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Comparison of single- and multi-channel AOD from MAPSS data

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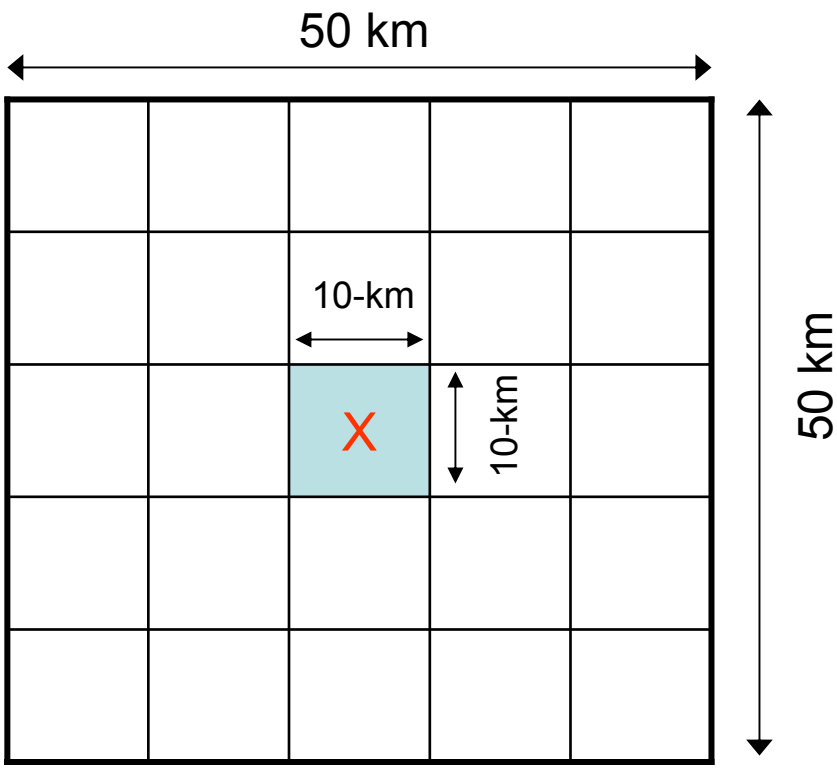
Objective and Strategy

- Objective:
  - Compare single-channel (NOAA/NESDIS) and multi-channel (NASA/GSFC) retrievals of AOD when **only** the algorithms differ.
- Strategy:
  - Retrieve single-channel AOD_S at 25 oceanic locations from reflectances in the NASA/GFSC MODIS Atmosphere Parameters Subset Statistics (MAPSS) dataset.
  - Compare AOD_S with multi-channel (level 2 MOD04) AOD_M from MAPSS.

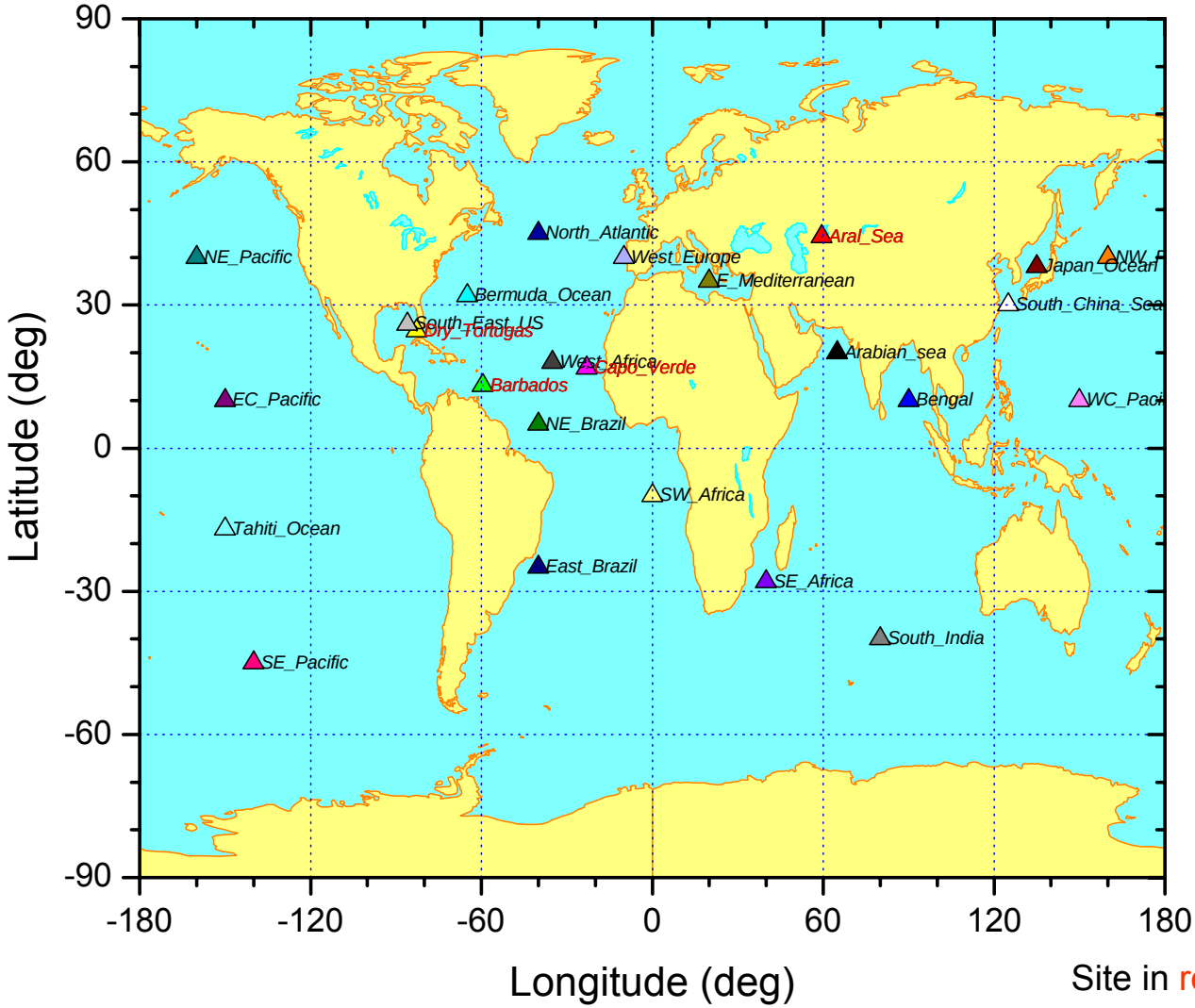
The MAPSS data



MODIS Atmosphere Parameters Subset Statistics (MAPSS) dataset has spatial statistics for 5 by 5 boxes:

- the reflectance at the middle point in a 5 by 5 box,
- AOD at the middle point in a 5 by 5 box,
- average of 10-km reflectances in a 5 by 5 box used in AOD retrieval,
- average of 10-km AOD in a 5 by 5 box.

