

The Permafrost Carbon Feedback to Climate

Key Findings from a Decade of Synthesis

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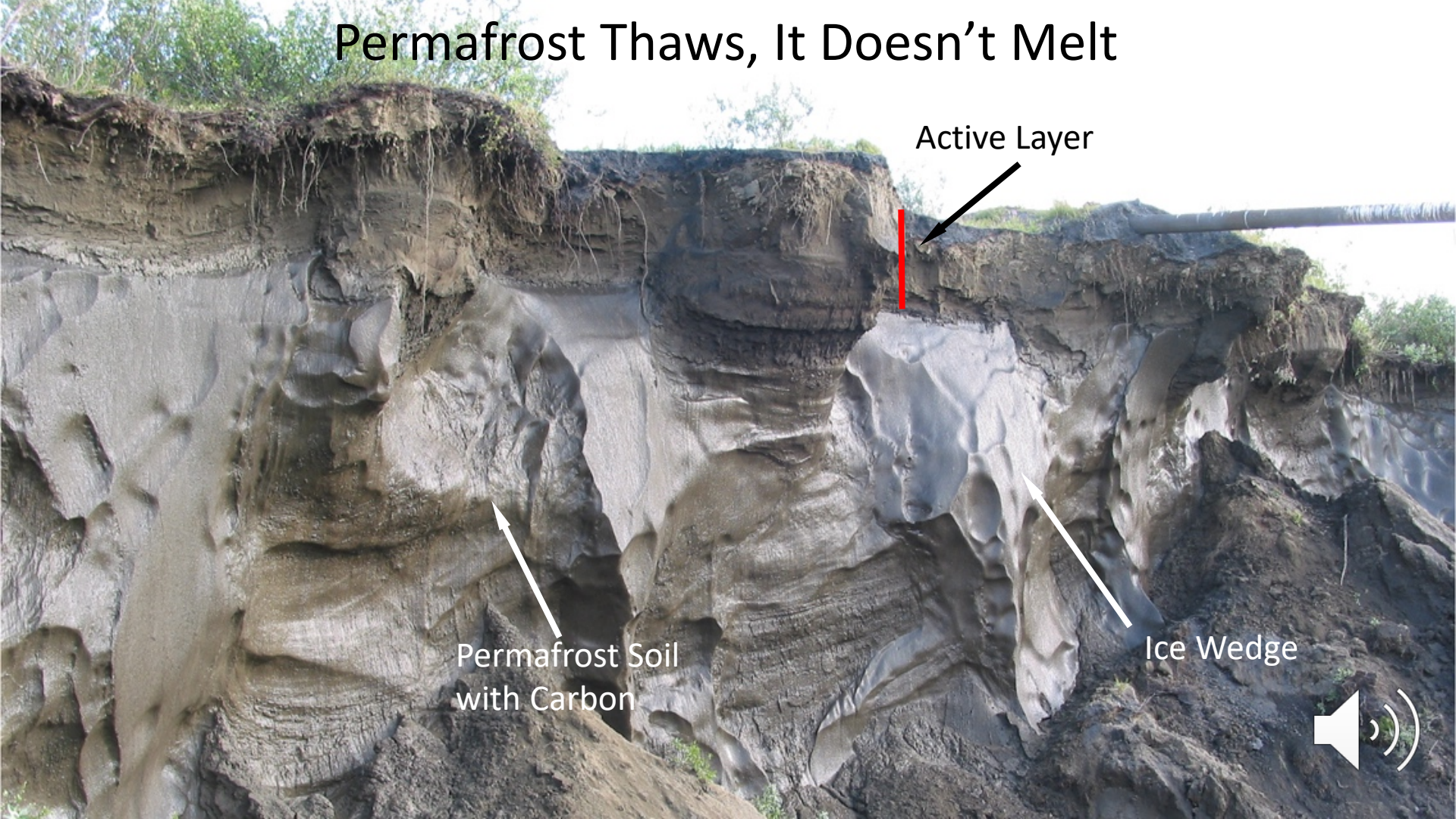
Center for Ecosystem Science and Society
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Permafrost Carbon Network



