NOAA JPSS and GOES Fire Products

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NOAA/NESDIS/STAR

Outline

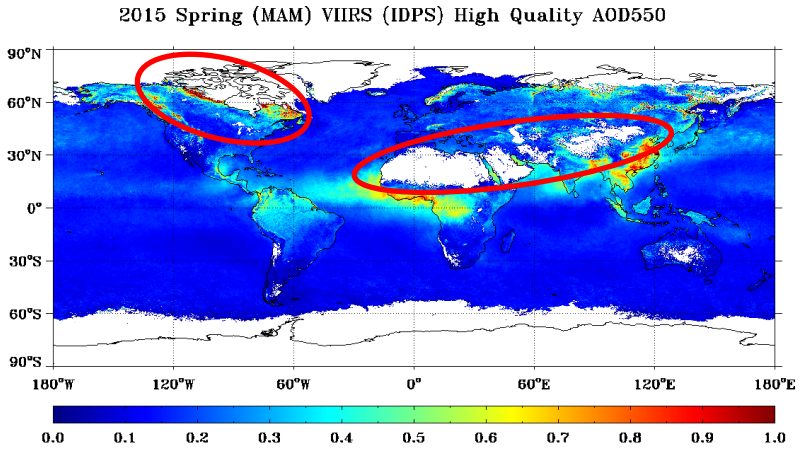
VIIRS Aerosol Optical Depth and Fire Radiative Power
ABI Aerosol Optical Depth and Fire Radiative Power
CrIS/ATMS Full Spectral Resolution Carbon Monoxide Retrievals

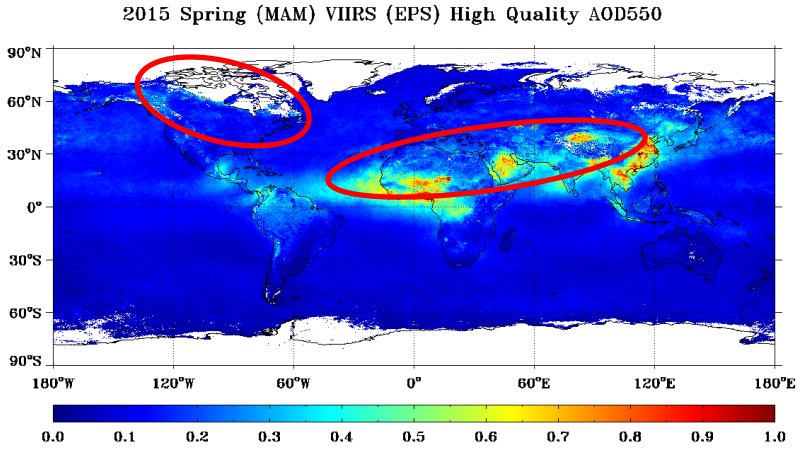
2017 IBBI Workshop • 10-11 July 2017 • Boulder, CO, USA

SNPP VIIRS Aerosol Products

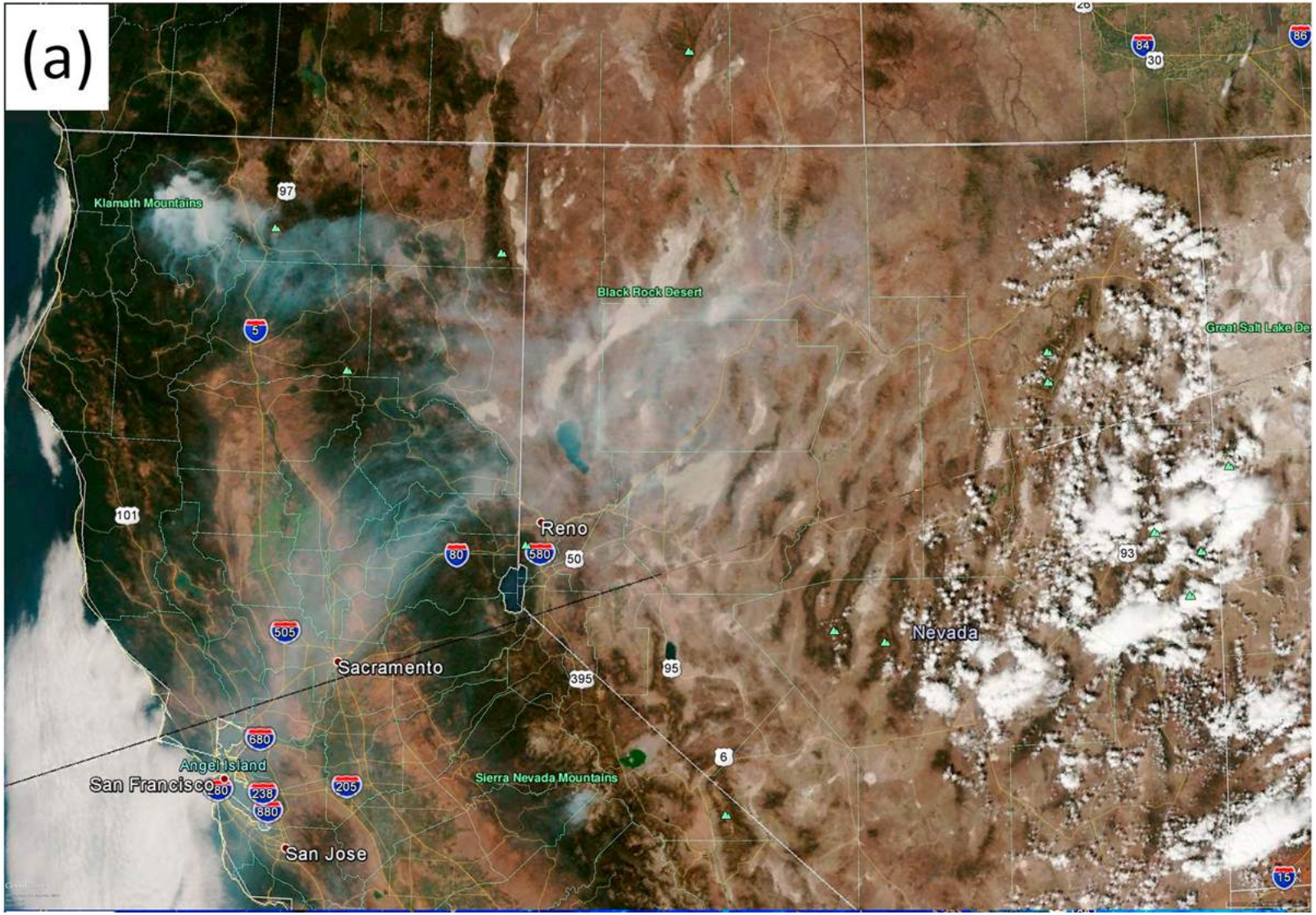
The Visible Infrared Imaging Radiometer Suite (VIIRS) sensor onboard the Suomi National Polar-orbiting Partnership (SNPP) satellite provides **Aerosol Optical Thickness (AOT), Aerosol Particle Size Parameter (APSP), and Suspended Matter (SM),** Environmental Data Records (EDRs)

- **New** *Enterprise Processing System (EPS)* expected to become operational July 2017: replaces current *Interface Data Processing Segment (IDPS)* algorithm
  - Retrieval over bright land, extended reporting range [-0.05-5.0], extensive internal test
  - The enhanced algorithm [Zhang et al., 2016] uses surface reflectance ratios including bright surfaces and are functions of region and geometry.

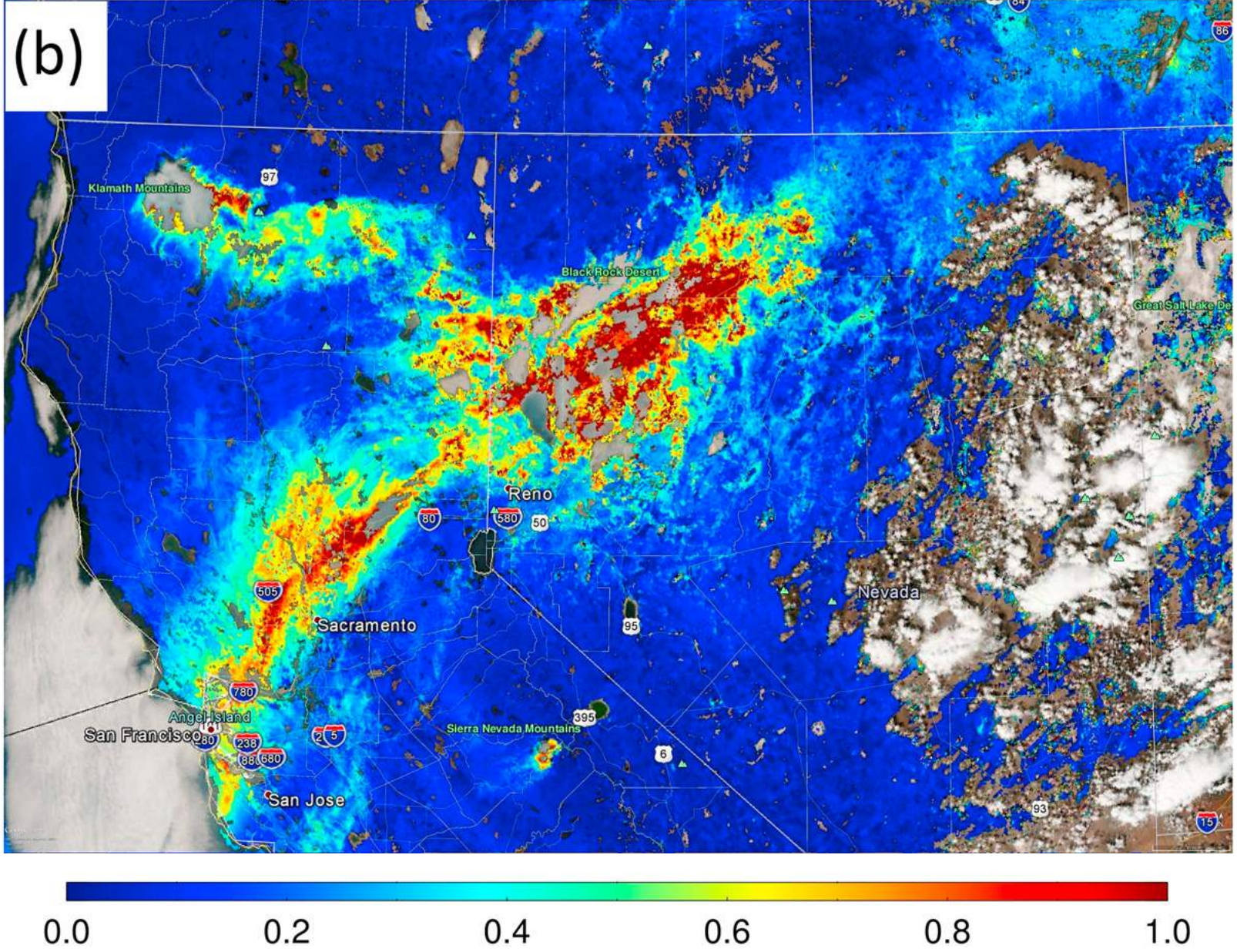




Zhang, H., S. Kondragunta, I. Laszlo, H. Liu, L. A. Remer, J. Huang, S. Superczynski, and P. Ciren (2016), An enhanced VIIRS aerosol optical thickness (AOT) retrieval algorithm over land using a global surface reflectance ratio database, J. Geophys. Res. Atmos., 121, 10,717–10,738, doi:10.1002/2016JD024859.



Smoke over the western United States on 9 September 2014.
(a) VIIRS RGB image; (b) VIIRS EPS; (c) VIIRS IDPS AOT retrievals.



