PAST AND FUTURE CHANGES OF SEA LEVEL ALONG THE EAST COAST OF THE UNITED STATES OF AMERICA

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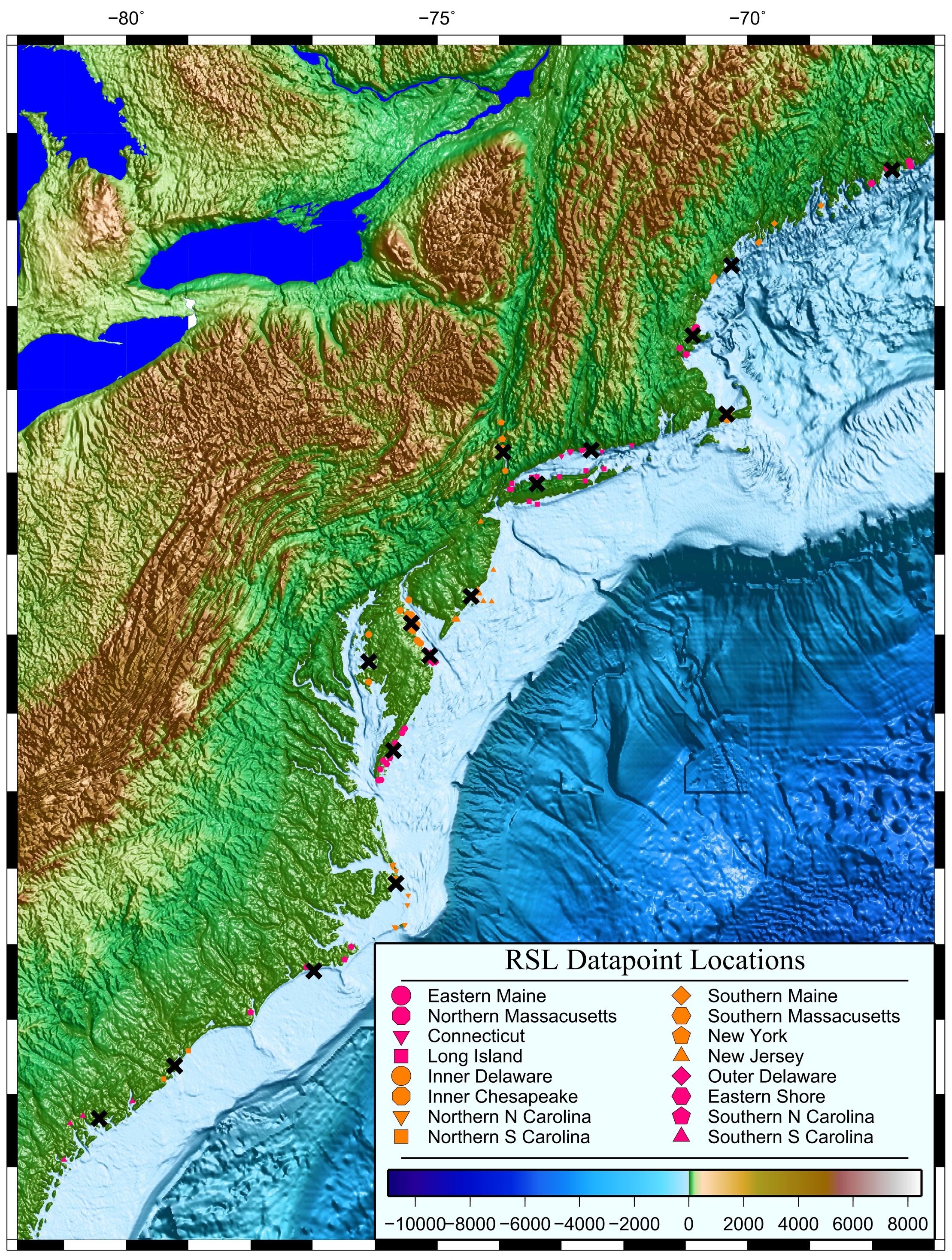

Figure 1: A map of the RSL database of Engelhart and Horton[2], model output is compared against the record for each individual point while for the curves in Figure 2 the index points are aggregated into 16 sites.

