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Partitioning carbon fluxes in a Mediterranean oak forest to disentangle changes in ecosystem sink strength during drought

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ABSTRACT

Net carbon flux partitioning was used to disentangle abiotic and biotic drivers of all important component fluxes influencing the overall sink strength of a Mediterranean ecosystem during a rapid spring to summer transition. Between May and June 2006 we analyzed how seasonal drought affected ecosystem assimilation and respiration fluxes in an evergreen oak woodland and attributed variations in the component fluxes (trees, understory, soil microorganisms and roots) to observations at the ecosystem scale. We observed a two thirds decrease in both ecosystem carbon assimilation and respiration (R_{eco}) within only 15 days time. The impact of decreasing R_{eco} on the ecosystem carbon balance was smaller than the impact of decreasing primary productivity. Flux partitioning of GPP and R_{eco} into their component fluxes from trees, understory, soil microorganisms and roots showed that declining ecosystem sink strength was due to a large drought and temperature-induced decrease in understory carbon uptake (from 56% to 21%). Hence, the shallow-rooted annuals mainly composing the understory have a surprisingly large impact on the source/sink behavior of this open evergreen oak woodland during spring to summer transition and the timing of the onset of drought might have a large effect on the annual carbon budget. In response to seasonal drought R_{eco} was increasingly dominated by respiration of heterotrophic soil microorganisms, while the root flux was found to be of minor importance. Soil respiration flux decreased with drought but its contribution to total daily CO_2-exchange increased by 11.5%. This partitioning approach disentangled changes in respiratory and photosynthetic ecosystem fluxes that were not apparent from the eddy-covariance or the soil respiration data alone. By the novel combination of understory vs. overstory carbon flux partitioning with soil respiration data from trenched and control plots, we gained a detailed understanding of factors controlling net carbon exchange of Mediterranean ecosystems.

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