Complex Vulnerabilities of the Water and Aquatic Carbon Cycles to Permafrost Thaw

Walvoord, M. and Striegl, R. (2021) Fron. Clim. https://doi.org/10.3389/fclim.2021.730402

Science Question

Permafrost thaw across heterogeneous arctic and boreal landscapes will be neither spatially uniform nor synchronous. How can we reduce uncertainty in predicting hydrologic and aquatic C responses to thaw as described in the 2019 IPCC Special Report on the Ocean and Cryosphere in a Changing Climate: Polar Regions?

Analysis and Results

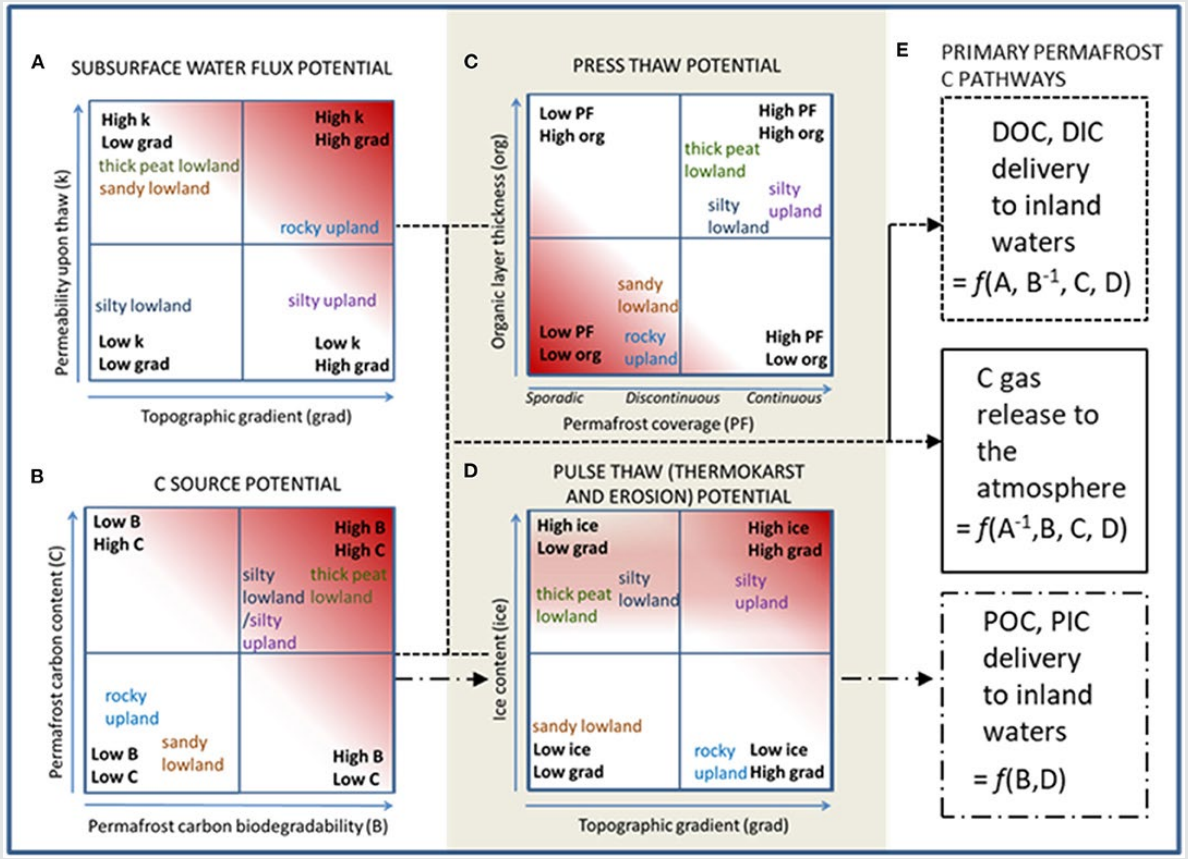
Through synthesis of recent topical field and modeling studies and evaluation of influential landscape characteristics, the study provides:

- state-of-the-science review of mechanisms and coupled factors that influence water and aquatic carbon cycling in thawing permafrost landscapes,
- framework for assessing vulnerabilities to specific modes of permafrost thaw in diverse landscapes, and
- discussion of scaling challenges relevant to model prediction of hydrologic and aquatic C response to permafrost thaw.

Significance

Unraveling the underlying physical and biogeochemical complexities that shape the hydrologic and aquatic C responses to various modes of permafrost thaw will elevate confidence in response prediction.

This work was supported in part by the Arctic Boreal Vulnerability Experiment (ABoVE), a NASA Terrestrial Ecology project, under award 14-TE14-0012.



Consideration of competing hydrologic, biogeochemical, and physical influences is required to determine the fate of permafrost carbon (E). Red shading in panels represents conditions having the highest potential for (A) subsurface water flux, (B) carbon source strength, (C) press thaw, and (D) pulse thaw.