Modeling of transboundary air pollution within CLRTAP and the role of EMEP

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Meteorological Synthesizing Centre-East of EMEP

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EMEP activities are carried out in close cooperation with various international Bodies and programs: AMAP, EEA, EU, ECHA, HELCOM, OSPAR, Stockholm Convention, UNEP, WHO, WMO . . .
Main fields of the EMEP activity

List of pollutants targeted by the Protocols under Convention:

- ozone and its precursors
- acidifying substances
- heavy metals (Pb, Cd, Hg)
- Persistent Organic Pollutants

can be transported on regional and global scale
TF serves as a forum for international scientific communication and collaboration in the field of fuller understanding of intercontinental transport
Available Hg/POP measurements in air

Regular measurements at EMEP monitoring sites
National measurement campaigns
Data from passive sampling campaigns (RECETOX, GAPS, EMEP)
Global EMEP Multi-media Modelling System (GLEMOS)

Main features:

• Multi-pollutant formulation (heavy metals, POPs, aerosol, …)
• Multi-media simulation approach
• Modular architecture
• Consistent approach for multi-scale simulations (multiple nesting)
From global to regional and local scale

Global scale simulations

Operational modelling on a regional scale (2008)

National/local scale assessment

Cd in precipitation (CZ1)

- Observed
- Model
Emission data for modelling

Hg emissions, 2005

Historical (1970 – 2010)

Current (2010)

Future Scenario (up to 2050)

Available global emissions of PCBs
Other input data for global modelling

Meteorology (WRF model)

- WRF-generated global precipitation field (2009)

Land Cover

- MODIS_Crops, %
- JRC_Crops, %
  - < 5
  - 5 - 10
  - 10 - 20
  - 20 - 30
  - 30 - 40
  - 40 - 60
  - 60 - 80
  - 80 - 100
Measured and calculated PCB-153 air concentrations in 2005, pg/m³ (calculated from 1970 to 2005)

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PCB-153 simulations on a global scale

Concentration of PCB-153 in soil (2008)

Concentration of PCB-153 in seawater (2009)

Historical changes of PCB-153 in media

Atlantic ocean transect at 45°N (July 2009)

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HCB simulations on a global scale

Concentration of HCB in air (2010)

Concentration of HCB in soil (2010)

Concentration of HCB in air at the EMEP monitoring sites (2010)

HCB content in environmental media

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Mercury simulations on a global scale

Modelling results:

- Assessment of mercury concentration and deposition levels on a global scale
- Estimates of intercontinental transport and source attribution
- Detailed evaluation against observations

Hg$^0$ concentration in ambient air (2005)
Source-receptor relationships for Hg, 2005

Deposition flux, g/km²/y

Europe

East Asia

- GEOS-Chem
- GRAHAM
- GLEMOS
- CMAQ-Hg

Deposition flux, g/km²/y

- Europe
- North America
- East Asia
- South Asia
- Other
- Natural & re-emission
Pathways of Hg transport

Relative contribution of South-eastern Asia to Hg concentration in air in 2000

December

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Intercontinental transport from different countries

PCB-153 transport

Air concentrations, annual means, relative units

from USA

from China

< 0.0001

0.0001 - 0.0005

0.0005 - 0.005

0.005 - 0.01

0.01 - 0.1

> 0.1
Atmospheric transport from point source

Simulation of a tracer transport from Fukushima-1 accident

Atmospheric dispersion of $^{131}$I from Fukushima-1 (Mar-Apr 2011)

Conventional source:
Tracer: $^{131}$I
Half-life: 8.02 days
Release: $2.5 \cdot 10^{16}$ Bq/day
Location: Fukushima-1
Atmospheric transport from point source

Sites location (Sweden)

Acknowledgements: Measurement data were provided by Swedish Radiation Safety Authority (SSM)
Simulations of chemical reactants

Purpose:
Support and improvement of HM and POP simulations with consistent data on reactants (SO$_x$, O$_3$, OH, BrO, …)

Annual mean SO$_2$ air concentration, mg[S]/m$^3$

Concentration in precipitation, mg[S]/L

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Data on organic carbon content in atmospheric aerosol

Purpose:
Support and improvement of HM and POP simulations with consistent data on atmospheric aerosol
Multi-scale simulations

Nesting in GLEMOS: regional simulations in lat-lon projection

Global Hg deposition (Jan 2009) (1°×1°)

Hg deposition in Europe (0.25°×0.25°)

Nesting procedure:
- Consistent geometries of inner and outer domains (projection, grids, vertical layers etc.)
- Possibility to use the same meteorological driver (WRF)
- Use of the same model code for different scales
- Temporal resolution of boundary exchange from hourly to monthly
Multi-scale simulations

GLEMOS application for local scale simulations in Europe

Hg deposition in Europe
(0.25°×0.25°)

Hg deposition over the Netherlands
(0.05°×0.05°)
Recent MSC-E publications and reports

Travnikov O. ‘Atmospheric transport of mercury’, In: Environmental Chemistry and Toxicology of Mercury (Eds. Liu, Cai and O’driscoll), Wiley & Son, in press.


EMEP/ESCAP cooperation

First stage:

Exchange of information in the field of:

- global emission data
- monitoring
- modelling

is highly appreciated

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Expert meeting on TAP in North-East Asia, St. Petersburg, 9-10 July 2012

Organization of the work under CLRTAP

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