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

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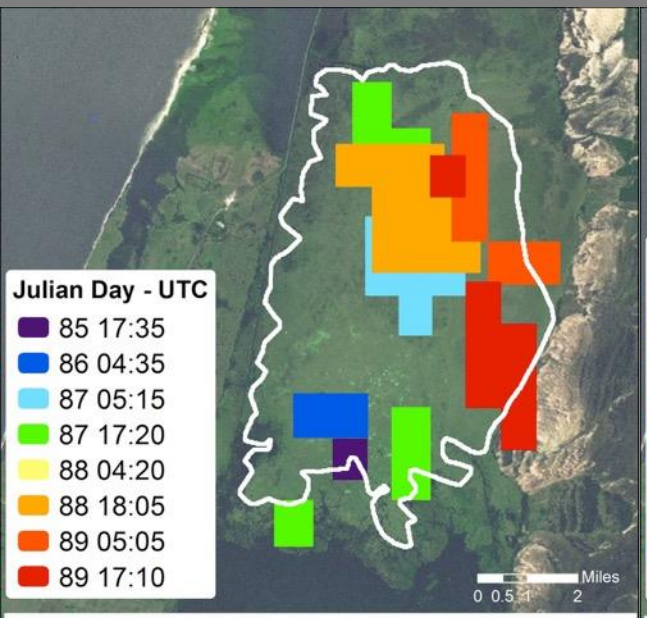
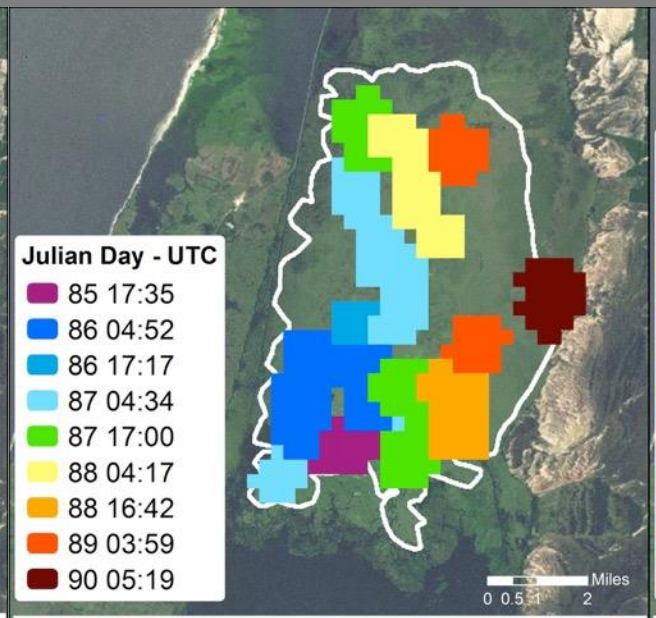
MODIS 1 km × VIIRS 750 m × VIIRS 375 m Fire Data Intercomparison



