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A history-matching analysis of the Antarctic Ice Sheet since the Last Interglacial – Part 1: Ice sheet evolution

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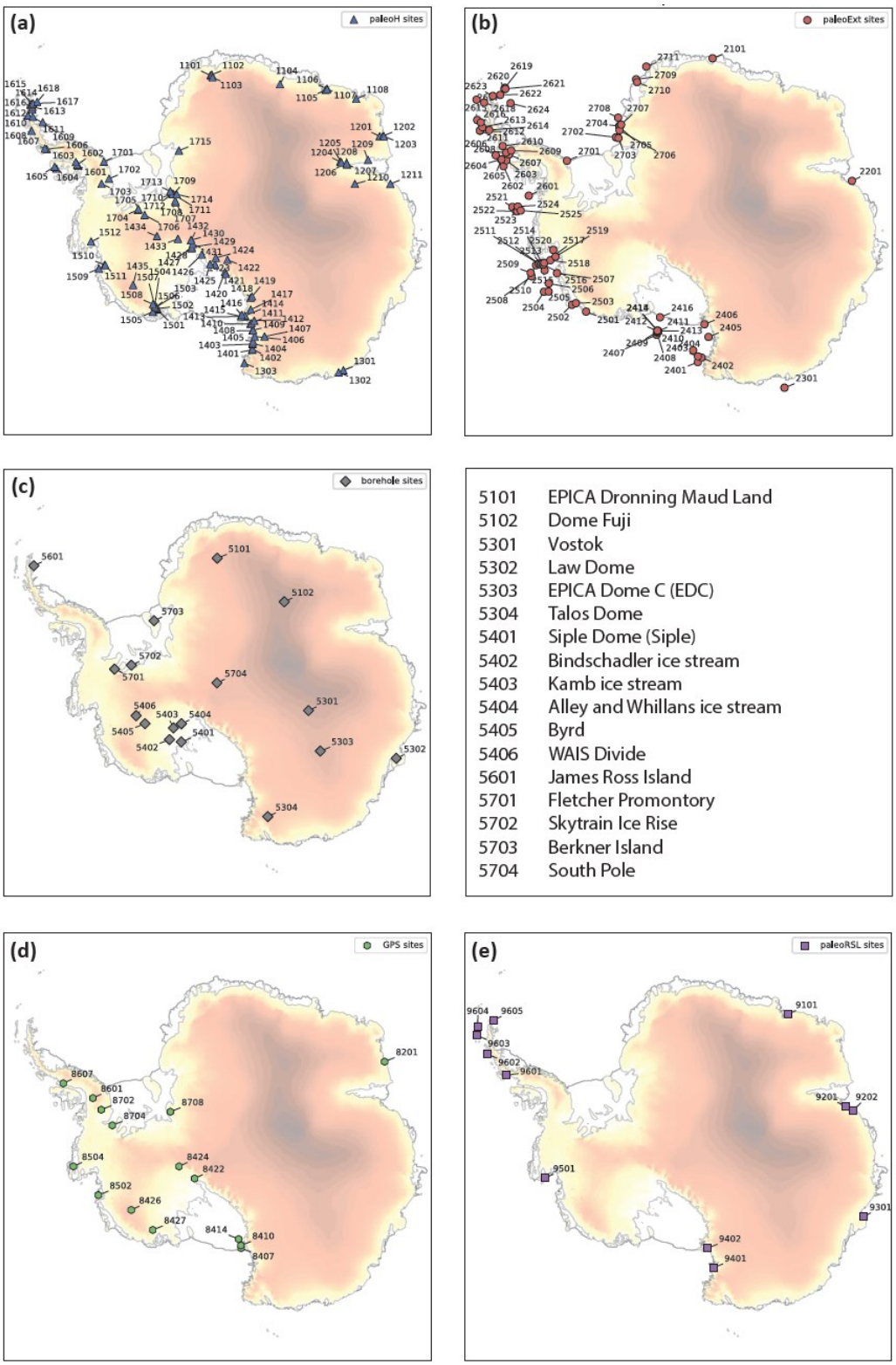

Figure S1: AntICE2 observational constraint database used to history match the Glacial Systems Model. a - f) are the site locations and identification numbers for past ice thickness data (paleoH), past ice extent data (paleoExt), ice core borehole temperature profiles (ICbore) and names, present-day uplift rates (rdotGPS), and past relative sea level data (paleoRSL) respectively.

