Spatial and Temporal Characterization of the Difference between Satellite Aerosol Retrievals and AERONET

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1. INTRODUCTION

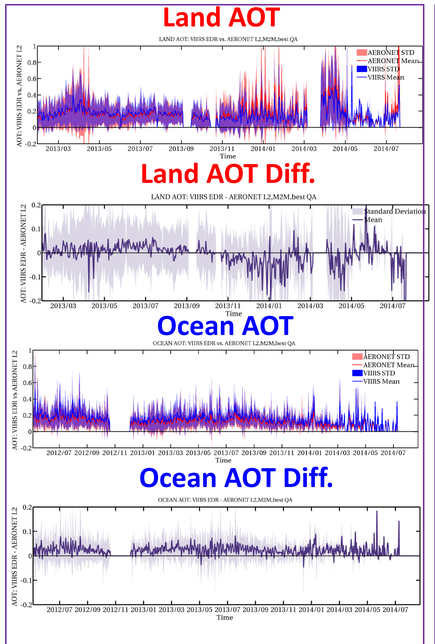
The Suomi National Polar-orbiting Partnership (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) provides the following validated aerosol Environment Data Records (EDRs):

- **Aerosol optical thickness (AOT)** (6km at nadir, released as Validated from 01/23/2013)
- **Aerosol particle size parameter (APSP)** (Angstrom Exponent (AE) herein, 6km at nadir, released as Validated over ocean from 05/02/2013, not recommended over land)

Satellite vs. AERONET comparison was conducted for **1/23/2013-8/31/2014 over land and 5/2/2012-8/31/2014 over ocean (excluding 10/15-11/27/2012)**. The focus of this study is finding the spatial and temporal patterns of the differences between the multi-sensor AOT retrievals and AERONET measurements.

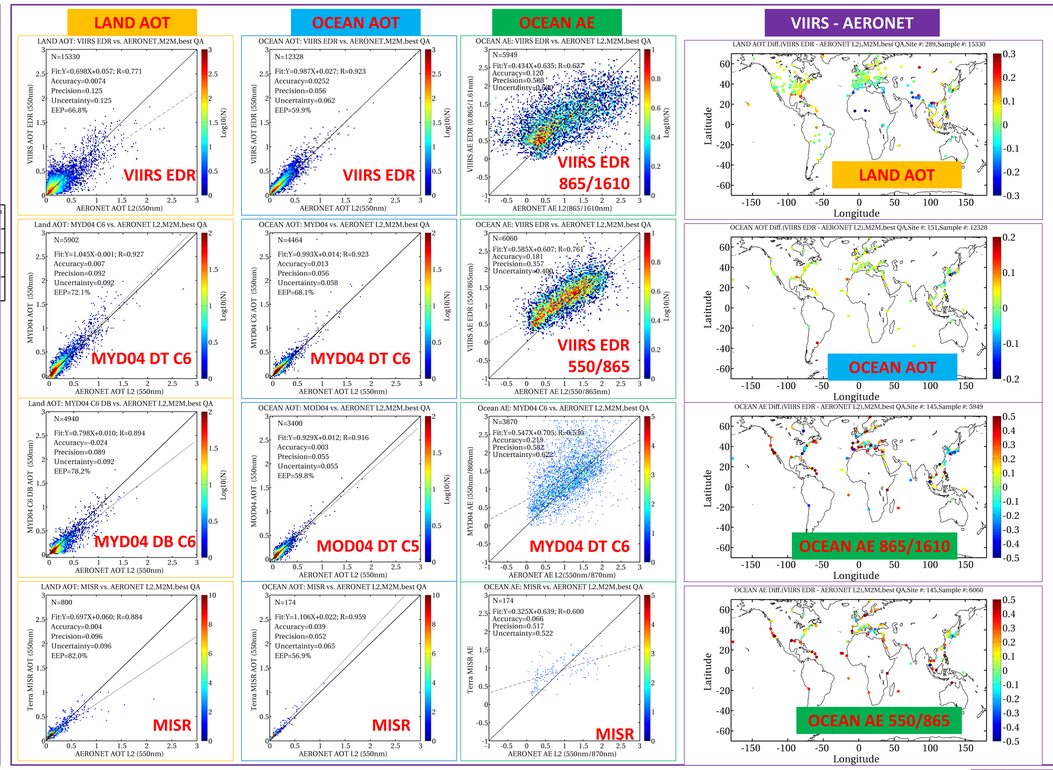
Accuracy (A) = Mean Biases
Precision (P) = Stand Deviation of Biases
Uncertainty (U) = Root Mean Square Error
Expected Error % (EEP) = % within ±0.05±15%τ (land) or ±0.03±5%τ(ocean)

2. VIIRS vs. AERONET L2: Time Series



Time series of global mean VIIRS and AERONET AOT are strongly correlated in time.

