Validation and Expected Error Estimation of Suomi-NPP VIIRS Aerosol Optical Thickness and Angström Exponent with AERONET

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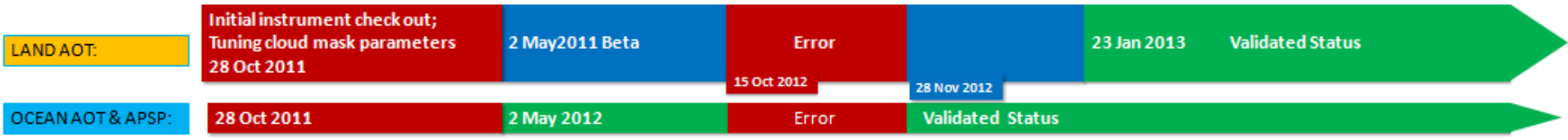
Outline

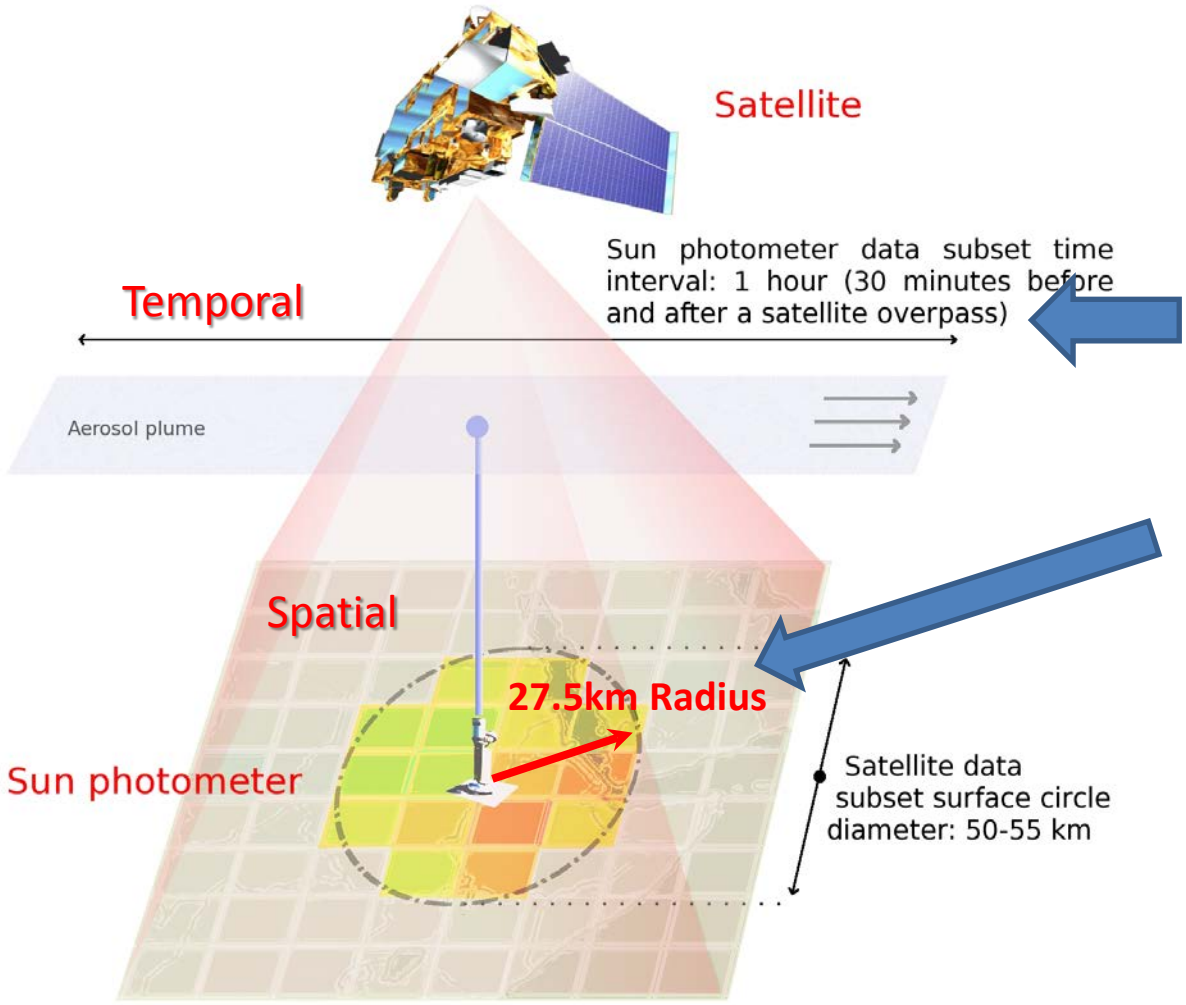
- VIIRS and AERONET Datasets
- VIIRS vs. AERONET Matchup Scheme
- Validation Results
- Expected Error Estimation
- Summary

VIIRS and AERONET Datasets

- **VIIRS:**
  - *Aerosol Optical Thickness (AOT)* Environmental Data Record (EDR) (6 km): *best quality AOT at 550 nm;*
  - *Aerosol Particle Size Parameter (APSP)* EDR over ocean (6 km) reported as the *Ångström Exponent (AE);*
  - Time period: Jan 23, 2013 to Dec 31, 2014 (land) and May 2, 2012 to Dec 31, 2014 (except Oct 15, 2012 to Nov 27, 2012) (ocean).
- **AERONET:**
  - Level 2.0 AERONET Direct Sun Algorithm AOT wavelengths 380-870 nm, and at 1640 nm (*Holben et al., 1998; Smirnov et al., 2000)*
  - AERONET AOTs are interpolated to VIIRS wavelengths using a 2nd order polynomial fit in logarithmic coordinates. (*Eck et al., 1999; Remer et al., 2005; Levy et al., 2010, Kahn et al., 2010*)