Aqua/MODIS 1 km

Pixel Area
1<>10 km^2

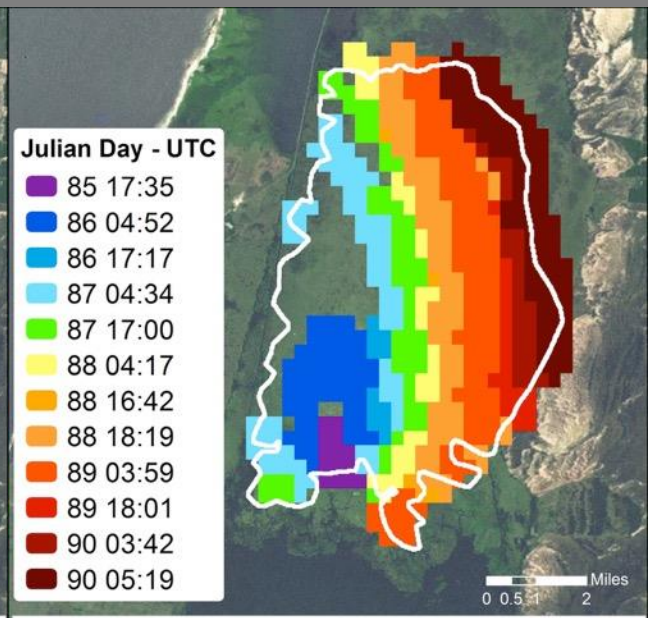
Image Swath
2330 km



NPP/VIIRS 750 m

Pixel Area
0.56<>2.5 km^2

Image Swath
3000 km

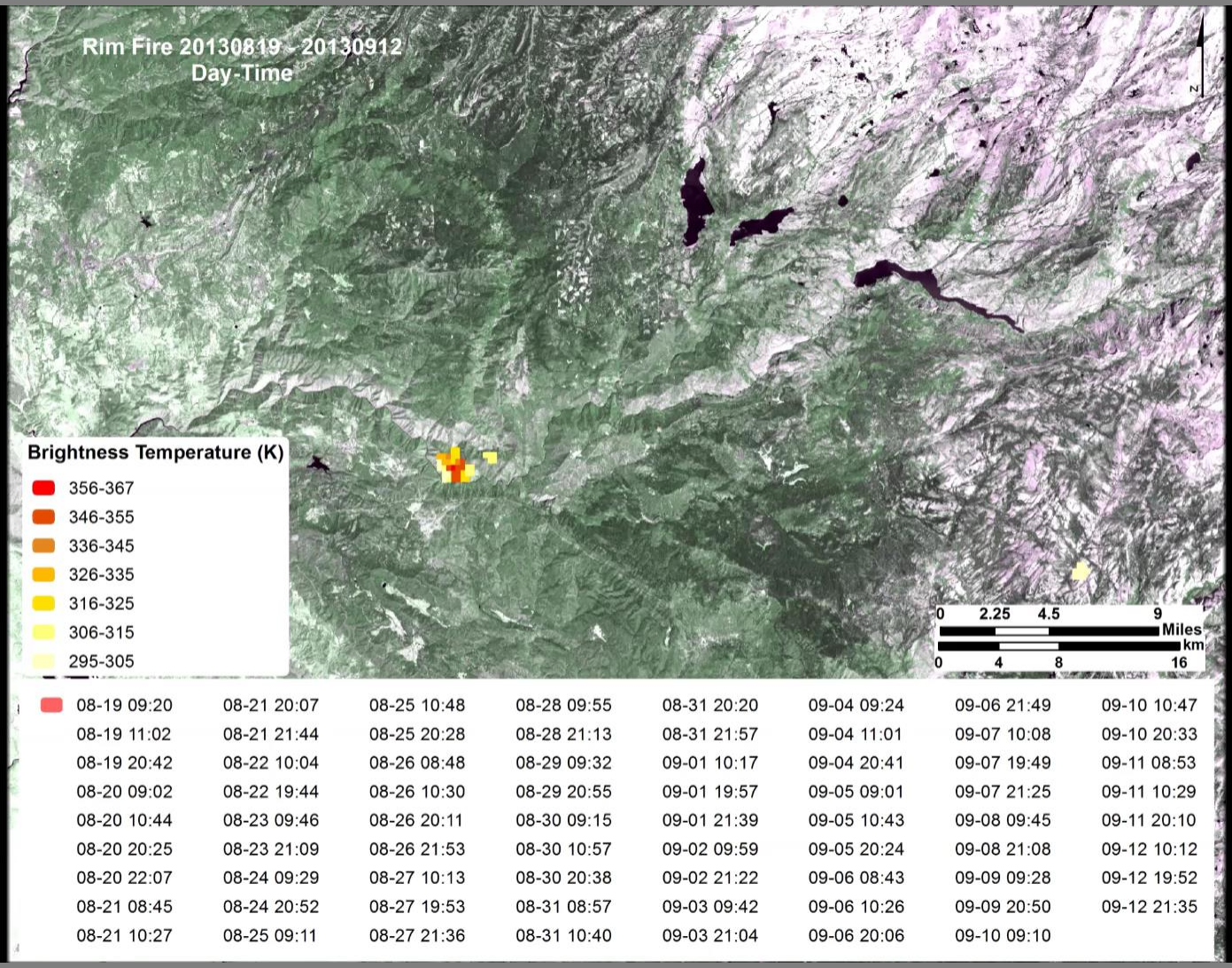


NPP/VIIRS 375 m

Pixel Area
0.14<>0.625 km^2

Image Swath
3000 km

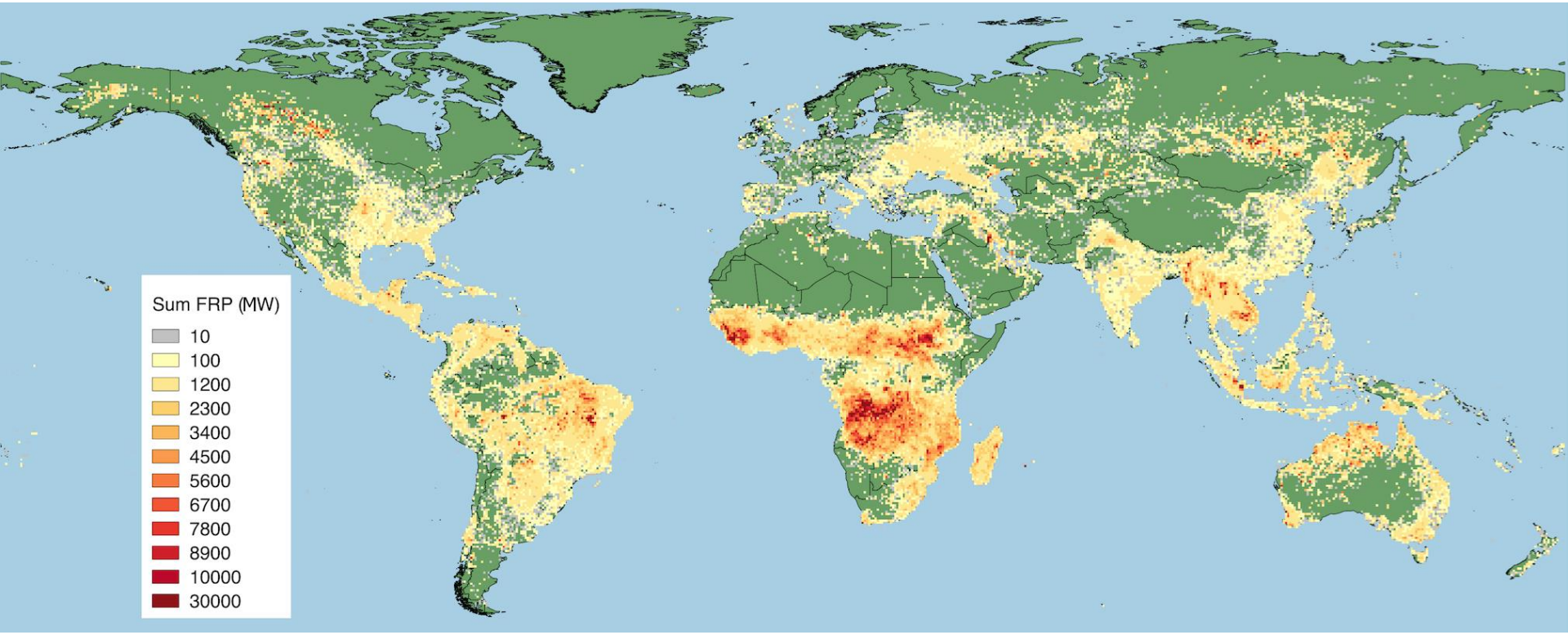
Routine GIS Mapping of Rim Fire, CA 2013 Using Reprojected VIIRS 375 m ≈12h Data



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



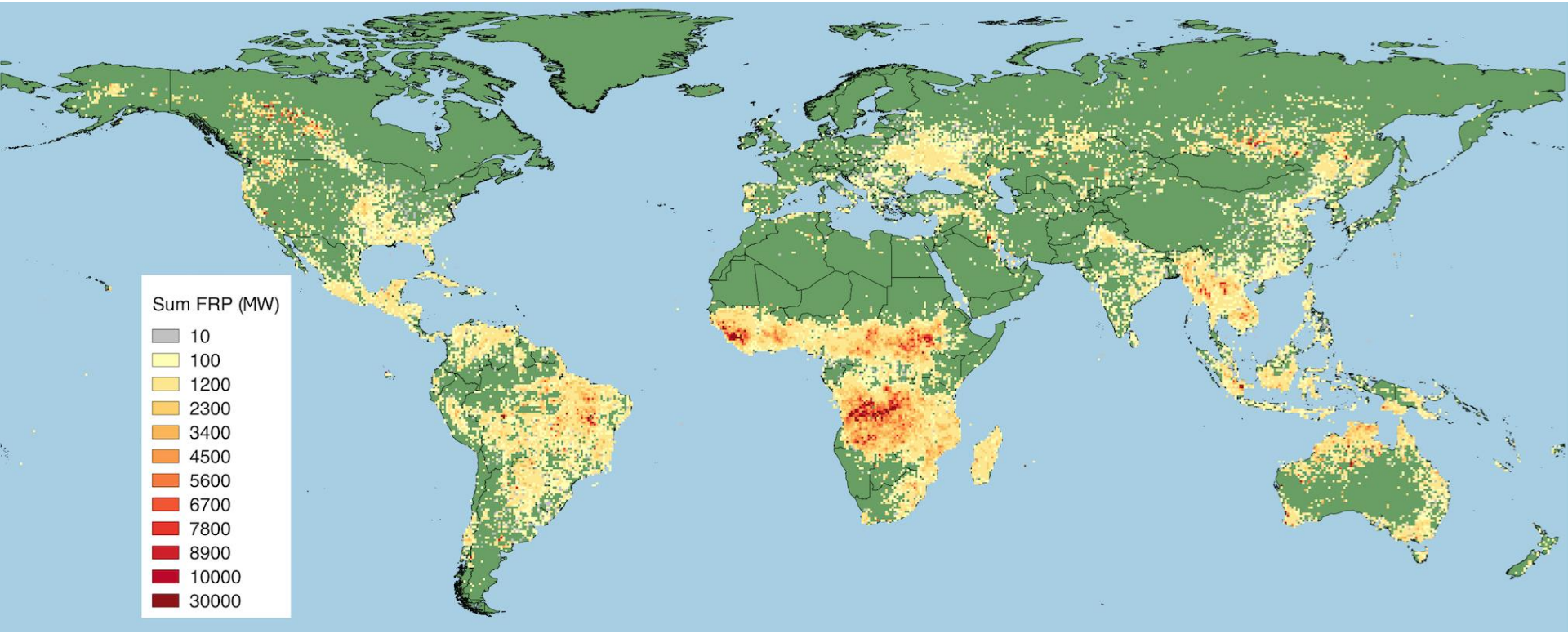
Frequent saturation prevents FRP retrieval using 375 m mid-IR data

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)

