Status of CERES/SSF EOS/MODIS and NOAA-KLM/AVHRR3 Aerosol Products over ocean

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NEW DEVELOPMENTS

• Two aerosol products over ocean on Terra/Aqua CERES SSF datasets (JAS CLAMS Special Issue, submitted, NESDIS/LaRC/GSFC)

• Operational Aerosol Observations from AVHRR/3 onboard NOAA-KLM (JTech, in press, NESDIS)

• Equator Crossing Times for NOAA, EOS and ERS Sun-synchronous satellites (Int. J. Rem. Sens., submitted, NESDIS)
Terra/Aqua CERES SSF

EOS/MODIS
1) Terra (Dec 1999, 10:30 AM)
2) Aqua (May 2002, 01:30 PM)

CERES SSF: Terra (FM1/2) & Aqua (FM3/4)
- Primary M-product: from MODIS aerosol group
- Secondary A-product: \( \tau_1(0.63) \), \( \tau_2(1.61/2.13 \mu m) \)

- Two aerosol products over ocean on Terra/Aqua CERES SSF
  (JAS CLAMS Special Issue, submitted, NESDIS/LaRC/GSFC)

M-/A-products documented/preliminarily analyzed
1) available in different domains
2) where both available: compare surprisingly well!
3) differences due to sampling not aerosol model
4) both M-/A-products correlate w/ambient cloud
5) band 1.61 \( \mu m \): truncated; inoperative on Aqua: Use 2.13 \( \mu m \)
Aqua $\tau_1@0.659 \mu m$: 1-7 Sep 2002

- Data good
- Patterns similar
- $\tau$ coherent with cloud, $A_T$

\begin{itemize}
  \item $A_T\sim43\%$
  \item $A_T\sim42\%$
  \item $A_T\sim48\%$
  \item $A_T\sim59\%$
  \item $A_T\sim53\%$
\end{itemize}

\begin{itemize}
  \item $\tau_M$ & $\tau_A$: Correlated
  \item Scatter at low $\tau$: Aerosol model unlikely
\end{itemize}
Aqua $\tau_1@0.659 \mu m$: 1-7 Sep 2002

A-product

M-product

- $\tau_M$ closer to LN than $\tau_A$
- $\sigma_{\tau_M} < \sigma_{\tau_A}$
- No data with $\tau_M<0$
- ~2% of data: $\tau_A<0$

ALL DATA

OVERLAP

- $\tau_A-\tau_M$: bias $\sim -10^{-3}$; $\sigma_\tau \sim 0.04$
MODIS Aerosol/Cloud Correlation

τ₁ (0.659 µm)

τ₂ (1.640 µm)

α

Truncation @1.61 μm

AEROSOL RADIANCE

AVHRR-like AOD

MODIS AOD
SUMMARY TO MODIS

τ/α-Retrievals:
- Primary M-product: (τ, α) more self-consistent
- Secondary A-product: Insight into channel’s performance
- M-/A-products: much similarity
- Correlation: τ₁ (R~0.8-0.9), τ₂ (R~0.6-0.8), α (R~0.4-0.7)
- Differences: mainly due to sampling
  (As/more important as aerosol algorithm)
- Ambient cloud amount: Key parameter in both products

ISSUES/PLANS
1) Sampling vs. Algorithm
2) Cloud/Aerosol Correlations
3) Truncation of negative radiances @ 1.640 µm
4) Document/QC/QA TRMM VIRS aerosol product
NOAA-KLM AVHRR/3

1) NOAA-16 (L) (SEP 2000, 02:00 PM)
2) NOAA-17 (M) (JUN 2002, 10:00 AM)

- AEROBS Operational/PATMOS Plans
- A-product: single-channel $\tau_1(0.63)$, $\tau_2(0.83)$, $\tau_3(1.61\ \mu m)$

- Operational Aerosol Observations from AVHRR3 onboard NOAA-KLM Satellites (*JTECH, in press*)
  1) NESDIS 3rd gen (KLM/AVHRR3) algorithm documented
  2) AVHRR3 (0.63/0.83/1.61\ \mu m): Independent channel solution
  3) NOAA-16/afternoon & NOAA-17/mid-morning platforms
  4) Fully comparable to MODIS/VIRS A-products
$\tau_1$ (0.63 $\mu$m)
- $R_1 = 0.82$
- $\delta\tau_1 \sim +0.03$
- $\sigma_{\tau_1} \sim 0.05$

$\tau_2$ (0.83 $\mu$m)
- $R_2 = 0.80$
- $\delta\tau_2 \sim -0.01$
- $\sigma_{\tau_2} \sim 0.04$

