Seasonal and spatial distribution of aerosols between Neumayer- and Kohnenstation


Introduction

Atmospheric circulations are not only important for the transport of water vapour to different locations in Antarctica but also for the transport of trace elements included in firm and ice. Hence, ionic concentrations in ice cores highly depend on the meteorological conditions at the time of their deposition. Assumed a site where a firn core is drilled has an accumulation high enough to obtain seasonality in the data, atmospheric circulations can be determined from this data. But before this is possible it is important to understand the processes that stand behind the ionic data. Measurements from the vicinity of the Neumayer station show very high accumulation rates (~600 kg/m²*a, Oerter 2008), so that this location is convenient for this kind of research. Automatic weather stations are distributed at Dronning Maud Land. Therefore, it is possible to analyse meteorological data and relate them to the ionic compositions in different firn cores.

Methods

The cross section from Neumayer to Kohnen shows a rising topography. Katabatic winds are present next to the surface (from Kohnen to Neumayer). This explains the coherency of their signals. By contrast, the Sodium signal is more coherent with the one measured at Neumayer station (box). The source region of Nitrate is primarily the stratosphere. This makes its signal less sensitive to near-surface winds and hence matching to Neumayer station as well as Kohnen station.

Conclusions

The cross section from Halley to Neumayer shows only a small dome where the firn cores are located. Next to the surface some katabatic wind regime can be seen.

• Three of the six firn cores are located on two cross sections (Fig 5), one taken from Halley- to Neumayer Station, and the other one taken from Neumayer Station to Kohnen Station. The firn core on Neumayer is located on both sections.

• The cross section from Halley to Neumayer shows only a small dome where the firn cores are located. Next to the surface some katabatic wind regime can be seen.

• The cross section from Neumayer to Kohnen shows a rising topography. Katabatic winds are present next to the surface (from Kohnen to Neumayer) while the wind in higher altitudes has a north western direction (Neumayer to Kohnen). Due to this the main flow transporting trace compounds deposited in the snow is likely from south eastern directions (down the slope).

It is important to understand atmospheric processes when looking at proxy data in firn cores. In the annual mean as well as in a single event-assumed to be similar to the annual mean, the precipitation transporting wind comes from a south easterly direction. This especially drives the dispersion of trace compounds with a local source like sodium. Hence, firn cores that are drilled too far away from the coast cannot be taken as a proxy for processes related to the coast, e.g. the development of sea ice (see Röthlisberger et al 2010).

Fig. 2 Seasonal signal of MSA (Methanesulfonic acid), Sodium and Nitrate from the firm cores assessed and signal from aerosol measurements at Neumayer- and Kohnenstation. This was obtained by first taking monthly means of the years and second averaging these means. The MSA was used to improve the dating of the core by matching it with the MSA-Signal measured at Neumayer Station. This shows the coherency of their signals. By contrast, the Sodium signal is more coherent with the one measured at Kohnen Station (box). The source region of Nitrate is primarily the stratosphere. This makes its signal less sensitive to near-surface winds and hence matching to Neumayer Station as well as Kohnen Station.

If data from one day in a year looks similar to an annual mean this does not assure that it is the same. To get a better overview, more work needs to be done: Temperature reconstructions need to be made for the firn cores, the surface wind field has to be modeled for the region of interest and backward trajectories should be calculated to determine the source region of trace compounds. Additionally, a longer record from core data would be useful to smooth the ionic data.

References


Table 1: data of the firm cores used in this study

<table>
<thead>
<tr>
<th>core</th>
<th>latitude [°]</th>
<th>longitude [°]</th>
<th>elevation [m]</th>
<th>length [m]</th>
<th>time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB0201</td>
<td>71.21</td>
<td>6.79</td>
<td>~700</td>
<td>16,3</td>
<td>2002 - 1996</td>
</tr>
<tr>
<td>FB0202</td>
<td>70.63</td>
<td>8.25</td>
<td>~40</td>
<td>13,8</td>
<td>2002 - 1992</td>
</tr>
<tr>
<td>FB0203</td>
<td>71.46</td>
<td>9.66</td>
<td>~700</td>
<td>13.6</td>
<td>2002 - 1997</td>
</tr>
<tr>
<td>FB0501</td>
<td>74.13</td>
<td>9.67</td>
<td>~1500</td>
<td>11,5</td>
<td>2005 - 1975</td>
</tr>
<tr>
<td>FB0701</td>
<td>71.57</td>
<td>6.57</td>
<td>538</td>
<td>5.9</td>
<td>2007 - 2000</td>
</tr>
<tr>
<td>FB0703</td>
<td>71.41</td>
<td>9.92</td>
<td>654</td>
<td>6.6</td>
<td>2007 - 2002</td>
</tr>
</tbody>
</table>