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Using a moving measurement platform for determining the chemical composition of atmospheric aerosols between Moscow and Vladivostok

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Abstract. The TROICA-9 expedition (Trans-Siberian Observations Into the Chemistry of the Atmosphere) was carried out at the Trans-Siberian railway between Moscow and Vladivostok in October 2005. Measurements of aerosol physical and chemical properties were made from an observatory carriage connected to a passenger train. Black carbon (BC) concentrations in fine particles ($PM_{2.5}$, aerodynamic diameter $<2.5\ \mu\text{m}$) were measured with an aethalometer using a five-minute time resolution. Concentrations of inorganic ions and some organic compounds (Cl^- , NO_3^- , SO_4^{2-} , Na^+ , NH_4^+ , K^+ , Ca^{2+} , Mg^{2+} , oxalate and methane sulphonate) were measured continuously by using an on-line system with a 15-min time resolution. In addition, particle volume size distributions were determined for particles in the diameter range 3–850 nm using a 10-min time resolution. The continuous measurements were completed with 24-h $PM_{2.5}$ filter samples stored in a refrigerator and analyzed later in a chemical laboratory. The analyses included the mass concentrations of $PM_{2.5}$, ions, monosaccharide anhydrides (levoglucosan, galactosan and mannosan) and trace elements (Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sb, V and Zn). The mass concentrations of $PM_{2.5}$ varied in the range of 4.3–34.8 $\mu\text{g m}^{-3}$ with an average of 21.6 $\mu\text{g m}^{-3}$. Fine particle mass consisted mainly of BC (average 27.6%), SO_4^{2-} (13.0%), NH_4^+ (4.1%) and NO_3^- (1.4%). One of the major constituents was obviously organic carbon which was not determined. The contribution of BC was high compared with other studies made in Europe and Asia. High concentrations of ions, BC and particle volume were observed between Moscow and roughly 4000 km east of it, as well as close to Vladivostok, primarily due to local anthropogenic sources. In the natural background area between 4000 and 7200 km away from Moscow, observed concentrations were low, even though local particle sources, such as forest fires, occasionally increased concentrations. During the measured forest fire episodes, most of the aerosol mass appeared to consist of organic particulate matter. Concentrations of the biomass burning tracers levoglucosan, oxalate and potassium were elevated close to the forest fire areas observed by the MODIS satellite. The polluted air masses from Asia seem to have significant influences on the concentration levels of fine particles over south-eastern Russia.

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