Inter-consistency of Terra/Aqua MODIS aerosols over ocean

Alexander Ignatov
NOAA/NESDIS

LaRC: Pat Minnis & Team, Norman Loeb, Bruce Wielicki, Walt Miller, Erika Geier, Kathleen Morris
GSFC: Lorraine Remer, Didier Tanre, Yoram Kaufman
NESDIS: Istvan Laszlo

Terra/Aqua CERES SSF Aerosols

2 MODIS

- *Terra* (Dec 1999, 10:30 AM)
- *Aqua* (May 2002, 01:30 PM)
- Aerosol over ocean: GSFC/Univ. of Lille (MODIS-group)

4 CERES: 2 *Terra* (FM1/2) + 2 *Aqua* (FM3/4) = 4 SSF datasets

- M-aerosol: primary (Cloud/Sampling Aerosol LUTs: M-group)
- A-aerosol: secondary $\tau_1(0.63)$, $\tau_2(1.61/2.13\ \mu m)$
  (Cloud/Sampling: LaRC; Aerosol LUTs: NESDIS)
- Both mapped to CERES footprints

Previous M- vs. A- Comparisons (Terra)

(*JAS CLAMS Special Issue, 2004, submitted)*

- M- and A- Products: Available in different domains
- Where both available: Compare reasonably well
- Differences: Due mainly to sampling not aerosol model
- Both M- and A-: Correlate with ambient cloud

This study: Check τ_1(0.659 μm) for inter-consistency

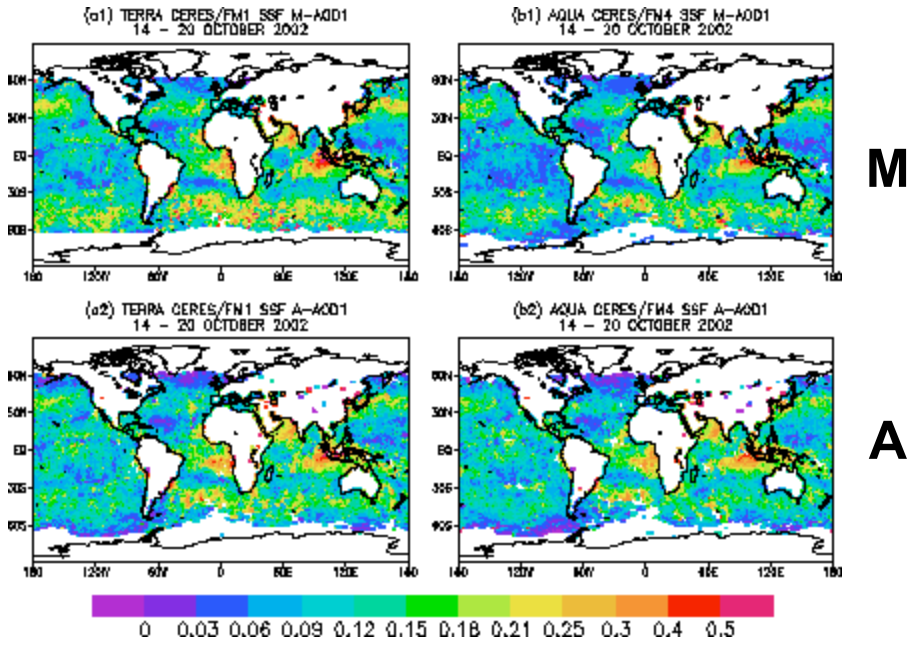
- M- vs. A-product (on both *Terra* and *Aqua*)
- *Terra* (FM1) vs. *Aqua* (FM4) (both M- and A-)

