Carbon allocation of mature spruce upon drought release – results from a whole-tree $^{13}$C-labeling study

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This contribution presents the result of a free-air $^{13}$C labeling experiment on mature Norway spruce ($P. abies [L.] KARST.$) upon watering after five years of recurrent summer drought in southern Germany, focusing on whole tree allocation processes. Mature spruce trees had been exposed to recurrent summer drought from 2014 to 2018 through complete exclusion of precipitation throughfall from spring to late fall (i.e., March to November). In early summer 2019, the drought stressed spruce trees were watered to investigate their recovery processes. In parallel with the watering, we conducted a whole-tree $^{13}$C labeling in canopies and traced the signal in various C sinks, i.e. stem phloem and CO$_2$ efflux, tree rings at different heights, coarse roots, fine root tips, mycorrhiza, root exudates, and soil CO$_2$ efflux.

We hypothesize that drought stressed spruce preferentially allocates newly assimilated C to belowground sinks upon drought release. Conversely to our expectations, allocation to belowground C sinks was not stimulated in drought stressed compared to control spruce. Likewise, the relative amount of recently fixed C allocated to aboveground sinks did not differ between treatments. Our findings suggest that the belowground C sinks are not of higher priority for the allocation of newly assimilated C upon watering after long-term drought. The observed allocation pattern is discussed taking total above- and belowground biomass as well as C source/sink relations into account.