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Temperature Response of Foliar Dark Respiration and Consequences for the Stand Carbon Budget

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Understanding the temperature response of photosynthesis and foliar dark respiration (R_d) is needed in formulating hypotheses about vegetation response to climate change. Proper representation of temperature response is also required of models used to predict these responses. Accordingly, we are evaluating alternative model formulations of leaf-level temperature responses of photosynthesis and R_d and their consequences for simulated carbon fluxes at the leaf, canopy, and stand levels. Here we report results for modeled temperature response of foliar R_d. We first compared simulated leaf-level R_d temperature response curves from nine alternative formulations with pre-treatment observations of black spruce (*Picea mariana*) at the SPRUCE (Spruce and Peatland Responses Under Changing Environments) experimental site in northern Minnesota. We found divergence across models at temperatures greater than 35°C, but the models as a group matched the observed temperature response below ≈30°C. We next integrated the different temperature-response functions into the ELM-SPRUCE model as alternative formulations for leaf maintenance respiration $R_{m,leaf}$ and simulated stand-level carbon flux across pre-treatment years 2011-2015. We found that the various formulations made little difference in simulated $R_{m,leaf}$, canopy maintenance respiration $R_{m,canopy}$, autotrophic respiration R_a, net primary production NPP or net ecosystem production NEP, largely because temperature was usually in the range over which the response functions are most similar and rarely exceeded 30°C. We next examined the impact of the alternative formulations on model response to the SPRUCE experimental treatments of +0.00, +2.25, +4.50, +6.75 and +9.00°C. In these simulations air temperature can exceed 35°C and differences in leaf-level temperature response became apparent in $R_{m,canopy}$, R_a, NPP and NEP. There was, however, a general narrowing of the differences when moving from the leaf to the stand. Effects of the different respiratory temperature-response formulations on five-year mean annual NEP at +9.0°C ranged from -10 to 3%. With formulations representing acclimation, simulated net carbon loss was reduced by ≈20% in some years. Choice of foliar R_d temperature response function can substantially affect simulated stand's carbon budget.