MAPSS sites used



Site in red has SP

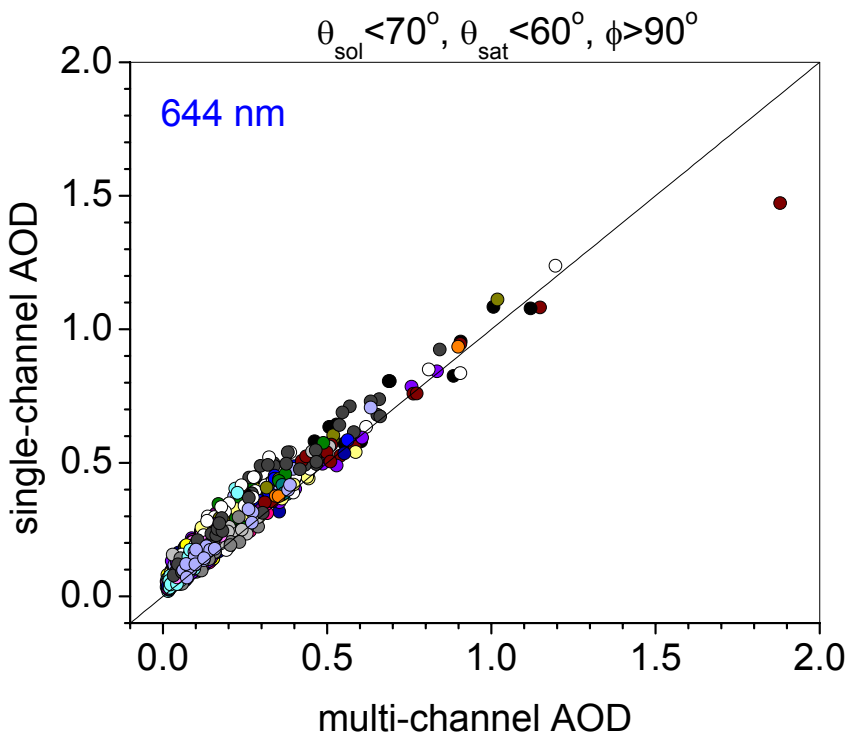
Single-Channel AOD Retrievals

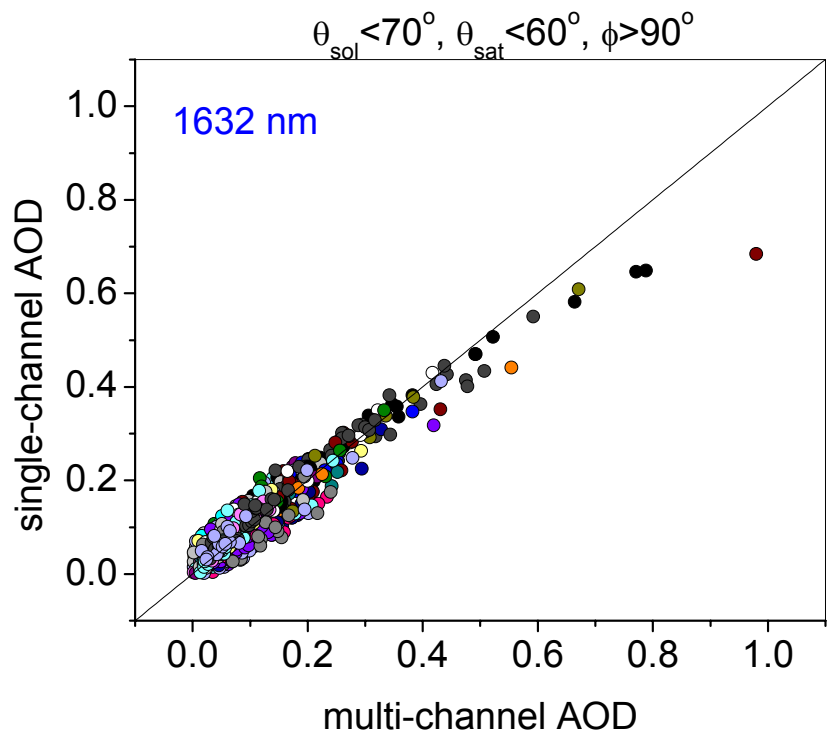
- *AOD retrieval from 10-km reflectance:*
  - for **anti-solar** side of orbit, and solar zenith < 70°, sensor zenith < 60°:
    - AOD from Terra/MODIS Collection 4 data (2000-2004);
    - AOD from Aqua/MODIS Collection 3 and 4 data (2002-2004);
  - for **solar** side of orbit, and solar zenith < 70°, sensor zenith < 60°:
    - AOD from Terra/MODIS Collection 4 data;
- *AOD retrieval from 50-km reflectance:*
  - for **anti-solar** side of orbit, and solar zenith < 70°, sensor zenith < 60°:
    - AOD from Terra/MODIS Collection 4 data.

AOD is retrieved from the 644 nm and 1632 nm channels.

