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Comparison of particles recovered from the Greenland Ice Core Project using computer controlled scanning electron microscopy

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Analysis of individual particles recovered from ice cores can be used to assess past climatic signatures. So far either the size and the number concentration or the elemental composition of individual particles have been analyzed. Size and number can be assessed using liquid particle counters and the elemental composition of the particles can be determined using electron microscopic techniques. However, only a limited number of particles have been analyzed for their elemental composition as these analyses have been performed manually.
In this paper, we have analyzed a large number of individual particles from samples of the Greenland Ice Core Project (GRIP) using computer controlled scanning electron microscopy (CCSEM) to determine elementally resolved particles size distributions including particles from 0.5 – 10 um.
We have analyzed 3 samples each from the Holocene and from the last glacial maximum (LGM). Ice core samples were defrosted in the microwave to about 4° C and filtered using 0.45 μm polycarbonate filters (Nuclepore). On each sample, we have analyzed particles from 5 randomly selected areas, each area comprising of 9 individual images. Particles were detected based on their backscattered electron signal and automatically analyzed using energy dispersive x-ray (EDX) analysis system. In total more than 20'000 particles have been analyzed.
The size distributions of individual samples were modeled using a log-normal distribution. The mode was around 1.8 μm (diameter) with slightly larger values for the samples from the LGM. This trend was paralleled by about a 10 fold higher particle number concentrations in the LGM compared to the Holocene samples.
Averaged elementally resolved particle size distribution did not show any size dependence (0.7 – 10 μm). Particles from both climatic periods were dominated by Si and Al, with minor contributions of K, Ca, Mg and Fe. The averaged values of Fe and Mg were slightly increased in the samples from the LGM compared to the Holocene samples. The observed compositions are typical for geological materials dominated by clay minerals. The higher Fe and Mg concentrations observed in the LGM samples most likely represent different clay minerals, originating from different source regions.
CCSEM analysis of a large number of single particles from GRIP samples revealed differences in number concentration and, less evident though, in the size and in elemental composition of samples from the Holocene and the LGM. The particle ensembles from the two different climatic periods will be statistically analyzed in more details and the results will be interpreted in terms of climatic changes.