Comparison and Validation of the Two Aerosol Products in the Terra CERES/SSF-MODIS Dataset

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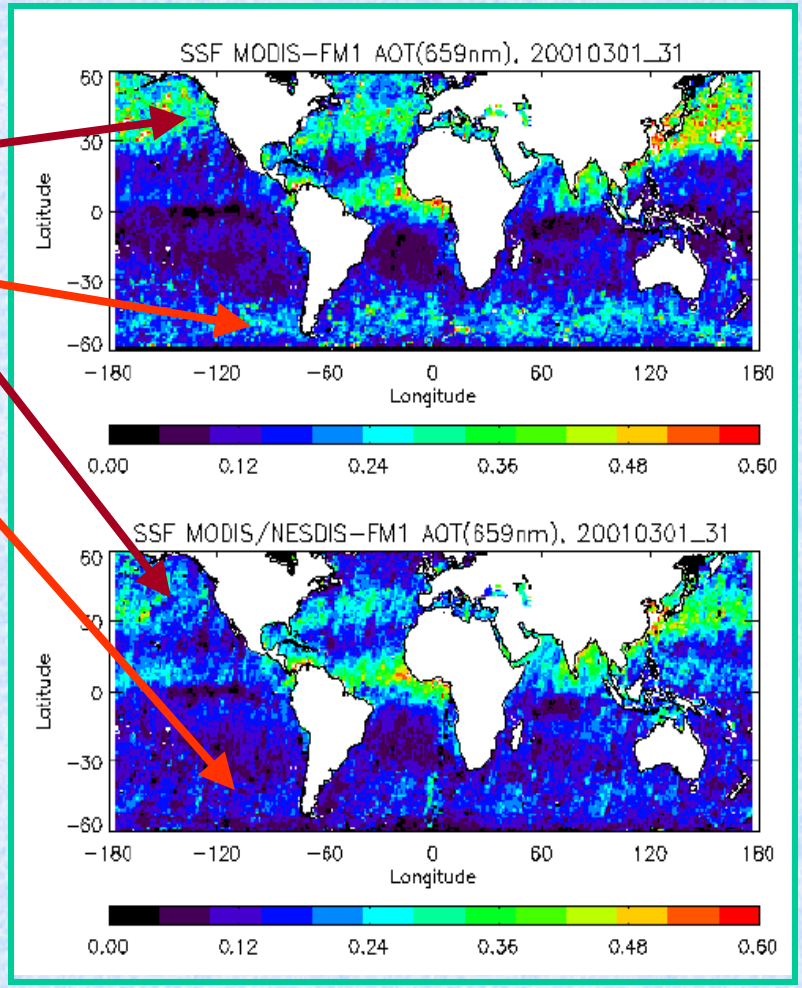
Motivation

Two aerosol products are available in the Terra CERES/SSF Data

There are some obvious differences in the two SSF aerosol products.

More data and detailed analyses are necessary to find the causes of the differences.

Example
(global map of two SSF AOTs at 0.66μm)
MARCH, 2001



Data Set

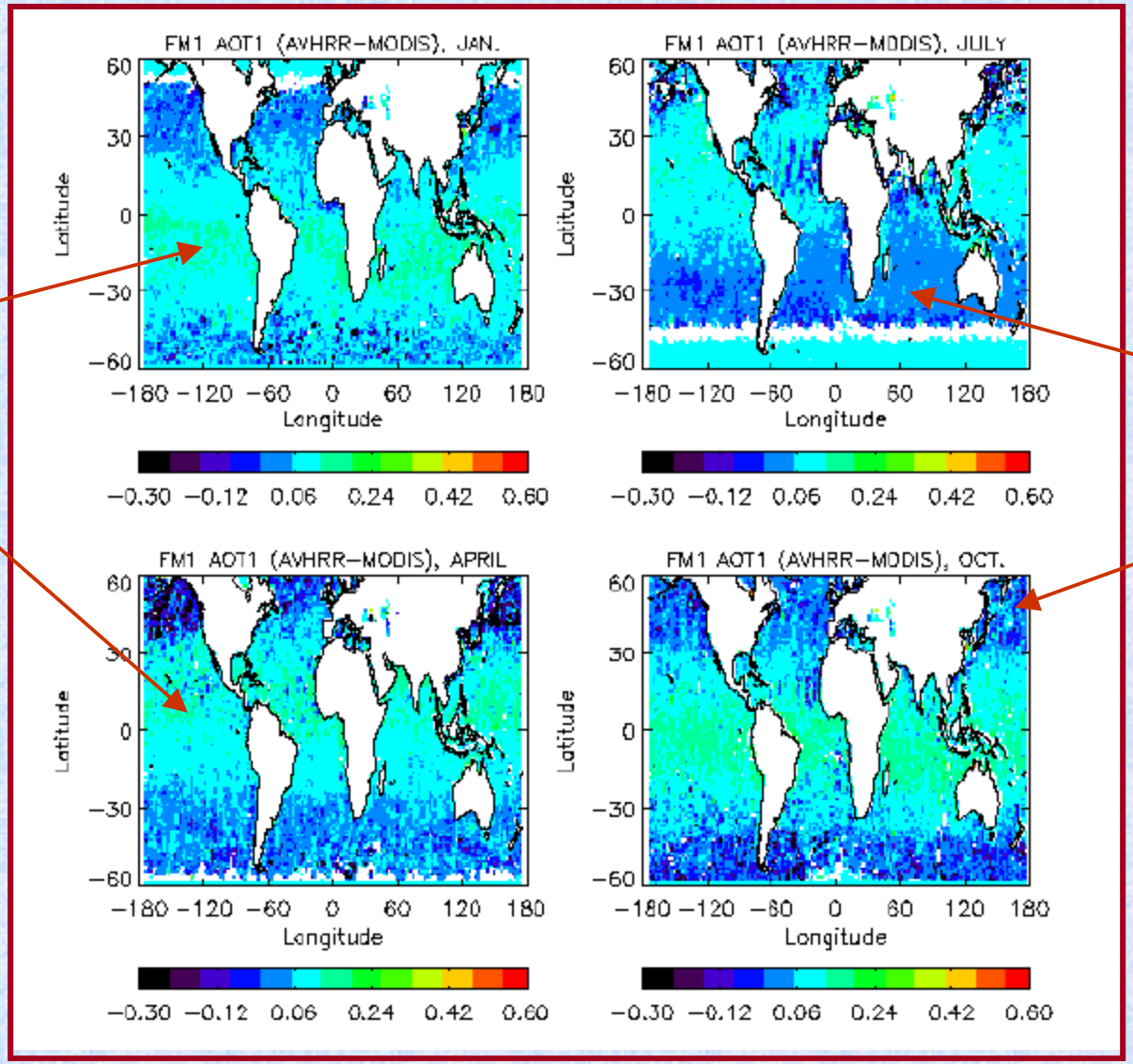
SSF-MODIS (Terra) Ed1A (FM1, FM2) Data
— Jan., April, July, Oct., 2001

