SUMMARY

This report presents the results of the work fulfilled by Meteorological Synthesizing Centre East of EMEP (EMEP/MSC-E) as a part (Activity 3) of the GEF project "Persistent Toxic Substances (PTS), Food Security and Indigenous Peoples of the Russian North". The study has been carried out under the Contract with Arctic Monitoring and Assessment Programme (AMAP) and with financial support of World Meteorological Organisation (WMO) and voluntary contribution of Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP).

The main objective of the Activity 3 of the GEF project is to provide the assessment of long-range atmospheric transport and depositions of mercury (Hg), selected polychlorinated biphenyls (PCBs), and lindane (γ-HCH) to five administrative units of the Russian part of the Arctic region:

- Murmansk Oblast (Kola Peninsula)
- Nenets Autonomous Okrug (Lower part of the Pechora basin)
- Yamalo-Nenets Autonomous Okrug and Taimyr Autonomous Okrug (Taimyr Peninsula)
- Chukotka Autonomous Okrug (Chukchi Peninsula)
- Sakha Republic (Lower basin of Lena River)

According to the Contract the fulfilment of this work was divided into three stages.

The first stage was aimed at the preparation of relevant meteorological information and the development and verification of atmospheric transport module for the hemispheric scale models. A special System of Diagnosis of lower Atmosphere (SDA) for generation of meteorological information for the Northern Hemisphere was elaborated. Testing the atmospheric transport module has shown that it can adequately simulate pollutant transport in the atmosphere and does not produce significant numerical errors and distortions.

The second stage was devoted to the preparation of input data on emissions, geophysical data, physical-chemical properties of Hg and selected POPs and the development of hemispheric multi-compartment transport models. To provide the models with geophysical data different sources of information were considered and analyzed. These data include information on land cover, leaf area index, organic carbon content in soil, ozone, sulphur dioxide, and chemical reactant concentrations in the atmosphere.

The development of Hg and POP hemispheric models (MSCE-Hg-Hem and MSCE-POP) were carried out step by step using the modular approach. It was started with the development of atmospheric transport module common for the series of HM and POP models. Additional modules necessary for modeling mercury and selected POPs on the hemispheric scale have been also developed. The hemispheric mercury model was supplied with the module describing chemical transformations of mercury in the atmosphere. This module was elaborated using the experience of ongoing Hg model intercomparison study performed under EMEP. The hemispheric POP model was supplied with

modules describing the distribution of POPs within soil, vegetation, and seawater compartments. The model description of POP fate in the seawater compartment takes into account POP transport with sea currents, POP partitioning in seawater and the influence of ice cover dynamics in the Arctic. POP fate within soil, seawater and vegetation compartment has not been adequately explored and requires further investigations.

The third stage was focused on the assessment of pollution of five selected regions of the Russian North by Hg, PCBs and γ-HCH from distant sources using the developed models and collected input data. This assessment includes the evaluation of concentration and deposition levels of these contaminants and contributions of main emission sources within the Russian Federation and the Northern Hemisphere to the selected areas and the Arctic as a whole. Main pathways of pollutants in question are considered.

Hg

The assessment for Hg is based on the modeling results of its long-range transport in the Northern Hemisphere. Particular attention is paid to the effect of Mercury Depletion Events (MDE) on the Arctic pollution. Satisfactory agreement of modeling results with available measurements verifies reasonable reliability of the model. Concentration levels of mercury in the ambient air and deposition fields are evaluated for all the selected regions of the Russian North. Seasonal variation of the pollution is considered. Main contributors to the contamination of the regions are determined and prevailing pathways of mercury transport are discussed.

PCBs

For the assessment of concentration and deposition levels of PCBs for the studied areas and contributions of major emission sources of the Russian Federation and other distant sources of the Northern Hemisphere several PCB congeners were selected for modeling: PCB-28, PCB-118, PCB-153, and PCB-180. These congeners make it possible to evaluate peculiarities of environmental behaviour of individual PCB congeners caused by differences in their properties between light and heavy congeners. Verification of computed concentrations and deposition fluxes against the measurements made in the Arctic and European regions is demonstrated. Detailed description of pollution levels and their seasonal variations and contributions from various emission sources to the contamination of the Russian Arctic is presented. Pathways of PCB atmospheric transport are analyzed.

γ-HCH

Model results on levels of γ-HCH air concentrations in and depositions to the Russian North regions originated from emission sources of Europe and the Northern Hemisphere are presented. γ-HCH modeling was based on available official information and expert estimates of γ-HCH emissions and its usage in different regions of the Northern Hemisphere. Seasonal variations of pollution levels and contributions to depositions and air concentrations of γ-HCH from different source groups are estimated. Pathways of γ-HCH atmospheric transport are analyzed.

Detailed description of input data preparation, model development and modeling results obtained in the framework of this study are presented in this Technical Report.