VIIRS product status

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University of Maryland, Department of Geographical Sciences

Outline

- VIIRS active fire product status and data access
  - VIIRS baseline (MODIS heritage) fire product
  - Improved hybrid VIIRS fire product
- Ongoing science issues and product improvements
- Examples of key operational applications
- Reprocessing the Suomi NPP VIIRS data record
- Summary

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

Fire pixel information is also available in text files

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

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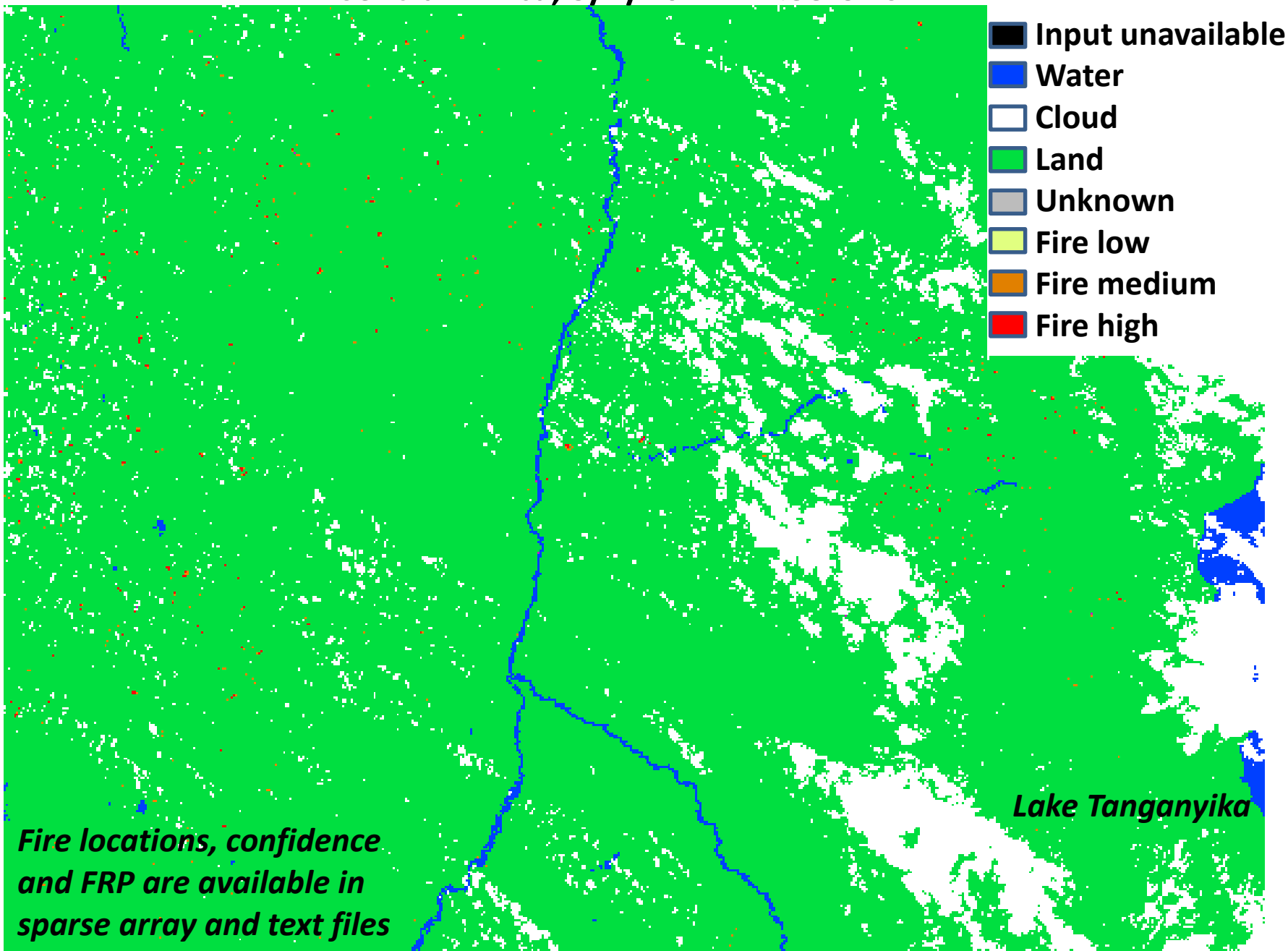
Fire pixel information is also available in text files

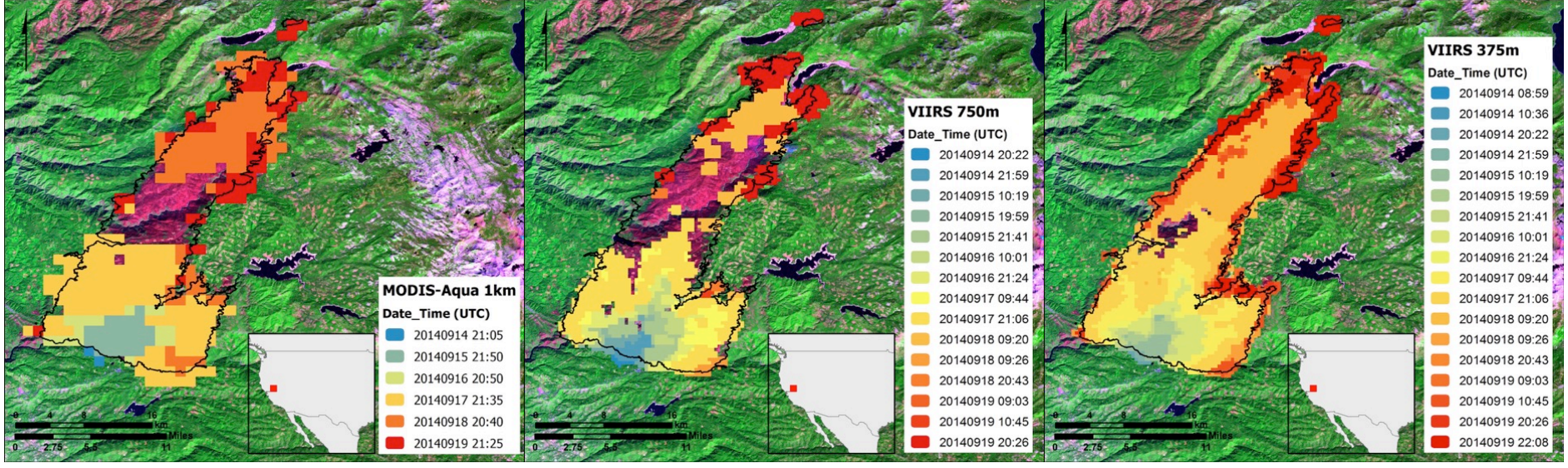
Missing – 0	Brightness temperatures for M13 or M15 unavailable
Scan – 1	Bowtie deletion
Other – 2	Not processed (other reason)
Water – 3	Pixel classified as non fire water
Cloud – 4	Pixel classified as cloudy
No Fire – 5	Pixel classified as non fire land
Unknown – 6	Pixel with no valid background pixels
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	EDR trim zone (0=false, 1=true)
3	Atmospheric correction performed (0=false, 1=true)
4	Day/Night (daytime = 1, nighttime = 0)
5	Potential fire (0/1)
6	Spare (set to 0)
7-10	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	Spare (set to 0)
20	Adjacent clouds (0/1)
21	Adjacent water (0/1)
22-23	Sun Glint Level (0-3)
24-28	Individual rejection test flags (0=false, 1=true)
29-31	Spare (set to 0)