14-20 October 2002

SSF re-mapped to $(1^o)^2$

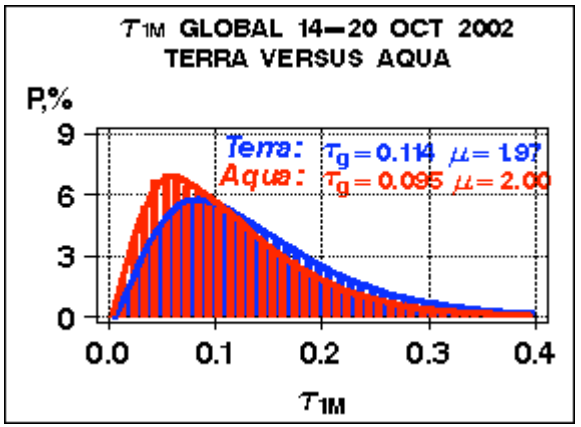
Terra/Aqua τ_1@0.659 μm: 14-20 Oct 2002

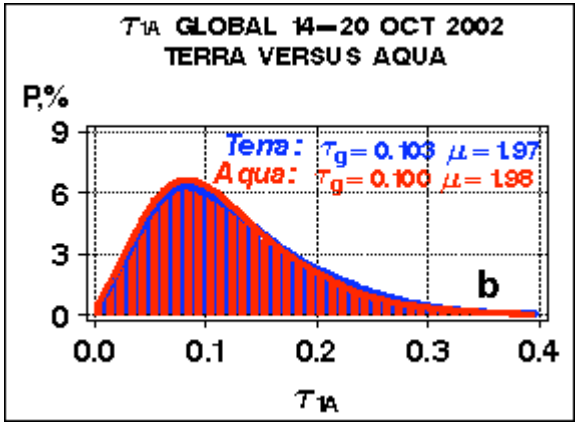
Terra ***Aqua***



M

A



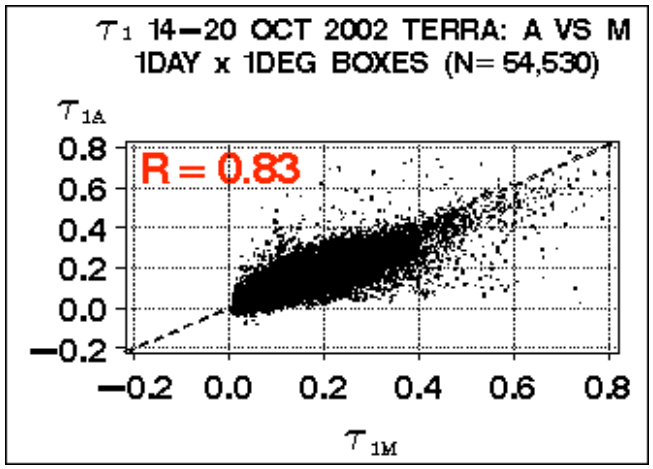


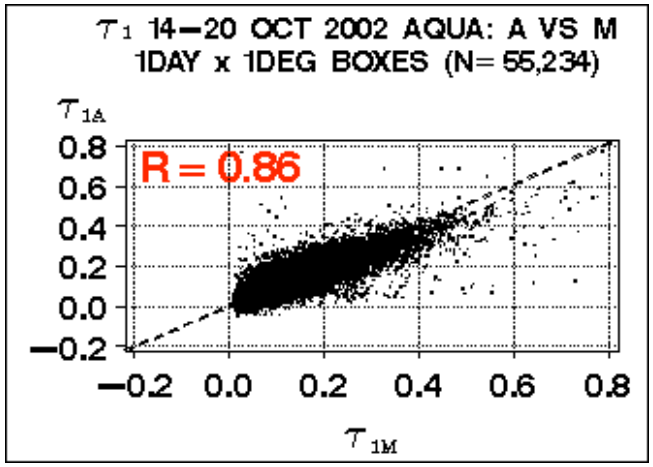
Terra vs. Aqua: ***M-Products: differ significantly***
A-Products: compare better

τ_1: (A vs. M) compared to (Terra vs. Aqua)

Terra/Aqua correlation in M lower than in A!

