Legacy GOES vs. GOES-R for Air Quality Applications

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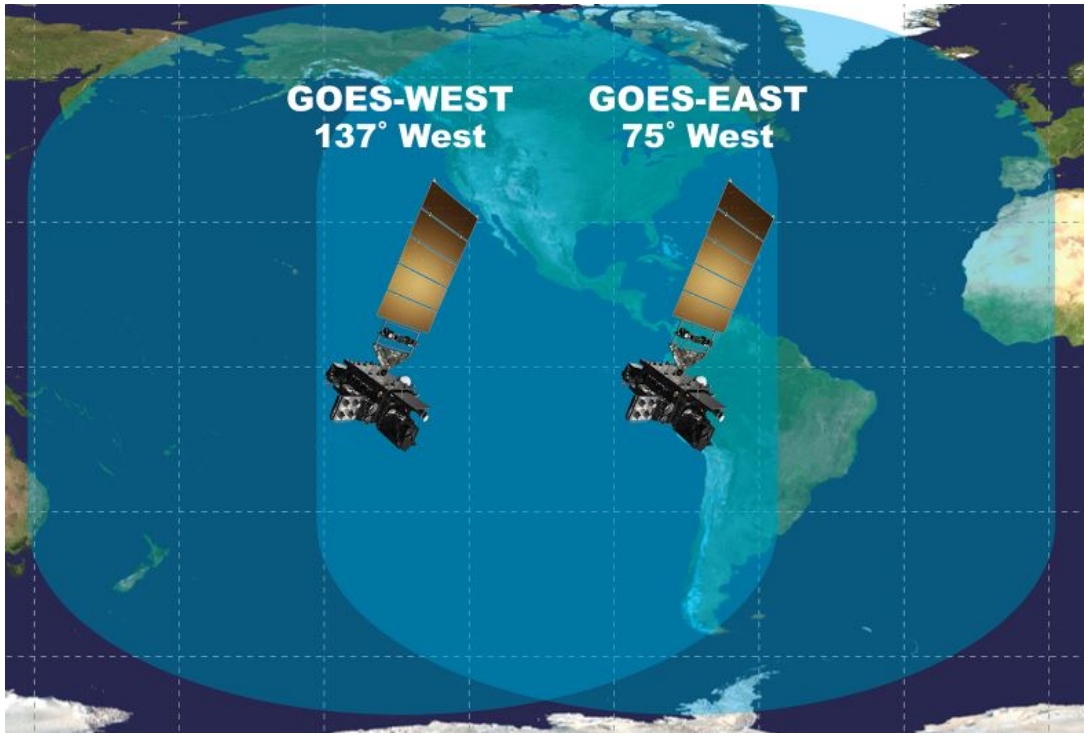
https://www.goes-r.gov/spacesegment/abi.html

GOES Imager

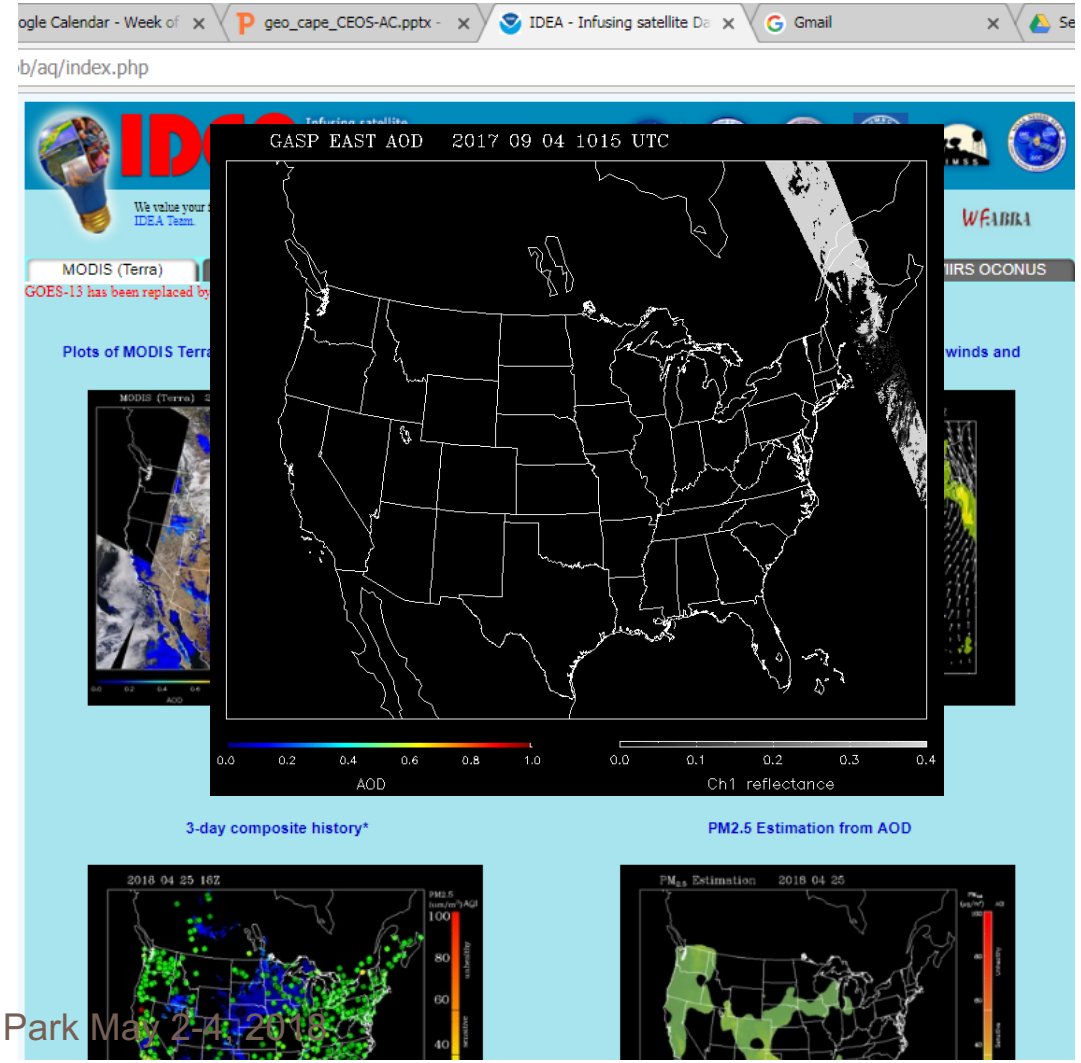
- Five channel imager for meteorological applications
- GOES visible (520 – 720 nm) band used to retrieve aerosol optical depth (AOD). *Product name GASP. Coverage CONUS only*
- GASP for GOES-E from 2003-2017 and for GOES-W from 2003-present
- Archived data available from NOAA CLASS (class.noaa.gov)
- Resolution: Spatial 4 km nadir Temporal 30 min



GASP Applications

- Air quality forecasting
- Numerical model verification
- Flight coordination during field campaigns
- Smoke exposure assessment
- Estimates of smoke plume areal extent and smoke concentration
- Diurnal variation etc.

Main tools for Air quality forecasters are yesterday's MODIS AOD and today's GOES AOD



