Assessing the accuracy of Empirical Bayesian Kriging on glacier thickness in northern Canada

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Introduction

- Empirical bayesian kriging (EBK) can be used to fill in spatial gaps between collected data points, a process known as interpolation
- EBK has been used previously to estimate ice thickness of ice caps in China (Kutuzov et al. 2018; Liang and Tian 2022), as well as to interpolate thickness of sediment (Smith et al. 2022)
- Accurate estimates of glacial thickness from a subset of data points is crucial in monitoring the status of glaciers in the face of climate change
- Thus, our objective was to determine the accuracy of EBK so as to inform the recommendation of its usage as an interpolation tool for glacial thickness

Methods

- Point data on ice thickness was from Glacier Thickness Database (2020)
- Comparative model from Millan et al. (2022) generated through thickness inversion modeling from velocity observations from satellites
- Ice thickness data was checked for normality, semivariogram fit, and spatial trends, then the Empirical Bayesian Kriging tool in ArcGIS Pro was used for interpolation and generation of the models

Results

- The EBK tool used the cross validation method to evaluate the fit of our model, and showed an average standard error of 92.19 m; our model had a continuous ranked probability of 24.92 rather than 0, indicating inaccuracy
- Additionally, we can compare our model to the ice thickness model made by Millan et al. (2022). We can see that as an overall trend the EBK model makes more extreme predictions of really high or low values compared to the Millan et al. (2022) model. However, there are some areas that the comparative model agrees, such as Sydkap Ice Cap and Müller Ice Cap.
- It should also be taken into consideration that the EBK model performs relatively consistently regardless of proximity to data points.

Discussion/Conclusion

- EBK is not completely inaccurate, but may suffer from a lack of uniform data; thus, EBK should be used to generate initial estimates for thickness
- Future research needs to explore EBK on other glaciers, and compare with other models generated with different methods
- More uniform data is needed to aid in interpolation; less data-void space in between data points may lead to more accurate predictions
- Limitations - resolution could have been improved by changing cell size within tool parameters, data may have had outliers that were not removed, data from multiple time periods was not corrected leading to time differences in thickness, and data did not perfectly fit normal distribution

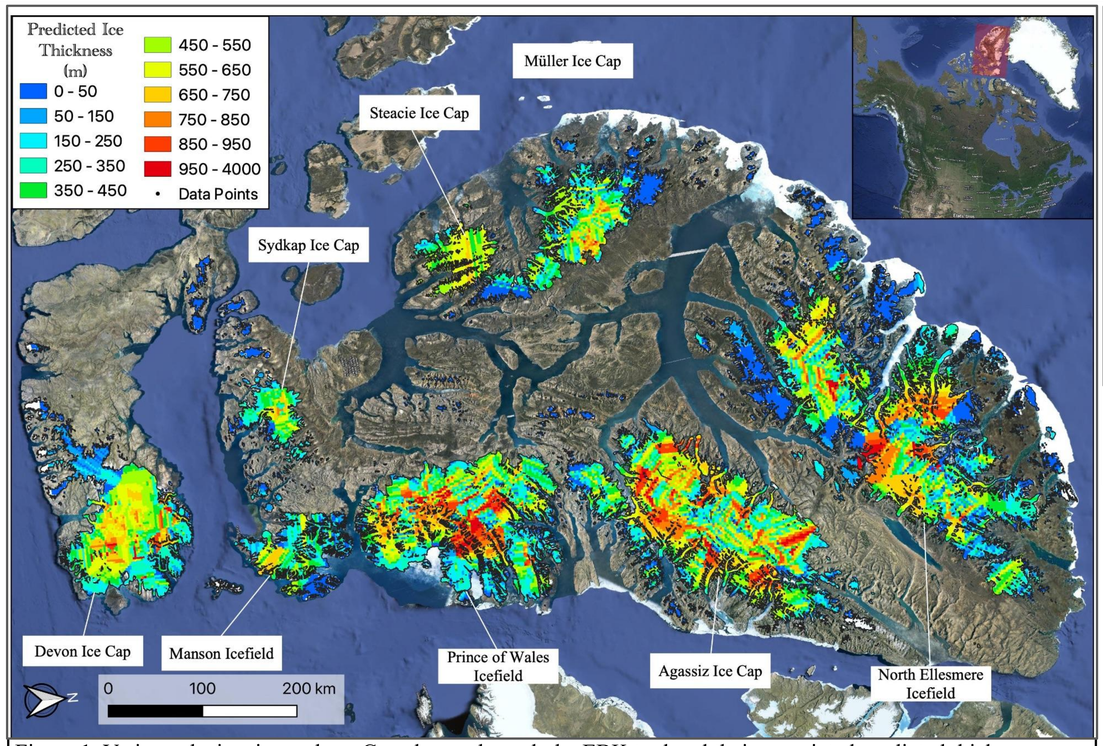

Figure 1. Various glaciers in northern Canada run through the EBK tool and their associated predicted thickness.

