Heavy metal pollution assessment within EMEP

Oleg Travnikov on behalf of MSC-E, CCC, CEIP and CCE

EMEP Steering Body, Geneva, 2012
Scope of EMEP activities on HMs in 2012

- Monitoring of heavy metals within EMEP (CCC)
- Collection and processing of heavy metal emissions data (CEIP)
- Operational modelling of heavy metal transboundary pollution (MSC-E)
- Research and development:
  - Further development of GLEMOS multi-scale modelling system (MSC-E)
  - National/local scale pollution assessment – Case studies (MSC-E, CCC, TFMM, Parties)
- Assessment of long-term changes of heavy metal transboundary pollution (1990-2010)
- Co-operation with national experts, international organizations and programmes

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MSC-E publications on heavy metals

Peer-reviewed publications:


Further development of GLEMOS

Global EMEP Multi-media Modelling System (GLEMOS)

Main directions of development:

• Improvement of pollutant specific modules (Hg chemistry, wind re-suspension etc.)

• Elaboration of oceanic module for Hg multi-media modelling

• Development of chemical reactants (SO₂, OH, O₃, etc.) and aerosol modules

• Development and testing of the nesting procedure for multi-scale simulations
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Global (1°×1°)

- Global EMEP Multi-media Modelling System (GLEMOS)

Regional (0.25°×0.25°)

Local (0.05°×0.05°)

Benefits:

- Consistent geometries of inner and outer domains (projection, grids, vertical layers etc.)
- The same model code for different scales
- Possibility to use the same meteorological driver
Pollution assessment with high resolution: EMEP case studies

Countries involved:

<table>
<thead>
<tr>
<th>Country</th>
<th>Czech Rep.</th>
<th>Croatia</th>
<th>Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutants</td>
<td>Cd</td>
<td>Pb</td>
<td>Pb, Cd, Hg</td>
</tr>
<tr>
<td>Status</td>
<td>complete</td>
<td>in progress</td>
<td>in progress</td>
</tr>
</tbody>
</table>

Assessment results for Czech Republic:

- Evaluation of Cd pollution levels with high spatial resolution (5×5 km²)
- Source apportionment and transboundary fluxes between regions of the country
- Analysis of the key source categories of Cd pollution in the country
- Assessment of Cd deposition from individual large point sources

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Czech Republic: Input data

National data from Czech Republic (CHMI)

**Emissions data:**
- Cd anthropogenic emissions with high spatial resolution (5×5 km²)
- Gridded data on source categories
- Information on large point sources

**Monitoring data:**
- Cd measurements from extensive national monitoring network (72 sites)
- Aerosol measurements (PM2.5, PM10)
- Detailed meteorological observations
- Cd measurements in soil

Cd emissions in Czech Rep (5×5 km²)

National monitoring network (72 sites)
Czech Republic: Large point sources

**Contribution of large point sources to Cd deposition**

- **Prunéřov II Power Station**
  - Emission: 207 t/y (6%)

- **Arcelor-Mittal Ostrava Steel Plant**
  - Emission: 859 kg/y (26%)

**Note:** Contribution of single LPS can exceed 10-20% of Cd total anthropogenic deposition over large areas of the country
Evaluation of pollution abatement under the Protocol on HMs

Objective:

- Support of revision of the 1998 Protocol on Heavy Metals

Main topics of the assessment:

- Emission changes of HMs in the EMEP countries
- Monitoring of HM pollution within EMEP
- Long-term trends of HM deposition (1990-2010)
- Changes in transboundary fluxes over 20 years
- Key source categories of heavy metal pollution

Contributing institutions:

MSC-E, CCC, CEIP, CCE

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Heavy metal emission changes

Statistics of emissions reporting

- Number of Parties reported emission data increased from 30 to 46
- Gridded emission data are reported only by 28 Parties

Changes of HM emissions in the EMEP countries over 1990-2010

- Pb: 90% decrease
- Cd: 65% decrease
- Hg: 60% decrease
Monitoring of HMs within EMEP

EMEP monitoring network for HM:

- Number of monitoring sites increased from 44 in 1990 to 66 in 2010
- Data quality is controlled by regular laboratory intercomparisons
- Significant territories in Eastern and Southern Europe remain uncovered

Measured changes of Pb and Cd air concentration (1990-2010)

