Modeling characteristic surface elevation changes reveals dominant process control

Donglai Yang, Kristin Poinar, Sophie Nowicki

Department of Geology, University at Buffalo, NY

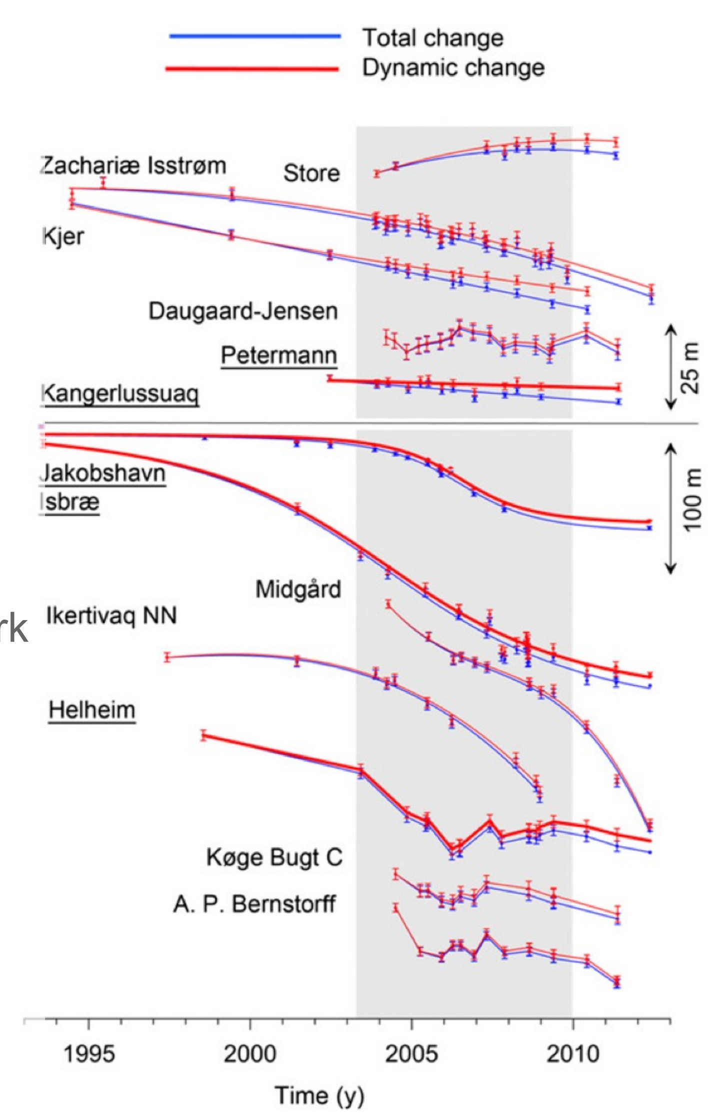
Introduction

Laser altimetry time series revealed complex ice thinning and thickening patterns (Csatho et al., 2014, figure below) characteristic of controls by local fjord geometry and physical processes.

Q: What geometries and processes are dominant in regulating surface elevation changes?

Objectives

We use synthetic glacier testbeds to numerically simulate the glacier surface elevation time series $h(t)$, with various geometries and forcing parameterizations. Using synthetic testbeds scales the detailed modeling work up to "glacier type", with which we aim to lessen future need to painstakingly carry out studies on individual glaciers.

