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SeaRISE experiments revisited: potential sources of spread in multi-model projections of the Greenland ice sheet

F. Saito et al.

Correspondence to: F. Saito (saitofuyuki@jamstec.go.jp)

S1 Difference between simulated surface topography and the present-day observation

Figure S1 shows the simulated surface elevation relative to the present-day observation, obtained by SeaRISE/IcIES compatible configuration `O:v1`. As shown in the figure, thickness is overestimated overall the margin area except for the northwest and northeast region. Figure S2 shows the simulated surface elevation relative to the present-day observation, obtained by the experiments with free transient spinning-up configuration, `B` and `B′` with three uniform basal sliding coefficients (cases `v1` to `v4`). General features are similar as Fig. S1: interior, northwest and the northwest regions are underestimated while the other regions including margin are overestimated.

S2 Trends in the volume evolution under the constant climate scenario

Figure S3 shows the evolution of simulated 'volume above flotation' (VAF) during 500 years under constant climate scenario `C0` obtained by some of the experiments in the present paper. Unlike Fig. 1 in the main material, not relative but absolute values of VAF are plotted. The experiments in Figs. S3c-f all start from the present-day topography with different internal temperature, thus the trends are varied among the experiments. Both transient and steady-state spin-up are plotted, but their differences are too small to distinguish.

S3 Ordered list of the changes in simulated volumes

Table S1 shows ordered lists of the fractional changes in Δ VAF at 500 years by replacing one model property, under configuration of `C1:v1`, `C1:v4`, `C3:v1` and `C3:v4`. As shown in the table, generally the impact of replacement of the surface mass balance (denoted as 'ms' in the table) and that of initialization whether free or fixed as observation ('fo' and 'to') come highest among the others. Impact of replacement of the ice-sheet margin advance ('am') come relatively high under mild future climate scenario `C1`. Impact of replacement of the submelt sliding methods ('bs') come relatively high under larger basal sliding coefficient case `v4`.

S4 Sensitivity experiments of the multiple combinations of the focused aspects

In addition to the experiments in the main paper, multiple combinations of changes in most of the model properties are tested in order to check for interactions between the uncertainties. Bedrock topography is set to the JHKP data set through the experiments, thus four model properties, submelt sliding inclusion, free or fixed topography spin-up, treatment of the ice-sheet margin advance and the surface mass balance are tested. In addition, whether steady-state or 125 kyr transient spin-up (for internal temperature) is tested for some

Table S1: Ordered lists of the 'one-at-a-time' effects tested in the present-paper. Fractional changes of ΔVAF between two experiments are summarized (0 means no change and negative means the latter is larger). 16 representative pairs are chosen for the configuration C1:v1, C1:v4, C3:v1 and C3:v4, which is sorted by the magnitude of fractional changes. The symbols in each third column denote the difference between the model properties: 'am' stands for advance in the margin; 'ms' surface mass balance; 'fo' free topography spin-up and fixed topography spin-up as the observation; 'to' fixed topography spin-up as corresponding free spin-up and as the observation; 'bs' submelt sliding; 'r' bedrock topography; 'ti' steady-state or transient spin-up; respectively.

