STAR JPSS

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Impacts of JPSS

NOAA Center for Weather and Climate Prediction
Conference Center • 5830 University Research Court
College Park, MD 20740

The EPS Aerosol Optical Depth Algorithm and Product

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- Approach
  - Multi-spectral aerosol retrieval

- Heritage
  - MODIS and VIIRS

- Retrieval Coverage
  - Daytime cloud and snow/ice-free areas
  - Land: dark and bright
  - Ocean: non-glint deep water
  - AOD at 0.55μm: from -0.05 to 5.0

- Sensors Applied
  - VIIRS and ABI/AHI

Features

Inputs and Outputs

- Inputs
  - Geolocation and geometry
  - SDR
    - SW reflectance
    - Brightness temperature at 11 and 12 μm
  - Cloud masks
    - Cloud confidence
    - Land/water mask
    - Snow/ice mask
    - Fire mask
    - Glint mask
    - Cloud shadow mask
    - Heavy aerosol mask
  - Model data
    - Surface pressure
    - TPW
    - Ozone
    - Wind speed and direction
  - Auxiliary data
    - Lookup tables
    - Coefficients and thresholds
    - Surface spectral reflectance relationship
    - Land cover type

- Outputs
  - AOD550
  - AOD at sensor channels
  - Ångström Exponent over water (M4/M7 and M7/M10)
  - Aerosol model selected
  - Fine mode weight over water
  - Quality flags
    - Overall quality
    - External masks
    - Invalid inputs
    - Internal tests
    - Retrieval paths
    - Retrieval quality
  - Diagnostics
    - Surface reflectance
    - Retrieval residual
    - Spatial inhomogeneity
    - AOD and residual for each land aerosol model

Retrieval Process
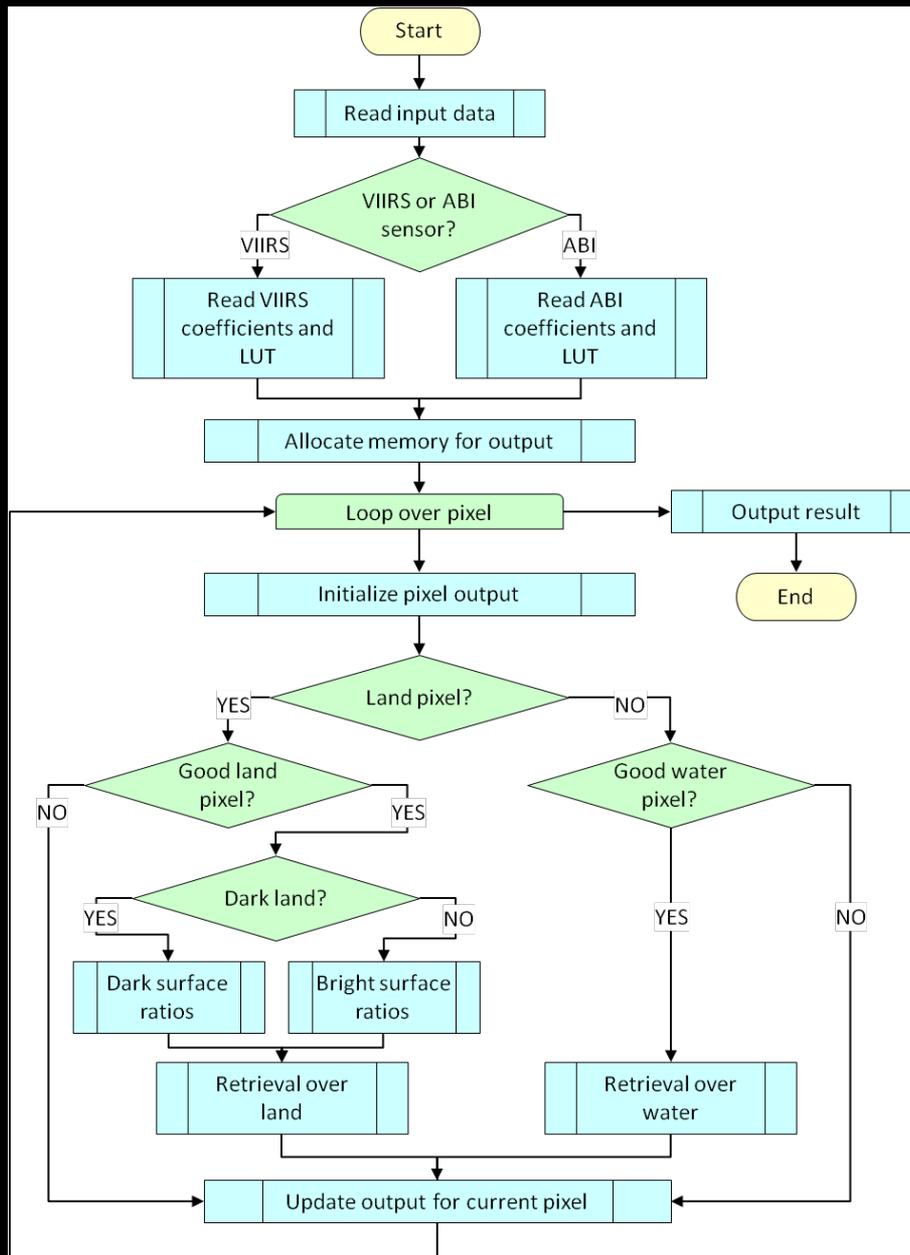
- Inputs
  - Land: M1,2,3,5,11
  - Water: M4,5,6,7,8,10,11

