Environment and Climate Change Canada | Environnement et Changement climatique Canada

Theme 3 (Modelling) update

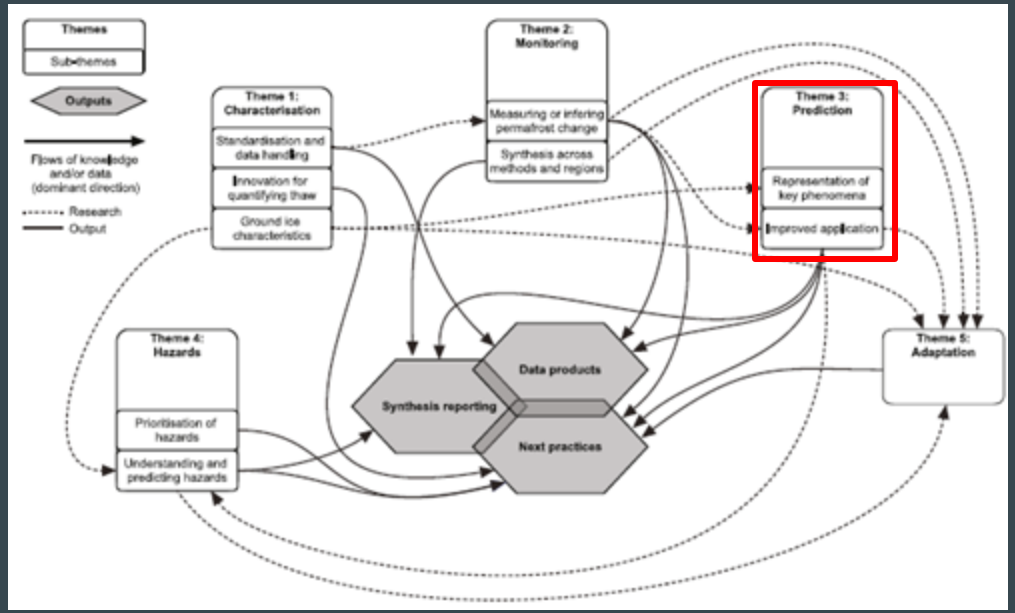
PermafrostNet AGM
Dec 2024

Environment and Climate Change Canada's 50th anniversary
50e anniversaire d'Environnement et Changement climatique Canada
Meteorological Service of Canada's 150th anniversary
150e anniversaire du Service météorologique du Canada