C1 v1			C3 v1			C1 v4			C3 v4		
E′-D′	-0.310	am	F-D	+0.398	to	F-D	+0.807	to	F-D	+0.452	to
E′-E	-0.305	ms	E′-E	-0.370	ms	D-B	-0.436	fo	F′-D′	+0.427	to
D′-B′	-0.293	fo	F'_s-F_s	-0.361	ms	F'_s-F_s	-0.433	ms	E′-E	-0.409	ms
D-B	-0.287	fo	F′-F	-0.359	ms	F′-F	-0.425	ms	F′-F	-0.363	ms
F-D	+0.246	to	F′-D′	+0.347	to	B′-B	-0.386	ms	F'_s-F_s	-0.359	ms
D'_s-D_s	-0.245	ms	B′-B	-0.337	ms	B-A	+0.379	bs	D'_s-D_s	-0.353	ms
F′-D′	+0.244	to	D′-D	-0.335	ms	E′-D′	-0.315	am	D′-D	-0.352	ms
F'_s-F_s	-0.244	ms	D'_s-D_s	-0.333	ms	F′-D′	+0.267	to	B′-B	-0.347	ms
E-D	-0.239	am	D-B	-0.261	fo	E′-E	-0.259	ms	D′-B′	-0.263	fo
F′-F	-0.235	ms	D′-B′	-0.258	fo	D′-B′	-0.247	fo	D-B	-0.257	fo
D′-D	-0.234	ms	E′-D′	-0.157	am	E-D	-0.243	am	E′-D′	-0.166	am
B′-B	-0.228	ms	E-D	-0.109	am	D'_s-D_s	-0.188	ms	B-A	+0.155	bs
B-A	+0.034	bs	B-A	+0.045	bs	D′-D	-0.180	ms	E-D	-0.085	am
A-O	+0.034	r	F_s-F	+0.014	ti	F_s-F	+0.015	ti	A-O	+0.009	r
D_s-D	+0.021	ti	A-O	+0.011	r	A-O	+0.013	r	D_s-D	+0.007	ti
F_s-F	+0.013	ti	D_s-D	+0.009	ti	D_s-D	+0.007	ti	F_s-F	+0.004	ti

combinations. Figures S4 to S6 are the summary of all the combination tested here under future climate scenarios `C1` to `C3`, respectively.
Figure S4 contains three groups which are the summary of the basal sliding coefficient cases from `v1` to `v4`. A group contains two graphs and one matrix: the upper graph is impact of replacement in one model property in terms of difference; the lower is in terms of fractional change (1.0 means identical). Graphs are divided into five blocks. One block show the impact of replacement indicated by the top. The first block (most left) shows the impact of replacement in the submelt sliding, from y (with submelt sliding) to n (without). The second block shows the impact of replacement from the free topography spin-up to two different spin-up: to fixed topography spin-up as the observation, and to fixed-topography spin-up as the final state of free spin-up experiments. The third block shows the impact of replacement in the treatment of the ice margin advance, from free margin to no advance. The fourth block shows the impact of replacement in the surface mass-balance method, from Tarasov and Peltier (2002) to Huybrechts and de Wolde (1999). The fifth block shows the impact of replacement in the temperature spin-up from 125 kyr transient to steady-state at the present-day. A group contains a matrix, which indicates the model properties of each experiment configuration before the changes indicated at the top. The properties changed in the experiment are indicated by circles, while kept are by rectangles. The results are sorted by difference in the ΔVAF in each block.

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Tarasov, L. and Peltier, W. R.: Greenland glacial history and local geodynamic consequences, Geophys. J. Int., 150, 198–229, doi:10.1046/j.1365-246X.2002.01702.x, URL `http://dx.doi.org/10.1046/j.1365-246X.2002.01702.x`, 2002.

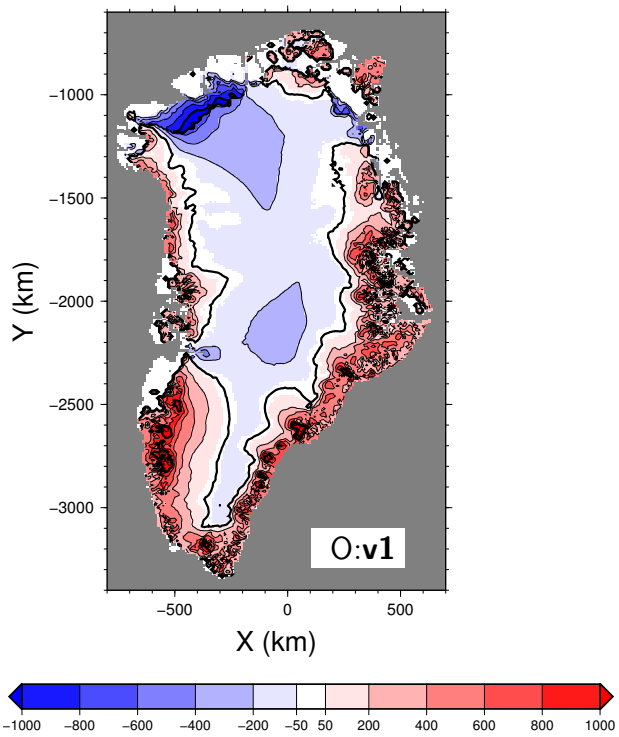

Figure S1: Simulated surface elevation (m) relative to the present-day observation obtained by `O:v1`.

