



Active fire

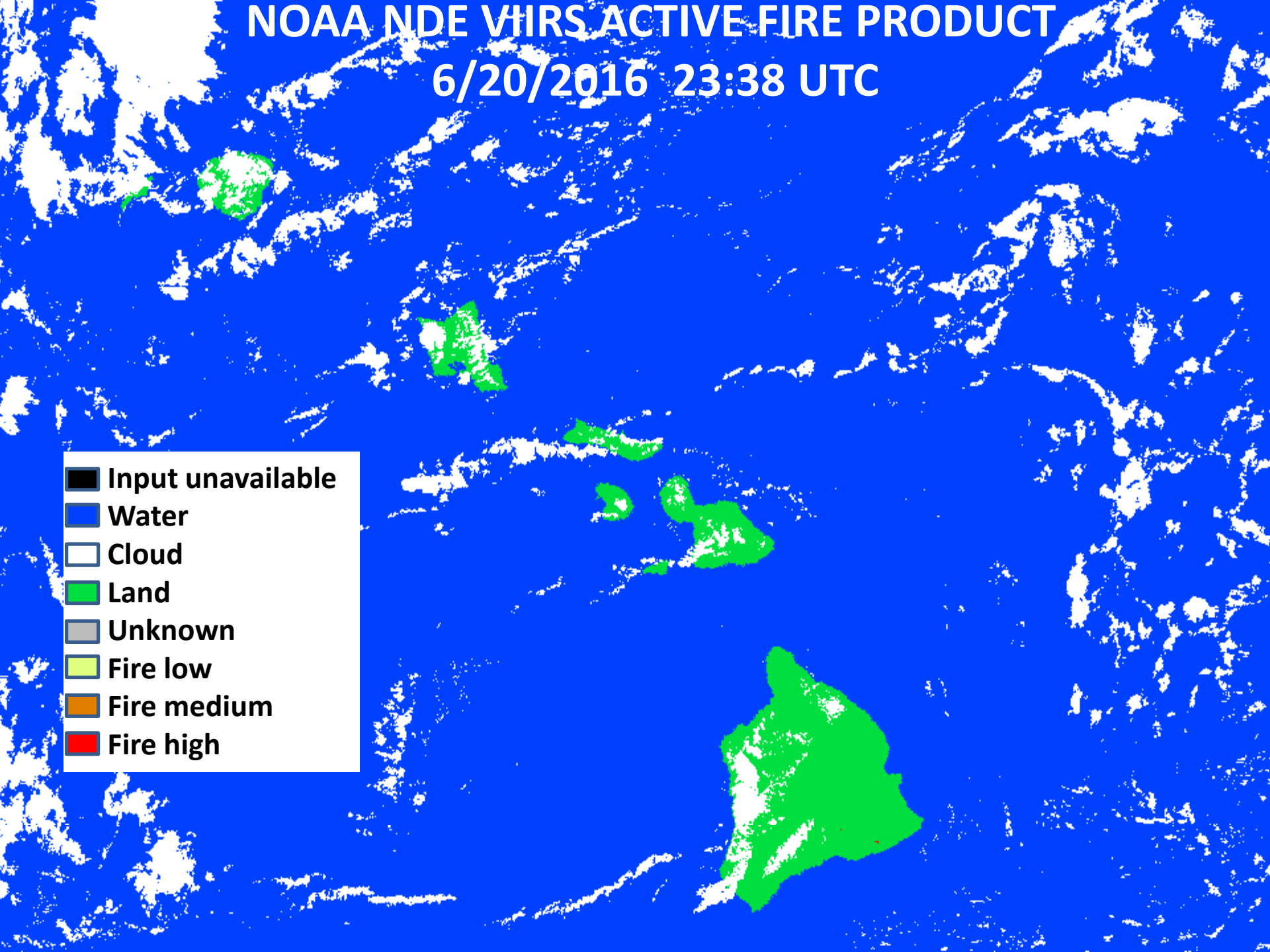
Ivan Csiszar, Shobha Kondragunta (STAR),
Marina Tsidulko (IMSG), Wilfrid Schroeder,
Louis Giglio, Evan Ellicott (UMD)

additional credits are given on select slides



NOAA NDE VIIRS ACTIVE FIRE PRODUCT

6/20/2016 23:38 UTC



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
 - currently 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 will be available in August
 - all operational data will be backfilled by late summer from the STAR archive
- Long-term quality monitoring ongoing (including both NDE and IDPS products)
 - https://www.star.nesdis.noaa.gov/jpss/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.

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

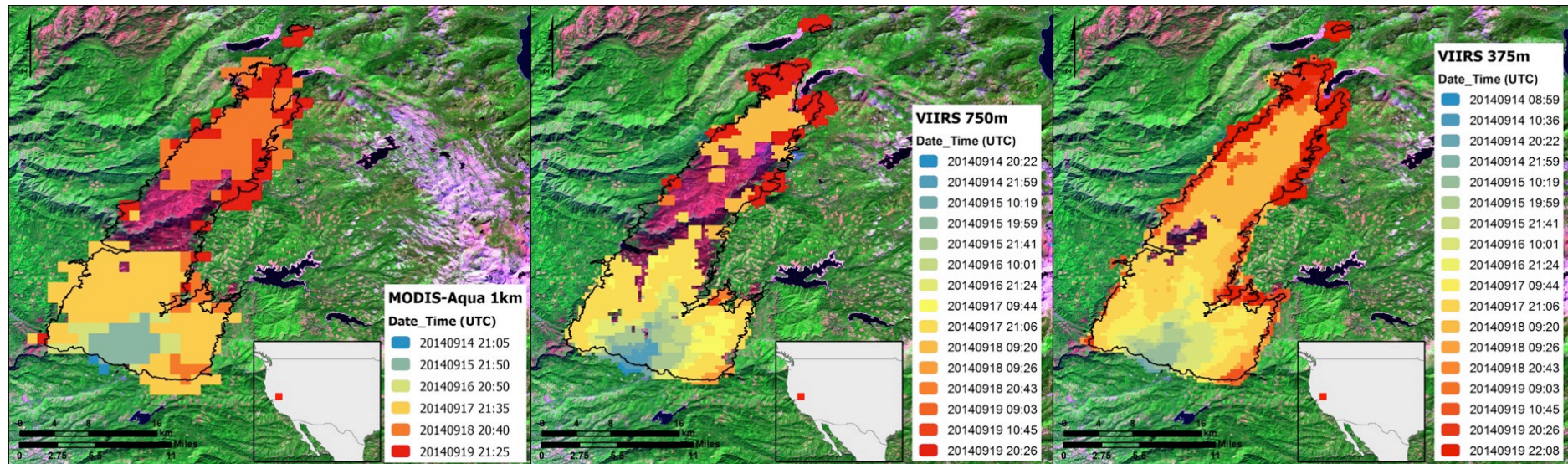
Missing – 0	Brightness temperatures for M13 or M15 unavailable
Scan – 1	Not processed (trim)
Other – 2	Not processed (other reason)
Water – 3	Pixel classified as non fire water
Cloud – 4	Pixel classified as cloudy