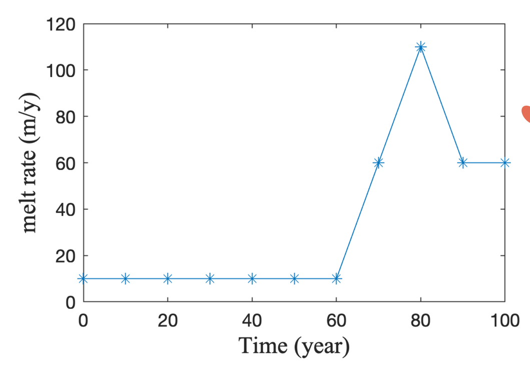


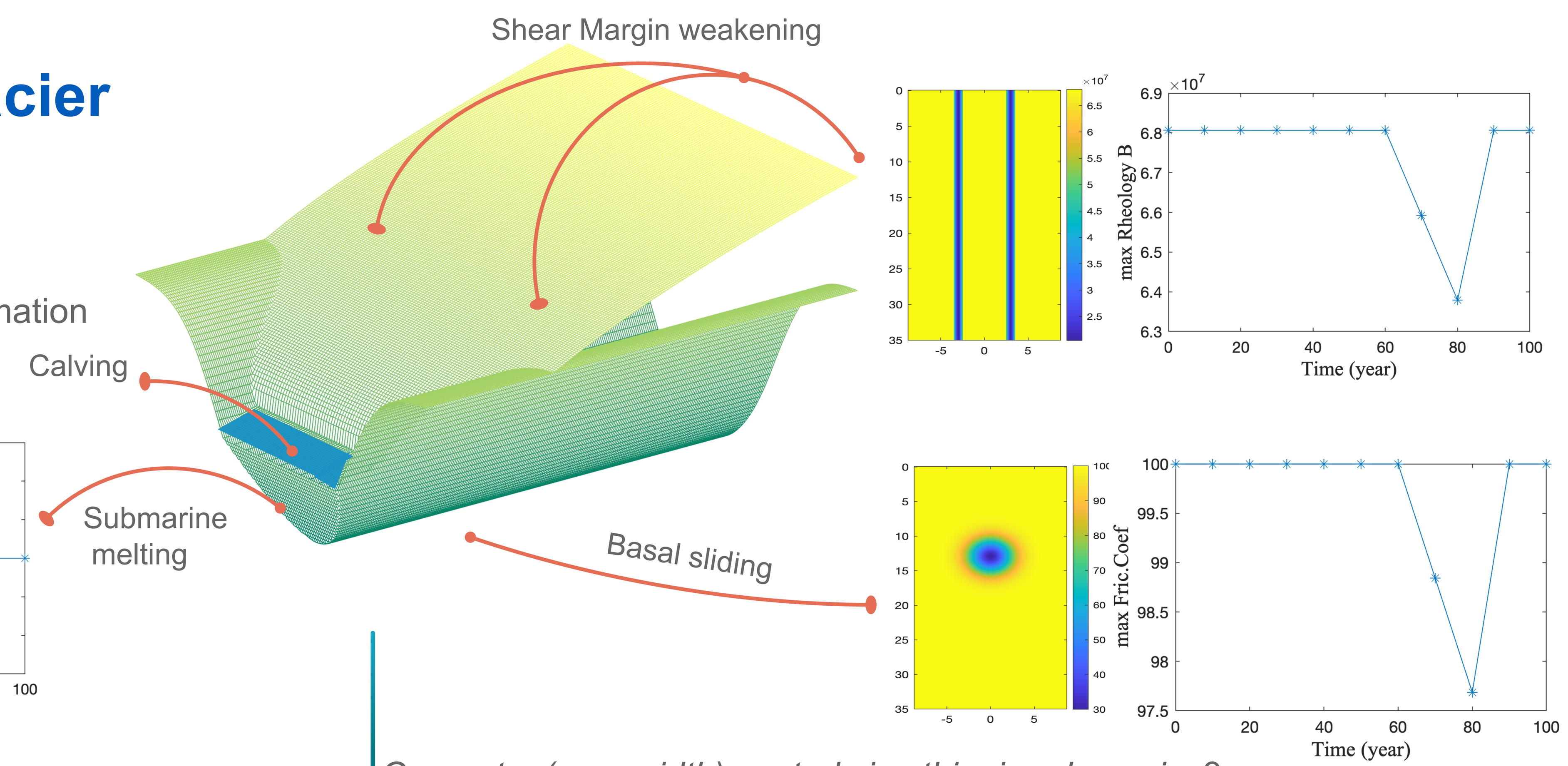
With each testbed, we wish to:

- Quantify the relative contribution of each forcing to $h(t)$
- Provide qualitative and potentially quantitative comparisons between simulated and observed $h(t)$
- Provide rudimentary insights in inferring local physical process from $h(t)$

