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Chances and challenges of forest scale CO_2 enrichment

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Rising CO_2 is changing the biosphere's diet. As with any dietary change, both amount and quality of food matter. Atmospheric CO_2 enrichment is clearly providing a rather one-sided, C-rich diet. Hence, the reaiistic experimental simulation of its effect on the single biggest C reservoir of the biosphere, that is forest, requires experimental conditions that resemble exactly that situation. In the past, trees where most commonly exposed to elevated CO_2 while provided with ample other constituents of a plant's diet (soil nutrients), yielding exaggerated growth stimulation, unlikely to reflect real world responses. So, by either selecting fertile soils, disturbing the system by fire or planting activities, offering ample soil space to isolated individuals or even adding fertilizer, almost any CO_2-response can be 'designed'. The 'art' of designing future Free Air CO_2 Enrichment (FACE) experiments will be to avoid exactly these pitfalls. Plants can incorporate additional C only to the extent the provision of chemical elements other than C will permit, given the stoichiometry of life. Site selection (soil fertility), degree of canopy closure, recent disturbance regime or successional stage will influence CO_2 effects. It is the fundamental dilemma in CO_2-enrichment research that simple, homogenous, artificial test systems offer statistical power, while systems that account for 'naturalness' and species diversity do not. Any new FACE program needs to handle that tradeoff between precision and relevance. In this presentation I will advocate a pragmatic approach that will inevitably have to lean on individual tree responses, across a wide as possible range of neighborhoods, age and growth conditions, with the statistical power depending in obtaining the best possible pre-treatment traits and responses. By illustrating the results of 15 years of FACE with 30-40 m tall forest trees, I will caution against over-optimistic ecosystem scale approaches with just ONE technology, given the sheer size such test systems would require. I rather suggest combining the best choice technology at different scales, which is not necessarily the most costly FACE approach. FACE emerged from overestimating potential bias from atmospheric conditions and greatly unerestimating the key role of soil conditions and biodiversity. Reference: Körner C (2006) Plant CO_2 responses: an issue of definition, time and resource supply. New Phytol 172:393-411. Bader MKF, et al. (2013) Central European hardwood trees in a high-CO_2 future: synthesis of an 8-year forest canopy CO_2 enrichment project. J Ecol 101:1509-1519.