Different numerical coupling strategies lead to diverging carbon-nutrient interactions

Jinyun Tang, William J. Riley and Qing Zhu

Carbon-nutrient interactions are essential in determining the strength of biogeochemistry-climate feedback. In order to deliver mechanistically robust simulations, models not only have to incorporate necessary processes, they also have to implement the mathematical formulations of these processes robustly. Based on the default ELM-v1-ECA parameterization, we here include another two variants that incrementally tighten the coupling among different biogeochemical components. In the first variant, closer aboveground coupling is achieved using the multiple-nutrient-flux limiter algorithm, while the second variant further implements closer above-belowground nutrient coupling using the Biogeochemical Transport Reaction (BeTR) module in ELM. Our simulations indicate that tighter coupling decreases the simulated nutrient stress of various ecosystems, particularly, the phosphorus limitation in tropical ecosystems. Even with identical biogeochemical parametrization, the simulations diverge significantly, although the divergence is still within range of that of the Coupled Model Intercomparison Projects. In summary, our experiments indicate that improper numerical implementation could force models to use incorrect parameters even though the correct processes are incorporated.