Which observations would best reduce hindcast and projection uncertainties about the U.S. terrestrial carbon sink?

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Objectives: Our objective is to elucidate how currently available and potential future observations based on flux towers and ecosystem perturbation experiments can improve hindcasts and projections of the terrestrial carbon sink in the United States. The proposed work contributes to key NICCR objectives by synthesizing existing measurements to characterize and reduce scientific uncertainty about how climate change may modulate terrestrial carbon fluxes.

Location: The focus will be on the United States of America.

Hypothesis: We hypothesize that different carbon cycle observation systems differ drastically in their ability to reduce the hindcast and projection uncertainties of the U.S. terrestrial carbon sink. Specifically, we hypothesize that the ability of investment to improve the hindcast and projection errors decreases in the order of: (i) decadal-scale ecosystem manipulation experiments combined with flux-tower observations, (ii) decadal-scale ecosystem experiments alone, (iii) decadal-scale flux towers alone, and (iv) shorter term ecosystem experiments or flux towers.

Methods: We will test our hypotheses using a Bayesian synthesis analysis. We will adopt the TRIFFID model, a well-tested mechanistic dynamic global vegetation model, integrated into an Earth System Model of Intermediate Complexity. We will assimilate observational constraints into this model to derive probabilistic hindcasts and projections of the U.S. terrestrial carbon sink. These constraints are plot-scale flux tower observations with three or more years of data, plot-scale ecosystem manipulation experiments, as well as globally averaged atmospheric CO_2 concentrations and oceanic carbon flux constraints. A statistically sound combination of local- and global-scale information will improve the hindcasts and projections as well as potentially point to structural model problems. We will test our hypotheses about the utility of potential future observation systems by virtually deploying them into the model and comparing the resulting probabilistic hindcasts and projections.

Key Deliverables: The proposed work contributes to key NICCR objectives by synthesizing existing measurements to characterize (and reduce) the scientific uncertainty about how climate change may modulate terrestrial carbon fluxes.