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Constraints to nitrogen acquisition of terrestrial plants under elevated CO_2

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A key part of the uncertainty in terrestrial feedbacks on climate change is related to how and to what extent nitrogen (N) availability constrains the stimulation of terrestrial productivity by elevated CO_2 (eCO_2), and whether or not this constraint will become stronger over time. We explored the ecosystem-scale relationship between responses of plant productivity and N acquisition to eCO_2 in free-air CO_2 enrichment (FACE) experiments in grassland, cropland and forest ecosystems and found that: (i) in all three ecosystem types, this relationship was positive, linear and strong (r2 = 0.68), but exhibited a negative intercept such that plant N acquisition was decreased by 10% when eCO_2 caused neutral or modest changes in productivity. As the ecosystems were markedly N limited, plants with minimal productivity responses to eCO_2 likely acquired less N than ambient CO_2-grown counterparts because access was decreased, and not because demand was lower. (ii) Plant N concentration was lower under eCO_2, and this decrease was independent of the presence or magnitude of eCO_2-induced productivity enhancement, refuting the long-held hypothesis that this effect results from growth dilution. (iii) Effects of eCO_2 on productivity and N acquisition did not diminish over time, while the typical eCO_2-induced decrease in plant N concentration did. Our results suggest that, at the decennial timescale covered by FACE studies, N limitation of eCO_2-induced terrestrial productivity enhancement is associated with negative effects of eCO_2 on plant N acquisition rather than with growth dilution of plant N or processes leading to progressive N limitation.