S-NPP/VIIRS and Landsat-8/OLI Global Active Fire Data Sets

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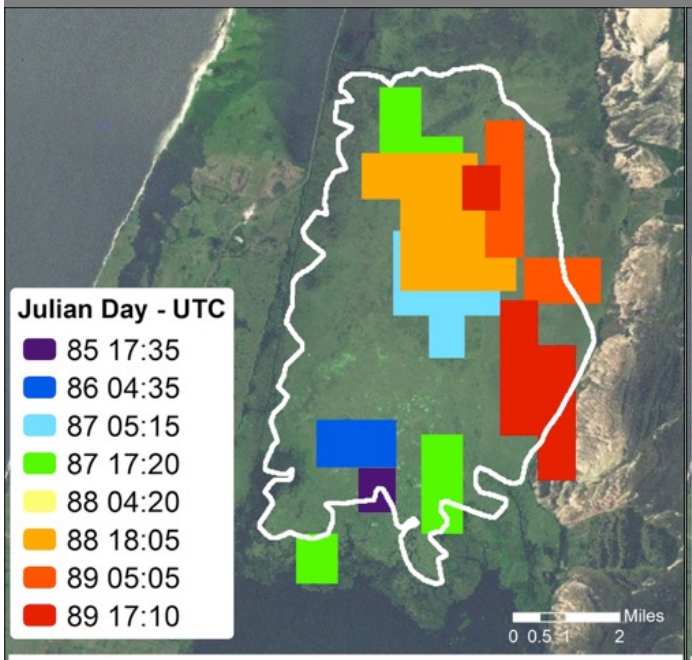
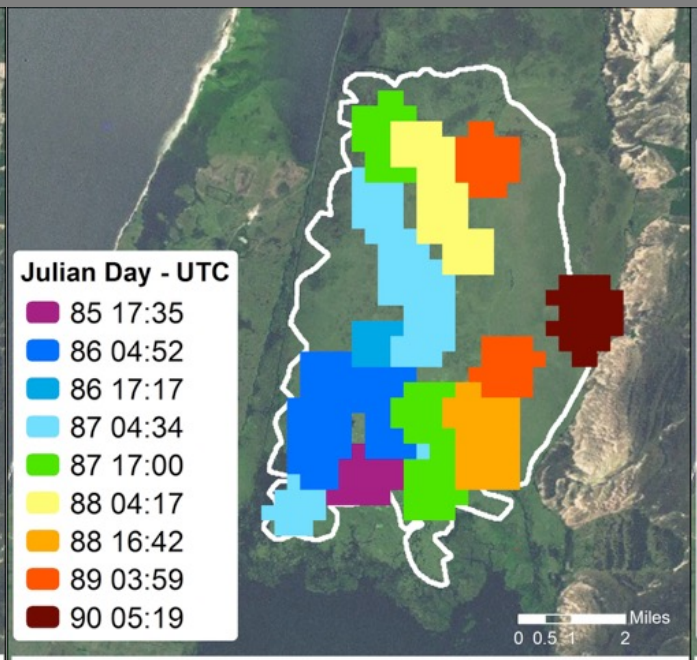
MODIS 1 km × VIIRS 750 m × VIIRS 375 m Fire Data Intercomparison



