Thawing permafrost and natural wetlands can make it more difficult to limit global warming

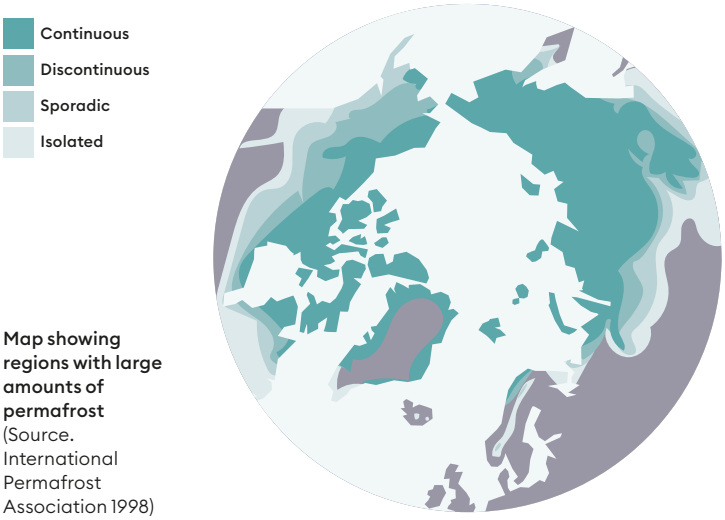
A warming climate will trigger extra, but natural, emissions of carbon dioxide and methane into the atmosphere. These gases arise from thawing permafrost and warming wetlands. As both gases are greenhouse gases, they add to those emitted from the burning of fossil fuels by humans. These mechanisms are well known. They are typically not considered when estimating the allowable human carbon emissions that correspond to particular warming levels.

For a 1.5°C warming target, we estimate the inclusion of thawing permafrost and of wetland emissions reduces the allowable human carbon emissions by around 116 $GtCO_2$.

What this research is about

The majority of countries have agreed to set targets to limit dangerous climate change. The Paris Agreement sets a target of restricting warming to 2°C above pre-industrial temperatures, with a further aspirational target of 1.5°C. The question then becomes: what emissions from fossil fuels are compatible with these temperature targets? These are called "allowable global carbon emissions".

The CLIFFTOP project calculates how the amount of allowable global carbon emissions is affected by permafrost thaw and wetland emissions in a warming world by 2100. Permafrost is soil or rock that is below freezing temperature. In a warming world, this thaws, and the previously frozen organic carbon can be released into the atmosphere as carbon dioxide (mainly) and methane (minor but this is amplified by its greater warming potential). Similarly, wetlands, which cover a significant fraction of the Earth's land surface, will release more methane as the planet warms.

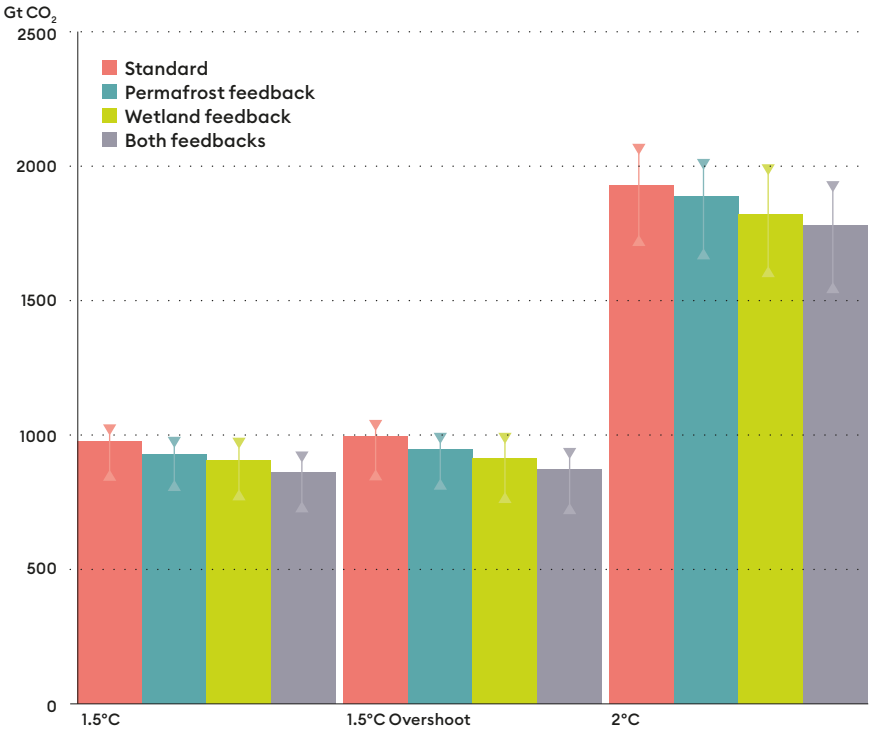


Map showing regions with large amounts of permafrost (Source. International Permafrost Association 1998)

Study findings

To keep the planet below 1.5°C of global warming, the CLIFFTOP project found that increased methane and carbon dioxide emissions from wetlands and permafrost thaw implies allowable carbon emissions by humans must be 12% (range 9-15%) lower than previously thought (7.4% due to methane from natural wetlands, 4.5% to carbon dioxide from thawed permafrost and 0.1% to methane from thawed permafrost). Similar levels of reductions are required if there is a temporary overshoot of warming (to 1.75°C), but still ultimately leading to stabilisation at 1.5°C.

The reduction in allowable emissions for stabilisation at 2°C,(163 (range, 122-189) Gt CO2) is similar in magnitude to that to achieve 1.5°C (116 (range, 90-131) Gt CO2). This is therefore a much lower fraction of the total emission budget, as humans can burn more fossil fuels and keep below this higher temperature threshold.



Allowable emission budgets with and without the various natural feedback processes. The red bars represent the absolute emission budget for the 2015-2100 period in the absence of the natural feedback process, the blue and green bars represent the budget when permafrost thaw and wetlands, respectively, are included; the grey bars represent the budget when including both permafrost thaw and wetland feedbacks. The coloured bars represent the median values of the climate model ensemble, while the error bars show the interquartile spread of the ensemble.

CAVEATS AND LIMITATIONS

- Projections are made with the JULES-IMOGEN climate impact model which reproduces the climate projections made by multiple climate models. This generates uncertainty bounds on the estimates, which reflect differences between climate models, as to how fast the planet will warm.
- The magnitude and distribution of wetlands is used to check how well the model performs for the present day, before being used to estimate future changes. However there remains some uncertainty on expected future wetland evolution.
- We computer model to year 2100, but even for a stabilised climate, permafrost thaw will continue beyond that date.

Policy relevance

As the planet warms, both permafrost thaw and wetlands will release greenhouse gases.

This will lower the amount that humans can emit though fossil fuel burning, in order to constrain global temperature rises to either 1.5°C or 2°C above pre-industrial temperatures.

The results reinforce the need for urgency in reducing emissions, and the need to ratchet up the size of emission reduction pledges.

TO FIND OUT MORE SEE

Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks: Edward Comyn-Platt, Garry Hayman, Chris Huntingford, Sarah Chadburn, Eleanor Burke, Anna Harper, William Collins, Christopher Webber, Tom Powell, Peter Cox, Nicola Gedney and Stephen Sitch. Nature Geoscience, 2018, doi: 10.1038/s41561-018-0174-9

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