- Lookup tables
  - Pre-calculated with 6SV RTM

- Pixel-level retrieval

- Separate algorithms for land and water

- Separate paths for dark and bright land

Ocean Algorithm
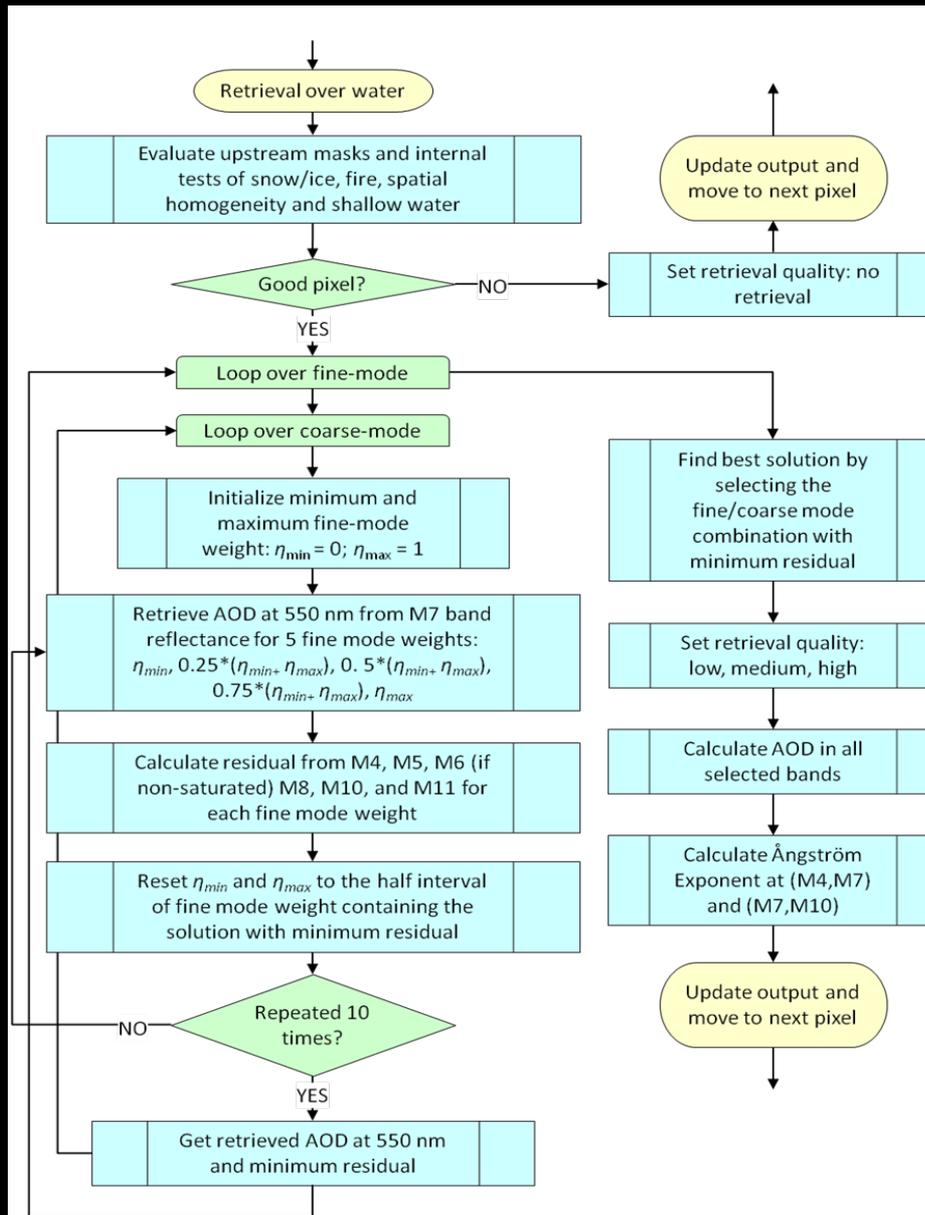
- Linear combination of one (out of four) fine mode and one (out of five) coarse mode