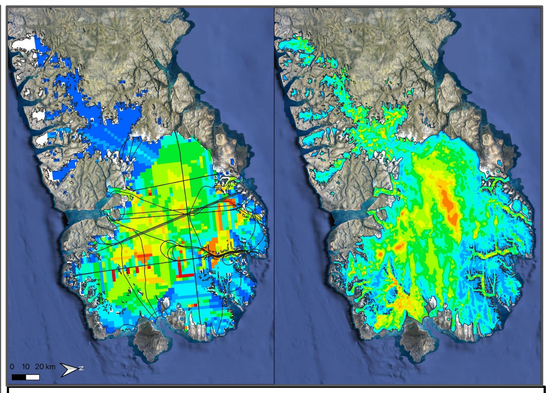

Figure 2. Devon ice cap; left is our thickness model, while right is comparative model from Millan et al. (2022).

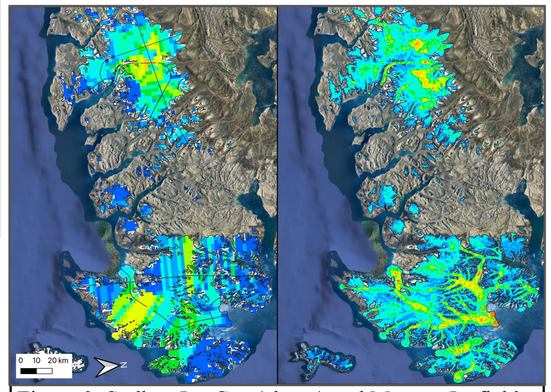

Figure 3. Sydkap Ice Cap (above) and Manson Icefield (below); left is our thickness model, while right is comparative model from Millan et al. (2022).

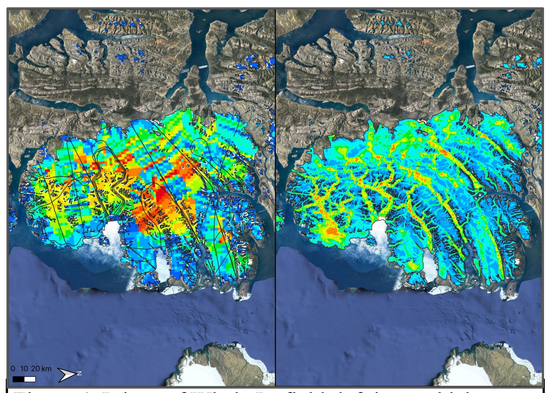

Figure 4. Prince of Whale Icefield; left is our thickness model, while right is comparative model from Millan et al. (2022).

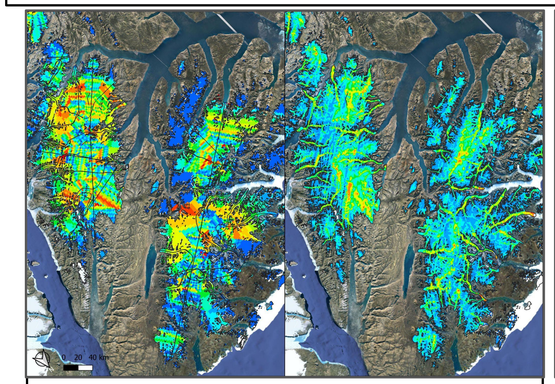

Figure 5. Agassiz Ice Cap and Northern Ellesmere Icefield; left is our thickness model, while right is comparative model from Millan et al. (2022).

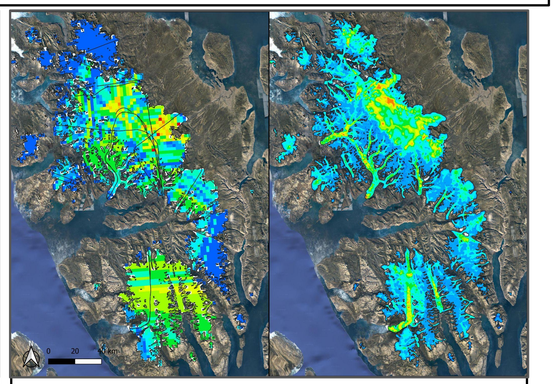

Figure 6. Müller Ice Cap (above) and Steacie Ice Cap (below); left is our thickness model, while right is comparative model from Millan et al. (2022).

References

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