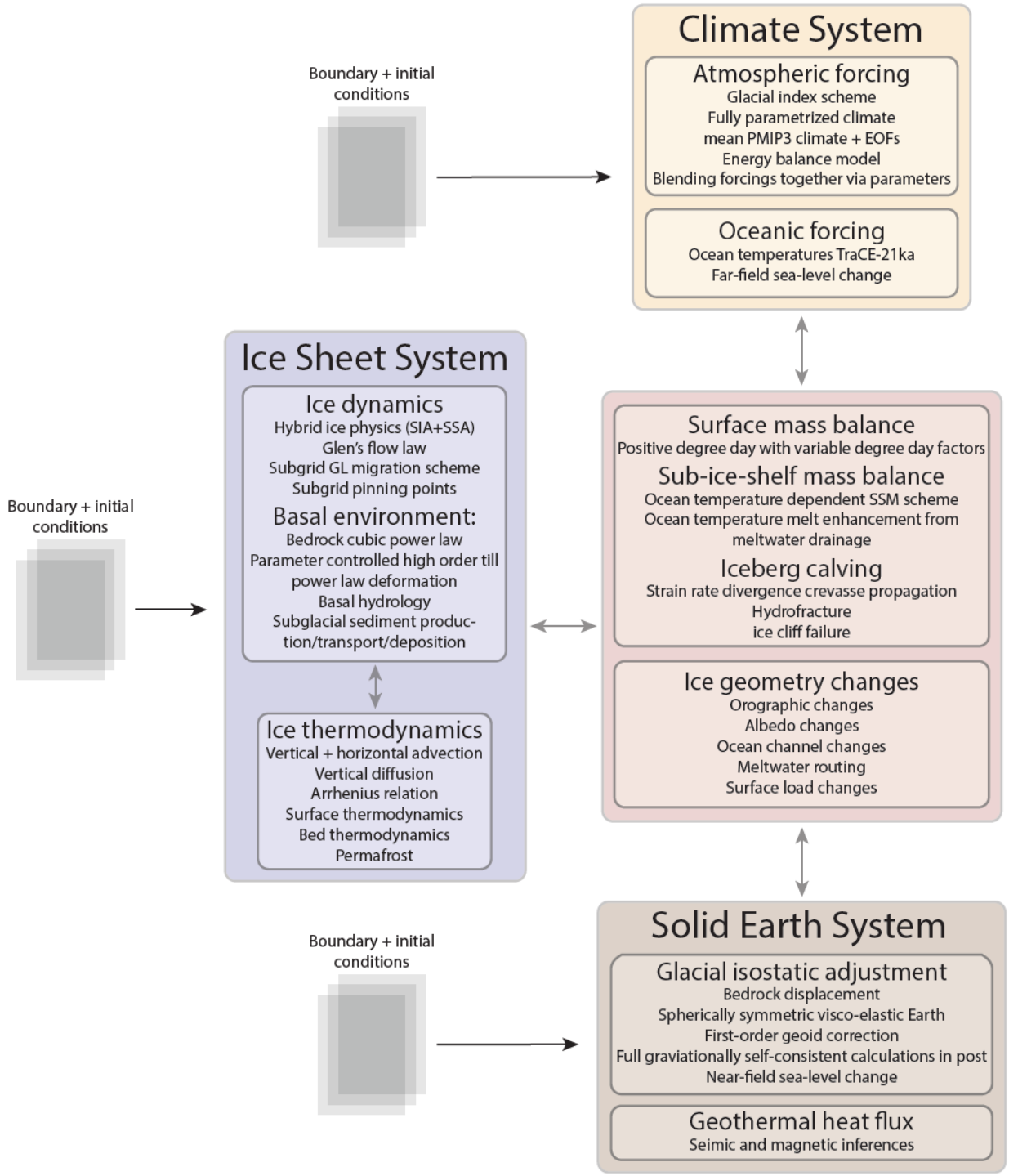

Figure S2: Diagram summarizing major components of the Glacial Systems Model (GSM).

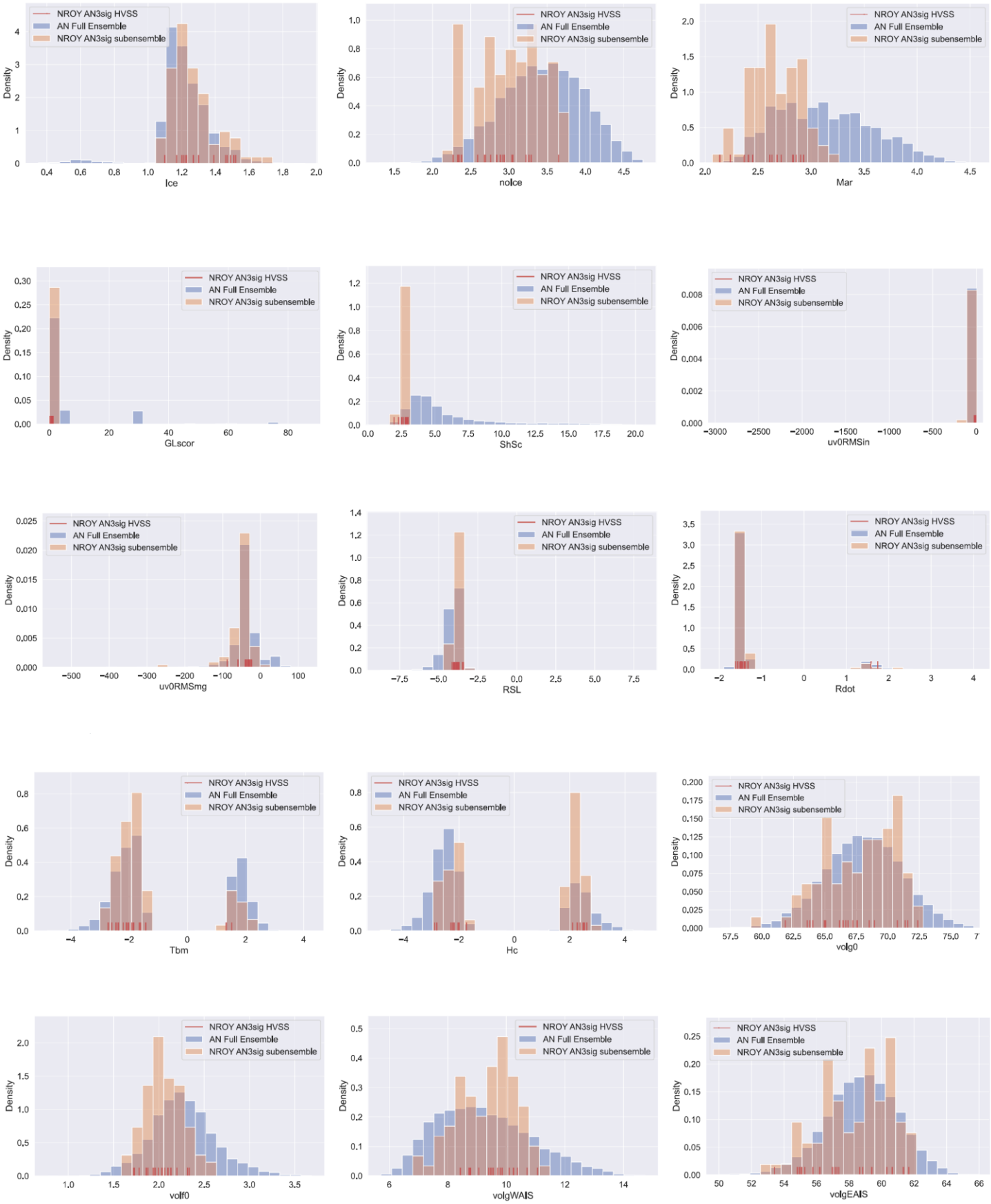

Figure S3: Distribution of output scores and metrics for the full ensemble (blue), not-ruled-out-yet (NROY) AN3sig sub-ensemble (orange), and NROY sub-ensemble high variance subset (red). The individual model scores are defined in Table S1. The present-day (PD) metrics shown are the PD grounded ice volume (volg0), PD floating ice volume (volf0), PD West AIS grounded ice volume (volgWAIS), and PD East AIS grounded ice volume (volgEAIS).

