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Supplement of

Diverging runoff drives uncertainty in Antarctic surface mass balance projections under a high emission scenario

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1 Supplementary

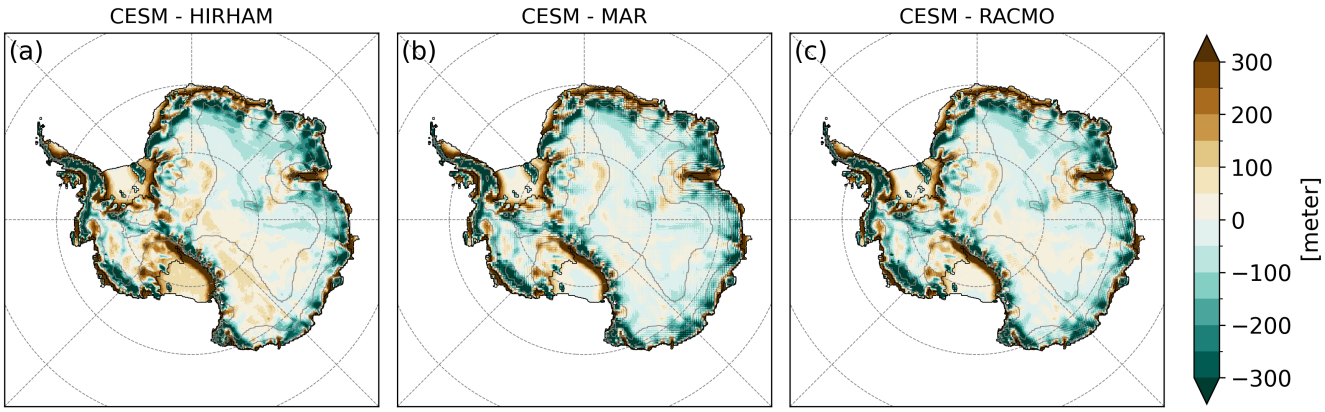


Figure S1. Surface Height differences between CESM and RCMs : HIRHAM (a), MAR (b), and RACMO (c), driven by CESM, in meters.

$$\text{NRMSE}(\%) = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}(M_i - O_i)^2}}{\frac{1}{N}\sum_{i=1}^{N} O_i} \times 100 \tag{S1}$$

Equation of the normalized root mean square error (NRMSE) between models (M) and observations (O) over N years.