Synthetic glacier modeling

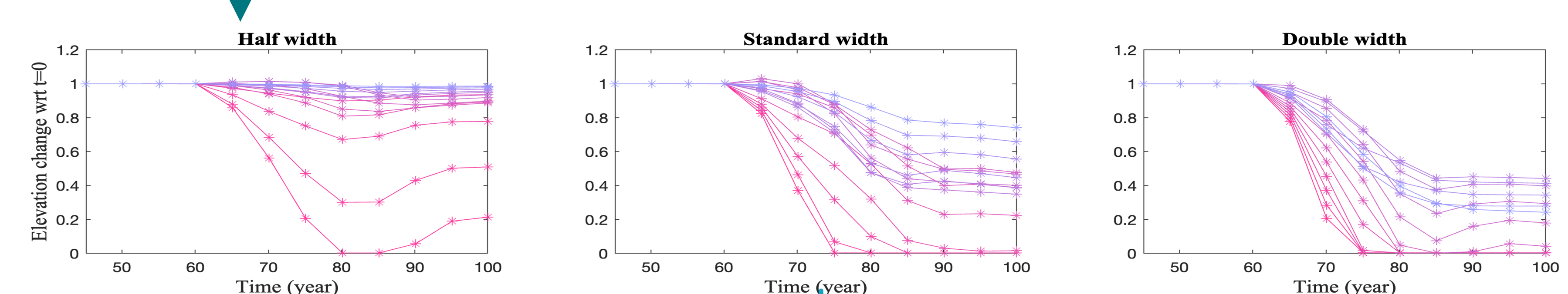
Model formulation:
Shelfy-Stream Approximation (SSA) in ISSM



