The effects of abrupt permafrost thaw on carbon exchange in Northern Norway – current work and future directions

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Emerald Seminar, 23 September 2020

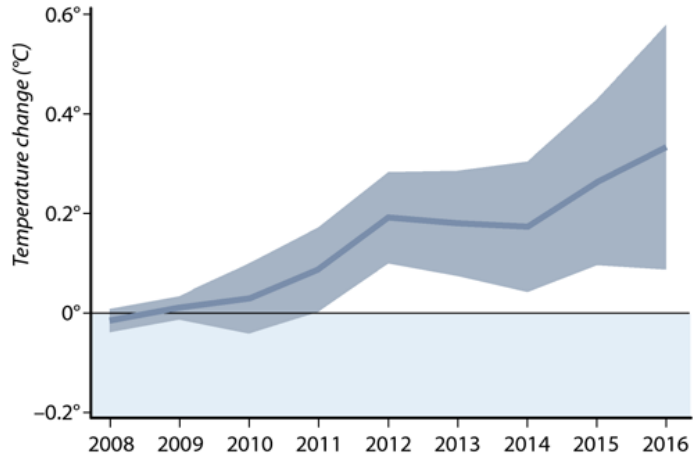
Source: International Permafrost Association, 1998. Circumpolar Active-Layer Permafrost System (CAPS), version 1.0.

Permafrost Is Warming Up

As global temperatures rise, permafrost zones are also warming quickly. Scientists found that in the past decade, temperatures at dozens of permafrost test sites at least 30 feet deep had risen on average about half a degree Fahrenheit (0.3°C).

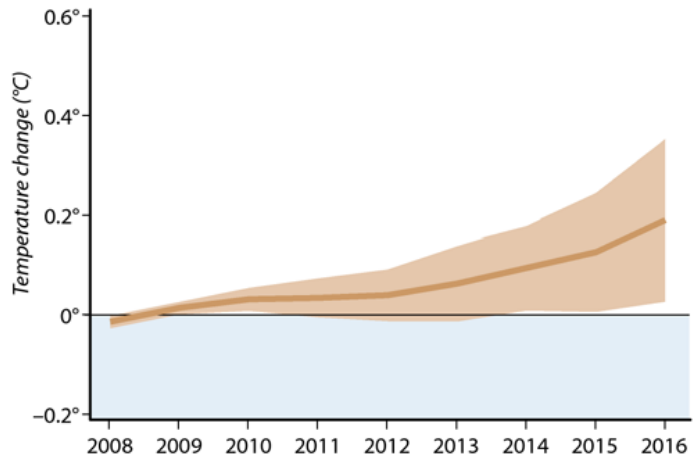
CHANGE IN ANNUAL AVERAGE CONTINUOUS ARCTIC PERMAFROST TEMPERATURE

Relative to 2008-2009 baseline



CHANGE IN ANNUAL AVERAGE HIGH MOUNTAIN PERMAFROST TEMPERATURE

Relative to 2008-2009 baseline



SOURCE: Biskaborn et al., Nature Communications, 2019

InsideClimate News

Source: International Permafrost Association, 1998. Circumpolar Active-Layer Permafrost System (CAPS), version 1.0.

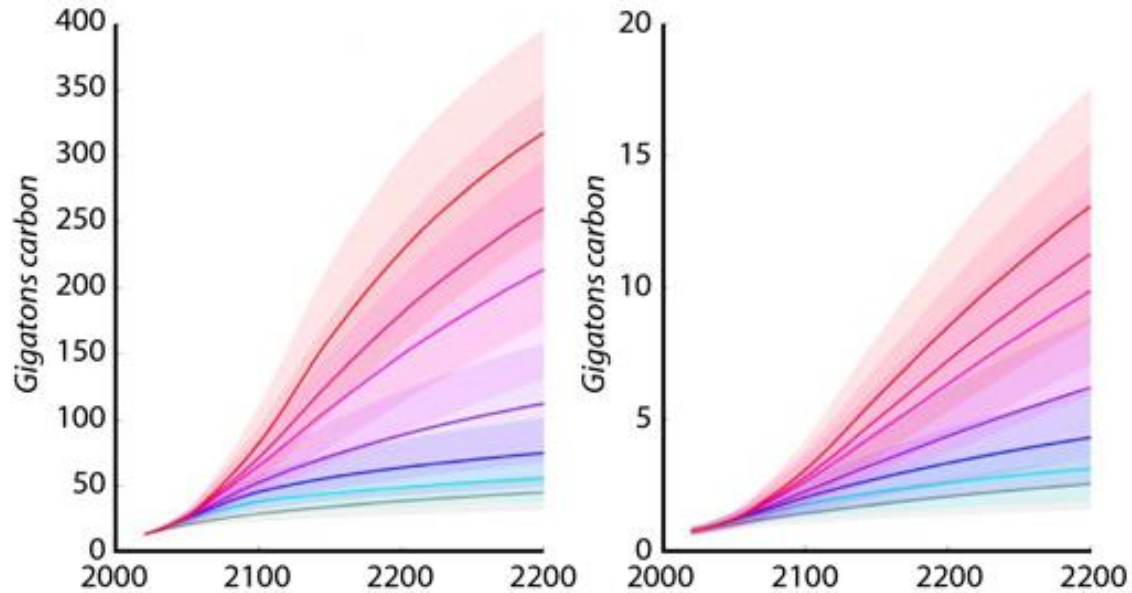
Thawing Permafrost's Climate Threat

As permafrost thaws, once-frozen organic matter starts to break down, releasing carbon dioxide and methane gas. A new study estimates how much of these greenhouse gases will be released from permafrost as global temperatures rise.

- Business as usual
- Partially implemented Paris pledges
- Paris pledges (NDCs)
- 2.5°C
- 2°C
- 1.5°C
- Zero emission

CUMULATIVE EMISSIONS FROM THAWING PERMAFROST

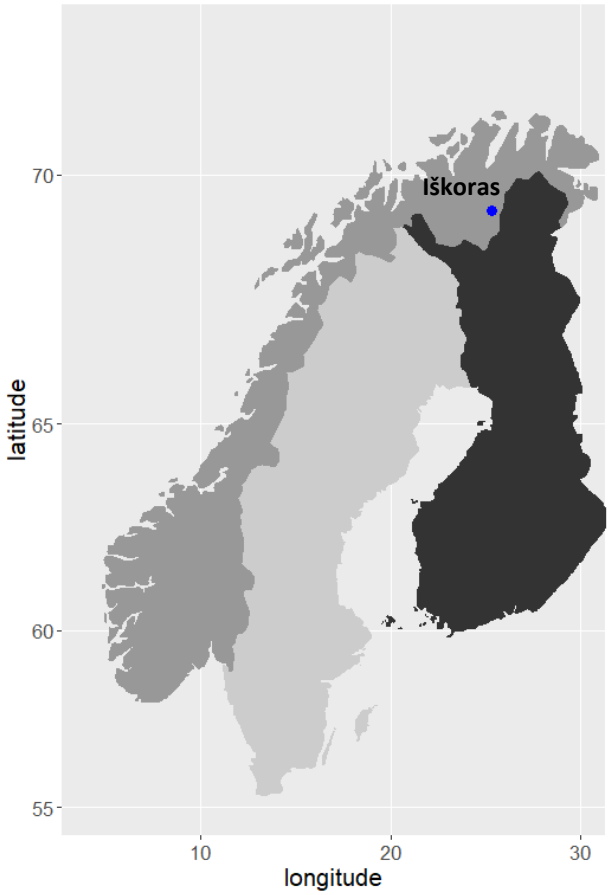
Carbon dioxide and methane emissions, in gigatons carbon



