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Using the deuterium-excess to quantify lake water contributions along a pre-alpine stream

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The stable isotopes oxygen-18 and deuterium (^{18}O and ^{2}H) are both often used to study runoff processes. In situations involving surface water evaporation the combination of these two isotopes into the so called deuterium-excess can be useful to trace flow contributions. In our study, we collected isotope samples in the Reppisch catchment (24 km^2) in Switzerland, where a lake (0.5 km^2) is located at the top of a long narrow valley. The Reppisch river runs through this valley and the different tributary streams are all smaller than 1 km^2. The goal was to investigate whether it was possible (1) to observe the stable isotope signal of the lake (i.e.the deuterium-excess) in the downstream runoff and (2) to use this signal to quantify the local flow contributions along the main stem of the river. For this we collected water samples from the inflows to the lake, the lake, different sampling points along the 25 km long stream and its tributary streams. The different sampling locations were sampled weekly during the snow free period of 2010, 2011 and 2013. Precipitation was collected at two locations during the snow free period of 2013. All water samples were analyzed on the stable isotopes composition (δ^{18}O and δ^{2}H) from which the deuterium-excess was calculated. Results showed that the deuterium-excess from the side branches had a deuterium-excess near the Global Meteoric Waterline (GMWL, 8 to 10 ‰. The deuterium-excess from the lake was near the GMWL but decreased from spring towards autumn towards 2 ‰Ṫhis enriched signal from the lake was up to 12 km downstream of the lake still clearly traceable. After this point with increasing distance and catchment area the deuterium-excess approached the Global Meteoric Waterline (GMWL). However, the distance was variable due to the variability in discharge contribution of the lake and the state of the subsurface reservoirs. The results showed that the the combination of δ^{18}O and δ^{2}H represented by the deuterium-excess contains valuable information that allowed quantifying the contribution of the lake along the main stem of the stream network.