Thermo-Hydro-BiogeoChemical modeling of permafrost carbon feedback

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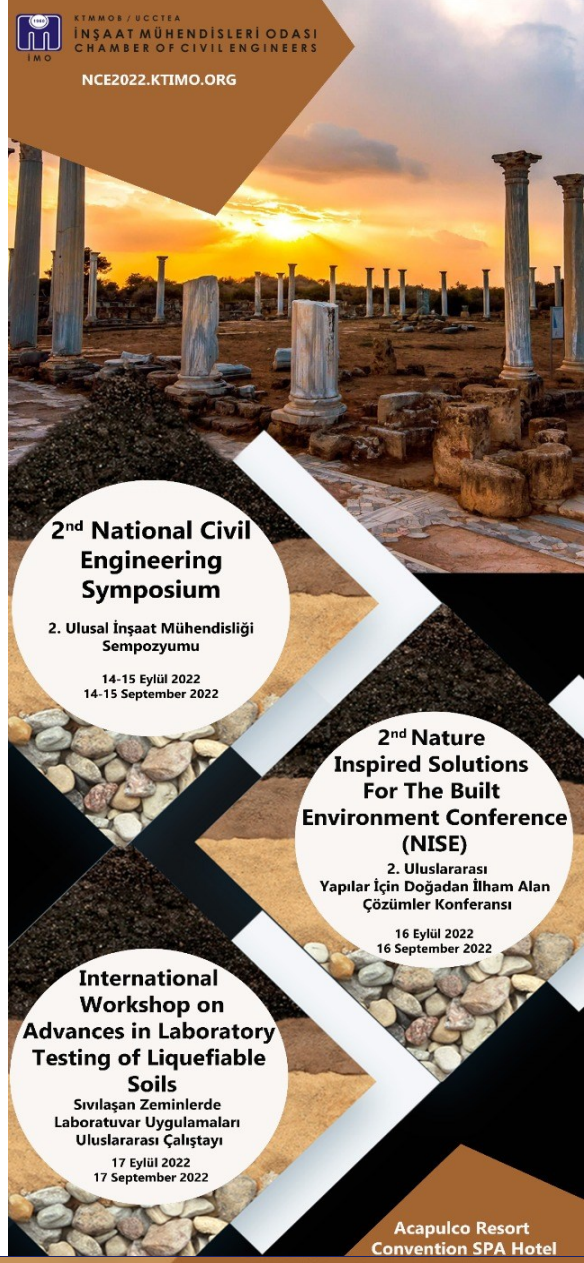


Permafrost

- ✓ Permafrost is defined as any ground that remains at or below 0°C for at least 2 consecutive years.
- ✓ The top layer of permafrost, called the active layer, undergoes seasonal freeze–thaw cycles.
- ✓ Climate warming will lead to permafrost thaw and increasing the thickness of the active layer in many different permafrost sites.

A block of permafrost collapsed on Alaska's Arctic coast.
Credit: U.S. Geological Survey

