

## SUMMARY

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Persistent organic pollutants (POPs) are semi-volatile toxic organic compounds, characterized by resistance to degradation, significant potential to long-range transport, and harmful effects to human health and wildlife. POPs are within the scope of the UNECE Convention on Long-range Transboundary Air Pollution (hereafter, CLRTAP or the Convention) since coming into force the Aarhus Protocol on Persistent Organic Pollutants in 1998. Monitoring of pollution levels and compiling data on emissions as well as assessment of transboundary transport of POPs is carried out by scientific centres of Co-operative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP).

In this report the outcome of recent activities of the EMEP Centres in the field of POP pollution assessment, performed in accordance with the 2016-2017 Workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1), is presented. The information on the pollution of the EMEP region by 4 PAHs (benzo(a)pyrene (B(a)P), benzo(b)fluoranthene (B(b)F), benzo(k)fluoranthene (B(k)F), and indeno(1,2,3-cd)pyrene (IP)), PCDD/Fs, HCB, and PCBs is provided for 2015, based on reported anthropogenic emissions, modelling results, and measurements. Main emphasis is given to the evaluation of PAH pollution levels in the EMEP countries. Besides, the progress in the transition of operational POP modelling to the new EMEP grid is presented. Particular attention is also paid to the co-operation and exchange of information between Meteorological Synthesizing Centre East (MSC-E) and subsidiary bodies to the Convention, as well as different national and international organizations.

Assessment of POP pollution levels in the EMEP countries for 2015 was carried out using gridded emission data, prepared by the Centre on Emission Inventories and Projections (CEIP). Information on vertical distribution and intra-annual variations of emissions as well as compilation of emission scenarios for global-scale modelling were prepared by MSC-E. Emissions from anthropogenic sources within the EMEP region in 2015 were lower for PAHs, and higher for PCDD/Fs, PCBs, and HCB comparing to the level of emissions in 2014. While the completeness and consistency of national emission inventories is gradually improving, POP emissions of some countries are still subject of substantial uncertainties. Particularly important are completeness of sector-wise data on emissions and speciation of emissions for PAHs, PCDD/Fs, and PCBs.

Measurements of POP air concentrations in 2015 were carried out at 34 EMEP monitoring sites, most part of which performed monitoring of PAH concentrations. At the same time, data on PCBs and HCB were reported by less than 10 sites and no measurements were made for PCDD/Fs. Substantial amount of monitoring data on PAHs is available in the EEA AirBase and for other POPs in the UNEP Stockholm Convention Global Monitoring Plan Data Warehouse, which can be used for the evaluation of spatial and temporal variations of POP concentrations.

Available time trends of HCB at some EMEP sites show increasing air concentrations during the last five to ten years. The reasons of these changes require more research and better understanding of the relative importance of primary and secondary sources of HCB. This also highlights the critical importance of continuous and consistent long-term monitoring of regulated POPs, even after periods of decline. Comparing data from different sampling sites and laboratories is a complicating factor when interpreting POP measurements (e.g. for HCB) due to differences in sampling and analytical methodologies. Thus,

there is a need for further focus on harmonization of sampling strategies within CCC and EMEP to enhance the spatial comparability of POP monitoring data.

High levels of air concentrations of B(a)P in urban areas of the EMEP countries have been indicated as an important issue by thematic session on B(a)P during the third joint session of the Working Group on Effects and the Steering Body to EMEP. Specific attention was paid to the importance of PAH emissions from residential combustion and biomass burning as well as to spatial and temporal trends in B(a)P pollution. Analysis of B(a)P concentrations, measured by national monitoring sites in the period 2005-2015, indicates exceedances of the EU target level for B(a)P for countries in Central and Eastern Europe, with highest observed B(a)P concentrations in Poland. Monitoring sites show both decreasing and increasing pollution levels in the EMEP countries. About 65% of sites reported decreasing B(a)P concentrations during this period. Nevertheless, significant amount of sites indicates increasing concentrations, which can be noted for Poland, Czech Republic, and Italy, as well as for the UK, Ireland, Spain, Austria, Slovakia, and Cyprus.

