Geophysical Research Abstracts
Vol. 19, EGU2017-19132-1, 2017
EGU General Assembly 2017
© Author(s) 2017. CC Attribution 3.0 License.

Storage-discharge hysteresis and its impact on stream flow O-18 and D isotope signatures

Laurent Pfister (1), Julian Klaus (1), Gwenael Carrer (1), Christophe Hissler (1), Núria Martínez-Carreras (1), Nicolas Rodriguez (1), and Jeffrey J. McDonnell (2)

(1) Luxembourg Institute of Science and Technology, ERIN, Esch sur Alzette, Luxembourg (laurent.pfister@list.lu), (2) Global Institute for Water Security, University of Saskatchewan, 11 Innovation Boulevard, Saskatoon SK S7N 3H5

Catchment storage-discharge relationships are known to be non-linear and to exhibit hysteretic patterns. Antecedent storage and catchment scale largely control the degree of the hysteresis – as a translation of differences in velocities and celerities differently in each individual catchment. Following up on recent calls in the literature for a more systematic combination of hydrograph and stable isotope investigations, here we focus on catchment storage dynamics and how these may be correlated with isotopic signatures of O-18 and D in stream flow. Our study area is located in the Alzette River basin and consists of 12 nested catchments, covering a wide range of physiographic settings with clean and mixed bedrock geology, landuse, soil types, and topography.

First, we used daily water balance calculations over an 8-year period (2006-2014) to estimate daily storage deficits. The daily storage deficit-discharge pairs were found to evolve along an envelope line that is tangential to hysteretic loops of these same variables. Each catchment's envelope line was found to have a distinct slope – the variety of slopes being controlled by bedrock type and its subsequent permeability.

Next, we investigated the dynamics of isotopic signatures of O-18 and D in stream flow along the complete range of observed daily discharge and storage deficit values. A common feature in most (but not all) of our study catchments is that isotopic signals became more and more depleted as storage deficits tended to zero (i.e. saturation). Likewise, isotopic depletion in streamflow O-18 and D was highest when storage deficits were smallest and discharge values highest.

Our investigation of isotopic signatures in stream flow across 12 catchments through multiple wetting-up and drying cycles has revealed relationships between catchment bedrock geology, storage and isotopic signatures of O-18 and D in stream flow. These signatures are largely (but not exclusively) controlled by storage dynamics on a seasonal time scale. Event-scale isotopic signatures observed along the hysteretic loops (characteristic of the storage deficit-discharge relationship) exhibit a larger heterogeneity – translating substantial contributions to streamflow from surface and/or subsurface runoff processes.