CARBOFLOW

Discovering the missing link between groundwater flow and carbon transport in a thawing permafrost environment

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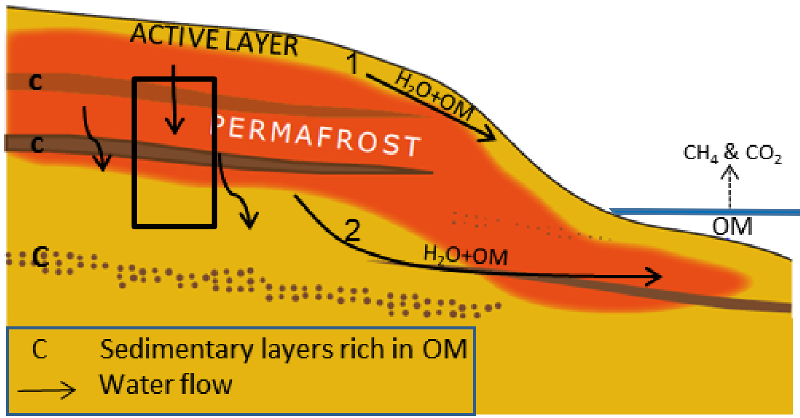
Aim

Increase understanding of the physical processes required to model the release of carbon into deep groundwater from thawing permafrost, to improve model forecasts.



Transport of OC in groundwater:

$$\nabla \cdot [\mathbf{D}\nabla C_{OC}] - \frac{\vec{q}}{\theta_w}\nabla C_{OC} = \frac{\partial C_{OC}}{\partial t} + R_{OC}$$

Release of carbon parametrised as function of hydrogeological conditions and soil properties

Heat flow:

$$\nabla \cdot [\kappa_a \nabla T] - \Gamma_f \vec{q} \cdot \nabla T = \Gamma_a \frac{\partial T}{\partial t} + L\frac{\partial \theta_w}{\partial t}$$

Latent heat effects of freezing-thawing

Water and heat-transfer functions with added solute transport parameter

Previous

Moving the Field into the Lab: Simulation of Water and Heat Transport in Subarctic Peat

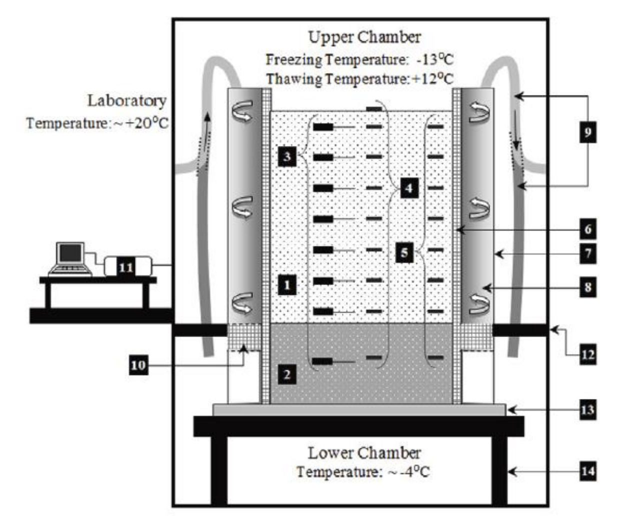
Ranjeet M. Nagare,[1] Robert A. Schincariol,[1] William L. Quinton[2] and Masaki Hayashi[3]*

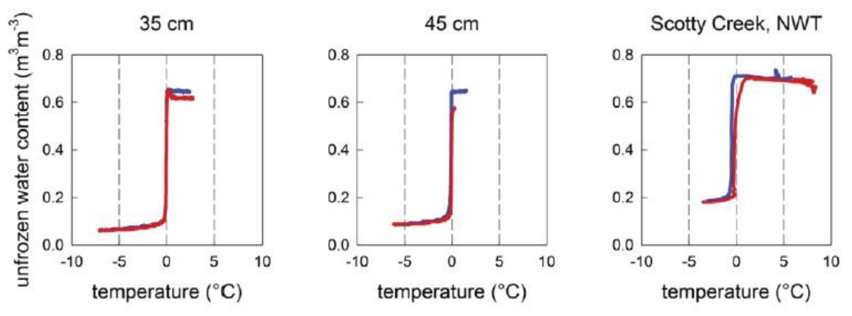
Reproducing Field-Scale Active Layer Thaw in the Laboratory