Evaluation of PAH pollution levels and transboundary transport in the EMEP region was carried out for the selected 4 PAHs, namely, B(a)P, B(b)F, B(k)F, and IP. Relatively high annual mean PAH concentrations are estimated for countries in Central Europe, namely, in Poland, the Czech Republic, Slovakia, Slovenia, Romania, Montenegro, and Hungary. Areas of high PAH concentrations are also indicated for Spain, Portugal, Germany, and northern Italy. Assessment of PAH distribution in the EMEP domain indicates importance of the long-range transport of pollution between the countries. Source-apportionment of PAH deposition shows that for 70% of countries the contribution of emission sources, located beyond their territories, exceeds the contribution of their own national emissions.

Comparison of model predictions with measurements of B(a)P, B(b)F, B(k)F, and IP for 2015 demonstrates generally reasonable capturing of observed spatial variations of PAH air concentrations by the model. At the same time, for several monitoring sites in France, Belgium, the Netherlands, and Sweden the model tends to overestimate observed concentrations. The overestimation is most likely caused by the uncertainties in the reported PAH emissions as well as in their speciation and spatial distribution. Particularly, analysis of monitoring data and reported emissions for B(a)P shows noticeable disagreement between observed concentrations and mean emission fluxes for Poland, Germany, and Belgium, which may point out possible underestimation of PAH emissions in Poland, and overestimation of emissions in Germany and Belgium. Thus, further refinement of PAH emission data, reported by the EMEP countries, is of importance for the reduction of uncertainties of pollution assessment.

Special attention in the activities of MSC-E during this year was paid to the transition of POP operational modelling to the new EMEP grid system. The Centre continued the work on the adaptation of the Global EMEP Multi-media Modelling System (GLEMOS) for modelling using the new grid and preparation of necessary input data including meteorological and geophysical information. Particularly, the input of gridded emission data including vertical structure, intra-annual variations, and distribution by sectors was refined. A new system of preparation and input of the initial and boundary conditions for regional modelling was developed. A number of modifications were made in the parameterizations of POP deposition, gas-particle partitioning, and degradation processes applied in the model. Pilot simulations of B(a)P pollution on the new EMEP grid have shown generally better agreement with measurements of EMEP monitoring network in comparison with the results for older EMEP grid. At the same time, for some of the stations model predictions noticeably differ from the observed pollution levels. For better

performance of the GLEMOS model there is a need of further refinement of model parameterization of gas-particle partitioning, degradation, and deposition processes.

Detailed analysis of PAH pollution at a country scale has been initiated for Spain in the framework of country-specific case studies following the recommendation of the third joint session of the Working Group on Effects and the Steering Body to EMEP. To analyze spatial variations of B(a)P concentrations over the country, fine resolution modelling using detailed emissions data and measurements of B(a)P at national monitoring network was carried out. According to available measurements, spatial distribution of B(a)P pollution levels in Spain is characterized by relatively higher levels of B(a)P pollution in its northern areas and lower in other areas of the country. Comparison of model predictions with measurements indicates overestimation of observed B(a)P air concentrations for central and western parts of the country, which can be attributed to possible uncertainties in the reported national PAH emissions as well as uncertainties in modelling approach and measurements.

Particularly, national PAH emission inventory of Spain is characterized by noticeably high contribution of emissions from field burning of agricultural residues (about 70%), while contribution of residential combustion is less important. This pattern of emissions distinctly differs from the inventories of other EMEP countries, where residential combustion is dominating source category (except for Portugal and Cyprus). Experimental model simulations with several emission scenarios and analysis of observed levels of PAH pollution have indicated possible uncertainties in estimates of PAH emissions from agriculture. Thus, further refinement of emissions related to the burning of agricultural residues and analysis of their uncertainties is appreciated to improve accuracy of model predictions. In addition, analysis of major factors, influencing B(a)P pollution levels, and comparison of EMEP and national modelling results for Spain is planned to be performed.

