



GOES-16

Advanced Baseline Imager (ABI)

Aerosol Optical Depth (AOD)

Algorithm and Product Status

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Product Overview



- Aerosol optical depth (AOD)
 - A measure of the extinction (scattering + absorbing) of radiation by aerosols in an atmospheric column. Proportional to the aerosol amount (number or mass concentration).
- Products in file
 - 550-nm AOD for Full Disk (every 15 min) and CONUS (every 5 min) in range -0.05 to +5
 - Quality flag (0=high; 1=medium, 2=low, 3=not produced)
 - Mean, max, min and standard deviation of 550-nm AOD (and in 10-degree latitude zones) over land/water

MODIS and VIIRS heritage

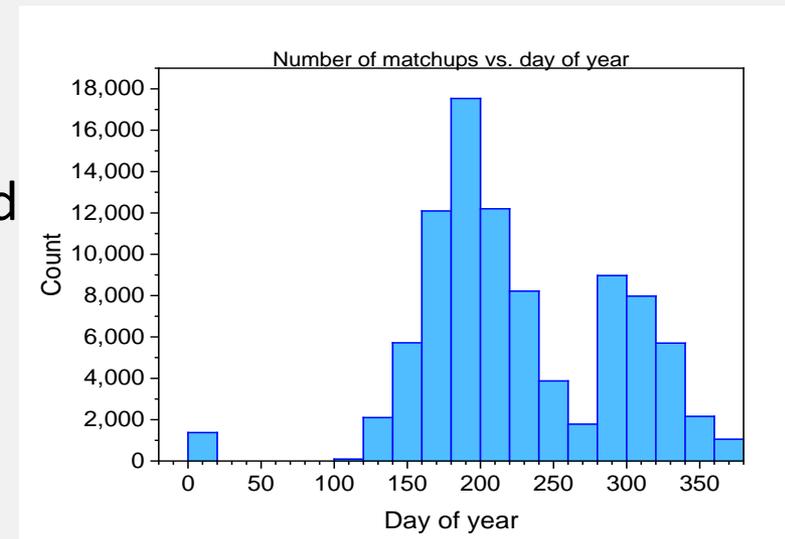
- Calculates look-up-table for a set of AOD, aerosol models and geometries;
- Compares VIS and NIR reflectances in multiple channels with observations;
- Selects the AOD and aerosol model to best match observation.

Channels used in AOD Algorithm

ABI Band	Central Wavelength (μm)	Retrieval		Internal Test	
		Land	Water	Land	Water
1	0.470	X		X	X
2	0.640	X	X	X	X
3	0.865		X	X	X
4	1.378			X	X
5	1.610		X	X	X
6	2.250	X	X	X	X
14	11.200			X	X

Algorithm Overview (2)

- Separate algorithm for water and land
 - *Water*: surface reflectance calculated from model;
 - *Land*: VIS surface reflectance estimated from 2.2 μm via preset relationships;
 - Matchups collected for 4/29/2017 – 1/15/2108 between ABI L1b reflectances and AERONET AOD;
 - solar zenith angle dependence;
 - NDVI dependence.
- Internal tests to qualify pixels for retrieval





Algorithm Overview – Internal Tests

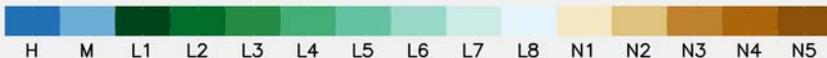
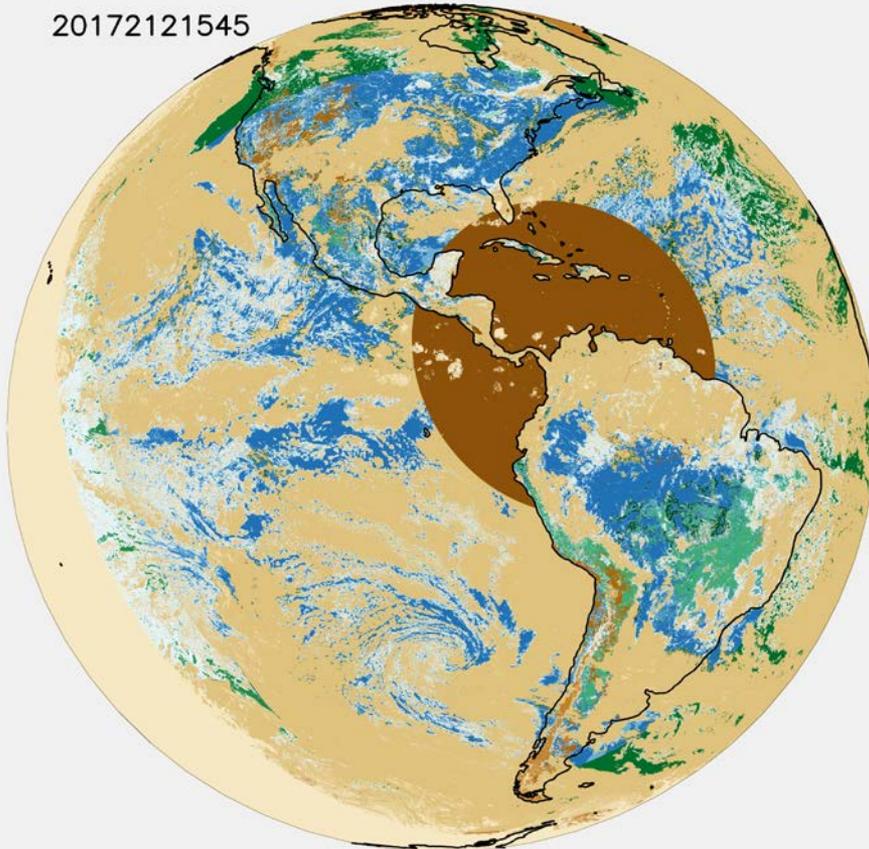
Quality Level	Condition	Applies to		Detected by	
		Land	Ocean	External Mask	Internal Tests
No Retrieval	Invalid input data	X	X		X
	Cloud	X	X	X	X
	Snow/Ice	X	X	X	X
	Ephemeral Water	X			X
	Sun Glint		X		X
	Bright Land Surface	X			X
Low	AOD Out of Range	X	X		X
	Low Sun (solzen > 80°)	X	X		X
	Low Satellite (satzen > 60°)	X	X		X
	E & I cloud tests contradict	X	X	X	X
	Coastal	X	X	X	
	Shallow Inland Water		X	X	X
	High Inhomogeneity	X	X		X
	High Residual	X	X		X
Medium	Cloud/Snow Adjacency	X	X		X
	Shallow Ocean		X	X	X
	Probably Clear	X	X	X	
	Medium Inhomogeneity	X	X		X
	Medium Residual	X	X		X

Algorithm Overview – Quality Flag

07/31/2017 at 15:45 UTC

Quality Flag

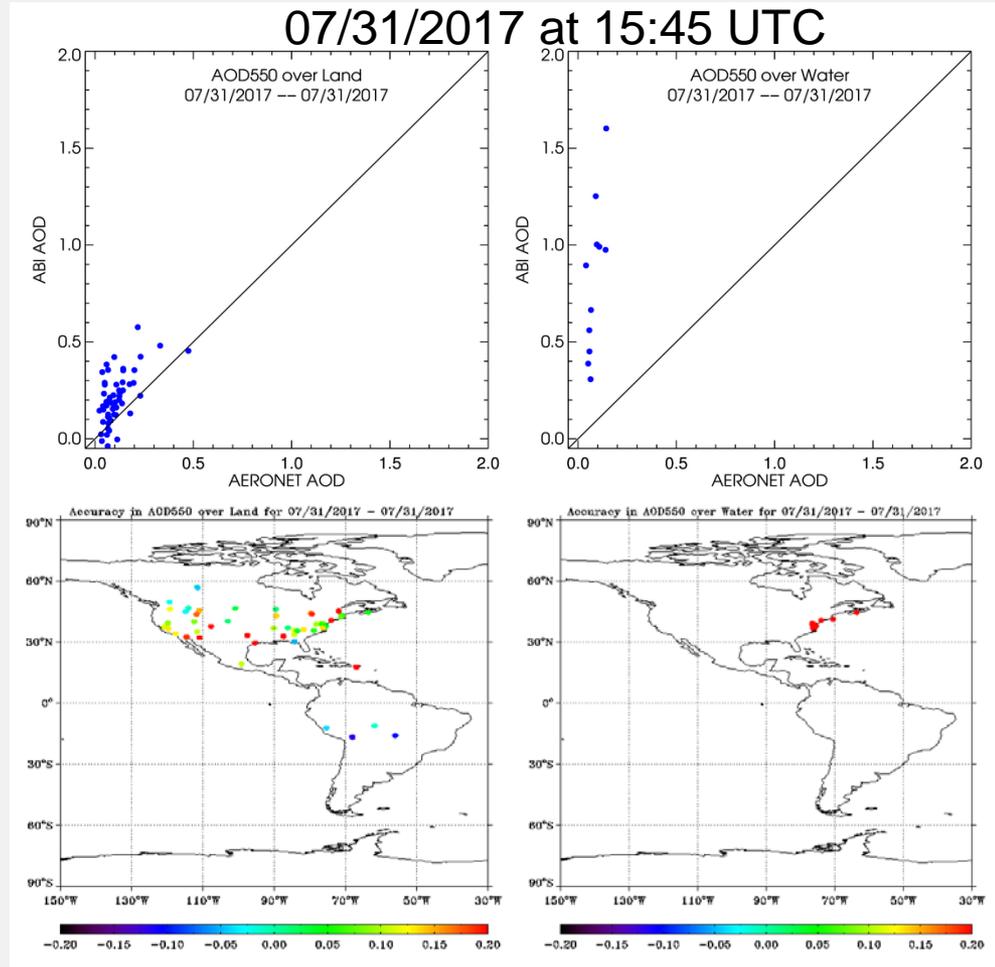
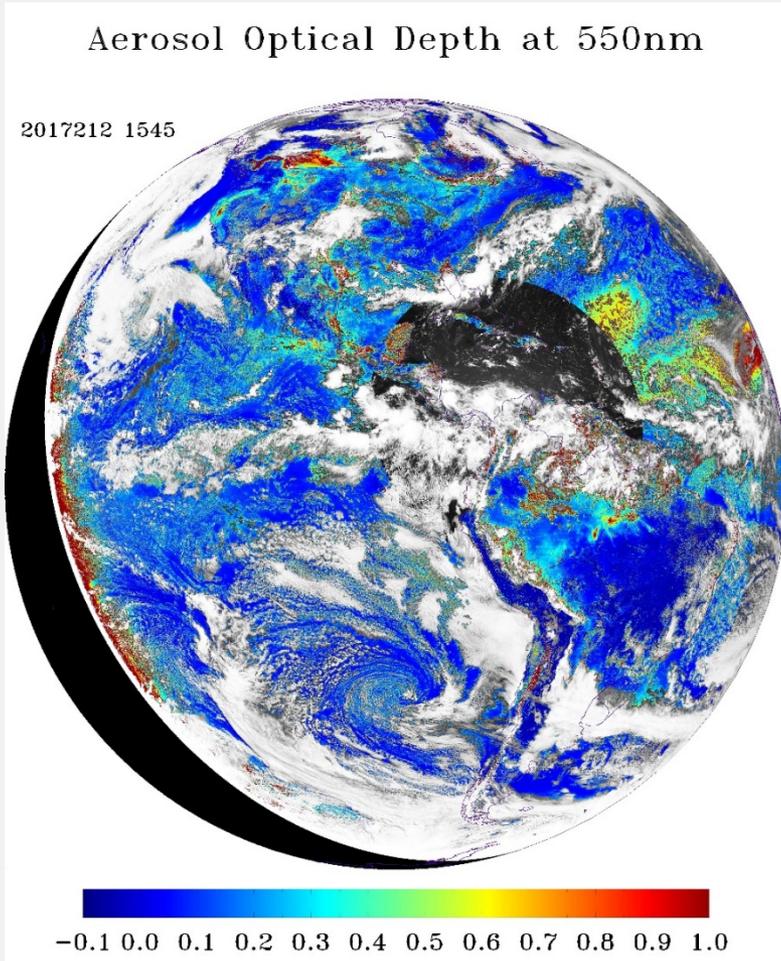
20172121545



H	High
M	Medium
L	Low
L1	Contradicting Cloud Masks
L2	Low Satellite Angle
L3	Low Sun Angle
L4	Out of Spec Range
L5	Coastal Area
L6	Shallow Inland Water
L7	High Residual
L8	High Inhomogeneity
N	No Retrieval
N1	Invalid Input
N2	Cloud
N3	Snow
N4	Bright Land Surface
N5	Sun Glint