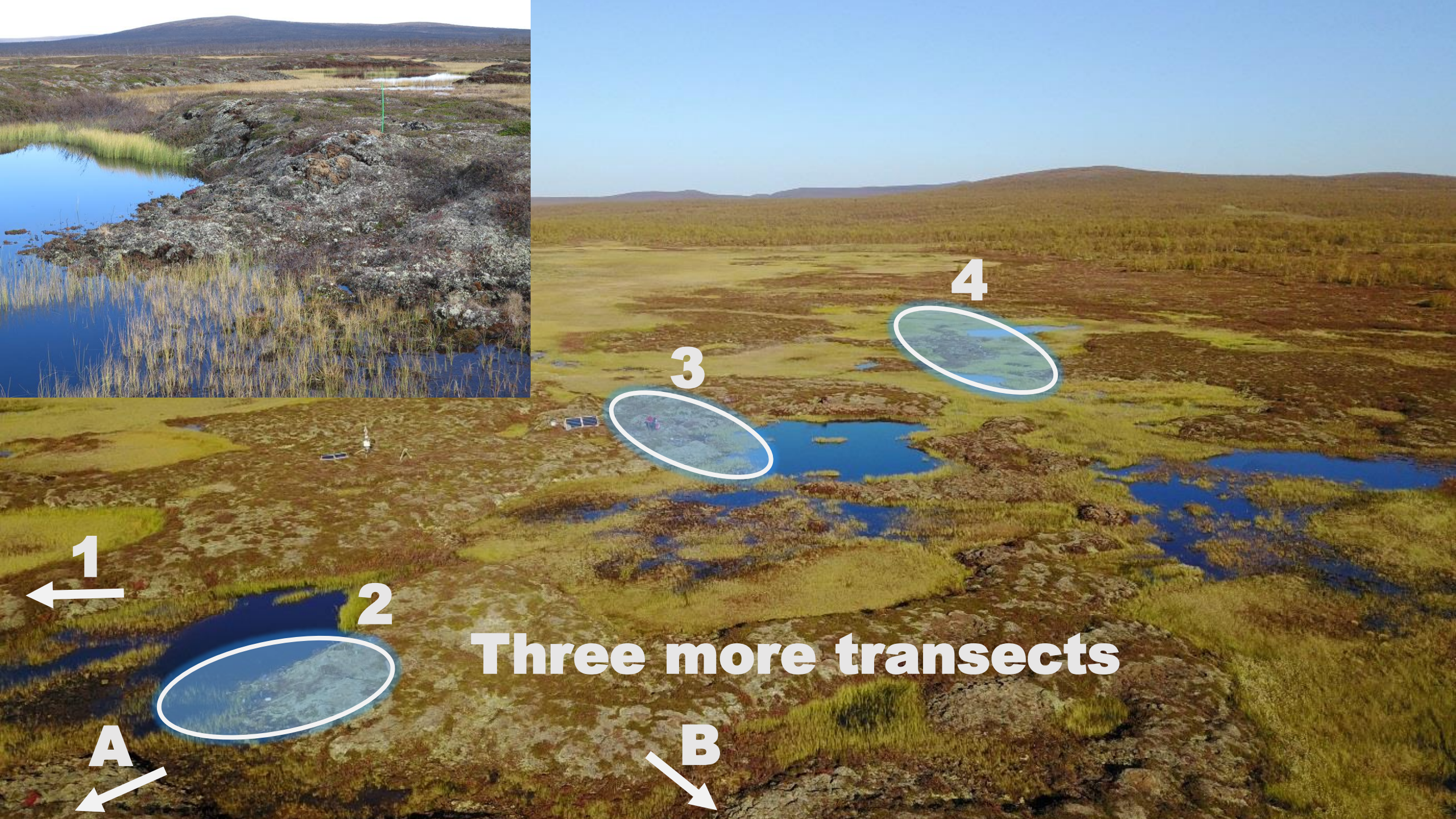
Note: Lines show the average, shaded areas show one standard deviation.

SOURCE: Dmitry Yumashev, et al., 2019

InsideClimate News



Permafrost affected palsa-mire


4
3
1
2
Three more transects
A
B

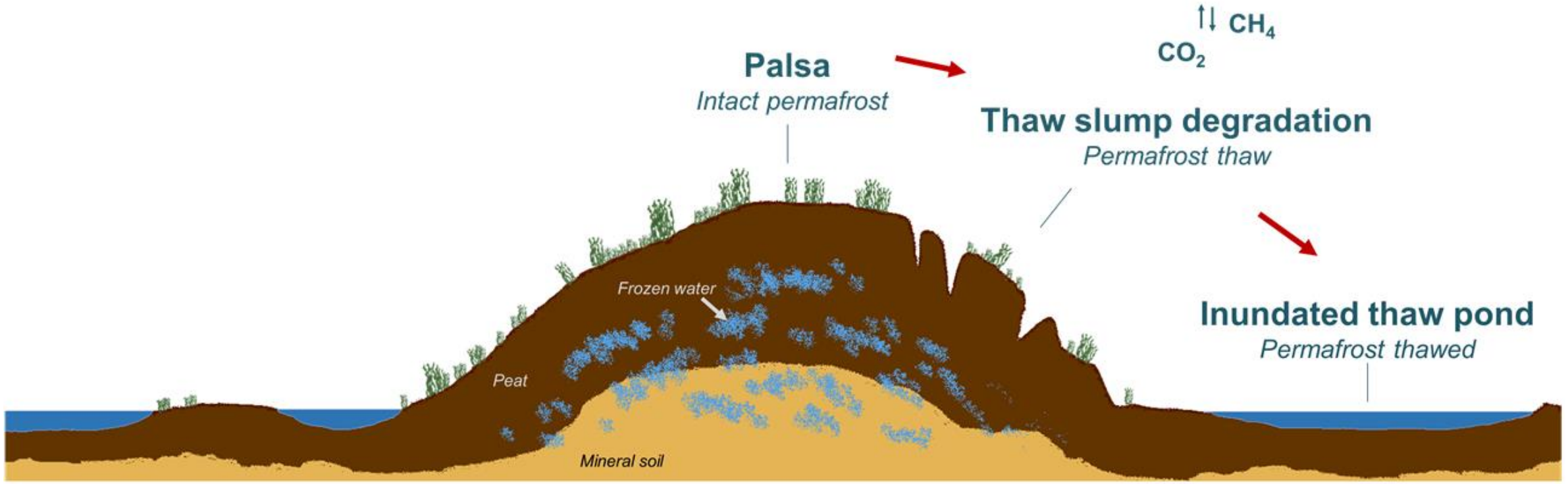
Vegetated palsa
+ OTC (2019)

Soil palsa
+ OTC (2019)

Thaw slump
+ OTC (2019)

Thaw pond

Sedge and moss
+ OTC (2020)



Vegetated palsa
+ OTC (2019)

Soil palsa
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Thaw slump
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Thaw pond

Sedge and moss
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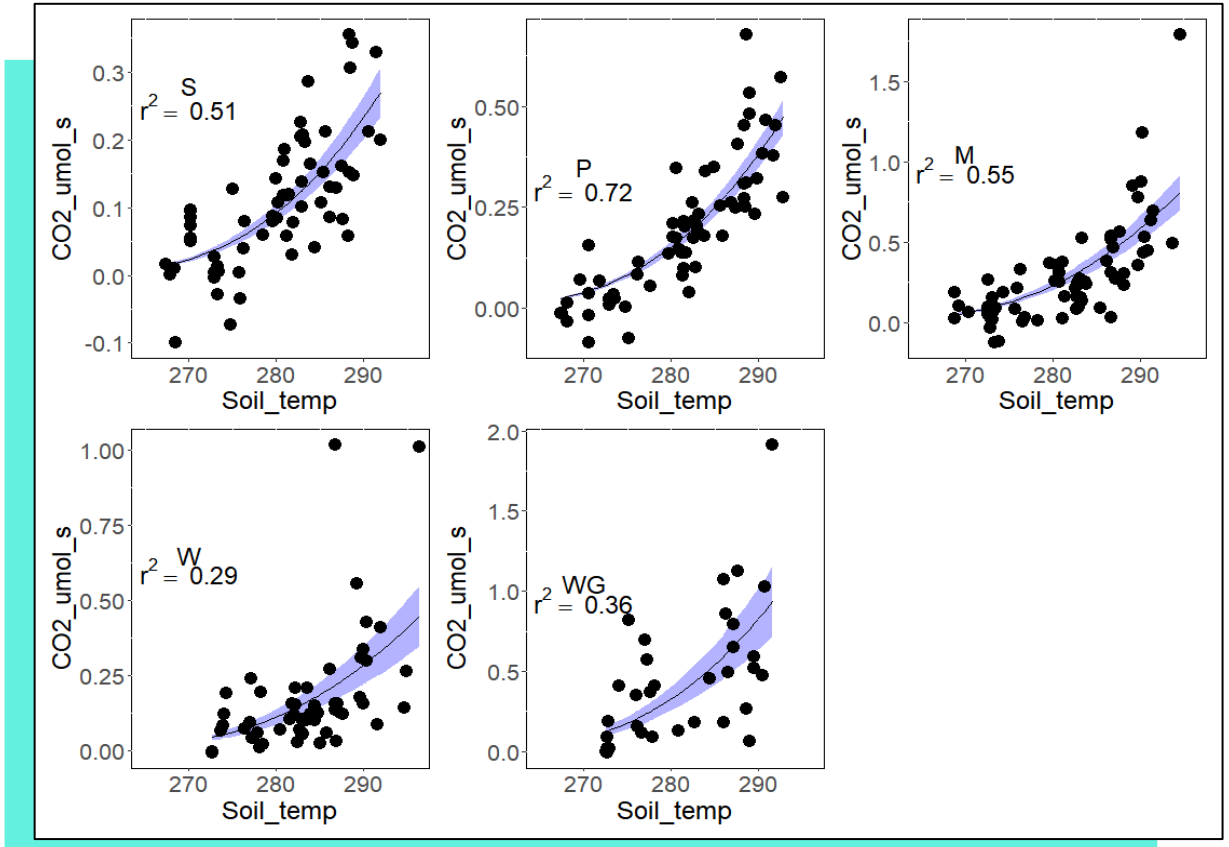
Soil Respiration
(vial + GC method)