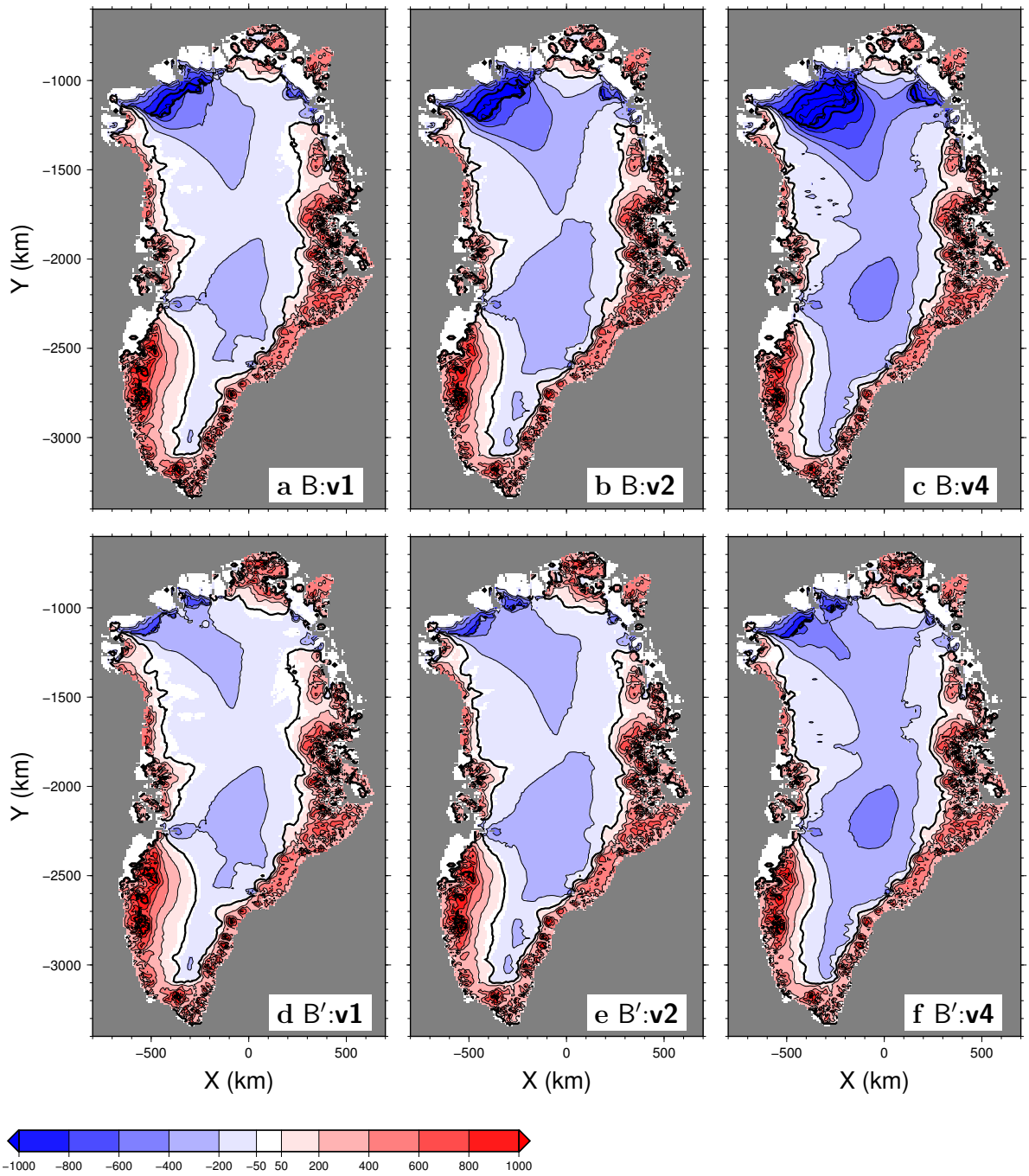

Figure S2: Simulated surface elevation (m) relative to the present-day observation, obtained by experiments `B` (upper panels) and `B′` (lower panels).

