Geophysical Research Abstracts
Vol. 13, EGU2011-10962, 2011
EGU General Assembly 2011

Pollution transported to the Arctic during the POLARCAT-France spring and summer 2008 campaigns: source regions and aerosol properties.

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Within the frame of the POLARCAT-France campaign, part of the 4th International Polar Year, the French research aircraft ATR-42 was deployed at Kiruna, Sweden and Kangerlussuaq, Greenland in April and July 2008, respectively. The aim of the campaigns was to characterise pollution plumes of different origins as they are transported to the Arctic. This study is focusing on the physical, chemical and optical properties of aerosol particles transported to remote Arctic regions.
Spring measurements are presented through two principal kind of pollution, i.e. a fresh anthropogenic plume originating from central Europe sampled during three consecutive days and Russian forest fires both characterised by aerosol size distributions, air mass age, single particle transmission electron microscopy and X-ray spectrometry, volatility and optical properties. Air mass origins and ages are obtained through the lagrangian particle dispersion model FLEXPART. In general, the ageing of anthropogenic particles during long-range transport is characterised by the enlargement of the mean Aitken mode diameter, a decrease of particle concentration and carbon monoxide (CO) mixing ratio along the transport pathway. The filamentous structure of long-range transport pollution is illustrated by an aerosol Lidar onboard the research aircraft. With respect to sampled air masses from anthropogenic plume TEM-EDX analysis of sub-micron aerosol particles reveals soot particles in an external mixture and sulphate-rich particles with soot-like inclusions; which is in good agreement with expected results. Pollution aerosol from forest fires transported to the Arctic shows important amount of absorbing materials mainly related to black carbon particles. Forest fire aerosol particles are widely dominated by the very concentrated accumulation mode and are always correlated with high values of CO enhancement. TEM-EDX analysis of forest fire air mass samples illustrates particles particularly enriched in Potassium and with soot-like inclusions.
The summer measurements are dominated by North American air masses, principally influenced by boreal forest fires in the Ohio valley. Measurement of CO mixing ratio, aerosol chemical composition (from Aerodyne Mass Spectrometer), size distributions, volatile fractions and aerosol light absorption (mainly from black carbon) are utilised in order to study the relationship between CO enhancement, ageing of the air masses, aerosol particle concentrations and size distributions. These parameters, especially aerosol size distributions, are compared with previous studies and are in good agreement regarding the Aitken mode concentration whereas the accumulation mode appears largely less concentrated. This difference is explained by wet scavenging potentially occurring on the pathway between the emission sources and Greenland. Aitken and accumulation modes are found to be composed mainly of black carbon and organics (seen in the important aerosol volatility), respectively. In all studied cases, during the summer campaign, rather small amount of climate relevant black carbon from the North American continent are transported to Greenland.