Soil carbon inputs and ecosystem respiration: a field priming experiment in Arctic coastal tundra

High latitude soils have been a historical carbon sink due to low decomposition rates in frozen, cold, or anoxic soils. Future soil carbon stocks will depend on the balance between plant carbon inputs and organic matter decomposition, which are both expected to change with warming of high-latitude landscapes. Important to this balance, vegetation and decomposition may interact via the quantity, chemistry, and spatial distribution of plant-derived soil carbon inputs. This study addresses the priming effect, one such interaction whereby increased root exudation alters the background rate of SOM decomposition via microbial biomass increases, co-metabolism of substrates, induced nitrogen limitation, or other possible mechanisms. The priming effect has been observed in numerous laboratory and greenhouse experiments, and there is considerable interest in including this process in ecosystem models. Only few studies, however, have evaluated the priming effect with in situ field experiments. Addressing this gap, we conducted a two-year field experiment in Barrow, Alaska to test for a priming effect under natural environmental variability. In September 2014 and August 2015, we added 1.2g of ^{13}C-labeled glucose to 25cm diameter mesocosms, 15cm below the soil surface in the mineral soil layer. We chose this carbon addition rate to equal an estimated 50% of the layer's microbial biomass carbon. For one month following each substrate pulse, we quantified effects on the rate and temperature sensitivity of background (non-glucose-derived) ecosystem respiration, GPP, and CH_4 emissions. Soil samples were collected twice following each glucose injection, at 1 and 3 weeks in 2014 and 1 and 4 weeks in 2015, for microbial biomass and community composition analysis. Additionally, we buried ion exchange membranes for one week following the 2014 treatment to assess nitrate and ammonium availability. In contrast to many laboratory incubation studies using soils from a broad range of ecosystems, our preliminary results show no significant priming effect. In spite of a clear signal of ^{13}C-glucose decomposition in respired CO_2, we detected no significant differences in background ecosystem respiration between treatment and control plots. Further analyses will include microbial biomass, microbial community composition, and ^{13}C recovery from soil profiles. This study is part of the Next Generation Ecosystem Experiments (NGEE-Arctic), which aims to improve models of Arctic greenhouse gas fluxes by integrating a broad range of measurements from the cm- to the landscape-scale. To best inform models representing complex and dynamic ecosystems, this study calls for continued research relating theory, laboratory findings, and field experimentation.