



VIIRS fire products

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additional credits are given on select slides

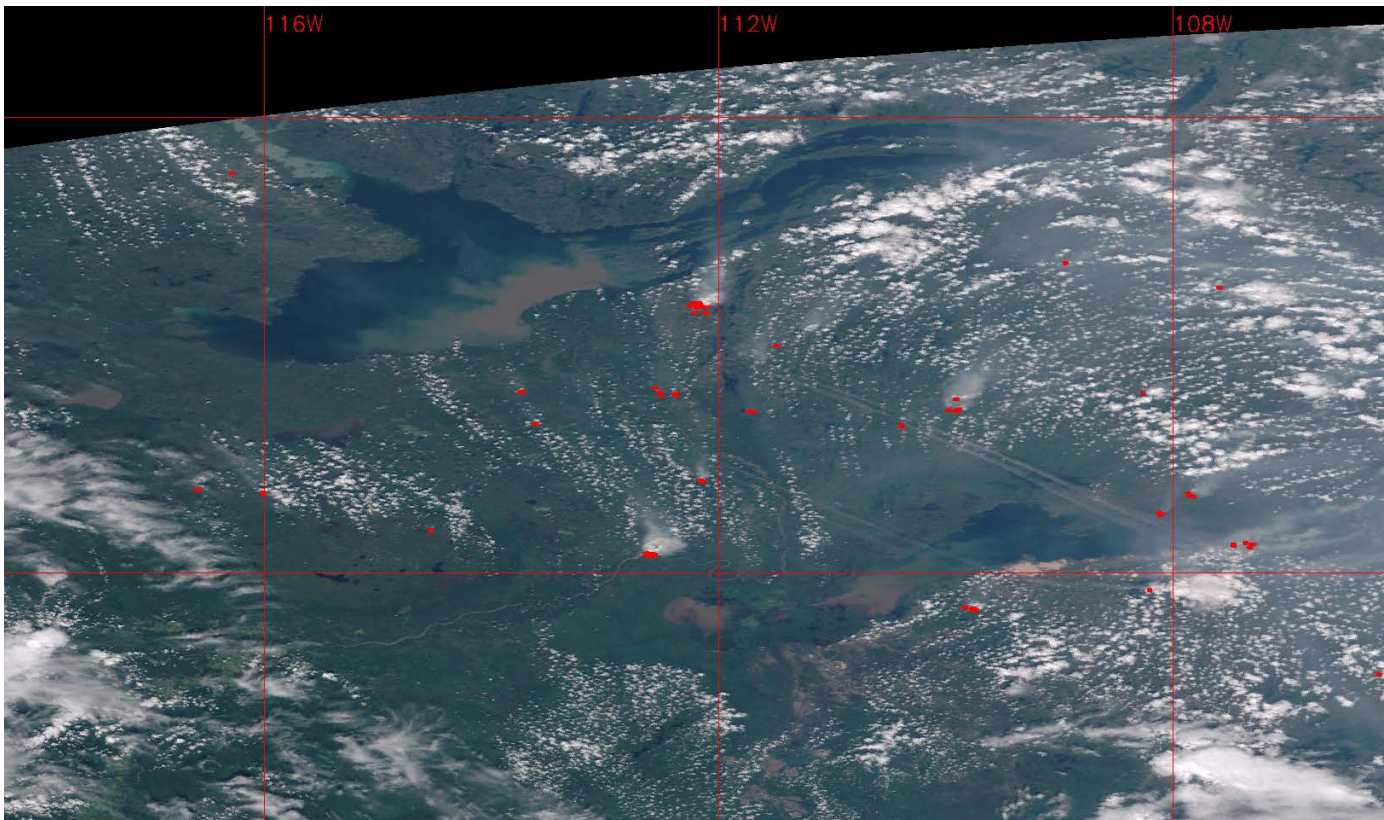


VIIRS Heritage: MODIS and AVHRR

VIIRS			MODIS Equivalent			AVHRR-3 Equivalent			OLS Equivalent		
Band	Range (um)	HSR (m)	Band	Range	HSR	Band	Range	HSR	Band	Range	HSR
DNB	0.500 - 0.900								HRD	0.580 - 0.910	550
									PMT	0.510 - 0.860	2700
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000						
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000						
M3	0.478 - 0.498	750	3	0.459 - 0.479	500						
			10	0.483 - 0.493	1000						
M4	0.545 - 0.565	750	4	0.545 - 0.565	500						
			12	0.546 - 0.556	1000						
I1	0.600 - 0.680	375	1	0.620 - 0.670	250	1	0.572 - 0.703	1100			
M5	0.662 - 0.682	750	13	0.662 - 0.672	1000	1	0.572 - 0.703	1100			
			14	0.673 - 0.683	1000						
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000						
I2	0.846 - 0.885	375	2	0.841 - 0.876	250	2	0.720 - 1.000	1100			
M7	0.846 - 0.885	750	16	0.862 - 0.877	1000	2	0.720 - 1.000	1100			
M8	1.230 - 1.250	750	5	SAME	500						
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000						
I3	1.580 - 1.640	375	6	1.628 - 1.652	500						
M10	1.580 - 1.640	750	6	1.628 - 1.652	500	3a	SAME	1100			
M11	2.225 - 2.275	750	7	2.105 - 2.155	500						
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000	3b	SAME	1100			
M12	3.660 - 3.840	750	20	SAME	1000	3b	3.550 - 3.930	1100			
M13	3.973 - 4.128	750	21	3.929 - 3.989	1000						
			22	3.929 - 3.989	1000						
			23	4.020 - 4.080	1000						
M14	8.400 - 8.700	750	29	SAME	1000						
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000	4	10.300 - 11.300	1100			
I5	10.500 - 12.400	375	31	10.780 - 11.280	1000	4	10.300 - 11.300	1100	HRD	10.300 - 12.900	550
			32	11.770 - 12.270	1000	5	11.500 - 12.500	1100			
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000	5	11.500 - 12.500	1100			

Background of VIIRS IDPS Active Fire Product

- VIIRS represents continuity with NASA EOS MODIS and NOAA POES AVHRR fire detection (and also international missions such as (A)ATSR)
- VIIRS design allows for radiometric measurements to detect and characterize active fires over a wide range of observing and environmental conditions
- The VIIRS fire product is expected to be used by real-time resource and disaster management; air quality monitoring; ecosystem monitoring; climate studies etc.
- IDPS product is a sparse array of lan/lon or fire pixels and row/column and quality flag



*NW Canada
07 July 2013
20:14:55-20:20:34 UTC*

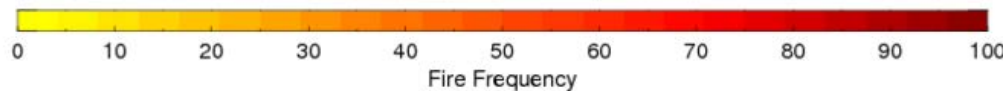
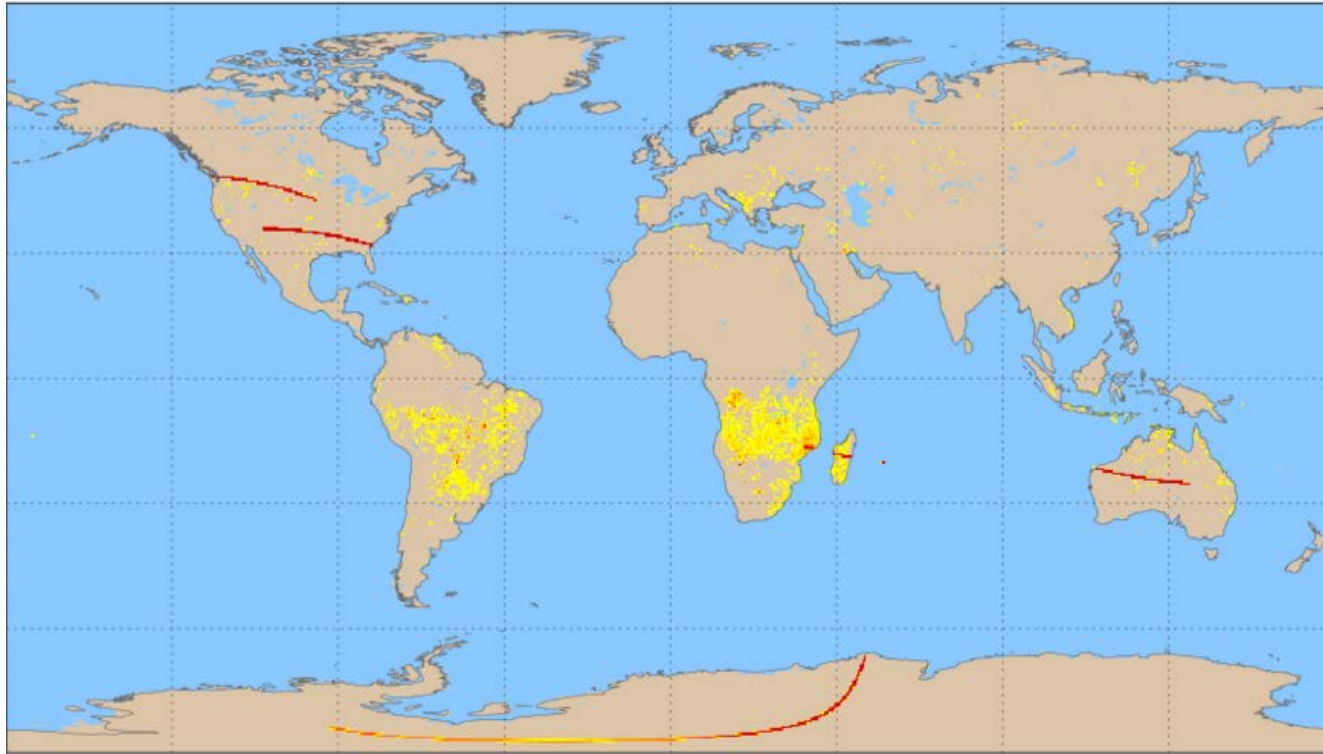
An example of the early IDPS VIIRS fire product

from the NOAA NESDIS STAR long-term monitoring system

https://www.star.nesdis.noaa.gov/jpss/EDRs/products_activeFires.php

Suomi NPP VIIRS - IDPS Active Fires

31 Aug 2012



***Example of the operational real-time IDPS product as archived in NOAA CLASS.
Not reprocessed; not to be used for science analysis. Planning for reprocessing is ongoing.***

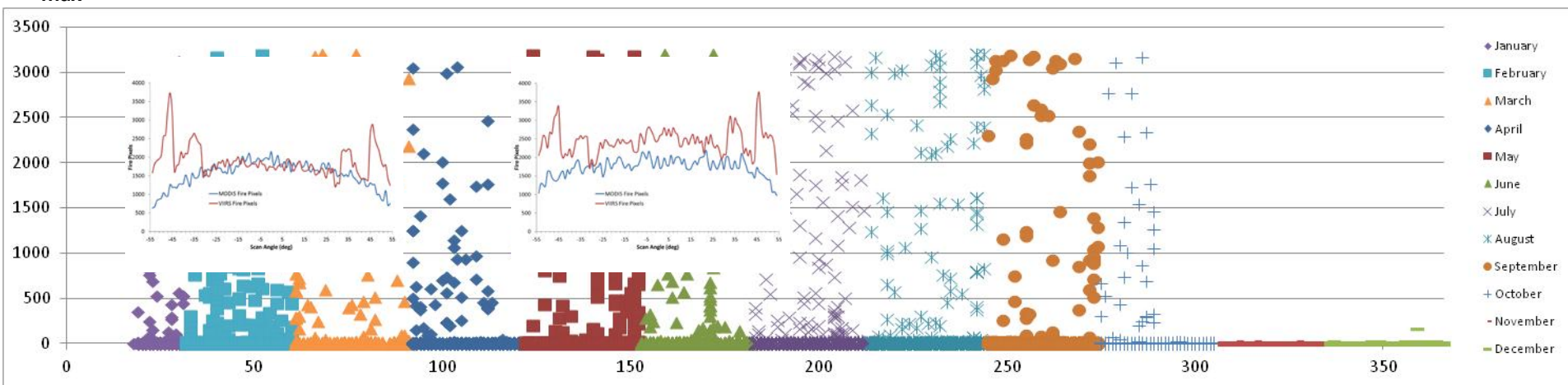
IDPS Suomi NPP Active Fire Product history: data anomalies and product maturity (3/1)

2012

April 3, 2012
IDPS Mx5.3

October 16, 2012
IDPS Mx6.3

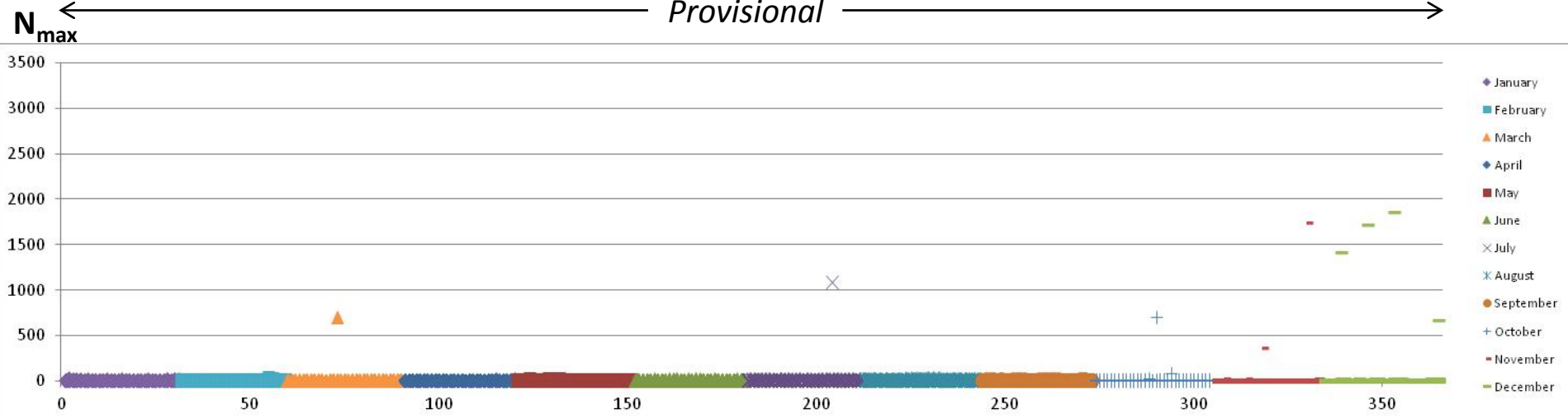
N_{max} ← Pre-Beta → | ← Beta → | ← Provisional →



