**Atmospheric deposition of PCDD/Fs on the Baltic Sea**

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**Key message**

Annual atmospheric deposition fluxes of PCDD/Fs over the Baltic Sea have decreased in period from 1990 to 2015 by 67%.

**Results and Assessment**

***Relevance of the indicator for describing the developments in the environment***

This indicator shows the levels and trends in PCDD/F atmospheric deposition to the Baltic Sea. Levels of atmospheric deposition of PCDD/Fs represent the pressure of emission sources on the Baltic Sea aquatic environment.

***Policy relevance and policy reference***

HELCOM adopted a Recommendation in May 2001 for the cessation of hazardous substance discharges/emissions by 2020, with the ultimate aim of achieving concentrations in the environment near to background values for naturally occurring substances and close to zero for man-made synthetic substances.

***Assessment***

Annual atmospheric deposition fluxes of PCDD/Fs over the surface of the Baltic Sea have decreased in period 1990-2015 by 67% (Figure 1). The figure illustrates relative changes of computed total annual PCDD/F atmospheric deposition on to the Baltic Sea. Along with that the changes of normalized deposition are presented, which reflect the effect of emission variations without taking into account the influence of inter-annual variations of meteorological conditions. Description of the procedure applied for normalization of annual deposition is given in the Annex D of the Joint report of the EMEP Centres (Bartnicki et al., 2017).

The most significant decrease of PCDD/F atmospheric deposition can be noted for the Sound (76%) and the Western Baltic (74%) sub-basins. For other sub-basins the decline of deposition varies from about 50% to 72% (Table 1).

Evaluation of PCDD/F contamination of the Baltic Sea region is performed using two scenarios of emission data, namely, officially submitted PCDD/F emissions and scenario of PCDD/F emissions prepared by EMEP/MSC-E. Model simulations based on official emission data underestimate observed levels of PCDD/F concentrations. The use of emission scenario obtained on the basis of inverse modelling approach and available measurements permit to obtain reasonable agreement of modelling results with observed PCDD/F pollution levels. Description of this approach and prepared scenario of PCDD/F emissions for the EMEP domain can be found in the EMEP Status Report (*Shatalov et al.*, 2012). According to modelling results with scenario emissions the highest level of PCDD/F atmospheric deposition fluxes in 2015 is estimated for the Sound sub-basin (2.1 ng TEQ/$m^2$/y), while the lowest one for the Bothnian Sea sub-basin

(0.2 ng TEQ/$m^2$/y). In other sub-basins the level of deposition fluxes varies from about 0.3 to 1.0 ng TEQ/$m^2$/y. Among the HELCOM countries the most significant contributions to deposition over the Baltic Sea belong to Russia and Poland.

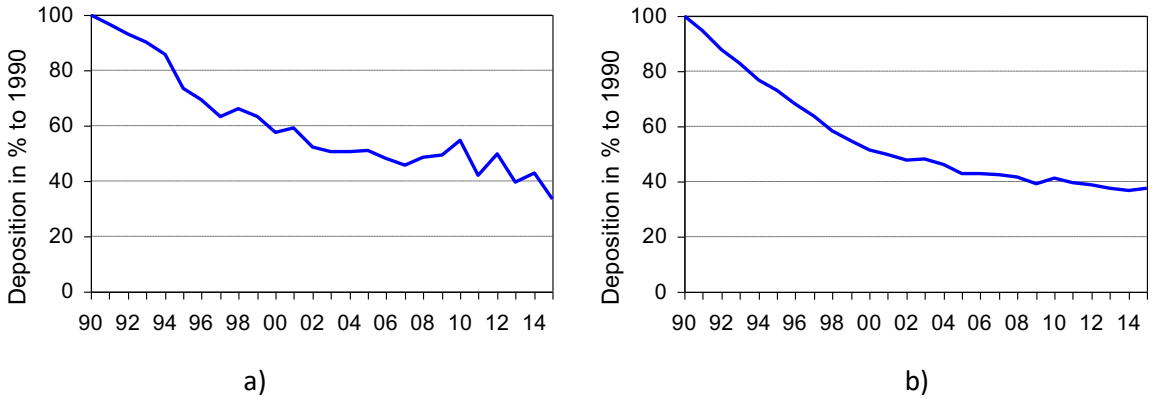


**Figure 1:** Relative changes of modelled absolute (a) and normalized (b) total annual atmospheric deposition of PCDD/Fs to the Baltic Sea for the period 1990-2015, (in % to deposition in 1990).