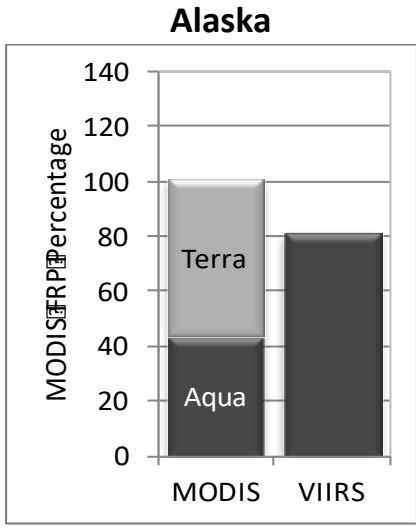
Sum of top-of-atmosphere (TOA) FRP over sampling period using 0.5^{o} grid

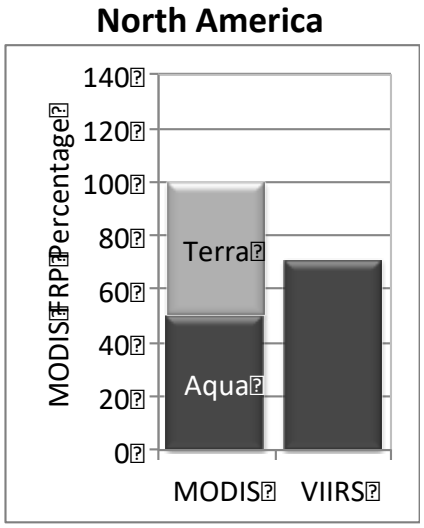


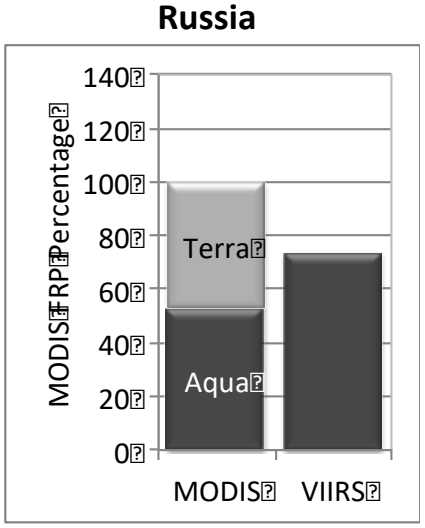
Higher VIIRS spatial resolution means:
3-4 more daytime fire pixels
20-25 more nighttime fire pixels
Compared to Aqua/MODIS

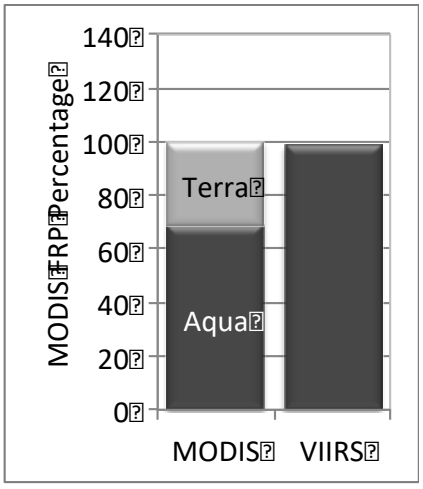
Global TOA FRP totals:
Terra/MODIS: 6.1×10^{6} MW
Aqua/MODIS: 13.4×10^{6} MW
S-NPP/VIIRS: 19.6×10^{6} MW

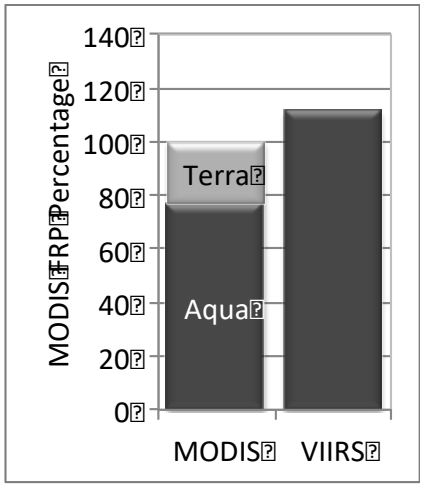
VIIRS 375 m x MODIS 1km
TOA Fire Radiative Power (FRP)

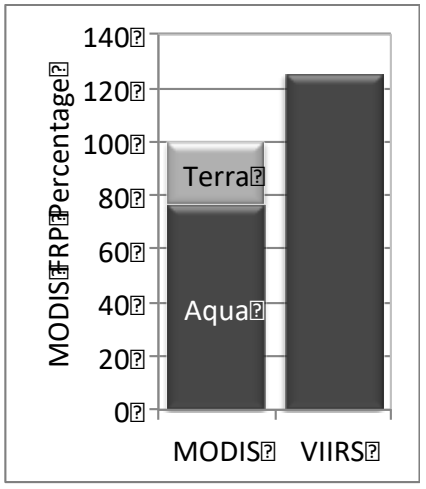












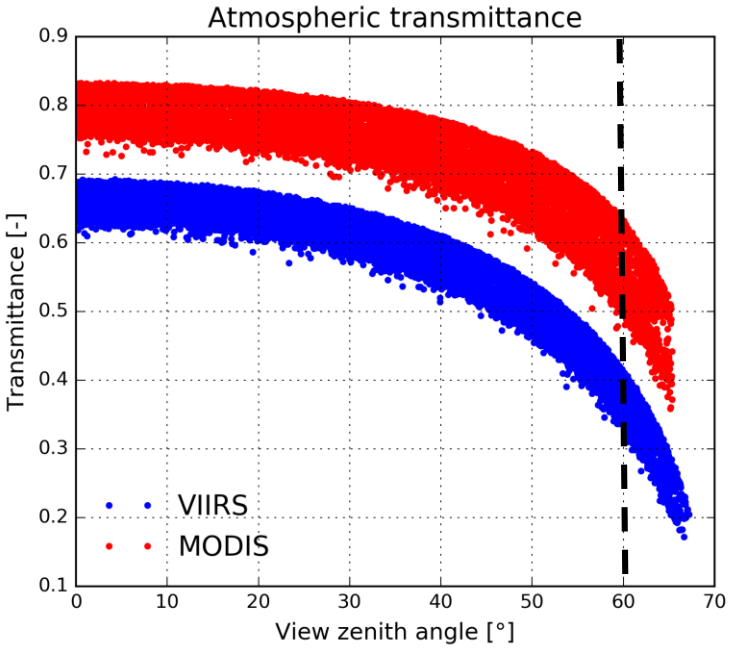
45% of daytime and 80% of nighttime VIIRS fire pixels have no match in Aqua/MODIS fire data

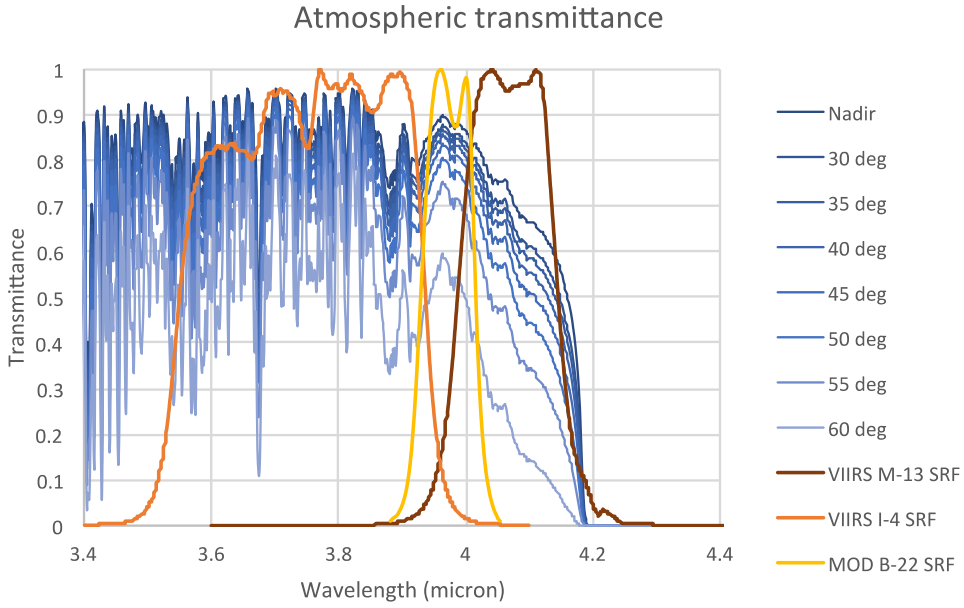
VIIRS systematically detecting more fires than same-day MODIS (Terra & Aqua) in areas dominated by small/low-intensity fires