Retrieval Algorithm Comparison

	AVHRR-type (Ignatov et al., 2002)	MODIS (ocean) (Tanrĕ et al., 1997)
Channels (μm)	λ_1=0.66, λ_2=1.64	λ_1=0.55, λ_2=0.66, λ_3=0.87, λ_4=1.24, λ_5=1.64, λ_6=2.13
Pixel Sampling	outside of sunglint ($\gamma > 40^0$) anti-solar side of orbit	outside of sunglint ($\gamma > 40^0$)
Retrieved Parameters	τ_1, τ_2 α (derived)	τ_1, τ_2, τ_3, τ_4, τ_5, τ_6, r_{eff} α (derived)
Aerosol Model	globally fixed model mono-lognormal	dynamic variable model bi-lognormal (4 small/5 large)
Cloud Screening	multi-channels & -thresholds test 2x2 clear uniformity test (Minnis et al., 1995)	multi-channels & -thresholds test 3x3 clear uniformity test (Martins et al., 2002)
Surface Treatment	Fresnel (V=1 m/s) & small diffusive reflection	Fresnel (V=6 m/s) & black surface
General Comments	simple & economical insensitive to aerosol types	sophisticated sensitive to aerosol types

Notes: λ is wavelength, γ is glint angle, τ is aerosol optical thickness, r_{eff} is aerosol effective radius, α is aerosol Angstrom wavelength exponent, and V is ocean surface wind speed.

Global Map of $\Delta\tau_1$ — (AVHRR - MODIS)



Jan.

July

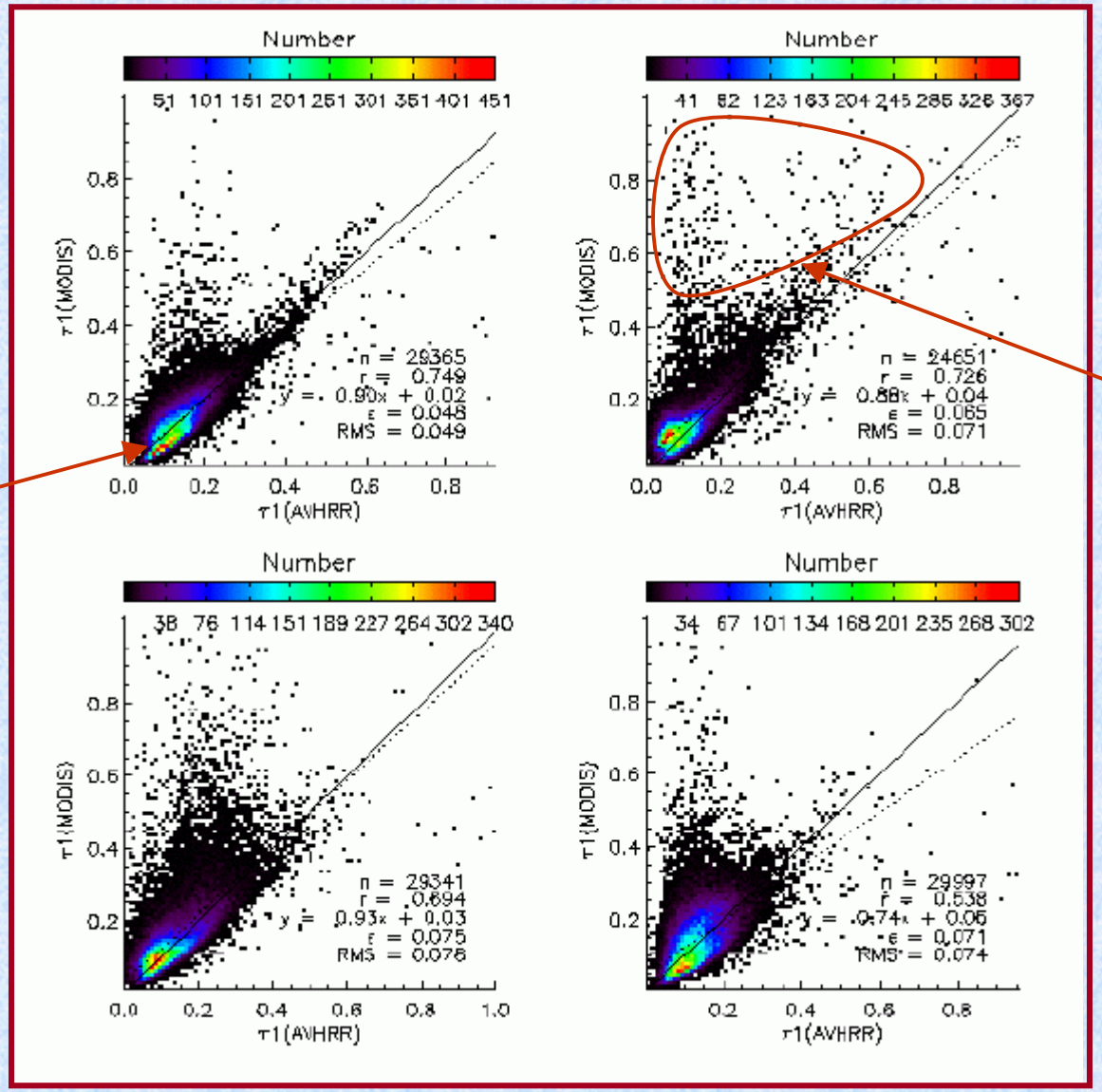
April

Oct.

