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Response of grassland soil respiration to drought: Results from an ecosystem manipulation experiment including 19 sites differing in productivity and diversity

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Soil respiration returns around 80-100 Pg carbon (C) per year from ecosystems globally to the atmosphere and thus is the main component of the natural respiratory carbon dioxide (CO_2) release to the atmosphere. Despite its crucial role in global C cycling, its potential response to climate change, in particular extreme events such as drought, is subject to large uncertainty. One reason for this knowledge gap is the uncertain role of above-ground drivers, such as productivity and diversity, in the response of soil respiration to drought.

We had the unique chance to investigate this aspect within an ecosystem manipulation experiment at 19 grassland sites differing in productivity and diversity levels in central Germany (Thüringer Schiefergebirge/Frankenwald). Drought was simulated by rainout shelters in early summer 2002 and 2003. Soil respiration was measured every 2-3 weeks during the growing seasons and annual courses of soil respiration were estimated separately for control and drought conditions.

Soil respiration was significantly reduced in response to drought in both years, the reduction outlasted the actual drought treatment for several weeks and was not overcompensated on the annual basis. The mean reduction in mean daily C release by soil respiration was 9.9 $\pm$ 11.8% in 2002 and 12.8 $\pm$ 12.1% in 2003 (mean $\pm$ SD). The overall mean daily C release was correlated with annual above-ground productivity in both years and the drought-induced change was fully explainable by the change in annual above-ground productivity in 2003 (but not in 2002). The relative extent of the drought response of soil respiration, however, was dependent on the level of below-ground standing biomass and soil C at the respective site, with higher reductions at sites with soils characterized by low levels of standing below-ground biomass and soil C. Our results clearly call for the integration of above-and below-ground productivity as well as soil C concentrations, when it comes to quantifying the effect of future drought events on grassland soil respiration.