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Spatial variability of soil respiration in an heterogeneous and ecotonal Mediterranean forest in NE Iberian Peninsula

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Terrestrial CO2 efflux derived from soil respiration (SR), which is the result of aerobic respiration of roots and microbes, plays a crucial role in the carbon cycle at a global scale. However, due to the limited knowledge of the mechanisms underlying its temporal and spatial variability, it is still unclear how SR may change under different climate change scenarios. Understanding the factors that drive soil respiration processes is essential to estimate carbon fluxes at different scales. We investigated the spatial variability of SR at stand scale in a mixed and heterogeneous Mediterranean forest ecotone where pine populations (Pinus sylvestris) that has suffered several episodes of drought-induced dieback during the last decades are gradually being replaced by holm-oaks (Quercus ilex). Soil respiration was measured in 2 plots (16.2 X 16.2 m) on a grid of 1.8 m to a total of 100 sampling points per plot using a static close chamber method (soda lime technique). Biotic and abiotic variables, such as soil temperature, moisture, organic matter content, tree canopy coverage and stoniness, were also recorded. At the spatial scale covered by the 1.8 grid experimental design we found no spatial dependence of SR within plots, which suggests that spatial patterns of SR should be sought by means of exploring smaller (less than 1.5 m) or larger (more than 16 m) scales. A mixed-effects model indicated that among the explicative variables included in the study, only basal area of Pinus sylvestris and soil organic moisture exerted a significant effect on soil respiration. Soil respiration under pines was on average 20% higher than under oaks, emphasizing the role of forest composition and stand structure on the spatial distribution of SR. Nine months of high-frequency (every 15 minutes) soil respiration data inferred from solid-state sensors (GMT220, Vaisala, Finland) supports this result. High frequency SR data further revealed that both the magnitude of SR as its response to abiotic (climate) and biotic (productivity) drivers were strongly affected by the degree of defoliation of pines. We therefore hypothesize that increasing summer-droughts due to climate change, which could consolidate the ongoing succession process in plant community, could therefore modify substantially ecosystem CO2 fluxes and its environmental drivers. Our current work is therefore focused on understanding the mechanisms behind the observed spatial and temporal patterns of soil respiration.