Estimation of the Permafrost Carbon Feedback Using The SiBCASA Terrestrial Carbon Cycle Model

Elchin Jafarov[1], Kevin Schaefer[1] and Jennifer Watts[2]

[1]National Snow and Ice Data Center, CIRES, University of Colorado Boulder
[2]Flathead Lake Biological Station, University of Montana

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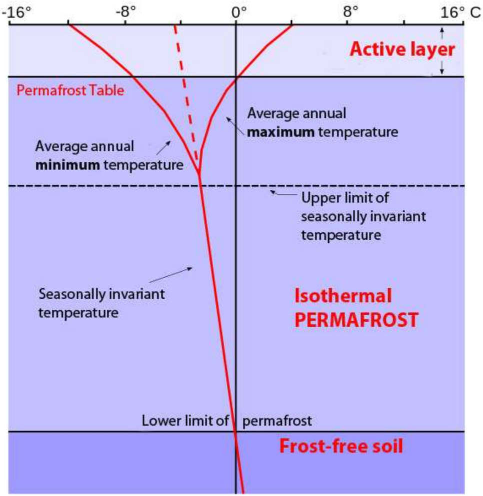
Permafrost spatial distribution

Figure 1. Latitudinal zonation of permafrost. Source: Brown and colleagues (1998).

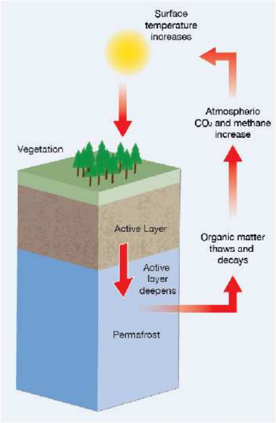
Secondary source: Schuur et al. (2008)

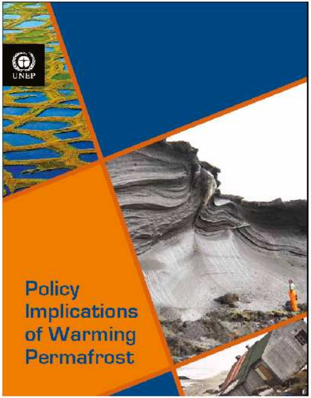
Schematic representation of permafrost temperature



http://en.wikipedia.org/wiki/Active_layer

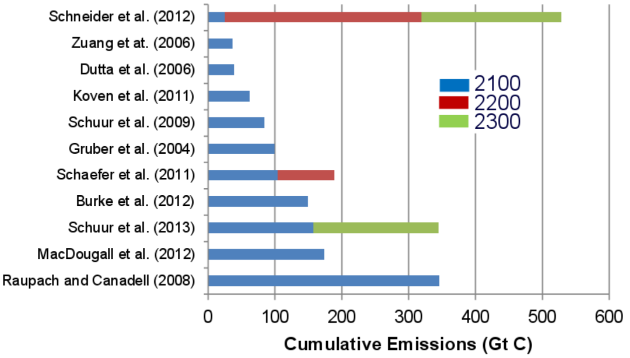
Permafrost Carbon Feedback





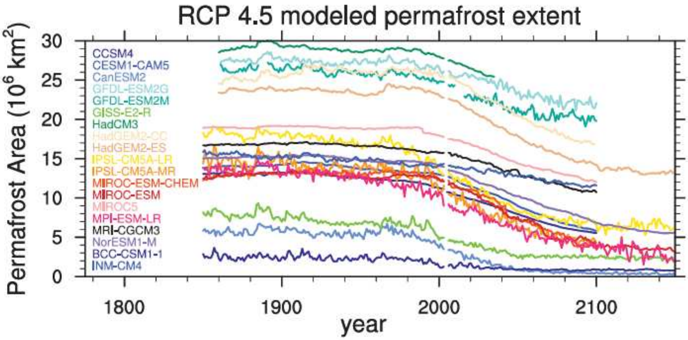
Schaefer et al., 2012. Policy Implications of Warming Permafrost.

