2 Fig. S1 Initial conditions and spin-up in stand-alone ice sheet model simulations. (a) ice

3 topography from Tarasov et al. (2012, m) and (b) bedrock topography [m]. Differences of

4 bedrock between 21ka and 0ka in Tarasov et al. (2012) are added on modern bedrock

5 topography. (c) shows the evolution of total ice volume in the 5000 year spin-up with stand-

6 alone Bisicles under spatially uniform surface mass balance and surface air temperature. (d)

7 Correlations of the final ice volume after the spin-up and surface mass balance during the

8 spin-up. In (c) and (d), grey lines and blue dots represent each ensemble member.

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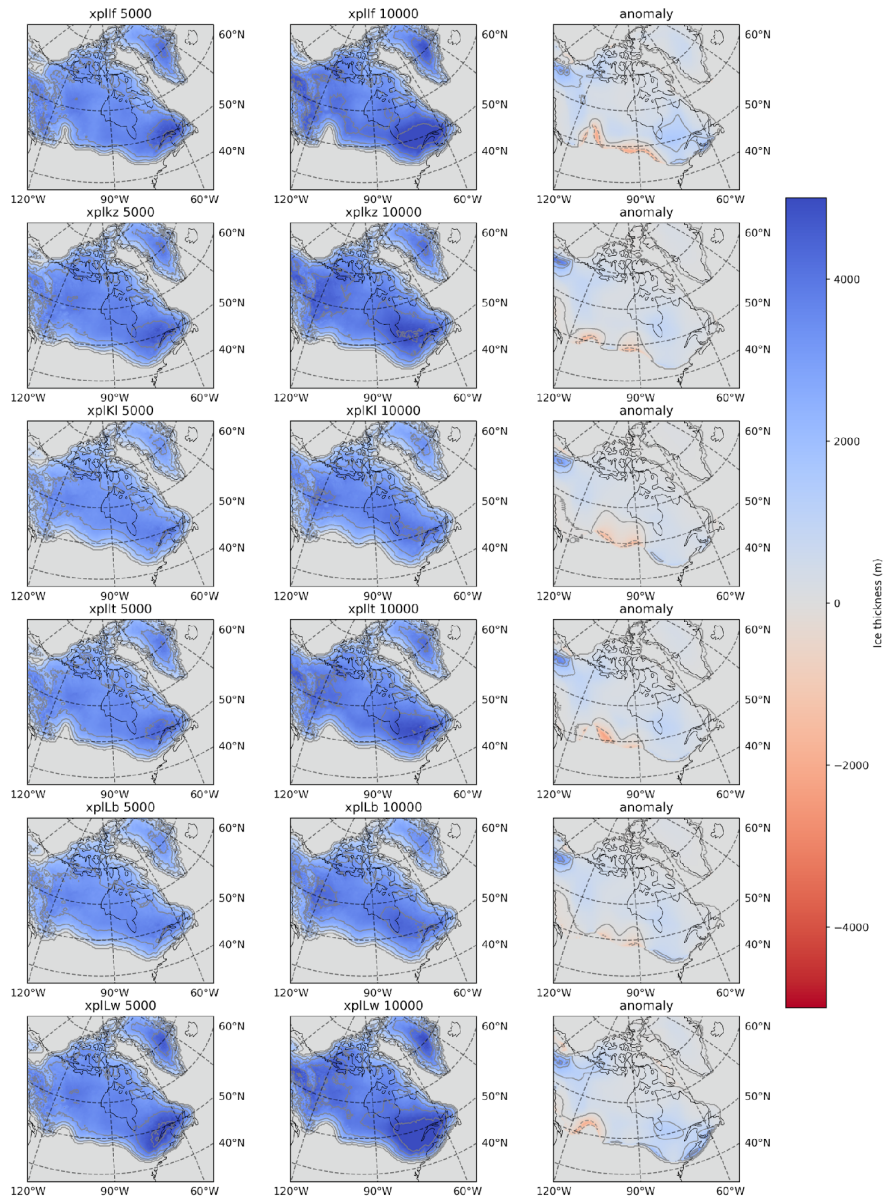
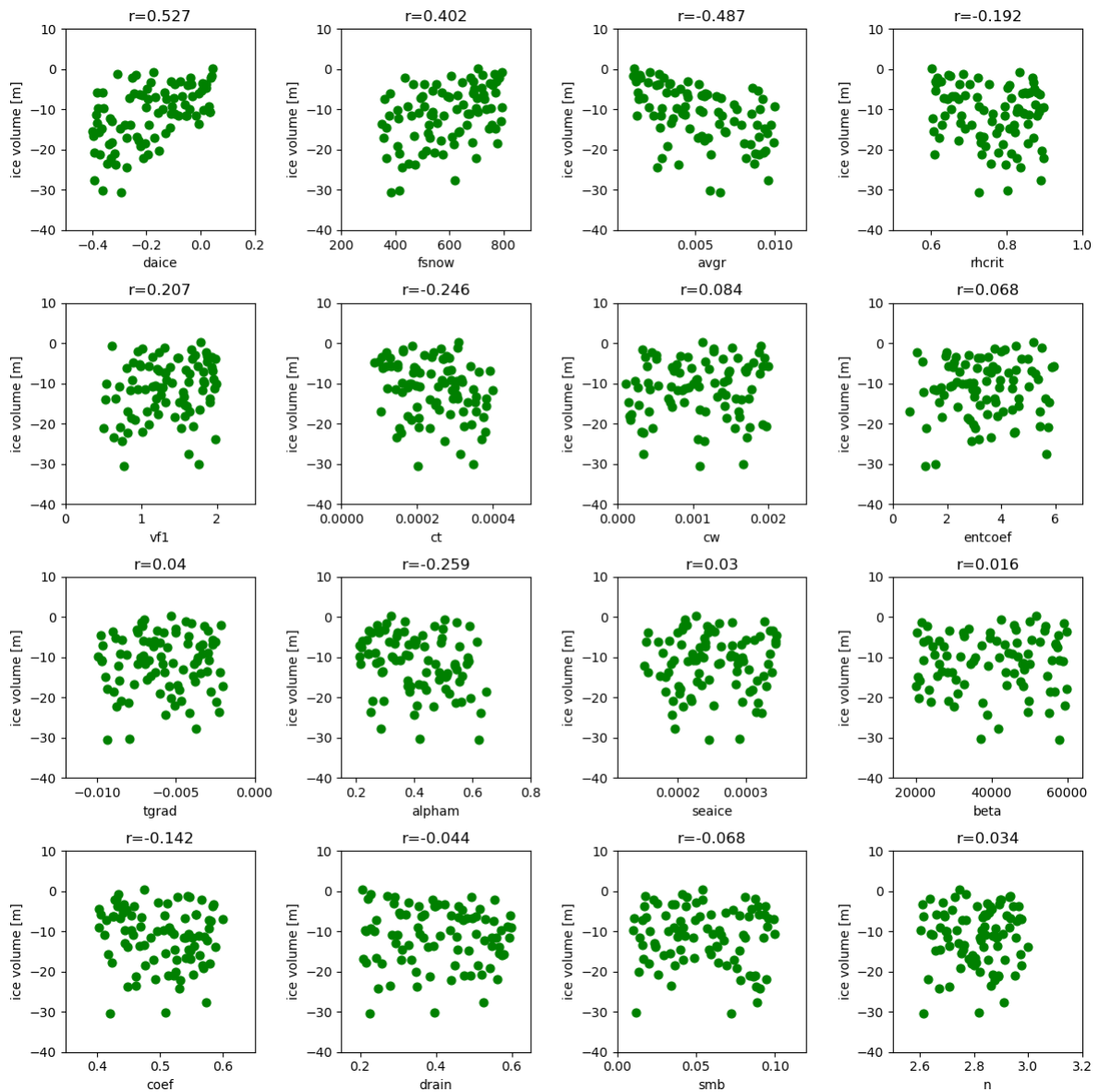