Aaron A. Mohammed,* Robert A. Schincariol, Ranjeet M. Nagare, and William L. Quinton

Freezing experiments on unsaturated sand, loam and silt loam

Kunio WATANABE,[1] Tetsuya KITO,[1] Tomomi WAKE,[1] Masaru SAKAI[2]

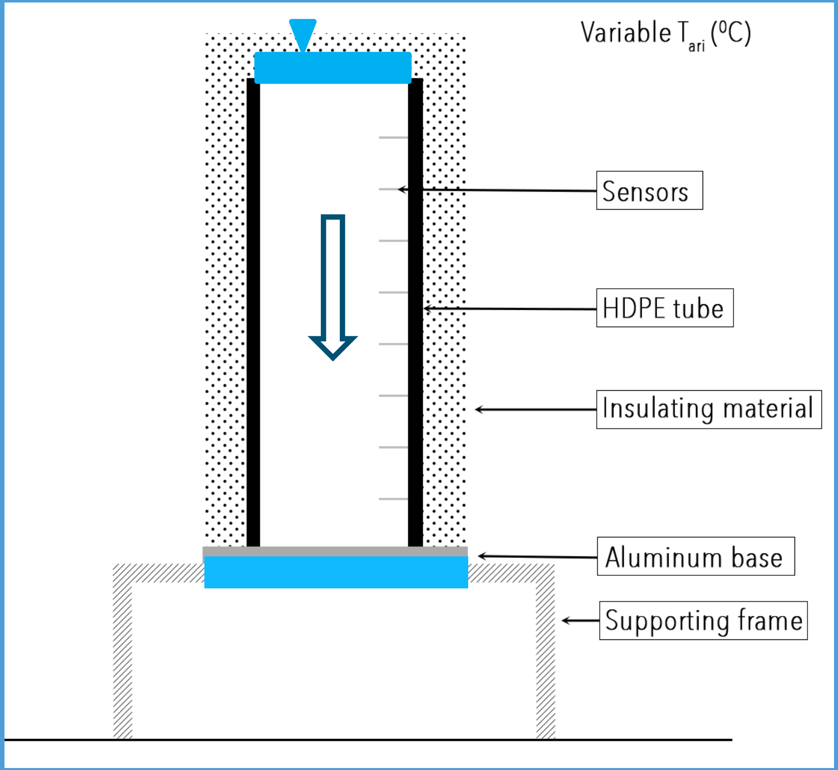




Objective

How large is the contribution of different soil physical parameters to the release of carbon from thawing permafrost soils?

- Controlled soil column experiments
  - Climate chamber with regulated air temperature
  - Increased complexity of soil content, varying grain size (distribution) and carbon content (SOC)
  - No flow situation vs. constant head gradient imposed during thaw
- Temperature, soil moisture, preferential flows, DOC content

