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Seasonal, synoptic and diurnal variation of atmospheric water-isotopologues in the boundary layer of Southwestern Germany caused by plant transpiration, cold-front passages and dewfall.

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Atmospheric water is an enormously crucial trace gas. It is responsible for ~70 % of the natural greenhouse effect (Schmidt et al., JGR, 2010) and carries huge amounts of latent heat. The isotopic composition of water vapor is an elegant tracer for a better understanding and quantification of the extremely complex and variable hydrological cycle in Earth's atmosphere (evaporation, cloud condensation, rainout, re-evaporation, snow), which in turn is a prerequisite to improve climate modeling and predictions. As $H_2^{16}O$, $H_2^{18}O$ and HDO differ in vapor pressure and mass, isotope fractionation occurs due to condensation, evaporation and diffusion processes. In contrast to that, plants are able to transpire water with almost no isotope fractionation. For that reason the ratio of isotopologue concentrations in the boundary layer (BL) provides, compared to humidity measurements alone, independent and additional constraints for quantifying the strength of evaporation and transpiration. Furthermore the isotope ratios contain information about transport history of an air mass and microphysical processes, that is not accessible by humidity measurements.

Within the project MUSICA (MUlti-platform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric water) a commercial Picarro Analyzer L2120-i is operated at Karlsruhe in Southwestern Germany, which is continuously measuring the isotopologues $H_2^{16}O$, HDO and $H_2^{18}O$ of atmospheric water vapor since January 2012.

A one year record of $H_2^{16}O$, HDO and $H_2^{18}O$ shows clear seasonal, synoptic and diurnal characteristics and reveals the main driving processes affecting the isotopic composition of water vapor in the Middle European BL. Changes in continental plant transpiration and evaporation throughout the year lead to a slow seasonal HDO/$H_2^{16}O$-variation, that cannot be explained by pure Rayleigh condensation. Furthermore, cold-front passages from NW lead to fast and pronounced depletion of the HDO/$H_2^{16}O$-ratio within minutes. Superimposed to these variations are local diurnal processes like dewfall, which cause a diurnal pattern captured by the deuterium excess.