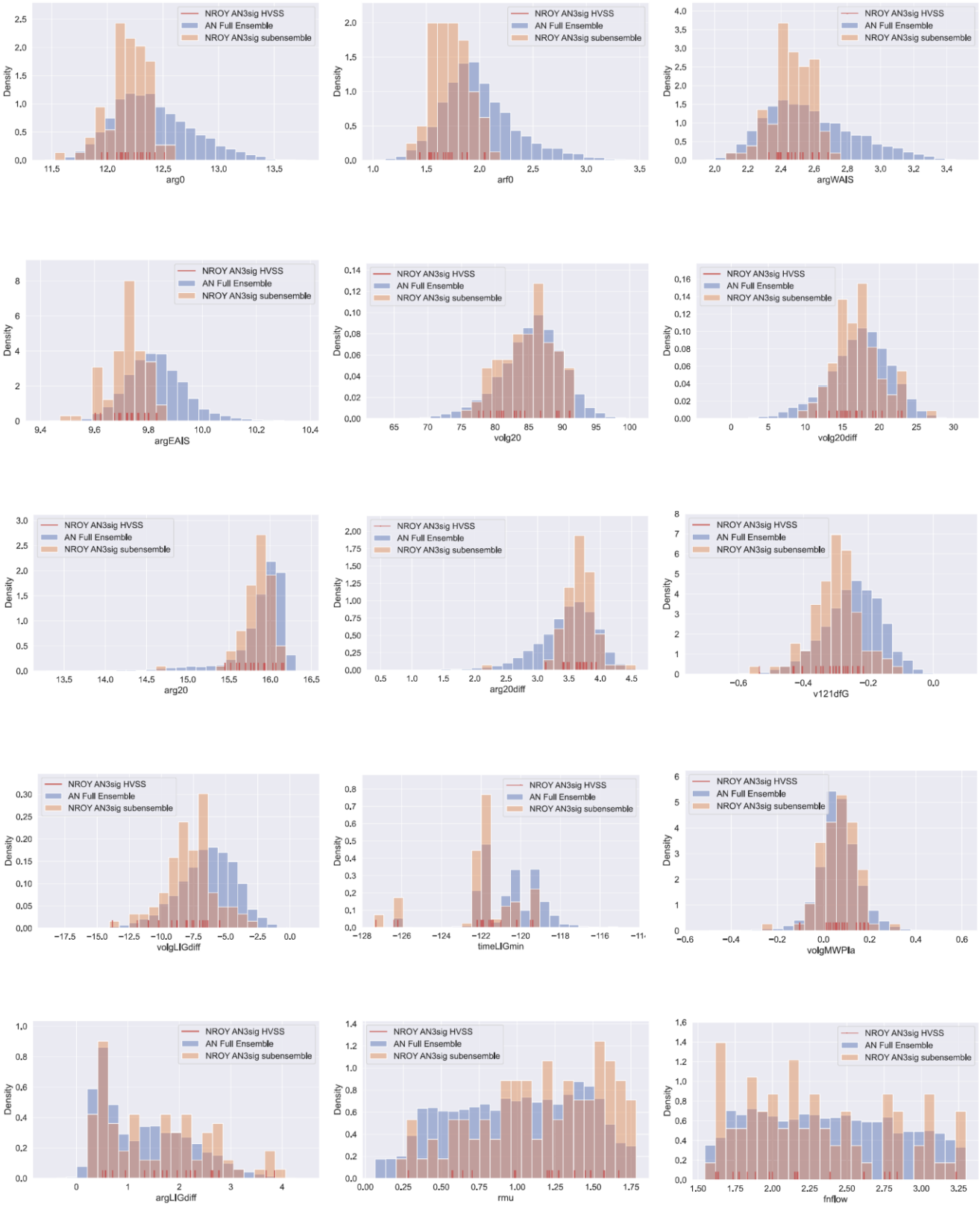

Figure S4: Distribution of output metrics, scores, and ensemble parameters (detailed in Table 1) for the full ensemble (blue), not-ruled-out-yet (NROY) AN3sig sub-ensemble (orange), and NROY sub-ensemble high variance subset (red). The present-day (PD) metrics shown are PD grounded ice area (arg0), PD floating ice area (arf0), PD West AIS grounded ice area (argWAIS), and PD East AIS grounded ice area (argEAIS). The LGM metrics shown are the 20 ka grounded ice volume (volg20), 20 ka grounded ice volume excess relative to present (volg20diff), 20 ka grounded ice area (arg20), 20 ka grounded ice area excess relative to present (arg20diff). The Meltwater Pulse 1a (MWP1a) metric is the grounded ice volume change over the MWP1interval (volgMWP1a). The last interglacial (LIG) metrics

are the timing of the LIG AIS minimum (timeLIGmin), LIG grounded ice volume deficit relative to present (volgLIGdiff/v121dfG), and LIG grounded ice area deficit relative to present (argLIGdiff).