AOD Scatter Plot

10-km MODIS/Terra reflectance

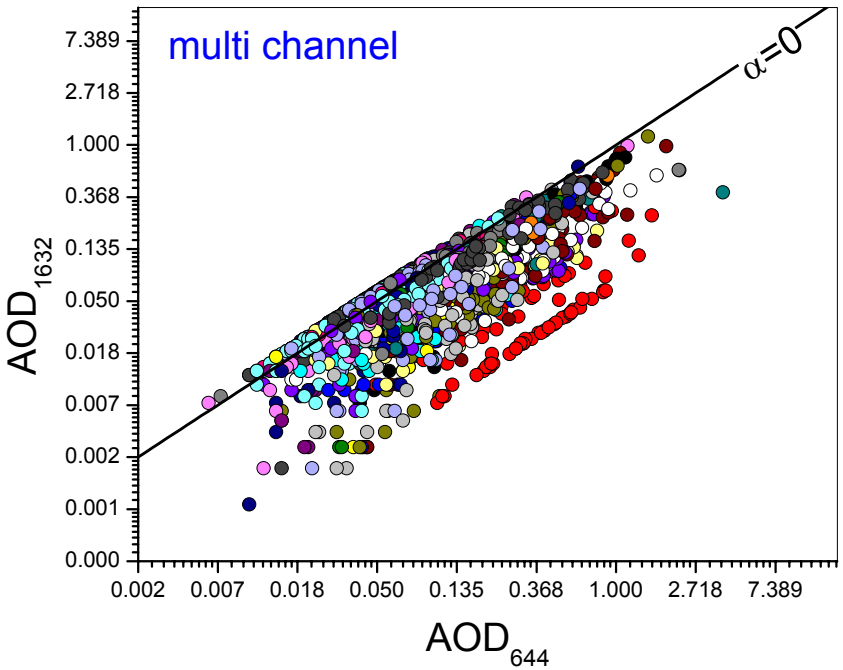


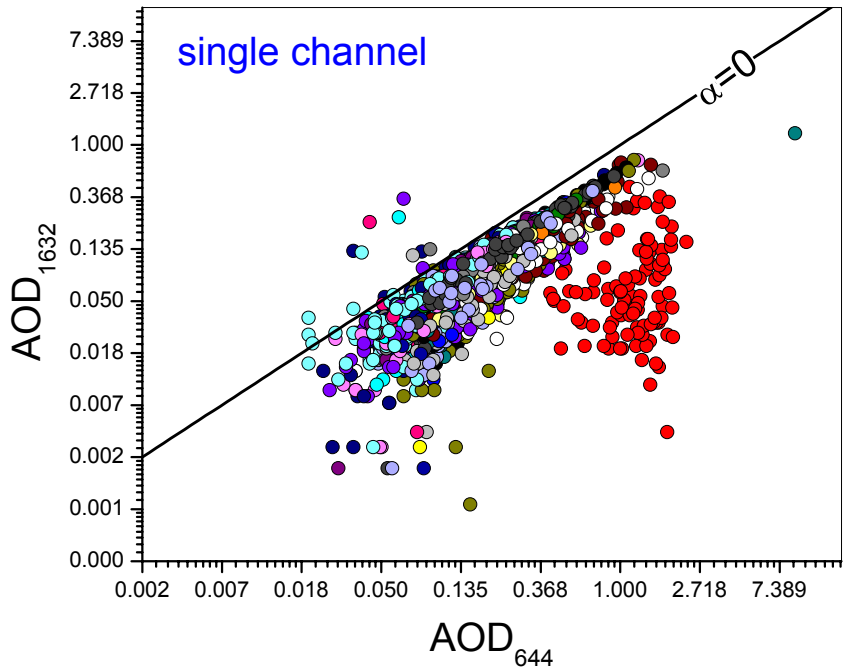


Scatter plot of single-channel AOD vs. multi-channel AOD at 644 nm and 1632 nm for the single-channel geometry (solar zenith angle $\theta_{sol} < 70^o$, satellite zenith angle $\theta_{sat} < 60^o$, and relative azimuth angle $\Phi > 90^o$).

AOD Scatter Plot (2)

10-km MODIS/Terra reflectance





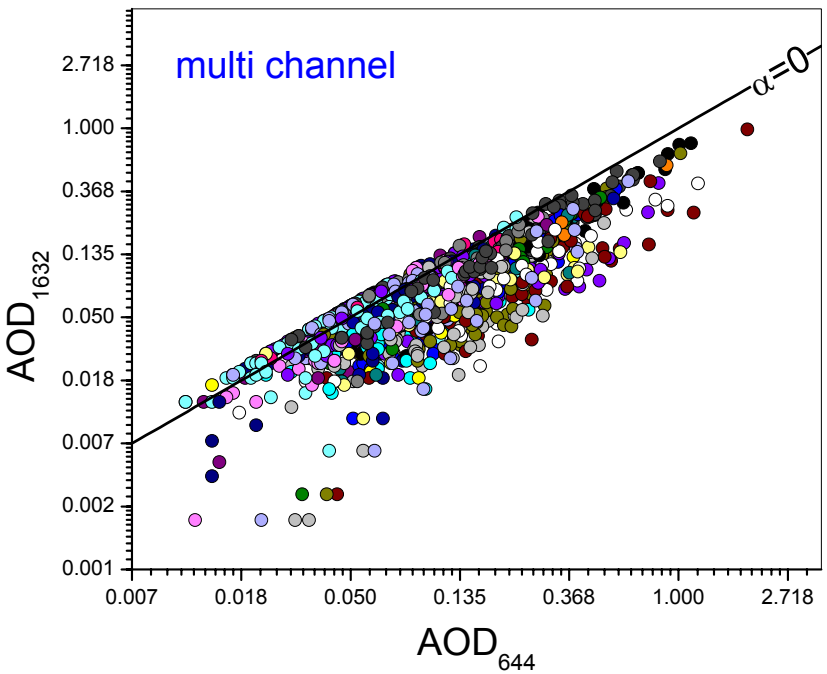
Note *ln-ln* scale!

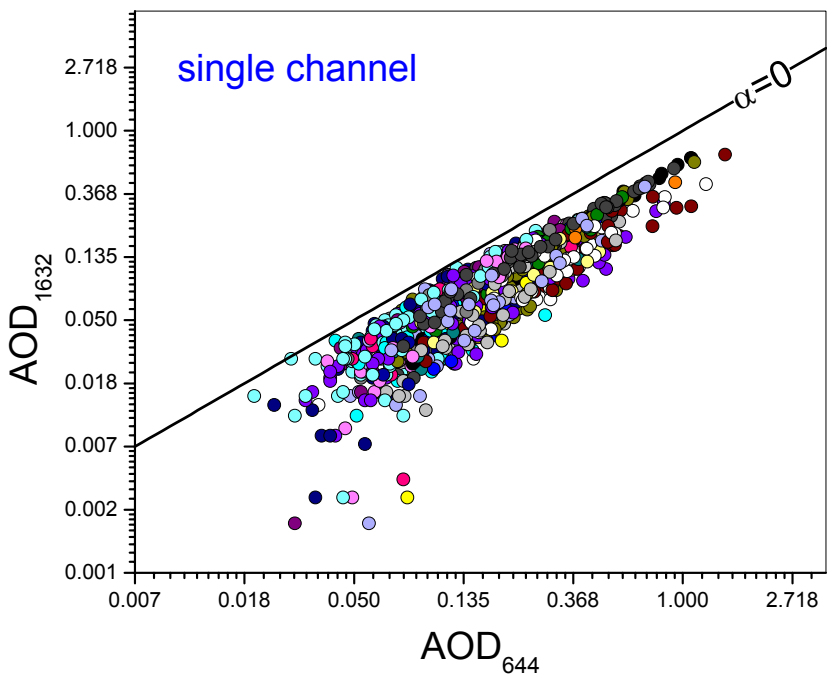
For fixed aerosol size and composition, $\ln(\tau_2) = \ln(\tau_1) + \alpha \ln(\lambda_1/\lambda_2)$

Data from all Collections!

