SUMMARY

(Status report 2/2017)

Heavy metal pollution remains a matter of public concern despite significant mitigation efforts undertaken under the UNECE Convention on Long-range Transboundary Air Pollution (hereafter, CLRTAP or the Convention). Decline in pollution levels over the past two decades has resulted in reduced impact for both human health and biota. However, human health and ecosystems continue to be at risk in many UNECE countries [*Maas and Grennfelt*, 2016]. Heavy metals that are within the scope of the Convention include lead (Pb), cadmium (Cd) and mercury (Hg). Collection and analysis of variety of information related to heavy metal pollution and transboundary transport are performed by research centres of the Co-operative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP).

This Status Report outlines recent activities of the EMEP Centres in the field of heavy metal pollution assessment performed in accordance with the workplan of the Convention for 2016-2017 [ECE/EB.AIR/133/Add.1]. The major topics presented in the report include assessment of heavy metal pollution in the EMEP region based both on monitoring and modelling, further development and improvement of the modelling approaches associated with transition to the new EMEP grid, co-operation with national experts in the framework of case studies on heavy metal pollution in selected EMEP countries, and collaboration with other Bodies to the Convention, international organisations and programmes.

Model assessment of heavy metal pollution levels in the EMEP domain for 2015 was carried out using gridded emission data on lead, cadmium and mercury provided by CEIP. The total values of anthropogenic heavy metal emissions in the EMEP countries for 2015 are lower than the corresponding values for 2014 in previous submission and amount to 3704 tonnes for lead, 200 tonnes for cadmium and 142 tonnes for mercury. Detailed information on heavy metal emissions in each country, as well as the gap-filling methods that have been used for the 2015 Gridding Nomenclature for Reporting (GNFR) inventory can be found in the CEIP Technical Report 01/2017 [*Tista et al*., 2017]. Auxiliary information on emissions height distribution and chemical speciation of mercury emissions was prepared by MSC-E based on expert estimates. Besides, a global inventory of mercury anthropogenic emissions [*AMAP/UNEP*, 2013] was used for mercury simulations on a global scale and evaluation of boundary conditions for regional modelling.

Measurements of lead and cadmium in the EMEP region in 2014 were carried out at 66 sites, and mercury – at 28 sites. In total, 22 Parties to the Convention report heavy metal data to EMEP, 8 of these fulfil their monitoring obligations as defined in the EMEP monitoring strategy [*UNECE*, 2009] with at least one level 2 site with both air and precipitation measurements of heavy meals and mercury in air and precipitation. The lowest concentrations for all elements were generally found in northern Scandinavia, and the highest ones were noted for central and south-eastern Europe. It should be noted that some of the high concentrations are due to too high detection limit of the method applied, i.e. Cd in aerosols in Portugal, and Hg in precipitation in Portugal and Ireland. The EBAS database [http://ebas.nilu.no], which hosts data from EMEP, GAW, AMAP, CAMP, HELCOM, ACTRIS and more, has been improved this year to include additional metadata and information on quality assurance. A more detailed information about the sites and the measurement methods are found in the EMEP/CCC data report for 2015 [*Aas and Nizzetto*, 2017].

Lead, cadmium and mercury pollution levels in the EMEP region were assessed for 2015. The highest pollution levels of these heavy metals took place in the central part of Europe (Poland, northern Italy, western and south-western Germany). The lowest levels were noted for the northern part of Scandinavia and the Russian Arctic. Heavy metal deposition in the EMEP region was formed by EMEP anthropogenic, EMEP secondary and non-EMEP sources. Secondary sources made the largest contribution to lead and cadmium deposition that exceeded half of total deposition in 45 countries for lead and in 29 counties for cadmium. EMEP anthropogenic sources contributed from 25% to 50%, and non-EMEP sources – less than 15% to deposition in most of countries. In case of mercury non-EMEP sources contributed more than 50% of total deposition in majority of the EMEP countries. Contribution of transboundary deposition of lead, cadmium, and mercury exceeded the deposition caused by national anthropogenic sources in 39, 42, and 33 countries, respectively. In most of the EMEP countries 60-90% of emitted heavy metals were transported beyond the national borders.

