Reply to community comment CC1: 'Basal Heat Flow BC' by William Colgan

We thank William Colgan for the valuable comment on the matter of basal heat flow. It is certainly true that there is a significant spread in existing heat flux maps for the area underneath the Greenland ice sheet. While we acknowledge that the basal heat flux has an influence on the thermal state of the ice sheet and hence the viscosity of the ice, we expected that the choice of geothermal heat flow map has a negligible effect on sea-level projections in our specific setup. During spin-up the basal friction coefficients are adjusted in order to nudge the ice sheet to match the observed geometry. The bed friction thereby compensates many inaccuracies, including uncertainties in basal conditions. We mention this shortcoming of our setup in section 2.3.1.

Nevertheless, we tested the influence of the geothermal heat flux on the SMB-only experiments for three selected forcing cases, by prescribing six alternative geothermal heat flux maps according to the provided reference (https://doi.org/10.5194/tc-18-387-2024) during initialization, as well as throughout the historical run and the future projection. Resulting projections of sea-level contribution are shown in Fig. 1. We find that the differences in projected sea-level contribution due to a different choice of geothermal heat flux amount to a maximum of 0.93 mm at a total of 187 mm, or 0.5% for the strongest forcing (UKESM1-0-LL ssp585). For an intermediate forcing (NorESM2-MM ssp585) the differences are maximal 0.6 mm for a total of 68 mm or 0.9 %, while for the lowest forcing (MPI-ESM1-2-HR ssp126) the differences are not more than 0.45 mm for a total of 21.4 mm or 2.1 %. We therefore conclude that it is justified to refrain from sampling the uncertainty due to the use of different geothermal heat flow maps in our ensemble. We will add information about the limited influence of the choice of geothermal heat flux field on the projections in the discussion section in a revised version of the manuscript.

Best wishes,

The authors
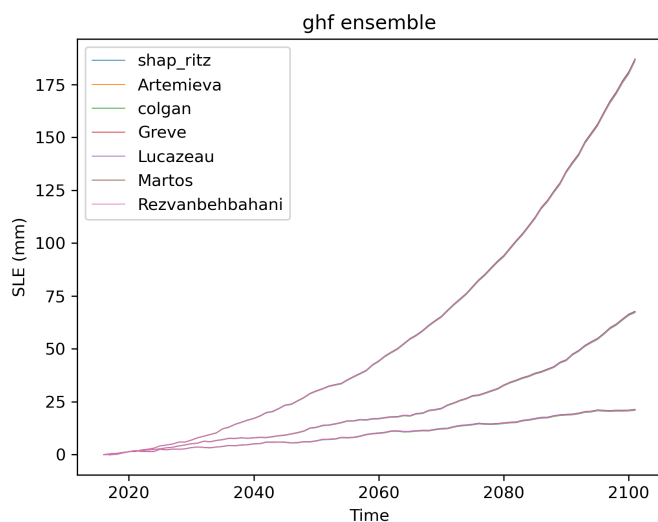
Figure 1: Projections of sea-level contribution for the SMB-only experiment relative to 2015 for three selected forcings (see text above for details). The different line colors denote simulations using different geothermal heat flux maps during initialization, with shap_ritz referring to our standard configuration. Note that differences due to geothermal heat flux are small and lines are mostly overlapping.