AOD Scatter Plot (3)

10-km MODIS/Terra reflectance





Note *ln-ln* scale!

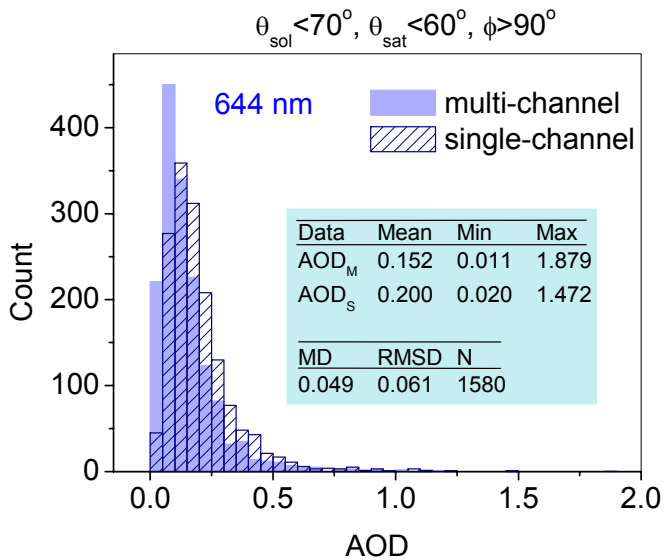
For fixed aerosol size and composition, $\ln(\tau_2) = \ln(\tau_1) + \alpha \ln(\lambda_1/\lambda_2)$

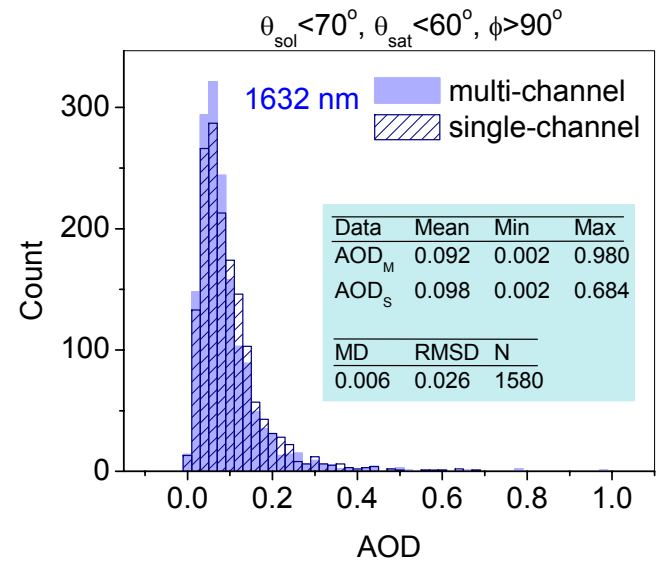
Collection 4 data only !

