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Long-Term Measurements of Carbon Monoxide and Aerosols at the ZOTTO tall tower, Siberia

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The Zotino Tall Tower Observatory (ZOTTO), operated by the Max Planck Institutes for Biogeochemistry and Chemistry and the Institute of Forest (Krasnoyarsk), is located at 89.35°E, 60.80°N, 114 m asl. at a very remote continental site in Siberia, Russia. It centers on a 300-m tower designed for scientific measurements of chemical (trace gases, aerosol) and physical (meteorological) properties. The instrumentation at the observatory includes a CO Monitor, a Particle Soot Absorption Photometer (PSAP) for determining the aerosol absorption coefficient, a nephelometer for the determination of the aerosol scattering coefficient, and a Differential Mobility Particle Sizer (DMPS) to measure the aerosol number size distribution.

We present measurements made from October 2006 until March 2011, with some interruptions due to technical reasons. An annual cycle of the background CO mixing rations was observed with summer minima around 90 ppb and winter maxima of about 175 ppb. Amplitude and phase of the annual cycle were generally similar to that reported by NOAA-ESRL for latitude 61°N, but showed an earlier onset of the elevated winter values. Episodes of elevated CO and aerosol concentrations, typically lasting for several days, are superimposed on the background seasonal cycle. During winter, these pollution episodes are usually associated with air masses that have passed over the central Siberian region around Omsk and Novosibirsk – a heavily industrialized area. During spring and summer, elevated levels of CO and aerosols are often caused by agricultural fires in southern Siberia and Kazakhstan or by forest fires in boreal Siberia.

The optical properties of the aerosol showed more pronounced seasonal variability than the aerosol mass and number concentrations. Wintertime aerosols were highly absorbing, with single scattering albedos (SSA) around 0.85, consistent with a dominant fossil fuel combustion source. In contrast, summertime aerosols had very low absorption coefficients with SSA values reaching 0.97. These aerosols were present in airmasses from northern Siberia with low CO mixing ratios, which suggests that they are predominantly of biogenic origin. The lowest particle number concentrations (averaging ∼430 cm-3) were present in northern Siberian and Arctic airmasses, with similar values in summer and winter. Chemical analysis shows that sulfates and “black” carbon are elevated in the winter aerosol, while organic carbon from biomass burning and terpenoid oxidation dominate in summer.

The measurements at ZOTTO are being continued, in the expectation that long-term variations in the continental background signal could give new insights into the feedback of ecosystems on a continental scale to changing climatic conditions.