Modeling tree crown photosynthesis in elevated atmospheric CO_2

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While much effort has been devoted toward measuring and modeling the leaf-level response of trees to elevated atmospheric CO_2, far less effort has been dedicated to modeling whole-tree photosynthesis in elevated CO_2. We link a leaf photosynthesis model and a tree architecture model (using Y-PLANT; Pearcy and Yang 2006) to predict the effects of elevated atmospheric CO_2 concentration on crown-level carbon assimilation of two *Eucalyptus* species. The two species are characteristic of fast-growing plantations and stress-tolerant Eucalypt woodlands, respectively. Crown attributes of these species were measured by recording 3-dimensional point locations of leaves and stems for small saplings. Although the species differed by about 1/3 in their leaf-level maximum photosynthetic rates, modeled crown-level carbon assimilation normalised by plant size was similar for the two species at the sapling stage. For the fast-growing *Eucalyptus saligna*, crown carbon assimilation estimated by the YPLANT model in both ambient and elevated CO_2 was strongly determined by leaf area ratio, and leaf angle, both of which controlled the effective leaf area displayed. Elevated CO_2 enhanced leaf area ratio, which combined with enhanced leaf CO_2 assimilation to stimulate crown carbon assimilation. The results indicate that photosynthetic performance is strongly dependent on whole-plant architecture. Future refinements of the model will incorporate plant hydraulic considerations. The results suggest that elevated [CO_2] may affect the balance of competition between a fast-growing and slow-growing species of Eucalyptus, and suggest that plant form and architecture should be considered in the choice of appropriate species in schemes involving using trees for carbon offsets.