Supplement of Geosci. Model Dev., 18, 7853–7867, 2025
https://doi.org/10.5194/gmd-18-7853-2025-supplement

Geoscientific Model Development
Open Access
EGU

Supplement of

Interactive coupling of a Greenland ice sheet model in NorESM2

Heiko Goelzer et al.

Correspondence to: Heiko Goelzer (heig@norceresearch.no)

Additional figures

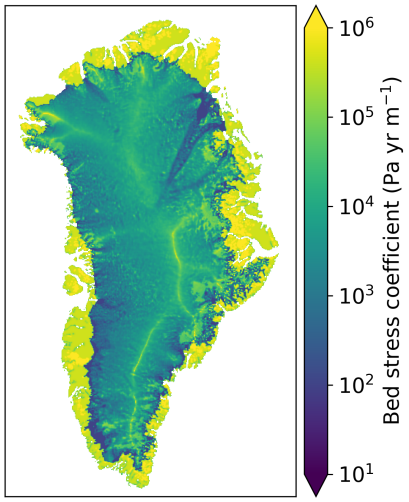

Figure S1. Inferred bed stress coefficient *beta* = $C_p\,|u_b|^{(1/m\,-\,1)}$ after calibration of the basal friction coefficient C_p (cf. Eq. 1) to minimise mismatch with the observed surface elevation (Morlighem et al., 2017) during initialisation.

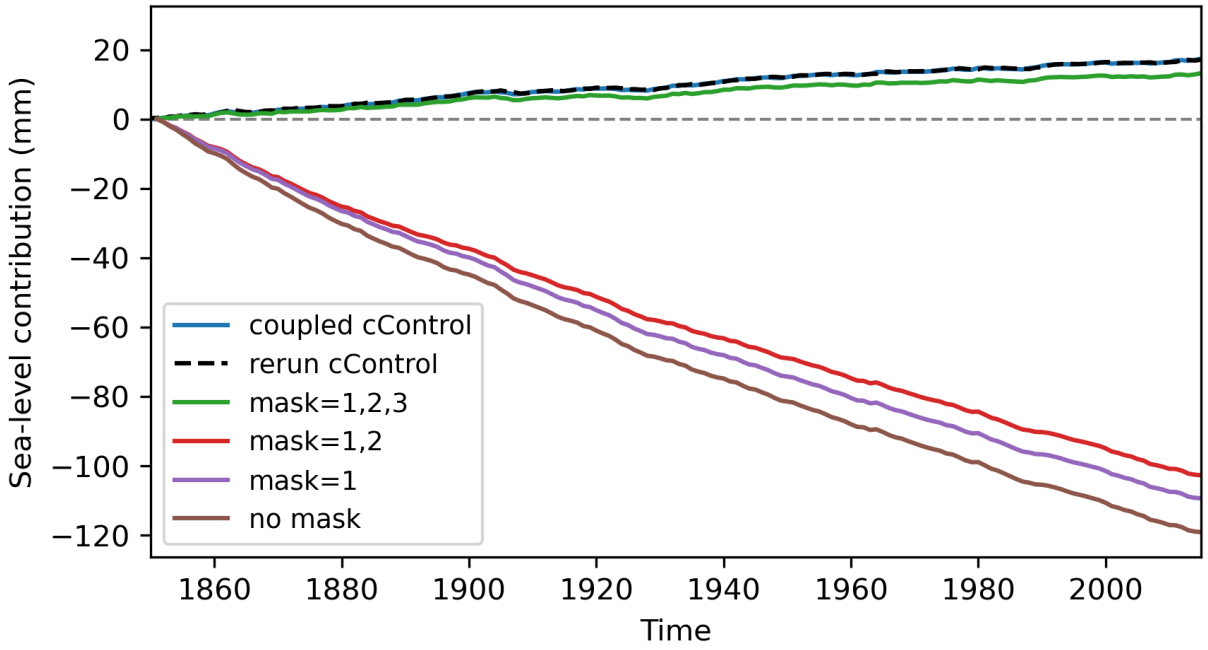

Figure S2. Standalone ice sheet experiments illustrating different masking options. Re-running the ice sheet component with the same applied SMB forcing (black dashed) reproduces the coupled experiment (blue) almost perfectly. Downscaling the land model elevation class output offline to the initial surface elevation (green) produces a slightly lower mass change, due to small differences

in the offline downscaling procedure. This latter experiment was repeated with different masking options (1-'remove_ice_caps', 2-'block_inception', 3-'force_retreat'; see main text for descriptions): i) turning off option 'force_retreat' (red), ii) additionally turning off option 'block_inception' (purple), iii) additionally turning off option 'remove_ice_caps' (brown). All three experiments show considerable mass gains as the ice sheet extends outside of the initial (observed) ice sheet mask in response to a positive SMB over the adjacent tundra regions (see Fig. S3).

