Snow depth manipulation experiments in a dry and a moist tundra

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As a result of global warming, precipitation in the Arctic is expected to increase by 25-50% by the end of this century, mostly in the form of snow. However, precipitation patterns vary considerable in space and time, and future precipitation patterns are highly uncertain at local and regional scales. The amount of snowfall (or snow depth) influences a number of ecosystem properties in Arctic ecosystems, such as soil temperature over winter and soil moisture in the following growing season. These modifications then affect rates of carbon-related soil processes and photosynthesis, thus CO_2 exchange rates between terrestrial ecosystems and the atmosphere. In this study, we investigate the effects of snow depth on the magnitude, sources and temporal dynamics of CO_2 fluxes.

We installed snow fences in a dry dwarf-shrub (Cambridge Bay, Canada; 69° N, 105° W) and a moist low-shrub (Council, Alaska, USA; 64° N, 165° W) tundra in summer 2017, and established control, and increased and reduced snow depth plots at each snow fence. Summertime CO_2 flux rates (net ecosystem exchange, ecosystem respiration, gross primary production) and the fractions of autotrophic and heterotrophic respiration to ecosystem respiration were measured using manual chambers and radiocarbon signatures. Wintertime CO_2 flux rates will be measured using soda lime adsorption technique and forced diffusion chambers. Soil temperature and moisture at multiple depths, as well as changes in soil properties and microbial communities will be also observed, to research whether these changes affect CO_2 flux rates or patterns. Our study will elucidate how future snow depth and its impact on soil physical and biogeochemical properties influence the magnitude and sources of tundra-atmosphere CO_2 exchange in the rapidly warming Arctic.