CO_2



Temperature sensitivity (Q_{10})

Soil Palsa (**S**) = 2.57

Vegetated palsa (**P**) = 2.79

Thaw slump (**M**) = 4.37

Thaw pond (**W**) = 2.7

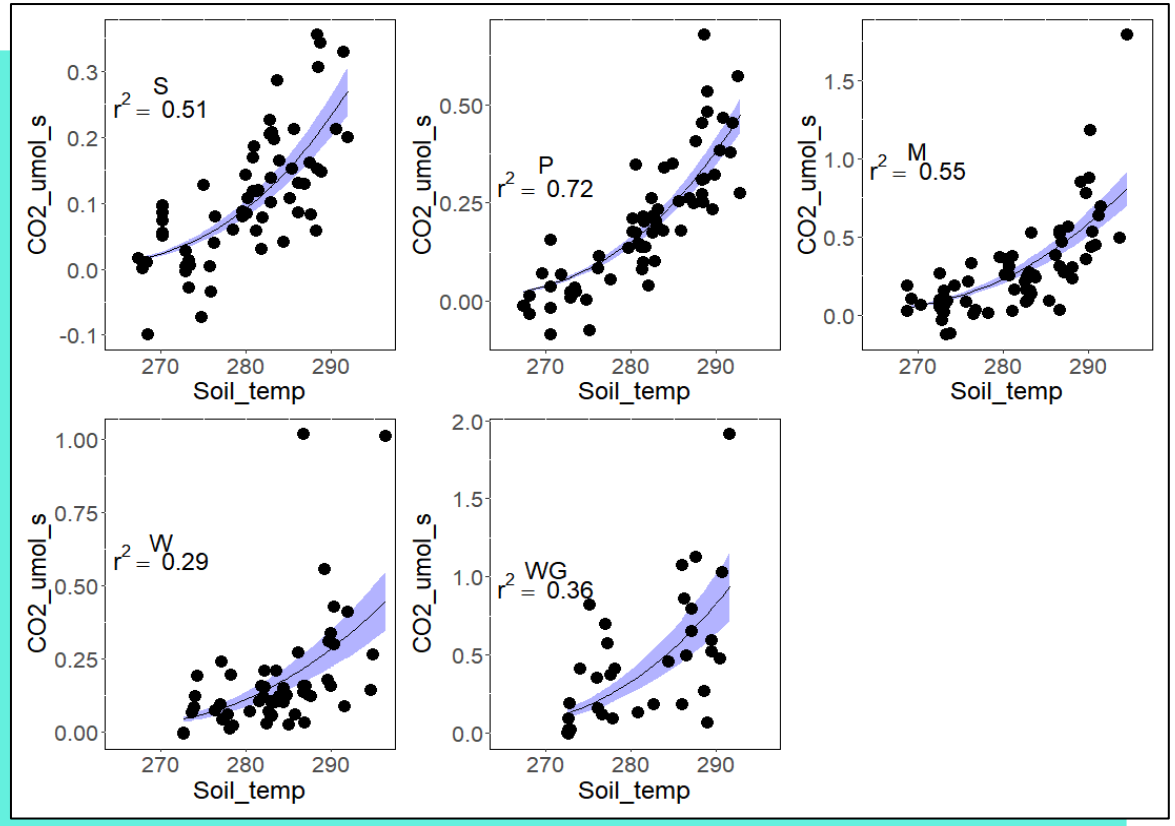
Vegetated pond (**WG**) = 3.4 *limited data

P **S** **M** **W** **WG**

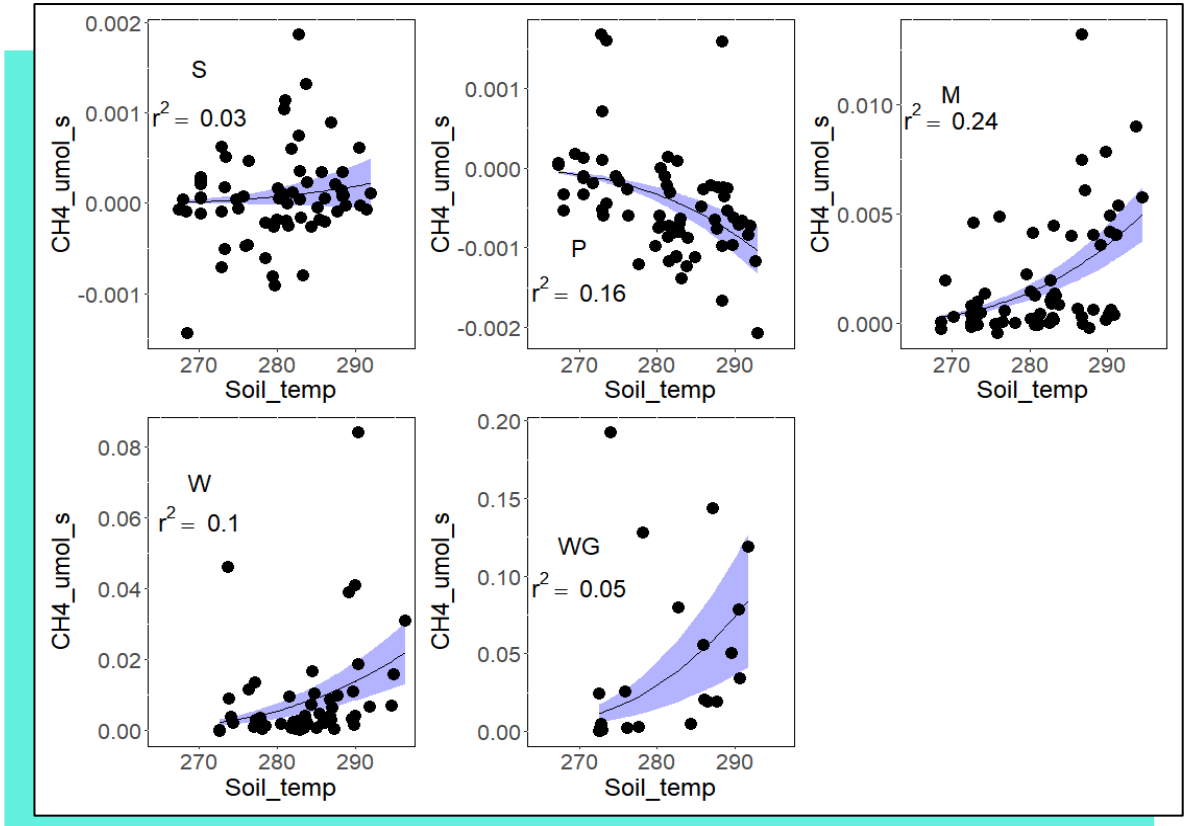
Soil Respiration

(vial + GC method)