No Fire – 5	Pixel classified as non fire land
Unknown – 6	Pixel with no valid background 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
```

UMD/NASA VIIRS Active Fire Product Update

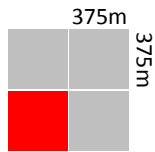
- Baseline **750 m active fire product** built on MODIS Collection 6 algorithm
 - L2 product basis for NOAA NDE
 - Small customization performed in order to account for unique L1B data
 - Fire detection and characterization (fire radiative power)
 - Output format supporting MODIS-VIIRS data continuity
- 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



King Fire/CA, September 2014

Hybrid (375+750m) FRP Retrieval

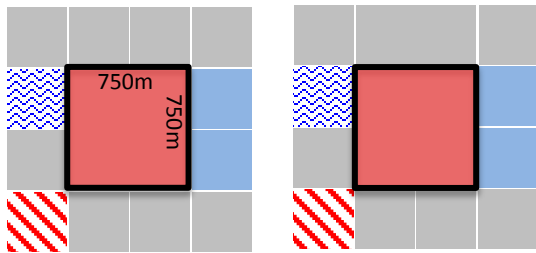
Scenario 1



Scenario 2



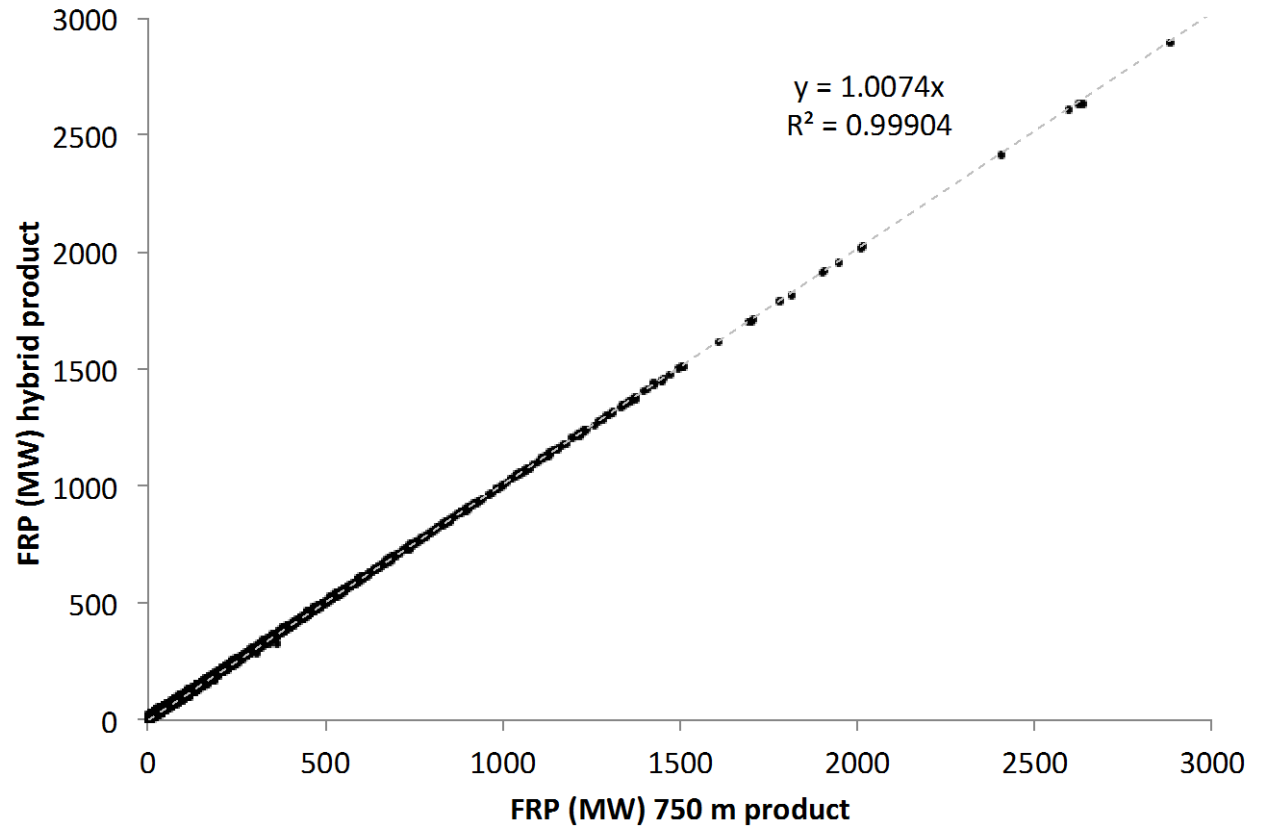
Co-locate
375 & 750 m
data



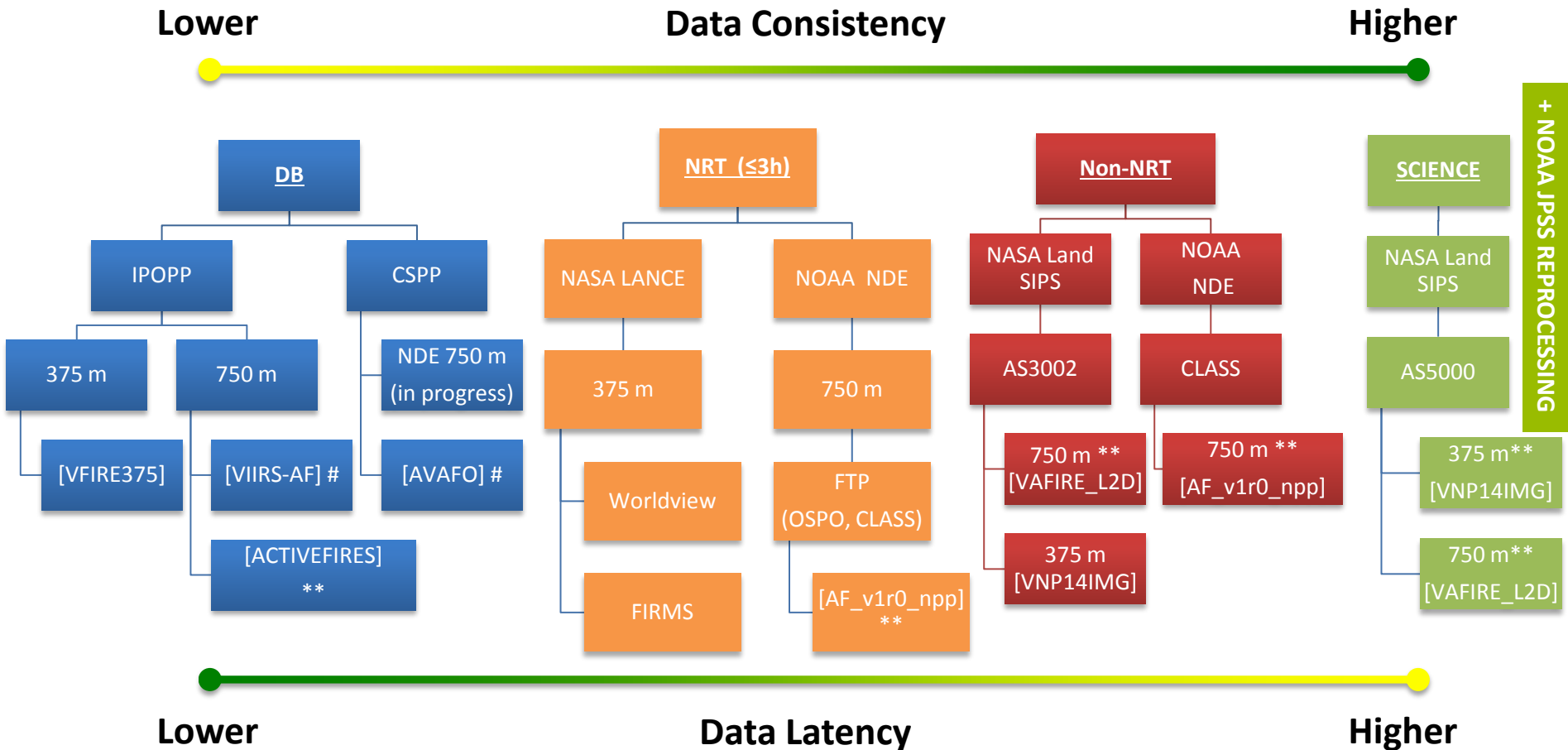
Calculate
FRP

$$FRP_i = FRP$$

$$FRP_i = FRP \div 2$$



VIIRS Active Fire Product Lineage

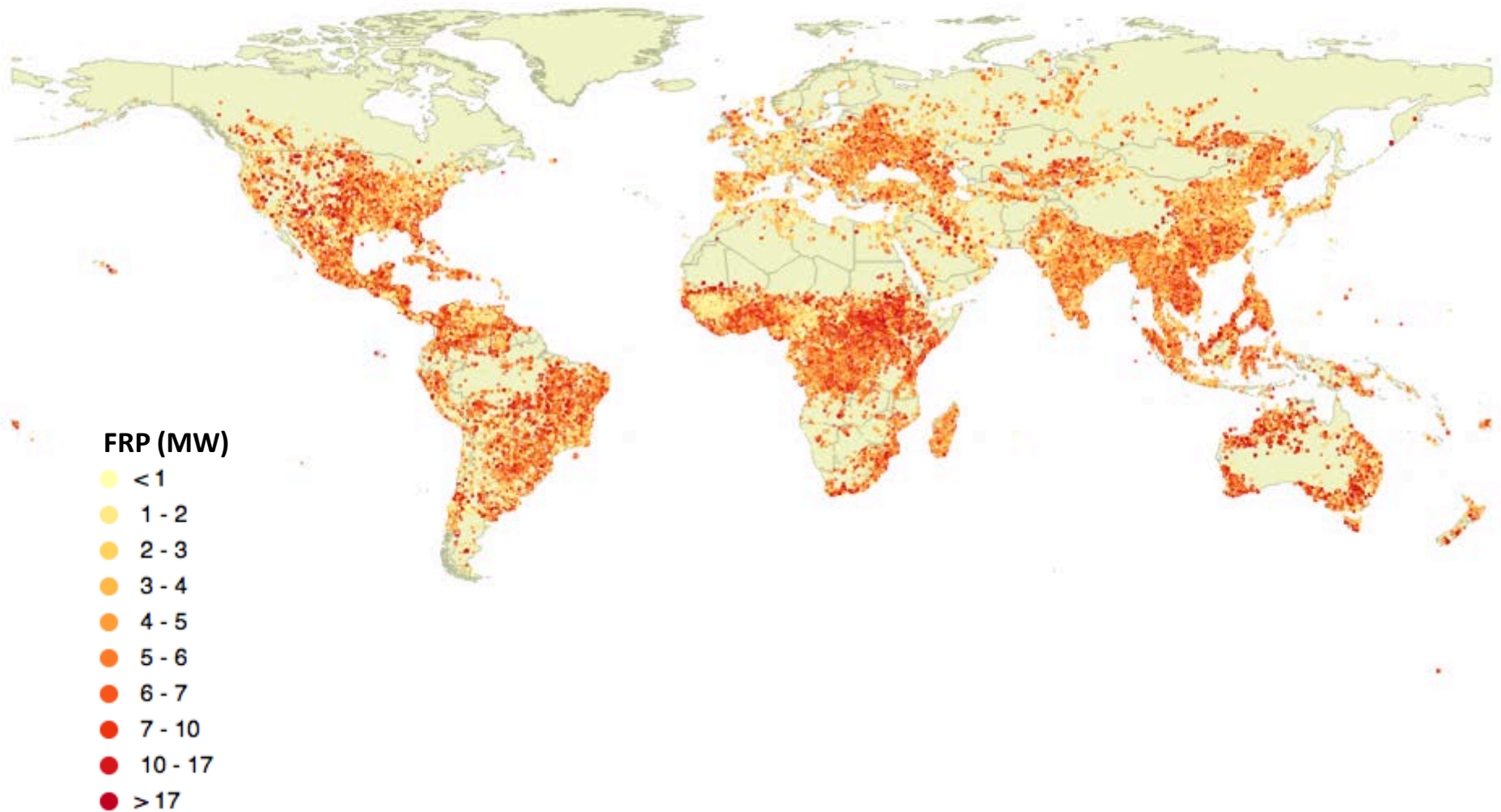