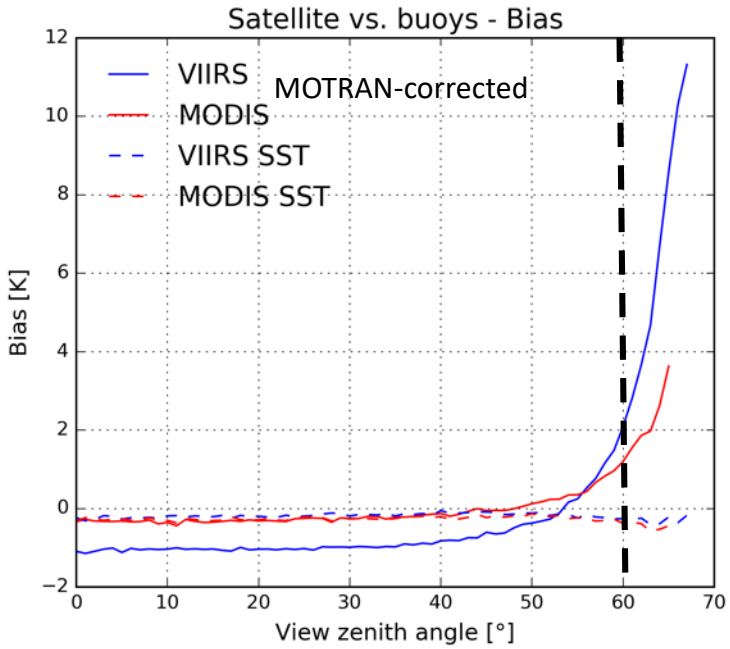
FRP Data Considerations

- 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

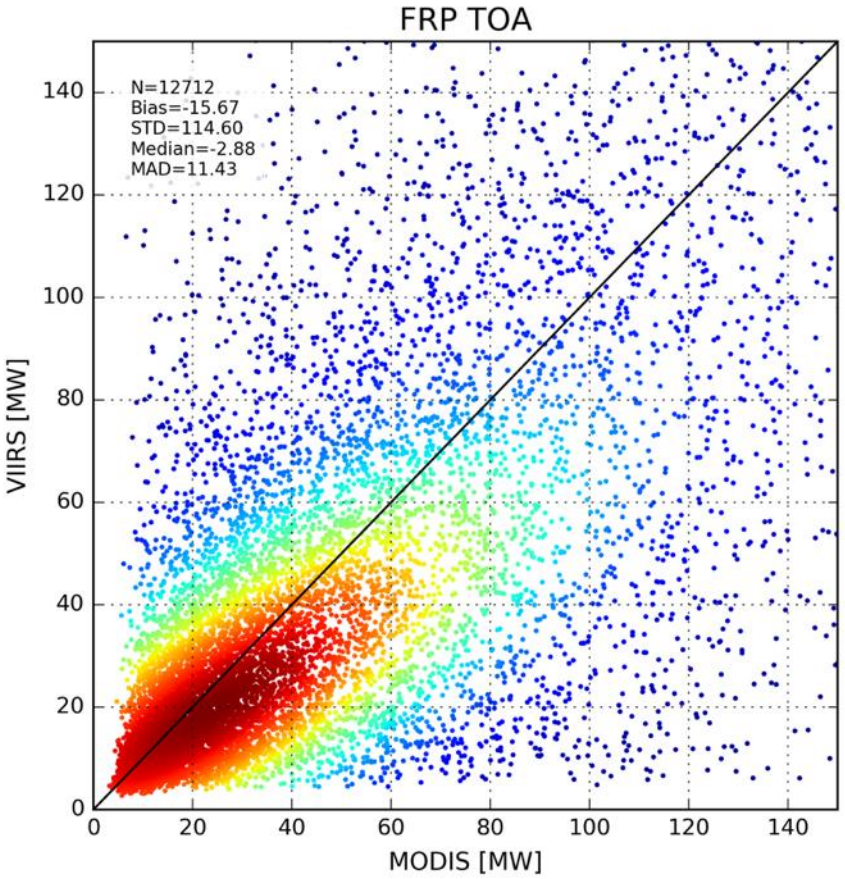




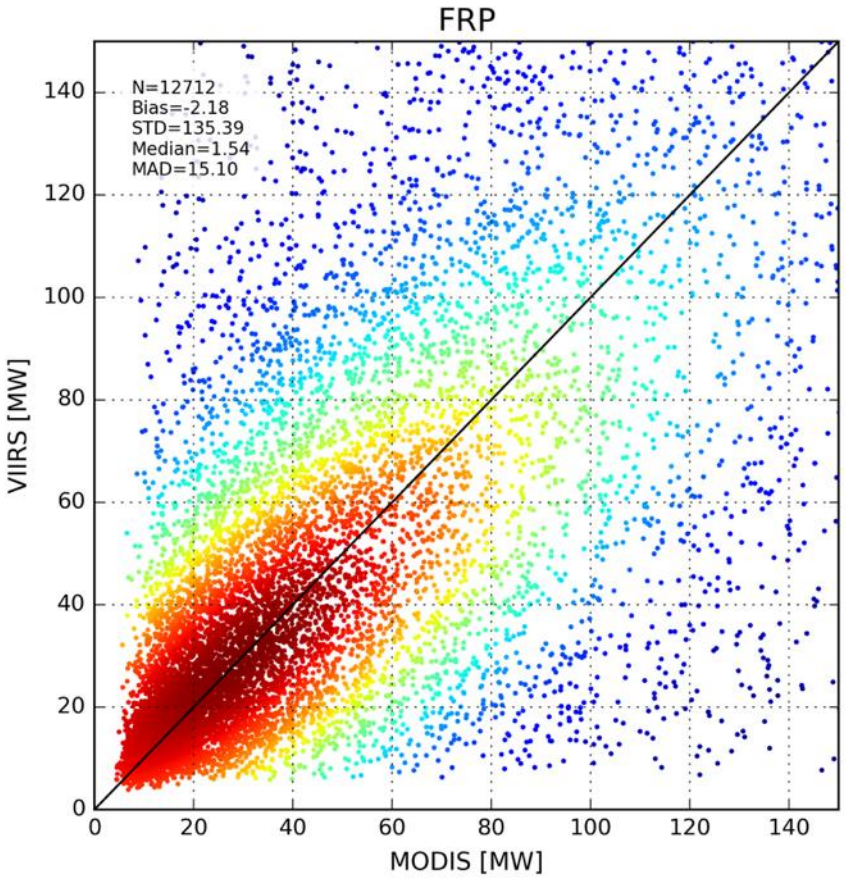


Cross-Validation of MODIS x VIIRS FRP Data

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



Before atmospheric correction



After atmospheric correction

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

