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High-resolution stable isotope signature of a land-falling atmospheric river in Southern Norway

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Gathering observational evidence of the long-range moisture versus local source contributions remains a scientific challenge, but is critical for understanding how hydrological extremes develop. Moisture transport to the west coast of Norway is often connected to elongated meridional structures of high water vapour flux known as Atmospheric Rivers. It is still an open question how well moisture sources estimated by different numerical models for such events of long-range transport correspond with reality. In this study, we present high resolution stable isotope information collected during a land-falling Atmospheric River in Southern Norway during winter 2016, and analyse the data with the aim to differentiate between moisture source signatures and below-cloud processes affecting the stable isotope composition.

The precipitation characterised by a pronounced warm front was sampled manually on a rooftop platform at a 10-20 minute interval during the 24h of the event and later measured by a laser spectrometer (Picarro L2140-i) in the lab for δ^{18}O, δD, and d-excess. Simultaneously, the stable isotope composition of water vapor was continuously measured at high resolution. To that end, ambient air was continuously pumped from a nearby inlet at 25 m above the ground and measured by another laser spectrometer (Picarro L2130-i). Stable water isotope measurements were supplemented by detailed precipitation parameters from a laser disdrometer (OTT Parsivel^2), Micro Rain Radar (MRR-2), Total Precipitation Sensor (TPS-3100), and a nearby weather station.

Measurements show a signature of two depletion periods in the main stable isotope parameters that are not apparent in precipitation amount and atmospheric temperature measurements. The deuterium excess in rainfall responds differently, with first and increase and then a decrease during these depletion periods. We interpret this as a combined consequence of airmass change, cloud microphysics, and below-cloud effects. Moisture sources identified during the atmospheric river event show a clear transition that points to the need to constrain this kind of analysis by additional stable water isotope observations en route and upstream.