AOD Histograms

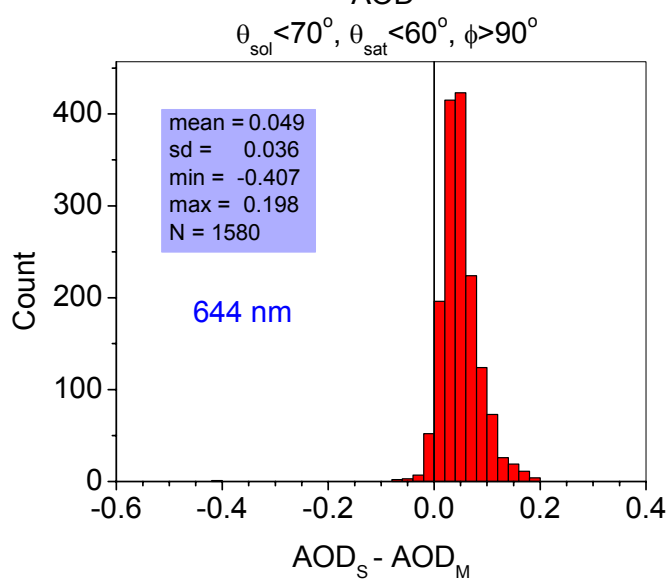
10-km MODIS/Terra reflectance

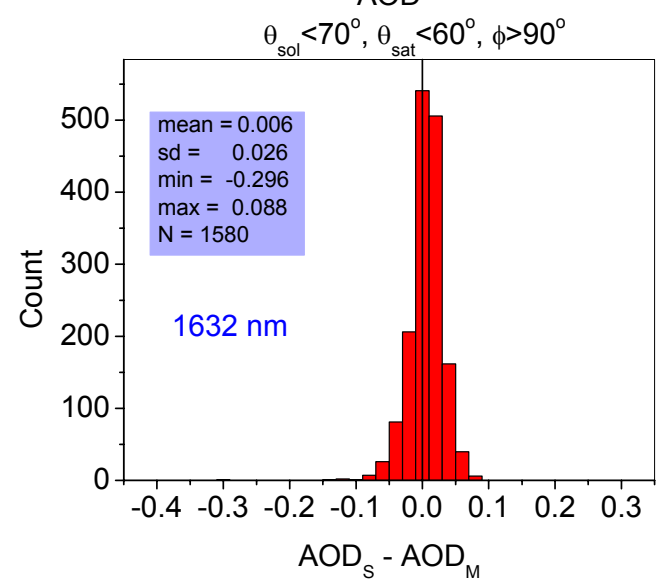
Histogram of AOD





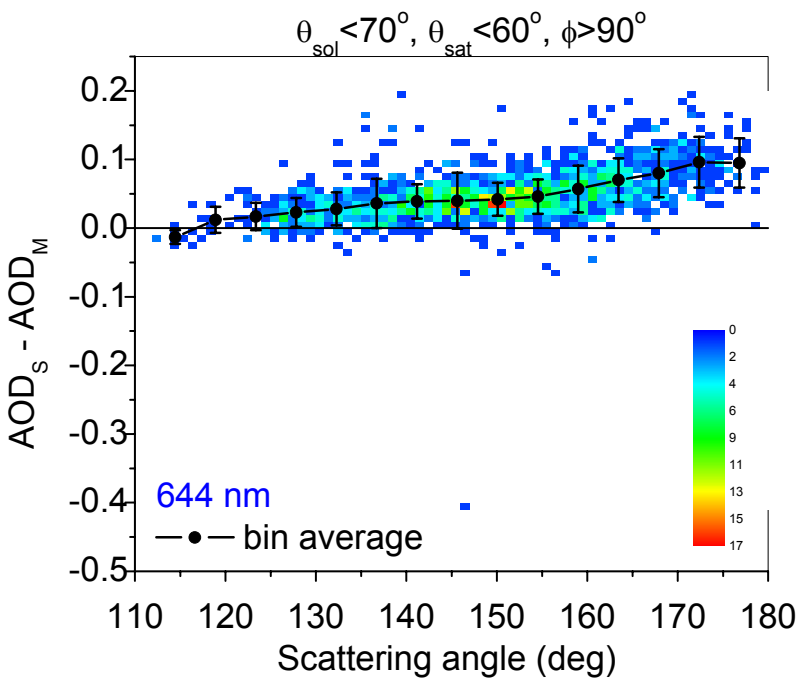
Histogram of differences

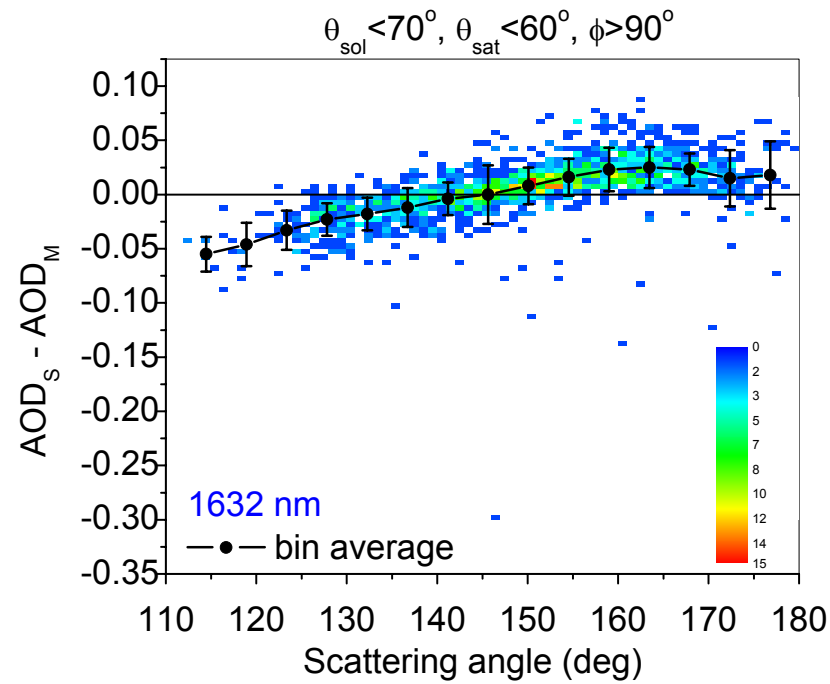




AOD Difference vs. Scattering angle

10-km MODIS/Terra reflectance

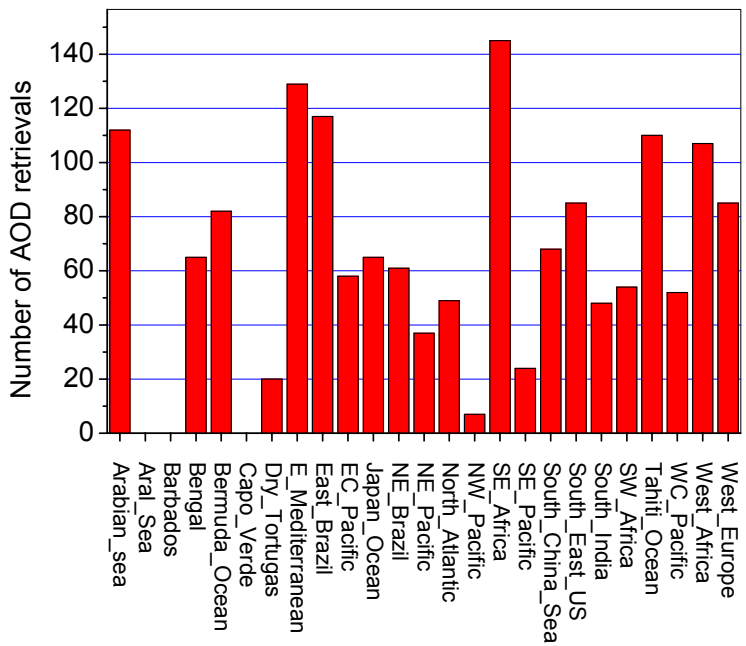


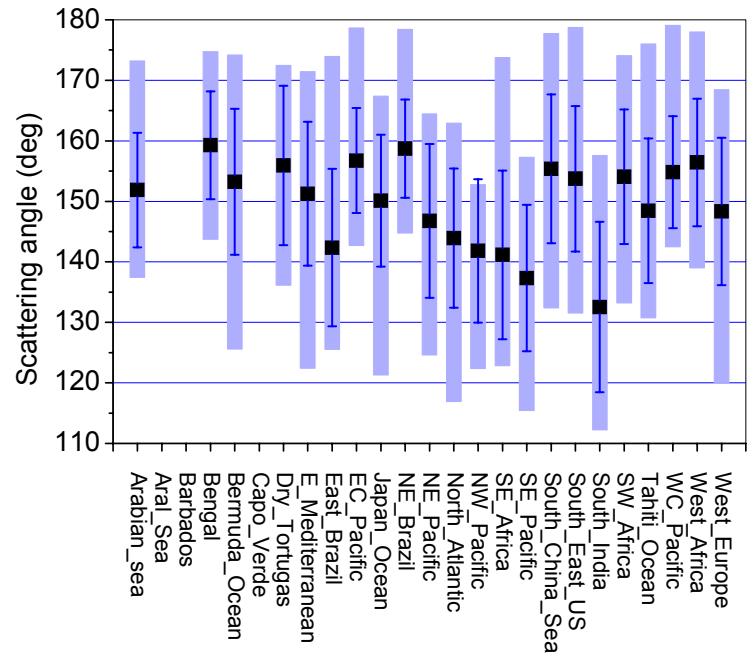


Interpretation is not trivial!