- Bisection (Interval-halving) method used to search for the solution of the AOD550 and fine-mode-weight for a given pair of aerosol modes
  - Matching TOA M7 reflectance
  - Compute residual as the difference between calculated and measured reflectance at other channels

- Find the best solution with minimum residual
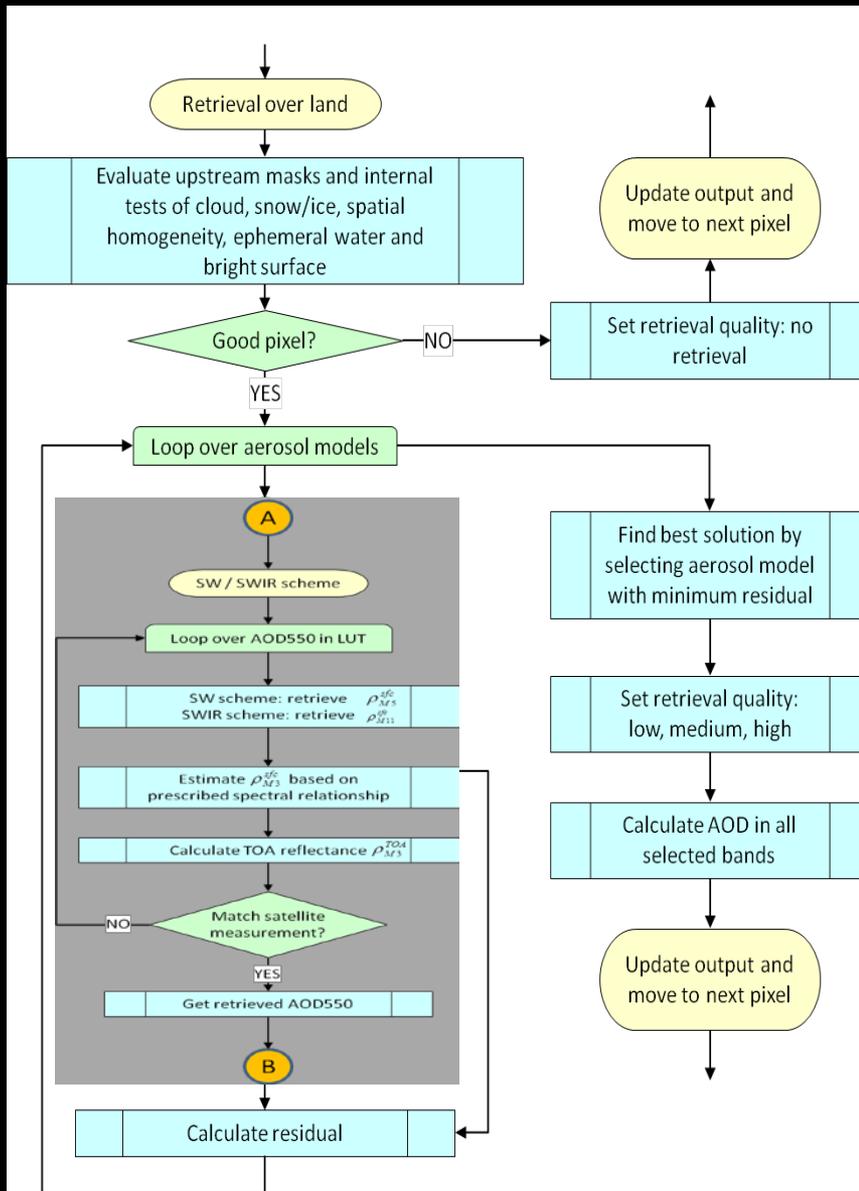
- Four candidate aerosol models built in the LUT
  - Dust, generic, urban, smoke