2013

Day of Year

Provisional



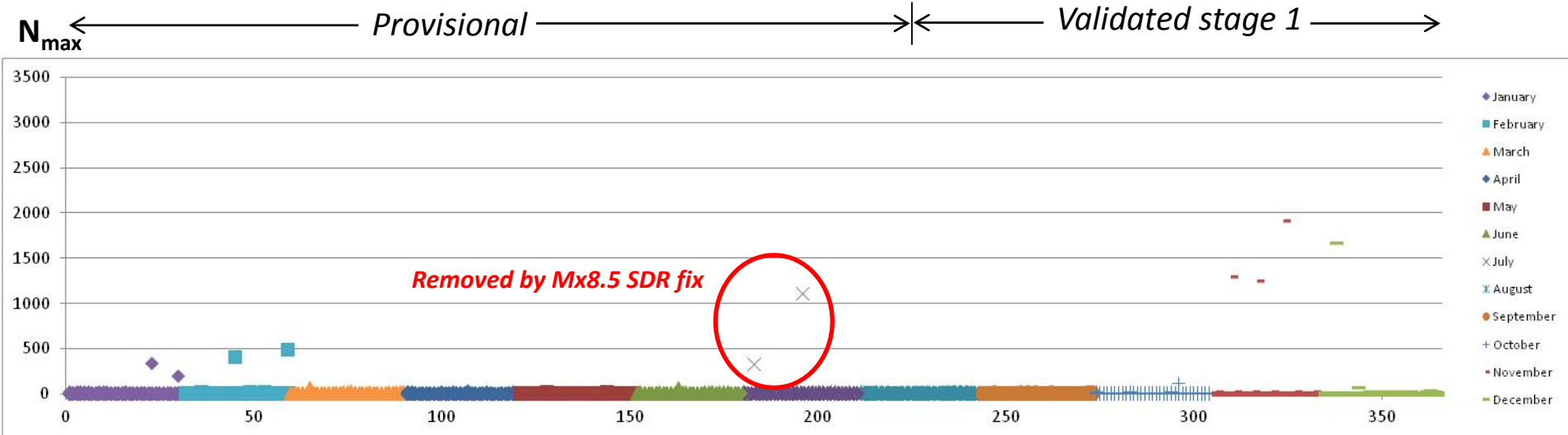
N_{max} : maximum number of detections within a scanline

Day of Year

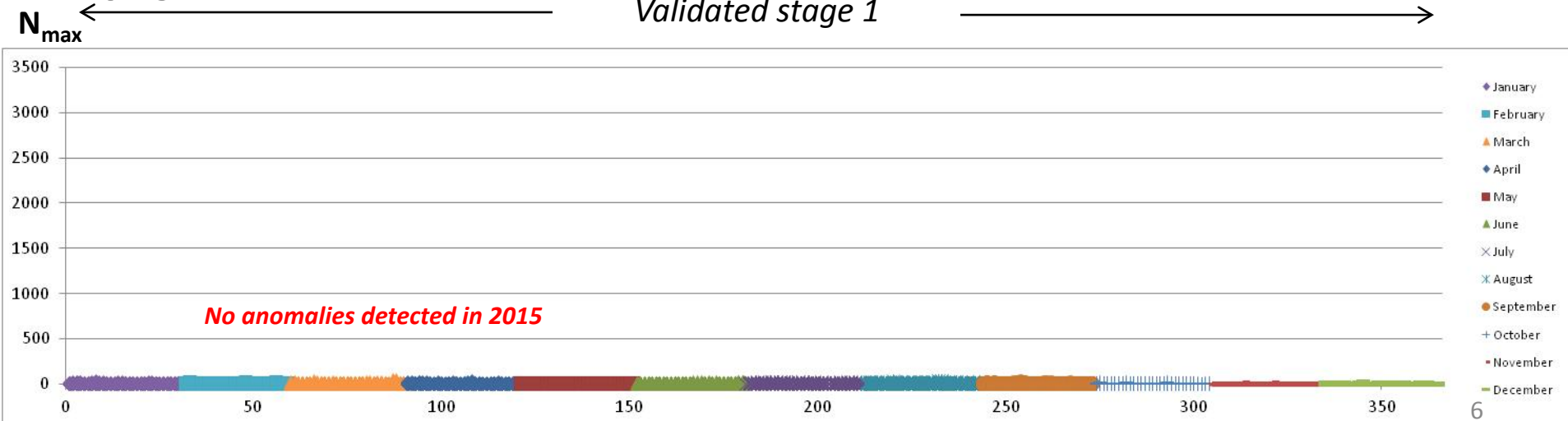
IDPS Suomi NPP Active Fire Product history: data anomalies and product maturity (3/2)

2014

August 13, 2014
IDPS Mx8.5



2015

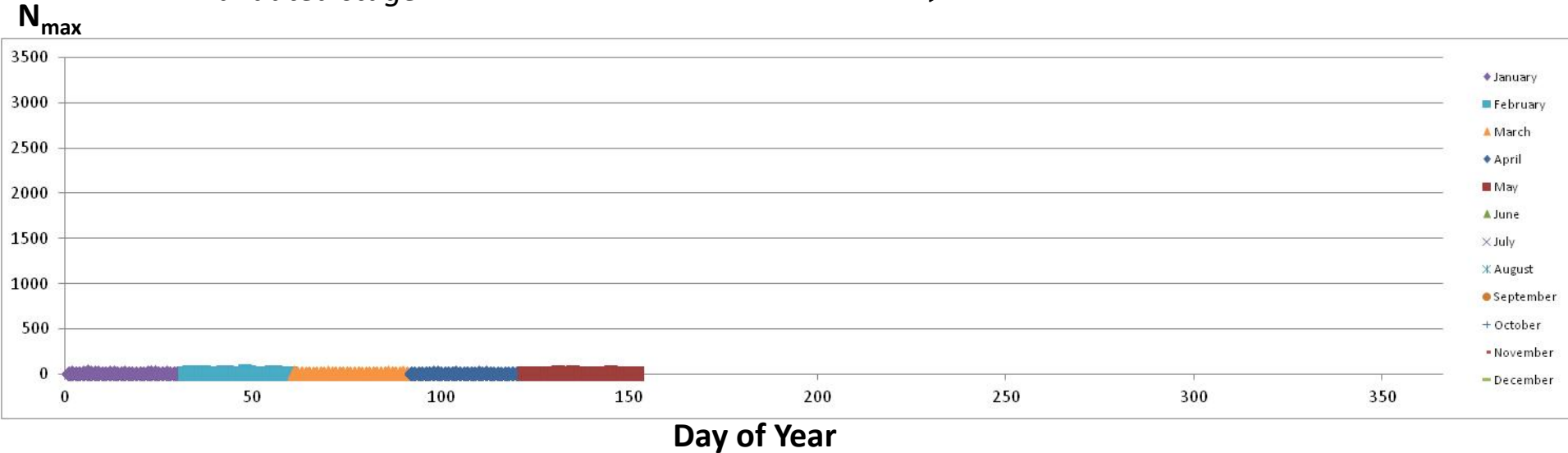


N_{max} : maximum number of detections within a scanline Day of Year

IDPS Suomi NPP Active Fire Product history: data anomalies and product maturity (3/3)

2016

← Validated stage 1 ----->



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

NOAA Operational VIIRS Fire Product Status (2/1)

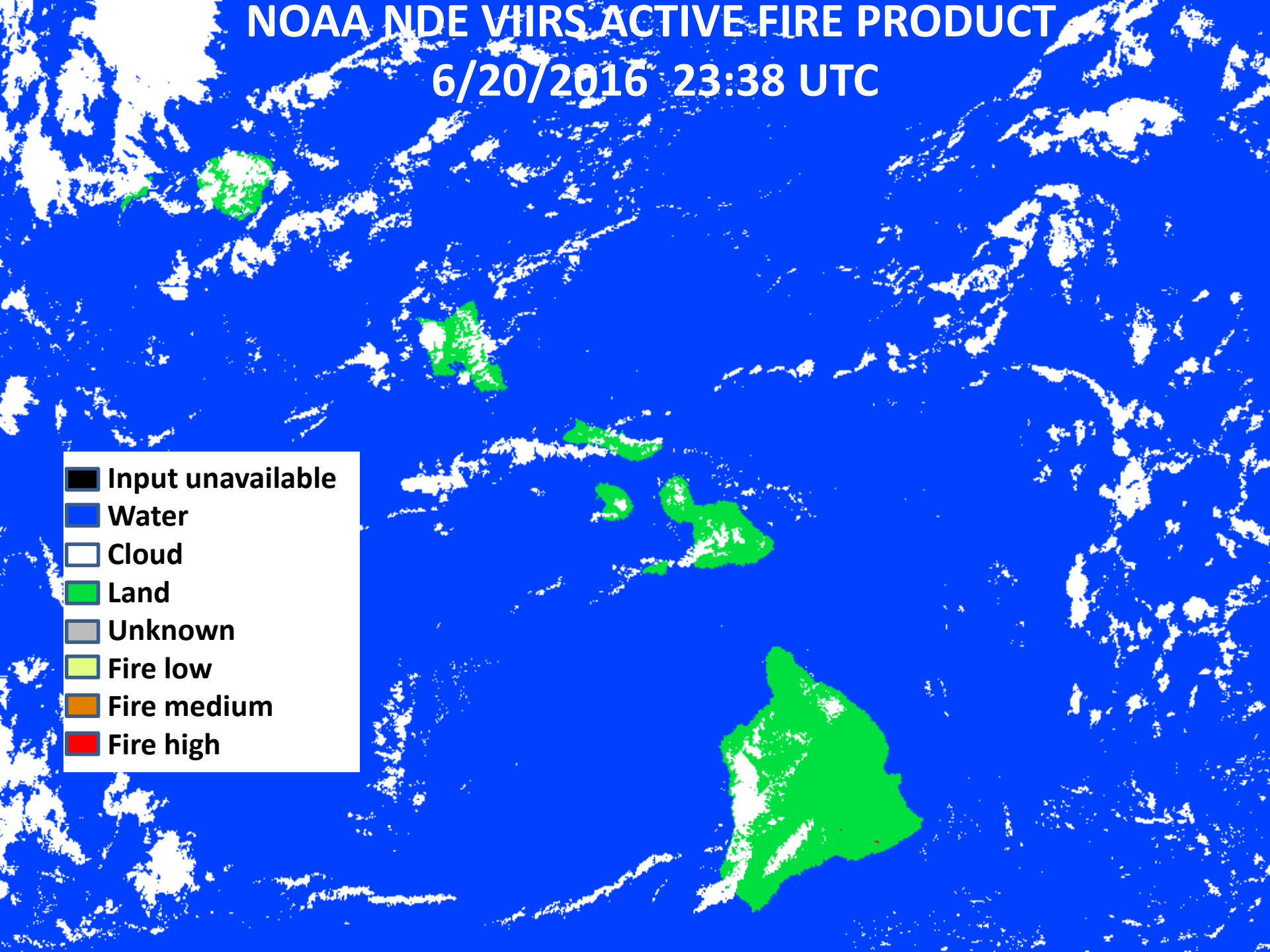
- Tailored version of the M-band UMD / NASA ST algorithm operational within the Suomi NPP Data Exploitation (NDE) system since March 15, 2016
 - includes fire mask and fire radiative power (FRP)
- Data available from OSPO in simplified text and other formats
 - <ftp://satepsanone.nesdis.noaa.gov/FIRE/VIIRS/>
- Data available from CLASS (<http://www.class.ncdc.noaa.gov/>)
 - ftp interface at <ftp://ftp-npp.class.ngdc.noaa.gov/>
 - pick the date, then to the folder NDE-L2/VIIRS-Active-Fire-EDR-NOAA-Enterprise-Algorithm/
 - ordering capability through the Web interface also available
 - all operational data from March 16, 2016 have been backfilled from the STAR archive
- Long-term quality monitoring ongoing (including both NDE and IDPS products)
 - https://www.star.nesdis.noaa.gov/jps/EDRs/products_activeFires.php

NOAA Operational VIIRS Fire Product Status (2/2)

- Ongoing integration into NOAA operational and experimental systems e.g.
 - Hazard Mapping System
 - eIDEA – extended Infusing Satellite Data into Environmental Applications
 - <http://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea/>
 - NWS Advanced Weather Interactive Processing System (AWIPS-II)
 - High Resolution Rapid Refresh (HRRR)
<http://rapidrefresh.noaa.gov/HRRRsmoke/>
- IDPS production, long-term monitoring and maintenance until all downstream products in NDE / NOAA ESPC Enterprise system
- Other ongoing activities:
 - JPSS-1 testing / preparations
 - preparations for VIIRS SDR reprocessing
 - code integration into CSPP (Community Satellite Processing Package)
 - work towards UMD / NASA I-band / hybrid product transition to operations
 - end user interaction / support - NOAA JPSS Fire and Smoke Initiative
 - RealEarth™ – Google Maps etc.

