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Analyzing carbon losses from dry soils after precipitation pulses by stable carbon isotopes

Stephan Unger (1,2,3), Cristina Máguas (2), João Santos-Pereira (3), and Christiane Werner (1)

(1) 1Exp. and System Ecology, University of Bielefeld, Universitätstr. 25, 33615 Bielefeld, Germany, (2) Stable Isotopes Lab. (CBA)), Faculty of Sciences, University of Lisbon, Campo Grande, C2, 4ª, 1749-016 Lisbon, Portugal, , (3) Instituto Superior de Agronomia (ISA), Technical University of Lisbon, Tapada da Ajuda, 1349-017 Lisbon, Portugal

Rain events after drought periods strongly increase soil respiration (Birch effect) and affect plant activity, and thus, may influence the isotopic signal of ecosystem respiration. These CO_2-pulses may largely affect the C-balance of arid and semi-arid systems. Here, we evaluate the origins of the Birch effect in a Mediterranean forest and its influence on the isotopic signal of ecosystem ($\delta^{13}C_R$) and soil respiration ($\delta^{13}C_{Soil}$). We conducted artificial rain pulses in May and August 2005 and estimated $\delta^{13}C_{Soil}$ on intact vegetation, bare and root-free soil in response to watering. After watering in May $\delta^{13}C_{Soil}$ showed strong enrichment (-18‰) and a rapid return to initial values (-27‰). This transient enrichment was smaller in August than in May (ca. -22‰). Further, we compared $\delta^{13}C_R$ and $\delta^{13}C_{Soil}$ after first natural rains in October 2005, where both revealed a good relationship over the diurnal and the fortnight cycle. We hypothesize that the "Birch effect" immediately after irrigation is the result of a hypo-osmotic stress response of the soil microbial community: during sudden moisture changes enriched osmoregulants are rapidly released and mineralized by the soil microbes to avoid cell lysis. After the pulse soil respiration followed a common moisture response. The overall impact of the Birch effect on C-sequestration will depend on both timing and frequency of the rains and thus, on whether the respired CO_2 source is microbial or soil organic matter carbon.