ABSTRACT

Reducing uncertainty about the effects of climatic variation on forest ecosystems by measuring, modeling, and analyzing intermediate-turnover carbon pools

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Objectives: Existing ecosystem models fail to predict measured interannual variation in net ecosystem CO_2 exchange (*NEE*), limiting their value for predicting potential climate change effects. Responding to Focus 3, our objective is improved understanding of the causes of interannual variation in *NEE* in three important forest types of the NICCR NE Region, represented by the Howland, Bartlett, and Harvard AmeriFlux sites. We believe that key processes involving significant interannual variation in intermediate-term (months–years) dynamic carbon pools are missing in most models. New field measurements (estimates of temporal variation of stemwood non-structural carbohydrates [TNC] and transient C sinks and sources in the forest floor litter layer) and ongoing CO_2 flux and ecosystem measurements will be used in a novel modeling framework to evaluate mechanisms that might be included to improve climate and carbon cycle models.

Hypotheses: H0 and H1 are testable functional relationships among assimilatory processes, intermediate storage pools, and respiration. H2 and H3 relate to testable differences in model performance with and without such storage pools.

H0. TNC concentrations increase following above-normal GPP and decrease following wood and foliage production.
H1. The forest floor (FF) is an important transient interannual source/sink of C, depending on rates of litterfall (related to GPP) and rates of decomposition (controlled largely by litter layer water content).
H2. Incorporating a dynamic TNC pool improves model simulation of interannual variation in *NEE*.
H3. Incorporating functions affecting transient C sources and sinks in the FF improves simulation of interannual variation in *NEE*.

Methods: TNC pools (sugars and starches) will be measured (four times/year) in sapwood samples obtained by increment cores of the three dominant tree species at each site. Interannual variation in FF decomposition will be measured in multi-year O horizon decomposition studies. Inverse analysis methods (Bayesian, non-linear optimization using simulated annealing) will be used to parameterize a forest C cycle model with dynamic carbon pools. Measurements of whole-ecosystem and soil CO_2 flux, soil C pool sizes and turnover rates, stand inventories, leaf area index and foliar chemistry (funded by other sources) will further constrain model optimizations. Our modeling approach balances model complexity sufficient to accurately represent system dynamics against the requirement that the model be well-constrained by the available data. Information theoretic methods will be applied to quantitatively evaluate tradeoffs between model performance and complexity.

Deliverables will include peer-reviewed papers, presentations, and posting of model code and ancillary data to CDIAC and a public ftp site.