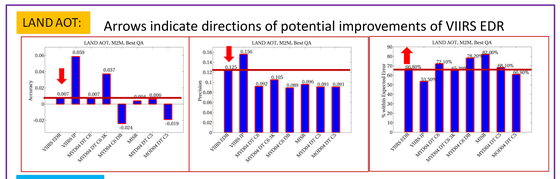
3. Multi-Sensor (VIIRS, Aqua MODIS, Terra MODIS, MISR) vs. AERONET L2: Scatterplots



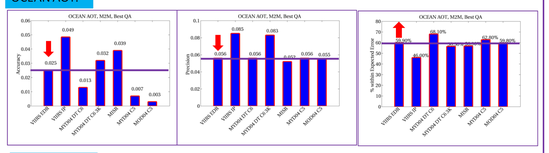
- VIIRS AOT retrievals over both land and ocean show similar levels of accuracy, precision, and uncertainty to heritage AOT products, except relatively larger uncertainty found in the VIIRS land AOT that are attributable to the use of globally constant spectral surface reflectance ratios. A set of NDVI-dependent spectral surface reflectance ratios or a location-specific spectral surface reflectance ratio database will be implemented to further improve the products over land;
- Satellite vs. AERONET AOT difference maps show notable regional patterns. i.e. VIIRS land AOT EDR has high biases over Eastern US but low biases over India and central Africa; and ocean AOT EDR generally has high biases along coasts except Northwestern Pacific.
- DT and DB denote the Dark Target and the Deep Blue algorithms

4. Satellites vs. AERONET L2: Statistics

LAND AOT: Arrows indicate directions of potential improvements of VIIRS EDR



OCEAN AOT:



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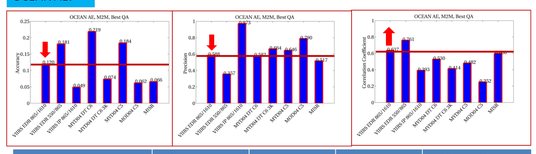
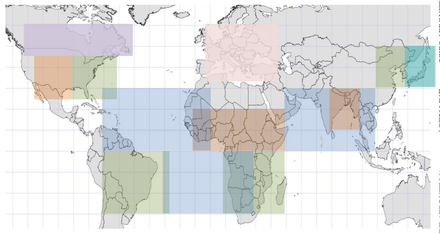


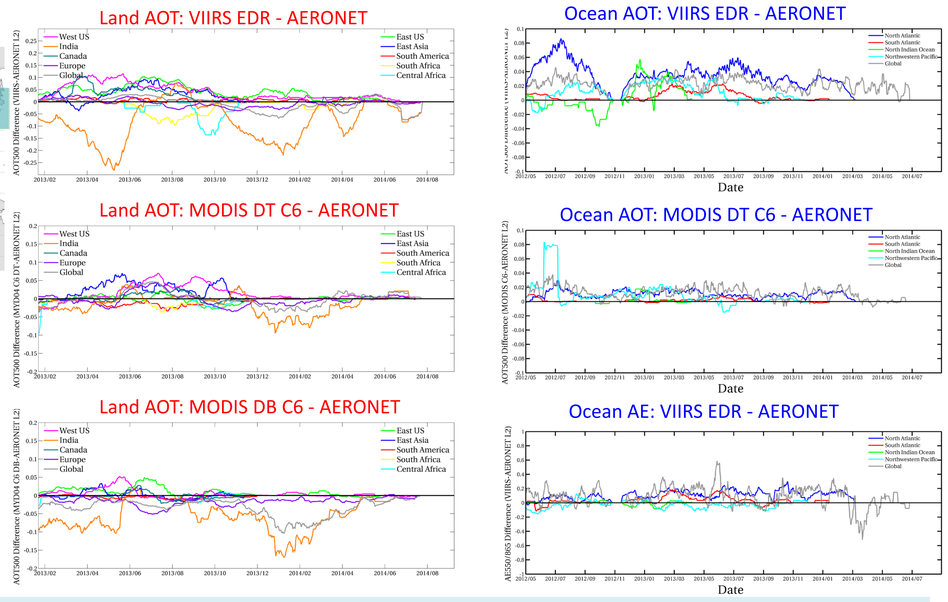
LAND AOT EDR vs. AERONET L2	A/P	J1 Specs	VS2	Achieved?
Land τ<0.1	Accuracy	0.06	0.0351	√
	Precision	0.15	0.0758	√
Land 0.1≤τ≤0.8	Accuracy	0.05	-0.0098	√
	Precision	0.25	0.1222	√
Land 0.8<τ≤2.0	Accuracy	0.20	-0.1772	√
	Precision	0.45	0.3146	√
Ocean τ<0.3	Accuracy	0.08	0.0246	√
	Precision	0.15	0.0415	√
Ocean τ≥0.3	Accuracy	0.15	0.0298	√
	Precision	0.35	0.1280	√
Ocean AE 865nm/1610nm	Accuracy	0.3	0.120	√
	Precision	0.6	0.588	√

