Submitted Abstract

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Abstract

Climate change is associated with a change in soil organic carbon (SOC) stocks, implying a feedback mechanism on global warming. Grassland soils represent 28% of the global soil C sink and are therefore important for the atmospheric greenhouse gas concentration.

In a field experiment in the Swiss Alps, we recorded changes in the ecosystem organic carbon stock under climate change conditions, while quantifying the ecosystem C fluxes at the same time (ecosystem respiration, gross primary productivity, C export in plant material and leachate water). We exposed 216 grassland monoliths to six different climate scenarios (CS) in an altitudinal transplantation experiment. In addition, we applied an irrigation treatment (+12-21% annual precipitation) and an N deposition treatment (+3 and +15 kg N ha-1 a-1) in a factorial design, simulating summer-drought mitigation and atmospheric N pollution.

In five years the ecosystem C stock, consisting of plant C and SOC, dropped dramatically by about -14% (-1034 ±610 g C m-2) with the CS treatment representing a +3.0 °C seasonal (Apr.-Oct.) warming. N deposition and the irrigation treatment caused no significant effects. Measurements of C fluxes revealed that ecosystem respiration increased by 10% at the +1.5 °C warmer CS site and by 38% at the +3 °C warmer CS site ($P \leq 0.001$ each), compared to the CS reference site with no warming. However, gross primary productivity was unaffected by warming, as were the amounts of exported C in harvested plant material and leachate water (dissolved organic C). As a result, the five year C flux balance resulted in a climate scenario effect of -936 ±138 g C m-2 at the +3.0 °C CS, similar to the C stock climate scenario effect. It is likely that this dramatic C loss of the grassland is a transient effect before a new, climate adjusted steady state is reached.