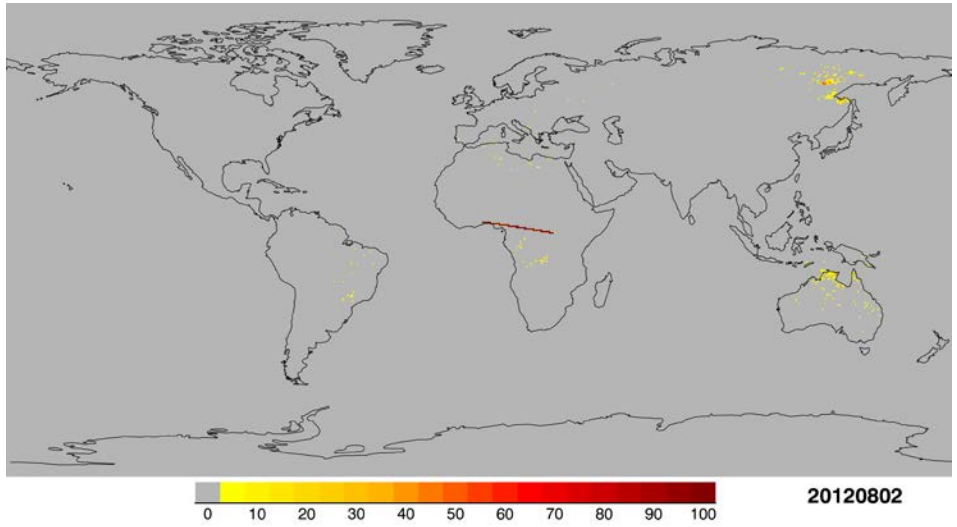
Suomi NPP/VIIRS AF and Aqua/MODIS MYD14 fire detection data produced for the King fire/California on 14-19 September 2014

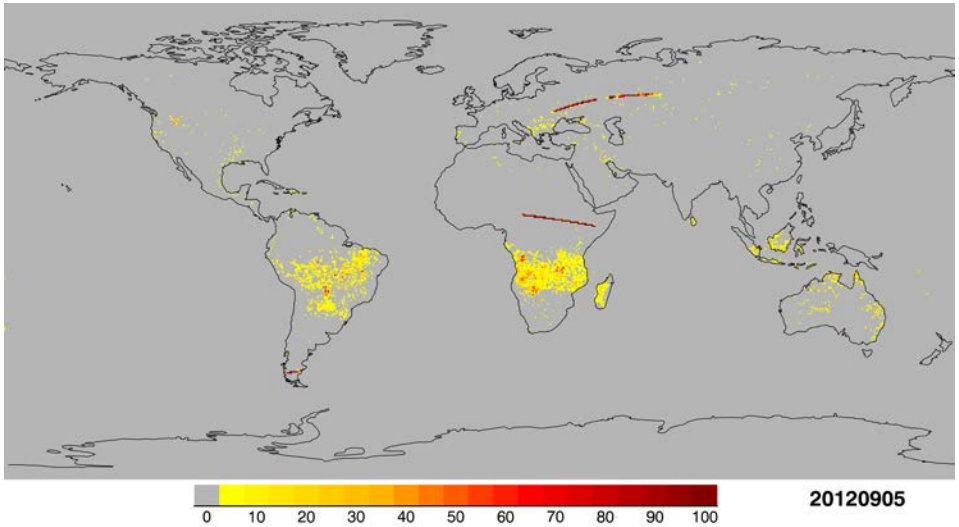
Frequent spurious detections in early IDPS product

Frequent occurrence of spurious scanlines during the first ~10 months of production









The active fire team has been working with the VIIRS SDR team to diagnose and reduce input data anomalies; and improve quality flagging to enable filtering of corrupt data.

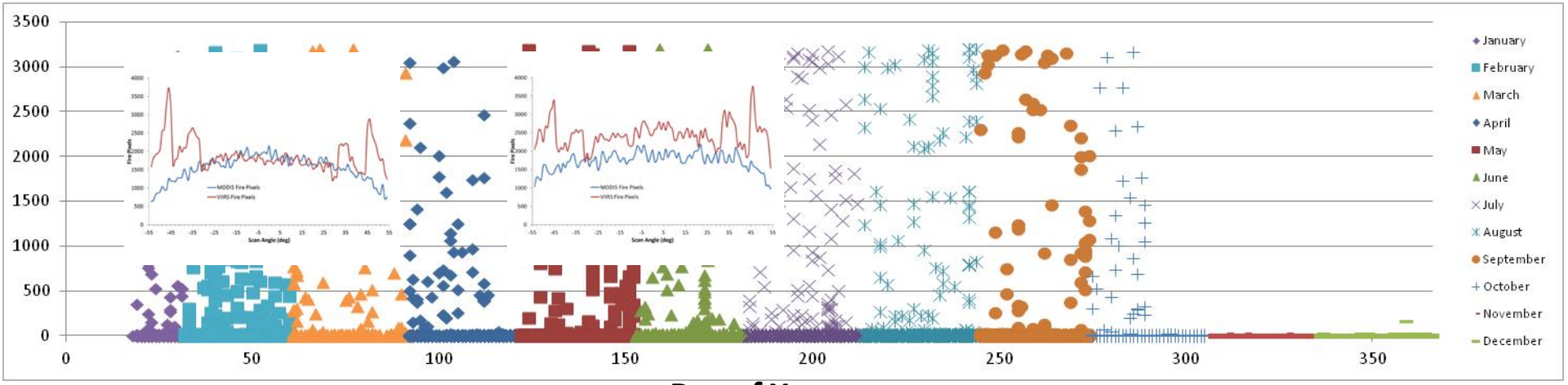
IDPS Suomi NPP Active Fire Product: data anomalies and product maturity (2/1)

2012

April 3, 2012
IDPS Mx5.3

October 16, 2012
IDPS Mx6.3

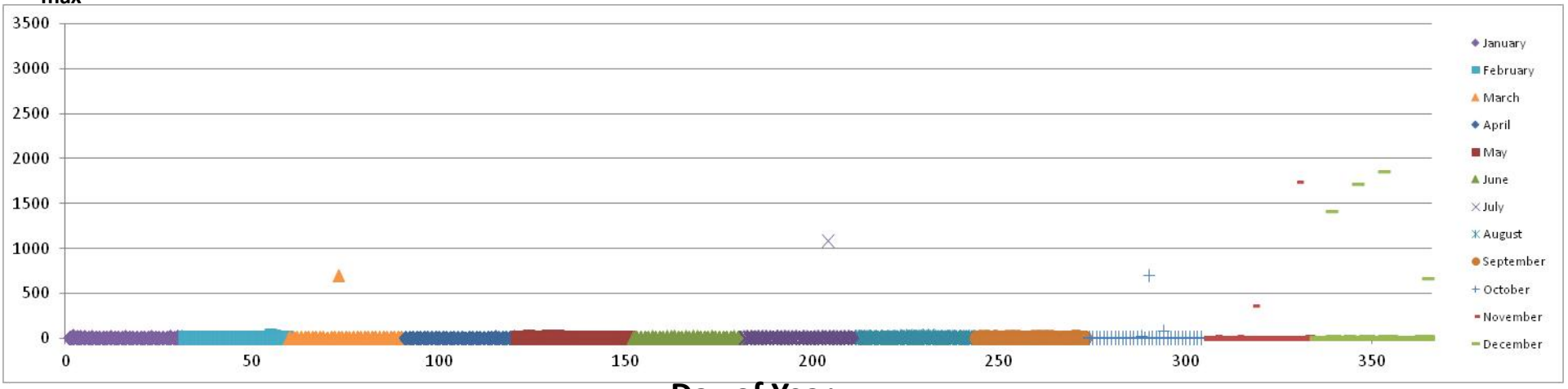
N_{max} ← *Pre-Beta* → | *Beta* | ← *Provisional* →



Day of Year

2013

N_{max} ← *Provisional* →



Day of Year

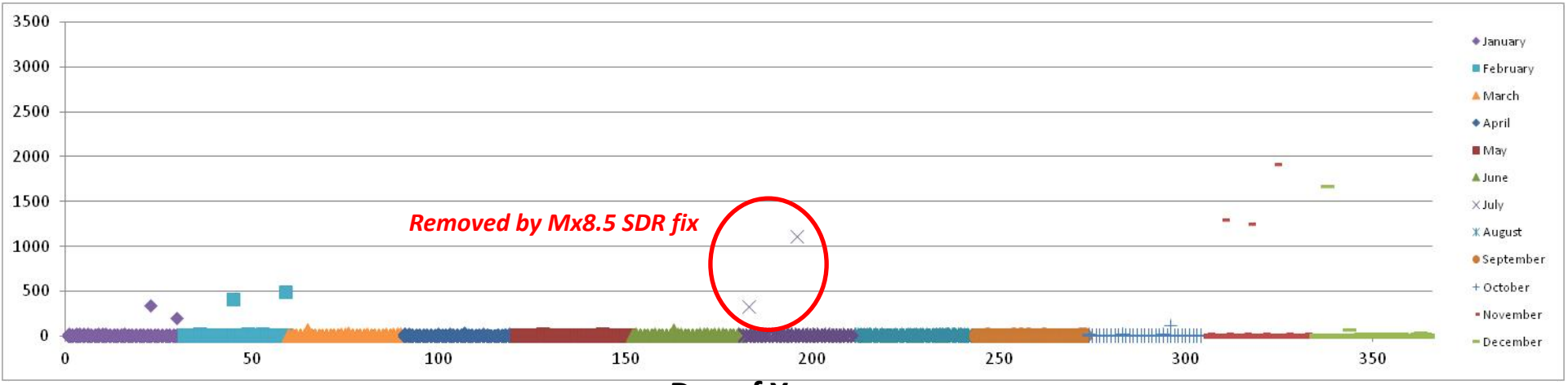
N_{max}: maximum number of detections within a scanline

IDPS Suomi NPP Active Fire Product: data anomalies and product maturity (2/2)

