

Importance of considering small-scale polygonal tundra geomorphology in large-scale terrestrial ecosystem models for assessing change in landscape-level carbon balance on the Barrow Peninsula

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Northern permafrost regions are estimated to cover 16% of the global soil area and account for approximately 50% of the global belowground organic carbon pool. However, there are considerable uncertainties regarding the fate of this soil carbon pool with projected climate warming over the next century. In northern Alaska, nearly 65% of the terrestrial surface is composed of polygonal tundra, where geomorphic land cover types (i.e. high-center polygon) disproportionately influence local surface hydrology, plant community composition, nutrient and biogeochemical cycling, over small spatial scales. Due to small-scale (1-100 m) geomorphic spatial heterogeneity of Arctic tundra, and the relatively large (1km² - 0.5°) spatial extent in which process-based biogeochemical models used for long-term change determination, it is uncertain which small-scale geomorphic types are critical to consider within a large-scale modeling framework to minimize error associated with simulated spatial and temporal patterns of change. This work evaluates the relative importance of multiple geomorphic types on large-scale modeling assessments, using the terrestrial ecosystem model (DOS-TEM). We parameterize and calibrate this model using data specific to the local climate, vegetation, and soil associated with tundra individual geomorphic types, and extrapolate model results at a 1km² resolution across the ~1800 km² Barrow Peninsula using a map that describes eight dominant geomorphic tundra types. Next, data for eight geomorphic types (initial) are iteratively simplified based on similar characteristics within a hierarchical cluster analysis, while the model is re-parameterized, re-calibrated, and re-extrapolated using 8, 6, 4, and 3 classes. We evaluate differences between initial and reduced class sizes on changes in landscape-level carbon balance between 1970 and 2100. Preliminary simulations for this region indicated temporal variability in response to carbon and active layer dynamics, specific to tundra geomorphic type, and presents the landscape-level potential error in simulated carbon balance associated with reduced class size.