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Soil respiration shifts as drought-induced tree substitution advances from Scots pine to Holm oak forest

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There is more and more evidences that the current global warming trend and the increase of frequency and intensity of drought events during the last decades in the Northern hemisphere are currently producing an increment of drought-induced forest die-off events, being the Mediterranean region one of the most affected areas. This drought-induced mortality could lead in a vegetation shift with unpredicted consequences in carbon pools, where soils are the most determinant factor in this carbon balance as they contain over two-thirds of carbon on forest ecosystems. There are several uncertainties related on the interaction between soil, environmental conditions and vegetation shifts that could modify their capability to be net carbon sinks or sources in a warming context. We studied soil respiration and its heterotrophic (RH) and autotrophic (Ra) (split in fine roots [Rr] and mycorrhizal respiration [Rs]) components in a mixed Mediterranean forest where Scots pine (Pinus sylvestris L.) are suffering from drought-induced die-off and replaced by Holm oak (Quercus ilex L.) as the dominant tree species. Soil respiration fluxes and its fractions were measured every two weeks during one year at four stages of the substitution process (non defoliated pines [NDP], defoliated pines [DFP], dead pines [DP] and Holm oak [HO]), using the mesh exclusion method. The aims were (i) to describe soil respiration fluxes in a drought-induced secondary successional process, (ii) to test whether the changes in vegetation affected soil respiration fluxes and (iii) to determine the influence of environmental and abiotic variables on the different soil respiration fractions. Total soil respiration was 10.10±6.17 TC ha-1 y-1, RH represented the 67% of the total, Ra represented the 34% of the total, and Rr and Rs were the 22 and 12%, respectively. Significant differences were found in total soil respiration and RH between NDP and HO, being lower in HO than in NDP (34% in total and 48% in RH). No differences were found in the annual Ra, Rr neither Rs between the different stages of the successional process. Season and the interaction between soil temperature, soil moisture and type of tree were able to explain two thirds of the variability in total soil respiration and RH, whereas no significant relation seemed to show with Ra and its components. RH was more sensitive at environmental variables and changes in vegetation than Ra. Additionally, RH was influenced by season independently of temperature and moisture changes, which could imply a control of phenology on RH and not on Ra. Our results suggested that soil respiration had a degree of resilience under climate-change induced die-off and subsequent secondary succession process, since no differences were found between NDP, DFP and DP. The observed vegetation shift is also implying a reduction of the CO_2 emissions from soil to the atmosphere, which could have strong consequences in the carbon balance as drought-induced substitution from Scots pines to Quercus species has been observed in different places in Mediterranean region.