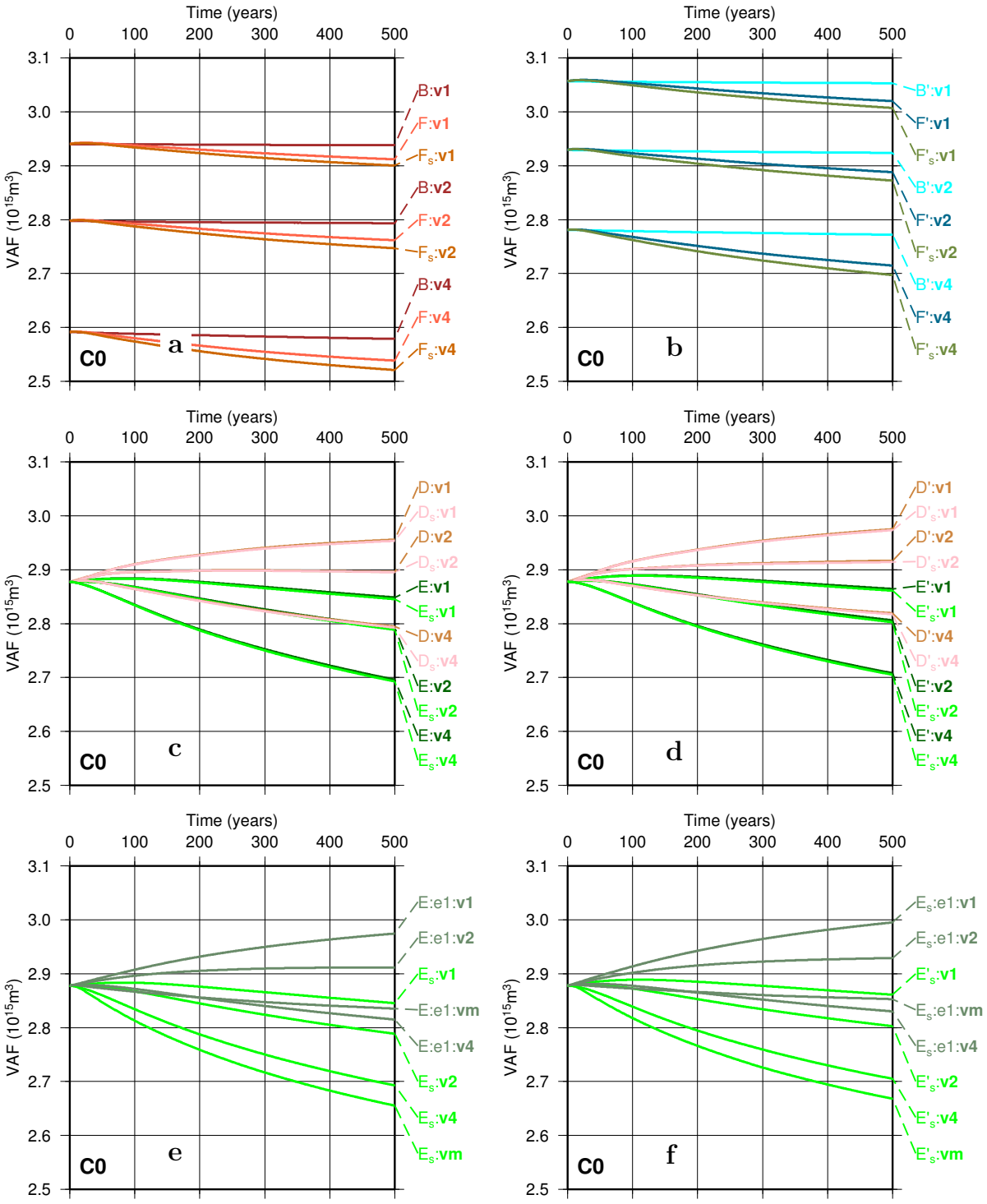

Figure S3: Evolution of simulated 'volume above flotation' (VAF) during 500 years under constant climate scenario `C0`. The left panels are the results of experiments with PDD following Tarasov and Peltier (2002) (e.g., `B`, `D`) while the right ares those with PDD following Huybrechts and de Wolde (1999). The upper panels are results of free and fixed topography spin-up (e.g. `B`, `F`). The middle panels are results of fixed topography spin-up with the observation (e.g. `D`, `E`). The lower panels are the results with prohibition of ice-sheet margin advance (`E`$_s$) including with the non-uniform basal-sliding coefficient fields (`vm`, `e1`:`vm`).