- Spectral surface reflectance relationship
  - Function of scene greenness (NDVI), redness (M4/M5), and geometry

- Hybrid algorithm
  - SW scheme
    - M3 vs. M5
    - Suitable for low AOD cases
  - SWIR scheme
    - M3 vs. M11
    - Suitable for high AOD cases
  - Switch from SW to SWIR scheme if the estimated surface reflectance at M3 is larger than 0.1

- Select aerosol model with minimum residual
  - Residual is computed as the difference between calculated and measured TOA reflectance at M1, M2 and M5(SWIR)/M11(SW)

- Applied where M11 TOA reflectance > 0.25
- Spectral surface reflectance ratios are prescribed
  - 0.1° by 0.1° spatial resolution
  - Function of scattering angle for forward/backward reflection

VIIRS bright surface reflectance ratio M3/M5

0.0   0.1   0.3   0.4   0.6   0.7
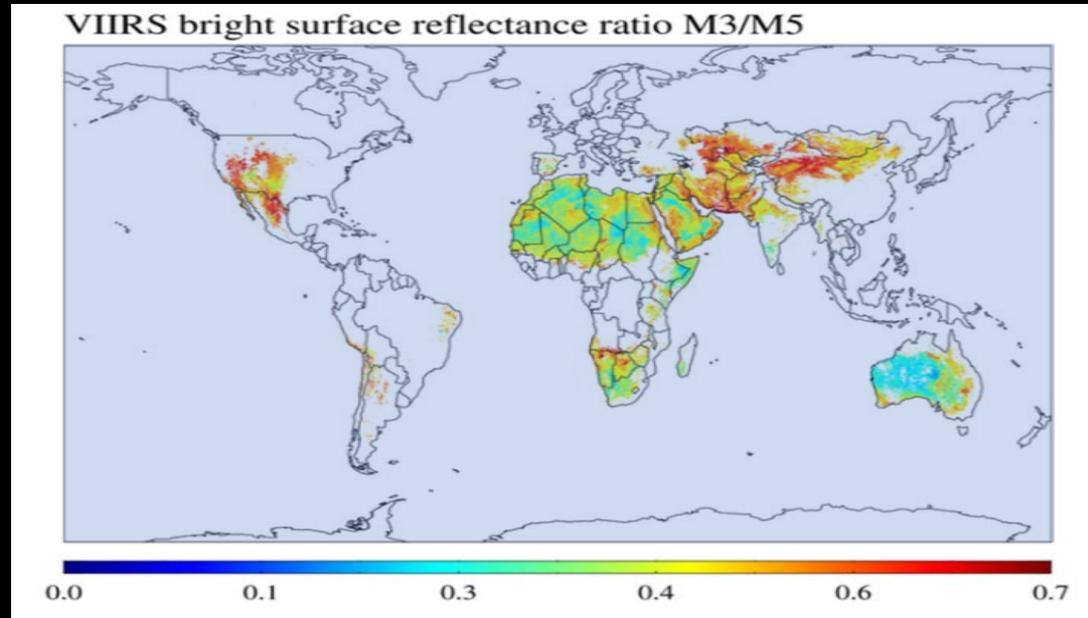
- Two separate domains
  - North Africa and Arabian Peninsula
    - Dust aerosol model
    - Retrieval at M3 channel
  - Other areas
    - Select aerosol model
   - Retrieval at M1 channel

- Retrieval with VIIRS inputs
  - High quality AOD550
  - High quality AE over water (M4 vs M7)