The major direction of further development of the Global EMEP Multi-media Modelling System (GLEMOS) during the past year was related to transition of the EMEP operational modelling to the new EMEP grid. The work started a few years ago was continued with adaptation and testing of pollutant-specific modules for new contaminants (particle-bound heavy metals and a selected persistent organic pollutant) as well as preparation of additional input data. Besides, the GLEMOS modelling system underwent considerable structural revision aimed to prepare it for public distribution as open-source software. Pilot simulations of lead and cadmium pollution performed with GLEMOS on the new EMEP grid demonstrate good succession between the old and new model versions for assessment of transboundary transport between the EMEP countries and ecosystem-specific deposition. However, evaluation of wind re-suspension of heavy metals requires further refinement including estimates of long-term accumulation of the pollutants in topsoil. Besides, anthropogenic emission data with fine spatial resolution is needed for improvement of the model performance for simulations on the new grid. In addition, model study of mercury chemistry and other processes in the atmosphere was finished and main conclusions were formulated to direct further model development. All results of the study were published in a series of peer-reviewed papers [*Travnikov et al.*, 2017; *Bieser et al.,* 2017; *Angot et al*., 2016].

Co-operation with Parties to the Convention in the framework of the country-specific case studies of heavy metal pollution with fine spatial resolution was continued. The first phase of the country-specific study for Poland has been complete this year. In this phase, a variety of input information (emissions, measurements, meteorological data etc.) were collected, model simulations of the country pollution by cadmium were performed and analysed. Further analysis of the transition to the new EMEP grid on a country scale showed improvement of the model performance at background regional stations in Poland and neighbouring areas. It was also shown that heavy metal emissions from some source categories (e.g. residential combustion) could have significant uncertainties and needed further refinement. Besides, the need to revise emissions data for Eastern Europe was demonstrated to improve quality of the model assessment. The study for Poland will be continued including further analysis of pollution levels over the whole territory and selected cities of the country.

MSC-E also collaborated with national experts from Italy and Russia supporting their activities on heavy metal assessment. In particular, the Centre provided ENEA (Italy) with calculated air concentrations of lead, cadmium, mercury and the second priority metals (arsenic, nickel, chromium, copper, zinc and selenium) required for determining boundary conditions of the national model domain. The Centre also collaborated with experts from Russia performing initial analysis of measurements from the national

monitoring network for heavy metals. The observations were compared with modelling results to evaluate uncertainties of measurements, national emission data and secondary emissions.

Another important aspect of MSC-E activities is collaboration with subsidiary bodies to the Convention and other international organisations. All results of the research and development were presented and discussed at the EMEP Task Force on Measurements and Modelling (TFMM). In particular, the progress in transition of the GLEMOS modelling system to the new EMEP grid was reported and pilot results of model simulations of heavy metal pollution on a country scale for Poland were presented. Important topics of pollution assessment were suggested for discussion at future meetings of the Task Force: (1) modelling of wind suspension of mineral dust and harmonization of land-cover data within the Convention and (2) peculiarities of evaluation of "grid cell-averaged" modelled pollution levels against "point" values of measurements at monitoring sites.

MSC-E also continues co-operation with the Working Group on Effects (WGE). Ecosystem-specific deposition of lead, cadmium and mercury is calculated annually for the EMEP region and individual EMEP countries to support work of the effect community. All variety of information is available at the MSC-E website [www.msceast.org]. This year MSC-E has also started a new joint activity with the Coordination Centre for Effects focused on evaluation of critical loads exceedances for mercury on a hemispheric scale. For this purpose, MSC-E performed modelling of mercury deposition to forests and (semi-)natural vegetation in the boreal and temperate region of the Northern Hemisphere under the current conditions (2010) and in future (2035).

EMEP closely collaborates with the United Nations Environment Programme (UN Environment). A new Global Mercury Assessment 2018 is now under development in accordance with the request of the UN Environment Governing Council (Decision 27/12). MSC-E takes part in the assessment coordinating work of an international group of experts focused on modelling of mercury pollution on global and regional scales. Besides, in cooperation with other EMEP Centres, MSC-E performs regular model assessment of atmospheric pollution of the Baltic Sea by various pollutants including heavy metals. This work is carried out in accordance with the Memorandum of Understanding between CLRTAP and the Baltic Marine Environment Protection Commission (HELCOM).

Future directions of MSC-E activities will be aimed at further improvement of heavy metal pollution assessment in the EMEP region. Further development and evaluation of the Global EMEP Multi-media Modelling System (GLEMOS) will include additional testing of the model performance and refinement of wind re-suspension of heavy metals on the new EMEP grid, and analysis of the key factors affecting mercury accumulation in and exchange between the environmental media. Country-specific case studies will be continued for a number of countries (Poland, the United Kingdom, Russia) using detailed national emission and monitoring data and in close cooperation with national experts. Finally, MSC-E will continue co-operation with subsidiary bodies of the Convention (WGE, TFMM, TF HTAP), international organizations (UN Environment, AMAP, HELCOM etc.) and national experts. These directions of future research and development are reflected in MSC-E proposals for the EMEP workplan for 2018-2019 and the updated Mandate of the Centre.