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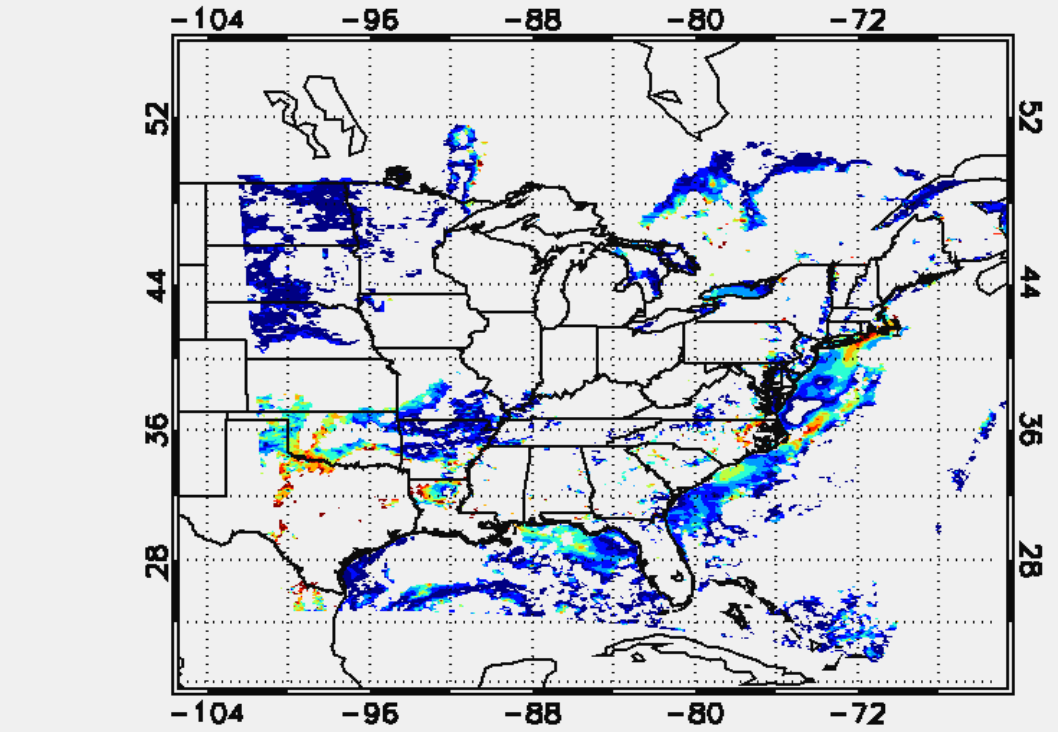
Kondragunta et al., JAMC, 2007



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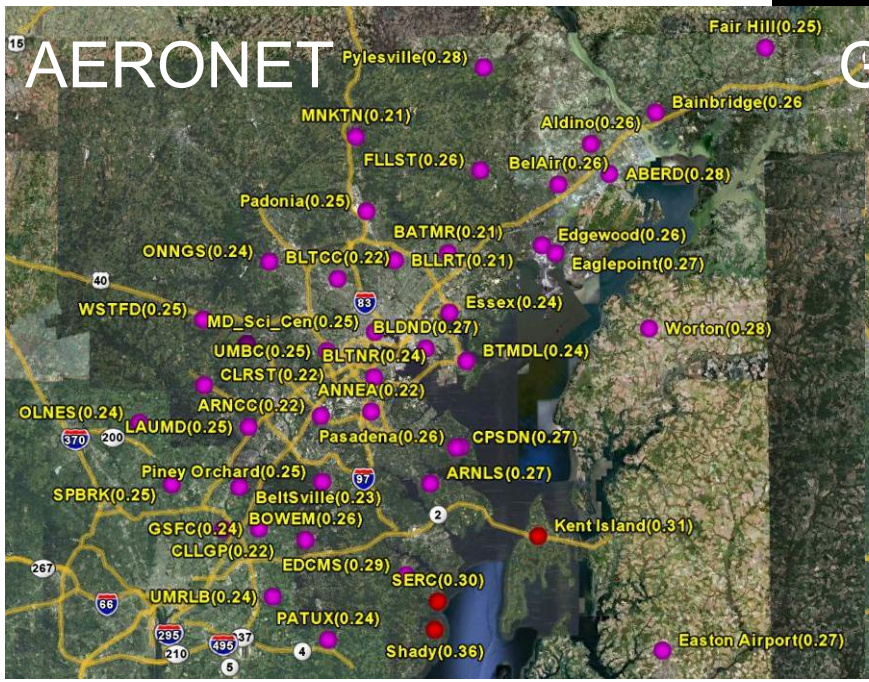
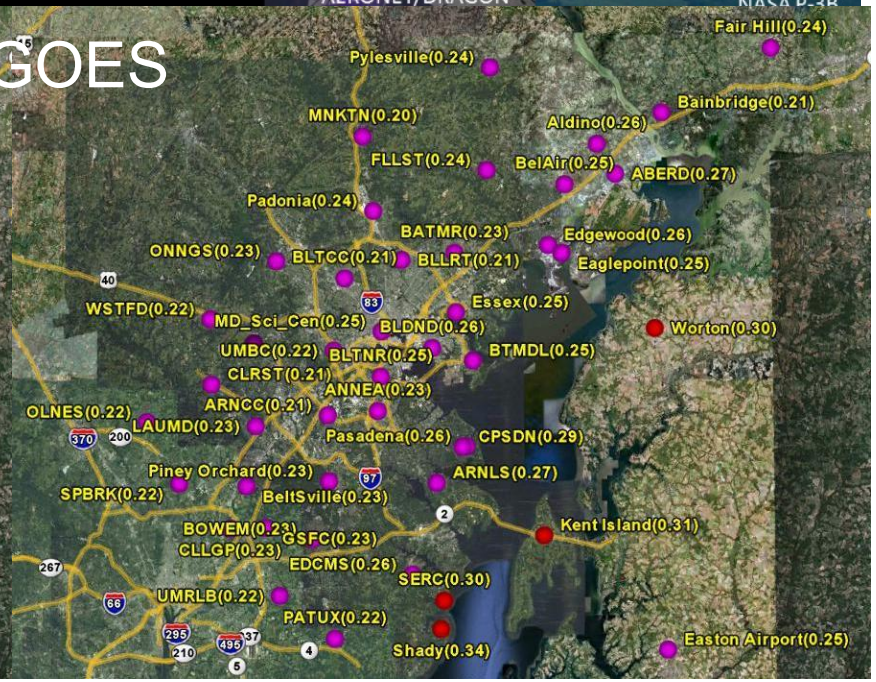
DISCOVER-AQ





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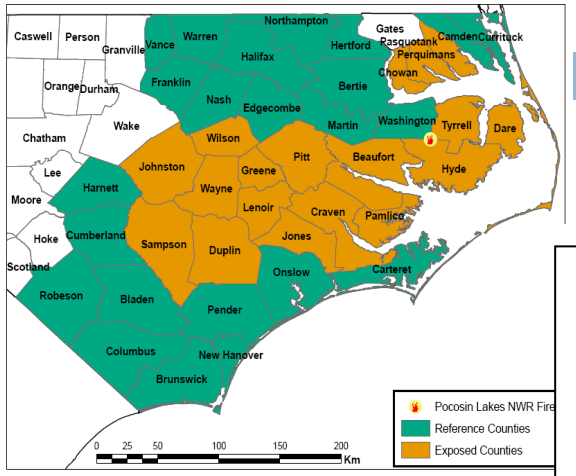
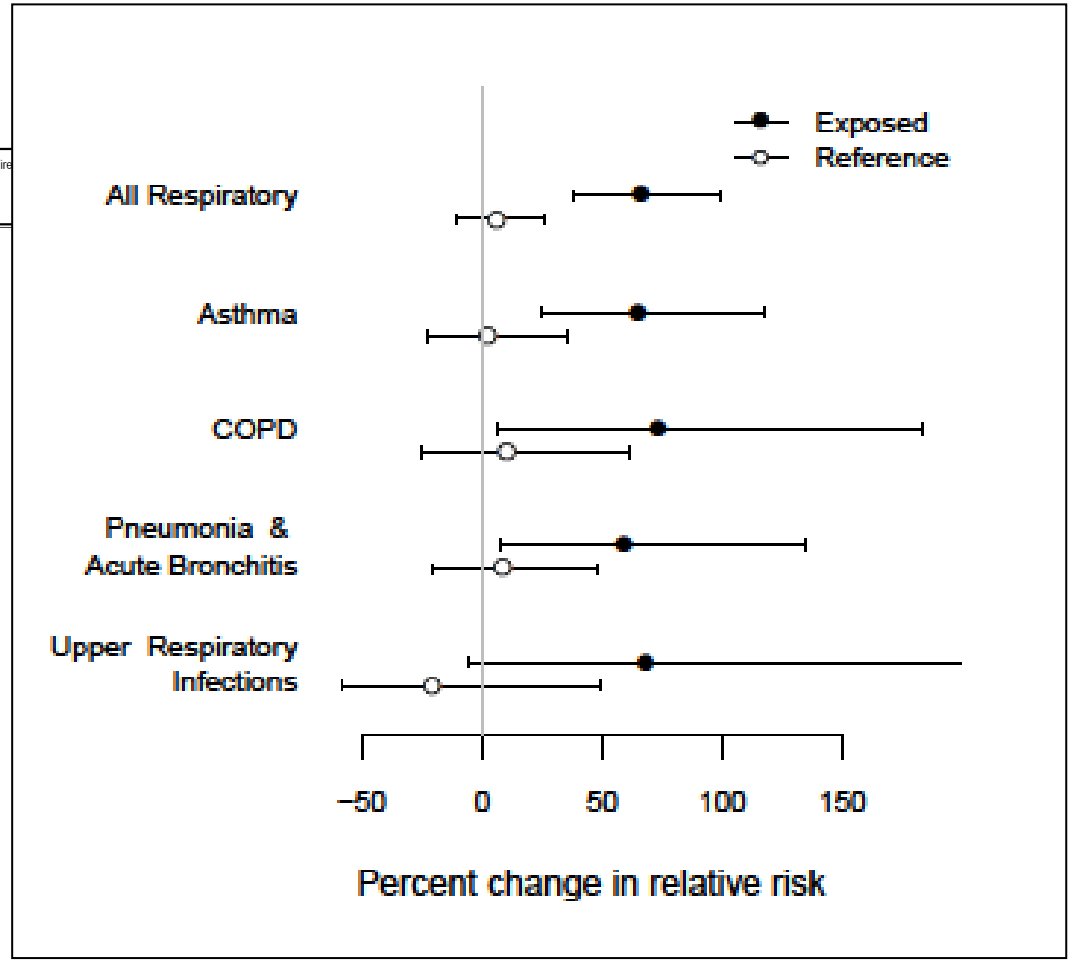