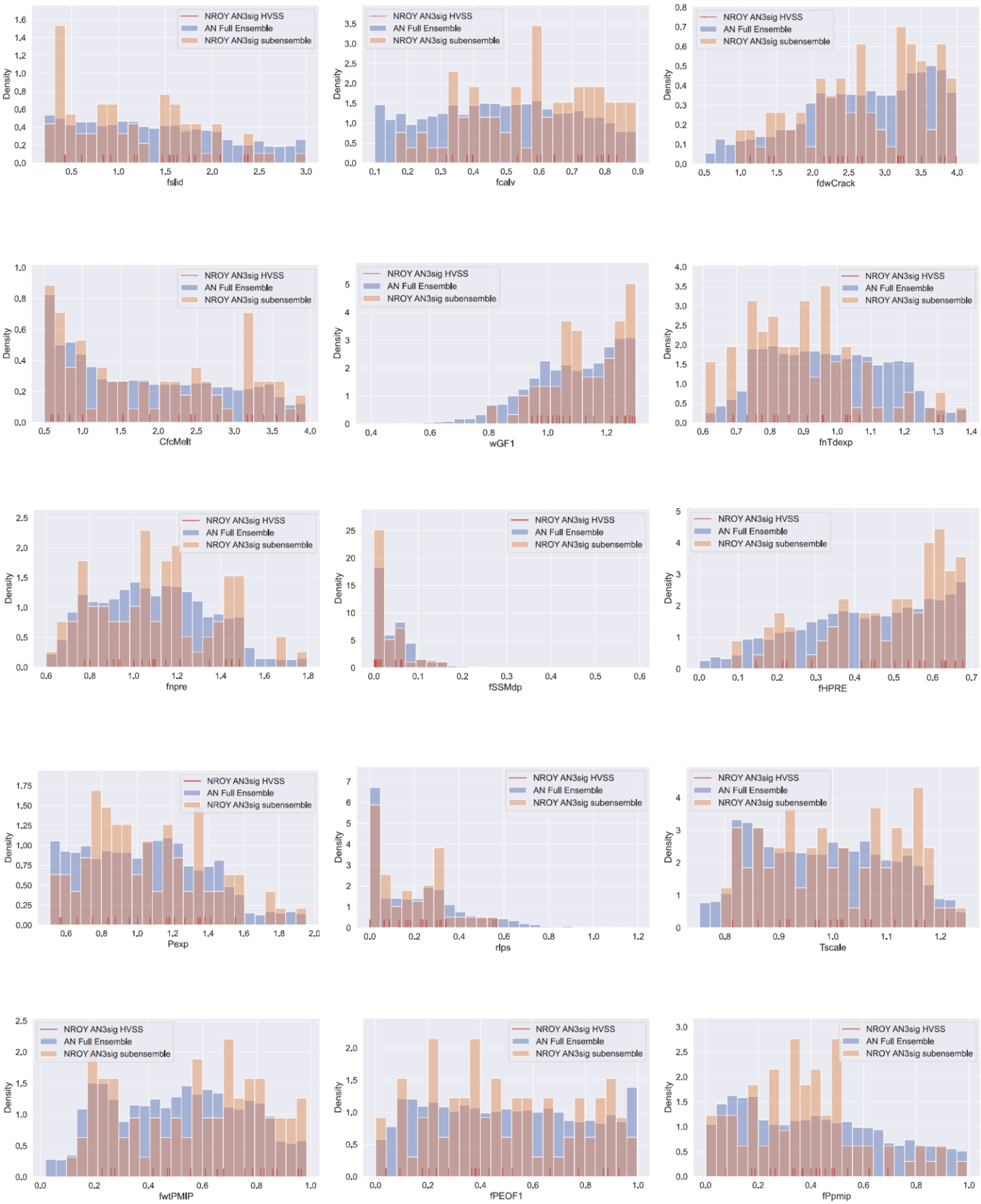

Figure S5: Distribution of ensemble parameters (detailed in Table 1) for the full ensemble (blue), not-ruled-out-yet (NROY) AN3sig sub-ensemble (orange), and NROY sub-ensemble high variance subset (red).

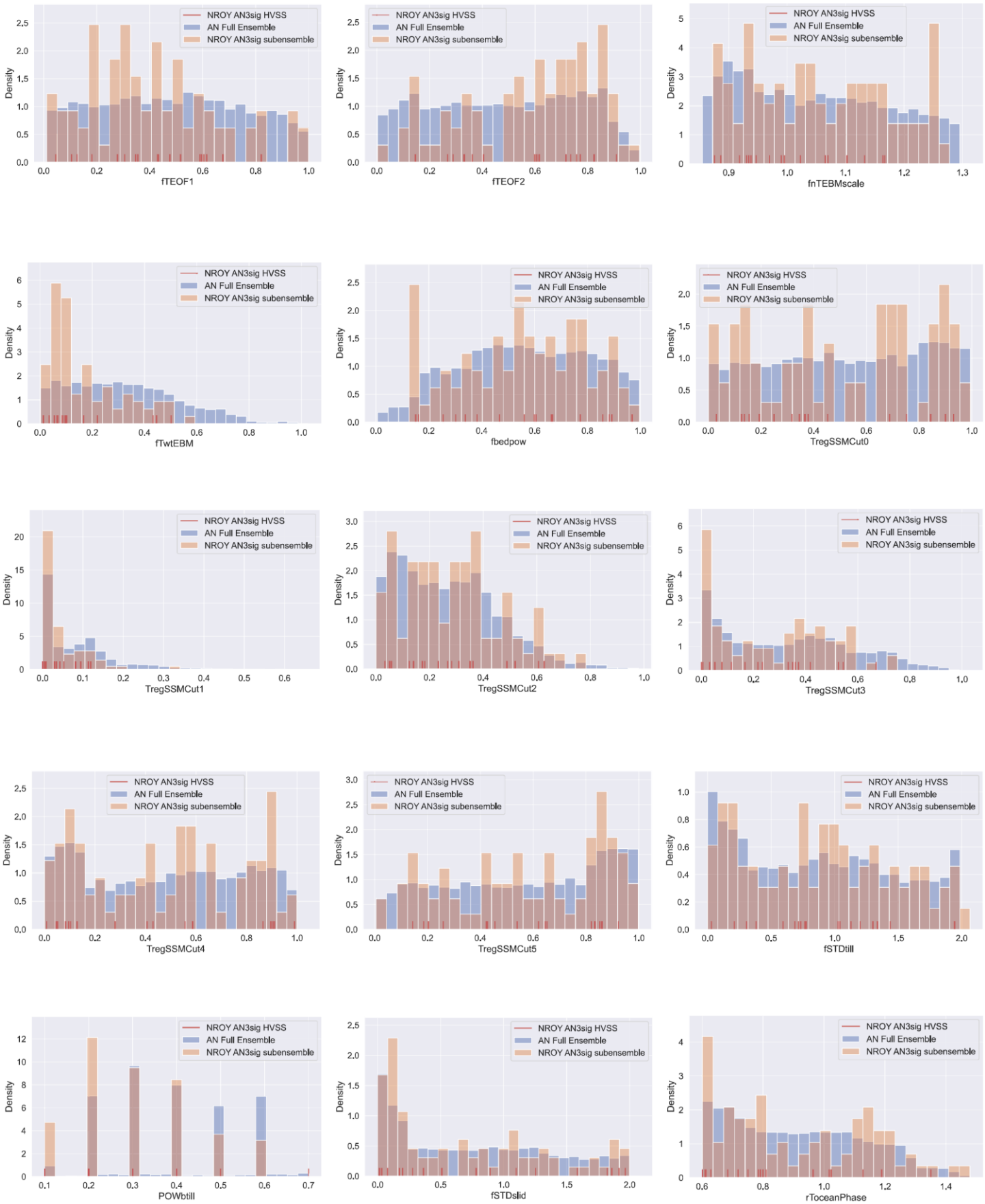

Figure S6: Distribution of ensemble parameters (detailed in Table 1) for the full ensemble (blue), not-ruled-out-yet (NROY) AN3sig sub-ensemble (orange), and NROY sub-ensemble high variance subset (red).