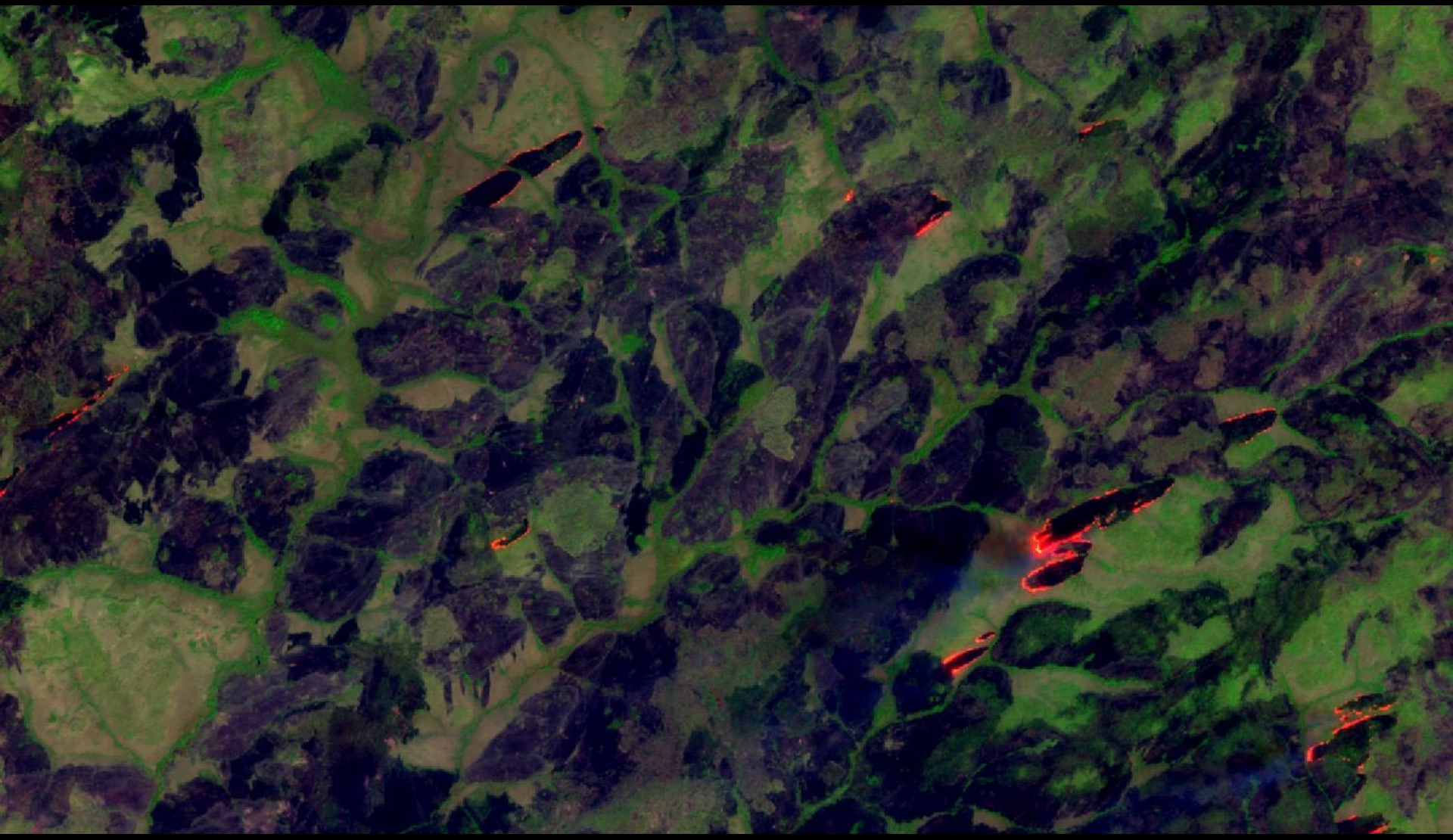
Cons:
Limited coverage/infrequent data

Potential:
Launch of similar sensors increasing data availability

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

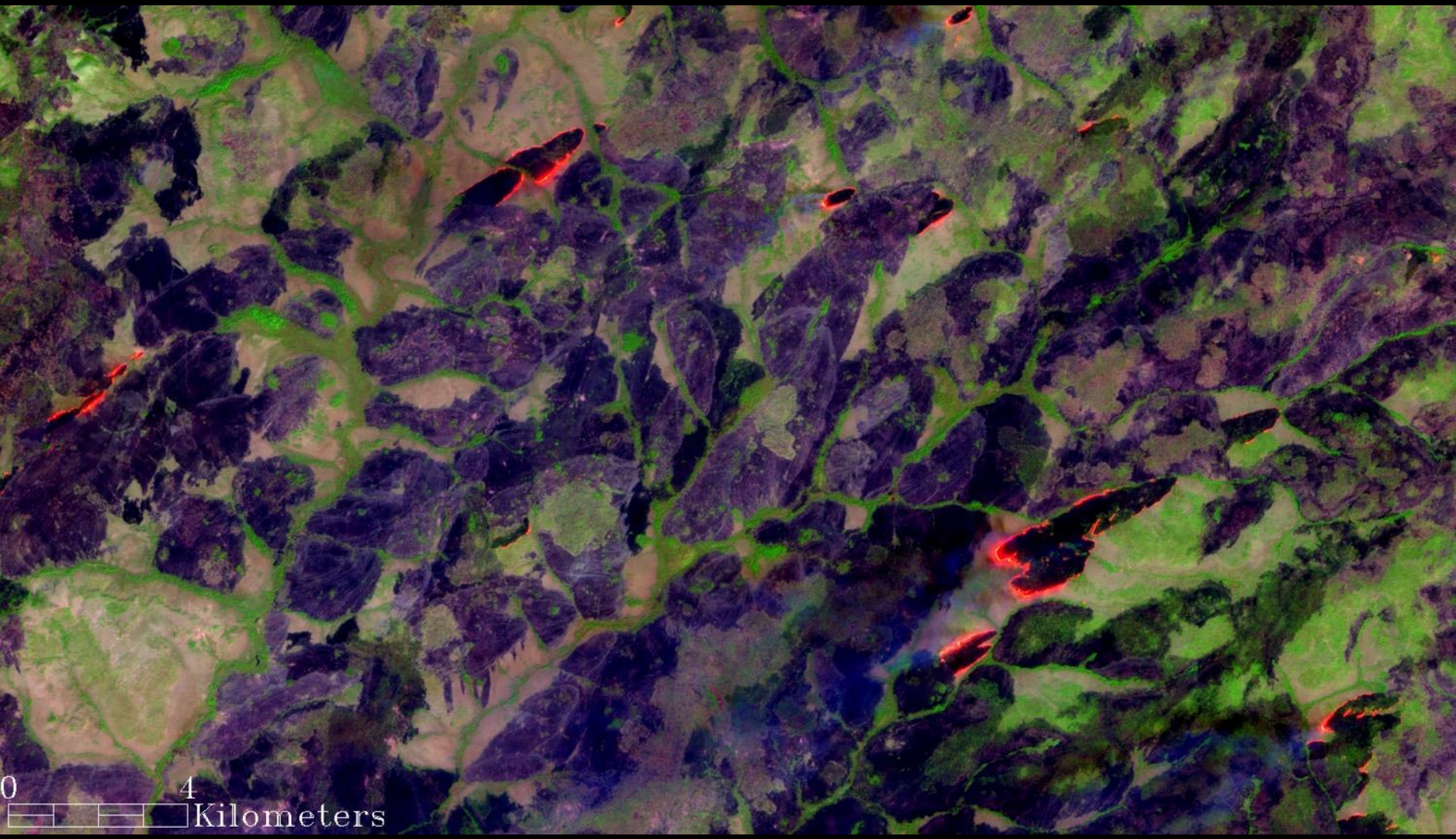
Near real-time data processing/distribution being explored
Community can/will have a major role defining the future of Landsat-class data applications