Aqua/MODIS 1 km

Pixel Area
1<>10 km^2

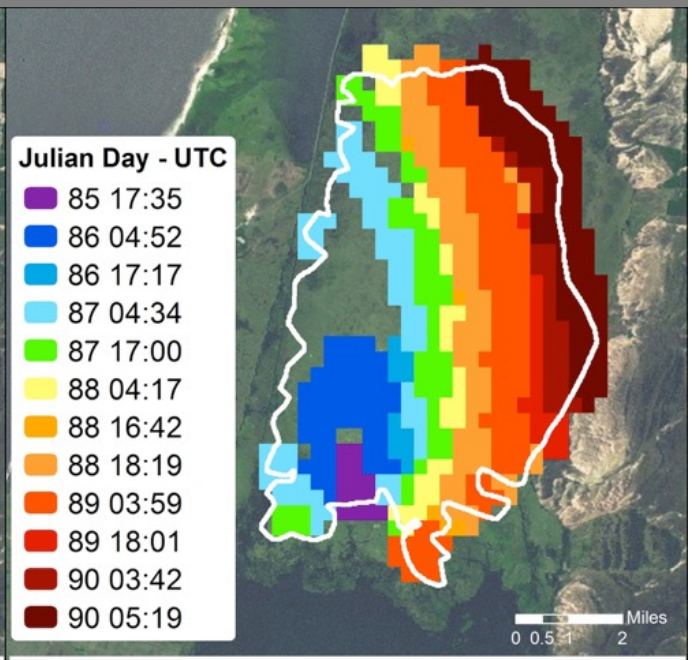
Image Swath
2330 km



NPP/VIIRS 750 m

Pixel Area
0.56<>2.5 km^2

Image Swath
3000 km

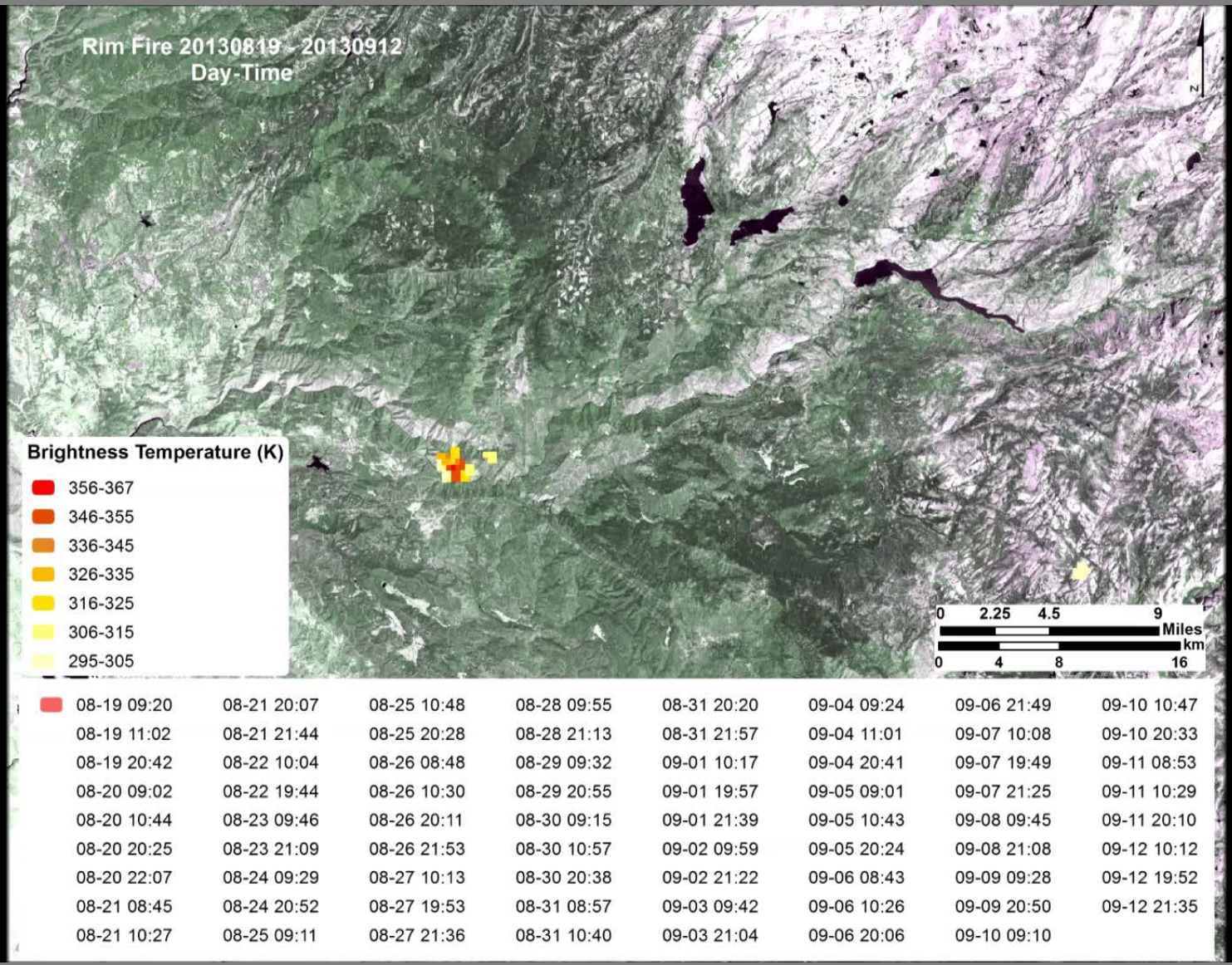


NPP/VIIRS 375 m

Pixel Area
0.14<>0.625 km^2

Image Swath
3000 km

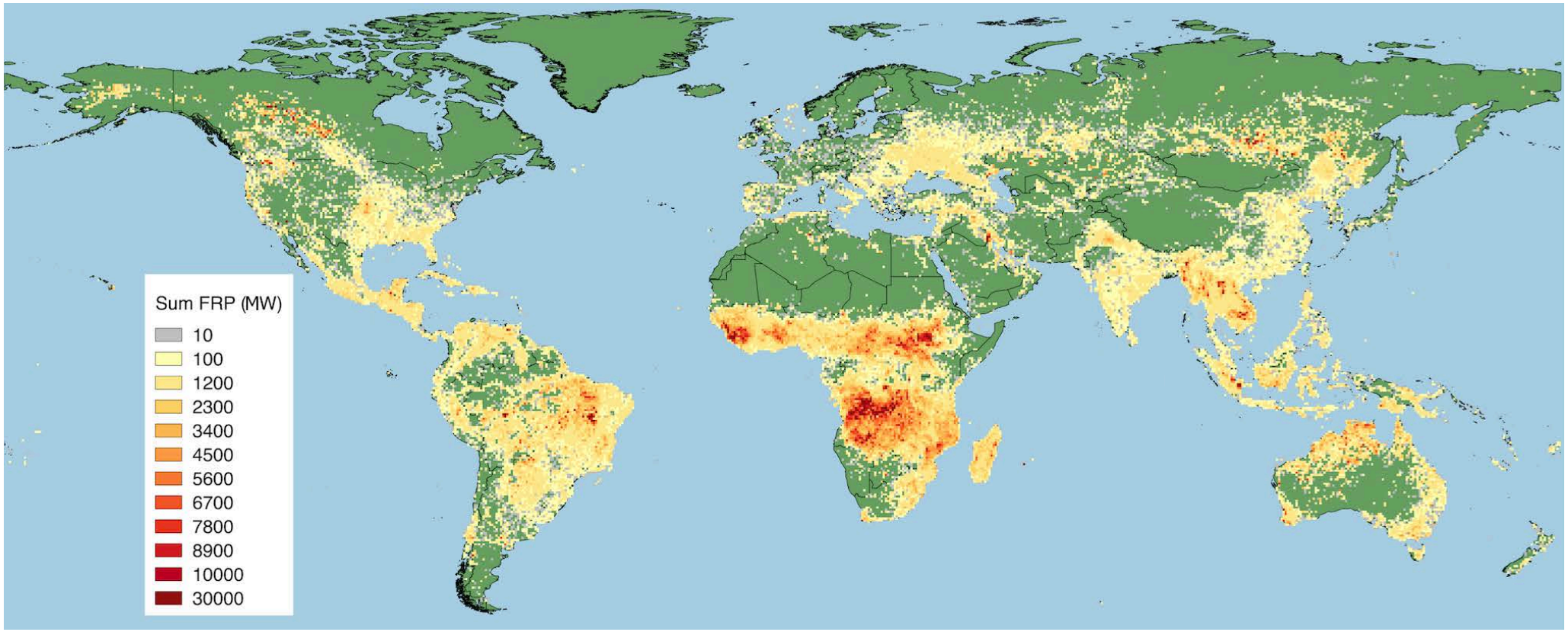
Routine GIS Mapping of Rim Fire, CA 2013 Using Reprojected VIIRS 375 m ≈12h Data



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



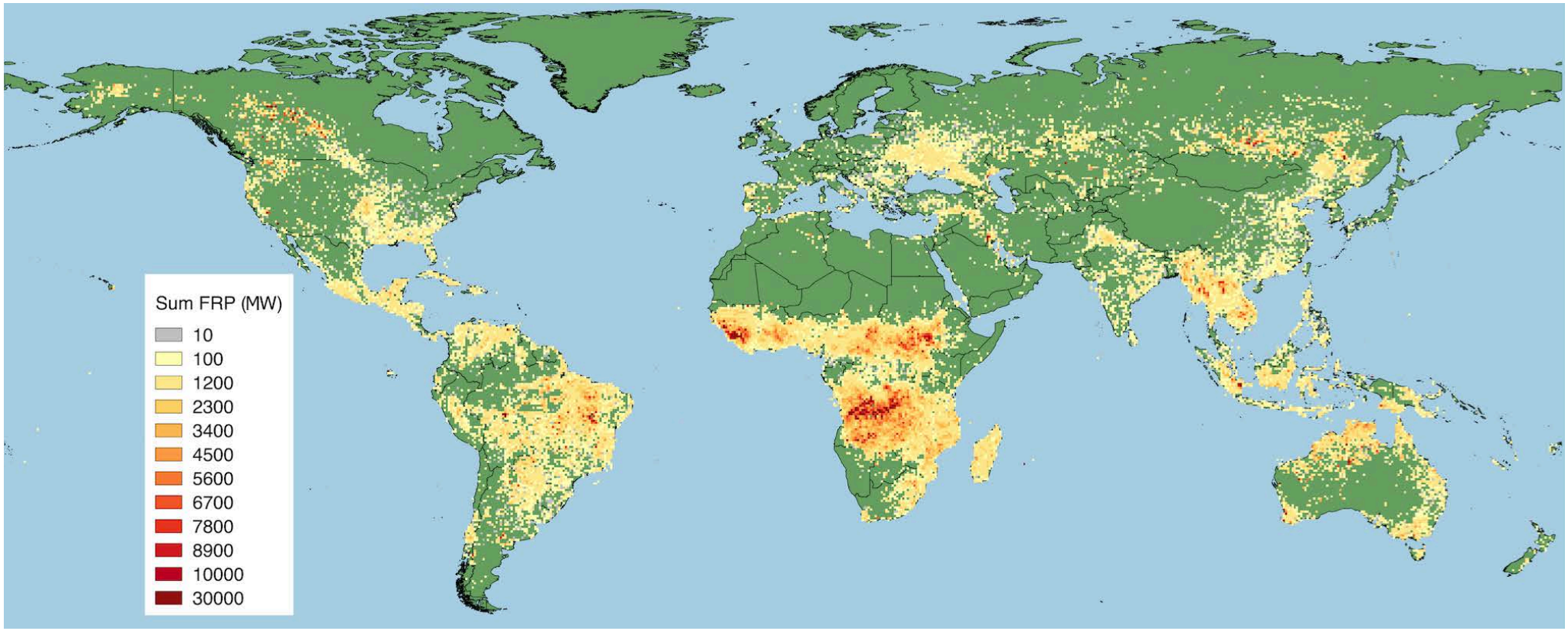
Frequent saturation prevents FRP retrieval using 375 m mid-IR data

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)

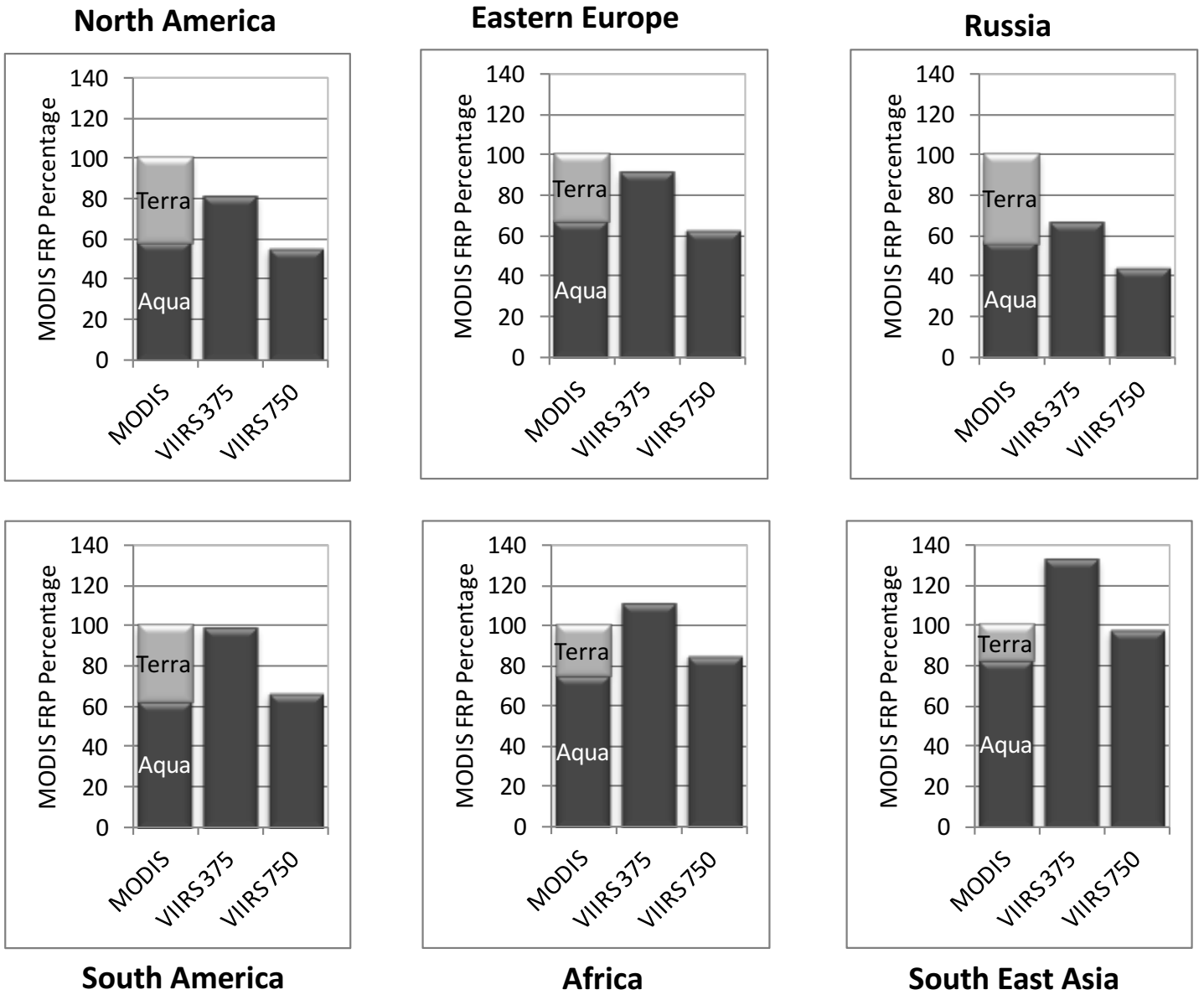
Sum of top-of-atmosphere (TOA) FRP over sampling period using 0.5^{o} grid



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 VIIRS 750 m x MODIS 1km TOA Fire Radiative Power (FRP)