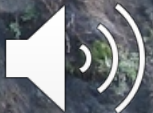
Permafrost Thaws, It Doesn't Melt



Active Layer

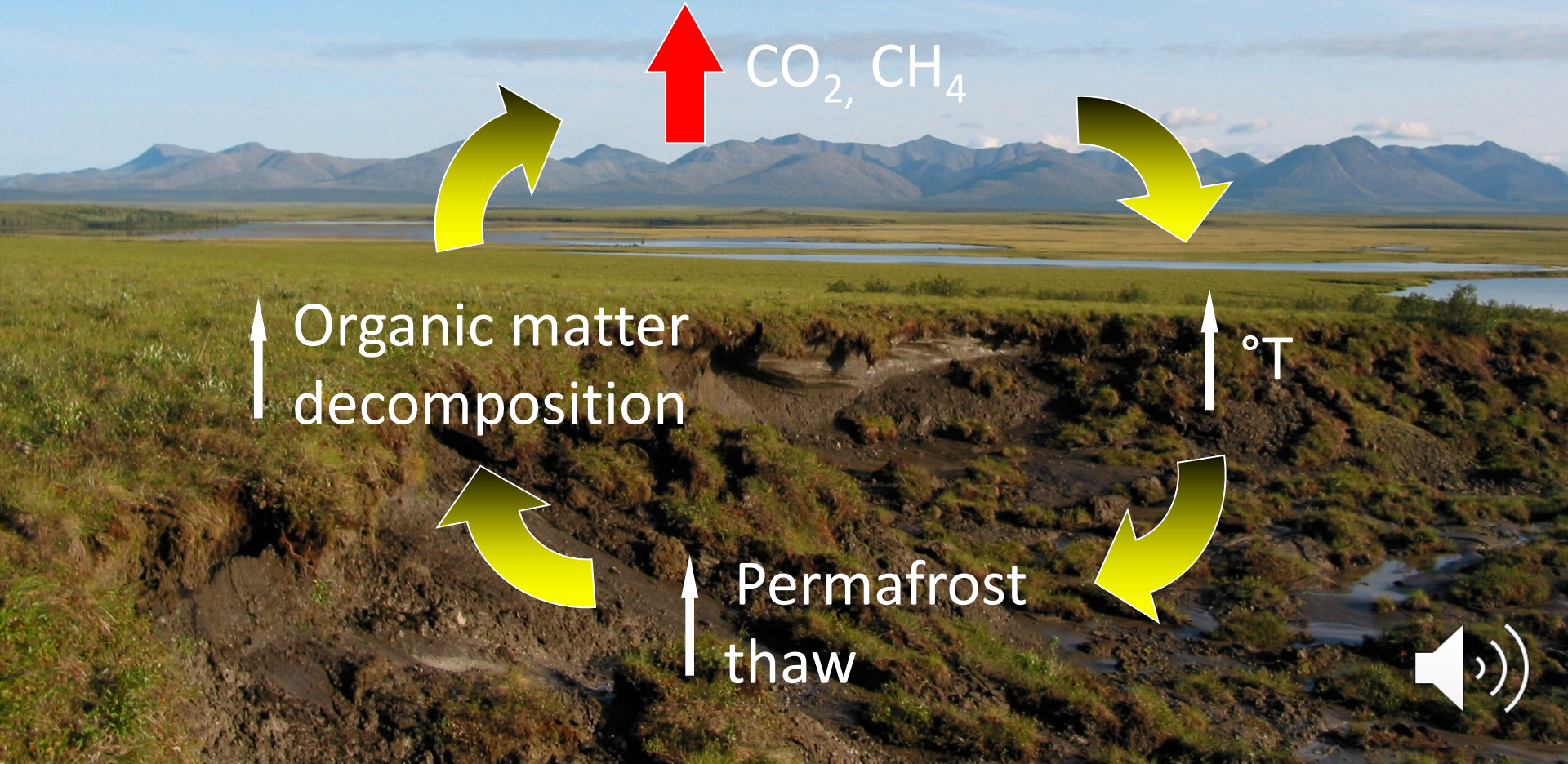
Permafrost Soil
with Carbon

Ice Wedge





Why Should Global Society Care?





