

Title 1: The NOAA VIIRS aerosol products and applications for air quality applications

Lorraine A. Remer¹, Hongqing Liu^{2,3}, Pubu Ciren^{2,3}, Hai Zhang^{2,3}, Shobha Kondragunta³, Jingfeng Huang^{3,4}, Steven Superczynski^{3,5} and Istvan Laszlo³

Title 1: The NOAA VIIRS aerosol products and applications for air quality applications

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Title 2: Broader perspective on the use of satellite data for air quality applications

Lorraine A. Remer with help from Ralph Kahn

Air Quality is defined in terms of PM_{2.5}.

Remote sensing of aerosols is generalized as AOD

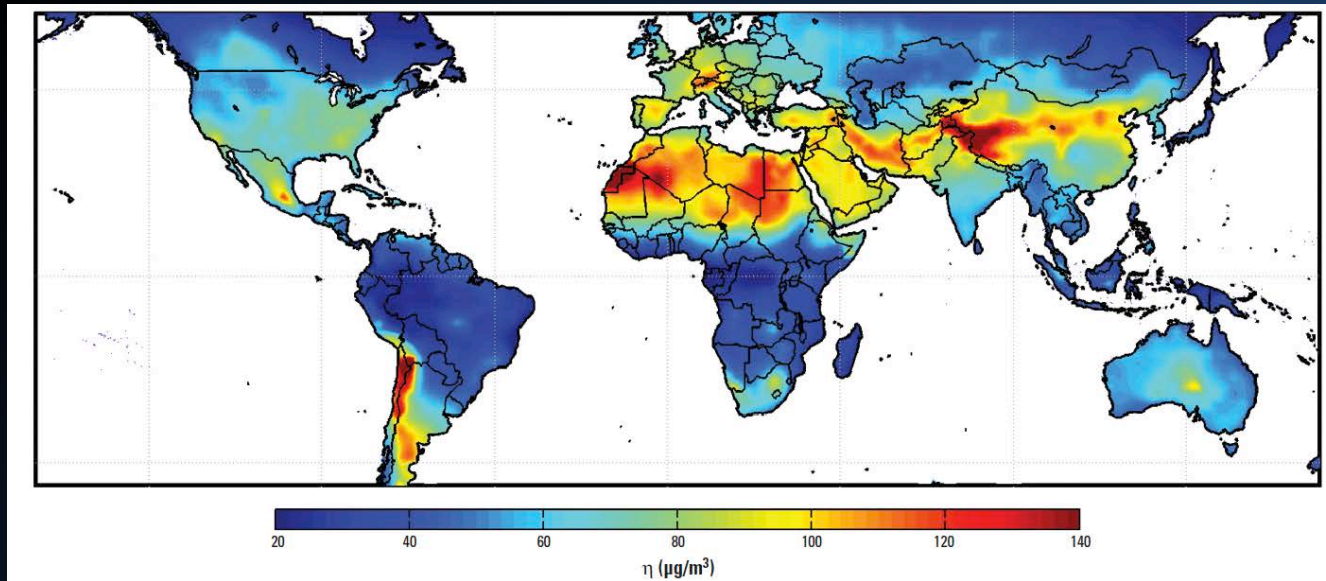
The two are proportional....

$$AOD = PM_{2.5} H f(RH) \frac{3Q_{\text{ext,dry}}}{4\rho r_{\text{eff}}} = PM_{2.5} H S$$

Assumes a well-mixed boundary layer of height H and no elevated aerosol layers,

And S is the specific extinction efficiency that contains all the information about aerosol 'type'.

MISR + MODIS AOD with GEOS-Chem Vertical Distribution



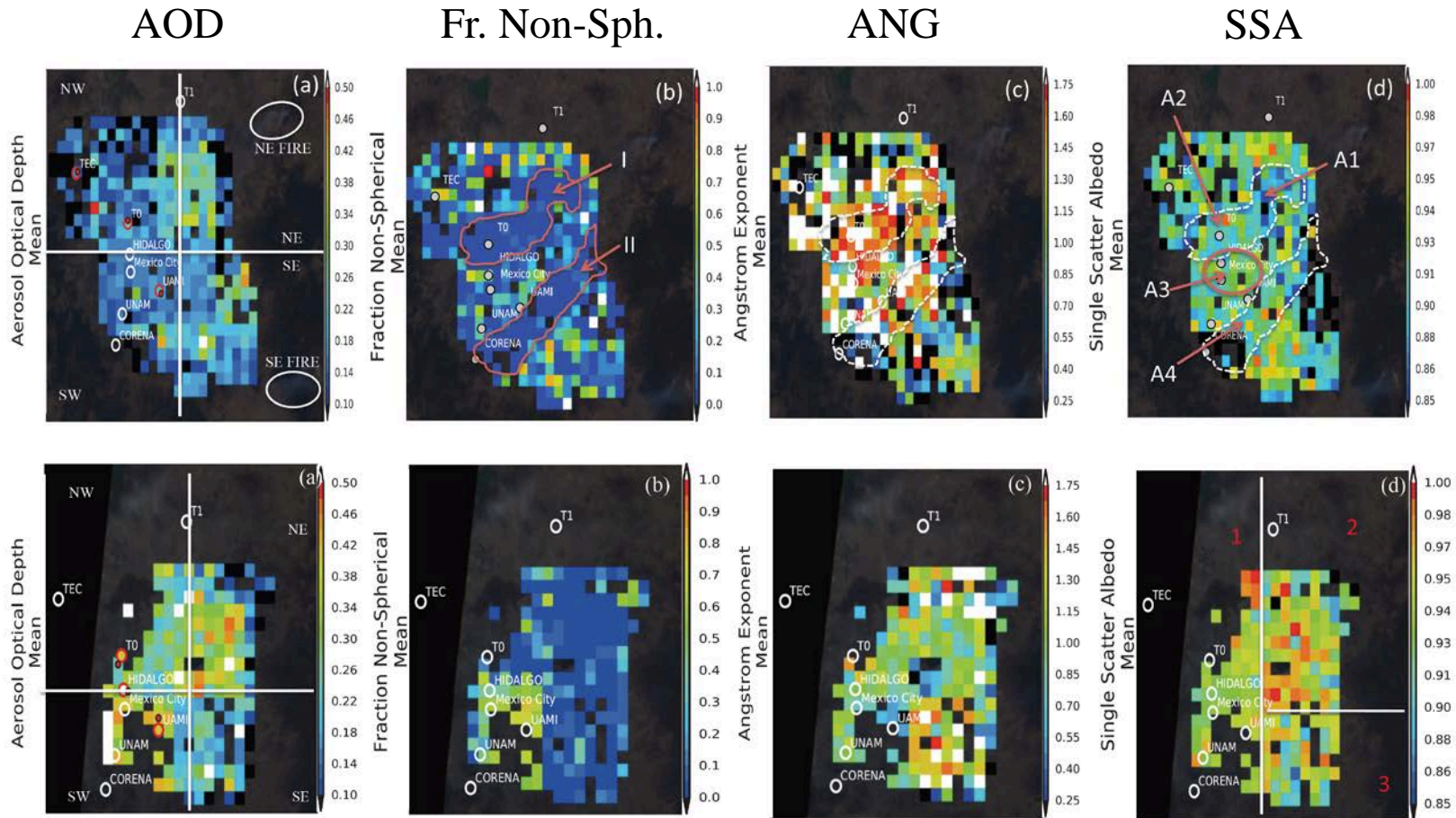
H*S
2001- 2006

For Long-term exposure

Van Donkelaar et al. 2010

Urban Pollution AOD & Aerosol Air Mass Type Mapping

INTEX-B, 06 & 15 March 2006



March
06

March
15

Aerosol Air Masses: *Dust* (non-spherical), *Smoke* (spherical, spectrally steep absorbing), and *Pollution* particles (spherical, spectrally flat absorbing) dominate specific regions

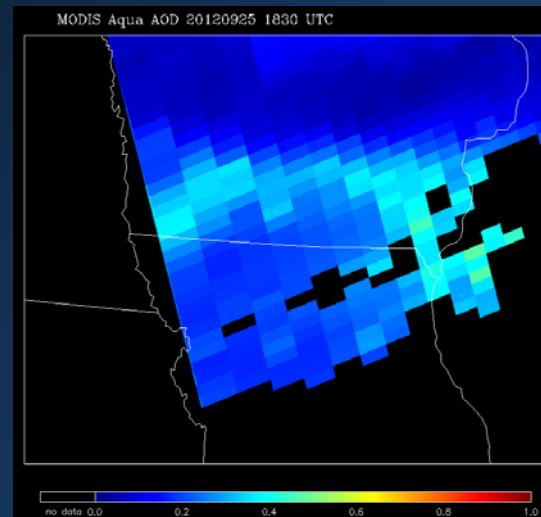
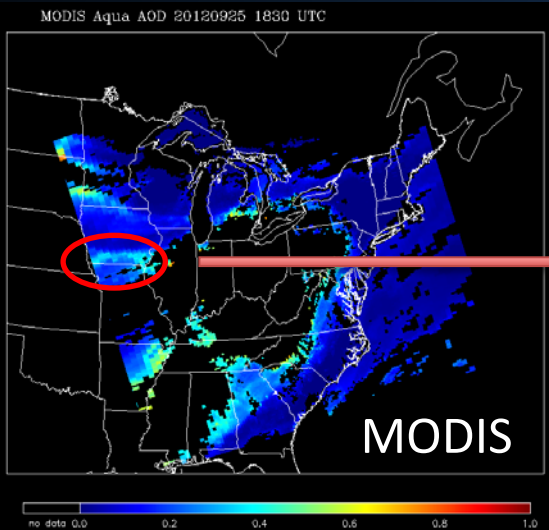
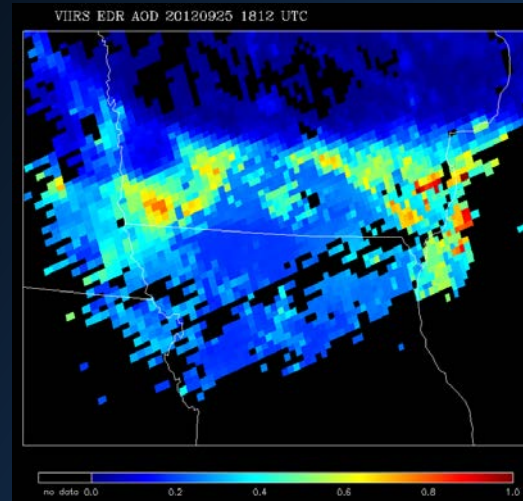
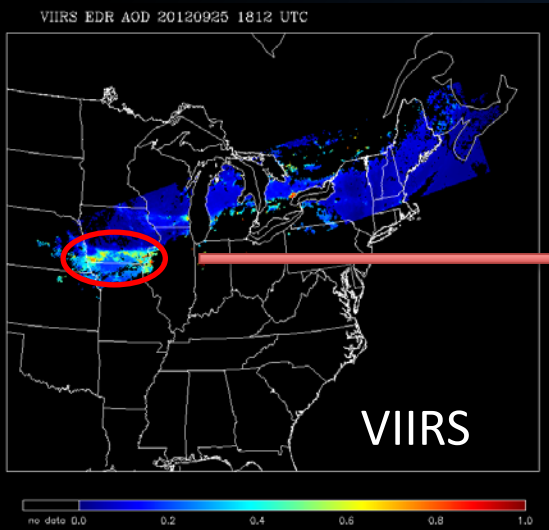
Yang Liu said,

“All we need is broader coverage, finer resolution and better accuracy.”

