Sensitivity of CERES Clear-sky ADM performance over ocean to the confidence of clear-sky scene identification

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Given a SSF, retrieve AODs for an aerosol model representing the fine mode aerosol and an aerosol model representing the coarse mode aerosol.

**Ed4ADM: AOD-and-type classified ADM**

**two-model-minimal-retrieval-error approach**

- **Compare two retrieval errors**
  - **Fine-mode-like aerosols**
    - 0-33% AOD bins
    - 33-66% AOD bins
    - 66-100% AOD bins
  - **Coarse-mode-like aerosols**
    - 0-33% AOD bins
    - 33-66% AOD bins
    - 66-100% AOD bins
ED4ADM: flux inversion

Is AOD value of a SSF available?

YES

infer flux with AOD-type-classified ADM

NO

infer flux with Ed.2-like ADM
How to quantify the performance of an ADM?

RMS of normalized radiance differences between ADM-prediction and observation

\[ \text{RMS} = \sqrt{\frac{1}{n} \sum \left( \frac{\hat{I}_i - I_o}{\langle \hat{I} \rangle - \langle I_o \rangle} \right)^2} \]

\( \hat{I}_i \) is the radiance value of ADM at \((w, \theta_0, \theta \text{ and } \phi)\),

\( I_o^i \) is the radiance value of the theoretical model at \((w, \theta_0, \theta \text{ and } \phi)\),

\( \langle \rangle \) is the grid mean.
RMS of normalized radiance differences between ADM-prediction and observation

Ed4SSF/updated-Ed2ADM
RMS = 6.41%

Ed4SSF/Ed4ADM
RMS = 4.32%

ΔRMS = -2.09%

(Terra 2002 cross-track SSFs with AOD retrievals)
ΔRMS for the each aerosols category bin

coarse-mode-like aerosol

fine-mode-like aerosol

0-33%

ΔRMS = -0.91%

33-66%

ΔRMS = -0.29%

66-100%

ΔRMS = 0.18%

ΔRMS = -0.52%

ΔRMS = -0.31%

ΔRMS = -0.45%

(Terra 2002 cross-track SSFs with AOD retrievals)
sensitivity of ADM performance to the confidence of clear-sky scene identification: clr_strong parameter
Retrieval confidence of clear-sky of SSF

Clr-strong=0
no imager pixel is confidently clear

clr-strong=100
all imager pixels are confidently clear

% of SSFs with Clr-strong >= 1

% of SSFs with Clr-strong >= 50

% of SSFs with Clr-strong >= 99

(Terra 2000-2005 RAP data)
Sensitivity of radiance RMS error to clr_strong parameter

(coarse-mode-like aerosol in 66-100-percentile bin only)

(Terra 2002 cross-track with AOD retrievals)
Sensitivity of ADM performance to clr_strong parameter

Terra 2002 cross-track SSFs with aerosol retrievals

<table>
<thead>
<tr>
<th>with SSF having clr_strong &gt;=</th>
<th>RMS(%)</th>
<th>ΔRMS (%)</th>
<th>Iadm-Iobs (w/m²/sr)</th>
<th>ΔF(w/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ed4SSF/Ed2ADM</td>
<td>Ed4SSF/Ed4ADM</td>
<td>Ed4SSF/Ed2ADM</td>
<td>Ed4SSF/Ed4ADM</td>
</tr>
<tr>
<td>Control run</td>
<td>6.41</td>
<td>4.32</td>
<td>-2.09</td>
<td>0.49</td>
</tr>
<tr>
<td>1</td>
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<td>4.11</td>
<td>-2.30</td>
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<tr>
<td>50</td>
<td>6.41</td>
<td>4.13</td>
<td>-2.28</td>
<td>0.49</td>
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<tr>
<td>99</td>
<td>6.41</td>
<td>4.17</td>
<td>-2.24</td>
<td>0.49</td>
</tr>
</tbody>
</table>
ADM performance: RMS error
(clr_strong >= 1)

Ed4SSF/update-Ed2ADM

Ed4SSF/Ed4ADM

(2002, Terra cross-track mode and SSFs with AOD retrieval)
ADM performance: RMS error
(SSFs with AOD retrieval Ed4SSF/Ed4ADM clr_strong >= 1)

ΔRMS = -2.30%

ΔRMS = -2.30%

ΔF = -0.19 w/m²

ΔF = -0.19 (w/m²)

(2002, Terra cross-track mode and SSFs with AOD retrieval)
ADM performance: radiance bias
(clr_strong >= 1)

\[ \Delta I = 0.49 \text{ (w/m}^2 \text{ /sr)} \]

(Terra 2002 cross-track mode and SSFs with AOD retrieval)
Fluxes and ADM performances calculated from all cross-track clear-sky SSFs over ocean

- Updated-Ed2ADM (built with ed2ADM approach and Ed4SSF)
- Ed4ADM
Change in flux from updated-Ed2ADM to Ed4ADM

Ed4SSF/updated-Ed2ADM
mean flux = 80.72 (W/m²)

Ed4SSF/Ed4ADM
mean flux = 80.64 (W/m²)

(Terra 2002 cross-track SSFs)
Change in radiance RMS error from updated-Ed2ADM to Ed4ADM

Ed4SSF/updated-Ed2ADM
RMS = 10.35%

Ed4SSF/Ed4ADM
RMS = 9.32%

(Terra 2002 cross-track SSFs)
Change in radiance bias from updated-Ed2ADM to Ed4ADM

(Terra 2002 cross-track SSFs)
Summary

- Aerosols are retrieved with 6 MODIS bands of reflectances and classified to coarse-mode-like and fine-mode-like aerosols by a minimal-error-approach with two aerosol models (OPAC maritime-tropic and urban aerosol models). The Ed4ADMs are developed for coarse-mode-like and fine-mode-like aerosol, respectively, with 3 percentile AOD bins in each category.

- Applying SSF clr-strong parameter filtering to develop ADM substantially improves the ADM performance in the coarse-mode-like-aerosol 66-100%-AOD bin, and ADM developed with clr-strong >= 1 delivers the best performance.

- Comparing Ed4SSF/Ed4ADM to Ed4SSF/updated-Ed2ADM, the instantaneous global mean flux is changed by -0.07w/m$^2$, the global mean ADM RMS error is reduced by 1.03% and the global mean radiance bias error is reduced from 0.41 to 0.19 w/m$^2$/sr.