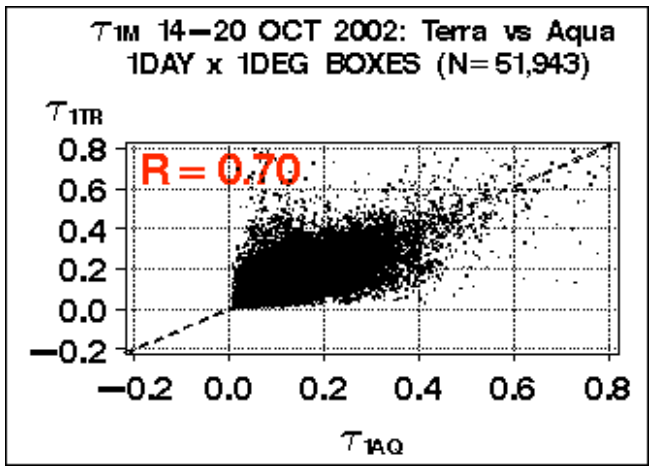
Terra: A vs. M

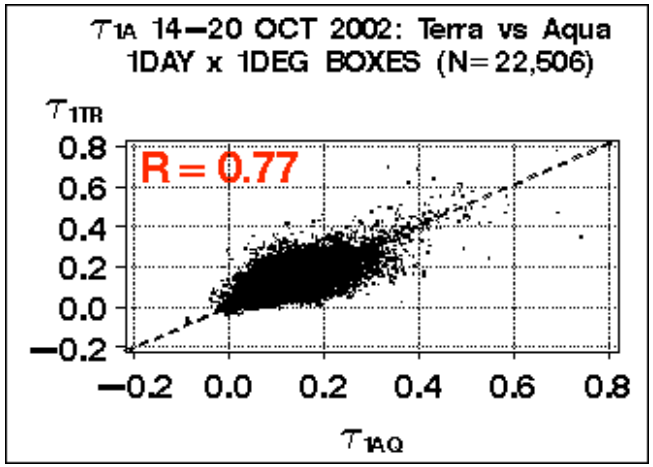




Aqua: A vs. M

M: *Terra* vs. *Aqua*



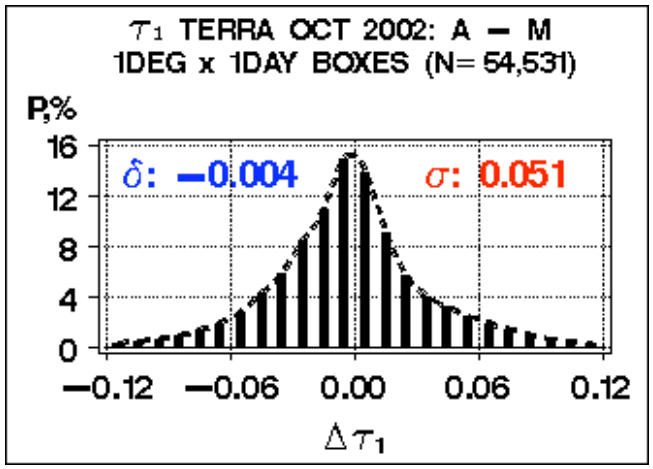


A: *Terra* vs. *Aqua*

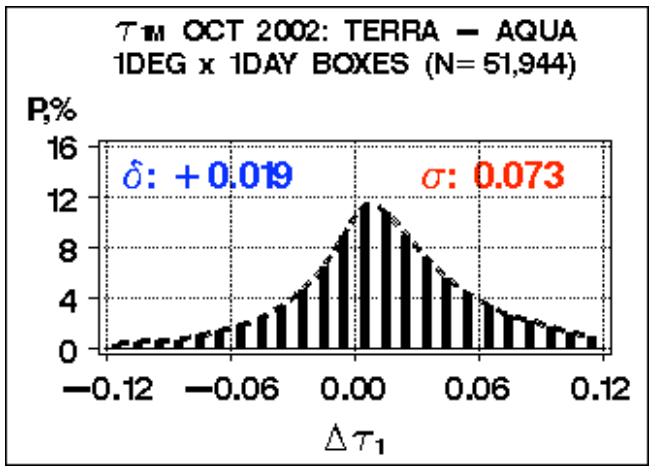
τ_1: (A vs. M) compared to (Terra vs. Aqua)

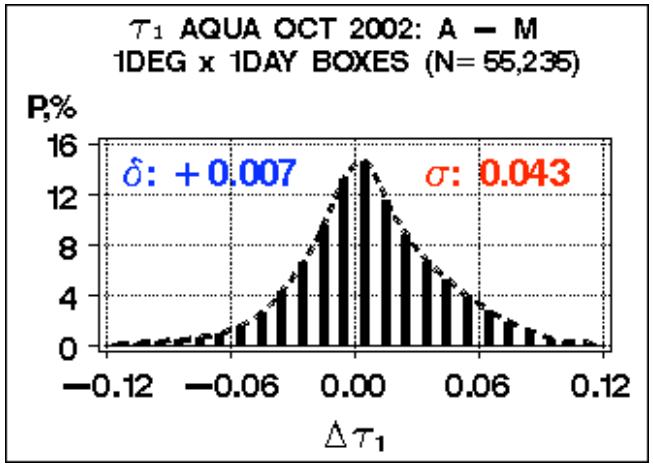
Terra/Aqua noise in M larger than in A!

