Spatial and Temporal Characterization of the Difference between Multi-Sensor Aerosol Retrievals and AERONET

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1. INTRODUCTION

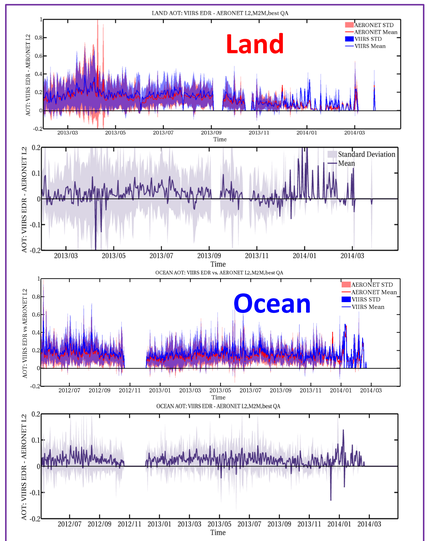
The Suomi National Polar-orbiting Partnership (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) provides the following aerosol Environment Data Records (EDRs):

- ❑ **Aerosol optical thickness (AOT)** (6km at nadir, released in Provisional from 01/23/2013)
- ❑ Aerosol particle size parameter (APSP) EDR (Angstrom Exponent (AE) herein, 6km at nadir, released in Provisional from 01/23/2013, not recommended over land)
- ❑ Suspended matter (SM) EDR (750m at nadir, released as Beta from 01/23/2013)

VIIRS Aerosol EDR validations were conducted for **1/23/2013-2/28/2014 over land and 5/2/2012-2/28/2014 over ocean** (unless noted otherwise) by comparing VIIRS observations to their counterpart datasets from AERONET and heritage satellite sensors, such as Aqua/Terra MODIS and Terra MISR.

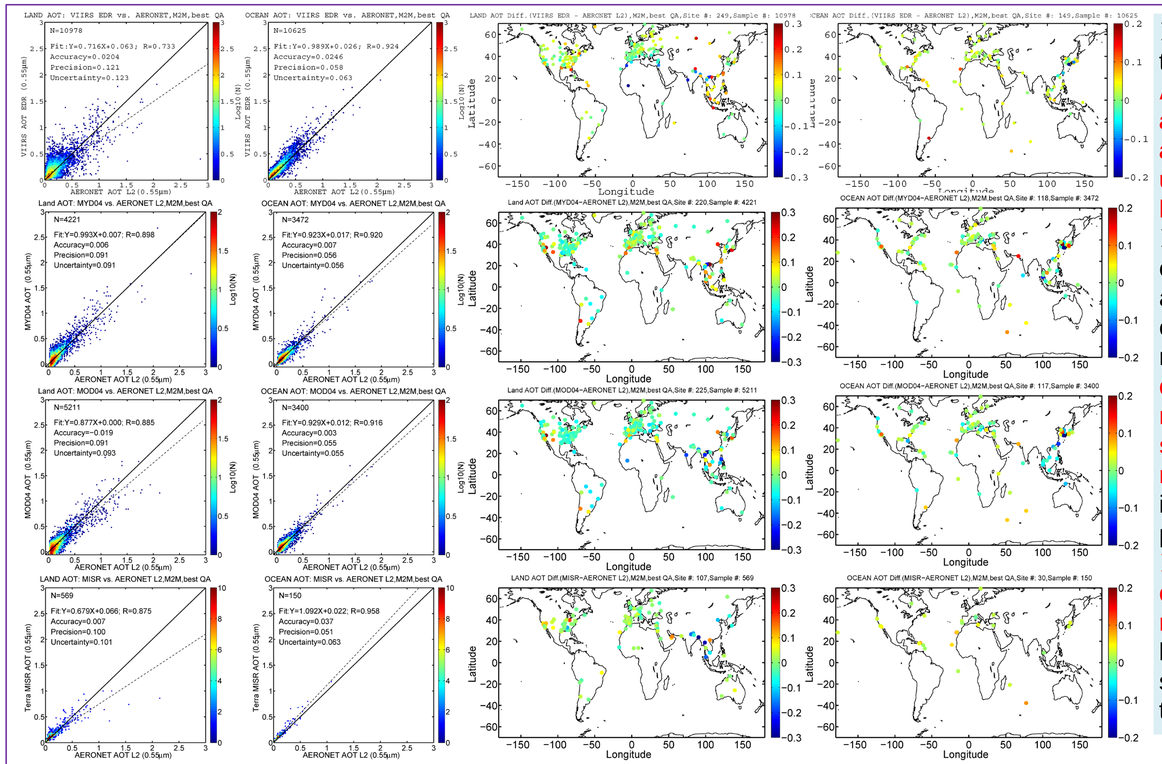
The focus of this study is finding the spatial and temporal patterns of the differences between the multi-sensor AOT retrievals and AERONET measurements.