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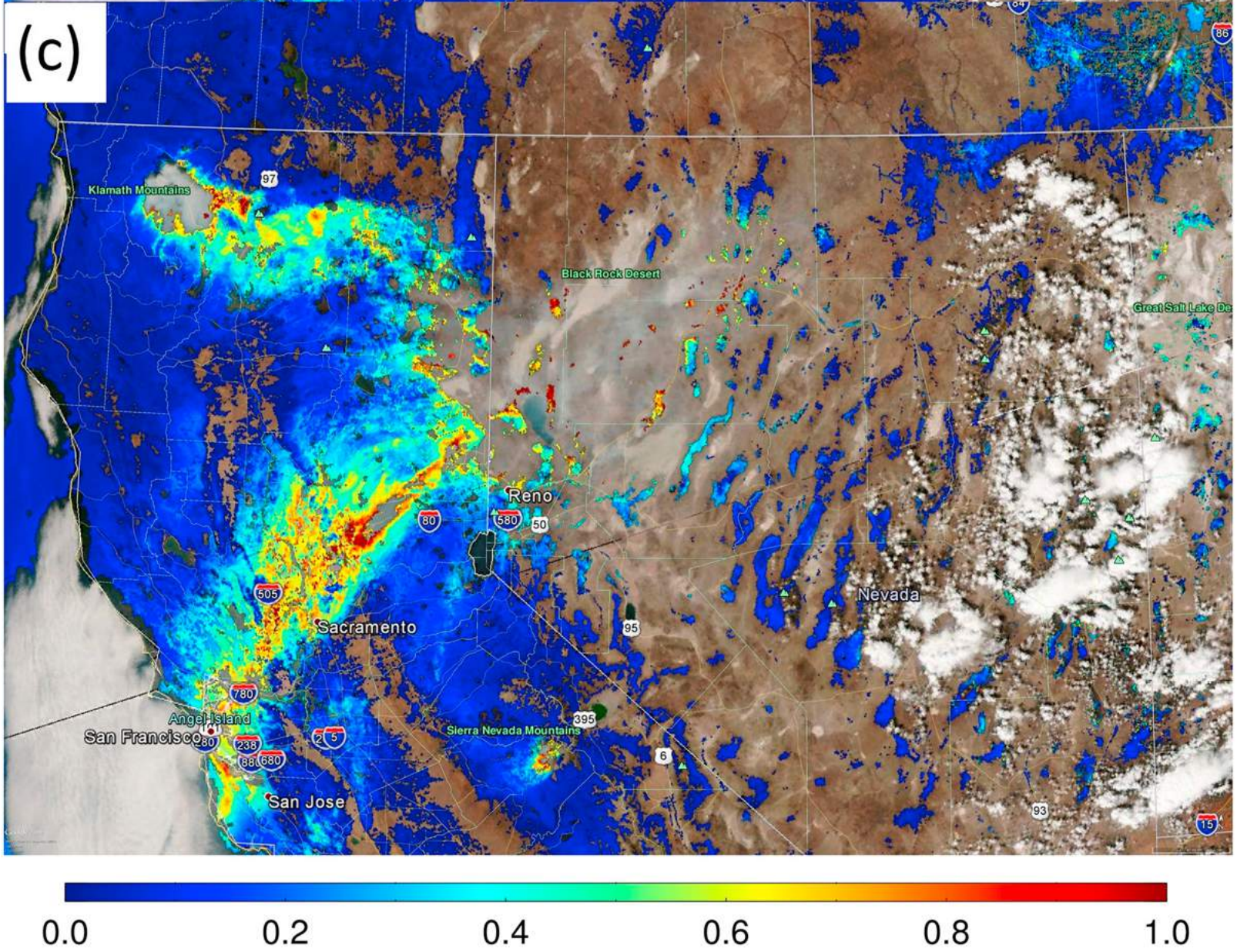
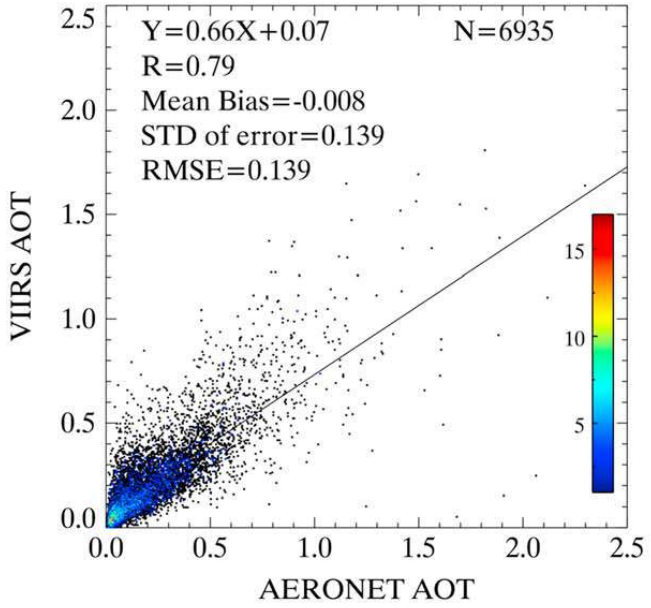


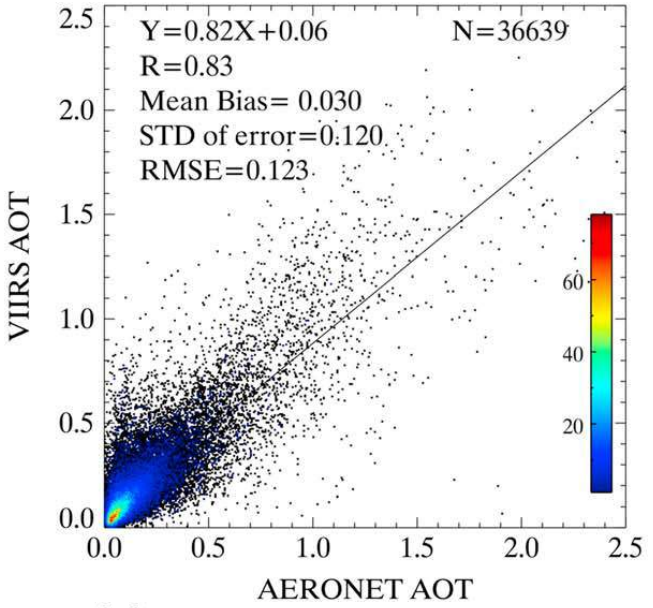
Smoke over the western United States on 9 September 2014.
(a) VIIRS RGB image; (b) VIIRS EPS; **(c) VIIRS IDPS** AOT retrievals.

Global 2 year (May 2012 to April 2014) AERONET AOT and VIIRS AOT

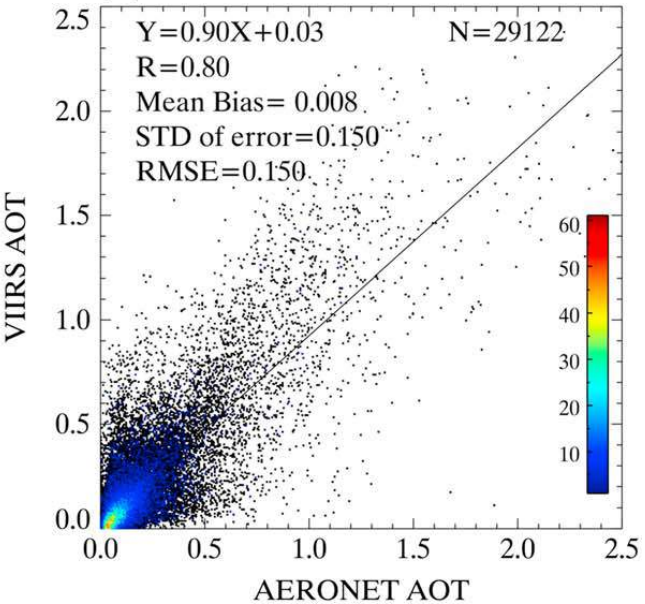
(a) EPS bright pixels



(b) EPS dark pixels



(c) IDPS dark pixels

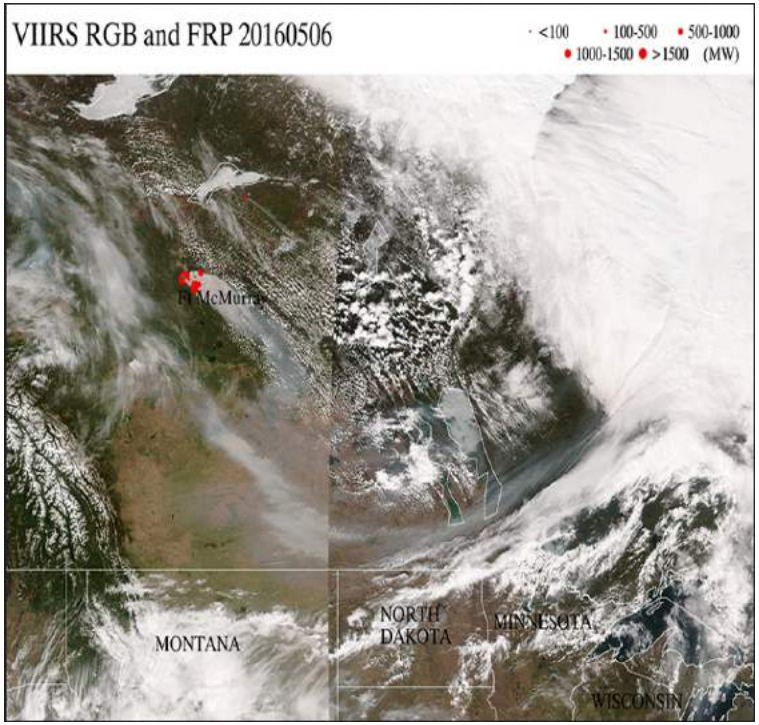


Over bright surfaces, the VIIRS AOT retrievals from the EPS algorithm have a correlation of 0.79, mean bias of 0.008, and standard deviation (STD) of error of 0.139 at AERONET (Aerosol Robotic Network) sites.

Over dark surfaces, the VIIRS EPS AOT retrievals improve the root-mean-square error from 0.150 to 0.123 and increases the data coverage of more than 20% over dark surfaces.

SNPP VIIRS Fire Products

- At launch, VIIRS operational fire product reported only fire location.
- The updated retrievals with pixel information and Fire Radiative Power (FRP) became operational in May 2016
- VIIRS fire products are provided to users in three different ways:
  - Direct readout (*for forecast applications*)
  - Subscription to near real time data by submitting a request form (*for assimilation*)
  - Archived product (*for research*)



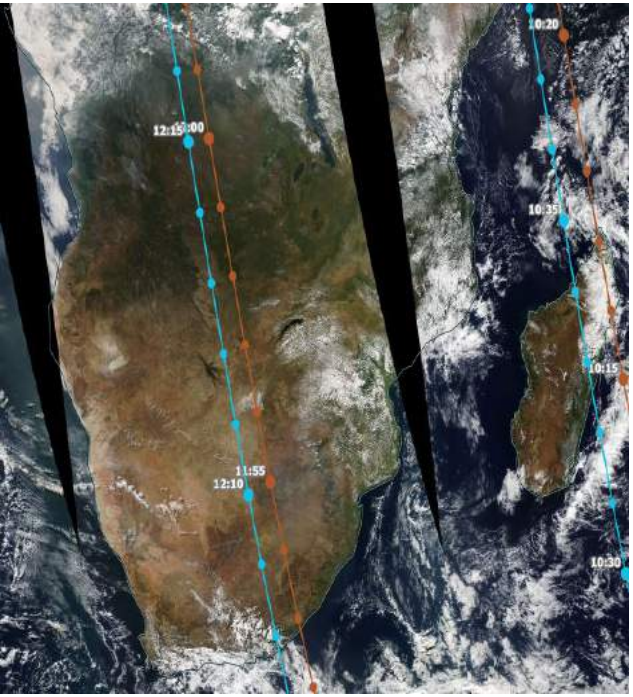
A. Huff and S. Kondragunta, Meteorologists Track Wildfires Using Satellite Smoke Images, EOS, April 4, 2017

