Heavy metal pollution assessment within EMEP

Oleg Travnikov on behalf of MSC-E and CCC
Main directions of HM activities in 2016/2017

2016/2017 workplan (ECE/EB.AIR/133/Add.1)

- Review and improvement of HM emissions data for modelling
- Monitoring activities: data use and challenges
- Analysis of long-term trends
- Assessment of HM transboundary pollution (local/regional/global)
- Ecosystem-specific pollution
- Country-scale pollution assessment – Case studies of HM pollution
- Transition of operational modelling to the new EMEP grid
- Scientific co-operation on improvement of model assessment quality
- Co-operation with subsidiary bodies, international organizations and programmes
## Review of HM emission data for modeling

### Joint CEIP / MSC-E technical report on emission uncertainties

### Key uncertainties of HM emissions

<table>
<thead>
<tr>
<th>Emission parameter</th>
<th>Pb and Cd</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of gridded anthropogenic emissions</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Chemical composition</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Temporal variation</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Vertical distribution</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Global emissions inventory</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Historical emissions</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Emissions to other media</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

Red - 1st priority  Yellow - 2nd priority  Green - 3rd priority

### MSC-E contribution to the joint report:
- Gridded annual emission data
- Chemical composition
- Temporal variation
- Vertical distribution
- Global emission inventories
- Historical and natural emissions

Report should be served as a basis for EMEP strategy to improve emission inventories

Joint EMEP/WGE meeting, Geneva, 2016
Monitoring activities

Measurements of heavy metals at the EMEP monitoring network (2014)

Problems and challenges:

- Low quality data is still reported by some monitoring sites. Further improvement of QA/QC of heavy metal measurements is needed.
- The monitoring network is scarce in Eastern and Southern Europe and Central Asia.
- Partly spatial coverage could be improved by use of biomonitoring data (mosses etc.)
Supplementary measurement data

Measurements of heavy metal concentration in mosses

HM measurements in mosses

Reduction of Pb in moss (observed)

Reduction of Pb deposition (model)

29th TF meeting of the ICP-Vegetation, Dubna, Russia, March 2016
Model assessment of HM pollution

Long-term pollution trends (1990-2014)

Long-term changes of HM deposition

Contribution to CLRTAP assessments

Reduction of HM deposition (1990-2012)

Joint EMEP/WGE meeting, Geneva, 2016
Model assessment of HM pollution

Current pollution of EMEP countries (2014)

Deposition of Pb in 2014

Source apportionment of Pb deposition in 2014

Pb deposition to Austria

Pb deposition to UK

Pb deposition to Portugal
Inter-annual variability of HM pollution

Relative changes of country-averaged Cd deposition between 2013 and 2014

Inter-annual changes from -40% to 80%

Large inter-annual variation of both HM levels and source apportionment requires regular assessment of transboundary pollution within EMEP

Main factors:

- Change in atmospheric transport pathways
- Re-calculation of emissions by countries
- Altering of secondary emissions (re-suspension)
Ecosystem-specific information

Heavy metal deposition to different ecosystems (2014)

Hg deposition to forest

Hg deposition to inland waters

Frequency distribution of Hg deposition

Deposition flux, g/km²/y

Frequency, %

Inland waters

Forest

Joint EMEP/WGE meeting, Geneva, 2016
Objective: Evaluation of pollution levels in a country with fine spatial resolution involving variety of national data.

Countries involved: Czech Republic, Croatia, Netherlands, Belarus, Poland, UK.

Case studies of HM pollution in selected EMEP countries:
- Poland
- Ukraine
- Germany
- Italy
- Belarus

Belarus (complete):
- Pollution levels with fine spatial resolution ($10 \times 10$ km$^2$)
- Source-receptor relationships for the country and its regions
- Pollution of large cities
- Pollution from particular emission sectors.

Contribution of industrial combustion sector.
United Kingdom (in progress):
- Joint study with Centre for Ecology and Hydrology (UK)
- Simulations of Pb levels with fine spatial resolution (10x10 km²)
- Evaluation against measurements
- Comparison of modeling results of MSC-E and FRAME model

Poland (initiated):
- National gridded emissions data (0.1°x0.1°) and emissions from LPS
- Collection of measurements and other data
- Planned simulations of Cd pollution levels with fine spatial resolution (10x10 km²)
Country-scale pollution assessment

Heavy metal pollution from Large Point Sources (LPS)

Contribution of LPS to Cd deposition
(Pruněřov II Power Station, Czech Rep.)