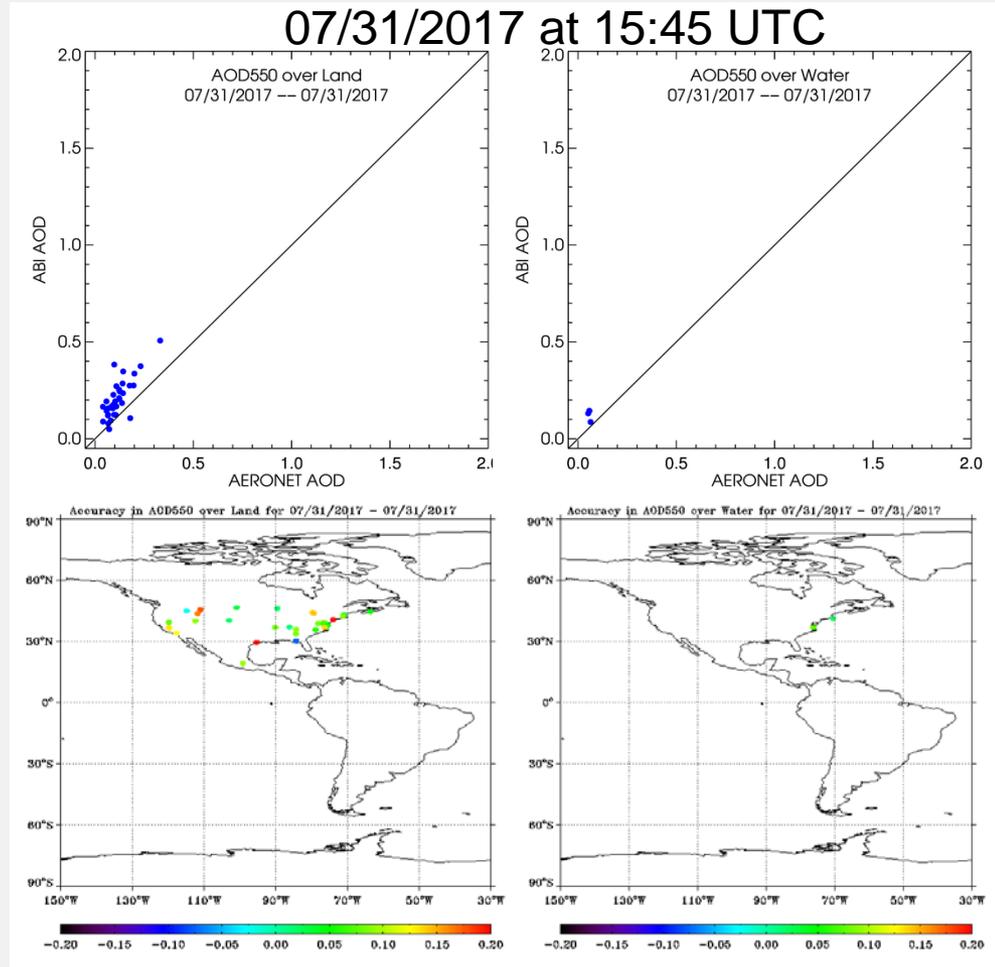
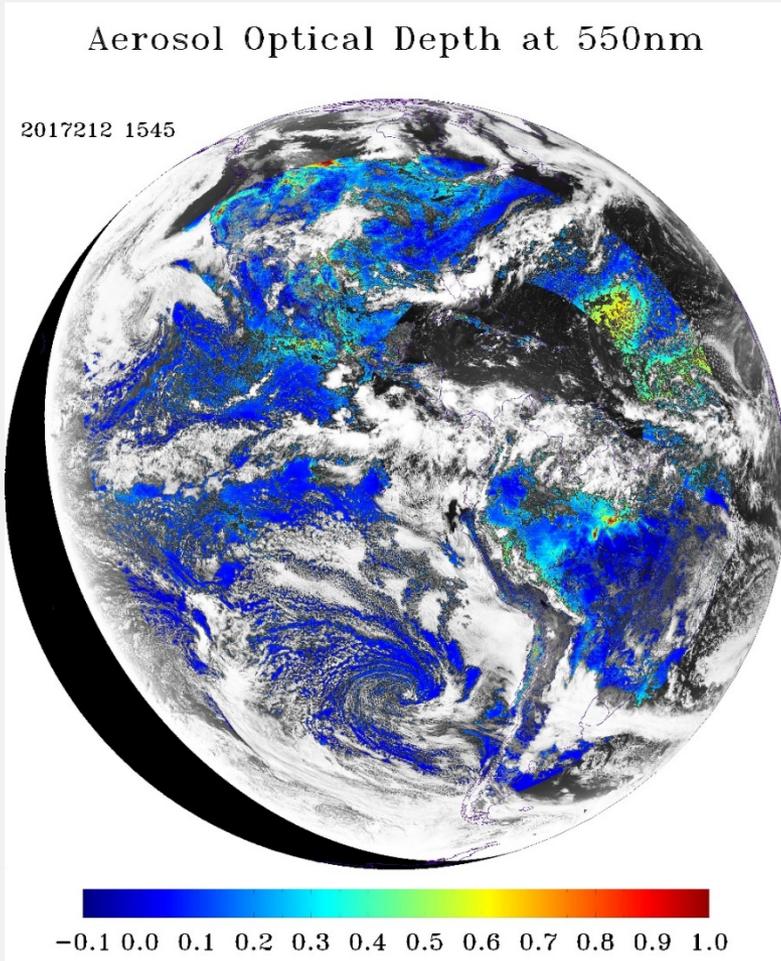
Algorithm Overview – Sample Analysis (1)

Low + Medium + High Quality AOD



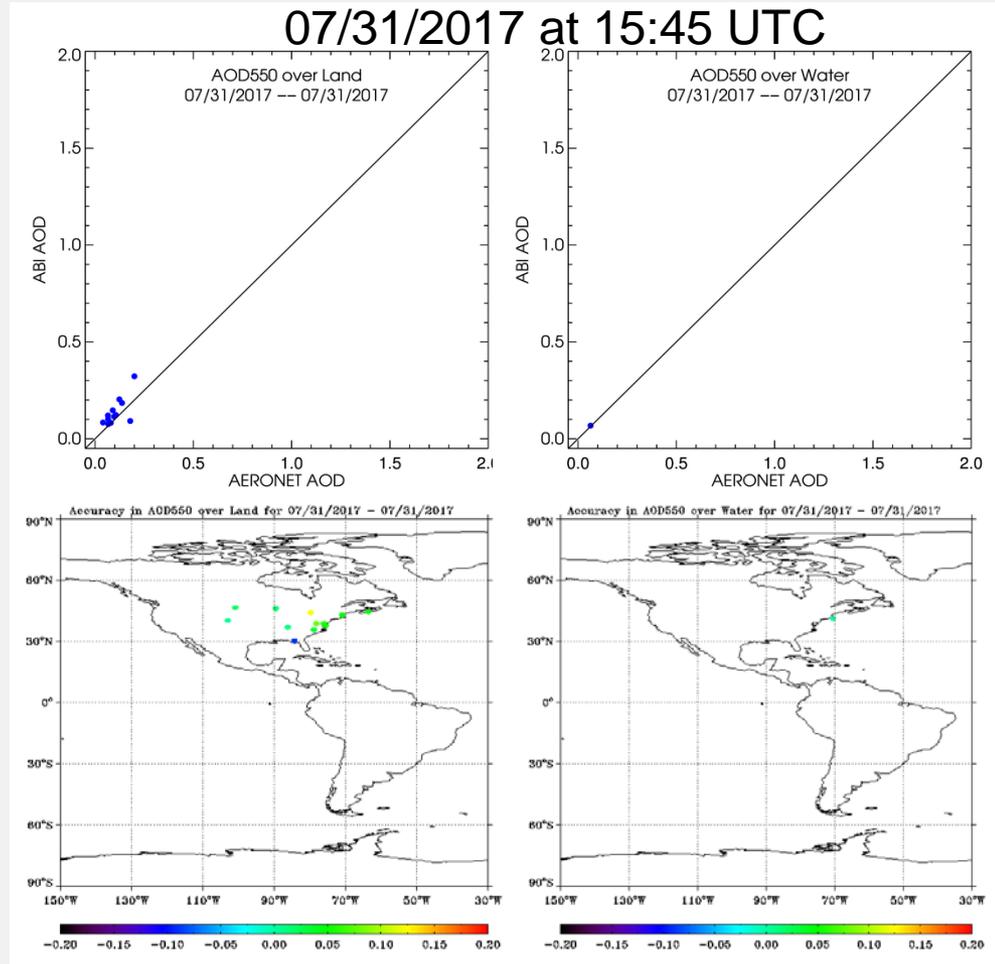
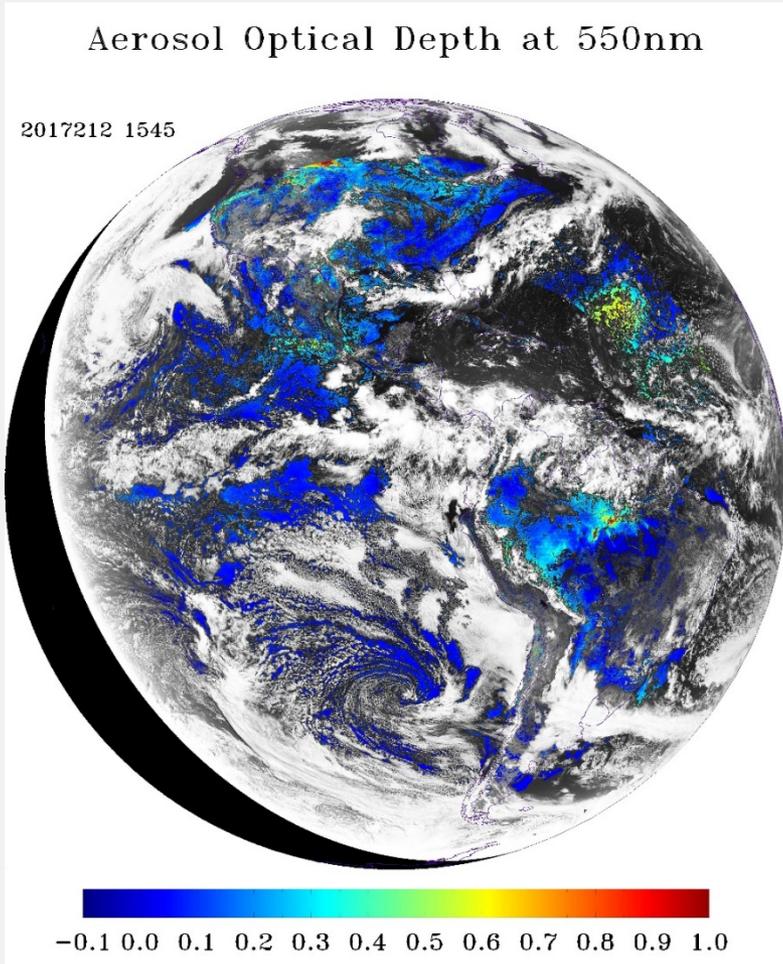
Algorithm Overview – Sample Analysis (2)

Medium + High Quality AOD



Algorithm Overview – Sample Analysis (3)

High Quality AOD





GOES-16 AOD Product Status

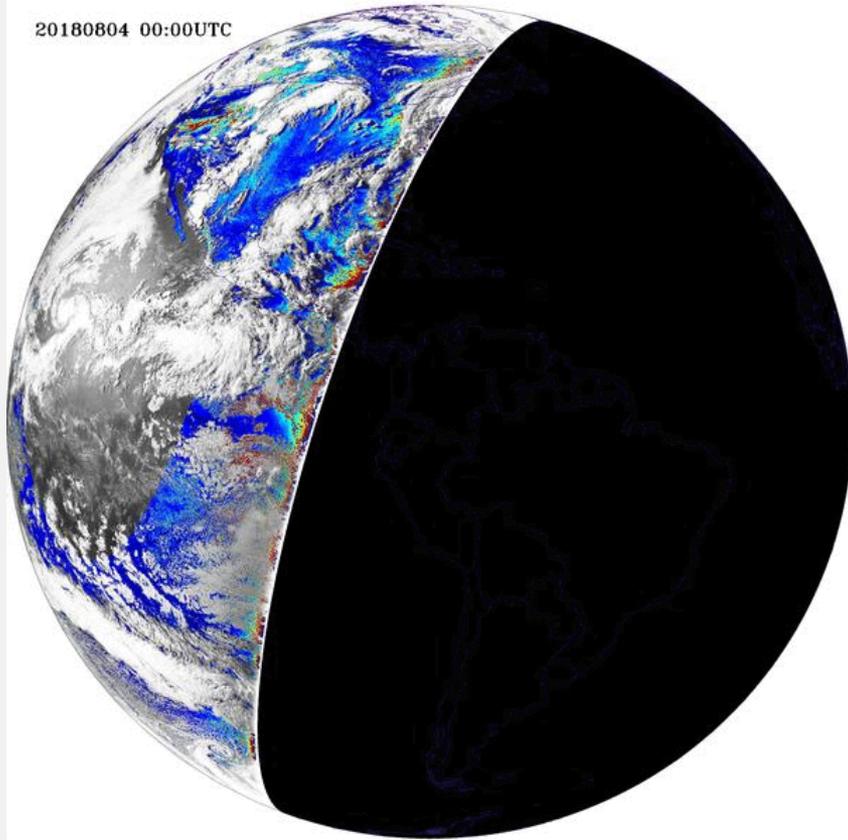
- Beta maturity status since May 24, 2017
- **30 Nov – 11 Dec 2017 GOES-16 drift from 89.5° W to operational East slot at 75.0° W**
- **Provisional maturity status since July 25, 2018**
 - GOES-16 AOD product is ready for operational testing and scientific studies starting 07/25/2018
- Will be available from NOAA's Comprehensive Large Array-Data Stewardship System (CLASS) at <https://www.class.noaa.gov> (access is restricted as of now)
- Look for “GOES-R Series ABI Products GRABIPRD (partially restricted L1b and L2+ Data Products)” - GOES-R ABI Products and Product type AOD