VIIRS vs. AERONET Matchup



Matchup Requirements:

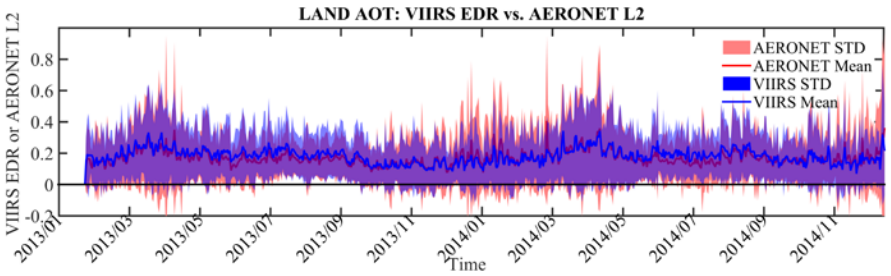
- At least 2 AERONET L2.0 measurements are available;
- At least 20% of VIIRS pixels are Best Quality AOT or AE Retrievals;
- AOT or AE averages over the spatial/tempo domains are matched up

Figure credit of NASA GSFC MAPSS Group, M. Petrenko & C. Ichoku (http://disc.sci.gsfc.nasa.gov/aerosols/services/mapss/)

VIIRS vs. AERONET Time Series

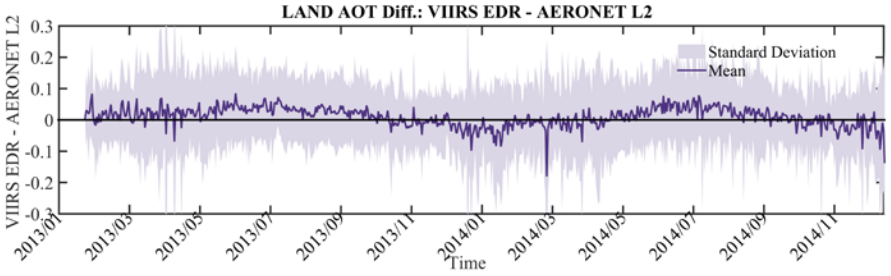
(a)

LAND AOT



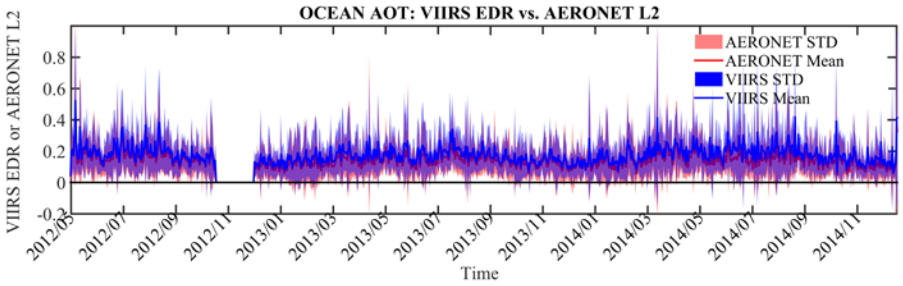
(b)

LAND AOT Bias



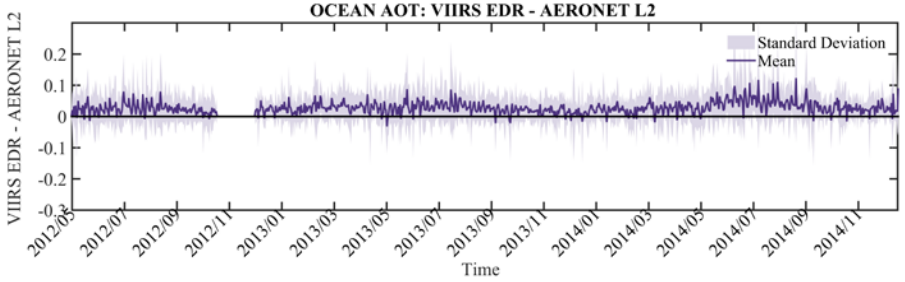
(c)

Ocean AOT



(d)

