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Impact of elevated CO_2, water table, and temperature changes on CO_2 and CH_4 fluxes from arctic tundra soils

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Large uncertainties still exist on the response of tundra C emissions to future climate due, in part, to the lack of understanding of the interactive effects of potentially controlling variables on C emissions from Arctic ecosystems. In this study we subjected 48 soil cores (without active vegetation) from dominant arctic wetland vegetation types, to a laboratory manipulation of elevated atmospheric CO_2, elevated temperature, and altered water table, representing current and future conditions in the Arctic for two growing seasons. To our knowledge this experiment comprised the most extensively replicated manipulation of intact soil cores in the Arctic. The hydrological status of the soil was the most dominant control on both soil CO_2 and CH_4 emissions. Despite higher soil CO_2 emission occurring in the drier plots, substantial CO_2 respiration occurred under flooded conditions, suggesting significant anaerobic respirations in these arctic tundra ecosystems. Importantly, a critical control on soil CO_2 and CH_4 fluxes was the original vascular plant cover. The dissolved organic carbon (DOC) concentration was correlated with cumulative CH_4 emissions but not with cumulative CO_2 suggesting C quality influenced CH_4 production but not soil CO_2 emissions. An interactive effect between increased temperature and elevated CO_2 on soil CO_2 emissions suggested a potential shift of the soils microbial community towards more efficient soil organic matter degraders with warming and elevated CO_2. Methane emissions did not decrease over the course of the experiment, even with no input from vegetation. This result indicated that CH_4 emissions are not carbon limited in these C rich soils. Overall CH_4 emissions represented about 49% of the sum of total C (C-CO_2 + C-CH_4) emission in the wet treatments, and 15% in the dry treatments, representing a dominant component of the overall C balance from arctic soils.