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Can process-based BGC models simulate drought-induced tree mortality worldwide?

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Drought-induced tree mortality has been increasing worldwide under climate change; therefore, forests will become more vulnerable as warming continues. With growing interest in tree decline due to increased climate variability, ecophysiological roles and dynamics of non-structural carbohydrates (NSCs) have drawn wide attention recently. Accordingly, a lot of field data have been collected, but these achievements were not well incorporated in process-based vegetation models yet, where NSCs ecophysiology was implicitly applied or ignored. In this study, we addressed five key modeling issues in simulating spatial and temporal patterns of NSCs dynamics across different scales as follows: (1) interconversion between dual NSCs pools (i.e., rapid soluble sugar and slown starch pools), (2) incorporation of the sink-limited growth allocation strategy, (3) hydraulic limitation of NSCs transports between organs, (4) feedback mechanisms between tree NSCs and root symbionts, and (5) large-scale simulations of NSCs dynamics. In addtion, we applied key issues (1) and (2) of NSCs to the BIOME-BGC model and evlauated across biomes. As a result, modified BGC model (BGC-NSCs) successfully simulated vegetation traits across different biomes, such as seasonal and interannual variations of St (mean R^2 of, 0.55, 0.62), and site-specific SS-to-St ratios, while the model did not simulate the SS temporal variation well. Nevertheless, in the factor analysis of several variables for the global tree mortality data, physiological variables such as NSCs and PLC (Percent loss of conductivity) produced in the BGC-NSCs model were important. Despite limitations of the current BGC modeling and simple assumptions of mortality mechanisms, this study demonstrated a potential to use key ecophysiological variables for simulating widespread drought-induced mortality across different biomes and climate regions.