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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. in Siberia, Russia. It centers on a 300-m tower designed for scientific measurements of chemical (trace gases, aerosol) and physical (meteorological) properties at a very remote, continental site. The instrumentation at the observatory comprises 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 May 2008, with some interruptions due to technical reasons. An annual cycle of CO was observed with summer minima around 80 ppb and winter maxima of about 180 ppb. Amplitude and phase of the annual cycle were comparable to that reported by NOAA-ESRL for latitude 61°N. Periods of elevated CO concentrations, typically lasting for one to three days, interrupted the mean annual cycle. Backward trajectories computed with the NOAA HYSPLIT model indicated changes of air mass origin associated with the CO peaks. It was found, that for several peaks air masses have passed over the region of Novosibirsk – a heavily industrialized area. During summer, very sharp peaks of CO concentration with no change of air mass origin were observed. In this case, local wild fires are most likely the cause of the increase of CO concentrations. This general picture was confirmed by the output of the MATCH (Model of Atmospheric Transport and Chemistry) model that predicted CO concentrations in good agreement with the measured CO concentration at the ZOTTO site, resembling the typical annual cycle of CO concentrations. Furthermore, some of the peaks related to changes of the air mass origin were also predicted by the model, while the peaks presumably caused by wild fires were not found.
The optical properties of the aerosol showed intense variations over the observation period. Episodes with strongly elevated absorption coefficients and particle concentrations occurred between periods of typical background readings. Using gaseous tracers, especially CO, and back-trajectories, these episodes could be traced to anthropogenic emission regions. The combination of CO concentration and aerosol properties with the determination of the air mass origin enables us to distinguish between continental background air and air masses being influenced by anthropogenic activities. 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.

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