2014

August 13, 2014
IDPS Mx8.5

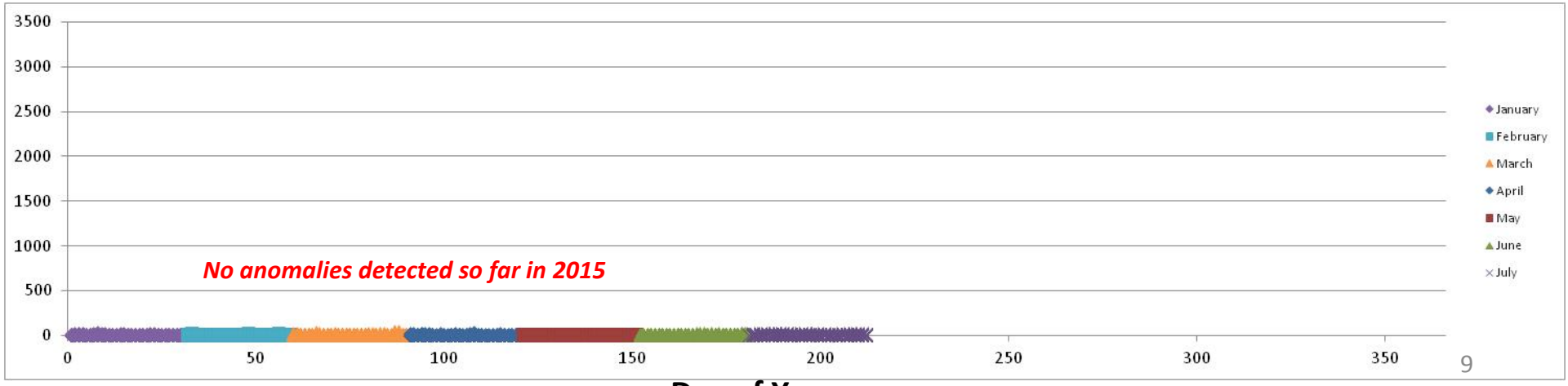
N_{max} ← *Provisional* → | ← *Validated stage 1* →



Day of Year

2015

N_{max} ← *Validated stage 1* - - - - - - ->



Day of Year

N_{max}: maximum number of detections within a scanline

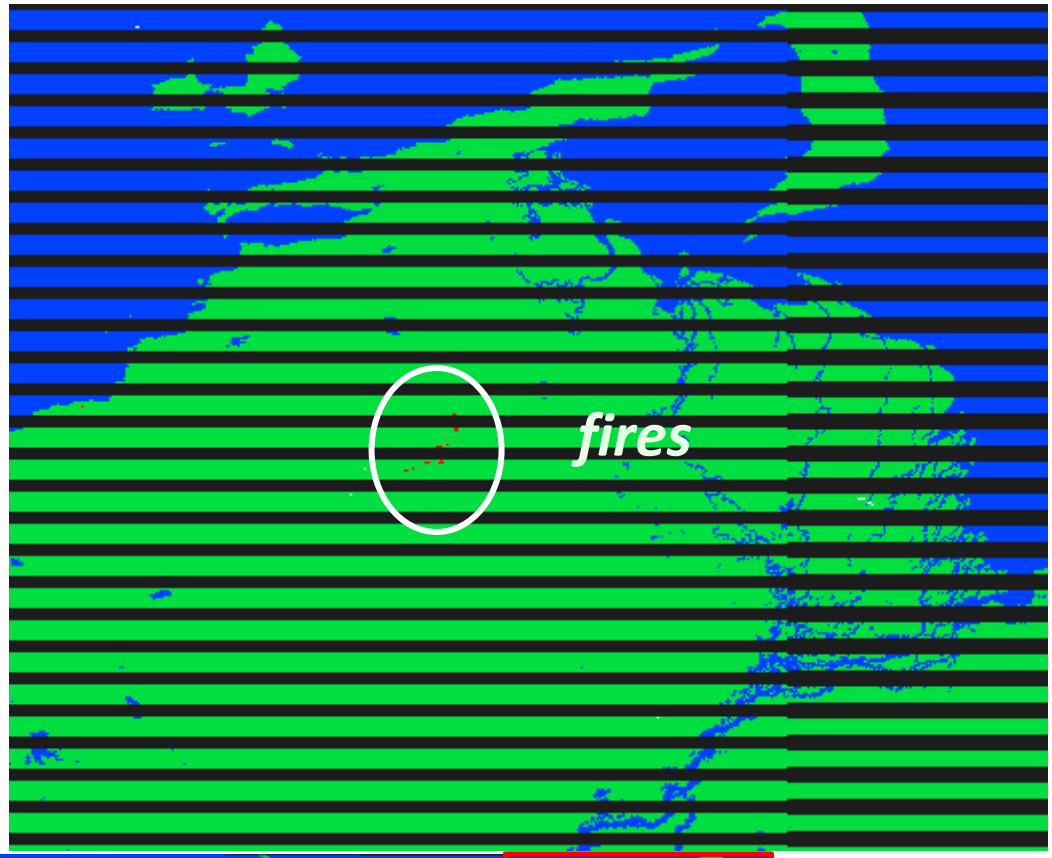
NOAA NDE VIIRS Active Fire Product

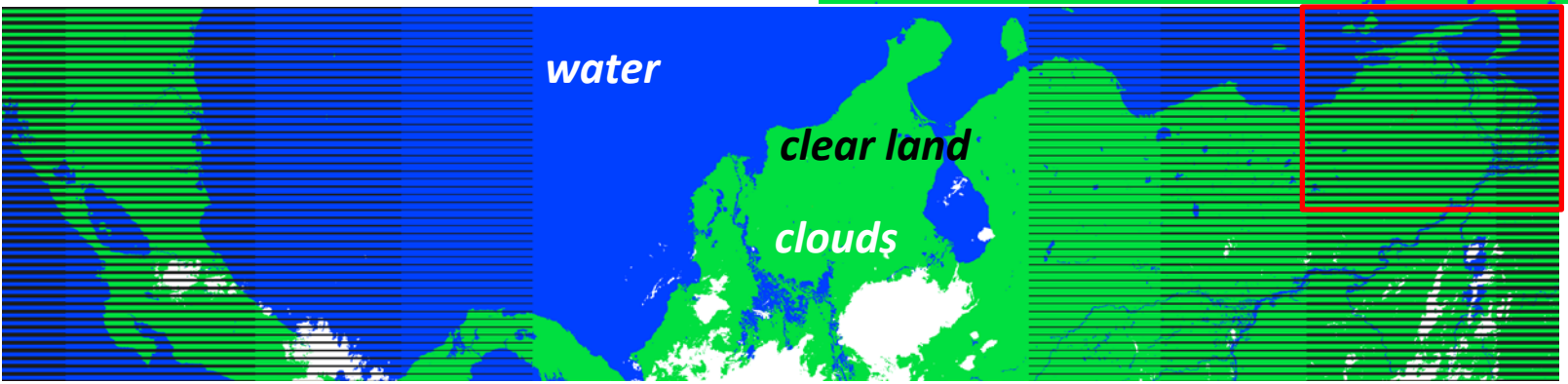
VIIRS fire mask over Central America and North-West South America on 3/1/2015 at 6:33 UTC. The horizontal lines are bow-tie deletions in the VIIRS granule.

VIIRS fire mask generated at NOAA/NESDIS/STAR from IDPS input data. The NOAA Level-2 product is a tailored version of the NASA science product developed at UMD.

(nighttime)

