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Sources and variability of mineral dust deposition to Greenland ice-core sites

Content

Mineral dust in ice cores is an important proxy to reconstruct the past input of nutrients to terrestrial and marine ecosystems and to investigate changes of the atmospheric circulation. On the Greenland ice sheet, isotopic and mineral evidence suggest, that the major fraction of the mineral dust deposited onto the ice sheet originates from the East Asian deserts with only minor contributions from Africa. The atmospheric circulation and precipitation en route and at the core location ultimately governs the transport efficiency as well as the deposition of the dust to the ice sheet.

Here we show results from the Lagrangian particle dispersion model (LPDM) FLEXPART and a state-of-the-art mineral dust emission scheme, driven by ERA-Interim reanalysis data. We apply the model to simulate dust deposition at five major ice-core sites in the interior of the Greenland ice sheet over the past 30 yrs. These simulations allow us to explore the drivers of the temporal variability of the dust deposition at the ice-core sites as well as the variability of the source area contributions to the total dust deposition. Furthermore, the simulations can be used to investigate the shared signals between the ice-core sites without influence of local surface processes such as snow-redistribution.

Initial results for the total dust deposition indicate a strong dependence on the co-occurrence of precipitation at the ice-core sites because precipitation scavenging is the dominating deposition process for far-travelled mineral dust aerosol. This indicates that the atmospheric circulation over the North Atlantic, which governs the variability of the precipitation in Greenland is a major contributor to the variability of the total mineral dust deposition in the interior of the ice sheet. This leads to large between-site variability of the total dust deposition and thus a poor representativeness of a single ice core site for inter-annual dust variability.

In our contribution we will elaborate on this observation and extent the analysis to the source area contributions for the different ice core sites and potential drivers of their temporal and spatial variability leveraging the detailed results from the LPDM simulations. These results will contribute to our understanding of the processes that are recorded in the ice-core dust records and their interplay and will help their interpretation as proxy records.

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