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High resolution dust measurements in the NGRIP ice core, Bølling-Allerød Interstadial

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Abstract

Atmospheric aerosol and in particular mineral dust is an important component of the climatic system and plays multiple roles in mediating physical and biogeochemical exchanges between the atmosphere, land surface and ocean (e.g. supply of micronutrients to the ocean)[1]. Greenlandic ice core studies have provided information about the variations of atmospheric aerosol content under different climatic conditions in the past [2]. They show an increase in eolian dust supply during glacial periods while the concentration of dust is low during warm periods [3]. Comparing the Last Glacial Maximum and the Holocene the mineral dust concentration in Greenland vary by a factor of approximately 80 [3]. Regarding the size distribution, larger particles were found during colder climates. Higher dust content in Greenland ice cores during glacial times can be explained by increased desert area in central Asia and a strengthening of the Asian winter monsoon [2]. Seasonally resolved dust size and concentration data exhibit systematic variations within a year. They provide detailed information about past abrupt climate fluctuations that occurred within a short period of time.

In this study, dust deposition has been examined in subannual resolution using dust concentration and size measurements on the Bølling-Allerød Interstadial in the NorthGRIP ice core. For this a Multisizer Coulter Counter (CC) has been used, which provides particle counts and sizes in an overall size range of 0.7 μm to 18 μm. A method to achieve a higher temporal resolution has been developed, which enables to sample the ice core in mm resolution without contamination. The new data set is in good agreement to previously measured Continuous Flow Analysis (CFA) dust data.

Our results show systematic variations of particle concentration changes. The measurements are performed in 5 mm depth resolution which corresponds to a temporal resolution of approximately 1 - 2 months. The seasonal variations show an increase by a factor of approximately 10 in the high-dust season compared to the low-dust season. In contrast, the size distribution of dust particles shows no clear seasonal signal although its mode varies from 1.4 μm to 4.0 μm. Dust size spectra provide information on past transport time by the fact that transport mechanisms and rates of the larger particles are stronger and faster than that of the smaller particles. Thus, no clear seasonal transport pattern can be pinned down for the Bølling-Allerød Interstadial as recorded in the NorthGRIP ice core.

References:

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