Geophysical Research Abstracts
Vol. 20, EGU2018-2823, 2018
EGU General Assembly 2018

Advances in ecohydrological modelling at multiple scales using stable isotopes

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Increasing availability of high resolution, long-term stable isotope data in precipitation, soil water, groundwater, xylem water and stream flow is allowing us to characterise ecohydrological systems in more detail. Traditionally, input-output relationships of the stable isotope tracer rainfall-runoff response have been analysed with a variety of modelling approaches to understand the nature and time variance of catchment travel time distributions. Increasingly, however, at many experimental sites, data sets are being collected showing tracer dynamics in different catchment water stores (e.g. soils, groundwater, vegetation etc.) which provide new information on the internal ecohydrological functioning of catchments at the soil-plant-atmosphere interface. Integrating such data in tracer-aided models is revolutionizing our quantitative understanding of the inter-relationships between the fluxes, storage and age of water in different components of catchment systems. Here, we will report on current modelling initiatives using data collected from long-term experimental catchments where there has been a particular focus on soil-vegetation interactions. This work is seeking to assess the role of these interactions in water partitioning into "green" and "blue" water fluxes and the associated implications for the age distribution of these fluxes and stored water. A range of modelling approaches will be described (probabilistic, conceptual and physically-based) at a range of scales (soil profile to small catchment scale). We will show examples of how integrated, cross-scale isotope approaches are important for advancing process understanding of the soil-plant-atmosphere interface. We will discuss the critical importance of the upper few centimetres of the soil and root zone at the catchment scale, and how the monitoring and simulation of xylem isotope dynamics remains a major challenge.