NOTE

EMEP /MCS-E current activities in the field of HM and POP emissions

This note has been prepared to respond to the questions posed by the EMEP Task Force on Emission Inventories and Projections (TFEIP) and to support discussions focused on the quality of HM and POP emissions and their improvement.

Introduction

Emission data currently provided by the EMEP countries in their national inventories cover only part of the information that is required for model assessment of HM and POP pollution. To provide reliable levels of concentrations and deposition fluxes within the EMEP domain officially reported data need to be complemented by various expert estimates as shown in Table 1.

Table 1. *Information on HM and POP emissions officially provided by EMEP countries. Additional emission data required for model assessment of pollution levels*

Information on HM (Pb, Cd, Hg) and POP (PAHs, HCB, PCBs, PCDD/Fs) emissions	**Official emission data (CEIP)**	**Emission data for modelling (MSC-E)**
Time-series of national total emissions (annually)	X	
Gridded sectoral emissions (once in five years)	X	
Emissions of Large Point Sources (once in five years)	X	
Gridded total emissions for the latest reported year generated by CEIP (annually)	X	
Time-series of gridded annual emissions 1990-2012		X
Vertical distribution of emissions		X
Speciation of Hg forms (Hg°, $Hg(II)_{gas}$, $Hg(II)_{part}$)		X
Congener composition for POPs (PCDD/Fs – 17 congeners, PCB-153)		X
Intra-annual variations of emissions		X
Historical emissions of PCBs, HCB, PCDD/Fs up to 1990		X
Emissions to other environmental compartments (PCDD/Fs, HCB)		X
Emissions for the non-EMEP countries within the EMEP domain. (North Africa and Middle East).		X
Natural emissions		X
Re-suspension, re-emissions		X
Global emission inventories (PCDD/Fs, HCB, PCBs, Hg)		X

The preparation of HM and POP emission data for the EMEP domain includes gap-filling of officially submitted data and generation of gridded time-series of annual emissions. Part of this work is currently carried out by CEIP, namely, gap-filling and gridding the emissions for the latest reported year.

At the same time, preparation of gridded *time-series* of emissions for the whole period of time from the base year to the latest reported year is performed at MSC-E including also *gap-filling and providing emissions for the non-EMEP countries within the EMEP domain* [*EMEP Status Report 2/2012*, Section 1.5; *EMEP Status Report 3/2013, Section 1.1*]. Along with this, model assessment requires evaluation of various parameters and characteristics of these gridded emissions, in particular, their *vertical distribution, chemical composition, and intra-annual variations* [*EMEP/MSC-E Technical Report 6/2005*, Section 2.2; *EMEP Status Report 3/2012*, Sections 1.2.2, 1.2.3]. This information is not provided by the EMEP countries and generated on the basis of expert estimates.

A number of HMs and POPs are the pollutants of global scale dispersion (e.g. Hg, PCBs, PCDD/Fs, HCB). Evaluation of pollution of non-EMEP emission sources, located outside of the EMEP domain, requires application of *global inventories of anthropogenic and natural emissions.*

Pollution levels of HMs and POPs are subject of the influence of *secondary emissions (re-suspension and re-emission)*. For long-lived pollutants it is important to take into account their *historic emissions and emissions to surface waters and land* which have essential effect on contemporary levels of pollution.

Requested by the TFEIP information on various aspects and issues related to the use of officially submitted emissions and expert estimates is given below.

1. Which pollutant(s) is/are your priority for improvement?

Priority for the improvement could be given to cadmium and PCDD/Fs which are characterized by essential uncertainties in emissions and the largest disagreement between modeling results and measurements. Particularly, the discrepancies (under-prediction) for cadmium are about a factor of 2 and for PCDD/Fs about a factor of 5 on the average.

A number of studies performed recently for these two pollutants have noted the uncertainties and incompleteness of available emission inventories for these two pollutants. In particular, analysis of anthropogenic HM emissions in Europe, carried out in the framework of the EU ESPREME project [*Pacyna et al*., 2007], indicated that officially submitted cadmium emissions were significantly lower (by more than a factor of 2) comparing to expert estimates made under the project. It was noted that official data on cadmium released from fuel combustion in various industrial, residential, and commercial units could be *underestimated by more than a factor of 3.* Model assessment of cadmium pollution in Europe performed on the basis of the expert estimates of the project showed satisfactory agreement with measurements.