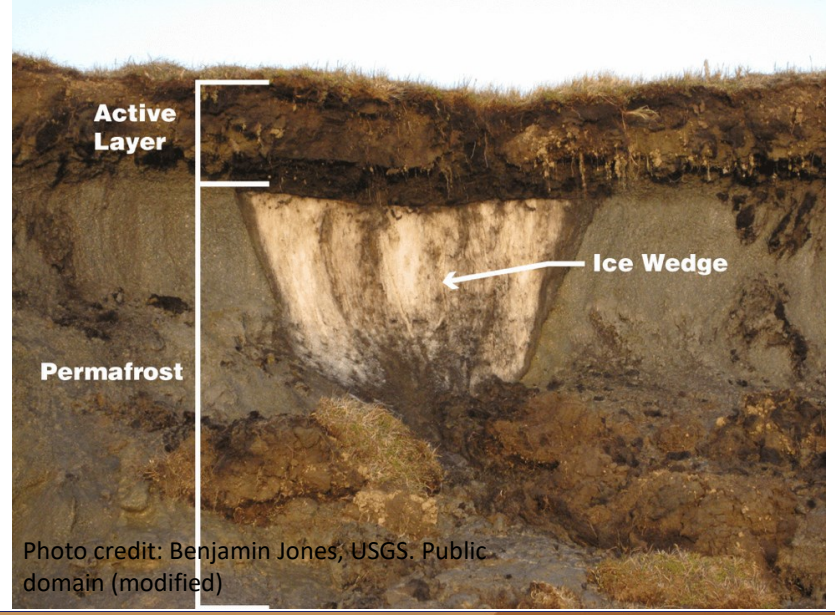
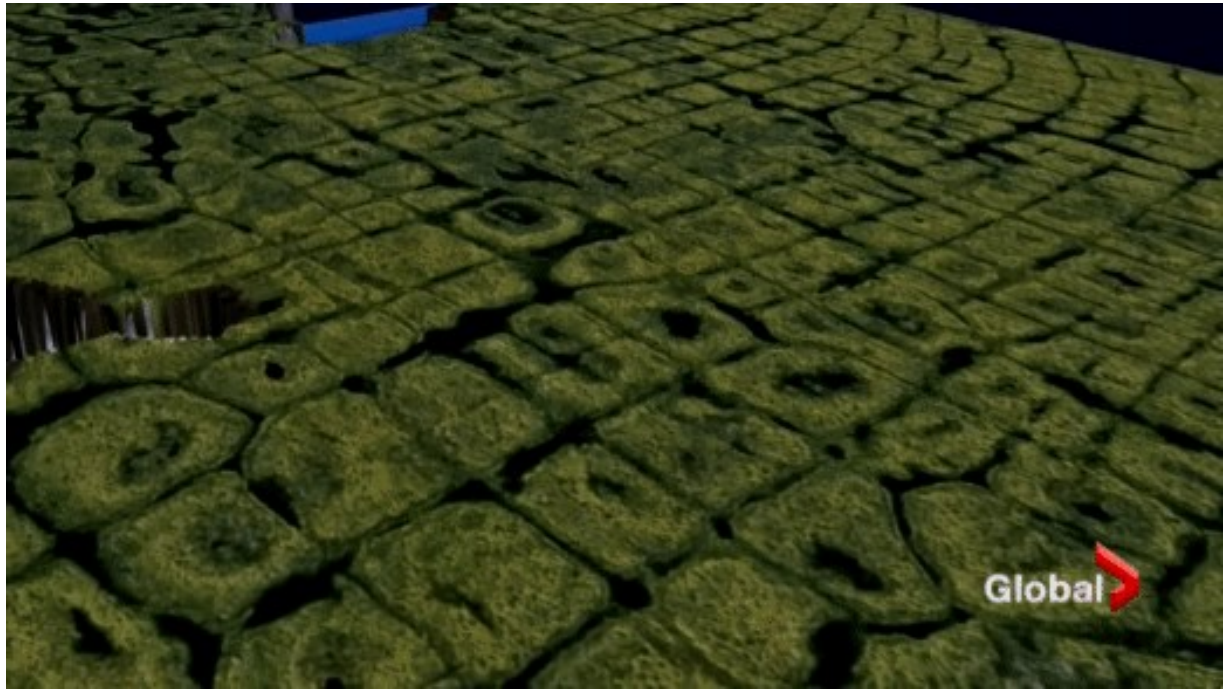


