INTRODUCTION

This report has been prepared in accordance with the EMEP work-plan (ECE/EB.AIR/83/add2, item 2.7) and recommendations of the EMEP Task Force on Measurements and Modelling (TFMM) as a background document for the review of MSCE-POP regional model.

The main goal of the review and evaluation of the MSC-E models is to establish whether they are state-of-the-art and fit for the purpose of evaluating the contribution of long range transport to the environmental pollution caused by HMs and POPs. MSC-E in close collaboration with the TFMM has started preparatory work for the review.

As a first step of this activity, MSC-E has presented a detailed description of MSCE-POP model and model sensitivity to variations of pollutant-specific and environmental parameters at the 6th TFMM meeting in Zagreb (Croatia) in April 2005. This information was summarized in the EMEP/MSC-E Technical report 5/2005 [*Gusev et al.*, 2005a]. Following to the conclusions of 6th TFMM meeting, the continuation of the review "would take place at a workshop in Moscow on 13-14 October 2005 and would be focused on comparison with observation and model inter-comparisons".

The present report is devoted to the evaluation of MSCE-POP model through the comparison with other modelling approaches and confronting its results with available measurement data on POPs.

The regional MSCE-POP model is aimed at the evaluation of long-range transport and deposition of POPs within the EMEP domain. These pollutants are defined in the Protocol on POPs as "organic substances that: (i) possess toxic characteristics; (ii) are persistent; (iii) bioaccumulate; (iv) are prone to long-range transboundary atmospheric transport and deposition; and (v) are likely to cause significant adverse human health or environmental effects near to and distant from their sources".

At present there exist a number of models of different types (box models, spatially resolved models of different scales, etc.) describing POP behavior in the environment. Different approaches to the description of POP environmental fate were compared in the POP model intercomparison study. This work was initiated under EMEP in 2002 in accordance with the recommendations of the Executive Body for the Convention on Long-Range Transboundary Air Pollution UN ECE [*ECE/EB.AIR/75*] to support the development of EMEP POP multicompartment transport model. The aim of the study was to review different model approaches for the evaluation of POP fate and to improve our understanding of POP behavior in various environmental compartments as well as to evaluate reliability of MSCE-POP model comparing its results with the ones of other POP models. National experts from Canada, the Czech Republic, Denmark, France, Germany, Japan, the Netherlands, Norway, Switzerland, the United Kingdom, and the USA take part in this study.

The results of the intercomparison study are used for the evaluation of MSCE-POP model parameterization, evaluation of uncertainties of main pollutant-related parameters and for evaluation of final uncertainties of MSCE-POP model output caused by uncertainties of pollutant-related parameters. Additionally, some results of model intercomparison are used for the comparison of calculation results obtained by MSCE-POP and other participating models. The emphasis is made at the description of gas/particle partitioning and intermedia fluxes of POPs. Additional details of model description of POP atmospheric transport (advection and diffusion) can be found in the report [*Travnikov and Ilyin*, 2005] since model approaches for the description of these processes are very similar in MSCE-POP and MSCE-HM models.

For the verification of the regional version of MSCE-POP model against observations the following POP species are chosen: B[a]P as a representative of PAHs and PCB-153 and 2,3,4,7,8-PeCDF as a representatives of PCBs and PCDD/Fs. Since PCB-153 is a pollutant of global/regional concern taking into account emission sources located outside the EMEP grid is necessary for this pollutant.

This was done by the usage of complex hemispheric/regional modelling approach. In the framework of this approach pollution of the EMEP region was calculated as a sum of background pollution caused by all emission sources of the Northern Hemisphere except for European (calculated by hemispheric version of the model) and regional pollution from EMEP sources (calculated by regional version of MSCE-POP). Such an approach is feasible since the results of hemispheric and regional models are compatible (see [*Gusev et al*., 2005a]). Of note, simulations of long-range transport of pollutants of purely global concern (HCB and γ-HCH) are performed in MSC-E with the help of the hemispheric model version.