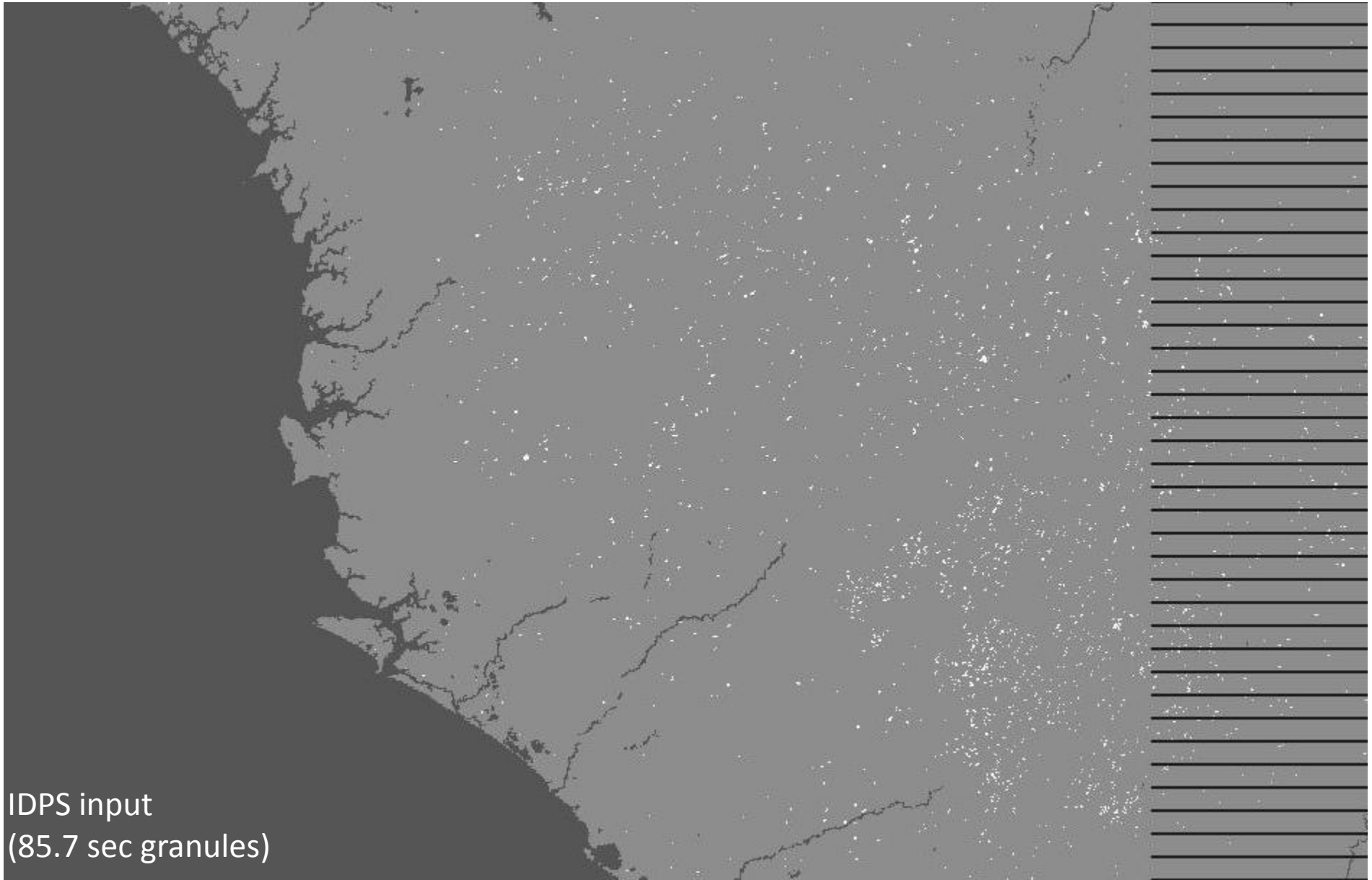
FRP: 4.36 – 212.39 MW



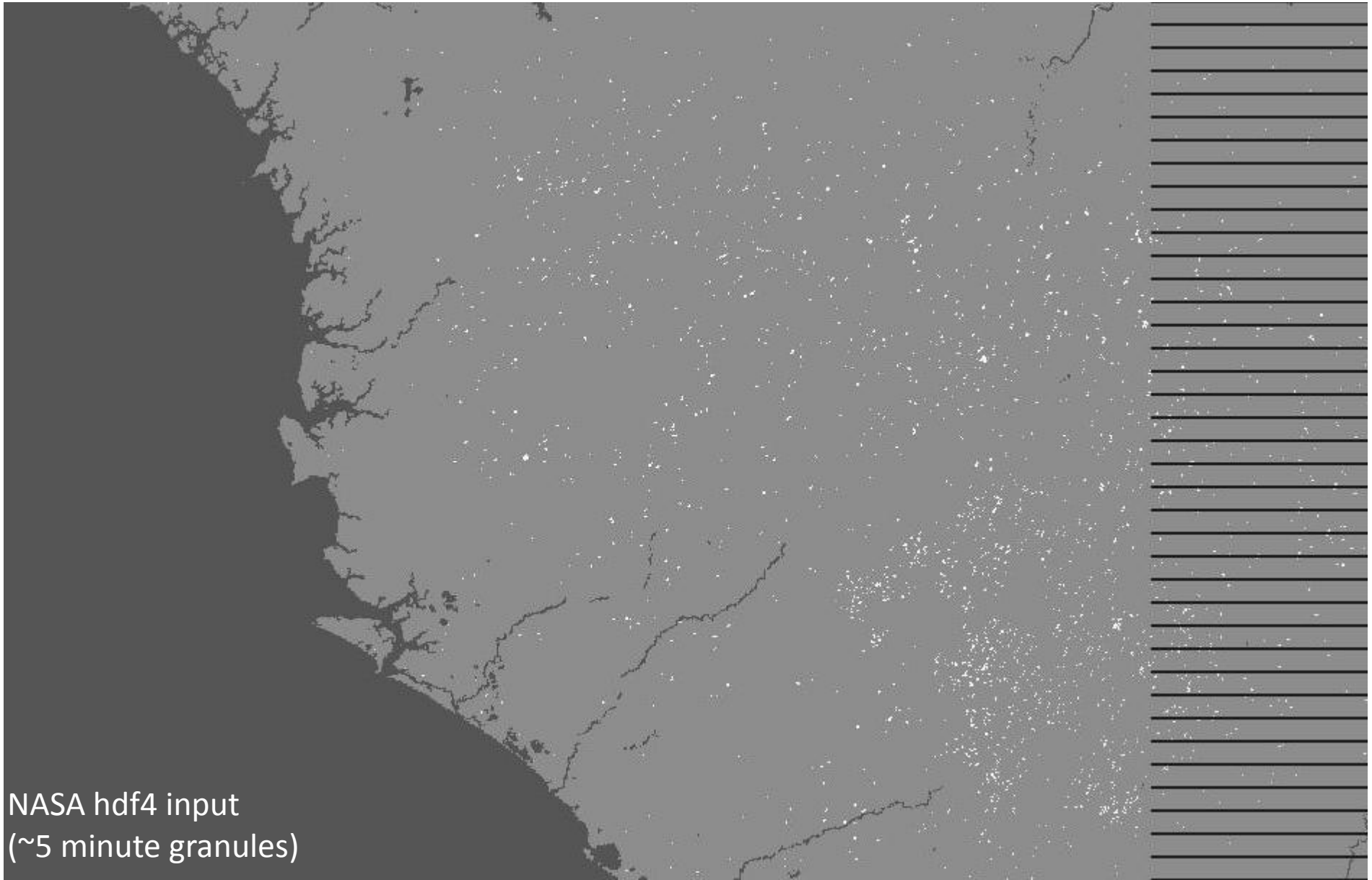


Data processed by STAR Algorithm Integration Team from IDPS input

NOAA operational version



NASA Science Product



NDE VIIRS Active Fire Output

Name	Type	Description	Dimension	Units	Range
fire mask	8 bit integer	Fire mask	3200 x 768	unitless	0 - 9
algorithm QA	32 bit Integer	Fire algorithm QA mask	3200 x 768	unitless	0 - 31
[18 diagnostic variables to be completed]					
FP_confidence	8 bit Integer	Fire detection confidence	Sparse data array 0 – N	%	0 – 100
FP_land	8 bit Integer	Land pixel flag	Sparse data array 0 – N	unitless	
FP_latitude	32 bit Float	Fire pixel latitude	Sparse data array 0 – N	degrees	-90 - 90
FP_line	16 bit Integer	Fire pixel line	Sparse data array 0 – N	unitless	0 - 768
FP_longitude	32 bit Float	Fire pixel longitude	Sparse data array 0 – N	degrees	-180 - 180
FP_power	32 bit Float	Fire radiative power	Sparse data array 0 – N	MW	0 - 5000
FP_sample	16 bit Integer	Fire pixel sample	Sparse data array 0 – N	unitless	0 – 3200
Nfire [TBC]					

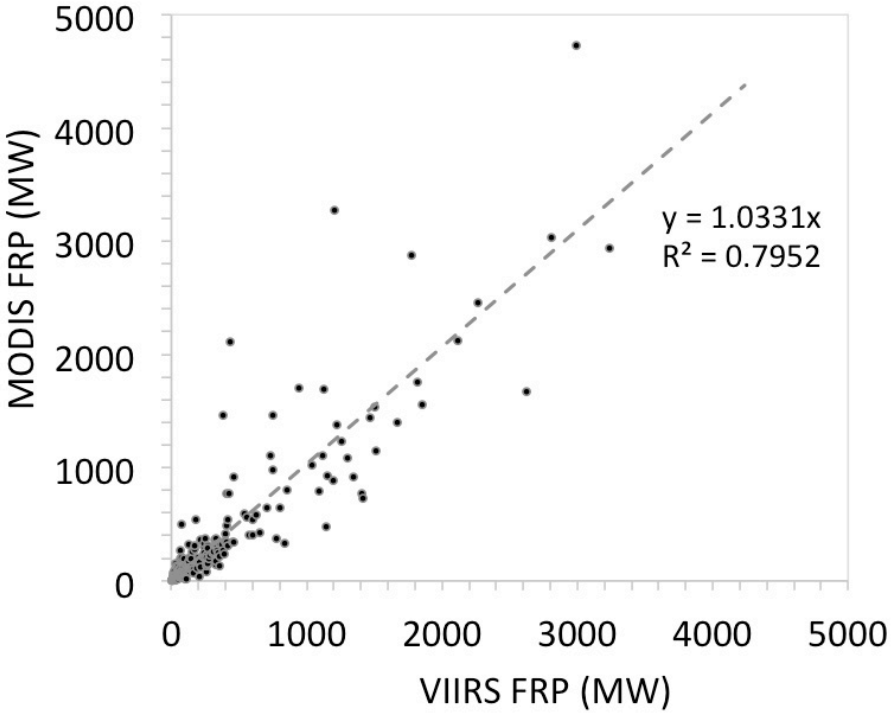
Details of two-dimensional arrays within the NDE VIIRS Active Fire output file

Output	Type	Description	
Fire Mask	8-bit unsigned integer	Missing – 0	Brightness temperatures for M13 or M15 unavailable
		Scan – 1	Not processed (trim)
		Other – 2	Not processed (other reason)
		Water – 3	Pixel classified as non fire water
		Cloud – 4	Pixel classified as cloudy
		No Fire – 5	Pixel classified as non fire land
		Unknown – 6	Pixel with no valid background pixels
		Fire Low – 7	Fire pixel with confidence strictly less than 20% fire
		Fire Medium – 8	Fire pixel with confidence between 20% and 80%
		Fire High – 9	Fire pixel with confidence greater than or equal to 80%
Fire Algorithm QA Mask	32-bit unsigned integer	Details in Table 1-3	

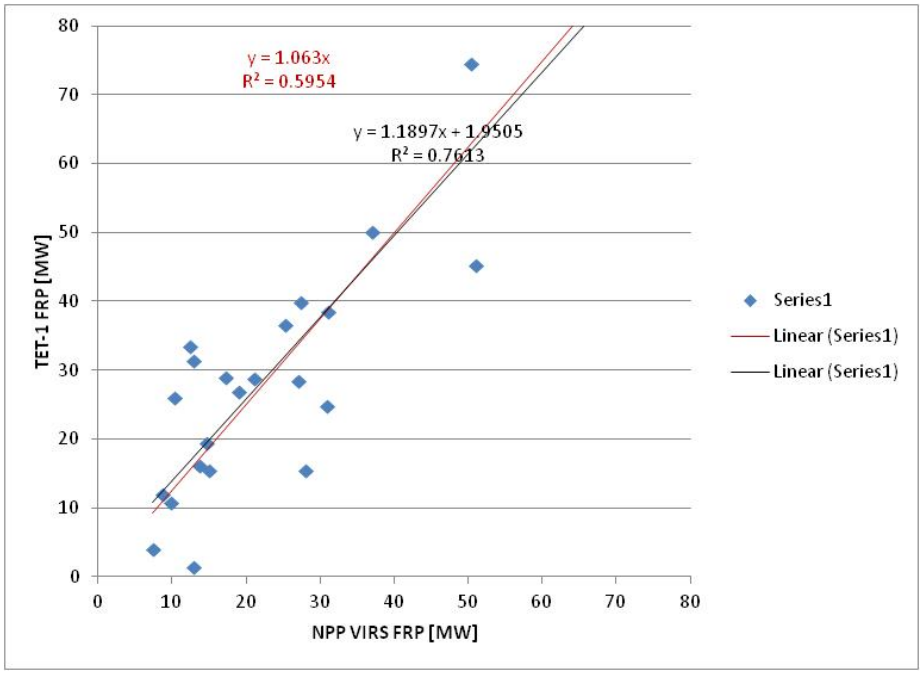
Details of the Quality Assessment (QA) mask within the NDE VIIRS Active Fire output file