- Validation against the Level 2.0 AERONET measurements
  - Period of 10/26/2012 – 3/12/2016 for ground measurements
  - Period of year 2015 for the Marine Aerosol Network (MAN) measurements
  - Statistics include accuracy (bias), precision (standard deviation of error) and number of match-ups
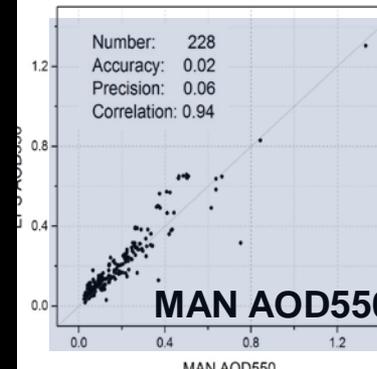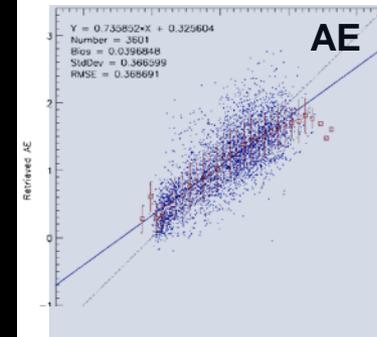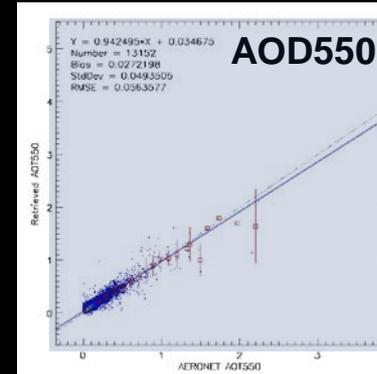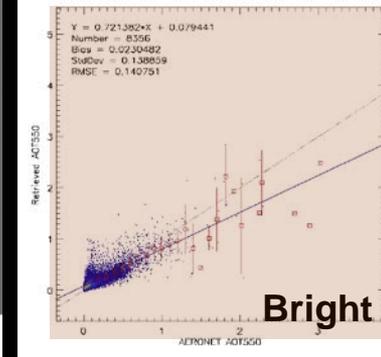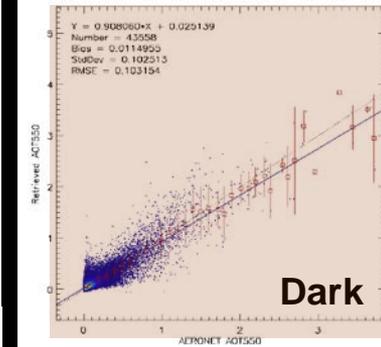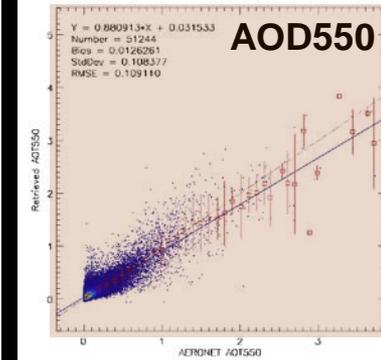
Validation

Water	EPS	Requirement
AOD550 < 0.3		
Accuracy	0.029	0.08
Precision	0.038	0.15
Number	12,049	
AOD550 ≥ 0.3		
Accuracy	0.011	0.15
Precision	0.113	0.35
Number	1,103	
All AOD550		
Accuracy	0.027	
Precision	0.049	
Number	13,152	
Ångström Exponent		
Accuracy	0.040	0.3
Precision	0.367	0.6
Number	3,601	

Land	EPS	EPS Dark	EPS Bright	Requir-ement
AOD550 < 0.1				
Accuracy	0.032	0.028	0.069	0.06
Precision	0.069	0.067	0.088	0.15
Number	26,842	24,097	3,393	
0.1 ≤ AOD550 ≤ 0.8				
Accuracy	-0.006	-0.009	-0.002	0.05
Precision	0.114	0.108	0.138	0.25
Number	23,396	18,641	4,785	
AOD550 > 0.8				
Accuracy	-0.048	-0.017	-0.198	0.20
Precision	0.381	0.377	0.367	0.45
Number	1,006	820	178	
All				
Accuracy	0.013	0.012	0.023	
Precision	0.108	0.103	0.139	
Number	51,244	43,558	8,356	