NOAA NDE VIIRS ACTIVE FIRE PRODUCT: FIRE MASK

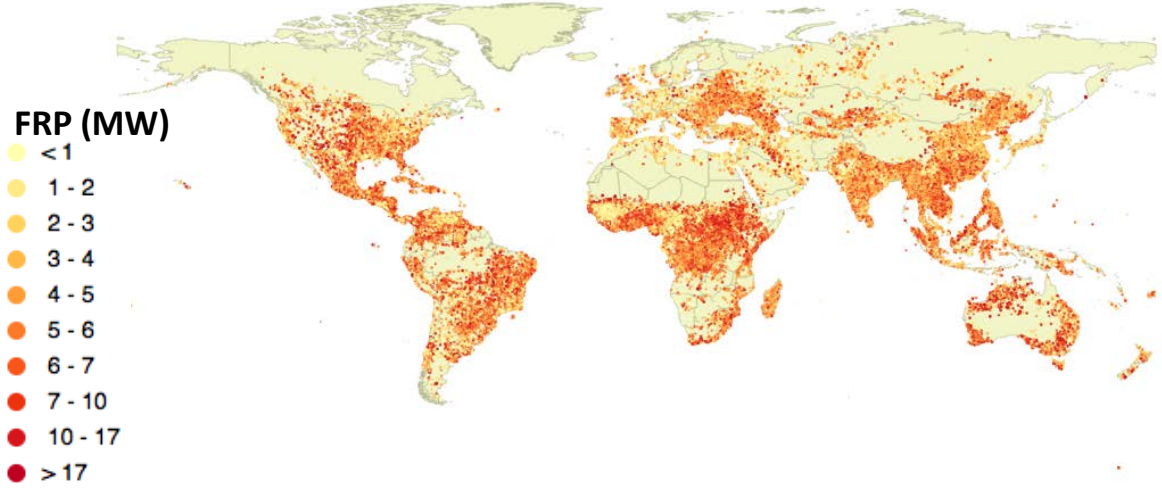
Central Africa, 5/1/2017 11:33 UTC

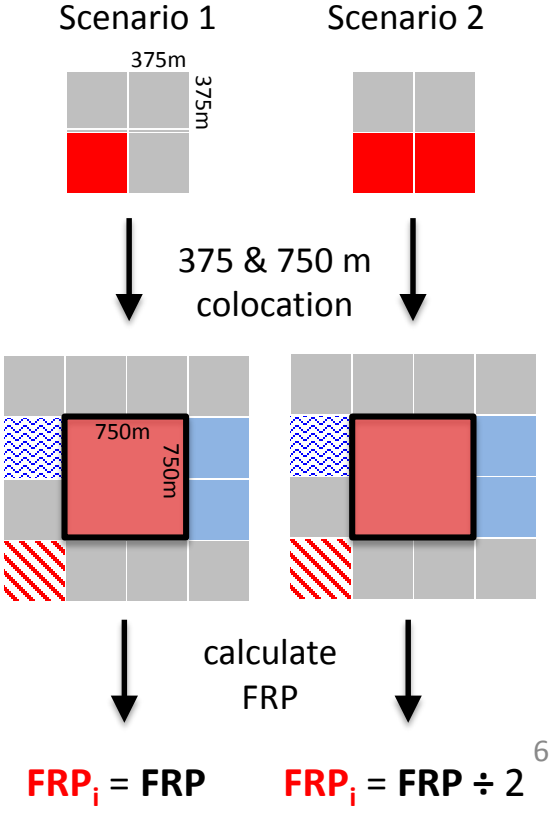




King Fire/CA, September 2014

Hybrid I/M-band product

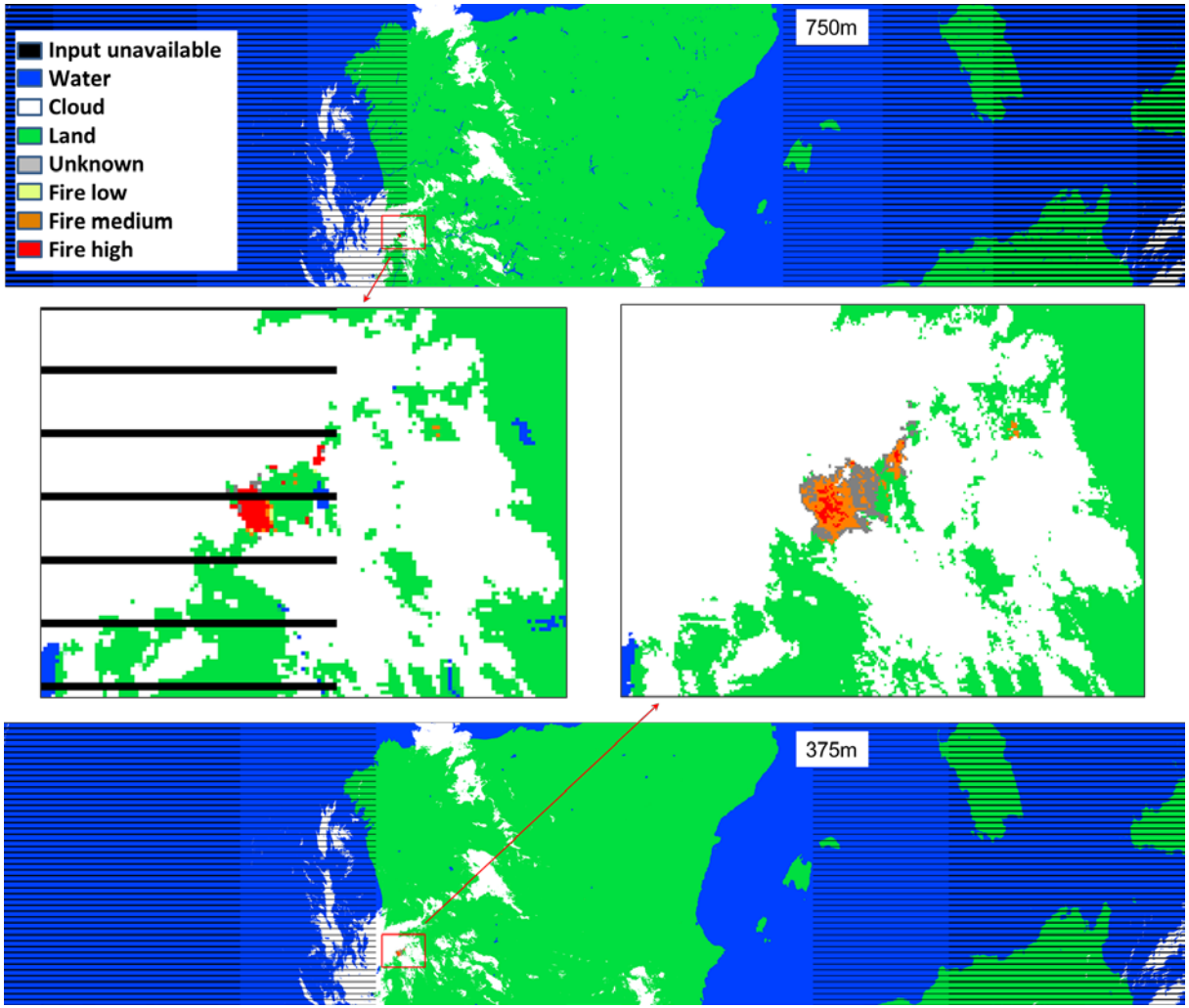




M-band vs. I-band

- The JPSS VIIRS active fire products provide high quality information
  - 750m M-band product in operations since March 15, 2016
  - 375m I-band algorithm evaluated for operational implementation
  - both products deliver fire mask and fire radiative power (FRP)
  - FRP used in air quality, and smoke analysis and prediction systems
  - FRP is incorporated into AWIPS-II

Updated M-band algorithm in delivery to NDE.



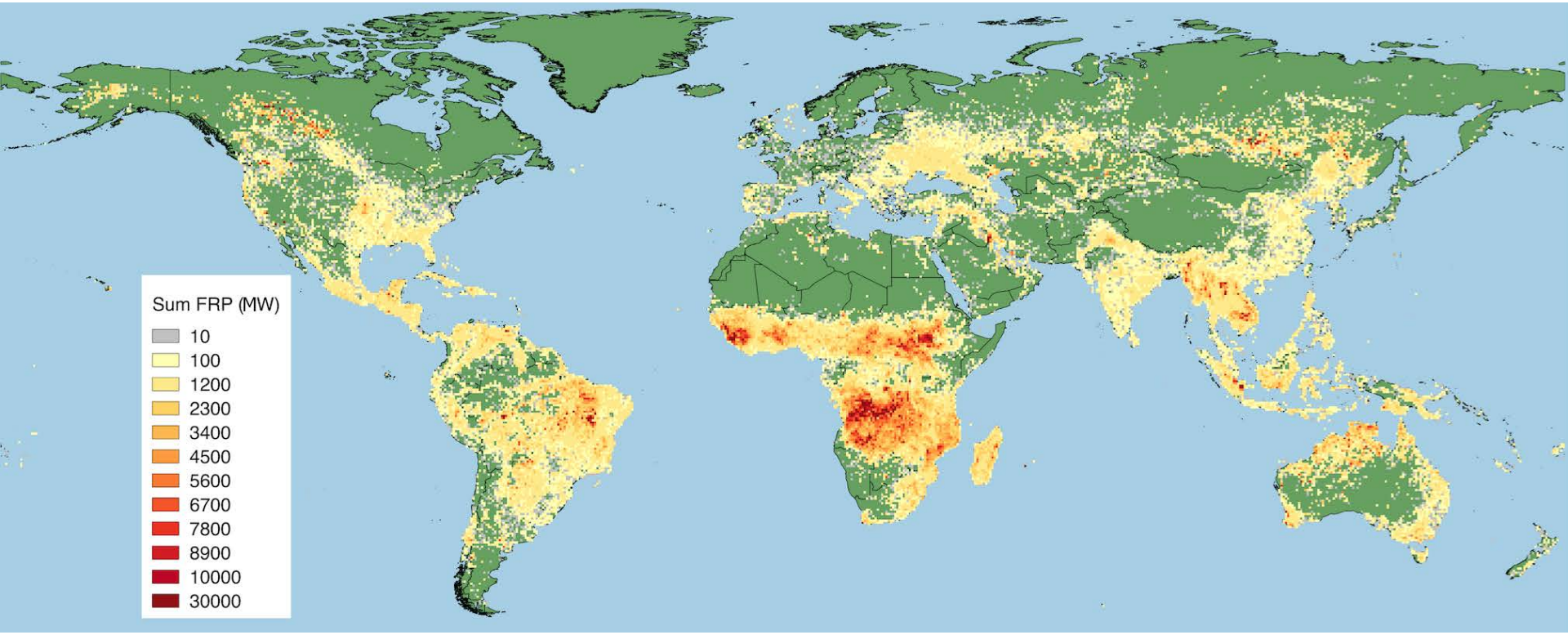
Fire masks from the M-band (top and left) and I-band (bottom and right) algorithms on 6/18/2017 02:04 UTC.

I. Csiszar, STAR; M. Tsidulko, IMSG@STAR, W. Schroeder, UMD

VIIRS 375 m Fire Radiative Power

Jan-Dec 2015 (Julian days 1,10,20,…,360)