Bits	Description
0-1	Surface Type (water=0, coastal=1, land=2)
2-3	Atmospheric correction
4	Day/Night (daytime = 1, nighttime = 0)
5	Potential fire (0/1)
6-10	Background window size parameter
11	Fire Test 1 valid (0 - No, 1 - Yes)
12	Fire Test 2 valid (0 - No, 1 - Yes)
13	Fire Test 3 valid (0 - No, 1 - Yes)
14	Fire Test 4 valid (0 - No, 1 - Yes)
15	Fire Test 5 valid (0 - No, 1 - Yes)
16	Fire Test 6 valid (0 - No, 1 - Yes)
17-19	N/A
20	Adjacent clouds (0/1)
21	Adjacent water (0/1)
22-23	Sun Glint Level (0-3)
24	Sun Glint rejection
25	False Alarm 1 (excessive rejection of legitimate background pixels)
26	False Alarm 2 (water pixel contamination)
27	Amazon forest-clearing rejection test
28-31	N/A

VIIRS FRP evaluation

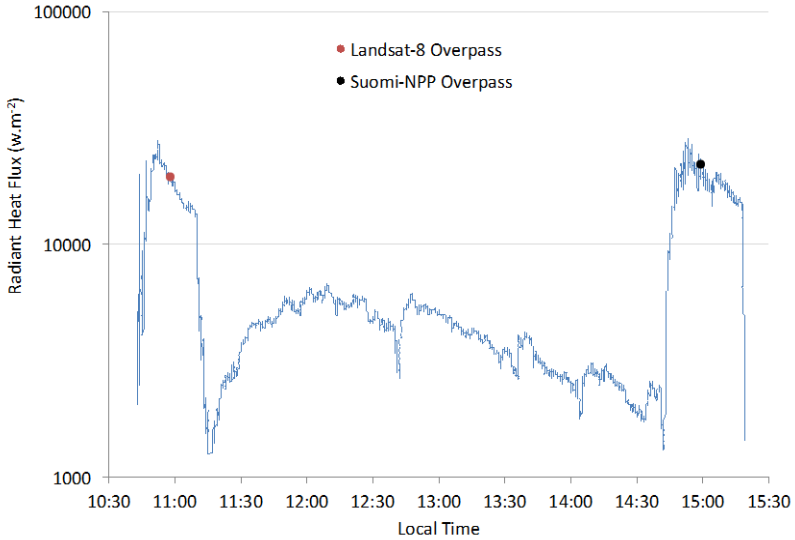


MODIS/VIIRS gridded data (0.5 degree) of near-coincident fires (<1km from each other) over different parts of the globe including atmospheric correction of both data sets.



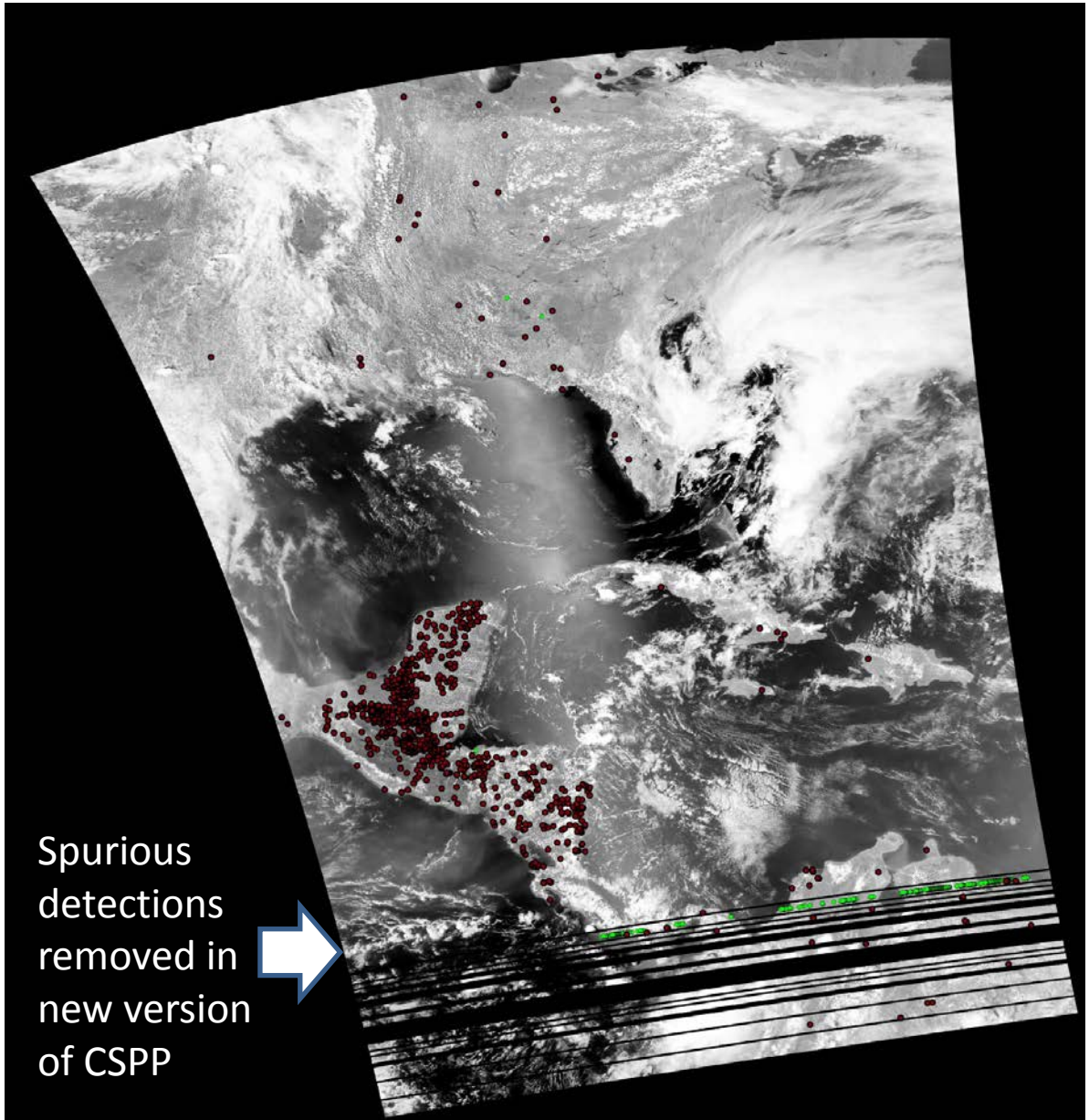
Comparison of FRP retrievals of gas flares in the Middle East on May 9, 12, 15, 18, 24 2015. TET-1: Technology Experiment Carrier-1by German Aerospace Agency DRL; dedicated 185m unsaturated measurements for hotspot characterization

Active Fire Validation



Small experimental fire implemented for the validation of same-day Landsat-8 and Suomi-NPP/VIIRS fire detection data in Brazil, Jan/2015. Tower-mounted radiometers provided 1Hz fire radiant flux data coincident with satellite overpasses.

Direct broadcast support



- *Missing / noisy data in Direct Broadcast transmission can result in incorrect SDR calibration and spurious detections.*
- *The frequency of DB data anomalies depend on the performance of the local DB processing system.*
- *Spurious detections can also be filtered by empirical techniques.*
- *Regular updates to include algorithm improvements is critical.*

Further fixes are needed to account for large data gaps – usually in DB – NASA DLR patch

CSPP V2.0 (SDR Mx8.4)
CSPP V2.1 (SDR Mx8.6)

CSPP: Community Satellite Processing Package (UW-Madison)

Courtesy Isabel Cruz CONABIO, Mexico

VIIRS Fire Data and Evaluation Portal

VIIRS Active Fire - Maps &

viirsfire.geog.umd.edu/pages/mapsData.php

Apps | Getting Started | Imported From Firef... | National Oceanic an... | Request for Adjust... | NOAA Email on a Pe... | Commerce - OCIO S... | NCWCP Tenant We... | Fwd: Alaska Fire Up... | New Tab

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

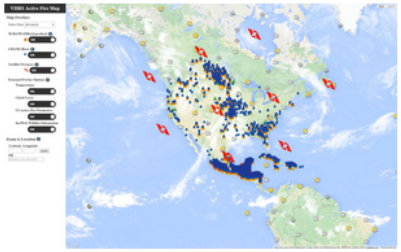
VIIRS AF Table Data

VIIRS Data Tutorial: VIIRS_data_tutorial.pdf

VIIRS 750m and 375m products over North America

Global VIIRS 750m product

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.

CONUS data download

Select a Date

09/04/2015

Search

09/04/2015 - CONUS data

View Global Active Fire Map

VIIRS daily global active fire detections.

GLOBAL data download

Select a Date

09/04/2015

Search

09/04/2015

No files found for that day.