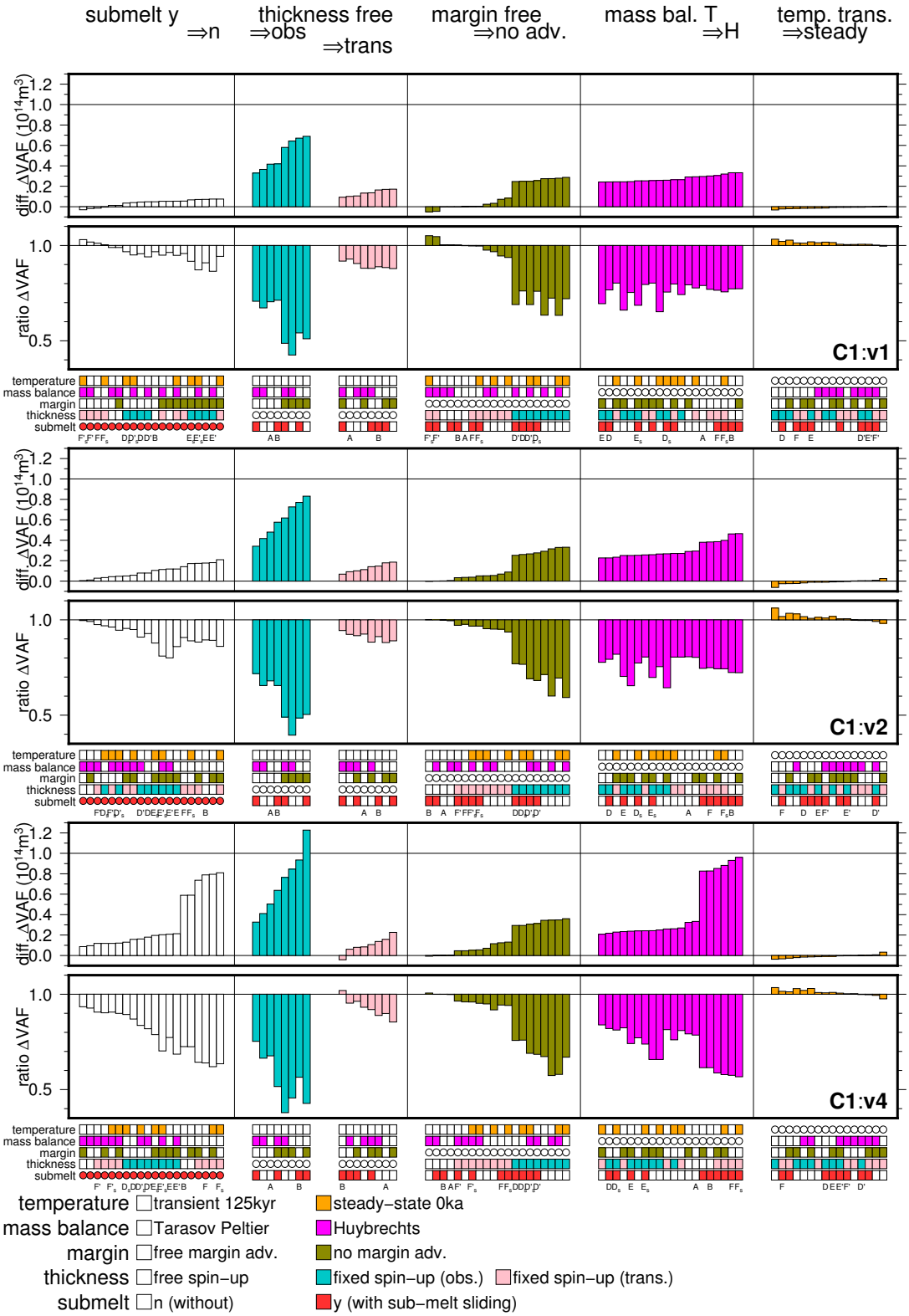

Figure S4: Summary of sensitivity experiment with multiple combination of the model properties under the future-climate scenario `C1`. It is described in the text how to read the graph.