Terra: **A vs. M**

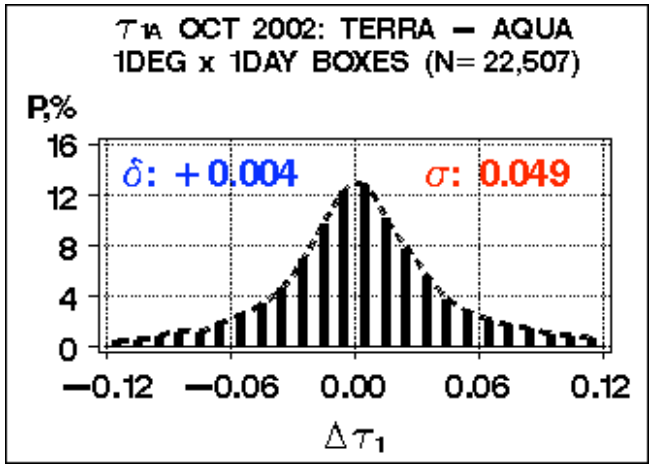


M: ***Terra*** **vs.** ***Aqua***





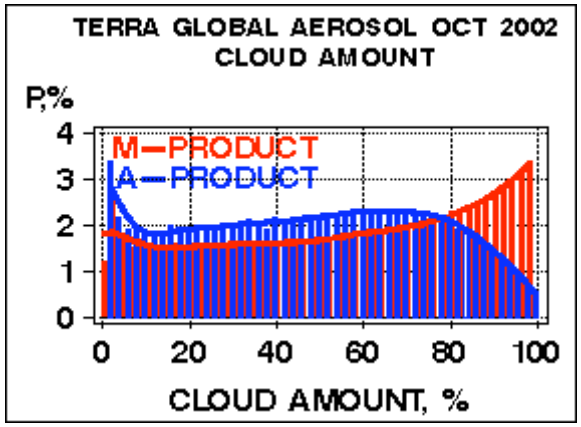
Aqua: **A vs. M**

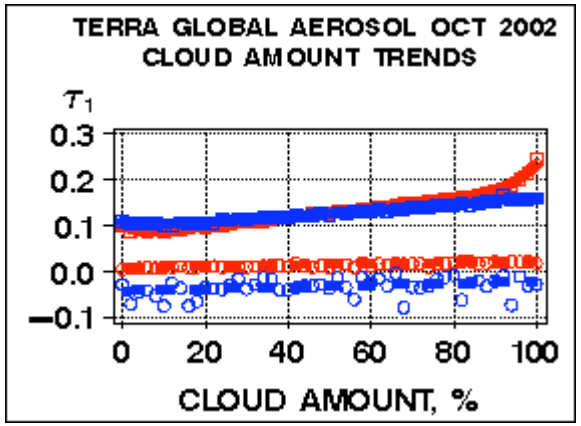


A: ***Terra*** **vs.** ***Aqua***

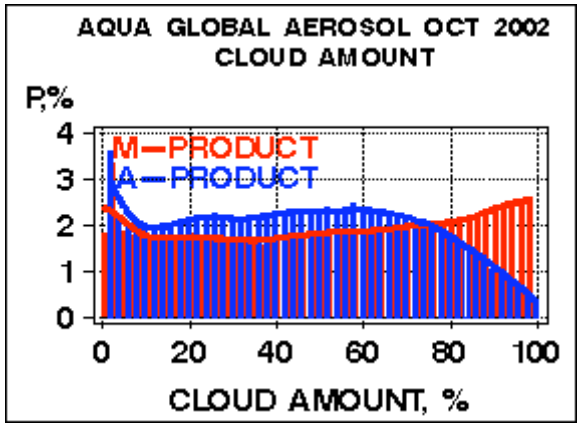
MODIS Cloud/Aerosol Correlation

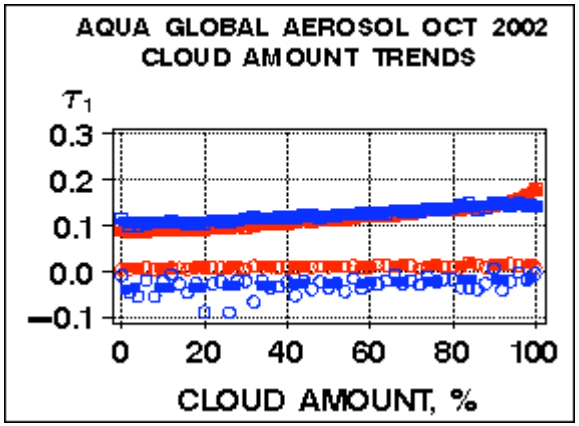
Terra





Aqua





Conclusion

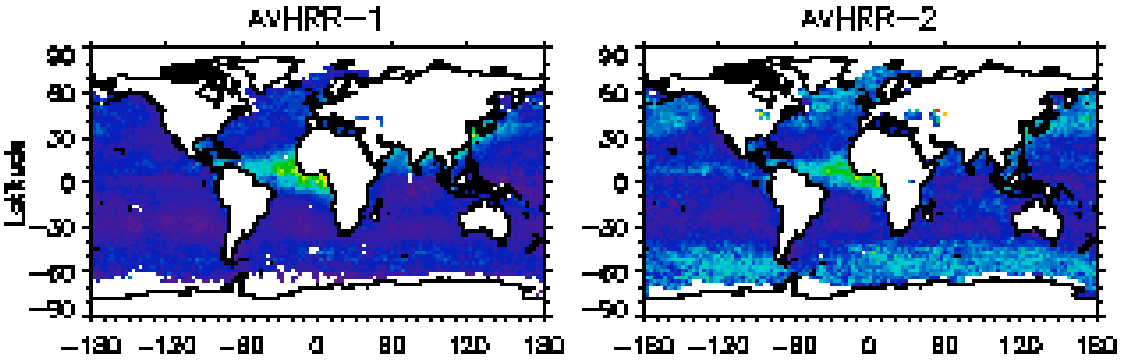
M-product:	Terra/Aqua differ significantly
A-product:	Terra/Aqua compare better
Terra/Aqua RMSD:	Larger in M- than in A-product
M(A)-product:	Aqua cleaner than Terra