viirsfire.geog.umd.edu

Products in various formats

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

Active Fire Team

Ivan Csiszar

Chris Justice

Louis Giglio

Evan Ellicott

Wilfrid Schroeder

Krishna Vadrevu

Antonio Sanchez

Links

JPSS

VIIRS

University of Maryland

NOAA

NOAA-STAR

USFS RSAC

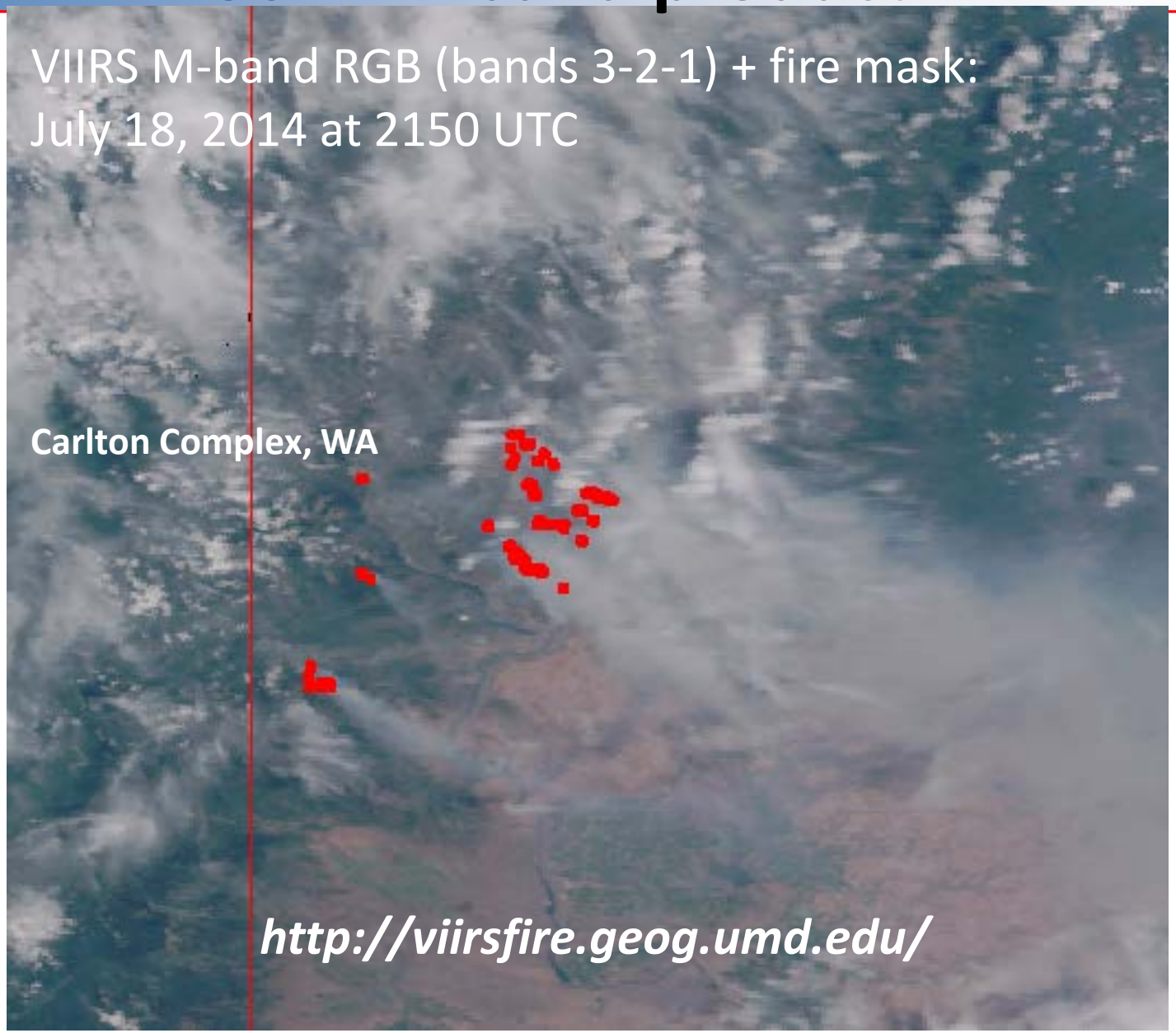
GOFC Fire

Global VIIRS fire data access

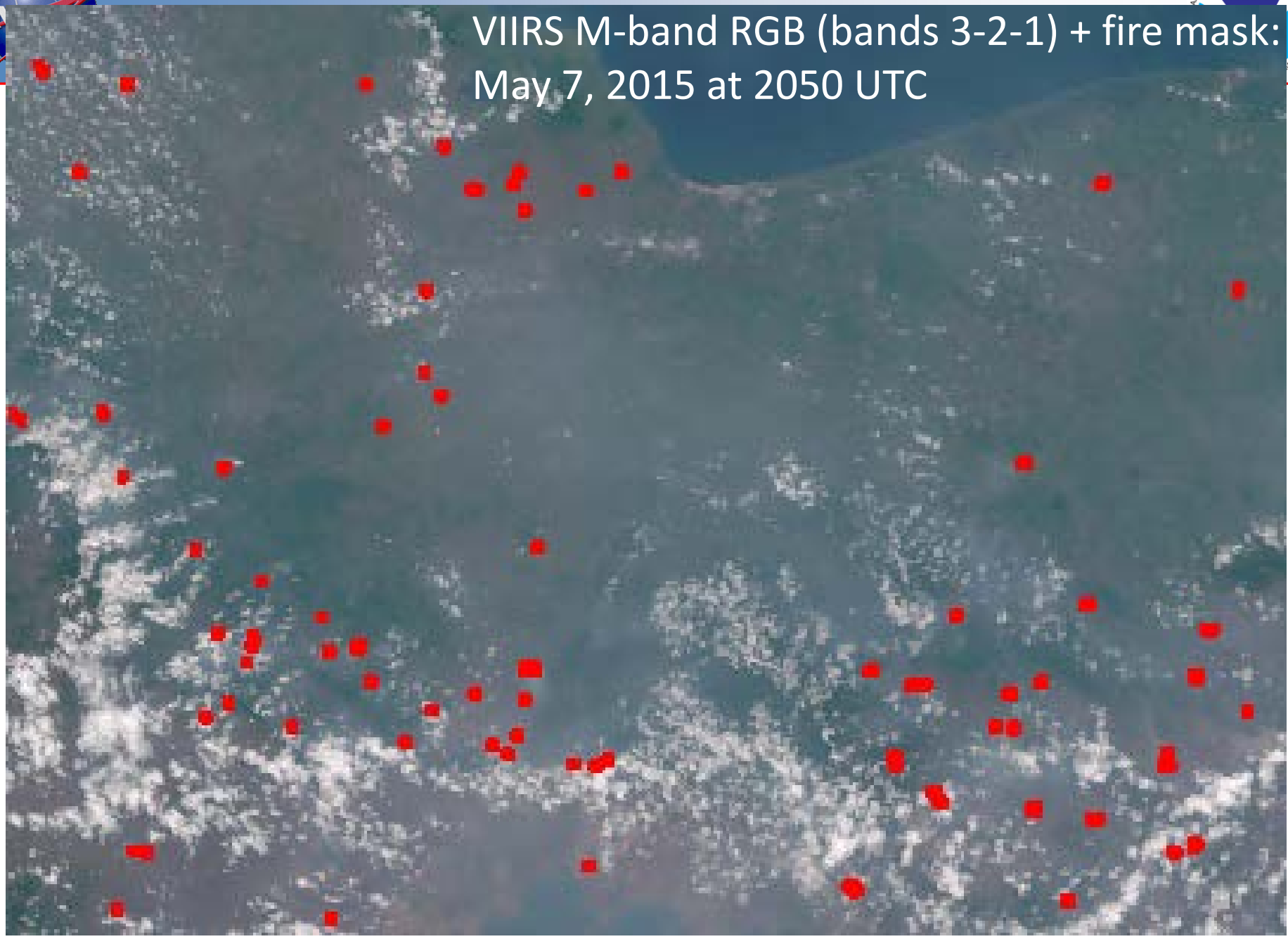
- Options:
  - NOAA CLASS Web
    - www.class.noaa.gov
  - NASA LAADS Web
    - ladsweb.nascom.nasa.gov/data/search.html
  - NOAA CLASS ftp (anonymous)
    - ftp-npp.class.ngcd.noaa.gov
  - NASA LAADS ftp (anonymous)
    - ladsweb.nascom.nasa.gov
- Detailed instructions:

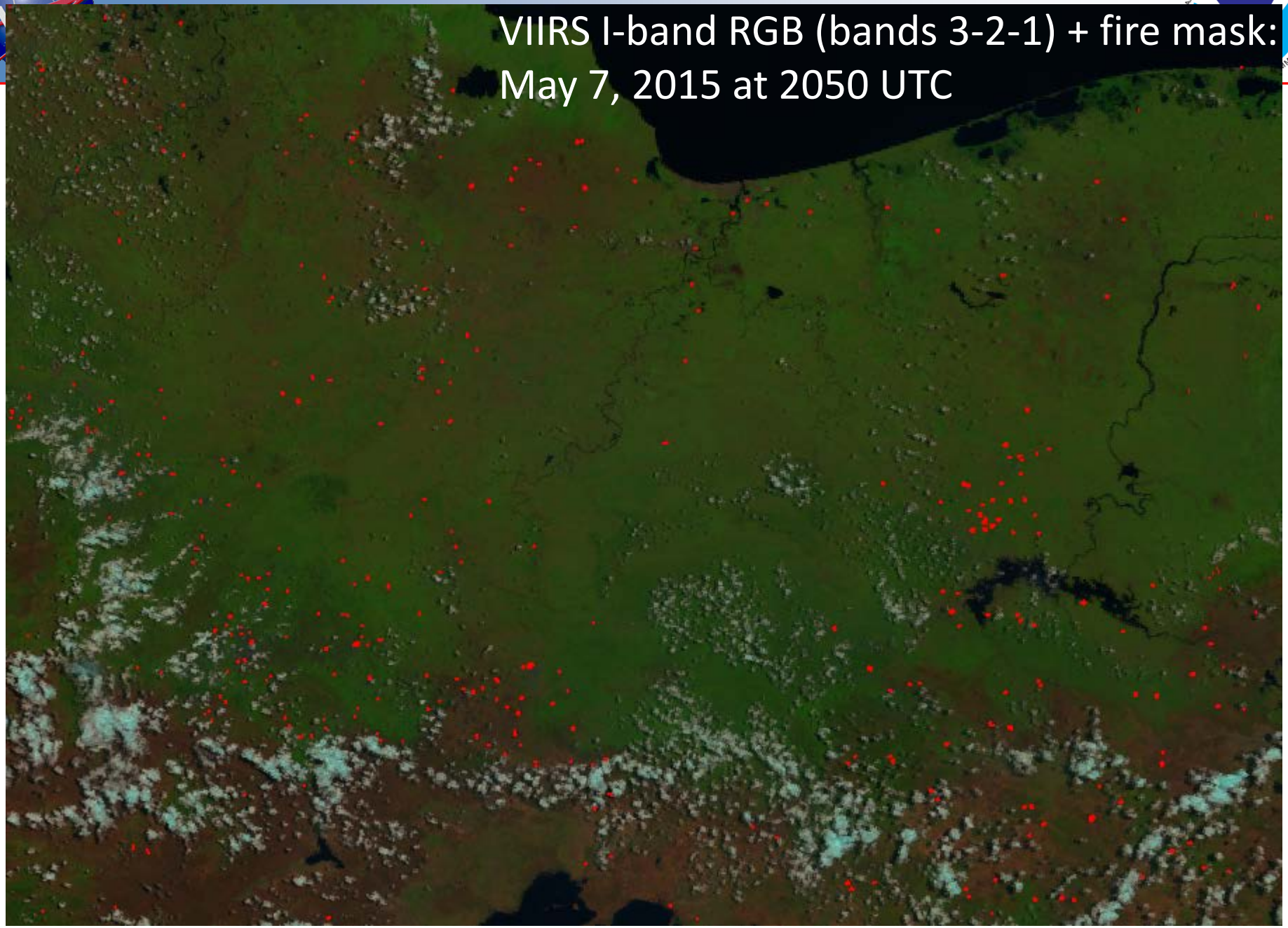
  viirsfire.geog.umd.edu/Documents/VIIRS_data_tutorial.pdf

Improving spatial resolution: from the 750m M-band product…



…towards the 375m I-band product


VIIRS M-band RGB (bands 3-2-1) + fire mask:
May 7, 2015 at 2050 UTC


VIIRS I-band RGB (bands 3-2-1) + fire mask:
May 7, 2015 at 2050 UTC

West Fork Complex

Image taken by NASA astronauts on the International Space Station: June 19, 2013

Rim fire

Mark Hale - FBAN

Ben Newburn - FBAN

West Fork Complex

Eric Morgan and Chris Johnson (FBANs)

Mark Loeffelbein and Kelly Hooper (IMETs)

Nick Giannettino (Planning Section Chief)

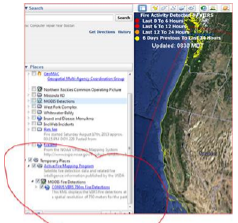
Rim fire "Debrief"
Evan Ellicott

Background: The objective of the JPSS VIIRS Active Fire (AF) Proving Ground and R
(PGRR) project is to maximize the benefits and performance of SNPP data, algorithms, anc
downstream operational and research users. The VIIRS Active Fire product is critical for d
resource management and expected to be used by real-time resource and disaster manag
quality monitoring; ecosystem monitoring; climate studies, etc. With this in mind our goa
project are product evaluation and improvement and the development of a near-real-tim
product delivery system to support fire management and NOAA operations.

