Supplementary I

Wildfire exacerbates high-latitude soil carbon losses from climate warming

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Supplementary Methods

Ecosys is a well-tested comprehensive mechanistic model with fully coupled carbon, energy, water, and nutrient cycles solved at an hourly time step[1]. A brief description of the model components that are most relevant to modeling the plant carbon uptake and soil carbon decompostion are described in the Methods section of the Manuscript. Detailed description of inputs, parameters, and algorithms for soil C, N, and P transformations; soil and plant water relations; gross primary productivity, autotrophic respiration, growth, and litterfall; soil water, heat, and solute fluxes; solute transformations; symbiotic N_2 fixation; CH_4 production and consumption; and inorganic N transformations used in the model can be found in the Supplementary Information II.

The model has been rigorously tested in many high-latitude ecosystems by comparing model estimates of carbon uptake, active layer development, soil moisture, plant biomass, and energy and carbon fluxes with site measurements (e.g., from Circumpolar Active Layer Monitoring (CALM), chambers, eddy covariance flux towers) in boreal forest[2-6] and Arctic[7-12]ecosystems across multiple years, and with large-scale vegetation remote sensing products including MODIS GPP and AVHRR NDVI[13-16]. Detailed *ecosys* processes most relevant to modeling changes in vegetation compostion and soil carbon in response to wildfire and climate change have been recently tested against observations [16-19].

