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The role of soil characteristics on measured and modelled carbon dioxide and energy fluxes for Arctic dwarf shrub tundra sites

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Four years of growing season eddy covariance measurements of net carbon dioxide (CO_2) and energy fluxes were used to examine the similarities/differences in surface-atmosphere interactions at two dwarf shrub tundra sites within Canada's Southern Arctic ecozone, separated by approximately 1000 km. Both sites, Trail Valley Creek (TVC) and Daring Lake (DL1), are characterised by similar climate (with some differences in radiation due to latitudinal differences), vegetation composition and structure, and are underlain by continuous permafrost, but differ in their soil characteristics. Total atmospheric heating (the sum of latent and sensible heat fluxes) was similar at the two sites. However, at DL1, where the surface organic layer was thinner and mineral soil coarser in texture, latent heat fluxes were greater, sensible heat fluxes were lower, soils were warmer and the active layer thicker. At TVC, cooler soils likely kept ecosystem respiration relatively low despite similar total growing season productivity. As a result, the 4-year mean net growing season ecosystem CO_2 uptake (May 1 - September 30) was almost twice as large at TVC (64 ± 19 g C m^{-2}) compared to DL1 (33 ± 11 g C m^{-2}). These results highlight that soil and thaw characteristics are important to understand variability in surface-atmosphere interactions among tundra ecosystems.

As recent studies have shown, winter fluxes play an important role in the annual CO_2 balance of Arctic tundra ecosystems. However, flux measurements were not available at TVC and DL1 during the cold season. Thus, the process-based ecosystem model CLASSIC (the Canadian Land Surface Scheme including biogeochemical Cycles, formerly CLASS-CTEM) was used to simulate year-round fluxes. In order to represent the Arctic shrub tundra better, shrub and sedge plant functional types were included in CLASSIC and results were evaluated using measurements at DL1. Preliminary results indicate that cold season CO_2 losses are substantial and may exceed the growing season

CO_2 uptake at DL1 during 2010-2017. The joint use of observations and models is valuable in order to better constrain the Arctic CO_2 balance.