** marked products include FRP retrieval
 # marked products describe discontinued algorithm
 [] indicate official product name

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

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

'Collection 2'

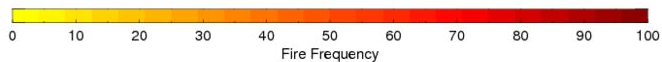
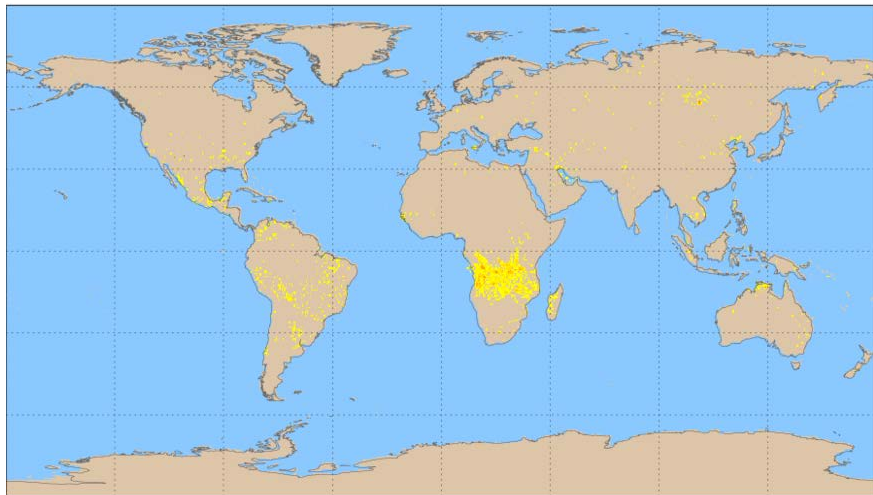


VIIRS Active Fire Long-term Monitoring

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

Suomi NPP - VIIRS - NDE - Active Fires

16 Jun 2016

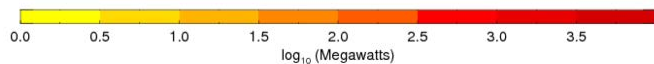
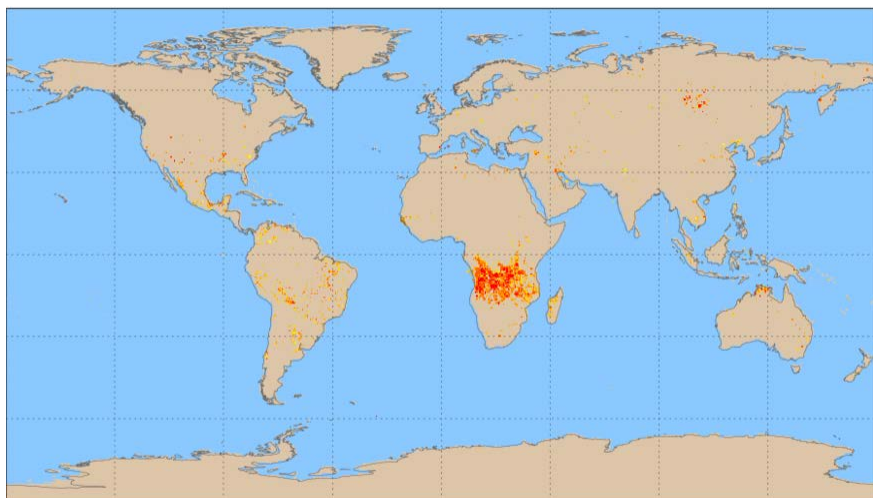


Fire Frequency



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

16 Jun 2016

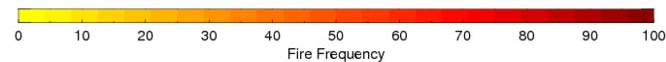
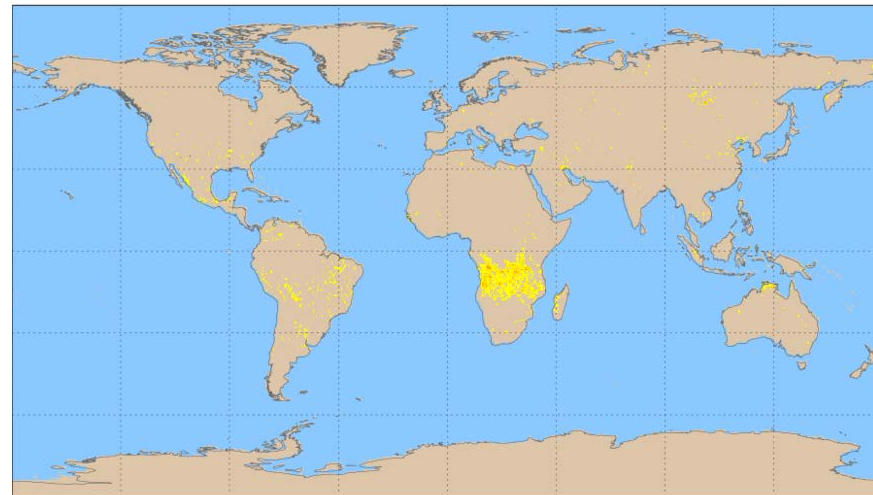


\log_{10} (Megawatts)



Suomi NPP - VIIRS - IDPS - Active Fires

16 Jun 2016

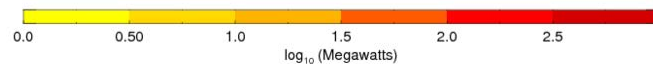
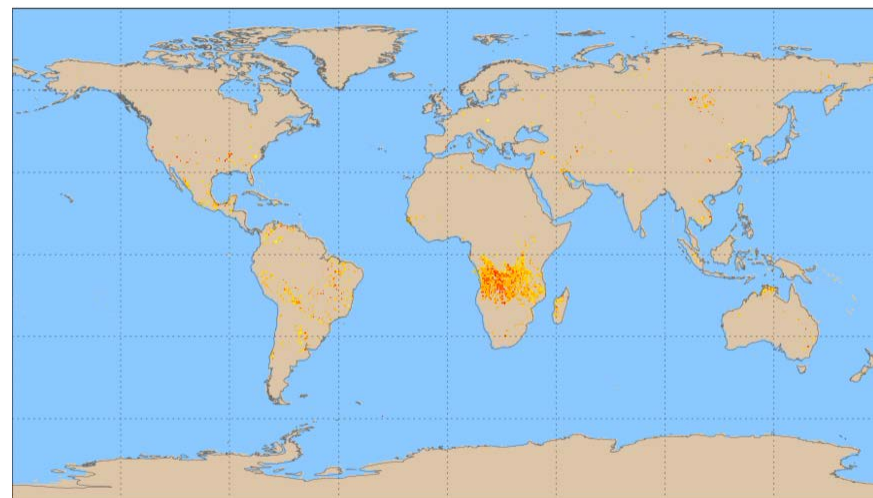


Fire Frequency



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

