Geophysical Research Abstracts
Vol. 21, EGU2019-3625, 2019
EGU General Assembly 2019

Small-scale variability in the isotopic composition of rainfall and its importance for hydrograph separation

Jan Seibert (1,2,3), Benjamin Fischer (3), and Ilja van Meerveld (1)

(1) Department of Geography, University of Zurich, Switzerland (jan.seibert@geo.uzh.ch), (2) Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Uppsala, Sweden, (3) Department of Physical Geography, Stockholm University, Sweden

Variations in the isotopic composition of precipitation provide the basis for several approaches to study hydrological processes. While regional variations in the isotopic composition of rainfall are relatively well understood, the small-scale variability has been studied much less and is often ignored. For studies in small headwater catchments, rainfall is usually collected at only one sampling location.

Here we present results from one of the very few studies where rainfall has been analyzed for its isotopic composition at several rain gauges within a short distance from each other. In a small Swiss headwater catchment, the 4.3 km2 Zwäckentobel catchment, rainfall was sampled sequentially at eight locations. Additionally stream water was collected in three subcatchments (0.15, 0.23, and 0.70 km2) during ten events.

The spatial variability in rainfall amount, average and maximum rainfall intensity and the isotopic composition of rainfall was different for each event. There was no statistically significant relation between the isotopic composition of rainfall and total rainfall amount, rainfall intensity or elevation. For the ten studied events, the temporal variability in the isotopic composition of rainfall was generally larger than the spatial variability in the rainfall isotopic composition. However, for many events, the spatial standard deviation in rainfall isotopic composition was in the range of 2 to 4‰ (delta-18O), which was as large as the observed temporal variability in the stream isotopic composition during events.

The question arises to which degree the observed spatial variability in the rainfall isotopic composition affects the results of runoff generation processes studies. To evaluate this, we applied isotope hydrograph separation (IHS) on the collected dataset. Commonly, IHS are performed using water samples of baseflow (pre-event water), streamflow and rainfall (event water) collected at one gauge, often located near the catchment outlet. Our results show that isotope hydrograph separation results varied considerably depending on which of the eight rain samplers was used to represent the isotopic composition of event water. The calculated minimum pre-event water contributions differed up to 60%. The differences were particularly large for events with a large spatial variability in the isotopic composition of rainfall and a small difference between the event and pre-event stream water isotopic composition.

These results demonstrate that even in small catchments the spatial variability in the rainfall isotopic composition can be significant and has to be considered for IHS studies. Using data from only one rain sampler can result in significant errors in the estimated pre-event water contributions to streamflow. These results highlight the need to consider and study small-scale variations in the isotope composition of rainfall.