To constrain our model's parameters we utilize paleo sea level data from the study of Engelhart and Horton[2] in which approximately 500 index points distributed between Maine and Southern Carolina were presented and assessed. The paleo sea-level data are compared to model output from over 360 spherically symmetric Earth models each driven by 35 different glaciation histories from the analysis of Tarasov[3] for a total of over 12000 RSL histories.

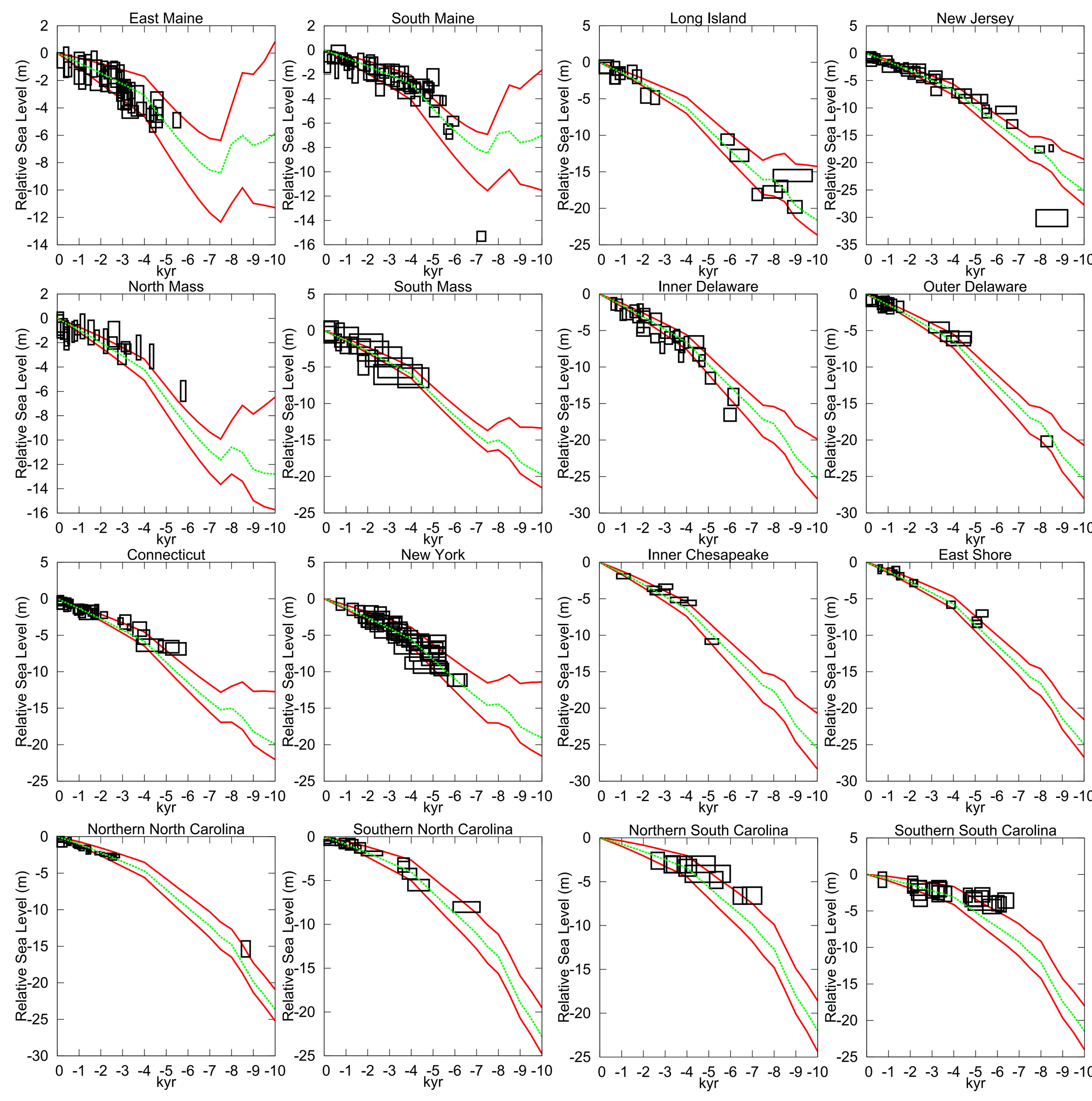

Figure 2: RSL curves of the best fitting model(green), the maximum and minimum values over the best ~50 runs(red). Sea-level index points from Engelhart and Horton[2] are shown with uncertainty in black.