Ambient cloud:	Key parameter in both aerosols

Need checking

- over extended periods of time (climate)
- *Aqua* Edition 1 (this study used Beta-version of Aqua)

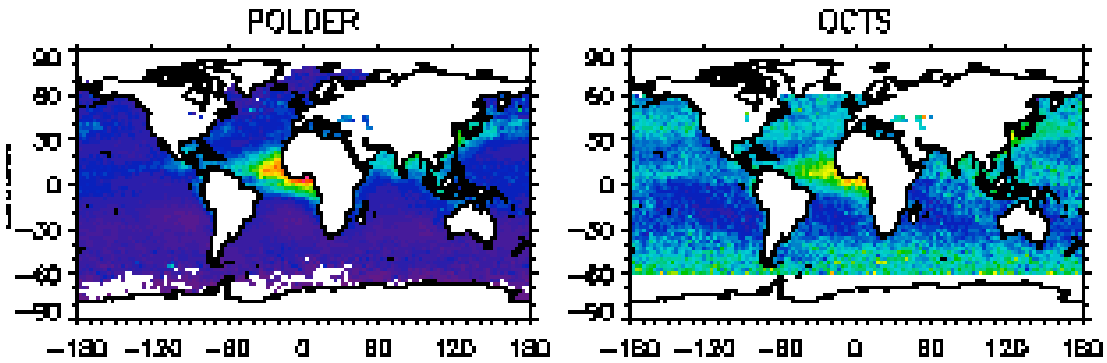
8-month average τ@0.55 μm: Nov 1996 - Jun 1997

NOAA14/AVHRR
PATMOS
(Stowe et al. 1997)



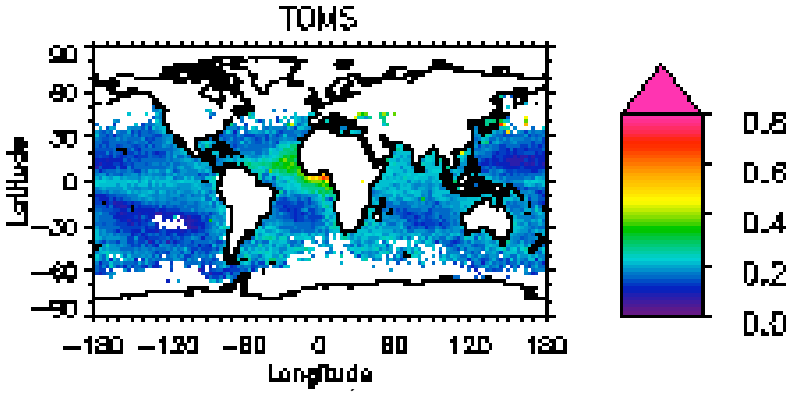
NOAA14/AVHRR
ISCCP/GACP
(Mishchenko et al. 1999)

ADEOS/POLDER
(Goloub et al. 1999,
Deuze et al. 2000)



ADEOS/OCTS
(Higurashi and
Nakajima 1999)

Myhre et al. (*JAS* 2004)



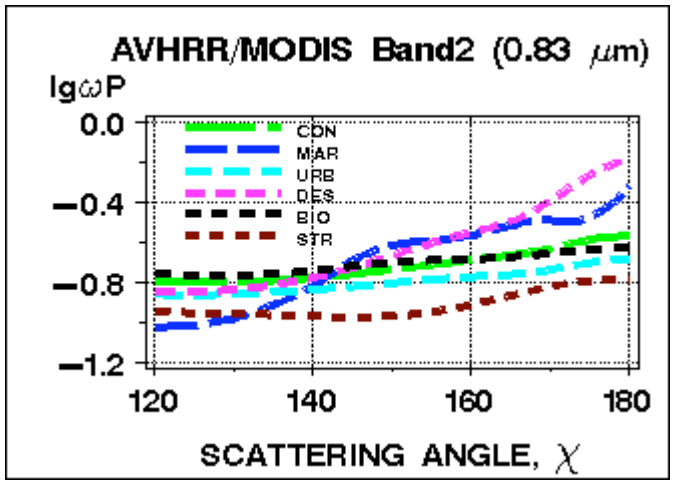
??/TOMS
(Torres et al. 2002)

