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Hydroclimatic versus geochemical controls on silicate weathering rates

Sylvain Kuppel[1], Yves Goddéris[1], Jean Riotte[1], and Laurent Ruiz[2]
[1]Géosciences Environnement Toulouse, CNRS - IRD - UPS - CNES, Toulouse, France
[2]G-EAU, INRAE - AgroParisTech - Cirad - IRD - Montpellier SupAgro - Univ Montpellier, Montpellier, France

Water is the first order controlling factor of the weathering reactions. In the recent years, efforts have been made towards the building of model cascades able to simulate the water fluxes and the residence time of the water in the various compartments of the critical zone. Those hydrological constrains are then injected into numerical models simulating the water-rock interactions from the surface down to the impervious bedrock. In this contribution, we describe such a model cascade, where the water-rock interaction model WITCH is fed by the process-based ecohydrological model EcH2O-iso. This model cascade, WITCH$_2$O, is designed for the modeling of water fluxes & stores, as well as the weathering reactions and transport of weathering products (including atmospheric CO_2 consumption), from the vertical profile to the catchment scale, and from the submonthly to decadal time scales. We deployed WITCH$_2$O along a gneiss-saprolite-ferralsol profile in a small tropical forested catchment in peninsular India. Long-term observations of water and geochemical fluxes are available, allowing for a 2-step model calibration and evaluation (hydrological and geochemical) across the different processes simulated. Using various temporal averages of simulated water fluxes and stores, preliminary results highlight that seasonal hydrological variability (driven by monsoon dynamics and deep root water uptake) is key for capturing groundwater nutrient concentrations, despite highly-buffered water table variations. We also explore how this non-linear dependence of weathering fluxes upon hydrological states is modulated by the propagation of uncertainties regarding i) modeled hydrology and ii) uncertainties in geohydrochemical properties (e.g. reactive surface and mineral abundance).