Canada

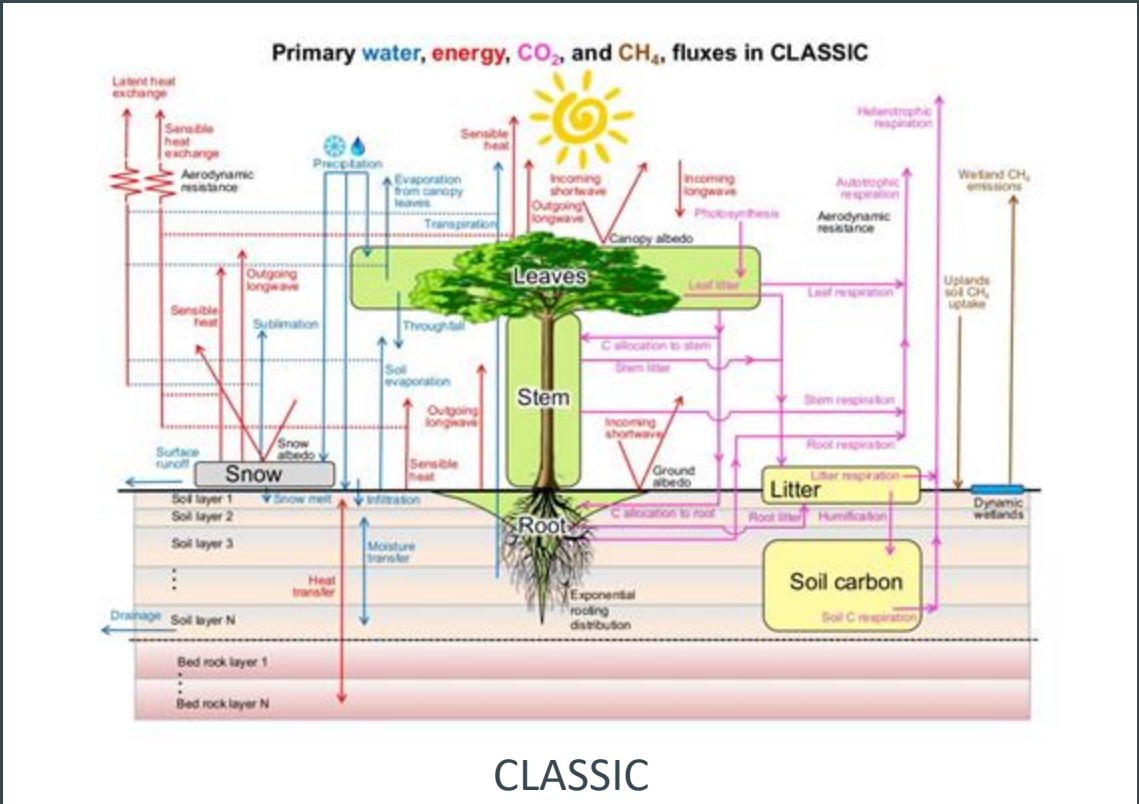
Theme 3's role in the network

Objective: Improve the accuracy and delivery of transient permafrost simulation so that its results can support stakeholder needs at local and national scales.



Theme 3's tools

FreezeThaw1DExIce



CLASSIC

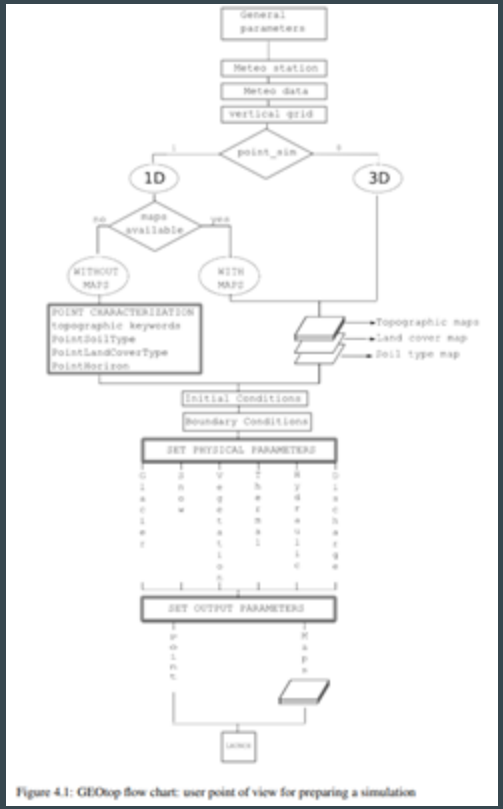
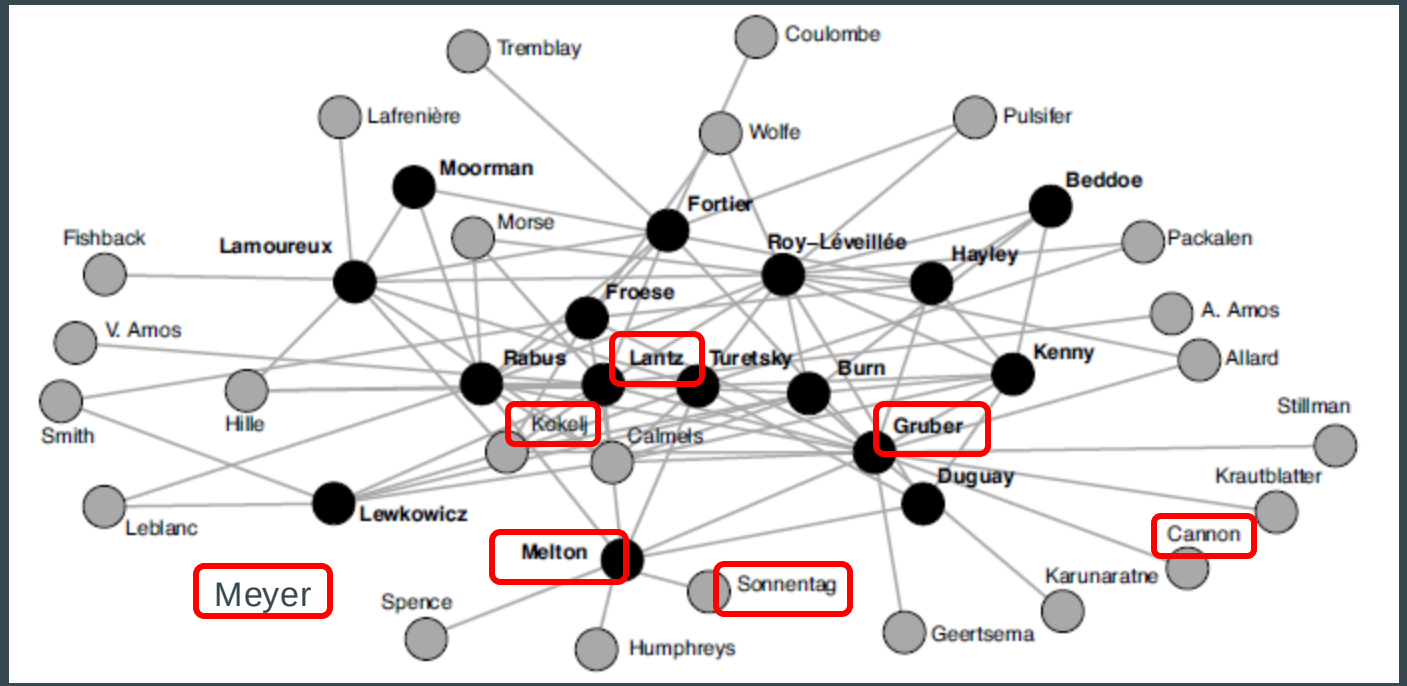