Contribution of LPS to Pb deposition
(Tata Steel IJmuiden BV, Netherlands)

Contribution of LPS to HM pollution can exceed 20-50% over significant areas of the country
Transition to the new EMEP grid

Current and new EMEP domains

Current activities on implementation of the new grid:

- Generation of meteorological data (time series)
- Preparation of data on chemical reactants in the atmosphere
- Preparation of emissions data based on expert estimates (official data is not available)
- Pilot simulations and evaluation against measurements
Transition to the new EMEP grid

Pilot simulations of Hg pollution over the new EMEP grid (2014)

Hg wet deposition (2014)

Evaluation vs. measurements

<table>
<thead>
<tr>
<th></th>
<th>Old grid</th>
<th>New grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.72</td>
<td>0.92</td>
</tr>
<tr>
<td>Reg. slope</td>
<td>1.40</td>
<td>1.35</td>
</tr>
</tbody>
</table>

Joint EMEP/WGE meeting, Geneva, 2016
Information for Research Community

Improvement of model assessment quality

Multi-model study of Hg pollution and processes

Participating models:

<table>
<thead>
<tr>
<th>Model</th>
<th>National experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLEMOS</td>
<td>EMEP/MSC-E</td>
</tr>
<tr>
<td>ECHMERIT</td>
<td>CNR-IIA (Italy)</td>
</tr>
<tr>
<td>CMAQ-Hg</td>
<td>HZG (Germany)</td>
</tr>
<tr>
<td>WRF-Chem</td>
<td>CNR-IIA (Italy)</td>
</tr>
<tr>
<td>GEOS-Chem</td>
<td>MIT (USA)</td>
</tr>
<tr>
<td>GEM-MACH-Hg</td>
<td>Environment Canada</td>
</tr>
<tr>
<td>p-TOMCAT</td>
<td>Cambridge (UK)</td>
</tr>
</tbody>
</table>

Hg$^0$ air concentration (2013)

TF HTAP Workshop, Potsdam, Germany, February 2016

Joint EMEP/WGE meeting, Geneva, 2016
Joint EMEP/WGE meeting, Geneva, 2016

Improvement of model assessment quality

Study of Hg oxidation chemistry in the atmosphere

Sites measuring Hg wet deposition

Information for Research Community

Study of Hg oxidation chemistry in the atmosphere

• Measurements  GLEMOS  GEOS-Chem

Wet deposition, ng/m²/day

Hg⁰ + Br

Hg⁰ + O₃

Hg⁰ + OH

99 sites

Joint EMEP/WGE meeting, Geneva, 2016
Information for Research Community

Peer-reviewed publications (2016)


Future scenarios of Hg deposition to EMEP countries (2035)

‘Current Policy’ Scenario

‘New Policy’ Scenario

‘Maximum Feasible Reduction’

Source regions

- Europe
- EECCA
- Africa
- North America
- Central America
- South America
- South Asia
- East Asia
- Southeast Asia
- Middle East
- Australia and NZ

Intercontinental transport

Deposition flux, g/km²/y

2013 CP 2035 NP 2035 MFR 2035

Deposition flux, g/km²/y

2013 CP 2035 NP 2035 MFR 2035

Information for Research Community

Current Policy’ Scenario

‘New Policy’ Scenario

‘Maximum Feasible Reduction’

European Union (EU28)

EECCA countries

Joint EMEP/WGE meeting, Geneva, 2016
Cooperation with UNEP & Minamata Conv.

- Participation in the Global Mercury Assessment 2013 (GMA 2013) to support negotiations of the Minamata Convention on Mercury.

- Coordination of work on the update of GMA 2013 with new modelling results (2015)

- Leading preparation of the modelling part of Global Mercury Assessment 2018 (in cooperation with AMAP)

Project Coordination Group of GMA 2018
(Geneva, April 2016)
Joint EMEP/WGE meeting, Geneva, 2016

Regular pollution assessment over EMEP domain:
- Substances – Pb, Cd, Hg
- Concentration and deposition maps
- Source-receptor relationships
- Long-term trends (1990-2014)

Complementary assessment on global scale:
- Substances – Hg
- Includes the whole AMAP region
- Intercontinental transport

Cooperation with AMAP

Joint CLRTAP/AMAP workshop (Potsdam, February 2016)
Workplan elements for 2017

- Operational **monitoring and modelling** of HM pollution transboundary pollution within EMEP
- Generation of data on **ecosystem-dependent deposition** of HMs for the effect community
- Country-scale assessment within the **Case Studies** (UK and Poland) in co-operation with TFMM and national experts
- Support of **EECCA countries** with information on HM pollution
- Assessment of **intercontinental transport** and contribution of **secondary sources** to HMs pollution in the EMEP domain
- Finalizing transition of HM operational modelling to the **new EMEP grid**
- Finalizing preparatory work and **distribution of the GLEMOS model** for public use as open source
- **Scientific co-operation** and **data exchange** with subsidiary and international bodies on HM pollution (TFMM, TF HTAP, UNEP, AMAP, HELCOM etc.)