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# Carbon isotopes as tracers of dissolved organic carbon sources and water pathways in headwater catchments

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Stable carbon isotopes ($\delta$13C) are assessed in further detail for their potential to (i) trace the relationship between spatial variations in the source of dissolved organic carbon (DOC) in soils and temporal variability of both DOC concentration and composition in streams, and (ii) elucidate water pathway changes during storm events in headwater catchments. For this purpose, we combine high-resolution monitoring ($\leq$ hourly basis) of stream $\delta$13CDOC values during a storm flow event with $\delta$13C of soil organic matter in a small, lowland catchment in western France (Kervidy-Naizin catchment). With increasing discharge, stream DOC concentration increases from 4 to 14 mg.L-1, accompanied by a marked decrease of $\delta$13CDOC from -27 to -29‰ suggesting a change in DOC sources between base flow and storm flow periods. This interpretation is consistent with previous hydrochemical and hydrological data showing that storm events can cause major modifications in water pathways in this catchment. The main water inputs during storm events are wetland runoff and wetland soil water (between 30 and 55% of the total water flow), while groundwater flowing into deeper soil horizons is the main water source during base flow periods. Such an interpretation is also consistent with the soil isotopic record. Indeed, $\delta$13CDOC values in soils from the Kervidy-Naizin catchment show a 6‰ vertical variation, with $\delta$13CDOC values of the uppermost soil horizons (0-10 cm) of the wetland domains close to those measured in the stream channel during the ascending limb of the hydrograph. Overall, the results presented in this study are consistent with a model in which the water-table rise and wetland runoff caused by rainfall lead to a flushing of the DOC stored in the uppermost soil horizons of the wetland domains near the channel network. Subsequently, these wetland soils become the dominant DOC source during storm events (ca. 70% of the total DOC flux). The export of DOC in this catchment ultimately constrains the hydrologic connectivity between the upper soil horizons of the wetland domain and the stream. In this way, the stream DOC isotopic composition reflects the combined effects of the vertical variation of soil organic matter composition as well as the changes in water routing through time. This study demonstrates the ability of the stable isotopes of carbon to serve not only as a tool for the location of stream DOC sources in landscapes but also the reconstruction of water pathways in headwater catchments.