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Atmospheric and oceanic stable isotope signatures of a cold-air outbreak in Iceland during YOPP SOP1 and IGP

Harald Sodemann (1), Alexandra Touzeau (1), Yongbiao Weng (1), Heidi Golid (1), Hans Christian Steen-Larsen (1), Idar Barstad (1), Mika Lazky (2), Jean-Lionel Lacour (3), John Burkhart (2), Ian Renfrew (4), and Árny Erla Sveinbjörnsdóttir (3)

(1) University of Bergen, Geophysical Institute, Bergen, Norway (harald.sodemann@uib.no), (2) Department of Geoscience, University of Oslo, Oslo, Norway, (3) Institute of Earth Sciences, University of Iceland, Reykjavik, Iceland, (4) Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich, UK

North-Atlantic Cold-air outbreaks are weather events characterised by extensive fluxes of latent heat to the atmosphere. Understanding the water budget of these weather events is important for the weather impact in downstream coastal areas. We use here observations of the stable isotopic composition of water vapour and precipitation, expressed by the quantities dD, d18O, d17O and the secondary parameters d-excess and 17O-excess, to extract information about the origin and condensation history of water vapour evaporating during a period of cold-air outbreaks north of Iceland.

During the campaign of the Iceland-Greenland Seas project (IGP) in March 2018, coinciding with the YOPP SOP1, water vapour isotope measurement instrumentation was deployed on the scientific vessel R/V Alliance, the research aircraft MASIN and a coastal location in Northern Iceland. With additional sampling of the snow deposited on land, a complete water cycle during continuous cold-air outbreak conditions could be sampled.

The isotope composition of water vapor was sampled continuously during the cruise using a Picarro L2140i with a heated inlet system. In addition, manual collection of precipitation and water column samples from CTD were performed for isotope analysis. On the research aircraft, a modified Picarro L2130i sampled the water vapour isotope composition during 10 research flights. Calibration was performed both during flight and after landing. Continuous water vapour isotope measurements were performed at the nearby coastal location Husavik. Calibrated vapour isotope data from ship, aircraft, and station show good agreement during periods of intercomparison flights. A more complete precipitation sampling program along two transects east and west of Akureyri and measurements at Husavik further supplemented the water isotope sampling during IGP, providing a uniquely complete overview of the water cycle of cold-air outbreaks.

Results from the comprehensive sampling campaigns provide insight into the spatial gradients and synoptic variability in the stable isotope composition during different weather events. In particular, our analyses show that evaporation conditions at the moisture sources are preserved to a variable degree in surface snow samples taken along topographic gradients. Initial modeling results also underline the importance of local topography for modifying the isotope signal deposited with precipitation.