Geophysical Research Abstracts
Vol. 13, EGU2011-8164, 2011
EGU General Assembly 2011

High resolution dust measurements of different climatic periods in the NorthGRIP ice core

Katrin Wolff (1,3), Anna Wegner (1), Hubertus Fischer (2), and Michael Schulz (3)

(1) Alfred Wegener Institute for Polar and Marine Research, Germany (katrin.wolff@awi.de), (2) University of Bern, Oeschger Centre for Climate Change Research, Bern, Switzerland, (3) MARUM – Center for Marine Environmental Sciences, Bremen, Germany

Atmospheric aerosol and in particular mineral dust is an important component of the climate 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]. Greenland ice core studies provided information of past variations of atmospheric aerosol content under different climatic conditions [2] and show an increase in eolian dust supply during glacial periods, while the concentration of dust during warm periods decreased [3]. 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]. High resolution dust measurements provide detailed information about past abrupt climate fluctuations.

In this study we present dust concentration data measured in a sub-annual resolution on 5 selected ice segments, each 55 cm long, extracted from the NGRIP ice core, for the early Holocene (∼9980 yr BP), Allerød Interstadial (∼13640 yr BP), LGM (∼20870 yr BP), pre-LGM (∼25920 yr BP) and DO event 7 (∼35420 yr BP). The amount of particles and the size distribution for discrete samples were measured using a Multisizer 3 Coulter Counter (CC). The depth resolution ranged between 2-7 mm depending on the accumulation rate, which corresponds to a temporal resolution of at least 7 samples per year.

Pronounced systematic variations of mass concentration changes are observed in all analysed ice intervals. On average, the Holocene ice interval shows a mass concentration of ∼250 μg kg-1. Often a secondary maxima can be determined in the course of the year. The seasonal variations show an amplitude of ∼10. In the Allerød Interstadial ice section an averaged mass concentration of ∼380 μg kg-1 was recorded. The seasonal variations of the mass concentration vary by a factor of ∼16. Similar to the Holocene ice interval a secondary maxima was found. In contrast to the Holocene and Allerød samples, the LGM and pre-LGM ice sections reveal seasonal variations with one clear maximum per year. The LGM dust concentration varies between ∼300 μg kg-1 in the low-dust season and ∼5000 μg kg-1 in the high-dust season, whereas the pre-LGM samples vary in the range from ∼1500 μg kg-1 to 12000 μg kg-1. The dust maximum is marked by a sharp increase within a short period of time, followed by a moderate decrease to the low dust level later on during the year. On average, the DO event 7 ice interval shows a mass concentration of ∼570 μg kg-1. The seasonal variations show an amplitude of ∼6.

Regarding the total amount of dust measured in the selected ice segments, the results are in good agreement with previously measured Continuous Flow Analysis (CFA) dust data. The seasonal dust concentration amplitudes vary in the range of ∼6 to 17 in the CC data set. These variations are highly smoothed out in the CFA dust data, which show an amplitude of ∼2.
Comparing our dust measurements with the visual stratigraphy (VS), significant correlations were found. The deeper ice sections of the DO event 7 (r = 0.82) and pre-LGM (r = 0.92) correlate especially well with the VS. The storage of the LGM ice section at NGRIP for 1 year (potentially leading to a deterioration of the VS signal due to relaxation processes) and the lower dust concentration in the Allerød Interstadial ice section result in lower correlations of r = 0.64 (LGM) and r = 0.49 (Allerød). Clear seasonal variations in the dust concentration, and strong correlations with the VS, suggest that dust can be used as an additional parameter to determine the annual layer thickness and evaluate the GICC05 timescale.