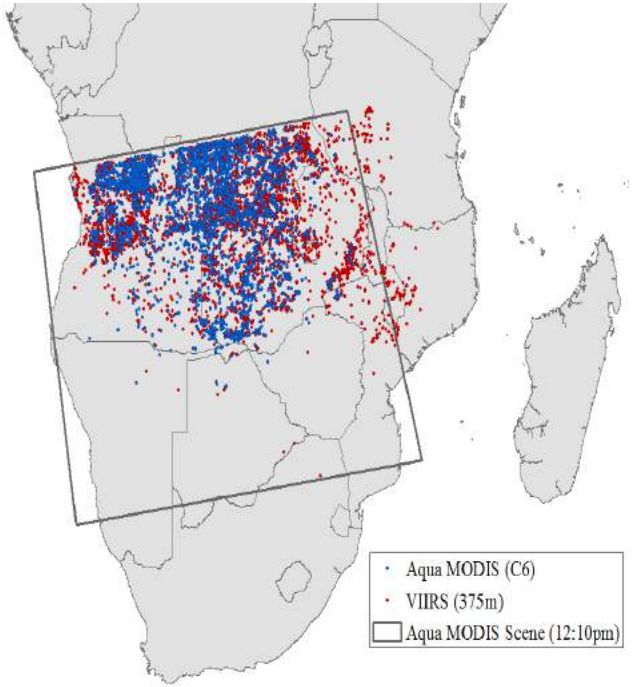
VIIRS vs. MODIS

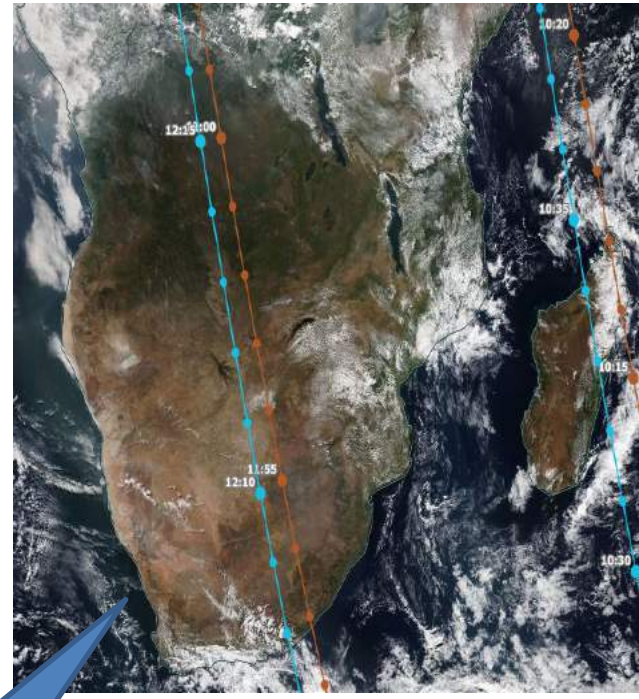
MODIS

June 3, 2016

VIIRS





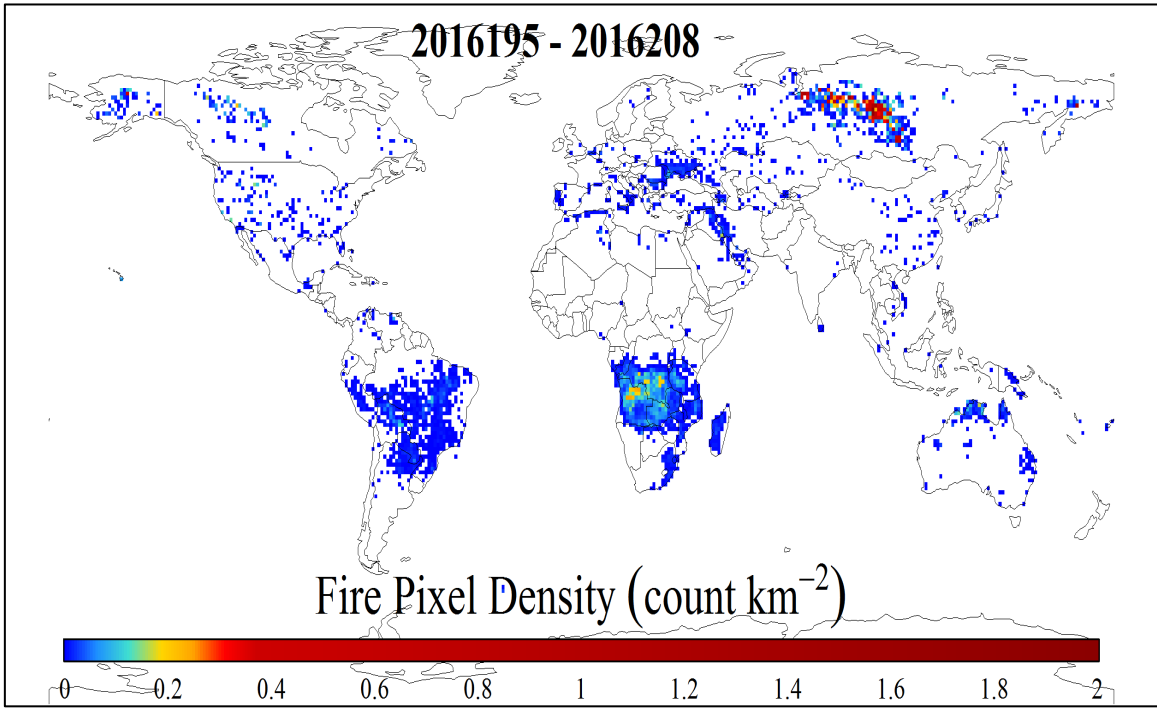


Pixel size:
1 km to 4 km

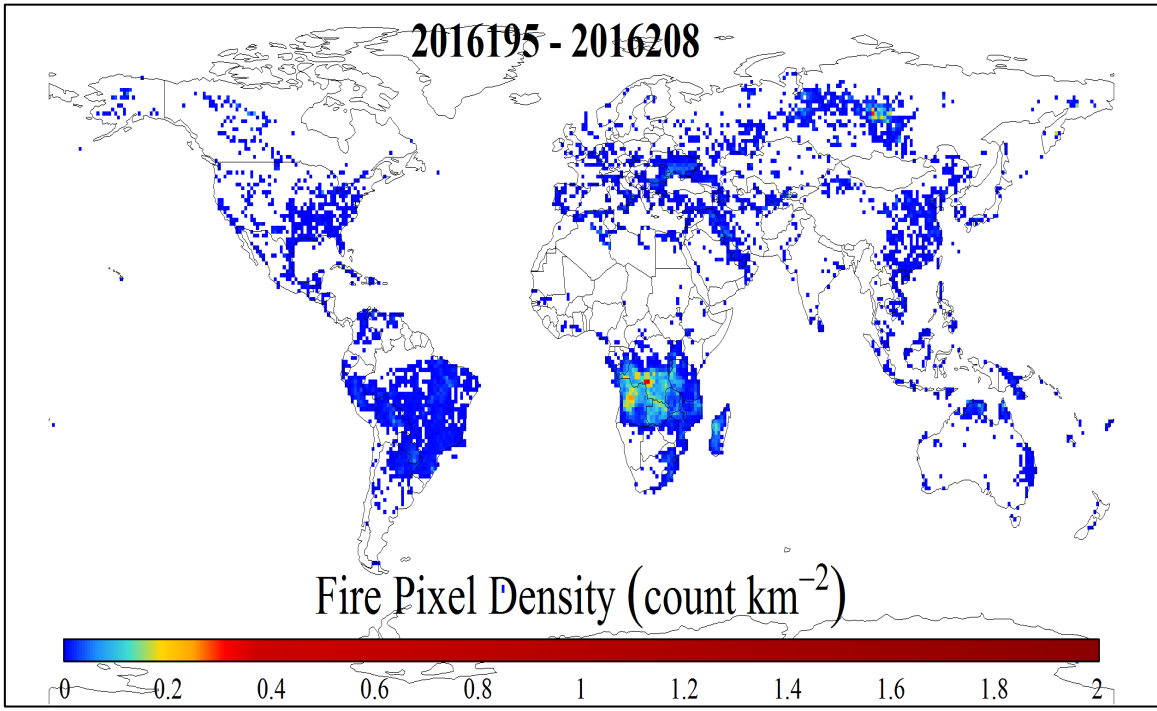
Pixel size:
750 m to 1.2 km

Li, Zhang, Kondragunta, and Csiszar, GRL, submitted, 2017

VIIRS matched to MODIS



Additional Fires Detected by VIIRS



FRP Calculation

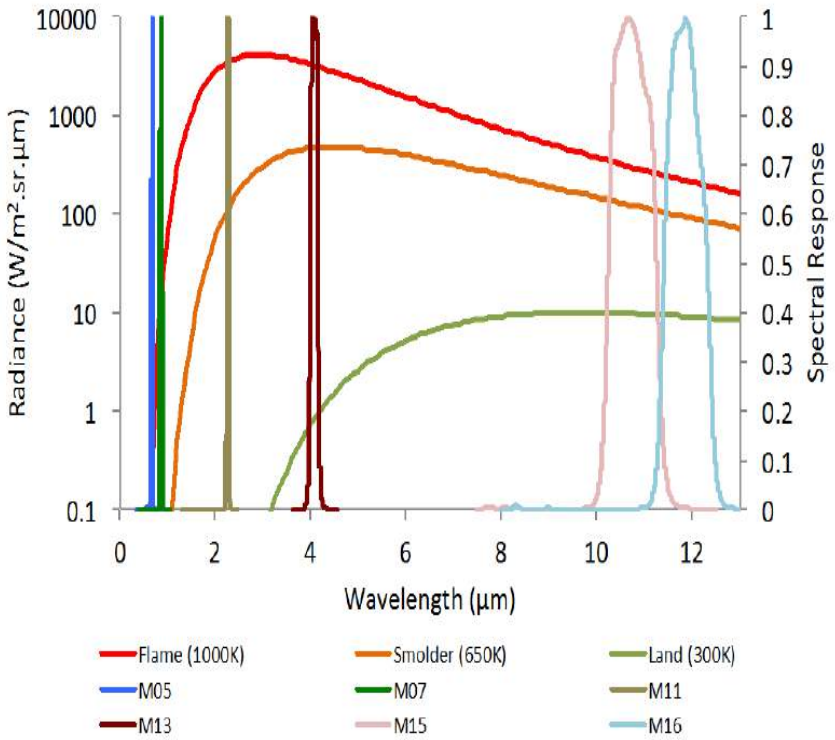
3.9 um radiance (fire minus background)

S-B const.

Pixel area

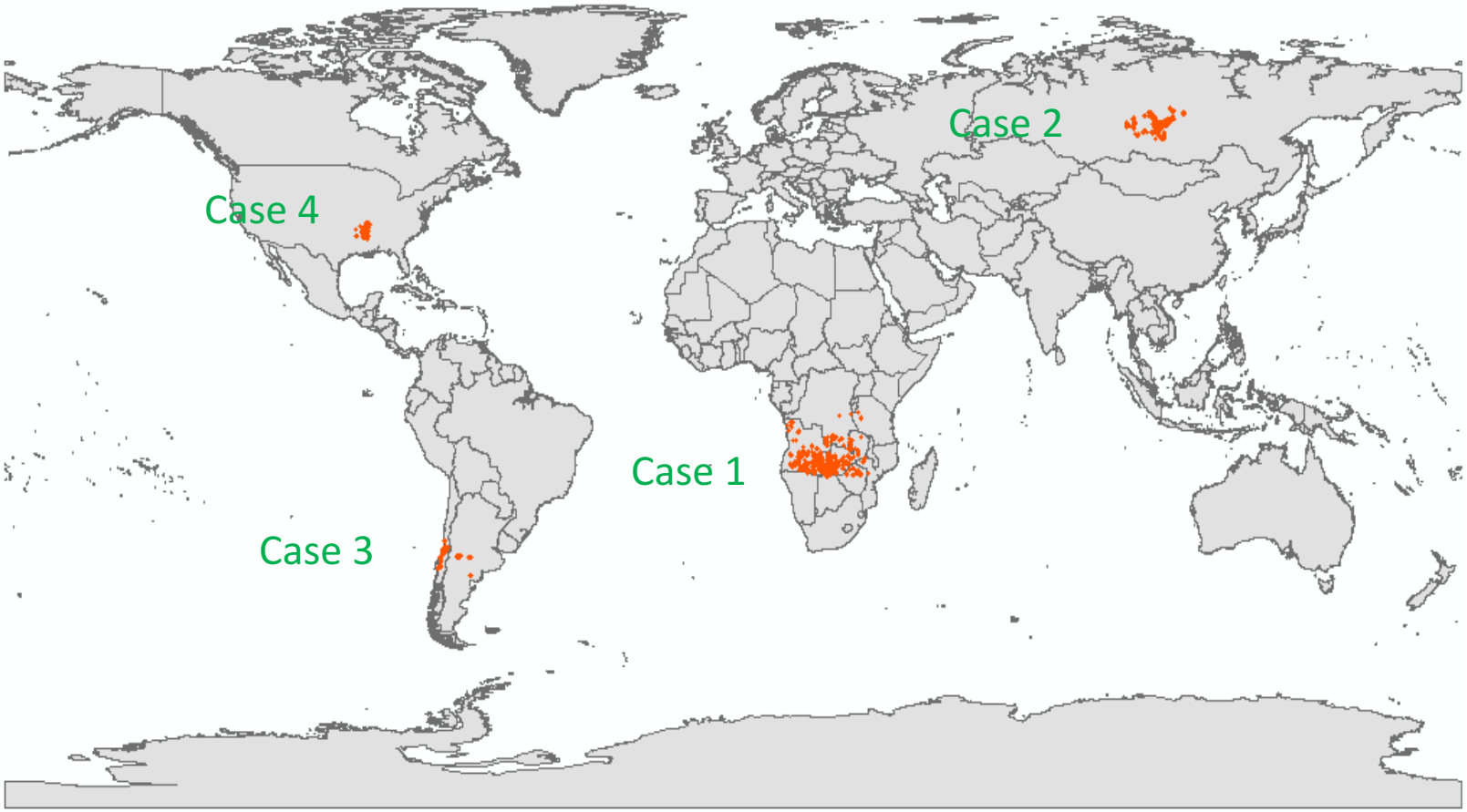
$$FRP = \frac{S_p \cdot \sigma \cdot (L_F - L_B)}{c} \cdot 10^{-6}$$