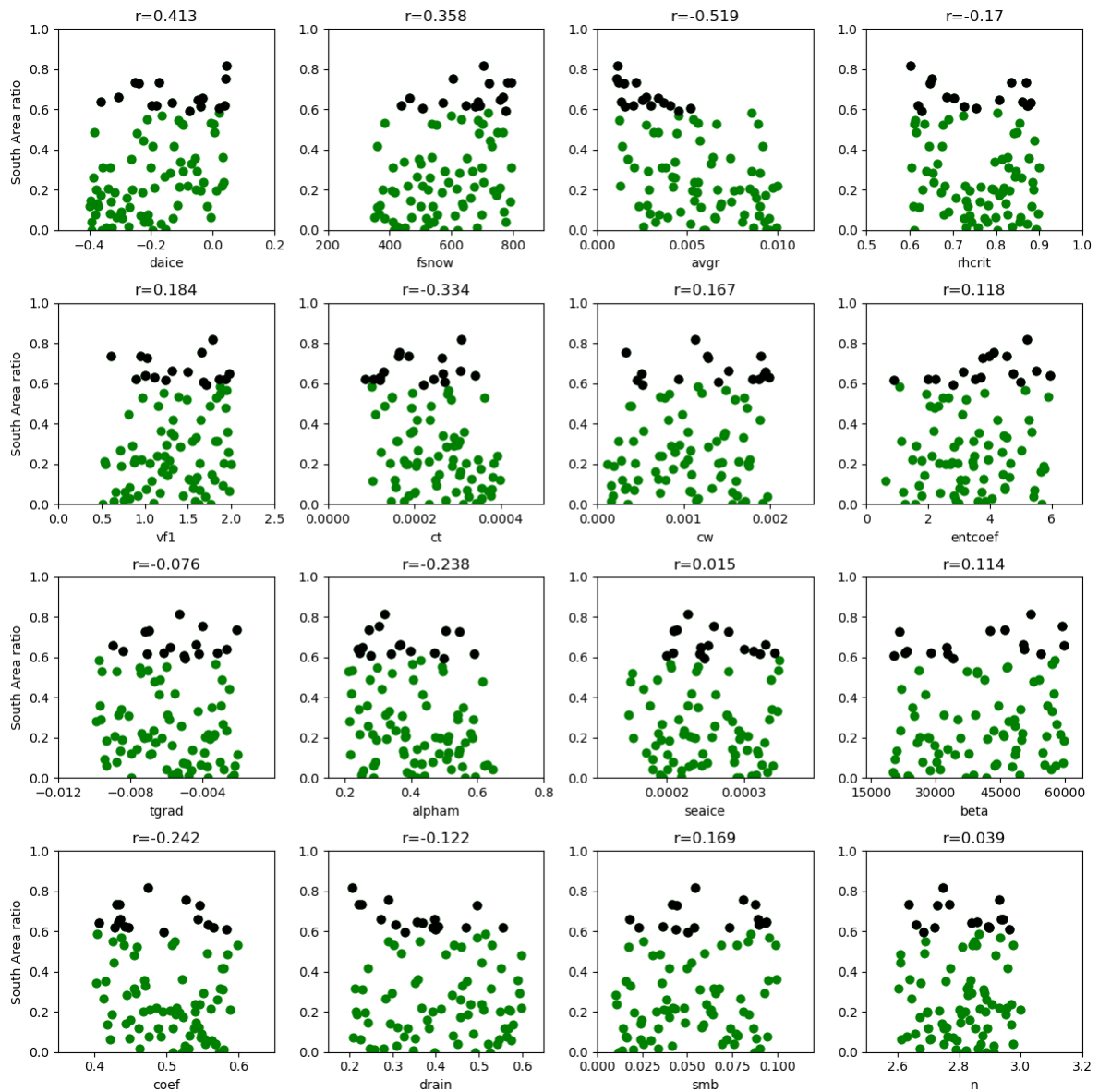
Fig. S2 Differences in ice thickness between ice year 5000 and ice year 10000. Results of 6