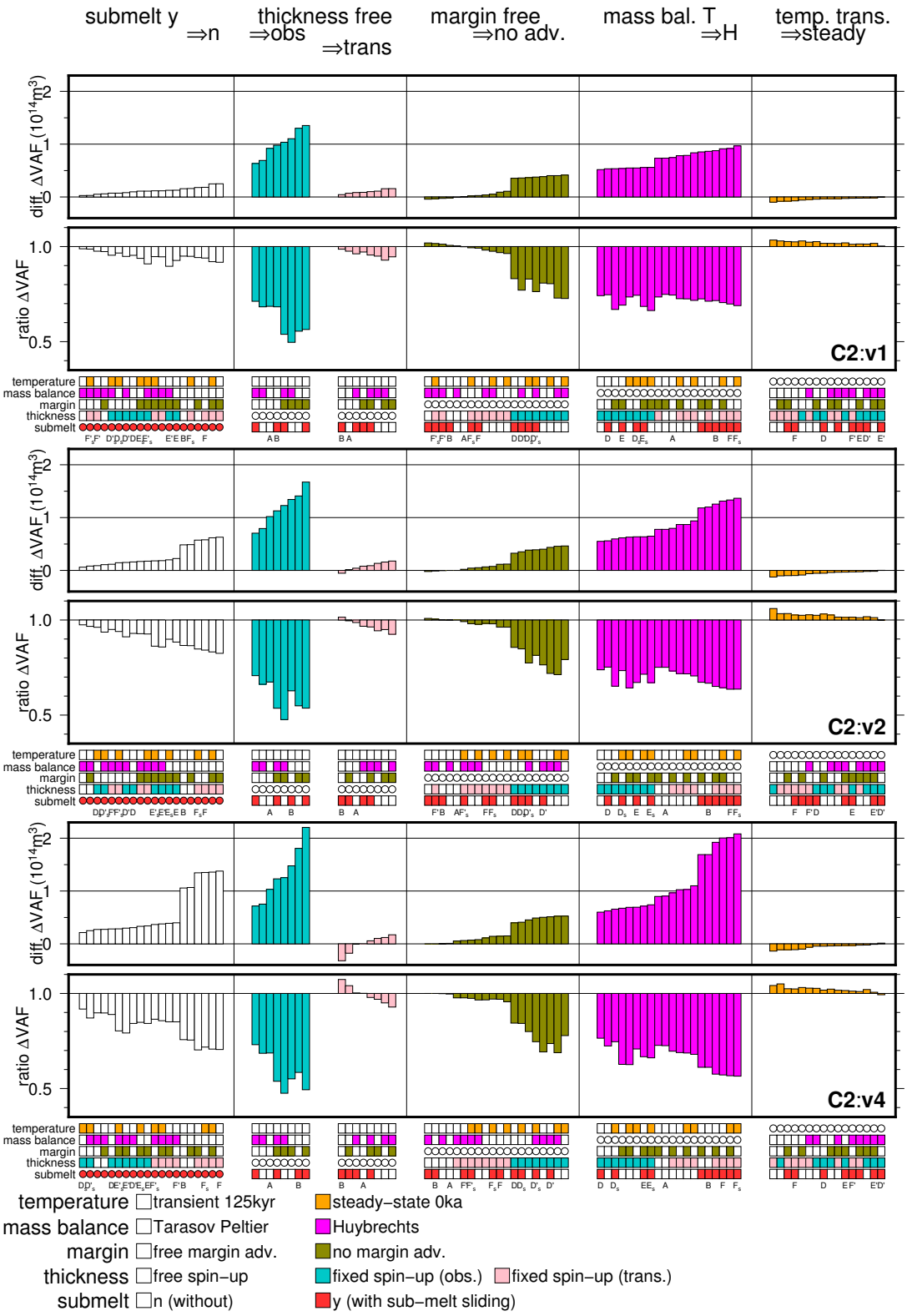

Figure S5: Summary of sensitivity experiment with multiple combination of the model properties under the future-climate scenario C2.