GOES-16 AOD Image – Full Disk

Low + Medium + High QC

Aerosol Optical Depth at 550nm

20180804 00:00UTC

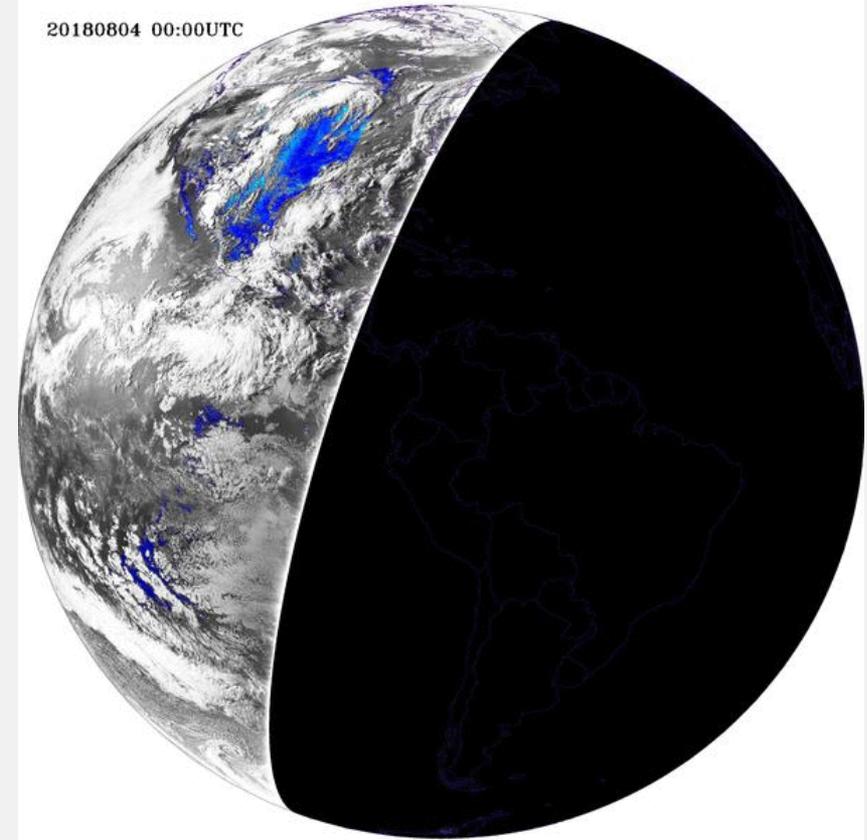


0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

High QC

Aerosol Optical Depth at 550nm

20180804 00:00UTC

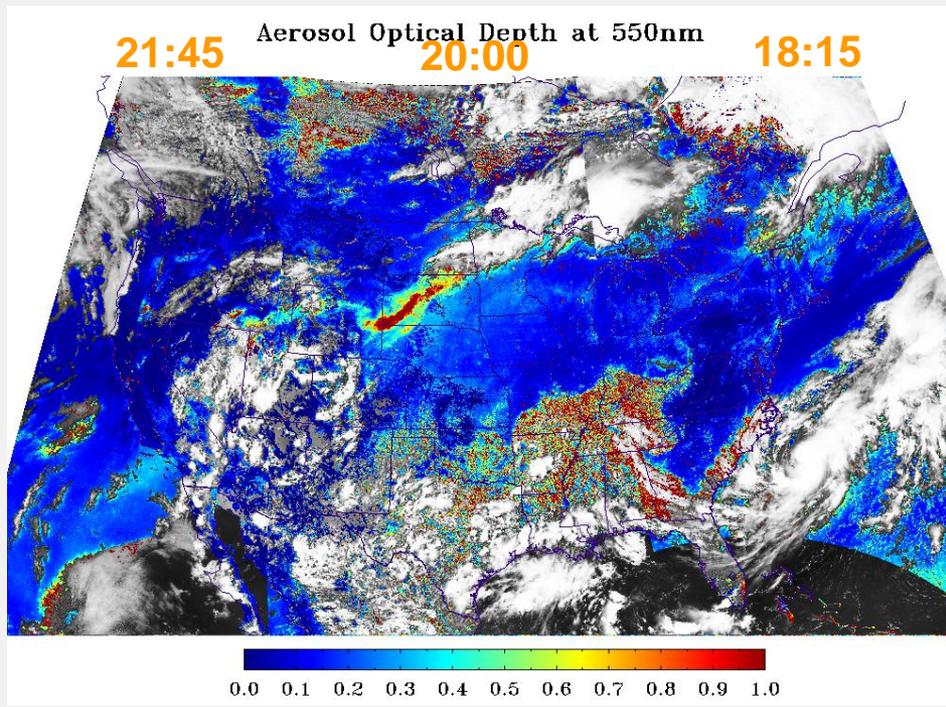
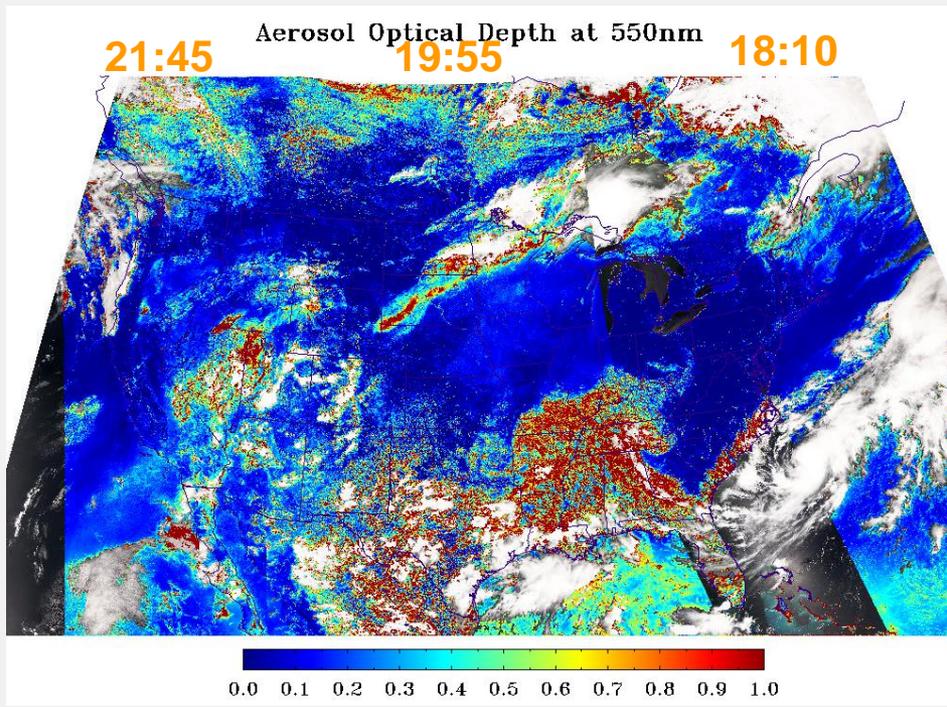


0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

VIIRS NPP EPS AOD vs. GOES-16 ABI AOD

VIIRS

ABI

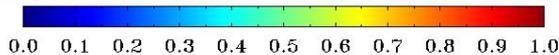
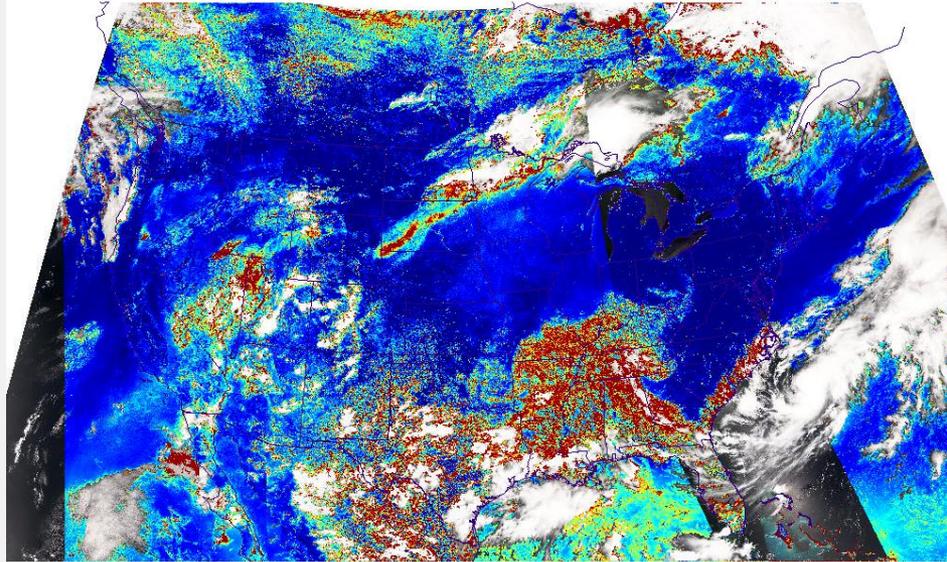


VIIRS NPP EPS AOD vs. GOES-16 ABI AOD

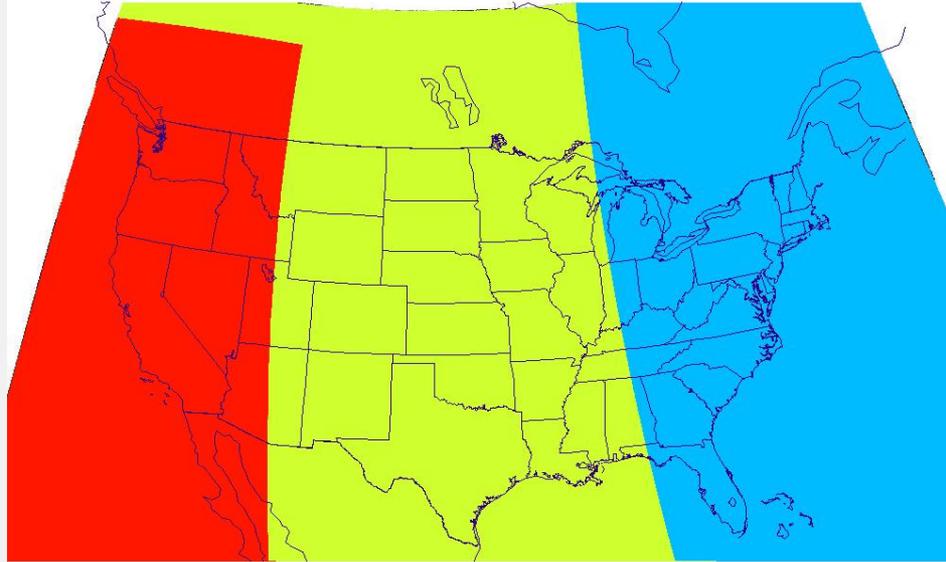
VIIRS

Mask for ABI

21:45 Aerosol Optical Depth at 550nm 19:55 18:10



21:45 19:55 18:10



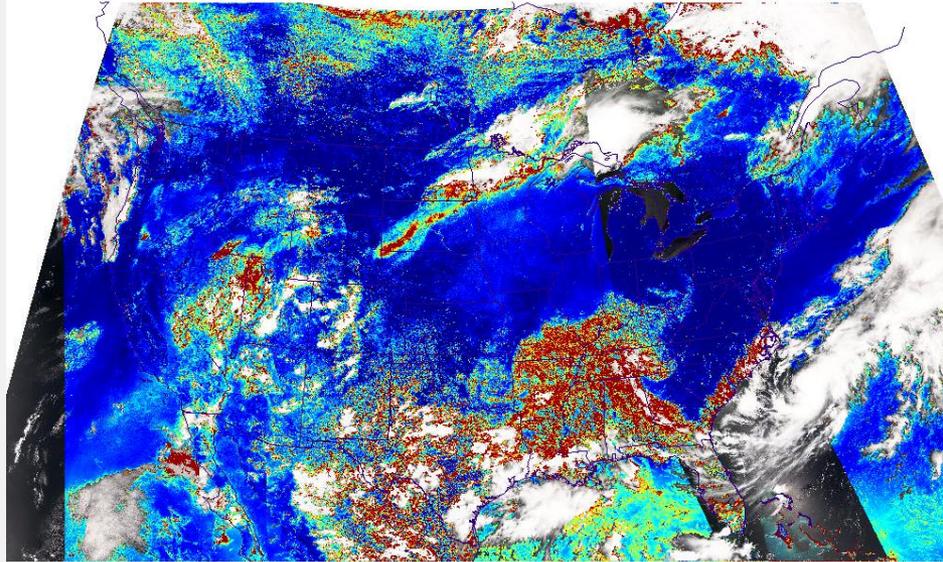
VIIRS

07/08/2018

All QC

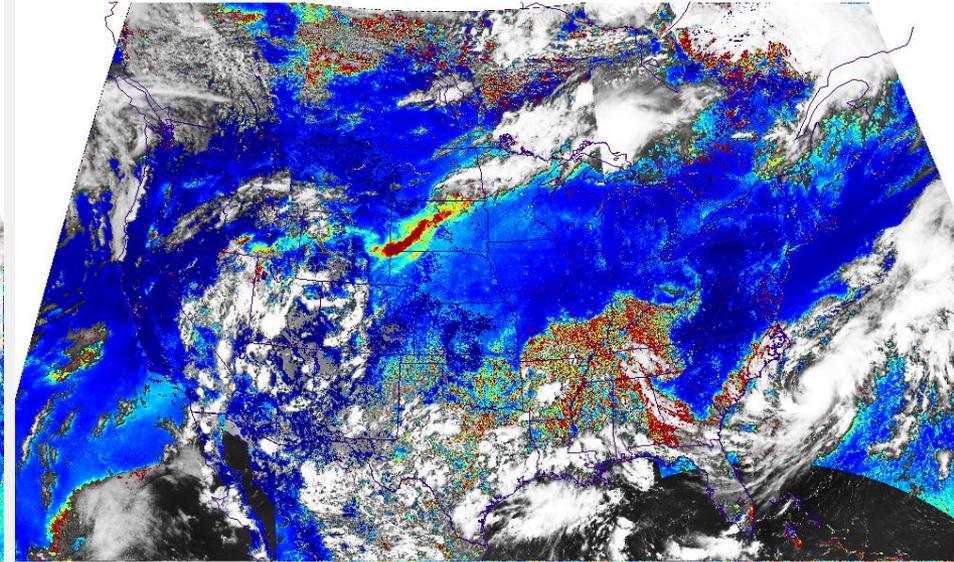
ABI

21:45 Aerosol Optical Depth at 550nm 18:10



0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

21:45 Aerosol Optical Depth at 550nm 20:00 18:15



0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

- At some places ABI AOD is higher/lower than VIIRS AOD, but ...
- Overall ABI and VIIRS low+medium+high QC AOD fields are visually similar enough.
- Fewer ABI retrievals (2-km ABI vs. 0.75-km VIIRS; larger ABI glint region).