CO_2

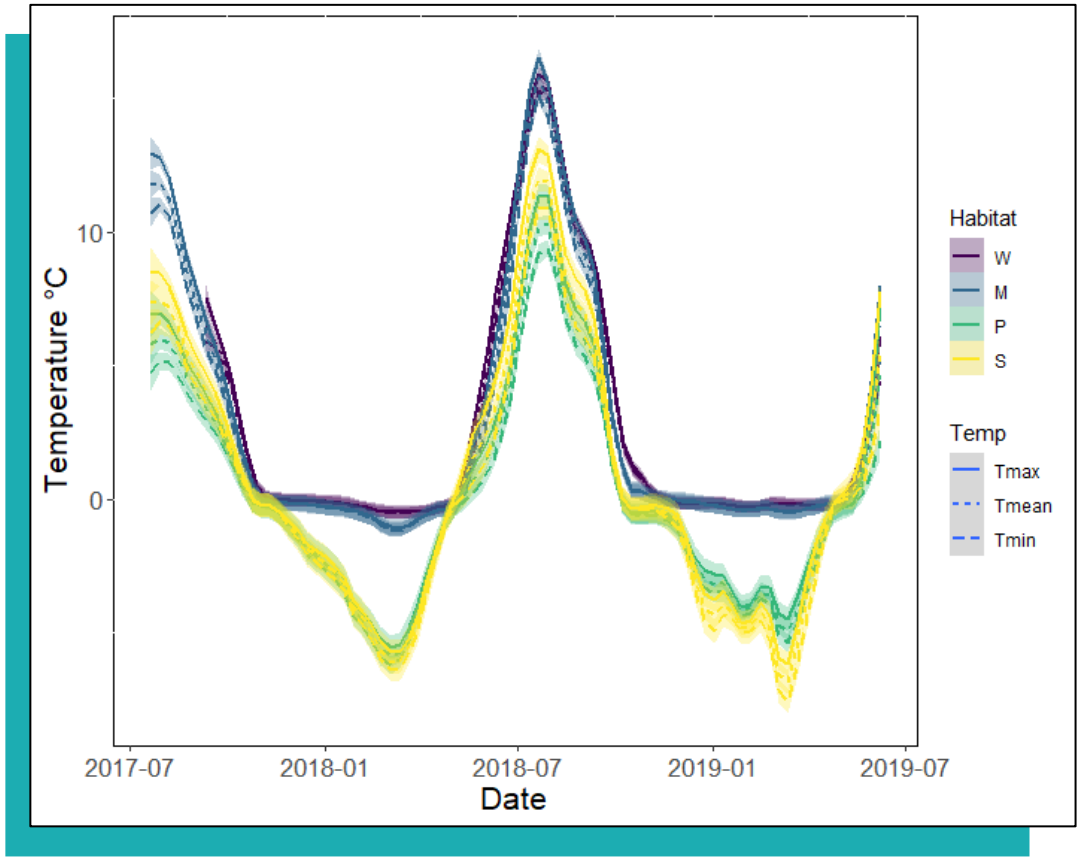


CH_4

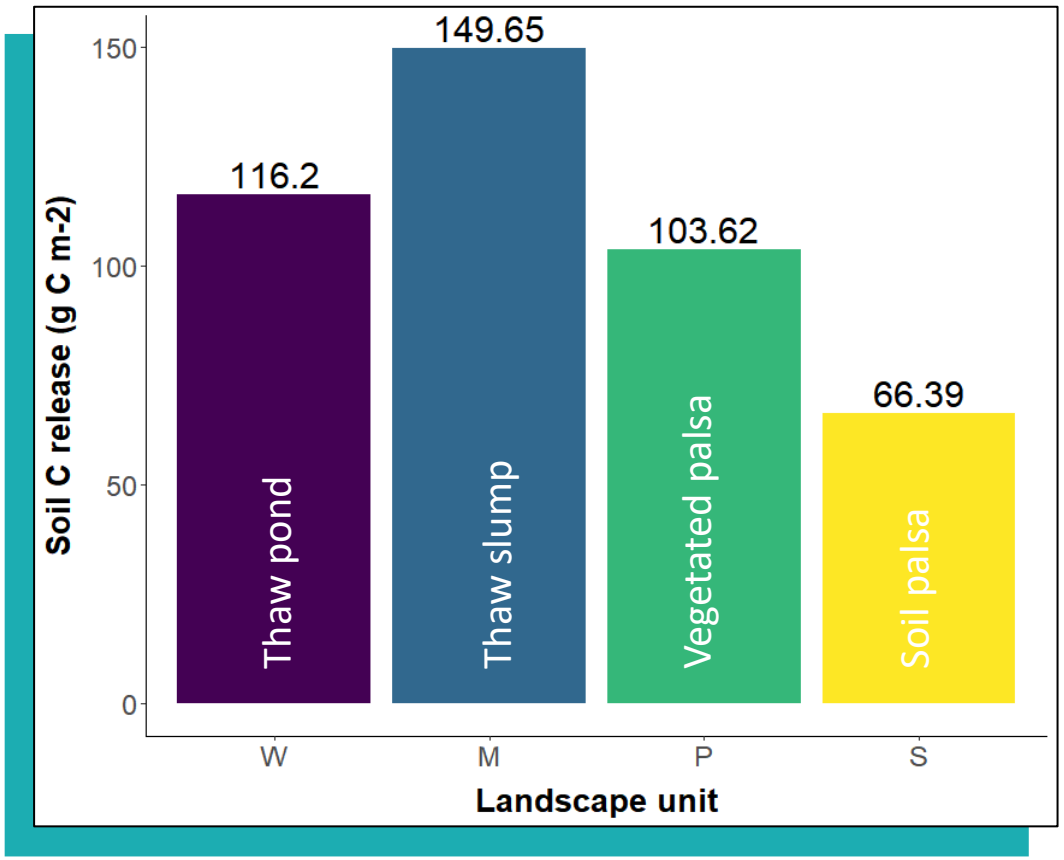


Annual Budgets of soil GHG release

SOIL TEMPERATURE

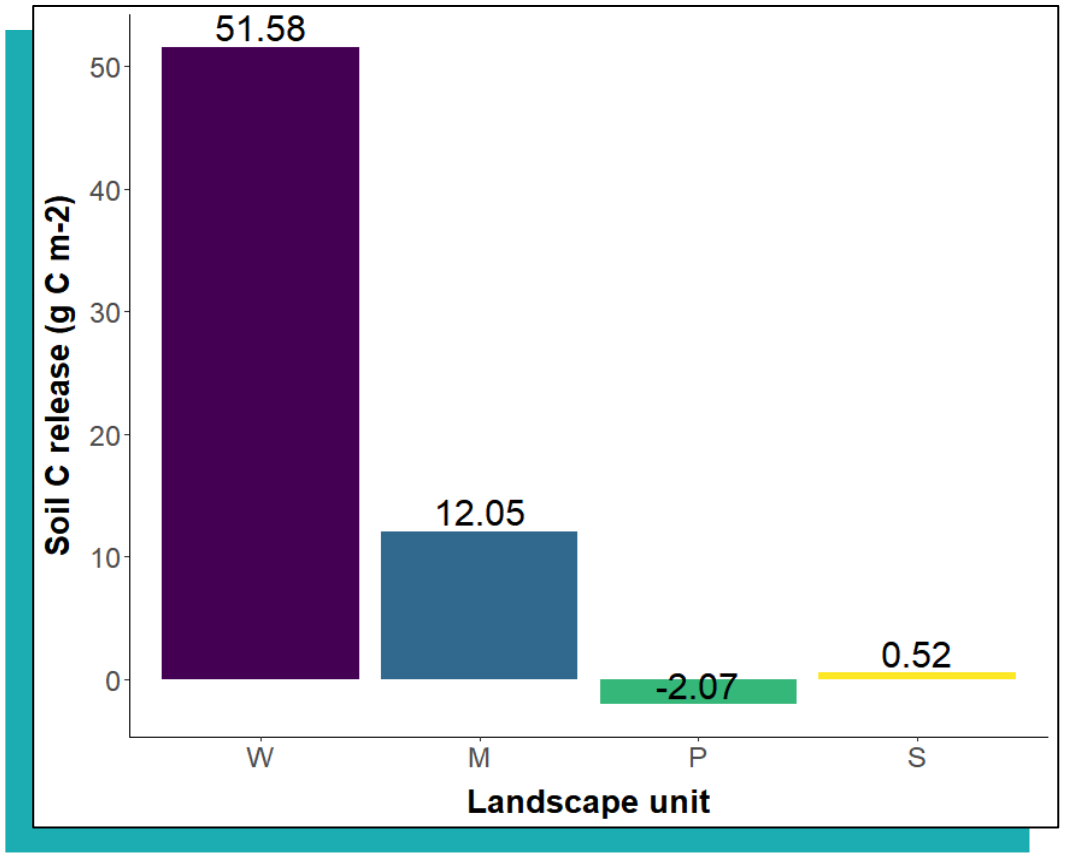


CO_2

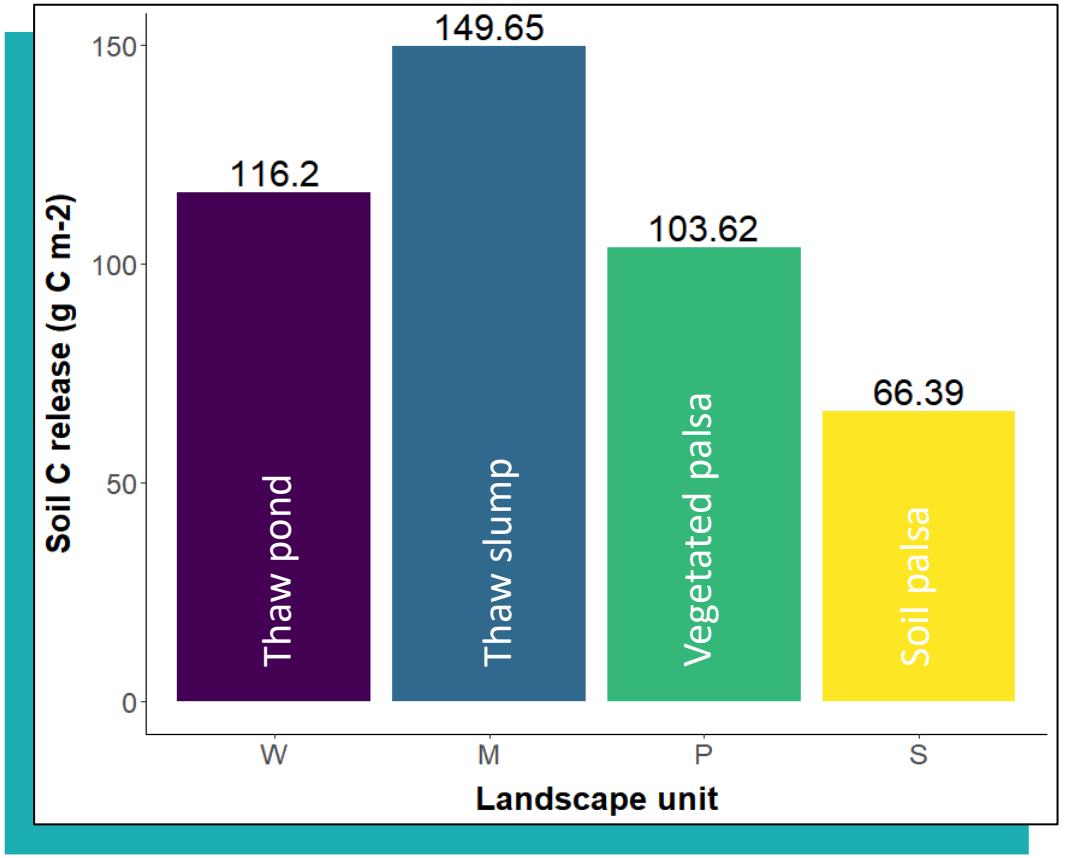


