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After the flood: high-frequency sampling reveals the influence of antecedent conditions and diurnal cycles on stream isotope dynamics

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High-frequency (4-hourly) δ2H and δ18O isotope sampling of precipitation and stream water during storm event peaks and subsequent recession periods in the winter and summer 2009 were carried out in a small (2.3 km2) lowland agricultural catchment. During the hydrograph peak, little difference in the response of δ2H and δ18O were observed in both summer and winter events: both tracers revealed the dominance (in average 70 %) of old previously stored water, which decreased with antecedent wetness conditions. Transit Time Distributions (TTDs) fitted to the isotope event responses using a gamma function again revealed similar behaviour for both δ2H and δ18O isotopes. However, the shape and scaling parameters varied dramatically for summer and winter events: when antecedent wetness was high mean transit times were in the order of days, when drier, they increased to months. Moreover, whilst the δ2H and δ18O response during winter storm period recessions exhibited similar gradual recovery to pre-event conditions, the tracers differed dramatically on recessions during the summer. Time series analysis showed that δ2H isotopes were strongly positively correlated with the diurnal cycle of air temperature suggesting an evaporative fractionation pattern. This could be reproduced by a first order autoregression model using temperature as an exogenous regressor. In contrast, the heavier δ18O isotope showed no diurnal variability. The study underlines the value of high-frequency stable isotope sampling in storm events in understanding time variant TTDs. Furthermore, it shows that the time of sampling in a diurnal cycle may have crucial significance for interpreting stream isotope signatures.