Emissions for CLRTAP modelling - experience and feedback

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25.04.2008 Workshop - Verification of emission estimates, Sofia, Bulgaria
Overview

• The effect of the new gridded emissions in 0.1°x0.1° long-lat resolution on model results
• GNFR versus SNAP - temporal and height distribution of emissions
• International shipping emissions - availability and challenges
• How can CAMS81 contribute to EMEP work and vice versa
• Experiences from the NMR+Russia project
EMEP 0.1° x 0.1° emissions and model results for 2015 – comparison to observations

- 22 countries reported sectoral gridded sectoral emissions in the new grid (0.1° x 0.1° long-lat resolution)
- Remaining areas: gap filled and spatially distributed by CEIP
- Model runs performed using both 0.1° x 0.1° and 50km x 50km emissions for 2015
- Comparison to EMEP (background) and Airbase measurements (rural, suburban, urban, excluding traffic stations)
- Why Airbase data?
  - Because we do not expect to see that much change in the background (that is how the EMEP network was designed).
  - We need a lot of data to look at the spatial distribution (EMEP not enough).
NO$_2$ – spatial correlation (mod-Airbase) within each country

-improved spatial correlation for NO$_2$

-some countries should be revised (e.g. BG, PL, RO)

Left of the green line: countries that reported in the new grid
Parenthesis: number of sites
Denmark

Significantly improved spatial correlation

Old emissions (50kmx50km)

New emissions (0.1x0.1)
United Kingdom

Significantly improved spatial correlation

Old emissions
(50kmx50km)

New emissions
(0.1x0.1)
Romania

Worse spatial correlation, but better results for several stations. (Sources missing in gridding? Or non-representative stations?)

Feedback from the country would be very useful, (emissions, observations, local modelling).

Old emissions (50kmx50km)

New emissions (0.1x0.1)
Poland

Worse spatial correlation, but better results for several stations (Sources missing in gridding? Or non-representative stations?)

Old emissions (50kmx50km) Feedback from country would be very useful, emissions, observations, local modelling

New emissions (0.1x0.1)
O$_3$ mean – spatial correlation (mod-Airbase) within each country

Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

Large improvements in O$_3$ related to the NO$_2$ improvements
Improved spatial correlation for O$_3$ – titration effect
Better reflect long-term exposure and deposition
SO\textsubscript{2} – spatial correlation (mod-Airbase) within each country

It is more difficult to use surface observations of SO\textsubscript{2} to validate SO\textsubscript{x} emissions since a large part of it arises from sources released higher in the atmosphere - mixed results

Left of the green line: countries that reported in the new grid
Parenthesis: number of sites
United Kingdom

Significant improvement

Old emissions (50kmx50km)

New emissions (0.1x0.1)
Bulgaria

Not much improvement

Old emissions
(50kmx50km)

New emissions
(0.1x0.1)
Improved spatial correlation in the majority of countries

*PM*$_{10}$ – spatial correlation (mod-Airbase) within each country

Left of the green line: countries that reported in the new grid
Parenthesis: number of sites
PM$_{2.5}$ – spatial correlation (mod-Airbase) within each country

Improved spatial correlation in the majority of countries, but more mixed results (and less measurements)
Wet deposition of SO$_4$

Some improvement, similar for NO$_3$
Summary

• Both the regridding done by the countries and by CEIP provide NO_{x} emissions that improves the model results for NO_{2} (and O_{3}).
• For SO_{2} the results are more mixed, as expected.
• Smaller improvements for PM, as expected.
• Improved observation-model correlation for wet deposition (especially for SO_{x} and NO_{x})
• For countries that have few observations it is difficult to interpret whether the new gridding is better than the old.
• More knowledge about the national observation networks is necessary to judge the performance.
• Some countries might benefit from revising their gridding, others should submit gridded data - feedback is very welcome (both with respect to observations, emissions, local modelling, local scientific expertise).
GNFR versus SNAP

A ‘PublicPower’ (1)
B ‘Industry’ (3)
C ‘OtherStationaryComb’ (2)
D ‘Fugitive’ (4)
E ‘Solvents’ (6)
F ‘RoadTransport’ (7)
G ‘Shipping’ (8)
H ‘Aviation’ (8)
I ‘Offroad’ (8)
J ‘Waste’ (9)
K ‘AgriLivestock’ (10)
L ‘AgriOther’ (10)
M ‘Other’ (5)

SNAP 1 ‘Combustion in energy and transformation industries’
SNAP 2 ‘Non-industrial combustion plants’
SNAP 3 ‘Combustion in manufacturing industry’
SNAP 4 ‘Production processes’
SNAP 5 ‘Extraction & distribution of fossil fuels and geothermal energy’
SNAP 6 ‘Solvent and other product use’
SNAP 7 ‘Road transport’
SNAP 8 ‘Other mobile sources and machinery’
SNAP 9 ‘Waste treatment and disposal’
SNAP 10 ‘Agriculture’
SNAP 11 ‘Other sources and sinks’

Mapping of GNFR sectors to time factor, height distribution and emission split classes (originally defined for SNAP sectors). Better data are needed.
International shipping emissions in the EMEP area

- For trend studies consistent shipping emissions are important
- Discontinuities because of regulations, linear interpolation between years (or based on economic growth) is not sufficient
- Change from TNO-MACC to FMI shipping emissions (in 2017)
- Future: rely on CAMS? (MET, FMI, TNO, CEIP partners)
- How to estimate shipping emissions in the past?