16 Jun 2016



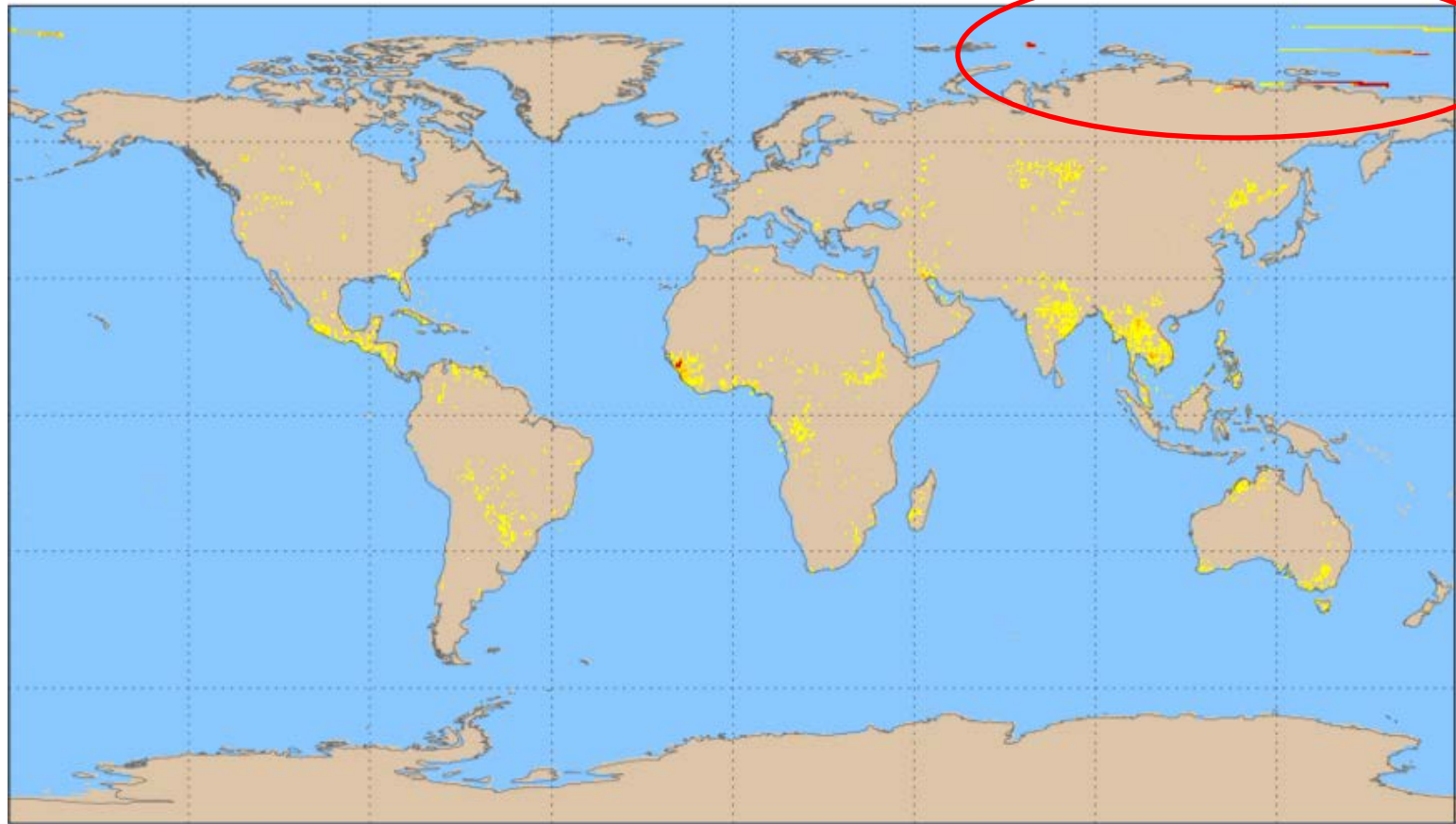
\log_{10} (Megawatts)



Active fire data anomaly during VIIRS flight software update

Suomi NPP - VIIRS - NDE - Active Fires

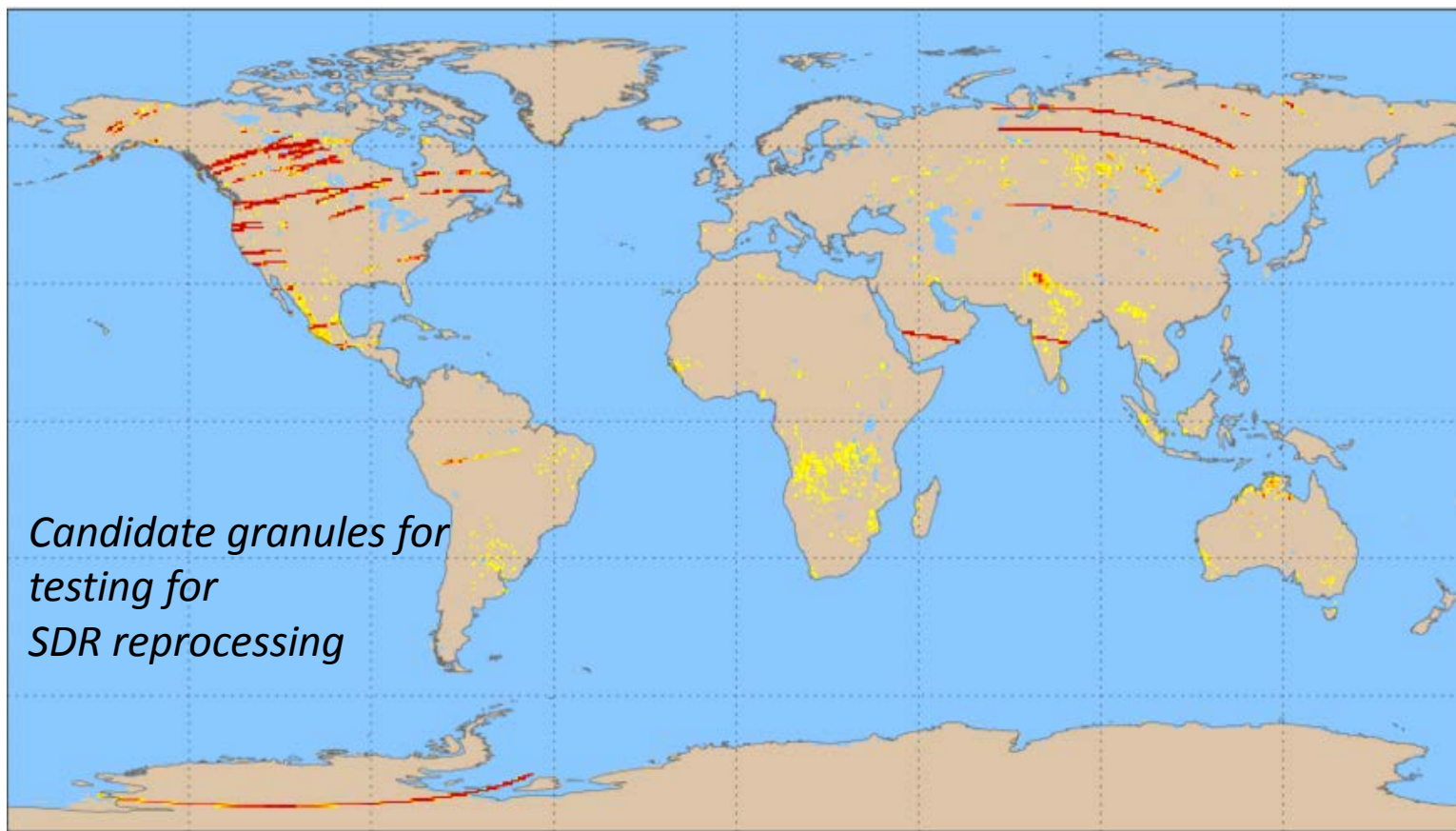
19 Apr 2016



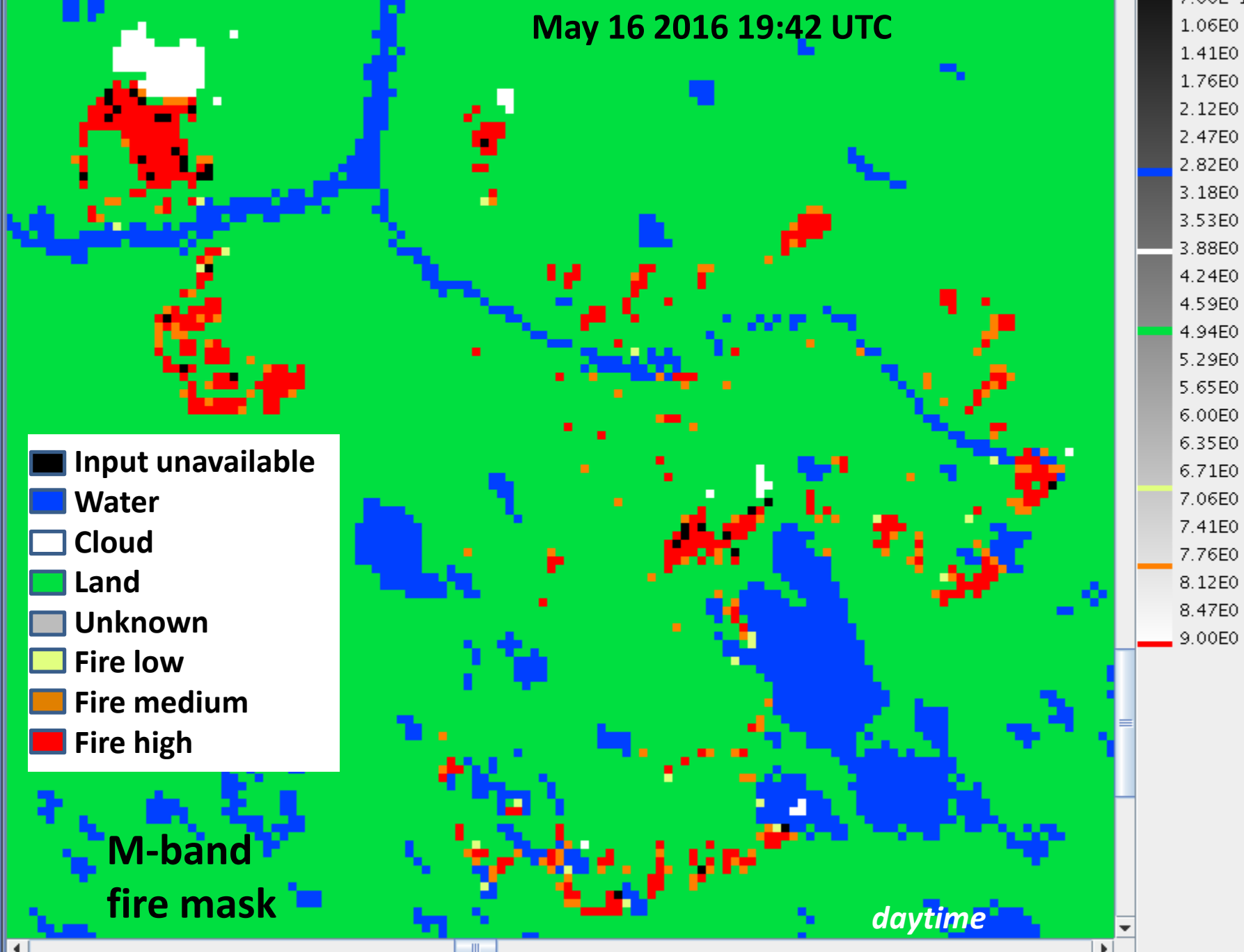
Active fire data anomalies during the early period of the Suomi NPP data record

Suomi NPP VIIRS - IDPS Active Fires

15 May 2012



May 16 2016 19:42 UTC



- Input unavailable
- Water
- Cloud
- Land
- Unknown
- Fire low
- Fire medium
- Fire high

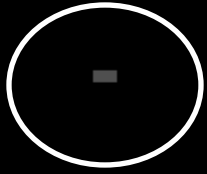
- 7.00E0
- 1.06E0
- 1.41E0
- 1.76E0
- 2.12E0
- 2.47E0
- 2.82E0
- 3.18E0
- 3.53E0
- 3.88E0
- 4.24E0
- 4.59E0
- 4.94E0
- 5.29E0
- 5.65E0
- 6.00E0
- 6.35E0
- 6.71E0
- 7.06E0
- 7.41E0
- 7.76E0
- 8.12E0
- 8.47E0
- 9.00E0

M-band
fire mask

daytime

x=1876, y=127, value=5

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

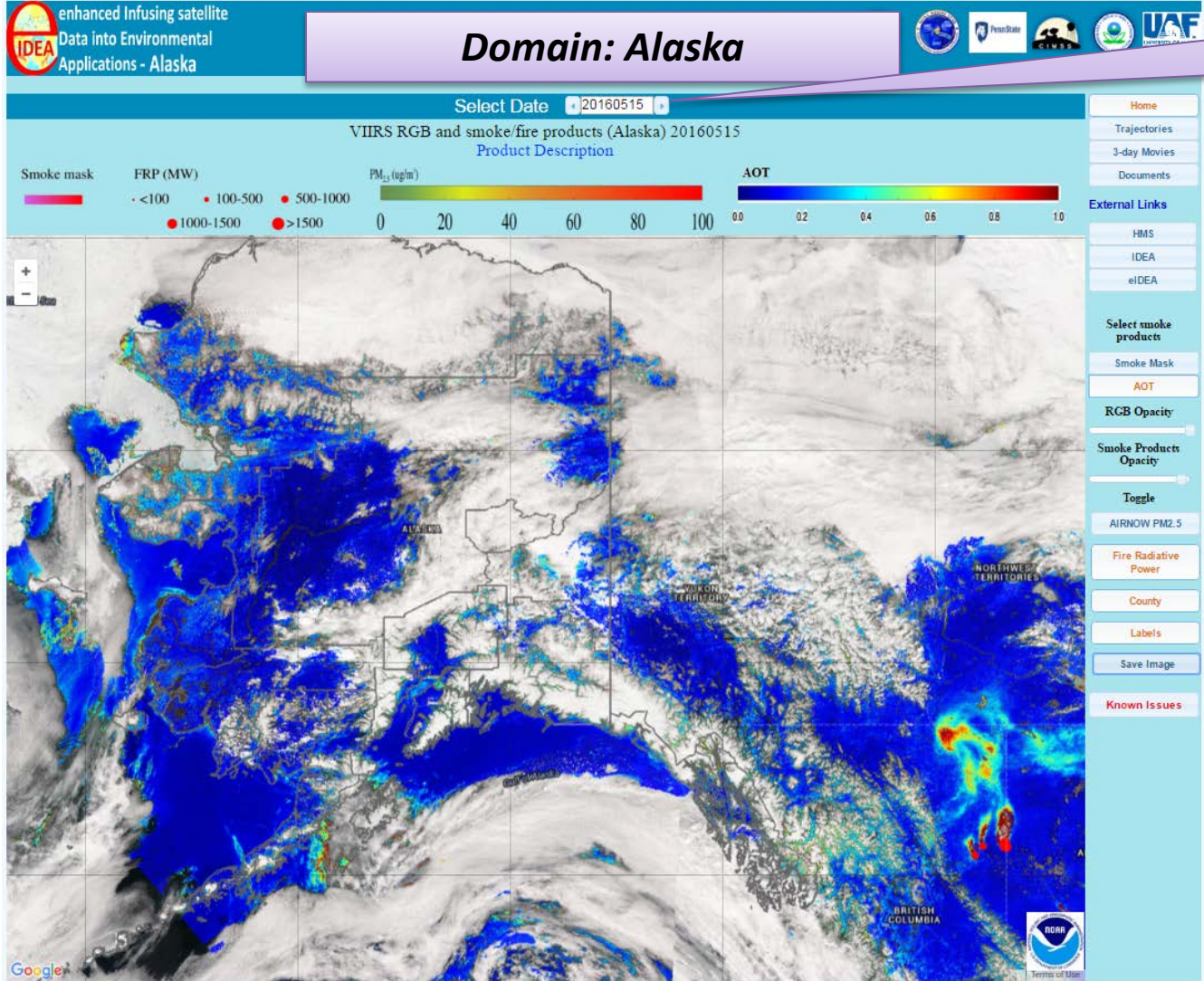


Saturated native
resolution M13
measurements!