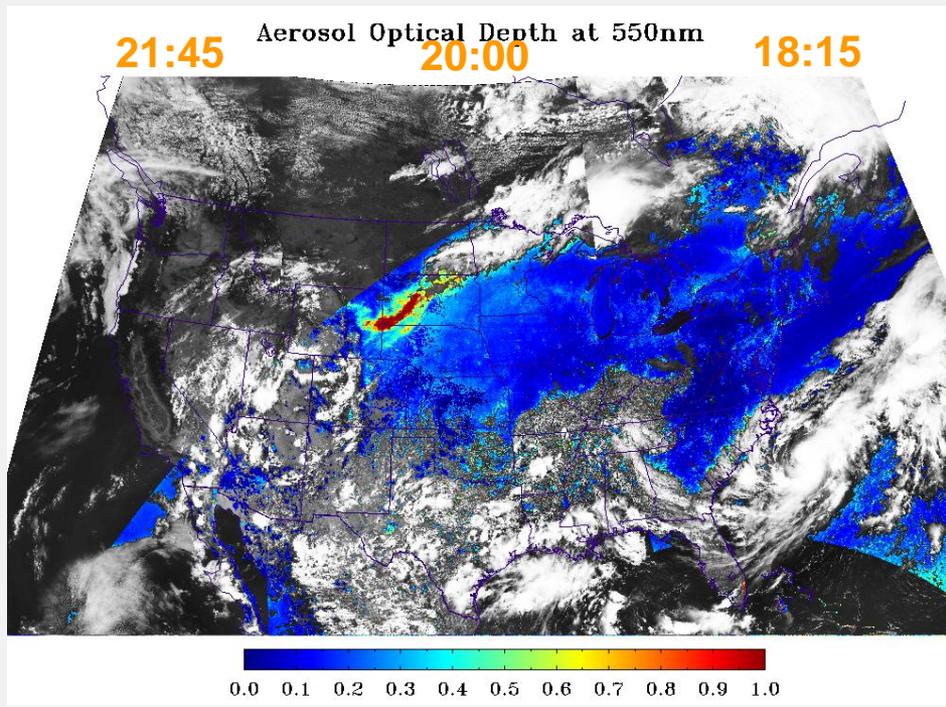
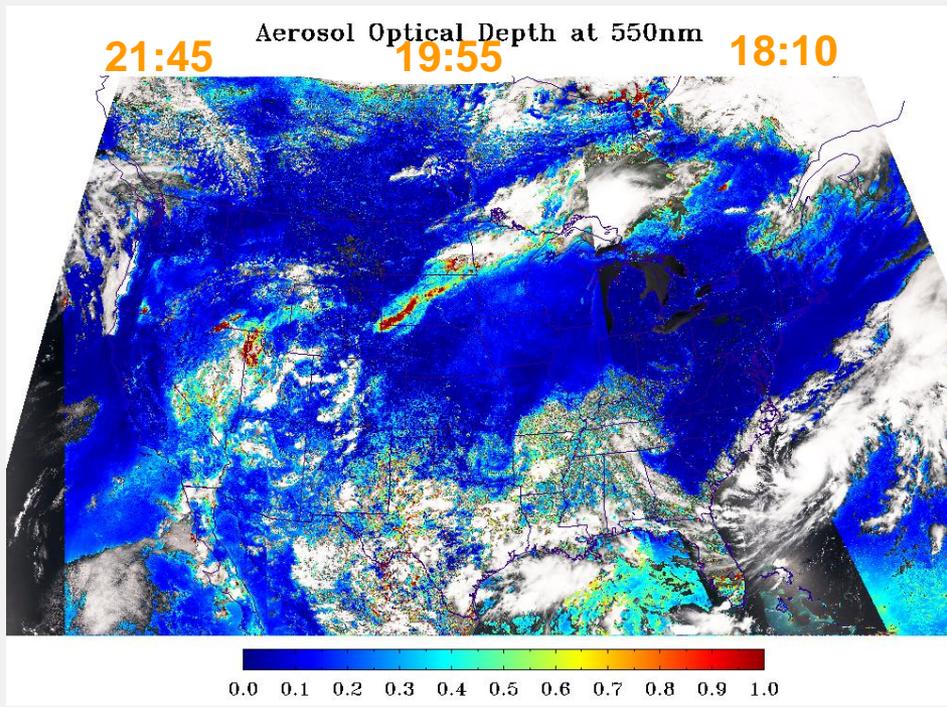
VIIRS NPP EPS AOD vs. GOES-16 ABI AOD

VIIRS

07/08/2018

Medium+High QC

ABI



- ABI satellite zenith angle threshold of 60° excludes retrievals over North West.
- Internal tests (spatial variability of 3x3 pixels) exclude pixels with high spatial variability. More ABI pixels are excluded due to larger pixel size (2-km ABI vs. 0.75-km VIIRS).

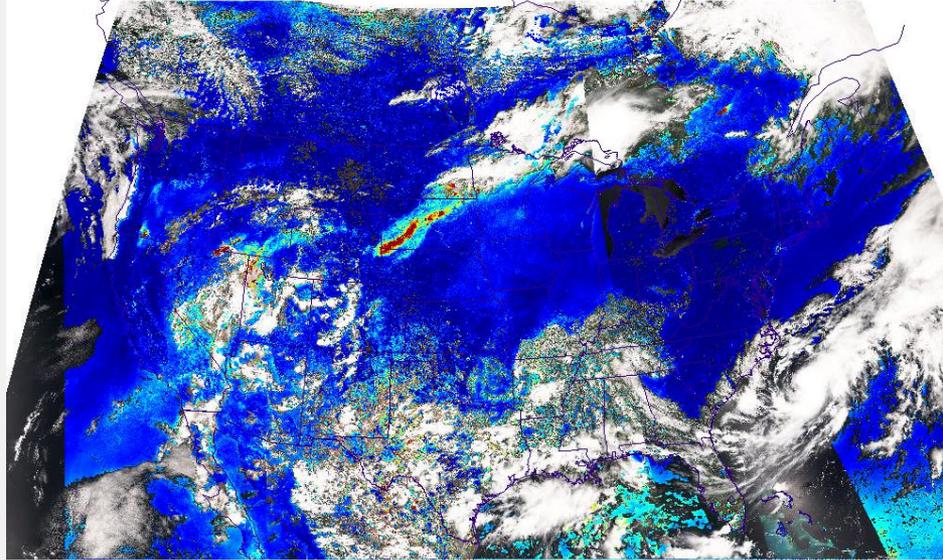
VIIRS NPP EPS AOD vs. GOES-16 ABI AOD

VIIRS

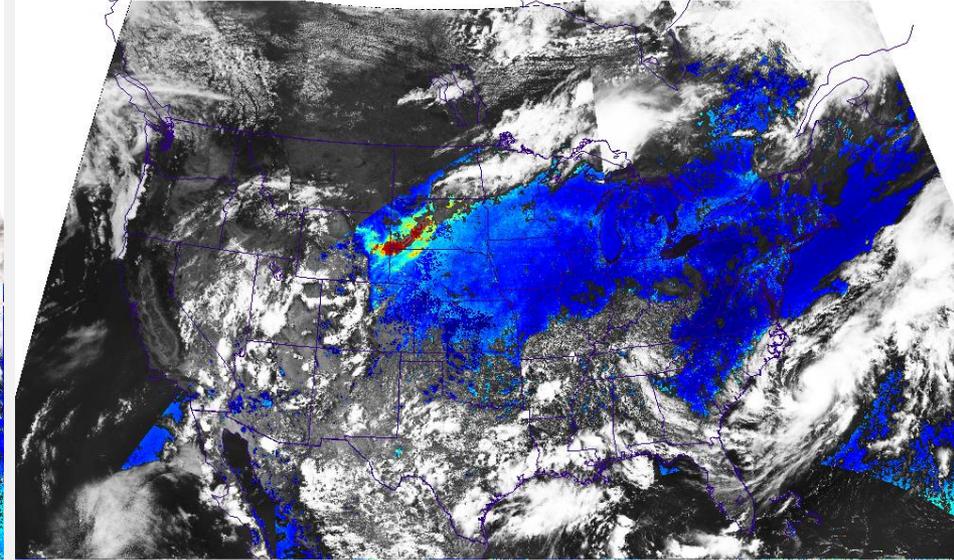
07/08/2018
High QC

ABI

21:45 Aerosol Optical Depth at 550nm 18:10
19:55

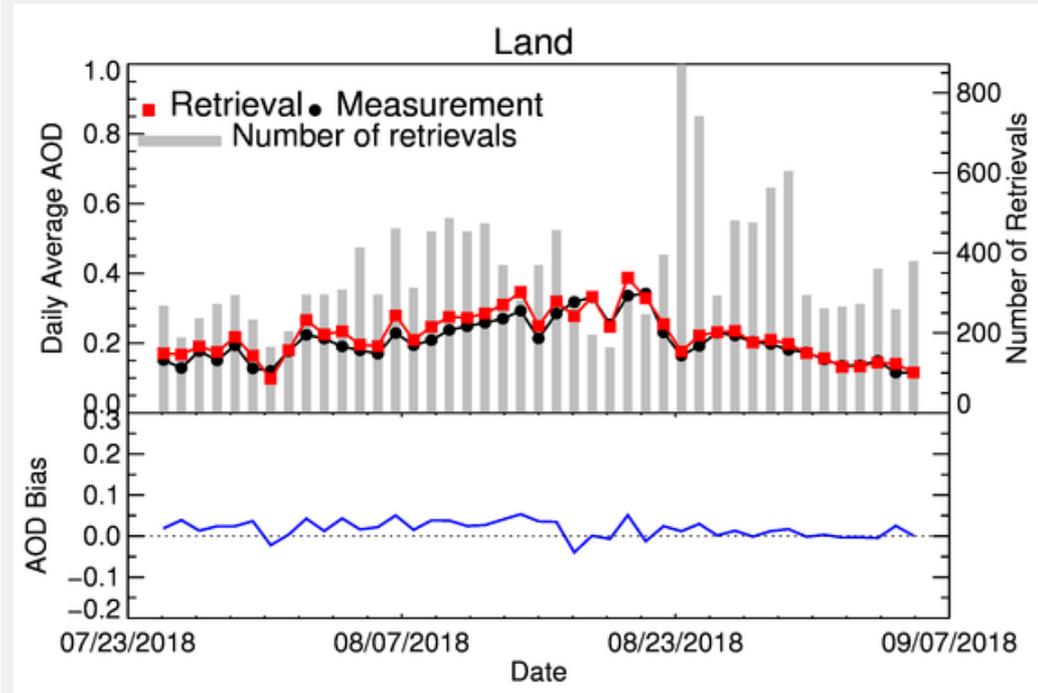
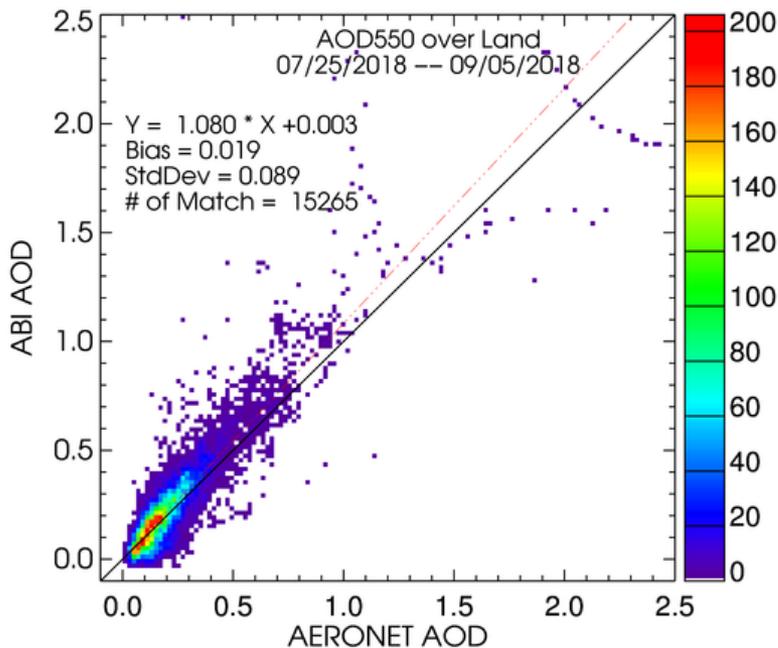


21:45 Aerosol Optical Depth at 550nm 18:15
20:00



- Additional internal tests and more stringent criteria for spatial variability excludes more pixels in both ABI and VIIRS AOD fields.

