ABSTRACT: The processes that control soil organic matter (SOM) decomposition have traditionally been modeled as a function of temperature and to a lesser extent soil moisture. Recent research suggests that inputs of labile carbon (C) – through their effects on soil microbial activity – can mediate the SOM responses to environmental drivers. We sought to better understand how precipitation and temperature mediate the magnitude of such “priming effects”, and whether consideration of priming effects can aid in developing more accurate representations of soil C dynamics in land surface models.

We conducted two field experiments at the Boston-Area Climate Experiment (BACE) – an old-field ecosystem subjected to experimental changes in precipitation (-50% and +50% of ambient precipitation) and warming (from +1°C to +4°C above ambient) since 2008.

First, we released model root exudate mimics semi-continuously into soils and measured microbial and SOM responses. Our results indicate that although an exudate solution containing low concentrations of sugars, amino acids and low molecular weight organic acids increased microbial respiration by 48% relative to water controls (p=.007), this effect was unaffected by temperature and precipitation (p > 0.05). Further, the enhanced microbial activity was insufficient to alter extracellular enzyme activities (and hence SOM decomposition) which responded to temperature and moisture changes but not exudate inputs.

In a second field experiment, we quantified the magnitude of recently-fixed root-derived C inputs to soil from plants in the BACE plots. To do this, we trained roots and mycorrhizal fungi or mycorrhizal fungi alone to grow into soil cores containing “C4 soils” which contain a unique isotopic signature relative to plants in these plots. Carbon inputs from roots and hyphae together were two orders of magnitude greater than those from hyphae alone, indicating that belowground C fluxes in these plots are dominated by root inputs. Notably, the magnitude of the root-derived C fluxes were positively correlated with microbial activities (e.g. net nitrogen mineralization), indicating that root exudates were likely fueling microbial release of nutrients from SOM.

Collectively, our preliminary results provide some of the first field-based estimates of the extent to which changes in soil moisture and temperature can directly and indirectly alter the size of the SOM pool via root-derived priming effects, and lay the groundwork for the development of more mechanistic and better predictive models of SOM decomposition under climate change.