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Infiltration processes in karst characterized using an event-based rainfall-discharge model coupled with a mixing model of organic carbon transport

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The aim of this study is to characterize the infiltration processes in a karst aquifer using an hydrological modelling approach coupled with a solute transport model of dissolved organic carbon (DOC). DOC is a non-conservative tracer derived from the enrichment of infiltrated water into soil humic substances. Hydrological modelling is based on a classical model with 3 connected reservoirs: SOIL (and epikarst), that feeds the aquifer partitioned into DIFFUSE and CONDUIT reservoirs. DOC transport modelling is a mixing model, including an empirical retardation factor and a first order solute decay. The model is applied on the small karst system of Fertans in the French Jura mountains, where discharge and continuous measurements of DOC fluorescence are recorded. Seventeen flood events are selected to test model performances at a hourly time step. Various extensions of the model are tested by the addition of reservoirs and/or functions. Results show that the best configuration of the model to simulate properly discharges and concentration fluctuations during flood events is to split the SOIL reservoir to feed DIFFUSE and CONDUIT with different DOC concentrations, and to add a PISTON reservoir simulating pre-event water in the CONDUIT drained via piston flow-type at the beginning of the flood. In this configuration, the model simulates the contributions of pre-event and event waters during flood events and allows to better quantify the available resource considering the mixing effect of DOC. It shows, in particular, that a purely classical hydrological rainfall-runoff model may underestimate the volume of water mobilized during infiltration transit in the system, and that total discharge of some flood events during dry periods are mainly composed by pre-event water via piston flow-type processes. Finally, this approach demonstrates the utility of coupling hydrodynamics with hydrochemistry to calibrate hydrological models and to improve understanding of karst functioning.