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Future methane emission from arctic thaw lakes modelled for different climate scenarios.

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Thawing of ice-rich permafrost in lowlands may create thaw lakes on a large scale. Many Arctic lowlands are covered with these thaw lakes, and drained lake basins. Methane emission from thaw lakes is considered as a major source of methane, contributing to the Arctic global warming feedback.

To quantify this methane source, we used the stochastic, landscape-scale model of thaw lake evolution THAWLAKES, in combination with climate model simulations for the IPCC Fourth Assessment report. The model contains all key elements of the thaw lake life cycle: initiation by localized melting of ice-rich permafrost, lake expansion by bank erosion, lake drainage by contact with the drainage system, and re-growth of ground ice in drained lake basins.

The model was parametrized for a typical north Siberian lowland with continuous permafrost. Methane flux data from the area are available. We simulated the effects of applying different initial terrain conditions (ground ice, drainage system) and different emission scenarios (IPCC SRES scenario A2 and B1).

The future development of the lake area is restricted by lake drainage since at continued lake growth the likelihood that lakes drain by contact with river channels increases. This is also reflected by experiments with different drainage density; at lower drainage density the lake area grows larger. Climate model data for both SRES scenarios indicate that in both cases continuous permafrost would likely still exist. With the A2 scenario, largest lake area is reached after approximately 70 years, with the B1 scenario after approximately 100 years. The lake area hardly differs between the two scenarios for the next century, the same holds for the methane emission. This suggests that climate change mitigation will not have a strong effect on arctic permafrost degradation on the short term.