Site Statistics

10-km MODIS/Terra reflectance

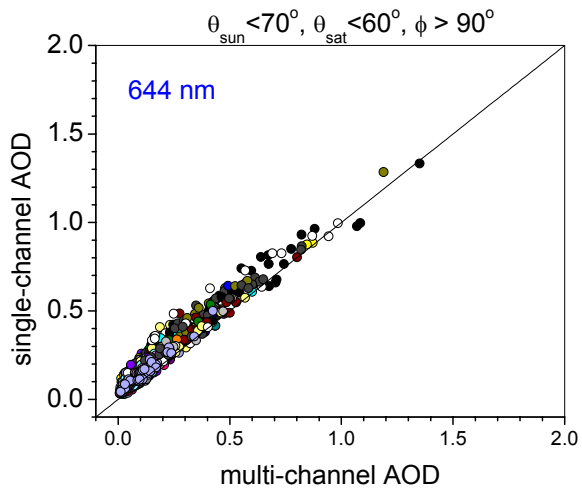




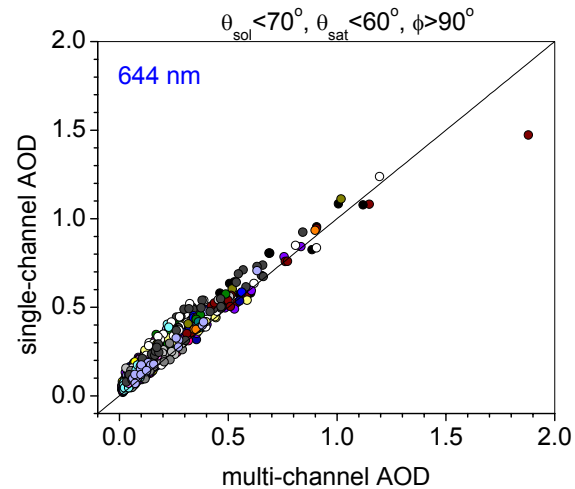
AOD Scatter Plot

10-km MODIS/Aqua/Terra reflectance

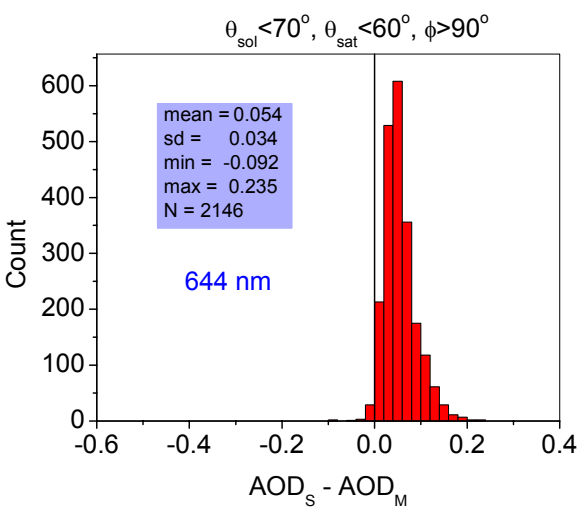
Aqua

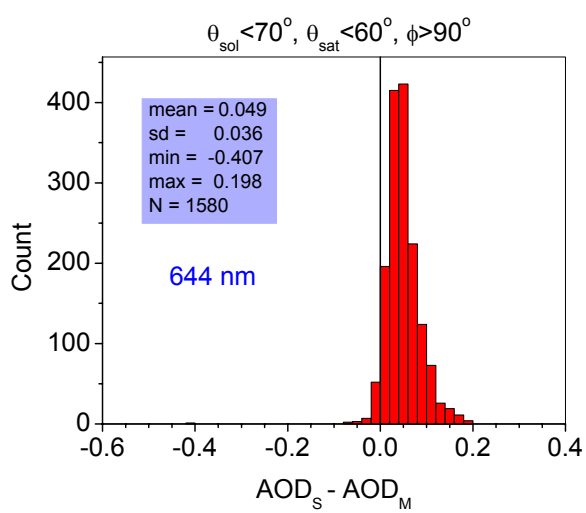


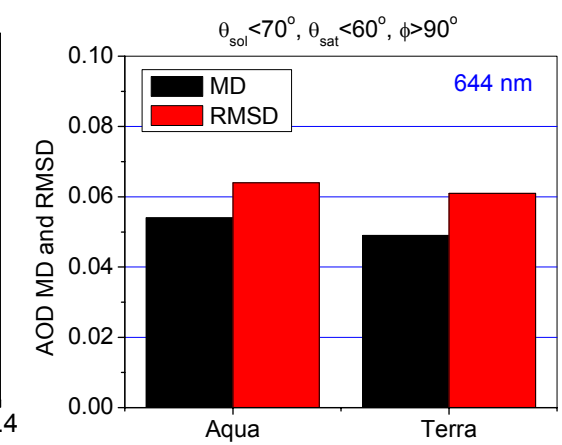
Terra



644-nm single-channel AOD retrievals from MODIS/Aqua and MODIS/Terra, relative to the multi-channel AOD retrievals, are similar.