Annual Budgets of soil GHG release

CH_4



CO_2

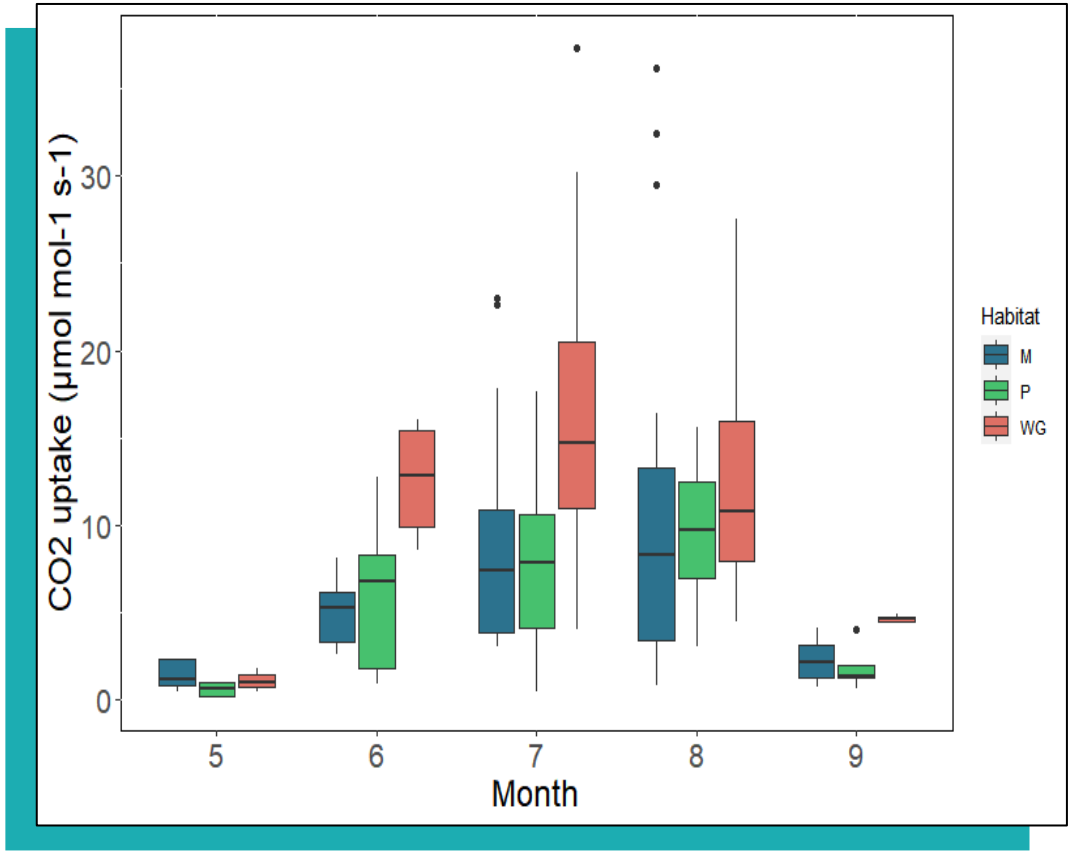


*Calculated in CO_2 equivalents

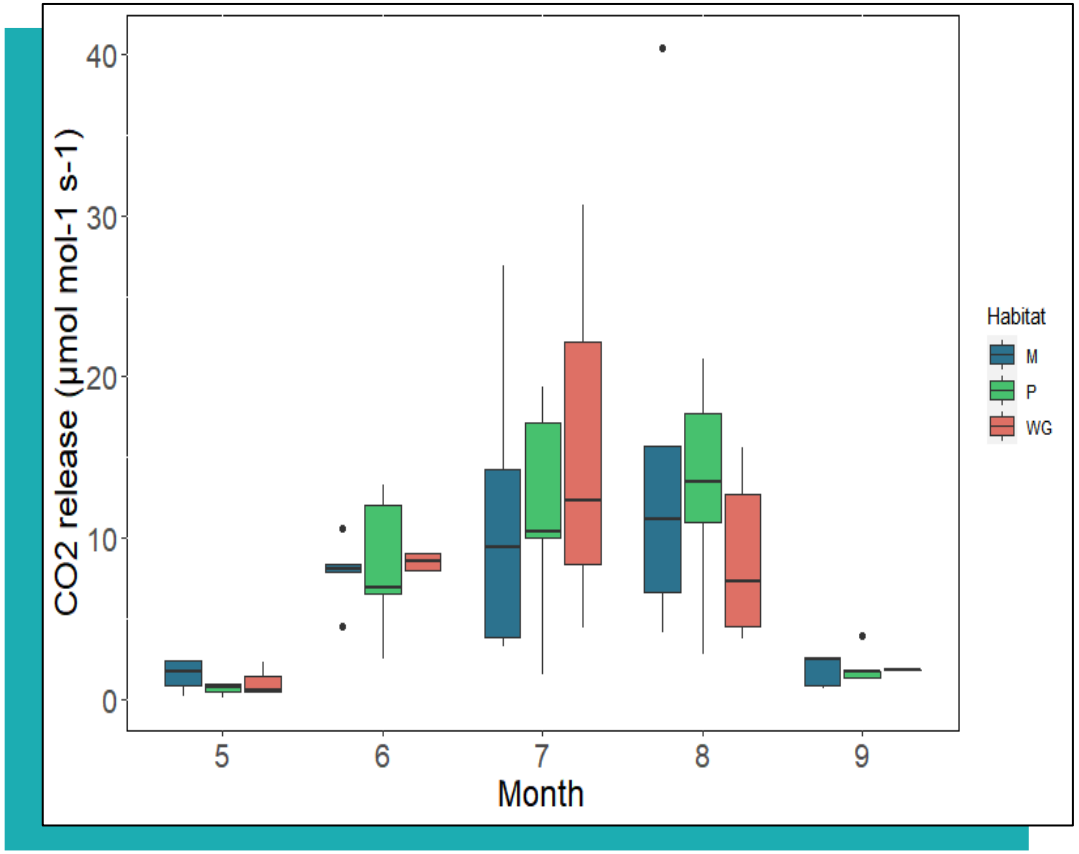
Ecosystem Carbon Exchange

(static chamber method)

