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Variation of stable water isotopes in soil water demonstrate heterogeneous water flow and transport in six lysimeter replicates

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Lysimeter experiments have been shown to be excellent tools studying water flow and transport heterogeneities in the unsaturated zone. Particularly in combination with stable isotopes of water as environmental tracers and mathematical modelling, not only information about water flow but also about transport is provided. In previous studies, it was therefore possible to quantify fractions of preferential flow depending on land use and soil type and to calibrate and validate transport models. To date, stable water isotope analysis was mainly restricted to precipitation and drainage collected from individual lysimeter experiments neglecting heterogeneous processes along flow paths in soils and not giving any information about the reproducibility of processes. In the SOILCAN lysimeters, we now have the great opportunity to compare water flow and transport in the same soil type, with the same land use and along the flow paths in replicates. Therefore, the objective of this study was use stable water isotopes to investigate water flow transport in replicates and study heterogeneities depending on soil depth and soil type. Stable isotopes of water were weekly measured in precipitation, soil water in three depths (0.1m, 0.2m and 0.5m below ground) and drainage (1.5m) in six lysimeters at the TERENO observatory in Scheyern. These six lysimeters contained two different soil types. In each lysimeter and all samples a seasonal isotopes variation was observed over time which was attenuated with depth. Differences in isotopic distribution between the two soil types were smaller compared to the total variability in the replicates. Comparison of replicates indicated small differences in isotopic composition in soil water which increased with depth. Differences were mainly associated with transport parameters (dispersivites) rather than soil hydraulic properties due to similar timing but different attenuation of seasonal isotopic peaks. The isotope monitoring campaign in other SOILCAN lysimeters containing the same soils will enable us in future to study the impact of boundary conditions on water flow and transport which will help to further conclude on impacts of climate change and land use. Additionally, these data will be used to quantify preferential flow and its dependency on soil depth and land use and validate models simulating flow and transport in the atmosphere-plant-soil-groundwater continuum.