North Carolina Peate Fire Summer 2008



Susan Stone, USEPA

GASP Applications

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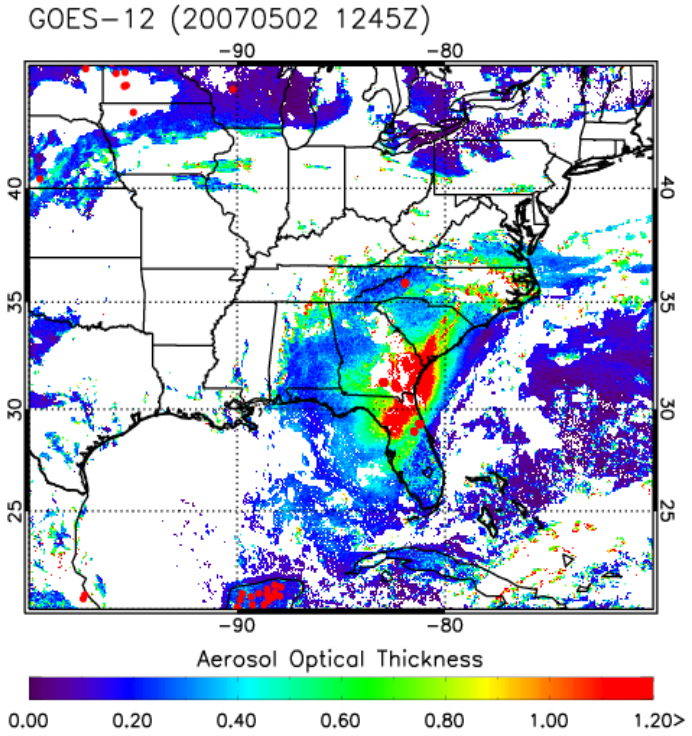
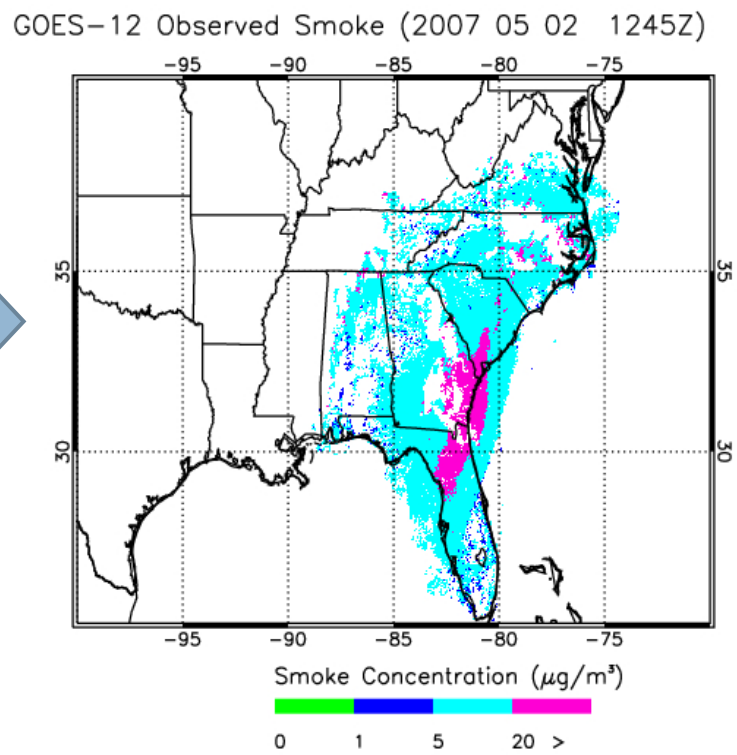
$$m_c = \frac{\tau}{k * h}$$





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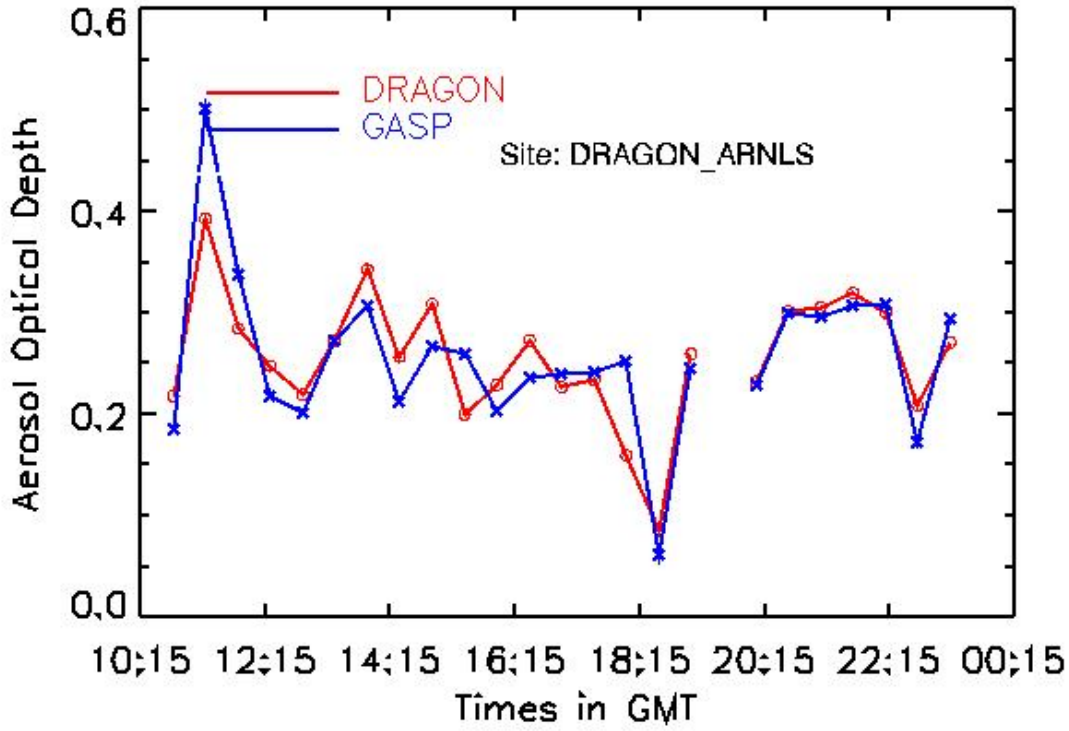
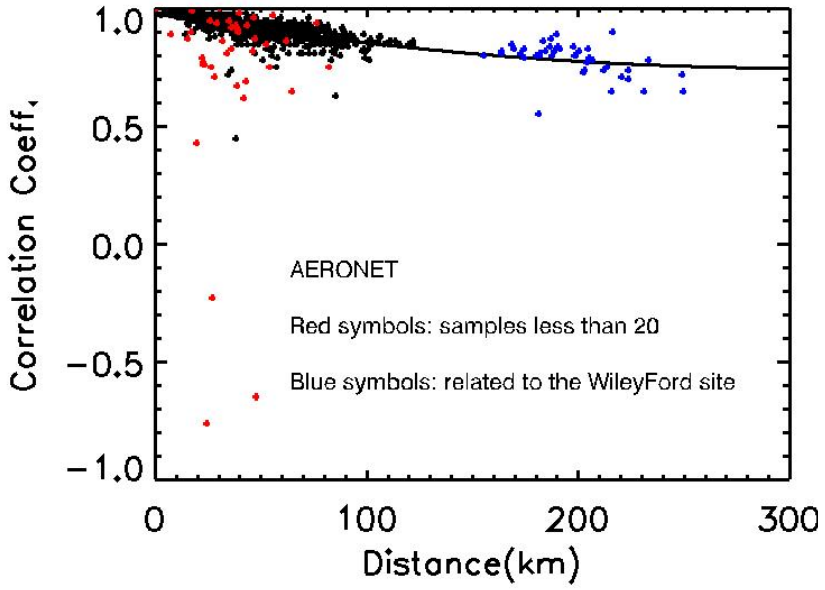
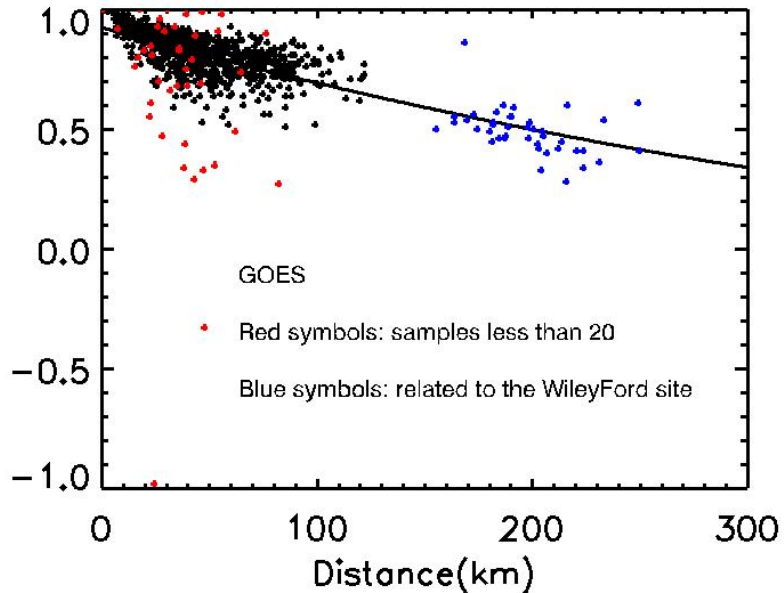


