Geophysical Research Abstracts
Vol. 21, EGU2019-13370, 2019
EGU General Assembly 2019

Effects of climate change on microbial growth, turnover and carbon use efficiency

Eva Simon (1), Alberto Canarini (1), Ivana Bogdanovic (1), Joana Séneca (1), Erich M. Pötsch (2), Michael Bahn (3), Wolfgang Wanek (1), and Andreas Richter (1)

(1) University of Vienna, Microbiology and Ecosystem Science, Vienna, Austria (alberto.canarini@univie.ac.at), (2) Institute of Plant Production and Cultural Landscape, Agricultural Research and Education Centre, Raumberg-Gumpenstein, Austria, (3) Institute of Ecology, University of Innsbruck, Innsbruck, Austria

Soils store more than double the amount of carbon (C) than currently present in the biosphere and atmosphere combined. Microbial physiology ultimately controls soil C storage, depending on the proportion of organic C taken up being allocated to microbial catabolism (energy production, respiration) in comparison to microbial anabolism (growth and biosynthesis). Changes in this balance lead to either soil C losses or to the build-up of microbial necromass, which is thought to represent the most important part of stable C in soil. This partitioning of organic C taken up is estimated as microbial carbon use efficiency (CUE), a key parameter in describing the effectiveness of organic C conversion to either potentially stable soil organic matter (SOM) versus C losses from soil to the atmosphere in the form of respiratory CO_2.

The aim of this study was to assess potential effects of seasonality and of climate change on microbial physiology (growth, turnover, respiration, and CUE). In a managed montane grassland in Styria, Austria, field plots were subjected to either ambient climate conditions or to simulated future climate conditions , with combinations of elevated temperature (+1.5 or +3 °C) and/or elevated atmospheric CO_2 (+150 or +300 ppm) for 3 years in a response surface design. A summer drought treatment was also superimposed on ambient climate plots and on future climate plots (combined +3 °C and +300 ppm CO_2), in a full factorial design in 2017. Samples were collected in 3 different periods: May, July and October 2017. To determine microbial growth, CUE and turnover we used a novel technique based on the incorporation of 18O-labelled water into microbial DNA.

Our results demonstrate that overall season had a significant effect on microbial physiology, with reduced activity in autumn compared to spring and summer. Season modulated climate change effects, especially of elevated temperature which showed the most prominent effects. In July (peak plant growing season), elevated temperature significantly decreased microbial growth, and respiration, leading to slow-down of microbial turnover. However, the resulting CUE exhibited strong non-linearity (quadratic response) to temperature, with highest values at intermediate temperature (+1.5 °C). In contrast, both growth and respiration increased with temperature in autumn. Elevated atmospheric CO_2 did not play a major role in modulating microbial physiology, with significant effects only on growth rate and turnover early in the season (May). Drought increased microbial activity (growth and respiration) in combination with the combined climate change treatment (+3 °C, + 300 ppm) only, leading to an increased microbial turnover under these conditions.

Our study demonstrates that climate change can have strong effects on microbial physiology, mainly caused by elevated temperatures. Moreover, the strong seasonal, interactive and non-linear effects of global change drivers highlight the complexity of understanding climate change effects on soil microbial processes and the necessity of studying these effects in multiple time points over the growing season and at multiple levels of experimental factors.