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Three methods - one tale? An intercomparison study to estimate snowmelt contribution to streamflow using a tracer-based, a tracer-aided and a hydrologic model

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Cryospheric water resources are essential for water supply in many mountainous and foreland regions. Various methods exist to estimate the contribution of snowmelt to streamflow, but the frequently used models differ in their conceptualization (from black-box steady-state linear mixing models solving the mass balance of water and tracer to process-based models solving the energy and mass balance of various processes in a catchment). In our investigation we present a direct comparison among the following three approaches: (i) a tracer-based mixing model (isotope-based hydrograph separation), (ii) a tracer-aided model including the transit-time of water (TRANSEP) and (iii) a hydrologic model (HBV Light including the quantification of input components). We applied the three different models to estimate the snowmelt contribution to streamflow during melt events with various magnitudes in the glacierized Rofen valley (Oetztal Alps, Austria). We assume that the contribution of snowmelt to streamflow estimated with the three approaches deviates due to the fact that those models differ in their internal structure. We use four years of hydrometric and meteorologic data, as well as oxygen-18 isotope data, to explore how the models reproduce the physical reality under various catchment system states. In this work we present first results and discuss them concerning estimated contribution, physical realism, flow path, travel time, storage of water, and data requirements. We assess advantages and drawbacks of the applied methods and provide suggestions for trade-offs between applicability and performance of the model.