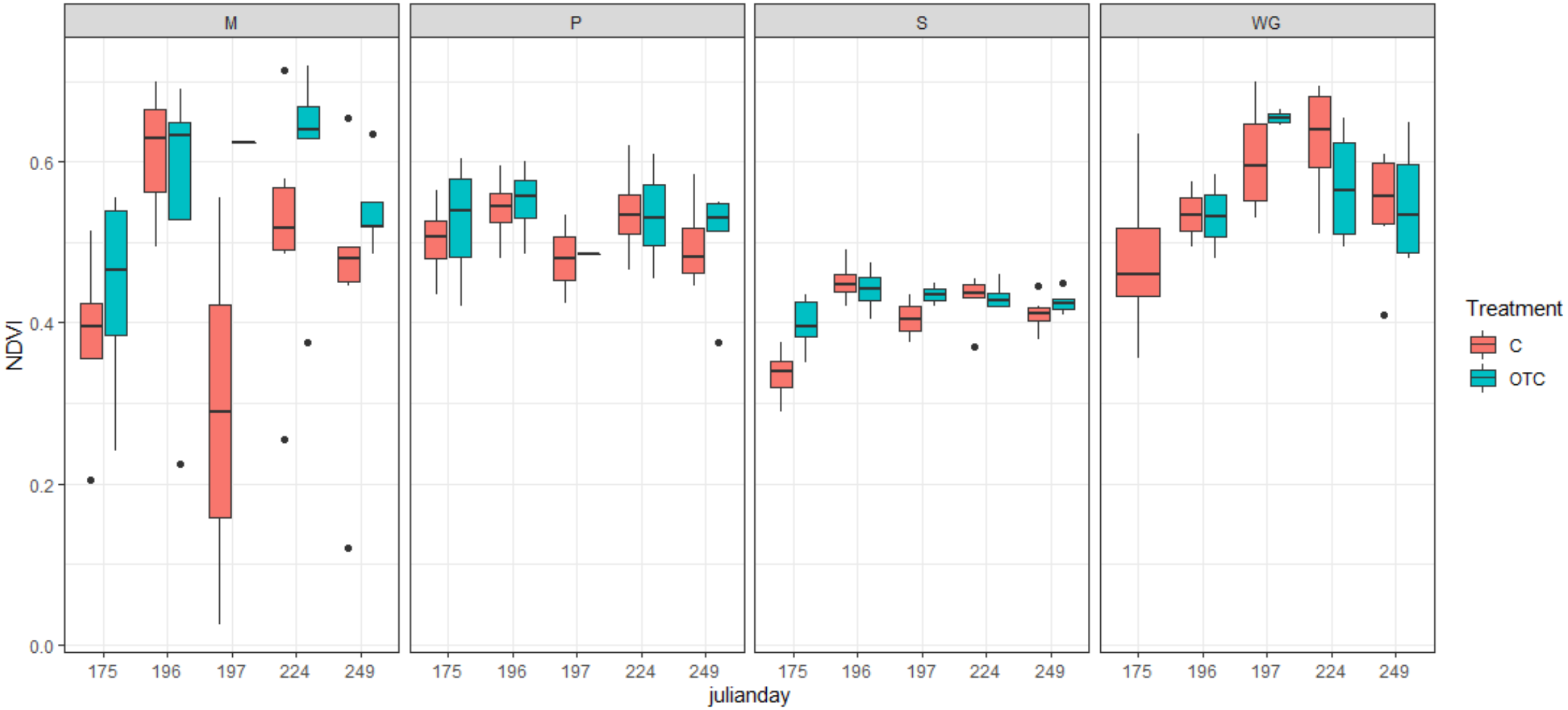
GPP



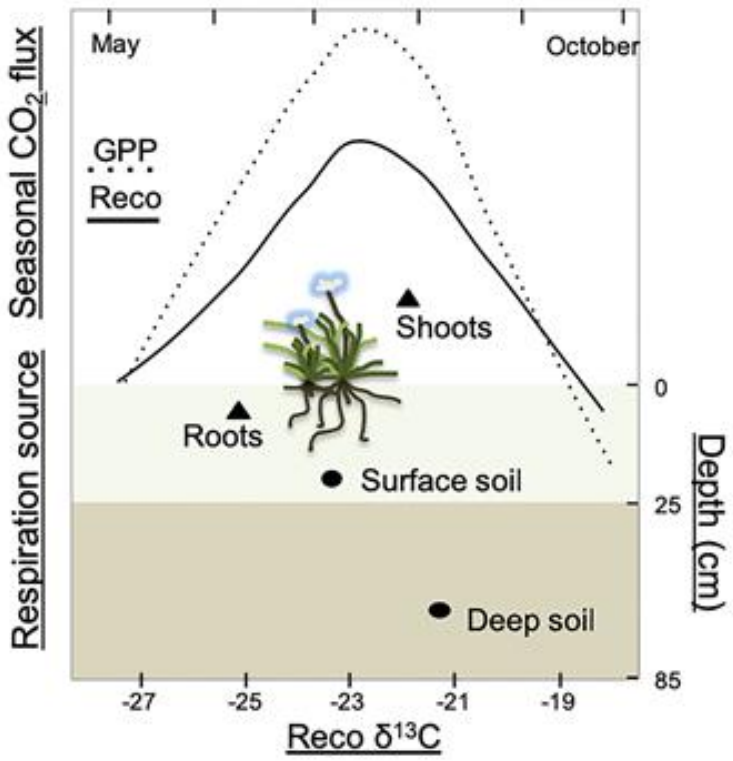
RECO

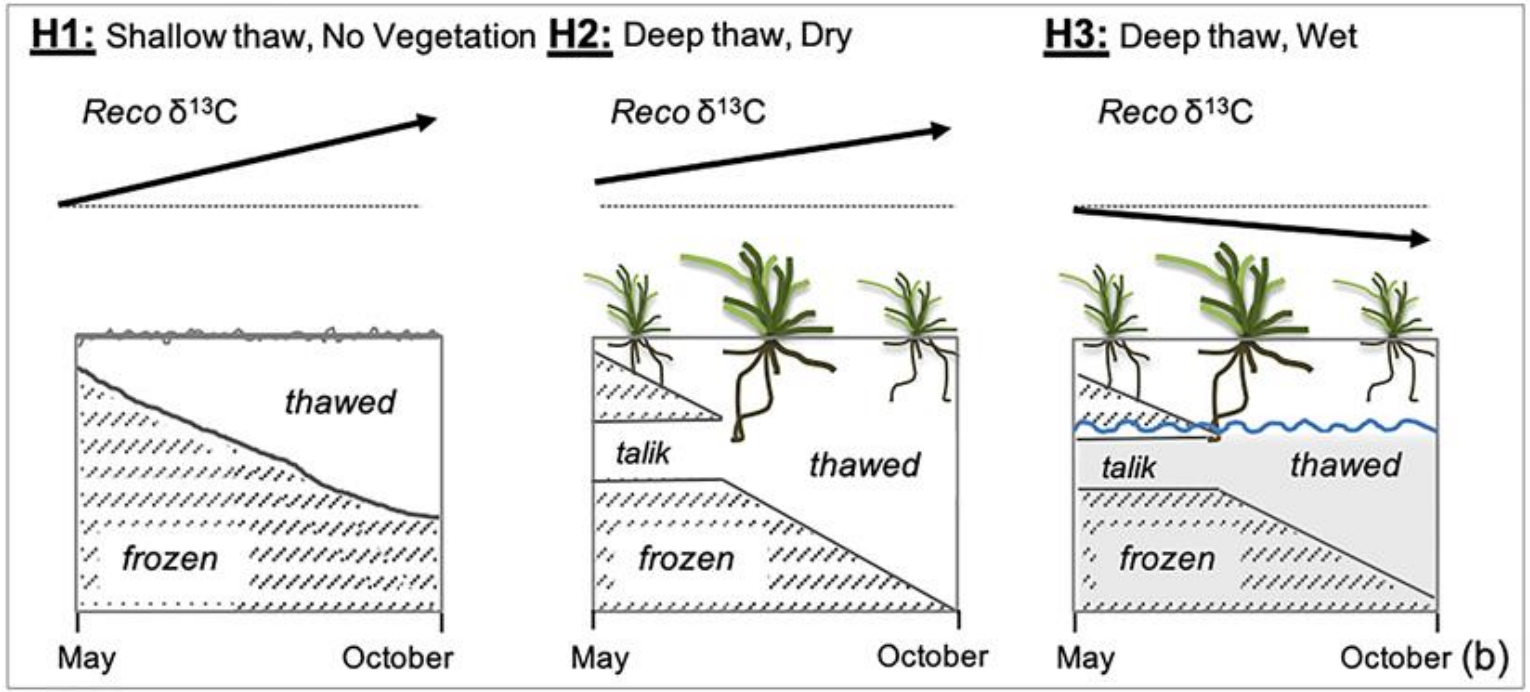


NDVI (Greenseeker)



