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Validation of a simple biogeochemistry variant of SORTIE-PPA in two temperate forests using the Erde modeling framework

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While vegetation model development has accelerated over the past three decades, less progress has been made in software interfaces that bind models and data. Such interfaces become necessary as model complexity increases, making models more cumbersome for new users to parameterize, run, and analyze. Furthermore, model wrappers may provide new modeling capabilities, such as Bayesian optimization. Toward this end, we have developed a simple geoscientific simulation model API and toolkit in R and Python known as the Earth-systems Research and Development Environment (Erde). While Erde is primarily intended for vegetation models, its data structures and algorithms are applicable across a range of geoscientific modeling domains. We demonstrate an application of Erde with a simple biogeochemistry variant of SORTIE-PPA known as PPA-SiBGC. The PPA-SiBGC model combines the Perfect Plasticity Approximation with explicit above-and-below-ground biogeochemical pools and simple flux models. We parameterized, ran, and validated PPA-SiBGC at two research forests in the Eastern United States: (1) Harvard Forest, Massachusetts (HF-EMS) and (2) Jones Ecological Research Center, Georgia (JERC-RD). We assessed model fitness using these temporal metrics: net ecosystem exchange, aboveground net primary production, aboveground biomass, C, and N, belowground biomass, C, and N, soil respiration, and, species total biomass and relative abundance. Without applying any optimization, we found that a simple biogeochemistry variant of SORTIE-PPA was able to outperform an established forest landscape model (LANDIS-II NECN) across the metrics tested. While LANDIS-II NECN showed better NEE fit, PPA-SiBGC demonstrated better overall correspondence to field data for both sites (HF-EMS: $\overline{R^2} = 0.73, +0.07$, $\overline{RMSE} = 4.84, -10.02$; JERC-RD: $\overline{R^2} = 0.76, +0.04$, $\overline{RMSE} = 2.69, -1.86$).