# Fate of carbon in Canadian permafrost-affected soils

Charles Gauthier[1], Joe Melton[2], and Oliver Sonnentag[1]
*1. Université de Montréal, Montréal, Québec, Canada.*
*2. Environment and Climate Change Canada*

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**This research has shown us the importance of considering both the quantity of carbon in soils as well as the flux of carbon out of soils when modelling the response of soil carbon to climate change, especially in permafrost soils. This is important because many efforts made to improve models only consider the amount of carbon in soils while paying little attention to fluxes. For example, this research showed that considering fluxes when improving climate models can greatly help narrow down the errors.**

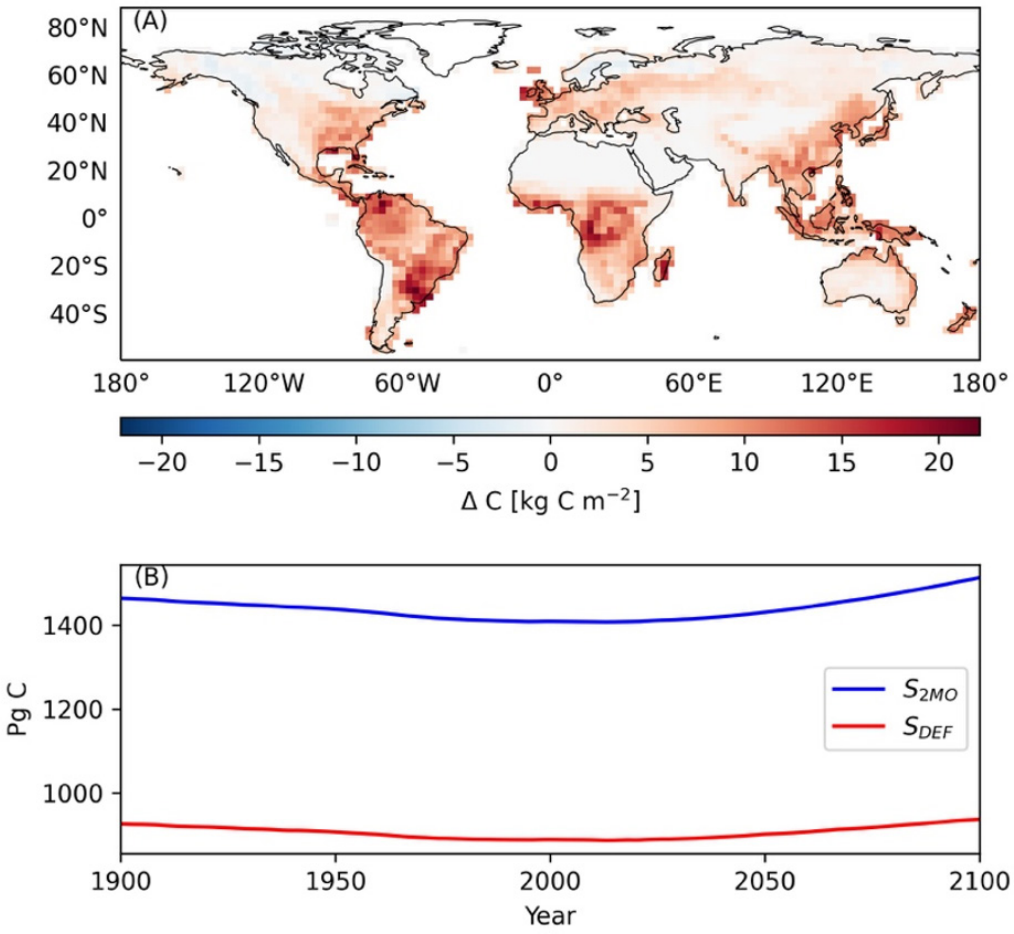


**Figure 1.** (A) Difference in simulated soil carbon at the end of the century (2100) between CLASSIC using its default parameter values ($S_{DEF}$) and our optimized parameters ($S2_{MO}$). (B) Historical and future simulation of global soil carbon stock using the $S_{DEF}$ and $S_{2MO}$ parameter sets. The figure indicates that with the new optimized parameters, CLASSIC predicts an increase of soil carbon globally, with less carbon in high latitude than the default parameterization predicts.

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## Research summary

Terrestrial biosphere models that are used to simulate the fate of soil organic carbon under climate change contain uncertainty due to poorly constrained parameters. Parameters related to soil carbon are impossible to measure in the field due to the scales at which they operate. Therefore, their value has to be assigned arbitrarily. In this research, we optimized the soil carbon parameters of CLASSIC. To do so, we used a global sensitivity analysis and a Bayesian optimisation framework that used bulk soil carbon data as well as soil respiration data. We were able to generate a parameter set that improved CLASSIC's simulation of high-latitude soil organic carbon and soil respiration. Our results provide the modelling community with an improved soil carbon scheme that can more adequately represent soil carbon dynamics. From those improved parameters, modellers will be able to make better predictions about the fate of soil carbon under climate change.

## Taking action

Models such as CLASSIC are important tools for deepening our understanding of permafrost thaw and therefore have the potential to play a significant role in addressing the issues caused by thawing permafrost. Firstly, permafrost-related processes should be included in soil carbon schemes of terrestrial biosphere models. Then, to improve those processes, a wider variety of data should be collected to offer parameter optimization efforts more ways to constrain parameters. Data such as isotopic carbon concentration in soil which are poorly represented in permafrost soil could be part of next data collection campaigns.

## Connections to other projects

3 This project is part of Theme 3 — *Prediction of permafrost change* and related to other projects in the theme, such as *Evaluating the influence of mosses on the carbon and nitrogen cycles in the boreal forest* by Rose Lefebvre and *Simulating land cover change and its influence on permafrost in CLASSIC* by Muhammad Umair.

## Partners, team members and support

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The vast majority of this project was produced at Université de Montréal which is located on the traditional territory of the Kanien'kehà:ka in Tiohtiá:ke/Montréal. This territory as long been a place of exchange between several First Nations including the Kanien'kehá:ka of the Haudenosaunee Confederacy, Huron/Wendat, Abenaki, and Anishinaabeg. We recognize and respect the Kanien'kehà:ka as the traditional custodians of the lands and waters of this territory. This work was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), NSERC PermafrostNet and Environment and Climate Change Canada (ECCC).

## References

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