members out of 16 good simulations are shown.

13

14 Fig. S3 Relationship between the changes in the North American ice sheet volume in the first

15 500 ice years in FAMOUS-BISICLES and each perturbed parameter. Only those ensemble

16 members that satisfy the global temperature constraint are used. Correlation values are

17 displayed above each panel.

18

19 Fig. S4 Relationship between the southern extent of North American ice sheet at 5000 ice

20 years in FAMOUS-BISICLES and each perturbed parameter. Only those ensemble members

21 that satisfy the global temperature constraint are used. Correlation values are displayed above

22 each panel. Black dots correspond to the best sixteen members.

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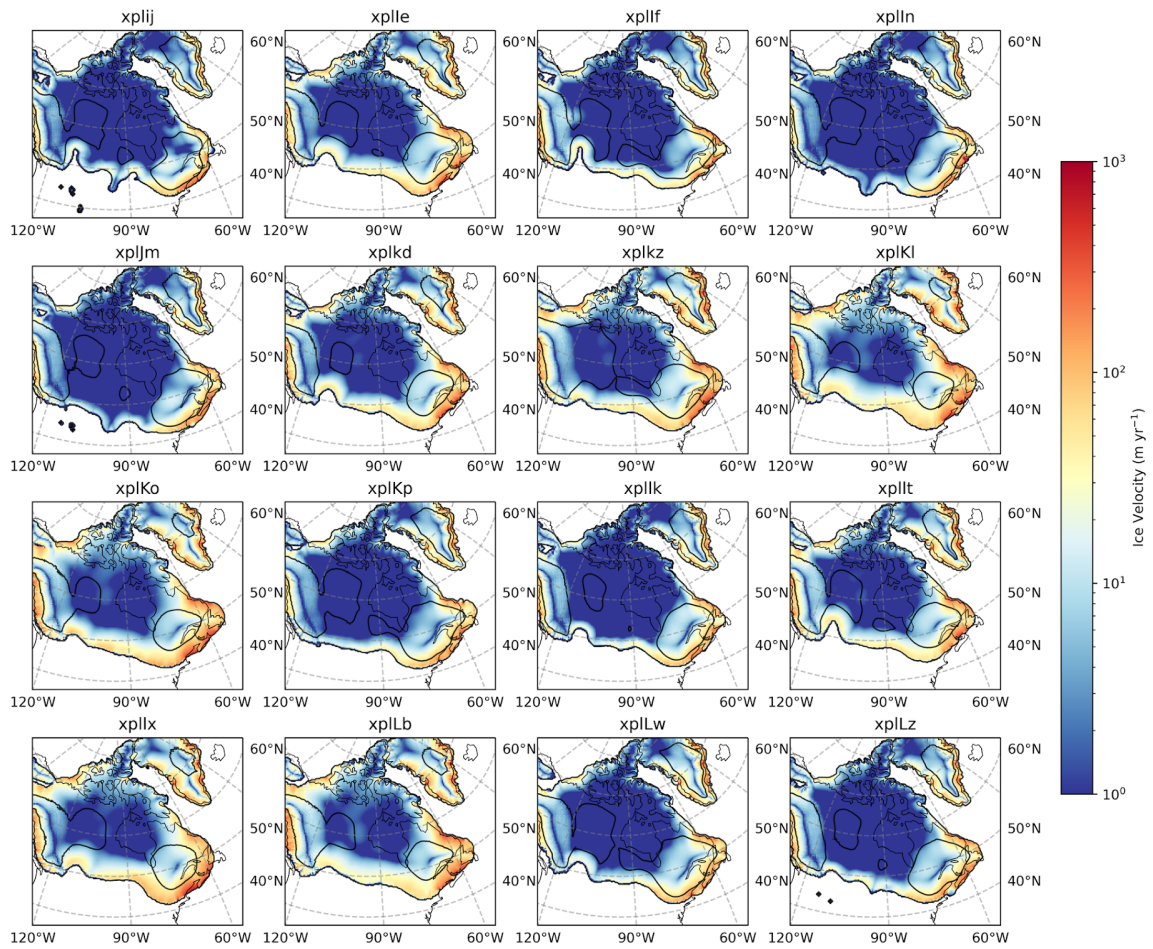

25

26   Fig. S5 Spatial maps of ice velocity (colour, m/year) and surface elevation (thick black

27   contour, 0 and 3000 m) from sixteen good simulations.