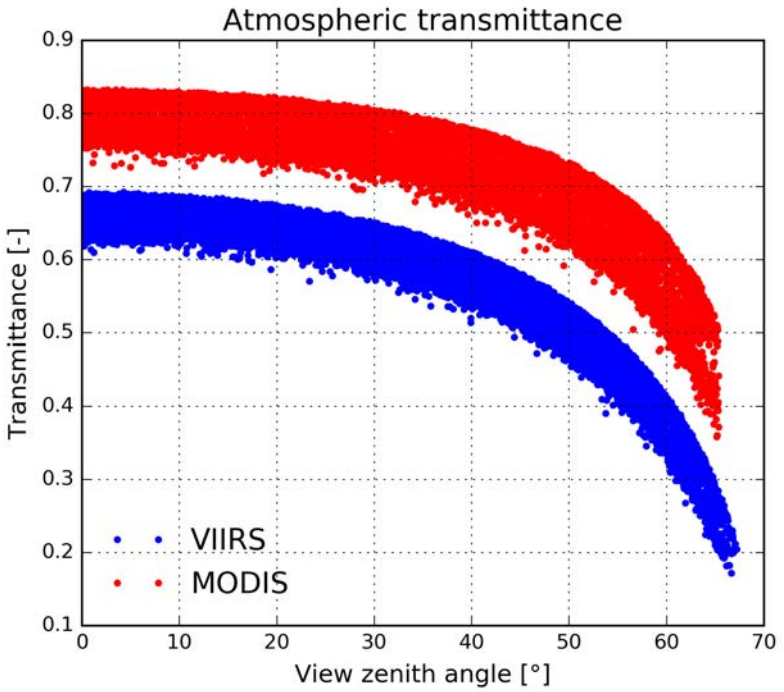
45% of daytime and 80% of nighttime VIIRS fire pixels have no match in Aqua/MODIS fire data

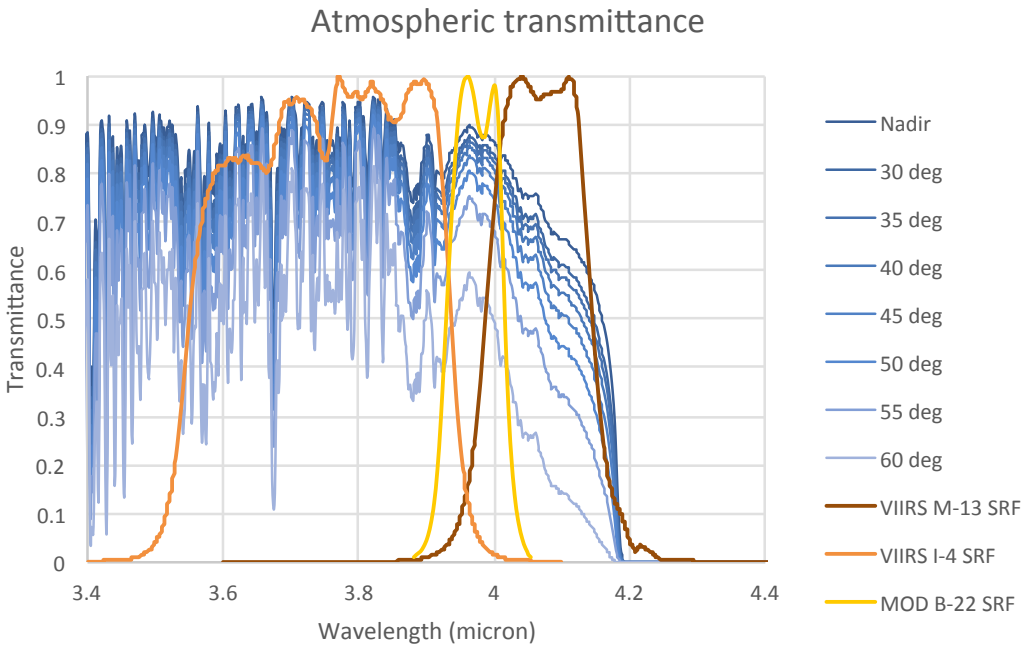
VIIRS systematically detects more fires than same-day MODIS (Terra & Aqua) in areas dominated by small/low-intensity fires

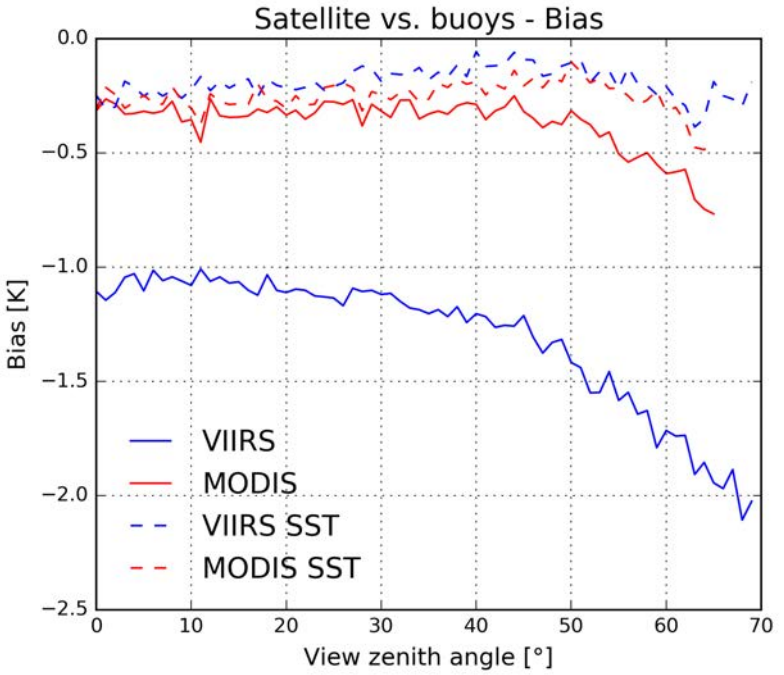
FRP Data Considerations

- Majority of VIIRS bowtie pixels are deleted onboard the spacecraft prior to data downlink. MODIS bowtie pixels are still present in Level 2 data resulting in potential double counting at far-off nadir angles

- VIIRS mid-IR band overlaps with CO_2 absorption band causing FRP underestimation
  - Provisions added to Level 2 data to facilitate atmospheric correction implementation