<table>
<thead>
<tr>
<th></th>
<th>Sulphur Gg SO₂</th>
<th>NOx Gg NO₂</th>
<th>CO Gg CO</th>
<th>PM₂.₅ Gg, see caption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SO₂</td>
<td>SO₄</td>
<td>NO₂</td>
<td>Ash</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>10.3</td>
<td>0.8</td>
<td>321</td>
<td>1.5</td>
</tr>
<tr>
<td>North Sea</td>
<td>23.8</td>
<td>1.5</td>
<td>695</td>
<td>3.4</td>
</tr>
<tr>
<td>Mediterr. Sea</td>
<td>675</td>
<td>40</td>
<td>1353</td>
<td>6.4</td>
</tr>
<tr>
<td>Black Sea</td>
<td>68</td>
<td>3.9</td>
<td>172</td>
<td>0.9</td>
</tr>
</tbody>
</table>


01.01.2015 SECA for Baltic Sea and North Sea (from 1% to 0.1% sulphur content)
How will CAMS81 contribute to EMEP work and vice versa?

CAMS81: Contract on emissions, under the Copernicus Atmosphere Monitoring Service

Partners: CNRS (coordinator), TNO, FMI, CUNI, MSC-W (MET Norway), CEIP (EAA), Chalmers, BSC, MPIC

- European anthropogenic emissions: based on officially reported data, but enhanced/gap-filled by expert knowledge (TNO) and international shipping emissions (FMI) - in coordination with CEIP
- Ship emissions for 2016 currently under review at TNO (to resolve the issue of double counting: distinction between inland/marine shipping is not the same as domestic/international) (FMI)
- Time factors: detailed profiling for key pollutant source categories will be developed using meteo parameters and sector-specific statistics. The source categories that are envisaged to be selected include residential combustion, agriculture and road traffic (TNO)
How will CAMS81 contribute to EMEP work and vice versa? (cont’d)

- BVOC: calculated with MEGAN model and ERA-interim meteo data for the period 2000-present (CUNI)
- Soil-N (MET Norway)
- Volcanic emissions: SO2 emissions provided by Chalmers University in coordination with the NOVAC network (2005-2016). Ash emissions provided by MET Norway in the case of a major eruptions in Europe
- Natural emissions from oceans: DMS, OCS and halogens, based on what is available in the literature and recalculated using ECMWF meteorological parameters.
Towards improving emission data from Russian Federation (some highlights from the joint NMR+Russia project, IVL coordinator)

According to the national experts (SRI Atmosphera St. Petersburg, Russia), discrepancies have been identified between CEIP and official emissions. Particularly large differences are found for SO\textsubscript{x}, which are probably due to different location of LPS applied by CEIP.

### CEIP vs. national data, SO\textsubscript{2} emissions

**Russian Federal Districts with major differences in 2010 emissions**

- **diff = CEIP - National**

<table>
<thead>
<tr>
<th>N</th>
<th>Region</th>
<th>Diff, kt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Murmansk oblast</td>
<td>-182</td>
</tr>
<tr>
<td>2</td>
<td>Komi Republic</td>
<td>-94</td>
</tr>
<tr>
<td>3</td>
<td>Orenburg oblast</td>
<td>-87</td>
</tr>
<tr>
<td>4</td>
<td>Moscow oblast</td>
<td>69</td>
</tr>
<tr>
<td>5</td>
<td>Arkhangelsk oblast</td>
<td>-58</td>
</tr>
</tbody>
</table>

**Total difference for European part of Russia:** 100 kT (2012 update), 320 kT (2015 update)
Scatterplots for model (50x50 km) vs observation for 2013

CEIP emis

SRI Atm emissions for RF

Improved model results for Russian (RU0001, RU0018) and some Nordic sites (NO0042, FI0036)
Conclusions

• Emissions in the new 0.1°x0.1°long-lat grid improve the model performance.
• Further improvement is expected when more countries report gridded emissions in the new grid and/or revise their gridding.
• More up-to-date temporal distribution of emissions should be developed (CAMS81, national expertise or a dedicated project).
• Shipping emissions are important, it is challenging to estimate emission trends based on the available data.
• Several deliverables for the CAMS81 project can be useful for CLRTAP modelling.
• National emission data should be reported within deadline in order to be included in the modelling.
Utskifting av bakgrunsbilde:

- Høyreklikk på lysbildet og velg «Formater bakgrunn»
- Under «Fyll», velg «Bilde eller tekstur» og deretter «Fil…»
- Velg ønsket bakgrunnsbilde og klikk «Åpne»
- Avslutt med å velge «Lukk»