Aerosol Retrieval Physics

Cloud/Glint free TOA reflectance

$$\rho = \frac{\pi L}{F\mu_S}; \qquad \rho = \left[\frac{P^R(\chi)\tau^R}{4\mu_S\mu_V} + \frac{\omega P(\chi)\tau}{4\mu_S\mu_V} + \rho^S T \right] \times t^g$$

M-product: try capture (_P) variability



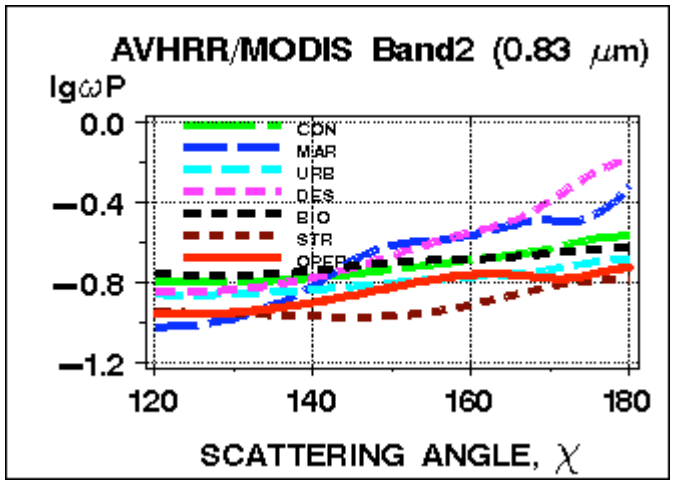
Aerosol Retrieval Physics

Cloud/Glint free TOA reflectance

$$\rho = \frac{\pi L}{F\mu_S}; \qquad \rho = \left[\frac{P^R(\chi)\tau^R}{4\mu_S\mu_V} + \frac{\omega P(\chi)\tau}{4\mu_S\mu_V} + \rho^S T \right] \times t^g$$

M-product: try capture (_P) variability

A-product: fix (_P) non-variable



Cloud Screening

M-product (Martins et al.): Done by MODIS Team

A-product (Minnis et al): Consistent w/ TRMM/VIRS

Glint Screening

M-product: Beyond 40° glint

A-product: Beyond 40° glint & anti-solar side of orbit

Aerosol Algorithm

M-product (Tanre et al. 1997; Remer et al. 2004)

Spectral: 6 bands from 0.55-2.13 μm

Aerosol: Var Bi-LogNormal (Mode Location/Ratio)

Surface: Fresnel (V=7 m/s) + Black (except 0.55 μm)

RT Model: Ahmad-Fraser (1981)

A-product (Ignatov Stowe 2002; Ignatov et al. 2004)

Spectral: Single-Channel: 0.659 & 1.640 μm

Aerosol: Prescribed (Fixed) Mono-LogNormal

Surface: Fresnel (V=1 m/s) + Small Diff.Ref.

RT Model: Vermote et al. 6S (1997)