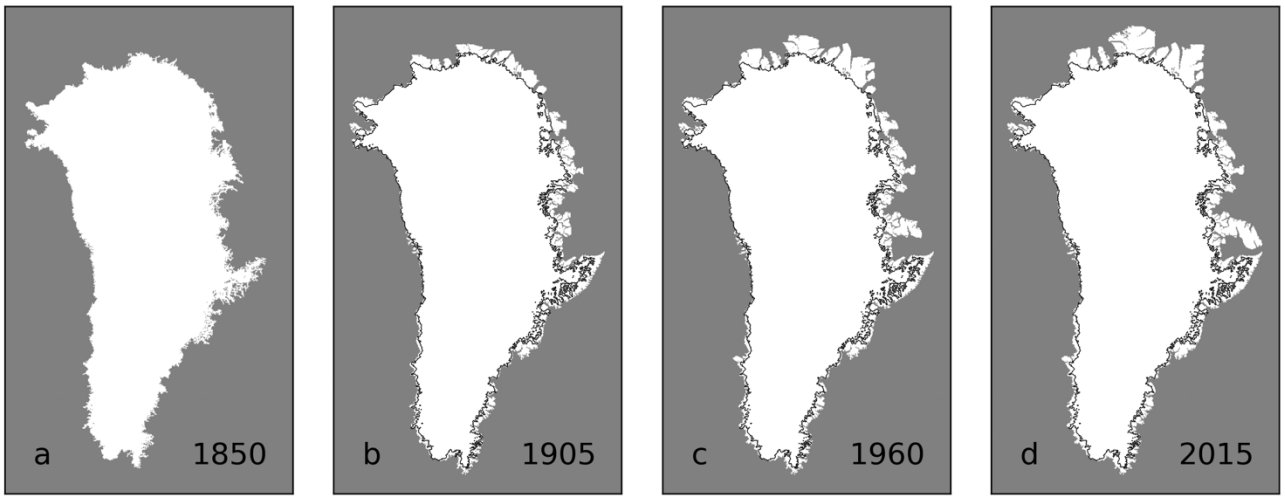

Figure S3. Ice sheet mask evolution for option 'force_retreat' turned off (red line in Fig S2). The black contour in b-d is the initial ice sheet mask in a. For the default settings with all three masking options turned on (green, black and blue lines in Fig S2), the ice mask is visually indistinguishable in similar plots from 1850 to 1905, 1960 and 2015 and therefore not shown.