The accuracy and precision of VIIRS AOT and AE EDR meets JPSS1 Specs and demonstrates performance that is comparable to its counterparts from MODIS and MISR.

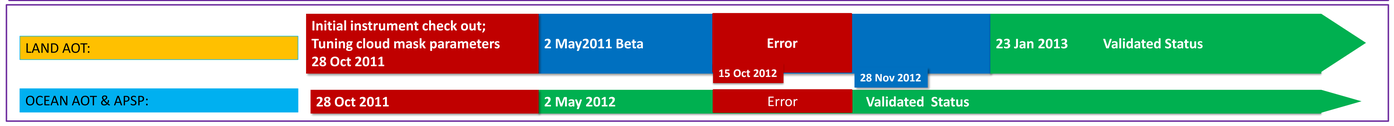
5. Satellites vs. AERONET L2 over Land: Regional and Seasonal Patterns



Domain	Longitude	Latitude
Over Land		
East US	100° W-70° W	25° N-45° N
West US	125° W-100° W	25° N-45° N
East Asia	100° E-140° E	20° N-40° N
South America	80° W-35° W	30° S-0°
South Africa	10° E-40° E	30° S-0°
Central Africa	20° W-40° E	0° -20° N
India	70° E-90° E,	10° N-30° N
Europe	10° W-35° E,	35° N-60° N
Canada	130° W-60° W,	45° N-60° N
Over Ocean		
North Atlantic Ocean	80° W-10° W	0° -30° N
South Atlantic Ocean	40° W-20° E,	30° S-0°
North Indian Ocean (including Arabian Sea and Bay of Bengal)	40° E-100° E	0° -30° N
Northwestern Pacific	120° E-140° E,	20° N-40° N



Among the 9 study regions over land, VIIRS AOT appears to have large biases over India, Western US, and Central Africa compared to the rest of the regions. Further, the overall bias trend shows significant seasonal cycles. In contrast, Aqua MODIS DT AOT tends to have smaller biases than VIIRS with the largest biases over Western US, and DB AOT shows low biases over India but smaller biases over other regions. Similarly, VIIRS also have relatively larger positive biases than MODIS for the four regions over ocean.



6. SUMMARY

- The overall performance of the VIIRS aerosol products on average is comparable to that of their counterparts from the heritage MODIS and MISR sensors
- The validated VIIRS aerosol products meet the JPSS-1 threshold requirements
- Spatial and temporal patterns were observed in the comparison between satellite AOT and AE and AERONET, showing different characterizations of various algorithms
- VIIRS aerosol EDRs are available form **NOAA's Comprehensive Large Array-data Stewardship System (CLASS)** at http://www.class.ngdc.noaa.gov
- **VIIRS Aerosol Products Users' Guide** is available at: http://www.star.nesdis.noaa.gov/jpss/ATBD.php#S126472
- **VIIRS Aerosol Products README** file is under "VIIRS Aerosol" at: http://www.nsof.class.noaa.gov/saa/products/welcome
- **VIIRS Aerosol Products ATBD:** http://npp.gsfc.nasa.gov/documents.html

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