Permafrost in rock walls of western Canada

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Introduction

Rising air temperatures cause the rock and ice filling its cracks and crevices to warm, **rendering some rock walls unstable**. When they fail, thousands or millions of cubic metres of rock can slide down the mountain, posing a risk to infrastructure, wildlife habitats and human life.

To assess the potential **hazard of rock falls** in an area, we need to know where permafrost exists and how it is changing, something that is unknown for the greater part of the mountainous regions of western Canada.

The presence of permafrost depends on topography and climate which dictate the amount of solar radiation received. This relationship between permafrost and its environment is normally evaluated with **rock temperature measurements**.

Due to difficult access and high expense, there are few such observations in rock walls of permafrost environements of western Canada, making it challenging to detect patterns in this highly variable environment.

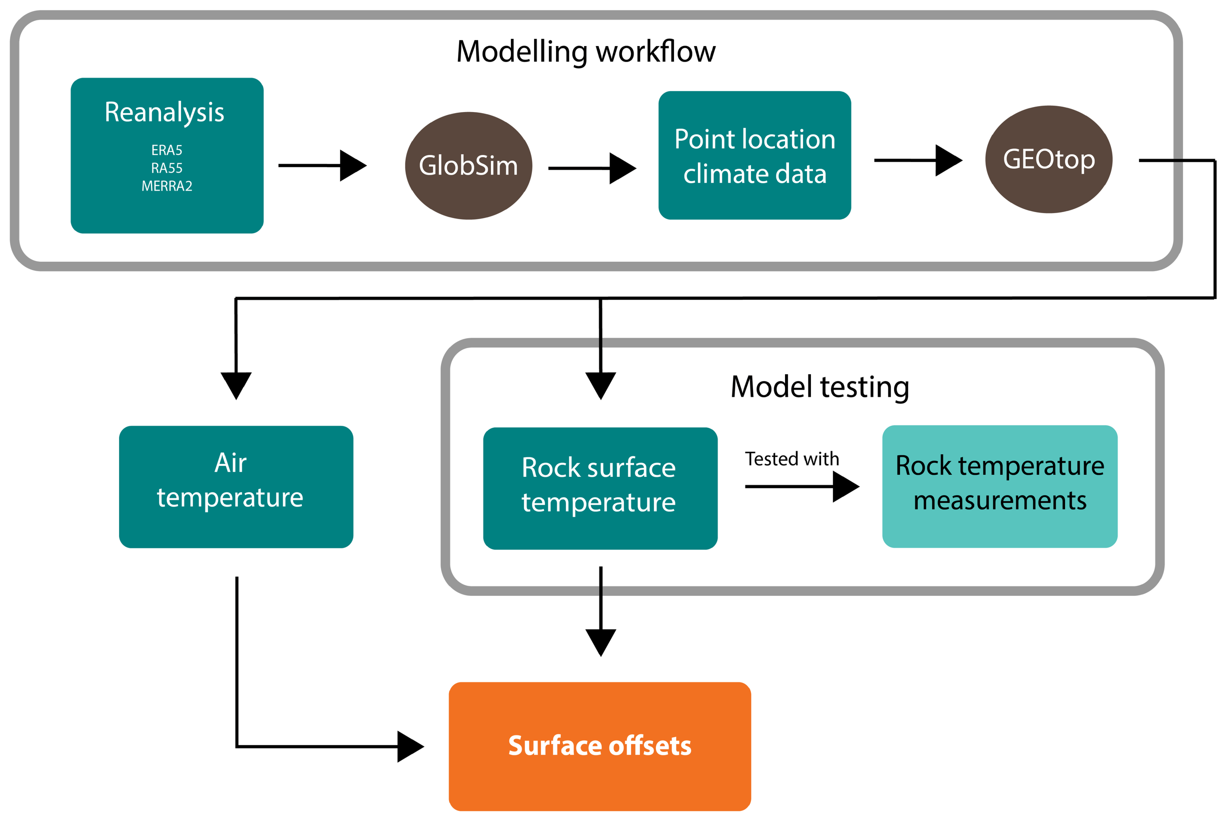
This study makes use of **modelling,** as it allows us to surpass these difficulties by extrapolating observations to a larger spatial and temporal context.