NOAA NDE VIIRS ACTIVE FIRE PRODUCT

6/20/2016 23:38 UTC



NDE output file content

Name	Description	Type
fire mask	Fire mask 2D array (unit-less)	8 bit int
algorithm QA	Fire algorithm QA mask 2D array (unit-less)	32 bit Int
FP_line	Fire pixel line Sparse data array	16 bit Int
FP_sample	Fire pixel sample Sparse data array	16 bit Int
FP_latitude	Fire pixel latitude Sparse data array (deg)	32 bit Float
FP_longitude	Fire pixel longitude Sparse data array (deg)	32 bit Float
FP_power	Fire radiative power Sparse data array (MW)	32 bit Float
FP_confidence	Fire detection confidence Sparse data array (%)	8 bit Int
FP_land	Land pixel flag Sparse data array	8 bit Int

Total output for one granule: 11.7 Mb
+ number of fires * 79 bytes

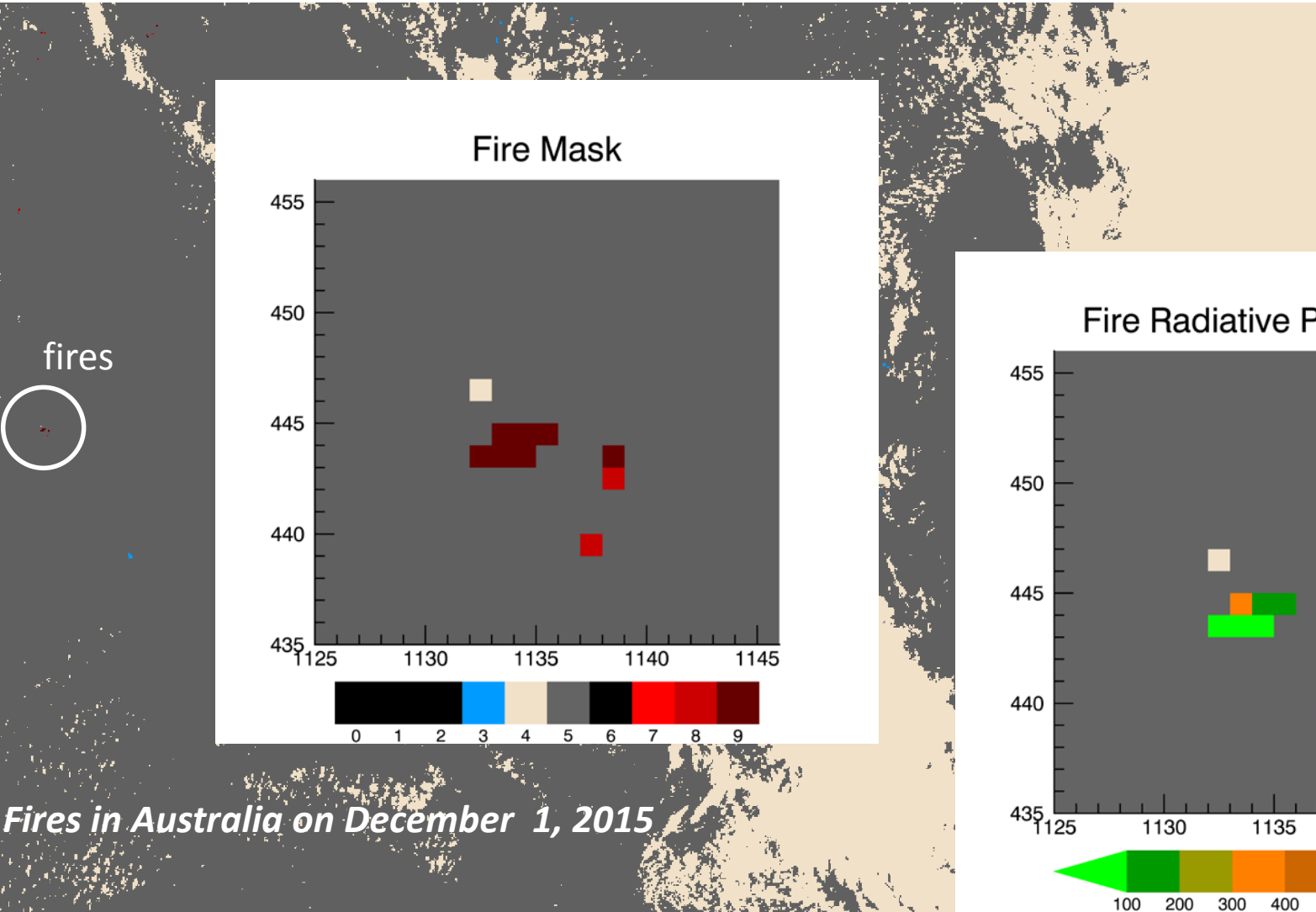
Missing – 0	Brightness temperatures for M13 or M15 unavailable
Scan – 1	Not processed (trim)
Other – 2	Not processed (other reason)
Water – 3	Pixel classified as non fire water
Cloud – 4	Pixel classified as cloudy
No Fire – 5	Pixel classified as non fire land
Unknown – 6	Pixel with no valid background 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%
0-1	Surface Type (water=0, coastal=1, land=2)
2-3	Atmospheric correction (reserved for future use)
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

NDE VIIRS Fire Text Output* Example

```
year,month,day,hh,mm,lon,lat,mask,confidence,bright_t13,frp,line,sample
2016, 06, 30, 13, 31, 14.393053, -16.983391, 8, 57, 316.378326, 28.955824, 75, 114
2016, 06, 30, 13, 31, 14.396797, -16.972019, 8, 53, 339.941559, 77.328888, 84, 113
2016, 06, 30, 13, 31, 14.384778, -16.974693, 8, 69, 344.900421, 97.380959, 84, 114
2016, 06, 30, 13, 31, 14.405772, -16.956085, 8, 44, 313.854004, 19.589737, 85, 112
2016, 06, 30, 13, 31, 14.393543, -16.958811, 8, 37, 321.766541, 32.511524, 85, 113
2016, 06, 30, 13, 31, 15.573229, -15.742855, 8, 49, 306.925323, 23.677296, 228, 4
2016, 06, 30, 13, 31, 14.185258, -15.916477, 8, 69, 310.967590, 21.830891, 246, 103
2016, 06, 30, 13, 31, 14.688642, -15.625280, 8, 64, 327.718658, 63.247353, 267, 60
2016, 06, 30, 13, 31, 14.691998, -15.618657, 8, 55, 321.560547, 41.713535, 276, 59
2016, 06, 30, 13, 31, 14.678295, -15.621688, 8, 75, 358.754883, 197.803665, 276, 60
2016, 06, 30, 13, 31, 14.688756, -15.604889, 8, 42, 314.810394, 27.194593, 277, 59
2016, 06, 30, 13, 31, 14.675403, -15.607850, 9, 88, 332.556183, 75.214859, 277, 60
2016, 06, 30, 13, 31, 14.976258, -14.989869, 8, 72, 312.135651, 30.420597, 358, 26
2016, 06, 30, 13, 31, 14.554691, -12.548762, 8, 56, 314.716003, 35.709991, 731, 5
2016, 06, 30, 13, 31, 14.559263, -12.547178, 8, 57, 314.763763, 35.436863, 740, 4
2016, 06, 30, 13, 31, 14.450356, -12.540216, 8, 74, 313.761322, 33.999859, 742, 11
2016, 06, 30, 13, 31, 14.410105, -12.396758, 8, 47, 311.148468, 25.756071, 761, 11
```

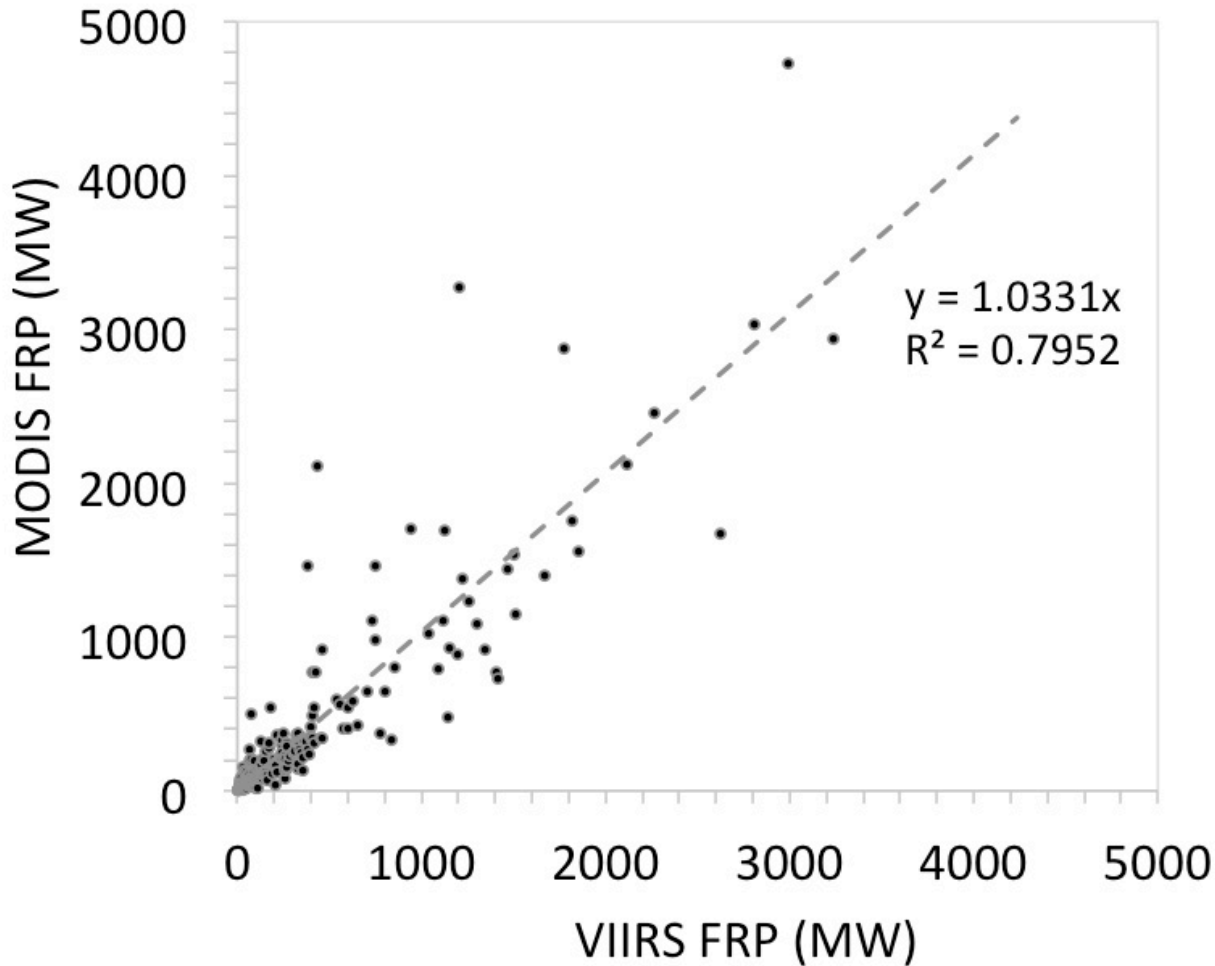
****Text output files are not part of the core NDE production, but are generated by OSPO and STAR.***

Characterizing Fires: confidence and radiative power



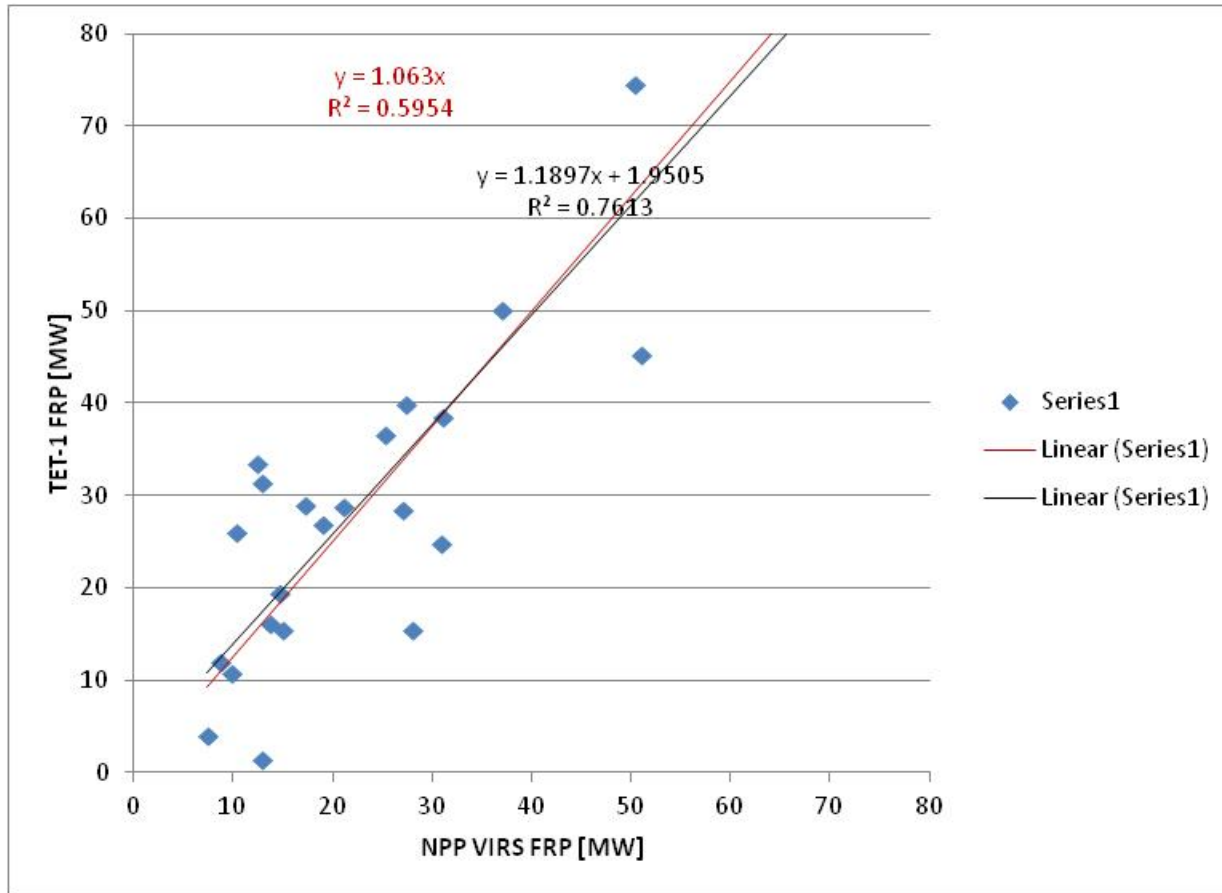
Fires in Australia on December 1, 2015

FRP evaluation using MODIS



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.