Constant

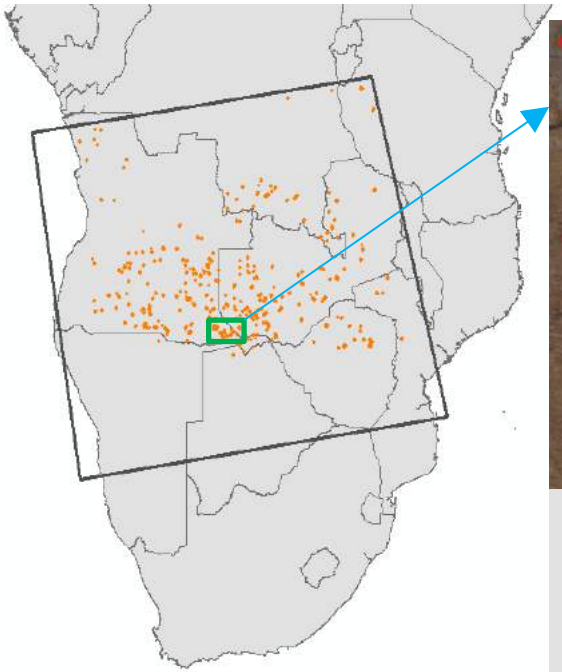


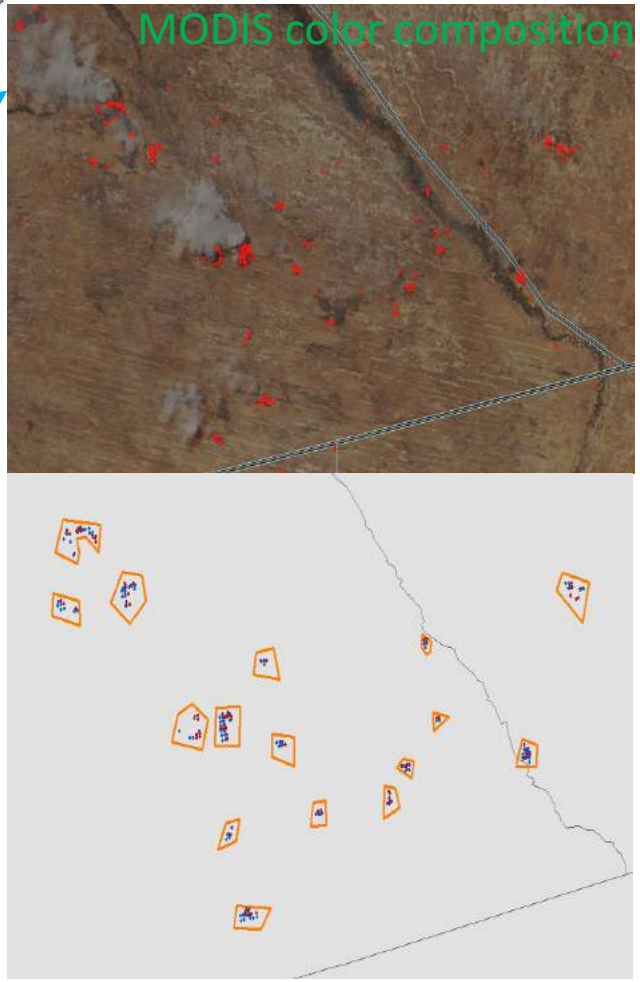
Giglio et al., VIIRS Active Fire Algorithm Theoretical Basis Document, Version 2.6, NOAA, June 2016

VIIRS Case Studies

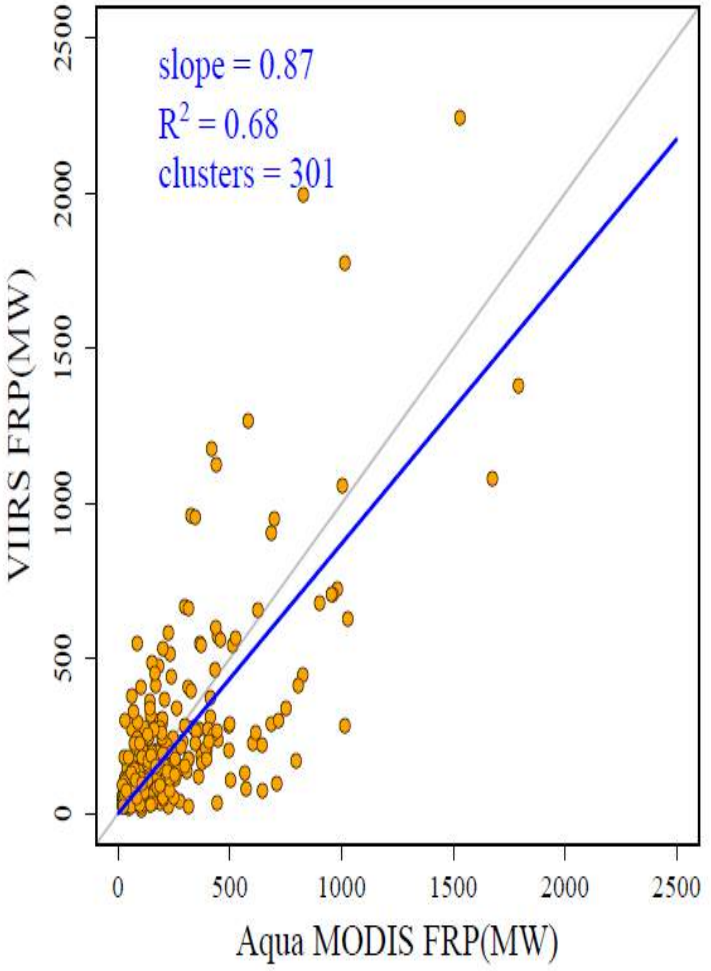


Case 1: August 22, 2016

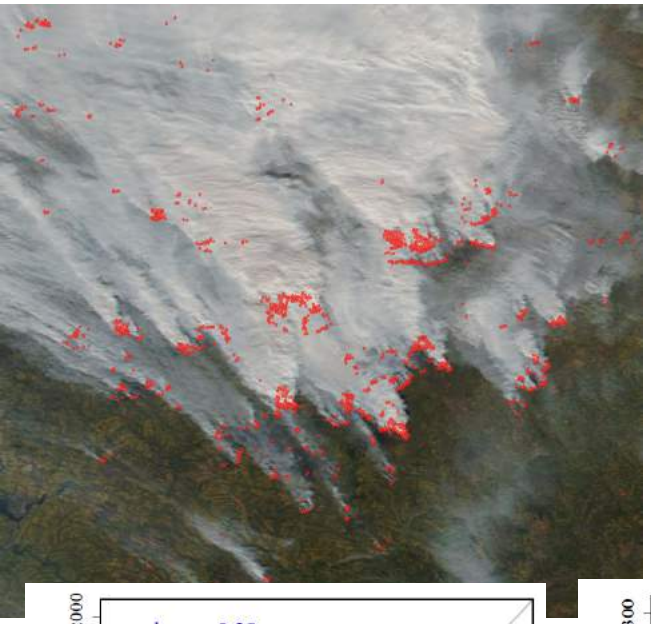


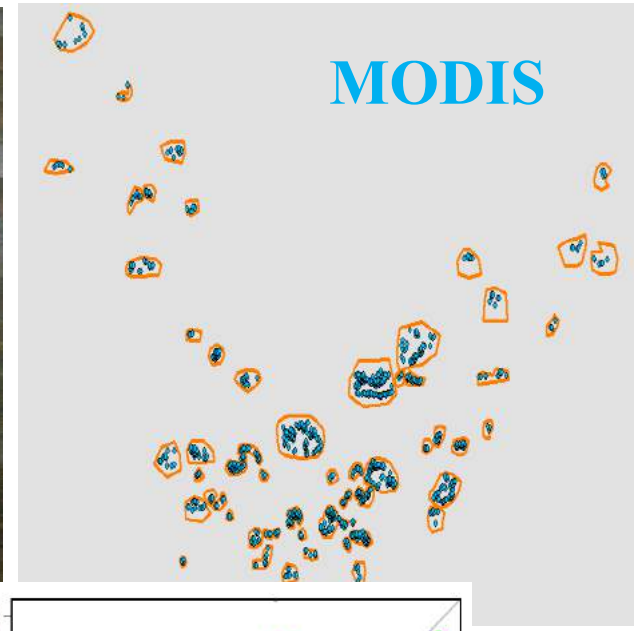


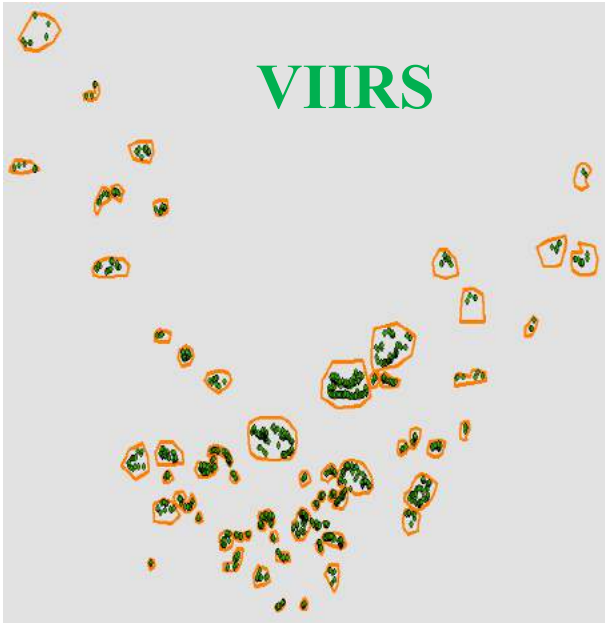
Fires from MODIS and VIIRS matched in individual fire events. Each fire event is considered as a cluster (total 301 fire events were selected)

