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Spatially distributed modeling of nitrate fluxes at the catchment scale using a transit time distribution approach

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Predicting dynamic nitrate fluxes at the catchment scale is relevant to understand solute transport processes, assess eutrophication risks and improve water quality management. In order to simplify the complex biogeochemical processes without disregarding the spatial heterogeneity and changing flow paths, we combine physical modeling and a conceptual transit time approach. First, we use the physically-based, 3D, spatially distributed hydrologic model HydroGeoSphere (HGS) to extract transit time distributions (TTDs) of a conservative tracer for different parts of a catchment (partitioned by land use). We systematically combine different initial and boundary conditions analyzing apparent changes in shape and scale of the TTDs. Then we modify the resulting land use-specific TTDs according to the typical decay and retardation processes that are associated with nitrate. This includes retention of organic nitrogen, as well as attenuation by plant uptake and denitrification of inorganic nitrate. Finally, we superimpose and convolve the time series of nitrate-specific TTDs to compute the total nitrate outflux from the catchment.