Poster #46

Synthesis of Four Forest CO_2 Enrichment Experiments Demonstrates a Strong and Sustained Decadal Carbon Sink in Aggrading Temperate Forest Biomass

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Predictive understanding of the future terrestrial carbon sink remains elusive. Forest responses to increasing CO_2 are a large contributor to uncertainty in this understanding. Synthesizing data from the only four, decade long, forest CO_2 enrichment experiments replicated at the forest stand scale, we show a strong, decadal-scale CO_2 sink in aggrading forest biomass. Across ambient and elevated CO_2 treatments, biomass increased over the decade of the experiments in a linear relationship with NPP, i.e. CO_2 did not affect the relationship between biomass increment and cumulative NPP. However, because wood allocation increased as NPP increased, the retention of NPP as biomass was more efficient under increased CO_2. Each forest showed strong within treatment variability in NPP suggesting that the factors governing the retention of NPP as biomass across a range of natural climatic and edaphic variability also govern the retention of CO_2 stimulated NPP.

At the two sites that were not confounded by uncertainty or adaptation to frequent fire disturbance, state-of-the-art ecosystem models under-predicted the biomass stimulation by CO_2. This under-prediction was caused by an under-prediction of both the NPP response to CO_2 and the increase in the wood allocation fraction in response to CO_2. These data, synthesized as part of the Free Air CO_2 Enrichment Model Data Synthesis (FACE-MDS) project, clearly demonstrate a sustained long-term stimulation of forest biomass in response to CO_2 concentrations predicted for the middle of the century. Properly accounting for this CO_2 stimulation of biomass in aggrading forests will be necessary for accurately projecting the future terrestrial carbon sink.