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Water stable isotopes quantify water balances on river basins and water mixing in a karst area

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The stable isotopic composition of water remains unaltered by transpiration, but usually changes due to evaporation. If water isotope measurements of precipitation input to catchments and outflow exist over time periods of at least one hydrological year, biological water fluxes (i.e. transpiration and interception) can be separated from evaporation over large areas. For instance, when compared as percentages, case studies of the Great Lakes basin revealed much stronger evaporative loss (23 % of the incoming precipitation) than the Clyde River basin in Scotland (1.3 % of the incoming precipitation). This difference is due to the much larger area covered by open water in the Great Lakes basin (i.e. 30 % of the entire catchment). Surprisingly, despite a proportionally smaller land area, plant transpiration and interception were also larger in the Great Lakes basin (47 % of incoming precipitation) when compared to the Clyde River basin (24 % of incoming precipitation). This difference was most likely controlled by plant coverage that was dominated by trees in the Great Lakes area compared to the prevalence of grassland in the Clyde Basin.
In contrast, water isotope studies of a karst catchment in Southern Germany revealed almost identical weighted average 18O isotope values of the incoming precipitation and the catchment runoff (e.g., the Blautopf Spring in the Swabian Alb). This suggests negligible evaporative loss of the incoming water in this catchment that has cave systems but hardly any open surface water area. Furthermore, 18O isotope values of cave drip waters were found to be almost identical to the weighted average of the precipitation. This indicates that seasonal variations in the incoming precipitation were already homogenized in the unsaturated zone of the karst system. The mixing also shows that fast conduit systems such as subsurface cave streams play a minor role in influencing the overall isotopic composition of the Blautopf Spring.