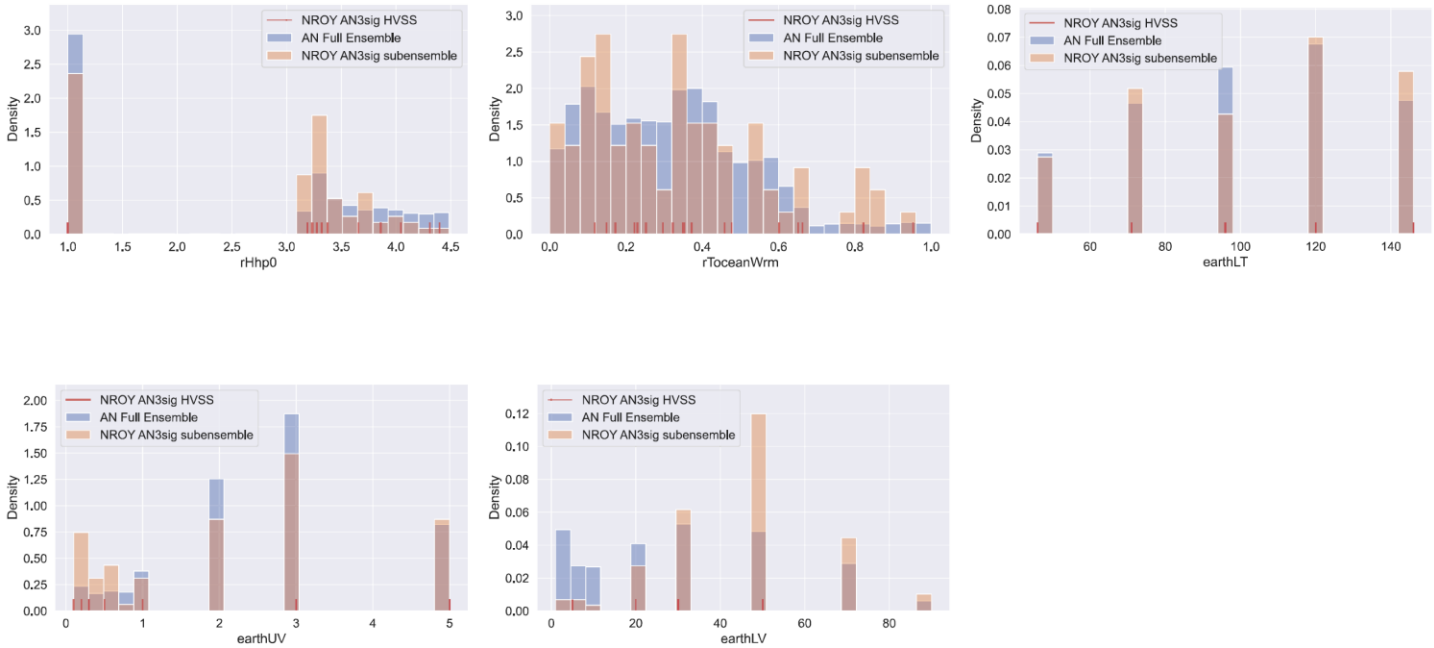

Figure S7: Distribution of ensemble parameters (detailed in Table 1) for the full ensemble (blue), not-ruled-out-yet (NROY) AN3sig sub-ensemble (orange), and NROY sub-ensemble high variance subset (red).

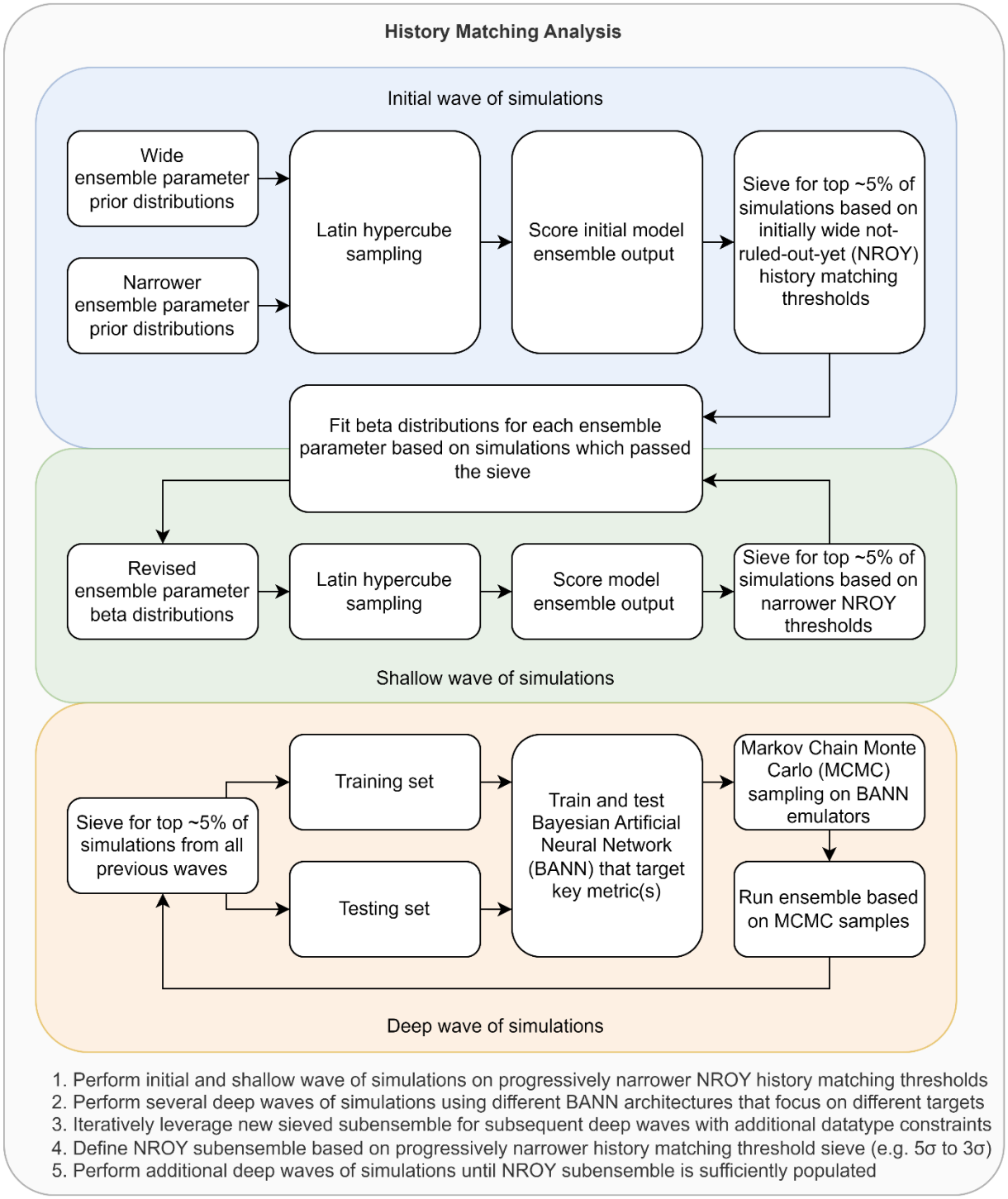

Figure S8: Diagram illustrating the history matching analysis methodology.