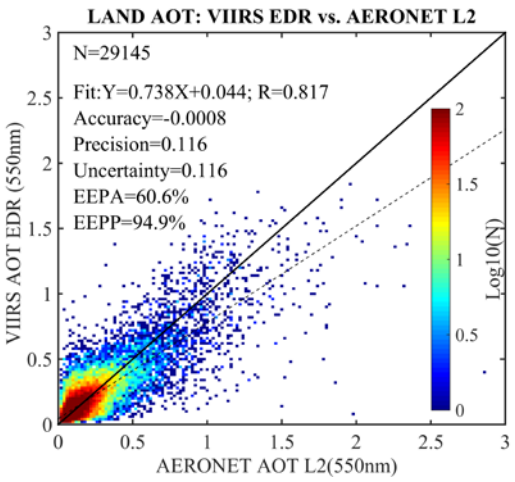
Ocean AOT Bias

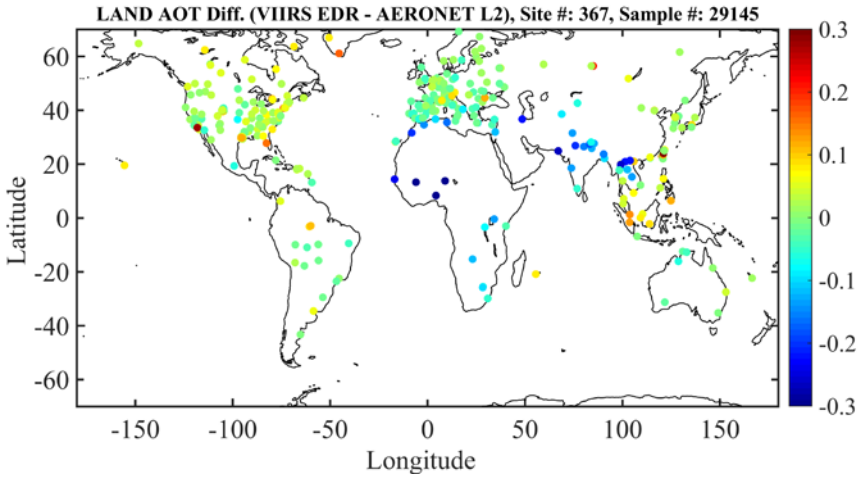


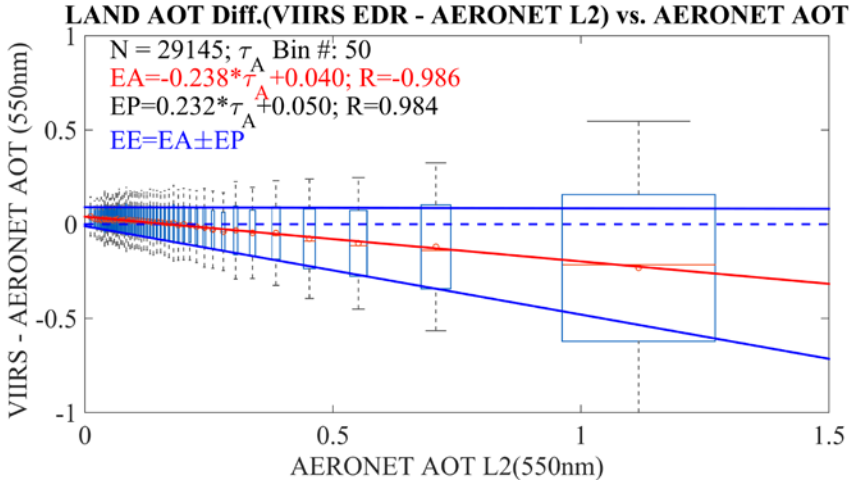
❑ Large seasonal dependence of bias over land (**b); >0 during NH summer, <0 NH winter.**

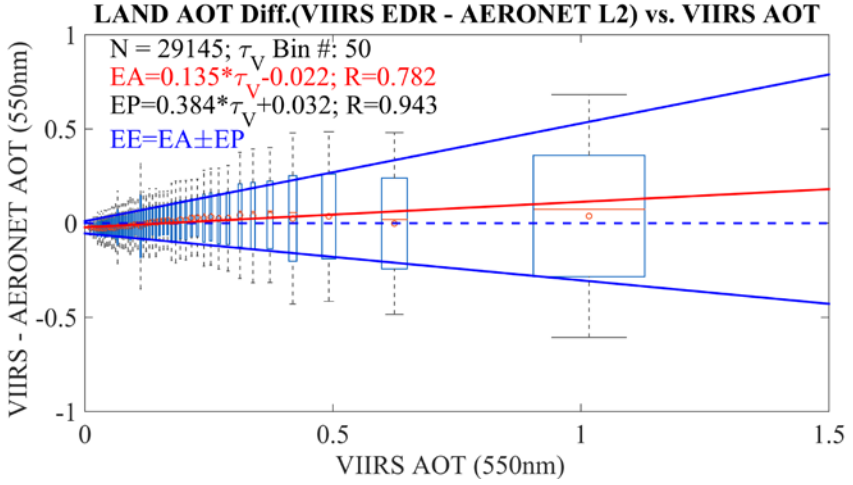
❑ No significant seasonal variability of bias over ocean, but persistent positive bias is present (**d).**

