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Sustaining effect of soil warming on organic matter decomposition

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Global warming affects various parts of carbon (C) cycle including acceleration of soil organic matter (SOM) decomposition with strong feedback to atmospheric CO_2 concentration. Despite many soil warming studies showed changes of microbial community structure, only very few were focused on sustainability of soil warming on microbial activity associated with SOM decomposition. Two alternative hypotheses: 1) acclimation because of substrate exhaustion and 2) sustaining increase of microbial activity with accelerated decomposition of recalcitrant SOM pools were never proven under long term field conditions. This is especially important in the nowadays introduced no-till crop systems leading to redistribution of organic C at the soil surface, which is much susceptible to warming effects than the rest of the profile. We incubated soil samples from a four-year warming experiment with tillage (T) and no-tillage (NT) practices under three temperatures: 15, 21, and 27 °C, and related the evolved total CO_2 efflux to changes of organic C pools. Warmed soils released significantly more CO_2 than the control treatment (no warming) at each incubation temperature, and the largest differences were observed under 15 °C (26% increase). The difference in CO_2 efflux from NT to T increase with temperature showing high vulnerability of C stored in NT to soil warming. The Q10 value reflecting the sensitivity of SOM decomposition to warming was lower for warmed than non-warmed soil indicating better acclimation of microbes or lower C availability during long term warming. The activity of three extracellular enzymes: β-glucosidase, chitinase, sulphatase, reflecting the response of C, N and S cycles to warming, were significantly higher under warming and especially under NT compared to two other respective treatments. The CO_2 released during 2 months of incubation consisted of 85% from recalcitrant SOM and the remaining 15% from microbial biomass and extractable organic C based on the decrease of respective OM pools during incubation. The dominance of CO_2 from recalcitrant SOM was especially pronounced in NT. We conclude that the accelerated decomposition of recalcitrant SOM due to stimulation of microorganisms by warming is sustainable. Consequently, predictions of redistribution or even accumulation of C in the topsoil of no-till should be taken with high caution, as global warming could potentially sustain high rates of decomposition.