Table S1: The thresholds imposed on the AntICE2 data-model scores in the history matching analysis. The thresholds to define the AN4sig and AN3sig sub-ensembles are based on internal/external discrepancy bias corrections plus 4 or 3 multiples of the standard deviations, respectively.

Constraint datatype	Score	Bias	Standard deviation
Present-day	WAIS H RMS (waisRMS)	0	161
Present-day	EAIS H RMS (eaisRMS)	16	135
Present-day	Floating ice H RMS (fltRMS)	34	65
Present-day	Ice shelf score (ShSc)	0	1
Present-day	PD grounding line score (GLscor)	0	1
Borehole temp	Borehole ice temp score (Tbm)	0	1
Borehole temp	Ice core site H diff score (Hc)	0	1
Paleo extent	Marine extent score (Mar)	0.14	1.04
Paleo ice thickness	Deglaciated no ice score (noIce)	0.22	1.02
Paleo ice thickness	Glaciation ice score (Ice)	0.15	1
Paleo RSL	RSL score (RSL)	-0.1	1.01
GPS	Uplift rate score (Rdot)	-0.02/0.06	1.06

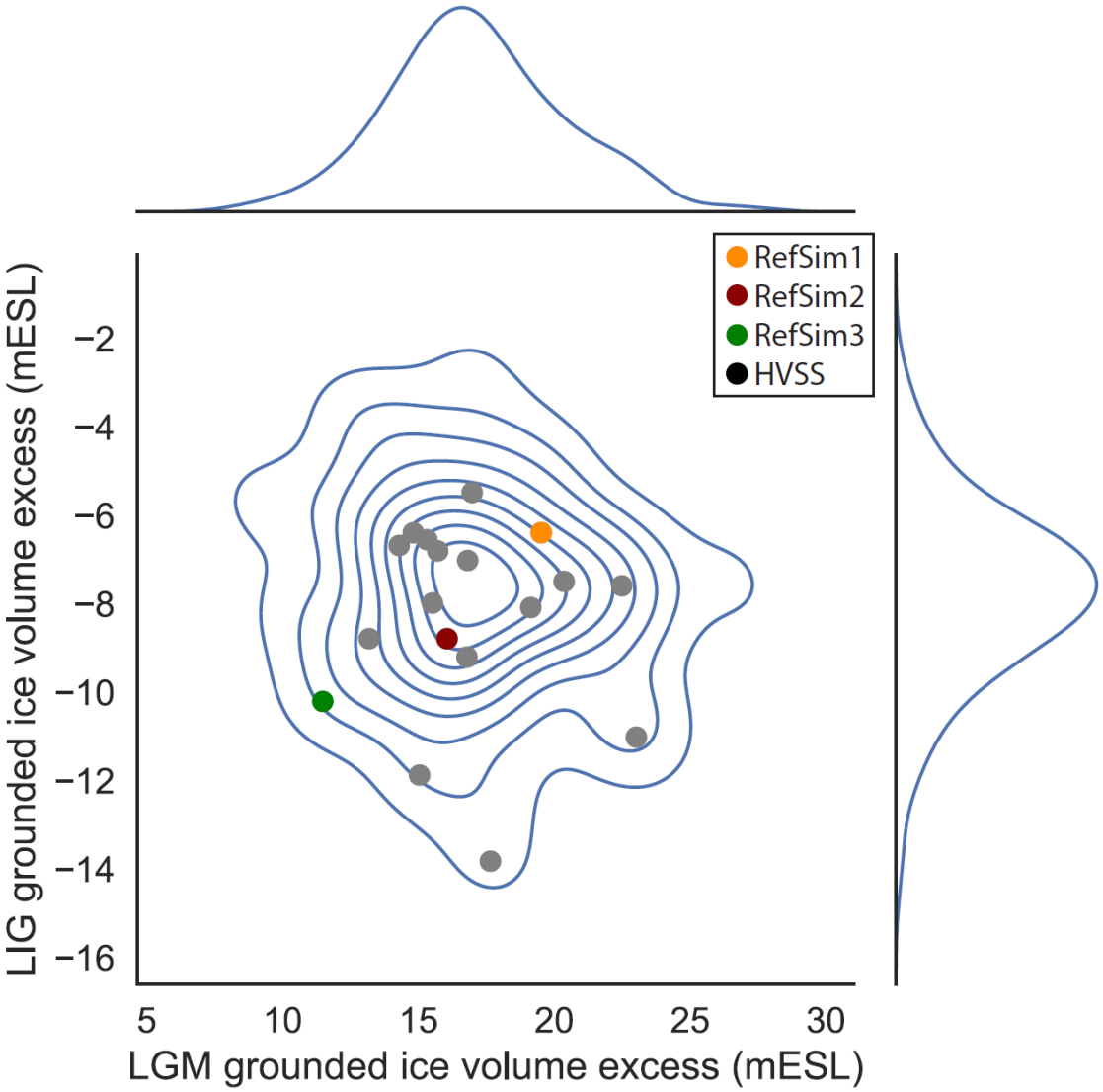

Figure S9: High variance subset (HVSS; N=18) of simulations in the not-ruled-out-yet (NROY) AN3sig sub-ensemble.