Figure 4.1: GEOtop flow chart: user point of view for preparing a simulation

GEOtop

Who is connected to the theme at present?

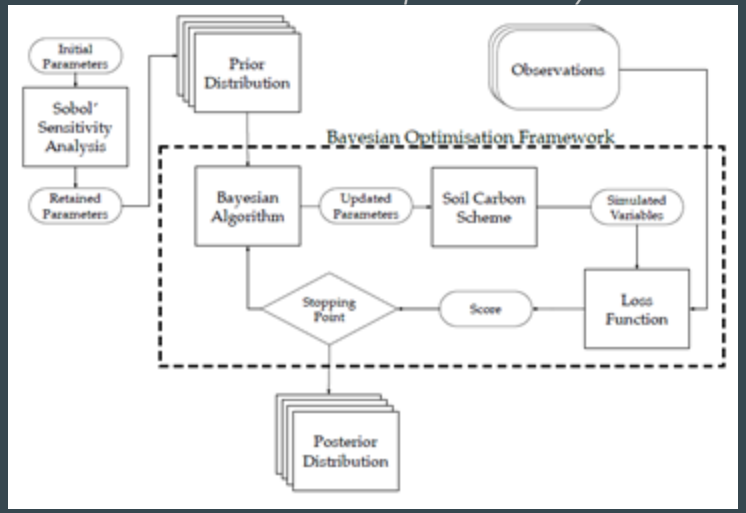


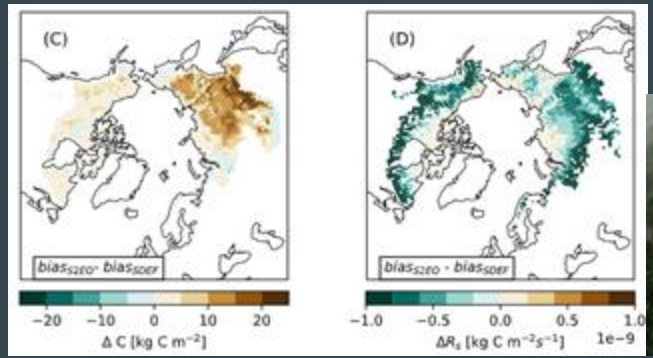
Present status: Completed projects

Charles Gauthier, MSc (with J. Melton and O. Sonnentag)

- Where: Global
- Methods:
  - Performed parameter sensitivity analysis for soil carbon scheme of CLASSIC terrestrial biosphere model
  - Most sensitive parameters were optimized in Bayesian framework against observations
    - soil C and respiratory fluxes
  - Optimal parameters used in global simulations of present day and future conditions and compared to CLASSIC default values
- More accurate soil C simulation and response to future climate change
    - Important differences: SSP-370 now sees a net loss in soil C, default model gave increase

Thesis:
Optimisation des paramètres de carbone de sol dans le modèle CLASSIC à l'aide d'optimisation bayésienne





