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Pan-Arctic Precipitation Isotope (δ^{18}O & δ^{2}H) Characteristics and Processes

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The Arctic water cycle is changing dramatically as evidenced by marked shifts in Arctic sea ice conditions, atmospheric processes, and hydrological regimes. Understanding these complex interactions across a wide spatial and temporal scale is necessary to assess how the whole Arctic water cycle is responding to changes today and in the future, including its potential to feedback into the global climate system. Yet, an empirical and process-based understanding of the interactions between these individual components is currently lacking in the Arctic and further limits our ability to respond, adapt and develop resilient communities in the future.

Measurements of oxygen and hydrogen stable isotopes in precipitation (δ^{18}O, δ^{2}H, *d-excess*) are a valuable and increasingly applied tool for tracing hydrological processes. We are using a new coordinated network of 20 EU-INTERACT stations across the Arctic to collect, analyze, and synthesize how precipitation isotope geochemistry varies in space and time across the north. These new event-based data are combined with observed and modelled analyses of storm tracks, cyclones, and sea ice traits to determine how isotopic variability is controlled by synoptic-scale atmospheric processes and sea ice patterns.

Our goal is to produce weekly maps of precipitation δ^{18}O and δ^{2}H values across the Arctic (e.g., "Isoscapes") that will provide a coherent framework to the community for understanding both modern and past changes in the Arctic water cycle. For example, initial δ^{18}O and δ^{2}H data from summer 2018 show that divergent storm tracks along the west coast of Greenland can lead to distinct isotopic gradients with latitude. During mid-July we observed a 10 ‰ depletion in δ^{18}O over a 1500 km latitudinal span (64°N to 76°N) at our stations in Nuuk (SW), Disko Island, and Thule (NW), from -11‰ -16‰ to -21‰ respectively. This south to north depleting δ^{18}O trend can be reversed within weeks depending upon the prevailing synoptic atmospheric circulation pattern. These precipitation isotope fractionation processes along Greenland's west coast occur when relatively enriched moisture is transported into the Arctic from the North Atlantic; the reverse trend occur when moisture is transported south from the Arctic Basin into the lower latitudes along the west coast of Greenland.

This is the first coordinated network to quantify the spatial patterns of isotopes in precipitation, simultaneously, across the entire Arctic, and our process-level studies will inform us about atmospheric transport processes within the Arctic, and between the Arctic and mid-latitude regions.