M13 unaggr.
Brightness temperature

daytime

Web-Based Blended Fire and Smoke Product: eIDEA-Alaska



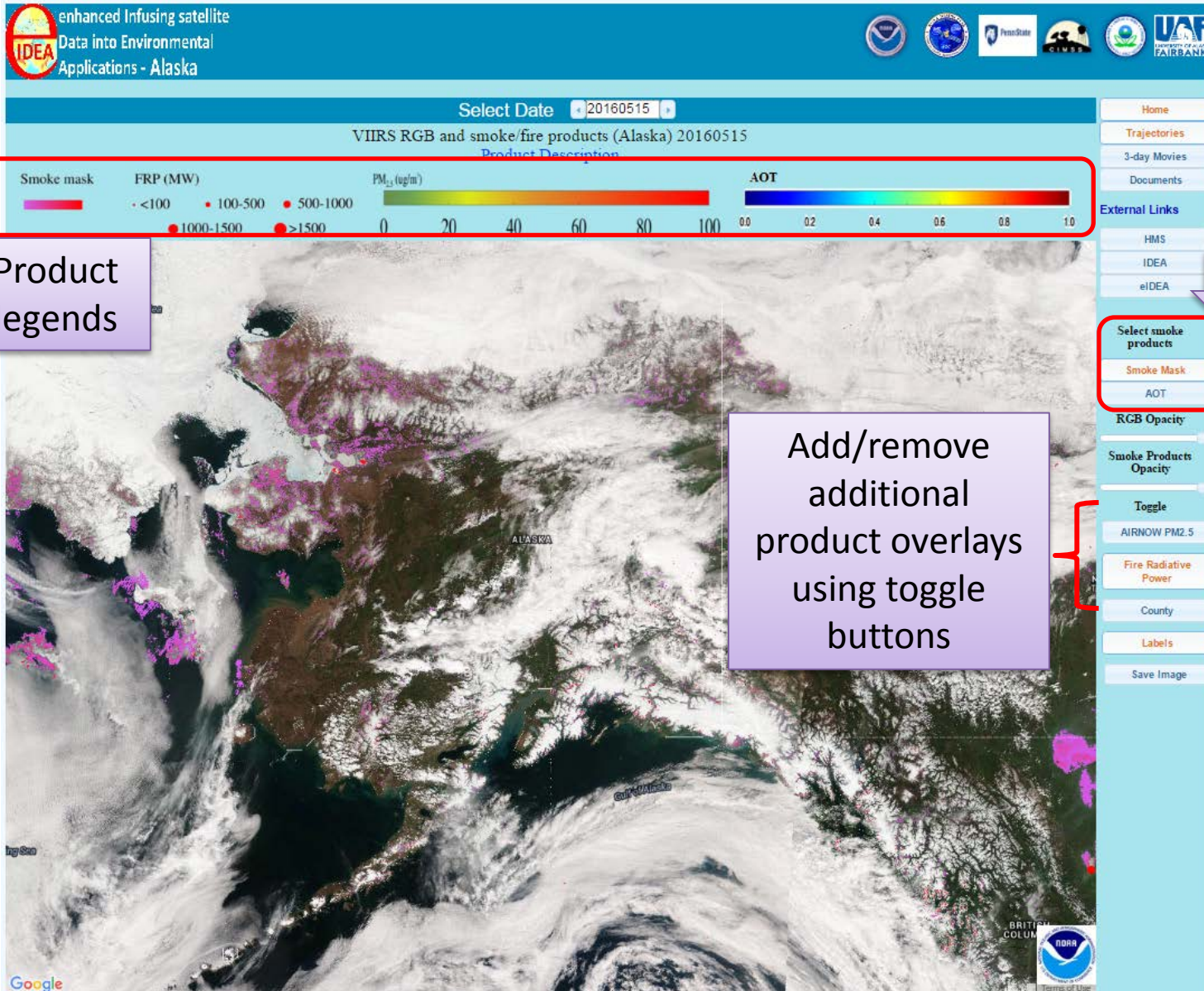
Calendar to select date of interest

Main product overlay buttons

VIIRS SDR data from GINA DB. Aerosol and fire products generated at STAR.

<http://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea-ak/>

eIDEA - Alaska: Overlays



“Smoke Mask” is default smoke product; click on “AOT” or “Satellite Derived PM_{2.5}” to switch b/w smoke products

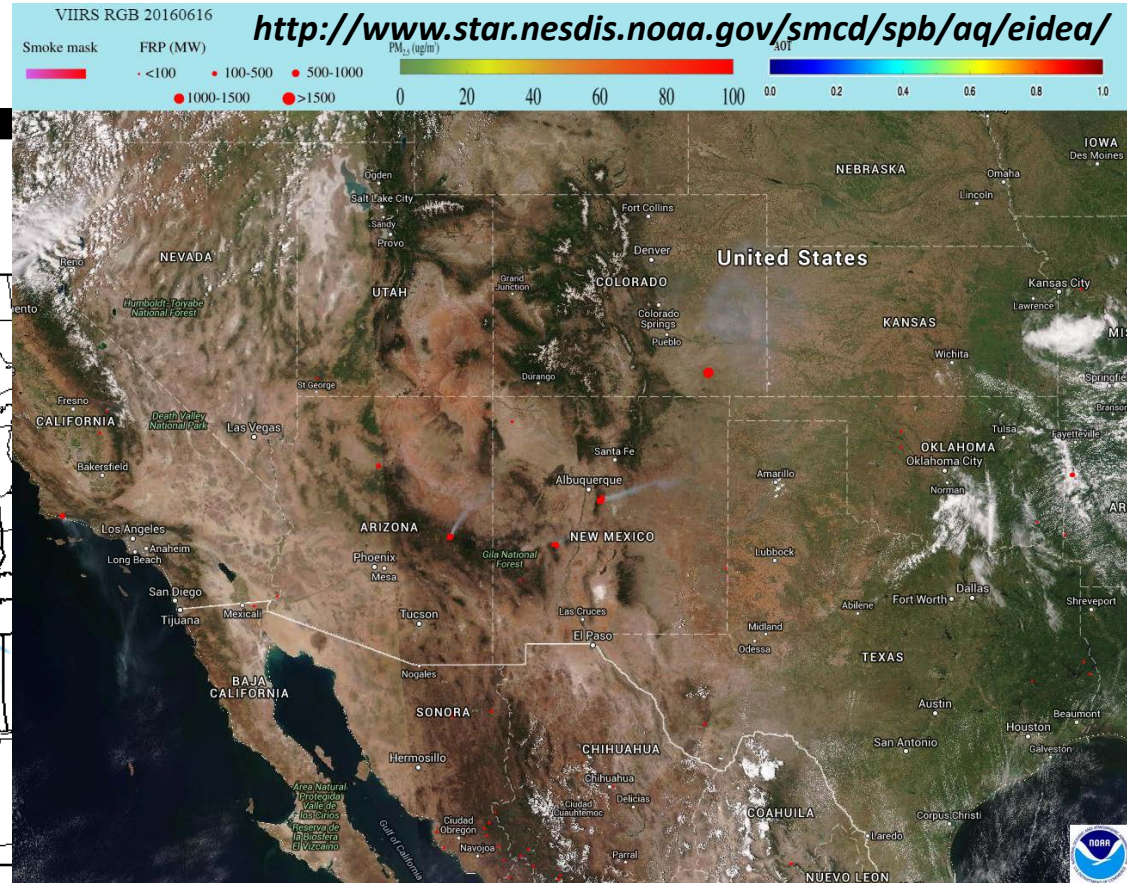
Product legends

Add/remove additional product overlays using toggle buttons

Slider bars adjust opacity of RGB and smoke products

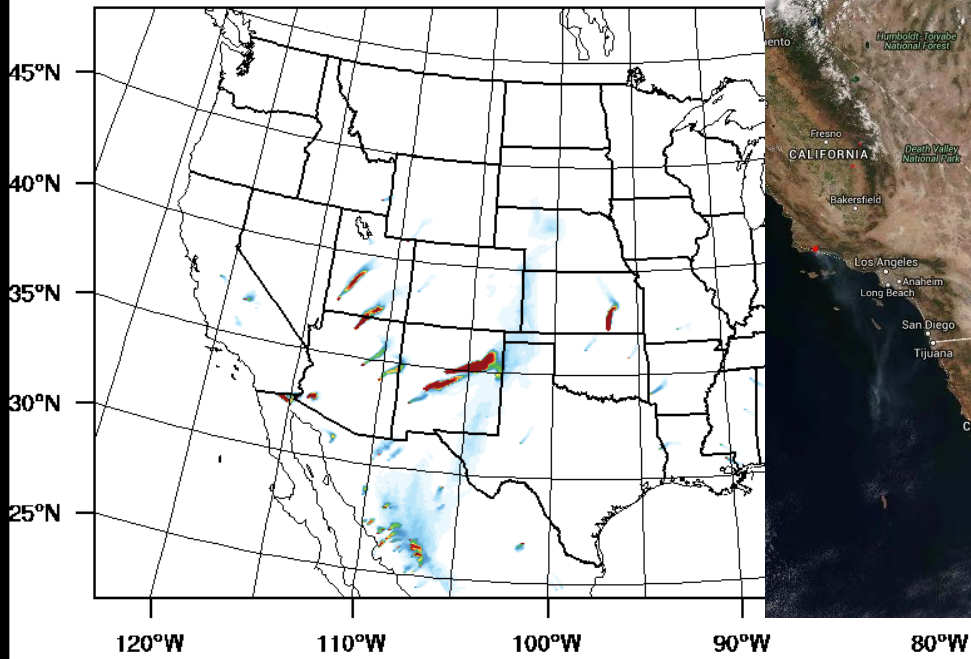
Click “Save Image” to save configuration as a graphics file

HRRR smoke forecast vs. eIDEA observations



Near-Surface Fire Smoke 16 EDT