My visit to the West Fork Complex near Pagosa Springs, Colorado, in June 2013 of
hand insight to the operational structure, work and information flow, as well as an opport
demonstrate th

- **Latency** – this is critical component to operational management of an incident. Getting RS data to the Situation Unit Leaders and others in the Planning Section, as well as Command Cadre, as quickly as possible. That said, the current RS data they use – primarily NIROPS, is only once a day and at night. I explained how VIIRS (and MODIS) f around the same time NIROPS flights are imaging the additional sampling points to confirm heat sources an difference between NIROPS, VIIRS, and MODIS could using MODIS-Terra (~10am/pm) along with afternoon information, would offer a sense of the fire's diurnal
- **User-friendly format** – this has been a consistent the the format be easily ingested into a GIS or Google Eart straightforward, both in terms of where to go to get it metadata file with clear, concise descriptions should
- **Product availability user knowledge** – there is a spec of data is available, the most appropriate application, accuracy with and between datasets. This may be the

Based on feedback from members of the recommendations to Brad Quayle at the many in the wildland firefighting community



3. And then reading about the VIIRS footprint is a little confusing for some folks:
   a. *"This KML displays the VIIRS fire detections at a spatial resolution of 750 meters for the past 6 hours, 6-12 hours, 12-24 hours and the previous 6 day period. Each 750 meter VIIRS fire detection is depicted as a point representing the centroid of the 1km pixel where the fire is detected. The 750 meter footprint of the VIIRS pixel for each detection is*

blackbox.

1. *The KML feeds on the "Fire Data in GoogleEarth" for VIIRS, AVHRR, and GOES are often confused with the maps above them. In other words, I spoke with several individuals who state that they thought the VIIRS data was only for Alaska. Although a little bit of clicking quickly resolves this confusion, I can also see how someone might initially come to this conclusion:*

The following is insight and comments gathered from specific user-groups:

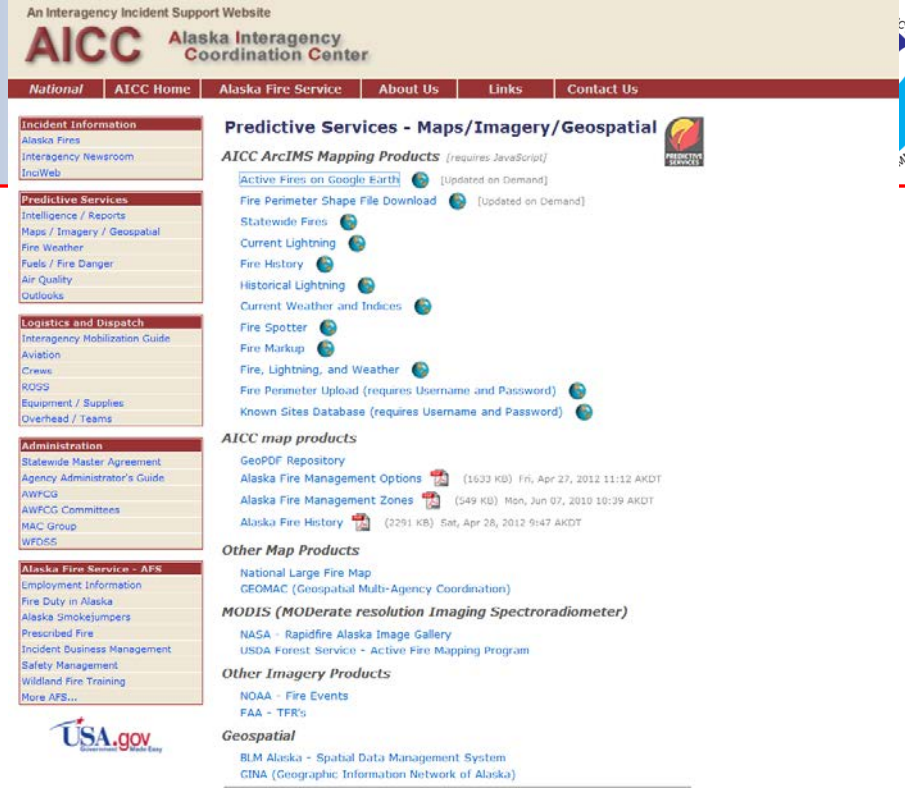
- **IMETs:** My discussions with the IMETs (Mark Pellerito and Joel Curtis) offered simila what I had heard at the West Fork Complex, mainly that they were not really up to sp VIIRS sensor's characteristics and capabilities, particularly fire detection (and hopefu fire characterization).
  - What they want in any data source is timeliness and user-friendly format. For on Wednesday and Thursday (9/11-12) a cold front moved in to the East of th producing convective cells and lightning activity. There was concern about out stirring up the fire as well as lightning activity generating new fires. The IMETs checking their models and GOES regularly (meaning constantly) during these e

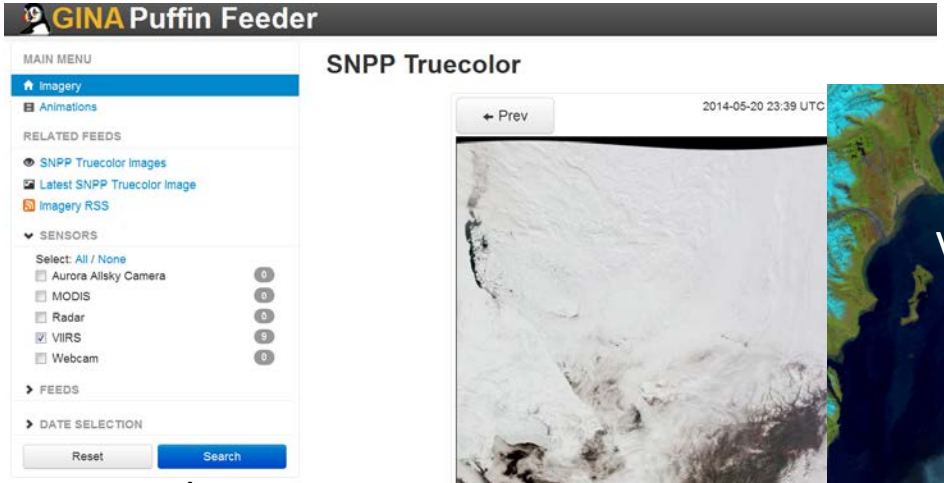
2. *When you click on the VIIRS detection (current) link and it opens in Google Earth the content*

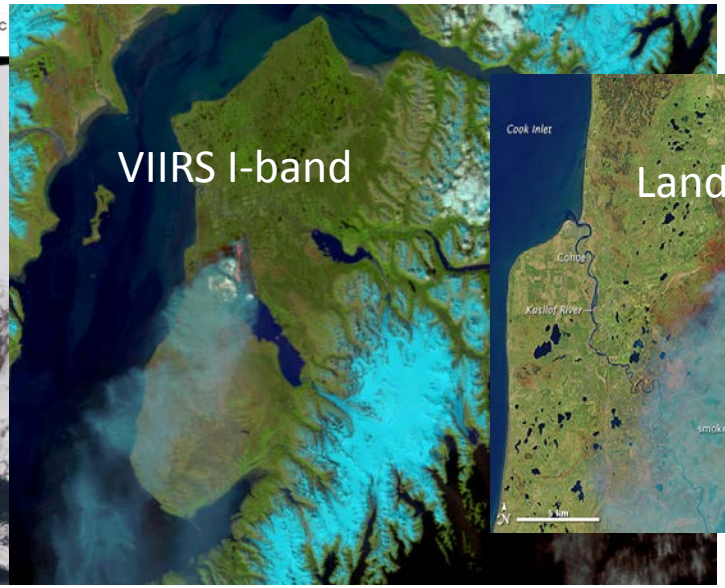
Sample of web-based resources

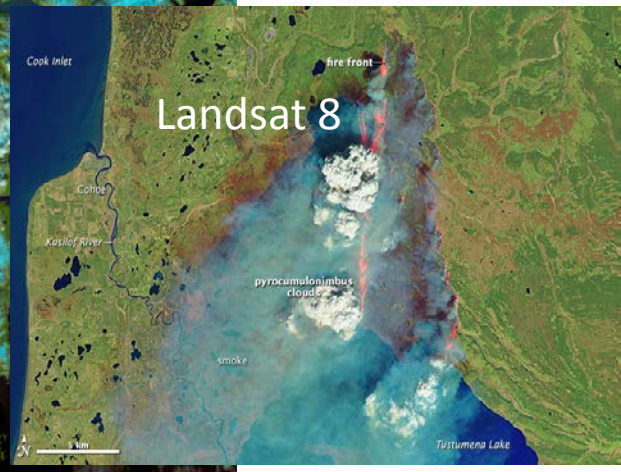
- USFS Remote Sensing Applications Center (RSAC)
- Geographic Information Network of Alaska - GINA (Puffin Feeder)
- UMD VIIRS AF website (viirs.geog.umd.edu)
- Geospatial Multi-Agency Coordination (GeoMAC)
- Geographical Area Coordination Centers (GACCs) – e.g. Northwest Interagency Coordination Center (NWCC)
- Hazard Mapping System (HMS)
- Infusing satellite Data into Environmental Applications (IDEA)
- Western Regional Air Partnership's (WRAP) Fire Emissions Tracking System (FETS)
- Real-time Air Quality Modeling System (RAQMS)

