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Carbon balance of a subarctic meadow under 3 °C warming – unravelling respiration

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Boreal and arctic terrestrial ecosystems are central to the climate change debate, as the warming is expected to be disproportionate as compared to world averages. Northern areas contain large terrestrial carbon (C) stocks further increasing the interest in the C cycle's fate in changing climate. In 2013, we started an ecosystem warming experiment at a meadow in Eastern Finnmark, NE Norway. The meadow was on a clay soil and its vegetation was common meadow grasses and clover. Typical local agronomy was applied. The study site featured ten 4m-wide hexagonal plots, five control and five actively warmed plots in randomized complete block design. Each of the warmed plots was continuously maintained 3 °C above its associated control plot with infrared heaters controlled by canopy thermal sensors.

In 2014-2015, we measured net ecosystem exchange (NEE) and respiration twice per week during growth seasons from preinstalled collars of each site with dynamic, temperature-controlled chambers combined to an infrared analyzer. Despite warming-induced differences in yield, species composition and root biomass, neither the NEE nor the respiration responded to the warming, all sites remaining equal sinks for C. Following this observation, we carried out an additional experiment in 2015 where we aimed at partitioning the total CO_2 flux to microbial and plant respiration as well as at recording the growth season variation of those parameters *in situ*. Here, we used an approach based on natural abundances of ^{13}C. The $\delta^{13}C$ signature of both autotrophic plant respiration and heterotrophic microbial respiration were obtained in targeted incubations (Snell et al. 2014). Then, the $\delta^{13}C$ – signature of the total soil respiration was determined in the field by Keeling approach with dynamic dark chambers combined to CRDS. Proportions of autotrophic and heterotrophic components in total soil respiration were then derived based on ^{13}C mixing model. Incubations were repeated at early, mid and late growth season and field measurements conducted once per week throughout the growth season.

We observed differences in the partitioning of the total soil respiration over the three periods: plant respiration consistently dominated in the control plots (60-100 %), whereas the warmed plots exhibited a considerably higher share of microbial respiration in the autumn (70 %; $p= 0.03$). The share of microbial respiration was also elevated in spring as compared to the control sites. These results indicate that 1)Partitioning exhibits seasonal variation 2) Warmer climate may induce a larger proportion of $\delta^{13}C$-enriched C being decomposed.

At our site, warming had little effect on total respiration but enhanced microbial respiration at the expense of plant respiration at early and late growth season. Therefore, even if the local CO_2 budgets remained unaffected by the warming climate it may be important to pay attention to the resilience of soil C on a longer run.

References:

Snell HSK et al. 2014. Rapid Commun. Mass Spectrom. 28: 2341–2351.