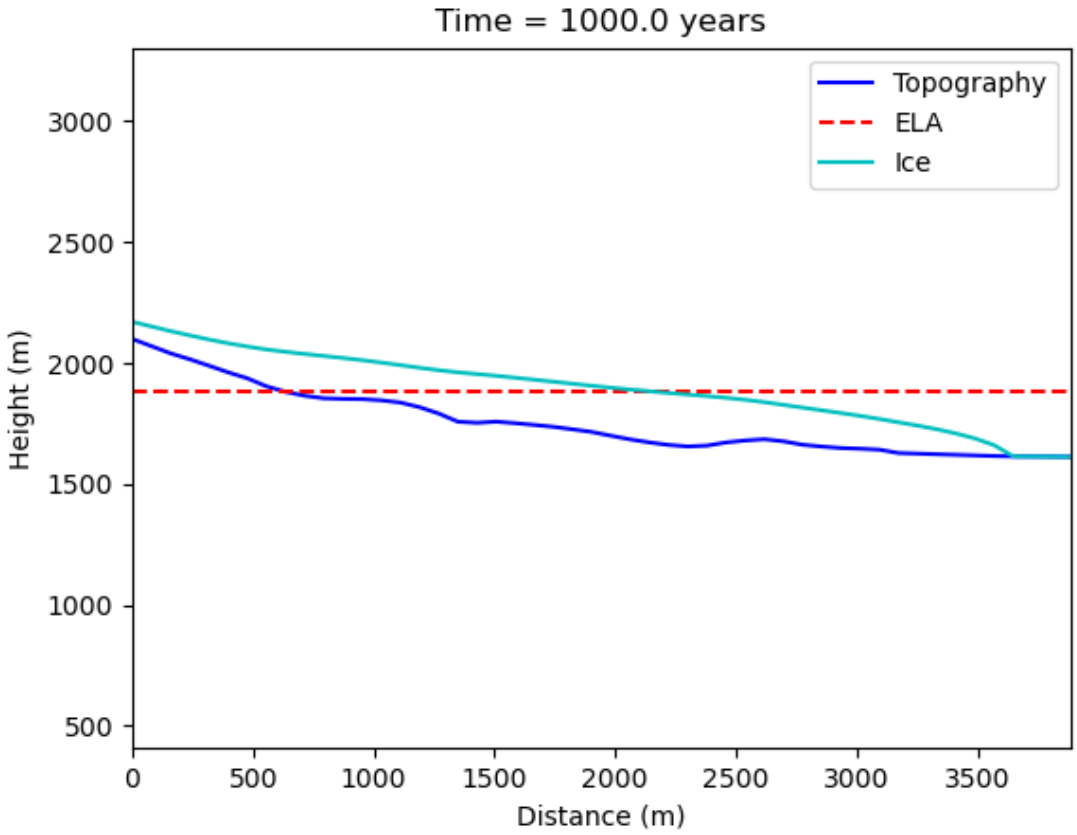
# Fall 2024 Semester Progress Report

This semester I made considerable progress both on running the ISSM model and my own Shallow Ice Approximation (SIA) model. I have managed to get the ISSM model to run with the Shallow Shelf Approximation equations and solve for stress balance. For my own SIA model, I have implemented the ice dynamics equations, confirmed the ice mass is being conserved and I have also created a bed topography for the model using data from Robert Jacobel.

The ISSM model has been quite tricky to work on. I first had to get data on the surface elevation which was quite easy to do using a DEM from the USGS which was used to create the model mesh. Then I needed velocity data which was also easily available from the USGS. Things started to get complicated when I needed to calculate a bed topography. I first tried to use the shear stress equation $\tau = pgH\sin(\alpha)$ with an estimated shear stress of 100 kPa to solve for the thickness and subtract that from the surface to get a bed topography. Unfortunately, this caused a whole bunch of issues with the model initialization. “I tried to fix it, but it consumed a great deal of time without yielding progress, so I reached out to Robert Jacobel to see if he had any bed topography data which he did. This data was a collection of points which I was able to interpolate across the glacier area using ArcGIS Pro’s Kriging interpolation function to obtain a bed topography I could feed into the model. The rest of the work I did was related to debugging the errors from the model and trying to figure out what input variables needed to be set to what so that it could run. Once I get it running, I will focus on inputting the correct mass balance and initial ice thickness to spin it up to the glacier it is today.

Since Thanksgiving Break, I have been focused on my SIA model. I started with some old code I had from a previous project which I was able to easily implement my ice flux equation. For now, it does not take glacier width into account because I am still working on getting that data and putting it in a usable format for the model. I used the aforementioned bed topography data to create a series of points that my model uses to calculate a bed topography line. I then use the equation mass balance= (ice elevation-

equilibrium line altitude) *gamma to spin up the glacier to its 1958 extent by tunning the gamma parameter. An image of the spun-up glacier is provided below.




SIA model output after a 1000-year spin-up with gamma=0.0038 and a max ice thickness of 214.3 meters

I verified that ice mass is conserved by creating an initial ice thickness using the equation $ice\ thickness(x) = 300 \cdot \exp\left(-\frac{1}{2}\left(\frac{x-700}{300}\right)^2\right)$ and running the model for 1000 years with a mass balance of 0. I calculated the area of the glacier using the equation $sum\big(x \cdot ice\ thickness(x)\big)$ and verifying that it was the same across the 1000-year model run time.

There is much still left to be done on this project. By the end of January, I plan to implement the glacier's width into the ice flux equations and the overall model. I also plan to implement a mass balance model using data from USGS publications to model the ablation and accumulation of ice and snow on the glacier as well as the snowmelt in the

rest of the basin. I plan to resume working on the ISSM model in February after I have made more progress on the SIA model. By March I hope to be starting on an outline of my thesis and verifying results from both models.