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Carbon allocation changes: an adaptive response to variations in atmospheric CO_2

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Given the ubiquity of nutrient constraints on primary production, an optimal carbon allocation strategy is expected to increase total below-ground allocation (fine root production and turnover, allocation to mycorrhizae and carbon exudation to the rhizophere) as atmospheric CO_2 concentration increases. Conversely, below-ground allocation should be reduced when atmospheric CO_2 concentrations were low, as occurred during glacial times. Using a coupled generic primary production and tree-growth model, we quantify the changes in carbon allocation that are required to explain the apparent homoeostasis of tree radial growth during recent decades and between glacial and interglacial conditions. These results suggest a resolution of the apparent paradox of continuing terrestrial CO_2 uptake (a consequence of CO_2 fertilization) and the widespread lack of observed enhancement of stem growth in trees. Adaptive shifts in carbon allocation are thus a key feature that should to be accounted for in models to predict tree growth and future timber harvests, as well as in large-scale ecosystem and carbon cycle models.