Air Quality perspectives

	Forecasting	Short term exposure	Long term exposure	Exceptional events
Accurate AOD		XXX	XXX	XXX
Particle properties		XX	XX	XX
Vertical info	X	XX	XX	XX
Fine resolution		X	X	X
Broad coverage	XX	X		
Quick	XXX			
Ancillary/ fires	X			XXX

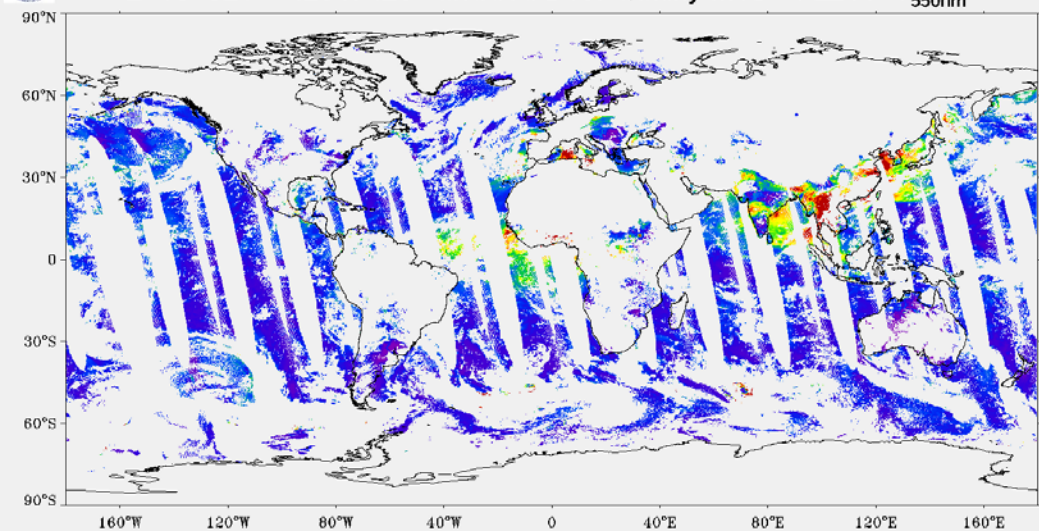
The VIIRS instrument has interesting properties



	MODIS	VIIRS
Orbit altitude	690 km	824 km
Equator crossing time	13:30 LT	13:30 LT
Granule size	5 min	86 sec
swath	2330 km	3040 km
Pixel nadir	0.5 km	0.75 km
Pixel at edge	2 km	1.5 km
AOT nadir	10 km	0.75 km
AOT at edge	40 km	1.5 km



20150321 0.25°x0.25° Gridded Best Quality MYD04 L2 AOT_{550nm}



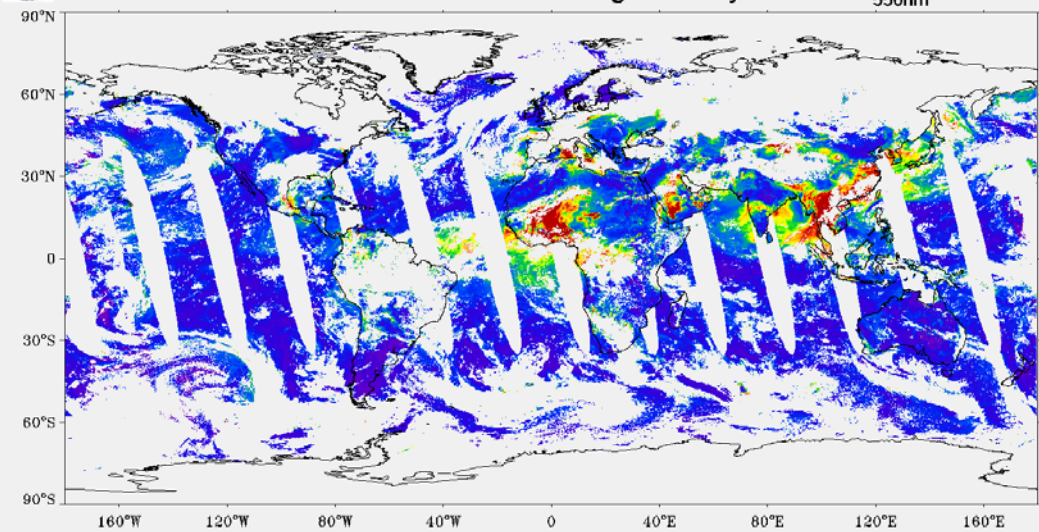
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Single day coverage

MODIS



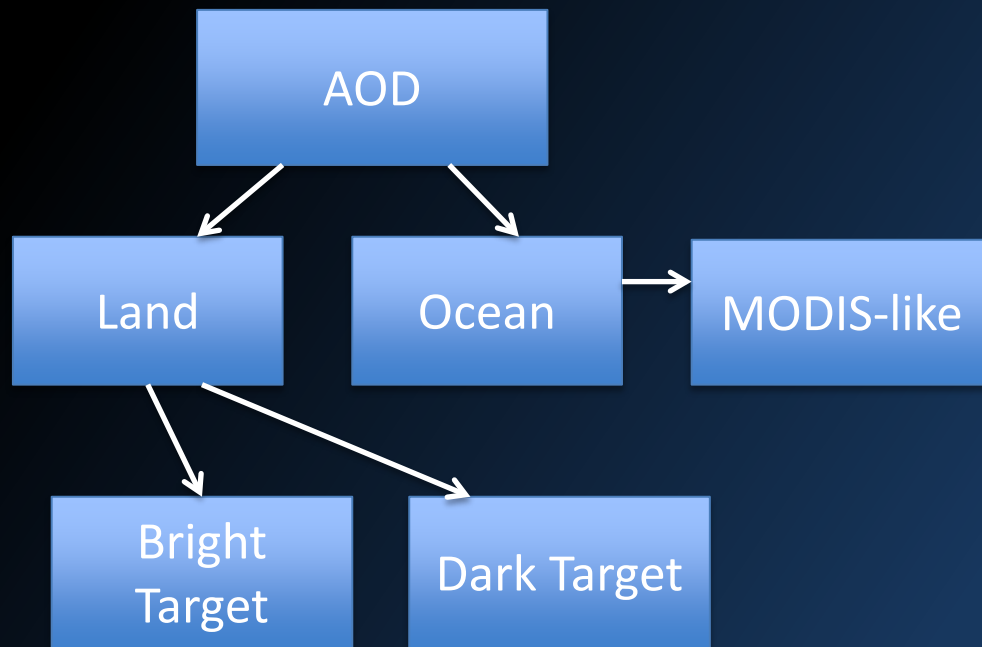
20150321 0.25°x0.25° Gridded High Quality EPS AOT_{550nm}