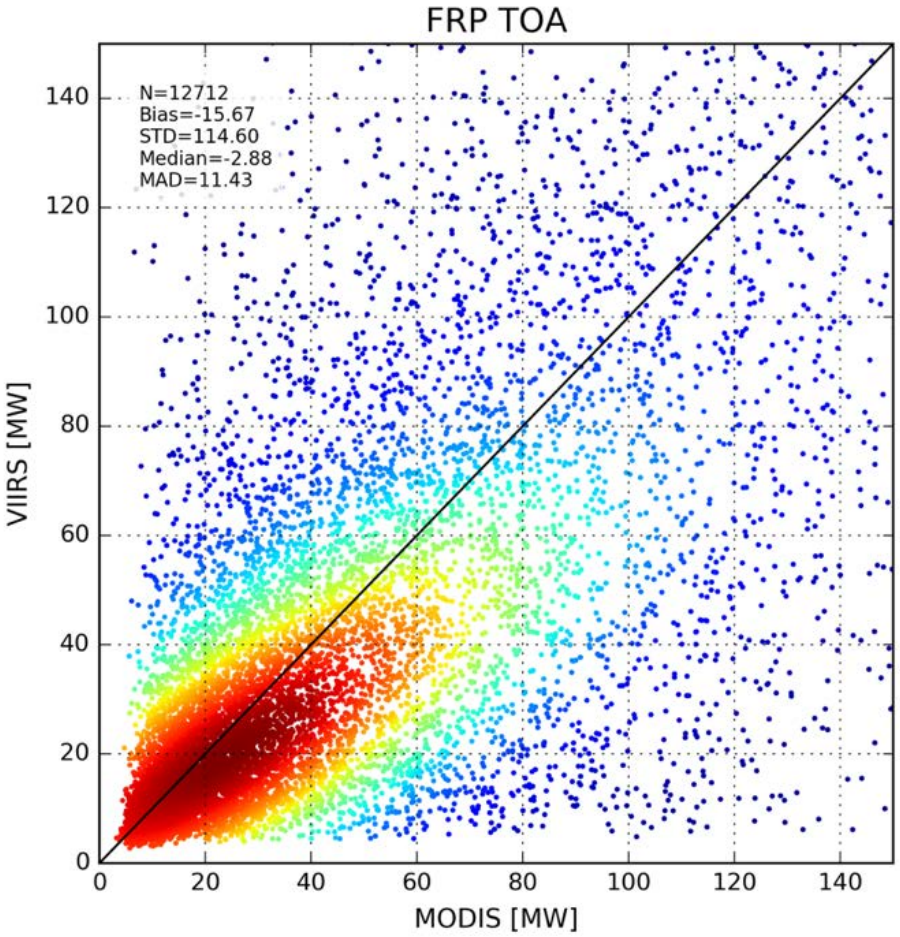




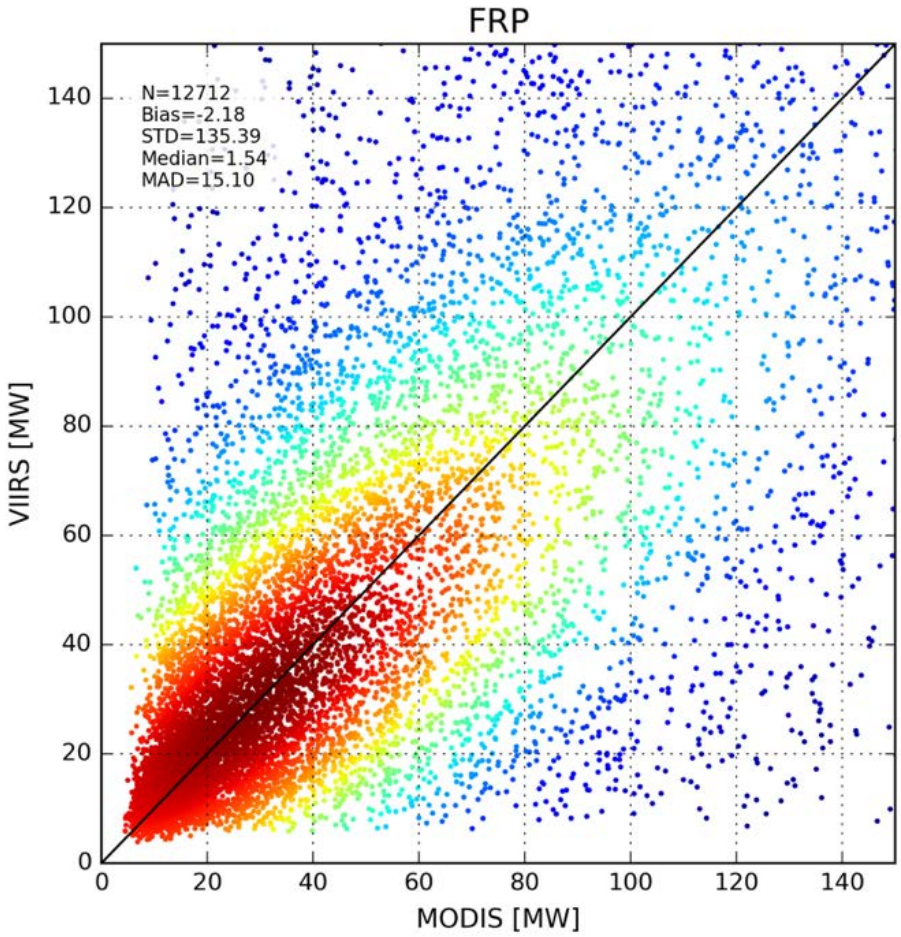


Cross-Validation of MODIS x VIIRS FRP Data

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

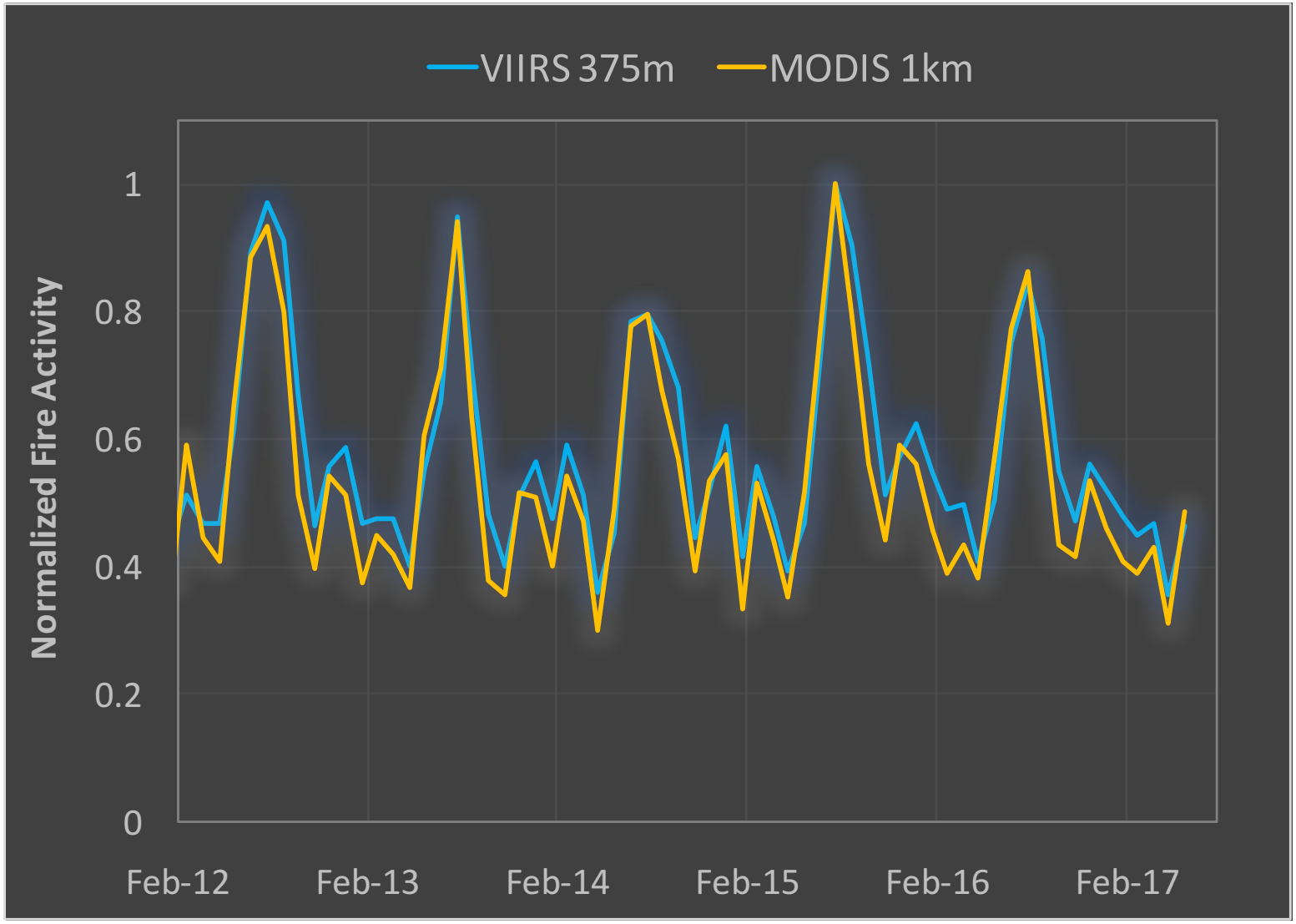


Before atmospheric correction

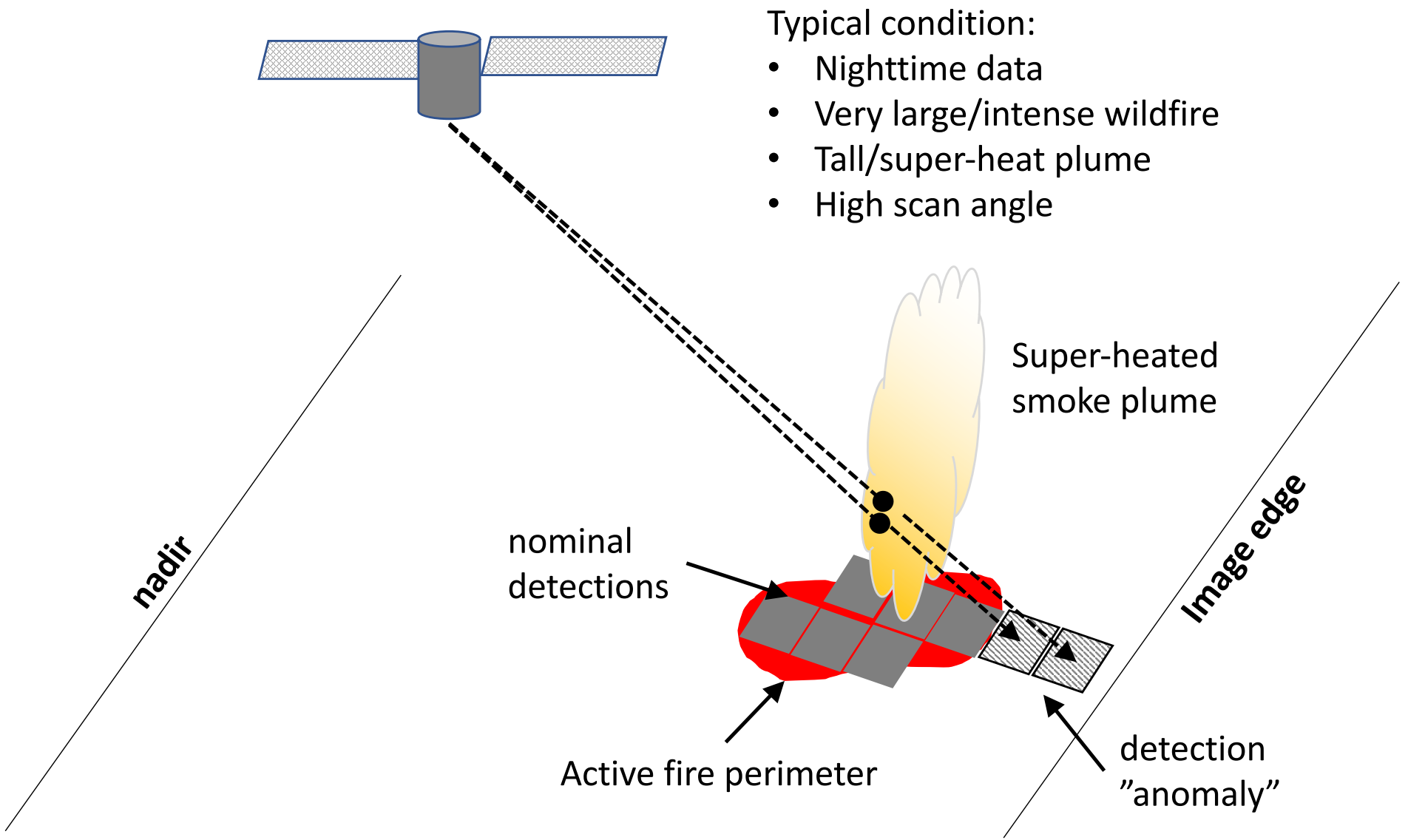


After atmospheric correction

S-NPP/VIIRS 375 m x Aqua/MODIS 1km
5-Year Normalized Fire Activity Comparison (pixel counts)