As can be seen in Figure 2, the best fitting model accurately reproduces past changes in sea level over the last 10ka along the east coast of the United States. Using the best fitting viscosity models along with the best fitting ice input models to predict values of sea level change we obtain the following.

2000-2100	Charleston, SC, USA		Boston, MA, USA		New York, NY, USA		Portland, ME, USA	
	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)
ICE5G	0.046	0.049	0.079	0.087	0.154	0.160	-0.024	-0.014
8005	0.035	0.069	0.080	0.105	0.096	0.127	0.048	0.081
8967	0.029	0.065	0.100	0.133	0.123	0.159	0.067	0.099
9894	0.038	0.064	0.086	0.119	0.113	0.149	0.046	0.074
2100-2300								
ICE5G	0.091	0.098	0.156	0.172	0.305	0.316	-0.049	-0.028
8005	0.077	0.147	0.160	0.212	0.195	0.257	0.098	0.162
8967	0.065	0.138	0.201	0.267	0.247	0.320	0.134	0.198
9894	0.082	0.134	0.173	0.238	0.228	0.299	0.093	0.147

References & Acknowledgements

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[3] Tarasov et. al., Earth and Planetary Science Letters, 315-316, 30-40 (2012)
[4] Peltier, W.R., Global glacial isostasy and the surface of the ice-age Earth: the ICE-5G (VM2) model and GRACE. Annual Review of Earth and Planetary Sciences, May 2004, Vol 32, 111-149.
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uOttawa PAGES PAST GLOBAL CHANGES INQUA International Union for Quaternary Research WUN Worldwide Universities Network PALSEA

Introduction

We seek to quantify future changes of sea level along the Eastern coast of North America with particular emphasis on heavily populated areas which may be susceptible to such changes. There are several processes that will contribute to the sea level signal and each needs to be considered in order to produce accurate projections[1]. The primary component signals are: changes in sea surface height due to ocean steric changes and the associated dynamic signal, changes in relative sea level due to melting of land ice (ice caps, glaciers and ice sheets), changes in relative sea level due to glacial isostatic adjustment (GIA) associated, mainly, with the melting of the now absent Laurentide ice sheet. This poster focuses on the contribution of the latter to estimates of future sea level change. To understand future changes through our model we need to determine which of our inputs, in combination with our model, most accurately represents past behaviour.

Methodology

We utilize a model which is spherically symmetric and whose parameters vary only as a function of depth. It features parameters varying as defined by PREM[5] and utilizes a three layer model for the viscosity structure from the surface of the lithosphere to the base of the lower mantle. Through varying the viscosity of the upper mantle, lower mantle, thickness of the lithosphere, and input Laurentide ice sheet model we obtain a relative sea level(RSL) history. We compare each of these RSL histories to index points provided by the database of Engelhart and Horton[2] and by summing the model misfit over the database we can get a metric of the quality of fit. Plots of this metric as a function of upper and lower mantle viscosity, lithosphere thickness and input ice model may be seen in Figure 3.