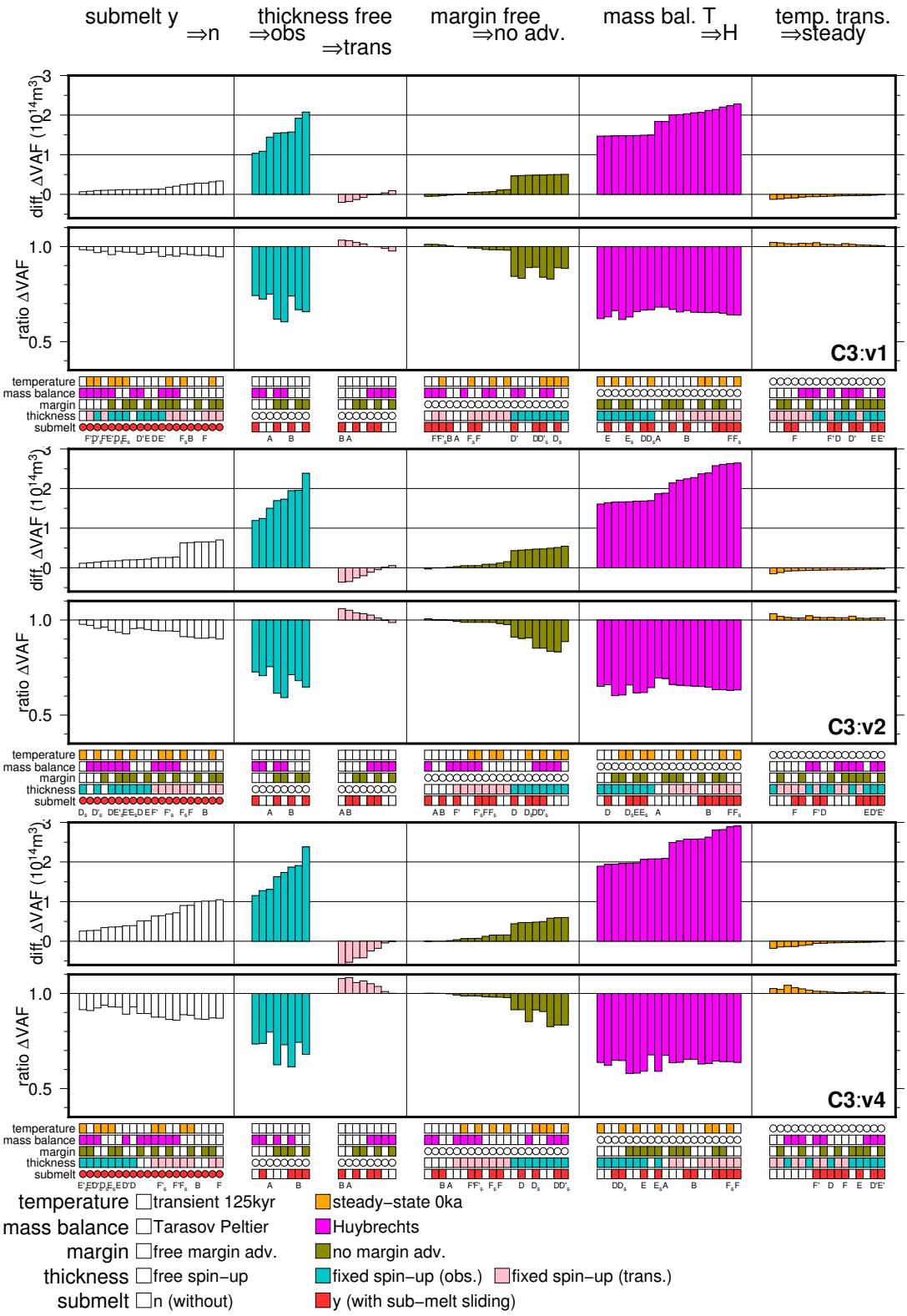

Figure S6: Summary of sensitivity experiment with multiple combination of the model properties under the future-climate scenario C3.