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Modelling of stable water isotopes during frontal passages with COSMOiso

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Numerical models can help to better understand the complex processes influencing isotopic variability in atmospheric moisture and precipitation. They can provide information on the full three-dimensional structure of the isotopic composition of water vapour at locations where no measurements can be performed, and can be used for sensitivity experiments clarifying the role of specific processes governing isotopic variability. Isotope-enabled general circulation models have proven to successfully reproduce the large-scale climatological mean isotopic composition of surface precipitation. However, due to their typically coarse spatial resolution, they show difficulties in simulating isotopic variability associated with meso-scale weather events like fronts and convective systems. The implementation of stable water isotopes in limited-area models with high resolution is required to study the corresponding processes.

In this study we present a one-year simulation for Europe with a recently introduced isotope-enabled version of the limited-area model COSMO (COSMOiso). The model is validated against observations at different locations, including high-resolution measurements of isotopes in water vapour in north-eastern Switzerland. Based on the simulation with COSMOiso, the connection between different meteorological parameters and the stable water isotopes is studied, with a focus on the passage of fronts. Composites of several events are used to characterise the typical three-dimensional structure and temporal evolution of stable water isotopes in water vapour associated with fronts. By using data from different vertical model levels we can gain new insight into the mechanisms influencing the isotopic composition in the atmospheric column during frontal passages. This allows to assess the process chain of precipitation formation in detail and will help in the interpretation of the resulting isotopic trends observed in surface precipitation.