Land AOT EDR vs. AERONET L2





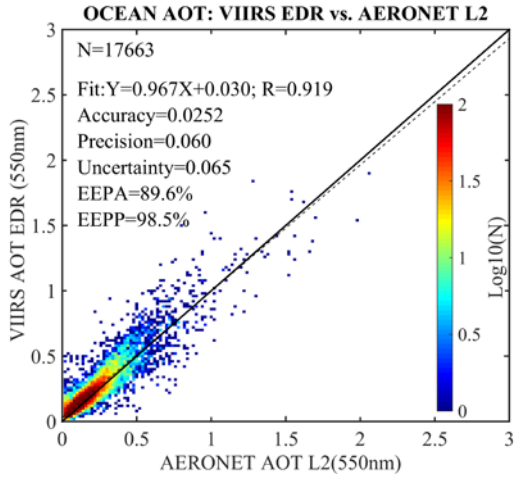


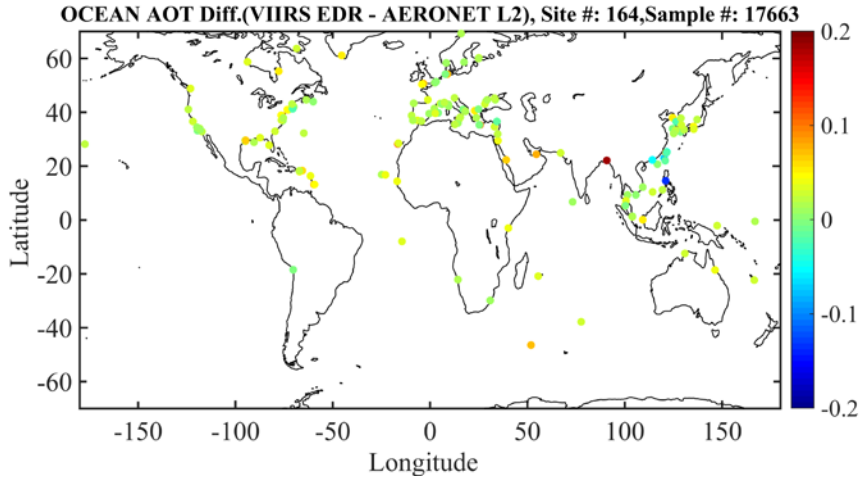


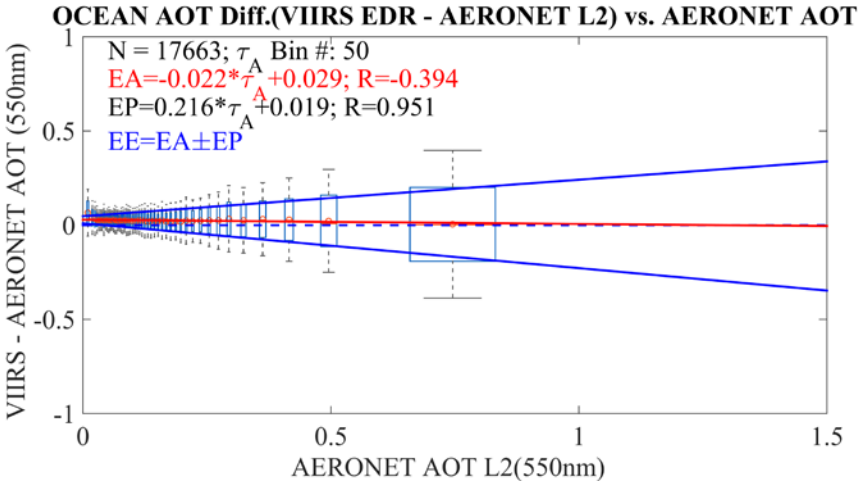
EE(EA ±EP)	[-0.47×τ_A-0.010, -0.0058×τ_A+0.090]	78.24% (sample % within EE range)

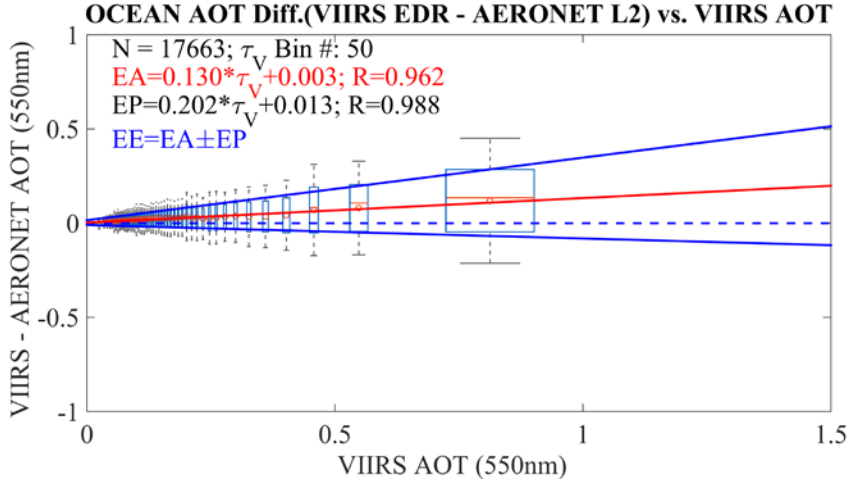
EE(EA ±EP)	[-0.249×τ_V-0.054, 0.519×τ_V+0.010]	80.01% (sample % within EE range)

