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A Novel Forest Regeneration Submodel for Vegetation Demographic Models

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Earth system models are used to project the fate of forests in response to climate and land use change. They are increasingly adopting vegetation demographic modeling approaches that explicitly represent tree growth, mortality, and recruitment, enabling advances in the projection of forest resilience and vulnerability. Despite recent progress in the representation of vegetation demographics, explicit representation of forest regeneration processes, such as flower and seed production, seed longevity, seedling dynamics, and sapling recruitment have largely been neglected in these (and earlier) models. This is despite the central importance of regeneration in mediating key ecological phenomena under global change: compositional turnover, post-disturbance trajectories of forest recovery, and geographic range shifts. Here we present a regeneration submodel that improves current representations of forest regeneration processes in a format compatible with vegetation demographic models (VDMs). The submodel explicitly and efficiently represents allocation to reproduction, seed bank dynamics, seedling dynamics, and recruitment into the adult population. It has been formulated and parameterized for seasonally dry tropical forests using data from Barro Colorado Island. The model includes four plant functional types that vary in shade and soil moisture tolerance. This model demonstrates PFT-specific size-dependent reproductive allocation, soil-moisture-dependent seedling emergence and mortality, light-dependent seedling mortality, and light-dependent recruitment rates. At BCI the submodel has reduced biases in VDM-predicted recruitment rates, simulated observed seasonality of seedling emergence and interannual trends in recruitment. Adam is currently working on model sensitivity analyses and testing the model at new sites to evaluate model performance and biogeographic generalizability.