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Continuous measurements of methane fluxes by eddy covariance in the Arctic: Results of a large-scale manipulation of water status at Barrow, Alaska.

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The Arctic tundra contains more than 191.8 Pg C as soil organic matter. Increasingly, this carbon is, or is at risk of, being released to the atmosphere as carbon dioxide (CO_2) (Oechel *et al*., 1993, 1994) and/or methane (CH_4) (Vourlitis and Oechel, 1993). However, predictions of future rates of release CO_2 and CH_4 flux, following changes in temperature, moisture, and other variables associated with climate change, are uncertain. In order to predict with confidence future CO_2 and CH_4 releases to the atmosphere, it is necessary to understand the controls on net CO_2 and CH_4 fluxes. The patterns and controls on net ecosystem CO_2 and CH_4 fluxes are complex and non-linear. Warming and drying of the tundra can result in increased net CO_2 emissions from the Arctic to the atmosphere. However, areas that become warmer and remain wet, or become wetter, may be larger net emitters of CH_4 to the atmosphere.

Here we describe diurnal and seasonal CH_4 fluxes and evaluate controls on current and future CH_4 fluxes. Reported controls on CH_4 fluxes include the rates of Net Ecosystem Exchange (NEE) of CO_2 (as an indicator of excess photosynthate available to the methanogenes), active layer depth (as an indicator of the soil volume available for methane production or oxidation), soil water table (as an indicator of the position of the anoxic, methane-producing layer in the soil). Here we report the effect of primary environmental variables on CO_2 and CH_4 fluxes in the Alaskan Arctic at the Barrow Experimental Observatory at Barrow, Alaska. Presented are continuous measurements of CH_4 and CO_2 flux as affected by environmental variability and the large-scale

manipulation of soil water table.

According to our study, water table does not have a consistent impact on methane flux, and in certain conditions, a drop in water table causes an increase in methane efflux. This unexpected result is likely due to a lower physical resistance to methane emission from plant stem bases as water table approaches the surface. A further decrease in the water table depth, below the soil surface, resulted in decreased methane emission, presumably do to an increasing aerobic environment conducive to the activity of methanotrophs. Unsurprisingly, daily mean soil temperature, as has been previously reported, was also found to be an important parameter in predicting methane fluxes and, together with water table, explained a large part of the variability in methane emissions.

However, unexpectedly, there is a lack of a relationship between NEE and net CH_4 emissions. Past authors reported a positive correlation between NEE and methane emission. However, as reported here, NEE had only a very slight correlation with net methane emission rates, probably because methane emission is not limited by labile carbon supply.

Our observations, made continuously over several months and over footprints of several thousands of m^2, appear helpful in ascertaining relationships not obvious from chamber measurements that tend to be discrete in time and space. Additional large scale continuous measurements, coupled with realistic large scale manipulations, may prove very helpful in further understanding the environmental controls on methane flux and could improve our ability to predict future methane release from the Arctic tundra.