τ_1(AVHRR) > τ_1(MODIS) on the low latitudes

τ_1(AVHRR) < τ_1(MODIS) on the middle & high latitudes

Inter-comparison of τ_1(FM1)— Scatter Plot



Jan.

July

April

Oct.

τ_1(majority) < 0.2 & τ_1(AVHRR) ~ τ_1(MODIS)

For most of the outliers: τ_1(MODIS) >> τ_1(AVHRR)

Global Map of Δα — (AVHRR-MODIS)

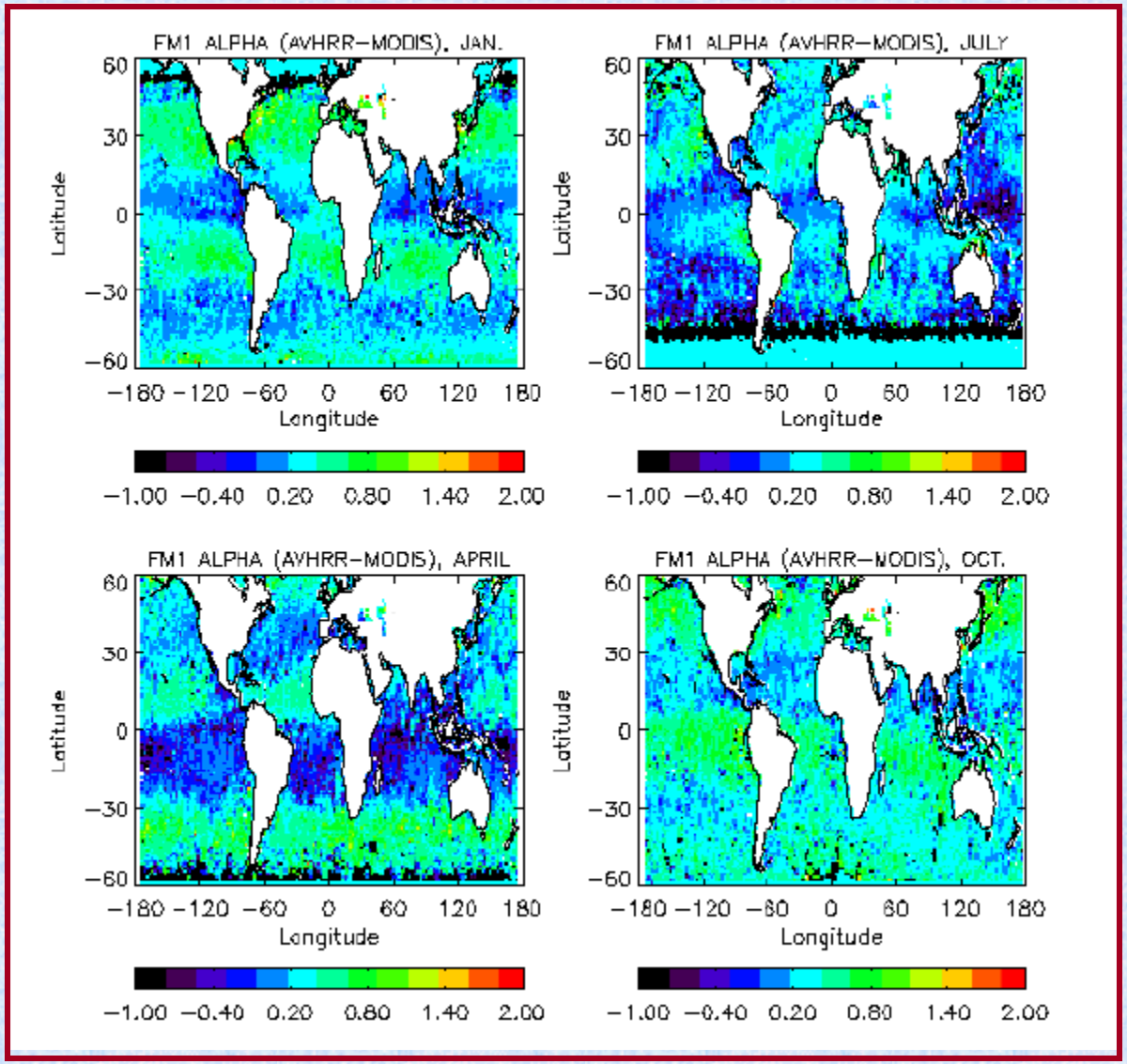
Jan.

July

α difference is more obvious than τ difference

April

Oct.