Sum of top-of-atmosphere (TOA) FRP over sampling period using 0.5^{o} grid



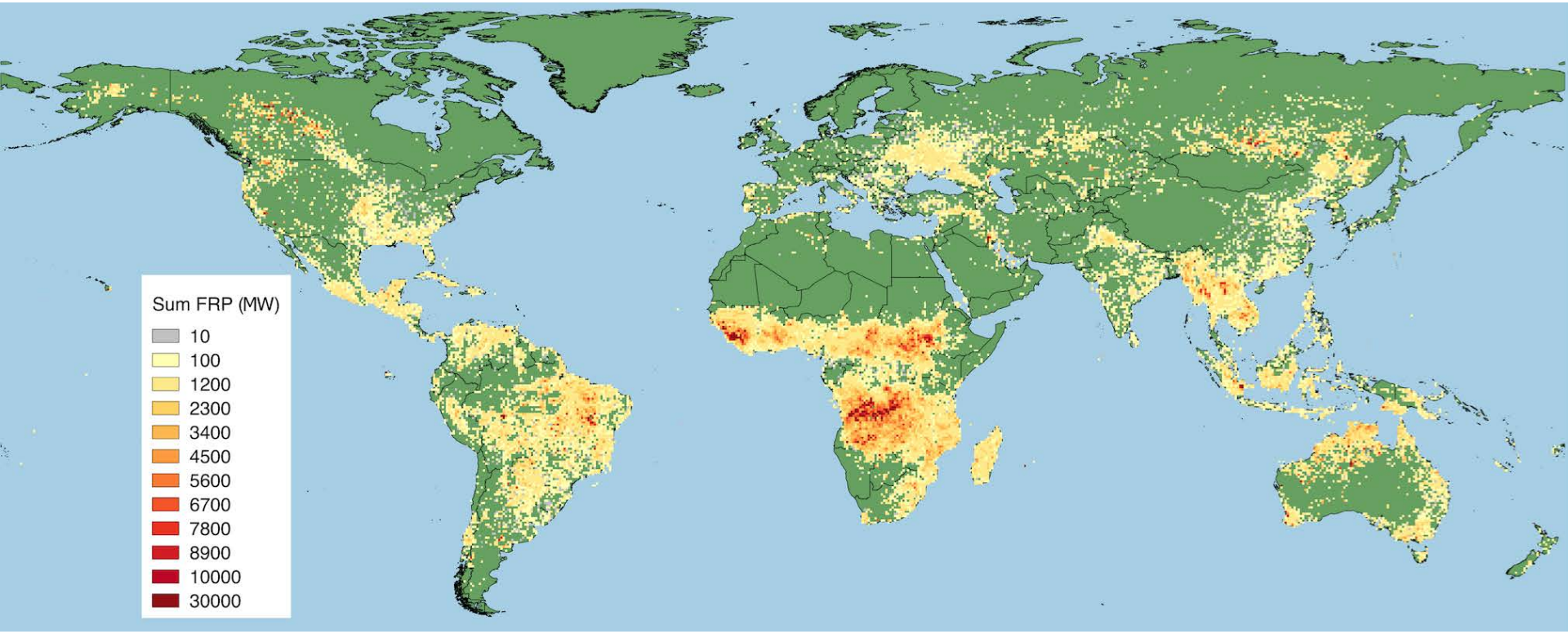
Frequent saturation prevents FRP retrieval using 375 m mid-IR data

Alternative calculation implemented using co-located 750 m mid-IR unsaturated data

MYD14 1km Collection 6 Fire Radiative Power

Jan-Dec 2015 (Julian days 1,10,20,…,360)

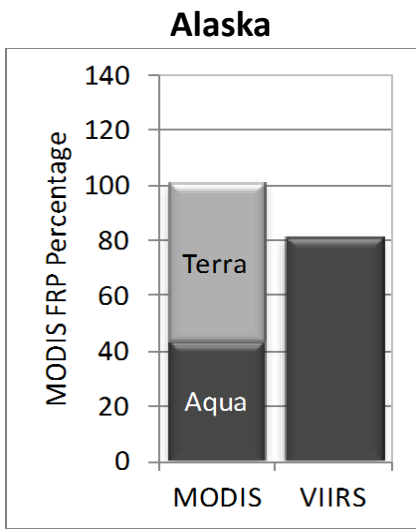
Sum of top-of-atmosphere (TOA) FRP over sampling period using 0.5^{o} grid

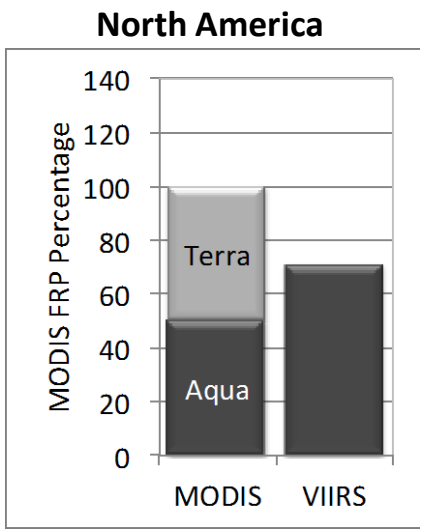


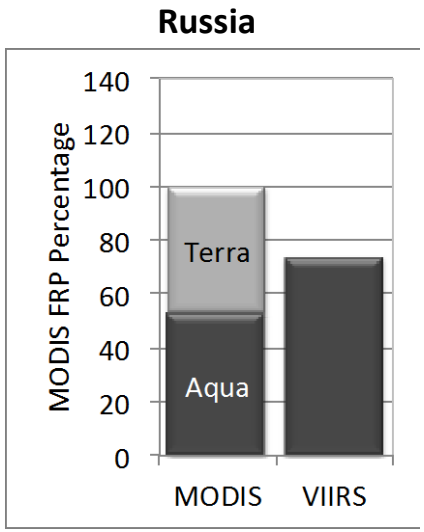
Higher VIIRS spatial resolution means:
3-4 more daytime fire pixels
20-25 more nighttime fire pixels
Compared to Aqua/MODIS

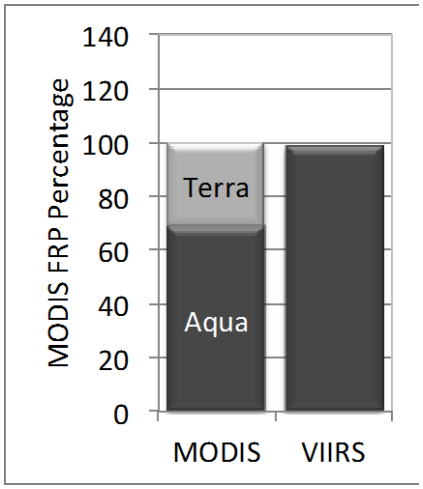
Global TOA FRP totals:
Terra/MODIS: 6.1×10^{6} MW
Aqua/MODIS: 13.4×10^{6} MW
S-NPP/VIIRS: 19.6×10^{6} MW

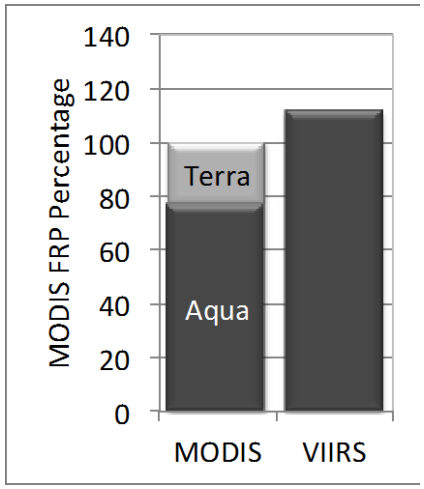
VIIRS 375 m x MODIS 1km
TOA Fire Radiative Power (FRP)

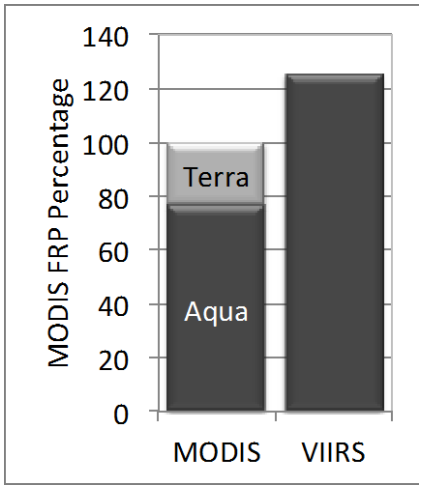








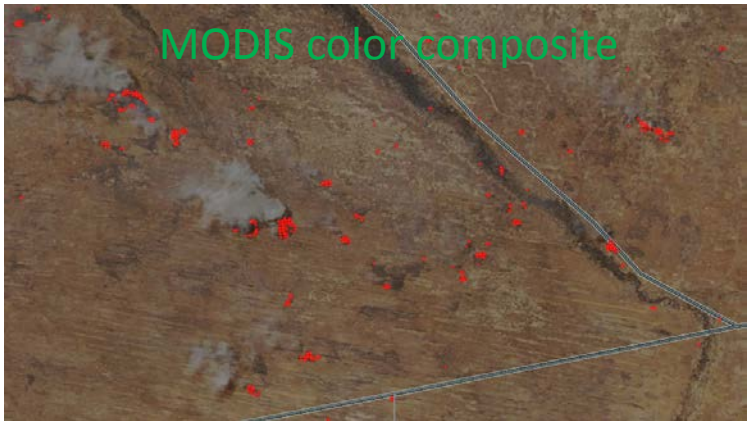


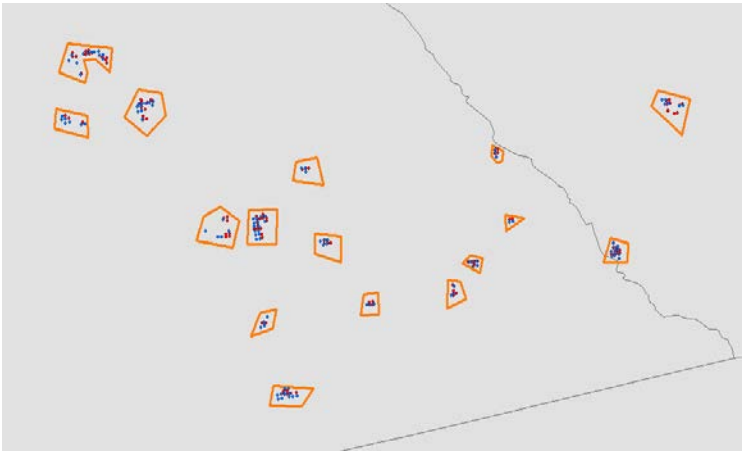


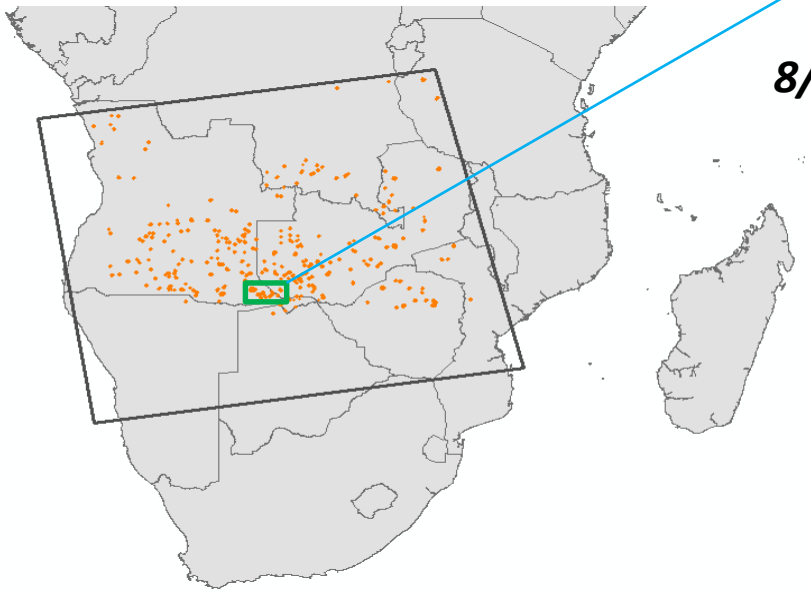
45% of daytime and 80% of nighttime VIIRS 375m fire pixels have no match in Aqua/MODIS fire data

