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Will climate change reduce the ability of biological soil crusts to act as a carbon sink in drylands?

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Biological soil crusts (BSCs) are specialized communities dominated by mosses, lichens, liverworts, cyanobacteria, and other organisms that may constitute as much as 70% of the living cover in dryland ecosystems. These organisms not only fix CO_2 from the atmosphere, but also control the small-scale spatio-temporal soil CO_2 fluxes in the ecosystems where they are present. Given their coverage and prevalence in many dryland ecosystems, BSCs have critical roles in the C cycle of these areas. Some studies have found that the Q10 of microsites dominated by BSCs is higher than that from areas dominated by bare ground or vascular plants, suggesting that these microsites could lost C under climate change scenarios. We conducted a manipulative factorial experiment to examine how predicted changes in temperature (increase of 2.5 ºC per year) and rainfall (reductions of 30% of total rainfall), as well as BSCs, modulate C fluxes in two semi-arid sites from central (Aranjuez) and SE Spain (Sorbas). We measured the dynamics of the BSC community in response to the climate change treatments evaluated (reduction in rainfall and increase in temperature), as well as in situ soil CO_2 flux and net CO_2 exchange for over three years at the Aranjuez site (one year in Sorbas). Important changes in the composition of the BSC community were found in response to warming, as the cover of lichens decreased significantly, while that of mosses increased. Soil CO_2 efflux significantly increased with warming at both sites, but only in those microsites dominated by BSCs (the increase was non-significant in bare ground areas). Net CO_2 fixation from the atmosphere was found only during autumn and winter in BSC-dominated microsites, and was reduced with warming. Rainfall reduction per se had no significant effects on the C fluxes measured. These results highlight the importance of biological soil crusts as key modulators of the response of the C cycle to climate change in drylands. Our results suggest that the increase in temperature predicted by climate change scenarios can reduce the ability of BSC-dominated microsites to fix C, which indeed may switch from being C sinks to being net sources of CO_2 to the atmosphere. Given the prevalence and cover of BSCs worldwide, these responses can have important implications at the global scale.