FRP evaluation using DRL TET-1



Comparison of FRP retrievals of gas flares in the Middle East on May 9, 12, 15, 18, 24 2015

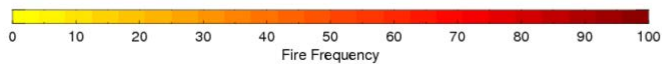
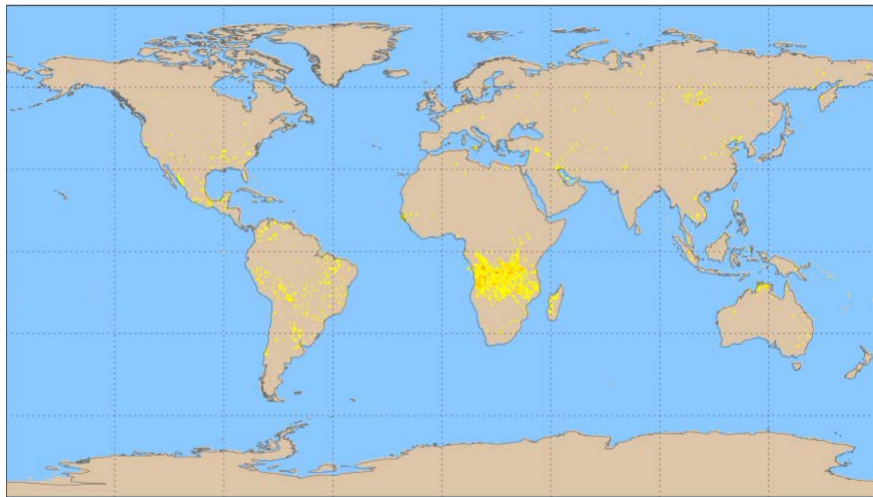
TET-1: Technology Experiment Carrier-1 by German Aerospace Agency DRL; dedicated 185m unsaturated measurements for hotspot characterization

VIIRS Active Fire Long-term Monitoring

http://www.star.nesdis.noaa.gov/jpss/EDRs/products_activeFires.php

Suomi NPP - VIIRS - NDE - Active Fires

16 Jun 2016



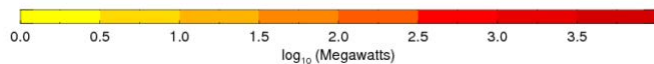
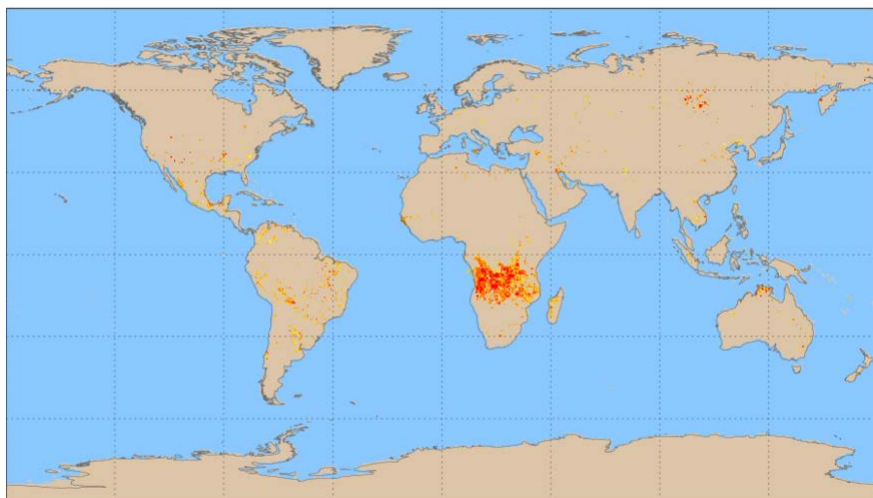
Fire Frequency



NOAA/NESDIS/STAR

Suomi NPP - VIIRS - NDE - Fire Radiative Power - Total

16 Jun 2016



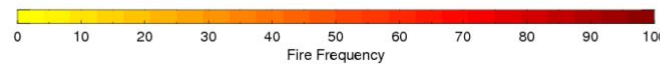
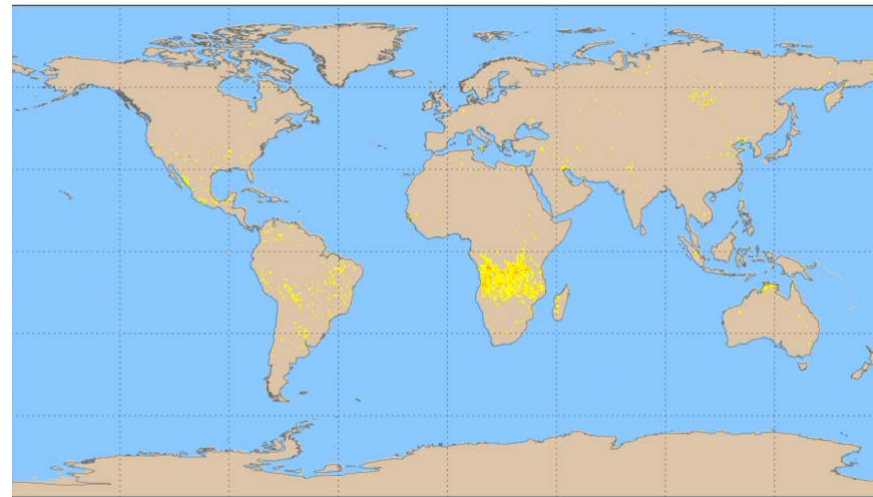
\log_{10} (Megawatts)



NOAA/NESDIS/STAR

Suomi NPP - VIIRS - IDPS - Active Fires

16 Jun 2016



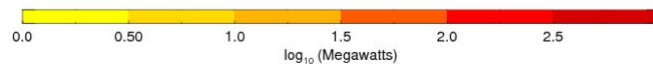
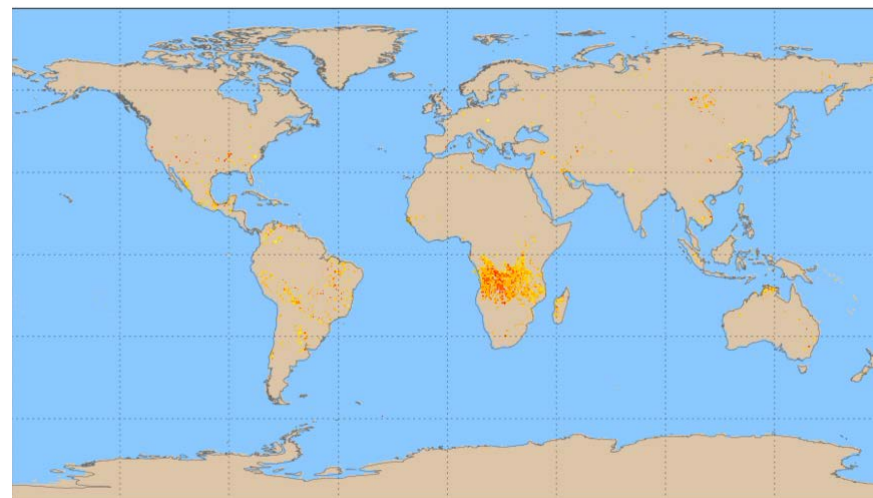
Fire Frequency



NOAA/NESDIS/STAR

Suomi NPP - VIIRS - NDE - Fire Radiative Power - Mean

16 Jun 2016



\log_{10} (Megawatts)