Smoke Concentration ($\mu\text{g}/\text{kg}_{\text{air}}$) at Level 1

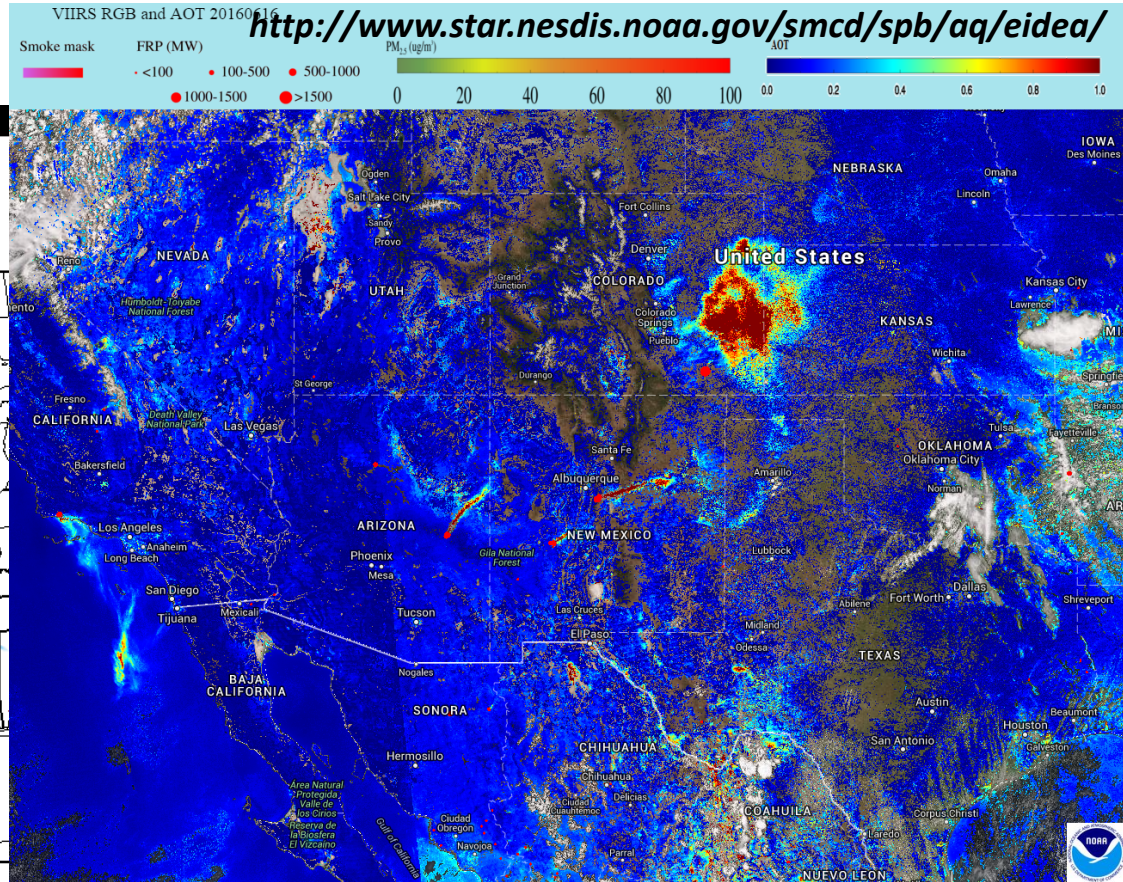


<http://rapidrefresh.noaa.gov/HRRRsmoke/>

OUTPUT FROM * PROGRAM:WRF/CHEM V3.6.1 MODEL
 WLE: 1800 ; SN 1060 ; Levels 51 ; Dis 3km ; PhysOpt 28 ; HBL Opt 5 ; Cu Opt 0

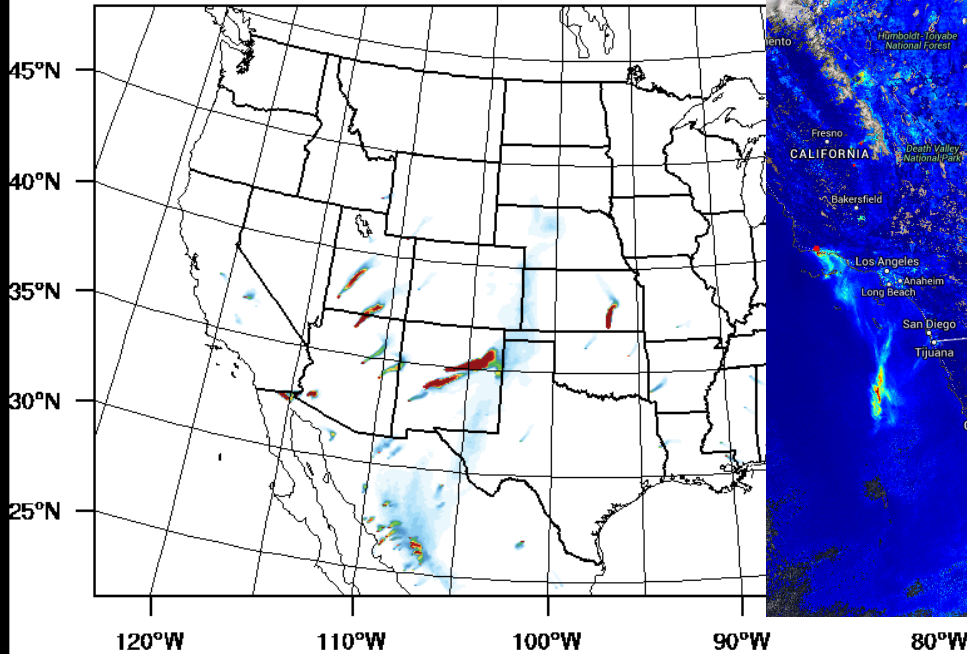
June 16, 2016

HRRR smoke forecast vs. eIDEA observations



Near-Surface Fire Smoke 16 EDT

Smoke Concentration ($\mu\text{g}/\text{kg}_{\text{air}}$) at Level 1



<http://rapidrefresh.noaa.gov/HRRRsmoke/>

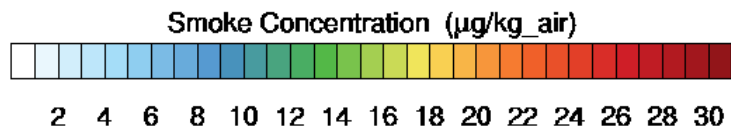
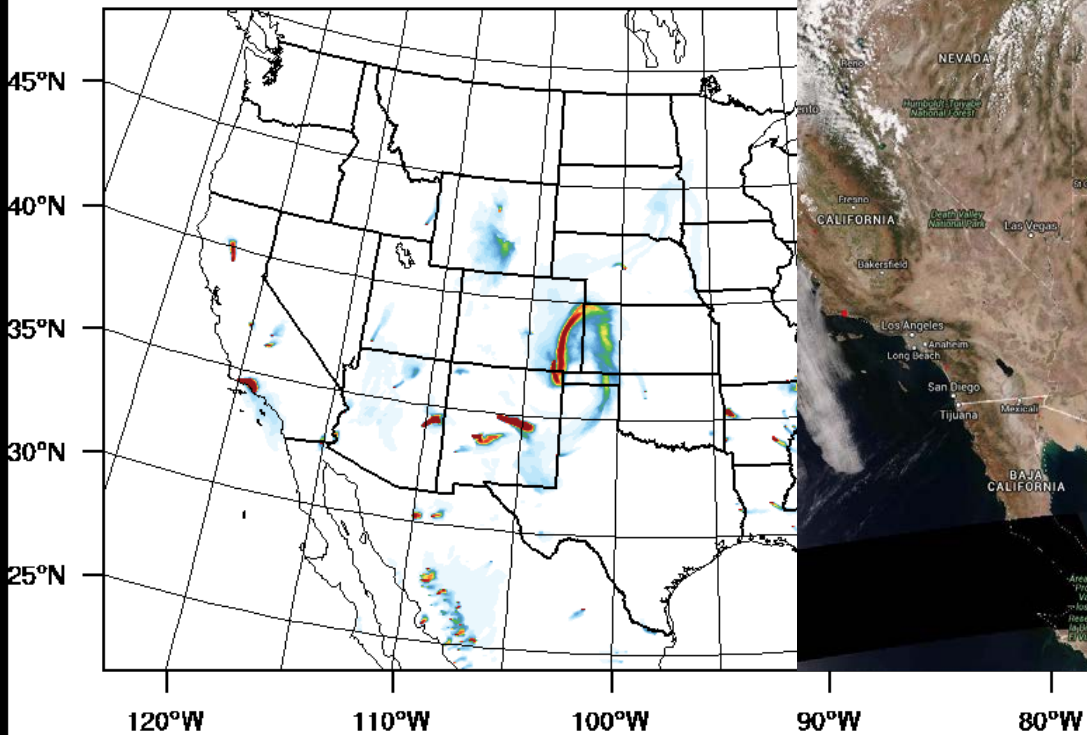
OUTPUT FROM * PROGRAM: WRF/CHEM V3.6.1 MODEL
 WLE: 1800 ; SN: 1060 ; Levels: 51 ; Dis: 3km ; PhysOpt: 28 ; HBLOpt: 5 ; Cu Opt: 0

June 16, 2016

HRRR smoke forecast vs. eIDEA observations

Near-Surface Fire Smoke 16 EDT

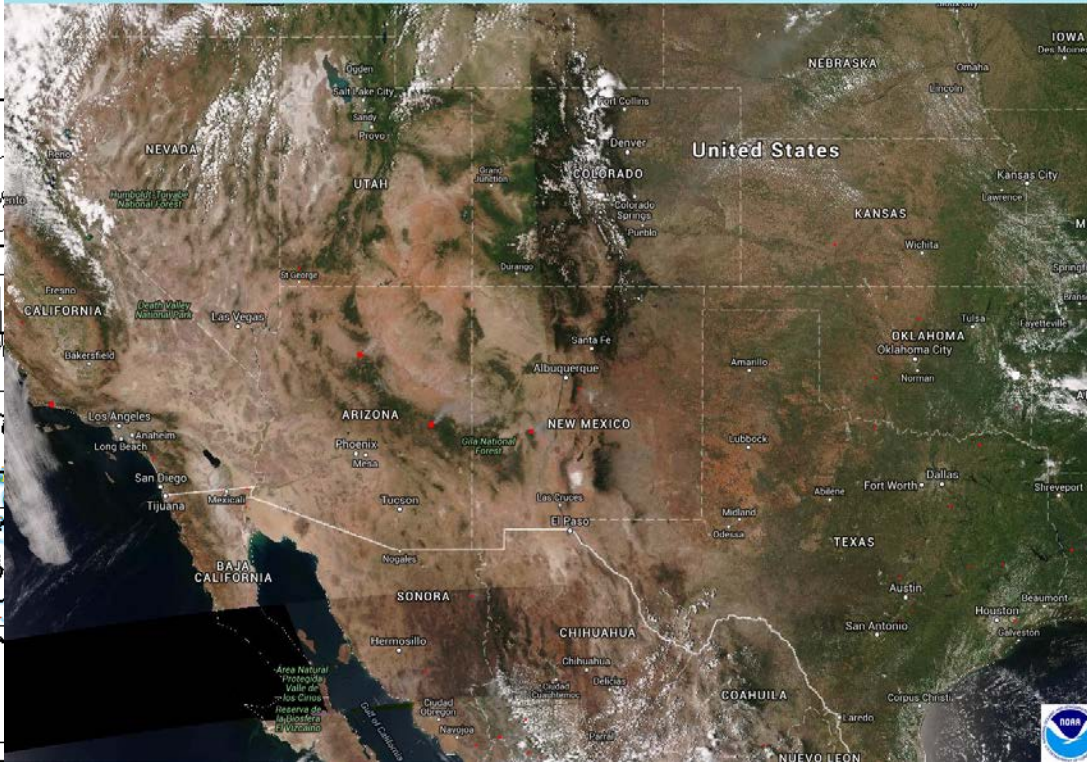
