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Contribution of the biological crust to the soil CO_2 efflux in a Mediterranean ecosystem

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Lately, the important role of the soil biological crust (hereafter biocrust) in Mediterranean ecosystems is emerging from a multitude of articles. It is becoming apparent that the biocrust has an important role in regulating ecosystem functions and that it interacts with the woody and herbaceous vegetation to a degree depending on the availability of water among other factors. Here we present the first results of a wider project and focus on the contribution of the biocrust to soil CO_2 efflux, and on how the respiration of the biocrust responds to soil water content and temperature. A manipulative experiment was performed in a Mediterranean shrubland ecosystem in Sardinia (Italy) to assess the contribution of the bicocrust to soil CO_2 efflux and to identify the main environmental drivers of the CO_2 efflux in this ecosystem. For 19 months,in situ soil CO_2 efflux was measured over three different surfaces: soil deprived of biocrust (hereafter Soil), biocrust (hereafter BC) and intact soil (hereafter Soil+BC). For these surfaces, three different approaches were used to investigate the dependency of CO_2 efflux on soil temperature and soil water content, e.g. a simple linear regression, a multi-linear equation, and a modified version of the most common used Lloyd and Taylor model (Lloyd and Taylor, 1994).
Results showed that CO_2 effluxes emitted by Soil, BC and Soil+BC were differently driven by soil moisture and temperature: BC respiration was mainly controlled by soil moisture at 5 cm depth, whereas both soil temperature and water content at 20 cm depth determined Soil CO_2 efflux. Soil temperature and water content at 5 cm depth drove Soil+BC respiration. We also found that biocrust can contribute substantially (up to 60%) to the total soil respiration depending on its moisture content. This contribution persists even in periods in which deeper soil layers are inactive, as small water pulses can activate lichens, mosses and cyanobacteria associated to the biocrust as well as the metabolism of carbon in soils, while deeper soil layers remain dormant. The important differences observed in CO_2 efflux between Soil and Soil+BC suggest that projections on carbon budgets may underestimate soil CO_2 efflux in spatially heterogeneous Mediterranean areas. Thus, our results highlight the relevance of accounting for the biocrust contribution to soil respiration and its responses to environmental drivers. The ongoing and planned activities to understand the full complexity of all factors determining respiration in water limited environments are briefly discussed.
Lloyd, J., Taylor, J. A., 1994. On the temperature dependence of soil respiration. Funct. Ecol. 8, 315–323.