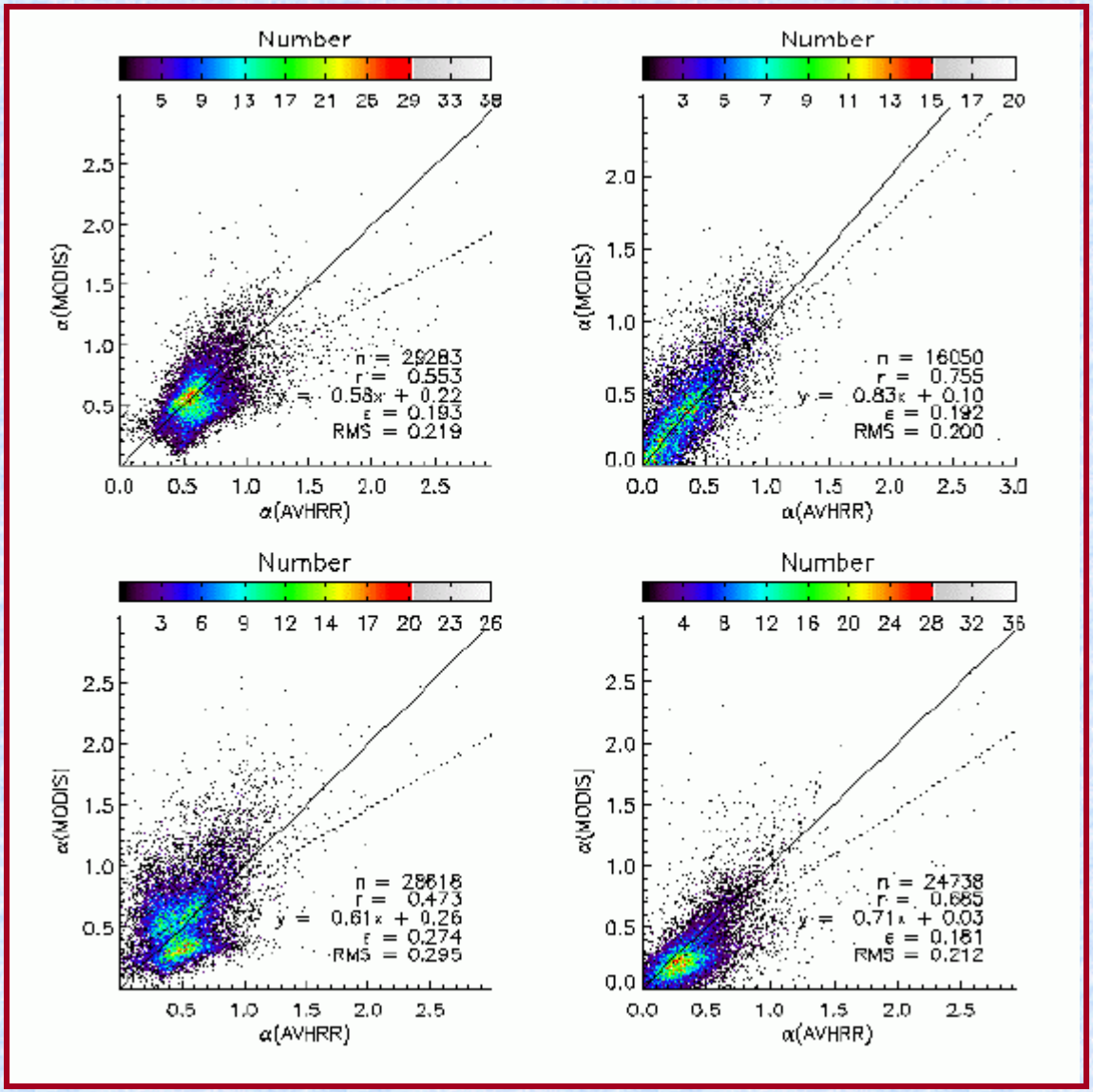
Inter-comparison of α (FM1)— Scatter Plot

Jan.

July

April

Oct.

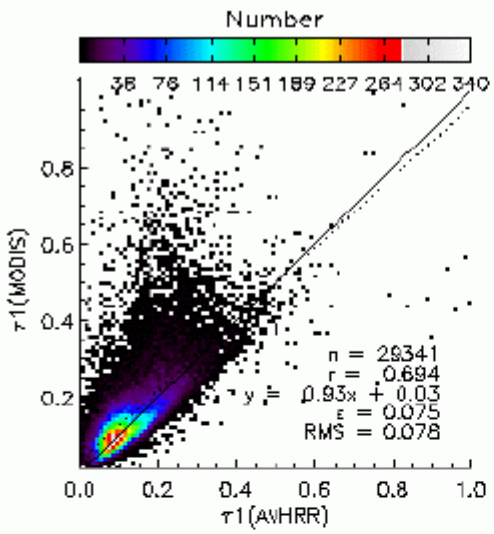


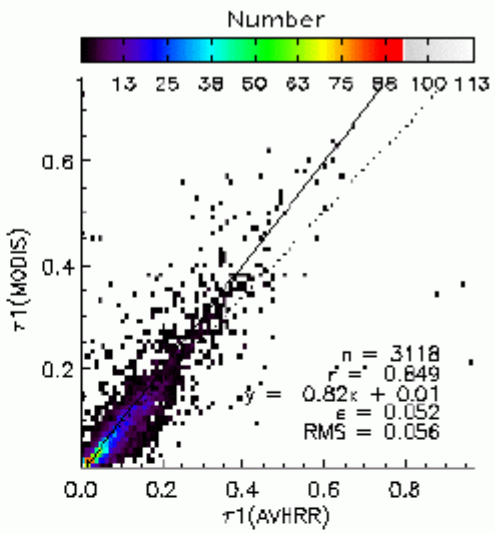
Potential Cloud & Surface Contamination—τ_1

(CSI: clear strong index; V: wind speed)