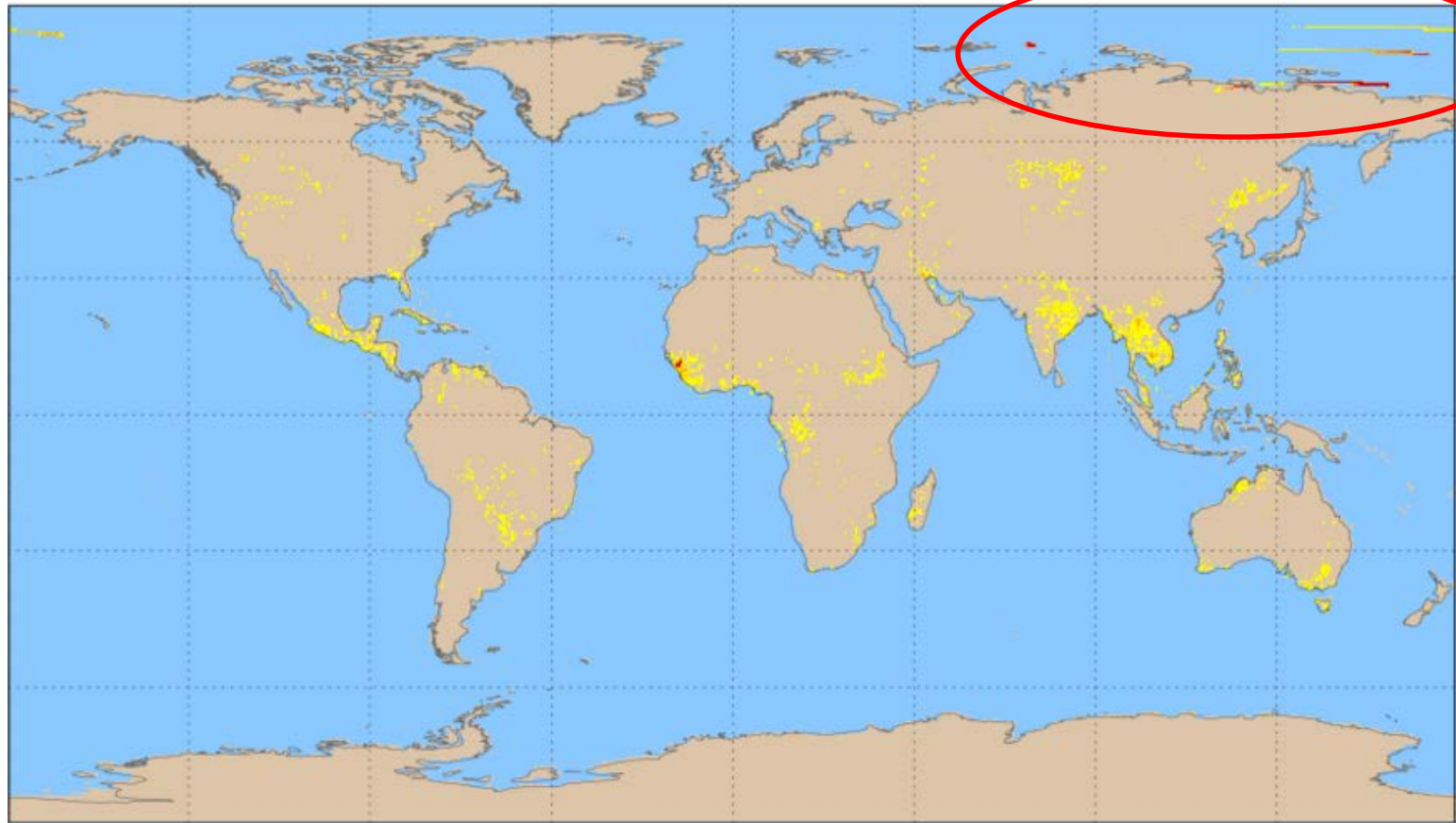


NOAA/NESDIS/STAR

Active fire data anomaly during VIIRS flight software update

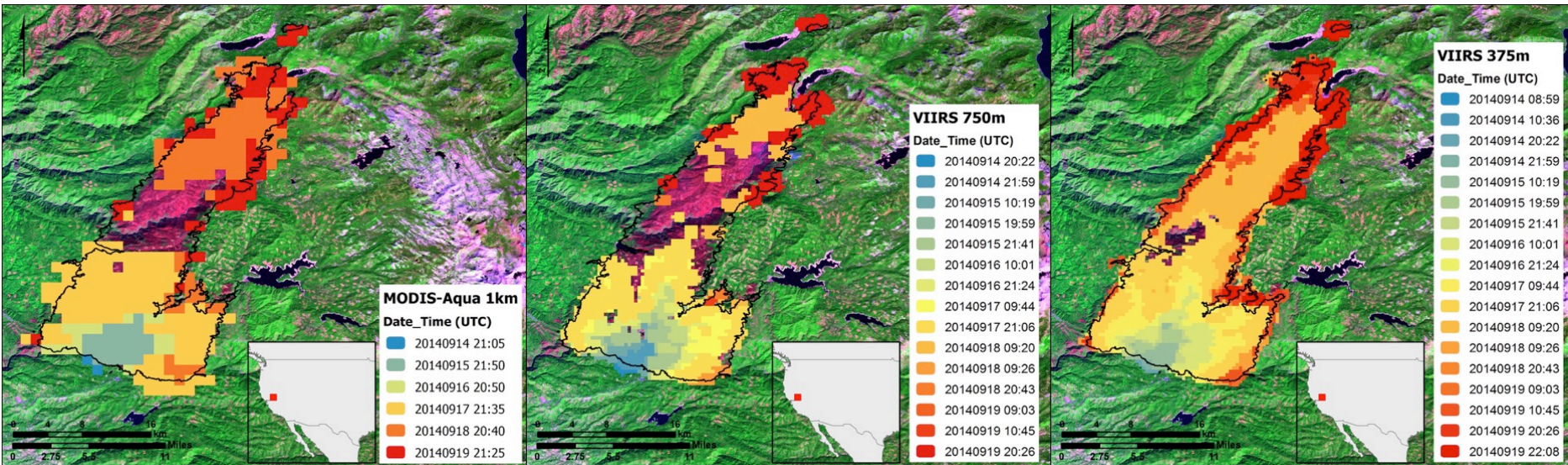
Suomi NPP - VIIRS - NDE - Active Fires

19 Apr 2016

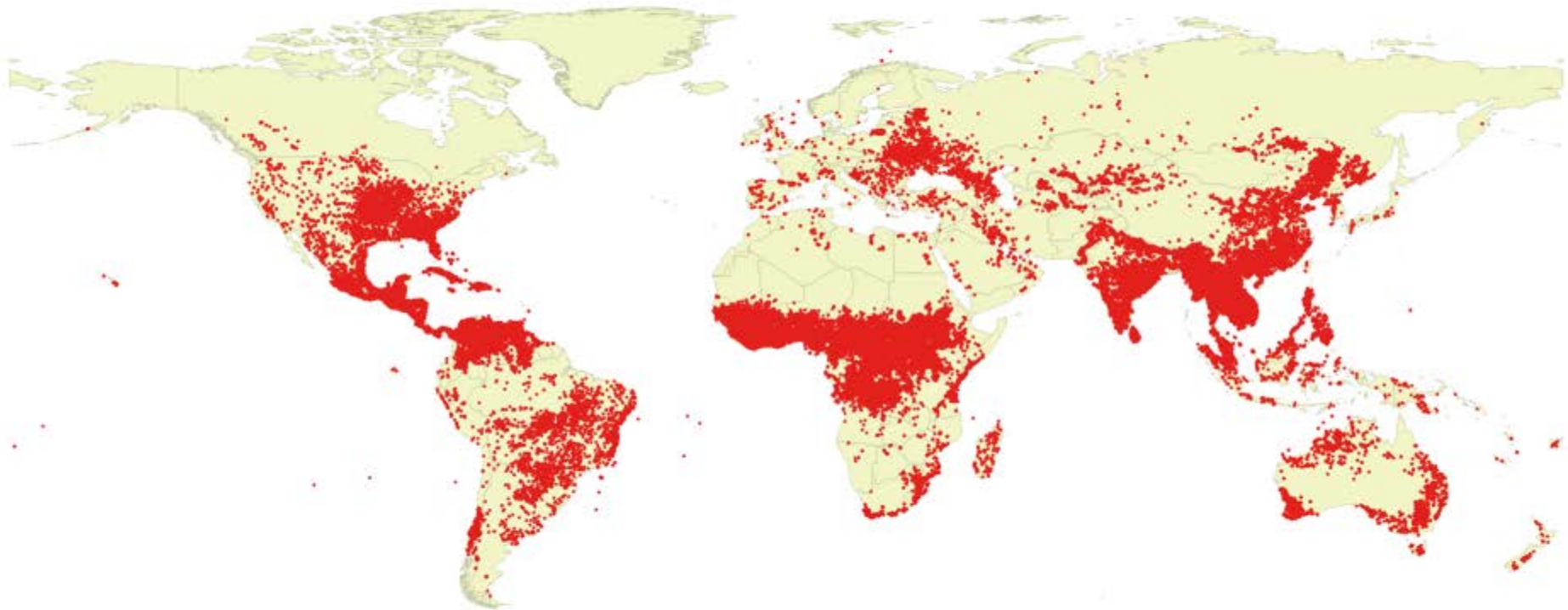


UMD/NASA VIIRS Active Fire Product Update

- Baseline **750 m active fire product** built on MODIS Collection 6 algorithm
 - L2 product basis for NOAA NDE
 - Small customization performed in order to account for unique L1B data
 - Fire detection and characterization (fire radiative power)
 - Output format supporting MODIS-VIIRS data continuity
- Alternative **375 m active fire product** developed
 - Unique algorithm optimizing use of channel I4 (MIR) data (frequent saturation, folding)
 - First version produced fire detections only
 - Latest version providing fire detection and FRP
 - Hybrid approach using 375 and 750 m data
 - Output format supporting MODIS-VIIRS data continuity

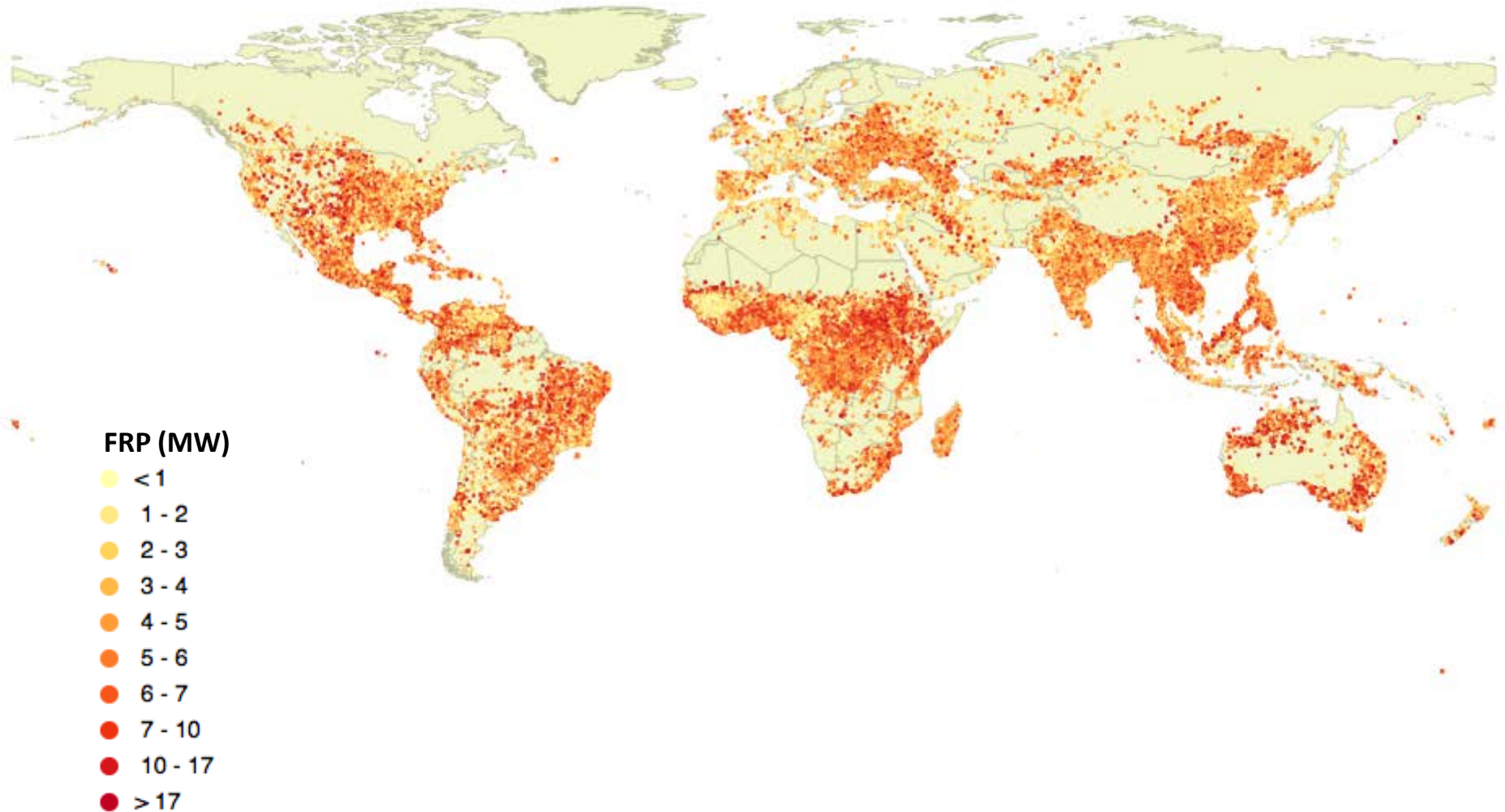


VIIRS 750 m Fire Pixels (March 2016)
VAFIRE_L2D (consistent with NOAA JPSS NDE)



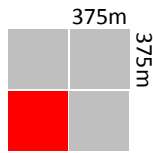
VIIRS 375m (hybrid) Fire Pixels (March 2016)

'Collection 2'



Hybrid (375+750m) FRP Retrieval

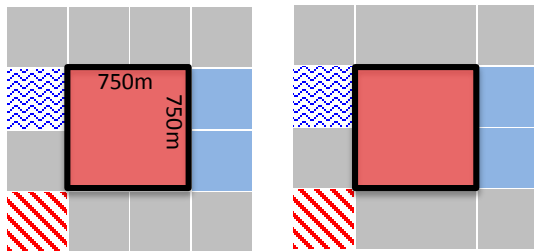
Scenario 1



Scenario 2



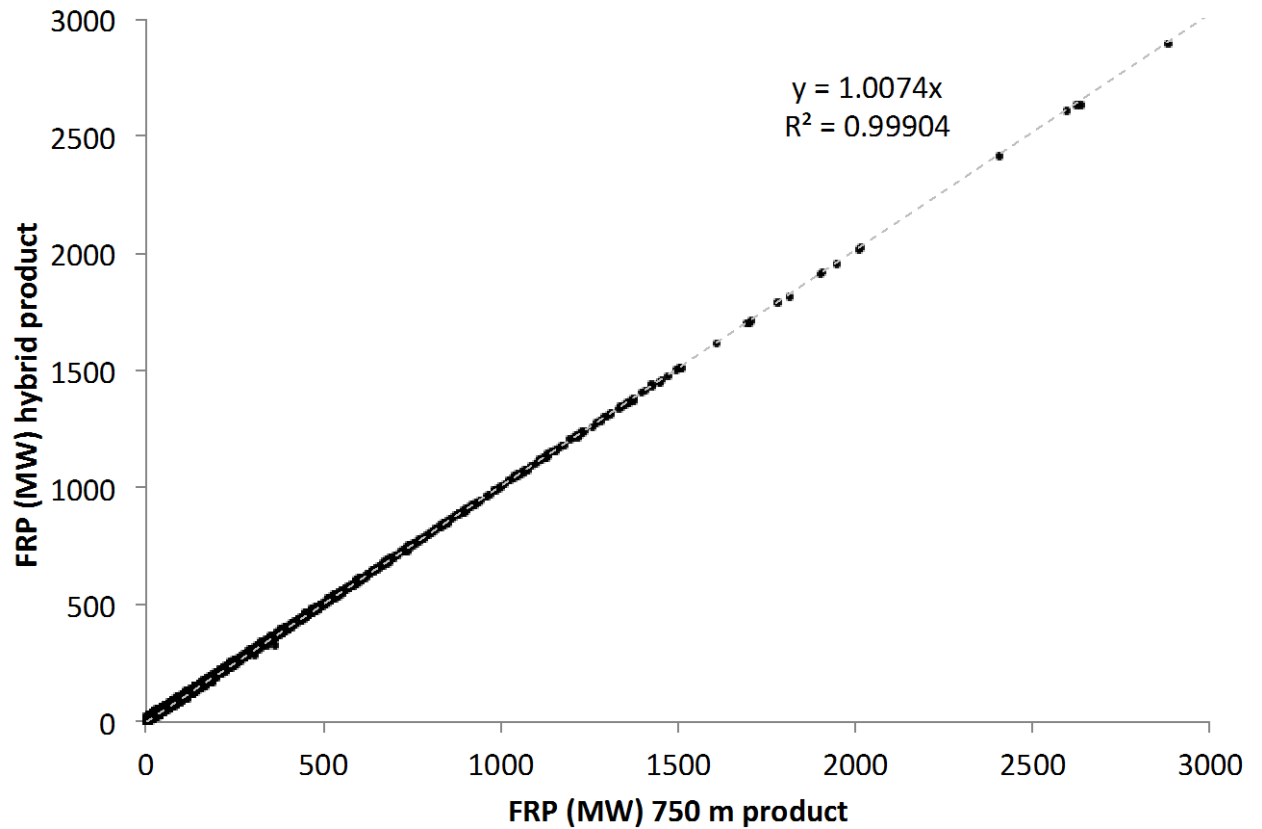
Co-locate
375 & 750 m
data



Calculate
FRP

$$FRP_i = FRP$$

$$FRP_i = FRP \div 2$$



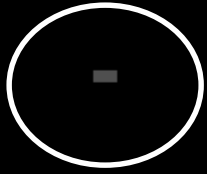
May 16 2016 19:42 UTC

M13 aggr.
brightness temperature

daytime

4.66E1
6.94E1
9.23E1
1.15E2
1.38E2
1.61E2
1.84E2
2.06E2
2.29E2
2.52E2
2.75E2
2.98E2
3.21E2
3.43E2
3.66E2
3.89E2
4.12E2
4.35E2
4.57E2
4.80E2
5.03E2
5.26E2
5.49E2
5.72E2
6.06E2

May 16 2016 19:42 UTC



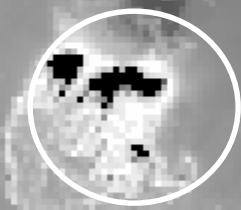
“some saturated”

M13 quality flag
Byte 1

daytime

1.25E
1.88E
2.51E
3.14E
3.76E
4.39E
5.02E
5.65E
6.27E
6.90E
7.53E
8.16E
8.78E
9.41E
1.00E
1.07E
1.13E
1.19E
1.25E
1.32E
1.38E
1.44E
1.51E
1.60E

