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Where has all the carbon gone - in search of a missing sink in the whole-tree carbon balance

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Plants carbon reserves are thought to be an energy buffer during periods of environmental extremes and may be stored either via active or passive mechanisms when the environment induces conditions either favorable or necessary for storage.

Here we present results of an intensively monitored experimental manipulation of whole-tree carbon balance using reduced atmospheric [CO_2] and drought. Net above-ground assimilation, belowground respiration, carbon storage pool size and allocation to plant compartments and to specific carbon pools (glucose, fructose, sucrose, starch, biomass) were assessed at a high temporal resolution. We tested whether observed carbon pools could be estimated by a simple model driven by the measured carbon balance and observed allocation patterns.

Under high [CO_2] the model predicted patterns of carbon storage across tree compartments and storage pools. Surprisingly, predicted pool sizes were higher than observed pools, indicating the existence of a carbon pool not assessed in our study. Under low [CO_2] the relative proportion of carbon not accounted for by our model increased dramatically. Because the absolute deviation from observations was relatively constant within irrigation treatments, the missing sink for assimilated C may be actively controlled and dependent on hydration status. This sink represented a non-negligible expenditure when carbon availability declined and thus may be critical to drought survival.