VIIRS 375m systematically detecting more fires than same-day MODIS (Terra & Aqua) in areas dominated by small/low-intensity fires

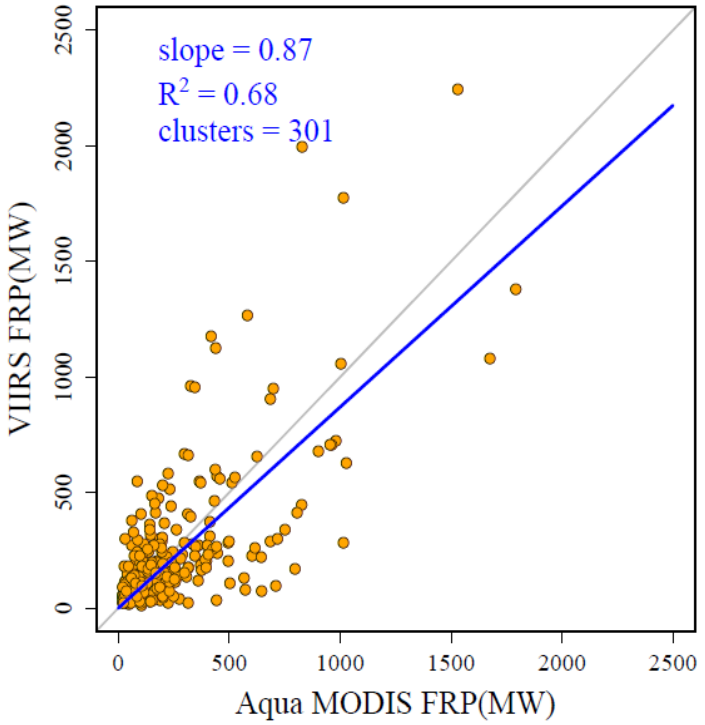
Aqua MODIS vs. VIIRS 750m FRP







8/22/2016

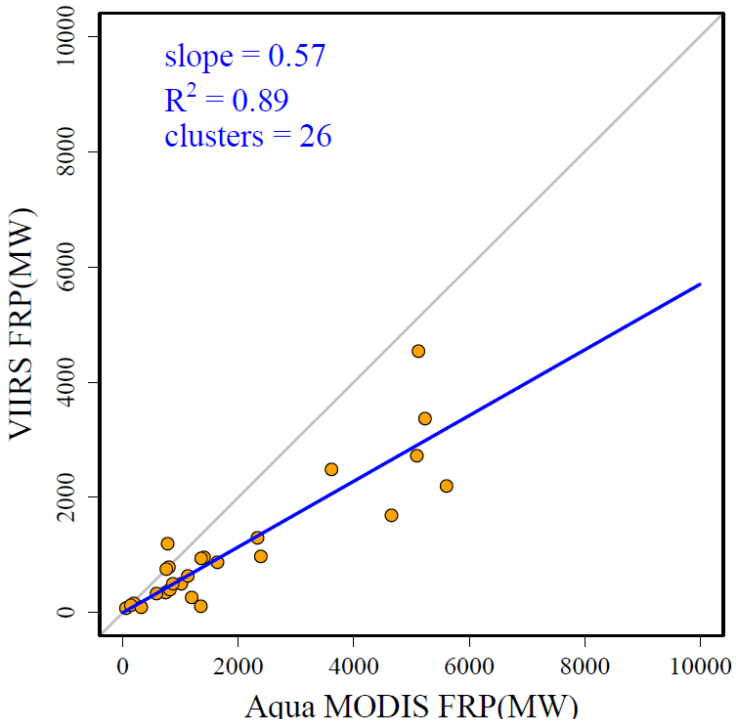


Fires from MODIS and VIIRS matched in individual fire events. Each fire event is considered as a cluster (total 301 fire events were selected)

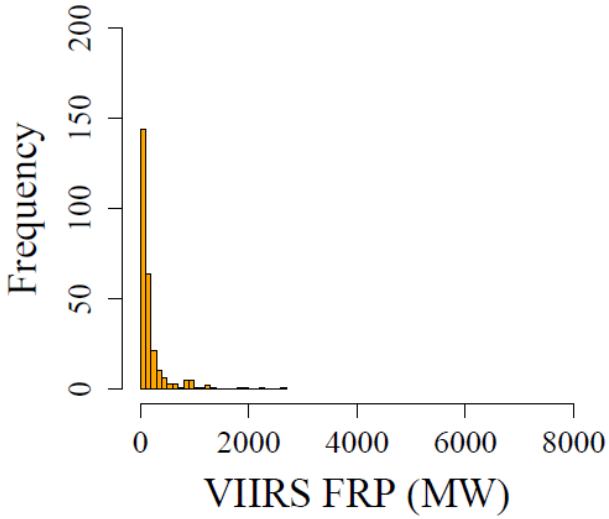
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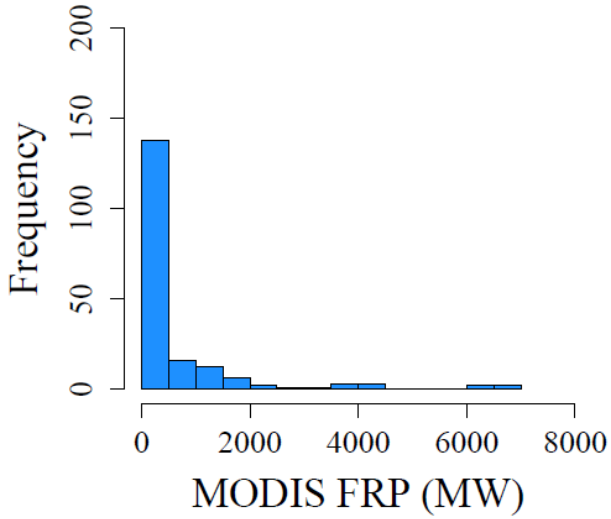


1/21/2017



Comparison of current Operational / systematically generated products

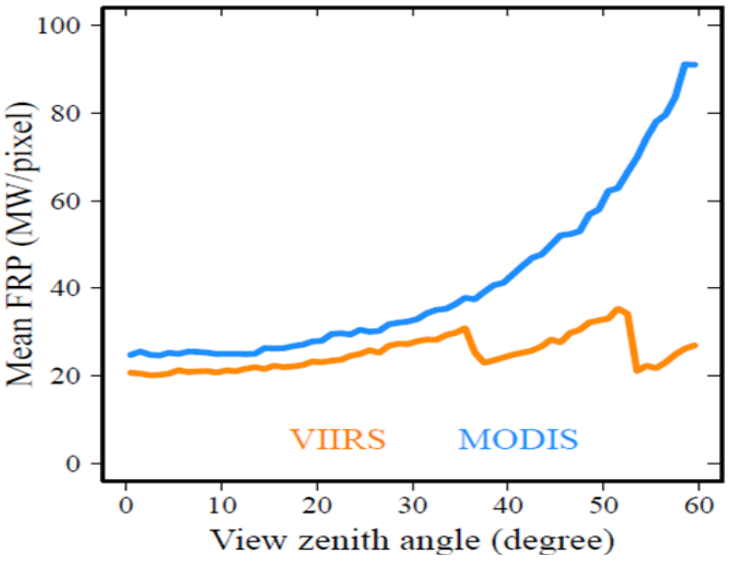


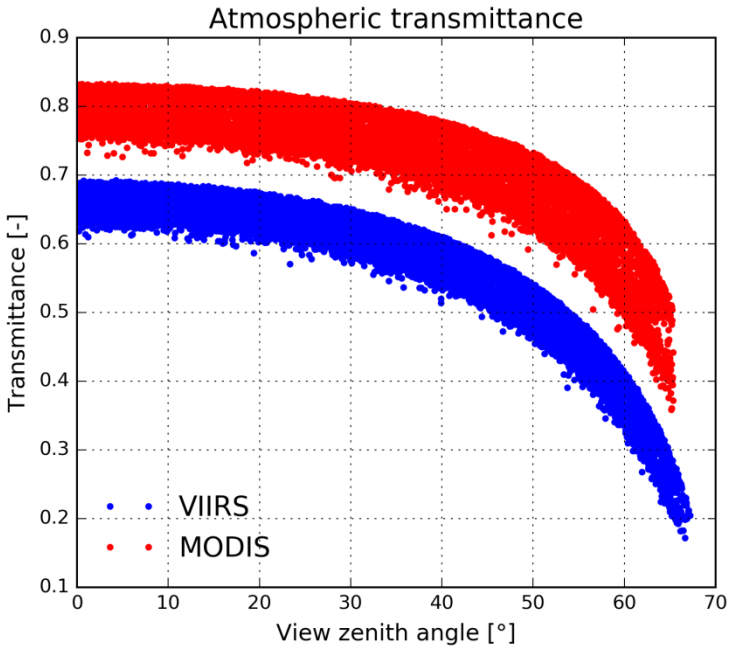


MODIS vs. VIIRS FRP considerations

- Differences in
  - Scanning geometry
    - Pixel size distribution
  - Handling of bow-tie effects
    - Duplicate detections
  - Pixel aggregation
    - Relative signal within pixel
  - Atmospheric transmittance
    - More CO_2 absorption in VIIRS M13