28

29

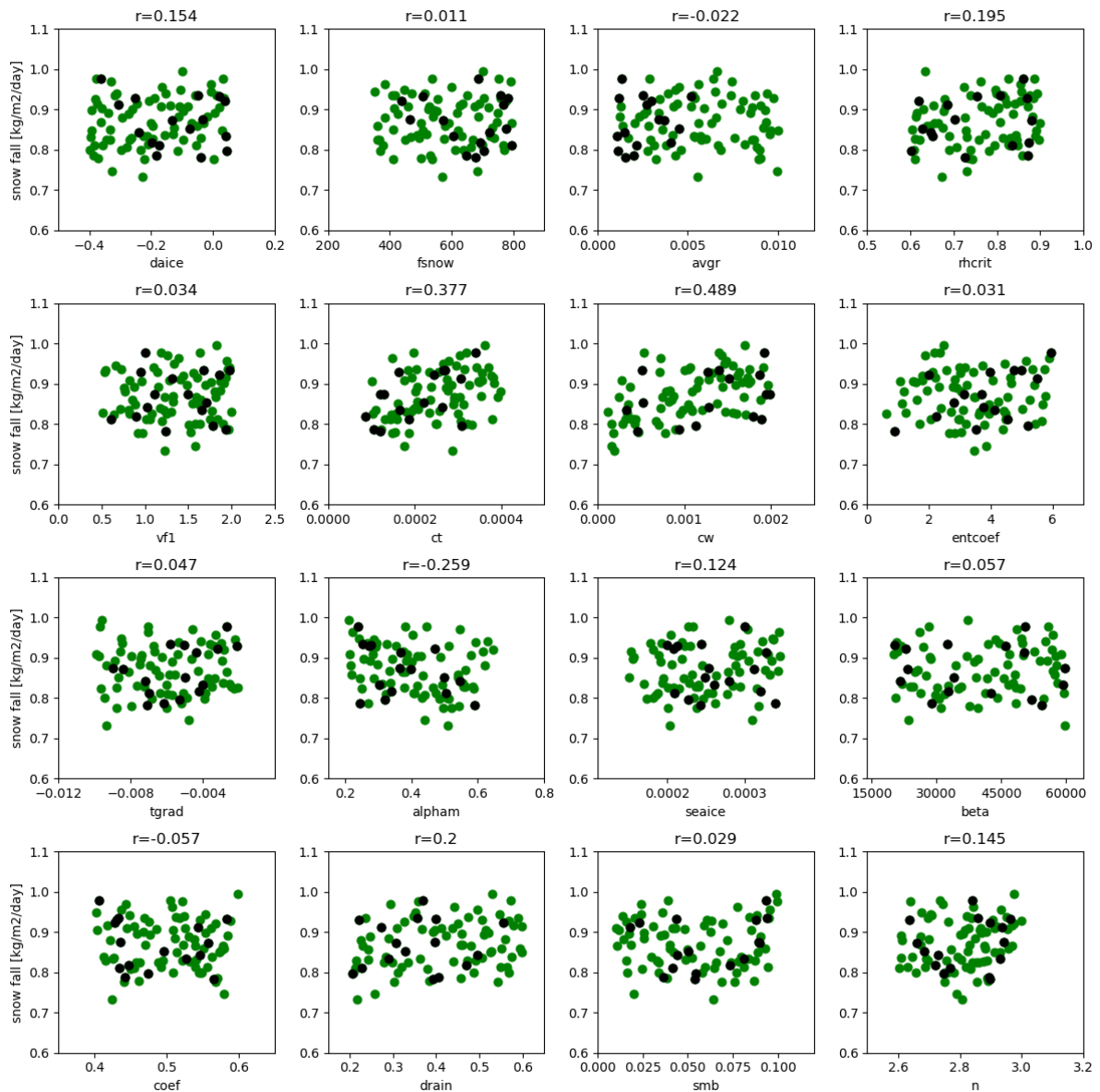
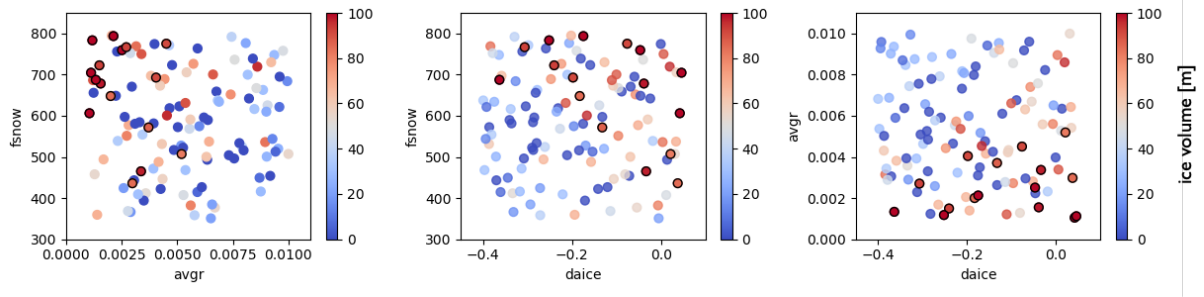



Fig. S6 Relationship between the snowfall rate (kg/m²/day) over the southeastern North
America (82.5˚W-52.5˚W, 35˚N-60˚N) in FAMOUS-BISICLES and each perturbed
parameter. Only those ensemble members that satisfy the global temperature constraint are
used. Correlation values are displayed above each panel. Black dots correspond to the best
sixteen members.

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36 Fig. S7 Pair plot analysis exploring the combined effects of *fsnow*, *avgr* and *daice* on the ice

37 volume of the North American ice sheet (colours, m SLE). Filled circles outlined in black are

38 the best sixteen members.

39

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