Alaska: a key focus area







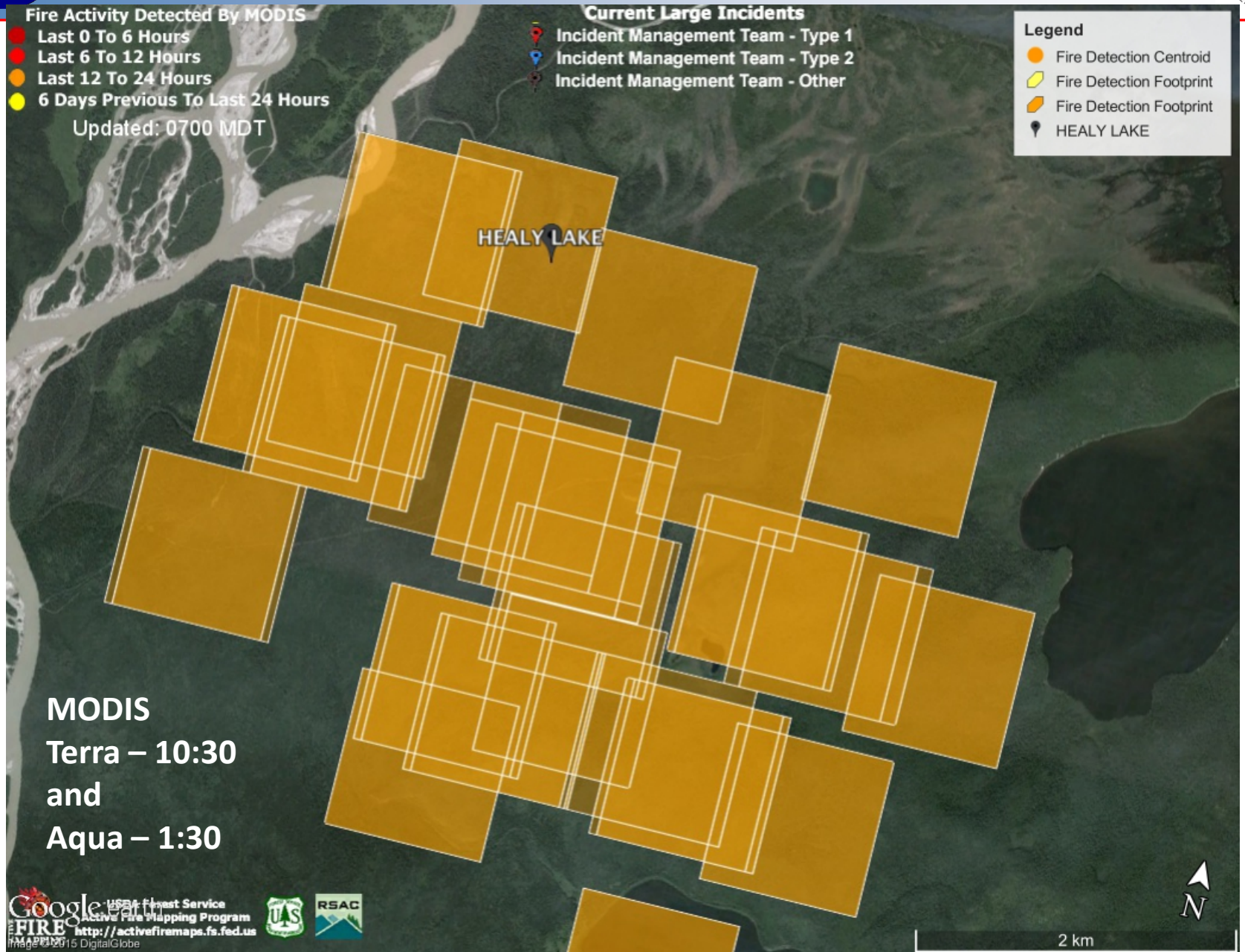


AICC and GINA to get VIIRS AF in user-friendly format for operations.

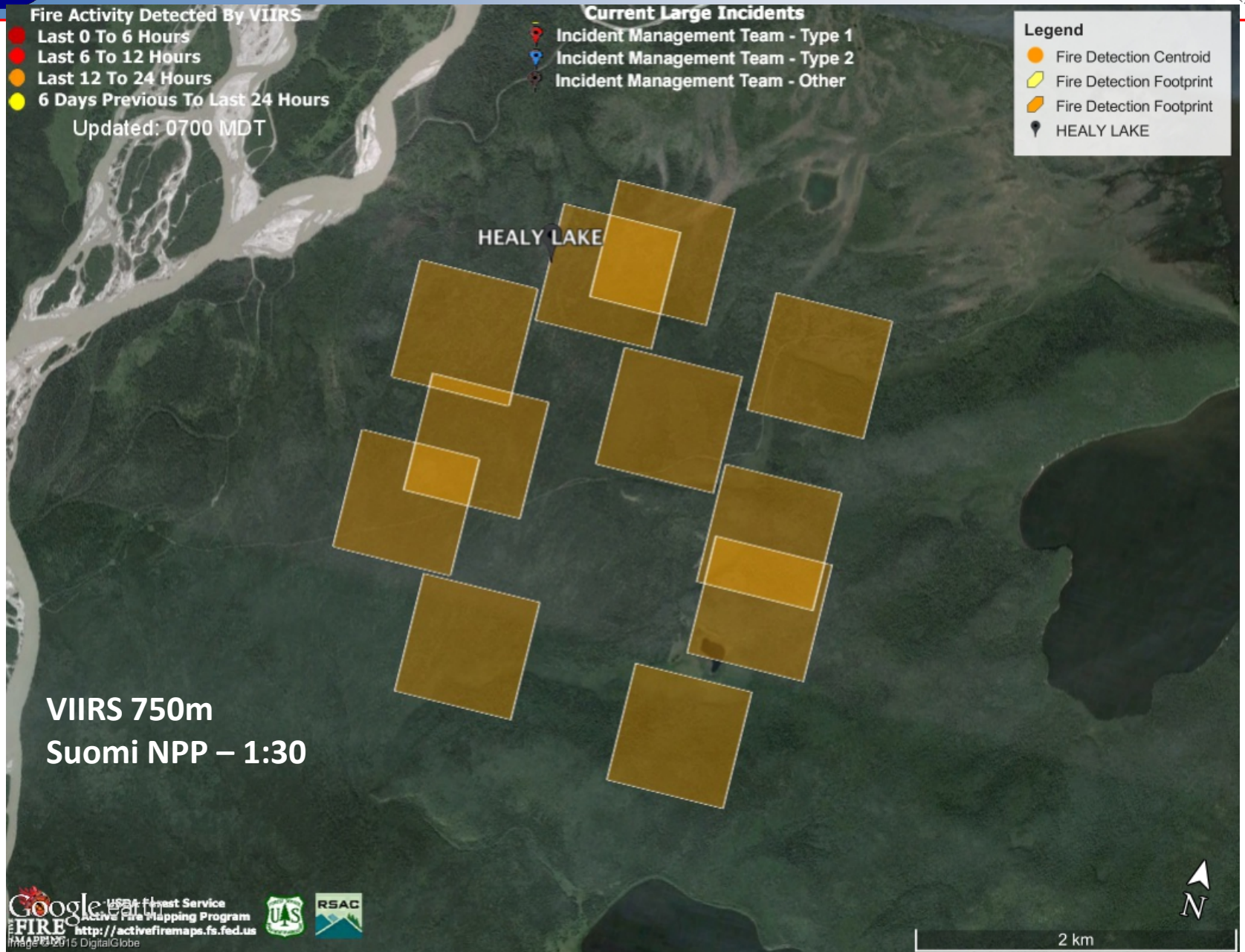
Alaska VIIRS fire data access

- GINA:
  - KML feed
    - http://kml.gina.alaska.edu/
  - Imagery
    - http://feeder.gina.alaska.edu
- USFS RSAC
  - GIS Fire Detections
    - http://activefiremaps.fs.fed.us/gisdata.php?sensor=modis&extent=alaska
  - KMLs
    - http://activefiremaps.fs.fed.us/googleearth.php?sensor=modis&extent=alaska
- AK Interagency Coordination Center
  - http://fire.ak.blm.gov/predsvcs/maps.php

Healy Lake Fire (Alaska)



Healy Lake Fire (Alaska)



