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Seasonal and inter-annual dynamics in the stable oxygen isotope compositions of water pools in a temperate humid grassland ecosystem: results from MIBA sampling and MuSICA modelling

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The oxygen isotope composition (δ^{18}O) of water in terrestrial ecosystems usually shows strong and dynamic variations within and between the various compartments. These variations originate from changes in the δ^{18}O of water inputs (e.g. rain or water vapour) and from ^{18}O fractionation phenomena in the soil-plant-atmosphere continuum. Investigations of δ^{18}O in ecosystem water pools and of their main drivers can help us understand water relations at plant, canopy or ecosystem scale and interpret δ^{18}O signals in plant and animal tissues as paleo-climate proxies.

During the vegetation periods of 2006 to 2012, soil, leaf and stem water as well as atmospheric humidity, rain water and groundwater were sampled at bi-weekly intervals in a temperate humid pasture of the Grünschwaige Grassland Research Station near Munich (Germany). The sampling was performed following standardised MIBA (Moisture Isotopes in the Biosphere and Atmosphere) protocols. Leaf water samples were prepared from a mixture of co-dominant species in the plant community in order to obtain a canopy-scale leaf water δ^{18}O signal. All samples were then analysed for their δ^{18}O compositions.

The measured δ^{18}O of leaf, stem and soil water were then compared with the δ^{18}O signatures simulated by the process-based isotope-enabled ecosystem model MuSICA (Multi-layer Simulator of the Interactions between a vegetation Canopy and the Atmosphere). MuSICA integrates current mechanistic understanding of processes in the soil-plant-atmosphere continuum. Hence, the comparison of modelled and measured data allows the identification of gaps in current knowledge and of questions to be tackled in the future.

Soil and plant characteristics for model parameterisation were derived from investigations at the experimental site and supplemented by values from the literature. Eddy-covariance measurements of ecosystem CO_2 (GPP, NEE) and energy (H, LE) fluxes and soil temperature data were used for model evaluation. The comparison of measured and predicted ecosystem fluxes showed that the model captured the main features of the diurnal cycles of GPP, NEE, LE and H, as well as the soil temperature dynamics.

In this presentation I will present the main results of this model-data comparison, as well as results from a model sensitivity analysis performed over a range of soil, plant and meteorological parameters to evaluate the relative importance of each parameter on the δ^{18}O signatures of the various water pools.