Cooperation with international organizations - Helsinki Commission

In framework of cooperation with Helsinki Commission (HELCOM), MSC-E performs regular evaluation of airborne pollution load of heavy metals and POPs to the Baltic Sea. This work is carried out in accordance with the Memorandum of Understanding between the Baltic Marine Environment Protection Commission (HELCOM) and the United Nations Economic Commission for Europe (UN ECE) and is based on the long-term EMEP/HELCOM contract.

This year this activity was focused on the evaluation of cadmium, mercury and B(a)P pollution of the Baltic Sea. In particular, long-term variations of deposition fluxes of the considered pollutants to the Baltic Sea were estimated for the period 1990-2014. Source apportionment of deposition and verification of modelling results against measurements was made for 2014. Results of the assessment are available in a form of Joint report of EMEP Centres for HELCOM [*Bartnicki et al.*, 2016] and several indicator fact sheets, published on the HELCOM website [http://www.helcom.fi].

Heavy metals (Cd, Hg)

Anthropogenic heavy metal emissions of the HELCOM countries dropped substantially from 1990 to 2014 (by 39% for cadmium and 48% for mercury). In 2014 the largest contributors to heavy metal emissions of the HELCOM area were Russia, Poland, and Germany. The share of emissions from these countries in total emissions of heavy metals in the Baltic Sea region exceeded 90%.

Model simulations indicate substantial decline of annual total atmospheric deposition of cadmium and mercury to the Baltic Sea from 1990 to 2014. The drop of cadmium deposition during this period is more significant (54%) comparing to mercury deposition (24%) (Fig. 1a). Temporal changes of heavy metal pollution in different parts of the Sea are not homogeneous. Particularly, significant decrease of cadmium deposition is noted for the Bothnian Bay and the Gulf of Finland (68% and 64%). For mercury more significant changes took place in the Sound and the Kattegat (55% and 37%).

The rate of deposition decrease was higher in the early 1990-s, however after 2000 it became smaller or almost levelled off. Annual depositions to the Baltic Sea in 2014 were higher comparing to 2013 by 33% for cadmium and 9% for mercury, which can be explained by inter-annual changes of meteorological conditions, in particular, variability of atmospheric transport.

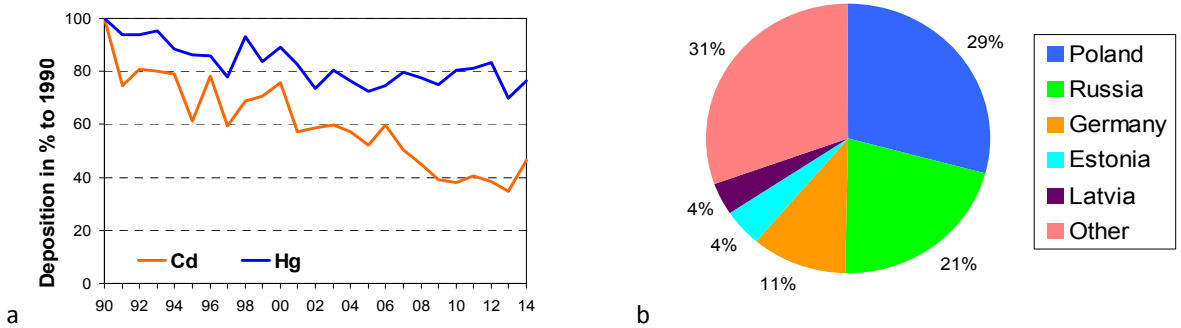

Fig. 1. *Relative changes of annual atmospheric deposition of cadmium and mercury to the Baltic Sea in the period 1990-2014 (a) and contribution of emission sources from the EMEP countries to total anthropogenic deposition to the Baltic Sea in 2014 (b)*

Spatial trends in cadmium deposition in the Baltic Sea region in 2014, are analysed in [*Bartnicki et al*., 2016]. Higher levels of deposition are estimated for southern and western parts of the region, while its northern part is characterized by relatively lower deposition fluxes. Similar pattern of deposition can also be noted for observed cadmium deposition fluxes.

Anthropogenic emission sources of HELCOM countries contributed to annual deposition over the Baltic Sea in 2014 about 27% for cadmium and 14% for mercury. Among the HELCOM countries the most significant contribution to cadmium and mercury deposition to the Baltic Sea was made by Poland, Russia, and Germany (Fig. 1.b). Along with anthropogenic emission sources significant contribution to cadmium and mercury deposition (more than 50%) was made natural emissions, re-suspension with dust, sources located outside the HELCOM counties, and re-emission.

Persistent Organic Pollutants - B(a)P

Following various measures, performed in the EMEP countries in early 1990-s in order to reduce emissions from industrial sources, atmospheric deposition of B(a)P to the Baltic Sea decreased substantially (about 40%) in the period 1990-2000 (Fig. 2a). However the subsequent period, namely, 2001-2014, is characterized by stabilization of emissions and levels of deposition to the sea. According to the model estimates the most significant changes of deposition (> 50%) took place in the Western Baltic and the Bothnian Bay sub-basins. Other sub-basins of the Baltic Sea were characterized by somewhat lower decrease of deposition (about 30-40%).

