Anastasia Horne
DSCI 403

Overview

I will be using BedMachine version 3 (Antarctica), a dataset from NASA MEaSUREs program, which looks at properties of glaciers. The data set provides a bed topography map of Antarctica along with firn air content (the compacted snow above a glacier), glacier/ice sheet thickness and ice surface elevation. I am currently doing research in the Mines Glaciology Laboratory, so I was hoping to work with a dataset that relates to my research that I haven't worked with before. I have attached a Documentation PDF for the dataset that gives all relevant information. This is an ambitious project as I am not sure what 'results' I can get from this dataset, however there are some questions I would like to address. A possible question I would like to answer is what does a flow accumulation map[1] of a specific region in Antarctica look like, and what features (beside elevation) contribute most to possible areas of high and low flow. Another loftier goal, would be to take a list of confirmed subglacial lakes (body of water under a glacier), and a list of non-lakes, and use a machine learning model to predict whether something is a lake or not based on the flow accumulation[2].

Related Work

I was unable to find any research using BedMachine and pysheds together, but there has been research into subglacial lakes. In a 2022 research paper that discusses subglacial lakes and their role in climate change, the researchers use one of the largest inventories of confirmed subglacial lakes and examines the crucial role the lakes play in providing climate history, supporting life, and influencing ice flow dynamics (Livingstone et al.). This research looks at subglacial lakes, but does not actively look into how we can better identify them, which is what I hope to do.

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[1] To find the flow accumulation, which is the area draining through a grid point, I will have to use an open-source python library, pysheds.

[2] Lakes can drain and fill, so it is possible a subglacial lake would fill and empty in a similar path as the surface flow accumulation.

Most of the research using BedMachine tries to create a better model for bed topography under specific glaciers. In a 2017 paper researchers used BedMachine data of Greenland to create a high-resolution bed topography map using ice thickness and bathymetry. From their bed topography, they were able to determine the sea level potential of the Greenland ice sheet, which provides future insights about the effect of global warming on sea level (Morlighem et al.). This research uses the BedMachine data of Greenland to create better bed topography maps, while my research will look at Antarctica and how the bed topography and accompanying parameters will influence the flow accumulation and the presence of subglacial lakes.

The research that relates most to the one I suggest is currently being conducted by PhD student Wilson Sauthoff at Colorado School of Mines, who is my research advisor in the Mines Glaciology Laboratory. The current phase of research he is on focuses on developing a machine learning model (and eventually a Bayesian inference network), that provides a comprehensive and highly accurate program to determine if an area contains a subglacial lake (Sauthoff). The research has involved flow accumulation maps (without pyshed), but only for visual purposes, and has yet to be explored further, or used in a machine learning model, which allows me to perform unique research.

References:

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Morlighem, M., Williams, C. N., Rignot, E., An, L., Arndt, J. E., Bamber, J. L., ... Zinglersen, K. B. (2017). BedMachine v3: Complete bed topography and ocean bathymetry mapping of Greenland from multibeam echo sounding combined with mass conservation. Geophysical Research Letters, 44, 11,051–11,061. https://doi.org/10.1002/2017GL074954

Sauthoff, Wilson. "Multi-mission altimetry of variable Antarctic active subglacial lake geometries and causal inference networks to inform geostatistics-based subglacial water modeling". 2022.