Data ”Anomalies” Associated with Large Wildfires



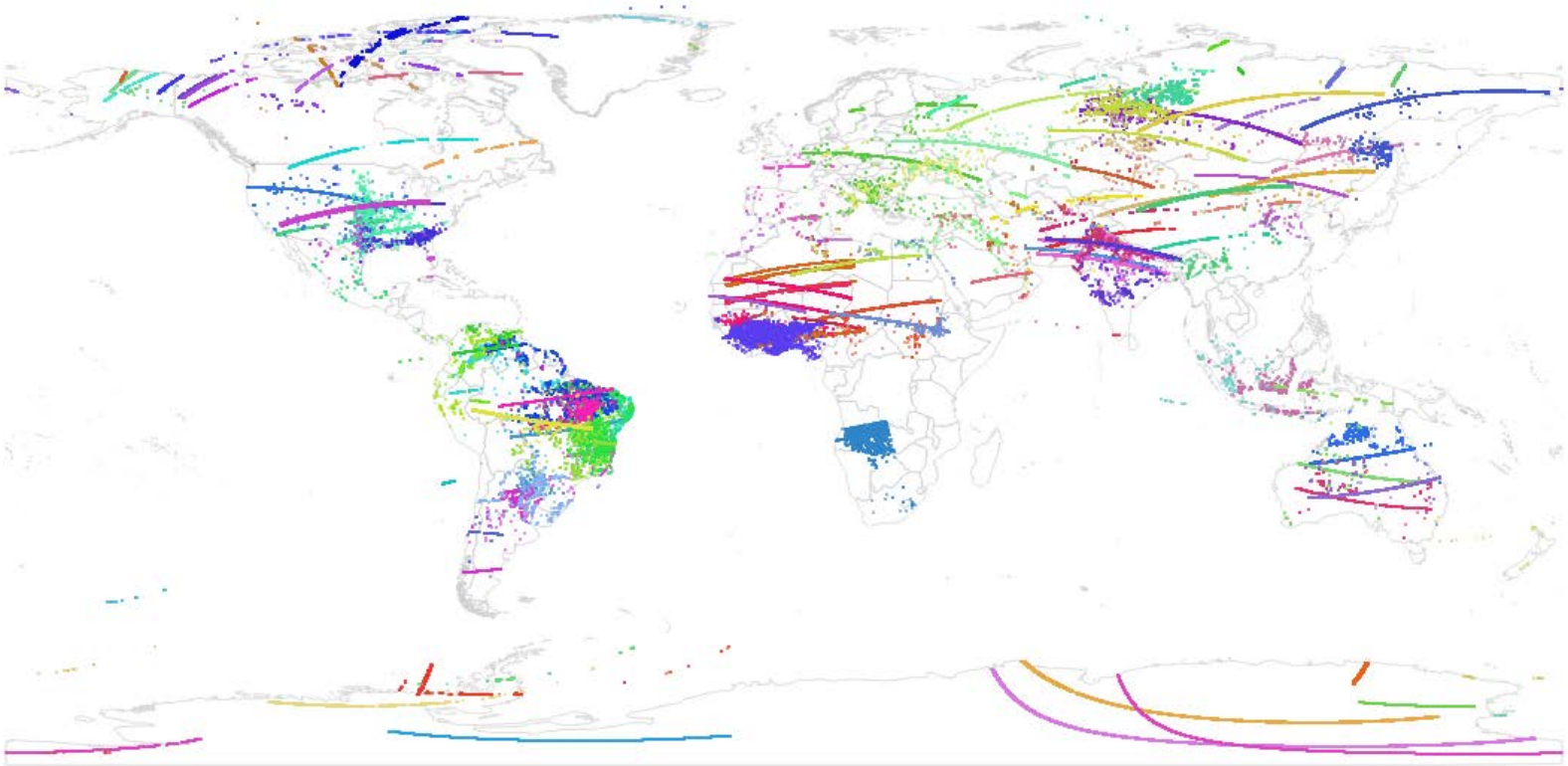
Current Data Status

VIIRS 375m Fire Product (VNP14IMG)

- Data reprocessing at NASA was completed during the summer
  - Time series : 19* Jan/2012 -> until present
  - Sensor was “warming up” during the first 24h (19 Jan 2012) causing artifacts in fire product
  - Effective/usable record starts 20 Jan 2012
  - Sporadic granules (~650 over 5 years) have been found to contain bad fire data due to corrupted L1B inputs. Those granules will be removed from public access
  - Data will be made available through public ftp at NASA
  - Level 2 (swath) data files use NetCDF4/HDF5 format
    - New mandate from NASA program office
    - Fire mask, FRP, etc. similar to MODIS *Fire and Thermal Anomalies* product

Current Data Status

VIIRS 375m Fire Product (VNP14IMG)



Granules containing spurious fires:
2012: 77
2013: 15
2014: 15
2015: 2
Total: 190

Granules containing corrupted data:
2012: 290
2013: 65
2014: 101
2015: 7
Total: 463

Current Data Status

VIIRS 375m Fire Product (VNP14IMG)

- Data have been made available in near real-time since late 2015 through NASA LANCE/FIRMS
  - FRP retrievals entered operations in early 2017
  - Data visualization and access points:

https://worldview.earthdata.nasa.gov/

https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data

- Simplified ASCII files (similar to MCD14ML format) available at:

  ftp fuoco.geog.umd.edu
  user: fire
  pswd: burnt
  directory: /VIIRS/VNP14IMGML/

- NASA direct readout data processing package (IPOPP) running slightly outdated version of algorithm. Latest version should be incorporated very soon

Current Data Status

VIIRS 750m Fire Product (VNP14)

- Data are currently being reprocessed at NASA
  - Expected to be completed soon
  - Also using NetCDF4/HDF5 format
  - Data to be made available through https://lpdaac.usgs.gov/

- Data are not available through NASA LANCE/FIRMS
  - Near real-time processing priority is being assigned to 375m product
- Alternative near real-time access available through NOAA:
  ftp://satepsanone.nesdis.noaa.gov/FIRE/VIIRS/
  OR
  ftp://ftp-npp.class.ngdc.noaa.gov/
  Select:
  Date -> NDE-L2 -> VIIRS-Active-Fire-EDR-NOAA-Enterprise-Algorithm -> NPP

- NASA direct readout data processing package (IPOPP) has the latest version of algorithm

Future Developments

- VIIRS Fire algorithm refinement should continue
  - Reduce omission in cold ambient conditions and along Sunglint zone
  - Minimize impact of hot/tall plume detection over large/intense wildfires
  - Better separate biomass burning from industrial sources

- JPSS-1 to be launched 10 November 2017!!
  - Carrying the second VIIRS instrument
  - Nominally identical sensor characteristics
  - Similar afternoon orbit
    - 30min separation from S-NPP, phased 180^{o} (more frequent near-nadir viewing)

Landsat-class Active Fire Detection Data

Approach:
No fire-science mid-IR data available
NIR+SWIR ratio/differencing approach (saturation/folding artifacts)

Pros:
>150x more information per unit area than VIIRS 375 m
>1000x more information per unit area than MODIS 1km

