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The environment of nature reserves under anthropogenic load: air transport of pollution to the North of European Russia

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Nature reserves are created to keep in their original states natural environment, flora and fauna of various ecological systems, territories, climatic zones, etc. Now natural objects everywhere exist under anthropogenic loading from man-made activities. It is impossible to avoid atmospheric or river transport of pollution to the environment of reserved territories.

The main idea of the work is to analyze atmospheric transport of anthropogenic metals (Ni, Cu, Pb, Fe, Al), as well as of soot (black carbon – BC) from Russian large industrial areas (source-regions) to the territories of nature reserves at the North of European Russia – the Kostomukshsky reserve (KR) in Karelia (64.57ºN, 30.67ºE) and the Nenetzky reserve (NR) at the Pechora River mouth (68,5ºN, 53,5ºE). The basic data for these 2 points were back trajectories of air mass transport calculated for every day of January, April, July, and October during 10 years from 2001 to 2010. We used NCEP/NCAR Reanalysis Data Files with HYSPLIT 4 model and two approaches for analyzing the trajectories. The main source-regions were chosen for each reserve. The annual source emissions for the last decade are generalized from the data published by Roshydromet of Russia (http://www.nii-atmosphere.ru/files/PUBL/Eg_2008.doc).

The deposition velocity was a sum of dry and wet components. The equal values of deposition velocities onto the surface were assumed for all impurities because they are mainly on submicron aerosol particles under atmospheric transport for a long distance. The seasonal and spatial variations of averaged deposition velocity were accounted in accordance with surface properties and precipitation regimes. As a result, the maximal air concentrations of aerosol pollutants are observed in cold seasons, whereas the maximal fluxes onto the surface occur in warm period. Thus, it's possible that the cleanest air does not indicate the same surface.

Fe and Al are the crust (dust or soil) elements. Thus, their main sources are open (snow free) land surface, as well as whole-year working Kostomuksha open-cast mine. From our estimates, about $\frac{3}{4}$ of Fe and $\frac{1}{2}$ of Al are yearly transported to the KR environment from the open-cast mine of Kostomuksha mineral processing plant, and the rest amount – from surrounding open land surface in summer time. We also computed that the transboundary input of Ni and Cu transported from Finland industry to the KR environment is less than (but quite comparable with) the total input from the Russian sources.

To the contrary, for the NR we applied the other approach: the spatial distributions of the potential pollution function were calculated, and showed the potential danger from the sources at different places to pollute the NR environment. These maps may be used for estimating the inputs not only from small (in comparison with the length of trajectories) source-regions but also from distant sources (forest fires and so on) to environmental pollution at the reserve.

The combination of such approaches allows us to study the environmental pollution at the remote and hard-to-reach areas of the Russian European North more carefully.