Analyses of firn cores of a pre-IPICS-campaign on its ionic and dust concentration

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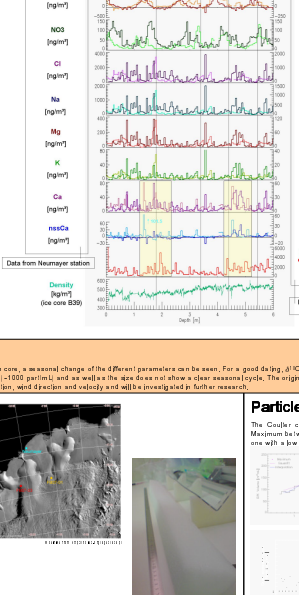
Motivation:

For this research, two 6m firn cores were taken in an area of very high accumulation adjacent to the German wintering station Neumayer. These drillings were part of a pre-IPICS-campaign to investigate possible sites for a deeper drilling covering last 2000 years. Due to its proximity to the the records obtained in firn are compared to the data measured in an air chemistry observatory located at the Neumayer station. Emphasis is given to the analysis on dust particle size and concentration.

Ionic and dust concentration of the firn core FB07-03:



Sea salt-Sodium:

Has a marine origin. Here a high concentration is found because of the position of the firn cores next to the sea. A second tracer for marine aerosol is Chloride.

Mineral dust:

Terrestrial aerosol is produced by wind-driven erosion. The concentration in Antarctica is effected by atmospheric circulation. Due to the fact that the Antarctic continent is nearly totally covered with snow, there are scarcely natural dust origins on the continent itself. As a conclusion, the dust measured in Antarctica must have another origin and hence gets there via a long range transport. In this case, South America is assumed to be the source region.

Elements like nss-Calcium, Magnesium and Potassium represent the mineral dust, but at this coastal site, the marine contribution dominates these elements.

Nss-Calcium was calculated according to Röthlisberger et al., 2002

Particulate dust

Total number of dust particles with a diameter between 1.11 and 30 µm, measured every 5 cm in the firn core. For the summer 05/06 and 04/03 there is a peak in the concentration that is visible in the nss-calcium, magnesium and potassium concentration as well (see box).

Data from Neumayer station:

The data was collected by aerosol sampling in an air chemistry observatory. The method is described in Weller and Wagenbach, 2007

δ18O:

Temperature proxy, shows a clear seasonal signal

Non sea salt-Sulphate:

An indicator for the biological activity in the ocean, as well as for the volcanic eruptions. Because of the location next to the ocean, the biological activity is more present.

nssSO4 was calculated according to Holland, 1978

MSA:

With the MSA, biological activity in the ocean can be detected. Hence the MSA is a second indicator for the seasonality, because this biological activity is low in the winter, and high in summer.

A post depositional loss is suitable, but can probably be neglected because of the high accumulation rate in the region of the firn core drilling.

Nitrate:

Nitrate is mainly a tracer for atmospheric air and long range transport from mid-latitudes.

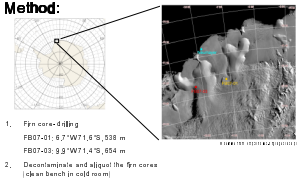
Dating:

In a first approximation, δ18O data was taken to determine the turn of the year. To improve this, MSA and nss-Sulphate data was used for a better overlay of the two data sets (Neumayer and FB07-03).

Take Home Message

By looking at the ionic and dust concentration of a firn core, a seasonal change of the different parameters can be seen. For a good dating, δ18O, Sulphate and MSA data can be taken into account, provided that there is a high accumulation. Dust concentrations are very low (<1000 part/mL) and as well as the size does not show a clear seasonal cycle. The origin and concentration, which also impacts the seasonality of these parameters depend on properties of the atmosphere like precipitation, wind direction and velocity and will be investigated in further research.

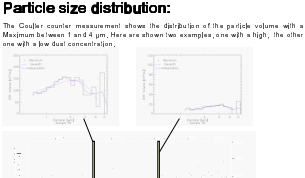
Method:



1. Firn core-drilling
   FB07-01: 6.7°W 71.6°S, 538 m
   FB07-03: 9.9°W 71.4°S, 654 m
2. Decontaminate and aliquot the firn cores (clean bench in cold room)
3. Melt the samples, measure dust (Coulter Counter M53) and ionic (Ion chromatography) concentration (clean bench)

Particle size distribution:

The Coulter counter measurement shows the distribution of the particle volume with a Maximum between 1 and 4 µm. Here are shown two examples, one with a high, the other one with a low dust concentration.



The lower plot shows the total distribution of the maximum of the volume. Due to a very low dust concentration in some samples it was impossible to get a good fitting for these. These samples were taken out of the data set and don't appear here.

Further research:

- investigate the impact of meteorological parameters like wind and precipitation on the dust concentration
- identification of possible origins of the dust by backward trajectories of the wind and circulation models with a focus on the events summer 05/06 and 04/03 (Box in the figure above)
- improve the data evaluation of the particle size measurement.