What is the **magnitude, timing, and form** of permafrost carbon release to the atmosphere in a warmer world?

#SROCC

IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)

Photo: Austin Schmid, Unsplash

Meredith, M., M. Sommerkorn, S. Cassota, C. Derksen, A. Ekaykin, A. Hollowed, G. Kofinas, A. Mackintosh, J. Melbourne-Thomas, M.M.C. Muelbert, G. Ottersen, H. Pritchard, E.A.G. Schneider, P. Boyd, W. Hobbs. 2019. Chapter 3 Polar Regions

Summary for Policymakers

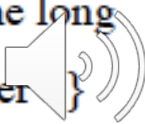
B: Projections – Global Impacts



B1.4 Widespread permafrost thaw is projected for this century (*very high confidence*)

and beyond. By 2100, projected near-surface (within 3–4 m) permafrost area shows a decrease of 24 +/-16% (*likely range*) for RCP2.6 and 69 +/-20% (*likely range*) for RCP8.5. The RCP8.5 scenario leads to the cumulative release of tens to hundreds of billions of tons (GtC) of permafrost carbon as CO₂ and methane to the atmosphere by 2100 with the potential to exacerbate climate change (*medium confidence*). Lower emissions scenarios dampen the response of carbon emissions

from the permafrost region (*high confidence*). Methane contributes a small fraction of the total additional carbon release but is significant because of its higher warming potential. Increased plant growth is projected to replenish soil carbon in part, but will not match carbon releases over the long term (*medium confidence*). {2.2.4, 3.4.2, 3.4.3, Figure SPM.1, Cross-Chapter Box 5 in Chapter