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

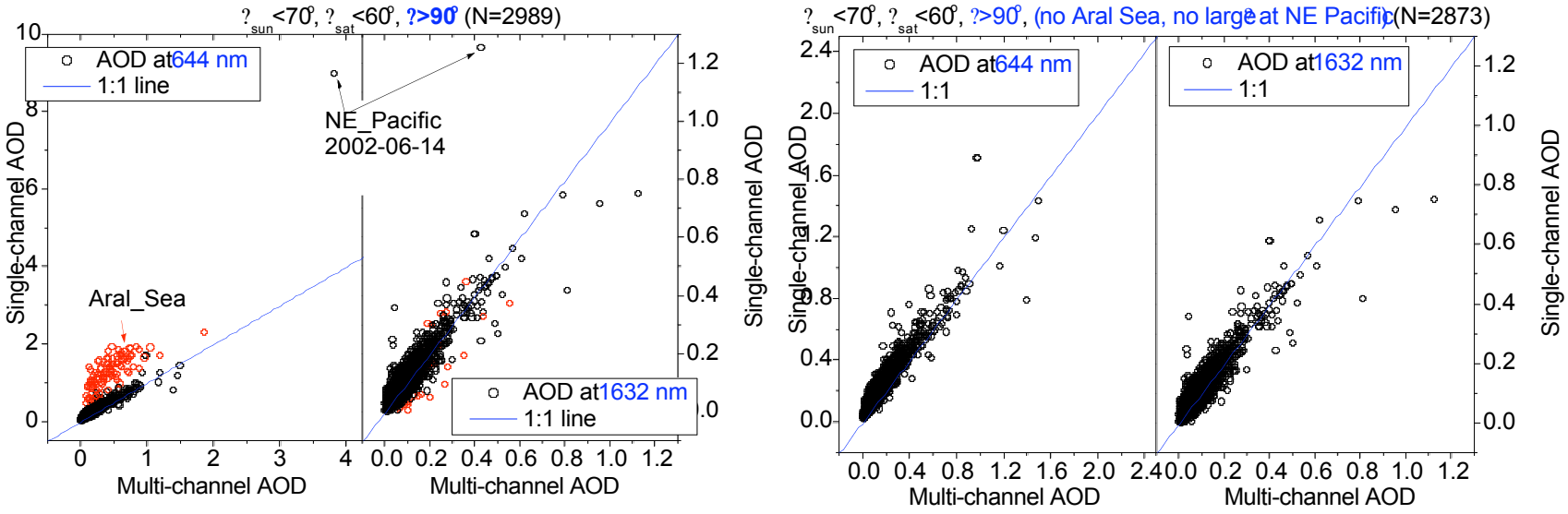
I. Laszlo and A. Ignatov
NOAA/NESDIS

with special thanks to
L. A. Remer
NASA/GSFC

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, τ_S, at 25 oceanic locations from 10-km reflectances in the MODIS Atmosphere Parameters Subset Statistics (MAPSS) dataset for the period of 2000-2003.
  - Compare τ_S with multi-channel (level 2 MOD04) AOD, τ_M, from MAPSS.

Single vs. Multi-channel AOD

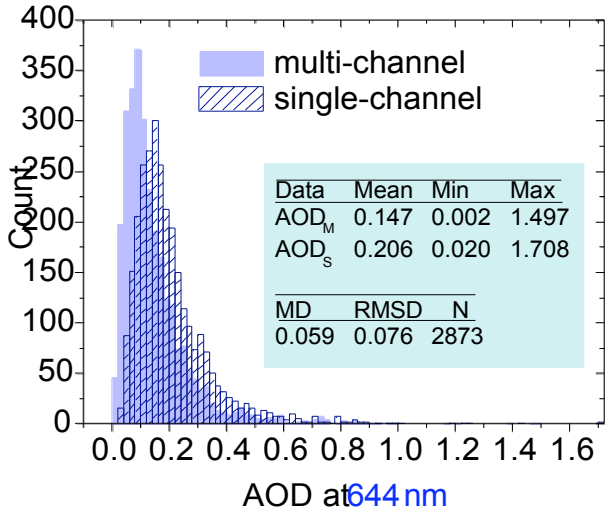


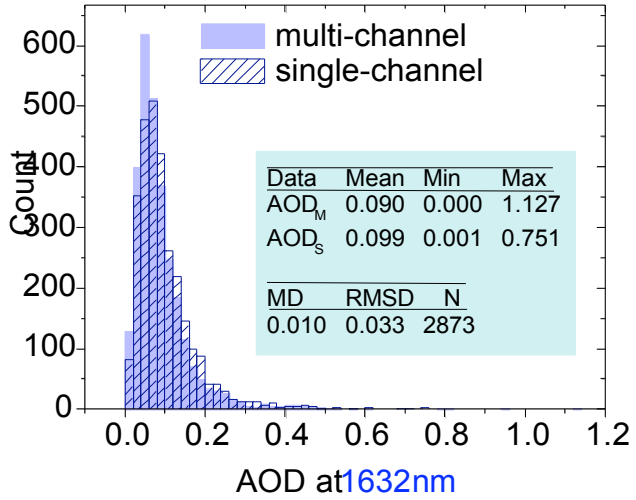
Left: Scatter plot of single-channel AOD vs. multi-channel AOD at 644 nm and 1632 nm for the single-channel geometry (solar zenith angle _$_{sun}$, satellite zenith angle _$_{sat}$, and relative azimuth angle _.

Right: Same as on the left, except the outliers are excluded.