May 16 2016 19:42 UTC



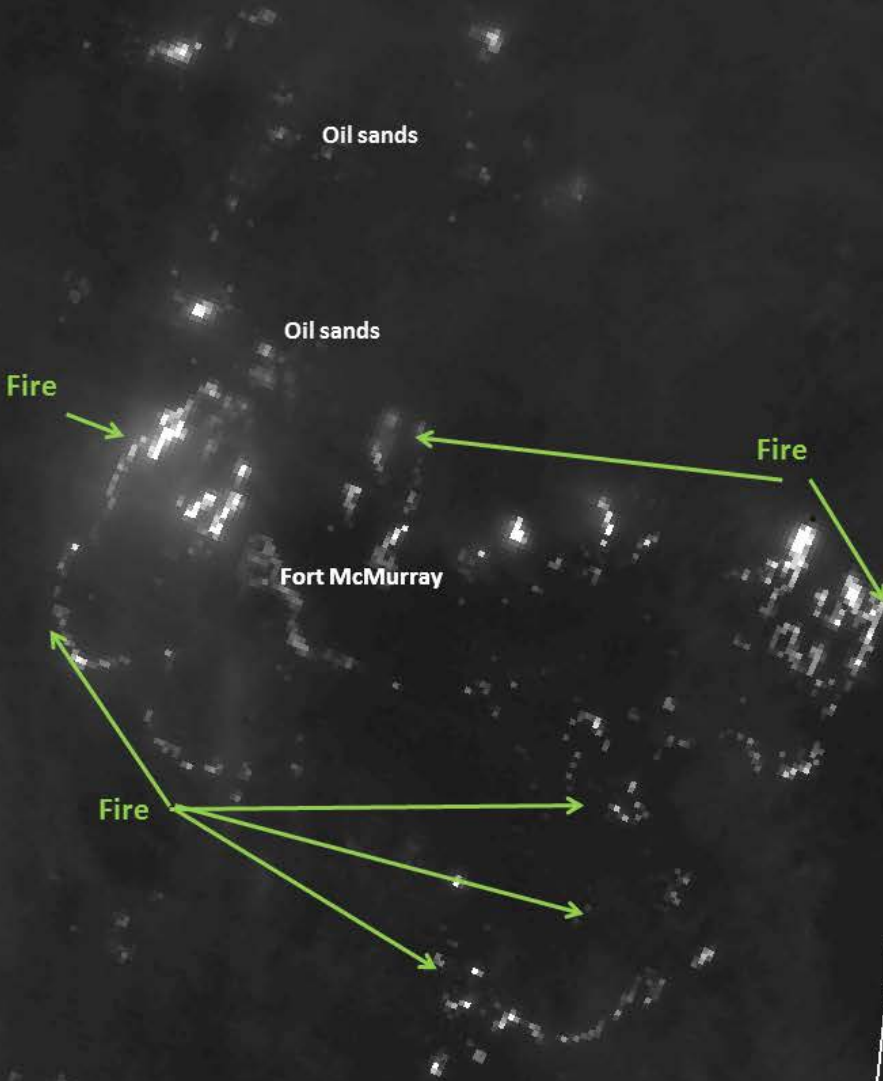
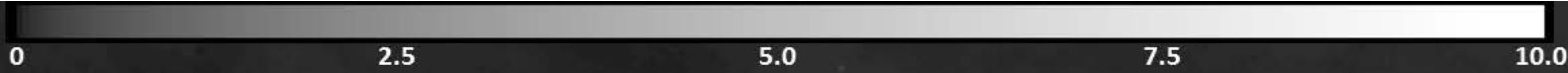
saturated
measurements;
spurious output

- 2.57E3
- 5.14E3
- 7.71E3
- 1.03E4
- 1.28E4
- 1.54E4
- 1.80E4
- 2.06E4
- 2.31E4
- 2.57E4
- 2.83E4
- 3.08E4
- 3.34E4
- 3.60E4
- 3.85E4
- 4.11E4
- 4.37E4
- 4.63E4
- 4.88E4
- 5.14E4
- 5.40E4
- 5.65E4
- 5.91E4
- 6.17E4
- 6.55E4

14 scaled radiance

daytime

x=3662, y=194, value=38294

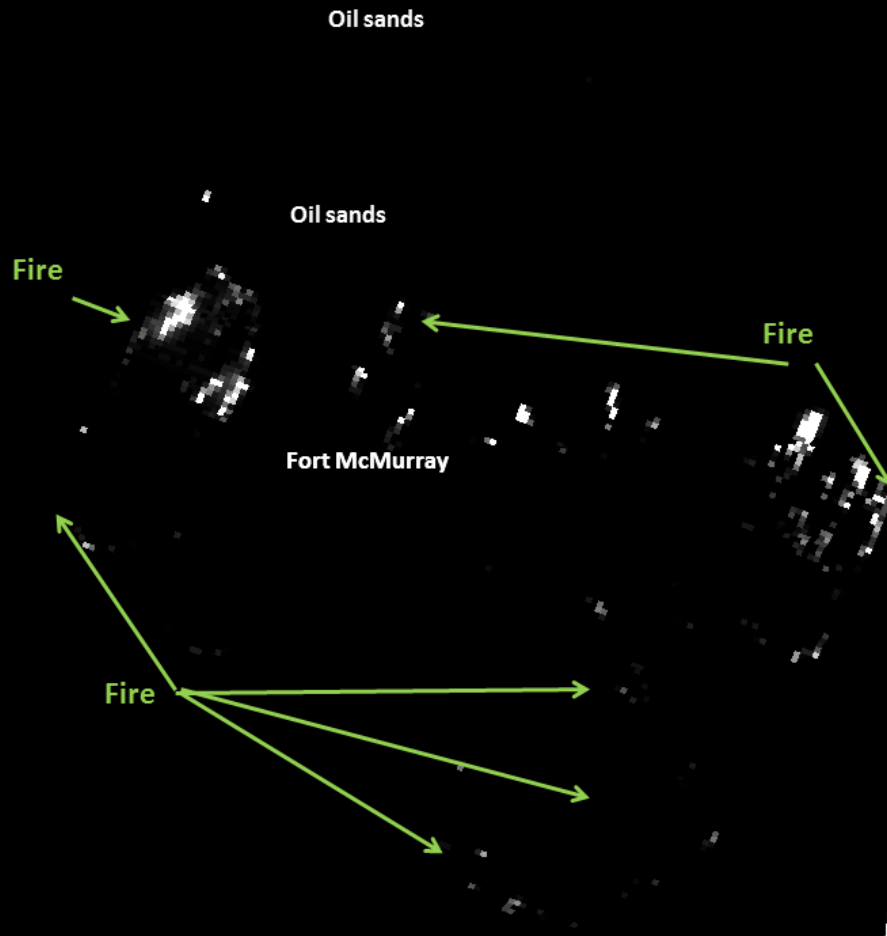


NOAA/NASA CIMSS/SSEC

VIIRS – Near Constant Contrast
May 17 2016, 0931Z

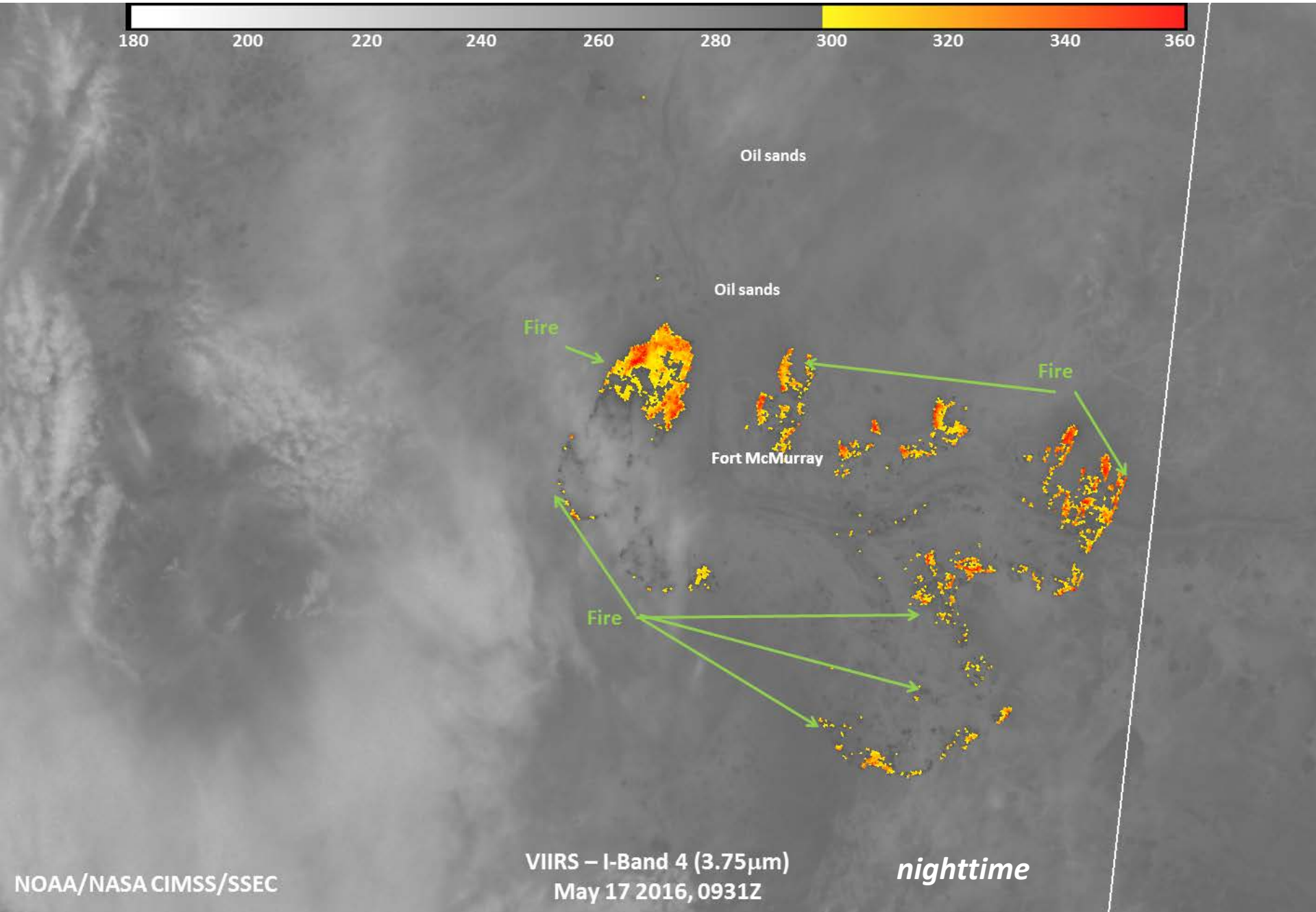
nighttime

courtesy of William Straka III (CIMSS SSEC)



VIIRS – M-Band 10 (1.61 μ m)
May 17 2016, 0931Z

nighttime



Oil sands

Oil sands

Fire

Fire

Fort McMurray

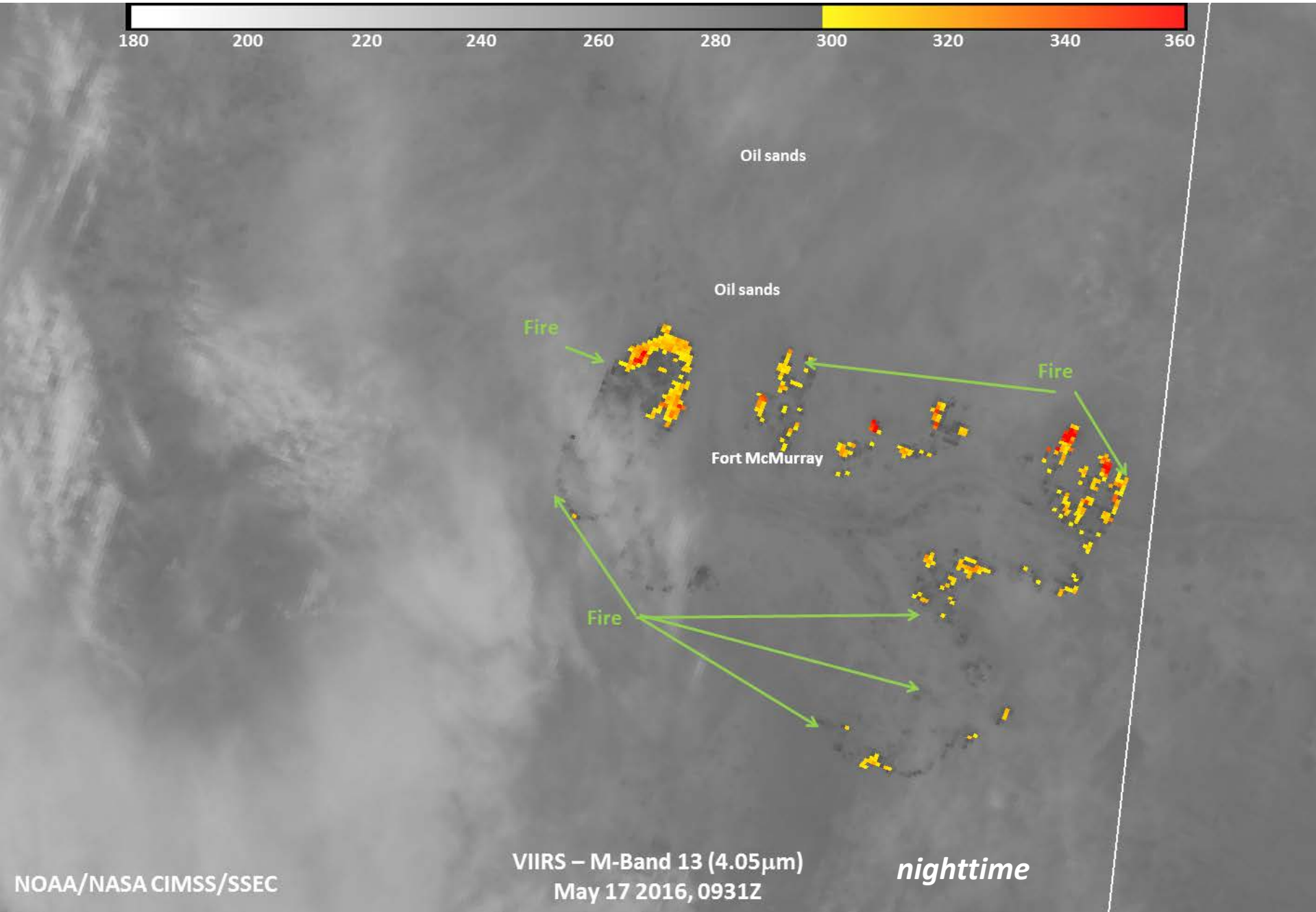
Fire

VIIRS – I-Band 4 (3.75 μ m)
May 17 2016, 0931Z

nighttime

NOAA/NASA CIMSS/SSEC

courtesy of William Straka III (CIMSS SSEC)