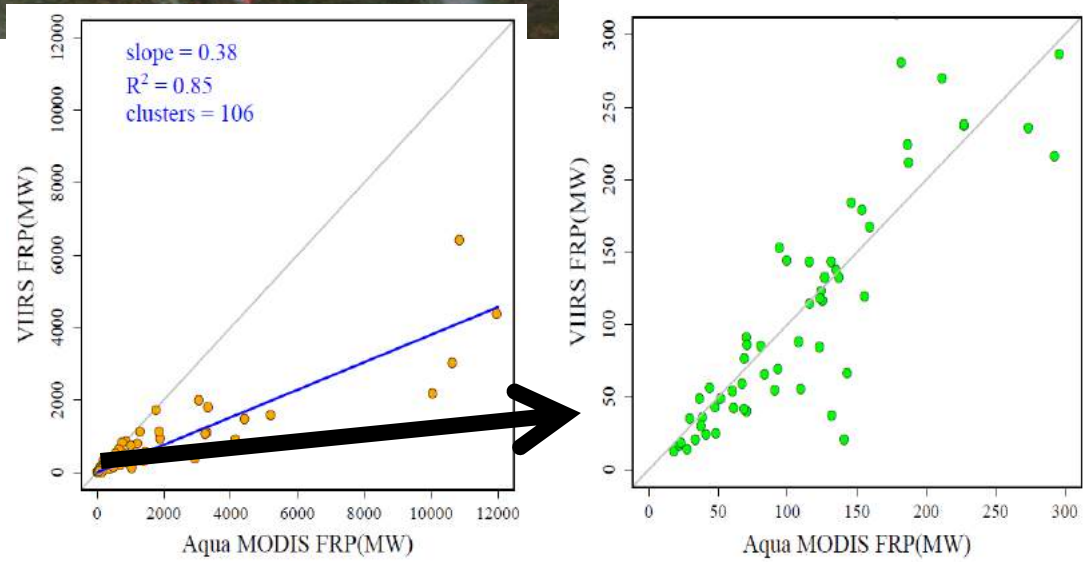


Case 2: September 18, 2016



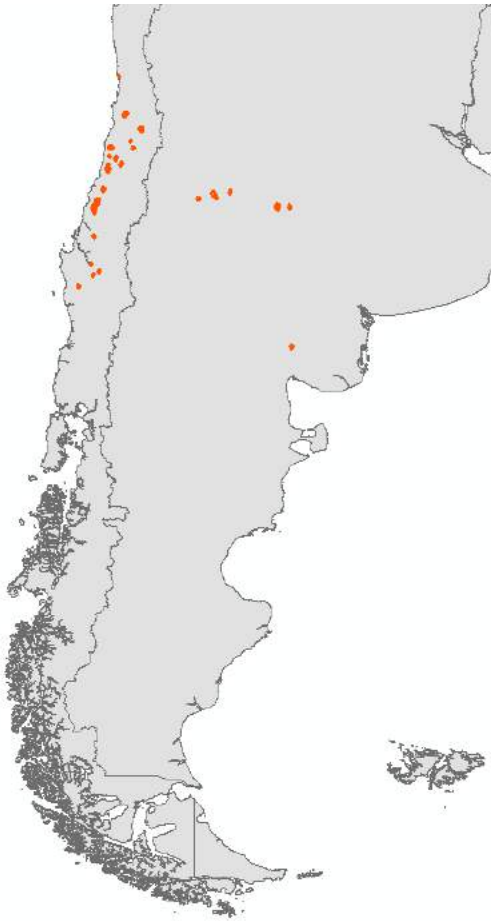


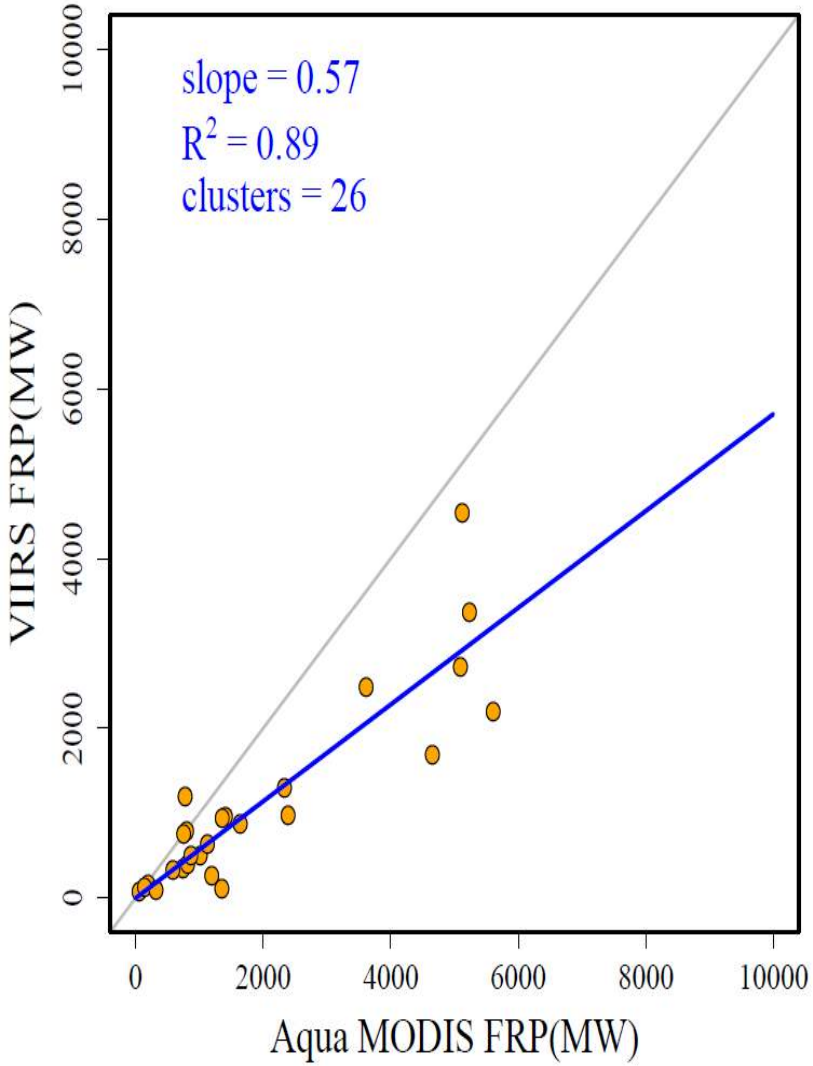




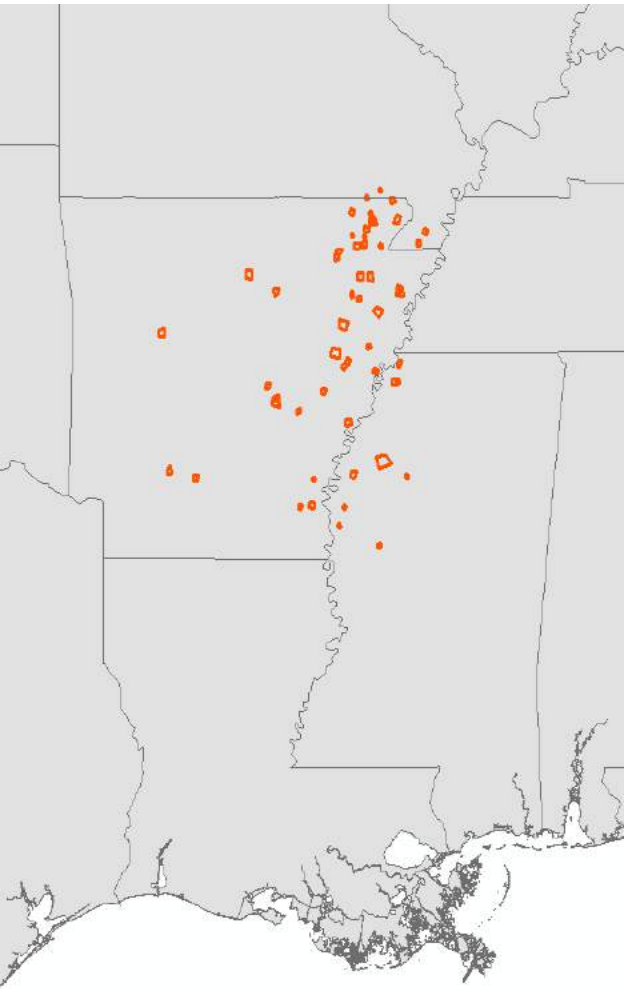
- **Fires from MODIS and VIIRS matched in individual fire events. Each fire event is considered as a cluster**
- **The MODIS FRP is much larger than VIIRS FRP in highest FRP cluster**
- **Both MODIS and VIIRS FRP are comparable if FRP < 300MW**

