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Permafrost

How Arctic lakes are accelerating climate change

Thawing permafrost's contribution to global warming could double by 2050

[20. August 2018] **In the future, climate change could abruptly increase the amount of methane released by lakes in the permafrost regions of the Arctic. The explanation: because of thawing permafrost, these lakes are expanding, and below them the water is gnawing away deeper and deeper into the previously frozen soil where microbes now can produce methane. An international research team, including experts from the Alfred Wegener Institute, has now determined that the rapid thaw under lakes has been neglected in models so far and that bacterial decomposition of organic matter in the thawed sediments may strongly increase the emissions of the greenhouse gas methane.**

Like a giant freezer, the permanently frozen soils of the Arctic store tremendous amounts of dead biomass, especially organic matter from ancient vegetation well preserved in the permafrost. Normally, only the uppermost centimetres or metres of this soil thaws during the brief Arctic summer and refreezes in autumn. But climate change is intensifying the degree of thaw: it now begins earlier in the year and lasts longer; the summertime thaw layer (active layer) now reaches greater depths, and more old biomass is thawing. The problem: when the soil thaws, bacteria start breaking down the ancient biomass, and their metabolisms release the climate-effective gases carbon dioxide and methane. The more intensive the thawing becomes, the more gas is released.

As an international team led by the American researcher Katey Walter Anthony from theWater and Environmental Research Center at the University of Alaska in Fairbanksreports in the journal Nature Communications that the thaw is progressing much faster than previously assumed. This can be observed in the soils surrounding and below the many lakes that are found throughout the permafrost region. In the ten-year NASA project "Arctic-Boreal Vulnerability Experiment (ABoVE)", the experts gathered the first precise measurements of gas released at various lakes in Alaska and used satellite imagery and computer simulations to more accurately gauge its scope. The team included researchers from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). Their findings show that the lakes are clearly and substantially amplifying the thawing of permafrost soils. Whereas the gradual thaw in the surrounding area tends to affect only the topmost centimetres, over the past few decades the soil below newly formed lakes as young as a few decades has thawed to depths of 15 metres. In and under these lakes, microorganisms can now break down the thawed biomass, transforming it into methane and carbon dioxide. The researchers estimate that this additional carbon dioxide and methane release could double the effect of permafrost carbon on the climate by 2050.

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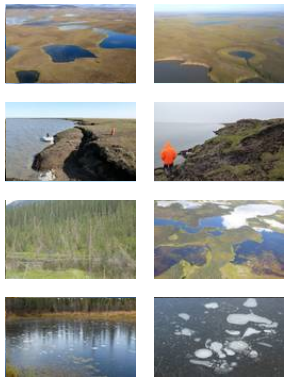

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In the course of the project, Ingmar Nitze from the AWI permafrost research unit in Potsdam analysed satellite images gathered from 1999 to 2014, and explains the phenomenon as follows: "With the thawing of the permafrost, the ground is sinking in different places. First, small meltwater pools are formed. On the edges of these pools and beneath, the water continually thaws the surrounding permafrost soil, which results in laterally expending and vertically deepening lakes." This can become critical if the lakes become deep enough that they don't freeze to the bottom, even in harsh winters. When this happens, the water temperature at the bottom of the lake remains above the freezing point – and the thawing continues throughout the winter. In this scenario, microorganisms can keep decomposing organic matter in the thawed sediments underneath the lakes, and therefore produce methane all year round. Scientists have speculated for some time now that this could have a major impact on the atmospheric greenhouse gas balance, since compared to carbon dioxide, methane has 30 times the climate-warming effect.

What's new, however, is the observation that this effect around and below the lakes is so intense and quick that it is referred to as "abrupt thawing". The team has for the first time precisely quantified the additional amount of greenhouse gases produced in this manner, for all permafrost regions around the globe. To do so, they took random samples of the gases being released at various lakes. Ingmar Nitze and the head of the AWI's Permafrost Research section, Guido Grosse, used images from Landsat satellites to calculate how many lakesin the vast permafrost regions of Alaska have expanded or disappeared: "To date, there have only been very rough global estimates regarding permafrost lakes, together with highly detailed calculations for very small areas; the findings couldn't be compared. What we've created now is the first precise quantification of the permafrost-lake balance, which allows us to draw conclusions regarding how much permafrost has actually been lost due to rapid lake growth over the past few decades," says Nitze.

AWI co-author Thomas Schneider von Deimling then fed the extensive data into a computer model to estimate the total permafrost emissions, including the lakes, for the next several decades. "The abrupt thawing below the lakes is a phenomenon that has never been included in any global climate model. But, as we've now discovered, it can effectively double the percentage of climate warming due to thawing permafrost. Accordingly, this process should be implemented into future climate models," says Schneider von Deimling. In the researchers' opinion, this feedback effect in the Arctic has nearly the same effect on climate change as global changes in land use.

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Original publication

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