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Using "StorAge Selection" functions and high resolution isotope data to unravel travel time distributions in headwater catchments

Paolo Benettin (1), Chris Soulsby (2), Christian Birkel (2,3), Doerthe Tetzlaff (2), Gianluca Botter (4), Andrea Rinaldo (1,4)

(1) EPFL, ENAC/IIE/ECHO, Lausanne, Switzerland (paolo.benettin@epfl.ch), (2) Northern Rivers Institute, School of Geosciences, University of Aberdeen, Aberdeen, United Kingdom, (3) Department of Geography, University of Costa Rica, San Jose, Costa Rica, (4) Dipartimento ICEA, Universita degli studi di Padova, Padua, Italy

We use high resolution tracer data from the Bruntland Burn catchment (UK) to test theoretical approaches that integrate catchment-scale flow and transport processes in a unified framework centered on selective age sampling by streamflow and evapotranspiration fluxes. Hydrologic transport is here described through StorAge Selection (SAS) functions, parametrized as simple power laws. By representing the way in which catchment storage generates outflows composed by water of different ages, the main mechanism regulating the tracer composition of runoff is clearly identified. The calibrated numerical model provides simulations that convincingly reproduce complex measured signals of daily deuterium content in stream waters during wet and dry periods. The results for the catchment under consideration are consistent with other recent studies indicating a tendency for natural catchments to preferentially release younger available water. The model allows estimating transient water age and its related uncertainty, as well as the total catchment storage. This study shows that power-law SAS functions prove a powerful tool to explain catchment-scale transport processes that also has potential in less intensively monitored sites.