

Winter Soil Processes in Transition

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Knowledge Mobilization Collaborator: Kara Hearne

GWF Pillar 3 Collaborators: Nandita Basu (University of Waterloo); Sean Carey (McMaster University); John Pomeroy, Angela Bedard-Haughn and Cherie Westbrook (University of Saskatchewan); William Quinton and Jennifer Baltzer (Wilfrid Laurier University); Ronald Stewart (University of Manitoba); Merrin Macrae (University of Waterloo)

Colder Soils in a Warming World?

Climate Warming: {
✓ Air temperature is rising
✓ Less extreme cold days (-30°C or colder)
✓ Rain is increasing

Climate Warming expose soils to:



The Cold Soil

- **Colder soil temperatures** due to loss of the insulating snowpack
- Influence on soil moisture content
- More frequent **Freeze-Thaw Cycles** over the winter season

Importance of **Winter Soil Processes** on the export of C and nutrients (N, P, S, Fe) to **Groundwater**, **Surface Water** and **Lakes**

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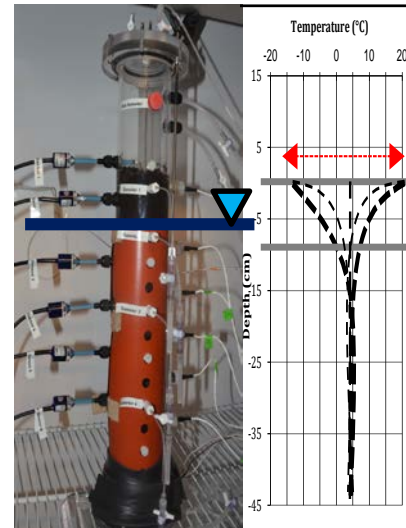
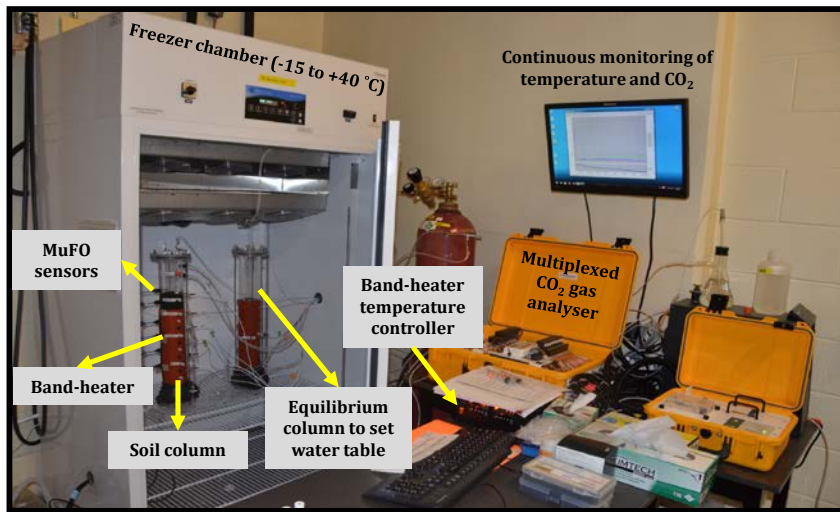
Short-Term Objectives (2018-2020)

Objective 1 (Flow-Through Reactor and Leaching Experiments)

Establish the dynamic temperature dependencies of carbon and nutrient mineralization rates, and the associated effects on winter microbial soil communities

Objective 2 (Soil Column Experiments)

Assess the mechanisms of soil biogeochemical processes under variable FTC and soil moisture content conditions, and determine the effects on C and nutrient cycling under variable snow cover and winter conditions



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Short-Term Objectives (2018-2020)