Oil sands

Oil sands

Fire

Fire

Fort McMurray

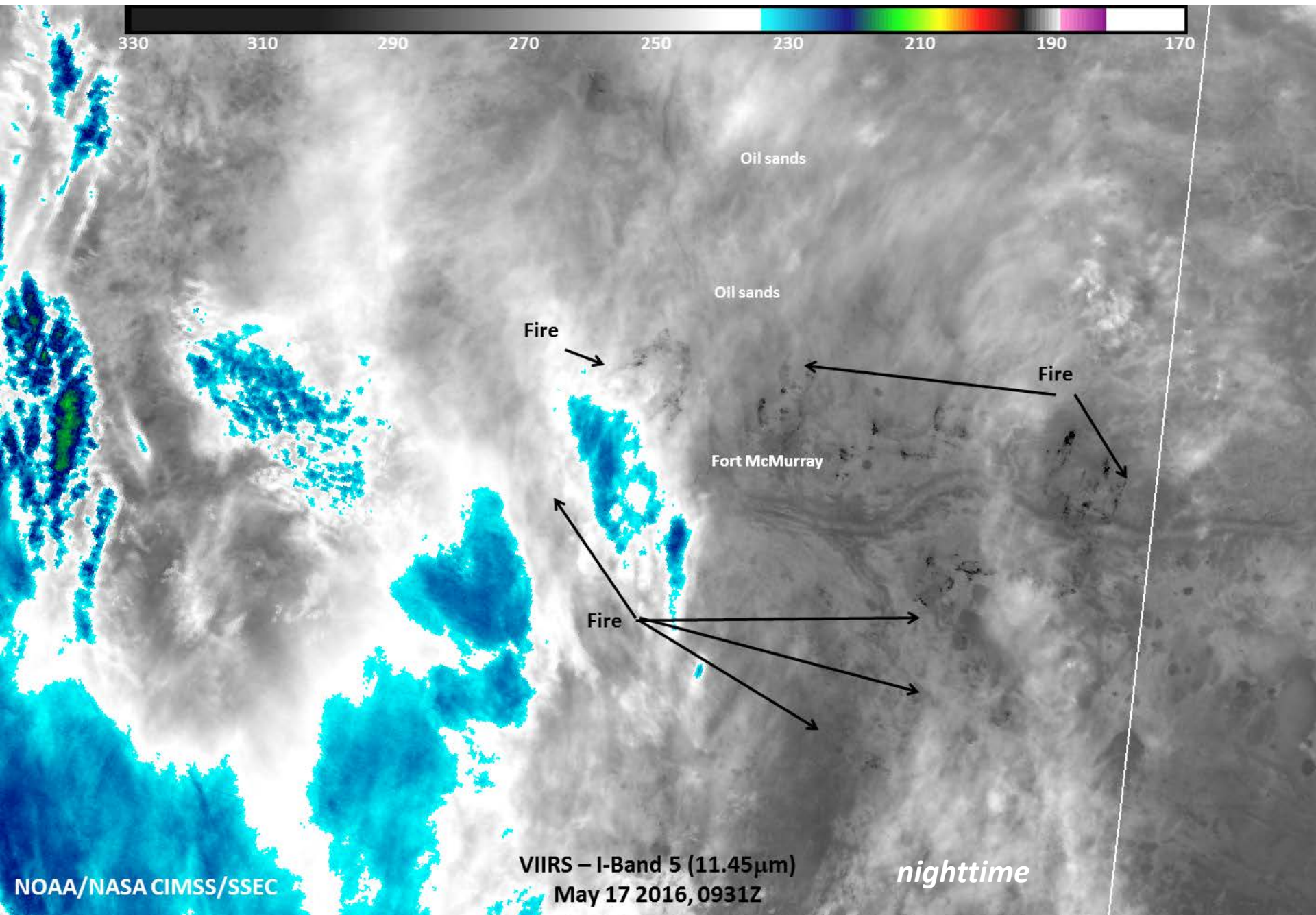
Fire

nighttime

VIIRS – M-Band 13 (4.05µm)
May 17 2016, 0931Z

NOAA/NASA CIMSS/SSEC

courtesy of William Straka III (CIMSS SSEC)



330 310 290 270 250 230 210 190 170

Oil sands

Oil sands

Fire

Fire

Fort McMurray

Fire

VIIRS - I-Band 5 (11.45µm)
May 17 2016, 0931Z

nighttime

NOAA/NASA CIMSS/SSEC

courtesy of William Straka III (CIMSS SSEC)

- 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

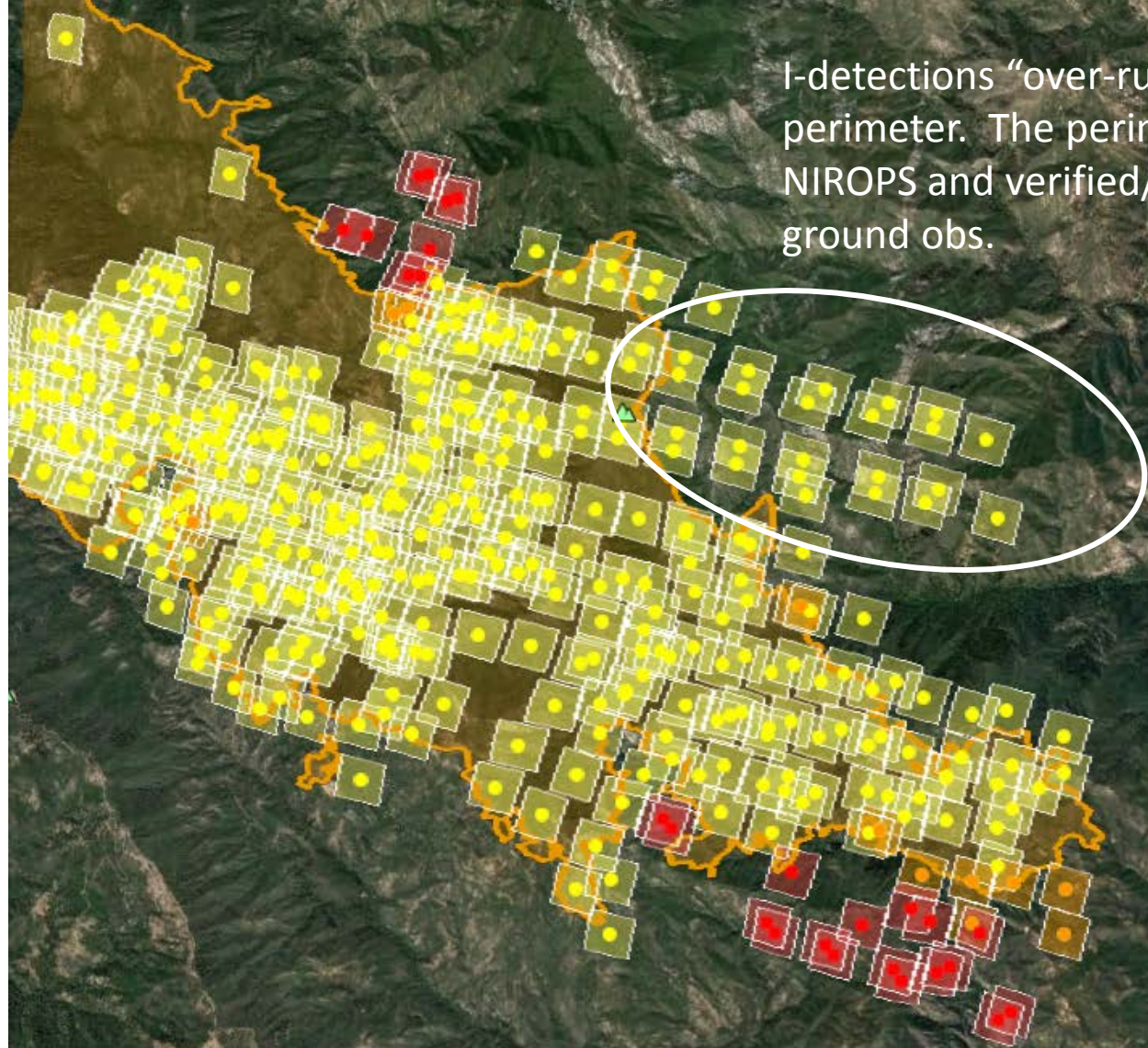
Updated: 1045 MDT

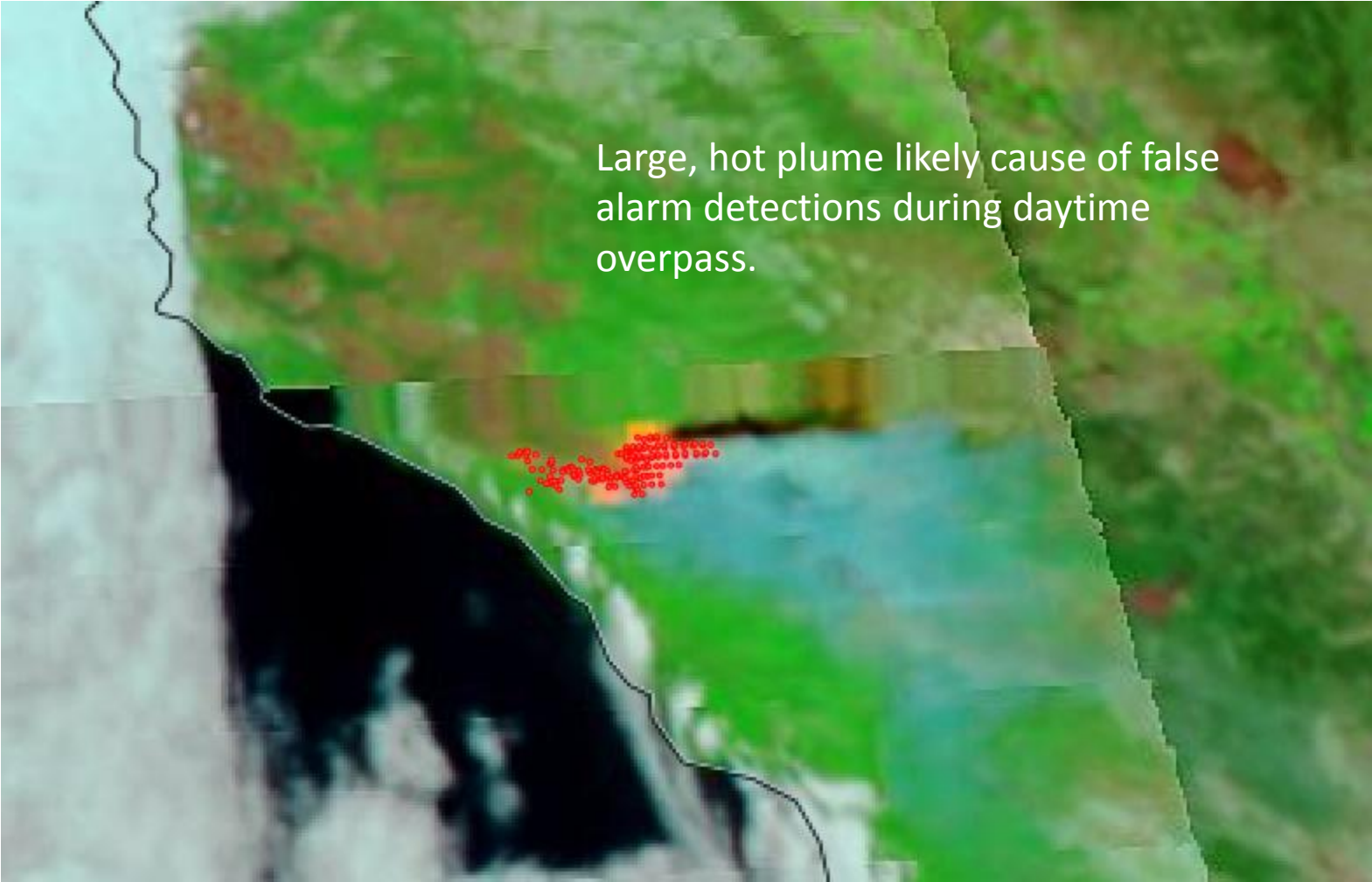
- Current Large Incidents
- Incident Management Team - Type 1
 - Incident Management Team - Type 2
 - Incident Management Team - Other

Sobranes Fire, California

I-detections "over-running" the fire perimeter. The perimeter is mapped by NIROPS and verified/updated with ground obs.

