ABSTRACT

Effects of Future Changes in Climate and Atmospheric Composition on Forest Ecosystems across the Northeastern U.S.: Model Development, Testing, and Projections

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Rationale: Across the Northeast, mean temperatures have increased 0.7 ^{o}C over the past 30 years and are expected to rise another 2-5 ^{o}C over the next century. Expected concurrent changes in multiple environmental factors (temperature, precipitation, CO_2 and O_3 concentrations, N deposition) can interact in ways that either accentuate or offset one another. Multi-factor manipulation experiments provide valuable tests of certain combinations of these changes, but ecosystem models are needed to predict interactive effects across the range of conditions likely to be experienced by northeastern U.S. forests.

Objectives: We intend to add new mechanisms to the PnET-CN model to quantify changes in forest C, N, and water balance across the Northeast for 1900-2000, and projected to 2100. PnET-CN includes linked C, N, and water cycles, driven largely by the response of forest physiology to climate variation. We propose to (1) augment the model's belowground processes, (2) test against multiple data sets, and (3) estimate the transient changes in forest ecosystem processes in response to historical and projected future changes in climate and atmospheric CO_2.

Location: The proposed modeling activities will cover the forests spanning from Pennsylvania to Maine. Forests cover over two-thirds of this land area, supply timber and drinking water, and provide C sinks disproportionate to their area.

Hypotheses: Our broad hypothesis is that the long-term response of northeastern forests to climate change and rising CO_2 will be heavily influenced by limitations by belowground resources (water and nitrogen) as they are affected by changes in decomposition, plant demands, and physical conditions within the soil environment.

Approach: Our approach has three main components:

1. Model Development: We propose to complement improvements in model canopy functions by emphasizing belowground processes, including: shifts in above- versus below-ground plant C allocation; soil freezing events; and multiple soil organic matter pools.

2. Testing: We will conduct rigorous tests of model hindcasts, comparing estimates of forest growth, stream discharge, and N export with long-term measurements from intensive research sites, and with contemporary measurements of from extensive forest inventory data.

3. Simulating the Future: Projections of future changes in forest C, N and water balance will be driven by newly available, statistically downscaled, CO_2 and climate change projections through 2100.

Expected Accomplishments: Consistent with past protocol, model code will be made available on the PnET web site. This synthetic modeling approach, linking new climate scenarios with observational data, will test and advance understanding of ecosystem processes and provide valuable model projections of future forest changes in response to climate change.