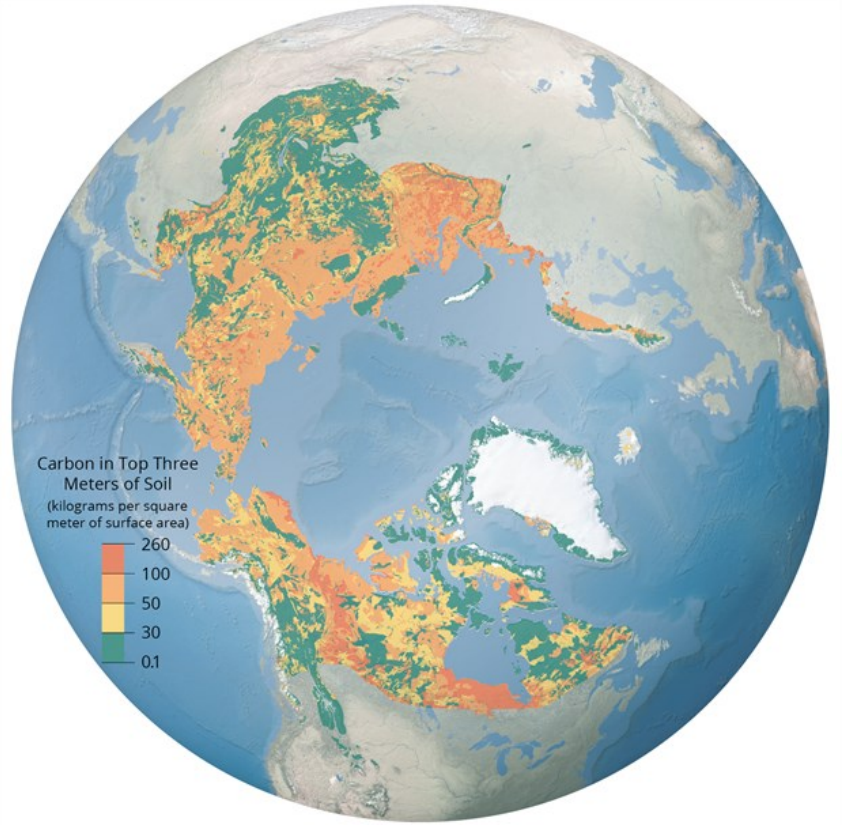
Photo credit: Benjamin Jones, USGS. Public domain (modified)

Why thawing permafrost matters?

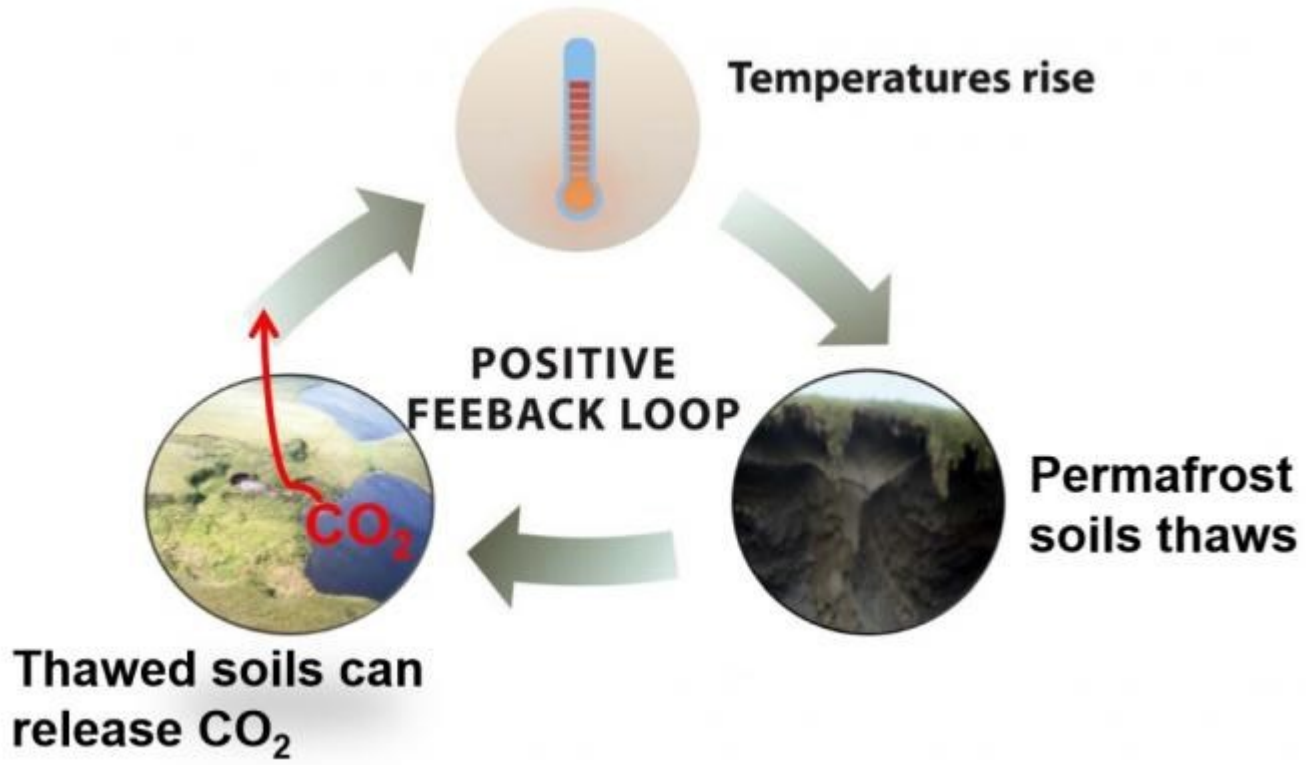
- ✓ The Arctic temperature record of 38°C measured in Siberia in 2020!
- ✓ The production of greenhouse gases and permafrost carbon feedback!



