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Broadleaved-coniferous Mediterranean ecotone forest: linking seasonal dynamics of soil metabolic activity with shifts in plant phenology and leaf functional traits

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Scots pine (*Pinus sylvestris* L.) forests in drought-prone regions, such as Mediterranean zones, have undergone recent and increasing episodes of dieback and mortality due to changing environmental conditions. Scots pine is particularly vulnerable to suffer drought stress in its lowermost altitudinal distribution limit where coexist with broadleaved species. Determining how evergreen and broadleaved species interact with environmental drivers of soil carbon (C) dynamics in these ecotones is necessary to understand soil metabolic responses to shifts in forest structure and composition. We monitored the autotrophic and heterotrophic soil C efflux under pure Scots pine and Pyrenean oak stands (*Quercus pyrenainca* Willd.) in their contact area of central Spain using the root-trenching method. We identified how physiological processes associated with the contrasting tree species phenology influenced both the total amount of root-derived C efflux and its seasonal sensitivity to climatic variables. We further confirmed that physiological activity of Scots pine is limited during summer, involving a higher probability to suffer a subsequent replacement by Pyrenean oak that showed a greater adaptation to the constraining water availability during the drought period. Decomposition processes of soil organic matter produced similar annual heterotrophic soil C efflux between forests despite litterfall rates and stored C in forest floor plus mineral soil are significantly higher under pine than under oak. This reflected an apparent limitation to soil microbial activity that may be attributable to two fundamental aspects. First, the strong and inverse water and thermal seasonality strongly limits the microbial decomposing activity during the whole year except spring. Second, the leaf and needle functional traits -i.e. nitrogen and lignin content of plant detritus in litter layer, which are strongly linked with the plant nutrient gain strategy- slow down the turnover rate of pine-derived organic matter compared to the oak-derived, contributing to accumulate greater soil C stocks. Our findings suggest that pine succession by oak forests driven by global change will affect the capacity of this ecotone forest to store soil C, however the magnitude of the impact would be strongly buffered by the concurrent soil microclimatic constraints -i.e. higher temperatures with lengthened droughts periods.