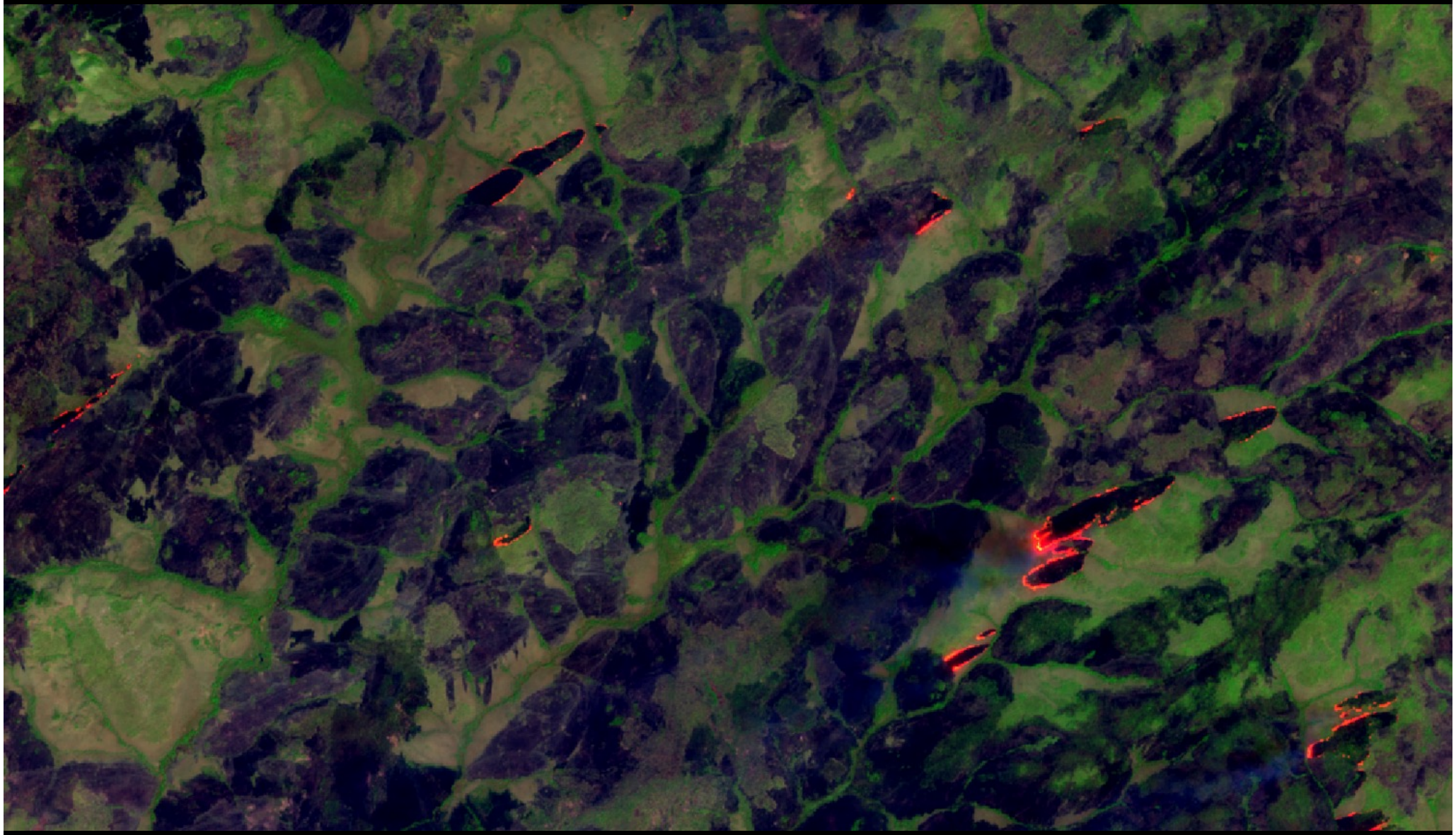
Cons:
Limited coverage/infrequent data

Potential:
Launch of similar sensors increasing data availability

- Landsat-8, Sentinel-2A/2B, Landsat-9

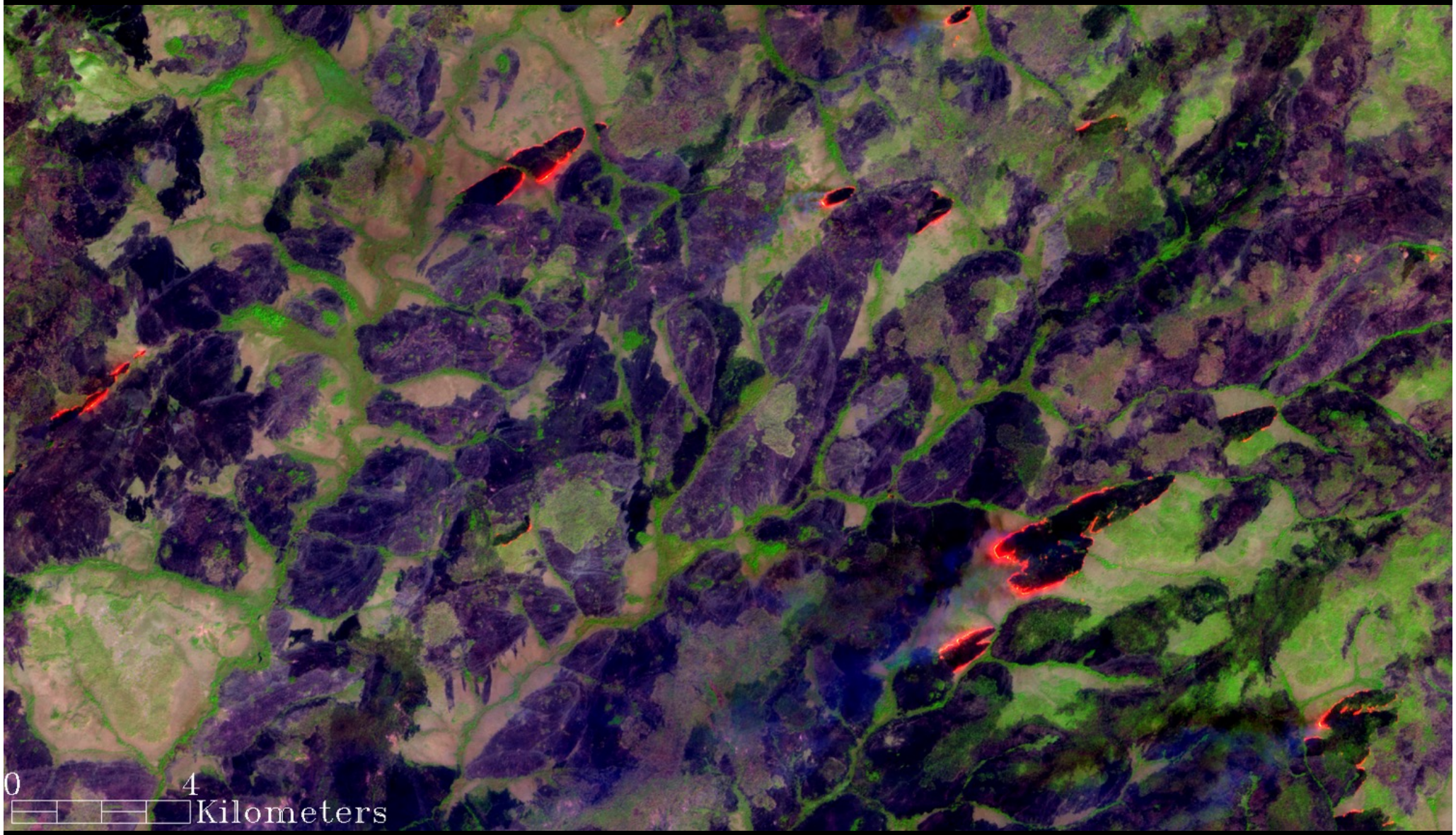
Near real-time data processing/distribution being explored
Community can/will have a major role defining the future of Landsat-class data applications

Landsat-8 + Sentinel-2A



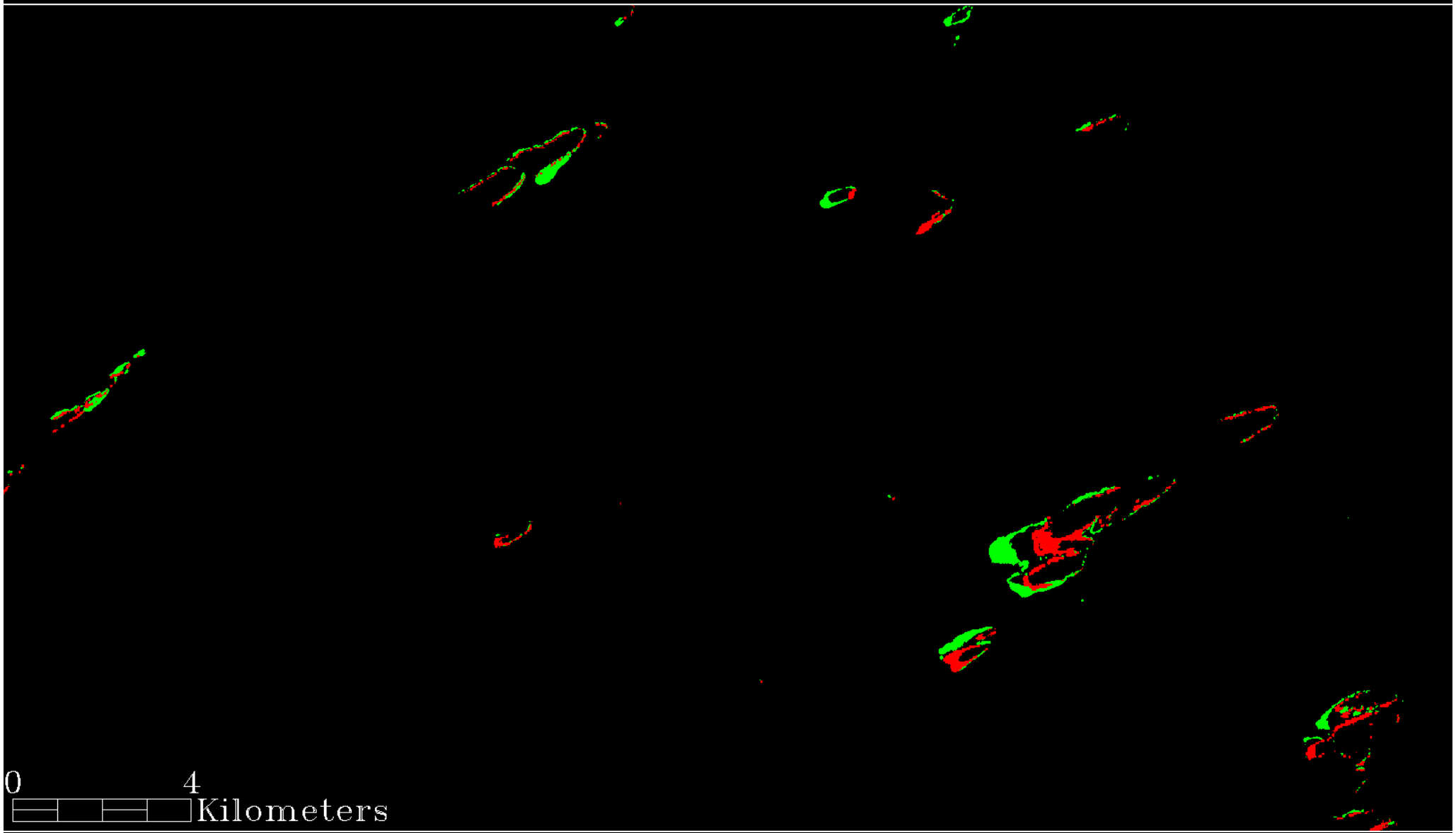
Landsat-8 (30 m)

