EGU2020-17782
https://doi.org/10.5194/egusphere-egu2020-17782
EGU General Assembly 2020

Water vapour and precipitation isotope measurements from different platforms during the IGP campaign, Iceland, in 2018 connect evaporation sources to precipitation sinks

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The water cycle in atmospheric and coupled models is a major contributor to model uncertainty, in particular at high-latitudes, where contrasts between ice-covered regions and the open ocean fuel intense heat fluxes. However, observed atmospheric vapour concentrations do not allow us to disentangle the contributions of different processes, such as evaporation, mixing, and cloud microphysics, to the overall moisture budget. As a natural tracer, stable water isotopes provide access to the moisture sources and phase change history of atmospheric water vapour and precipitation.

Here we present a unique dataset of stable isotope measurements in water vapour and precipitation from the IGP (Iceland Greenland Seas Project) field campaign that took place during February and March 2018. The dataset includes simultaneous measurements from three platforms (a land-station at Husavik, Iceland, the R/V Alliance, and a Twin Otter aircraft) during winter conditions in the Arctic region. Precipitation was collected on an event basis on the research ship, and along two north-south transects in Northern Iceland, and analysed at two stable isotope laboratories. Airborne vapour isotope data was obtained from 10 flights covering a large geographic range (64 °N to 72 °N). Careful data treatment was applied to all stable isotope measurements to ensure sufficient data quality in a challenging measurement environment with predominantly cold and dry conditions, and characterised by strong isotope and humidity gradients. Data quality was confirmed by inter-comparison of the vapour isotope measurements both between ship and aircraft, and between the aircraft and Husavik station.

We exemplify the value of the observations from the analysis of several flights dedicated to the

study of the atmosphere-ocean interactions, from low-levels legs and vertical sections across the boundary layer during Cold Air Outbreak (CAO) conditions. The precipitation in Northern Iceland collected at the precipitation sampling network shows clear co-variation with the upstream water vapour measurements at Husavik station, indicative of the wider spatial representativeness of the isotope signals. The land-based snow and vapour measurements are furthermore consistent with the isotope composition in upstream ocean regions sampled by the research vessel, and as linked from aircraft measurements.