Present status: Projects underway/recently finished

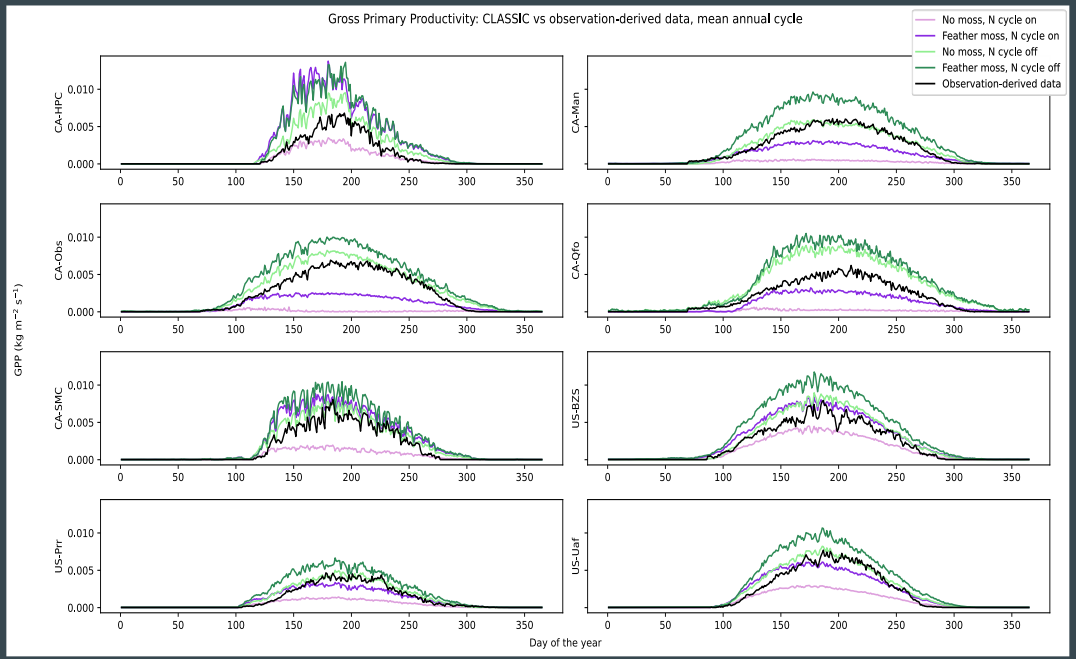
- Hannah Macdonell (MSc with S. Gruber)
  - Development and demonstration of a statistical ranking framework for ground temperature simulations, tailored towards permafrost environments

- Galina Jonat (PhD with S. Gruber)
  - Simulation-based climate services for permafrost environments

- Rose Lefebvre (MSc with O. Sonnentag and J. Melton)
  - Influence of feather mosses on soil physical characteristics and biogeochemistry in CLASSIC
  - **See poster (AGU 2024)**

- Muhammad Umair (postdoc with O. Sonnentag and J. Melton)
  - Implementation of plant hydraulics in CLASSIC
  - **See poster (Arctic Change 2024)**

Present status: Rose Lefevbre



Explicit N representation: the fertilizing effect of feather moss biological N fixation needs to be represented to adequately simulate total gross primary productivity.

Influence of feather mosses on soil physical characteristics and biogeochemistry

1 Feather mosses were implemented in the nitrogen (N) cycle of CLASSIC (terrestrial biosphere model developed at ECCC)

2 Study sites: Eight black spruce-dominated forest stands across the North American boreal forest

Present status: Muhammad Umair

Plant hydraulics in CLASSIC

1- Stomatal optimization based on xylem hydraulics (SOX, $CLASSIC_{SOX}$) explicitly connects the soil, plant, and atmosphere continuum compared to the empirical soil moisture stress function used in the default version of CLASSIC.

2- $CLASSIC_{SOX}$ uses plant hydraulic traits to allow/limit the photosynthesis in wet/dry conditions.

3- The number of parameters in $CLASSIC_{SOX}$ is less than in CLASSIC, making $CLASSIC_{SOX}$ a parameter parsimonious approach.

4- $CLASSIC_{SOX}$ was evaluated at eight boreal-forest flux tower sites using a simple numerical optimization approach (in revision; JAMES).

5- After implementing an advanced numerical optimization algorithm (Newton-Raphson), $CLASSIC_{SOX}$ is currently run at regional scale the Canadian boreal forest.

Benefit to the research project of being part of a network

- Access to expertise: e.g., CLASSIC in a permafrost context
- Opportunities for Collaboration: e.g., Melton & Sonnentag
- Resources: e.g., AGMs, Tristan (!), etc.
- Increased Visibility: e.g., AGU, EGU, CGU
- Funding Opportunities: e.g., student and postdoc stipends
- Networking and Career Development: e.g., Ouranos
- Broader Impact: e.g., sharing results beyond the scientific literature, e.g., Nordforsk/NFRF