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Moisture sources for Greenland ice core sites: Seasonality and land/ocean contributions

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The interpretation of the climate ice core isotope signal relies on the knowledge on the underlying moisture transport and variability hereof. From ice core records from Greenland and Antarctica we have access to unique climate archives that provide knowledge of past climate changes and variability. Availability of water vapor, formation of clouds and precipitation are all essential for shaping the radiative and hydrological conditions of the polar climate system. Understanding the mean state and the spatiotemporal variability of moisture transport towards the polar ice sheets is thus vital for exploring moisture and cloud processes affecting the energy and surface mass balance of the Greenland Ice sheet.

This study identifies moisture sources for both Greenland precipitation and near-surface vapor using a combination of backward trajectories and moisture source diagnostics. Using the Lagrangian moisture source diagnostic WaterSip, based on a global transport climatology calculated with the FLEXPART model, and spanning the entire ERA-Interim dataset, we identify Greenland moisture sources for present-day conditions (1980-2018). We focus on six deep ice core sites and identify the key moisture source areas and their patterns of variability. The role of land vs. ocean moisture sources are investigated, with a particular focus on land sources from North America and Greenland. Further, we evaluate moisture transport in relation to Greenland ice core isotopic composition observations of snow and ice, and explore how moisture sources of precipitation and near-source vapor can differ.

Results show that the deep ice core sites have different spatial patterns of moisture sources. Seasonality is important and large spatial variability with season exists due to precipitation seasonality. Land-sources are found to be dominating the full moisture uptake budget during summer for some ice core sites.Differences are found between transport patterns for sources of near-surface vapor and sources of precipitation at the same site. This finding highlight that sources and transport of respectively near-surface moisture and precipitation at the Greenland Ice Sheet are not necessarily comparable. This suggest that the atmospheric drivers and variability of moisture sources over the Greenland Ice Sheet can be different for near-surface vapor and precipating clouds at higher altitudes. This is relevant for a better understanding of isotope surface processes related to how the climate signal gets imprinted in the snow. Furthermore these results elucidate the mean state and variability of Greenland moisture sources at different altitudes above the ice surface. This analysis of drivers of Greenland moisture transport therefore contribute to the understanding on how moisture variability influences the energy budget and surface mass balance of the Greenland Ice sheet.