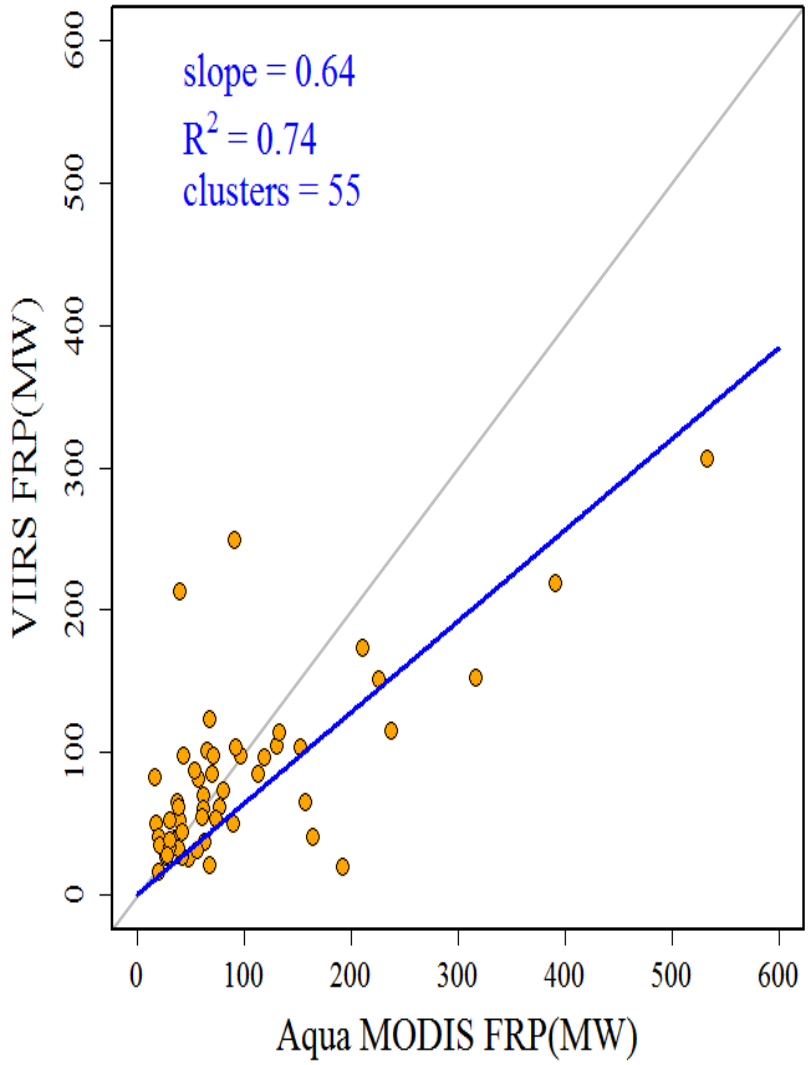
Case 3: January 21, 2017



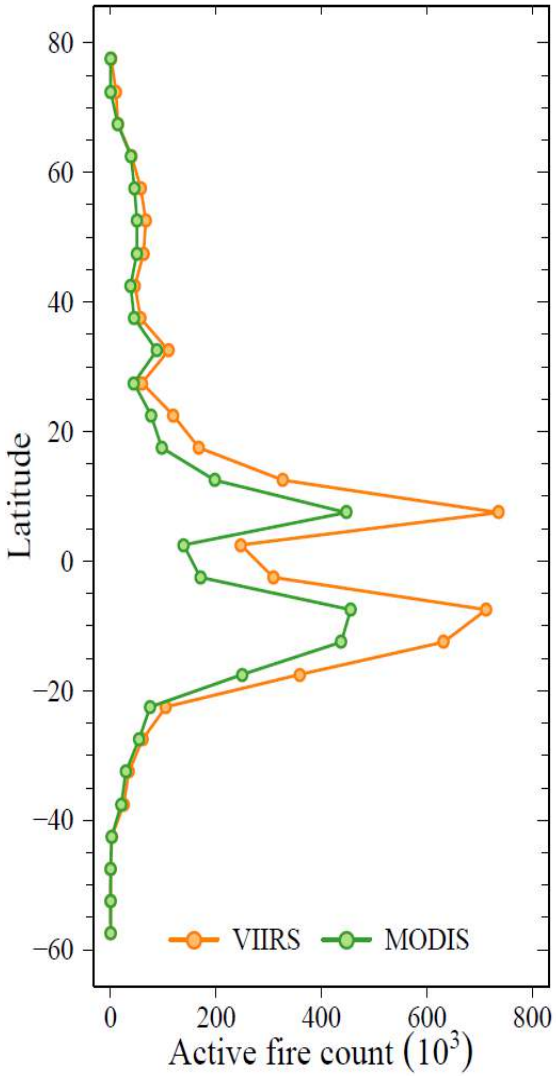


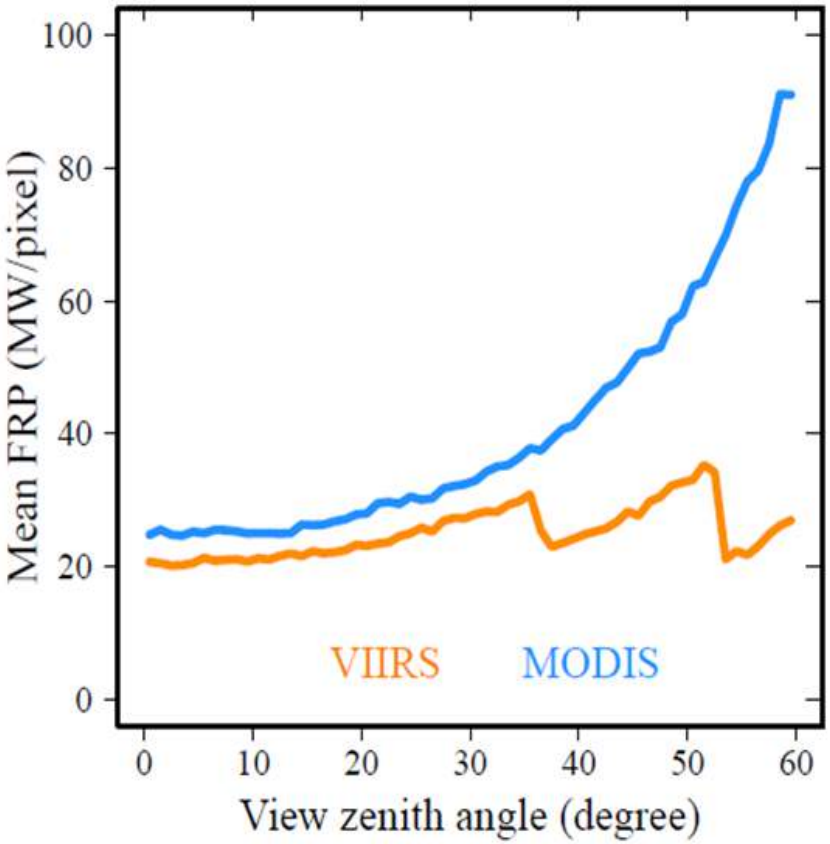
Case 4: January 28, 2017





VIIRS vs. MODIS





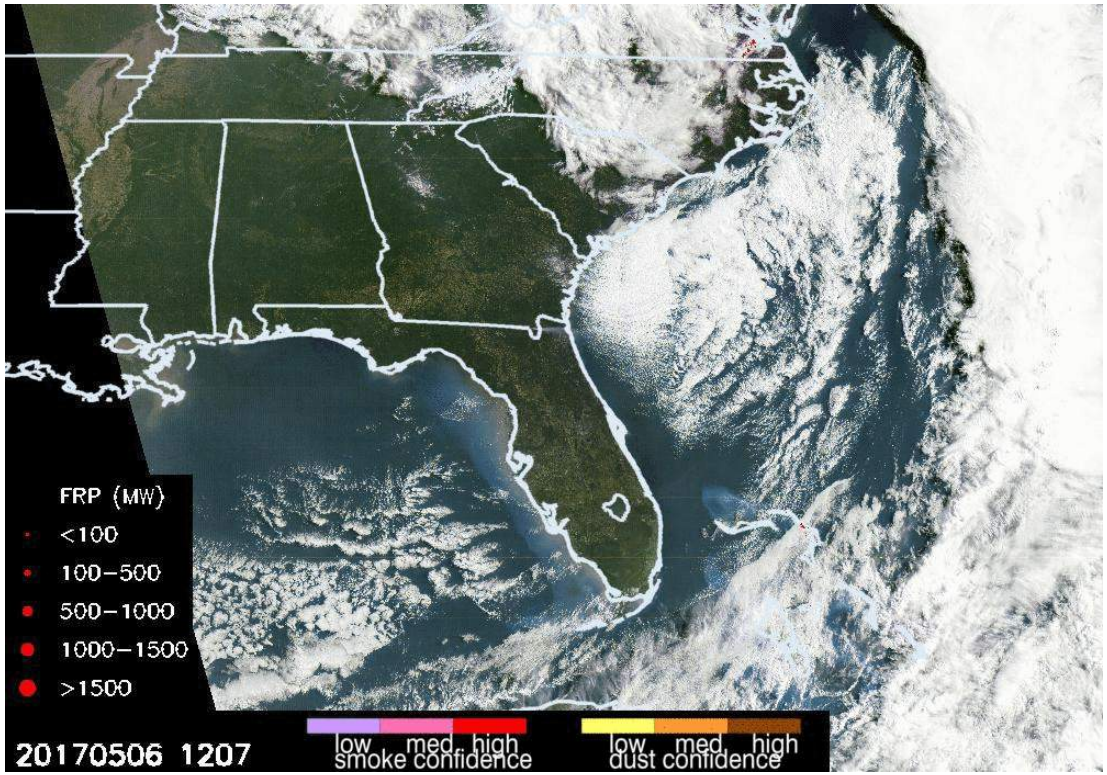
Data: April 2016 – March 2017
Location: 30°S-30°N

Li, Zhang, Kondragunta, and Csiszar, GRL, submitted, 2017

FRP Calculation: Sources of Differences between VIIRS and MODIS

- Pixel area
  - Area being burned is not always equal to the pixel area, especially when pixel size is large – sensor response is different based on where within the pixel the fire location is. Center of the pixel is optimal
- Atmospheric transmittance
  - VIIRS bandwidth slightly broader than MODIS. Atmospheric absorption reduces the radiance which partially explains lower FRPs of VIIRS. *Accounting for absorption by CO and CO_2 during large fires (high FRP) is expected to bring VIIRS closer to MODIS.*

GOES-16 ABI Fire/Smoke: West Mims Fire May 6, 2017



Smoke from fires in FL/GA overlaid on RGB image

Parts of smoke plume detected

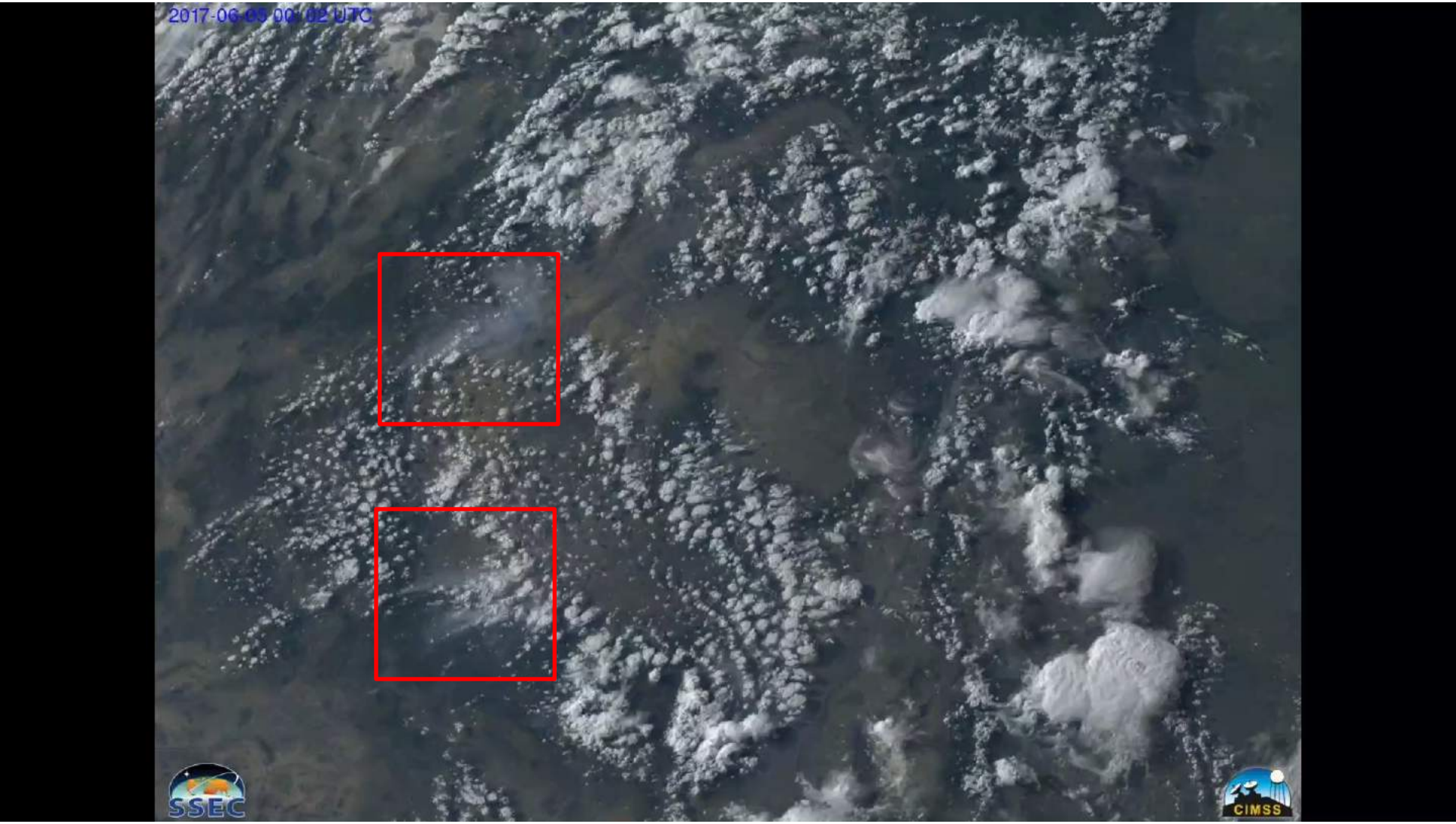
Algorithm upgrades to tune spectral threshold tests pending

False smoke over shallow water regions is due to sunglint.

