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Changes in background aerosol composition in Finland during polluted and clean periods studied by TEM/EDX individual particle analysis

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Abstract. Aerosol samples were collected at a rural background site in southern Finland in May 2004 during pollution episode (PM_1 ~16 μg m^{-3}, backward air mass trajectories from south-east), intermediate period (PM_1 ~5 μg m^{-3}, backtrajectories from north-east) and clean period (PM_1 ~2 μg m^{-3}, backtrajectories from north-west/north). The elemental composition, morphology and mixing state of individual aerosol particles in three size fractions were studied using transmission electron microscopy (TEM) coupled with energy dispersive X-ray (EDX) microanalyses. The TEM/EDX results were complemented with the size-segregated bulk chemical measurements of selected ions and organic and elemental carbon. Many of the particles in $PM_{0.2-1}$ and $PM_{1-3.3}$ size fractions were strongly internally mixed with S, C and/or N. The major particle types in $PM_{0.2-1}$ samples were 1) soot and 2) (ammonium)sulphates and their mixtures with variable amounts of C, K, soot and/or other inclusions. Number proportions of those two particle groups in $PM_{0.2-1}$ samples were 0–12% and 83–97%, respectively. During the pollution episode, the proportion of Ca-rich particles was very high (26–48%) in the $PM_{1-3.3}$ and $PM_{3.3-11}$ samples, while the $PM_{0.2-1}$ and $PM_{1-3.3}$ samples contained elevated proportions of silicates (22–33%), metal oxides/hydroxides (1–9%) and tar balls (1–4%). These aerosols originated mainly from polluted areas of Eastern Europe, and some open biomass burning smoke was also brought by long-range transport. During the clean period, when air masses arrived from the Arctic Ocean, $PM_{1-3.3}$ samples contained mainly sea salt particles (67–89%) with a variable rate of Cl substitution (mainly by NO_3^-). During the intermediate period, the $PM_{1-3.3}$ sample contained porous (sponge-like) Na-rich particles (35%) with abundant S, K and O. They might originate from the burning of wood pulp wastes of paper industry. The proportion of biological particles and C-rich fragments (probably also biological origin) were highest in the $PM_{3.3-11}$ samples (0–81% and 0–22%, respectively). The origin of different particle types and the effect of aging processes on particle composition and their hygroscopic and optical properties are discussed.

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