Ocean AOT EDR vs. AERONET L2





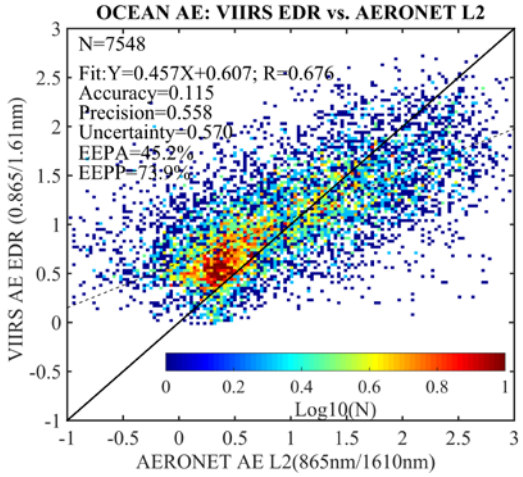


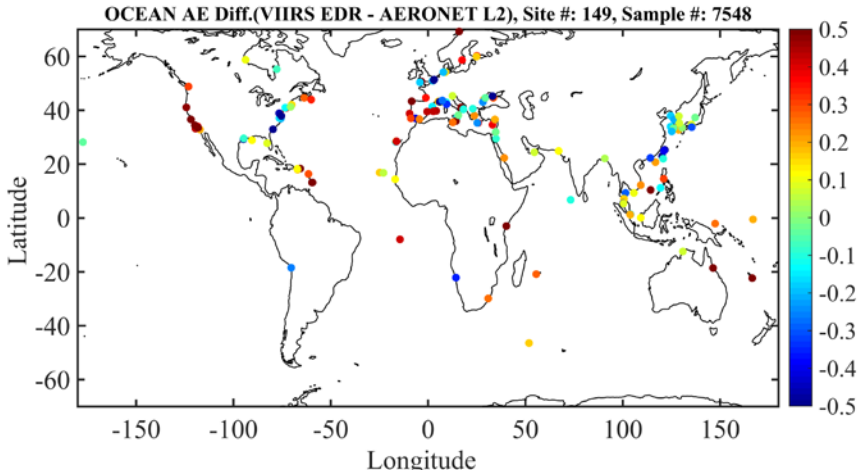


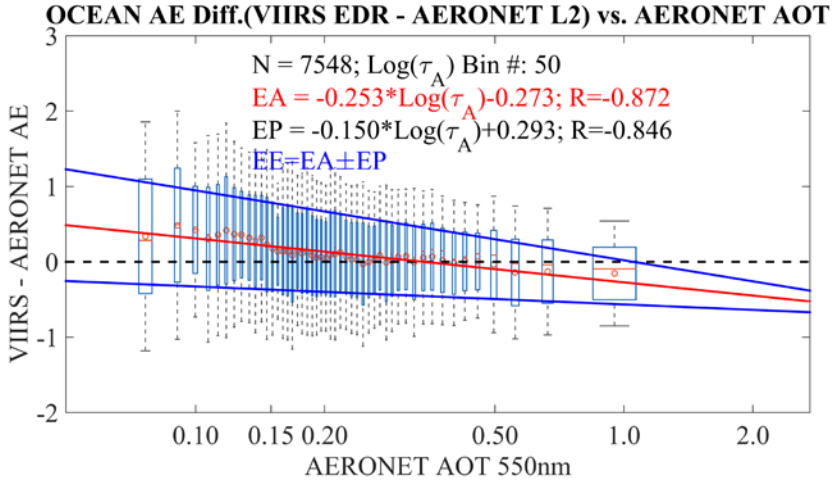
EE(EA ±EP)	**[-0.022×τ_A+0.029, 0.216×τ_A+0.019]**	75.61% (sample % within EE range)

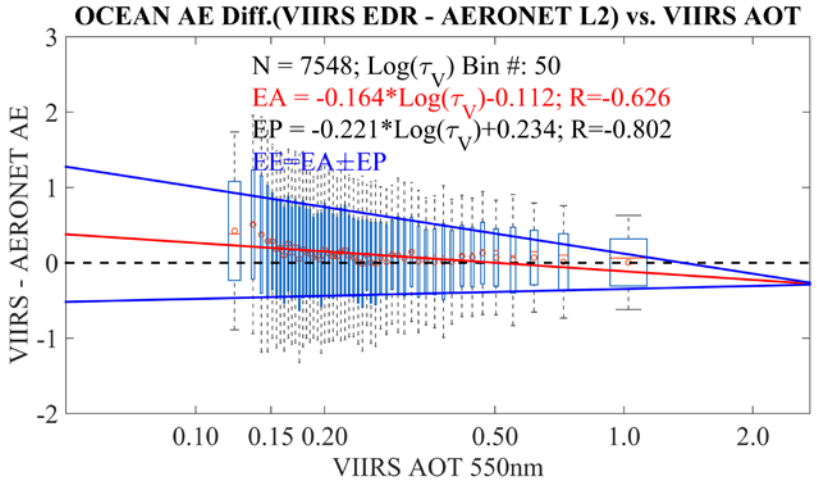
EE(EA ±EP)	**[-0.071×τ_V-0.010, 0.332×τ_V+0.016]**	76.99% (sample % within EE range)