Smoke Concentration ($\mu\text{g}/\text{kg}_{\text{air}}$) at Level 1



<http://rapidrefresh.noaa.gov/HRRRsmoke/>

VIIRS RGB 20160617 <http://www.star.nesdis.noaa.gov/smcd/spb/aa/eidea/>

Smoke mask	FRP (MW)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	AOT



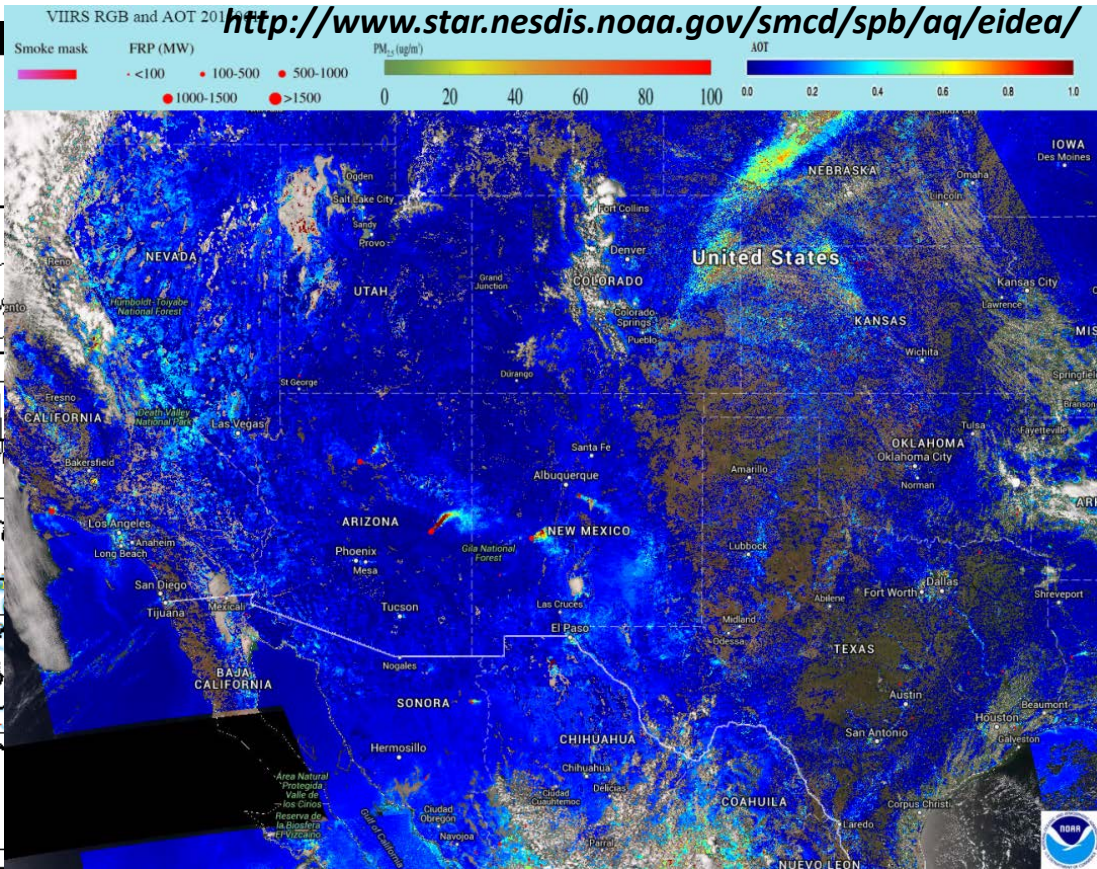
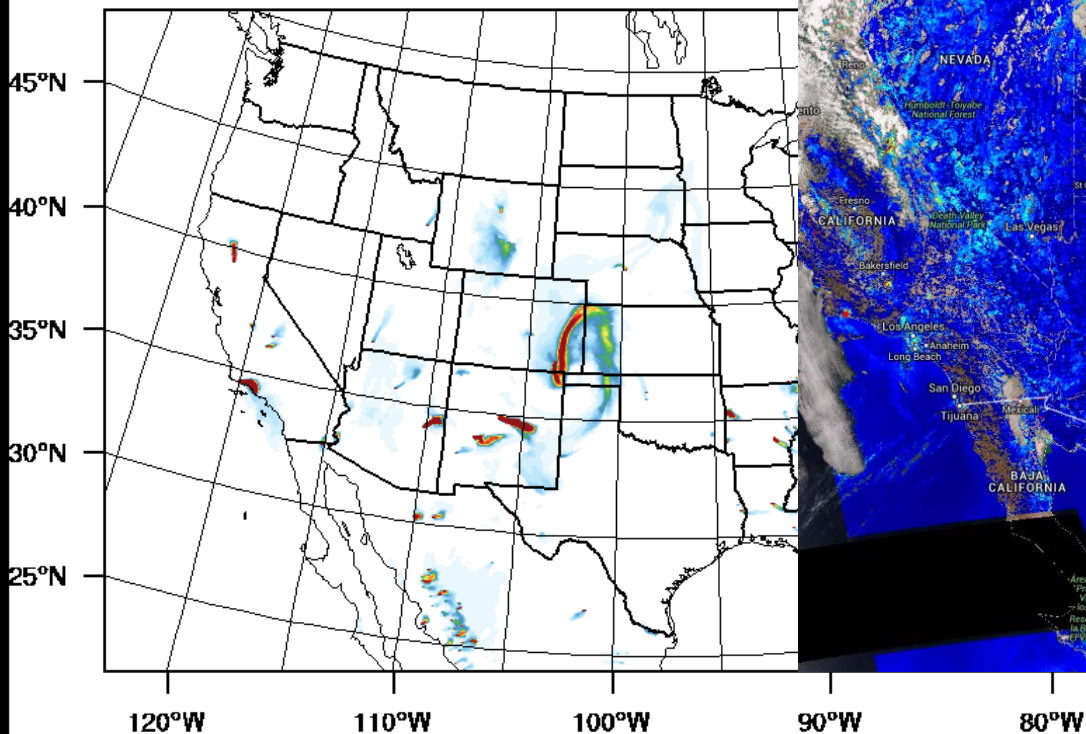
June 17, 2016

HRRR smoke forecast vs. eIDEA observations

<http://www.star.nesdis.noaa.gov/smcd/spb/aa/eidea/>

Near-Surface Fire Smoke 16 EDT

Smoke Concentration ($\mu\text{g}/\text{kg}_{\text{air}}$) at Level 1



<http://rapidrefresh.noaa.gov/HRRRsmoke/>

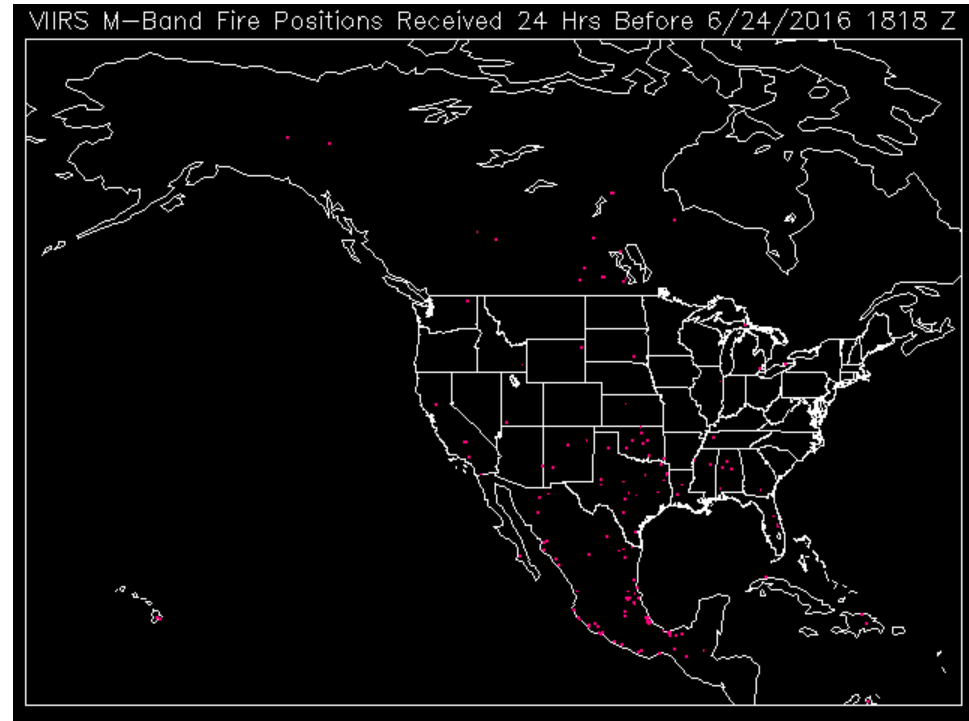
June 17, 2016

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

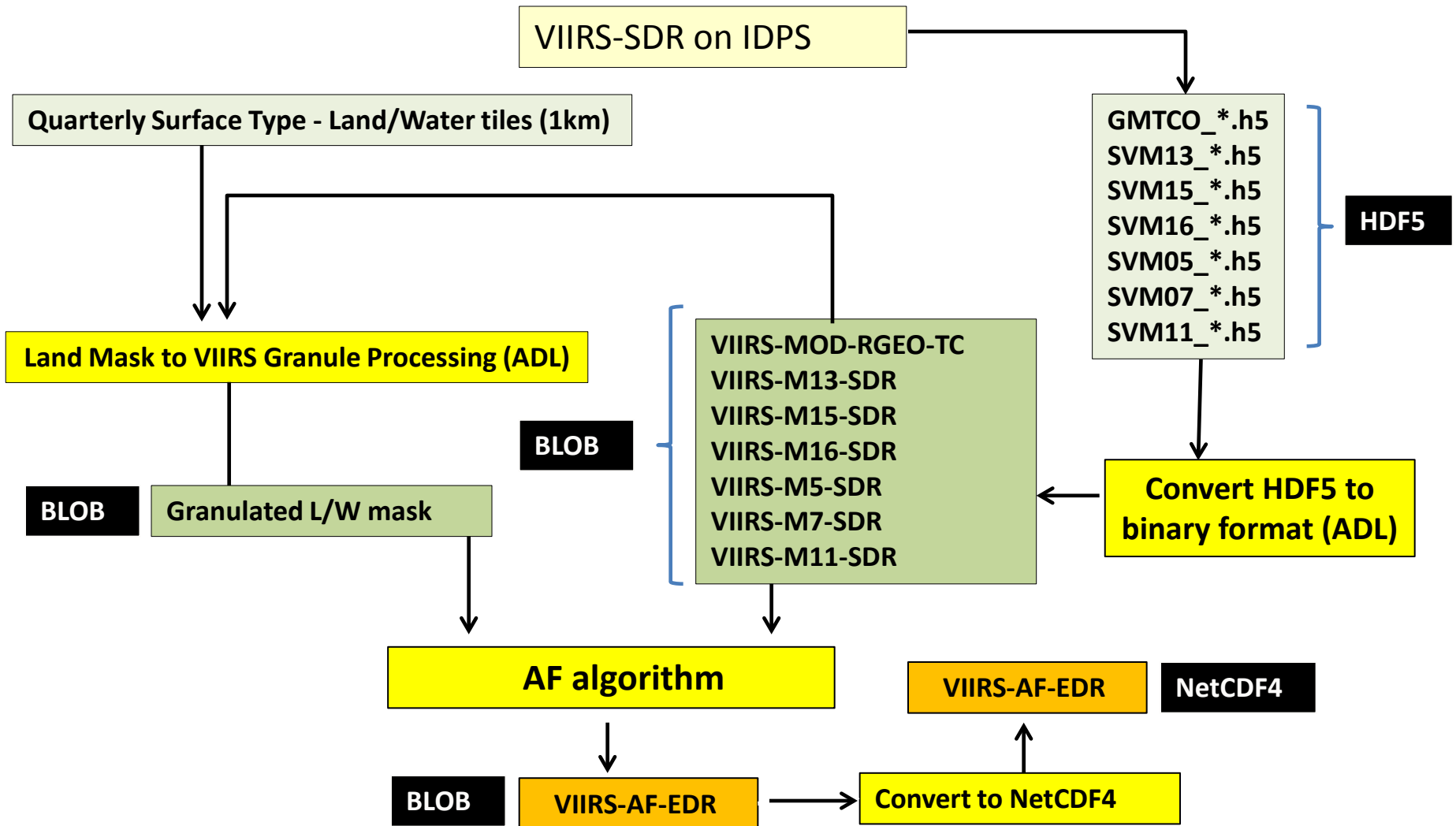
- Global NDE data are available in text format
 - granule-based (.txt) : real-time
 - daily summary (.dat)
