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Resistance and resilience of soil respiration to recurring summer drought in temperate mountain grassland

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Mountain grasslands are highly sensitive to climatic changes and soil respiration (Rs) is their largest source for CO_2 emissions. As a contribution to the EU-project Carbo-Extreme and a national (FWF) project we studied how experimental summer drought and subsequent rewetting affects soil respiration over five subsequent years. The study site was a temperate mountain meadow at 1820m in the Austrian Central Alps. Drought was simulated with rain-out-shelters keeping off precipitation over a period of ca. 2 months of each year, which reduced the soil water content in the main rooting horizon to less than 20%vol (i.e. 20-30% relative extractable water). Rs measurements were performed with automated chambers and were complemented by episodic manual measurements on shallow and deep collars. Rs and its temperature sensitivity decreased at a soil moisture threshold of 20 – 30%vol, with the threshold increasing to higher values from the first to the last year of drought. Soil CO_2 efflux was strongly stimulated after rainfall following drought, where Rs exceeded the flux rates of the control plots. Post-rewetting Rs remained enhanced for weeks in the first three years of the experiment. In the fourth and fifth year rewetting caused only a short pulse of soil CO_2 emissions, after which Rs decreased below values in control plots for weeks. We conclude that recurring summer drought may alter the resistance and resilience of soil respiration in temperate grassland, with implications for its annual carbon balance.