Supplementary Figures

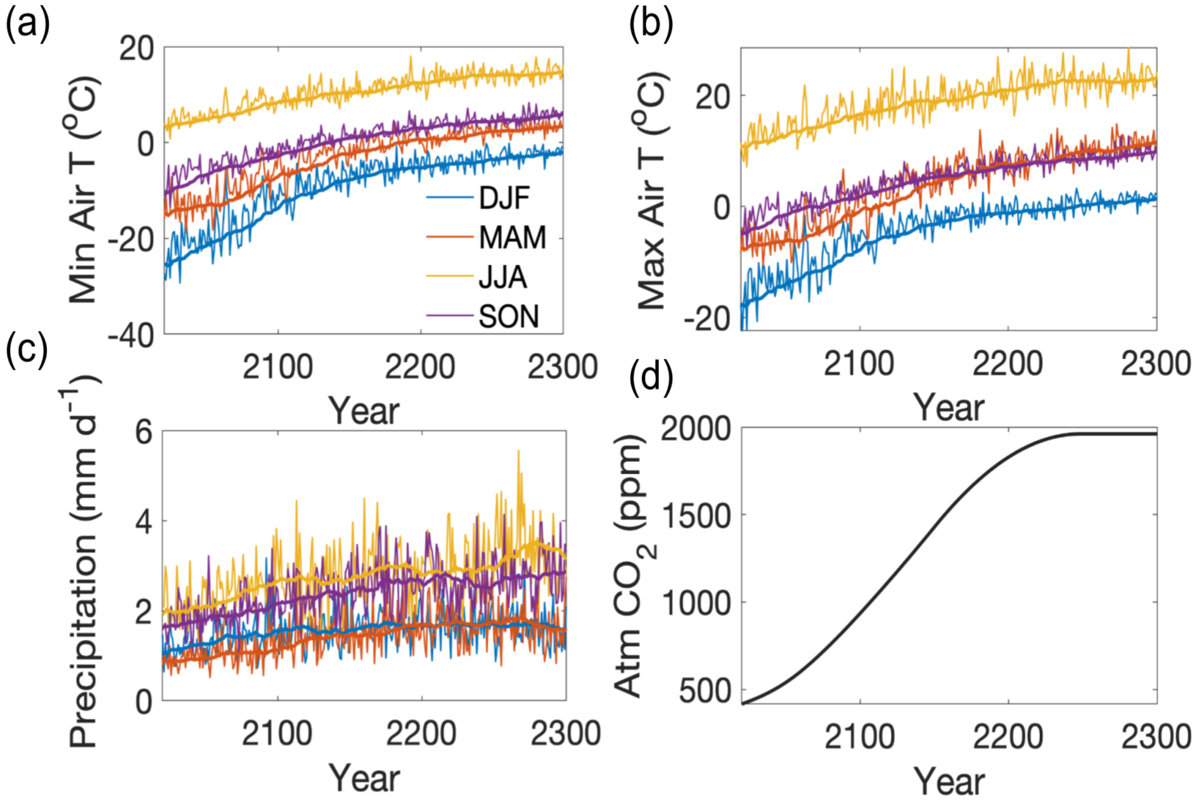

Figure S1. Climate forcing anomalies for daily (a) minimum and (b) maximum surface air temperature, (c) precipitation, and (d) atmospheric CO_2 used to drive the model. The climate anomalies were derived from the CCSM4 climate model under the RCP8.5 climate scenario. The smoothed curves in panels a, b, and c are 10-year moving averages.

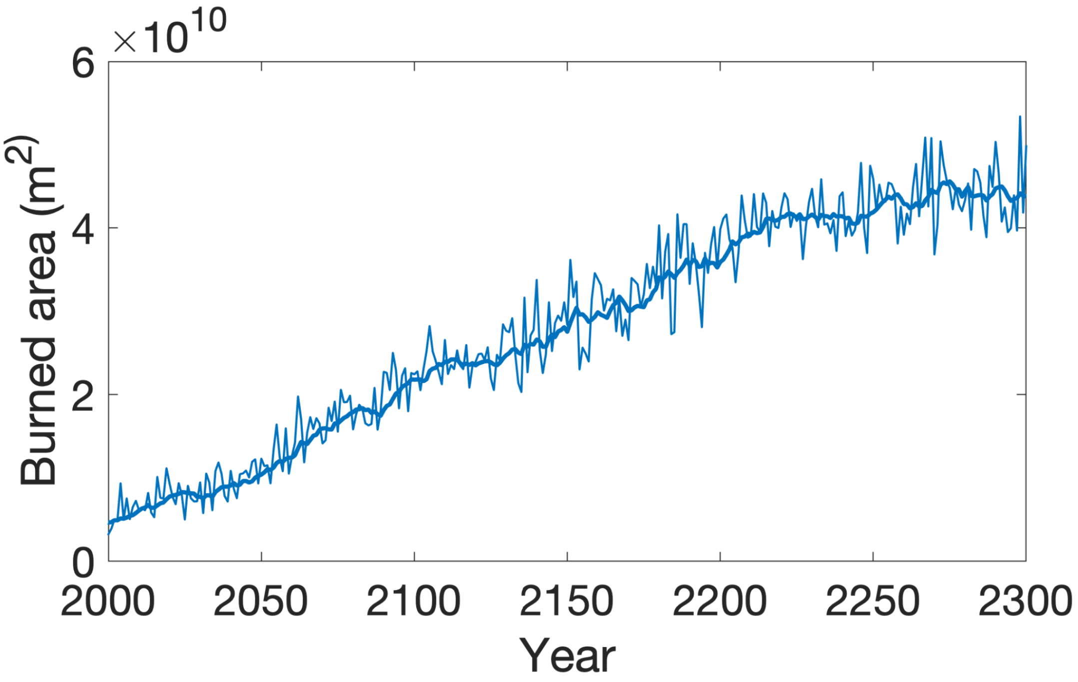

Figure S2. Changes in total annual burned area across Alaska. Changes in the prescribed wildfire were modeled statistically from the baseline map of mean fire return interval from the United States' Landscape Fire and Resource Management Planning Tools (LANDFIRE) product[20], which estimates the frequency of wildfire across Alaska. Increases in frequency of wildfire under future climate were applied to the baseline to match projected changes in burned area[15].