Permafrost carbon feedback



Soil organic carbon pools (0-3 m depth) for the northern circumpolar permafrost region. (modified from Scientific American, November 2016) Produced by Mapping Specialists, Ltd.



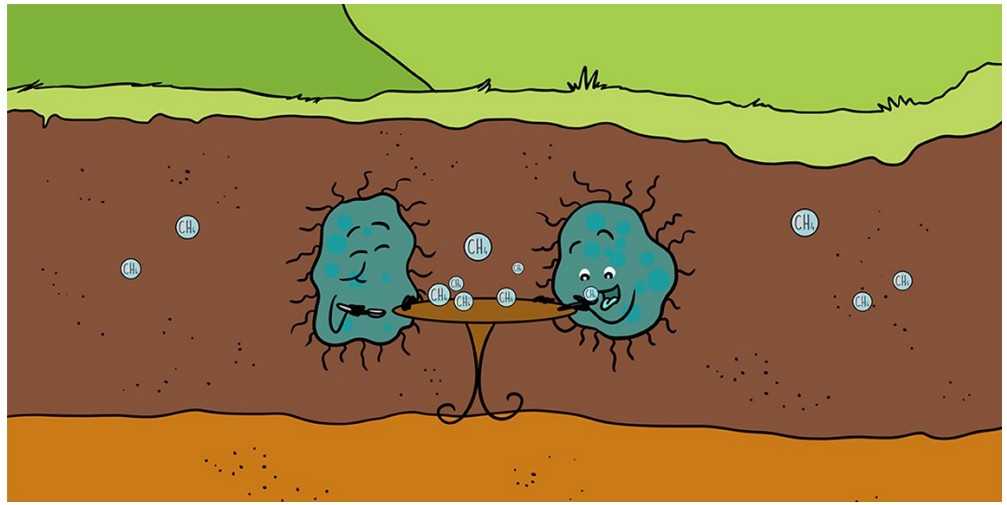
The permafrost positive feedback loop. Source: Dr. Rose Cory (University of Michigan)

Sources of Carbon

- ✓ An experimental study by Johnson et al. Showed the evidence of bacterial survival in samples up to half a million years in age.
- ✓ "They are the little factories that are producing these greenhouse gases."