Location of EMEP sites
Model assessment of long-term trends

Model applications:

- Simulation of continuous trends of HM pollution (1990-2010)
- Assessment of country-to-country transboundary fluxes
- Analysis of key sources categories contribution to HM deposition
- Evaluation of model results against EMEP measurements

Modelling results vs. observations (1990-2010)

- Pb wet dep.: Bias = -14%
- Cd wet dep.: Bias = 48%
- Hg wet dep.: Bias = 3%
Long-term trends of HM pollution

Reduction of heavy metal deposition in EMEP countries (1990-2010)

- **Pb**: 75% reduction
- **Cd**: 50% reduction
- **Hg**: 30% reduction

**Graphs:**
- Deposition flux
- 50% variation
- 90% variation
- EMEP measurements
- HM in mosses (WGE)

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Lead: Has the problem been solved?

Deposition of Pb in EMEP countries (75% reduction)

1990

2010

Key source categories contributing to Pb deposition

1990

Road transport, 76%

Stationary combustion in industry, 4%

Non-industrial combustion, 3%

Public electricity & heat production, 4%

Other, 4%

Metal production, 9%

2010

Stationary combustion in industry, 29%

Non-industrial combustion, 12%

Public electricity & heat production, 14%

Other, 8%

Metal production, 26%

Road transport, 11%

Exceedance of critical loads of Pb in 2010

Human health and the environment continue to be at risk in many EMEP countries

EMEP Steering Body, Geneva, 2012
Cadmium: Pollution ‘hot spots’

Deposition of Cd in EMEP countries (50% reduction)

Exceedance of critical loads of Cd in 2010
Cd deposition in Central Europe

EMEP Steering Body, Geneva, 2012
Mercury is a global pollutant

Deposition of Hg in EMEP countries (30% reduction)

Hg global deposition (2010)

Changes of Hg deposition in EMEP countries

Exceedance of critical loads of Hg in 2010
Transboundary pollution

Contribution of foreign sources to Cd deposition in EMEP countries

0% 25% 50% 75% 100% Emission reduction

Netherlands

Belgium

France

United Kingdom

1990

2010

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Transboundary pollution

Contribution of foreign sources to Cd deposition in EMEP countries

Slovakia

1990

2010

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Changes in key source categories

Contribution of source categories to HM deposition in EMEP countries

Note: Reduction of HM pollution levels was accompanied by changes of the key source categories of both emissions and deposition
Changes in key source categories

Prevailing sectors of lead, cadmium and mercury deposition in 2010

The key source categories of HM pollution:
- Green: Combustion in industry (1A2)
- Pink: Non-industrial combustion (1A4)
- Yellow: Metal production (2C)
- Blue: Public electricity and heat production (1A1a)

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HM pollution in EECCA countries

Deposition of Cd in the EECCA countries

Pollution levels:
• Relatively low reduction of HM deposition in EECCA countries
• The largest decrease in the western part of the region
• The analysis is limited by the lack of national data

Data reporting in the EECCA countries:
• Only 5 of 12 EECCA countries report data on HM emissions
• Two countries report gridded emissions data
• No monitoring data are reported so far

Completeness of data reporting:

- Republic of Moldova
- Ukraine
- Armenia
- Belarus
- Russian Federation
- Azerbaijan
- Georgia
- Kazakhstan
- Kyrgyzstan
- Tajikistan
- Turkmenistan
- Uzbekistan

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<thead>
<tr>
<th>Country</th>
<th>Completeness of data reporting, %</th>
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<tr>
<td>Republic of Moldova</td>
<td>80</td>
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<td>Ukraine</td>
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Parties to the Protocol
Voluntary contribution
Future activities

Workplan elements on HMs for 2013

Annual activities:

- Operational monitoring and modelling pollution levels in Europe and evaluation of modelling results against measurements (MSC-E, CCC)

Research and development:

- Further development of the GLEMOS modelling system (multi-media for Hg, chemical reactants and aerosol modules) (MSC-E)
- Preparatory work and testing the model for HM operational simulations in the lat-lon projection (MSC-E)
- Modelling study of Hg processes in the atmosphere in co-operation with TF HTAP and EU GMOS project (MSC-E, Parties)

Co-operation:

- Case studies: Continue co-operation with national experts for national/local scale HMs pollution assessment (MSC-E, TFMM, Parties)