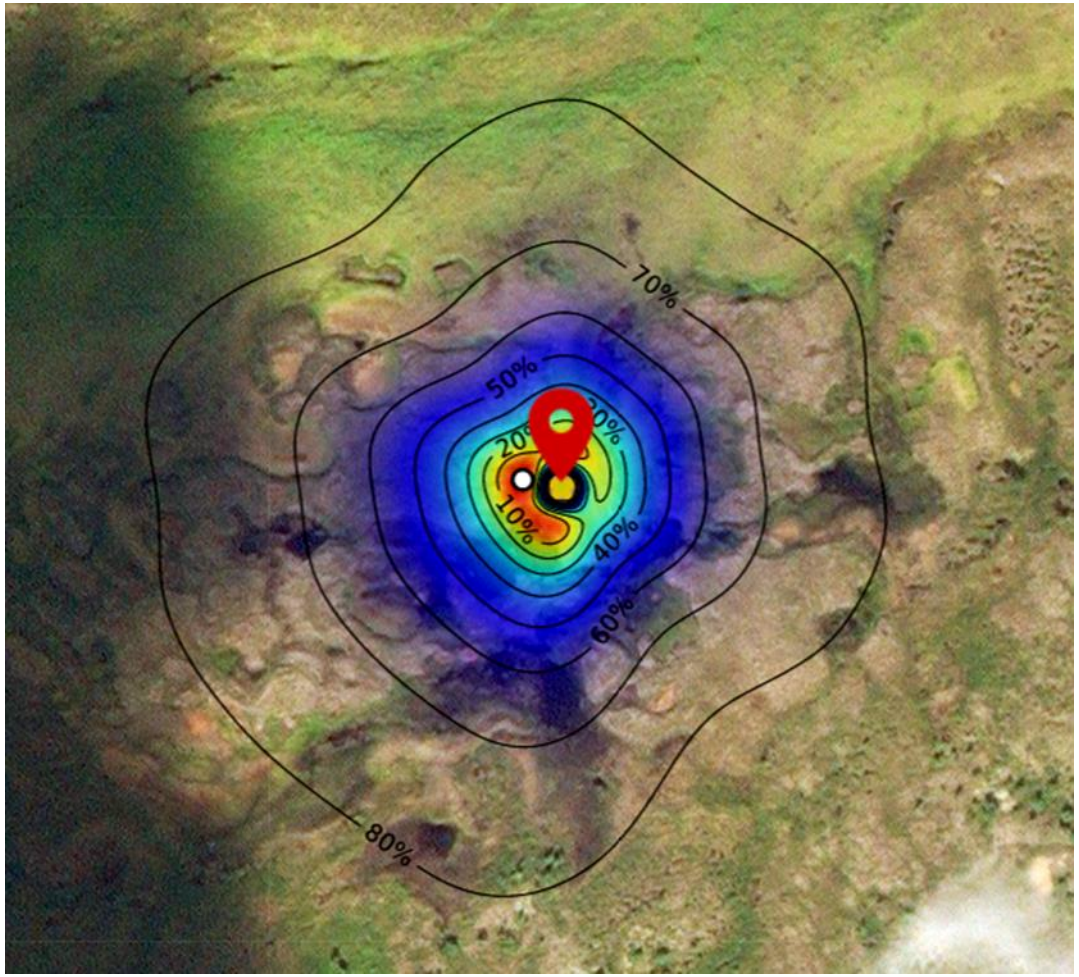
C-isotopes to determine origin of C release

