Integrated surface-subsurface reactive transport modeling

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In natural surface-subsurface systems, areas of disproportionately high reaction rates often heavily influence total elemental fluxes. These pockets of high reaction rates tend to occur at interfaces, such as the capillary fringe or hyporheic zone, where a hydrologic flowpath converges with either a chemically distinct hydrologic flowpath or a reactive substrate. Understanding the affects that these highly reactive zones have on the behavior of shallow subsurface systems is integral to the accurate quantification of nutrient fluxes and biogeochemical cycling. The numerical simulation of many of these areas of disproportionately high reaction rates requires an integrated surface-subsurface modeling approach. Here we present recent developments to the massively parallel reactive transport code ParCrunchFlow. This model, previously applicable only to steady-state, saturated subsurface flows, has been extended to transient, surface-subsurface environments, allowing the numerical simulation of reactive transport processes in highly-heterogeneous, field-scale systems. Proof-of-concept simulations involving the biogeochemical cycling of carbon (C) and nitrogen (N) in both hillslope and floodplain settings are presented.