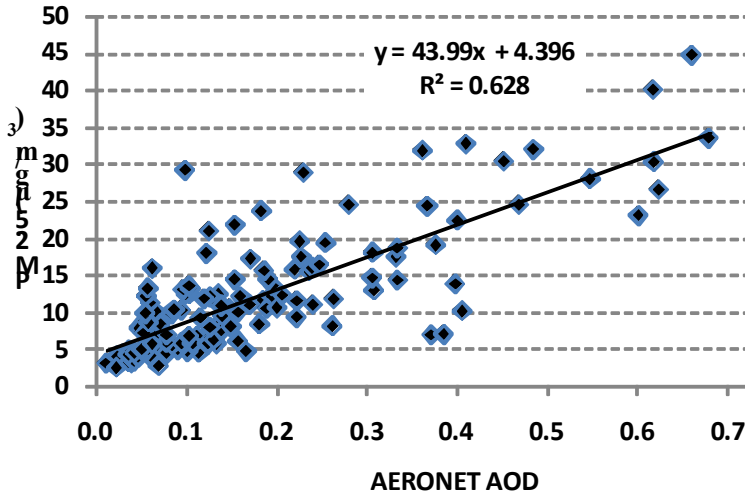


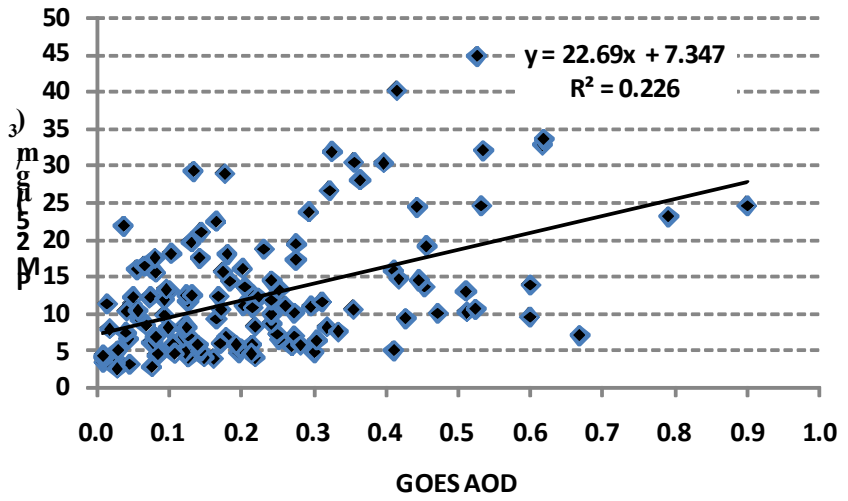


Kondragunta et al., AGU, 2013

GASP Data Quality and Usability

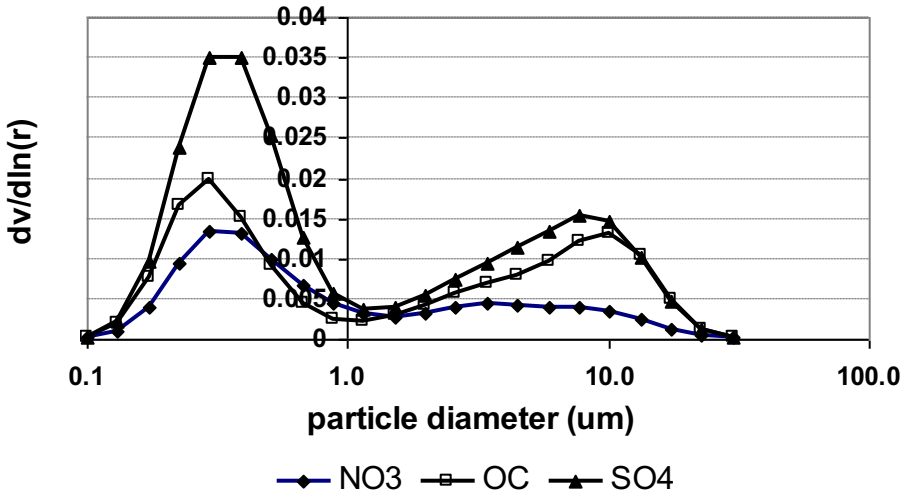
Bondville, IL

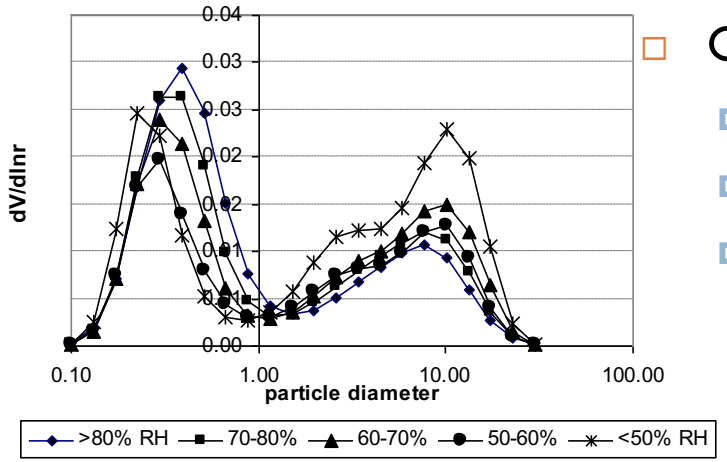




GOES vs. AERONET AOD

Season	Bias	RMSE	r
Winter	0.059	0.112	0.522
Spring	0.109	0.178	0.616
Summer	0.022	0.136	0.728
Autumn	0.042	0.060	0.695
All	0.044	0.149	0.646





- Correlation of AOD with PM2.5 high when
  - sulfates and organics dominate
  - RH is between 60% and 80%
  - Fine mode fraction is high

Green et al., ***Comparison of GOES and MODIS Aerosol Optical Depth (AOD) to AERosol RObotic NETwork (AERONET) AOD and IMPROVE $PM_{2.5}$ mass at Bondville, Illinois***, *JAWMA, 2009*