-0.1 -0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

VIIRS

NOAA STAR VIIRS “Enterprise” or “EPS” aerosol algorithm

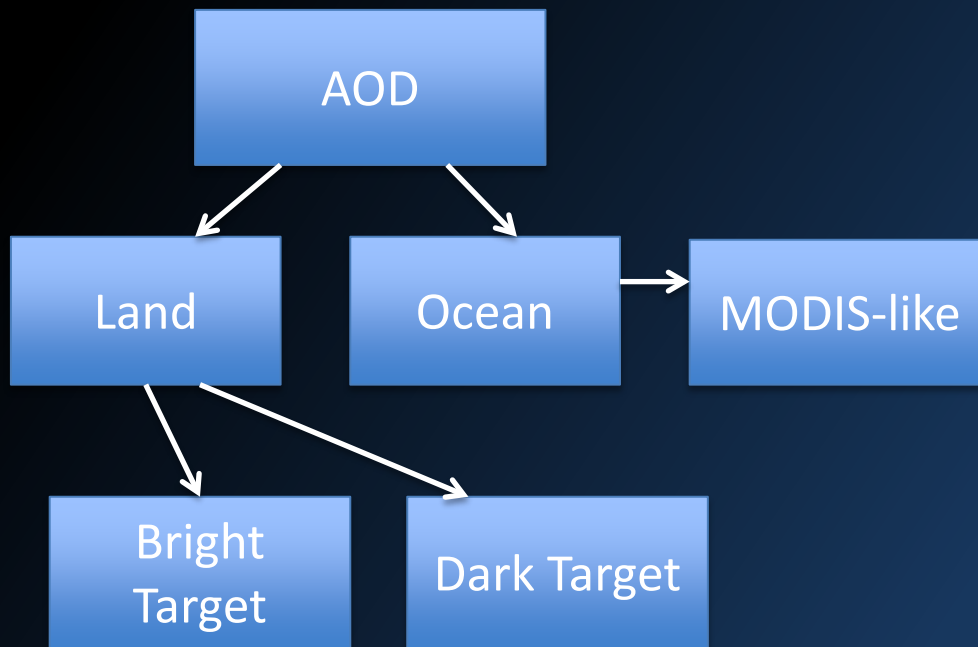


Designed by Liu and Zhang



Designed by Ciren and Kondragunta

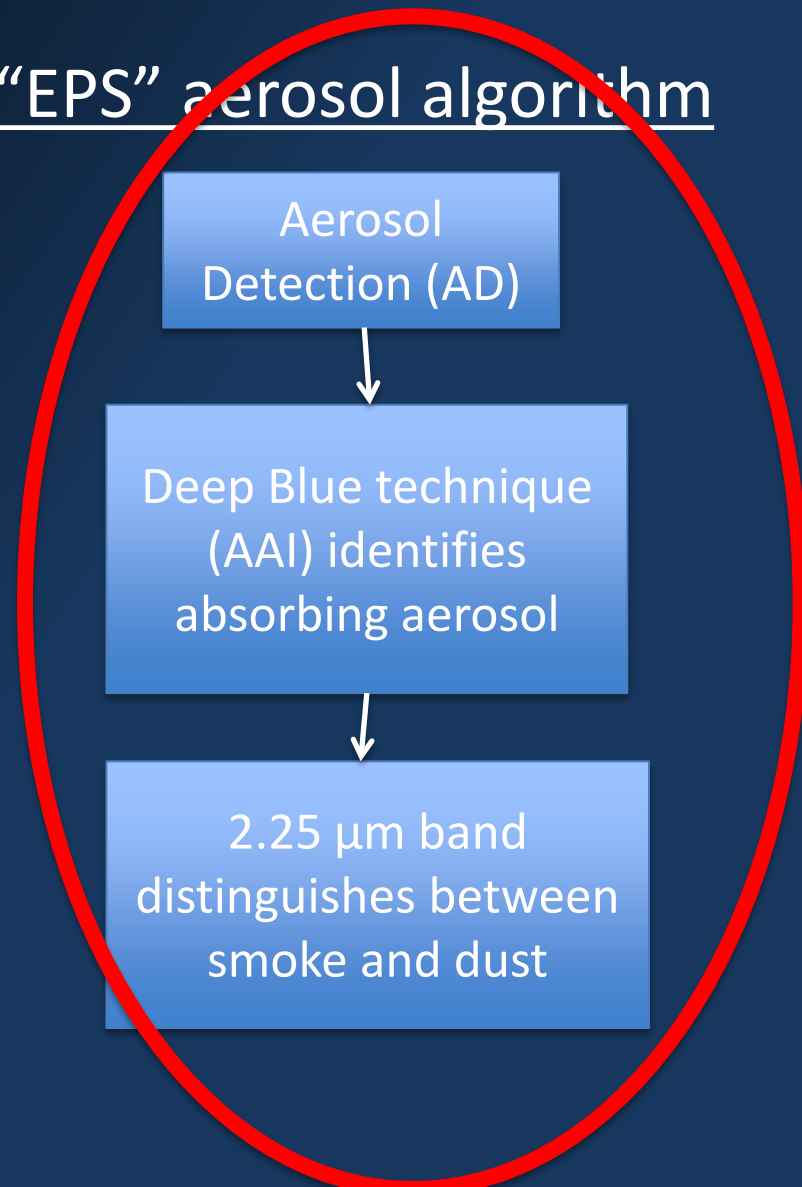
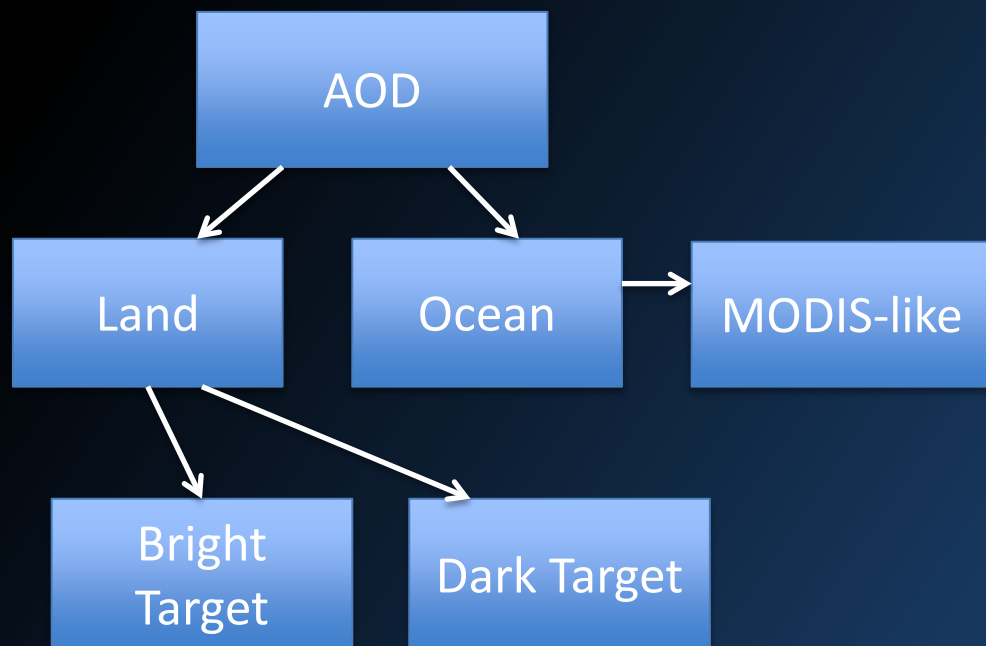
NOAA STAR VIIRS “Enterprise” or “EPS” aerosol algorithm



Land algorithm

1. Both bright and dark algorithms are different than counterparts on MODIS
2. AOD retrieved at 0.75 km at nadir
3. More coverage than either MODIS algorithms

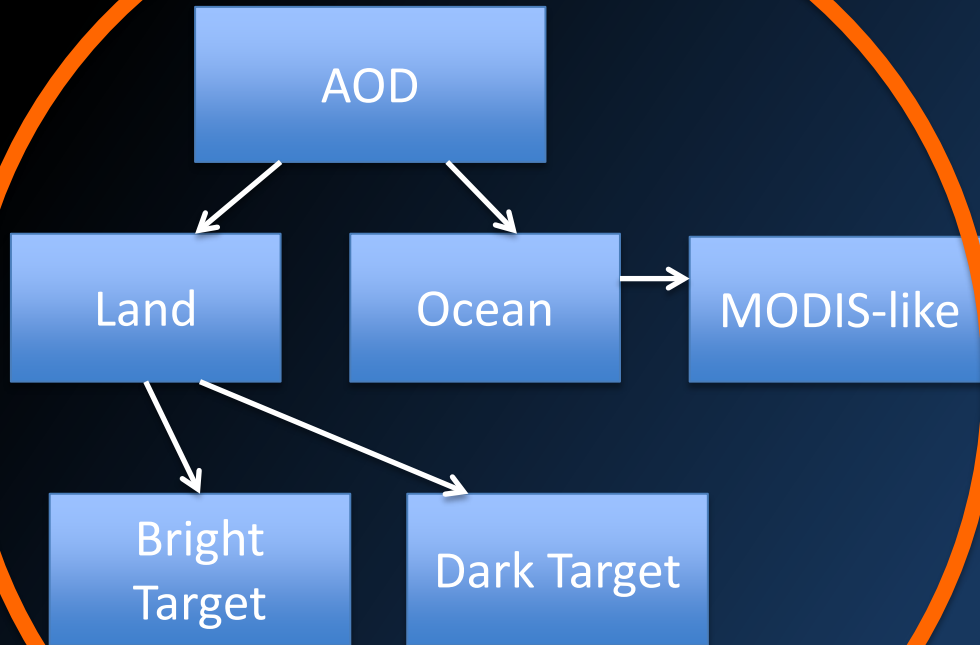
NOAA STAR VIIRS “Enterprise” or “EPS” aerosol algorithm



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Qualitative

NOAA STAR VIIRS "Enterprise" or "EPS" aerosol algorithm



1. Both bright and dark algorithms are different than counterparts on MODIS
2. AOD retrieved at 0.75 km at nadir
3. More algorithm