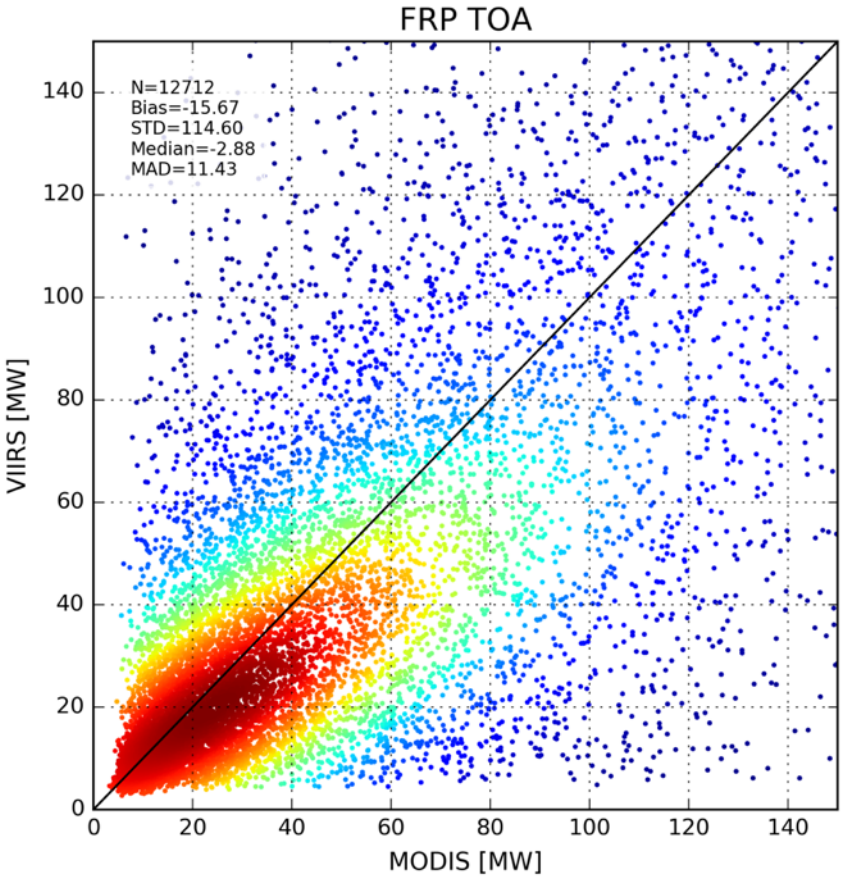
FRP is critical input for emission estimates!



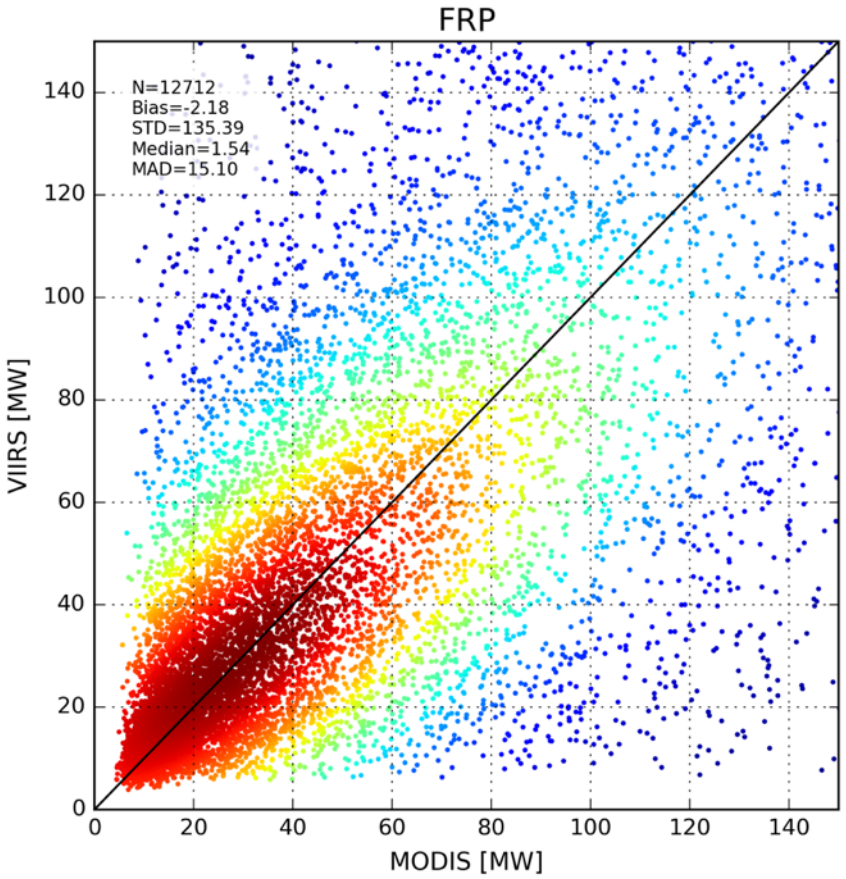


Cross-comparison of atmospherically corrected MODIS x VIIRS FRP Data

FRP retrievals corrected for atmospheric attenuation using MODTRAN + MERRA-2 (0.625º x 0.5º)