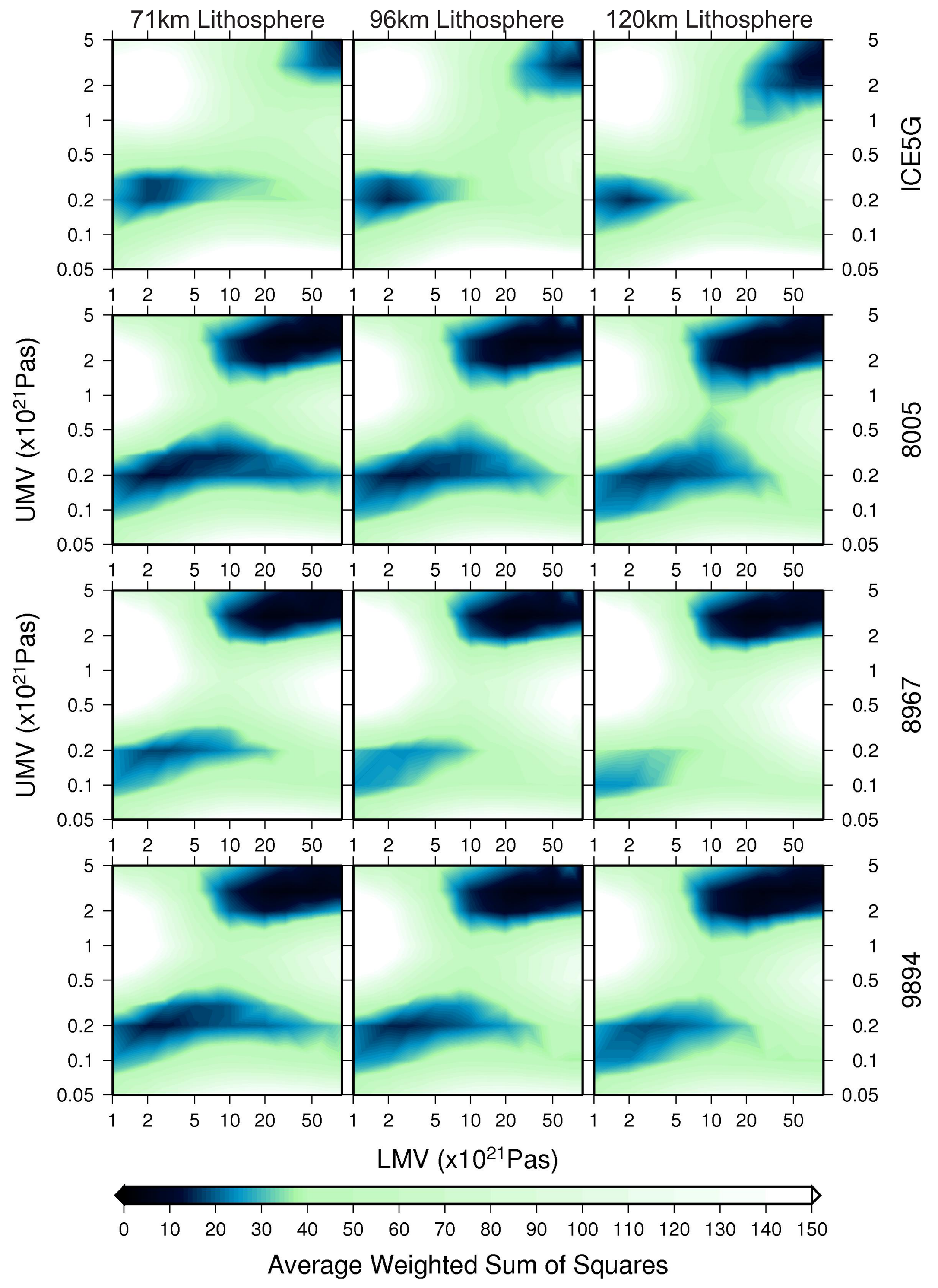

Figure 3: Phase space plots showing the quality of fit as a function of upper and lower mantle viscosity, lithosphere thickness and ice model. The best three fitting Laurentide models of Tarasov are shown in comparison to ICE5G.