APRIL

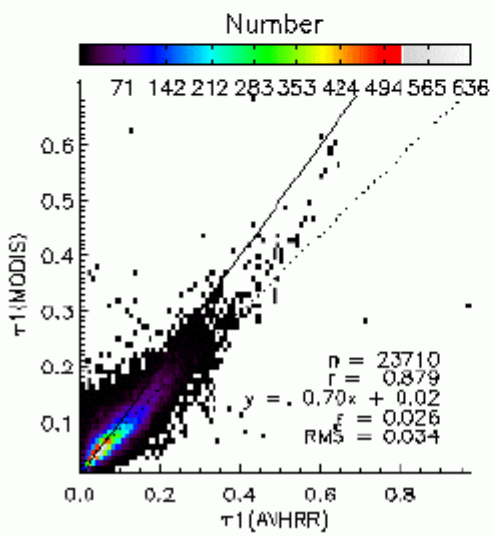
Original Data

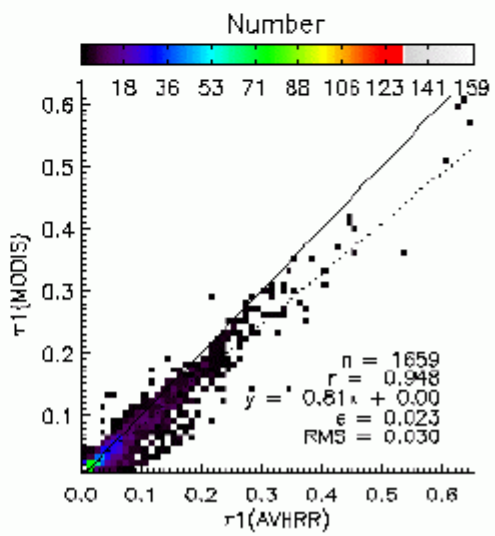




V ≤ 1 m/s

CSI > 90%





CSI > 90%
V ≤ 1 m/s

Potential Cloud & Surface Contamination—τ_2

(CSI: clear strong index; V: wind speed)

