Q-ARCTIC

Russian collaboration loss risks permafrost carbon emissions network

Preprint version

Edward (Ted) Schuur, Martijn Pallandt,
and Mathias Göckede

Published in: Nature Climate Change

Accepted manuscript version

Reference: Schuur, E. A. G., Pallandt, M., & Göckede, M. (2024). Russian collaboration loss risks permafrost carbon emissions network. Nature Climate Change, 14, 410-411. doi:10.1038/s41558-024-02001-6

This project has received funding from the European Union's H2020-EU.1.1. EXCELLENT SCIENCE - European Research Council (ERC) programme under grant agreement No 951288

Comment Title: Russian collaboration loss risks permafrost carbon emissions network

Authors: Edward (Ted) Schuur[1*], Martijn Pallandt[2], and Mathias Göckede[2]

Affiliations: [1]Center for Ecosystem Science and Society, and Department of Biological Sciences; Northern Arizona University, Flagstaff, AZ, 86011. [2]Department of Biogeochemical Signals, Max Planck Institute for Biogeochemistry Hans-Knoell-Str. 10, 07745 Jena, Germany

***ted.schuur@nau.edu**

Main text: While never overshadowing the dominant influence of human activities, additional greenhouse gas emissions from warming Arctic permafrost are expected to accelerate future climate change by 10-20% (1-4). The Russian Federation contains two-thirds of the northern permafrost area (5-6) and the loss of access to permafrost carbon flux sites and data due to the Russian invasion of Ukraine threatens our ability to detect this climate feedback.

Scientists are working to improve the Arctic carbon flux network, making sites more numerous and pushing the data processing and reporting towards real-time (annual) updates. Analogous to weather monitoring, real-time methane and carbon dioxide measurements do not slow emissions, but instead provide knowledge about the speed and strength of the permafrost carbon feedback to climate change. By 2100, The Arctic is expected to release permafrost carbon with the climate impact of a large, industrialized nation (1), and that must be accounted for as nations around the world determine their own greenhouse gas emission levels aimed at meeting specified temperature targets.

The disruption of science collaboration following the Ukraine invasion threatens the Arctic carbon network in quantifiable ways. At present, the network comprises individual study sites that voluntarily contribute data to international databases. Site-based eddy covariance measurements of methane and carbon dioxide fluxes are combined with remotely-sensed information about ecosystems to provide an integrated view of carbon emissions across the permafrost region. Previously published analysis (7) used a suite of environmental information available across the region, combined with direct methane and carbon dioxide eddy covariance tower measurements, to understand the landscape-scale ‘represented fraction’ of the Arctic carbon network. This measurement (on a 0 to 1 scale) shows how well the carbon flux network observes the full distribution of Arctic ecosystems in the region, and here we outline what happens without access to Russian data.

The Arctic carbon network based on the existing entire patchwork of field sites have a combined ecosystem represented fraction of 0.55, meaning that they capture somewhat more than half of the landscape variability in carbon dynamics. Removing all 27 sites within the Russian Federation drops this represented fraction to 0.36, which means the entire network has about 50% more information about landscape carbon fluxes as compared to a more-limited network without Russian collaboration (Figure 1). This information loss estimate is robust even when using a more conservative approach with multiple towers required to accurately describe environmental controls over carbon fluxes. The network is already a sparse under sampling of a vast region covering millions of square kilometers – a diminishment due to loss of science collaboration is a critical blow towards observing Arctic carbon fluxes.

Using the same approach, we asked whether the loss of Russian sites could be compensated by building additional carbon flux sites elsewhere. Building 27 new sites in North America, mirroring the environmental space of lost Russian sites and tied to infrastructure already in place, can increase the landscape represented fraction from 0.36 to 0.43. This means that improving science infrastructure elsewhere can compensate in part for the loss of Russian collaboration at the cost of installing and maintaining new infrastructure. Compensation, however, is incomplete. The new network describes only about 80% of the environmental space previously monitored by the full network that included Russia. Furthermore, adding an even greater number of new sites cannot overcome this information loss. There are permafrost ecosystems in Russia that do not have environmental analogs in North America and so cannot be compensated.

Expanding North American infrastructure is a way forward for climate science, but other factors may also ameliorate. Russian science collaborations with certain countries may continue to persist in some form, but it is difficult to see how the pre-invasion Arctic carbon flux network would not diminish over time. Remote sensing can partially compensate for loss of ground-based measurements, but greenhouse gas satellites have limited operation at high latitudes based on available sunlight and rely on models to indirectly infer changes in ecosystem carbon fluxes.

As the climate crisis unfolds, the Arctic remains a bellwether for change. The impact of science de-globalization is particularly profound for observations of permafrost methane and carbon dioxide emissions as they relate to climate change. We should compensate by expanding Arctic science infrastructure outside of Russian territory. When the time is right, we also need to seek new ways to support science research across the Western/Russian divide for the benefit of science and global diplomacy.

References

1. Schuur. E.A.G., et al. 2022. Annual Review of Environment and Resources. 47 (1), 343-371.
2. Canadell, J.G, et al. 2021. IPCC AR6 WGI, Final Government Distribution, Chapter 5, 2021.
3. Meredith, M., et al. 2019. Polar Regions. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].
4. McGuire, A.D. et al. 2018. Proceedings of the National Academy of Sciences 115:3882-3887.
5. Tarnocai, C. et al., 2009. Global Biogeochemical Cycles 23. GB2023.
6. Hugelius, G., et al. 2014. Biogeosciences 11: 6573-6593.
7. Pallandt, M., et al. 2022. Biogeosciences 19: 559–583.