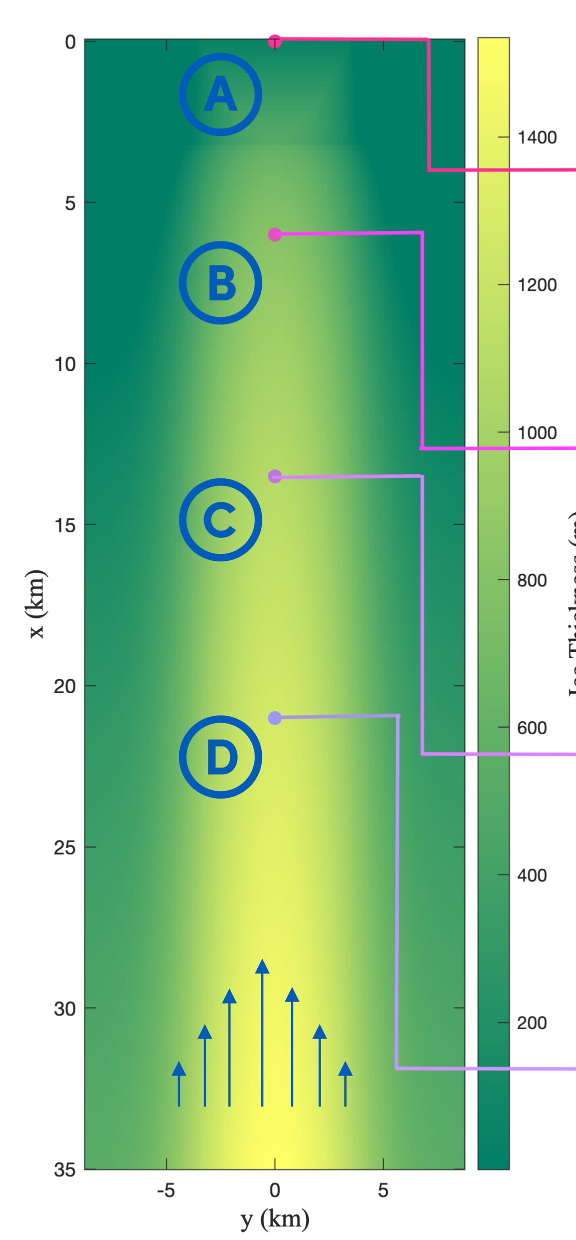


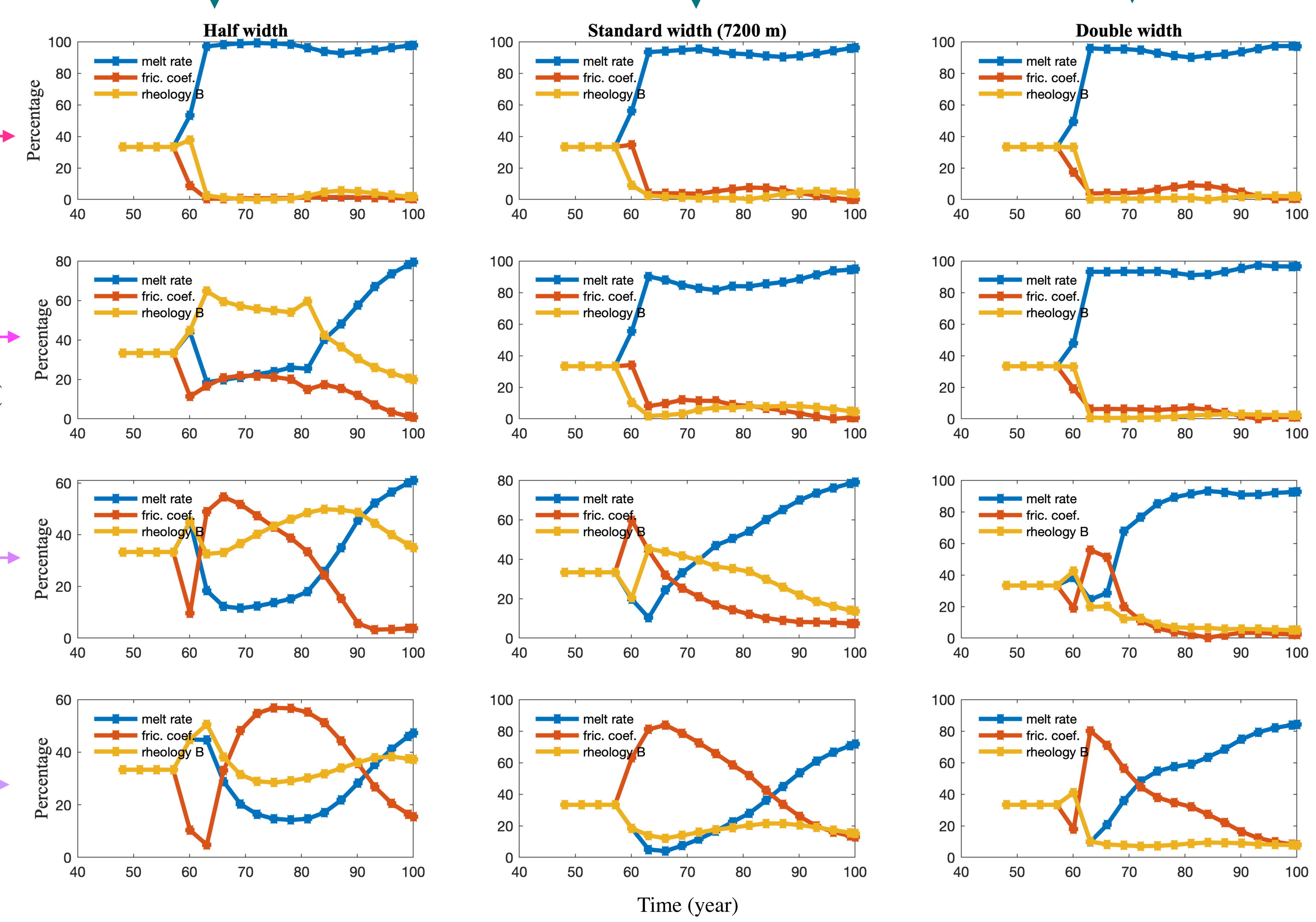
Parameterization
Basal sliding:
$v_b \propto N^{-q}\tau_b^p$
Calving:
Von Mises tensile stress
Shear margin:
Ice rigidity B ($\mu \propto B$)
Submarine melting:
Spatially uniform melt rate

Geometry (e.g., width) controls ice thinning dynamics?