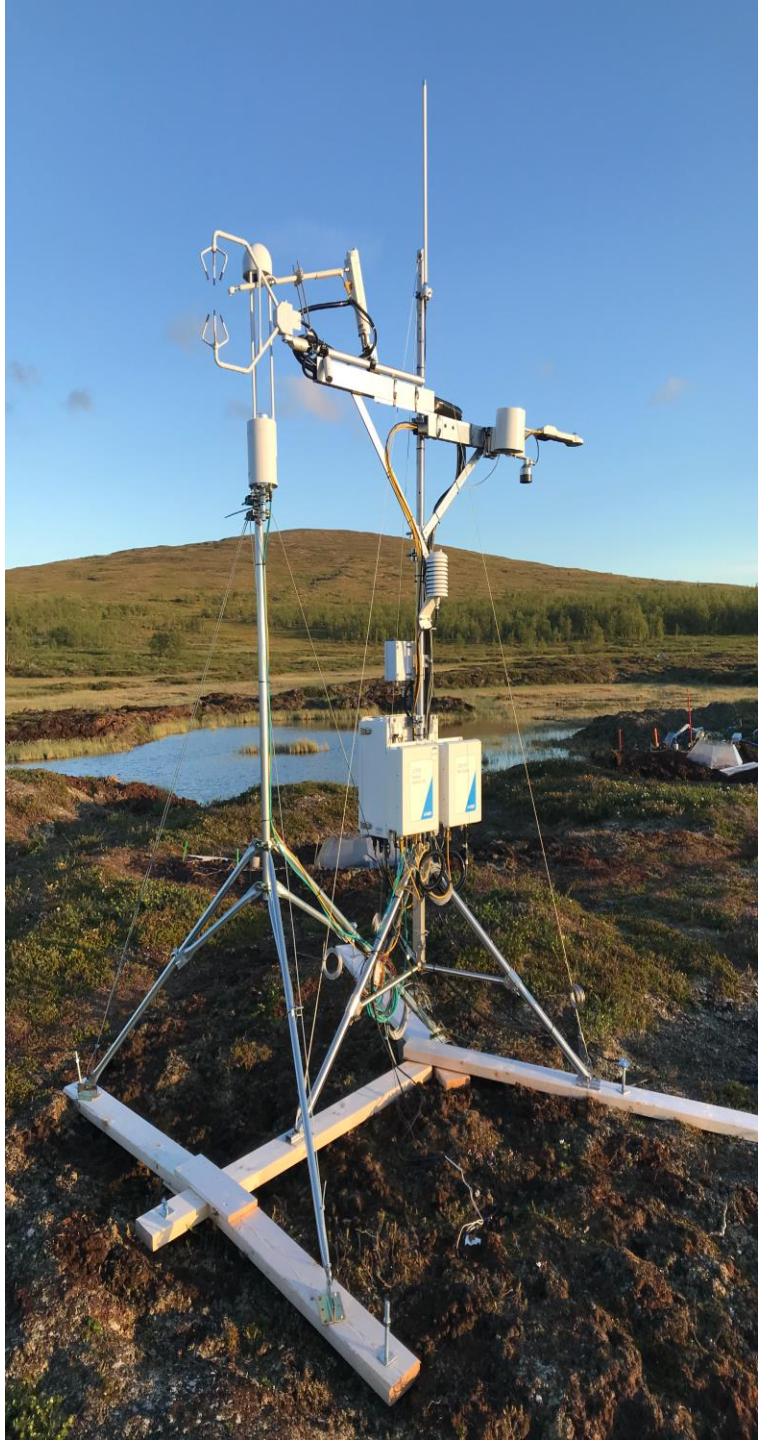




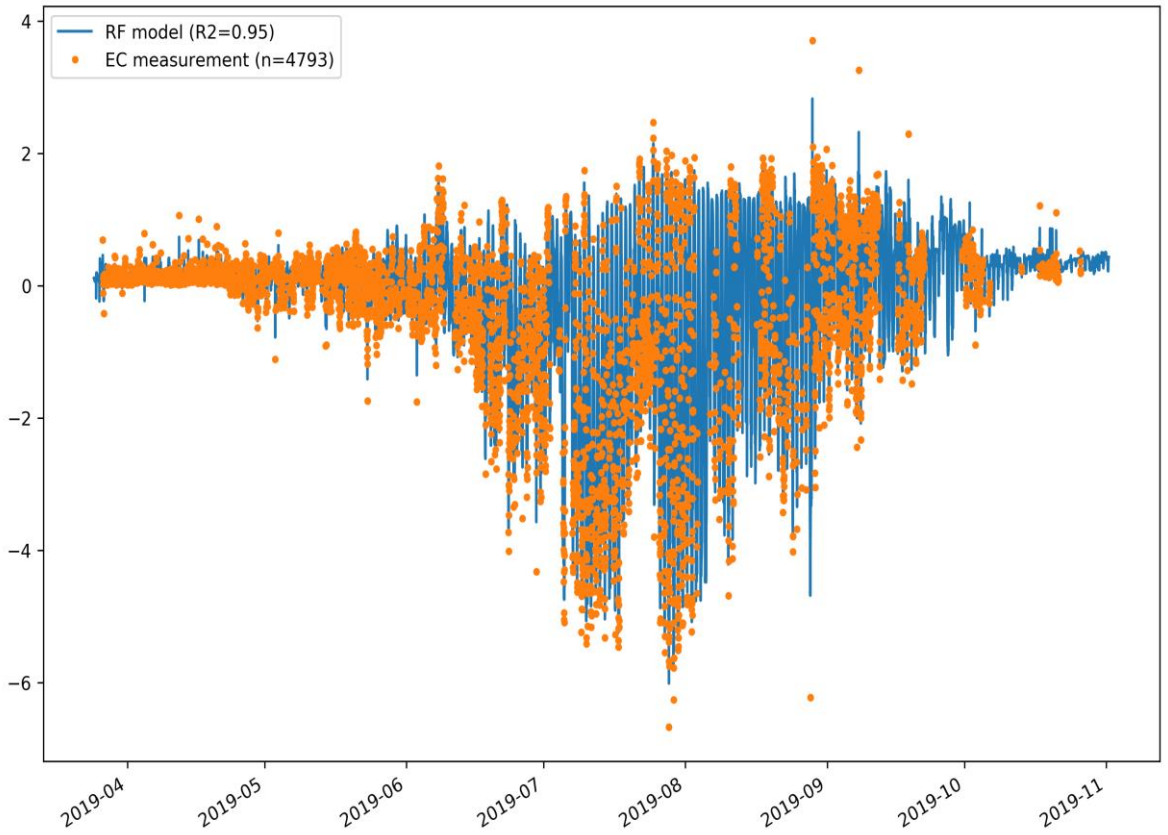
Mauritz, M., et al. (2019). Using stable carbon isotopes of seasonal ecosystem respiration to determine permafrost carbon loss. *Journal of Geophysical Research: Biogeosciences*, 124, 46– 60. https://doi.org/10.1029/2018JG004619

Eddy Flux Tower

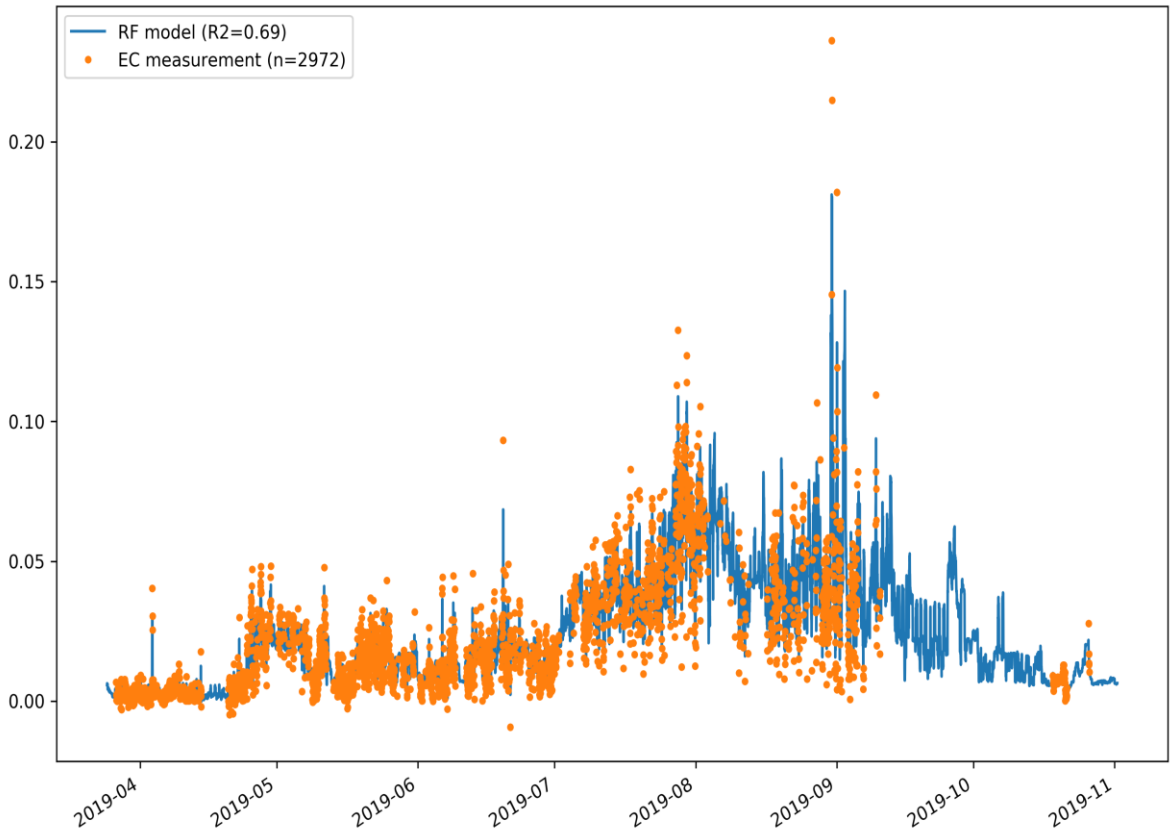




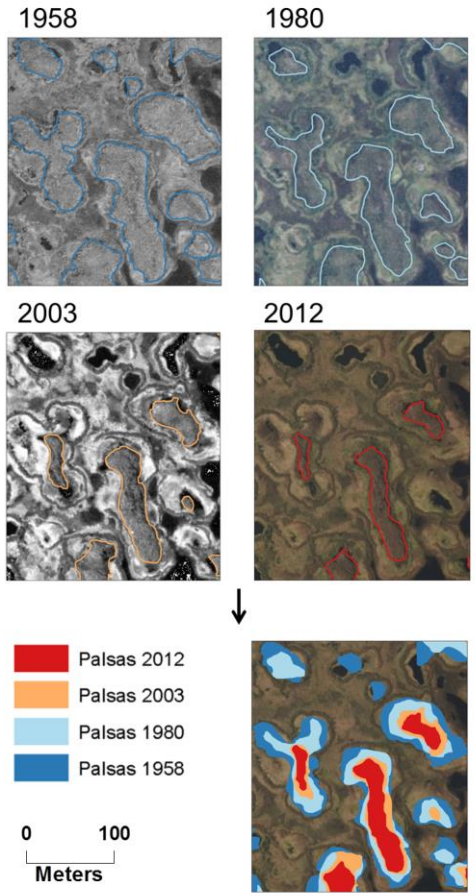
CO2 SINK



CH4 SOURCE

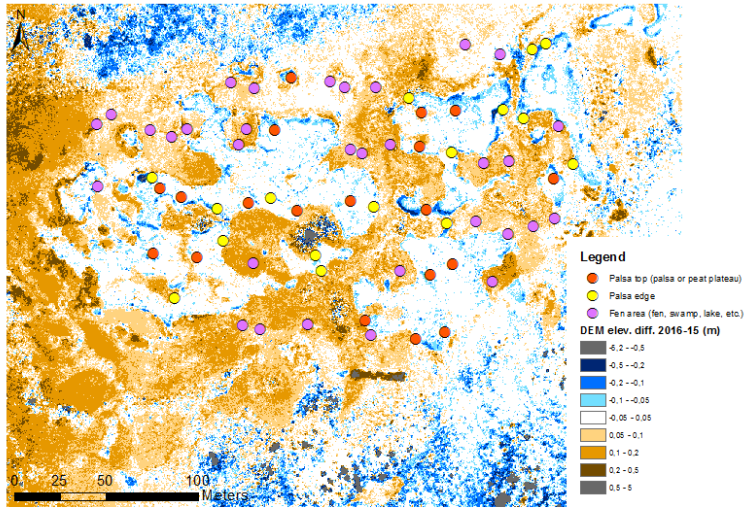


Upscaling from plot to catchment, and beyond?



Borge et al. 2017 Cryosphere

DEM elevation differences 2016-15 with loggers



DEM elevation differences 2017-16 with loggers