Aerosol distribution in coastal Dronning Maud Land

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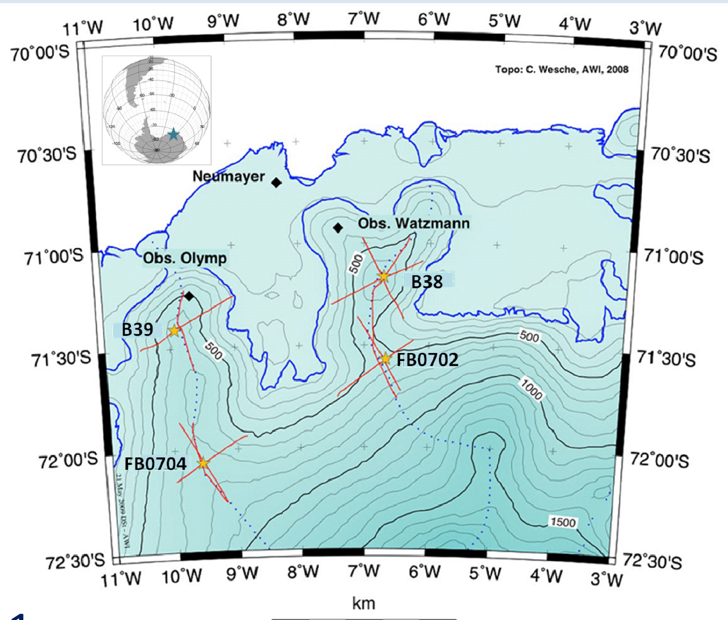
Introduction

Atmospheric circulation patterns and impurity concentrations in firn cores are highly related to each other. Atmospheric winds transport aerosols like sea salt and mineral dust over long distances and redistribute them. Because of this, it is possible to reconstruct the variability of atmospheric circulation bringing aerosol to Antarctica by analyzing impurities in firn and ice. With these analyses, the gap caused by sparse atmospheric measurements can be filled and this knowledge can then be used to improve the understanding of local and global circulation patterns. Here we present preliminary results on aerosol chemistry from four firn cores from coastal Dronning Maud Land, Antarctica, and study the spatial significance of their information.

Area of investigation



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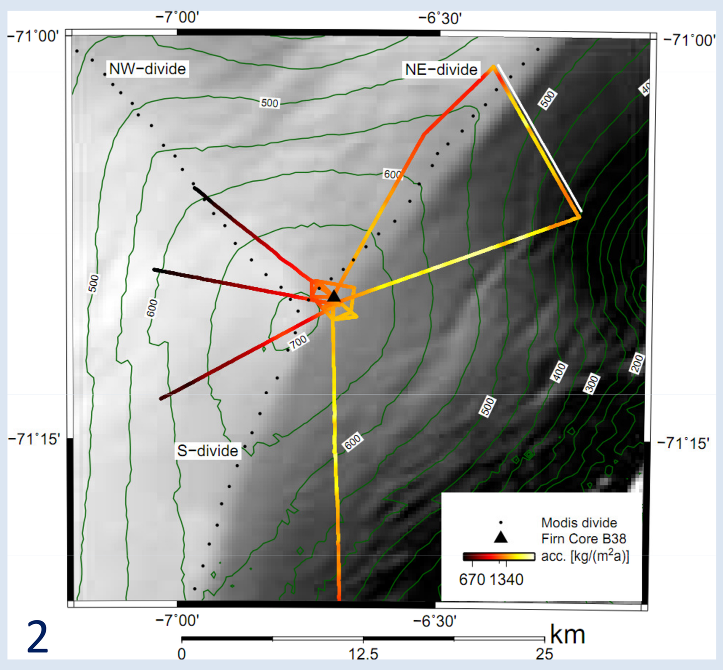