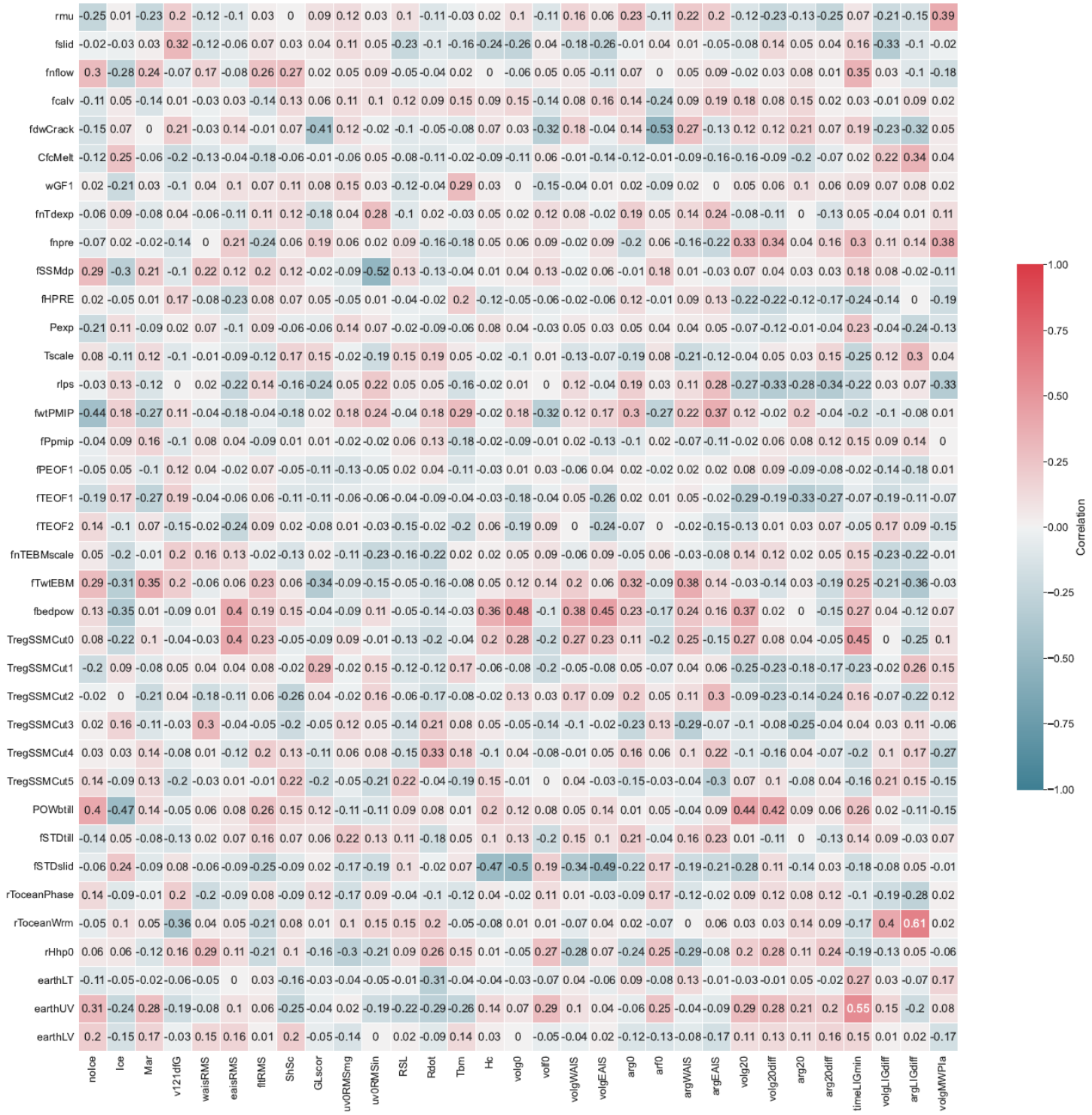

Figure S10: Metric/score-parameter correlation heat map of not-ruled-out-yet (NROY) AN3sig sub-ensemble. The ensemble parameters are defined in Table 1, the individual model scores are defined in Table S1. The present-day (PD) metrics shown are the PD grounded ice volume (volg0), PD floating ice volume (volf0), PD West AIS grounded ice volume (volgWAIS), PD East AIS grounded ice volume (volgEAIS), PD grounded ice area (arg0), PD floating ice area (arf0), PD West AIS grounded ice area (argWAIS), and PD East AIS grounded ice area (argEAIS). The LGM metrics shown are the 20 ka grounded ice volume (volg20), 20 ka grounded ice volume excess relative to present (volg20diff), 20 ka grounded ice area (arg20), 20 ka grounded ice area excess relative to present (arg20diff). The Meltwater Pulse 1a (MWP1a) metric is the grounded ice volume change over the MWP1interval (volgMWP1a). The last interglacial (LIG) metrics are the timing of the LIG AIS minimum (timeLIGmin), LIG grounded ice volume deficit relative to present (volgLIGdiff), and LIG grounded ice area deficit relative to present (argLIGdiff).