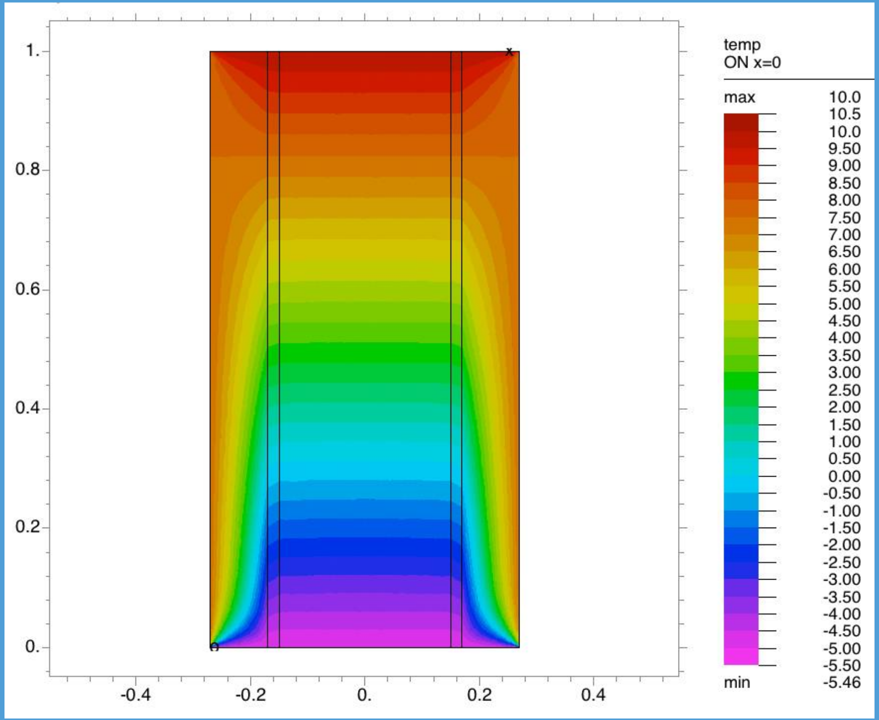


Schematical representation of experimental setup

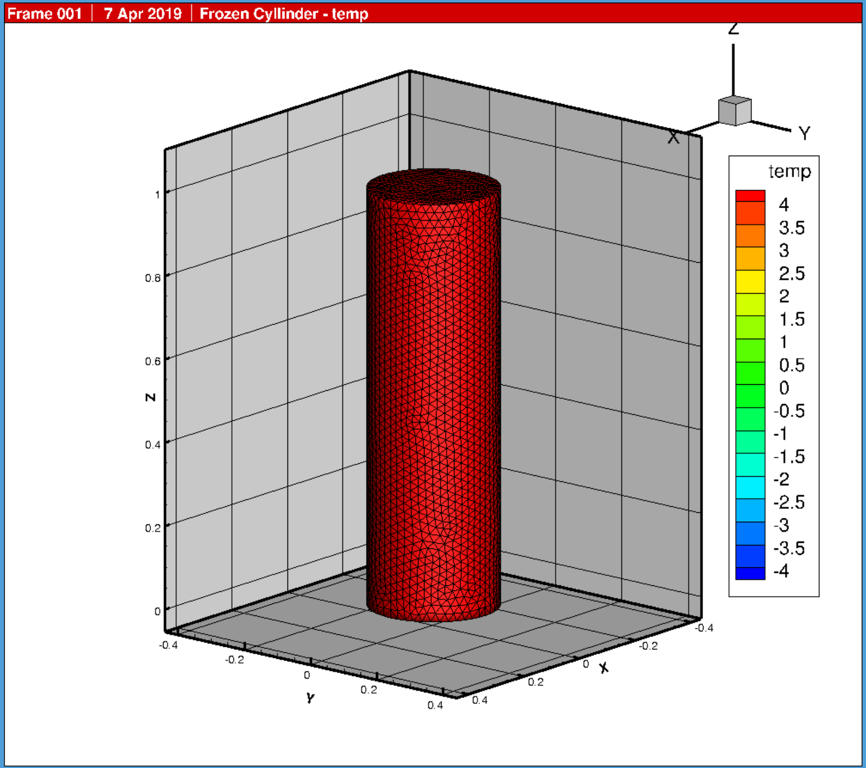
Objective

Implement carbon transport by groundwater into permafrost hydrological modelling routines using laboratory experiment results

- Implement carbon transport into permafrost hydrological modelling routines using gathered parameter values
    - FlexPDE finite element software, or other INTERFROST code
    - Simultaneous heat and water transport, development of solute transport representation (e.g., C)