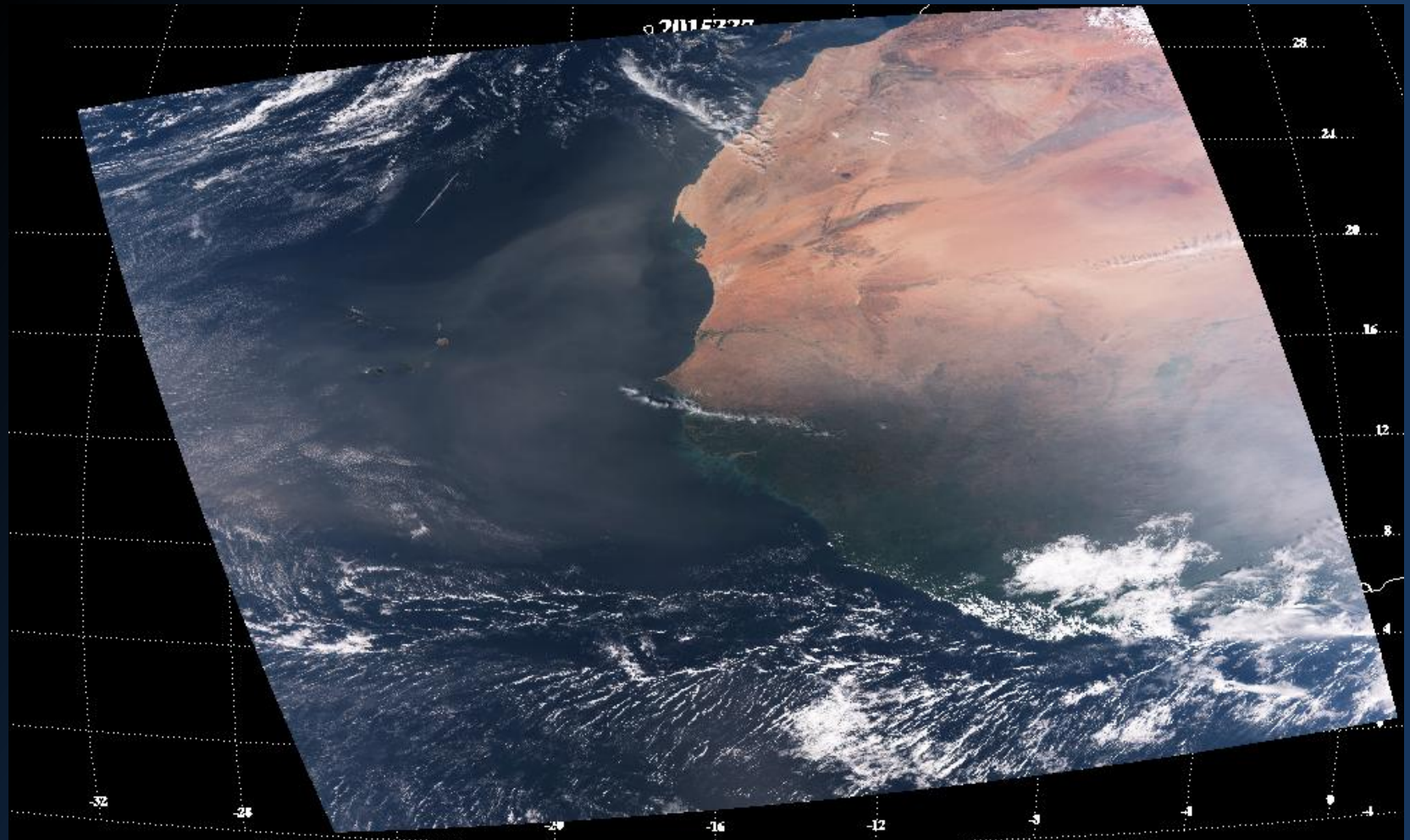
Quantitative



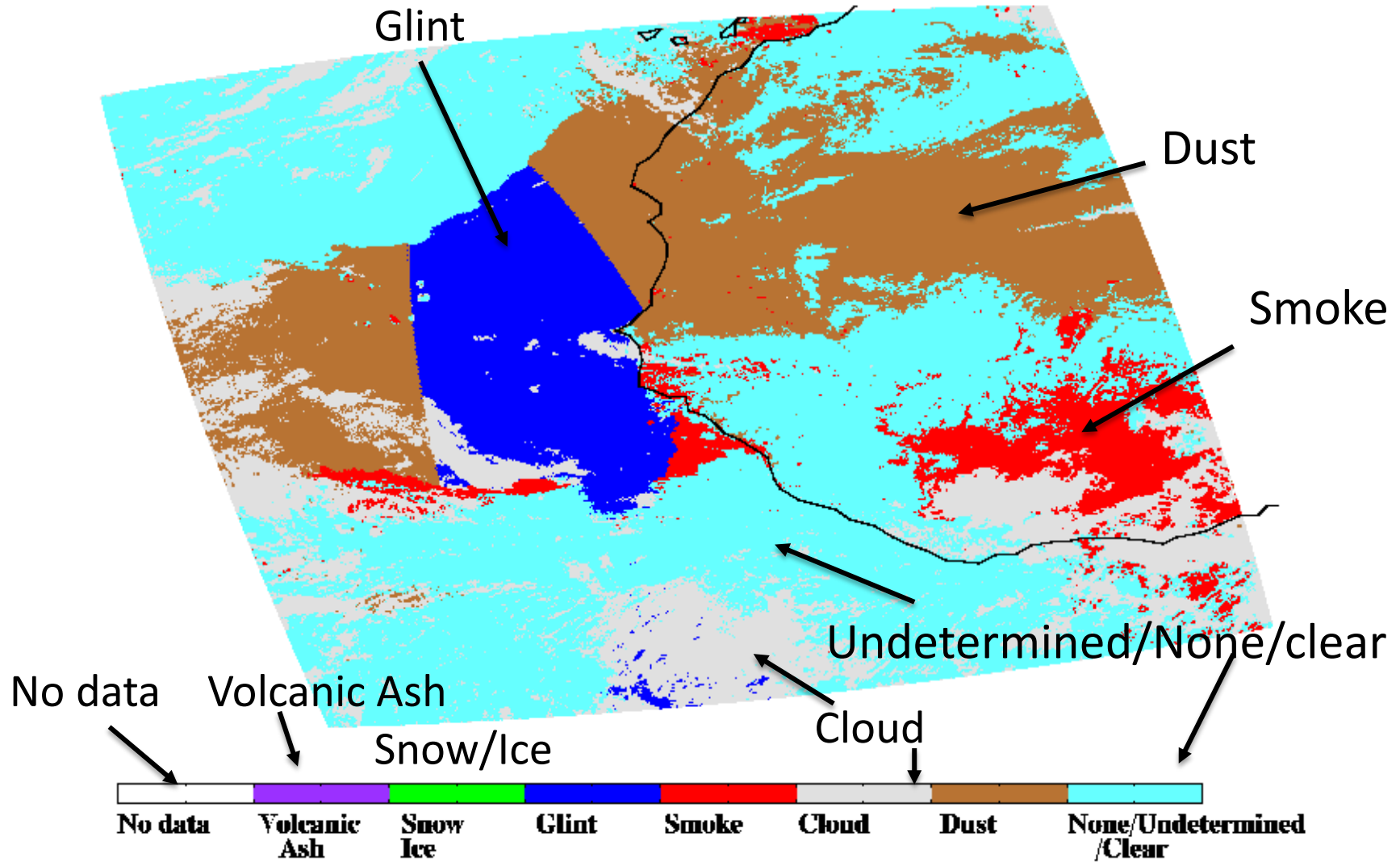
Qualitative

Qualitative aerosol detection

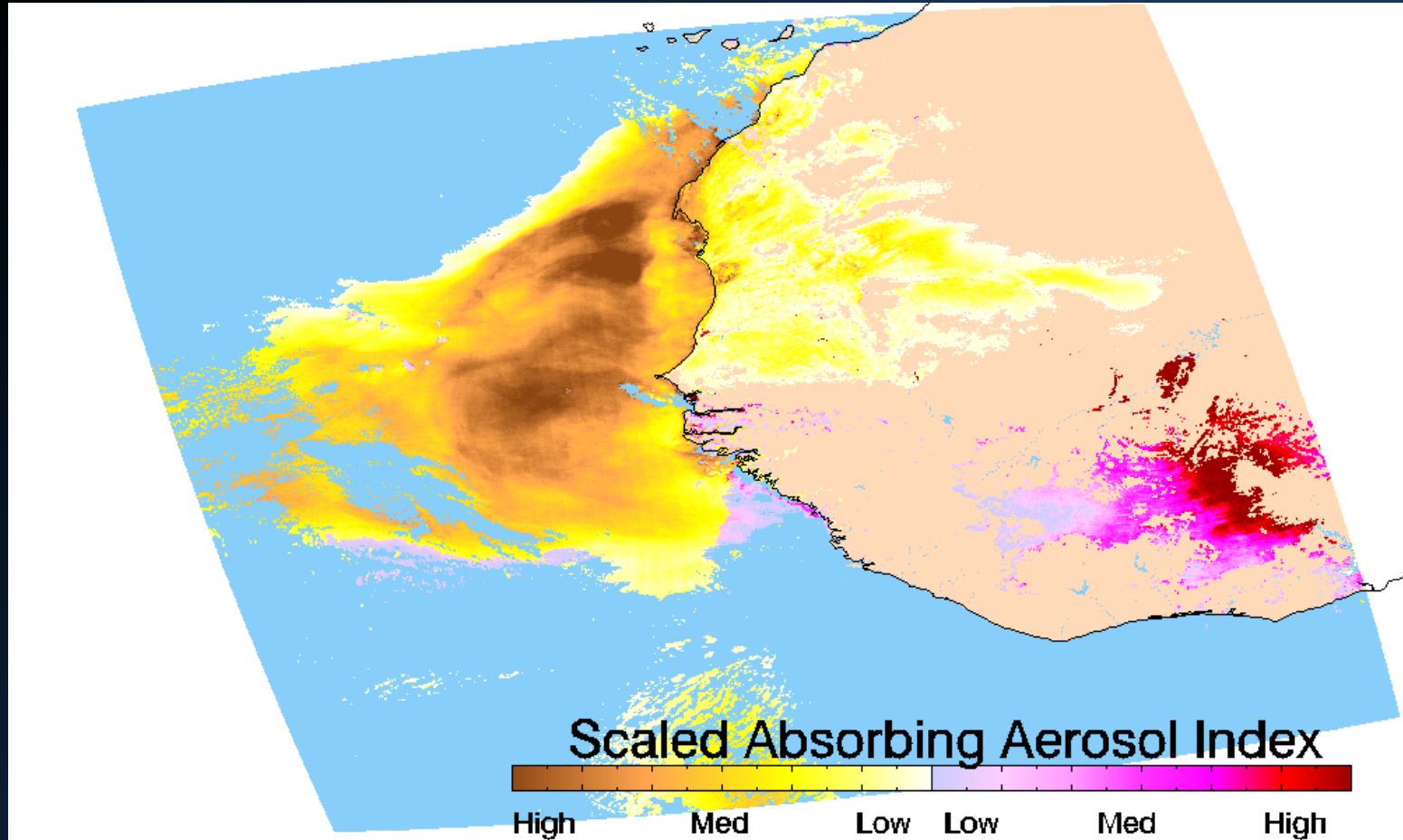
Example of output: dust/smoke event 12/03/2015



Type Flags:



Intensity: Scaled Absorbing Aerosol Index



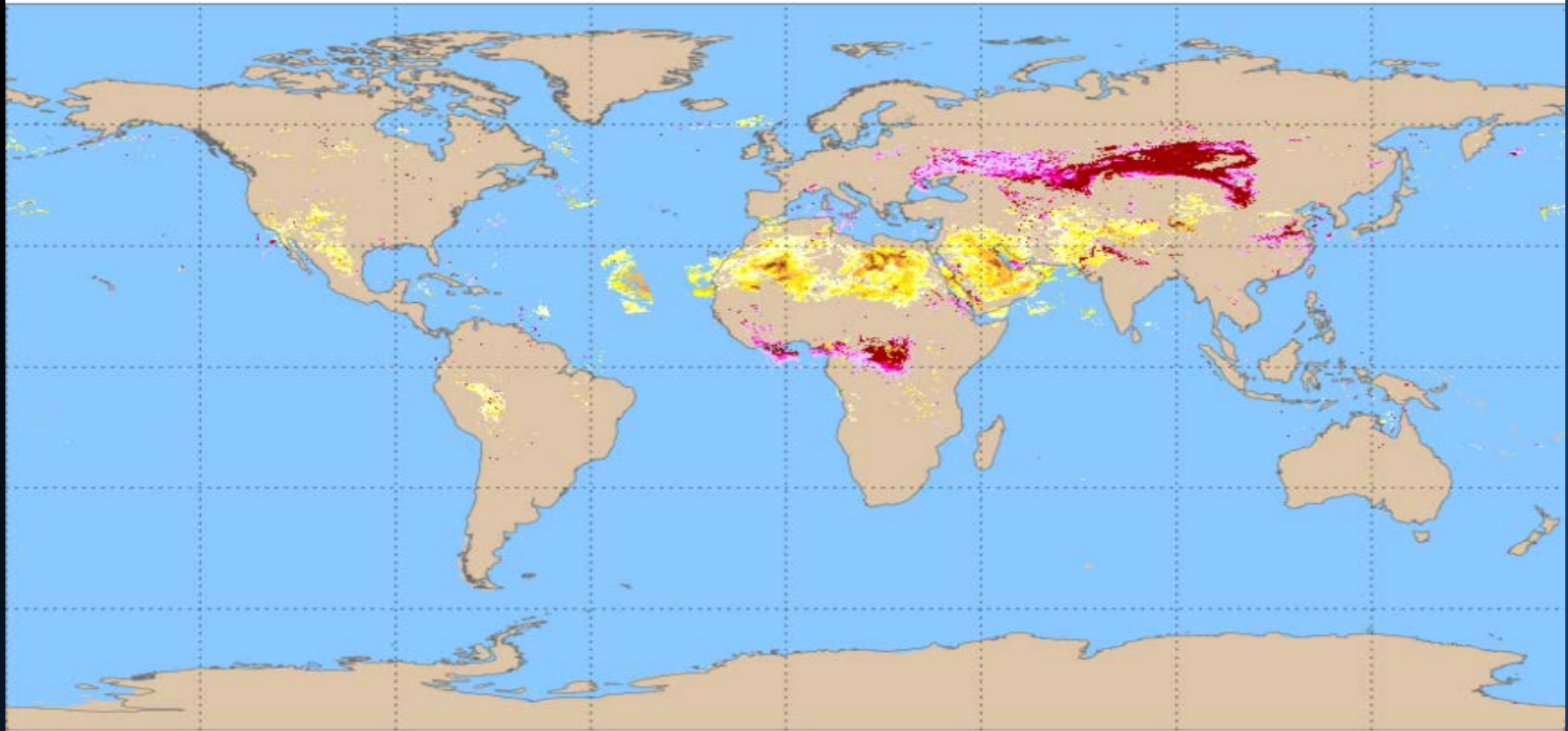
Pubu Ciren

Real-time EPS Aerosol Detection

http://www.star.nesdis.noaa.gov/jpss/EDRs/products_aerosols.php

Suomi NPP VIIRS - Enterprise Aerosols - Suspended Matter

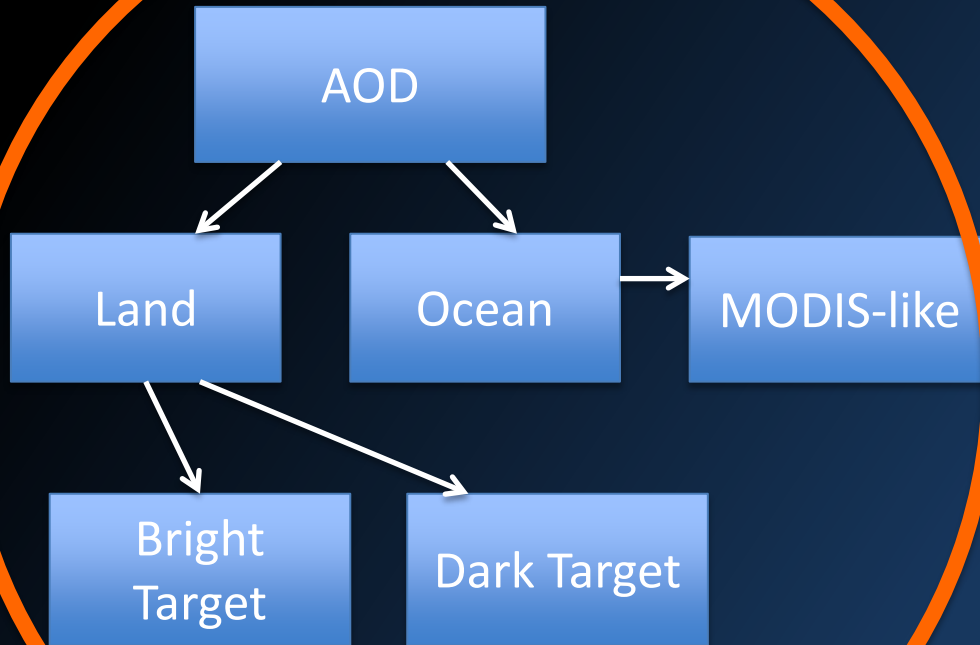
23 Jul 2016



NOAA/NESDIS/STAR

Pubu Ciren

NOAA STAR VIIRS "Enterprise" or "EPS" aerosol algorithm



1. Both bright and dark algorithms are different than counterparts on MODIS
2. AOD retrieved at 0.75 km at nadir
3. More algorithm

Quantitative



Qualitative

Quantitative NOAA STAR EPS AOD retrieval

Dark Target

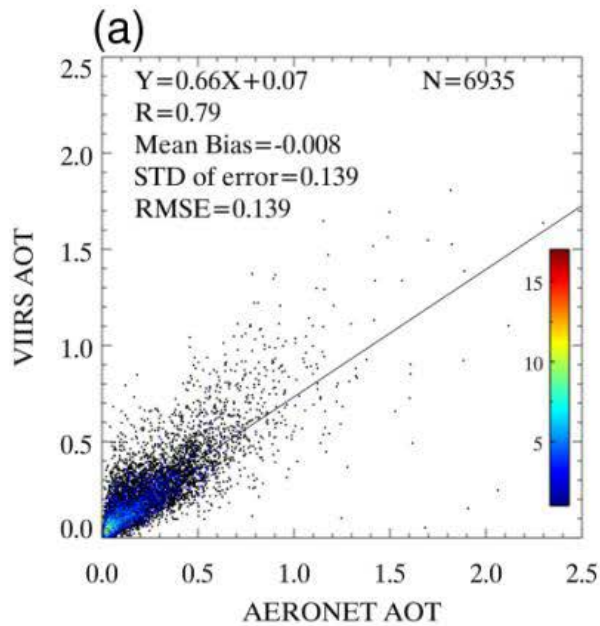
- Hybrid between MODIS DT over land, and the original VIIRS algorithm.
- Acts like MODIS for moderate to high AOD.
- For low AOD, does not use SWIR band. No need.

Bright Target

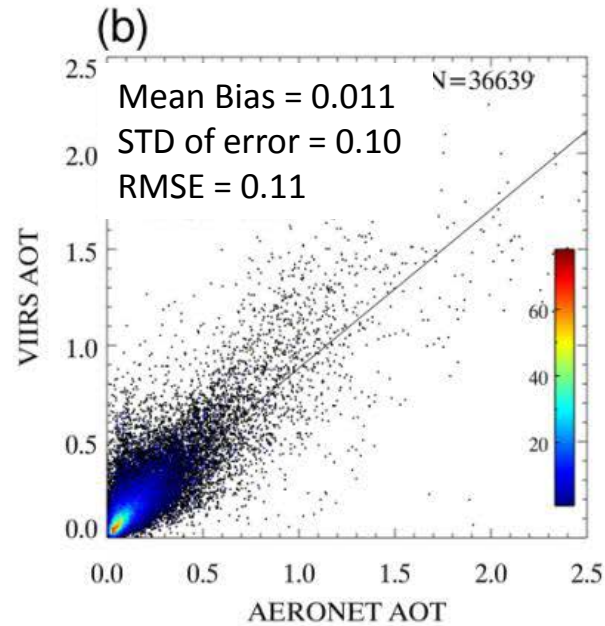
- Based on 0.1 deg x 0.1 deg global data base of surface reflectance ratios.
(Ratios are more stable than absolute surface reflectance.)
- Bright pixels use one set of ratios, and dark pixels use a different set.
- Bright is when $\rho_{2.25} > 0.25$;
- Ratios are a function of scattering angle.