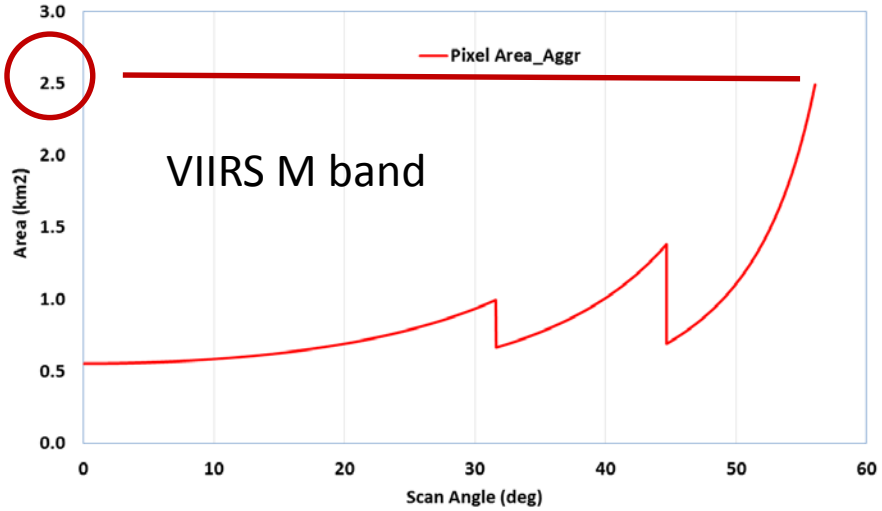


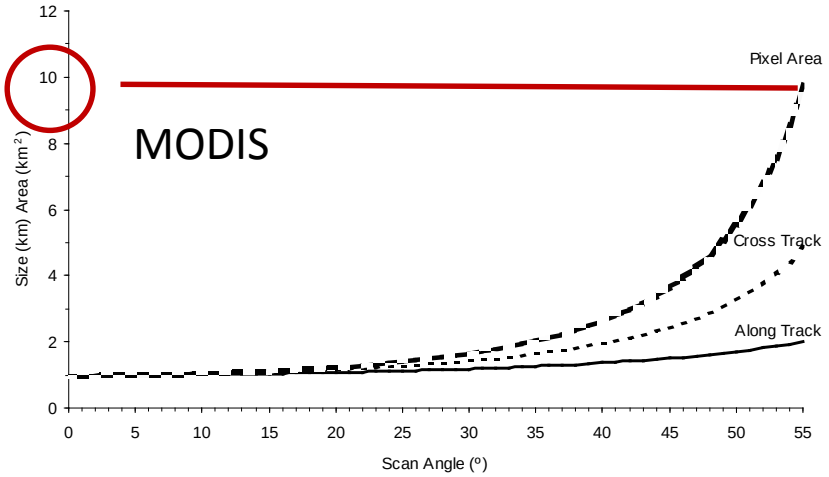
Before atmospheric correction



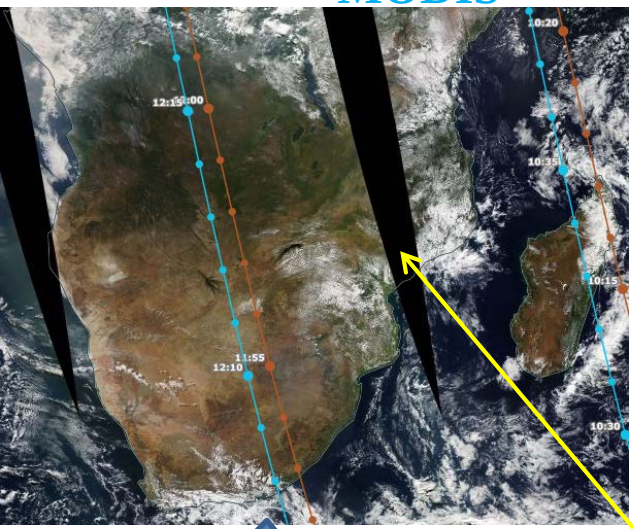
After atmospheric correction

VIIRS vs. MODIS pixel area and swath width

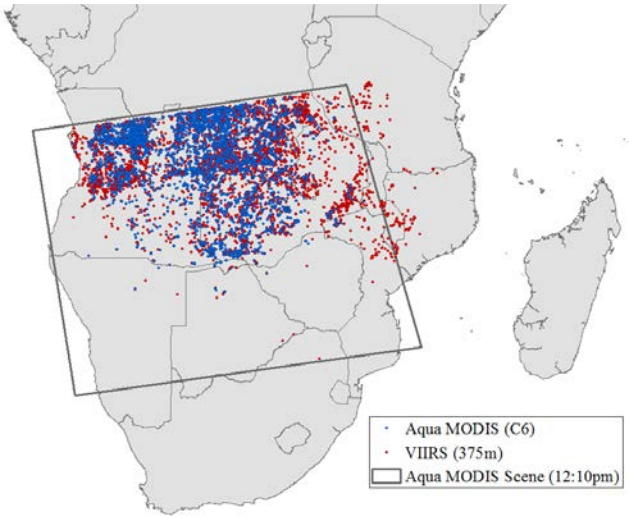




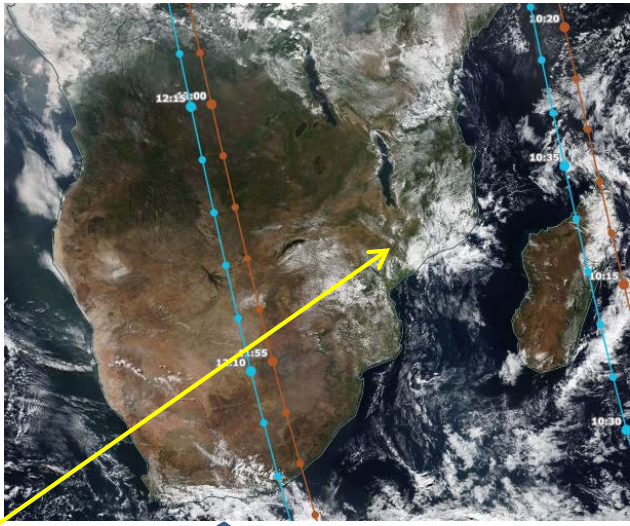
MODIS



June 3, 2016



VIIRS



1 km to 4 km

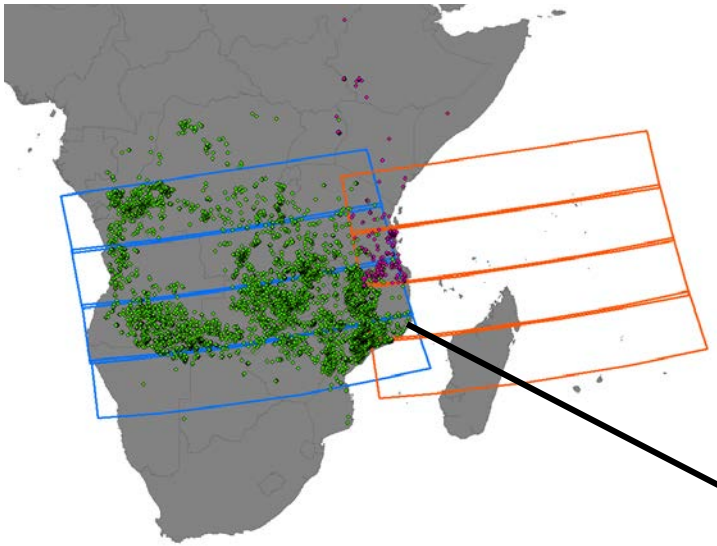
No VIIRS gaps at low latitudes!

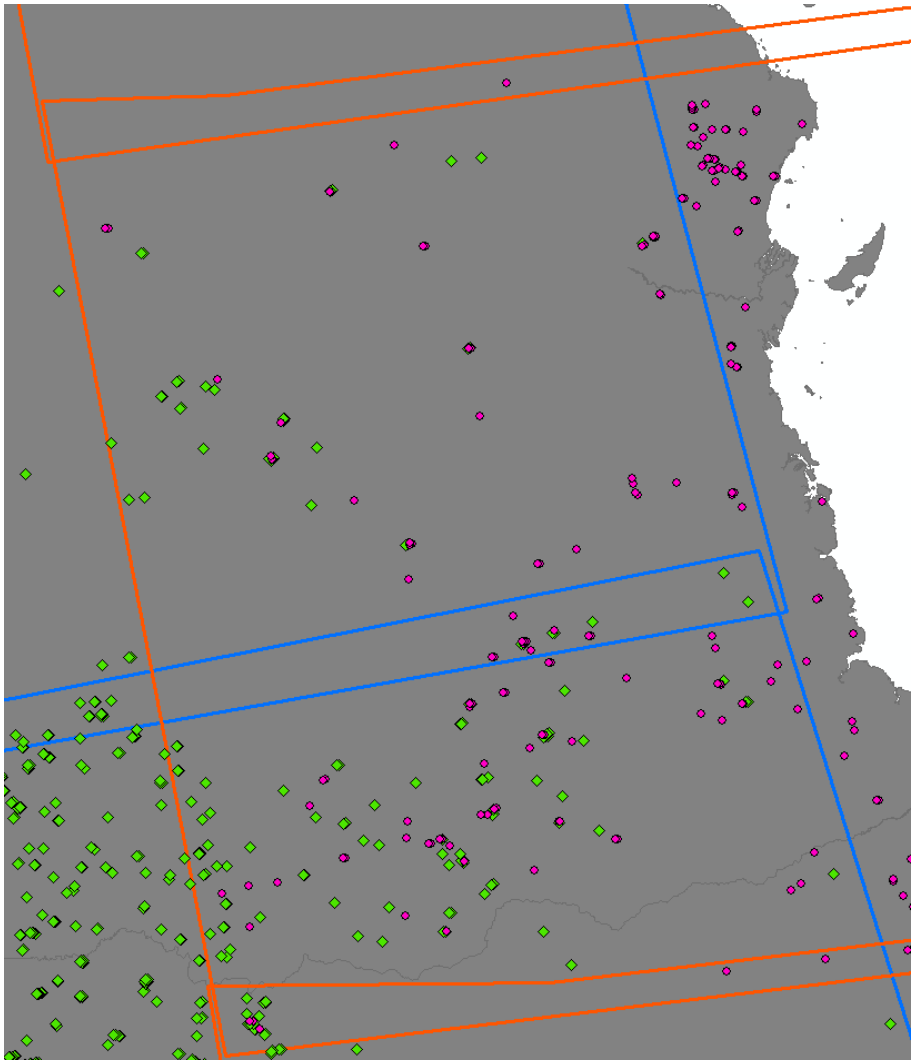
750 m to 1.2 km (M-band)

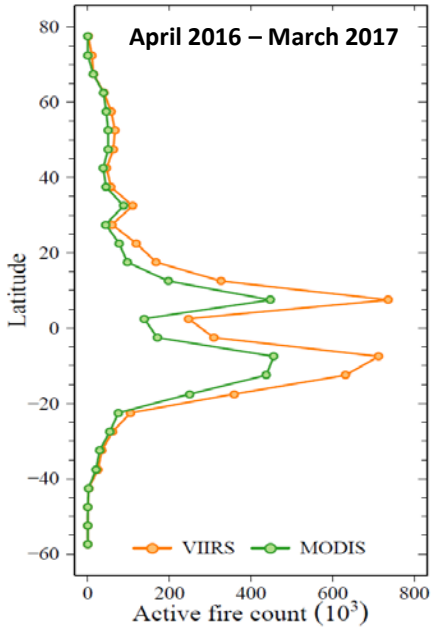
VIIRS vs. MODIS pixel area and swath width

Granules of two neighboring orbit tracks

(blue: 11:48-11:53am, orange: 10:09-10:12am)





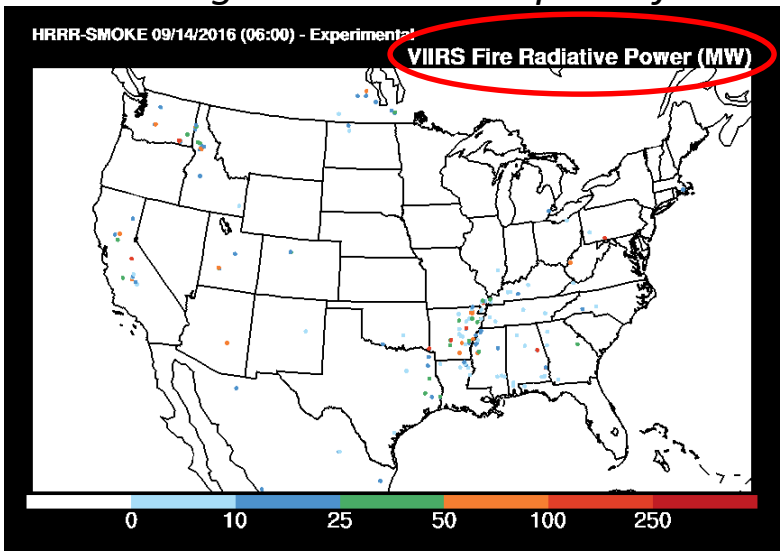


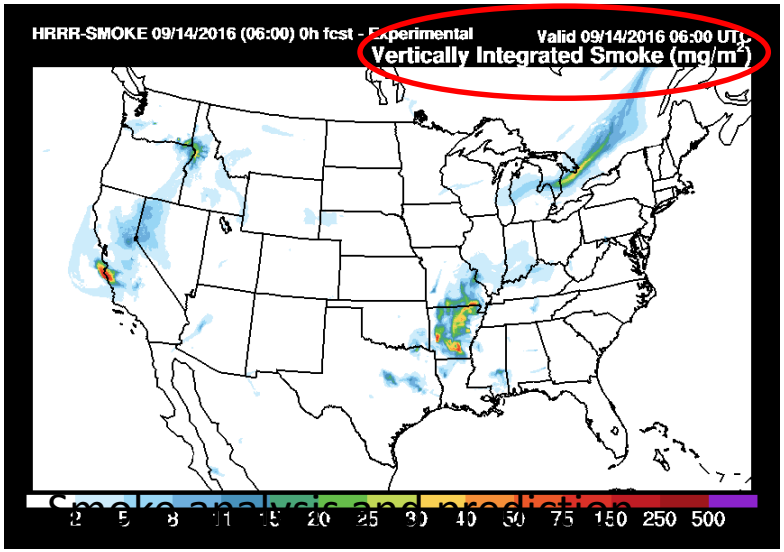
Significantly more VIIRS 750m detections at low latitudes

Good quality VIIRS observations at low latitudes from consecutive orbits!