GASP Data Quality and Usability

- Paciorek et al., Spatiotemporal associations between GOES aerosol optical depth and surface PM2.5, EST, 2011
- Prados et al., GOES Aerosol/Smoke Product (GASP) over North America: Comparisons to AERONET and MODIS observations, JGR, 2007
- Zhang et al., Aerosol optical depth (AOD) retrieval using simultaneous GOES-East and GOES-West reflected radiances over the western United States, AMT, 2013
- GASP algorithm adapted for GOCI (Korea)
- GASP algorithm adapted for INSAT-3D (India)

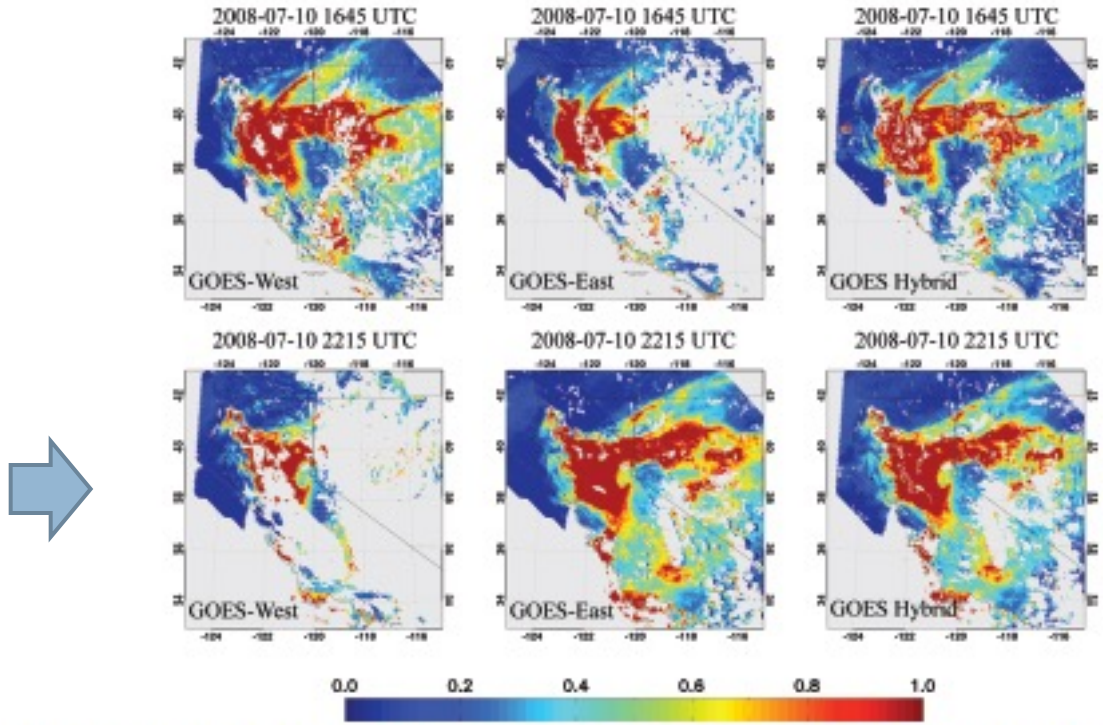


Fig. 12. Comparison of AOD retrievals from single satellite algorithms and from the hybrid algorithm for the California fire case on 10 July 2008 at two observation times: 16:45 UTC and 22:15 UTC. The retrievals from the combined algorithm are not plotted because they are the same as the single satellite retrievals with smaller scattering angles, i.e. GOES-West at 16:45 UTC and GOES-East at 22:15 UTC.

GOES-R ABI Requirements

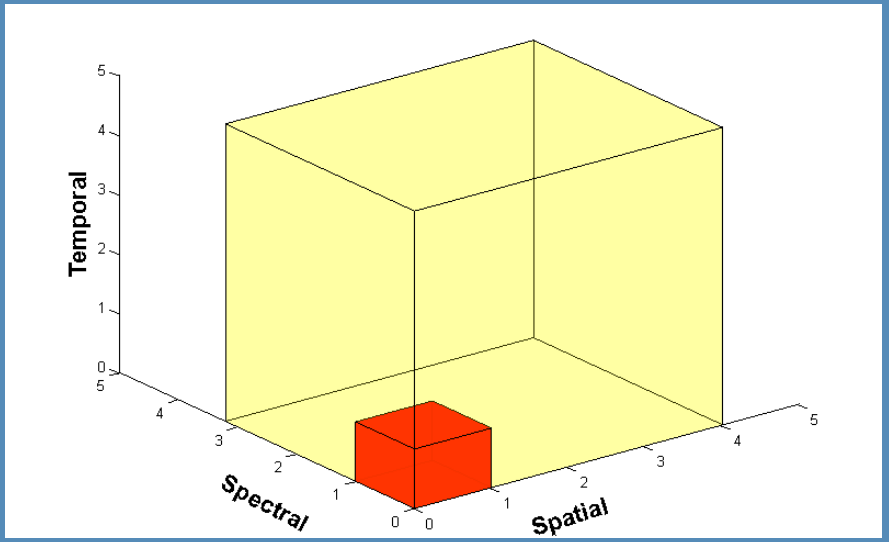
Land

AOD	Accuracy	Precision
<0.04	0.06	0.13
0.04 – 0.80	0.04	0.25
>0.8	0.12	0.35

Water

AOD	Accuracy	Precision
<0.4	0.02	0.15
>0.4	0.10	0.23

GOES-R ABI



5x Faster coverage (5-minute full disk vs. 25-minute)

4x Improved spatial resolution (2 km IR vs. 4 km)

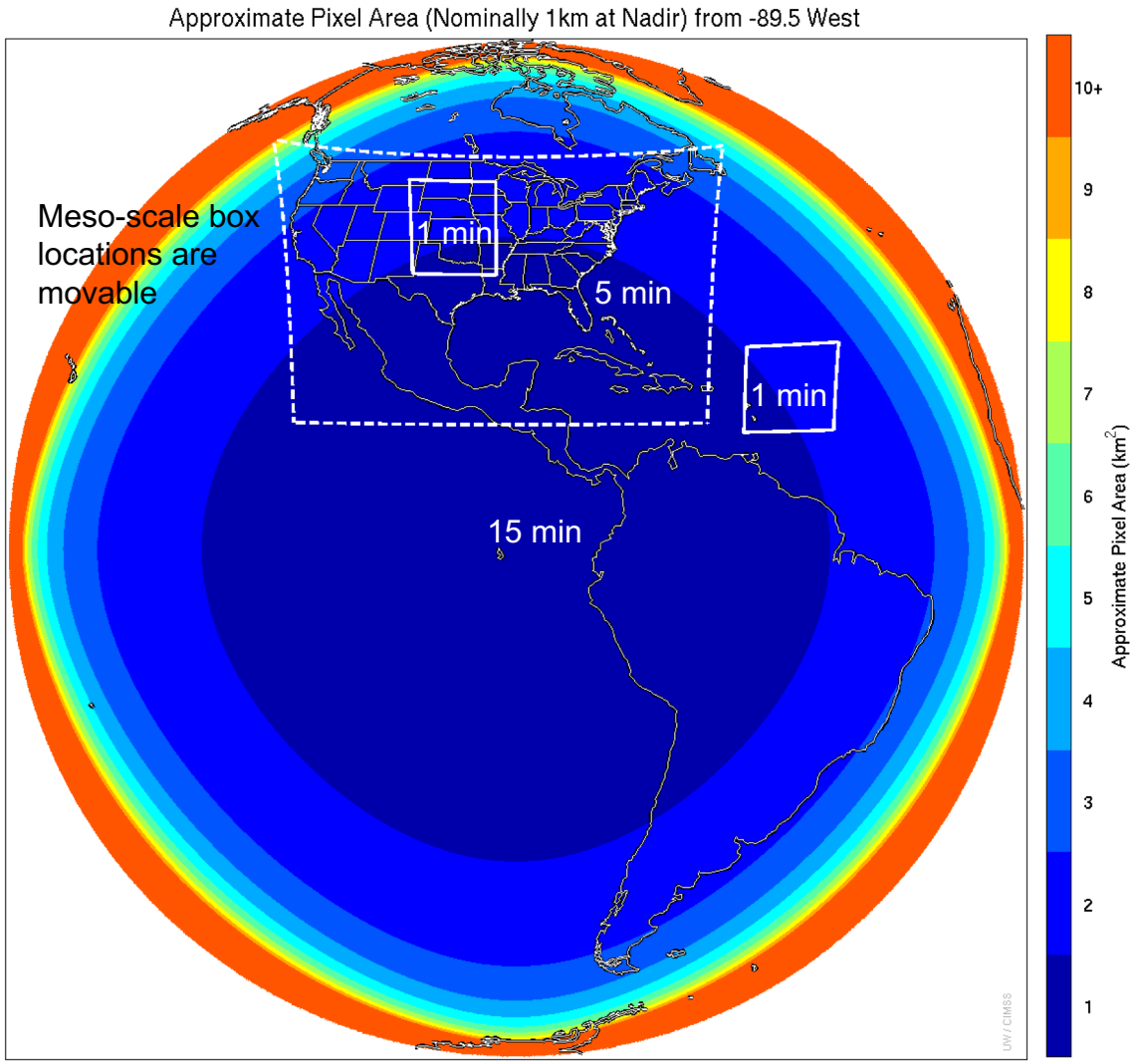
3x More spectral bands (16 on ABI vs. 5 on the current imager)