Ocean AE EDR vs. AERONET





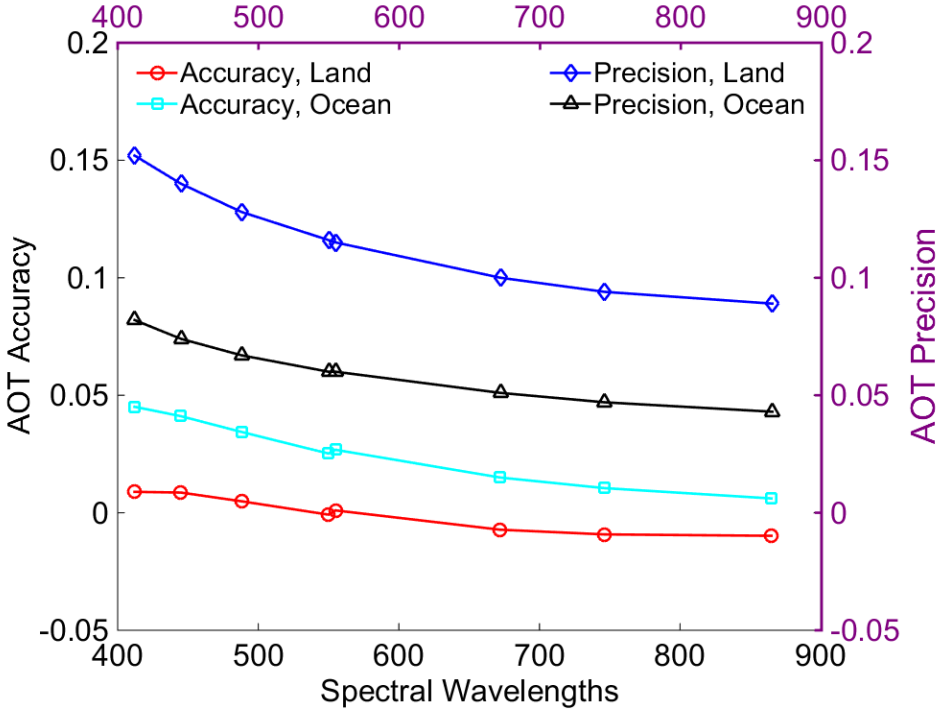


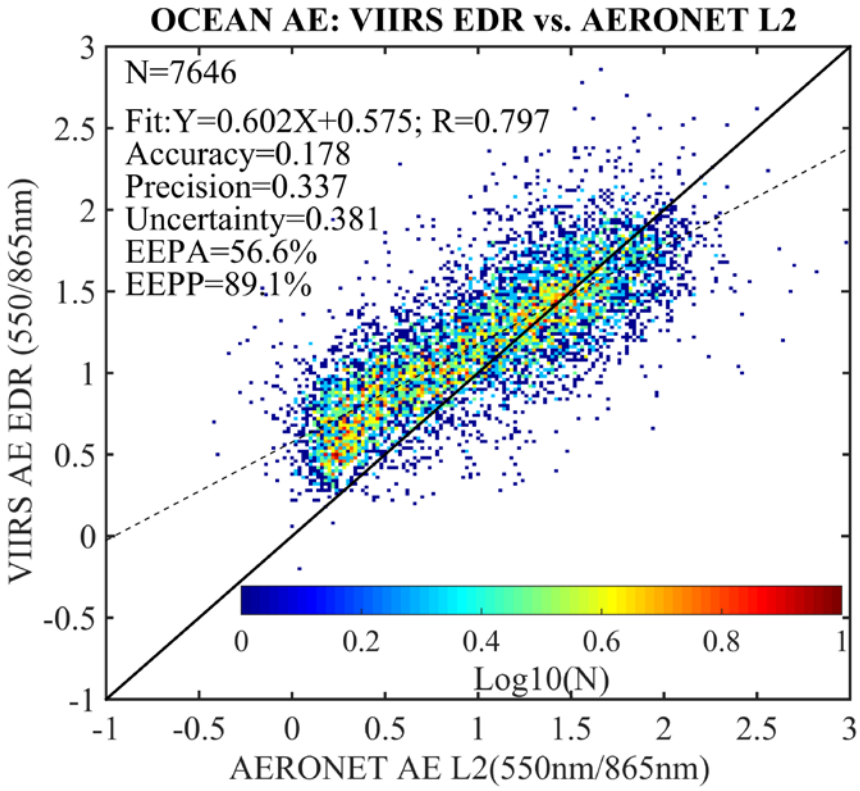


EE(EA ±EP)	**[-0.103×log(τ_A)-0.566, -0.403×log(τ_A)+0.020]**	69.78% (sample % within EE range)