2. VIIRS vs. AERONET L2: Time Series



The long term stability of the VIIRS vs. AERONET difference has been closely monitored. **The time series of the global AOT means from VIIRS and AERONET demonstrates strongly correlated temporal variability.**

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



- ➢ With much larger sample sizes to match against AERONET, **VIIRS AOT retrievals over both land and ocean show levels of accuracy, precision, and uncertainty that are similar to heritage AOT products**;
- ➢ The relatively larger uncertainty over land in the VIIRS retrieval are attributed 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** related to the localized performance of the satellite algorithms that is sensitive to surface characteristics

4. Satellites vs. AERONET L2: Statistics

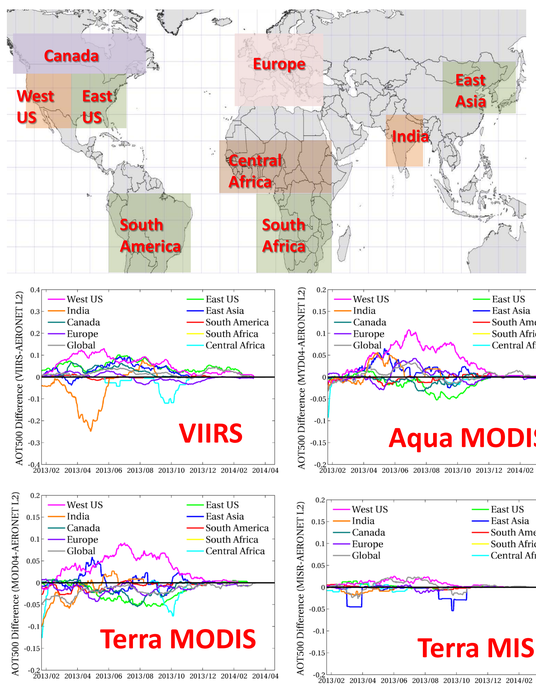
SAT. vs ARNT L2	VIIRS EDR	MYD04	MOD04	MISR	VIIRS EDR	MYD04	MOD04	MISR
AOT (550 nm)	LAND				OCEAN			
Sample Size	**10978**	4221	5211	569	**10625**	3472	3400	150
Accuracy	**0.020**	0.006	-0.019	0.007	**0.025**	0.007	0.003	0.037
Precision	**0.121**	0.091	0.091	0.100	**0.058**	0.056	0.055	0.051
Uncertainty	**0.123**	0.091	0.093	0.101	**0.063**	0.056	0.055	0.063
Cor Coef	**0.733**	0.898	0.885	0.875	**0.924**	0.920	0.916	0.958