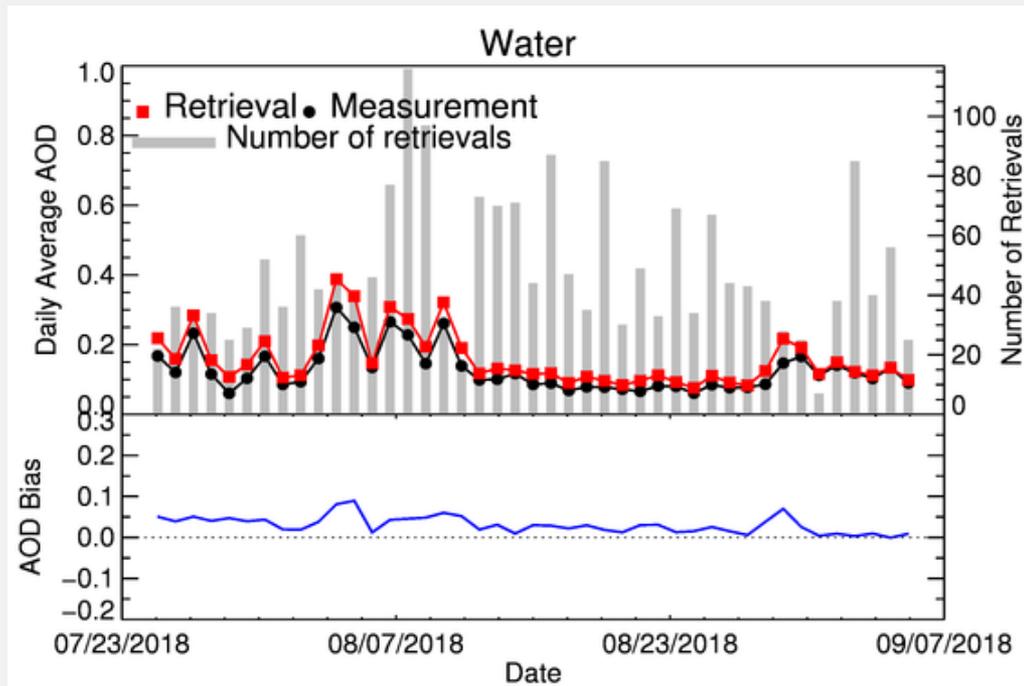
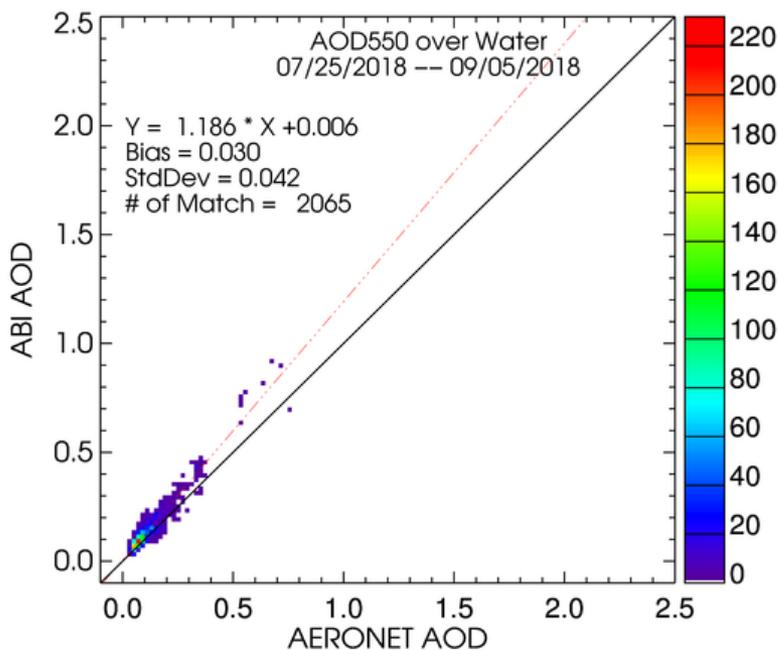
High QC 7/25/2018 – 9/5/2018



- AERONET uses Version 3 Level 1.5 data within a one-hour window centered on the ABI observation time.
- GOES-16 ABI AOD retrievals within a 27.5 km radius area around AERONET sites.

Evaluation with AERONET - Water

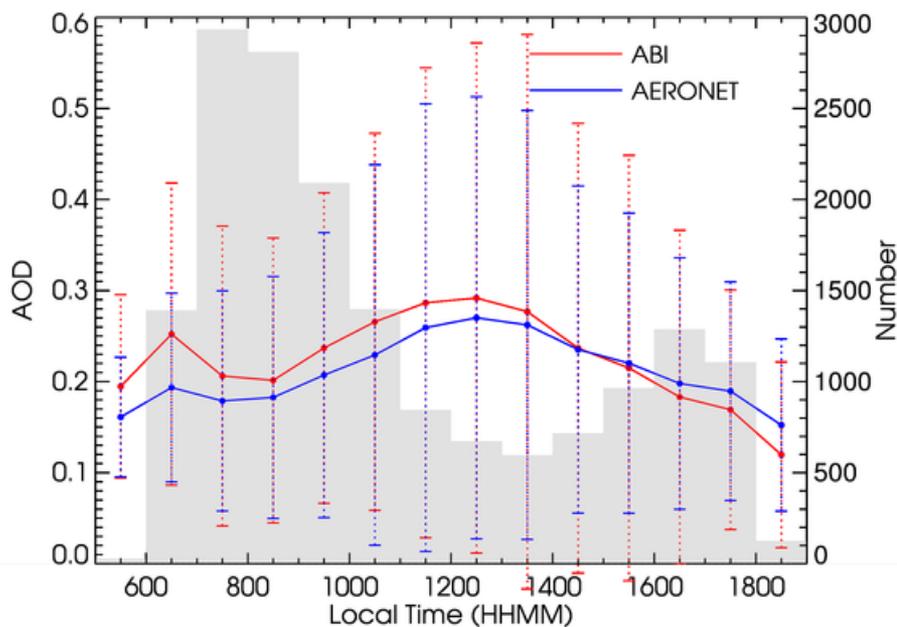
High QC 7/25/2018 – 9/5/2018



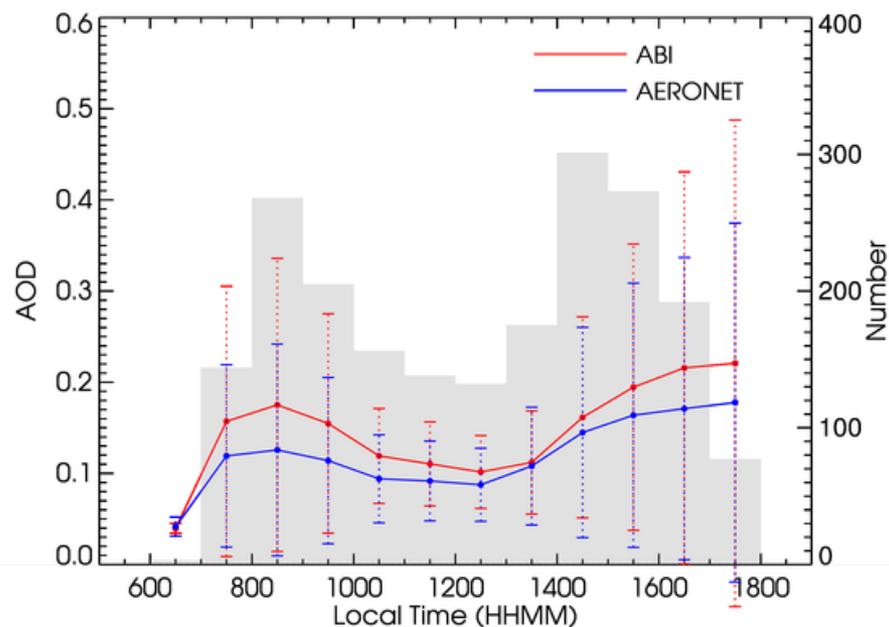
Evaluation with AERONET - Diurnal

High QC 7/25/2018 – 9/5/2018

Land



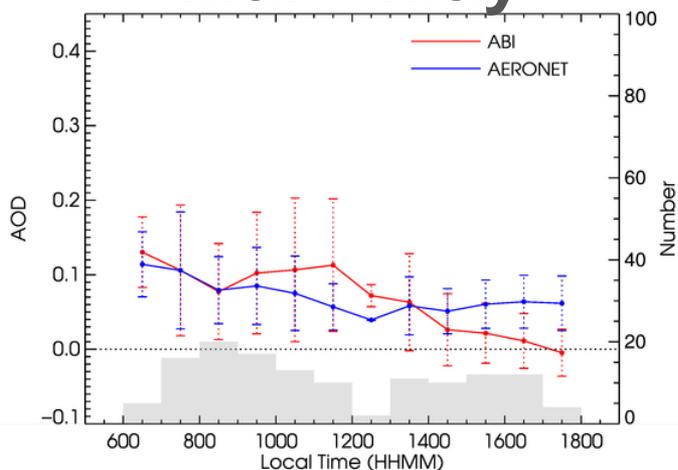
Water



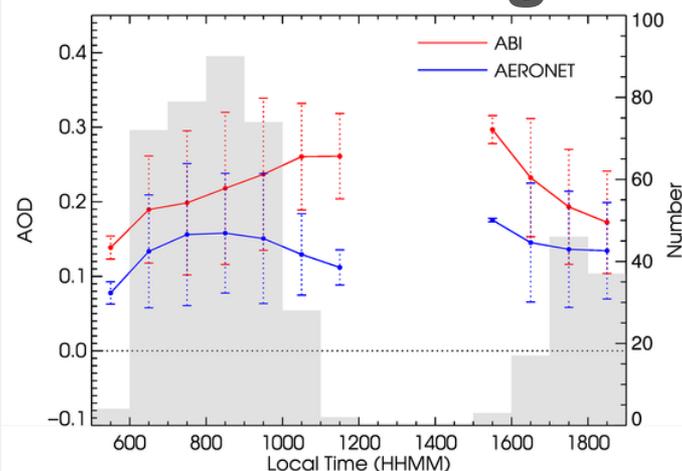
- The GOES-16 ABI AOD diurnal cycle follows diurnal cycle of AERONET AOD.
- The ABI diurnal variation is relatively larger.