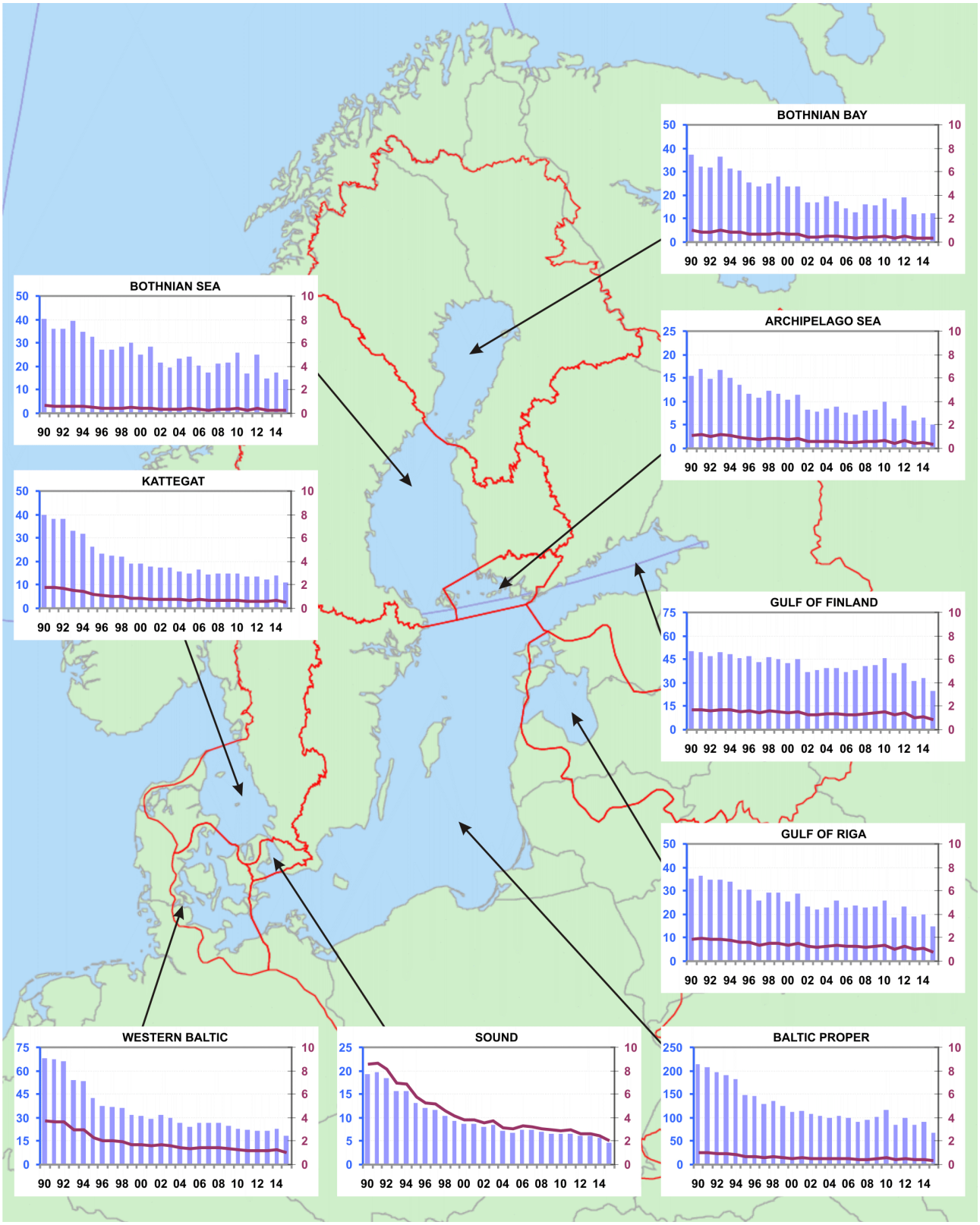


**Figure 2**: Time-series of computed annual atmospheric deposition of PCDD/Fs over the six sub-basins of the Baltic Sea for the period 1990-2015 in g TEQ/year as bars (left axis) and deposition fluxes in ng TEQ/m$^2$/year as lines (right axis). Note that different scales are used for deposition in g TEQ/year and the same scales for deposition fluxes.