- Graphics / web GIS under development
- VIIRS data to appear in HMS in the next release (October 2016)



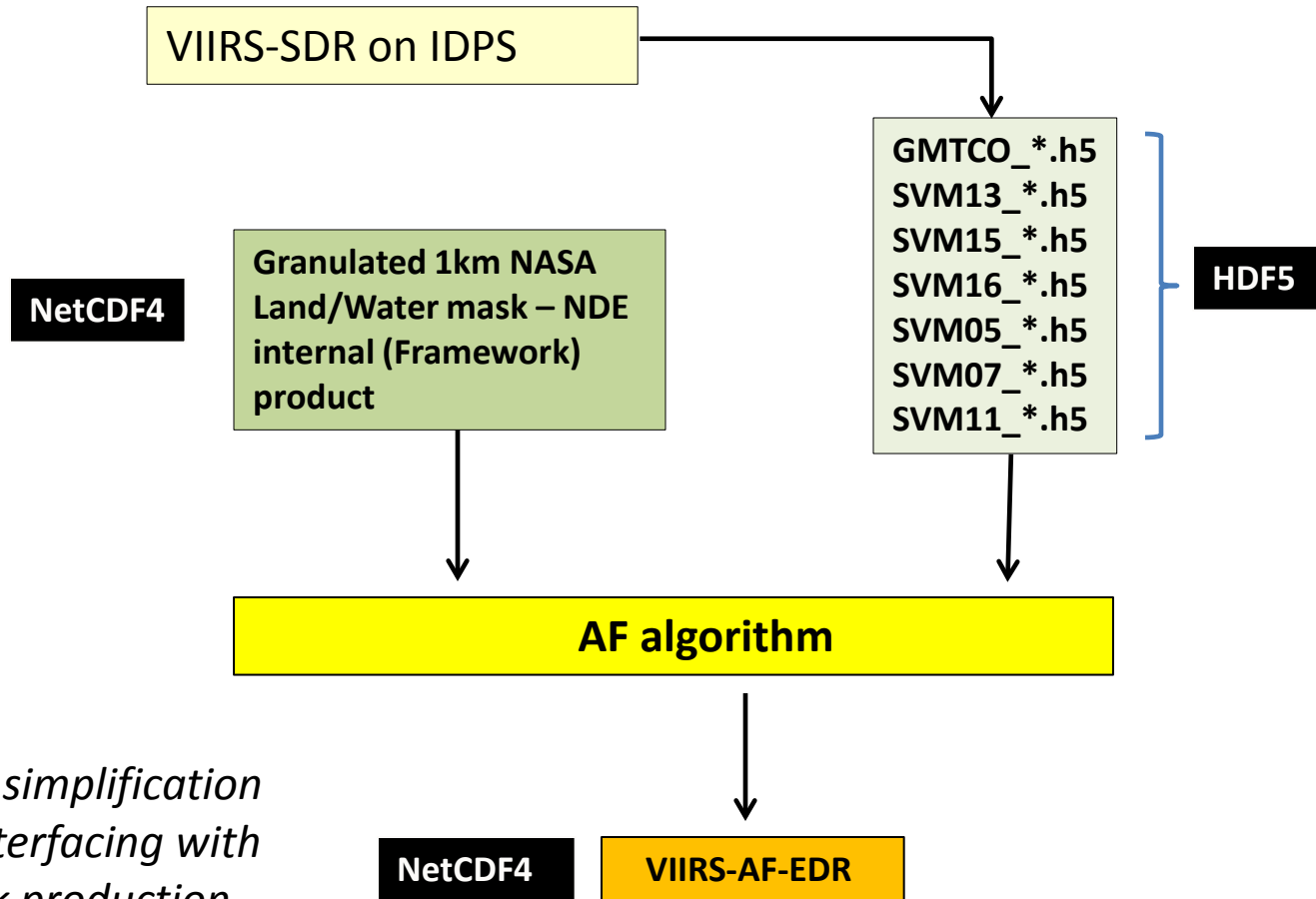
NOAA NESDIS Office of Satellite and Product Operations (OSPO)

<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

- NDE implementation was a major step forward in 2016
- New, advanced products are emerging
 - VIIRS fire product development and distribution is done by various key stakeholders
 - concerted effort ongoing to assist users to find the most appropriate product
 - NOAA, NASA, USDA Forest Service products and activities
 - work is starting towards I-band and hybrid product evaluation and integration
- New NOAA operational product is coupled with air quality / smoke modeling and user feedback has been very positive
 - eIDEA, HRRR etc.
- CSPP implementation and version control is critical for operational users