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High resolution climatology
- towards climate change services

Tracing the water cycle using measurements of stable water isotopes in ambient water vapour

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Short-term measurement series of the stable water isotope (SWI) composition of vapour can contribute to enhancing our process-based understanding of the spatio-temporal variability of the isotope signal in the atmospheric branch of the water cycle. Advanced knowledge about this variable can in turn give some hints on important moist atmospheric mechanisms like cloud formation, evaporation and transpiration at the land surface. In this sense, SWIs can be regarded as naturally available tracers of phase change processes in the atmosphere. There are still many open questions related to the processes determining isotope variability in atmospheric waters, in particular with regard to short-term variations and non-equilibrium fractionation. Furthermore, there is a need for measurements in order to constrain and validate simulations from isotope-enabled numerical weather and climate prediction models.

The objective of this work is to explore short-term variations in isotope measurements in near-surface water vapour over land and to improve our understanding of the processes which influence the variability of isotope signals at different temporal scales. Our focus is set upon the investigation of the importance of single meteorological events (frontal rain showers, dry periods) for monthly mean water isotope values. The influence of upstream processes during evaporation at the source location and transport of the air parcel on the measured isotope signal as well as its link with land-atmosphere exchange fluxes are central aspects in the present investigation.

Measurements of stable water isotopes with high (sub-hourly) temporal resolution have been performed in water vapour using a commercial laser spectrometer (Picarro, L1115-i) in an urban environment as well as in a pre-alpine catchment at an already existing extensive hydro-meteorological measurement station. The instrument and sampling system was assessed in terms of measurement precision, response time, instrument drift and system memory. First qualitative event-based analyses have been performed and the isotope measurements have been linked to the prevailing meteorological conditions.