The under-prediction of observed cadmium pollution levels, obtained in most of modeling studies, was also pointed out in the UNEP review on cadmium [*UNEP*, 2010]. The review indicated that the most likely reason of this under-prediction could be the underestimation of

anthropogenic cadmium emissions and uncertainties in data on natural *releases and re-emission of former cadmium deposition* which required further improvement.

As to PCDD/Fs, it was noted in the review of *Breivik et al*. [2004], that a number of recently made mass balance studies for PCDD/Fs indicated incompleteness and missing of significant sources in the available emission inventories. The incompleteness of PCDD/F emissions reported officially can be connected with the *underestimation of releases from diffuse and unregulated sources such as open burning of biomass or waste [Fiedler, 2007; Mareckova et al., 2012]*. According to the data of global PCDD/F inventory of the UNEP Stockholm Convention (SC) (more than 60 national inventories) the open burning is one of the most significant sources of PCDD/F pollution. In particular, in almost 25% of countries open burning contributed more than 80% of national total PCDD/F emissions [*Solorzano-Ochoa et al.,* 2012]. This type of information is very limited in officially reported emission data in the EMEP countries.

Along with anthropogenic emissions to the atmosphere the PCDD/F pollution levels are also affected by the secondary emission sources which are formed by the atmospheric deposition and direct emissions to land and surface waters. *Direct releases of PCDD/Fs to land, water, and residues are taken into account in the national emission inventories within the UNEP SC*. At the same time, the methodology on the inventory of POP emissions applied in the CLRTAP is oriented on the atmospheric emissions. Thus, the collaboration with the UNEP SC can be important for further improvement of the assessment of PCDD/F emissions.

2. For HMs and POPs, is the current issue poor geographical coverage? Lack of completeness of the national inventories currently being submitted? Or lack of consistency between Parties?

The completeness and consistency of national inventories of HMs and POPs are still the issues and require further improvement. Complete time-series of annual total emissions are reported by only 55% of the countries for HMs and 43% for POPs. The most complete datasets of emissions are currently available for the countries of the Northern and Western parts of Europe, while for the rest EMEP countries the information on emissions is much more incomplete. In particular, 9 countries for HMs and 8 countries for POPs (most of them are the EECCA countries) do not yet report any data on their national emissions. [*Mareckova et al.*, 2013].

In this respect it is important to mention the proposal of Belarus made at the recent session of the Executive Body for the Convention (December, 2013) to set up a project "Proposal on providing technical assistance to the EECCA countries on methodological and practical issues in preparing emission inventories of POPs, HMs, and TSP". The session recognized significance of supporting of this Belarusian capacity-building activity and technical assistance in the EECCA countries.

Besides in the EMEP Status report on emissions [*Mareckova et al.*, 2013], it was noted that recalculations of their emissions were made by 28 of 40 countries (Annex B). It should be mentioned also that the information on the range of uncertainty of reported emission data estimates (max-min) is essential for model assessment of pollution. However, at present only 8 countries provide the information on uncertainties of their national emissions in the informative inventory reports.

3. Have we solved the issue with metal emissions? If not, what needs to be done next?

Though the quality of officially reported data on emissions of heavy metals is slowly improving, they are still subject of deficiencies listed above. Along with these issues particular attention should be given also to the refinement of *information on emission temporal variations, speciation of mercury forms and congener compositions for POPs, vertical distribution of emissions, time-series of gridded annual emissions, contribution of wind re-suspension and etc.*

Wind re-suspension significantly contributes to heavy metal pollution in the EMEP region. Parameterization of re-suspension process is included in the model assessment of heavy metal pollution levels in the EMEP domain. It is likely that estimates of wind re-suspension currently used in the model are characterized by considerable uncertainties and partly compensate possible underestimation of the anthropogenic emissions. Therefore, further refinement of dust suspension parameterization and information on concentrations of HMs in soils, road dust etc. is needed.

Inverse modeling approach can be useful for evaluation and improving quality of emission data. The approach allows identifying regions where emissions may need special examination. MSC-E started to use inverse modelling for refinement of re-suspension from the urban territories [*EMEP/MSC-E Technical Report 1/2014*]. Similar approach may be also implemented for analysis of the anthropogenic emissions.

4. Can you give us a couple of paragraphs on how you make "expert estimates" to fill the gaps in the reported POPs/HM emissions data?

Filling of the gaps in the officially reported time-series of HM and POP emissions is performed on the basis of available emission inventories made by various experts and estimates of emissions carried out by MSC-E. To fill in the gaps of the officially reported data (time-series, spatial distribution, and distribution by sectors) MSC-E uses emission expert estimates worked out by TNO [*Denier van der Gon et al.*, 2005]. For some of the EECCA countries there is no emission data in the TNO inventory. In these cases emissions are derived from available global inventories or estimated from the emissions of other EMEP countries using relationship between emissions and gross domestic products. Details can be found in the *EMEP Status Report 2/2013* and *EMEP Status Report 3/2013*.