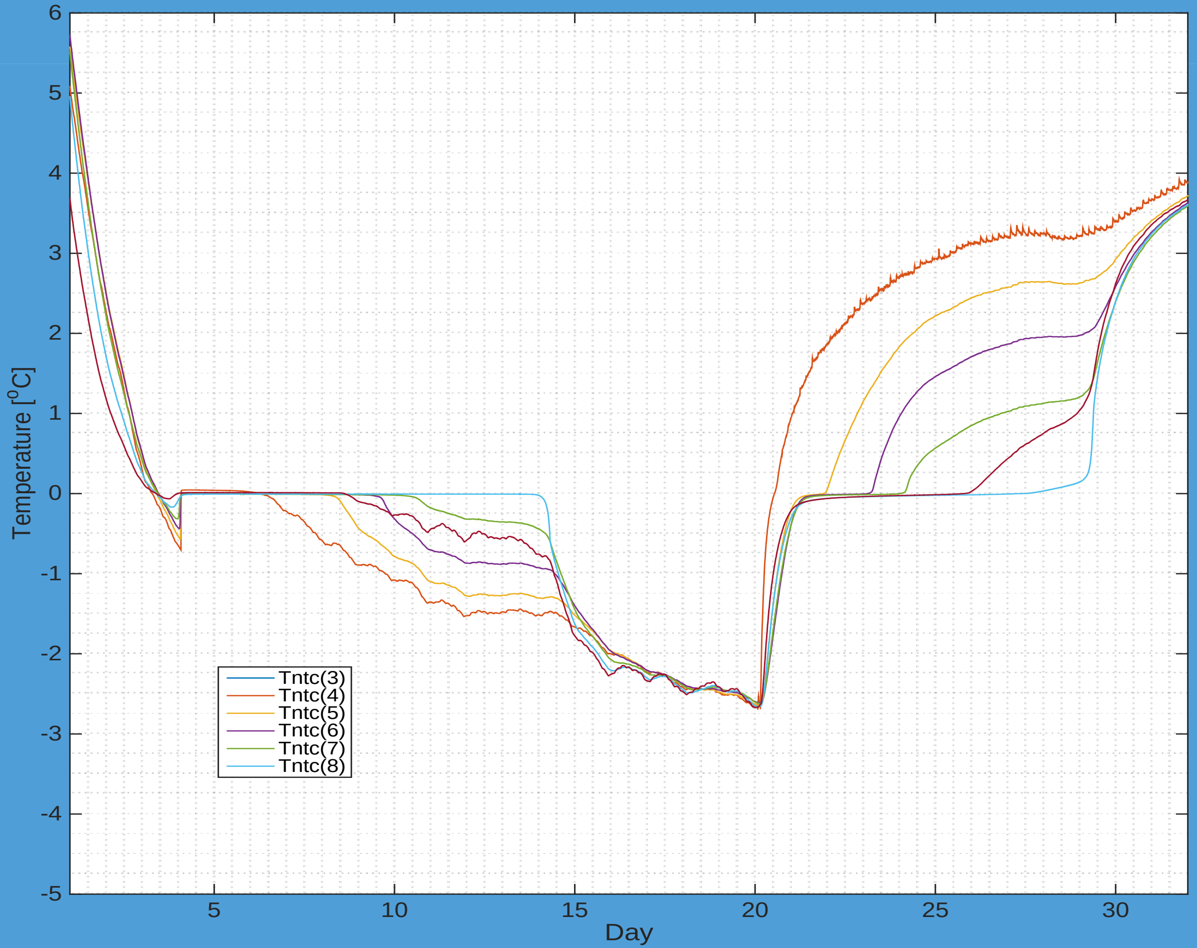


Example steady state model of the temperature development through a insulated soil column.



Frame 001
7 Apr 2019
Frozen Cyllinder - temp
temp
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
Z
X
Y

Initial results



Thanks for listening