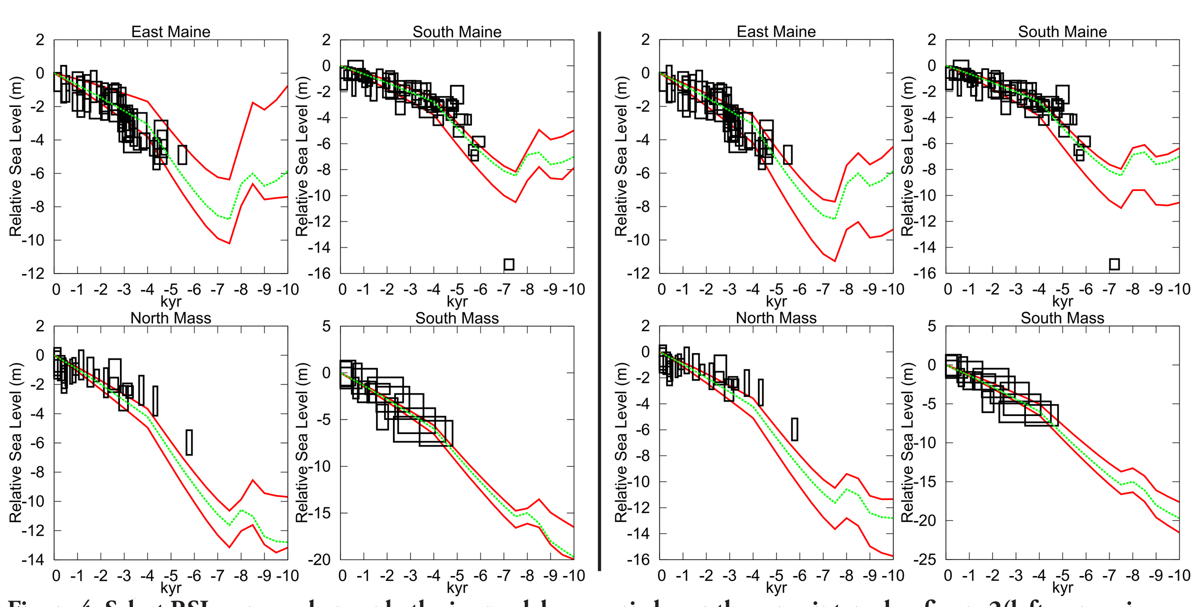

Figure 4: Select RSL curves where only the ice model was varied over the same interval as figure 2(left, same viscosity and lithosphere structure as the best fitting model) and where only the Earth model was varied(right, 9894 ice model). Curves are as follows: best fitting model(green), the maximum and minimum values(red).

Results & Conclusions

Our results indicate that high viscosity values for the upper and lower mantle best fit the RSL history provided by the study of Engelhart and Horton[2]. In those model runs which overall did not fit the data as well it was also found that viscosity in the range of (0.1-0.5)•10^{21}Pa•s for the upper mantle and (1-20)•10^{21}Pa•s fit the results equally well as the higher viscosity values. The best fitting model had the following parameters, 71km lithosphere, 3•10^{21}Pa•s for upper mantle viscosity, 70•10^{21}Pa•s for lower mantle and featured the 9894 Laurentide model. By comparison to ICE5G the models of Tarasov tended to produce greater future values of RSL change along the eastern coast of the United States while providing an improved fit to past observable RSL change.

The Model Input

In our study we utilize a suite containing 35 different inputs for the Launrentide ice sheet from the work of Tarasov[3] with a goal of examining performance by comparison to our previous standard model, ICE5G[4] of Peltier. Below are maps of the 3 best fitting input Laurentide models of Tarasov as well as ICE5G[4] of Peltier, presented at 21kabp. In this study only the Laurentide model is varied, surface ice over the rest of the Earth is provided by ICE5G [4].