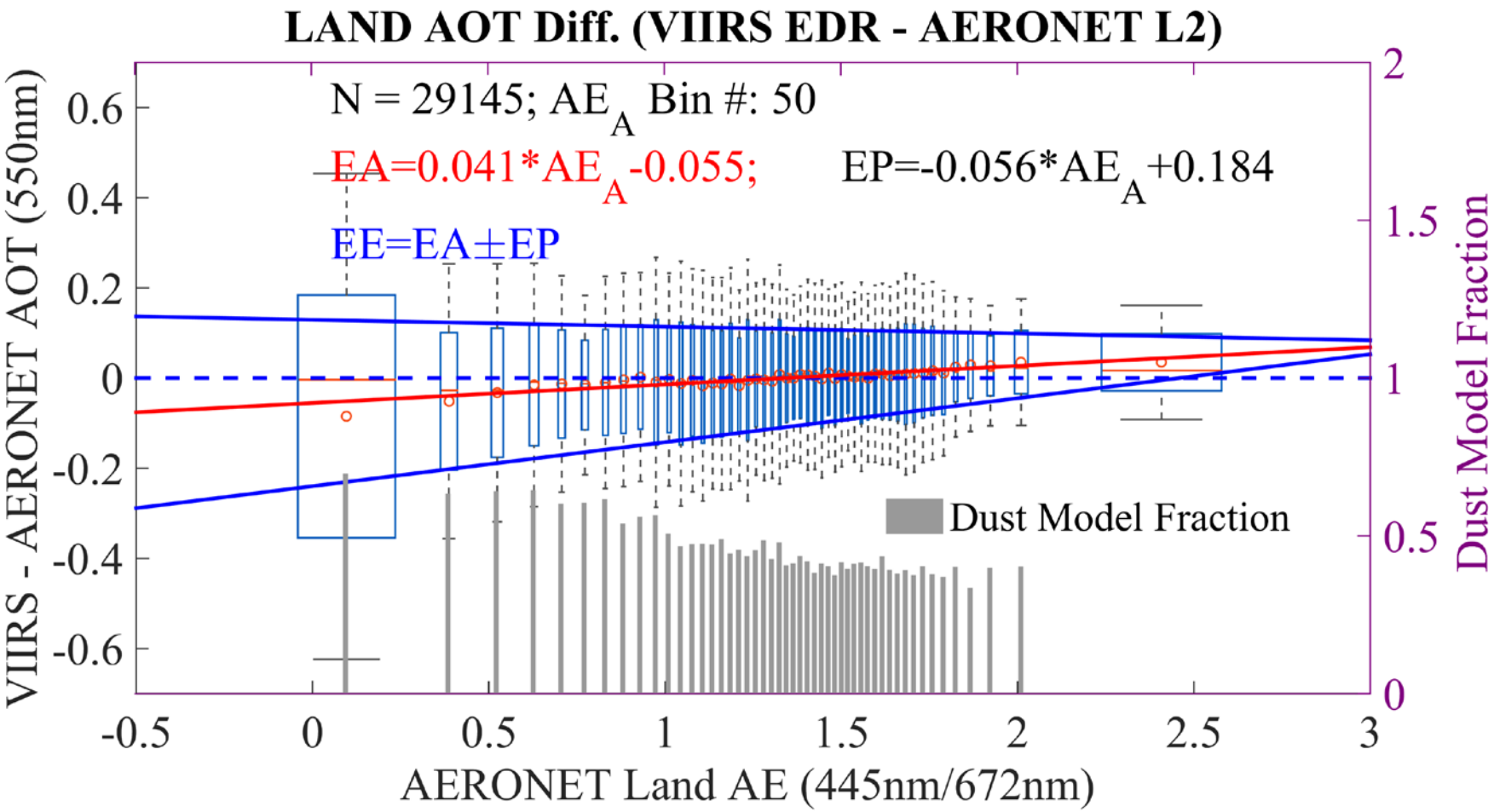
EE(EA ±EP)	**[0.057×log(τ_v)-0.346, -0.385×log(τ_v)+0.122]**	70.23% (sample % within EE range)

Spectral AOT EDR





Land AOT vs. AE



Summary

- ✓ Accuracy, Precision and Expected Errors of VIIRS AOT and APSP EDRs are estimated from a 2+ year record of VIIRS retrievals and AERONET L2 data;
- ✓ Accuracy and precisions are meeting the JPSS L1RD requirement specifications; Land AOT EDR reached ***Validation Stage*** since **01/23/2013**; and Ocean AOT EDR and AE EDR reached ***Validated Stage*** since **05/02/2012** (excluding the processing error period Oct 15-Nov 27, 2012);
- ✓ Lessons learned for developing better algorithms for JPSS1 VIIRS Aerosol Products with: *new spatial coverage over bright surfaces, wider reporting data range, better snow/snowmelt filtering, improved aerosol models, and dynamically changing surface reflectance ratios …*

References:

• Liu, H., L.A. Remer, J. Huang, H. Huang, S. Kondragunta, I. Laszlo, M. Oo, and J. Jackson, 2014: Preliminary evaluation of S-NPP VIIRS aerosol optical thickness, *J. Geophys. Res.: Atmos.,* 119, 3942–3962, doi:10.1002/2013JD020360.

• Jackson, J., H. Liu, I. Laszlo, S. Kondragunta, L.A. Remer, J. Huang, H. Huang, 2013:Suomi-NPP VIIRS aerosol algorithms and data products*, J. Geophys. Res. Atmos.*, **118**, 12,673–12,689, doi:10.1002/2013JD020449.

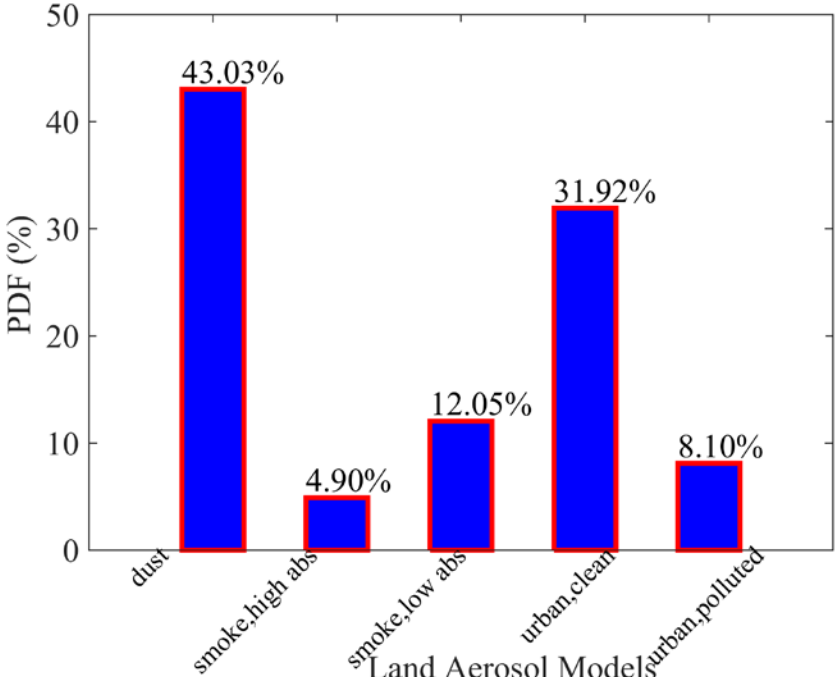
Thanks!