o Retrievals meet the requirement

Time Series
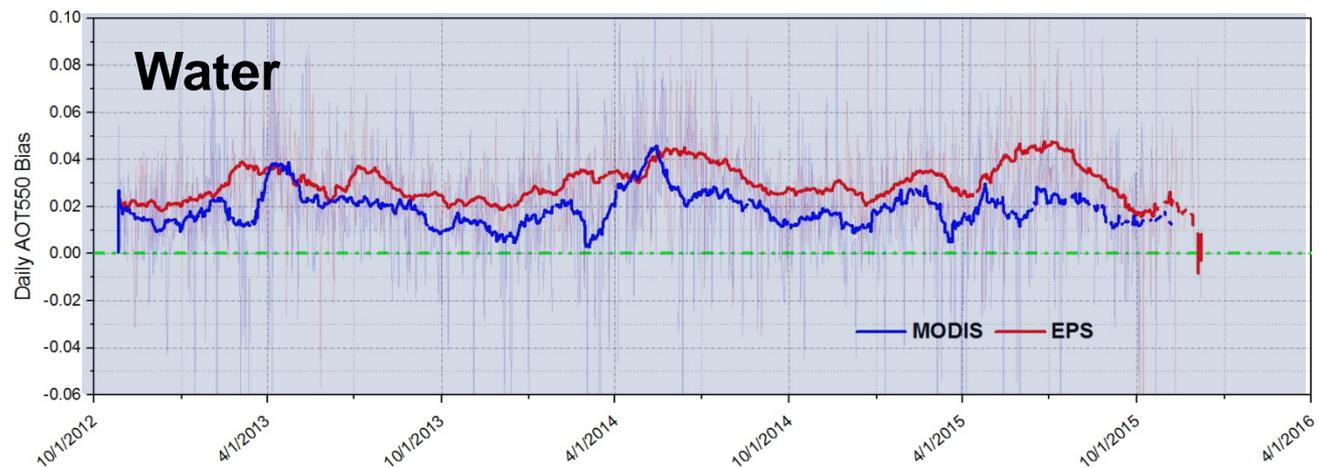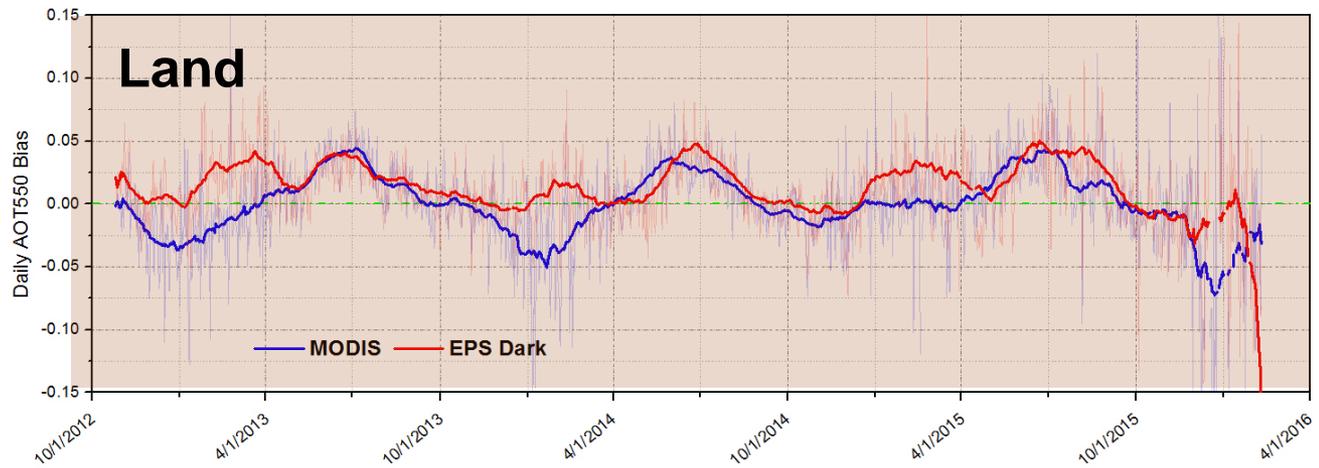
- Time Period
  - Year 2015
- Output Data
  - Pixel-level retrieval and diagnostic outputs in compressed HDF5 format for each granule
  - Total size 7.7T (about 22G per day)
- Data assimilation applications
  - NOAA Earth System Research Laboratory (ESRL)
  - NOAA Joint Center for Satellite Data Assimilation (JCSDA);
  - NOAA National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC)
  - University at Albany, State University of New York
  - Naval Research Laboratory (NRL)

