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Forest fire plumes sampled above Siberia during YAK-AEROSIB/POLARCAT airborne campaigns: properties and sources

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The composition of the Siberian troposphere remains highly unknown due to a lack of measurements in this area. Siberia is a key region for a quantified understanding of many land-atmosphere exchange processes. As an example, Siberian forest fire emissions are a major extratropical source of CO to the atmosphere. Fire-emitted trace gases and particles are subject to long-range transport and may contribute to pollution of nearby Arctic. However, establishing precise top-down estimates of sources strengths based on satellite or surface network measurements for species such as CO is limited by models‘ ability to represent sub-grid-scale dynamics associated to the wildfire (pyroconvection) and the injection height of the plume.

In an experimental effort to address this issue and to increase our knowledge of the properties of the Siberian troposphere, CO, O_3, CO_2 and fine particles were measured onboard a research aircraft in the frame of the YAK-AEROSIB project, partially as a contribution to the Summer 2008 POLARCAT programme. Two large scale transects were established over Northern and Central Siberia between 7 and 21 July 2008. The aircraft flight pattern consisted of ramp ascents and descents so as to sample as many vertical profiles as possible.

Very high CO concentrations were observed at various altitudes, essentially in Eastern Siberia near Yakutsk and Chokurdakh. The highest concentrations (up to 600ppb) were observed between 2 and 5 km (flight ceiling being at 7km) in very thin layers (few hundreds of m thick). A Lagrangian modelling analysis (FLEXPART) revealed that the aircraft sampled fire plumes from regional fire emissions, east of Yakutsk, after about 2 days of transport.

The observed fire plumes are also characterized by anomalies in O_3 and excess particle concentrations. These data provide new constraints on our understanding of forest fire plume transport. They also constitute a critical testbench for the models used to assess pyrogenic emissions and to predict transport of pollution to the Arctic and at the global scale.