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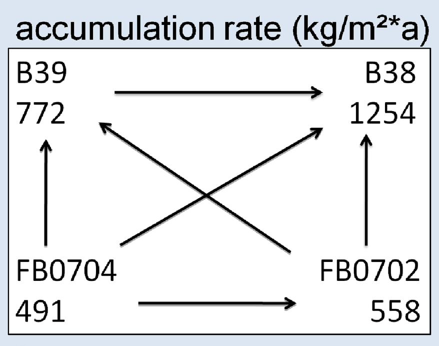
Four firn cores were drilled in 2007 in coastal Dronning Maud Land (1, graphic by D. Steinhage) on two elevations, Sørasen in the west and Halvfarryggen in the east. Using a continuous flow analyses (CFA) system (Kaufmann et al, 2008), these four cores were analyzed on particulate dust and ion concentrations (right box), as well as on stable water isotopes (Fernandoy et al 2010).

Figure 2 shows measurements of accumulation rates using radar at the ice divide of the Halvfarryggen (Drews et al, in preparation), were the B38 core was drilled. A clear decrease in accumulation from east to west can be seen.

The mean accumulation rates in the cores give a similar result (3, arrow directions indicate increasing accumulation rates):

The accumulation rate is decreasing from east to west and from north to south. The same applies for the mean values of Sodium (5), but the inverse if dust mean values are taken into account (6). Mean values for Nitrate (4) are hardly changing.



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First Results

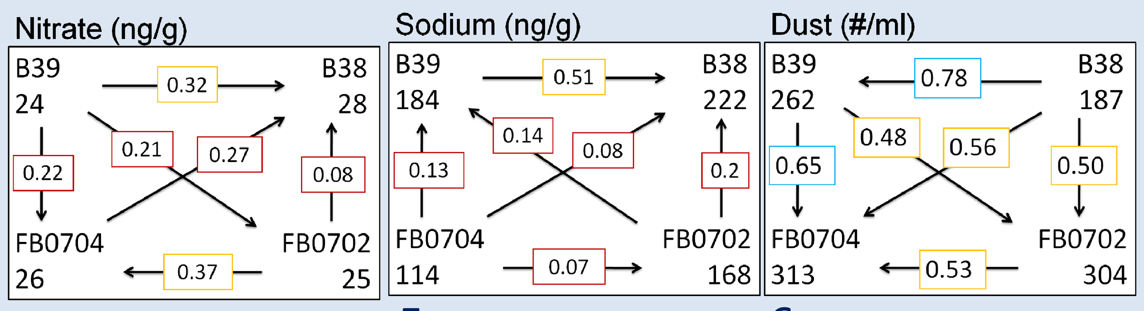
To get an overview on the relationship of the four cores, correlation coefficients and total means were calculated (4,5 and 6). Selected components from the CFA measurements are presented in figure 7,8 and 9.

Basically, in all components a high correlation between the two northern cores was found. Still, for every single component the distribution is very different. Here shown are Nitrate, which has its source in the stratosphere, sodium as a proxy for sea salt and particulate dust as a continental proxy.

For Nitrate, mean values and correlation coefficients do not differ too much from each other. Still, the respective northern and southern cores of Sørasen and Halvfarryggen have higher correlation coefficients.