201501 VIIRS (EPS) High Quality AOD550
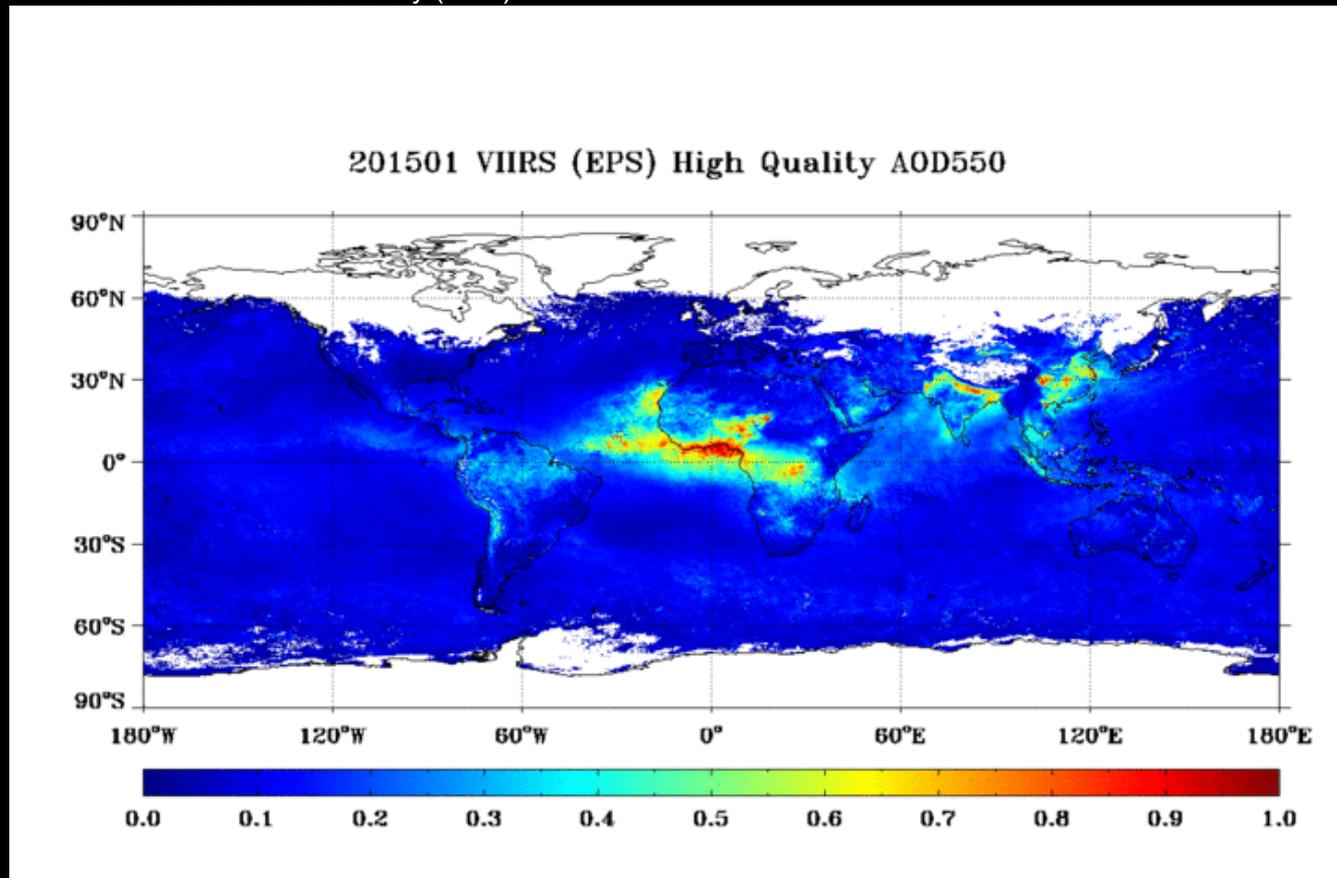
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Retrieval with AHI