0.47
0.64
0.86
1.6
1.38
2.2
3.9
6.2
6.7
7.3
8.5
9.7
10.3
11.2
12.3
13.3

Domain	Legacy GOES			
	AOD	Geo Color RGB	Dust RGB	Smoke/Dust Mask
CONUS	X			
Full Disk				
Mesoscale				

Domain	GOES-R/S			
	AOD	Geo Color RGB	Dust RGB	Smoke/Dust Mask
CONUS	X	X	X	X
Full Disk	X	X	X	X
Mesoscale		X	X	X

Onboard calibration * Better navigation * On demand mesoscale



Default Operational Mode:

Full Disk 15 min

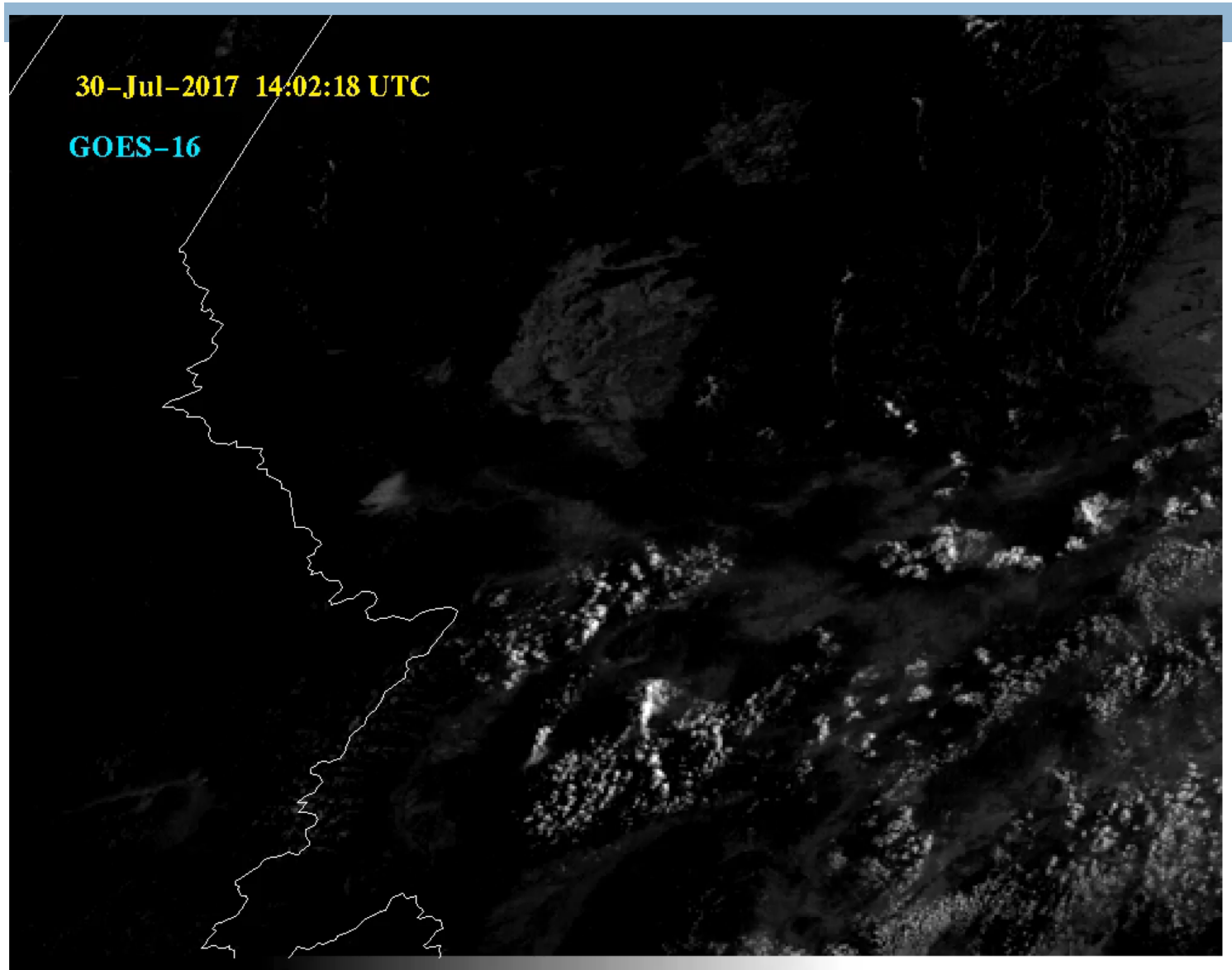
CONUS 5 min

Mesoscale 1 min

Proposed mode to be consistent with AHI

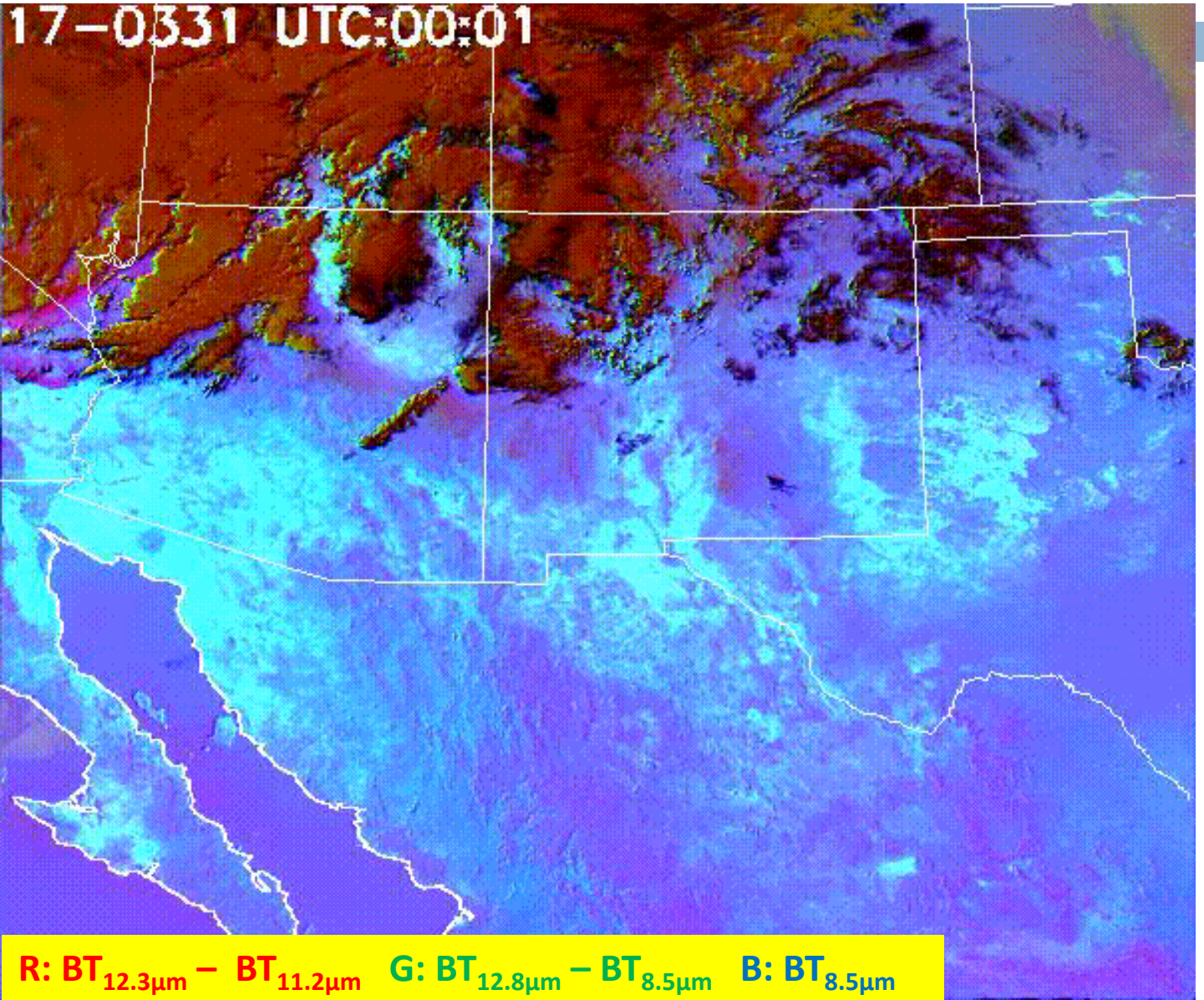
Full Disk 10 min

GOES-R ABI 0.62 µm



Smoke from several small plumes blend together and become one large plume.