But…

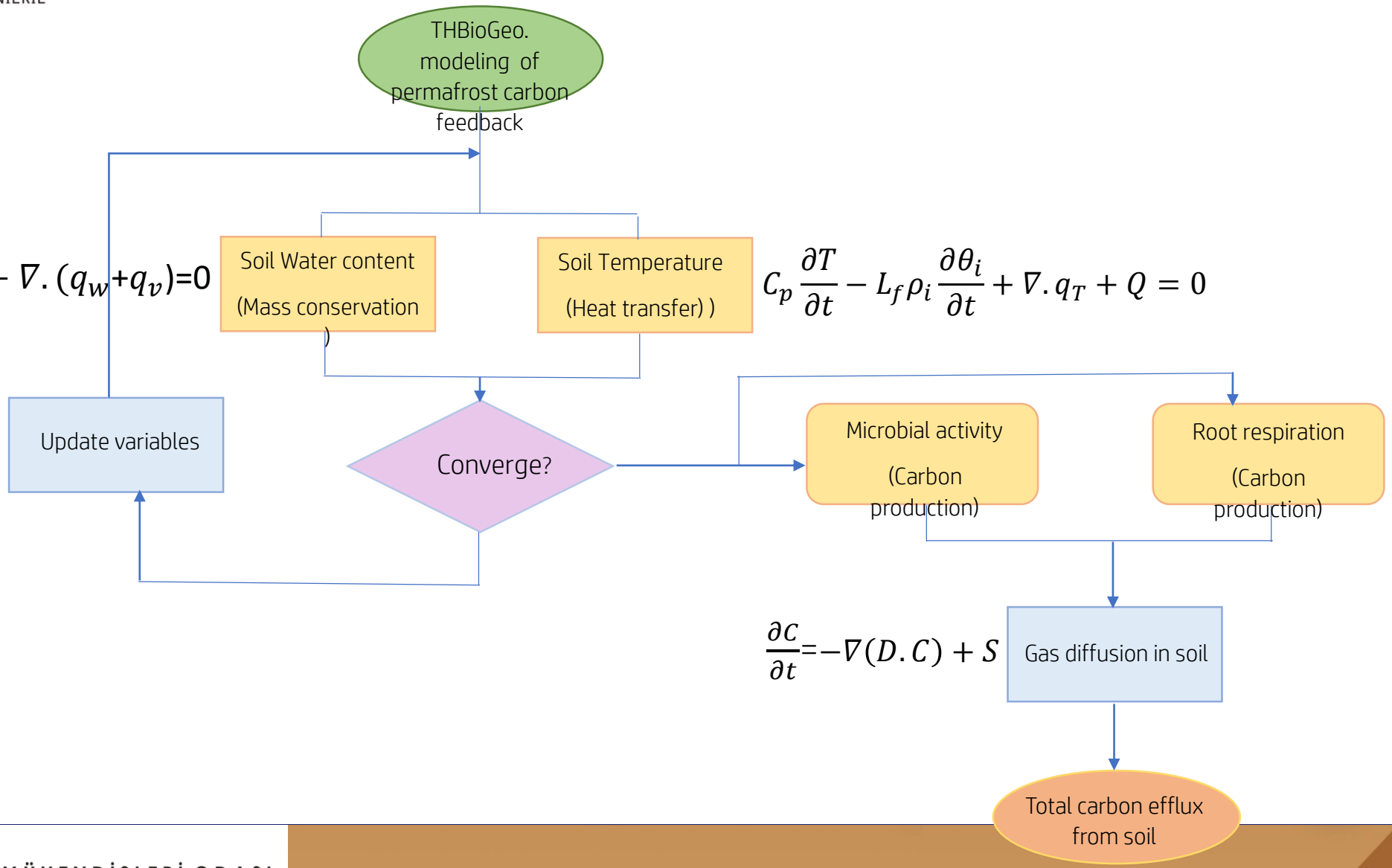
- ✓ How can microbes survive in ancient permafrost?
- ✓ What is the mechanism behind that?