Methods

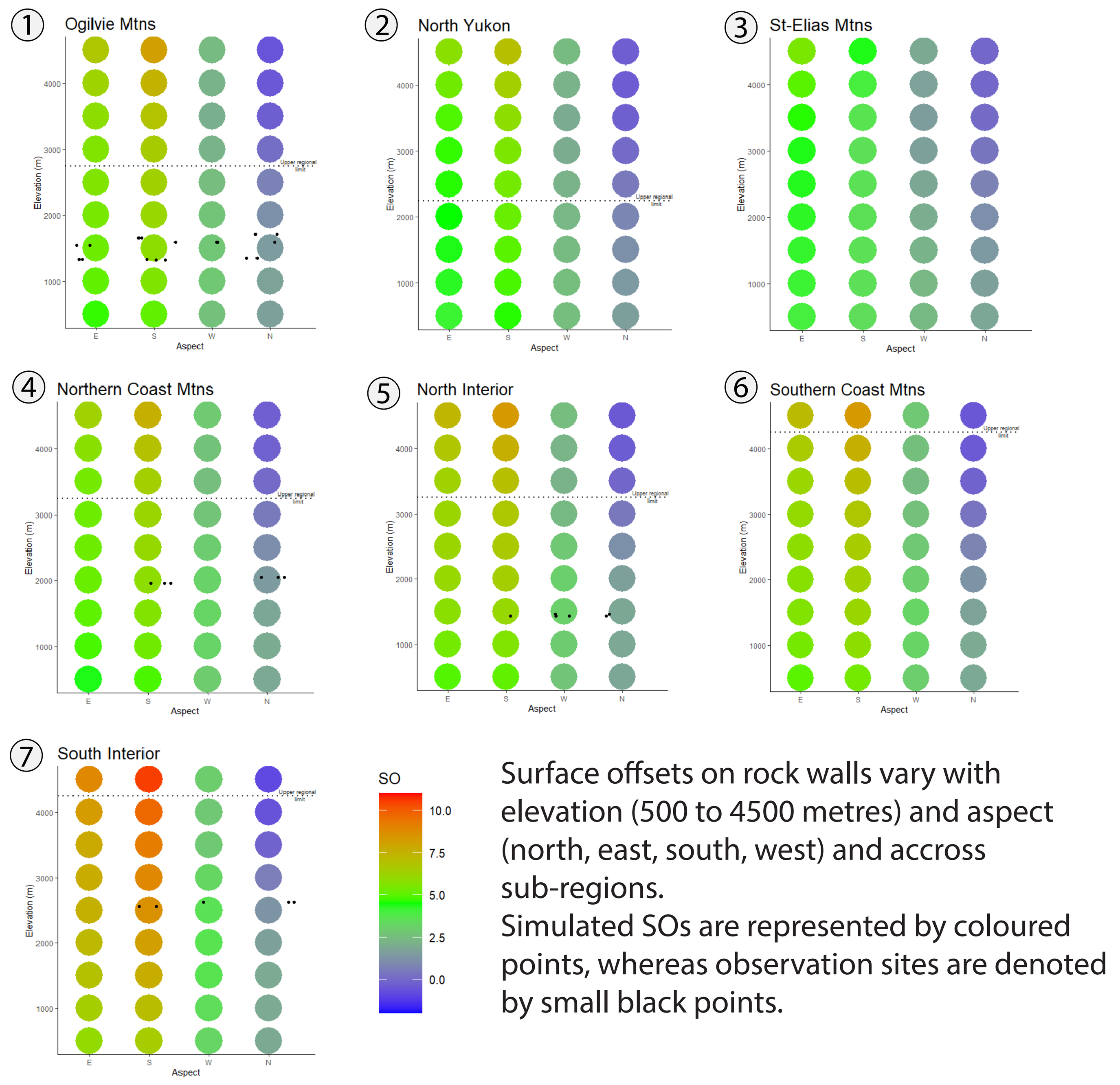
Model simulations are run to investigate the effects of topography on SOs in areas with different latitudes and continentality within permafrost regions of western Canada.

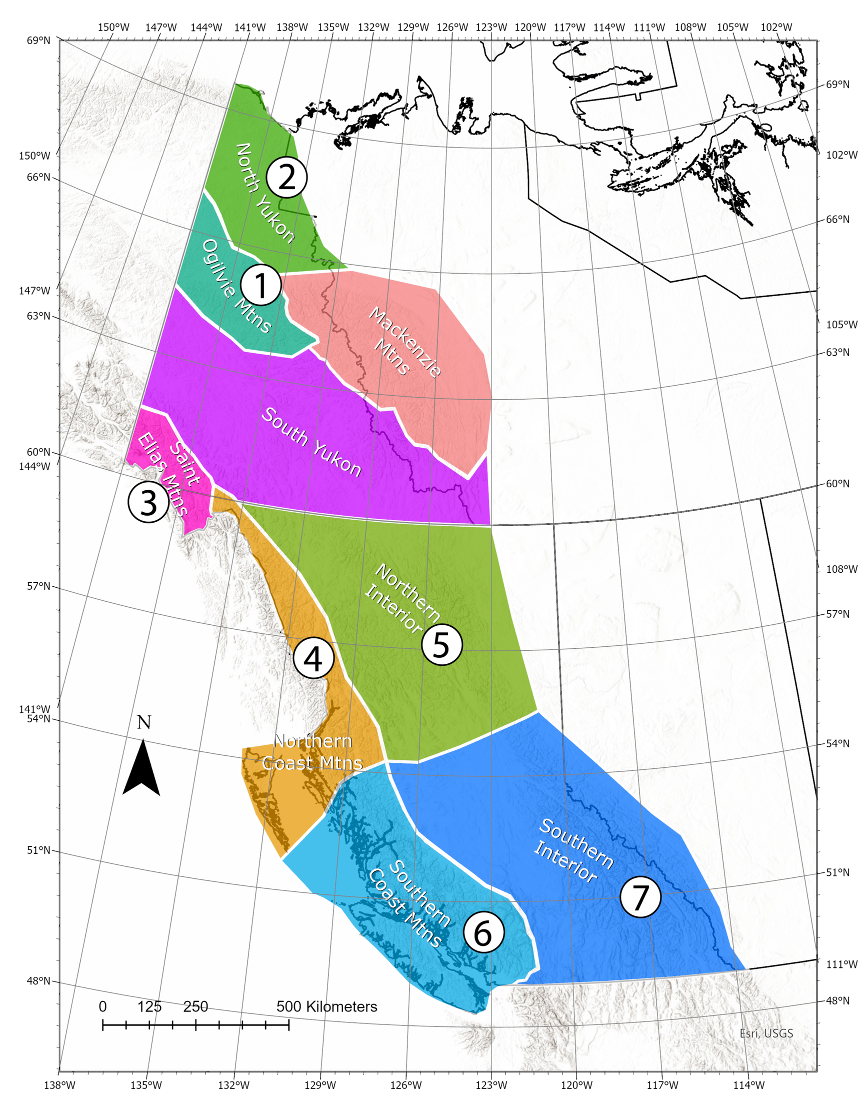
The study area is subdivided into **9 sub-regions** based on topo-climatic conditions (see map). Surface offsets are simulated at a point within each sub-region.