**Data**

Numerical data on computed PCDD/F depositions to the Baltic Sea are given in the following tables and can be found in the attached Microsoft Excel file (PCDDF_deposition_data.xls).

**Table 1.** Computed annual atmospheric deposition of PCDD/Fs over the six Baltic Sea sub-basins, the whole Baltic Sea (BAS) and normalized deposition to the Baltic Sea (Norm) for period 1990-2015 obtained using emission scenario.

**Table 2.** Computed contributions by country to annual total deposition of PCDD/Fs to nine Baltic Sea sub-basins for the year 2015 obtained using scenario emissions.

**Metadata**

Technical information:

1. Source:

EMEP/MSC-E

2. Description of data:

Annual atmospheric deposition fluxes of PCDD/Fs were obtained using the latest version of MSCE-POP model developed at EMEP/MSC-E (Gusev et al., 2005). The latest available official emission data for the HELCOM countries have been used in the model computations. Emissions of PCDD/Fs for each year of this period were officially reported to the UN ECE Secretariat by most of the HELCOM countries. These data are available from the EMEP Centre on Emission Inventories and Projections (CEIP) (http://www.ceip.at/).

3. Geographical coverage:

Annual atmospheric deposition fluxes of PCDD/Fs were obtained for the European region.

4. Temporal coverage:

Timeseries of annual atmospheric deposition are available for the period 1990 – 2015.

5. Methodology and frequency of data collection:

Atmospheric input and source allocation budgets of PCDD/Fs to the Baltic Sea and its catchment area were computed using the latest version of MSCE-POP model. MSCE-POP is the regional-scale model operating within the EMEP region. This is a three-dimensional Eulerian model which includes processes of emission, advection, turbulent diffusion, wet and dry deposition, degradation, gaseous exchange with underlying surface, and inflow of pollutant into the model domain. Horizontal grid of the model is defined using stereographic projection with spatial resolution 50 km at 60º latitude. The description of EMEP horizontal grid system can be found in the internet (http://www.emep.int/grid/index.html). Vertical structure of the model consists of 15 non-uniform layers defined in the terrain-following □-coordinates and covers almost the whole troposphere. Detailed description of the model can be found in EMEP reports (Gusev et al., 2005) and in the Internet on EMEP web page (http://www.emep.int/) under the link to

information on Persistent Organic Pollutants. Meteorological data used in the calculations for 1990-2015 were obtained using MM5 meteorological data preprocessor on the basis of meteorological analysis of European Centre for Medium-Range Weather Forecasts (ECMWF).

Results of model simulation of atmospheric transport and annual deposition of PCDD/Fs are provided on the regular basis annually two years in arrears on the basis of emission data officially submitted by Parties to CLRTAP Convention.

Quality information:

6. Strength and weakness:

Strength: annually updated information on atmospheric input of PCDD/Fs to the Baltic Sea and its sub-basins.
Weakness: uncertainties in officially submitted data on emissions of PCDD/Fs.

7. Uncertainty:

The MSCE-POP model results were compared with measurements of EMEP and national monitoring network [Gusev et al., 2006, Shatalov et al., 2005]. The model was evaluated through the comparison with available measurements during EMEP TFMM meetings held in 2005. It was concluded that the MSCE-POP model is suitable for the evaluation of the long range transboundary transport and deposition of POPs in Europe.

8. Further work required:

Further work is required on reducing uncertainties in emission data and modeling approaches used in MSCE-POP model.

***References***

*Gusev A., I. Ilyin, L.Mantseva, O.Rozovskaya, V. Shatalov, O. Travnikov [2006] Progress in further development of MSCE-HM and MSCE-POP models (implementation of the model review recommendations. EMEP/MSC-E Technical Report 4/2006. (http://www.msceast.org/reports/4_2006.pdf)*

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*Shatalov V., Gusev A., Dutchak S., Holoubek I., Mantseva E., Rozovskaya O., Sweetman A., Strukov B. and N.Vulykh [2005] Modelling of POP Contamination in European Region: Evaluation of the Model Performance. Technical Report 7/2005. (http://www.msceast.org/reports/7_2005.pdf)*

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