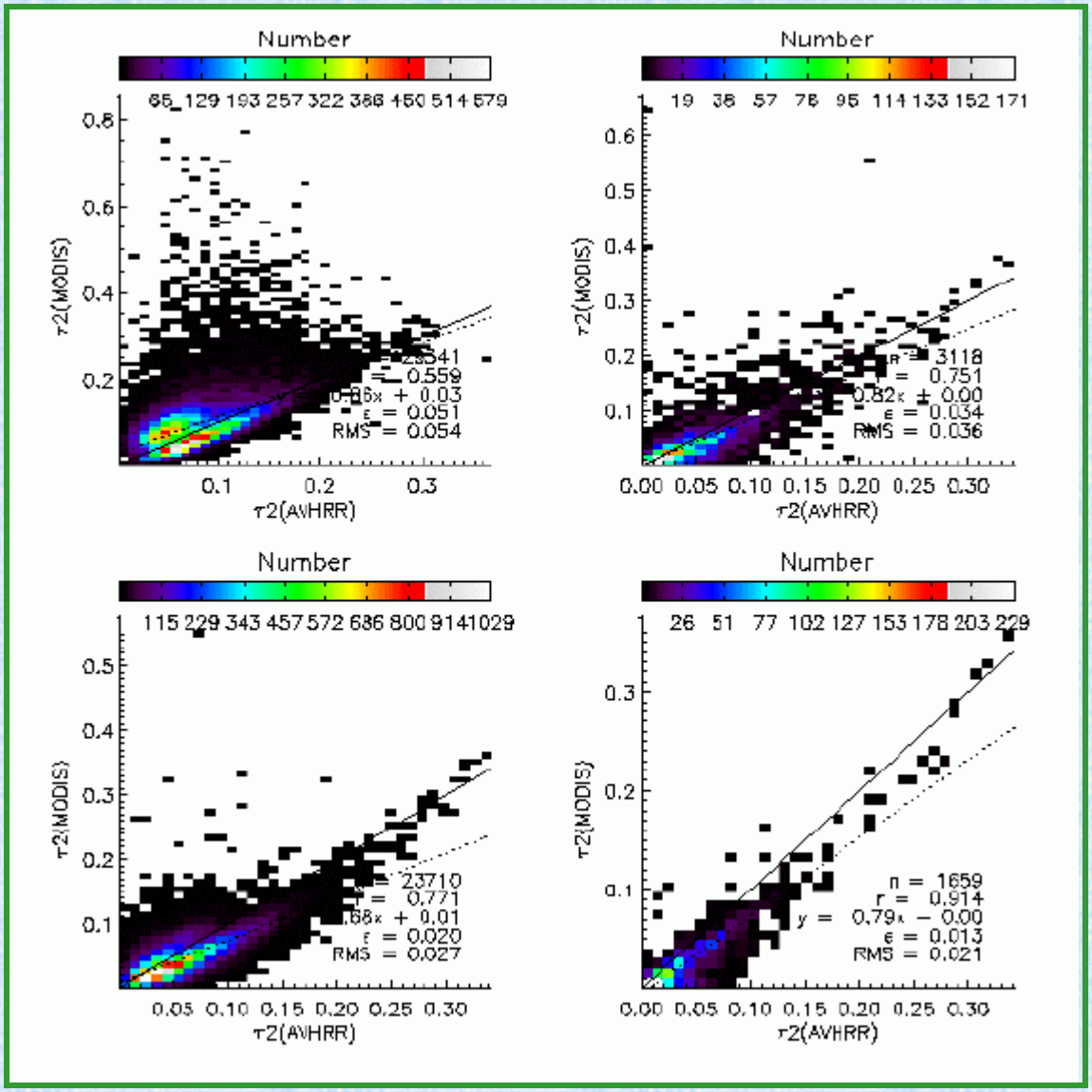
APRIL

Original Data

V ≤ 1 m/s

CSI > 90%

CSI > 90%
V ≤ 1 m/s



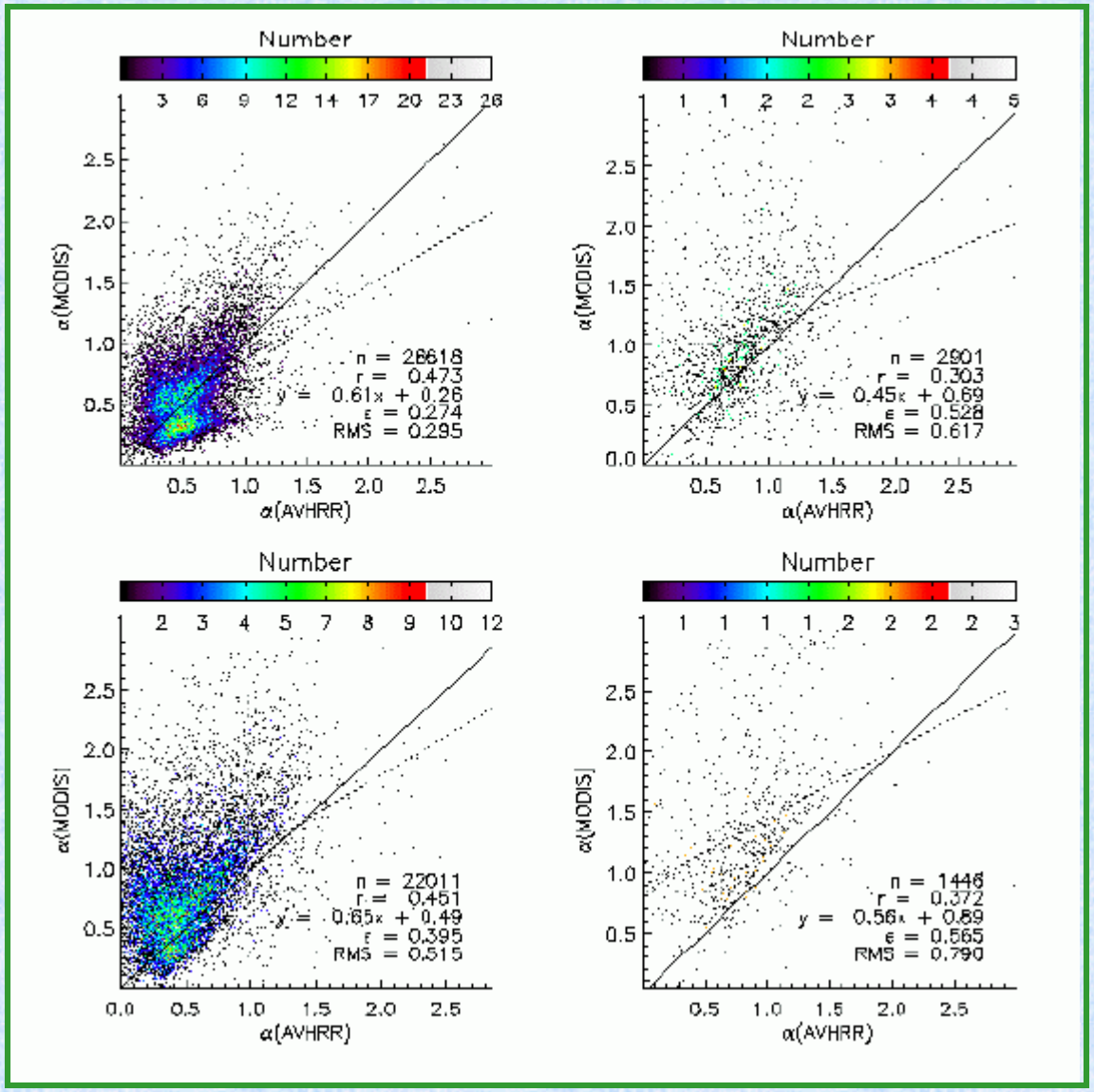
Potential Cloud & Surface Contamination—α

(CSI: clear strong index; V: wind speed)