Spatial distribution of annual B(a)P deposition fluxes to the Baltic Sea in 2014 is presented in Fig. 2b. Relatively higher levels of atmospheric load were estimated for the western sub-basins (the Sound and the Western Baltic). Source apportionment of B(a)P deposition indicates that HELCOM countries contributed about 60% to the pollution of the Baltic Sea. Among these countries the largest contribution to total deposition was made by Poland (24%) and Germany (10%). Significant input of B(a)P was also originated from other EMEP countries (about 40%).

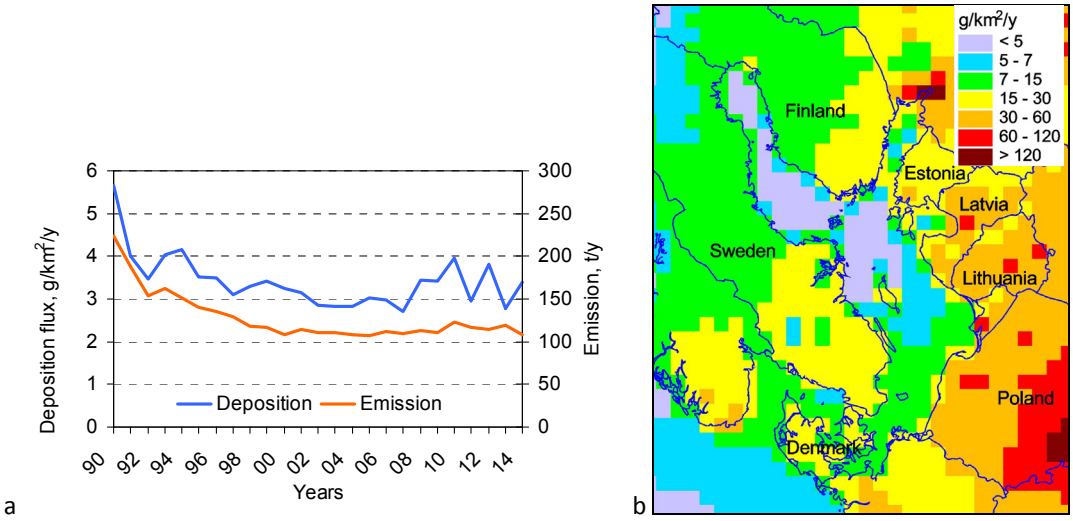

Fig. 2. *Changes of annual B(a)P emissions of HELCOM countries and annual deposition to the Baltic Sea in the period 1990-2014 (a) and spatial distribution of B(a)P deposition fluxes in 2014, g/km²/y (b)*

Seasonal variations of B(a)P pollution levels are characterized by significant difference between the cold and warm periods of the year. In particular, according to measurements and model estimates this difference can be up to an order of magnitude and higher (Fig. 3 a,b). Large seasonal variability of B(a)P pollution is caused by several factors including intra-annual changes of emissions, especially from the residential combustion sector, and effect of more intensive degradation during the warmer period. Modelled and observed levels of concentrations and deposition fluxes closely describe seasonal changes of B(a)P pollution for most part of the year 2014. At the same time, model predictions underestimate observed pollution levels for January, which indicates the need of further refinement of seasonal changes of B(a)P emissions.

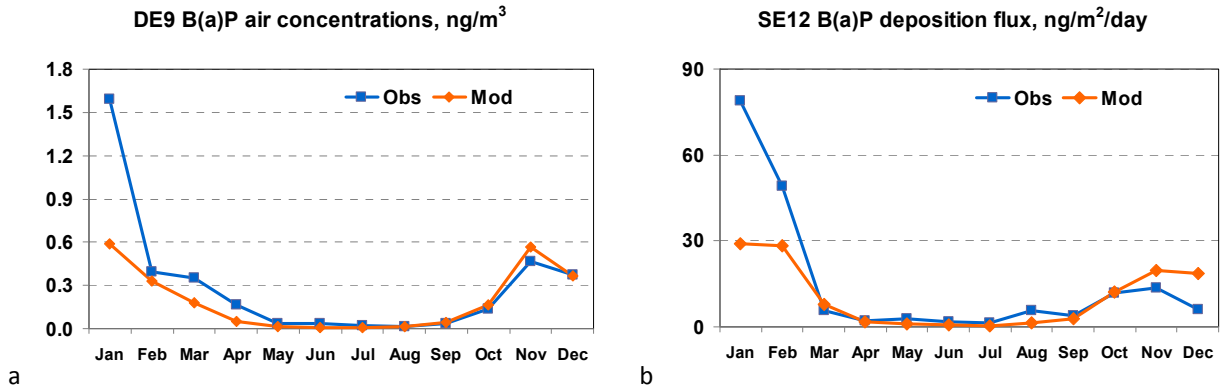

Fig. 3. *Comparison of monthly mean modelled and observed B(a)P air concentrations (ng/m^3) for the EMEP site DE9 (a) and monthly mean deposition fluxes (ng/m^2/day) for the EMEP site SE12 (b)*

Results of the model evaluation of B(a)P atmospheric input to the Baltic Sea were discussed at the meeting of the HELCOM PRESSURE group held in Warsaw in 2016. Particular attention was paid to the stabilization of long-term changes of B(a)P air concentrations and deposition fluxes during the recent decade as well as to the contribution of residential combustion sources to the pollution levels in the Baltic Sea region.