GSFC Seasonal Diurnal Cycle

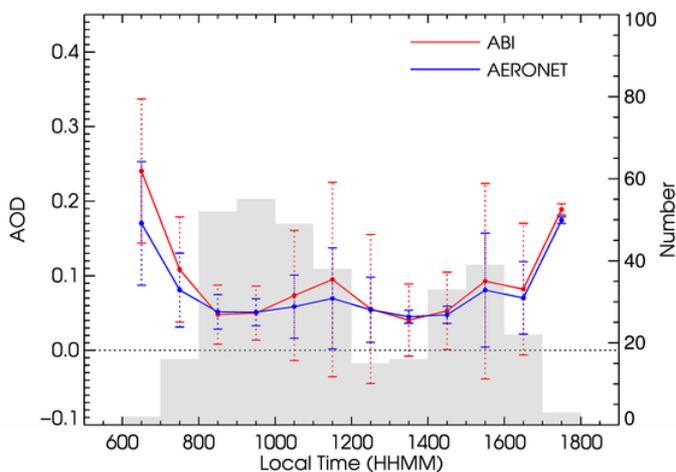
Mar - May



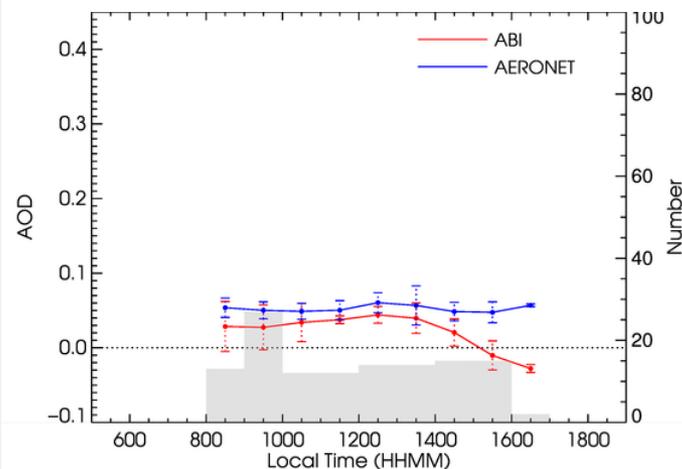
Jun - Aug



Sep - Nov



Dec - Feb



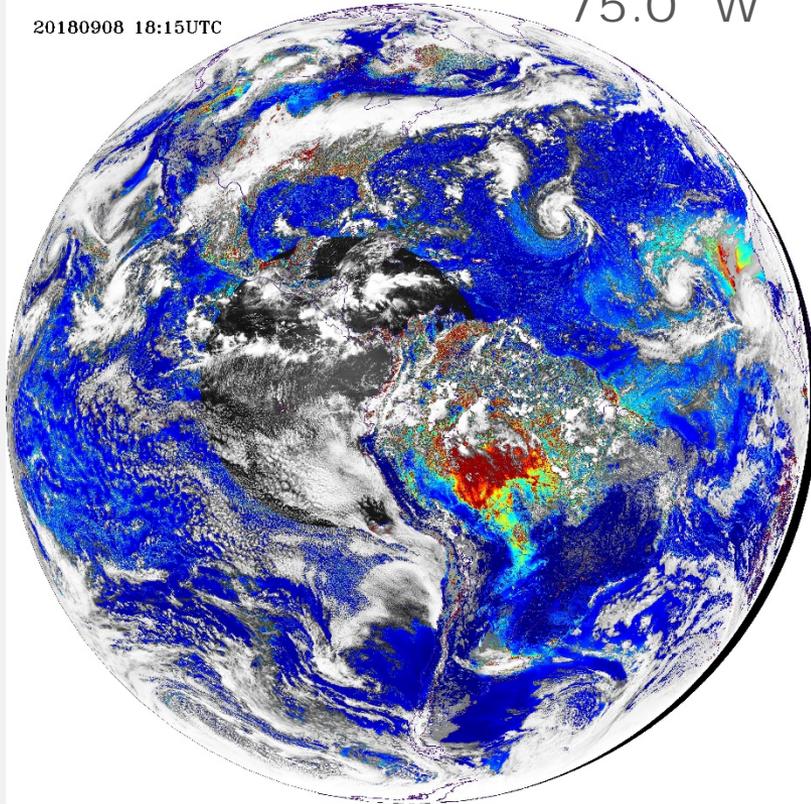
GOES-17 AOD Image – Full Disk

GOES-16 09/08/2018 18:15UTC GOES-17

Aerosol Optical Depth at 550nm

75.0° W

20180908 18:15UTC

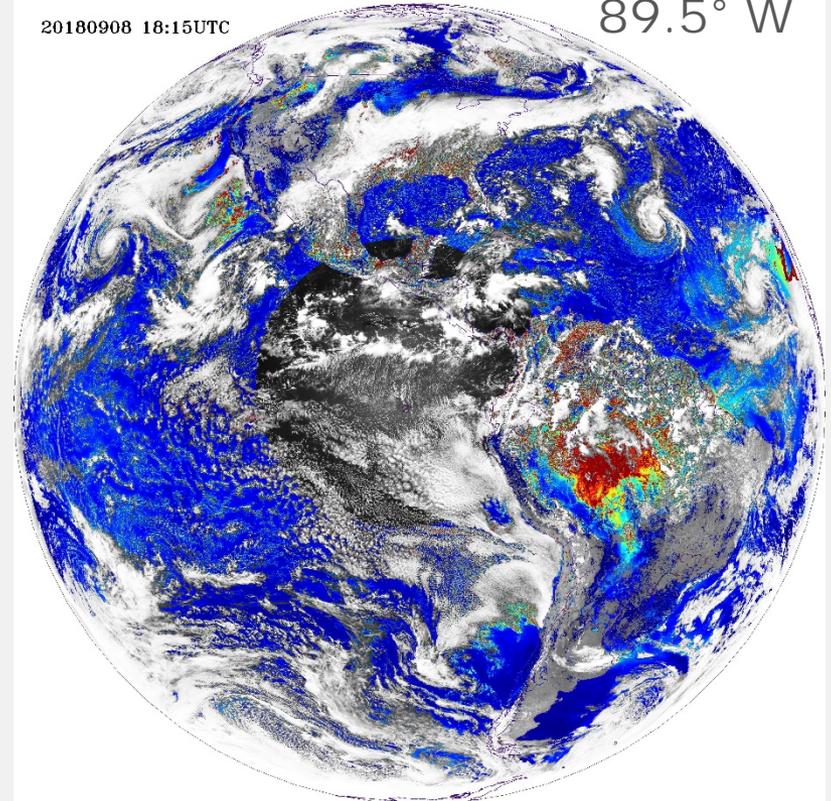


0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Aerosol Optical Depth at 550nm

89.5° W

20180908 18:15UTC



0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

GOES-17 AOD Image – CONUS

09/08/2018 21:02UTC

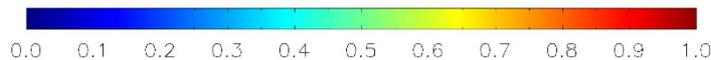
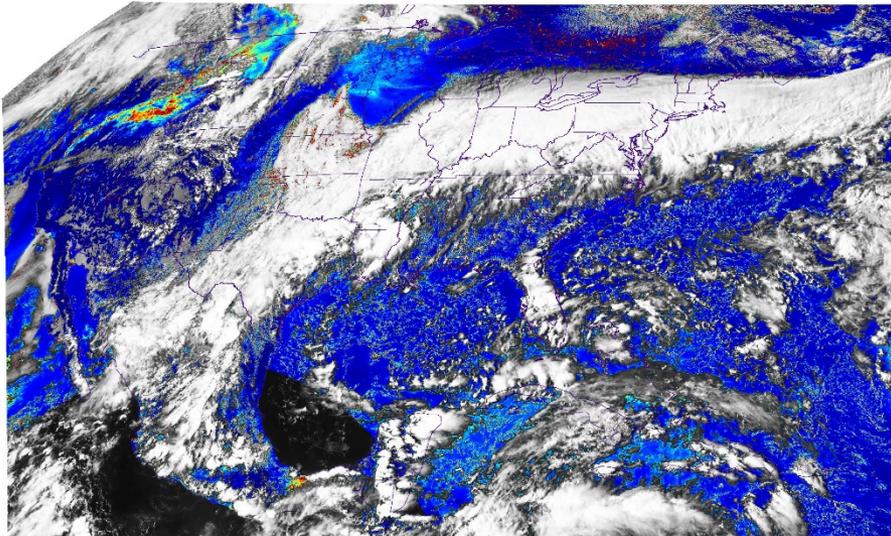
GOES-16

All QC

GOES-17

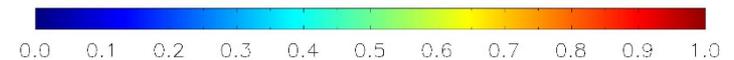
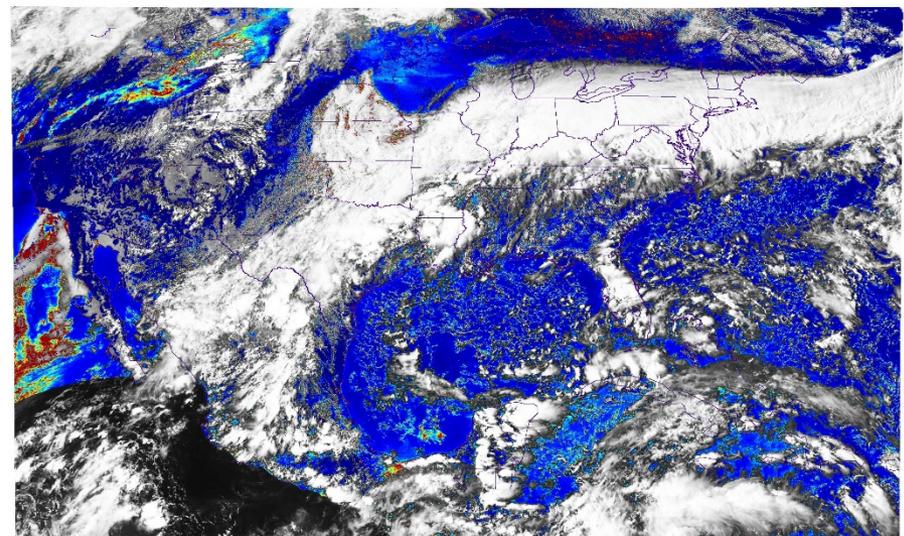
Aerosol Optical Depth at 550nm

20180908 21:02UTC



Aerosol Optical Depth at 550nm

20180908 21:02UTC



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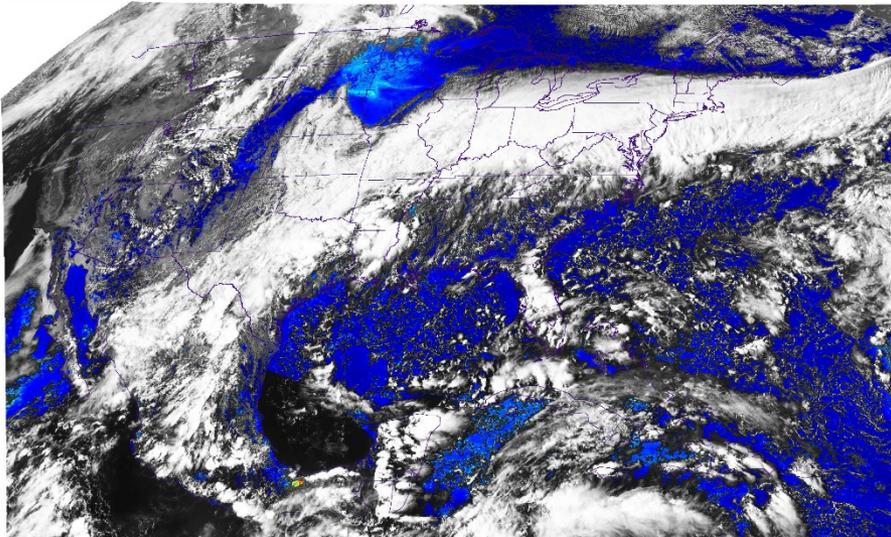
GOES-17 AOD Image – CONUS

09/08/2018 21:02UTC

GOES-16 **Medium + High QC** GOES-17

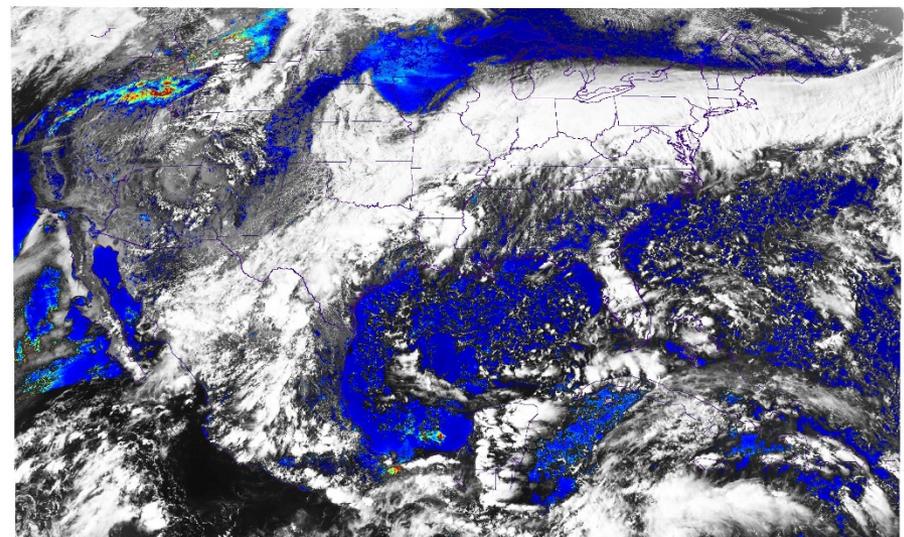
Aerosol Optical Depth at 550nm

20180908 21:02UTC



Aerosol Optical Depth at 550nm

20180908 21:02UTC



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- GOES-17 adds North West coverage for Medium and High QC retrievals



Summary



- GOES-16 ABI AOD is Provisional:
 - Ready for aerosol community to use starting 07/25/2018
 - In general, the high quality retrievals are recommended for quantitative applications; however, the lower quality retrievals also have their merit for qualitative use due to their greater spatial coverage.
- Evaluated with AERONET:
 - Overall bias is about 0.02/0.03 and standard deviation is about 0.09/0.04 over land/water for 07/25/2018 – 09/05/2018.
- Ongoing work with geometry dependence:
 - Solar/view angle dependent surface reflectance relationships;
 - Solar/view angle dependent internal test thresholds.