Examples of real-time fire and smoke monitoring systems using VIIRS active fire data

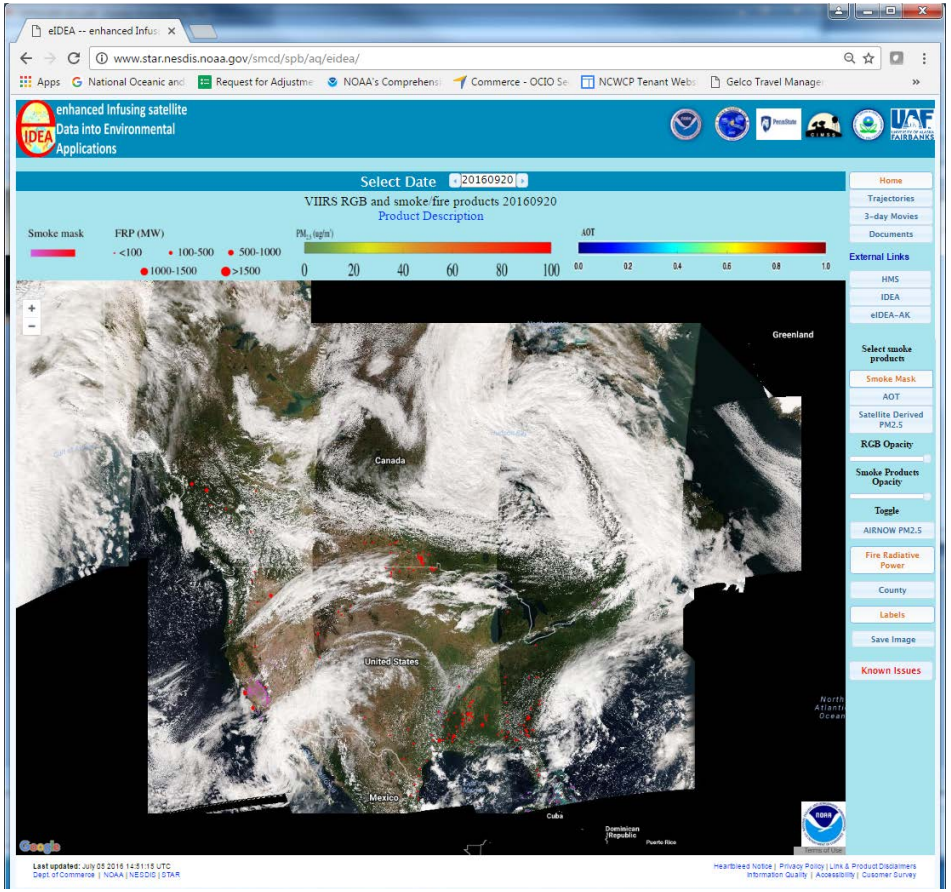
HRRR: High Resolution Rapid Refresh





https://rapidrefresh.noaa.gov/HRRRsmoke

eIDEA: enhanced Infusing satellite Data into Environmental Applications



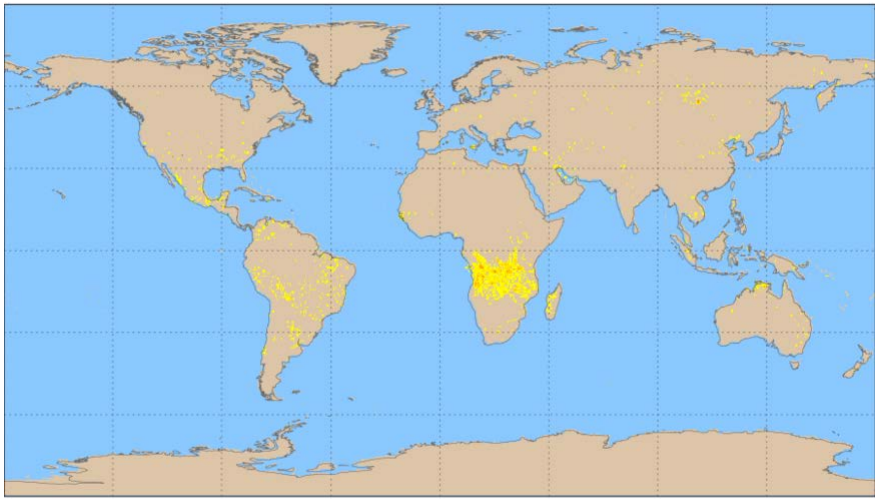
https://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea/
https://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea-ak/

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



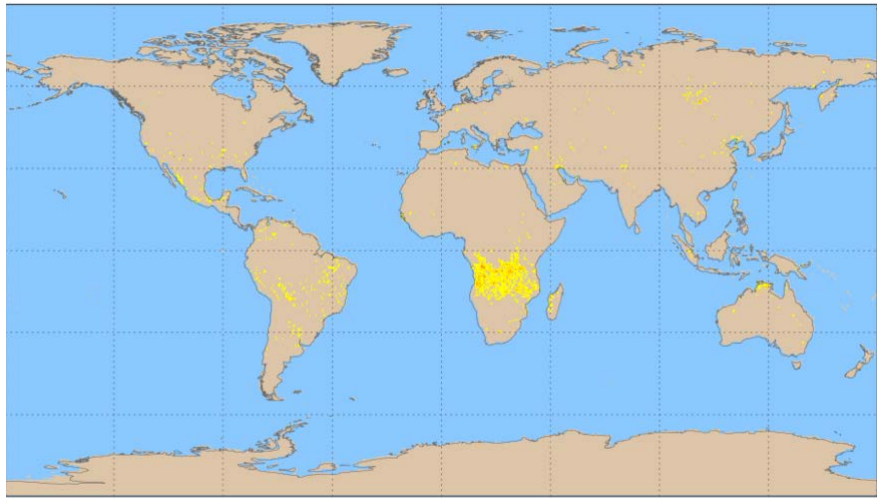
0 10 20 30 40 50 60 70 80 90 100

Fire Frequency

NOAA/NESDIS/STAR

Suomi NPP - VIIRS - IDPS - Active Fires

16 Jun 2016



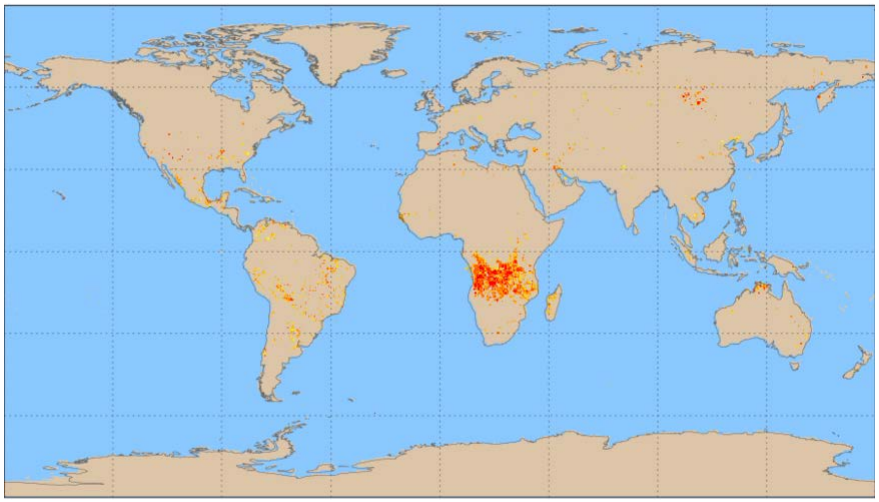
0 10 20 30 40 50 60 70 80 90 100

Fire Frequency

NOAA/NESDIS/STAR

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

16 Jun 2016



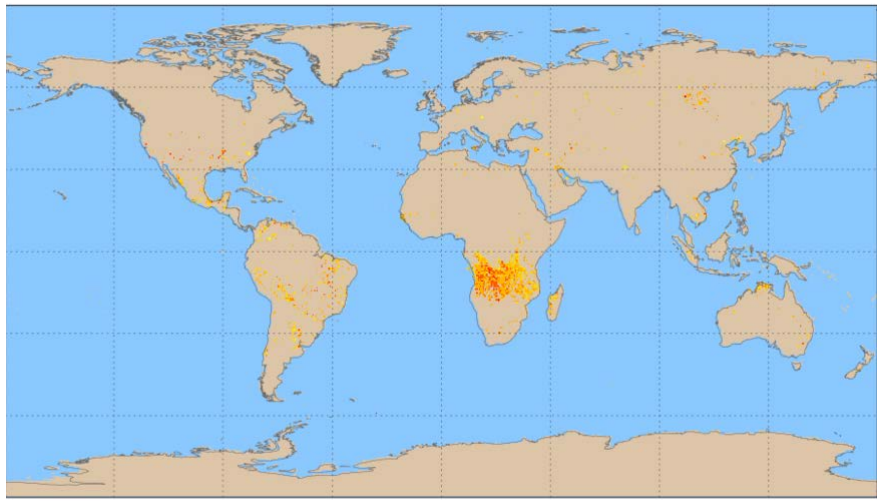
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5

$\log_{10}$ (Megawatts)

