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Lagrangian pathway-travel time theory and scenario analysis of tracer-pollutant and uncertainty propagation through catchments

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This paper presents how tracer, nutrient and pollutant transport through a catchment can be analyzed based on mean flow and other flow-transport properties given or resolved by simulations, by following the trajectories (pathways) of transport through the catchment and the flow-transport property distribution among them. Convolution of relevant property distributions across consecutive hydrological units, aggregated over the trajectories that originate from the tracer/pollutant-specific injection area, captures hydrological dispersion with its basic measure derived as the travel time coefficient of variation. Various memory functions can be introduced in a relatively simple manner for incorporating retention/mass transfer mechanisms under conditions of statistical stationarity.

The paper further shows how spatial and temporal flow variability can be accounted for in this general theory, and how each and both of these variability components influence hydrological transport in catchments. Moreover, the paper outlines how the theory can be used in a scenario analysis approach to quantify and map the effects of uncertainty in physical and biogeochemical characteristics on diffuse hydrological transport and its uncertainty.