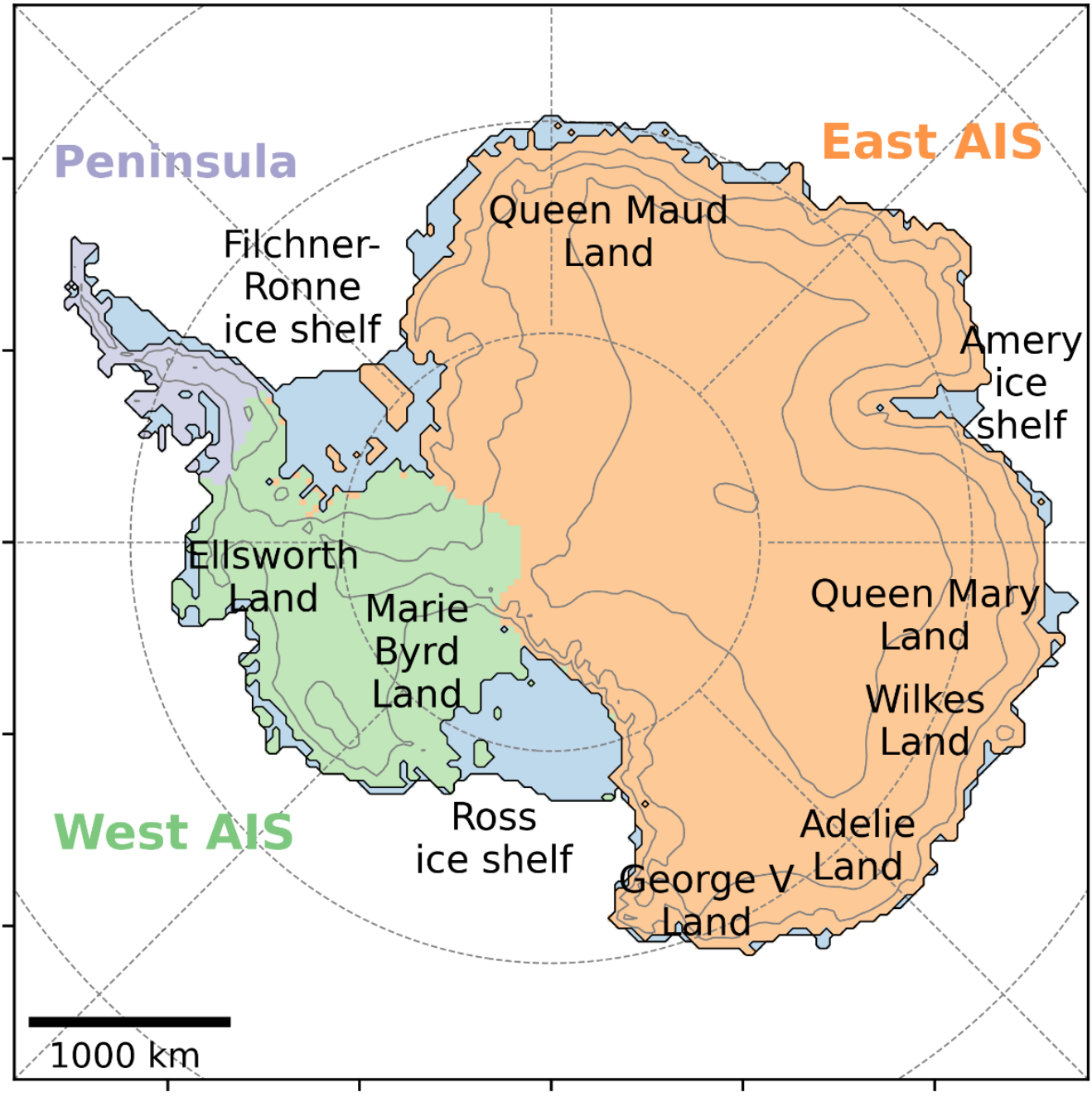


Figure S2. The Antarctic regions and sub-regions discussed in the manuscript with elevations contours every 1000m. The ice shelves are represented in light blue. The map was taken from the supplementary material of Kittel et al. (2021)