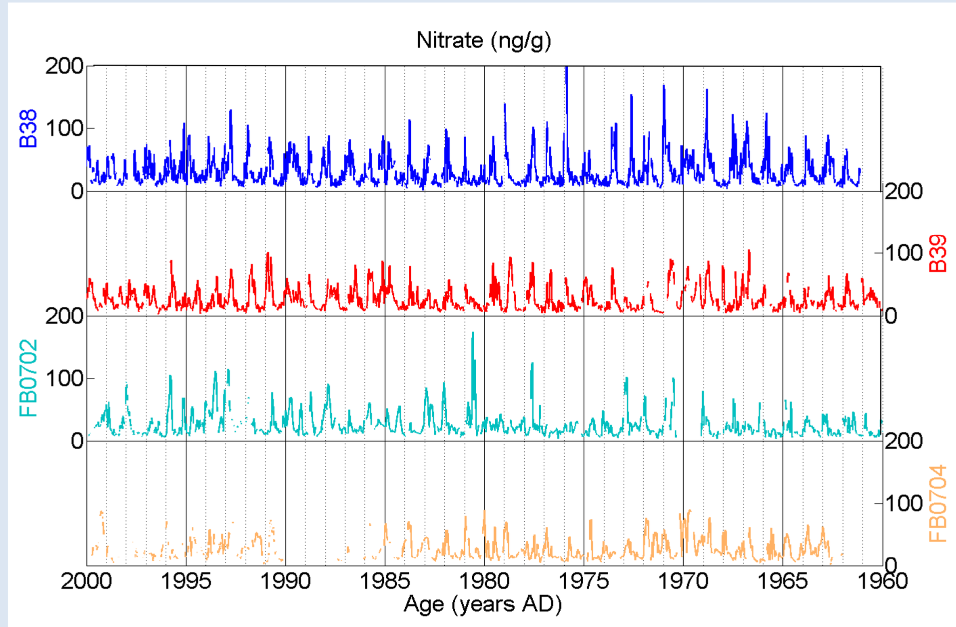
For Sodium, especially the cores B38 and B39 are highly influenced by the ocean nearby. Being further away from the coast decreases the amount of sea salt in the snow. This also has an influence on the correlation coefficients of the cores.

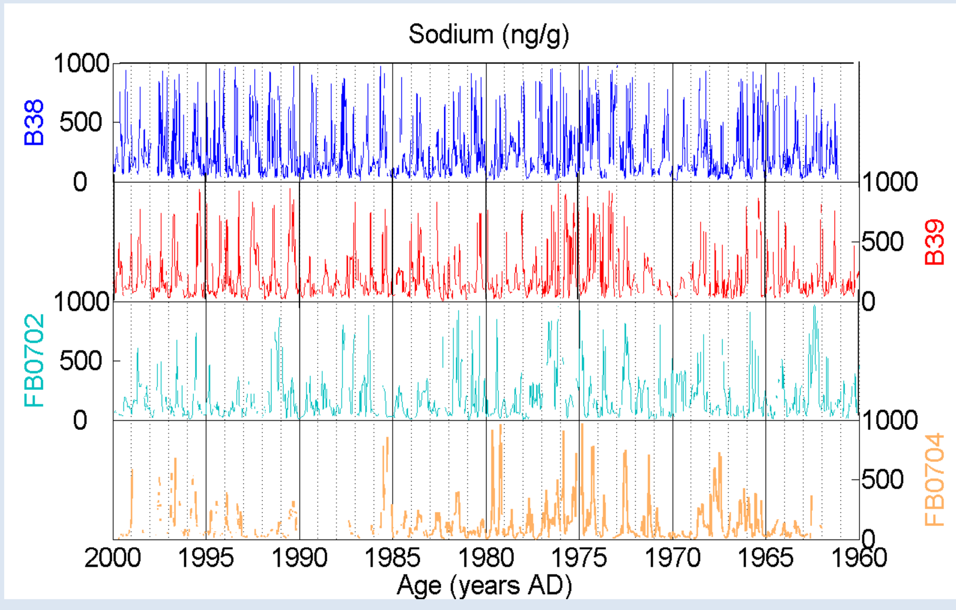
In dust, the correlation is especially very clear in the cores B38 and B39. There is also a high correlation between the cores B39 and FB0704 (both located on the Sørasen elevation). In total, dust shows much higher correlations than all the other components.