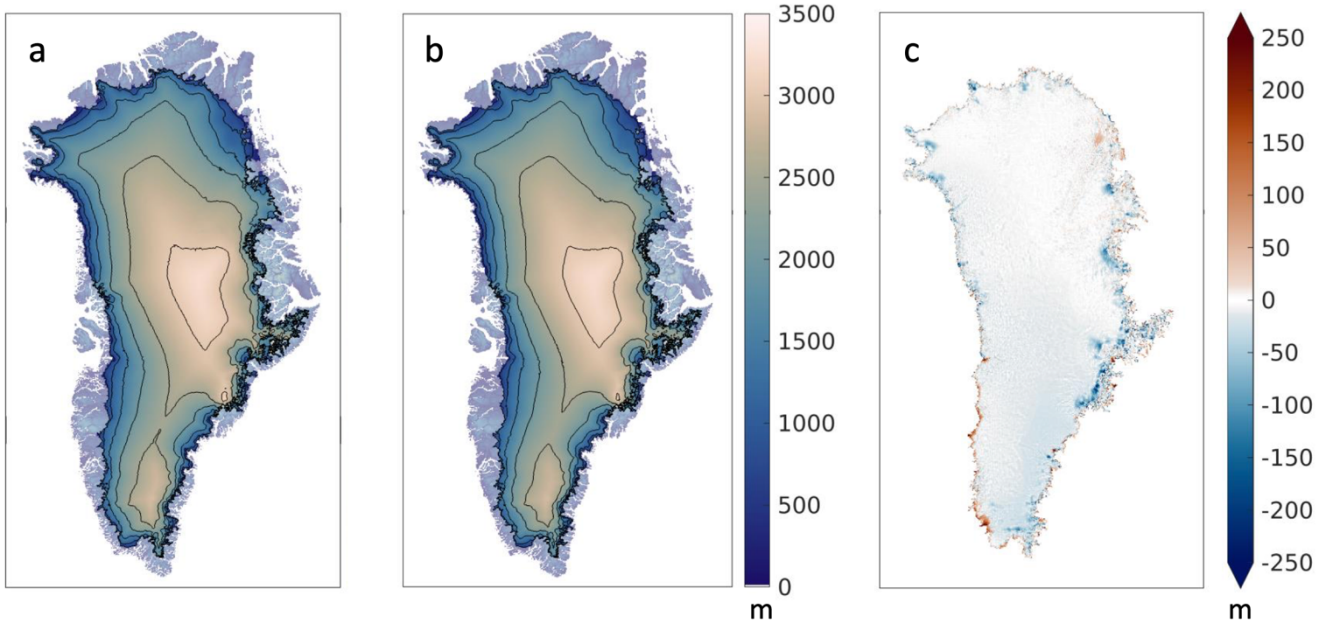

Figure S4. Similar to Figure 2 but towards the end of the historical run in year 1990. Ice sheet surface elevation. a) Initial target surface elevation based on present-day observations. b) Ice sheet model surface elevation for year 1990. c) Difference in surface elevation on the modelled ice mask.

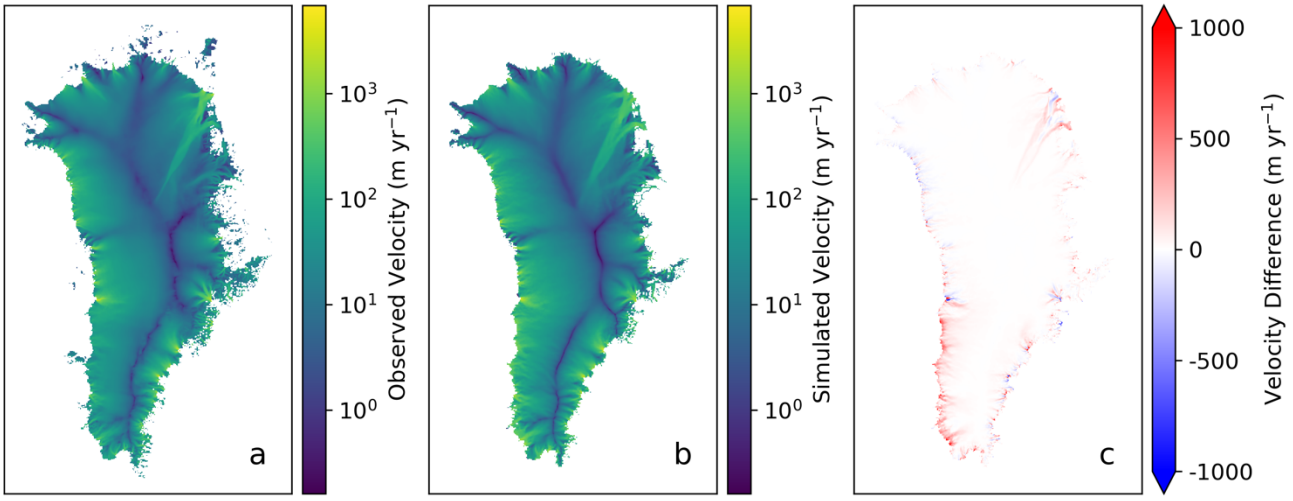

Figure S5. Horizontal surface velocity magnitude. a) Observed surface velocity (Joughin et al., 2016). b) Modelled surface velocity for year 1990. c) Difference in surface velocity magnitude on the modelled ice mask.

