EGU22-5266
https://doi.org/10.5194/egusphere-egu22-5266
EGU General Assembly 2022

Impact of sliding laws and surface mass projections on Greenland outlet glacier dynamics at 100-year timescales

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The Greenland Ice Sheet (GrIS) contributed to 10.6 mm of global sea level rise between 1992 and 2018 (Shepherd et al., 2020), which is forecast to increase to 90±50 mm by 2100, under RCP8.5 forcing (Goelzer and others, 2020). Thus, it is crucial that we accurately forecast near future ice losses from the GrIS and assess the relative contribution of surface mass balance (SMB) and accelerated discharge from outlet glaciers. Uncertainties in forecasts of GrIS mass loss, which stem from model uncertainties, climate modelling projections, ocean forcing and the calving process.

Here, we assess the relative importance of two major sources of uncertainty, namely the choice of sliding law and SMB forecasts. To do this we use the ice flow model Úa to perform a series of model experiments using different formulations of the sliding law, and different projections of future SMB. Úa is vertically integrated, uses the shallow ice stream / shelf approximation and has an adaptive mesh. We conducted this work at three major Greenland outlet glaciers: Kangerdlugssuaq (KG), Humboldt (HU) and Petermann (PG) glaciers. These glaciers were selected as they are major sources of ice loss from the GrIS and have a diverse range of characteristics (e.g. terminus type, speed and catchment geometry), meaning that we can assess the variability in the importance of sliding laws and/or SMB forecasts between different types of glacier.

First, we initialised the models for each study glacier using remotely sensed data from 2014/15. We then performed a series of model inversions using four different sliding laws (Weertman, Budd, Tsai and Cornford laws), to all closely match the observed ice flow velocities. For each sliding law, we then ran a forward-in-time model simulation using the rheology and basal slipperiness fields derived from each inversion and compared the difference in ice loss after 100 years between each sliding law. Our results demonstrated that the impact of using different sliding laws varied between our study glaciers, resulting in limited differences at HU and substantially variation at KG and PG. To test the impact of SMB projections we use SMB projections from the Modèle Atmosphérique Régional (MAR) for ISMIP6, which utilised six CMIP5 and five CMIP6 models (Hofer et al., 2020). We then run forward simulations for 100 years for each study glacier, using each of the SMB forecasts, and using the rheology and basal slipperiness fields from each inversion. Initial results demonstrate that the impact of the difference SMB forecasts is far greater than the impact of the choice of sliding law.

References:

Goelzer, H., et al., 2020. The future sea-level contribution of the Greenland ice sheet: a multi-model ensemble study of ISMIP6. The Cryosphere, 14(9), pp.3071-3096.

Hofer, S. et al., 2020. Greater Greenland Ice Sheet contribution to global sea level rise in CMIP6. Nature communications, 11(1), pp.1-11.

Shepherd, A. et al., 2020. Mass balance of the Greenland Ice Sheet from 1992 to 2018. Nature, 579(7798), 233-239.