Hongqing Liu's poster

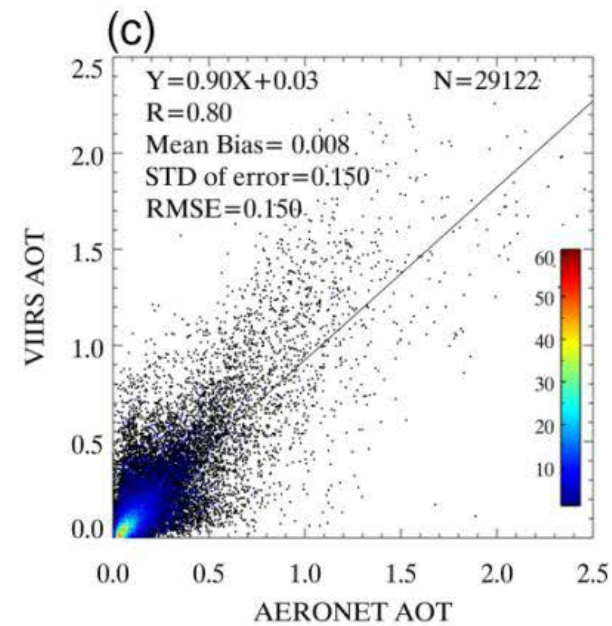
Validation against AERONET, global



Bright pixels
new

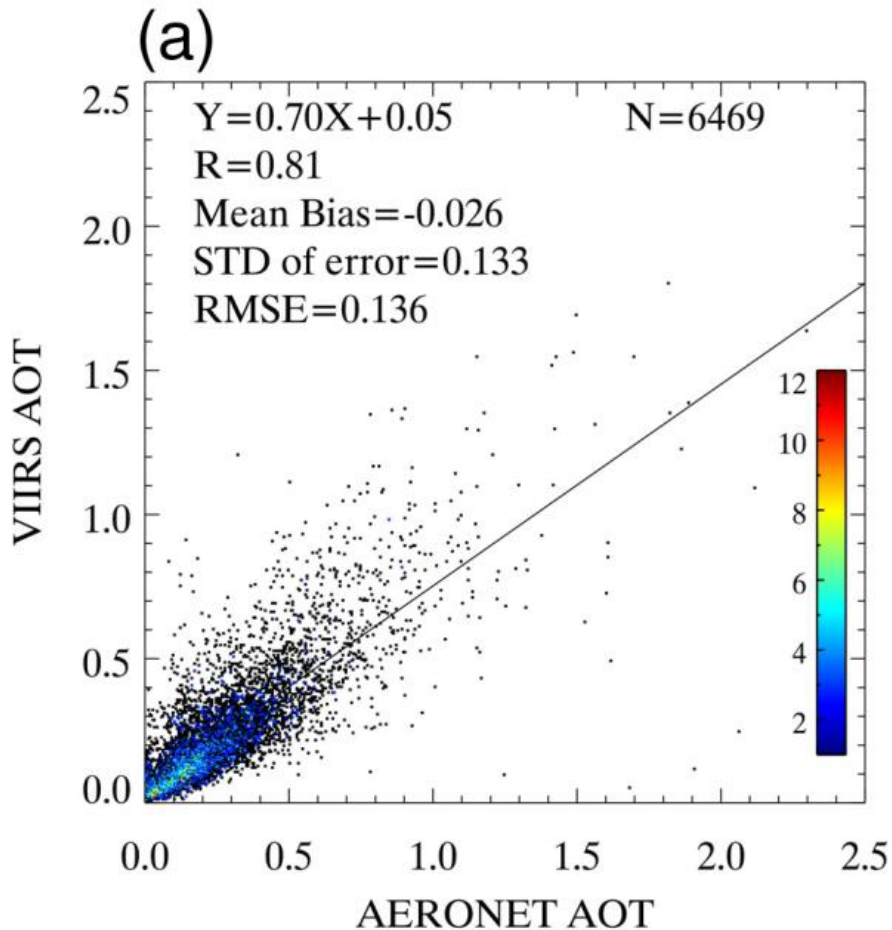


Dark pixels
new

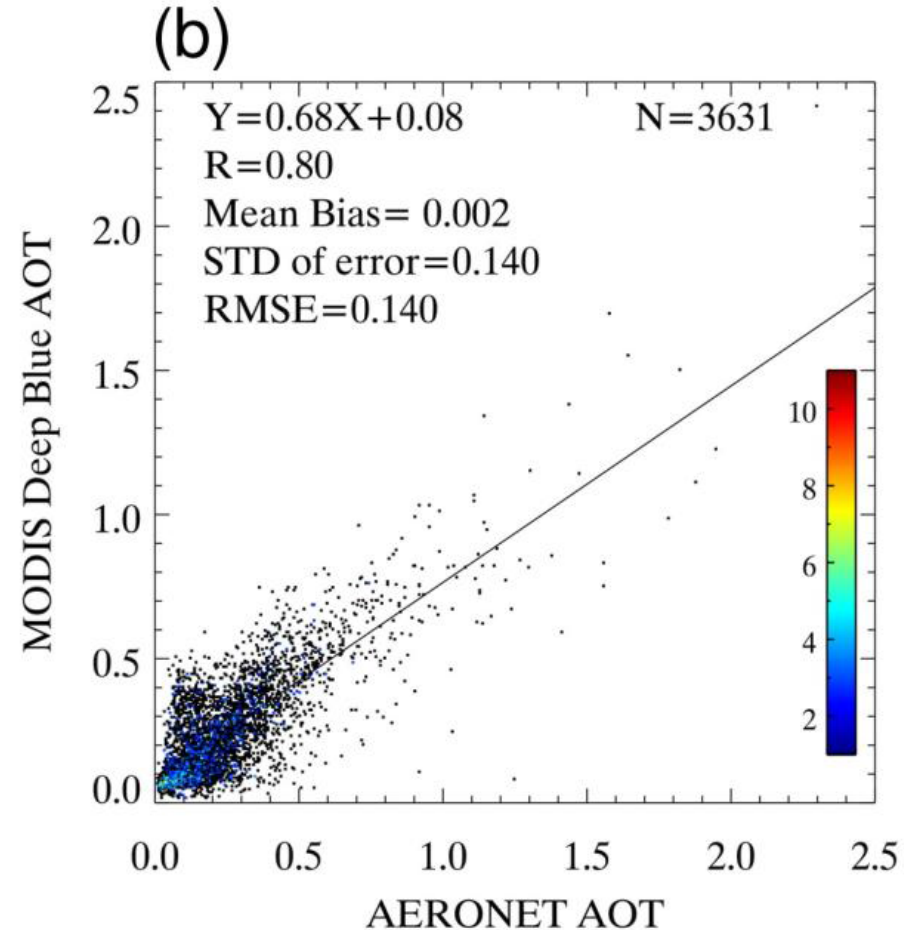


Dark pixels
old

Validation over North Africa and Arabian Peninsula

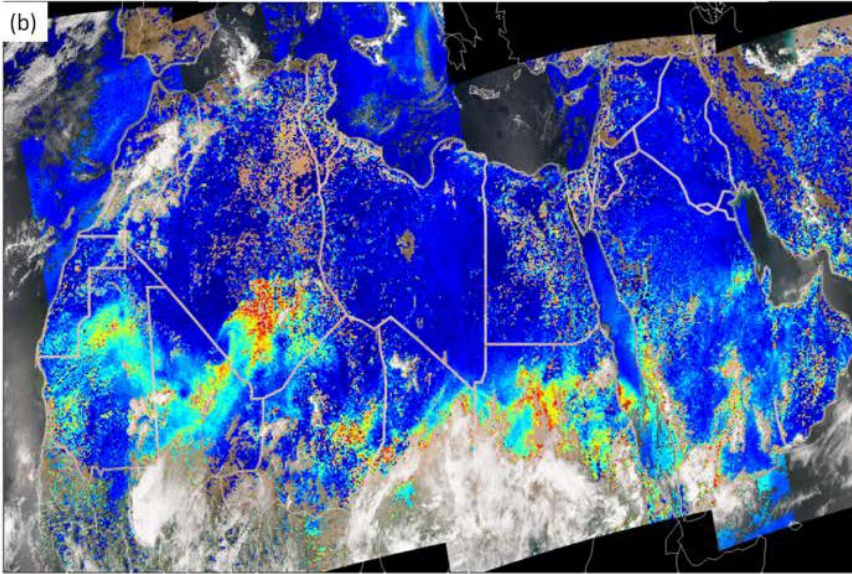


New VIIRS

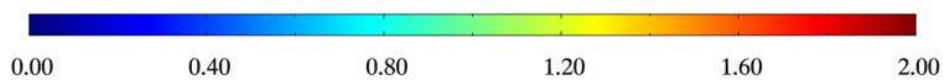
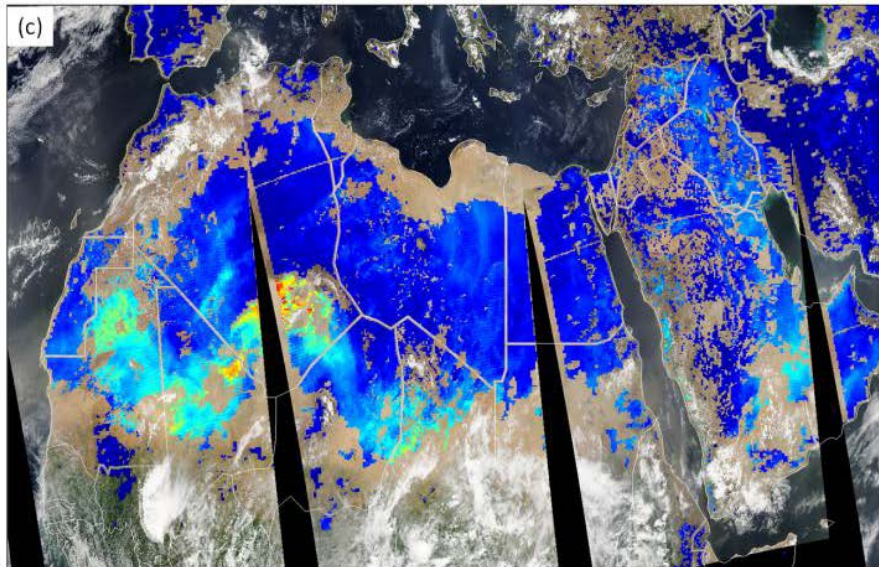


MODIS Deep Blue

VIIRS AOT 20130823



MODIS deep blue AOT 20130823



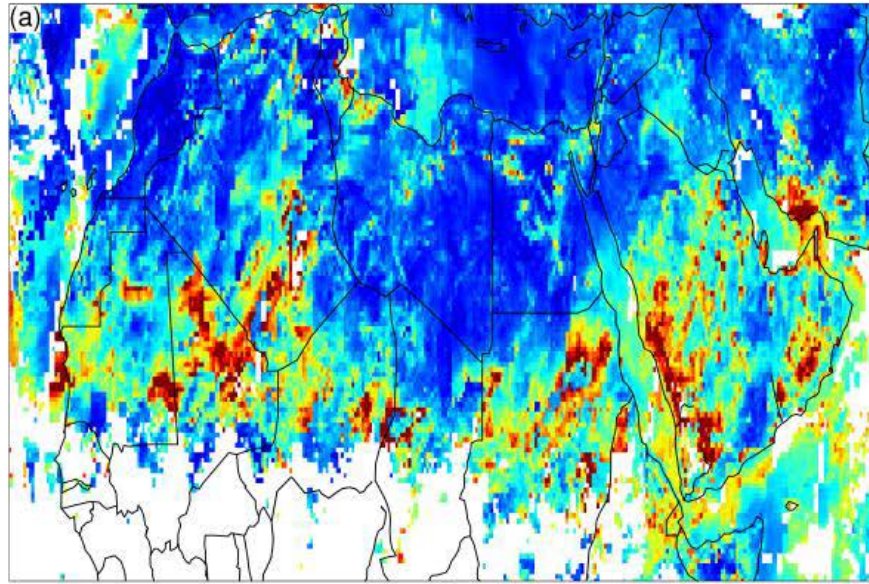
VIIRS

MODIS
Deep Blue

Zhang et al., 2016,
JGR in press

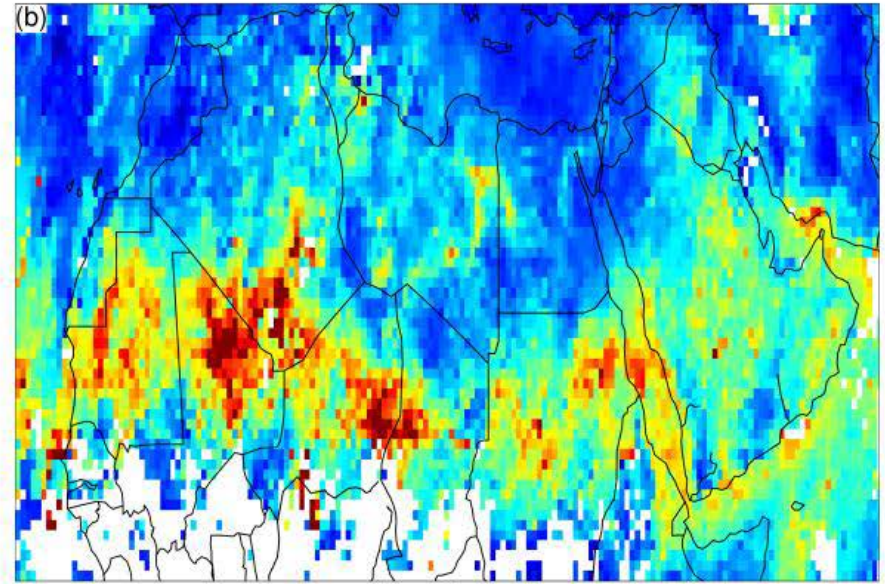
16 day average

Mean VIIRS AOT (20130822-20130906)



