Final meeting, 18 March 2008

‘The added value of satellite observations of aerosol optical depth for operational air quality forecasts”

General Description
Introduction

• Objective

• OSSE for aerosols

• Initial study results and recommendations

• Set-up of follow-up study
  • LOTOS-EUROS model
  • Time periods
  • Domain, resolution
  • Scenarios
  • Unforeseen elevated dust source
Objective

In the context of MTG

Quantify the impact of satellite derived aerosol information as observed by future instruments (Imager and Sounder A-2 band) on the operational forecasting and analysis of groundlevel PM2.5 concentrations over Europe
Objective

Formulated requirements for AOD measurements:
• Time resolution 30 minutes
• Vertical resolution 2km
• Horizontal resolution 10x10 km

Are the available requirements necessary to have a substantial impact relative to the impact of ground level observations of PM2.5?
What is an OSSE?

**OSSE** = Observing System Simulation Experiment
Assess the impact of future observations

- Production of synthetic observations
- State of the art model (LOTOS-EUROS)
- Active assimilation of observations in the model
- Assessment of added value of assimilation of the observations
What is an OSSE?

Production of synthetic observations:

- **Nature run** → simulate the ‘true’ state of the atmosphere
  → Simulation of synthetic ground-based observations at selected locations
  → Simulation of synthetic AOD from aerosol fields

Model (version) different from model used in assimilation
Initial study

Follow-up of:

“Operational use of satellite derived aerosol information” (Timmermans et al., 2006)

results were non-conclusive but more indicative

Recommendations → follow-up study
Results initial study

No assimilation

Assimilation of PM2.5

Assimilation of PM2.5 and total AOD Imager

RMSE

- 15
- 10
- 7.5
- 5
- 4
- 3
- 2
- 1
Results initial study

<table>
<thead>
<tr>
<th>No assimilation</th>
<th>Assimilation of PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5 + 3 layers AOD A-band</td>
<td>PM 2.5+ 4-hourly total AOD Imager</td>
</tr>
</tbody>
</table>

RMSE

- 15
- 10
- 7.5
- 5
- 4
- 3
- 2
- 1
Results initial study: forecast runs

RMSE with nature run

<table>
<thead>
<tr>
<th>Time (hour)</th>
<th>pm</th>
<th>pmaod</th>
<th>4h</th>
<th>3d_4h</th>
<th>distort</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>131</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Main recommendations from initial study

• Use a different model for production of synthetic measurements than for assimilation/forecast runs

• Incorporate the error covariance matrix of synthetic AOD measurements in assimilation system

• Use of emissions noise factors in forecast runs

• Higher resolution of model to better match resolution of instruments

• Add cloudy situations → advantage high-res imager

• Better separation of high altitude dust from ground level dust
Set-up of study

Production of synthetic measurements:
- Nature run with CHIMERE model (see presentation of Robert Vautard)
- Production of synthetic satellite measurements (presentation Richard Siddans)

Assimilation and forecast runs with LOTOS-EUROS model
LOTOS-EUROS: Introduction

• 3-D Eulerian chemistry-transport model

• Intermediate complexity to enable long term simulations with modest computing power

• Modelled components:
  • Oxidants (O₃, NO₂, NO, VOC, etc)
  • Particulate matter/aerosol (SO₄, NO₃, NH₄, EC, OC, SS, PMx)
  • Heavy metals (Pb, Cd)
  • Persistent Organic Pollutants (POP’s)

• Currently aimed at lower troposphere over Europe
LOTOS-EUROS: Introduction

LOTOS and EUROS have been used in a large number of studies in the past 2 decades.

Both models have been compared to other state of the art models on a regular basis:

- EUROTRAC-gloream-TOR2 model intercomparisons
- EMEP-review model intercomparison
- City-delta I and II
- EURO-delta I and II (2006)

In general the performance of LOTOS-EUROS is comparable to other models.

Peer reviewed publications appeared in a number of journals including JGR, ACP and atmospheric environment.
Model Description

- Choice of domain and resolution (standard 0.5x0.25 lon-lat).
- Dynamical vertical structure (depending on mixing layer height)
- Optional surface layer
- Top domain at 5 km for this study (5 layers)
Vertical extent of model

![Graph showing vertical extent of model over time with various lines representing different levels and dates from 1 July 2002 to 8 July 2002.](attachment:vertical_extent_graph.png)
Set-up of study

Time period:

- 15 July – 15 August 2003 (summer period)
  many cloudfree periods/areas
  high AOD episodes
  -- extra cirrus dataset

- 15 February – 15 March 2003 (winter period)
  periods of broken clouds
  AOD episode in Germany, model intercomparison study
Set-up of study

Domain and resolution:

• **European domain**
  - 5W to 30E and 42.5N to 60N
  - 0.25°x0.125° (~12 x 12 km²)

• **Paris Basin area**
  - 400x400 km around Paris
  - ~ 3x3 km²
Set-up of study

Main scenarios:

- European domain, summer
- Paris Basin area, winter
Set-up of study

Elevated unforeseen dust source

Investigate advantage of vertically resolved AOD

investigation of the ability of the assimilation system to improve the model performance in presence of unforeseen emissions.

→ More in presentation Robert Vautard