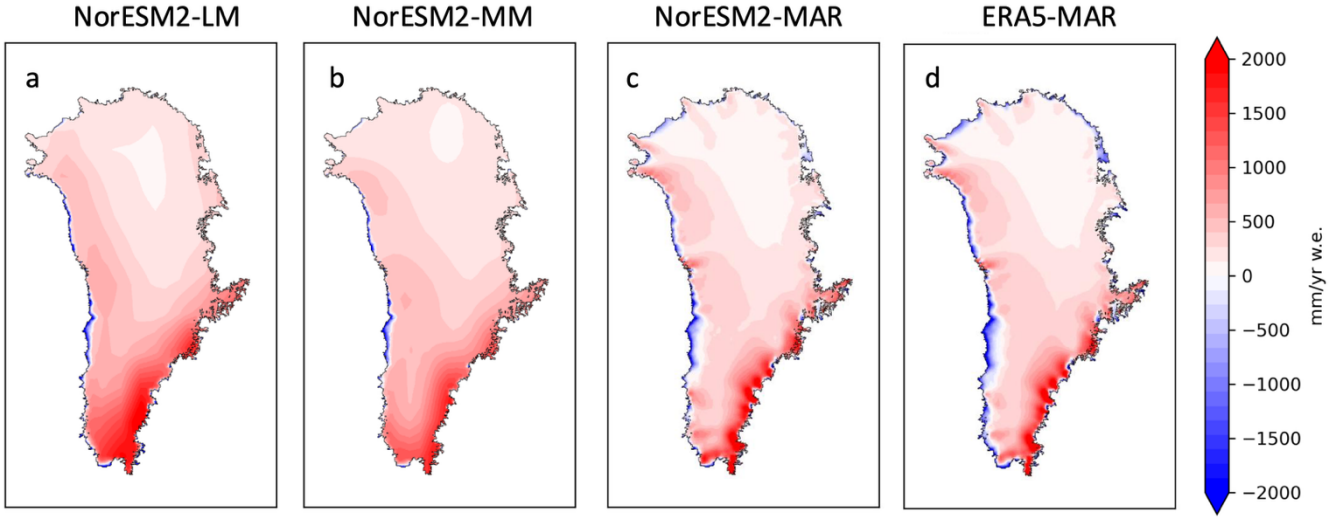

Figure S6. Similar to Figure 5 but including results for NorESM2-LM-EC with 2° horizontal resolution of the atmosphere model. Mean surface mass balance over the period 1960-1989 from a) low-resolution NorESM2-LM-EC, b) NorESM2-MM-EC, c) NorESM2-MAR and d) ERA5-MAR). All fields are masked to the modelled ice sheet area in NorESM2 at the end of year 2014.

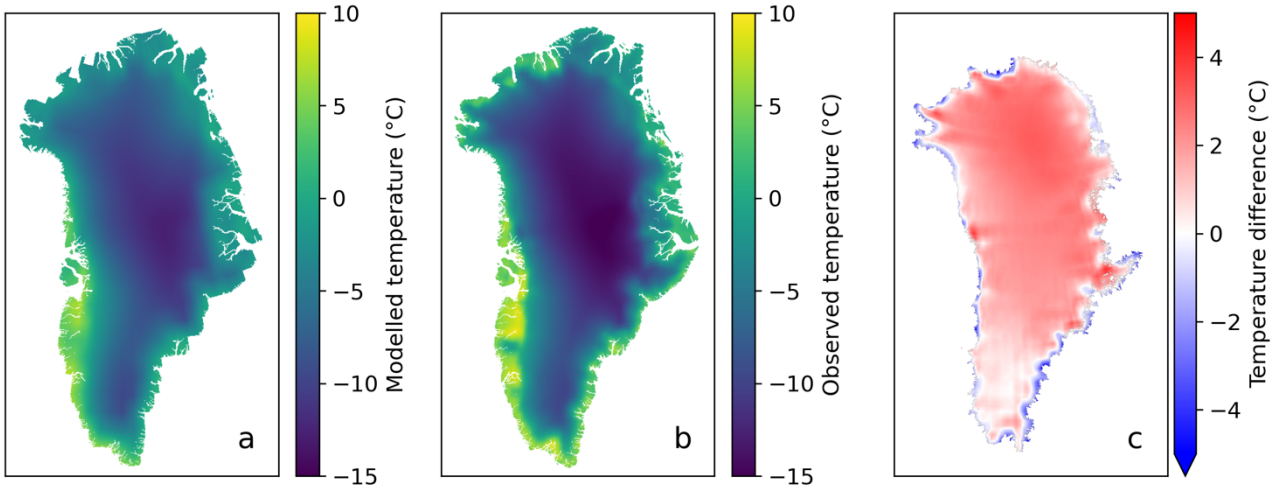

Figure S7. Similar to Figure 5 but average summer (jja) 2m air temperature for the period 1981-2010 in NorESM2 (a) compared to ERA5 (b) and differences (c). The differences in c are masked to the ice sheet extent to better visualise the narrow band of cold bias over the ice sheet margins.

References

Joughin, I., Smith, B., Howat, I., and Scambos, T.: MEaSUREs Multi-year Greenland Ice Sheet Velocity Mosaic, Version 1, https://doi.org/10.5067/QUA5Q9SVMSJG, 2016.

Morlighem, M., Williams, C. N., Rignot, E., An, L., Arndt, J. E., Bamber, J. L., Catania, G., Chauché, N., Dowdeswell, J. A., Dorschel, B., Fenty, I., Hogan, K., Howat, I., Hubbard, A., Jakobsson, M., Jordan, T. M., Kjeldsen, K. K., Millan, R., Mayer, L., Mouginot, J., Noël, B. P. Y. Y., O'Cofaigh, C., Palmer, S., Rysgaard, S., Seroussi, H., Siegert, M. J., Slabon, P., Straneo, F., van den Broeke, M. R., Weinrebe, W., Wood, M., Zinglersen, K. B., Cofaigh, C. Ó., Palmer, S., Rysgaard, S., Seroussi, H., Siegert, M. J., Slabon, P., Straneo, F., van den Broeke, M. R., Weinrebe, W., Wood, M., and Zinglersen, K. B.: BedMachine v3: Complete bed topography and ocean bathymetry mapping of Greenland from multi-beam echo sounding combined with mass conservation, Geophysical Research Letters, 44, 11,051-11,061, https://doi.org/10.1002/2017GL074954, 2017.