ECMWF MACC-II/NRL OP NAAPS
Performances evaluation on vertical dimension with MPLNET data: an overview

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Lidar: **essential to characterize model aerosol vertical structure**

- Aerosol **vertical distribution is poorly quantified** due to the numerous uncertainties on direct emissions and secondary processes.
- Main source of uncertainty to study the impact of aerosols on global radiation balance.
- Lack of sufficient altitude-resolved information on aerosol abundance and properties.
GSFC MACC-II Extinction Coefficient
24-28 March 2014

MACC-II MODIS + CALIPSO GSFC 2014

MPLNET LIDAR DATA GSFC 2014

MACC-II MODIS GSFC 2014

NOAA HYPLIT MODEL
Backward trajectories ending at 2100 UTC 27 Mar 14
GDAS Meteorological Data

Source: at 36.90 N 76.80 W

Meters AGL

Job ID: 117603  Job Start: Mon Jul 11 16:10:43 UTC 2016
Source 1 lat: 36.900000 lon: -76.800000 hgt: 500, 1500, 3500 m AGL

Trajectory Direction: Backward  Duration: 72 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 00002 22 Mar 2014 - GDAS1
Evaluation of the vertical model aerosol profiles vs. lidar measurements

Averaged extinction profiles are normalized to AOD=1(0-10KM)

Mean extinction height diagnostic:

\[ Z_α = \frac{\sum_{i}^{n} α_{ext,i} * Z_i}{\sum_{i}^{n} α_{ext,i}} \]
Operational NAAPS 2007-2011 GSFC

NAAPS v MPLNET at GSFC (2007-2011)

<table>
<thead>
<tr>
<th>MPLNET</th>
<th>NAAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean AOD</td>
<td>0.170 0.239</td>
</tr>
<tr>
<td>Mean Height of Max Extinction</td>
<td>1163m 584m</td>
</tr>
</tbody>
</table>

Dominant Species

- Sulfate
- Dust
- Smoke
- Salt
Operational NAAPS 2007-2011
KANPUR

NAAPS v MPLNET at Kanpur (2007-2011)

<table>
<thead>
<tr>
<th></th>
<th>AOD (n=10923)</th>
<th>Ext.: 450-1000m (n=43692)</th>
<th>1000-3000m (n=43692)</th>
<th>Above 3000m (n=98307)</th>
<th>Mean &amp; SDev. Extinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAAPS</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MPLNET</td>
<td>Mean AOD</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mean AOD</td>
<td>0.562</td>
<td>0.271</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Height of Max Extinction</td>
<td>547m</td>
<td>829m</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Dominant Species

Sulfate
Dust
Smoke
Salt
### Operational NAAPS 2007-2011

**SINGAPORE**

**NAAPS v MPLNET at Singapore (2007-2011)**

<table>
<thead>
<tr>
<th>NAAPS v MPLNET</th>
<th>Mean &amp; SDev. Extinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOD (n=3502)</td>
<td></td>
</tr>
<tr>
<td>Ext.: 450-1000m (n=14008)</td>
<td></td>
</tr>
<tr>
<td>1000-3000m (n=14008)</td>
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</tr>
<tr>
<td>Above 3000m (n=31518)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MPLNET</th>
<th>NAAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean AOD</td>
<td>0.272</td>
</tr>
<tr>
<td>Mean Height of Max Extinction</td>
<td>780m</td>
</tr>
</tbody>
</table>

- **Sulfate**
- **Dust**
- **Smoke**
- **Salt**

**Dominant Species**
Assessing MACC-II performances at NCU

• MACC-II: extinction profiles from 0000UTC 22 March 2014 to 0000UTC 27 March 2014 each 3 hours
• Lidar Data: gridded extinction profiles
• In-situ pm2.5 and pm10 measurements at NCU and Lulin stations
NCU: two different patterns

Lulin: Mostly constant wind pattern

NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 25 Mar 14
GDAS Meteorological Data

Lulin, 2800mt agl
In-situ PM2.5 and PM10

EPA Pingzhen Air Quality Data and NCU Meteorology Data
20140323~20140325

Lulin EPA Air Quality Data and Meteorology Data
20140323~20140325
23-26 March 2014 NCU

a) ECMWF MACC-II (CALIPSO) Extinction (km^-1) over Taiwan (Grid 81km x 81km) at 25.2 N 120.8E

b) Gridded MPLNET Extinction (km^-1) NCU station 24.986N 121.18E

c) AOD

aodMPLNET
aodAERONET
aodECMWF (CALIPSO)
CALIPSO on 23 March 2014


N/A = not applicable  1 = clean marine  2 = dust  3 = polluted continental  4 = clean continental  5 = polluted dust  6 = smoke
Evaluate model performances vs. observations:

- **Mean Fractional Error (MFE)**

\[ MFE = \frac{2}{N} \sum_{i=1}^{N} \frac{|\alpha_{mod,i} - \alpha_{obs,i}|}{(\alpha_{mod,i} + \alpha_{obs,i})} \]

- **Mean Fractional Bias (MFB)**

\[ MFB = \frac{2}{N} \sum_{i=1}^{N} \frac{(\alpha_{obs,i} - \alpha_{mod,i})}{(\alpha_{mod,i} + \alpha_{obs,i})} \]

- **Performance Goal**: \( MFE < 0.5 \) and \( -0.3 < MFB < 0.3 \)

- **Performance Criteria**: \( MFE < 0.75 \) and \( -0.6 < MFB < 0.6 \)
Performances Evaluation
MFE

MFE 23 MARCH 2014

MFE 24 MARCH 2014

MFE 25 MARCH 2014

RANGE (KM)
Performances Evaluation

MFB

MFB 23 MARCH 2014

MFB 24 MARCH 2014

MFB 25 MARCH 2014

RANGE (KM)
Global MFE-MFB 23-25 March

MFB 23–25 MARCH 2014

MFE 23–25 MARCH 2014
Conclusions and Future Perspectives

• Some results show that MACC-II and OP NAAPS tend to underestimate the aerosol load in the boundary layer and overestimate in the upper troposphere.

• MPLNET lidar are a useful tool to evaluate how DA from CALIPSO works.

• MACC-II: ad-hoc study is needed (and hopefully performed), where the assimilated profile is known and the model behavior evaluated.

• Soon (hopefully) a paper from these studies.
Thank you

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