Summary
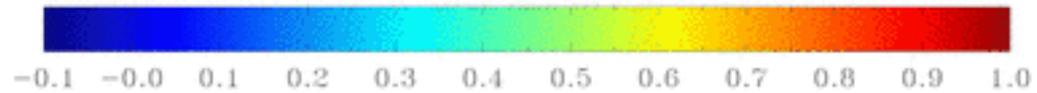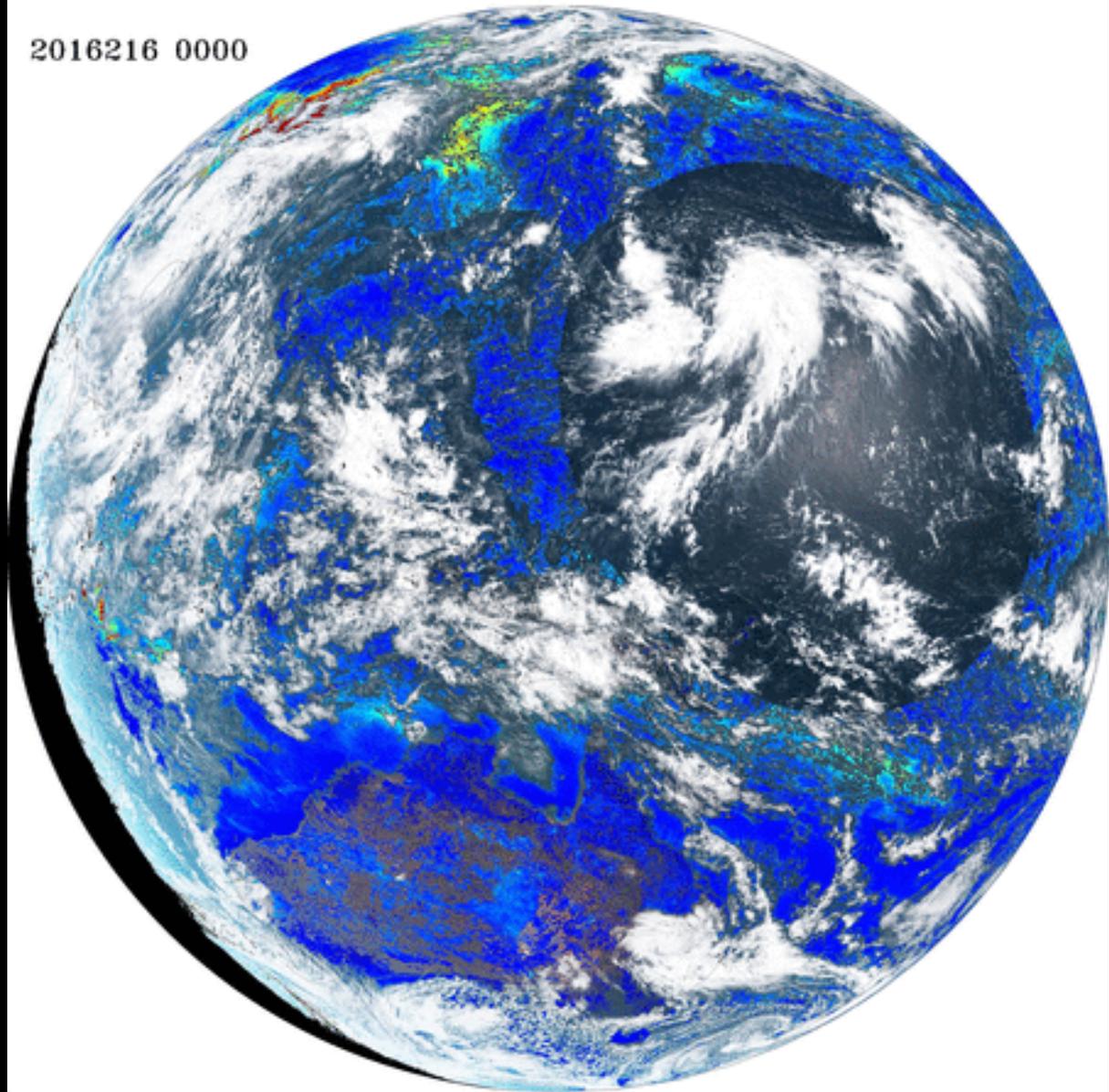
- EPS aerosol algorithm is developed to retrieve aerosol optical depth for both VIIRS and GOES-R ABI data to achieve a cross-platform consistency of NOAA satellite-based aerosol retrievals.

- Evaluation of the algorithm shows the performance meets requirement.

- Global application is performed with VIIRS and AHI data.