Evaluation of pollution by PCDD/Fs, PCB-153, and HCB was based on multi-media modelling approach to take into account their long-term cycling between and accumulation in different environmental compartments. Spatial variability of air concentrations and deposition fluxes within the EMEP domain was analyzed for 2015 on the basis of nested regional and global scale model simulations. Model simulations indicated substantial contribution of anthropogenic emissions to PCDD/F pollution levels in the EMEP countries. For PCB-153 and HCB significant contribution was estimated for secondary emission sources. Model predictions for non-EMEP emissions varied from several percents to 50% for PCDD/Fs and PCB-153, and from 30% to 70% for HCB. Estimates of PCDD/Fs, PCB-153, and HCB transboundary fluxes indicated significant role of air pollution transport between the EMEP countries. According to modelling results, the fraction of POP deposition over the territories of the countries, caused by the atmospheric transport from external emission sources, exceeds the fraction of deposition from their national emissions in 75% of the countries for HCB, in 65% of the countries for PCB-153, and in 55% of the countries for PCDD/Fs.

Important aspect of MSC-E work is co-operation with subsidiary bodies to the Convention. The outcome of recent research activities and model developments, performed by the Centre, was discussed at the EMEP Task Force on Measurements and Modelling (TFMM). In particular, the progress in the transition of POP modelling to the new EMEP grid was demonstrated. Besides, preliminary results of country-specific case study of B(a)P pollution in Spain were presented and discussed during the meeting. The representative of Spain informed participants about ongoing refinement of national inventory of PAH emissions in Spain and the need to update modelling results using refined emissions. To continue activities in framework of country scale pollution studies it was suggested to perform analysis of B(a)P

pollution levels in France and Poland. As an important topic, relevant to further improvement of pollution assessment, the application of modelling and monitoring data fusion approaches can be discussed at future meetings of the Task Force.

Collaboration of MSC-E and national experts of the EMEP countries is continued. To support national study of POP pollution in Italy, regional-scale modelling for the evaluation of POP air concentrations in the Mediterranean region was carried out. Results of model simulations will be used as information on boundary concentrations in national scale modelling. Besides, the Centre collaborated with national experts from Germany providing model estimates of atmospheric deposition fluxes of PAHs to inland waters of the country.

Co-operation and exchange of information with other international organizations and programmes is essential for the assessment of pollution of the EMEP region. In the framework of this activity MSC-E continues co-operation with the other EMEP Centres, aimed to assessment of atmospheric input of various pollutants including POPs to the Baltic Sea. This work is carried out in accordance with the Memorandum of Understanding between CLRTAP and the Baltic Marine Environment Protection Commission (HELCOM). Data of national emission inventories, provided by countries to the UNEP Stockholm Convention (SC), represent important source of information for studies of environmental pollution by PCDD/Fs and other POPs as for the EMEP region and for the global scale. Thus, further co-operation between the CLRTAP and SC in this field is highly appreciated.

Further activities of MSC-E will be directed to the refinement of assessment of POP pollution in the EMEP region. Development and testing of the Global EMEP Multi-media Modelling System (GLEMOS) performance for the new EMEP grid will be continued. Besides, analysis of key factors that affect POP transport in the atmosphere and exchange surface compartments will be performed. Country-specific case studies will include analysis of PAH pollution for France and Poland. Specific attention will be paid to the co-operation with subsidiary bodies of the Convention (TFMM, TF HTAP, TFEIP, and WGE), international organizations (AMAP, UNEP Stockholm Convention, HELCOM etc.) and national experts. These directions of future research and development are outlined in the MSC-E proposals for the EMEP workplan for 2018-2019 and the updated Mandate of the Centre.