Landsat-8 + Sentinel-2A



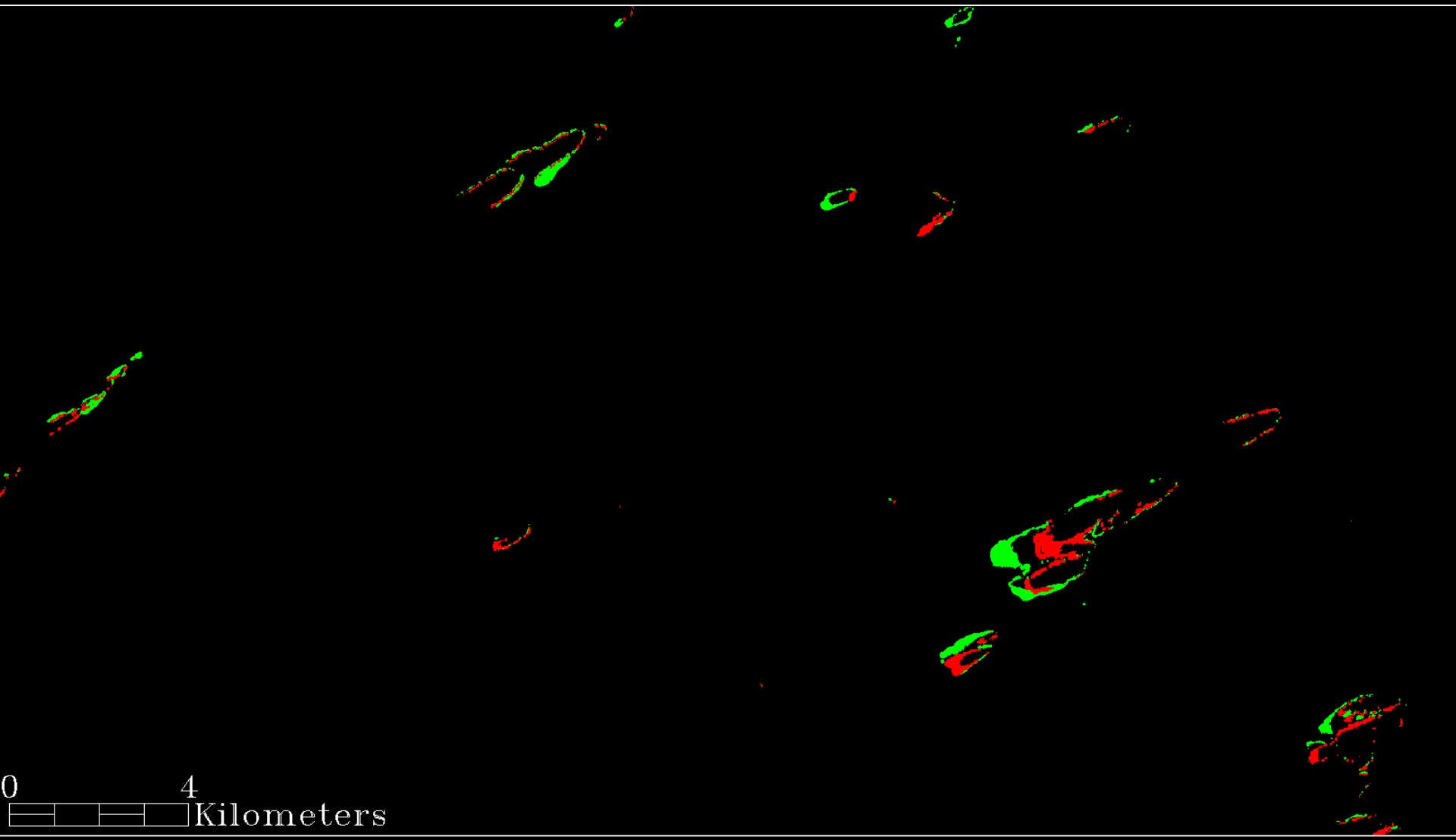
Landsat-8 (30 m)