VIIRS

Mean MISR AOT (20130822-20130906)



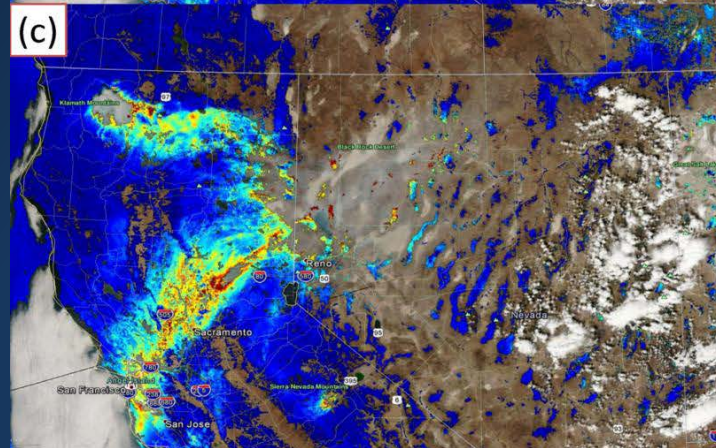
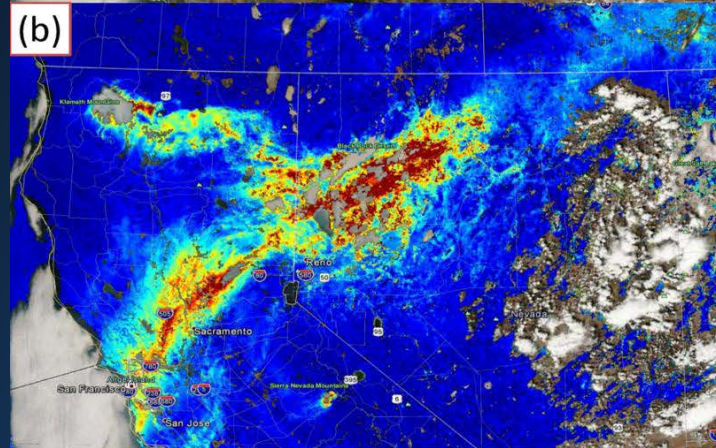
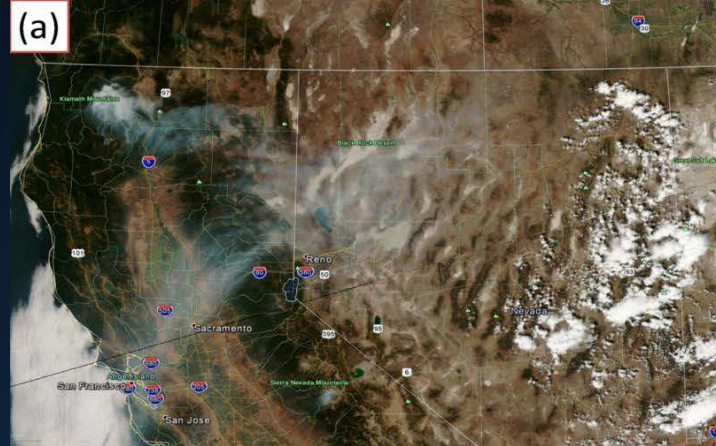
MISR

Zhang et al., 2016,
JGR in press

Smoke over the western U.S.

New VIIRS

Old VIIRS



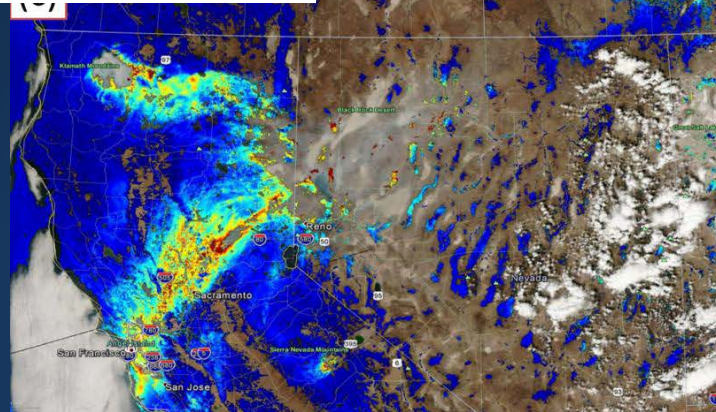
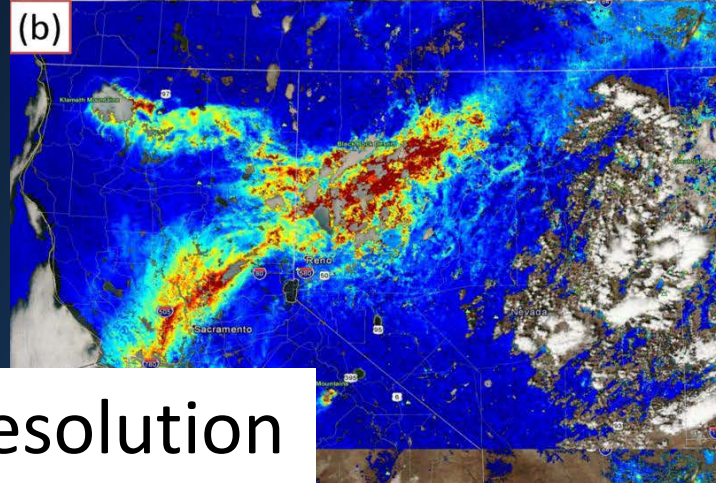
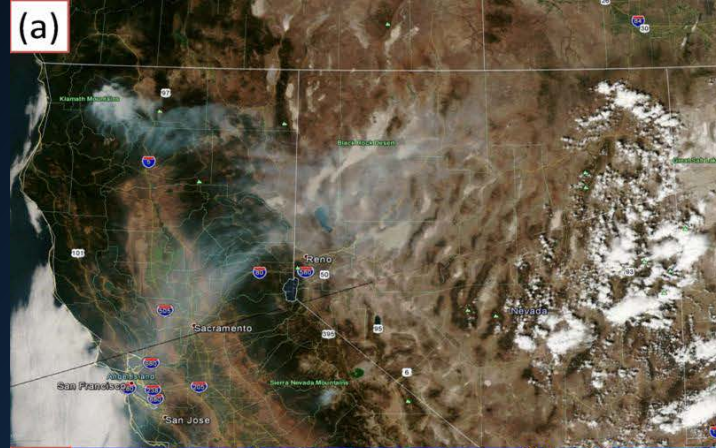
Zhang et al.
2016, JGR in
press

Smoke over the western U.S.

New VIIRS

Product is 0.75 km resolution

Old VIIRS



Zhang et al.
2016, JGR in
press

Main Points

1. AQ from space is not just about getting PM2.5 correct
(Ralph's points 1 and 2: near surface and speciation)
2. Spatial resolution
(Ralph's point 3)
3. Temporal resolution
(Ralph's point 4)
4. Spatial coverage also
(Ralph missed that)

And different AQ goals shift the priorities.

VIIRS EPS product, available this November addresses 2 of Yang Liu's 3 requests for "broader coverage, finer resolution and greater accuracy"

The NOAA VIIRS aerosol products are ready for prime time.

A full year of data exists for 2015.

This product will go 'live' hopefully before the end of 2016.

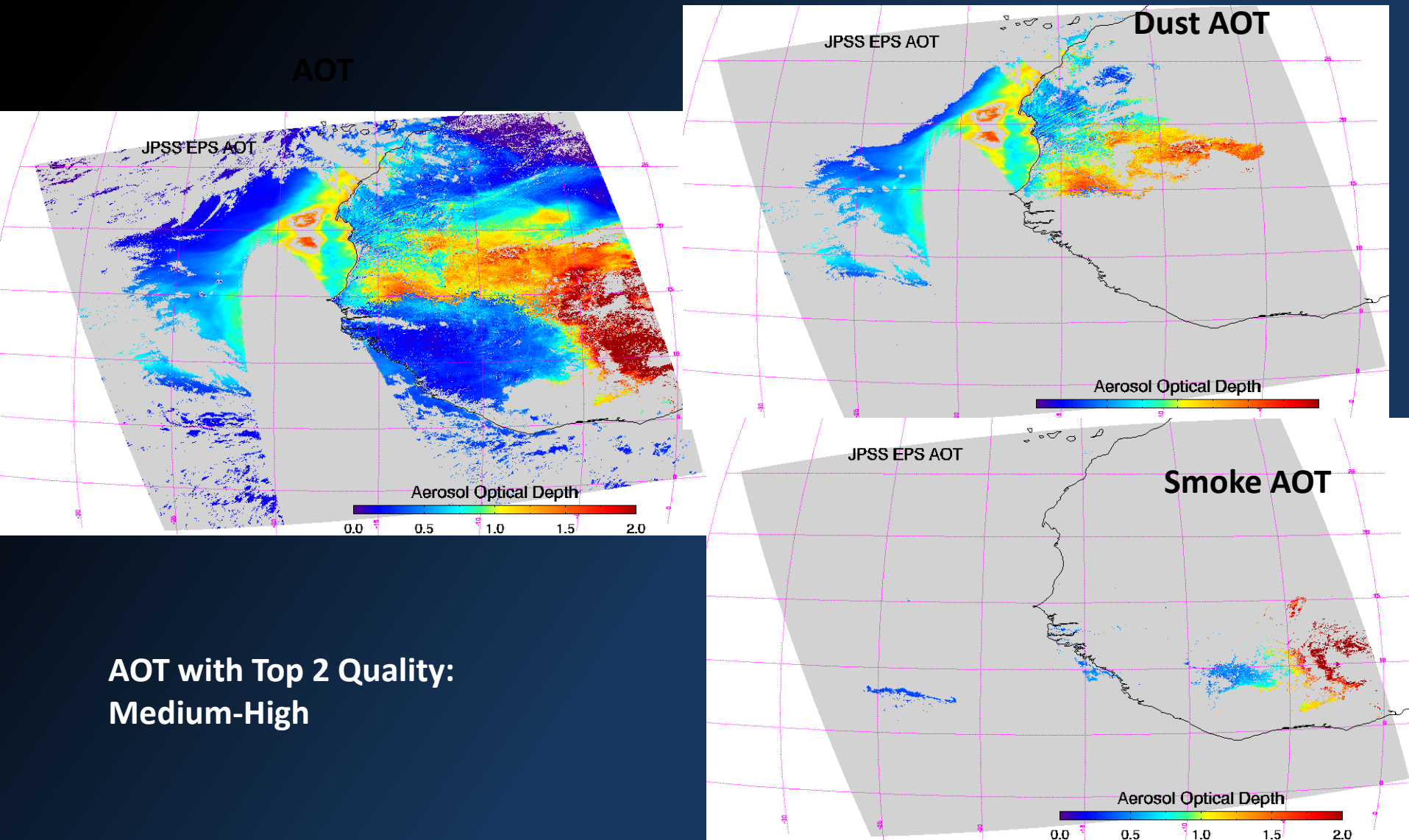
Granule products are available through CLASS

