Advancing our understanding of carbon-climate feedbacks in Arctic tundra: litter input controls on soil organic matter turnover and formation

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The Arctic has experienced substantial regional warming over the past 30 years that could turn the Arctic into a net source of carbon to the atmosphere as soil organic matter (SOM) decomposes. But in addition to temperature-driven acceleration of decomposition, several additional processes could either counteract or augment warming-induced SOM losses. For example, increased plant growth under a warmer climate will increase organic matter inputs to soils, which could fuel further soil decomposition by microbes, but will also increase the production of new SOM. Whether Arctic ecosystems store or release carbon in the future depends in part on the balance between these two counteracting processes, which this project focuses on. By differentiating SOM decomposition and formation and understanding the drivers of these processes, we will better understand how these systems function. We will integrate this new knowledge into a process-based biogeochemical model to improve our ability to forecast global change impacts on Arctic carbon stocks. Our project objectives are to (1) Improve our mechanistic understanding of Arctic climate-carbon feedbacks by evaluating how SOM priming and formation in Arctic tundra ecosystems are affected by plant C input chemistry and quantity, and temperature. (2) Characterize and quantify the net effects of long-term ecosystem warming on the molecular structure and distribution of C within SOM. (3) Characterize and quantify the mechanisms that lead to SOM priming and formation, and incorporate them in a scalable biogeochemical model integrated in CLM. (4) Evaluate the value of representing microbial controls over C cycling in a scalable biogeochemical model integrated in CLM and identify the measurements necessary to constrain uncertainty in predictions of SOM dynamics.