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Effects of elevated CO_2, warming and summer drought on the carbon balance in a Danish heathland after seven treatment years - results from the CLIMAITE project

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In a Danish heathland co-dominated by heather (*Calluna vulgaris*) and grasses (*Deschampsia flexuosa*) we simulated realistic future climate scenarios in a full-factorial design of elevated atmospheric CO_2 (510 ppm), increased temperatures (0.5-1.5 °Celcius) and intensified summer drought events (4-6 weeks per year). Treatments were initiated in 2005. Using manual chamber techniques, we measured soil respiration (SR), ecosystem respiration (ER) and net ecosystem exchange of CO_2 (NEE) and determined gross ecosystem photosynthesis (GEP) as NEE – ER. We also monitored carbon losses in the form of dissolved organic carbon (DOC) in leached soil water.

The results indicate that across all combinations of treatments with elevated CO_2, SR rates increased by 20-30%, whereas GEP rates increased by <5% leading to a net loss of carbon under elevated CO_2 compared to the carbon balance under ambient CO_2. Elevated CO_2 did not significantly affect above-ground ecosystem respiration rates or below-ground DOC leaching. The warming treatment had only small effects on both GEP and respiration rates, i.e. slightly decreased uptake rates by photosynthesis and slightly increased loss rates by respiration, resulting in increased overall net carbon losses from the system. In contrast, the drought treatment led to reduced rates of both photosynthesis and respiration, while the net balance was almost unaffected.

In terms of positive or negative feedback to climate change, the drought treatment therefore exhibited the smallest change in feedback (i.e. no change in NEE), whereas both warming, but especially elevated CO_2 treatments overall showed a surprising positive feedback to climate change even after seven years of treatments. Furthermore, the effects of elevated CO_2 interacted with the other climate drivers. The results highlight that not all ecosystems may be expected to increase their net carbon uptake in a future CO_2 enriched atmosphere especially because other climate drivers may significantly affect the final ecosystem response.