In the comparison the emphasis is put on measurement results obtained at EMEP monitoring sites [*Aas and Breivik*, 2004]. However, the data on POP measurements from EMEP monitoring network are limited. Besides, almost all EMEP monitoring sites (except for CZ3) are located in the northern part of Europe. To enlarge the base of the comparison, the data from other monitoring sites and national and international monitoring campaigns are included, in particular:

- Results of joint Canadian/German project “Quality of measuring data on atmospheric inputs of POPs” [*Gusev et al*., 2005b].
- Measurement data collected under POPCYCLING-Baltic project [*Pacyna et al*., 1999].
- Measurement data obtained at Czech site Kosetice (CZ3) both in air and precipitation and kindly presented at our disposal by Prof. I. Holoubek.
- Measurements of POP concentrations in the United Kingdom from DETR report [*Coleman et al.,* 1998].
- The results of passive sampling campaign performed by Lancaster University and Meteorological Service of Canada in June – July 2002 [*Jaward et al., 2004*].

It should be taken into account that no measurements of PCDD/Fs are carried out in the framework of EMEP, so that for this pollutant the comparison is based purely on the results of other national and international measurement campaigns.

The usage of measurement data for the comparison with the model results requires information on representativity of monitoring sites and the quality of their data. EMEP models are developed to provide information on pollution levels and transboundary transport with spatial resolution 50x50 km^2. Therefore for the purposes of model validation the location of monitoring sites and methodology of measurements should fit certain criteria. However at the moment not all of the sites that perform measurements of POPs follow exactly these requirements. In some cases there is a lack of information which might be helpful for the interpretation of the differences between the model results and observations, in particular, the description of site location, its surrounding, and typical metrological conditions. In spite of these limitations model results were compared with all available information on atmospheric levels of selected POPs.

Model simulations of long-range transport and accumulation of B[a]P, PCB-153 and 2,3,4,7,8-PeCDF were made for the period from 1990 to 2003 by regional version of MSCE-POP model with spatial resolution 50×50 km. According to the above described approach, the calculations for PCB-153 are supplemented by calculations at hemispheric level to take into account external emission sources. Emission data for B[a]P and PCDD/Fs were compiled on the basis of official data submitted to the UN ECE Secretariat by Parties to the Convention supplemented when necessary by expert estimates [*Pacyna et al.,* 1999; *Tsybulski et al*., 2001; *Berdowski et al*., 1997]. Emission data for PCB-153 were taken from emission inventory by K. Breivik with co-authors [*Breivik et al.,* 2002]. More detailed description of emission data used for modelling can be found below in Annex A.

Since the main goal of MSCE-POP model is calculating of atmospheric concentrations and depositions of POPs, we present the comparison of measured and calculated concentrations in the surface atmospheric layer, concentrations in precipitation and deposition fluxes. The comparison of calculated and measured concentrations in other media (soil, seawater and vegetation) can be found in MSC-E reports (see [*Shatalov et al.,* 2003]) and in the Internet (www.emep.int and www.msceast.org). The analysis is performed taking into account possible uncertainties of modelling, emissions and measurements.

In the course of the analysis the emphasis was put on the comparison of annual means of calculated and measured values of air concentrations and depositions. In addition, for the analysis of annual means seasonal variations of these parameters were considered as well. It should be taken into account that the pollution of short emission episodes cannot be correctly reproduced by the model without adequate information on emission seasonal variations. That is why the values of monthly averages of measurements lying outside 3σ-interval around mean value were excluded from the consideration.

The outline of the report is as follows.

Chapter I is devoted to the comparison of MSCE-POP model with other models describing POP behavior in the environment. Some results of POP model intercomparison are used in the Chapter. Here the comparison of POP physical-chemical properties implemented to MSCE-POP model parameterization with that of other models is performed. On the basis of this comparison the uncertainties of MSCE-POP output due to the uncertainties of main pollutant-related parameters are evaluated. Besides, model descriptions of main environmental processes influencing POP behavior (gas/particle partitioning and exchange between the atmosphere and underlying surface) are compared between the models participating in the intercomparison.

Chapter II is aimed at the analysis of the agreement of calculations with available monitoring data. For each of the three selected substances the analysis is divided into three parts: comparison of concentrations in surface atmospheric layer, comparison of concentrations in precipitation and comparison of deposition fluxes. Here long-term trends, seasonal variations and spatial distributions of calculated and measured values of air concentrations, concentrations in precipitation and deposition fluxes are compared.

In the end of the report main conclusions on the comparison of monitoring and modelling data are derived.

Annex A is devoted to the description of emission data used for modelling. Here the peculiarities of preparation of emission data for all three selected pollutants are presented. Annex B contains the set of pollutant-related parameters used in models participating in the model intercomparison study. The full set of measurement and calculation data used in the comparison of MSCE-POP results against measurements will be placed to the Internet www.msceast.org. Annex C presents available information on EMEP measurement sites involved into the comparison.

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