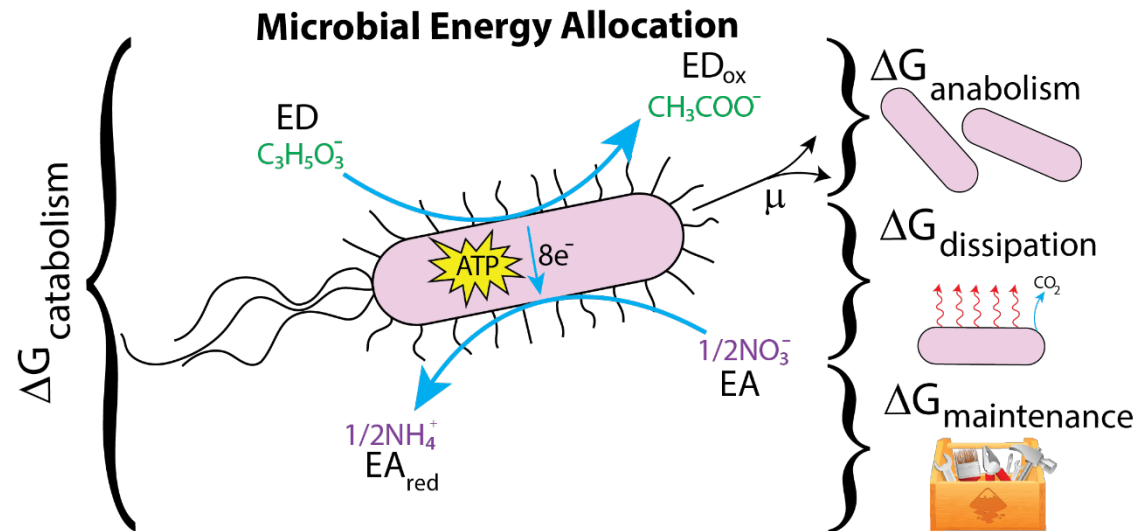
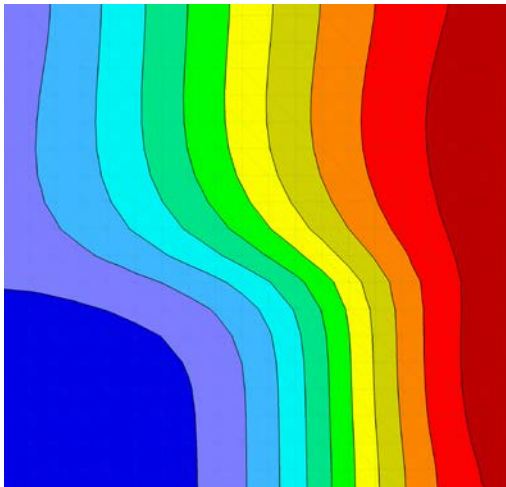
Objective 3 (Biogeochemical **Modeling**)

Develop a bioenergetic model for simulating microbial reaction systems under variable geochemical winter conditions

Objective 4 (Numerical **Modeling**)

Develop a reactive transport model to simulate the biogeochemical transformations of carbon and nutrients in winter soils

Transport Model



$$Y = \frac{\alpha \Delta G_{cat}^{\circ 2} - \beta \Delta G_{cat}^{\circ} \Delta G_{cat}}{\alpha v \Delta G_{cat}^{\circ 2} - \Delta G_{cat}^{\circ} (\beta v \Delta G_{cat} + \alpha \Delta G_{an}^{\circ} + \Delta G_{an}) + m \Delta G_{cat} \Delta G_{an}^{\circ}}$$

Work Plan and Team

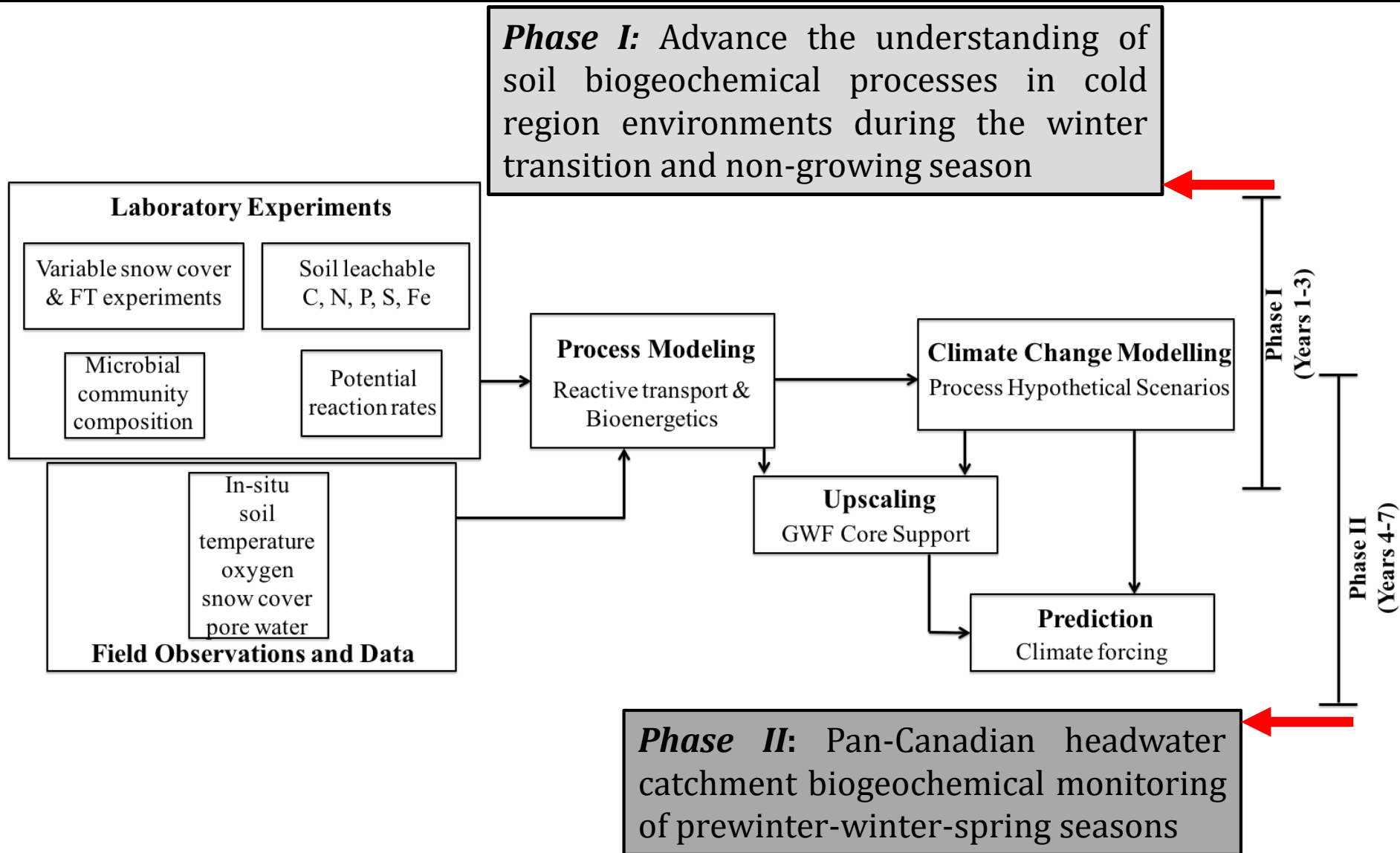
Objectives	HQP	Years	Team
Objective 1 (Flow-Through Reactor and Leaching Experiments)	PhD#1 UG Thesis #1,2 UG Coop #1 (<u>L. Norwood</u>)	2018 2019 2020	Hug, Smith, Parsons, Rezanezhad
Objective 2 (Soil Column Experiments)	PhD#2 (<u>K. Krogstad</u>) UG Thesis #3,4 UG Coop #2,3	2018 2019 2020	Rezanezhad, McCarter Rudolph, Van Cappellen
Objective 3 (Biogeochemical Modeling)	PDF#1 PhD#1	2019 2020	Van Cappellen, Smeaton Hug, Smith
Objective 4 (Numerical Modeling)	PDF#1 PhD#2	2019 2020	Van Cappellen, Rudolph, Rezanezhad

