Geophysical Research Abstracts
Vol. 18, EGU2016-15348, 2016
EGU General Assembly 2016

Simultaneous measurements of stable water isotopes in near-surface vapor and precipitation to constrain below-cloud processes

Pascal Graf (1), Harald Sodemann (2), Stephan Pfahl (1), Marc Schneebeli (3), Jordi Figueras i Ventura (3), Andreas Leuenberger (3), Jacopo Grazioli (4), Tim Raupach (4), Alexis Berne (4), and Heini Wernli (1)

(1) Institute for Atmospheric and Climate Science, ETH, Zurich, Switzerland (pascal.graf@env.ethz.ch), (2) Geophysical Institute, University of Bergen, Bergen, Norway and Bjerknes Center for Climate Research, Bergen, Norway (harald.sodemann@gfi.uib.no), (3) MeteoSwiss, Locarno Monti, Switzerland (marc.schneebeli@meteoswiss.ch), (4) Environmental Remote Sensing Laboratory LTE, EPFL, Lausanne, Switzerland (alexis.berne@epfl.ch)

Present-day observations of stable water isotopes (SWI) in precipitation on monthly time scales are abundant and the processes governing the variation of SWI on these time scales have been investigated by many studies. However, also on much shorter time scales of hours mesoscale meteorological processes lead to significant variations of SWIs, which are important to understand. There are only few studies investigating the variations of SWI on this short time scale, for which, e.g., frontal dynamics, convection and cloud microphysics play an essential role. In particular, the isotopic composition of both near-surface vapor and precipitation is significantly influenced by below-cloud processes that include precipitation evaporation and isotopic exchange between falling precipitation and surrounding vapor.

In this study, simultaneous measurements of SWI in near-surface vapor and precipitation with high (sub-hourly) temporal resolution in combination with observational data from radars, disdrometers, radiosondes and standard meteorological instruments are used for a detailed analysis of the relative importance of below-cloud and in-cloud (i.e. precipitation formation) processes during the course of three rain events in Switzerland in spring 2014. Periods are identified when the isotopic composition of near-surface vapor and equilibrium vapor above liquid rain drops agree and when they differ due to either evaporation of precipitation or incomplete equilibration of precipitation with surrounding vapor. These findings are verified by the supporting observational data. In addition, calculations with a simple rain-shaft model fed with observational data are compared to the actual isotopic composition of precipitation. This combination of isotope measurements and model calculations allows us to test the sensitivity of the precipitation isotope signal to rain intensity, drop-size distribution and temperature and humidity profiles.