Spatial and temporal variability of sea-salts in ice cores and snow pits from Fimbul Ice Shelf, Antarctica

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Abstract

Major ions were analysed in three firn cores from different ice rises located at Fimbul Ice Shelf (FIS): Kupol Ciolkovskogo (KC), Kupol Moskovskij (KM), and Blåskimen Island (BI), a 100 m long ice core drilled near the FIS edge (S100), and five snow pits (M1, M2, G3, G4, and G5) sampled on the ice shelf. Together, these sites are distributed so that they provide a variety of elevation and distance to the sea. The firn cores dated back to 1958 (KC), 1995 (KM) and 1996 (BI). The time scales were obtained by annual layer-counting of high-resolution $\delta^{18}O$ cycles in combination with volcanic horizons using non-sea salt sulphate ($nssSO_4^{2-}$) concentrations. The 100 m ice core covers the time between 1736 CE and 2000 CE (Kaczmarska et al., 2004). Surface mass balance (SMB) and $\delta^{18}O$ temporal trends from the KC core have a good agreement with other previously investigated cores in the area, whereas the cores retrieved at KM and BI seem to be more affected by local meteorological conditions and surface topography (Vega et al., 2016).

Sea-salt species dominate the precipitation chemistry in the study region. Concentrations of these ions were found to decrease with latitude and distance from the ice shelf edge. We associate a significant six-fold increase in sea-salts observed in the S100 core after the 1950s with a change in deposition regime. This increase in sea-salt concentrations is synchronous with a shift in non-sea-salt sulfate ($nssSO_4^{2-}$) toward more negative values, suggesting a possible contribution of frost flowers and/or wind-blown fractionated snow to the sea-salt load in the low altitude S100 core. In contrast, wet deposition of atmospheric sea-salts is dominant in the three ice rises cores, and evidence of a significant contribution of fractionated sea-salt to these sites was not found. In summary, these results suggest that the S100 core contains a more local sea-salt signal, dominated by young sea-ice formation in the neighbouring waters while the ice rises cores register the signal of changes in storminess and transport of sea-salt aerosols produced over open water rather than local changes. These findings are a contribution to the understanding of the mechanisms behind sea-salt aerosol production, transport and deposition at coastal Antarctic

sites, and for the improvement of the current Antarctic sea-ice reconstructions based on sea-salt chemical proxies obtained from ice cores.

Keywords: firn cores, sea salts, ice rises, ice shelf

References

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