Supplement of


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Supplement Figures
Figure S1. The ISSM Greenland mesh for (A) the entire ice sheet and (B) the northwest margin, which, for reference, is outlined in red on (A).
Figure S2. Spatial representation of differences in mean annual amplitude from 2003-2012 between various combinations of model spinup and the ISSM_GrIS MAR3.5.2 presented in the manuscript (i.e. MAR3.5.2 forced by ERA-I reanalysis and BOX SMB used as the reference relaxation climatology, $\overline{\text{SMB}}$). Comparison runs include: (A) ISSM_GrIS MAR3.5.2, where MAR3.5.2 is forced with NCEP1 reanalysis; (B) ISSM_GrIS MAR3.5.2, where MAR3.5.2 SMB is used for $\overline{\text{SMB}}$; and (C) ISSM_GrIS MAR2.0, where MAR2.0 SMB (forced with ERA-I reanalysis) is used for $\overline{\text{SMB}}$. Results are less sensitive to variations in RCM forcing (A) and choice of spinup product (B) than to RCM version (C).

Figure S3. Spatial representation of differences in mass trend from 2003-2012 between various combinations of model spinup and the ISSM_GrIS MAR3.5.2 presented in the manuscript (i.e. MAR3.5.2 forced by ERA-I reanalysis and BOX SMB used as the reference relaxation climatology, $\overline{\text{SMB}}$). Comparison runs include: (A) ISSM_GrIS MAR3.5.2, where MAR3.5.2 is forced with NCEP1 reanalysis; (B) ISSM_GrIS MAR3.5.2, where MAR3.5.2 SMB is used for $\overline{\text{SMB}}$; and (C) ISSM_GrIS MAR2.0, where MAR2.0 SMB (forced with ERA-I reanalysis) is used for $\overline{\text{SMB}}$. Results are less sensitive to choice of spinup product (B) than to variations in RCM forcing (A) or to RCM version (C).
Figure S4. (A) Modeled surface velocities (m/yr), from the relaxed ISSM Greenland and (B) the departure of modeled surface velocities from observations. Note the non-linear color scales.
Figure S5. (A) Modeled ice thickness (m), from the relaxed ISSM Greenland and (B) the departure of modeled ice thicknesses from observationally-based data [Morlighem et al., 2014b].
Figure S6. Spatial representation of trend in surface mass from 2003-2009 as estimated from (A) GRACE_JPL and (B) ICESat altimetry [Csatho et al., 2014], and (C) the difference: GRACE_JPL - ICESat.
Figure S7. Cumulative mass from 2003-2012 for (A) all of Greenland and (B) the Greenland Interior, comparing observations from GRACE (GRACE_JPL), with model outputs: ISSM over the Greenland Ice Sheet (ISSM_GrIS), SMB anomalies over the Greenland Ice Sheet (SMB_GrIS), ISSM_GrIS with mass from the periphery (ISSM_GrIS+P), and ISSM_GrIS+P for each individual SMB forcing (ISSM_GrIS+P MAR, ISSM_GrIS+P RACMO, ISSM_GrIS+P BOX).
Figure S8. (A) Change in modeled mean annual surface velocities (m/yr) and (B) change in model ice thicknesses (m) during the 10-year ISSM simulation period (2003-2012). Model output is presented as the mean of three different ISSM simulation runs (ISSM_GrIS BOX, ISSM_GrIS MAR, and ISSM_GrIS RACMO). Note the non-linear color scales.
Figure S9. (A) Total dynamic ice thickness change (difference between the cumulative mass contribution from the SMB forcing anomalies and the total ice thickness change) simulated by ISSM Greenland (2003-2012); (B) change in surface slope during the simulation; and (C) change in the magnitude of the driving stress over the same period. Model output is presented as the mean of three different ISSM simulation runs (ISSM_GrIS MAR, ISSM_GrIS RACMO, and ISSM_GrIS BOX).
Figure S10. Spatial representation of trend in surface mass for the Greenland periphery as estimated from (A) RACMO, (B) BOX, and (C) MAR.
Figure S11. Interior mascons, total cumulative mass timeseries for GRACE_JPL, SMB_GrIS, and ISSM_GrIS (including the mean and results from the individual simulations of ISSM_GrIS MAR, ISSM_GrIS RACMO, and ISSM_GrIS BOX). Also included is the residual between GRACE_JPL and ISSM_GrIS (green).
Figure S12. Southwest mascons, total cumulative mass timeseries for GRACE_JPL, SMB_GrIS, ISSM_GrIS (including the mean and results from the individual simulations of ISSM_GrIS MAR, ISSM_GrIS RACMO, and ISSM_GrIS BOX), and ISSM_GrIS+P. Also included is the residual between GRACE_JPL and ISSM_GrIS+P (green).
Figure S13. Same as Fig. S12 but for Northeast mascons.
Figure S14. Same as Fig. S12 but for Southeast mascons.
Figure S15. Same as Fig. S12 but for Northwest mascons.