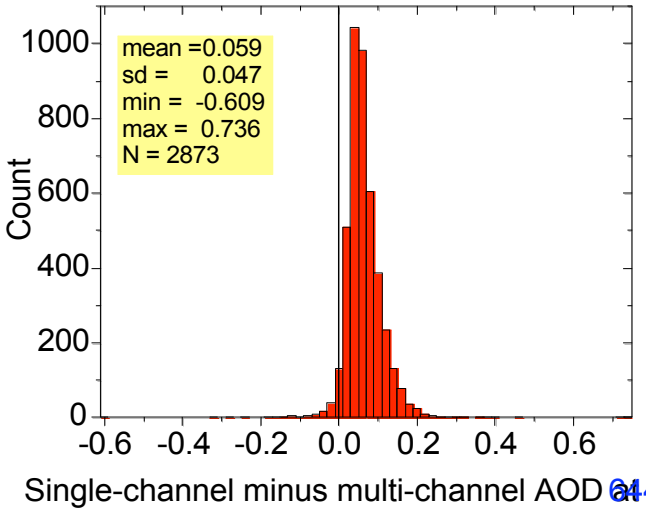
Single vs. Multi-channel AOD (cont.)

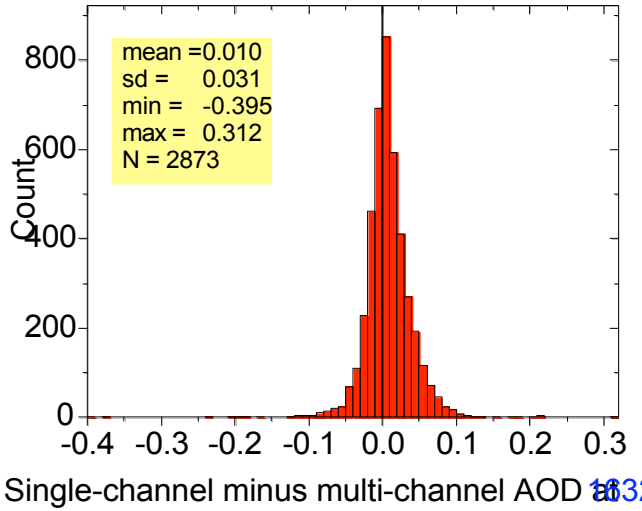
Histogram of AOD



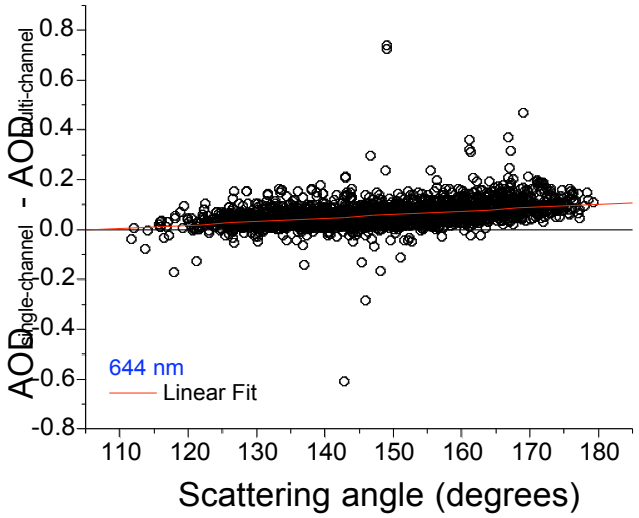


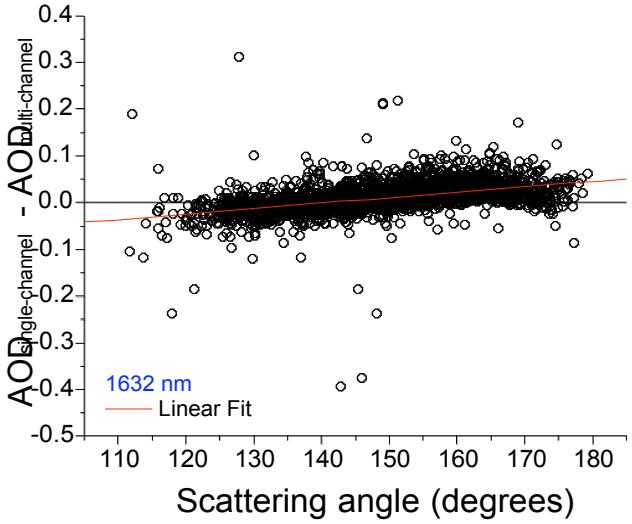
Histogram of differences





Single vs. Multi-channel AOD (cont.)





Summary

- Compared single- and multi-channel AOD derived from the same "aerosol" reflectance at oceanic sites.
- On average, $\rho_S \gg \rho_M$ at 644 nm for high altitude (inland) sea.
- For (open) ocean sites, on average:
  - $\rho_S > \rho_M$ at 644 nm
  - $\rho_S \geq \rho_M$ at 1632 nm
- In SSF, on average $\rho_S \approx \rho_M$ – compensation?
- Slight dependence of ρ_S-ρ_M on scattering angle – aerosol/surface model difference?