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Long-term observations of trace gas fluxes in the Arctic

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The Arctic is the “canary in the coalmine” for global change. It is the region where the greatest and most rapid warming and change was anticipated and subsequently observed. It is also the area with some of the greatest observed and expected positive feedbacks on global warming due to the huge, potential releases of CO2 (from soil organic carbon in the active layer and permafrost) and CH4 (from biogenic sources, permafrost, and clathrate deposits). The Alaskan Arctic was observed shifting from a long-term sink (23-27 gC m-2yr-1) to source in the early 1980’s (34-156 gC m-2yr-1). This was followed by a period of acclimation and a return to a summertime sink of 5-50 gC m-2yr-1 despite continued warming and drying of the permafrost. Long-term measurements of CO2 fluxes on the north slope of Alaska are reported from eight eddy covariance towers spanning up to 10 years in their current location. Sites are located in Barrow (5) Atqasuk (1) Ivotuk (1) and Arctic Ocean (1) (not continuous). The systems have been winterized and modified for operation under year-round Arctic conditions. The results can be compared to aerodynamic and latter eddy covariance Arctic measurements dating back to the 1960s.

Overall, on an annual basis, the Alaskan Arctic is still a source of CO2 to the atmosphere. However, there is significant year to- year and site-to-site variability. Distances of less than 5 km can result in significant variation in magnitude and sign of net summer CO2 flux. We have found that winter efflux can be significant, especially in the shoulder seasons. Current research is showing that methane fluxes are moderate in the Barrow region and with further data collection, we hope to better understand the changes of the Arctic because of these fluxes. The understanding of global warming impacts on terrestrial carbon flux and net sink/source activity is available because of long-term CO2 flux measurements along the North Slope. Unfortunately, no such records exist for Arctic Ocean CO2 fluxes, and have only recently been initiated for terrestrial CH4 fluxes. Given the even larger feedback possible from CH4 in the Arctic, when compared to CO2, initiation of a robust measurement campaign of CH4 fluxes is critical.