Permafrost Carbon Emissions

Permafrost Zone

Soil Carbon

Vulnerable Fraction

5-15% by 2100

146-160 billion tons

Equal to 75ppm CO₂

Similar in amount
to biospheric sources

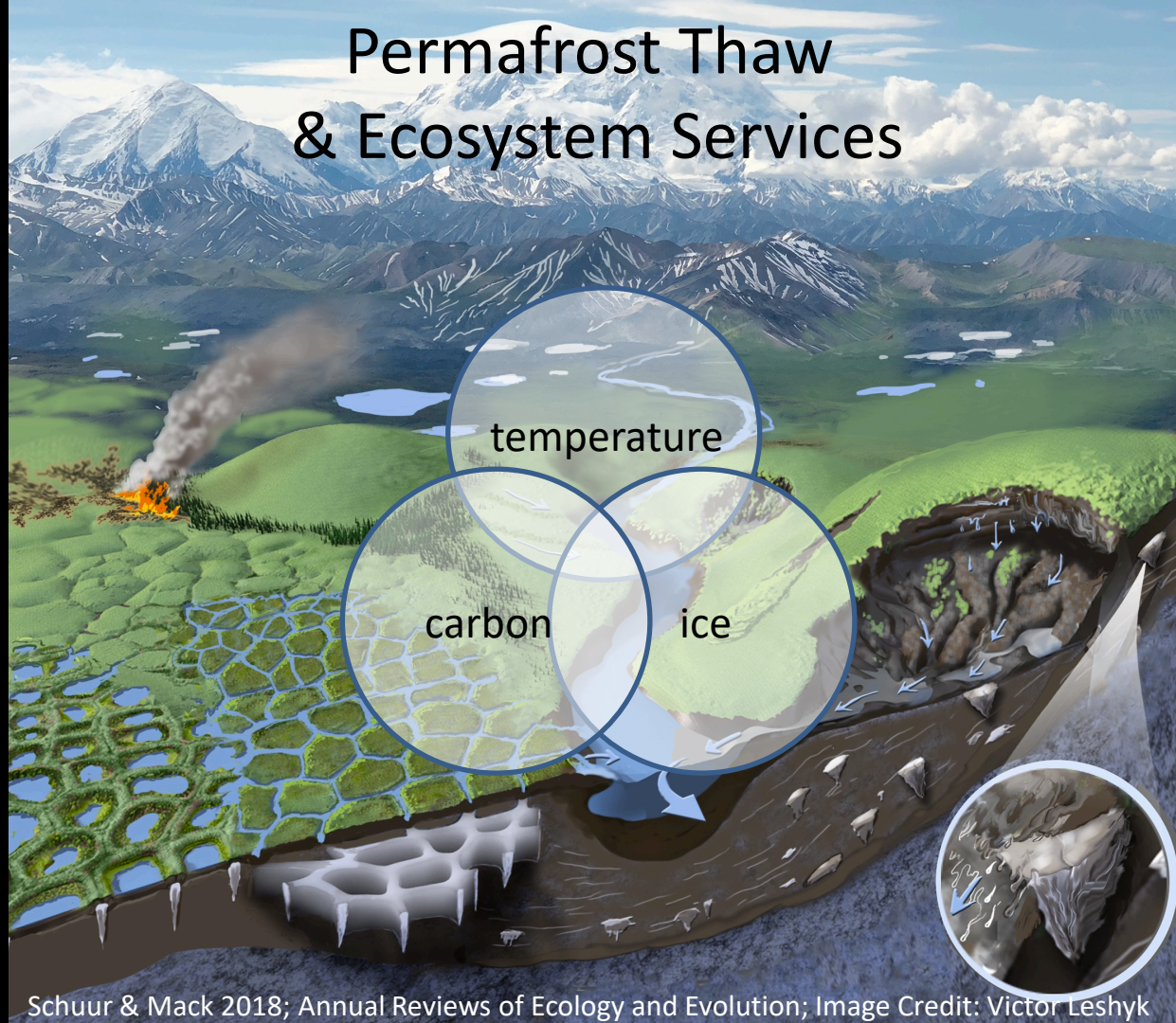
deforestation

Less than human sources

fossil fuels



Permafrost Thaw & Ecosystem Services



Schuur & Mack 2018; Annual Reviews of Ecology and Evolution; Image Credit: Victor Leshyk





The Batagaika crater in eastern Russia was formed when land began to sink in the 1960s owing to thawing permafrost.

Permafrost collapse is accelerating carbon release

The sudden collapse of thawing soils in the Arctic might double the warming from greenhouse gases released from tundra, warn Merritt R. Turetsky and colleagues.

This much is clear: the Arctic is warming fast, and frozen soils are starting to thaw, often for the first time in thousands of years. But how this happens is as murky as the mud that oozes from permafrost when ice melts.

As the temperature of the ground rises above freezing, microorganisms break down organic matter in the soil. Greenhouse gases — including carbon dioxide, methane and nitrous oxide — are released into the atmosphere, accelerating global warming. Soils in

the permafrost region hold twice as much carbon as the atmosphere does — almost 1,600 billion tonnes¹.

What fraction of that will decompose? Will it be released suddenly, or seep out slowly? We need to find out.

Current models of greenhouse-gas release and climate assume that permafrost thaws gradually from the surface downwards. Deeper layers of organic matter are exposed over decades or even centuries, and some models are beginning

to track these slow changes.

But models are ignoring an even more troubling problem. Frozen soil doesn't just lock up carbon — it physically holds the landscape together. Across the Arctic and Boreal regions, permafrost is collapsing suddenly as pockets of ice within it melt. Instead of a few centimetres of soil thawing each year, several metres of soil can become destabilized within days or weeks. The land can sink and be inundated by swelling lakes and wetlands.

Abrupt thawing of permafrost is dramatic

THE BATAGAIIKA CRATER

M. Turetsky & the Permafrost
Carbon Network
Nature Comment
May 2019



Summary for Policymakers

A: Observations



A1.3 Permafrost temperatures have increased to record high levels (1980s-present)

(*very high confidence*) including the recent increase by $0.29^{\circ}\text{C} \pm 0.12^{\circ}\text{C}$ from 2007 to 2016 averaged across polar and high-mountain regions globally. Arctic and boreal permafrost contain 1460–1600 Gt organic carbon, almost twice the carbon in the atmosphere (*medium confidence*).

There is *medium evidence* with *low agreement* whether northern permafrost regions are currently releasing additional net methane and CO_2 due to thaw.





Human Carbon Emissions Matter for Future of Permafrost

