Sustained enhancement of photosynthesis in mature deciduous forest trees after 8 years of free air CO2 enrichment

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Carbon uptake by forests constitutes half of the planet's terrestrial net primary production; therefore, photosynthetic responses of trees to rising atmospheric CO2 are critical to understanding the future global carbon cycle. At the Swiss Canopy Crane, we investigated gas exchange characteristics and leaf traits in five deciduous tree species during their eighth growing season under free air carbon dioxide enrichment in a 35-m tall, ca. 100-year-old mixed forest. Net photosynthesis of upper-canopy foliage was 48% (July) and 42% (September) higher in CO2-enriched trees and showed no sign of down-regulation. Elevated CO2 had no effect on carboxylation efficiency (V (cmax)) or maximal electron transport (J (max)) driving ribulose-1,5-bisphosphate (RuBP) regeneration. CO2 enrichment improved nitrogen use efficiency, but did not affect leaf nitrogen (N) concentration, leaf thickness or specific leaf area except for one species. Non-structural carbohydrates accumulated more strongly in leaves grown under elevated CO2 (largely driven by Quercus). Because leaf area index did not change, the CO2-driven stimulation of photosynthesis in these trees may persist in the upper canopy under future atmospheric CO2 concentrations without reductions in photosynthetic capacity. However, given the lack of growth stimulation, the fate of the additionally assimilated carbon remains uncertain.

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