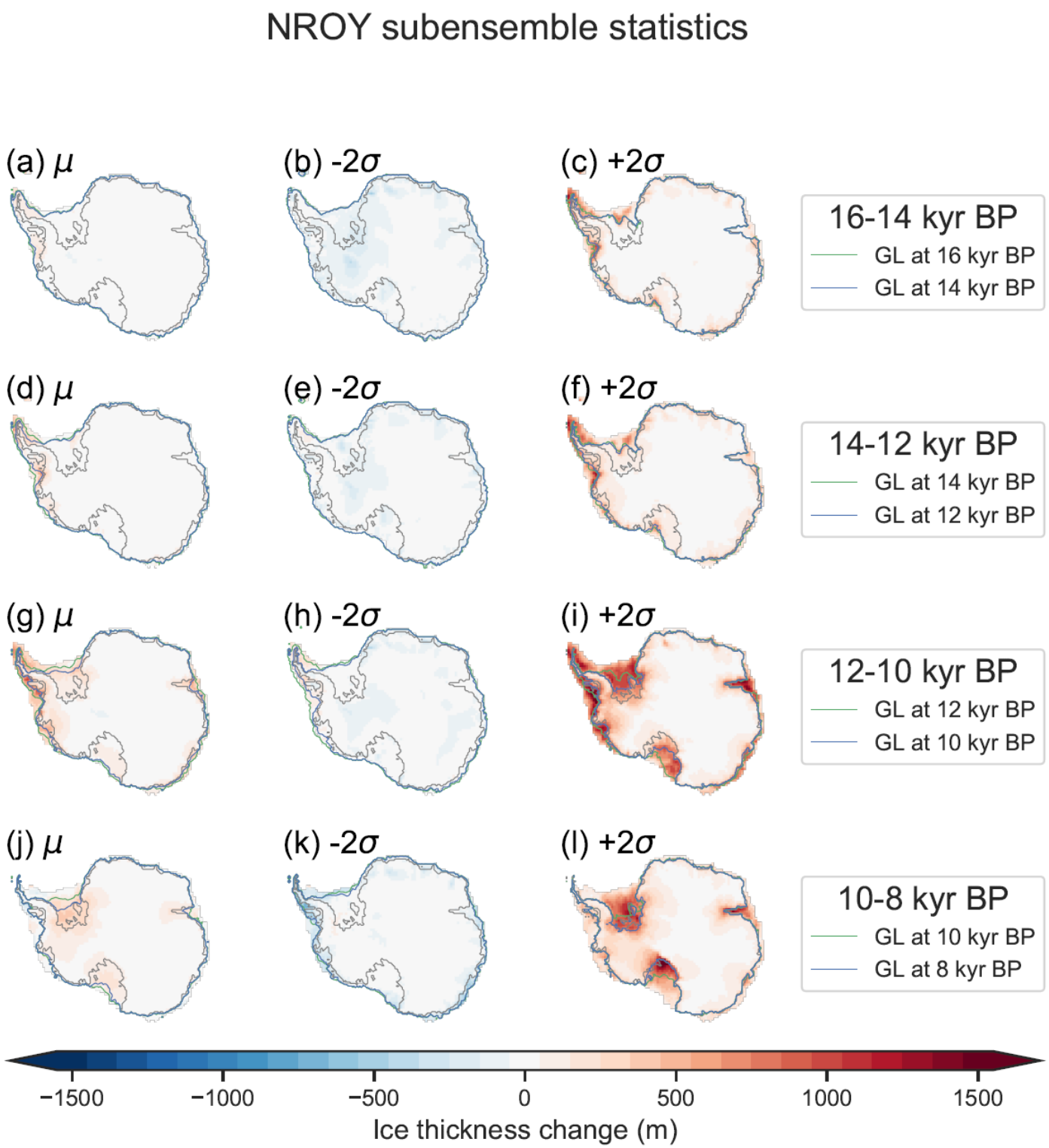

Figure S11: NROY AN3sig sub-ensemble deglacial ice thickness difference for the interval of a-c) 16-14 ka d-f) 14-12 ka g-i) 12-10 ka j-l) 10-8 ka and their respective grounding lines for the ensemble mean (leftmost column), -2σ bound (center column), and +2σ bound (rightmost column).

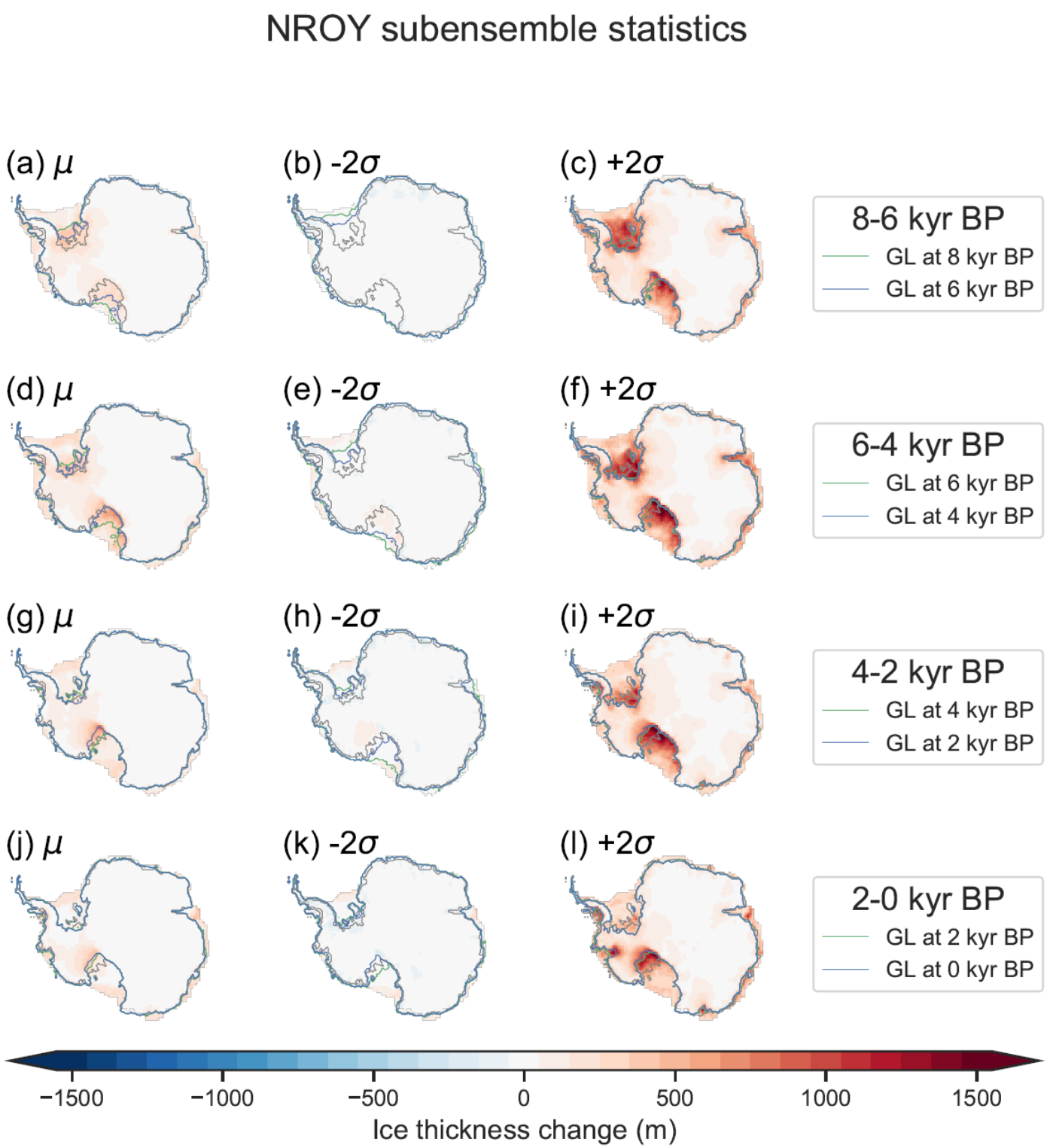

Figure S12: NROY AN3sig sub-ensemble deglacial ice thickness difference for the interval of a-c) 8-6 ka d-f) 6-4 ka g-i) 4-2 ka j-l) 2-0 ka and their respective grounding lines for the ensemble mean (leftmost column), -2σ bound (center column), and +2σ bound (rightmost column).