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Fall season atypically warm weather event leads to substantial CH4 loss in Arctic ecosystems?

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In the last century (during 1875-2008) high-latitudes are warming at a rate of 1.36^0C century-1, almost 2 times faster than the Northern Hemisphere trend (Bekryaev et al., 2010). This warming has been more intense outside of the summer season, with anomalies of 1.09, 1.59, 1.73^0C in the fall, winter, and spring season respectively (Bekryaev et al., 2010). This substantial temperature anomalies have the potential to increase the emission of greenhouse gas (CO_2 and CH_4) fluxes from arctic tundra ecosystems. In particular, CH_4 emissions, which are primarily controlled by temperature (in addition to water table), can steeply increase with warming. Despite the potential relevance of CH_4 emissions, very few measurements have been performed outside of the growing season across the entire Arctic, due to logistic constrains. Importantly, no flux measurements achieved a temporal and spatial data coverage sufficient to estimate with confidence an annual CH_4 emissions from tundra ecosystem in Alaska, and its sensitivity to warming. Fall 2013 was unusually warm in central and northern Alaska. Following a relatively warm summer with dramatically above-average rainfall, the October mean monthly temperatures was the 4th and top warmest in Barrow (1949-2013) and Ivotuk (1998-2013), respectively. As we just upgraded several eddy covariance towers to measure CO_2 and CH_4 fluxes year-round, the atypical weather conditions of fall 2013 represented a unique chance for testing the sensitivity of CH_4 loss to these atypically warm temperatures. All our sites across a latitudinal gradient (from the northern site, Barrow, to the southern site, Ivotuk), presented substantial CH_4 loss in the fall. Importantly, in two of these sites (Barrow, Ivotuk) where the fall weather was substantially warmer than the long term trend, fall CH_4 emission represented between 44-63% of the June-November cumulative emission. Surprisingly, in the southernmost site (Ivotuk), when the temperature anomaly was the highest, cumulative fall CH_4 emission outpaced even the summer emission. This shows the sensitivity of CH_4 loss to abnormal conditions, and the importance of fall periods for the annual CH_4 budget in these Arctic ecosystems.

Bekryaev, R. V., I. V. Polyakov, and V. A. Alexeev. 2010. Role of polar amplification in long-term surface air temperature variations and modern Arctic warming. Journal of Climate 23(14):3888–3906.