EGU25-7741, updated on 21 May 2025
https://doi.org/10.5194/egusphere-egu25-7741
EGU General Assembly 2025

Uncertainty in tundra plant functional traits outweighs climate scenario uncertainty

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Plant functional traits provide a link to scale from organism to community and ecosystem levels, making it critical to understand how traits will mediate ecosystem responses to climate change. Combinations of these functional traits, which are likely to shift under climate change, also provide insight into plant resource use strategies, determining whether plants have resource-use acquisitive or conservative growth strategies. In this study, we used meteorological and eddy covariance tower data from the Niwot Ridge Long Term Ecological Research site (Colorado, USA) to run point-scale Community Land Model (CLM; the terrestrial component of the Community Earth System Model) simulations with plant functional trait observations. We modified plant traits and parameters–including foliar traits, phenological characteristics, and hydraulic traits–to represent tundra growth strategies and to configure dry, moist, and wet tundra communities driven by differences in snow accumulation. After validating our simulations with local observations, we quantified the relative contributions of plant trait and climate change scenario uncertainties to future productivity outcomes by modifying parameters to represent more resource-use conservative or acquisitive communities under two climate change scenarios. We found that using foliar trait observations from each plant community significantly improved productivity estimates compared to overestimates in the default simulation. In addition, the relative contributions of plant trait and climate scenario uncertainties varied among communities and over time in future simulations. Overall, uncertainty in plant functional trait shifts had a larger effect on ecosystem carbon-cycle responses than uncertainty in the forced response from medium and high emissions scenarios. Our findings demonstrate the importance of plant functional traits in shaping ecosystem responses to climate change and the value of incorporating site-level observations into ecosystem models as a means to predict climate change impacts on ecosystem function.