APRIL

Original Data

CSI > 90%



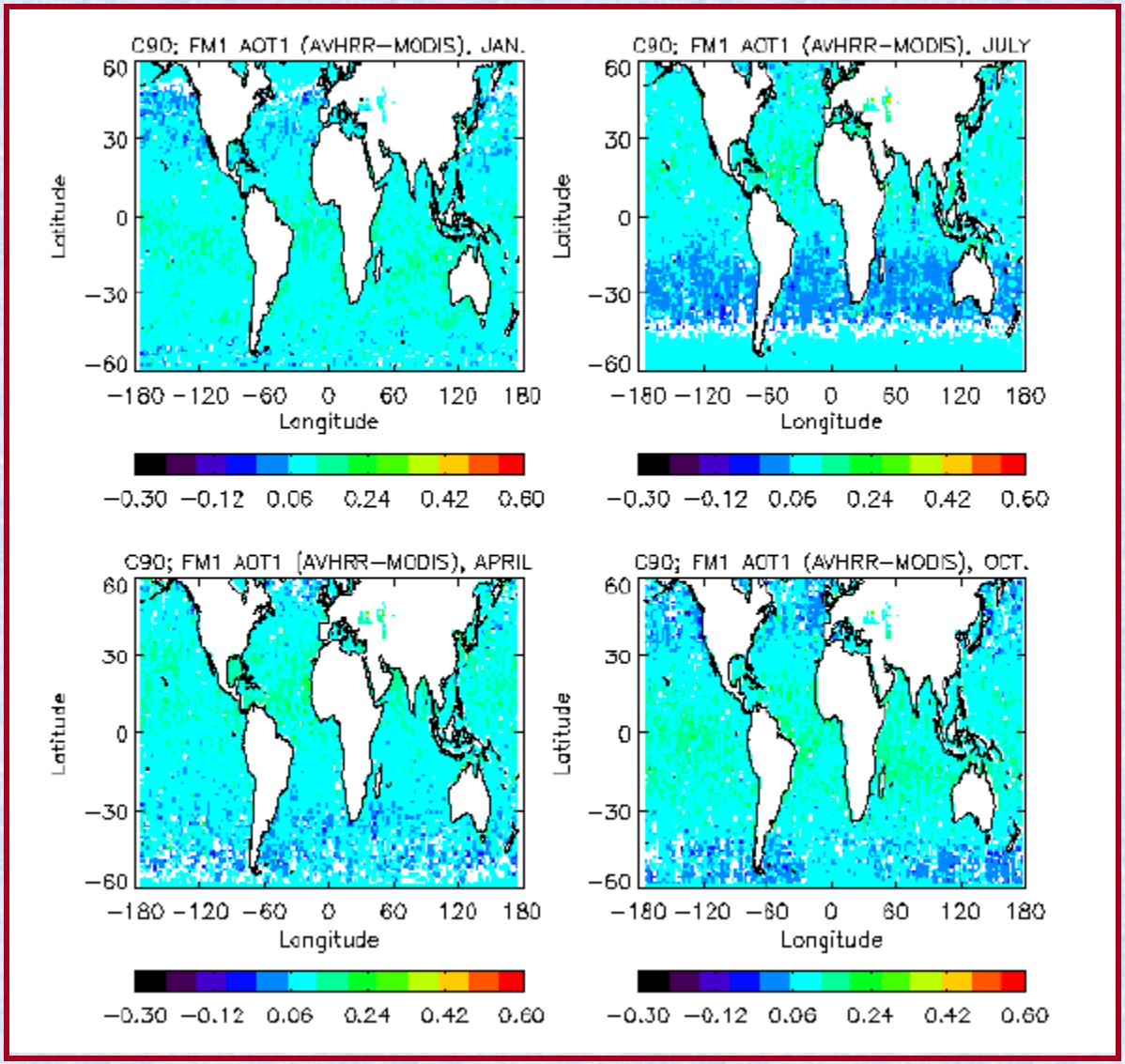
V ≤ 1 m/s

CSI > 90%
V ≤ 1 m/s

Global Map of $\Delta\tau_1$ — (AVHRR - MODIS)
(CSI > 90%)

Jan.

July



April

Oct.

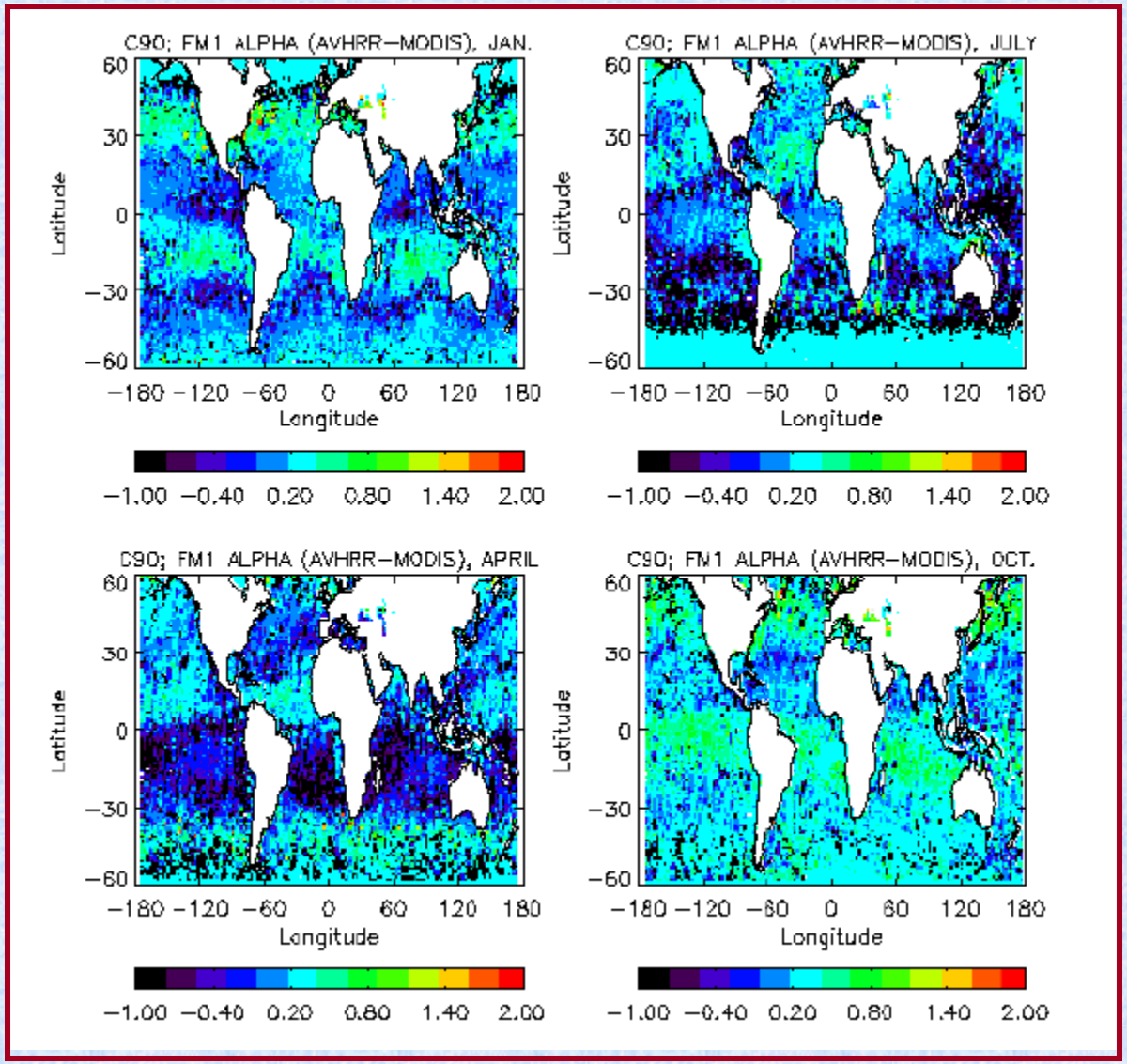
Global Map of Δα — (AVHRR-MODIS)
(CSI > 90%)

Jan.