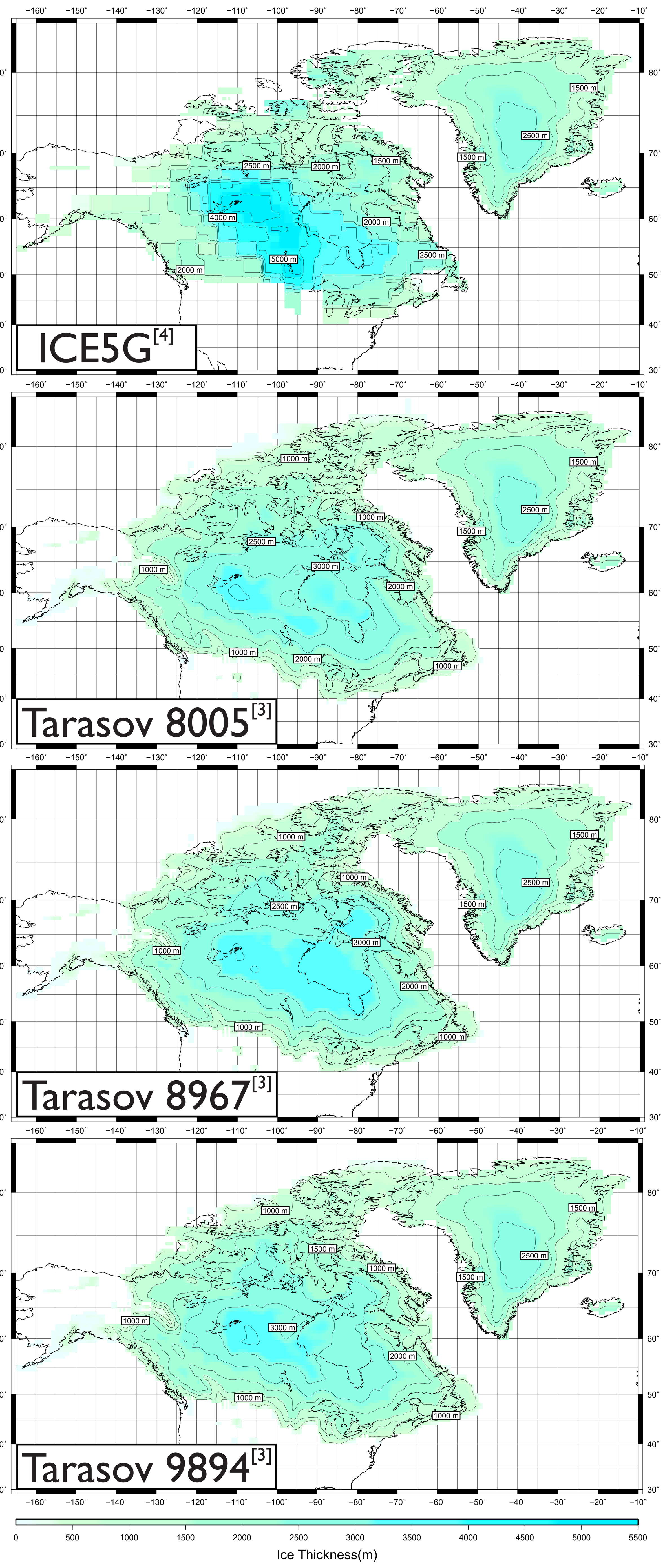

Figure 5: Plots of input ice thickness for the models of Tarasov and ICE5G of Peltier at 21kabp. Ice thickness of the Greenland ice sheet does not vary between input models.

The models of Tarasov[3] are calibrated, using a bayesian methodology, to a varying ensemble of observational datasets and have overall scores for fitting to these datasets as a whole. Input ice thickness near the last glacial maximum for the best 3 models of Tarasov and ICE5G[4] of Peltier are shown above in Figure 5.

8005 was the best scoring run for matching to RSL records from eastern Hudson's Bay as well as providing a good fit to records from southern Ontario, maritime provinces and the northeastern United States. 8967 was the best scoring run for fits to southern Ontario records as well as scoring well to maritime records and the northeastern US, while poorly fitting eastern Hudson's bay. 9894 was the overall best scoring model, of note however is that 9894 does not belong to a sieved sub-ensemble of which both 8005 and 8967 are members. Members passed a sieve with requirements for RSL values, present day uplift rates, marine limiting values, timing of the Hudson's Bay deglaciation, amount of margin forcing required and the total Barbados RSL value from 26kabp to 20kabp.

Interestingly, the best fit to the RSL dataset used in this study was provided by 9894 who did not pass this sieving, and is one of the best overall scoring models. Of note is that the ice models of Tarasov used VM5a viscosity structure of Peltier, with ICE5G using the earlier VM2, to determine the isostatic response for the purposes of model calibration whereas in this study we vary the viscosity structure to determine the best fitting structure. Both VM5a and VM2 feature much lower viscosity than was found to fit the data well. This presents an opportunity for expansion of the research by using ice models which have been calibrated using more rigid viscosity structures.