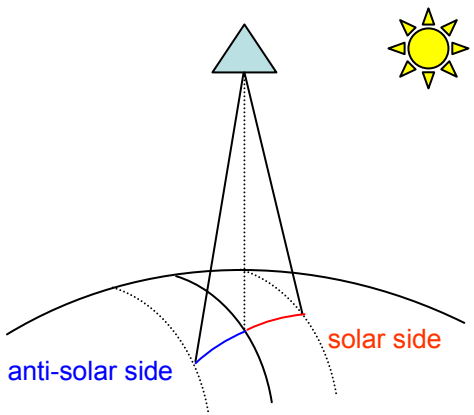


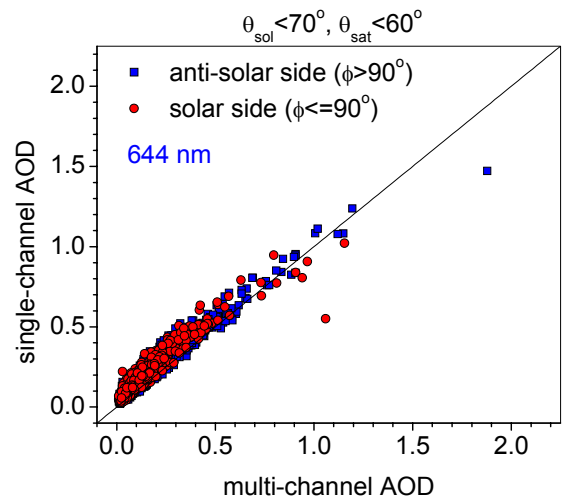


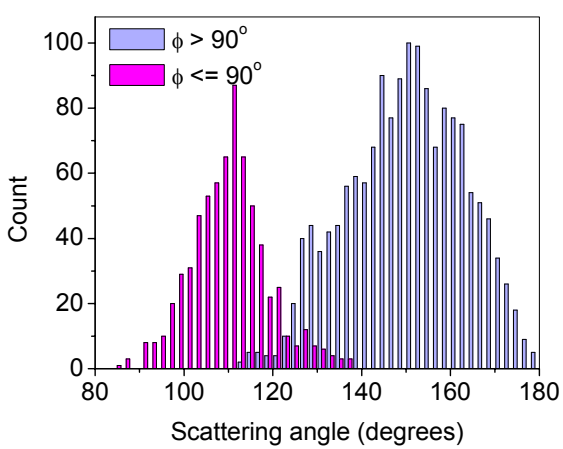


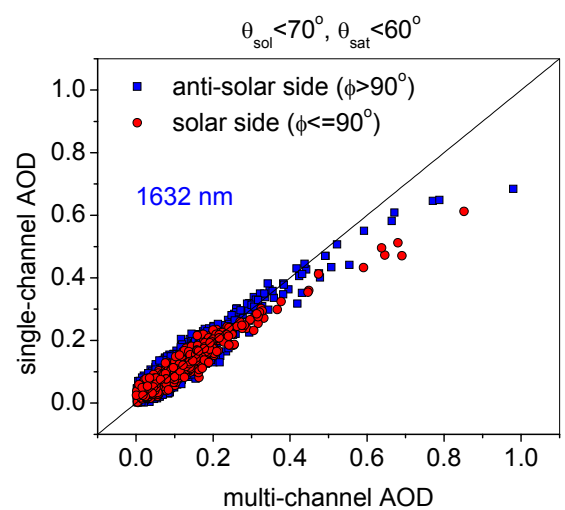
Solar Side vs. Anti-Solar Side

10-km MODIS/Terra reflectance









Solar Side vs. Anti-Solar Side

10-km MODIS/Terra Statistics Table

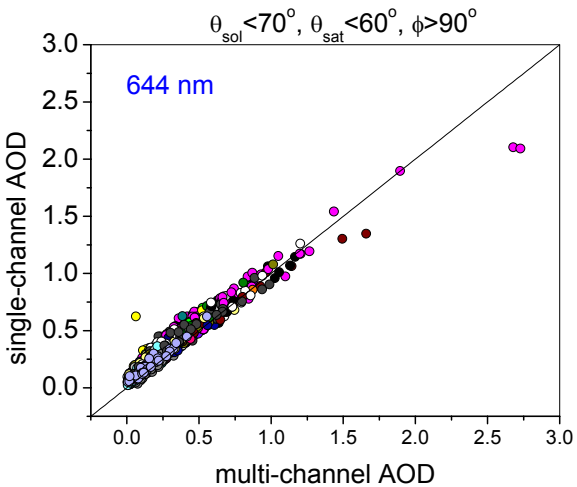
	644 nm					1632 nm				
	mean	min	max	md	rmsd	mean	min	max	md	rmsd
θ_{sun}<70°, θ_{sat}<60°, ϕ>90°, N=1580										
τ_M	0.152	0.011	1.879	0.049	0.061	0.092	0.002	0.980	0.006	0.026
τ_S	0.200	0.020	1.472			0.098	0.002	0.684		
θ_{sun}<70°, θ_{sat}<60°, ϕ<=90°, N=671										
τ_M	0.153	0.010	1.155	0.056	0.072	0.107	0.001	0.852	-0.005	0.028
τ_S	0.209	0.029	1.021			0.102	0.002	0.612		
θ_{sun}<70°, θ_{sat}<60°, all ϕ, N=2251										
τ_M	0.152	0.010	1.879	0.051	0.064	0.096	0.001	0.980	0.002	0.027
τ_S	0.203	0.020	1.472			0.099	0.002	0.684		

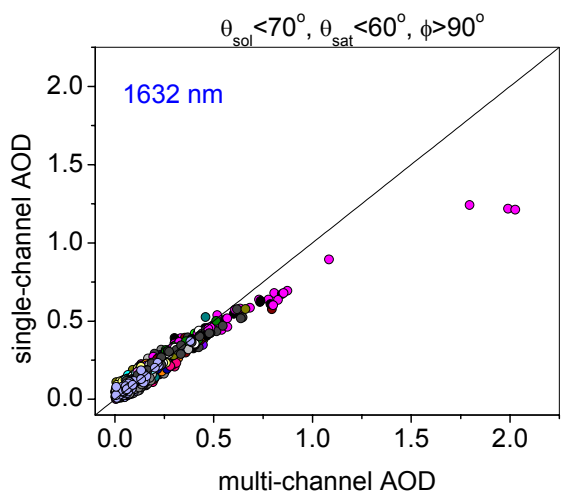
md: mean difference; rmsd: root mean square difference

AOD Scatter Plot

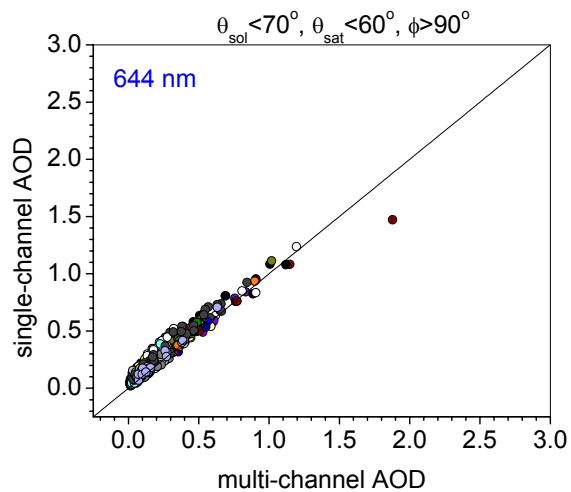
50-km MODIS/Terra reflectance

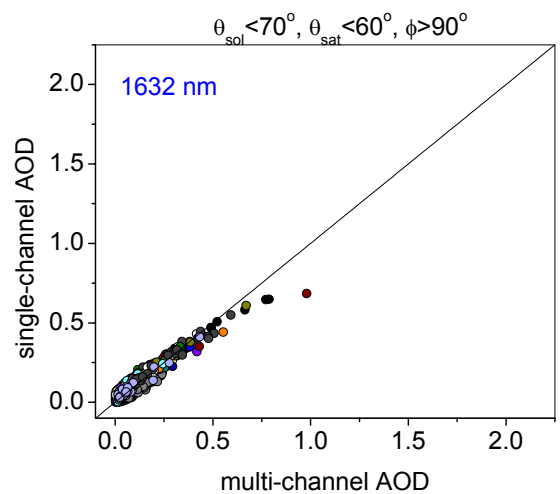
50-km





10-km





Pattern of 50-km and 10-km AOD retrievals are similar; on average:

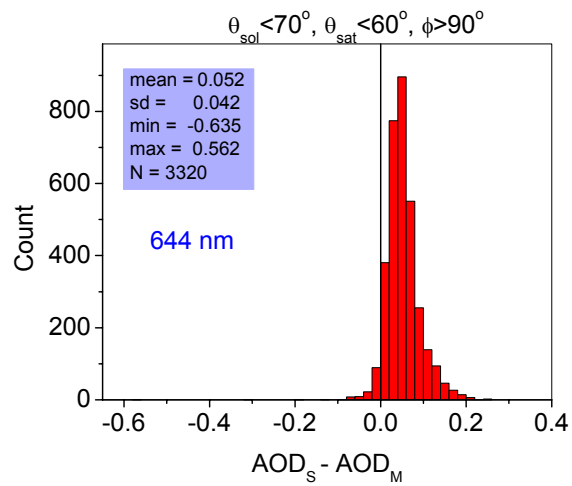
- $AOD_S > AOD_M$ at 644 nm
- $AOD_S \approx AOD_M$ at 1623 nm.

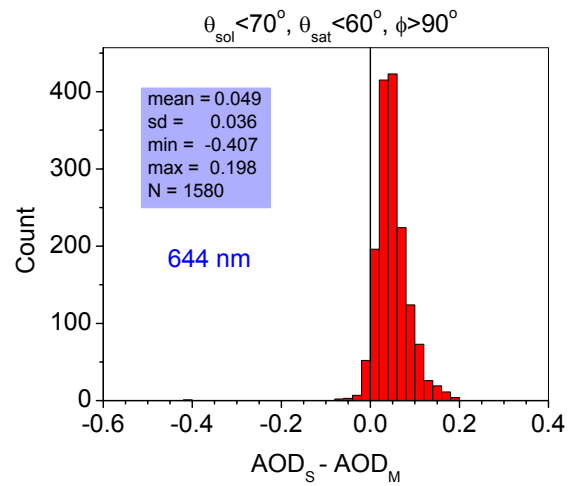
Histograms of AOD Difference

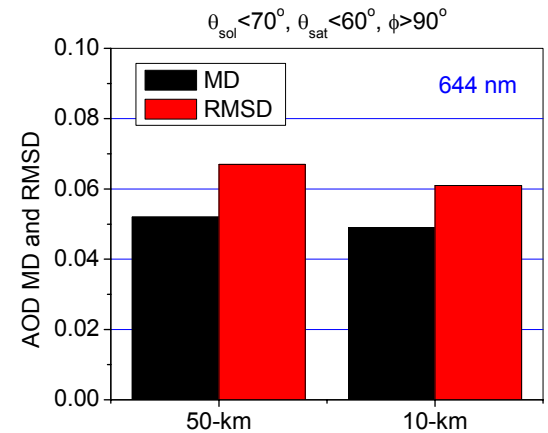
50-km MODIS/Terra reflectance

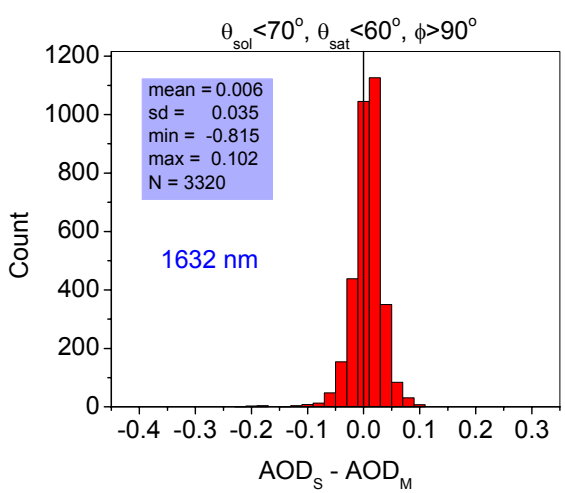
50-km

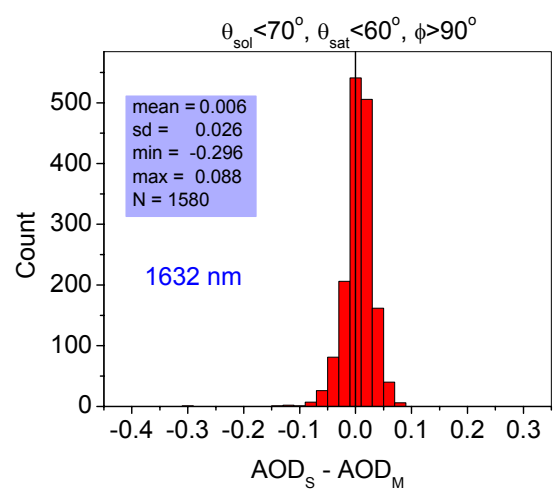
10-km

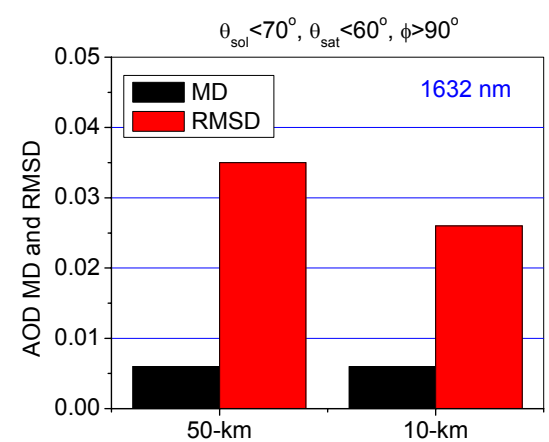












Summary

- Compared single- and multi-channel AOD derived from the same “aerosol” reflectance at oceanic sites.
- For both MODIS/Terra and MODIS/Aqua, on average:
  - $AOD_S > AOD_M$ at 644 nm
  - $AOD_S \geq AOD_M$ at 1632 nm
- No major difference between solar and anti-solar side.
- Slight dependence of AOD_S-AOD_M on scattering angle → aerosol/surface model, etc. difference?
- Mean and RMS of AOD_S-AOD_M differences are slightly larger from 50-km reflectances.