Landsat-8 + Sentinel-2A



ESA/Sentinel-2A (20 m)
16 min later

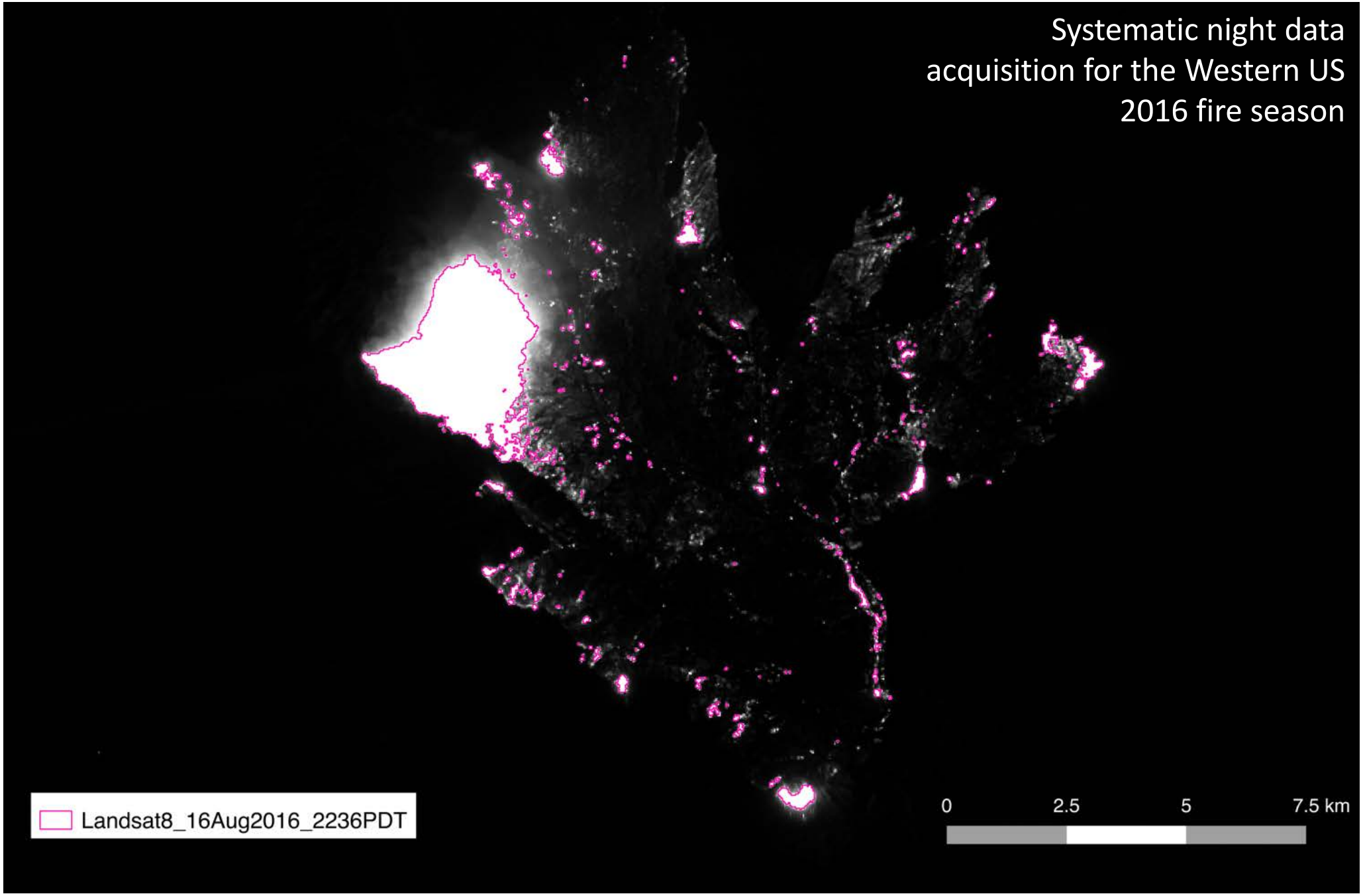
Landsat-8 + Sentinel-2A



Landsat-8 fire mask: red
Sentinel-2A fire mask: green

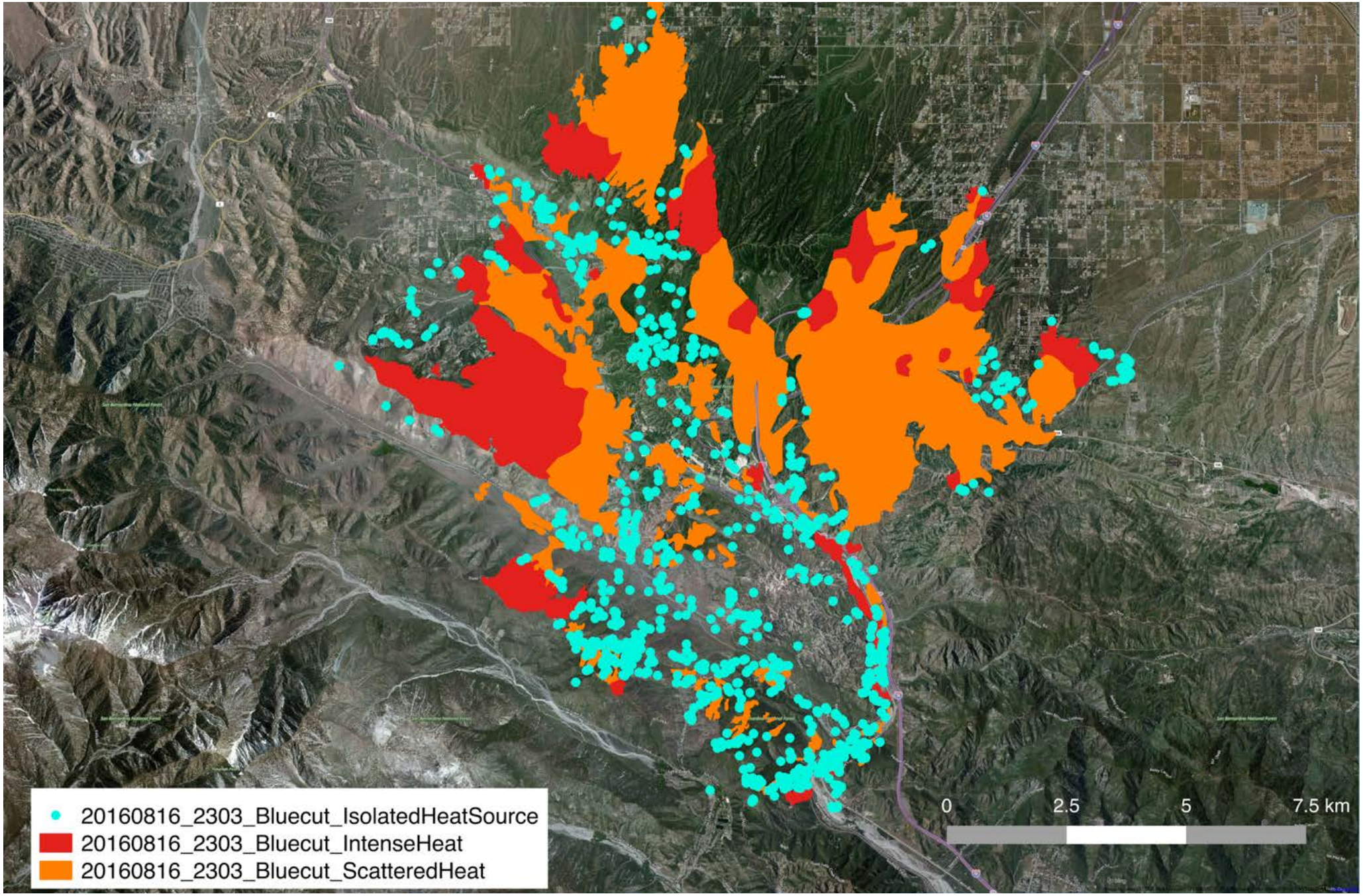
On-demand nighttime Landsat-8 acquisition

Blue Cut Fire 16 Aug 22:36 PDT



On-demand nighttime NIROPs acquisition

Blue Cut Fire 16 Aug 23:03 PDT



Current Data Status

Landsat-8/OLI 30m Fire Data

- Data are routinely processed by USDA Forest Service for the entire U.S.
  - Latency of approximately +4h
  - Currently serving the U.S. fire management community: https://fsapps.nwcg.gov/afm/gisdata.php

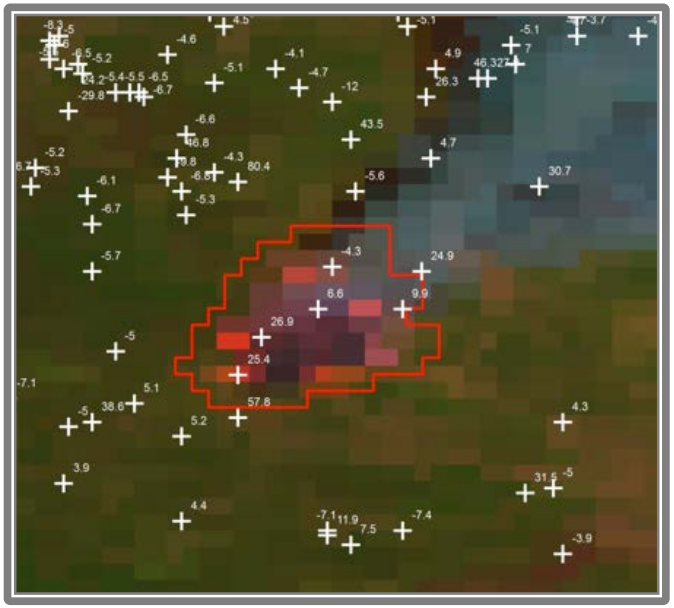
- Code being implemented at NASA's Advanced Supercomputing facility
  - Using platform for data testing and reprocessing
  - Expected to cover U.S. initially, then expand to achieve global coverage

Sentinel-2a/b 20m Fire Data

- Landsat-8/OLI algorithm ported to Sentinel-2 data
- Relatively small customization applied to algorithm
- Data are supporting science applications (e.g., validation of new GOES-16/ABI fire product for the western hemisphere)