GOES-17 AOD Image – CONUS



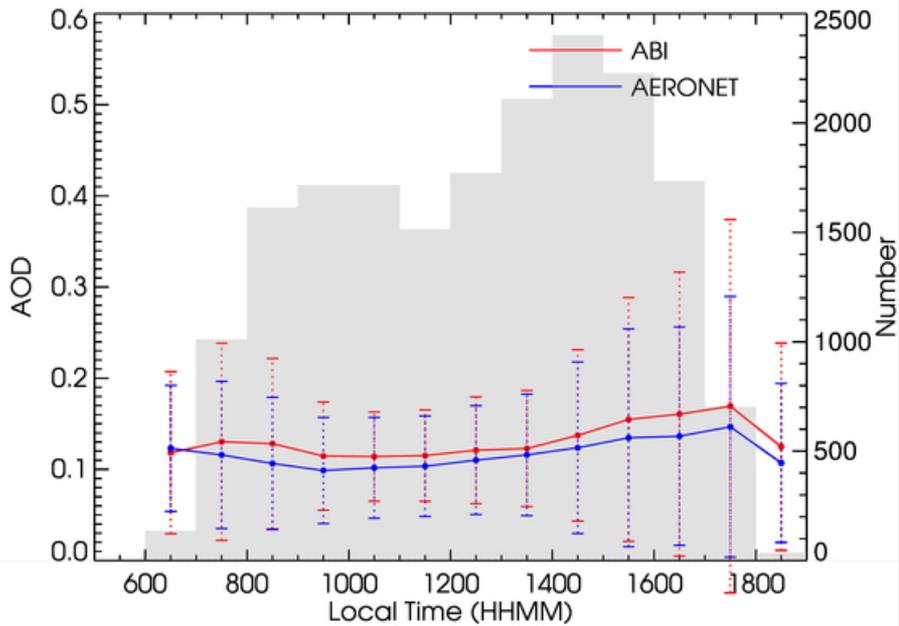
BACK UP

Evaluation with AERONET - Diurnal

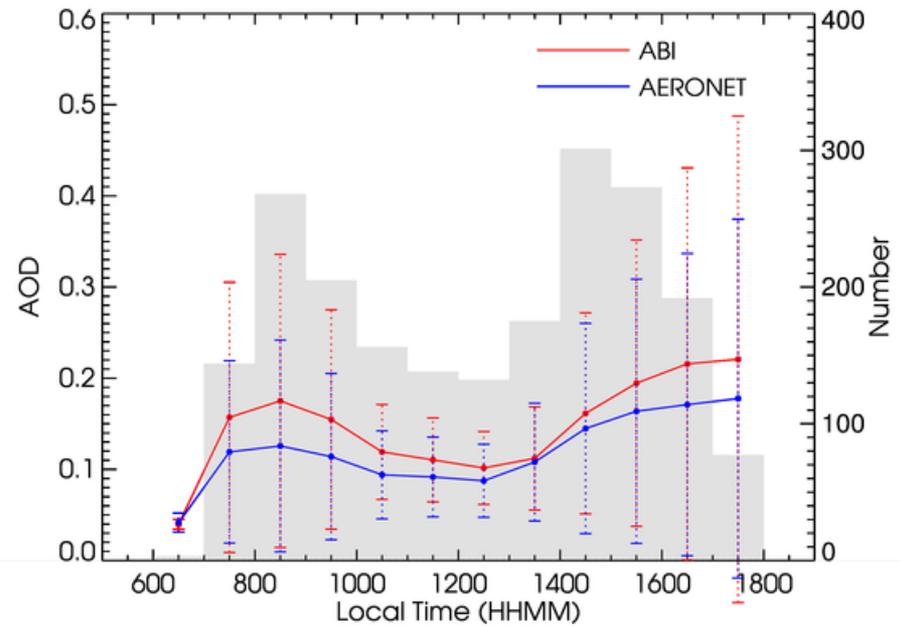
High QC 4/29/2017 – 8/16/2018

High QC 7/25/2018 – 9/5/2018

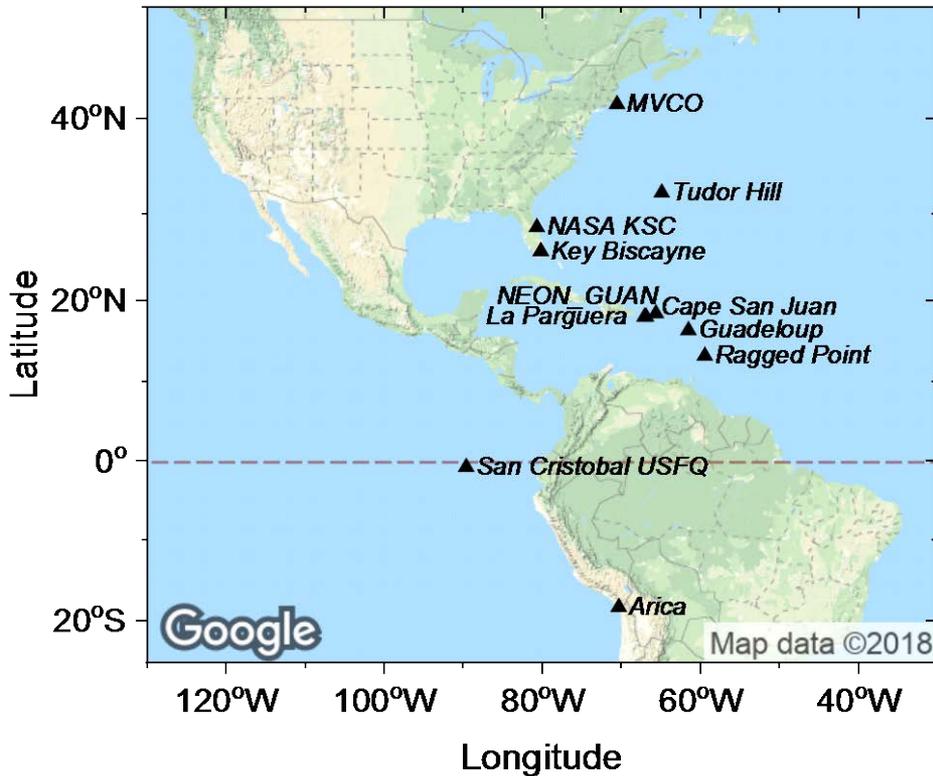
Water



Water



AERONET Site over Water

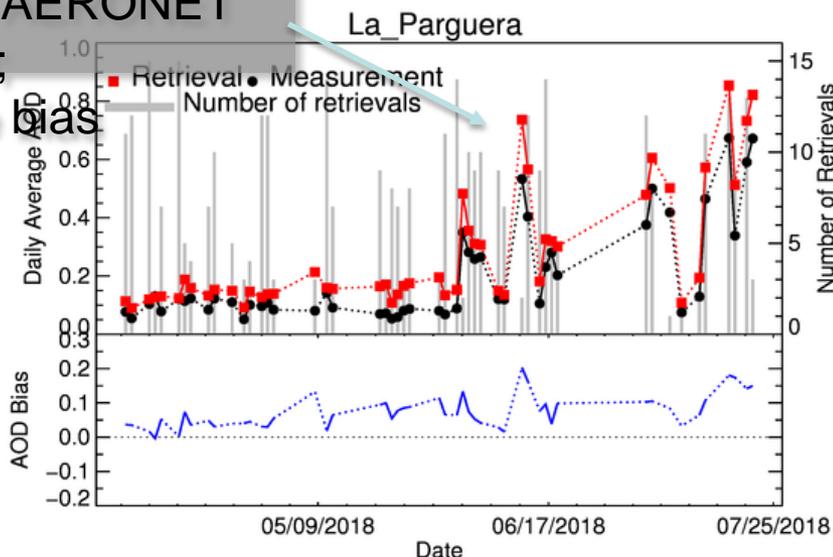
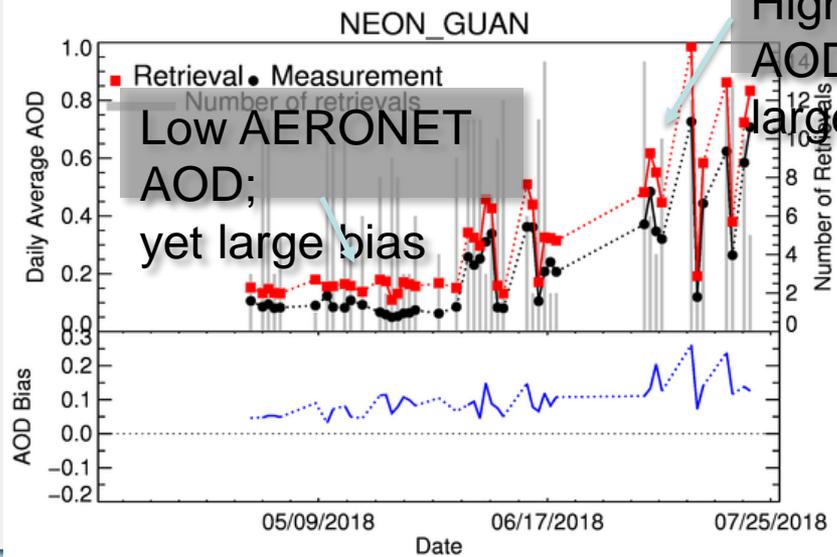
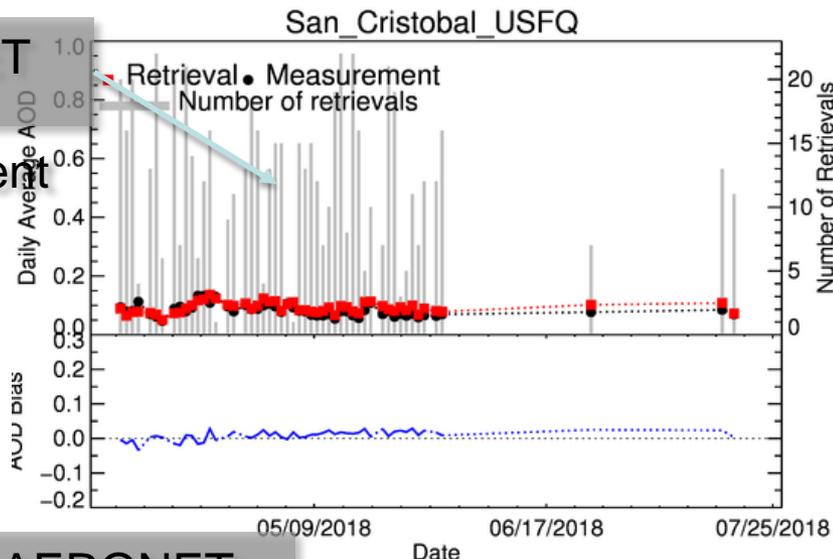
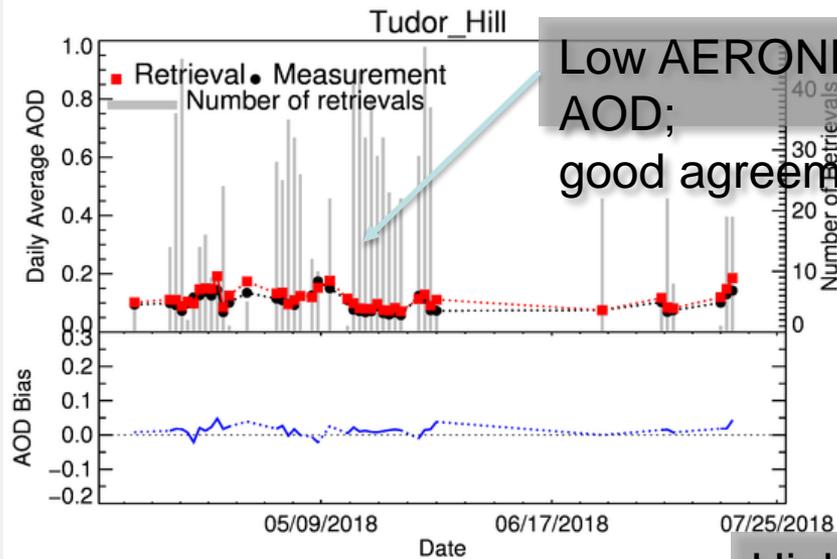


All sites are coastal or island sites.

Many are surrounded by shallow water that violates algorithm assumption.

May be impacted by “land” aerosol from time to time, but retrieval assumes ocean aerosol models.

Time Series of Daily AOD

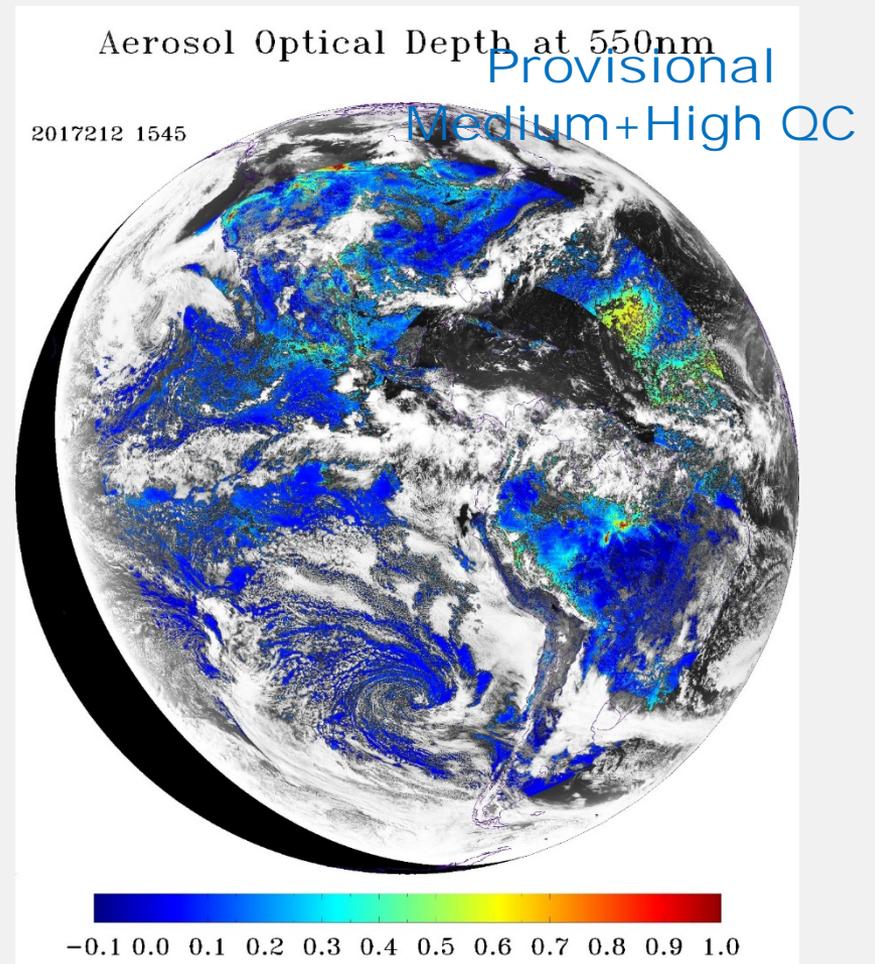
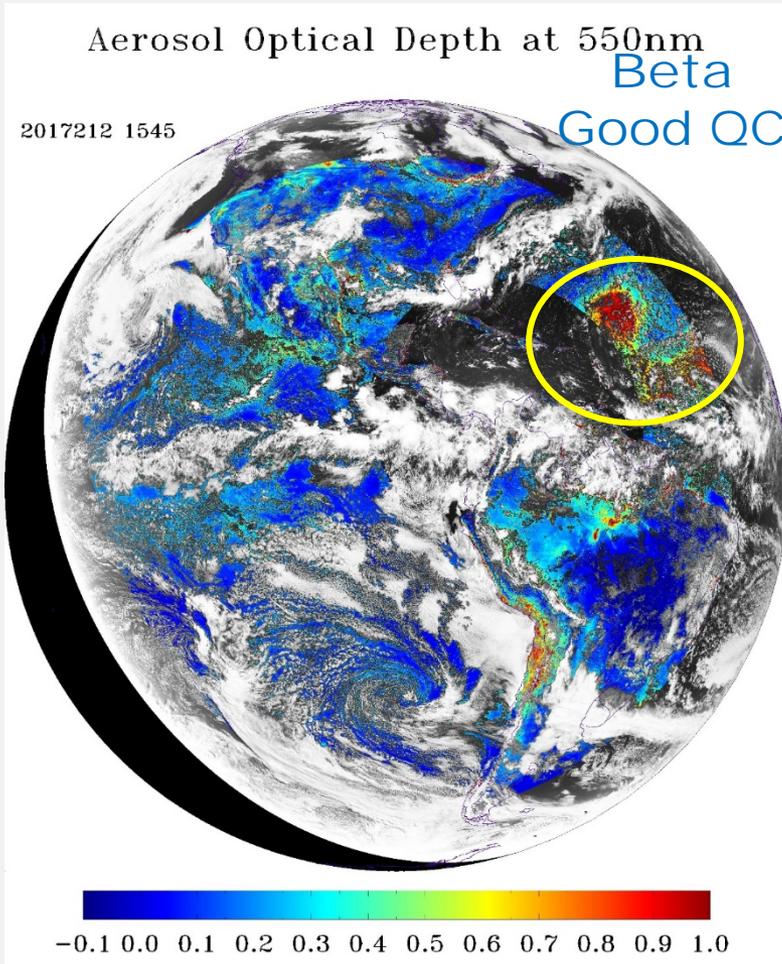


Sites with High AOD Bias



- Complex ocean surface.
- An accurate, high-resolution shallow-water mask is needed to screen out pixels that do not satisfy assumption of dark ocean surface.