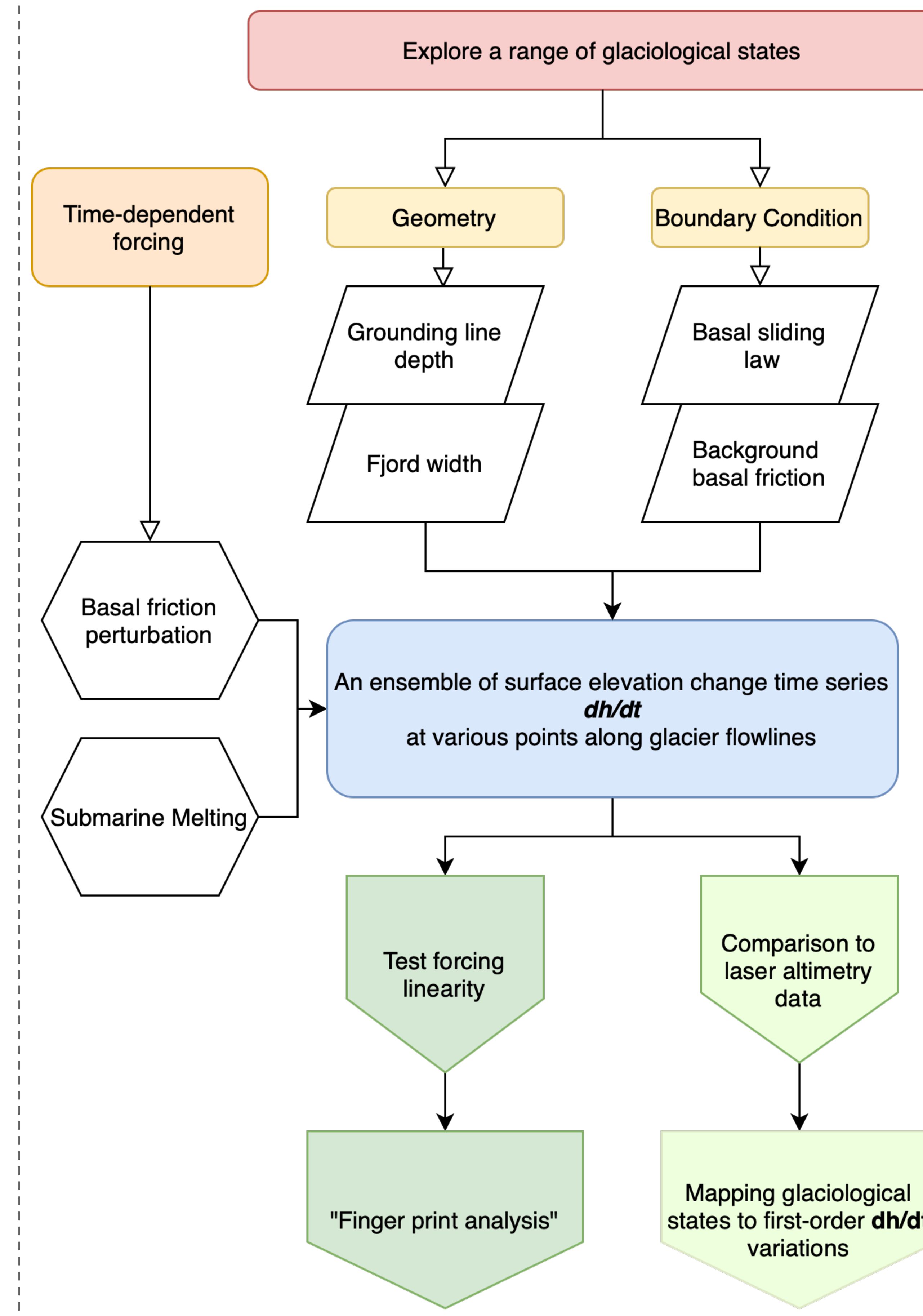


Relative contribution from each forcing?





Future directions



Land Acknowledgement

Glacier Modeling Lab at University at Buffalo resides on the land of the Seneca, a matrilineal Native society that has lived in western NY for at least 5000 years. The Seneca are a part of Haudenosaunee confederation.

References

1. Csatho et al., 2014. Laser altimetry reveals complex pattern of Greenland Ice Sheet dynamics. PNAS, 111 (52) 18478-18483

Email: donglaiy@buffalo.edu