Landsat-8 + Sentinel-2A



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

Landsat-8 + Sentinel-2A

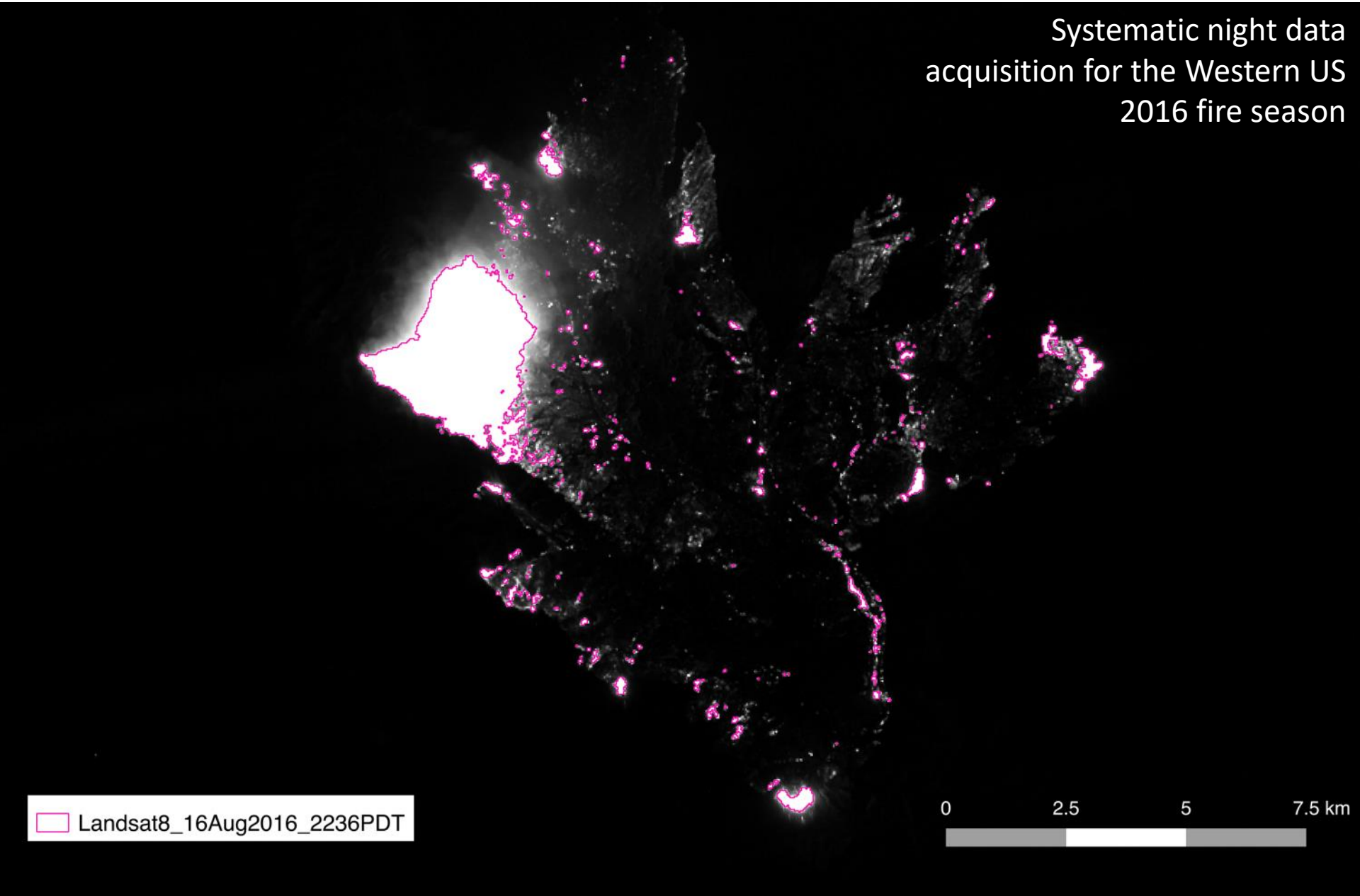


Landsat-8 fire mask: red

Sentinel-2A fire mask: green

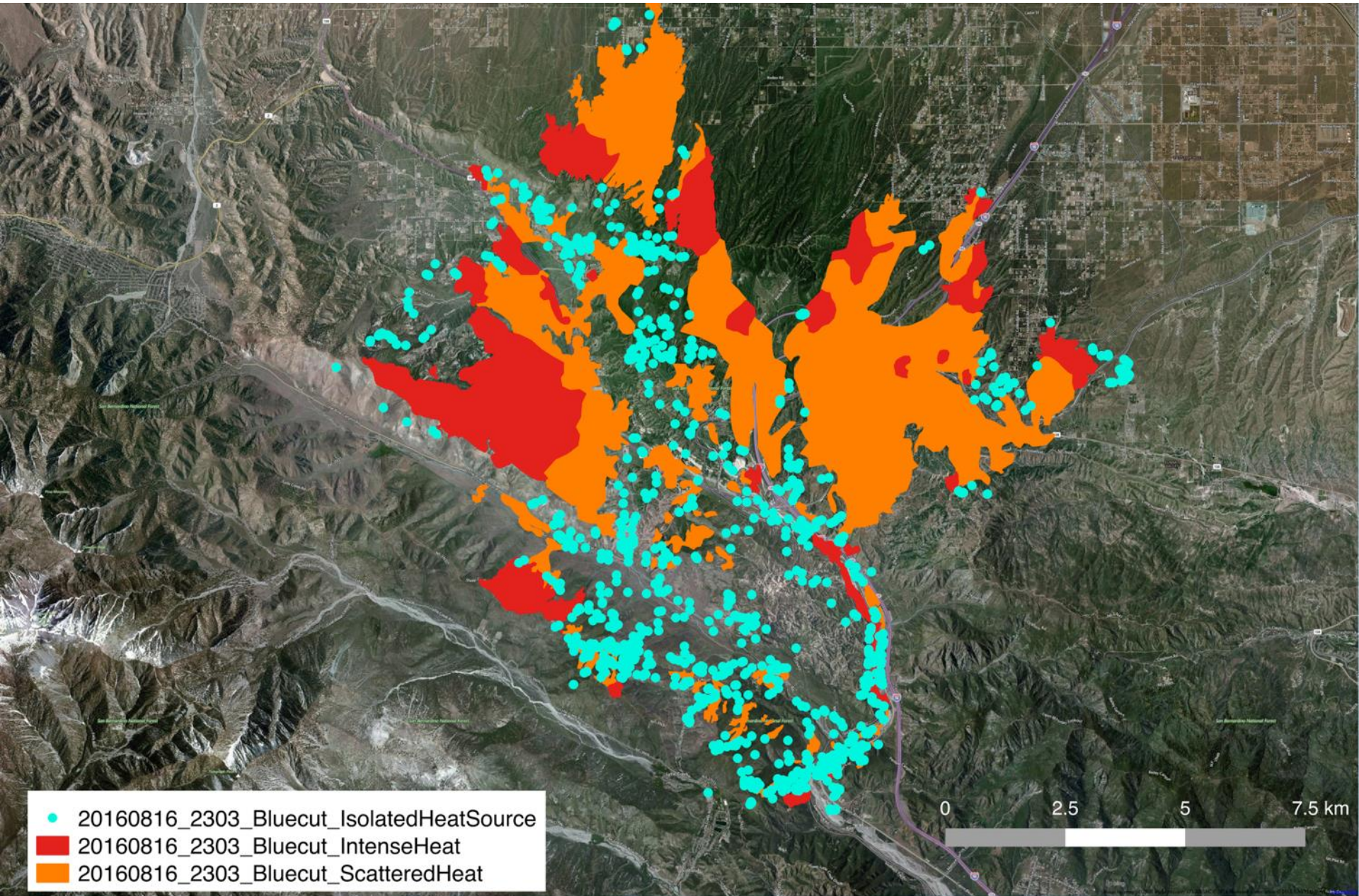
On-demand nighttime Landsat-8 acquisition