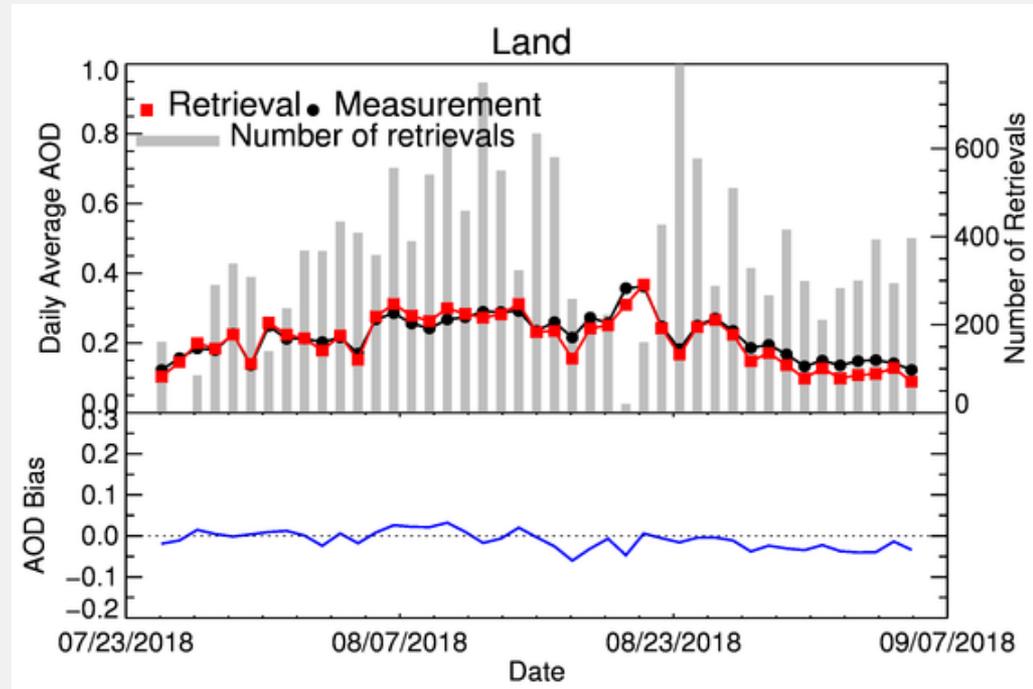
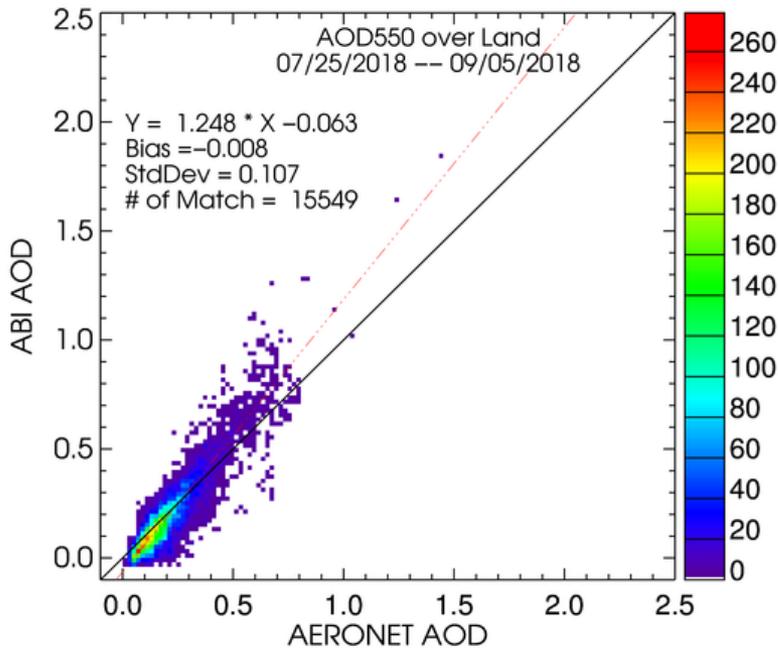
Algorithm Update – AOD Image



- Internal tests reduce contaminations from cloud/snow/shallow water.
- Large AOD bias over water is significantly reduced (result of bug fix in operational code).

GOES-17 Evaluation with AERONET - Land

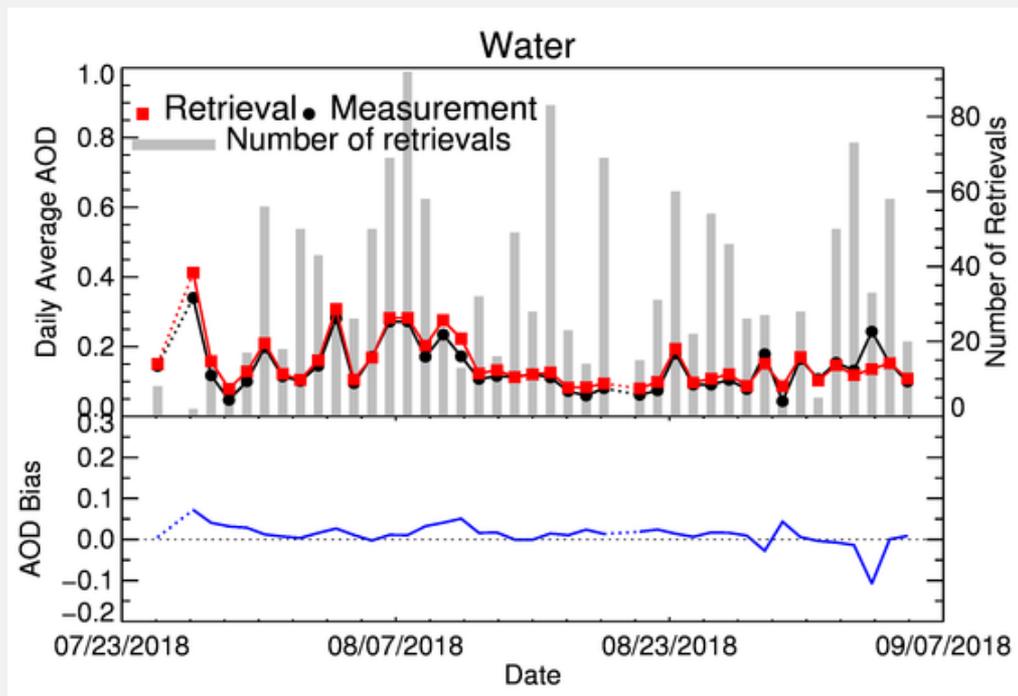
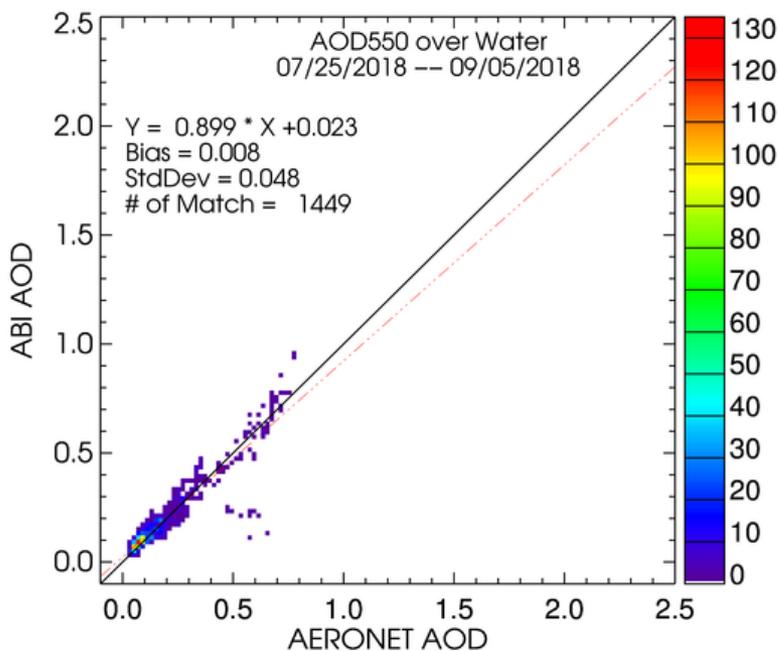
High QC 7/25/2018 – 9/5/2018



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GOES-17 Evaluation with AERONET - Water

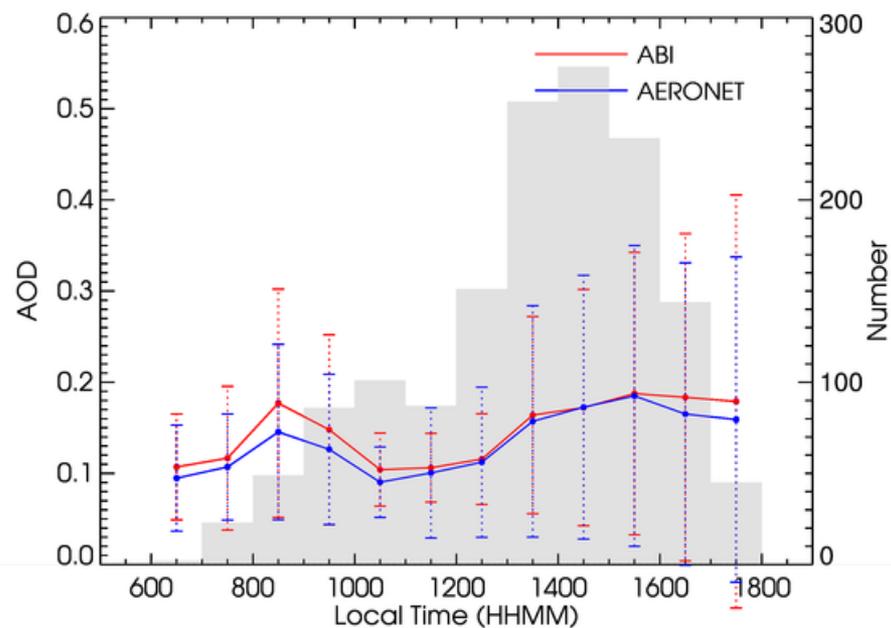
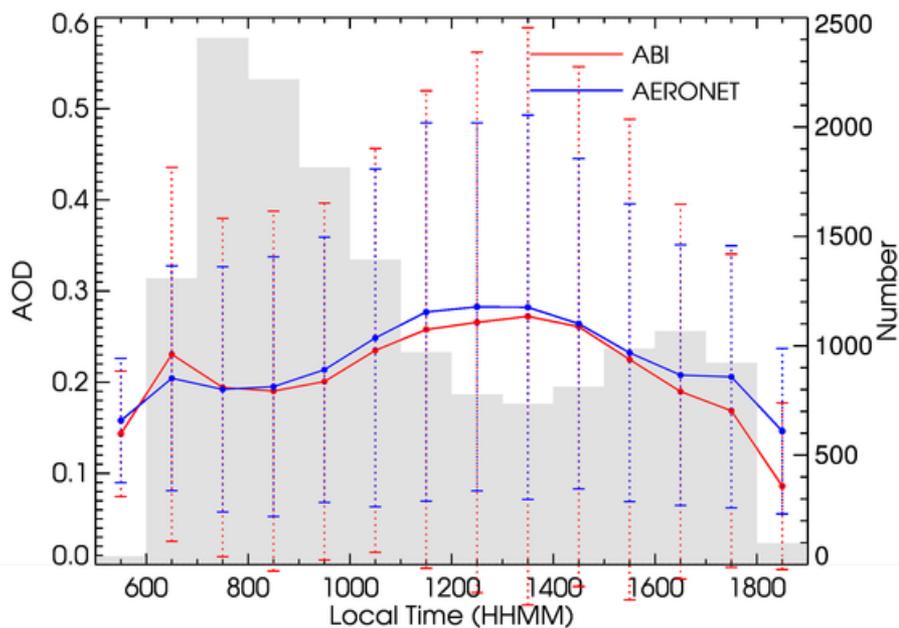
High QC 7/25/2018 – 9/5/2018



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GOES-17 Evaluation with AERONET - Diurnal

High QC 7/25/2018 – 9/5/2018



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