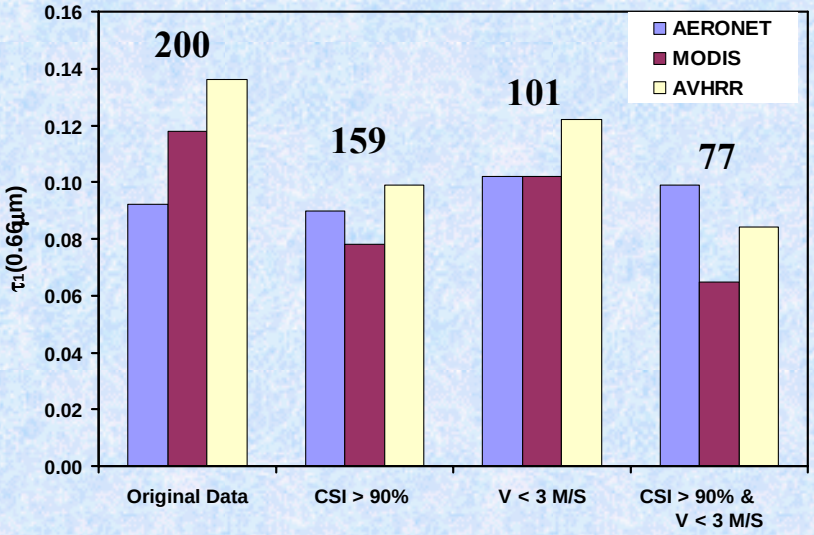
July

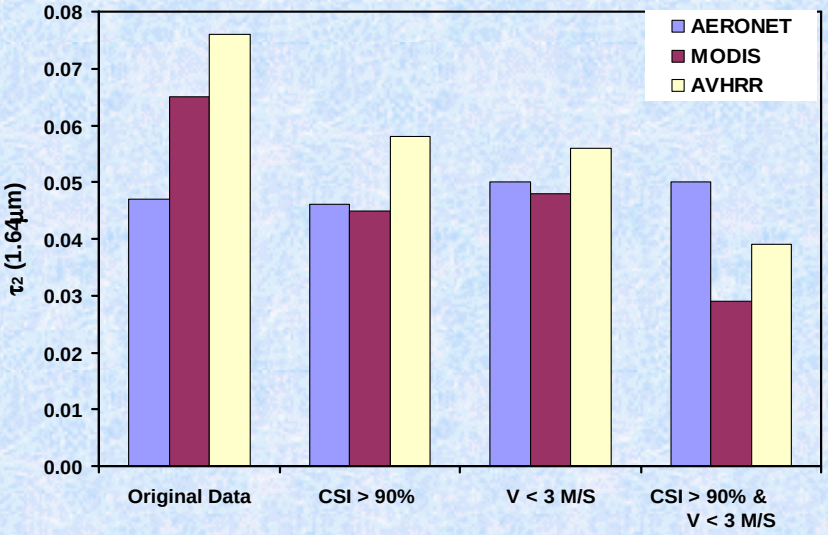
April

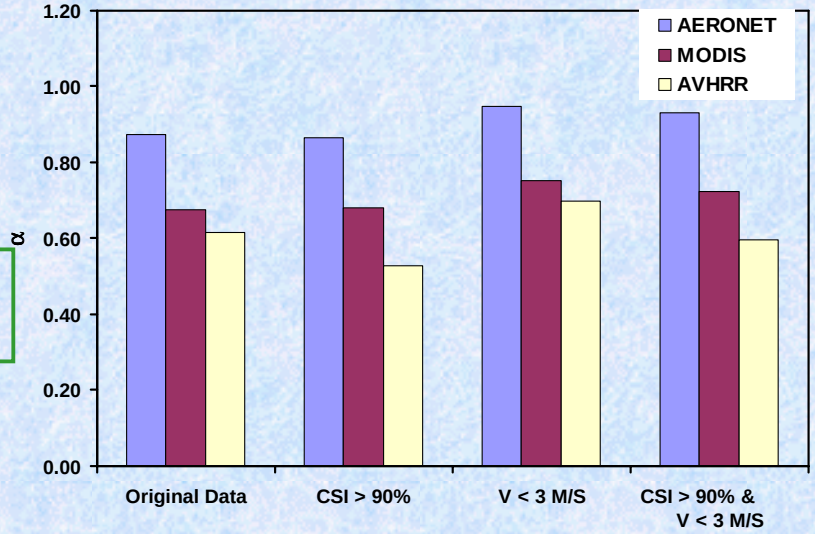
Oct.



Comparison of τ_1, τ_2, and α for the Global Match-ups of Two SSF Aerosol Products and AERONET Observations (FM1, 2001)







Original Data

$\tau(AER) < \tau(MOD) < \tau(AVH)$
$\alpha(AVH) < \alpha(MOD) < \alpha(AER)$

Less Contamination Condition

$\tau(MOD) < \tau(AVH) < \tau(AER)$
$\alpha(AVH) < \alpha(MOD) < \alpha(AER)$

Summary

- The two SSF AOTs agree reasonably well in their global mean, the NESDIS retrieval being slightly larger. The two SSF α comparison in the global mean are not as good as that of AOT, with MODIS values being larger.
- "Cloud contamination" may explain the major regional differences in the AOTs of the two SSF/MODIS aerosol products. The "surface disturbance" also induces some impacts.
- "Cloud contamination" and "surface disturbance" mask the difference in the two Angstrôm wavelength exponent α that are associated with the different aerosol model assumptions in the two SSF aerosol retrievals.
- Global validation using the AERONET observation also suggests possible "cloud contamination" and "surface disturbance" in the two SSF aerosol products.
- MODIS seems subject to more "cloud contamination" while AVHRR-type is subject to more "surface disturbance". After reducing the potential contamination, the mean AVHRR-type AOT values are closer to that of the AERONET while the mean MODIS α values are closer to that of the AERONET.

Future Works

- Make detailed regional comparison and analysis.
- Perform regional validation by including more data (such as a full year of 2001).
- Apply the quality assured aerosol data and the error estimations in aerosol radiative forcing studies.

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