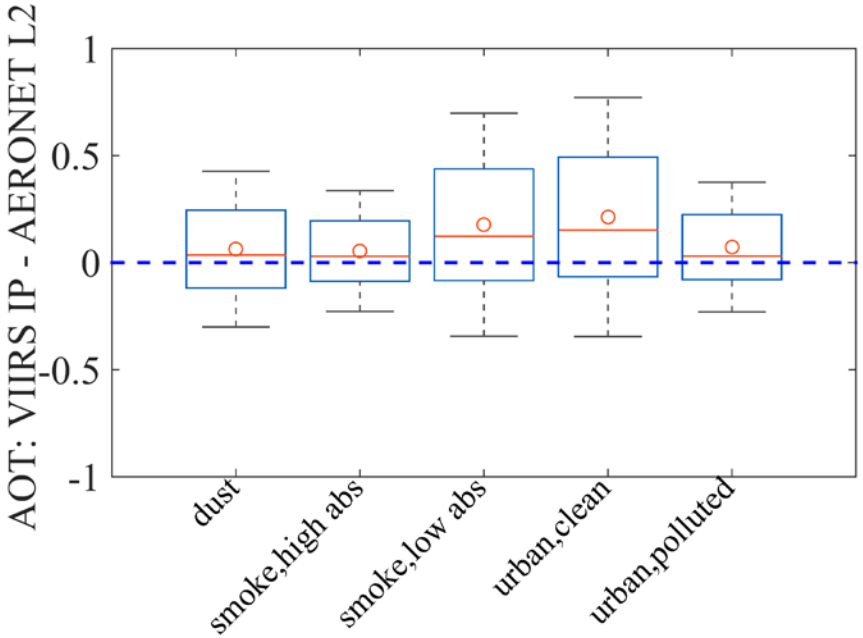
Backup Slides

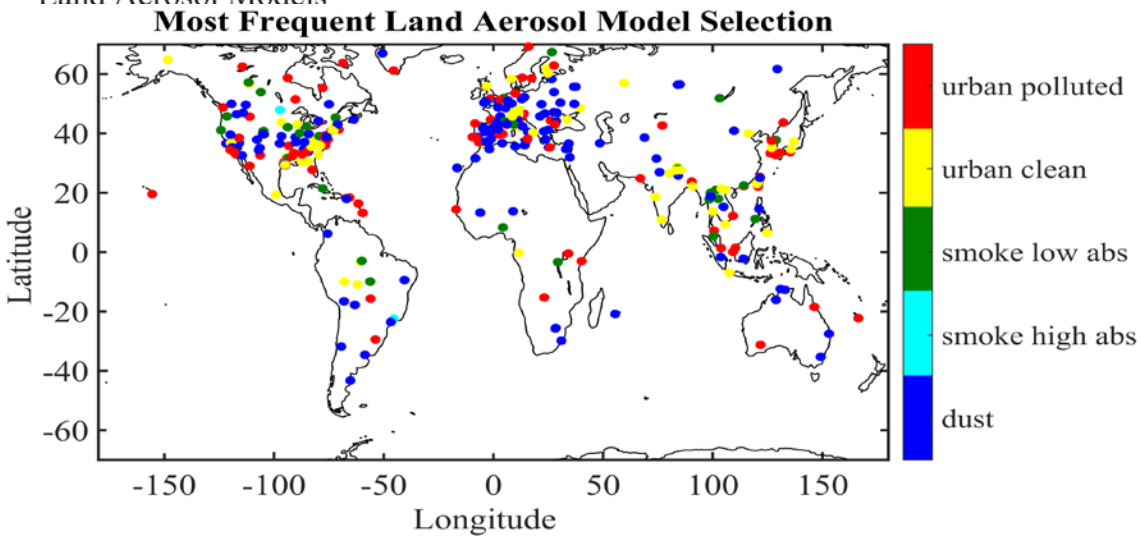
EDR vs. JPSS L1RD Requirements

Evaluation Condition	Accuracy or Precision	JPSS 1 Specification	VIIRS Aerosol EDR	Meet JPSS1 Specification
LAND AOT (01/23/2013-12/31/2014)				
AOT<0.1	Accuracy	0.06	0.024	**Yes**
	Precision	0.15	0.065	**Yes**
0.1≤AOT≤0.8	Accuracy	0.05	-0.015	**Yes**
	Precision	0.25	0.11	**Yes**
0.8<AOT≤2.0	Accuracy	0.20	-0.20	**Yes**
	Precision	0.45	0.34	**Yes**
OCEAN AOT (05/02/2012-12/31/2014, excluding 10/15/2012-11/27/2012)				
AOT<0.3	Accuracy	0.08	0.026	**Yes**
	Precision	0.15	0.044	**Yes**
0.3≤AOT≤2.0	Accuracy	0.15	0.022	**Yes**
	Precision	0.35	0.13	**Yes**
OCEAN AE (05/02/2012-12/31/2014, excluding 10/15/2012-11/27/2012)				
865nm/1610nm	Accuracy	0.30	0.12	**Yes**
	Precision	0.60	0.56	**Yes**

Land Aerosol Models







Regional/Seasonal Characterizations