Cadena et al., 2019.The Role of Microorganisms in the Methane Cycle

https://morningchores.com/plant-roots/

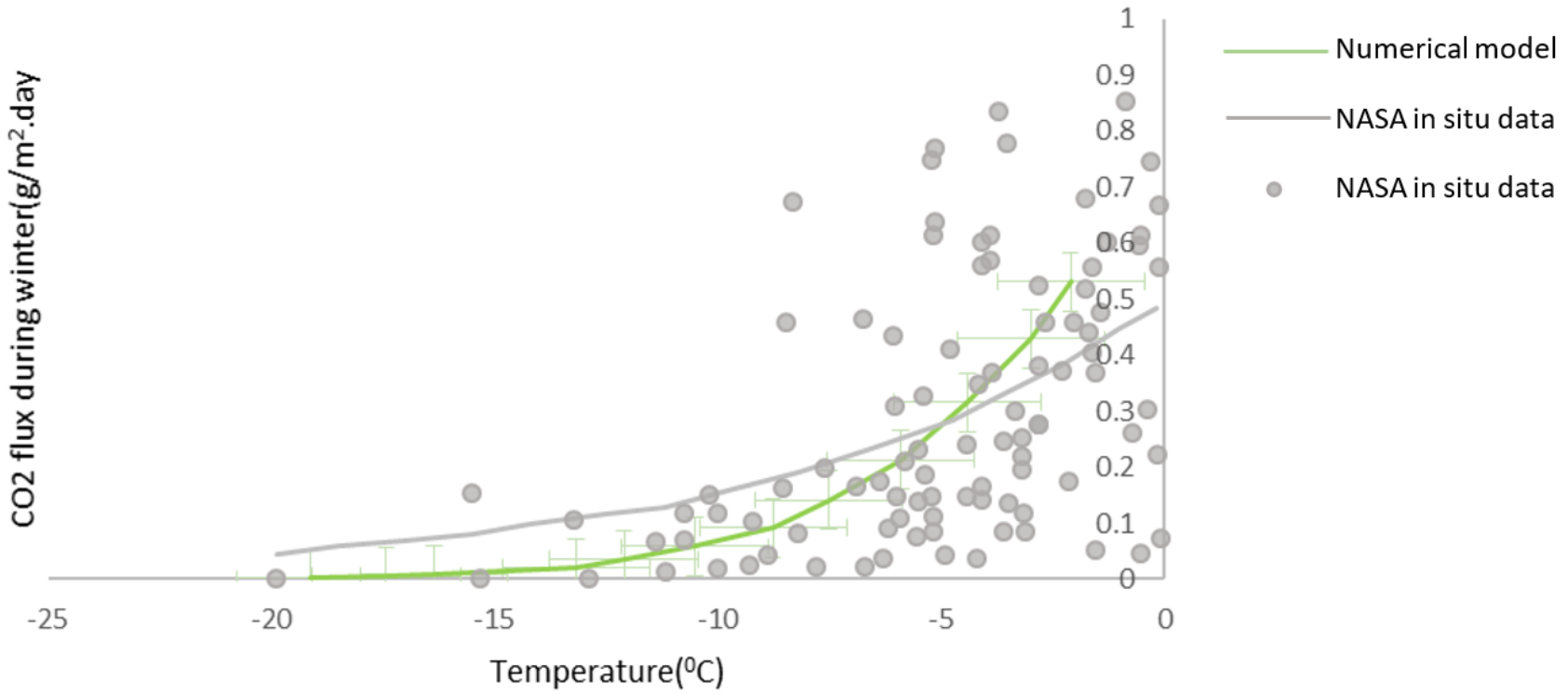
Numerical modeling of permafrost carbon feedback



Results

Effect of soil temperature on CO2 release from permafrost

Carbondioxide winter flux from Arctic permafrost region



Conclusion

- ✓ This model enable the accurate prediction of thermo-hydro characteristics of the soil such as soil temperature, pore-water pressure distribution and water content and the CO2 emission from the land which have reasonable agreement with field measurement, analytical and experimental data.

- ✓ This model predict and evaluate the microbial interaction with soil considering the effect of microbial activity and plant's root respiration as sources of carbon production in soil.

- ✓ The GHG(Co2) flux due to vegetation and root respiration and the microbial community in the soil has been calculated. Eventually, the net flux of carbondioxide which is released to atmosphere has been upscaled.

References

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