Climate reanalysis data is downscaled to point location using the software Globsim. Rock surface temperatures are modelled using the physically-based model GEOtop, forced with the reanalysis data.

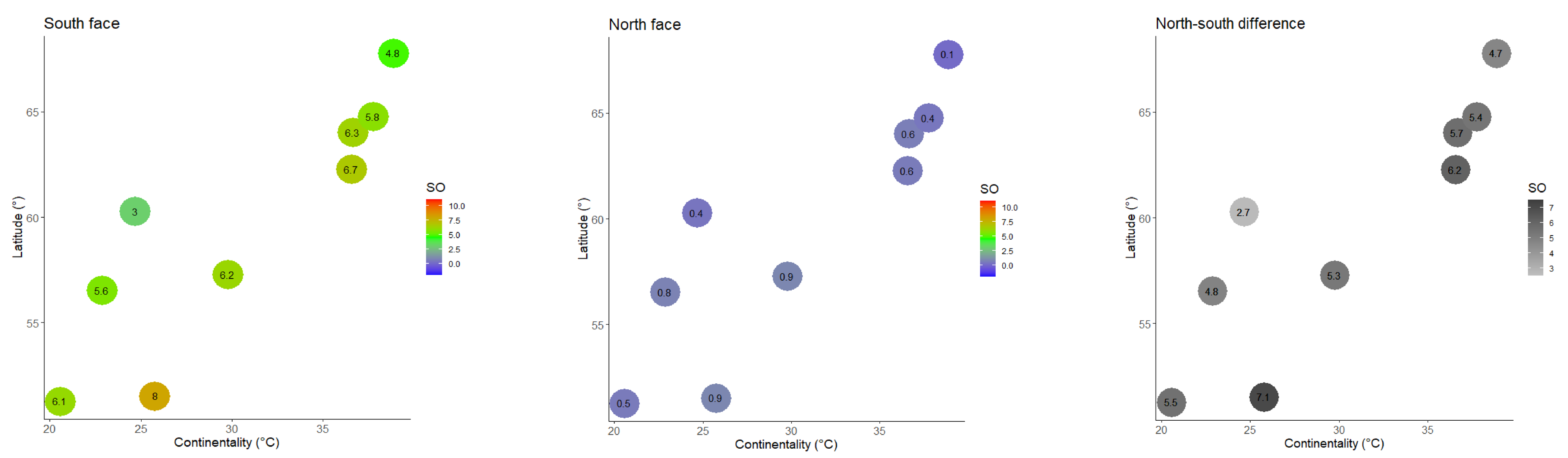


Results





Surface offsets on rock walls vary with elevation (500 to 4500 metres) and aspect (north, east, south, west) and accross sub-regions.
Simulated SOs are represented by coloured points, whereas observation sites are denoted by small black points.



The SOs at 2000 metres elevation for the 9 modelling sites, plotted against latitude and contineentality. Left is the SOs for a south face, middle is SOs for a north face, and right is the difference in SO between a north and south face. Overall latitude and continentality trends are not obvious, but trends within similar latitudes and continentalities are.

Conclusions

1. Surface offsets increase with elevation on south faces and decrease on north faces.
2. Surface offsets on east faces are greater than those on west faces
3. Higher surface offsets are found at lower latitudes and higher continentality.
4. Greater temperature differences between north and south facing rock faces are found at lower latitudes and higher continentality.

Definitions

Surface offsets (SO): The difference between the mean annual air temperature and the mean annual ground surface temperature.

Continentality: Increases with distance from the ocean or large bodies of water. Here it is expressed as the annual amplitude in air temperature.

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