➤ The team will be collaborating with several **GWF Pillar 3 projects** and **GWF Core Supporting Team** (Technician, Data Management, Modeling and Knowledge Mobilization)

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Deliverables and Timelines



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Field Sites

Local Agricultural Fields, rare site, Ontario

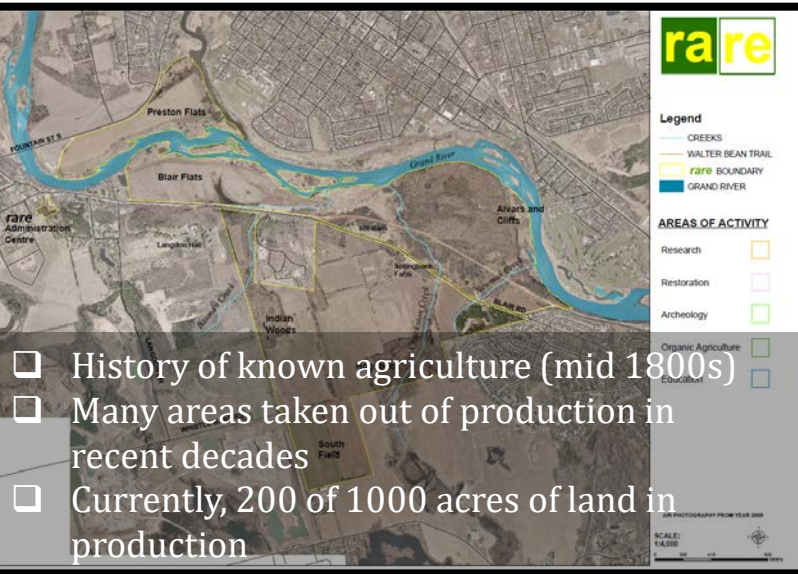
Link to Pillar 3 Projects



Biogeochemical processes and nutrient modeling in watershed-lake continuum models of the **GWF Lake Futures**.

Key hydro-climatic drivers to improve current/future agricultural water sustainability of the **GWF Agricultural Water Futures**.

Nutrient fluxes of frozen and unfrozen prairie agricultural soils to prairie lakes of the **GWF Prairie Water**.



Tributaries of the **Grand River** (in Grand River Watershed), largest watershed in Southern Ontario; contributes the majority of external nutrient loads to the **Lake Erie**

In Year 3 and Phase II (Years 4-7), the team will acquire soils from the field sites of the **GWF Northern Water Futures, Mountain Water Futures** and **Sibbald Research Wetlands**

Characterization of near 0°C winter precipitation scenarios of **Pillar 3 GWF Climate-Related Precipitation Extremes** project.

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