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Increased greenhouse gas emission from thaw ponds in Siberian arctic tundra on continuous permafrost.

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Arctic regions are expected to experience accelerate permafrost degradation due to future climate change. This includes both large scale phenomena (expansion of thaw lakes) and small-scale features, such as surficial pond formation and mass wasting.

The effects of thaw pond formation were studied at the Kytalyk research station, located in Indigirka lowlands, Northeast Siberia. This area is located on the drained bed of an Early Holocene thaw lake. A large part of the area is characterized by the presence of low palsas (flat ice mounds), covered with mosses and Betula nana shrubs. The edges of these palsas are subject to frequent thawing, resulting in shallow ponds with decaying palsa vegetation.

A comparison using high resolution satellite images from 1977 (American Keyhole project image) and 2010 (Geo-eye) show that the number of thaw ponds has increased. Flux measurement data show elevated emission of CO_2 and CH_4 from these ponds. A fresh pond with dead Betula nana showed fluxes of 261 mg CO_2 m^{-2} hr^{-1} and 29.6 mg CH_4 m^{-2} hr^{-1} in the summer of 2010. N_2O fluxes were not detected.

However, a decrease of greenhouse gas fluxes occurs when Carex and Eriophorum (sedges) vegetation invades these ponds. The CH_4 emission of this vegetation type is still high (9.1 mg CH_4 m^{-2} hr^{-1} or -208 mg CO_2 eq m^{-2} hr^{-1}), but this is largely compensated by rapid CO_2 uptake (-146 mg CO_2 m^{-2} hr^{-1}). It is therefore likely that greenhouse gas emission from this type of shallow permafrost degradation is strongly influenced by ecosystem recovery rates.