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Will anticipated future climatic conditions affect belowground C utilization? – Insights into the role of microbial functional groups in a temperate heath/grassland.

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The global terrestrial soil organic matter stock is the biggest terrestrial carbon pool (1500 Pg C) of which about 4 % is turned over annually. Thus, terrestrial ecosystems have the potential to accelerate or diminish atmospheric climate change effects via belowground carbon processes.

We investigated the effect of elevated CO_2 (510 ppm), prolonged spring/summer droughts and increased temperature (1 ˚C) on belowground carbon allocation and on the recovery of carbon by the soil microbial community. An in-situ 13C-carbon pulse-labeling experiment was carried out in a temperate heath/grassland (Denmark) in May 2011. Recently assimilated 13C-carbon was traced into roots, soil and microbial biomass 1, 2 and 8 days after pulse-labeling. The importance of the microbial community in C utilization was investigated using 13C enrichment patterns in microbial functional groups on the basis of phospholipid fatty acids (PLFAs) in roots. Gram-negative and gram-positive bacteria were distinguished from the decomposer groups of actinomycetes (belonging to the group of gram-positive bacteria) and saprophytic fungi. Mycorrhizal fungi specific PLFAs were not detected probably due to limited sample size in combination with restricted sensitivity of the used GC-c-IRMS setup.

Climate treatments did not affect 13C allocation into roots, soil and microbial biomass carbon and also the total microbial biomass size stayed unchanged as frequently observed. However, climate treatments changed the composition of the microbial community: elevated CO_2 significantly reduced the abundance of gram-negative bacteria (17:0cy) but did not affect the abundance of decomposers. Drought favored the bacterial community whereas increased temperatures showed reduced abundance of gram-negative bacteria (19:0cy) and changed the actinomycetes community (10Me16:0, 10Me18:0).

However, not only the microbial community composition was affected by the applied climatic conditions, but also the activity of microbial functional groups in their utilization of recently assimilated carbon. Particularly the negative effect of the future treatment combination ($CO_2 \times T \times D$) on actinomycetes activity was surprising.

By means of activity patterns of gram-negative bacteria, we observed the fastest carbon turnover rate under elevated CO_2, and the slowest under extended drought conditions. A changed soil microbial community in combination with altered activities of different microbial functional groups leads to the conclusion that carbon allocation belowground was different under ambient and future climatic conditions and indicated reduced utilization of soil organic matter in the future due to a change of actinomycetes abundance and activity.