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High-resolution modeling of flow partitioning: Comparison of water stable isotopes and electrical conductivity for model calibration

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The identification of water sources contributing to runoff is critical to understand the relation between water and biogeochemical cycles. During rainstorm events, runoff can be composed of event ("new") and pre-event ("old") water fractions. Geochemical tracers in simple mass balance end member mixing analysis are commonly used to investigate these relative contributions to total runoff. However, those methods do not intrinsically account for the hydrologic flow response and the tracer data are often only available at low temporal resolution, leading to high uncertainties in the estimation of flow components. Here, we present a numerical flow partitioning model (TraSPAN) that simulates both the tracer mass balance and the water flux response at the event scale. We tested four different TraSPAN structures representing different internal catchment hydrologic conditions. We used high-resolution (0.25-5 hours) hydrometric and geochemical tracer (water stable isotopes (WSI) and electrical conductivity (EC)) data to simulate flow partitioning and compare the results yielded by each tracer for a storm monitored at the HJ Andrews Experimental Forest in western Oregon, USA. Our results show that the same model structure provided the best hydrograph and tracer dynamics fits using either EC or WSI (NSE > 0.9). The structure corresponds to two reservoirs in parallel to route the event and pre-event water fractions following independent transit time functions (TTFs) and allows a time-variant fraction of effective precipitation routed as event water over the course of the storm. In addition, the level of agreement between the results attained with EC and WSI is remarkable in terms of flow partitioning proportions, parameter values, and TTFs. Given the high cost associated to the collection and analysis of WSI at high temporal resolution, our results provide great promise for the use of EC as a tracer in high-resolution flow partitioning modeling. The use of such an inexpensive tracer could allow for detailed investigation of the relative importance of catchment characteristics (e.g. precipitation seasonality, geology, topography) in the hydrologic response of catchments in other environments. The use of EC could also be incorporated in alternative non-stationary modelling approaches of hydrologic response that require long-term high-resolution data.