NOAA/NESDIS/STAR

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

16 Jun 2016

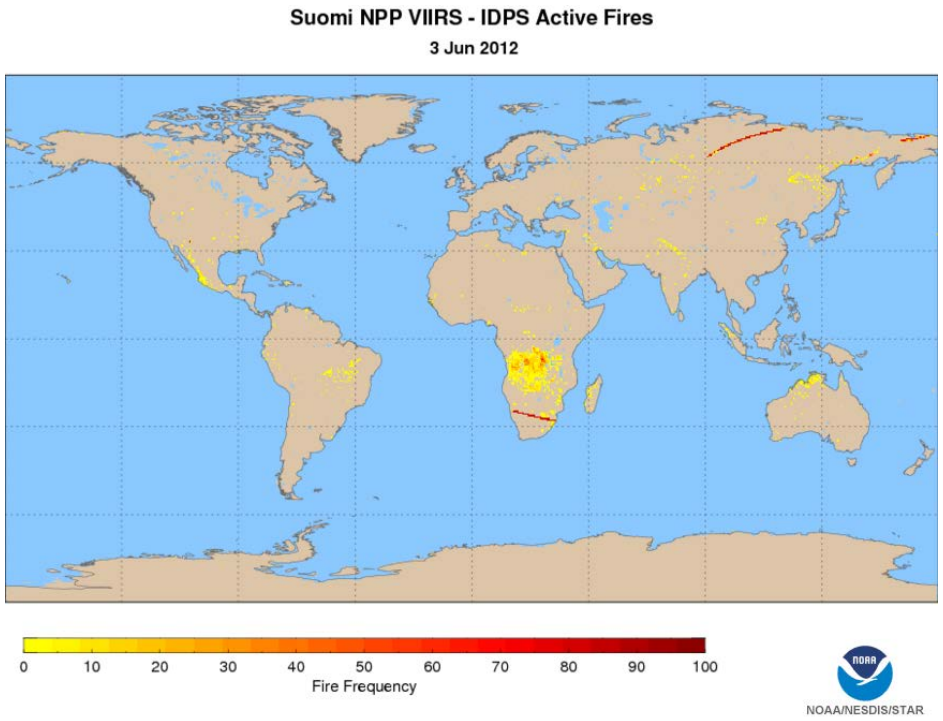


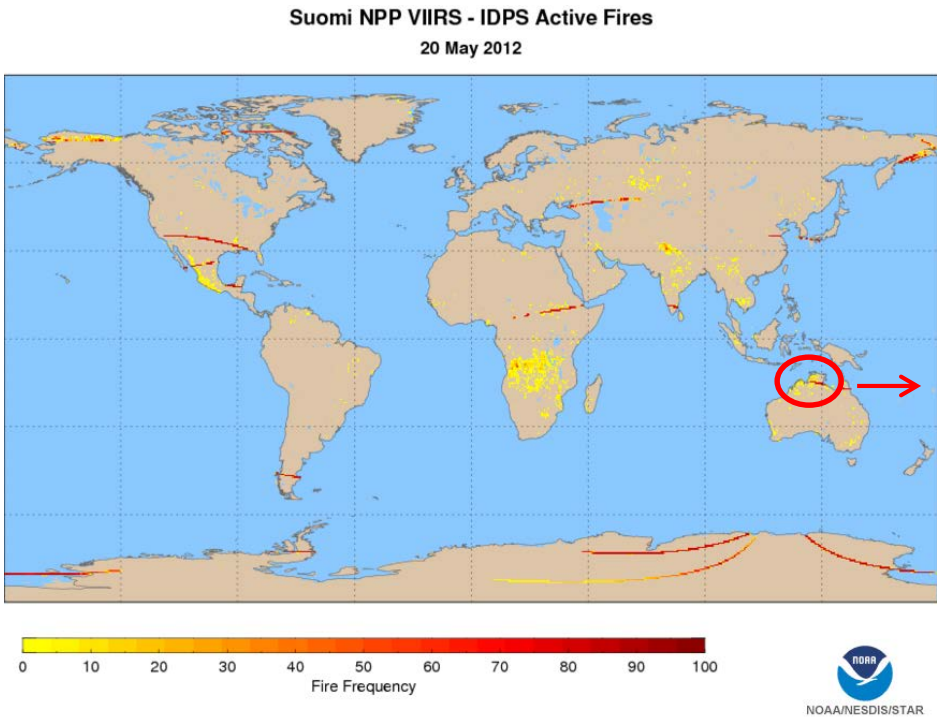
0.0 0.50 1.0 1.5 2.0 2.5

$\log_{10}$ (Megawatts)

NOAA/NESDIS/STAR

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



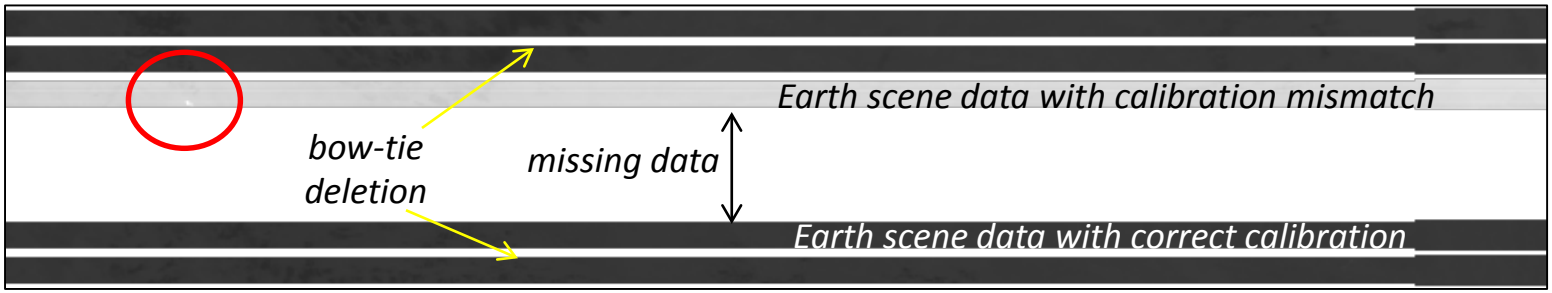


Examples of the first operational real-time IDPS product as archived in NOAA CLASS (http://www.class.ncdc.noaa.gov/).

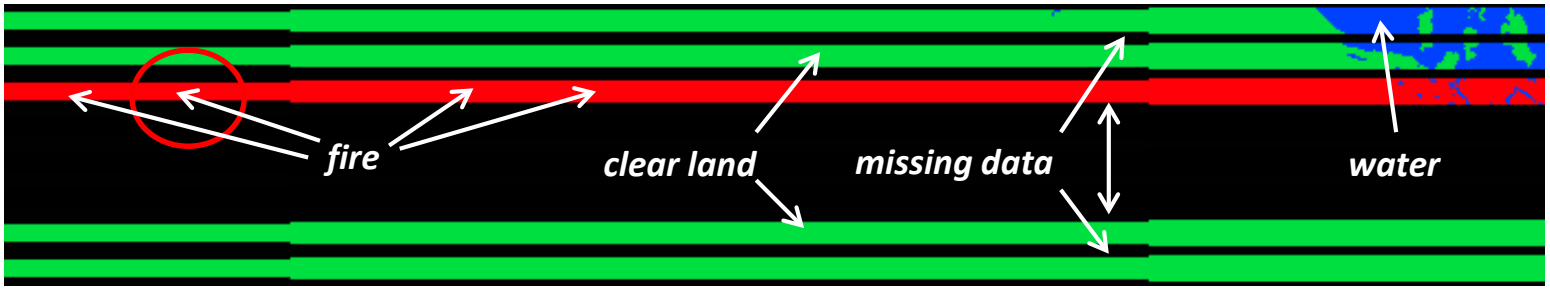
Not reprocessed; not to be used for science analysis. Reprocessing is ongoing.

Missing data packets / calibration mismatch

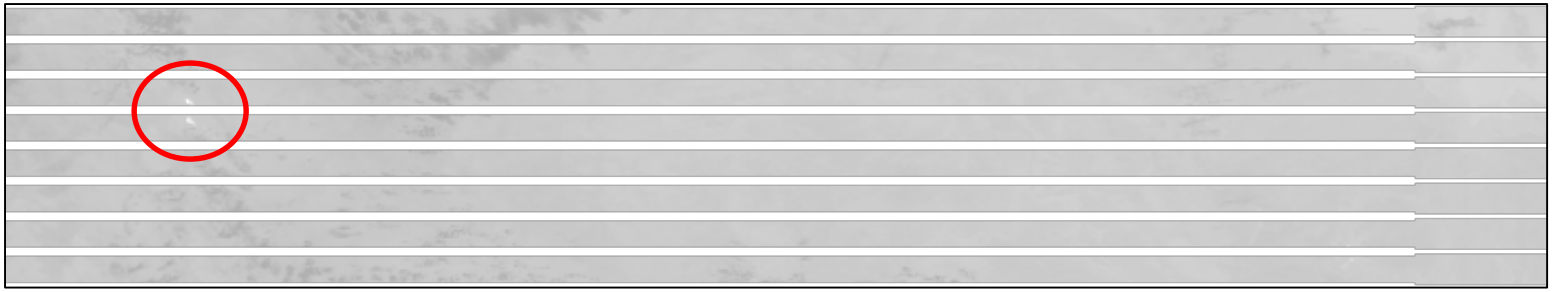
npp_d20120520_t1533555_e1535197



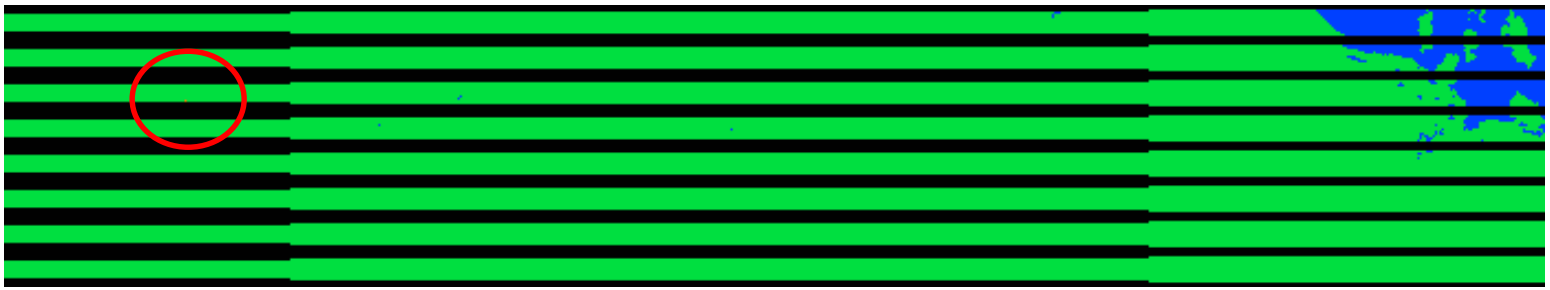
original
real-time
IDPS M13 SDR



NDE fire mask*



reprocessed
M13 SDR



NDE fire mask *

*including on ground bow-tie deletion

Summary

- Operational NDE production with a mature 750m algorithms is now ongoing
  - Some changes forthcoming
- Near-real-time product and distribution enables regional applications
- Algorithms incorporated into major direct broadcast packages
  - IPOPP and CSPP
- Extensive outreach, resulting in critical operational applications
  - e.g. coupled with air quality / smoke monitoring and modeling
  - Weather / fire
- Reprocessing of the data record with highest quality input and most mature algorithms is ongoing
  - Not only eliminates spurious detections, but also enables the detection of previously missed fires