

Investigating ANU and ICE-6G Ice Model Relative Sea Level Misfits to Determine Viscosity Constraints since the Last Glacial Maximum



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The following is an excerpt from a longer piece. For the full text and references, please visit https://scholar.colorado.edu/concern/undergraduate_honors_theses/z603qz79c, or scan the QR code.

Abstract

Glacial isostatic adjustment (GIA) incorporates glacial rebound and gravitational potential to calculate sea level rise. However, many ice models struggle to accurately represent these effects in relative sea level (RSL) predictions. Two widely used ice models that incorporate GIA effects, ANU (Lambeck et al., 2014, 2017) and ICE-6G (Peltier et al., 2015), require further analysis to gauge their validity.

In this thesis, we compare the model predictions of RSL of the ANU and ICE-6G models against six distinct RSL field datasets using a semi-analytic GIA model. To predict RSL, a GIA model requires an ice model and models of the Earth's mantle viscosity, density, and elastic structure. While mantle density and elastic structures are reliably constructed from seismology studies, mantle viscosity is not well constrained. We developed 864 simulated mantle viscosity models to run with the ANU and ICE-6G ice models to obtain the predicted RSL data. We analyzed the Root Mean Square (RMS) misfits of the simulated test RSL outputs against the observed RSL field data. We showed that RMS demonstrates error quality of field data is critically important to the GIA modeling process. We also showed the strengths and weaknesses of each ice model through further RMS analysis.

Lay Summary

Sea level change is not only a critical aspect of our climate's response, but also a novel gateway to understanding the structure of the Earth's mantle. This understanding is made possible by studying sea level changes over long timescales, such as since the Last Glacial Maximum. The Earth's crust responds to increased (or decreased) weight of ice on its surface by deforming (or rebounding) and reaching a new equilibrium state over thousands of years. The response time and altered geometry of the crust give information about mantle viscosity. Observations and calculations of sea level over time geospatially constrain historical ice models, creating an opportunity to determine the most appropriate viscosity. This research identified two widely used ice models (ANU and ICE-6G) to reconstruct present day sea level, combined with varying values for the Earth's upper and lower mantle. Findings were then compared with observations to identify minimum misfits—calculations that are closest to observation values. By understanding the factors that influence these discrepancies, the researchers hope to improve the accuracy of future models and predictions of sea level changes.