Global gridded products (0.25 deg x 0.25 deg) are available through NOAA Star's website. Discussion of offering 0.10 deg x 0.10 deg instead.

VIIRS launch at end of 2011... Cannot join an intercomparison organized for 2008. Keep that in mind.

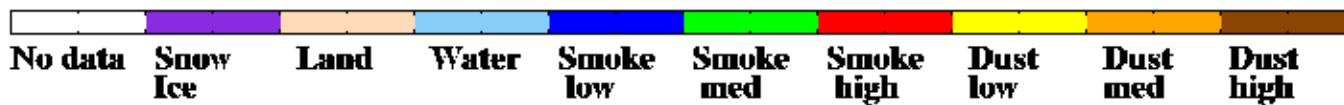
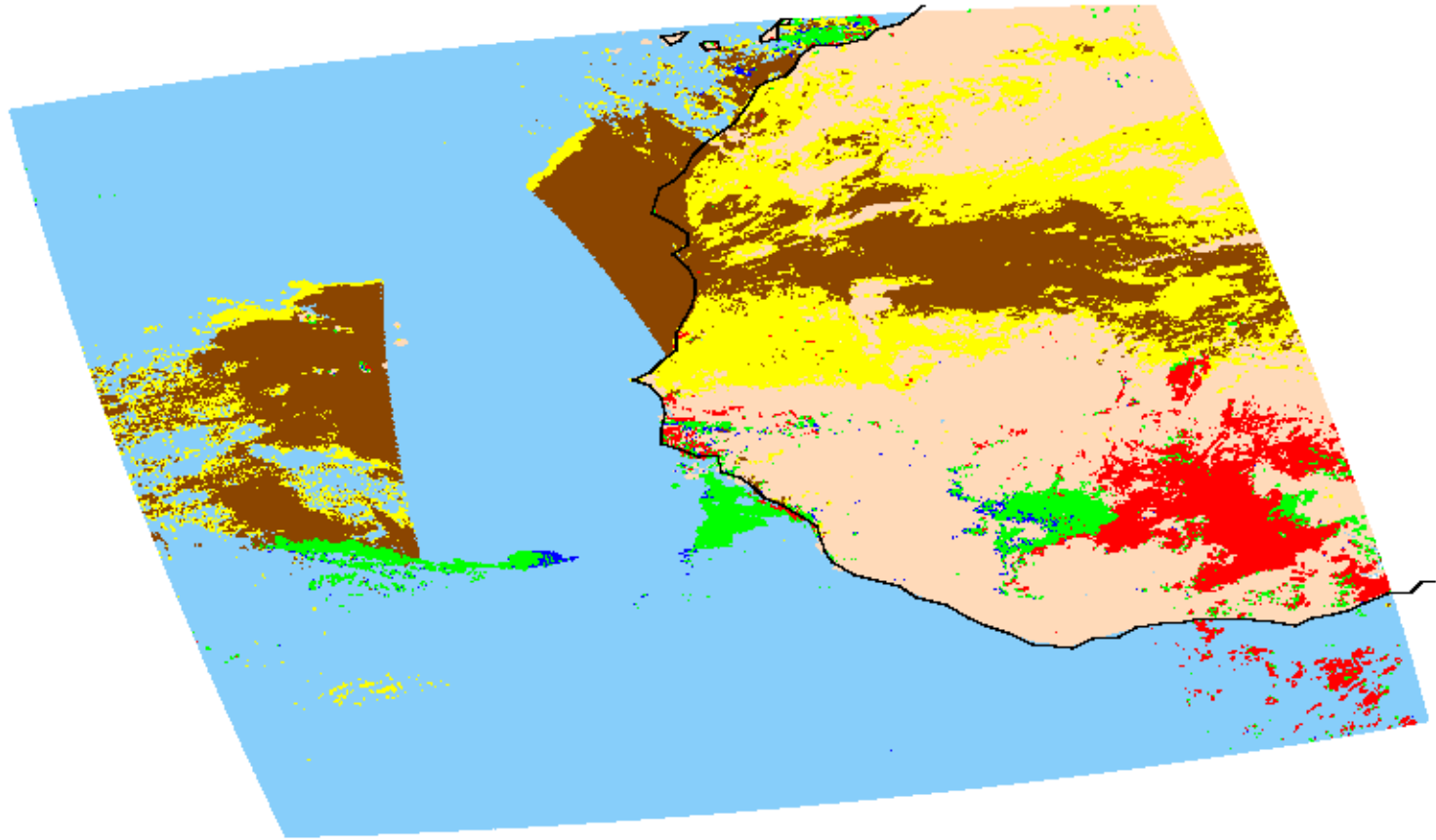
Back up

Smoke/Dust Aerosol Optical Depth: Combining EPS ADP with EPS AOD Product



**AOT with Top 2 Quality:
Medium-High**

Quality Flags for smoke/dust mask

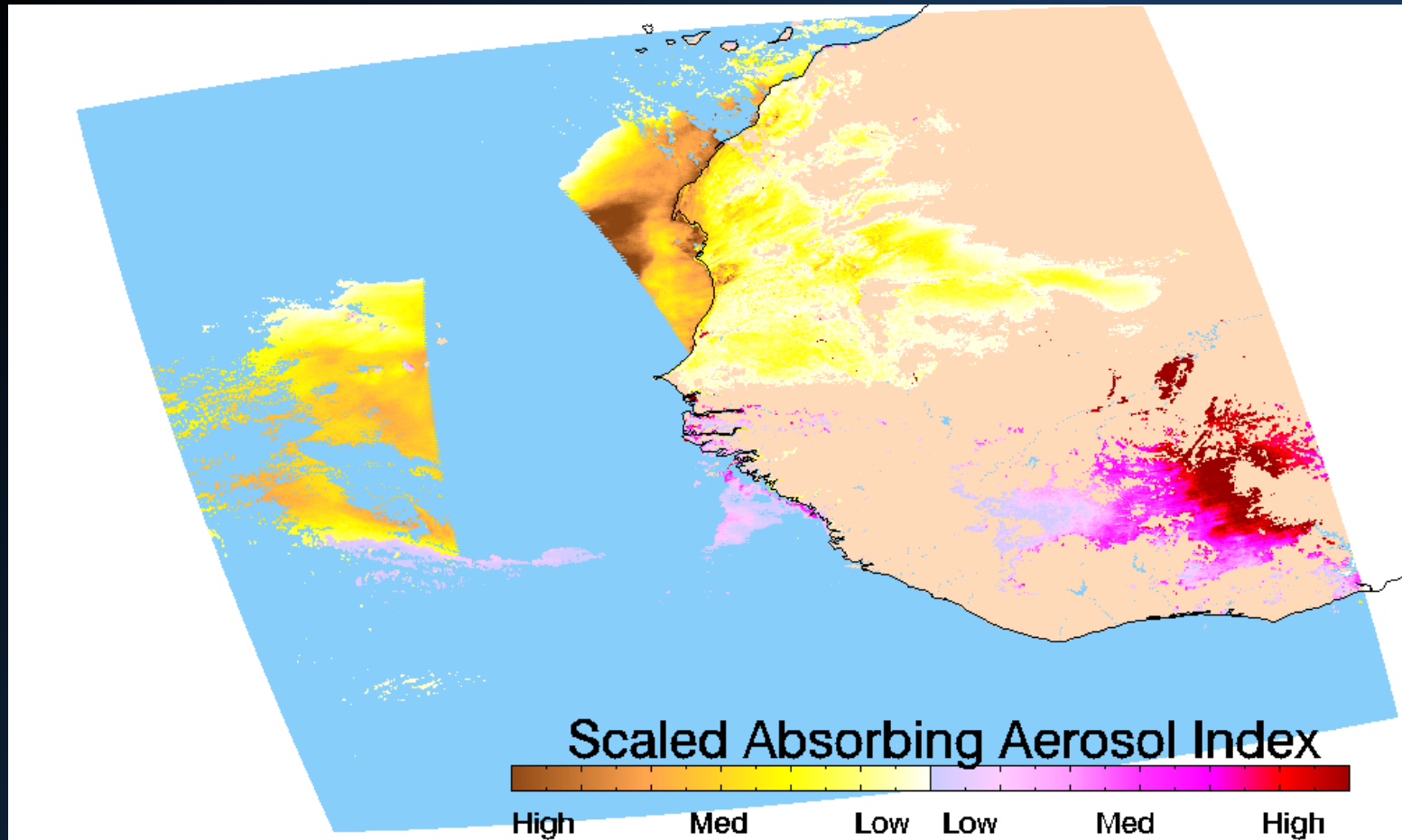


Pubu Ciren

Smoke Quality

Dust Quality

Intensity: Scaled Absorbing Aerosol Index



Pubu Ciren