Blue Cut Fire 16 Aug 22:36 PDT



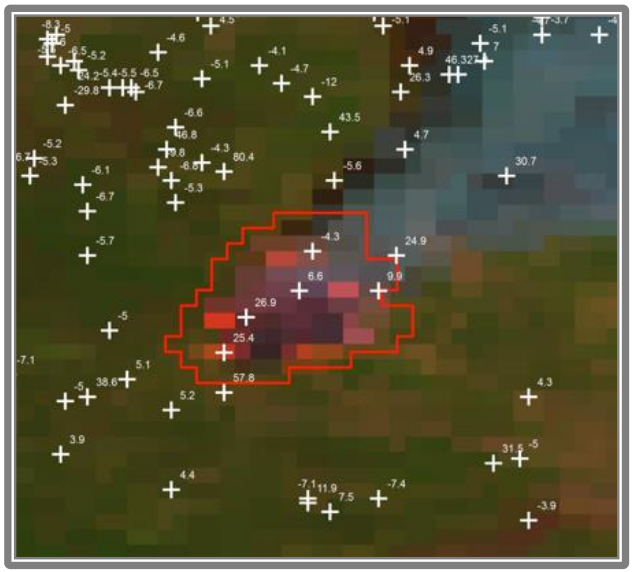
On-demand nighttime NIROPs acquisition

Blue Cut Fire 16 Aug 23:03 PDT



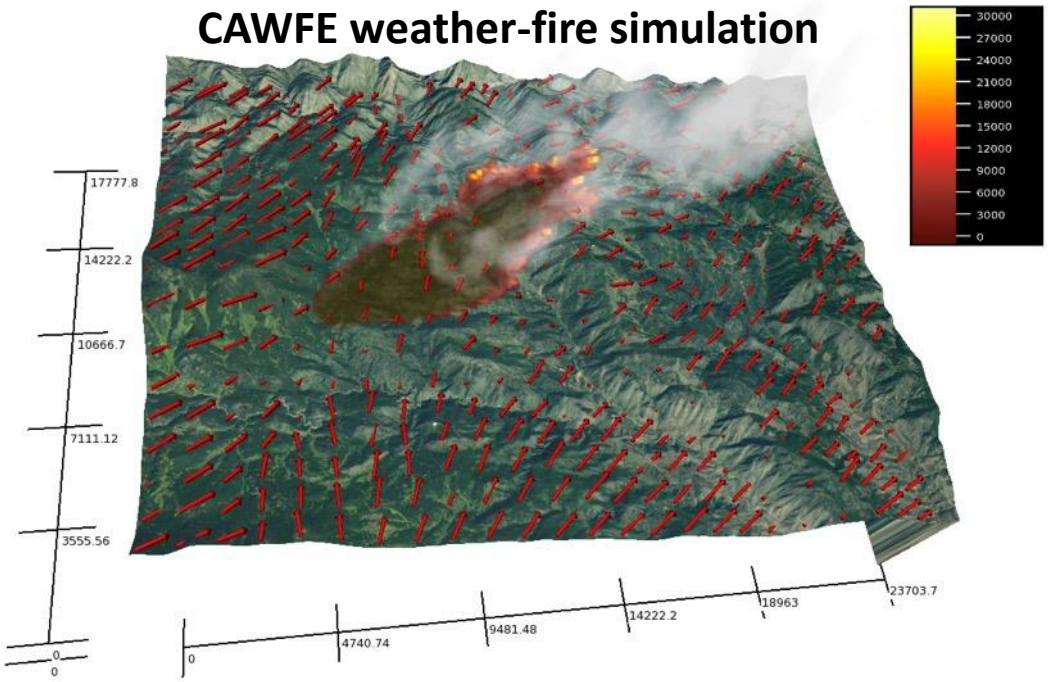
Fire Weather Applications

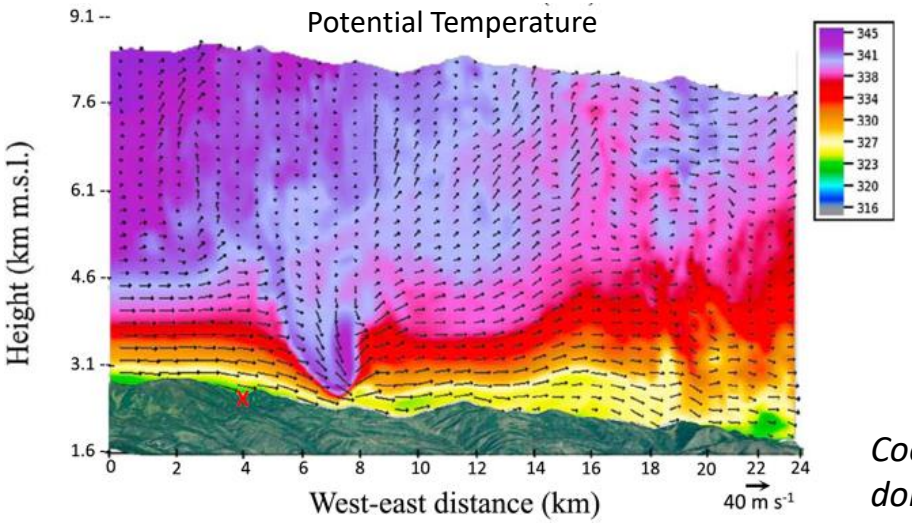
Lightning strikes 07 June 2012 overlaid on VIIRS 375m first detection on 09 June



Credit: Scott Rudlosky (NOAA)

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



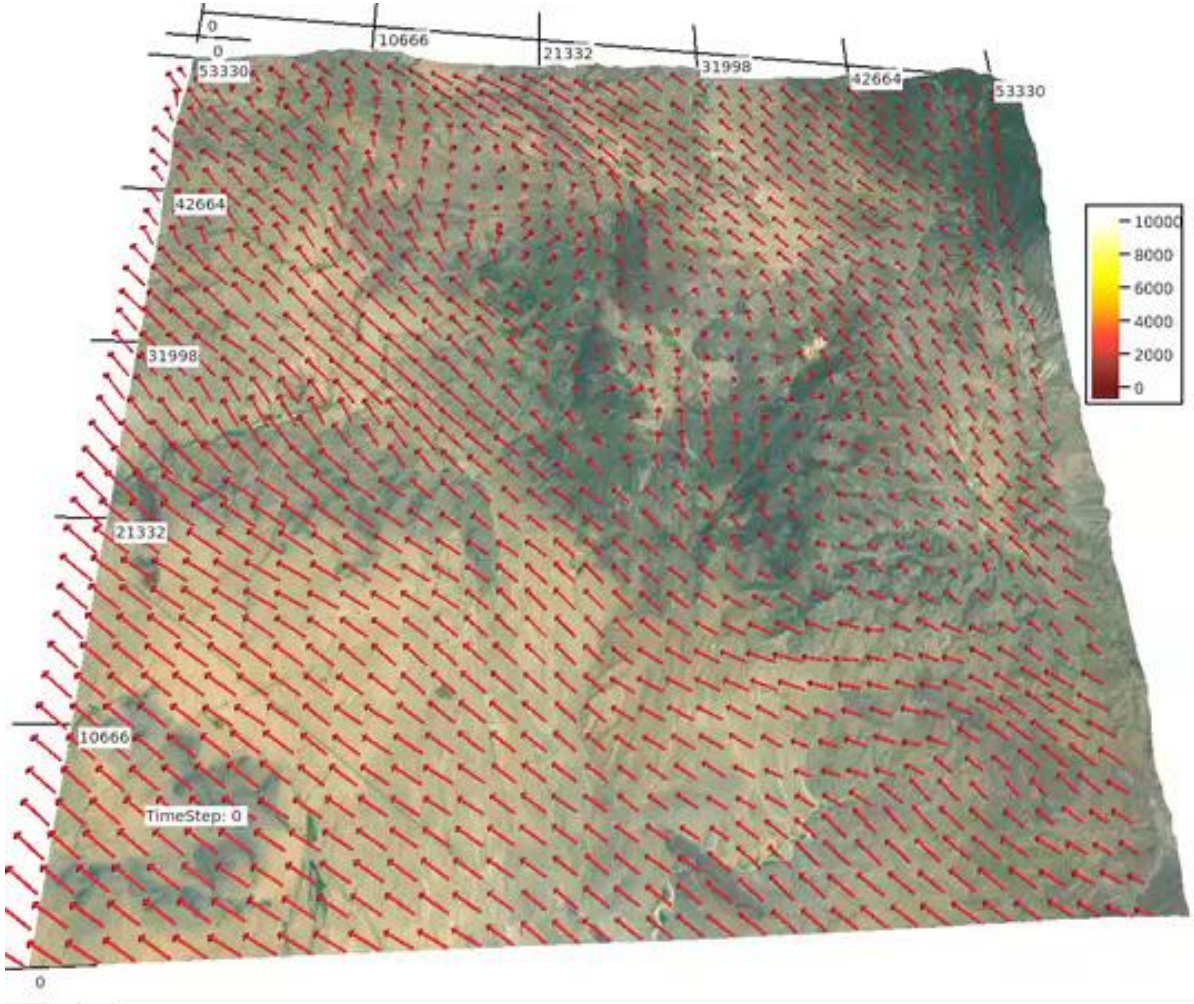


Gravity wave breaking leading to gusty winds at the surface, fueling fire spread two days after lightning ignition (location marked with X)

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

- Data transitioning to NetCDF format (HDF5 compatible). Consistency of archived data still a major issue
- Second major VIIRS 375 m algorithm update being implemented (e.g., new FRP layer, improved land/water processing, revised quality flags)
- VIIRS 750 m algorithm being maintained as is
- Second VIIRS instrument expected to operate later this year, more nadir views albeit at similar overpass times

Landsat-class Fire Data

- Landsat-8/OLI data transitioning to Collection 1 format
  - Routine fire data serving the U.S. fire management community. Data re-processing being considered
  - Near real-time fire data access could likely be pursued through Gilmore Creek ground station
- Sentinel-2/MSI fire algorithm being implemented. Data format and access still maturing
  - Nominal data latency expected to gradually decrease
  - ESA is open to near real-time applications (e.g., emergency response)

Data composites providing great fire mapping info and serving fire spread modeling tools