$\tau_3$ (1.61 $\mu$m)
- $R_3 = 0.74$
- $\delta\tau_3 \sim -0.02$
- $\sigma_{\tau_3} \sim 0.03$

- Patterns similar
- Correlation $R$ high
- $R$ decreases with $\lambda$
- Biases opposite in channels (calibration)
- $\sigma_\tau$ decreases with $\lambda$

NOAA-KLM AVHRR/3 Aerosols
12-20 February 2003

NOAA-16 (2 PM)  NOAA-17 (10 AM)
SUMMARY TO AVHRR

τ-Retrievals:
- NOAA-KLM/AVHRR3 3rd gen aerosol up & running
- Good to monitor: (1) aerosol; (2) AVHRR performance
  http://www.osdpd.noaa.gov/PSB/EPS/Aerosol/Aerosol.html
  http://www.saa.noaa.gov/
- AVHRR cal major issue
- Care advised in quantitative use

PLANS
1) PATMOS processing/Cal adjusted
2) Self-/Inter-consistency of NOAA-16/-17
3) Merge with Terra/Aqua MODIS for cross-checks
8-month average AOD@0.55 µm: Nov 1996 - Jun 1997

- NOAA14/AVHRR
  - PATMOS
    - (Stowe et al. 1997)

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

- ADEOS/OCTS
  - (Higurashi and Nakajima 1999)

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

- ??/TOMS
  - (Torres et al. 2002)

• Products different
• Cloud clearing?
ORBITAL “DEGRADATION”

- Equator Crossing Time for NOAA/ERS/EOS Sun-synchronous satellites
  1) Vis/Near-IR: illumination; thermal IR: diurnal cycle
  2) Consistency important for climate
  3) Analyzed all NOAA platforms, EOS, ERS
  4) fit NOAA: past EXT (within ½ min); future prediction
EQUATOR CROSSING TIME

NOAA PLATFORMS

- NOAA: Natural Evolution (One-two harmonics)
- Afternoon NOAA platforms
  - T~28-35 yrs; A~3.5-5.0 hrs
- Morning NOAA platforms
  - T~23 yrs; A~1.4-1.5 hrs

EOS & ERS PLATFORMS

- EOS: Stable within minutes
- ERS: Stable within seconds

Should be taken into account in climate analyses
**Terra \( \tau_1 @ 0.659 \mu m \)**

**15-21 Dec 2000**

**AVHRR-like**

\( A_T \approx 48\% \)

**MODIS-like**

\( A_T \approx 58\% \)

**ALL DATA**

\( A_T \approx 43\% \)

\( A_T \approx 53\% \)

**OVERLAP**

\( A_T \approx 48\% \)

\( A_T \approx 48\% \)

\( A_T \approx 41\% \)

\( A_T \approx 47\% \)

**COMPLEMENT**

\( A_T \approx 50\% \)

\( A_T \approx 65\% \)

\( A_T \approx 58\% \)
**Terra τ₂@1.640 μm**

*15-21 Dec 2000*  
AVHRR-like: \( \Lambda_T \approx 48\% \)  
MODIS-like: \( \Lambda_T \approx 58\% \)

*1-7 Jun 2001*  
AVHRR-like: \( \Lambda_T \approx 43\% \)  
MODIS-like: \( \Lambda_T \approx 53\% \)

**ALL DATA**  
AVHRR-like: \( \Lambda_T \approx 48\% \)  
MODIS-like: \( \Lambda_T \approx 48\% \)

**OVERLAP**  
AVHRR-like: \( \Lambda_T \approx 50\% \)  
MODIS-like: \( \Lambda_T \approx 65\% \)

**COMPLEMENT**  
AVHRR-like: \( \Lambda_T \approx 41\% \)  
MODIS-like: \( \Lambda_T \approx 58\% \)
Terra $\alpha$ (0.659/1.640 $\mu$m)

15-21 Dec 2000

AVHRR-like

MODIS-like

41 DATA

OVERLAP

COMPLEMENT

1-7 Jun 2001

AVHRR-like

MODIS-like
OUTSTANDING ISSUES

Cloud/Aerosol Correlation
- understand physics (residual cloud in the FOV vs. cloud/aerosol interaction)
- new strategies of cloud clearing: continuum aerosol-cloud

Data Quality (Sampling/Cal/Truncation)
- important for aerosol product
- more science in decision making
- unification/standartization
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)**
- **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 (JAS 1981)

**A-product (Ignatov Stowe 2002; Ignatov et al. 2003)**
- **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 (IEEE/TGARS 1997)