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Source apportionment of atmospheric pollutants at Pallas, Finland during 1996-2009

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Introduction

Source apportionment of atmospheric pollutants was studied at the Finnish Meteorological Institute's (FMI) Global Atmosphere Watch (GAW) station, Pallas (67°58′N, 24°06′E). The station is located at the northernmost limit of the northern boreal forest zone and represents well the continental background air of the subarctic region (Hatakka et al., 2003). The dataset from 1996 to 2009 (one week in a month) contains trace elements, the major inorganic ions, ozone, nitrogen dioxide, sulphur dioxide, and persistent organic pollutants (POP) including poly-cyclic aromatic hydrocarbons (PAH). POP samples were analyzed in the laboratory of the Swedish Environmental Research Institute (IVL). Positive Matrix Factorization (PMF) was applied in source apportionment and the source sector frequency distribution using EMEP air mass trajectories was calculated for each PMF factor in order to identify source directions.

Results and discussion

PMF-analysis of weekly samples yielded five potential source factors, which were identified as Kola factor (F1), insecticide factor (F2), sea spray factor (F3), soil factor (F4) and traffic and LRT factor (F5).

Factor 1 contains large amount of trace elements (As, Ni, Cu, Pb, V, Zn) with most of gaseous SO2 and 30-40% of the heavier PAH pollution. These pollutants are characteristic to the industries in Kola peninsula and air masses for this factor came from east.
Factor 2 contains most of the insecticides a-HCH and g-HCH (lindane) with high summer contribution, but without any specific source direction. This factor had a decreasing trend due to the reduction of the production and use of these compounds (Li et al., 2002).
Factor 3 is the sea spray factor without clear seasonal variation. Over 60% of PM10 was associated to this factor, i.e. maritime air masses and sea salt particles. The source direction was the Arctic Ocean and the northern Atlantic Ocean Majority of organochlorine compounds and 30% of the lighter PAH compounds were associated with this factor.
Factor 4 is a soil source; high loadings of aluminium, manganese, ammonium, potassium and PCBs with a systematic summer maximum. PCBs are found in particles and/or evaporation from the soil (Yi et al., 2008). The air masses related to this factor originated mainly from south and west.
Factor 5 includes approximately half of PAHs and NO2. The factor contribution was highest in winter and the dominating source directions were south and southwest. The high loadings of NO2 and long-range transfer (LRT) nitrate and ammonium particles suggest reasonably remote traffic sources. The high contribution of DDT and DDE also refers to LRT air masses from the southern areas, where DDT is still in use (ATSDR, 2002).

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