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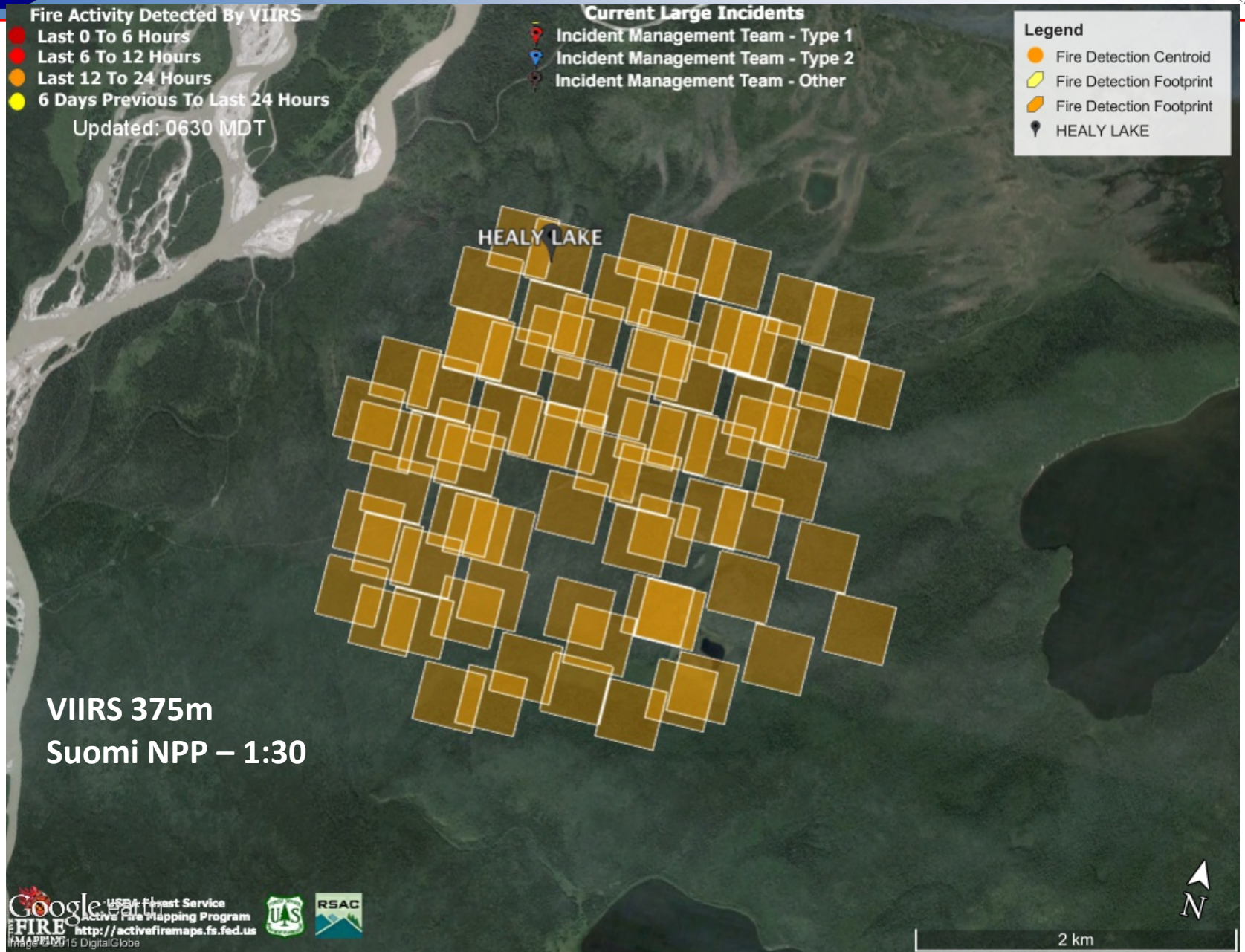
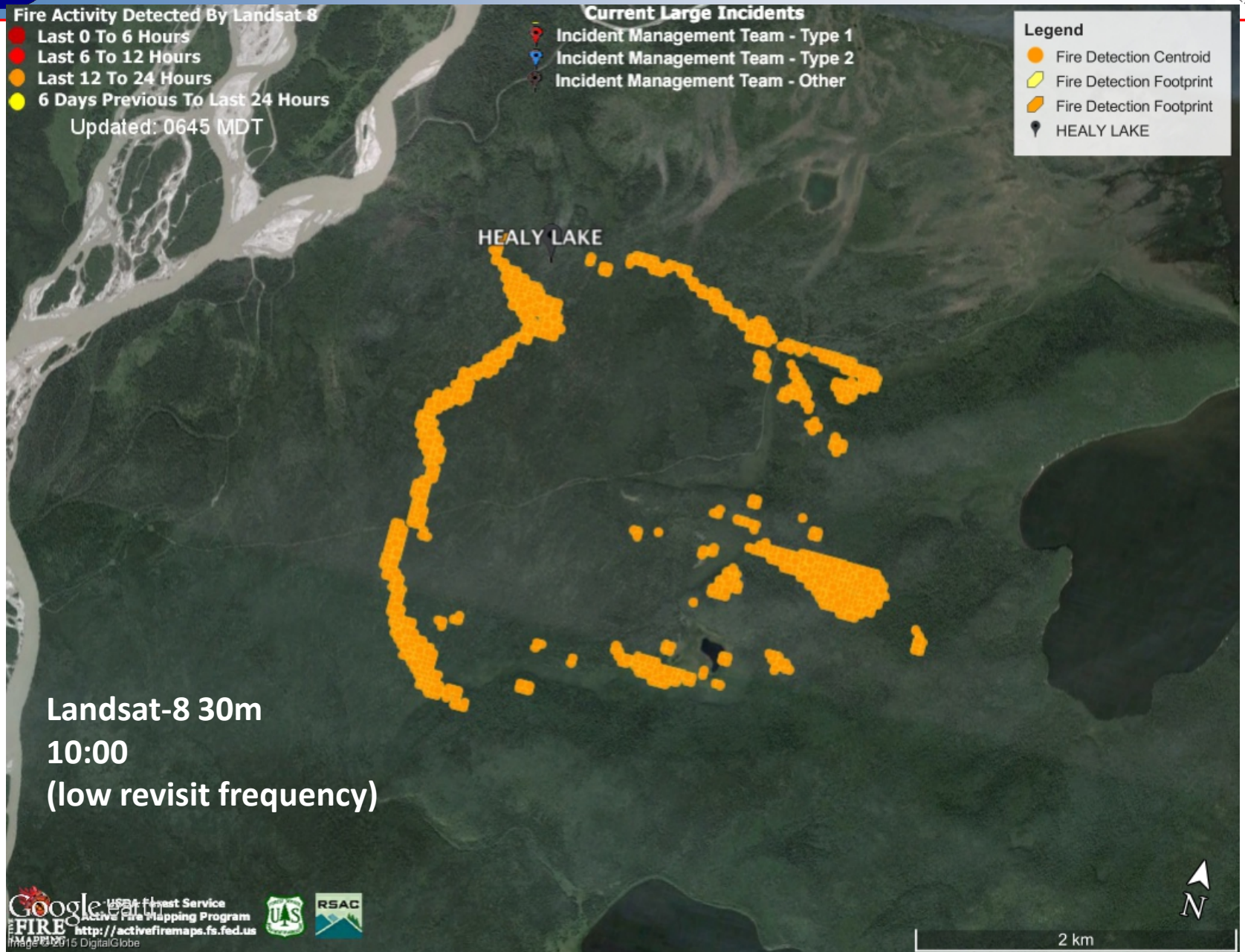


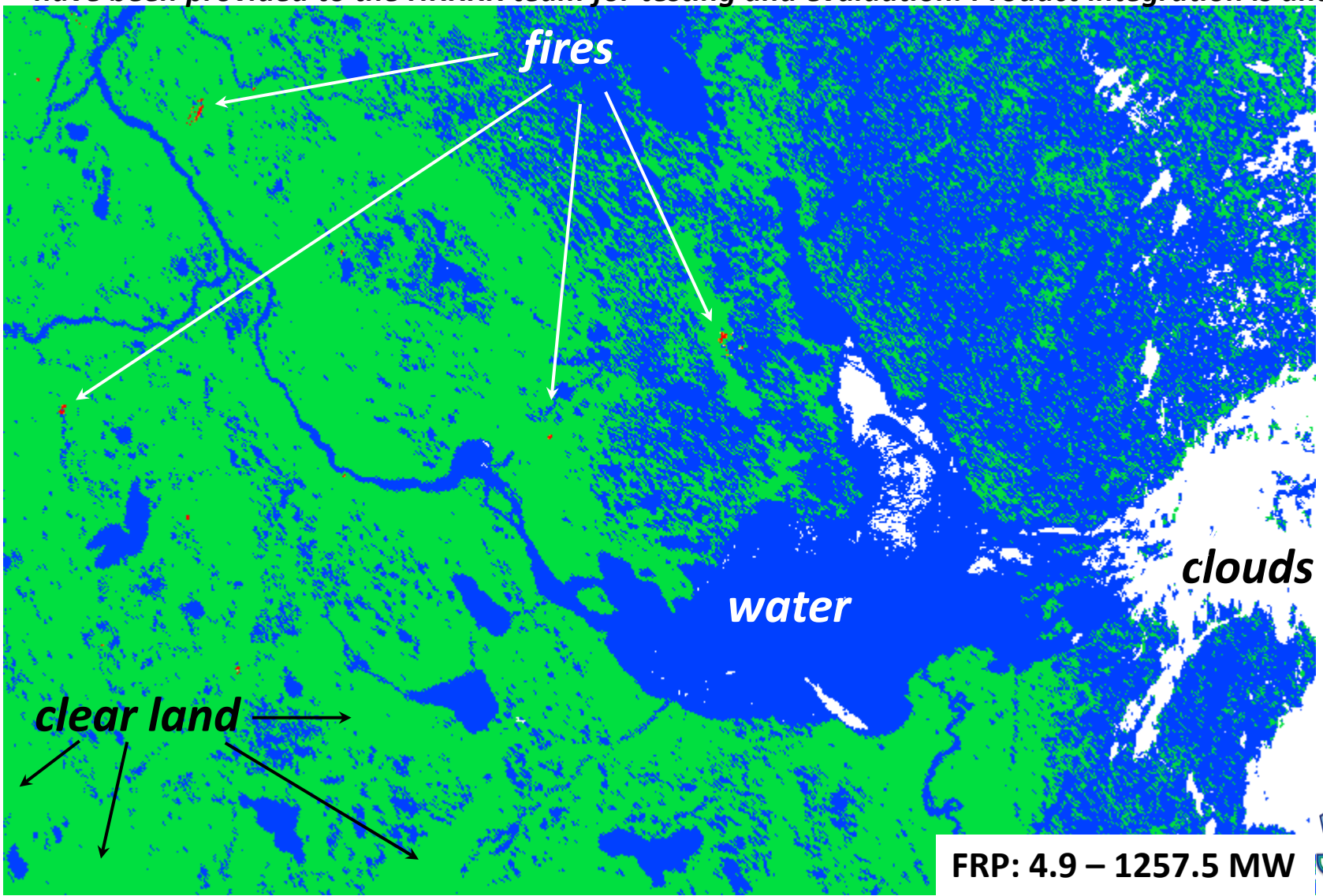
Healy Lake Fire (Alaska)



Towards the Inclusion of VIIRS Fire Products into the HRRR Real-Time Forecasts

Steven Packham, Georg A. Grell, Saulo Freitas (NOAA/ESRL); Ivan Csiszar (NESDIS/STAR)

Three days of sample data (May 29-31, 2015) from the new NDE Active Fire product over North America have been provided to the HRRRR team for testing and evaluation. Product integration is underway.



VIIRS fire mask over NW Canada 5/29/2015 20:06 UTC

Summary and path forward

- Algorithm readiness
  - Transition of experimental products into full NOAA operations
    - VIIRS 750m FRP (ongoing); 375m detection (future)
  - Science support to ensure algorithm updates in direct broadcast packages
    - CSPP and IPOPP support and coordination
  - Support product delivery to end users
    - e.g. GINA Alaska and Alaska Fire Service
- Data latency
  - Rapid delivery from direct broadcast systems
  - Global delivery with ~2-hour latency upcoming
- Direct end user support
  - Visualization through combined multi-product systems
    - NOAA STAR IDEA, AWIPS-II
- Improving emission estimates and smoke forecast
  - e.g. VIIRS FRP to NOAA's High Resolution Rapid Refresh (HRRR) system
- International outreach and collaboration
  - Global Observation of Forest and Landcover Dynamics
  - DLR German Aerospace Center TET-1 (Technology Experiment Carrier) mission
    - Product validation and technology demonstration