GOES-R ABI Dust RGB



Dust storms in the southeast form in late evenings and last into the night;

Polar-orbiting satellites miss them due to mid-afternoon overpass time;

ABI imagery capture the events

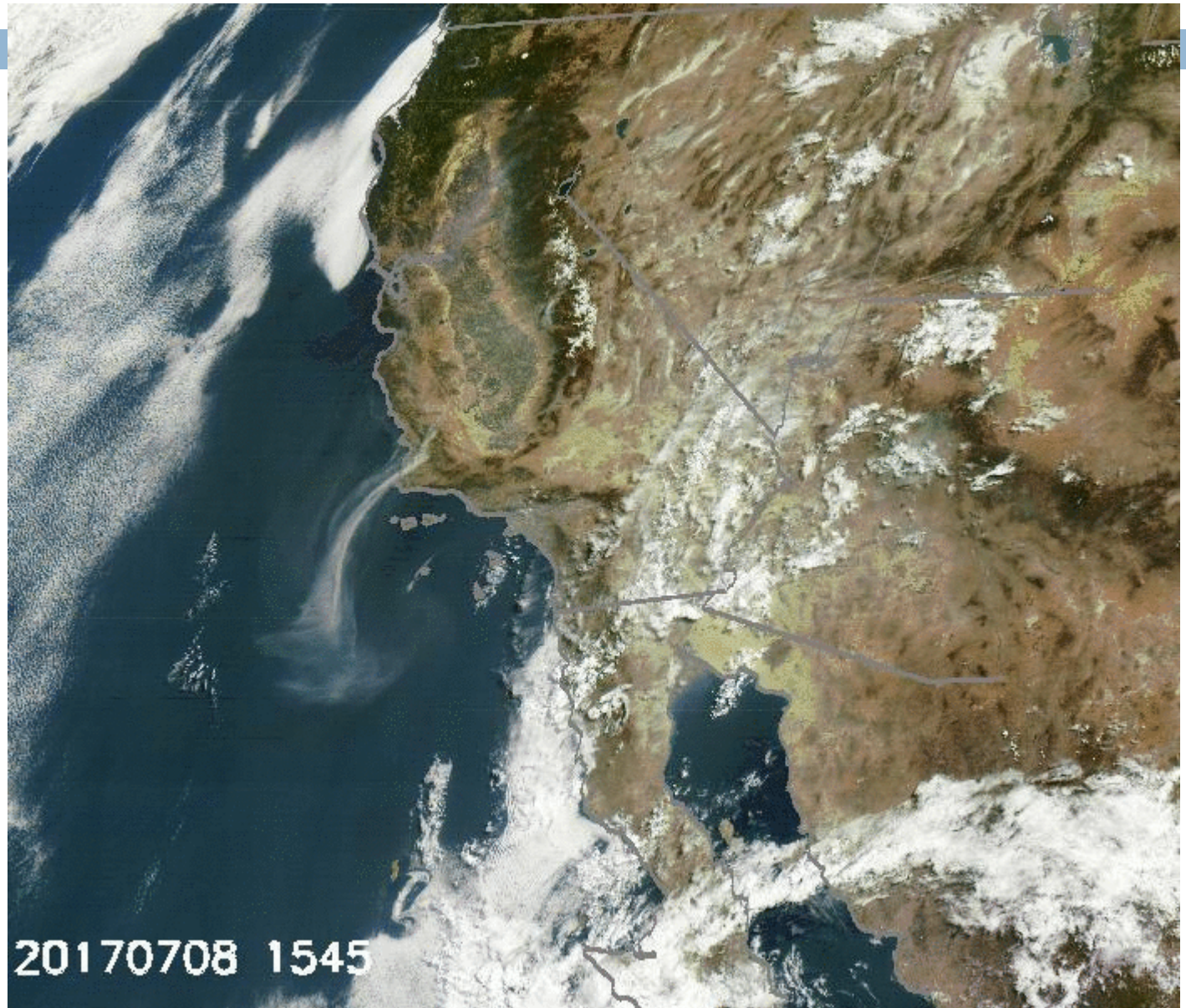
Kondragunta et al., Tracking dust storms using latest satellite technology, EM, 2018