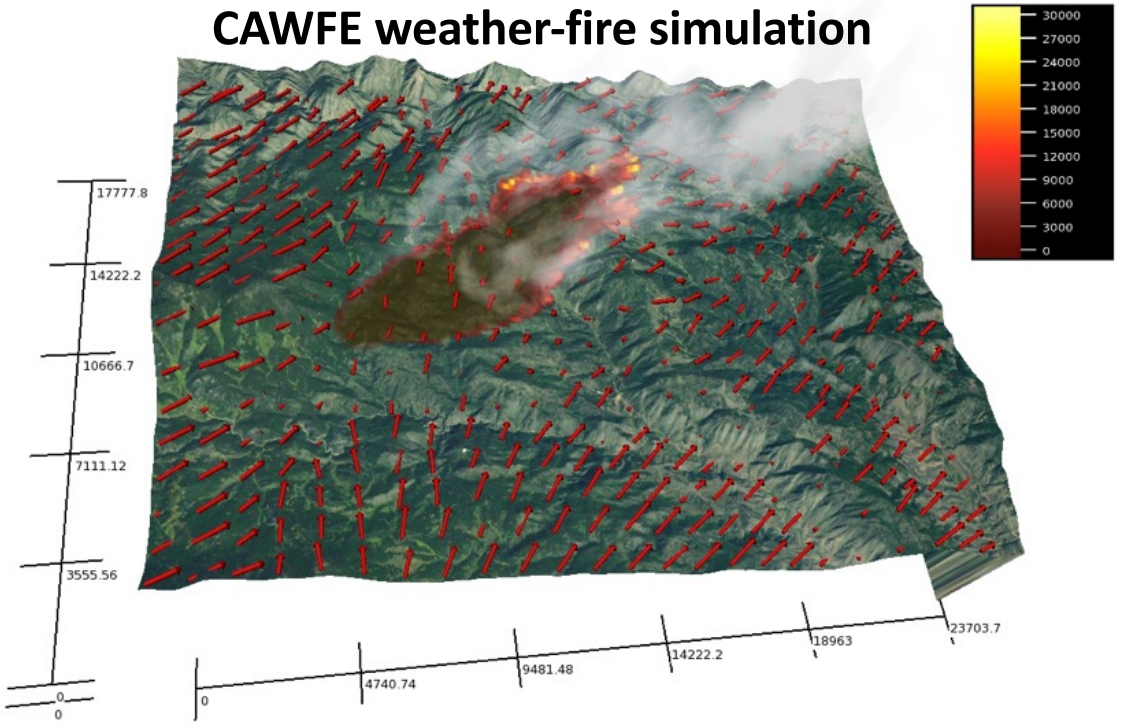
Fire Weather Applications

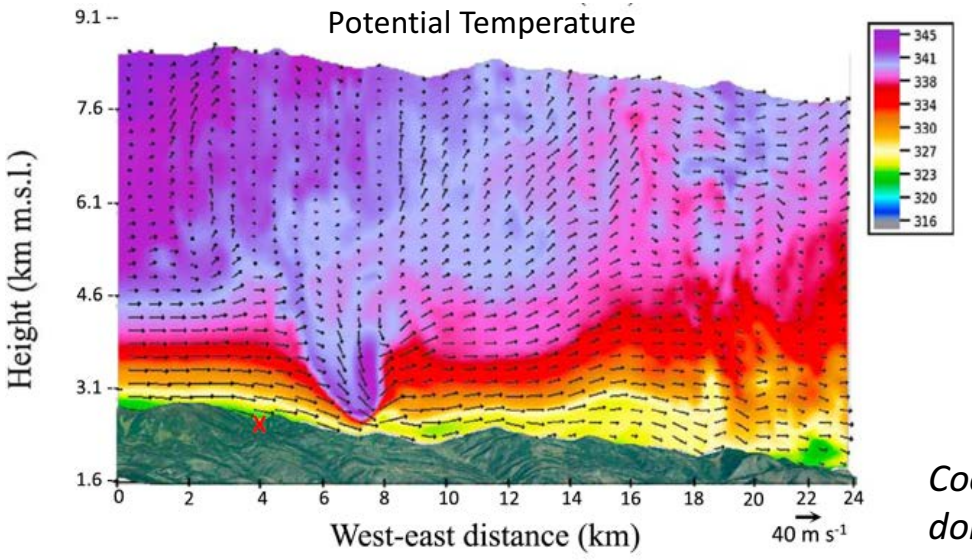
Lightning strikes 07 June 2012 overlaid on VIIRS 375m first detection on 09 June



Credit: Scott Rudlosky (NOAA)

High Park Fire/CO, June 2012
CAWFE weather-fire simulation



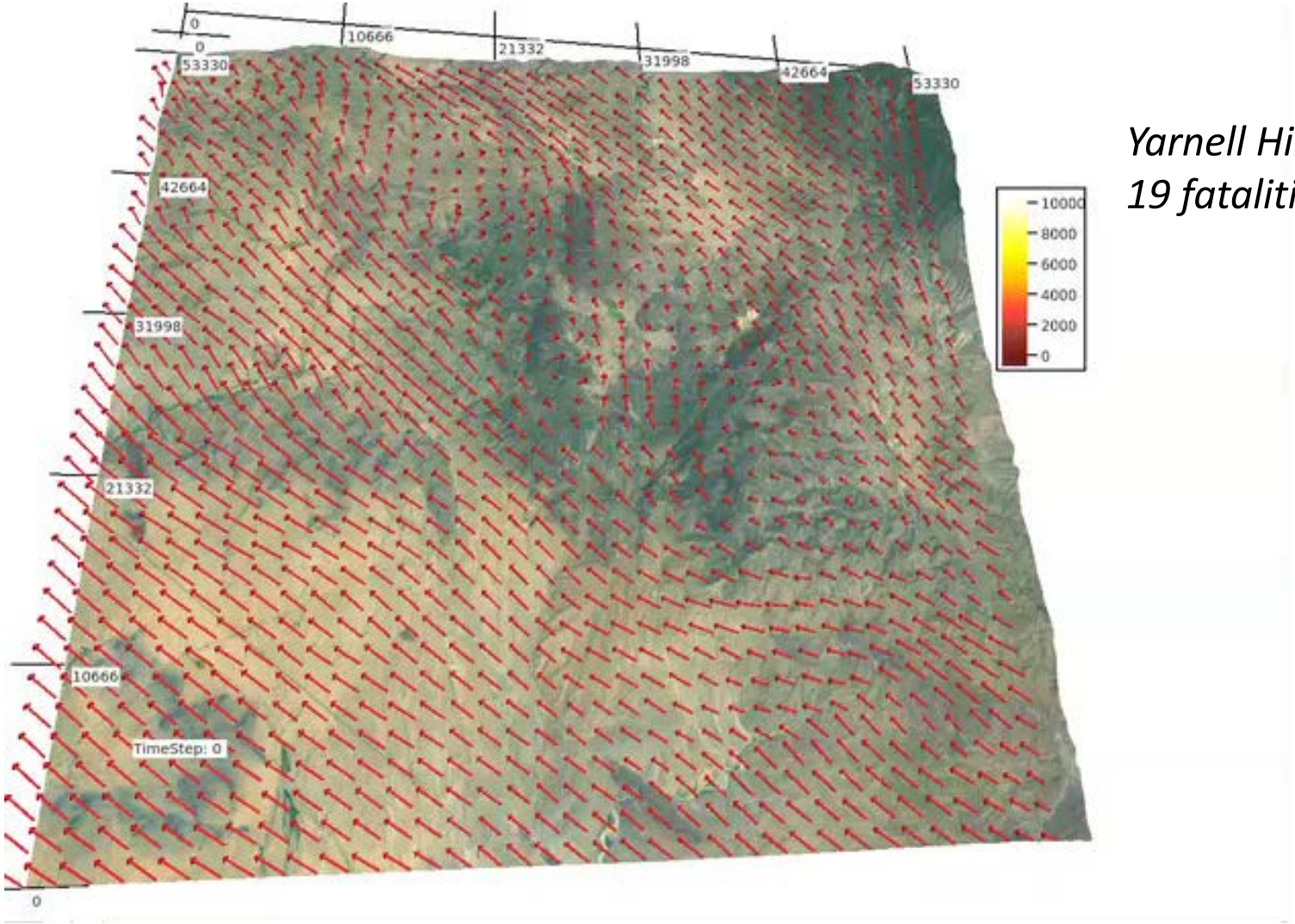


Gravity wave breaking leading to gusty winds at the surface, fueling fire spread two days after lightning ignition (location marked with X)

Coen and Schroeder [2015]
doi: 10.1002/2014JD021993

Fire Growth Mapping

"Need: Composite MODIS-VIIRS-GOES-R data representing fire radiative power or thermal signatures for near real-time fire modeling, growth mapping" (Randi Jandt)



Yarnell Hill Fire, AZ
19 fatalities among firefighters

Using composited satellite active fire data to initialize and evaluate weather-fire model (CAWFE)

NASA Applied Sciences project "*Development and Application of Spatially Refined Remote Sensing Active Fire Data Sets in Support of Fire Monitoring, Management and Planning*" [Schroeder *et al.*]

Final Remarks

VIIRS Fire Data

- More data becoming available
  - Like MODIS, new data “collections” will be released as improved calibration/algorithm refinements are implemented
- Level 3 (tiled) & 4 (gridded) data expected for 2018
- Science quality data availability supporting new investigations

Landsat-class Fire Data

- More data also becoming available although full global operational production still being worked out
- Overall detection performance is good, like VIIRS it could benefit from fine resolution urban mask

Helpful Links – VIIRS Fire Product

UMD VIIRS Fire Data:

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

NASA VIIRS Fire Data

https://viirsland.gsfc.nasa.gov/Products/NASA/FireESDR.html

NOAA VIIRS Fire Data

https://www.star.nesdis.noaa.gov/jpss/fires.php