Chemical composition and hygroscopic properties of aerosol particles from Siberian boreal area.

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Organic aerosols (OA) along with the elemental carbon (EC) and inorganic ions strongly contribute to direct and indirect aerosol effects on climate. Boreal forests in Eurasia are a major source of primary organic aerosols (POA) directly emitted from the surface to the atmosphere and secondary organic aerosols (SOA) formed from gaseous precursors in the atmosphere. In order to evaluate and understand the influence of aerosols on climate change in the Artic and Northern Eurasia, long-term observations of the OC, EC and ion content of aerosols in the boreal zone are needed.

In this work we present continuous measurements from April 2010 to June 2012 conducted at Zotino Tall Tower Observatory in Central Siberia (ZOTTO, 60º N, 89º E), Russia . The quartz fiber filters were analyzed for organic and elemental carbon by thermal-optical instrument (SunSet lab.). The Nuclepore filters were analyzed for major anions and cations by ion chromatography (Dionex, ICS-1100). With help from high time resolution CO and light absorption results and HYSPLIT back trajectories calculations, the filter samples were separate to episode samples and non-episode samples.

The aerosols chemical composition were clearly different between episode and non-episode samples, and between winter and other three seasons. The winter episodes associated with elevated concentrations for most of species were usually related to anthropogenic pollution, the air masses during such episodes had passed over the central Siberian region around Omsk and Novosibirsk – a heavily industrialized area. During spring and fall, a number of samples exhibited high K+, and oxalate levels, indicating an impact from biomass burning. In addition a notable episode with extreme high Na, Cl, and Mg were observed for the samples collected between 20 to 24 December 2010, which may result from long range transport of sea salt.

In the aerosol chemical mass closure calculations, six aerosol types were considered. Organic matter (OM) contributed by far the most to the PM mass; it accounted for about 60-70% of the average PM mass. Followed by Secondary Inorganic Aerosols species (SO4, NH4, and NO3), more than 30% of PM mass. OM contribution to PM mass was lower in winter than that in the other three seasons, while EC, Ammonium and Nitrite show higher contribution in winter. The mean PM mass attribution to the different aerosol types Zotto during non-episodes periods were similar to those for the 2007 campaign at the forested site of Hyytiälä, Finland. EC and Nitrate were more important and Ammonium was clearly less important at Zotto, though.

Key issues are the hygroscopic growth of boreal aerosol particles and their activation as cloud condensation nuclei (CCN). Water soluble organic carbon compounds typically account for ~50% or more of total OC (Timonen, 2011) but their impact on aerosol water uptake and cloud formation are not fully characterized. In this study the mass-based hygroscopicity measurements under sub-saturated conditions at 5-99% RH (FDHA, Mikhailov et al., 2013) were used to characterize CCN and hygroscopic properties of the boreal aerosols. It was shown that aerosol water uptake is basically controlled by concentration of inorganic ions in the aged particles.

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