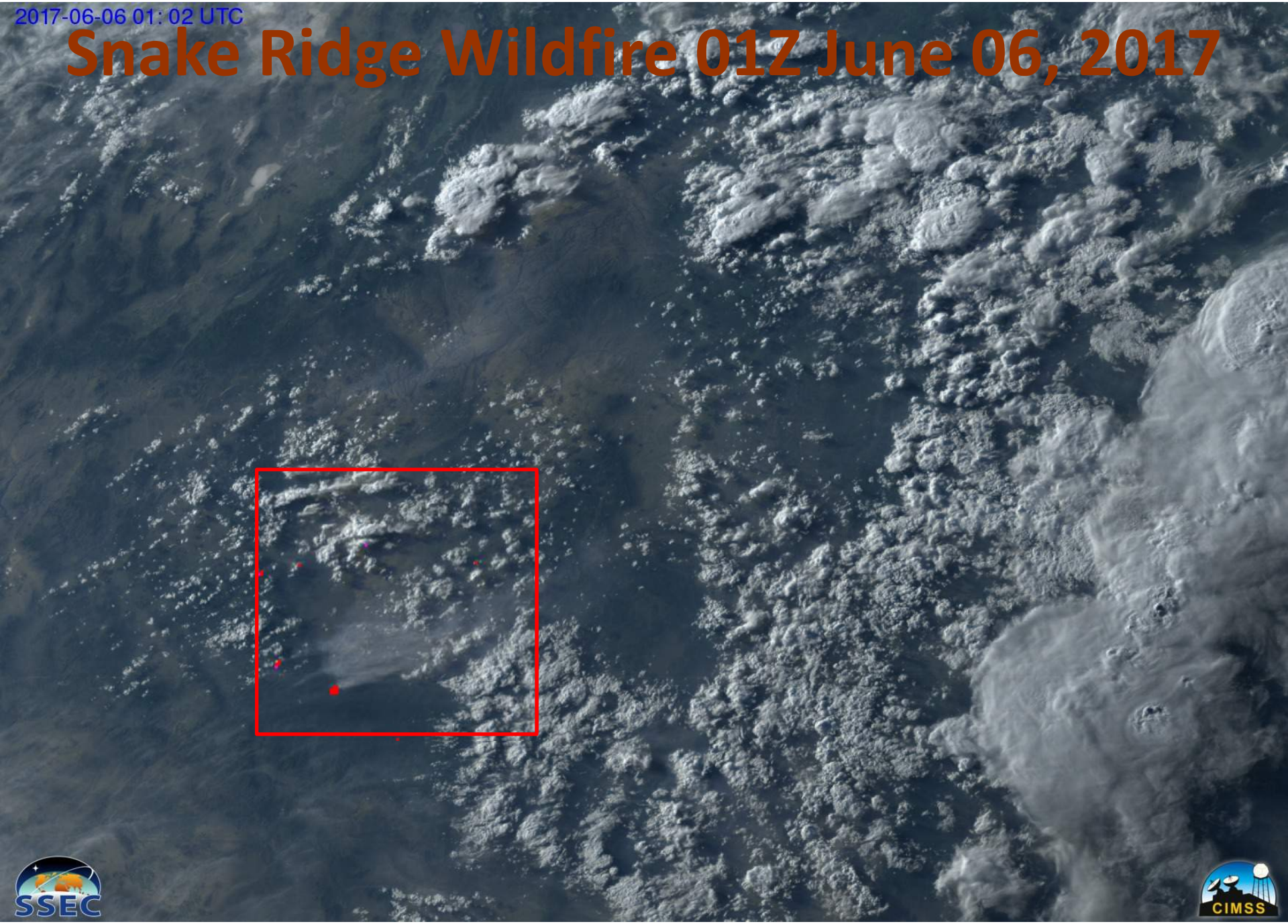
First implementation of smoke detection for a geostationary satellite sensor. Angle dependencies of various spectral tests still being investigated.

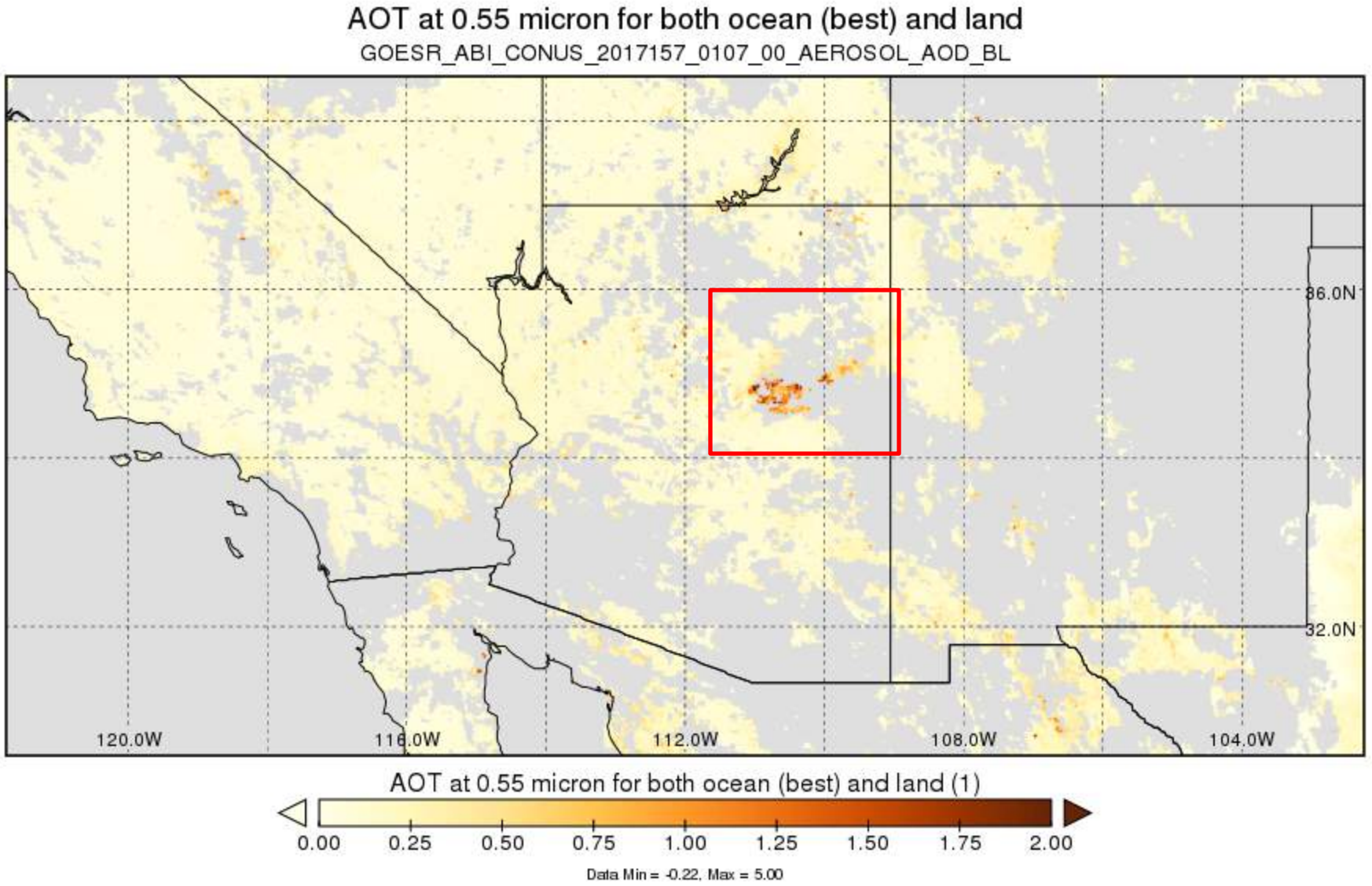
Credit: NOAA/NESDIS/STAR aerosol team
Contact: Shobha.Kondragunta@noaa.gov

Snake Ridge Wildfire June 05-06, 2017



Credit: ABI Imagery team
Contact: Tim.schmit@noaa.gov


2017-06-06 01: 02 UTC
Snake Ridge Wildfire 01Z June 06, 2017
SSEC
CIMSS



Disclaimer: Product preliminary at beta maturity. ***Not to be used in any science studies.*** *Satellite and instruments still in checkout phase. Parked at 89°W during Post Launch Testing. Will be moved to 75°W in November to its permanent East location and will replace GOES-13.*

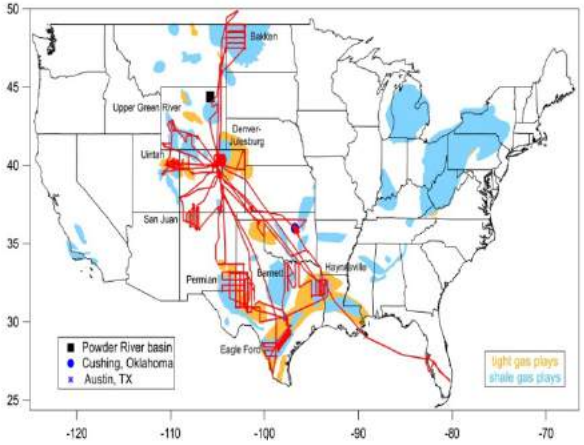
NUCAPS Trace Gas Retrievals (EDR)

- A science version of the NOAA-Unique CrIS-ATMS Processing System (NUCAPS) CO retrieval is being tested that using CrIS full spectral resolution radiances.

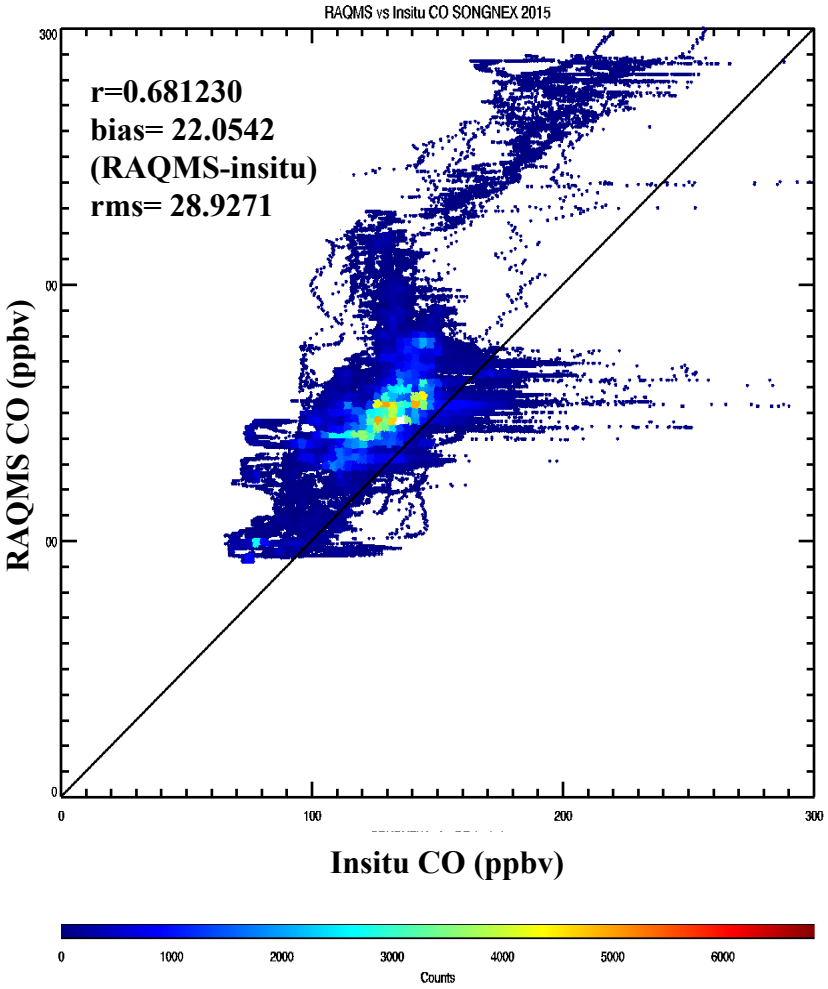
- Collaborative effort combining expertise in satellite retrieval development (STC), airborne trace gas measurements (ESRL/CIRES), and satellite trace gas validation (STAR/CIMSS) to characterize NUCAPS trace gas retrieval quality

- Output files include averaging kernel, apriori, interpolation and inverse matrixes for applying to model (or insitu) profiles for data assimilation (or validation) activities.