GOES-R ABI GeoColor RGB

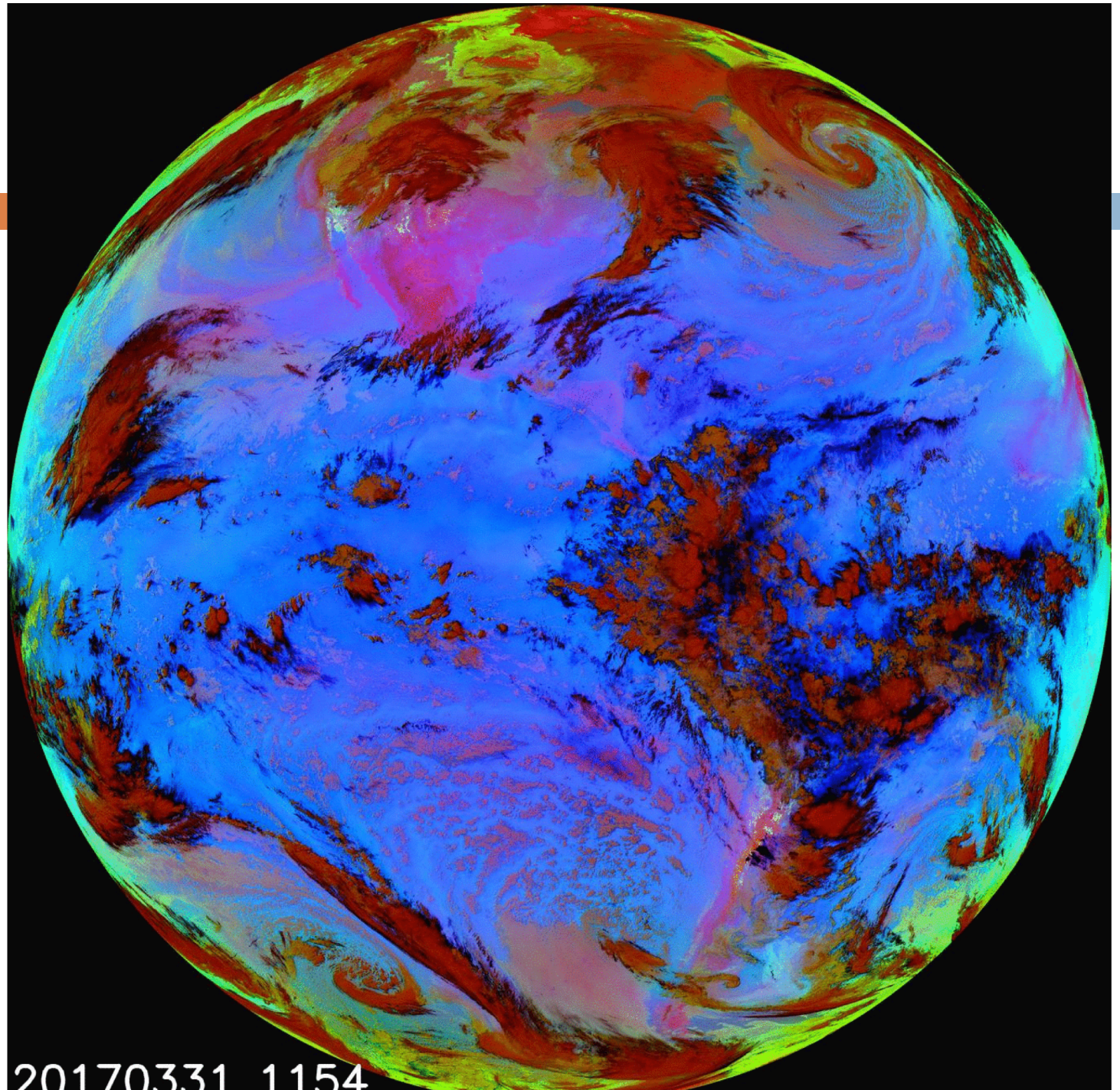
Alamo Fire

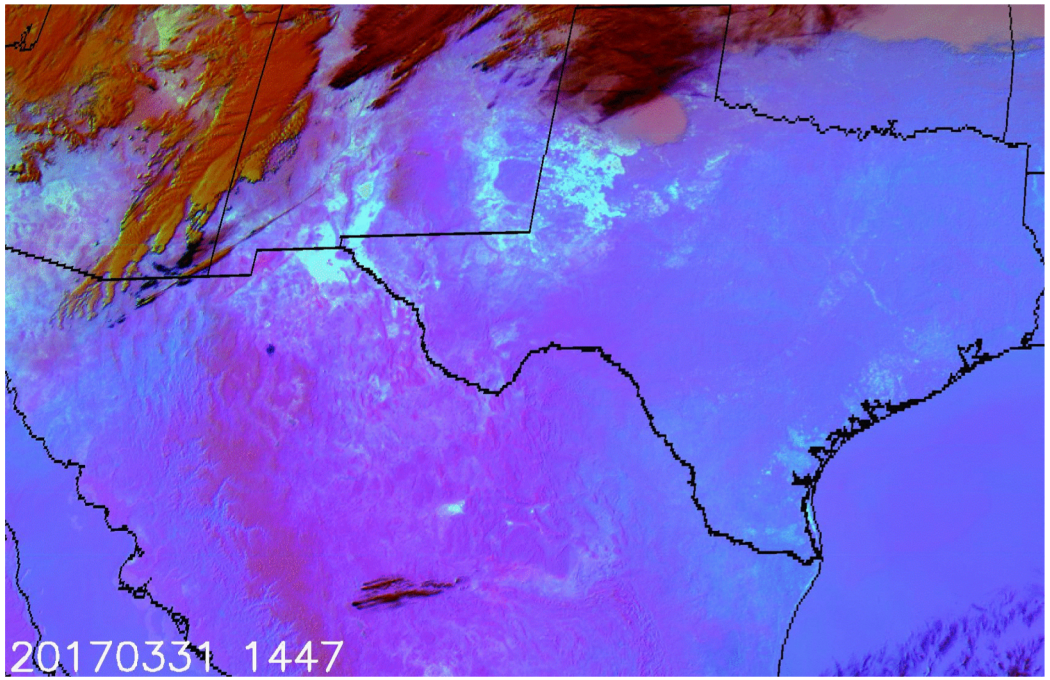
July 6 – July 19, 2017

~29,000 acres burned

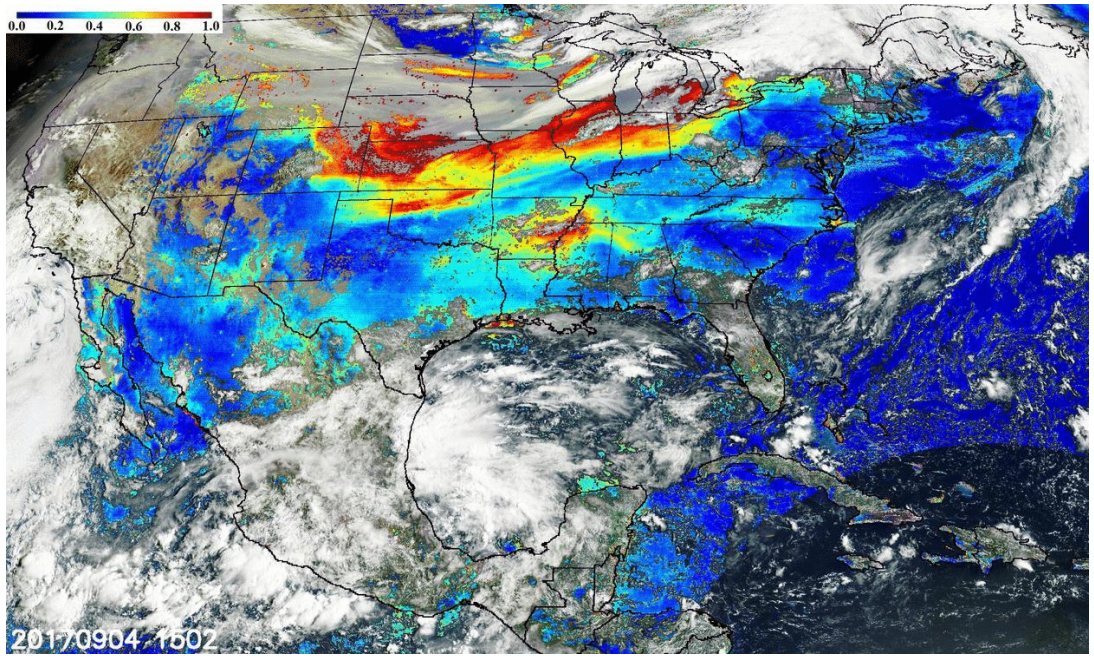


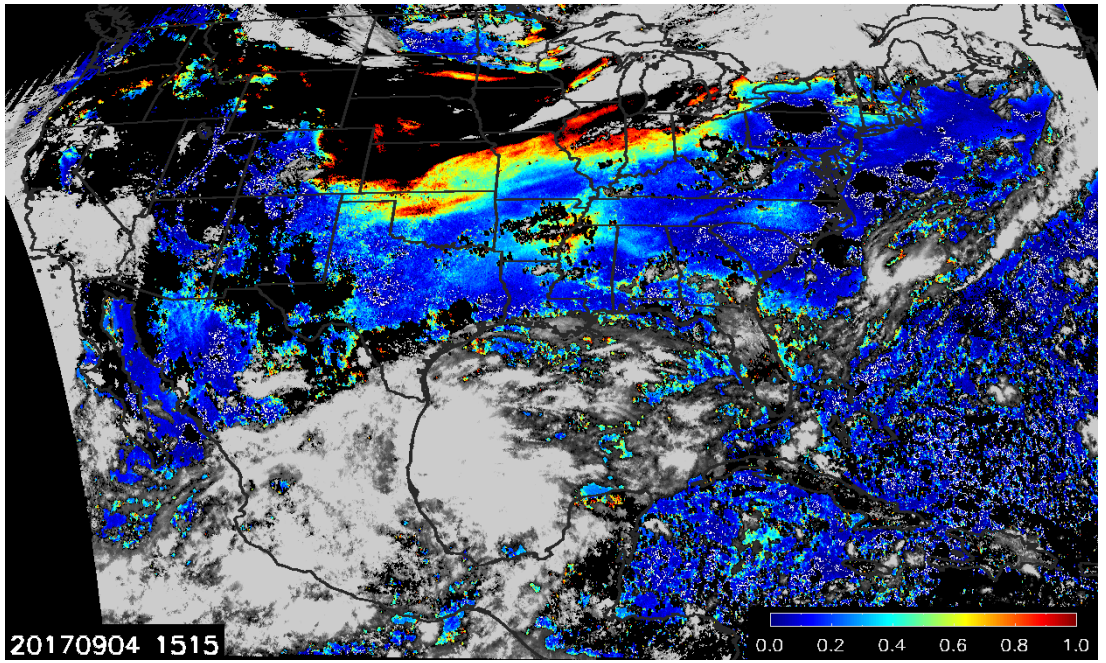
CONUS vs. Full Disk





GOES-R ABI AOD vs. GOES-13 AOD





Measurements in geostationary era:

- Viewing geometries different from polar-orbiting satellites. Need to gain experience working in this space
- Requirements are to be met for a statistically large sample. Uncertain how performance metrics will be as a function of time of the day ---> important for AQ