Permafrost Carbon Feedback previous studies



[Schaefer et al., 2014]. The ensemble mean estimate is 120±89 Gt of carbon by 2100.
5% to 39% of anthropogenic emissions

Global Permafrost Area CMIP5

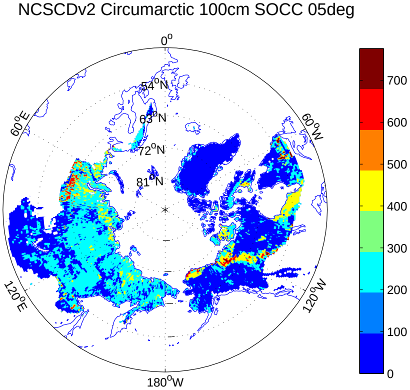


Koven et al., (2013)

Challenges in quantifying PCF

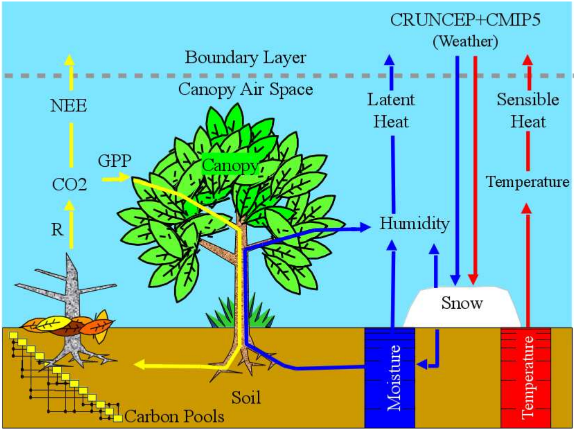
1. Initialization of frozen carbon
2. Frozen biogeochemistry
3. Soil development process (simulation of the soil organic layer)
4. Representation of methane emission from wetlands

Initialization of the Soil Carbon



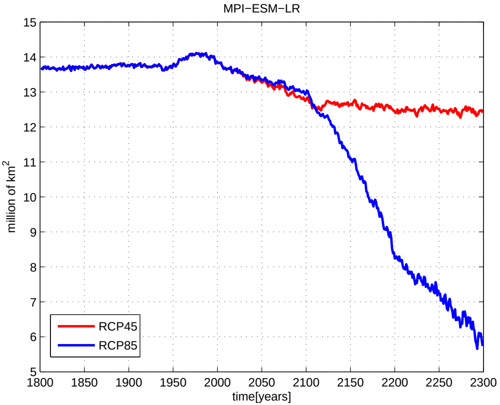
Soil organic carbon storage up to 1 m depth in $kg \cdot C \cdot m^{-2}$ (Hugelius et al., 2013).

SiBCASA Terrestrial Ecosystem Model



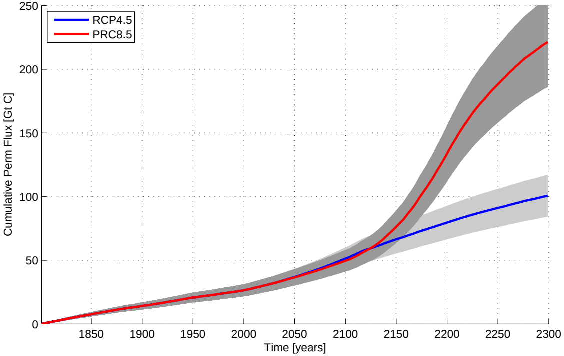
Schaefer et al., (2008)

Permafrost area extent modeled by the SiBCASA model



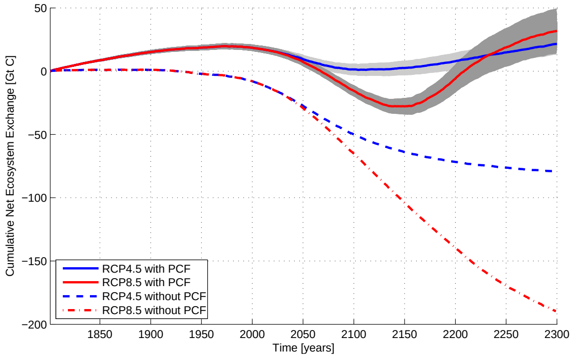
The near-surface (up to 2m) permafrost extent driven by historical datasets and trends from MPI-ESM-LR climate model.

Total Cumulative Permafrost Carbon Flux



After a year 2100 the carbon flux indicate ∼50% of carbon release for RCP45 and ∼76% release of carbon for RCP85.

Total Cumulative NEE



Total cumulative NEE for RCP45 and RCP85 with and without permafrost carbon flux.
The gray bars represent uncertainties.

Conclusions

1. Our preliminary results indicate 50 Gt of carbon release for both RCPs by a year 2100, and 100 Gt for RCP45, and 220 Gt for RCP85 by a year 2300 with 25% of the initial bias.
2. Most of the permafrost carbon releases after 2100, which changes the Arctic from sink to source.
3. Introduction of the dynamic organic layer into the SibCasa's soil model improves the overall permafrost thermal dynamics
4. Work is needed to better address methane emission from wetlands and reduce cumulative permafrost carbon flux bias