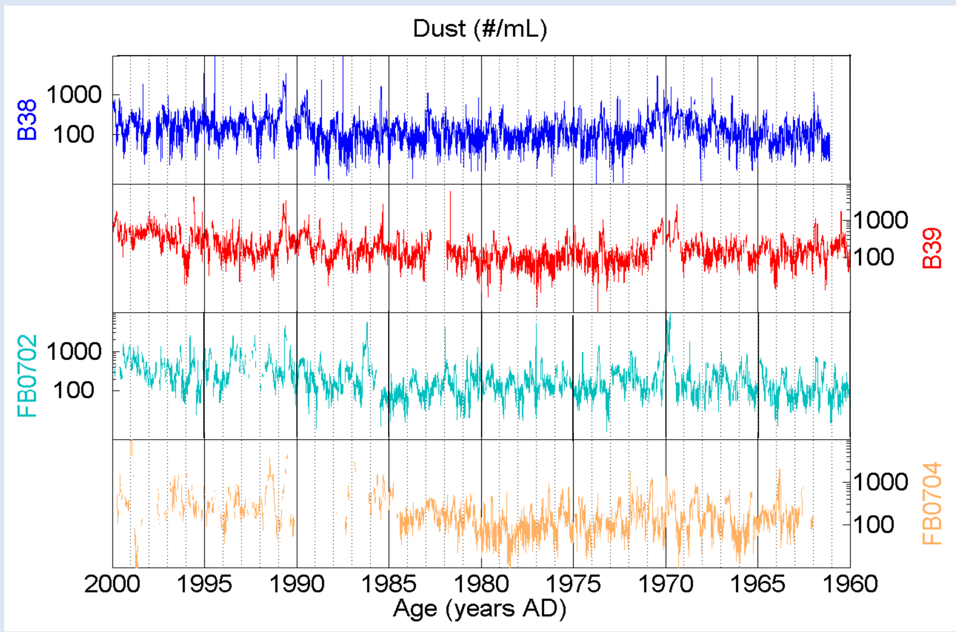


4 5 6

Figure 4-6: Total mean and correlation coefficients of the four firn cores. Correlation coefficients are located in the colored boxes (blue: $0.6 \le |r| \le 1.0$; yellow: $0.3 \le |r| \le 0.6$; red: $0.0 \le |r| \le 0.3$). Arrow directions indicate increasing values of the total mean. These are found under the core names.



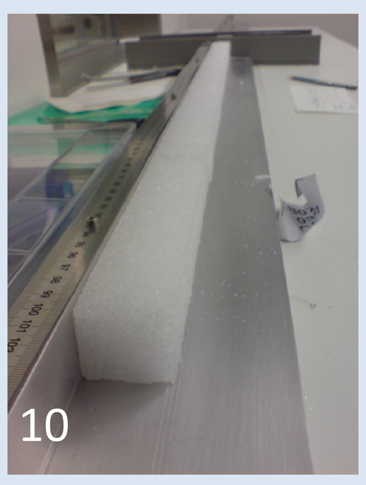




Conclusion

These four cores drilled in coastal Dronning Maud Land have a high potential to improve the knowledge of the variability of aerosol impurities in ice cores. First Results show that Nitrate acts as a regional representative in the mean values, while dust and sea salt both have a strong gradient along with the accumulation rate, but in different directions.

Method



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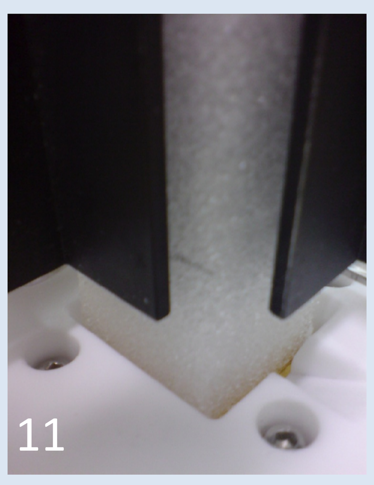