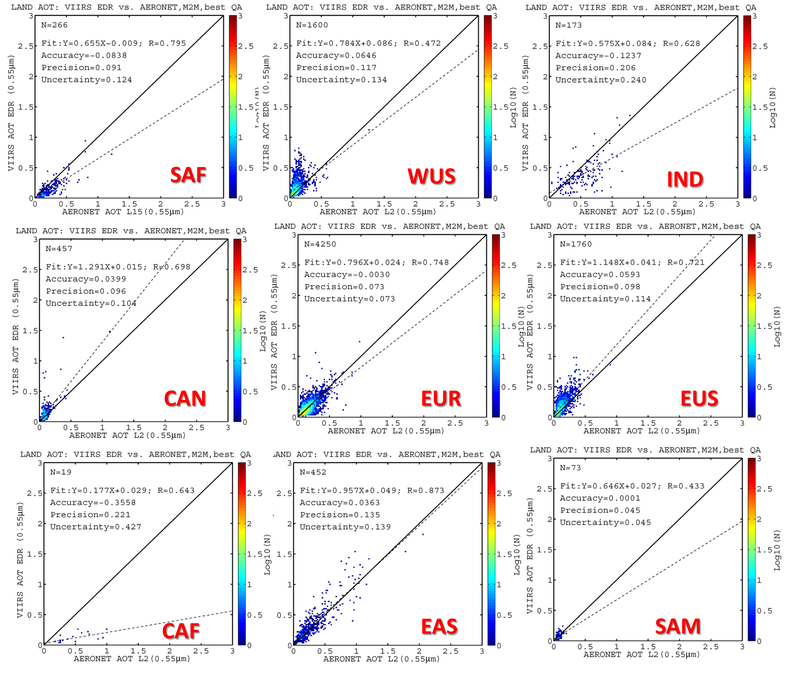
LAND AOT EDR vs. AERONET L2	N	A/P	J1 Spec	VS1	Spec Achieved?
τ<0.1	5450	Accuracy	*0.06*	**0.0374**	√
		Precision	*0.15*	**0.0782**	√
0.1≤τ≤0.8	5387	Accuracy	*0.05*	**0.0087**	√
		Precision	*0.25*	**0.1184**	√
0.8<τ≤2.0	137	Accuracy	*0.20*	**-0.1260**	√
		Precision	*0.45*	**0.3371**	√
τ>0.8	141	Accuracy	*0.20*	**-0.1909**	√
		Precision	*0.45*	**0.5533**	×
τ all	10978	Accuracy		**0.0204**	
		Precision		**0.1230**	

OCEAN AOT EDR vs. AERONET L2	N	A/P	*J1 Spec*	VS1	Spec Achieved?
τ<0.3	9485	Accuracy	*0.08*	**0.0239**	√
		Precision	*0.15*	**0.0418**	√
τ≥0.3	1140	Accuracy	*0.15*	**0.0302**	√
		Precision	*0.35*	**0.1281**	√
τ all	10625	Accuracy		**0.0239**	
		Precision		**0.0592**	

The accuracy and precision of VIIRS AOT EDR meet JPSS-1 validation thresholds and demonstrate performance that is comparable to its counterparts from MODIS and MISR.

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





Among the 9 study regions over land, **VIIRS AOT appears to have larger biases over India, West US, and Central Africa**, when compared to the rest of the regions. Further, the overall bias trend shows significant seasonal cycles. In contrast, Aqua/Terra MODIS AOT tends to have smaller biases than VIIRS, with the largest biases over West US. Terra MISR AOT is the least biased dataset with the smallest seasonal variability; however, this dataset has the smallest sample size.

6. SUMMARY

- Results indicated that the performance of the VIIRS aerosol products on average is comparable to that of their counterparts from the heritage MODIS and MISR sensors
- Validation results shoed that the VIIRS aerosol products meet the JPSS-1 threshold requirements
- Spatial and temporal patterns were observed when evaluating VIIRS AOT against AOT from other spaceborne sensors and AERONET. These findings will aid in improving VIIRS aerosol products as we transition from NPP to JPSS-1
- 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
- Other documents are available at: http://npp.gsfc.nasa.gov/science/documents.html

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