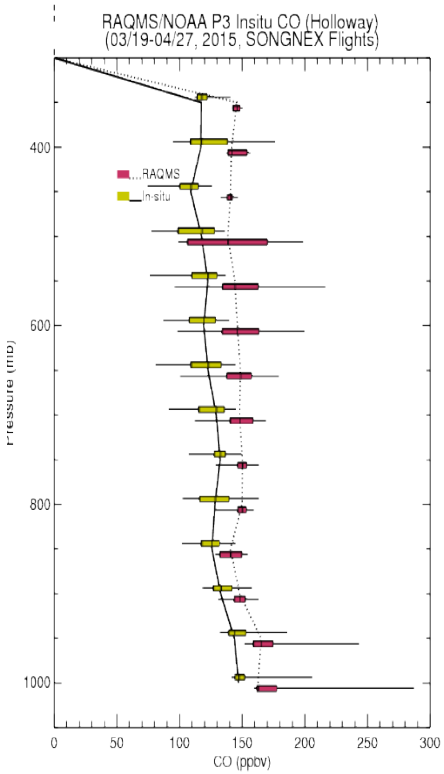
SONGNEX 2015
Shale Oil and Natural Gas Nexus



RAQMS vs Insitu SONGNEX 2015
(March 19-April 27, 2015)

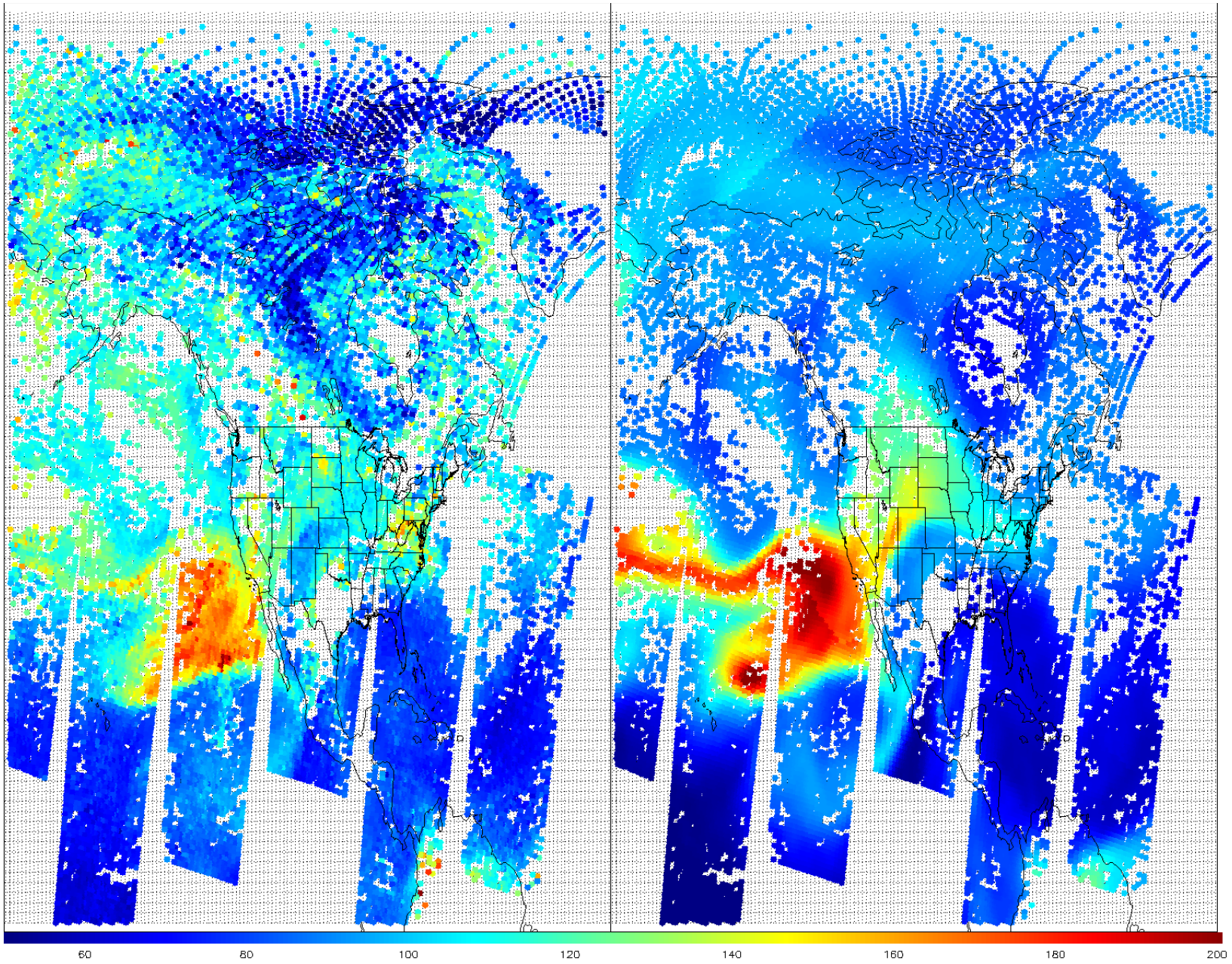


Evaluation of RAQMS vs insitu CO during NOAA/ESRL SONGNEX 2015 for indirect NUCAPS CO validation



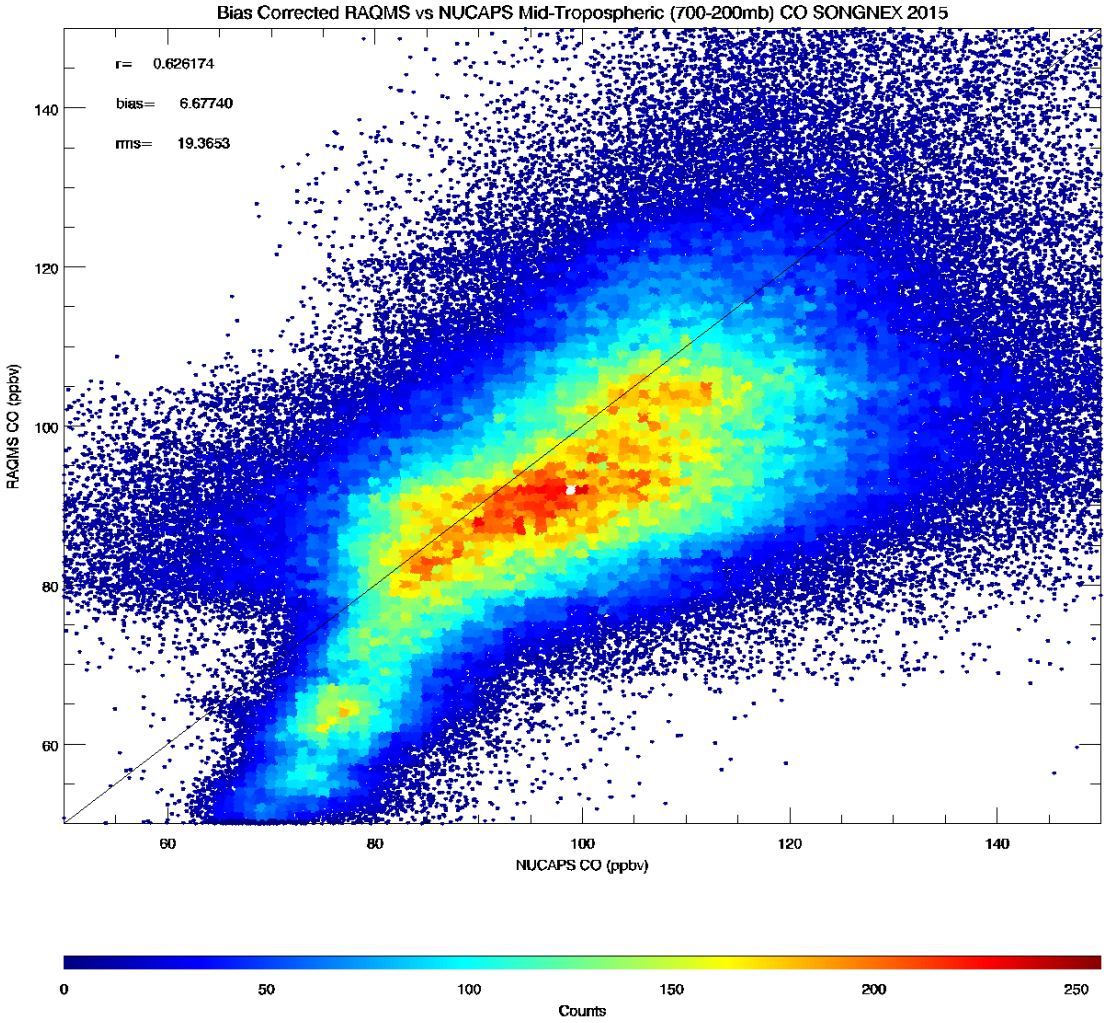
NUCAPS FSR CO 03/21/2015

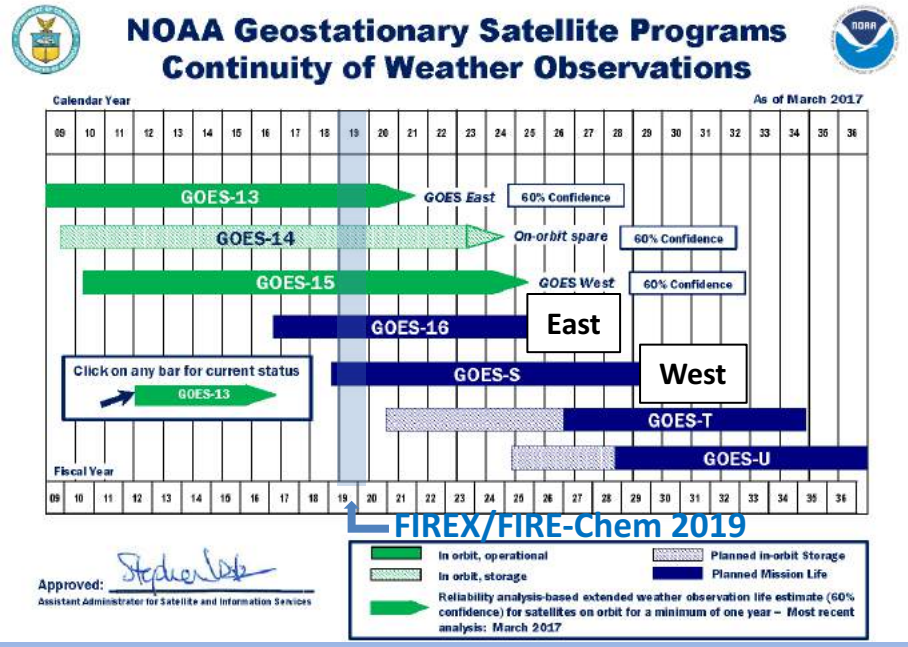
Bias corrected RAQMS CO 03/21/2015



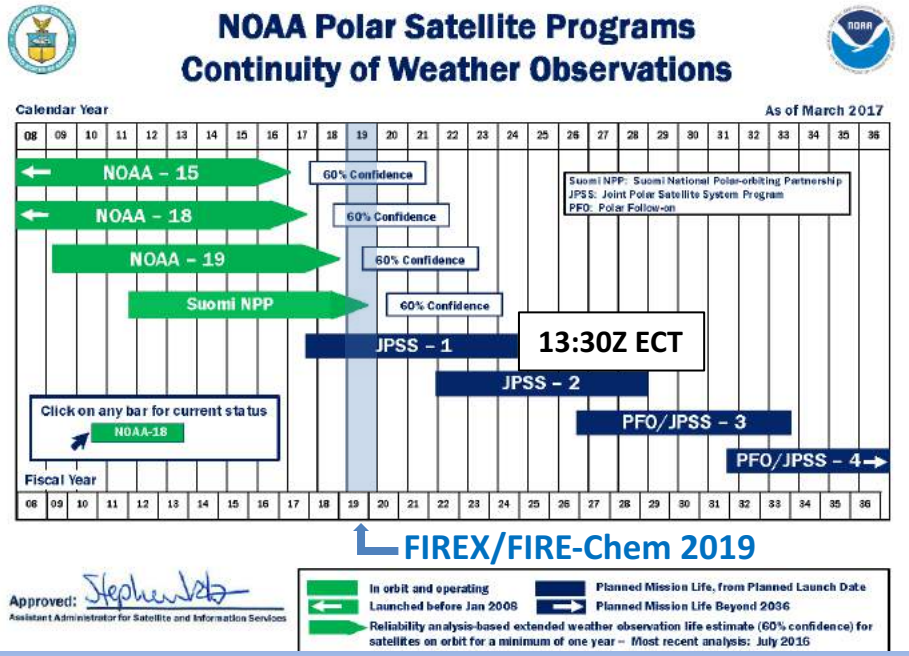
Mid Tropospheric (200-700mb) CO (ppbv)

Comparisons between bias corrected RAQMS and NUCAPS mid tropospheric CO suggests that NUCAPS has a 6.8 ppbv high bias relative to the insitu aircraft measurements





https://www.wmo-sat.info/oscar/satellites/view/152



https://www.wmo-sat.info/oscar/satellites/view/208

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Shobha.Kondragunta@noaa.gov