Acknowledgements: This work was based on support provided by the following programs: NSF PLR Arctic System Science Research Networking Activities (RNA) Permafrost Carbon Network: Synthesizing Flux Observations for Benchmarking Model Projections of Permafrost Carbon Exchange (2019-2023) Grant#1931333 (EAGS), the Minderoo Foundation; European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 951288, Q-Arctic) (MP and MG).

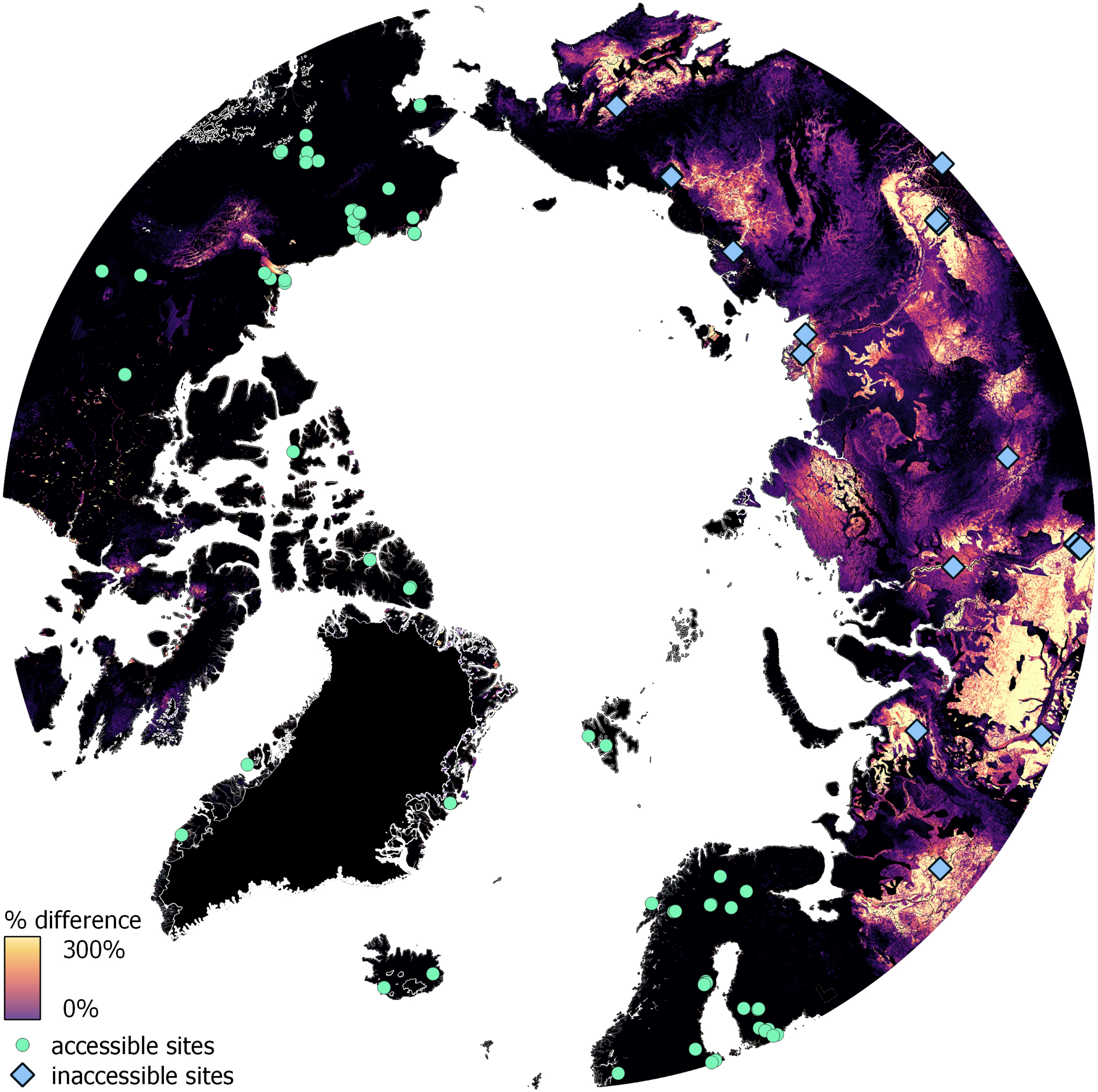
Contributions

All authors contributed substantially to this work. Based on previous collaborative work by the author group, ES concieved the initial idea and written draft; MP provided the analysis with figure, and contributed to the written text; MG provided the analysis with figure, and contributed to the written text.

Competing Interests

The authors declare no competing interests.

Figure Legend: Regions of environmental space described by the Arctic carbon monitoring network that are affected by loss of Russian science collaborations. Colors represent proportional difference based on a network with Russian sites (inaccessible sites/blue symbols + accessible sites/green symbols) as opposed to without (accessible sites/green symbols only), while black represents no change. This figure relies on methods and datasets detailed in (7). Eddy covariance site data is available at https://cosima.nceas.ucsb.edu/carbon-flux-sites/; a snapshot of the eddy covariance component of this database used for this paper is retained and available on request.


% difference
300%
0%
accessible sites
inaccessible sites