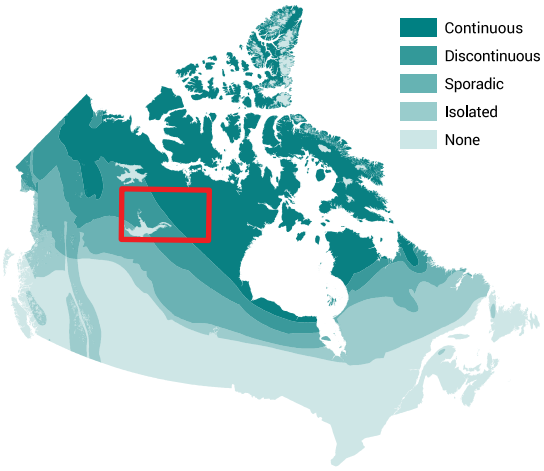
# Guiding model selection for effective adaptation decision making: A statistical ranking framework

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Study locations: Northwest Territories.

**Keywords:** Permafrost modelling, ground-surface temperature, model evaluation.

**This project produced a method for judging how well permafrost models perform. This is important because many decisions and research projects rely on results of computer simulations. The standardized interpretation and comparison of model performance in permafrost regions improves the development and application of models.**

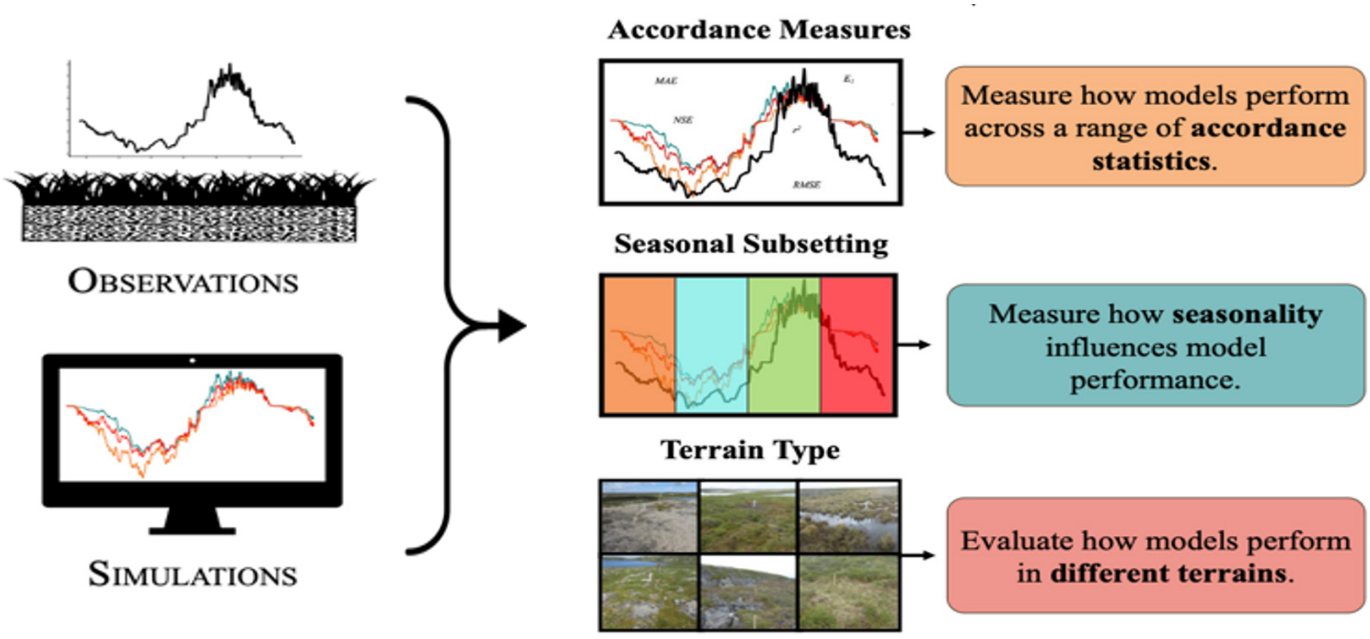


**Figure 1.** Steps of simulation analysis used to produce rank distributions of simulations.

## Research summary

This research introduces a statistical tool called Accomatic to assess and compare different simulations of ground temperature in permafrost regions. The framework tackles five main challenges in evaluating simulations: limited coverage of observations, differences between observed and simulated variables, disagreement on evaluation metrics, unclear statistical values, and incomplete observational datasets.

To overcome limited spatial coverage, we evaluate the performance of our model separately for different types of terrain to minimize the effect of bias in observations. Additionally, we analyze how well the model performs for different variables of interest at the surface and deeper in the ground. To assess model agreement, we use three measures: bias, mean absolute error, and the correlation coefficient. To account for incomplete data, we divide the time series data into month-long blocks and evaluate performance on random samples using a bootstrap procedure. Finally, we rank the models to facilitate comparison between statistics and to present clear results.

Model performance often varies with season and type of terrain. Exposing this variation helps identify areas for model improvement and can guide us in using simulation results with appropriate confidence.

## Taking action

Accomatic can be used to evaluate models that output any kind of timeseries data. By using this standardized ranking procedure, we can assess the strengths and weaknesses of different models more reliably and make more informed decisions.

## Connections to other projects

This project is part of Theme 3 — *Prediction of permafrost change*. The project aligns with Theme 3 modelling projects, by improving the ability to analyze simulation performance.

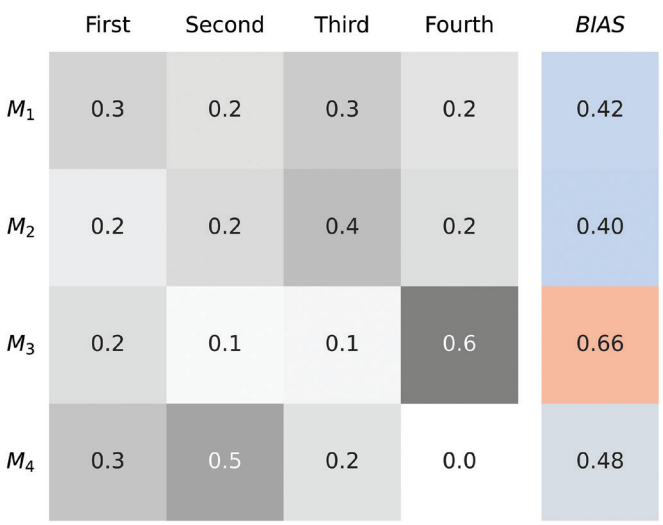


**Figure 2.** Final 'APEX' result that shows how clearly a best model can be identified given the observations available. Grey boxes indicate the proportion of instances each model ranked first, second, third, and fourth. Boxes in red and blue show the proportion of instances with warm or cold bias, respectively.

## Partners, team members and support

The project received technical support from Nick Brown and Bin Cao and advice from Joe Melton (ECCC). We used GTPEM developed with help from Carleton Research Computing Services.

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## References

Macdonell, H.G., (2025). *A statistical ranking framework for ground temperature simulations in permafrost environments*. MSc thesis, Carleton University. Available at: https://doi.org/10.22215/etd/2025-16379

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