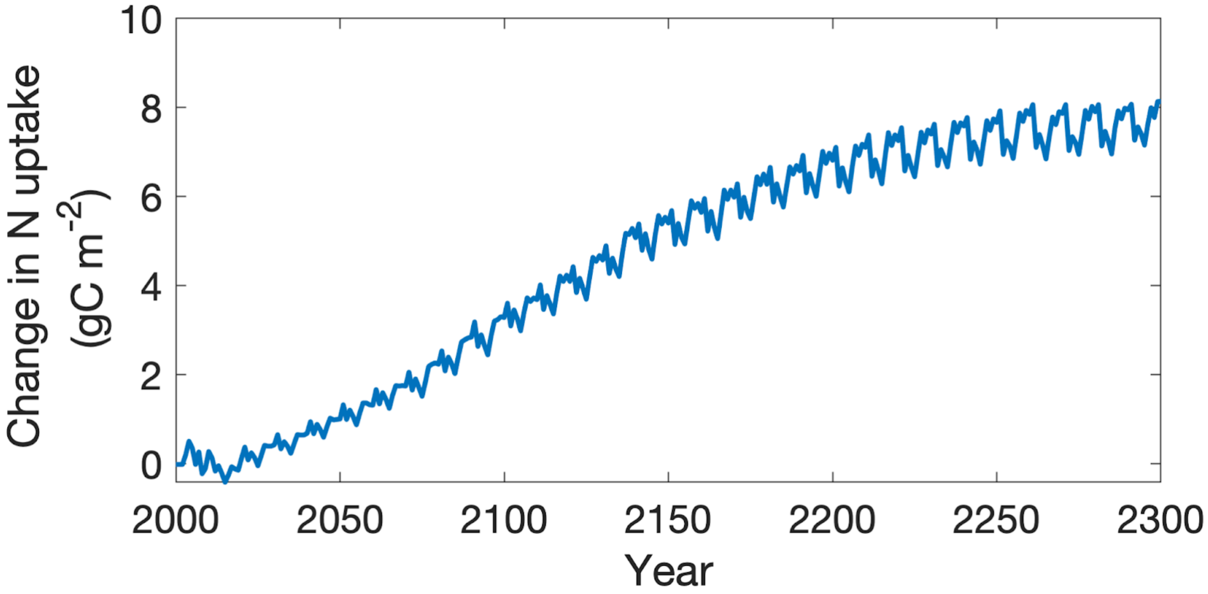

Figure S3. Modeled change (average of 2000 - 2010 subtracted from each year) in spatial average plant nitrogen uptake. Soil warming results in deeper active layers that increase nitrogen availability by hastening microbial mineralization, leading to greater plant root nitrogen uptake under future warmer climates.

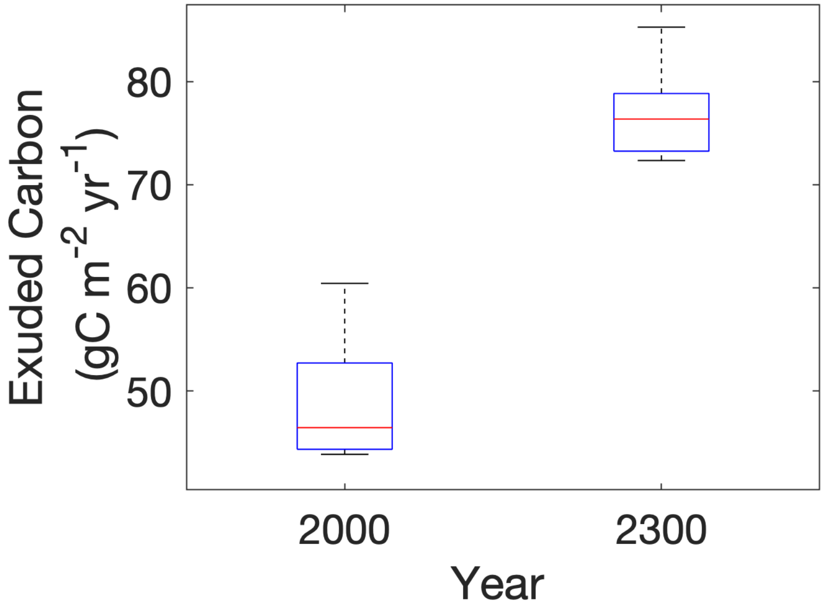

Figure S4. Modeled increases in root carbon exudation driven by increase in plant carbon uptake. The boxes represent root carbon exudation mean (2000-2010 vs. 2290-2300). Horizontal bars represent the 25th and 75th percentile bounds.