Additionally, expert estimates are essentially important in the preparation of emissions for the non-EMEP countries within the EMEP domain. For this purpose available global emission inventories are used (e.g. for Pb, Hg, and PCBs). These data are also applied for the evaluation of contributions of intercontinental transport and secondary emission sources (re-volatilization to the atmosphere) to the EMEP pollution levels. For the evaluation of HCB pollution historic HCB emission scenarios were prepared using available information on the application of HCB in various activities (e.g. agriculture, industry). Elaborated scenarios covered the period starting from 1940s and included low, average and high estimates of emissions. Gridded data were based on the distribution of cropland area for the emissions from agricultural use and on population density for other sources of HCB emissions [*EMEP Status Report 3/2012*, Section 1.2.4].

For PCBs a global emission inventory for the period from 1930 to 2010 [*Breivik et al.*, 2007] is applied for evaluation of the effects of historical emissions and intercontinental transport on the pollution in the EMEP countries.

There is ongoing work at the MSC-E on the development of scenarios for the PCDD/F emissions to the atmosphere and other media based on the inventories of the EU project "Releases of Dioxins and Furans to Land and Water in Europe" [*Wenborn et al.*, 1999; *EMEP/MSC-E Technical report 1/2013*, Section 1.2] and data of the UNEP SC PCDD/F emission inventory [*Cao et al.*, 2013].

Compilation of global PCDD/F emissions, using the UNEP Standardized Dioxins Toolkit [*UNEP*, 2013] is under preparation within the SC now.

A certain progress in the elaboration of global emission inventories is achieved for Hg. Particularly, during the preparation of the Minamata Convention the new global inventory of mercury emission was developed for the year 2010 by UNEP and AMAP [*AMAP/UNEP*, 2013]. These data have been applied for the recent model assessment of pollution levels of Hg for the EMEP region and on the global scale. Thus, collaboration with the UNEP Minamata and Stockholm Conventions as well as with AMAP is of importance and of mutual interest.

5. Do countries then submit these data in subsequent years?

Expert estimates used for the model assessment of pollution levels are available on the MSC-E website [*EMEP/MSC-E Technical report 1/2013*, *EMEP Status Report 3/2013*, *EMEP Status Report 2/2012*, *EMEP Status Report 3/2012*, *EMEP/MSC-E Technical Report 6/2005*].

It would be good to address this question to the countries to start dialogue on this issue.

6. Do you just use data at an annual resolution? If no, can you provide us with a brief description of how you generate the fine timescale emissions?

At present we consider intra-annual variations of emissions for PAHs and PCDDF/s, while for lead, cadmium, mercury, HCB, and PCBs annual resolution of emissions is applied for modeling of pollution levels. Temporal distribution of PAH emissions is made for several aggregated emission source groups. Particularly, fine timescale PAH emissions from residential heating source category are generated using the approach based on the assumption of the dependence of heating power supply on ambient temperature [*Aulinger et al.*, 2010]. Monthly, weekly, and diurnal variations of PAH emissions from road transport and industrial processes source categories are constructed in accordance to the emission temporal profiles used in LOTOS/EUROS model [*Schaap et al.*, 2005]. For other source categories annual emissions are used. Simplified description of seasonal changes of PCDD/F emissions is constructed on the basis of available measurements of air concentrations and variations of emissions of pollutants emitted by similar groups of sources, namely, PAHs [*EMEP Status Report 3/2012*, Section 1.2.2].

Concluding comments on further improvement of HM and POP emission data

1. The major issues with regard to the quality of officially reported emission data for the assessment of HM and POP pollution are connected with the completeness and consistency of inventories in line with the Emission Reporting Guidelines with special attention to the EECCA countries. Cd and PCDD/Fs are pollutants of a first priority.

2. Information on the range of uncertainty of reported emission data is needed to prepare scenarios of emissions for the evaluation of possible maximum and minimum levels of pollution of the EMEP domain.

3. Generating and updating of emission expert estimates, applied for the preparation of HM and POP emission data for modeling, is highly appreciated. (see table 1).

4. Collaboration with the UNEP Minamata and Stockholm Conventions as well as with AMAP is of mutual importance for further work on the evaluation of non-EMEP emission sources affecting pollution of the EMEP domain.

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