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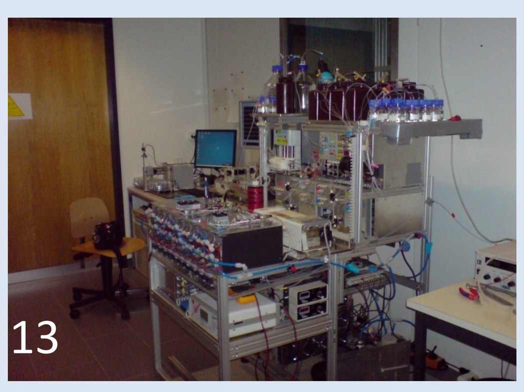
Experimental set-up of CFA-measurements (carried out at Bern University). First work is done in a cold room laboratory (~-20℃): Cores are prepared (10) and put in a tray (11). Then they can be placed on the melt head (12) and melted down from top to bottom.

The melt water is then analyzed on conductivity, particulate dust and ion concentrations with a CFA system (13). A second dust sensor and an auto sampler filling discrete samples were attached to the CFA system (14).



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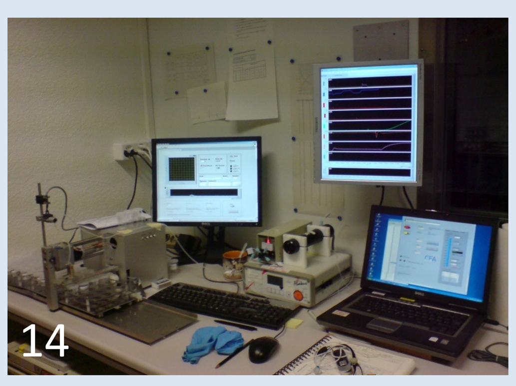

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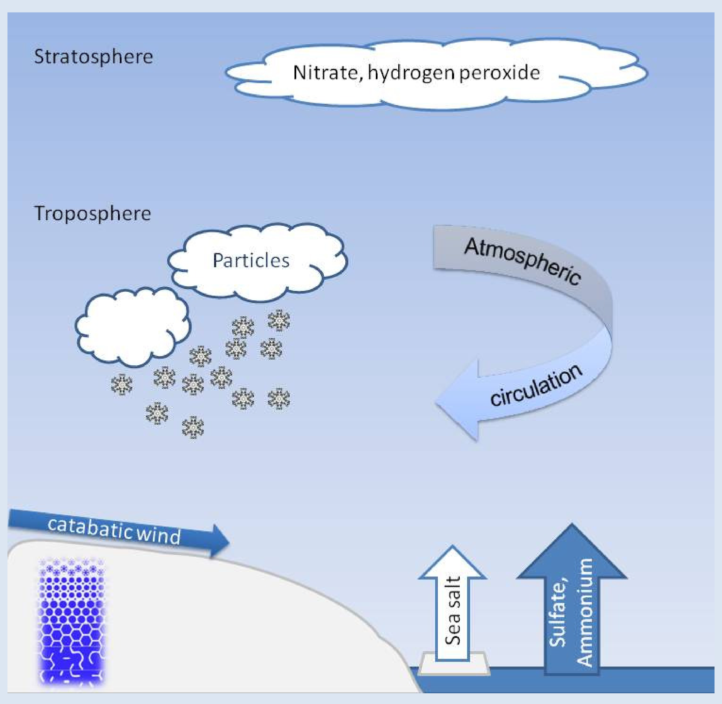
Ions as a proxy for atmospheric circulations



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By measuring atmospheric trace elements in firn cores on multiple locations in a small area, an assumption about their regional and seasonal variability can be made. Due to different source regions and processes in the atmosphere, the combination of different aerosols in a remote region can give an indication of the atmospheric circulations transporting these aerosols.

Still, this is a challenge because information about the sources of the aerosols as well as their transport pattern is limited.

For this, models have to be taken into account, and as many measurements as possible have to be made. Then, it might be possible to reconstruct atmospheric circulation further back in time by analyzing ice cores.

References

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