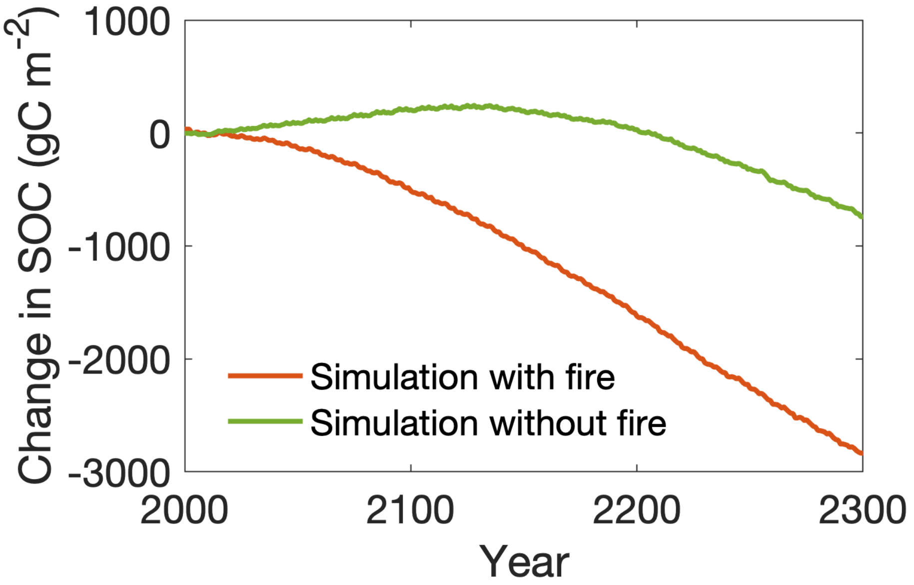

Figure S5. Modeled changes (average of 2000 - 2010 subtracted from each year) in spatially-averaged soil organic carbon stock in simulations driven by climate with and without prescribed fire. In both simulations soil organic carbon stocks declined compared to the average of 2000 - 2010. More soil organic carbon was lost in the simulation with fire.

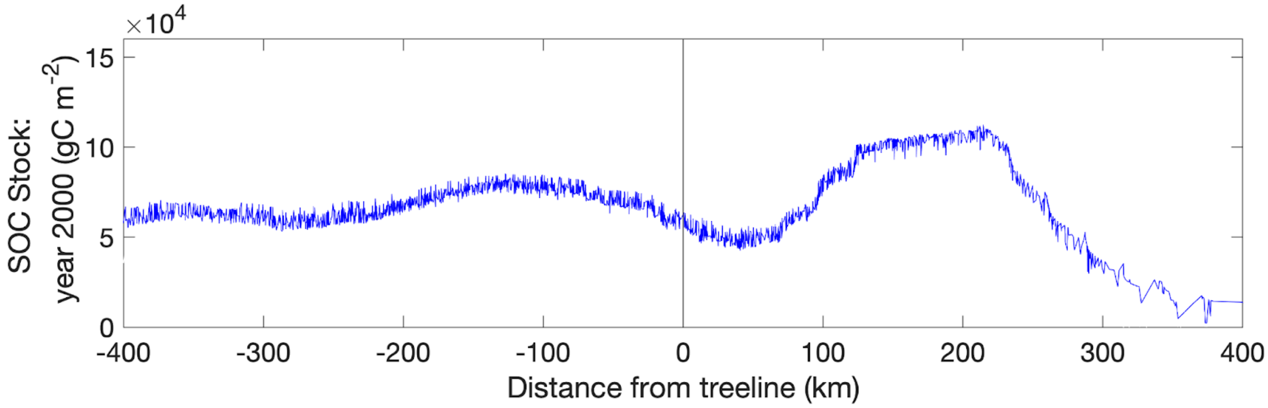

Figure S6. Spatial average (2000 -2010) soil organic carbon stocks exhibit spatial heterogeneity north and south of the treeline across Alaska. The zero in the x-axis represents the treeline, positive values represent north of treeline, and negative values represent south of treeline.

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