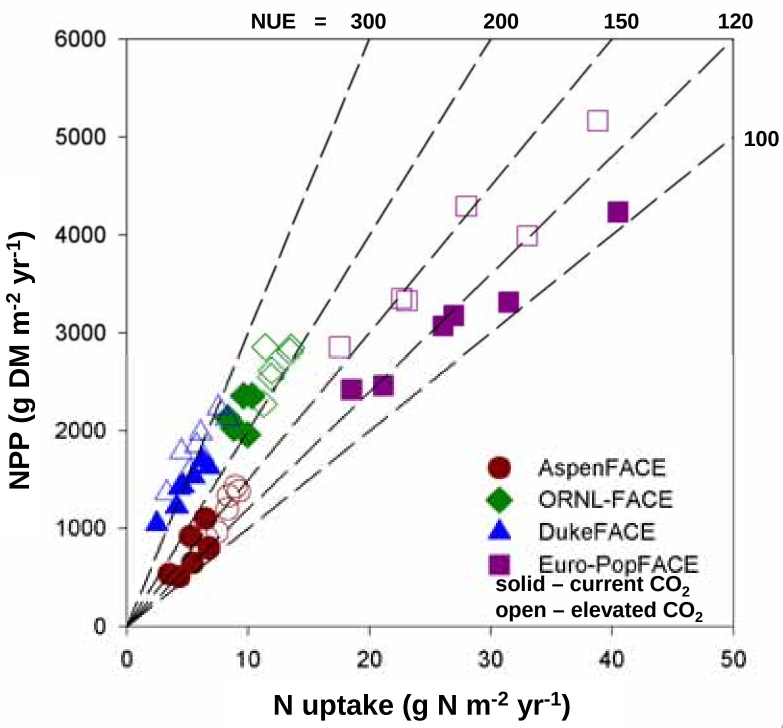
New analysis of nitrogen uptake by forests in elevated CO_2 challenges assumptions in biogeochemical models

Contact: Richard Norby, *rjn@ornl.gov*, 865-576-5261
DOE/Office of Science/Biological & Environmental Research

- Predictions of terrestrial productivity responses to climatic change will be improved by including feedbacks between carbon and nitrogen cycles.
- To better inform models, nitrogen uptake and nitrogen-use efficiency were measured in four free-air CO_2 enrichment (FACE) experiments in forest stands.
- Uptake of N increased under elevated CO_2 at the three of the FACE sites, two of which were demonstrably N limited.
- Possible mechanisms supporting greater N uptake include increases in fine-root production, soil organic matter decomposition, and carbon allocation to mycorrhizal fungi.
- Biogeochemical models must be reformulated to allow C transfers below ground that result in additional N uptake under elevated CO_2.



Oak Ridge National Laboratory

New analysis of nitrogen uptake by forests in elevated CO_2 challenges assumptions in biogeochemical models

Contact: Richard Norby, *rjn@ornl.gov*, 865-576-5261
DOE/Office of Science/Biological & Environmental Research

Nitrogen availability commonly limits forest productivity and may constrain increases in net primary production (NPP) that are otherwise expected to result from rising concentrations of atmospheric CO_2. To sustain increased rates of forest NPP in elevated CO_2, some combination of increased N uptake from the soil and more efficient use of the N already assimilated by trees is necessary. We analyzed the response of N uptake and N-use efficiency to elevated CO_2 (~550 ppm) in four free-air CO_2 enrichment (FACE) experiments in forest stands. Uptake of N increased under elevated CO_2 at the three of the FACE sites, yet fertilization studies at two of them showed that tree growth and forest NPP were strongly limited by N availability. By contrast, N-use efficiency increased under elevated CO_2 at the most productive site, where fertilization studies showed that N was not limiting to tree growth. Our analysis shows that the larger quantities of carbon entering the belowground system under elevated CO_2 result in greater N uptake, even in N-limited ecosystems. Some combination of increasing fine-root production, increased rates of soil organic matter decomposition, and increased allocation of carbon to mycorrhizal fungi is likely to account for greater N uptake under elevated CO2. Biogeochemical models must be reformulated to allow C transfers below ground that result in additional N uptake under elevated CO_2.

Finzi AC, Norby RJ, Calfapietra C, Gallet-Budynek A, Gielen B, Holmes WE, Hoosbeek MR, Iversen CM, Jackson RB, Kubiske ME, Ledford J, Liberloo M, Oren R, Polle A, Pritchard S, Zak DR, Schlesinger WH, Ceulemans R. 2007. Increases in nitrogen uptake rather than nitrogen-use efficiency support higher rates of temperate forest productivity under elevated CO_2. *Proceedings of the National Academy of Sciences* 104: 14014-14019.