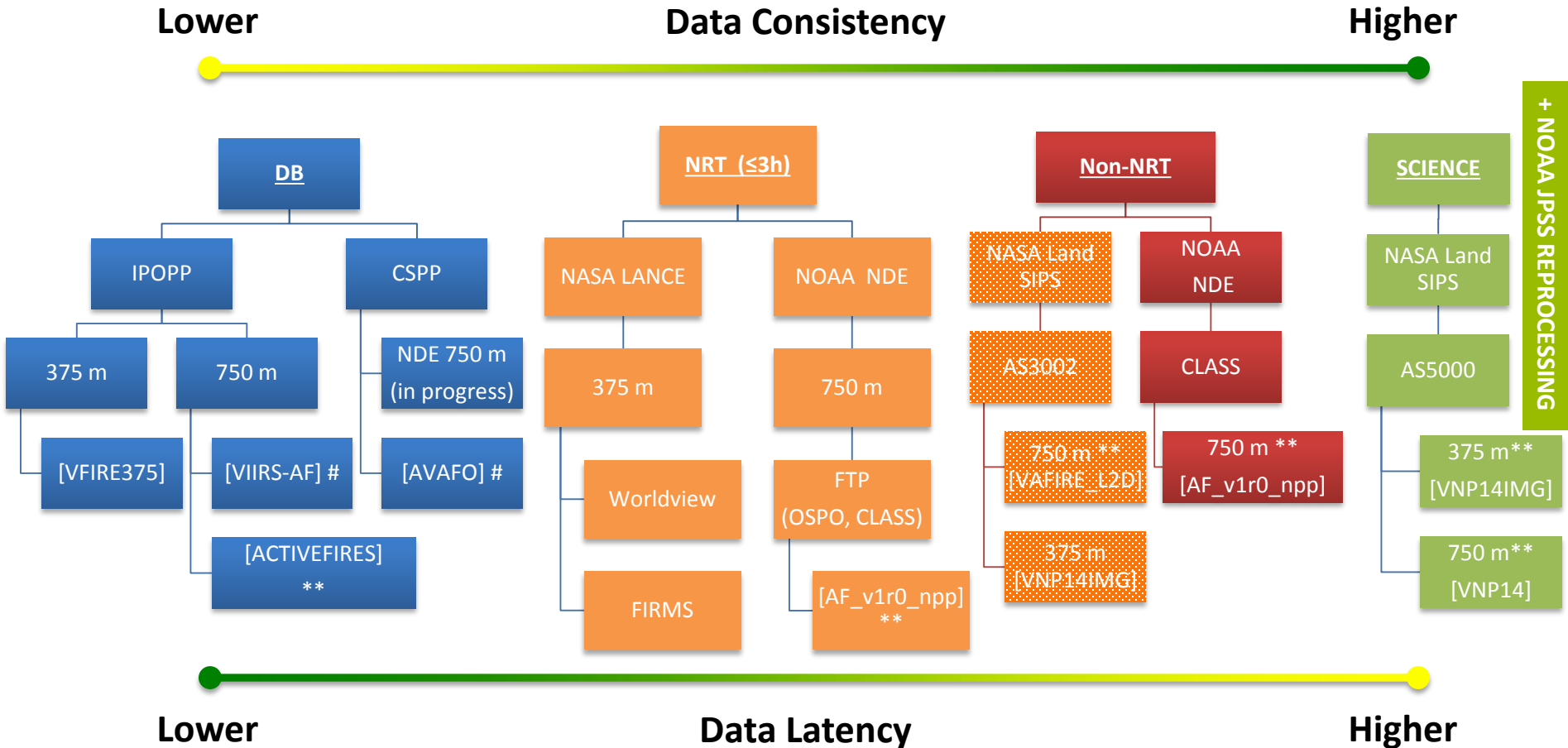
Tassajara Hot Springs



A satellite-style map of a coastal region, likely the Gulf of Mexico. The land is shown in shades of green and brown, while the water is dark blue. A large, dense cluster of red dots is visible in the water, representing a plume. The text is overlaid on the map in the upper right quadrant.

Large, hot plume likely cause of false alarm detections during daytime overpass.

VIIRS Active Fire Product Lineage



pattern indicates this directory is outdated
 # marked products describe discontinued algorithm
 [] indicate official product name

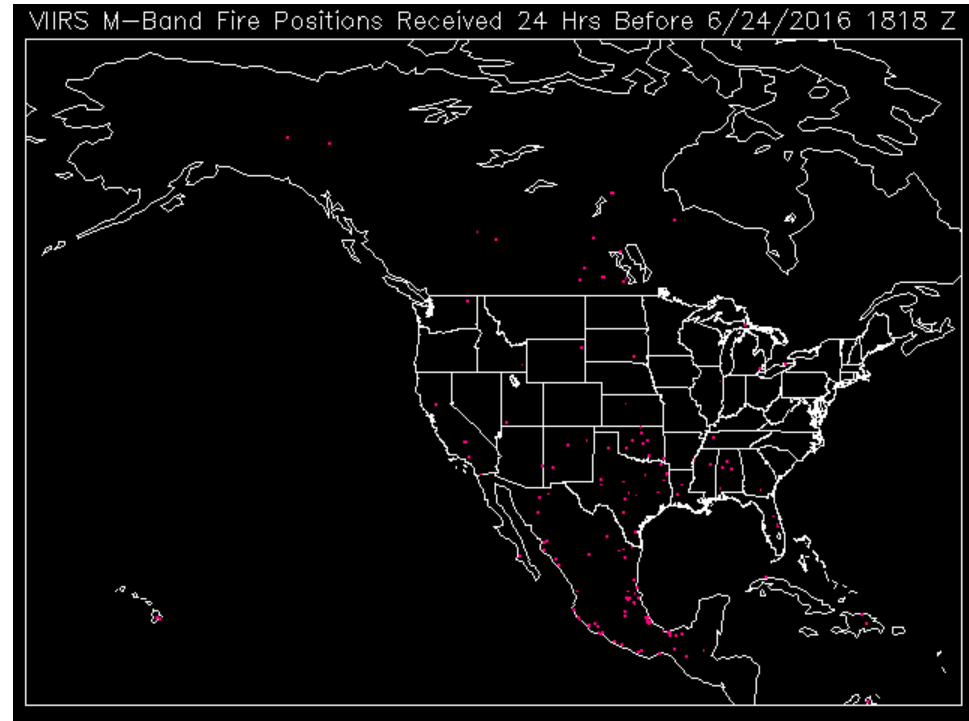
Details soon to be available at:
<http://viirsfire.geog.umd.edu/>

CSPP and AWIPS-II status

- CSPP
 - Currently IDPS product included
 - NDE product implementation ongoing
 - Current version – land /water mask from ADL
 - NDE code runs on DB for eIDEA
 - New version – land / water mask from Enterprise
- AWIPS-II
 - Software development, integration and testing ongoing
 - plans to submit for the next AWIPS release (16.4.1) in October 2016

Hazard Mapping System / OSPO status

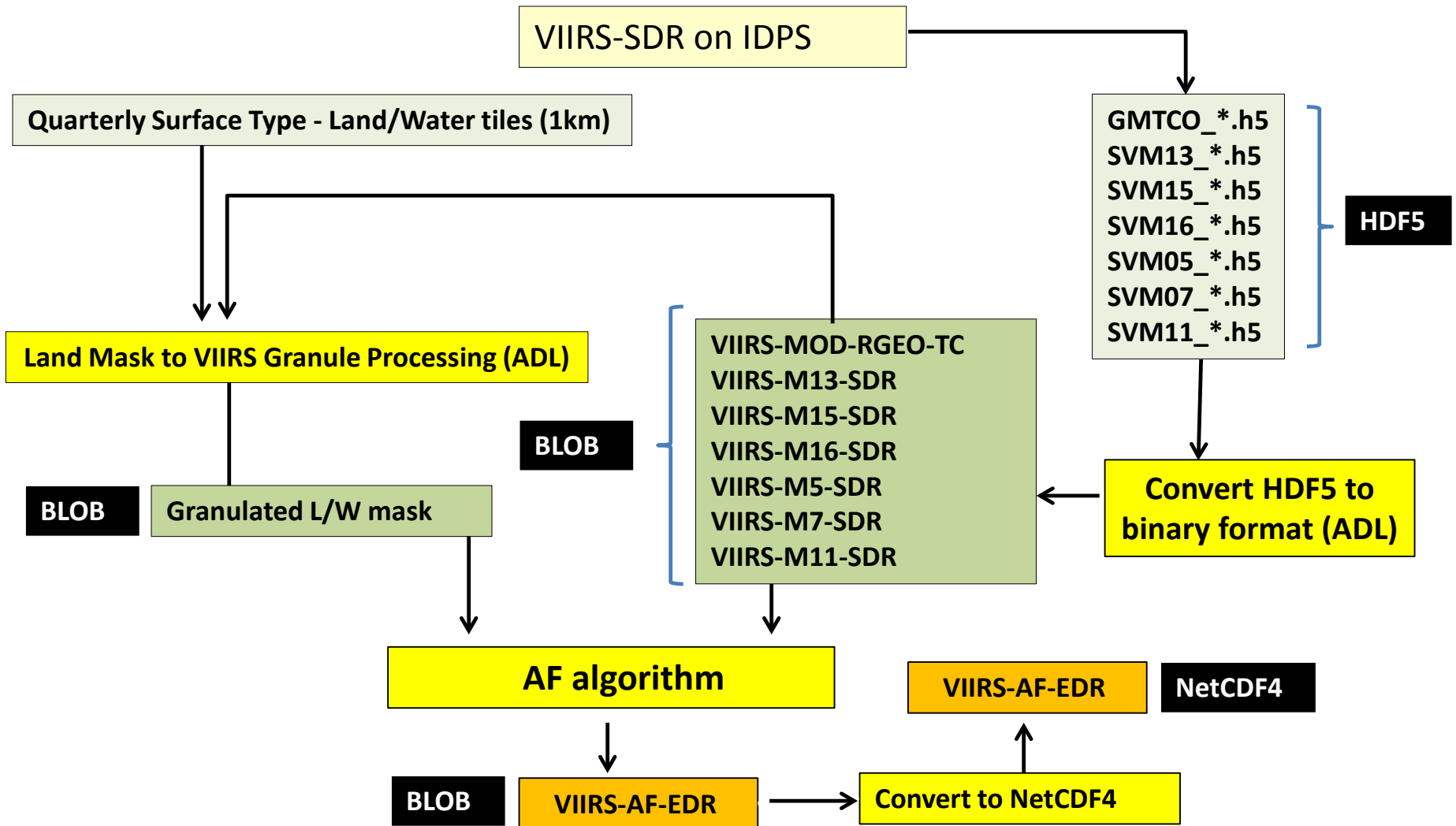
- Global NDE data are available in text format
 - granule-based (.txt) : real-time
 - daily summary (.dat)
- Graphics / web GIS under development
- VIIRS data to appear in HMS in the next release (October 2016)



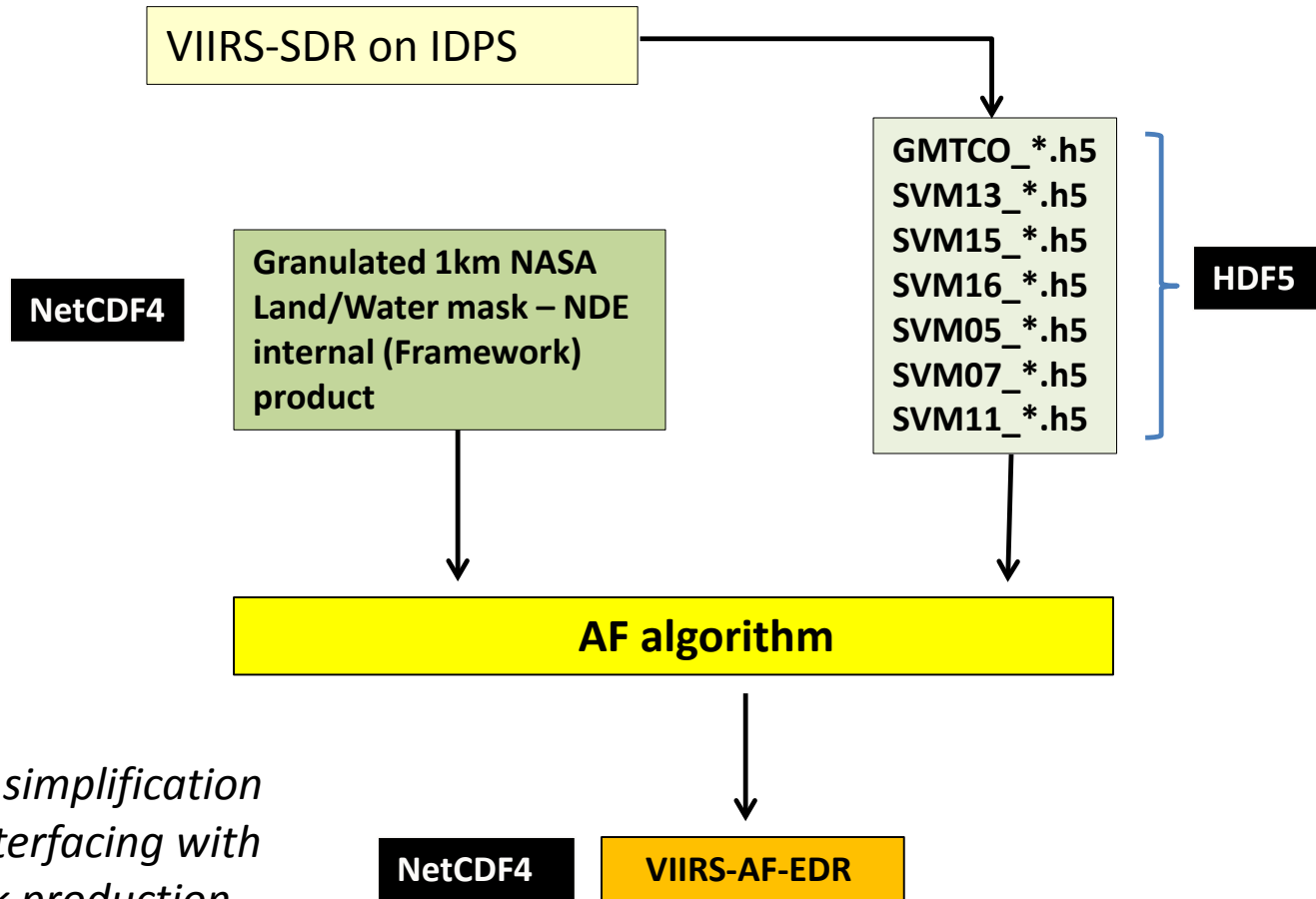
NOAA NESDIS Office of Satellite and Product Operations (OSPO)

<http://satepsanone.nesdis.noaa.gov/pub/FIRE/VIIRS/>

Current NDE AF Algorithm Processing



Future NDE AF Algorithm Processing



Significant simplification through interfacing with Framework production instead of ADL

Summary

- VIIRS is an excellent asset for fire monitoring
 - Multiple bands / band combinations used
 - New, advanced products are emerging
- VIIRS fire product development and distribution is done by various key stakeholders
 - Concerted effort to assist users to find the most appropriate product
 - NOAA, NASA, USDA Forest Service products and activities
- NOAA operational M-band product (with FRP) is available
 - coupled with air quality / smoke modeling
 - eIDEA, HRRR
- Reprocessing planned after SDR is reprocessed
- CSPP implementation and version control is critical
 - updating both SDR and EDR is critical!
- Enterprise fire algorithm TBD
 - VIIRS, ABI, etc.
 - high sensitivity to sensor / SDR / L1 characteristics