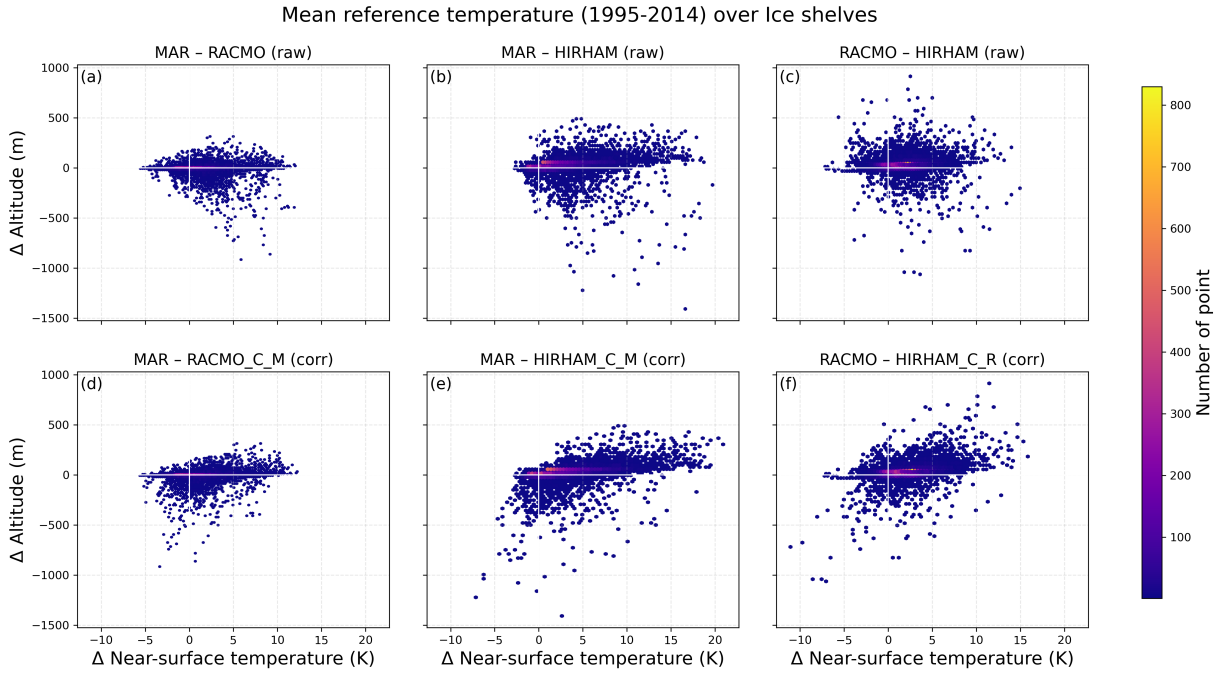


Figure S3. Scatter plots of ice-shelf altitude differences as a function of the reference-period (1995–2014) mean near-surface air temperature in K) between MAR and RACMO (a), MAR and HIRHAM (b), and RACMO and HIRHAM (c). Temperature-difference panels (d), (e), and (f) were corrected using a lapse rate of -1 °C per 100 m (Magand et al., 2004), with MAR used as the altitude reference in panels (d) and (e), and RACMO used as the altitude reference in panel (f).

Table S1. Contemporary means (1995–2014) integrated in $\mathrm{Gt\,yr^{-1}}$ of SMB, solid (SP) and liquid precipitation (LP), runoff (RU), melt (ME), refreezing (RF), and sublimation (SU), calculated as the mean for 2080–2099 relative to the reference period 1995–2014. For HIRHAM, MAR, and RACMO driven by CESM and CESM under the SSP5-8.5 scenario, over the grounded ice and ice shelves. All anomalies exceed interan-nual variability (i.e., the standard deviation) and are therefore considered significant.

Models	SMB	SP	LP	ME	RF	RU	SU
Grounded ice (11.98×10^6 $\mathrm{km^2}$)							
HIRHAM	2070 ± 30	2271 ± 34	13 ± 2	158 ± 9	125 ± 10	46 ± 2	158 ± 3
MAR	2232 ± 37	2335 ± 36	7 ± 1	25 ± 2	28 ± 2	4 ± 0	105 ± 2
RACMO	2001 ± 39	2134 ± 40	1 ± 40	27 ± 4	27 ± 4	1 ± 0	129 ± 2
CESM2	2399 ± 48	2557 ± 48	28 ± 2	86 ± 7	93 ± 7	21 ± 3	165 ± 3
Ice shelves (1.49×10^6 $\mathrm{km^2}$)							
HIRHAM	382 ± 11	495 ± 10	5 ± 1	297 ± 13	224 ± 13	78 ± 4	40 ± 1
MAR	374 ± 6	417 ± 6	6 ± 1	62 ± 3	56 ± 3	12 ± 1	36 ± 0
RACMO	420 ± 8	455 ± 8	2 ± 0	62 ± 6	62 ± 6	2 ± 0	35 ± 0
CESM2	471 ± 8	507 ± 7	26 ± 2	101 ± 5	114 ± 6	13 ± 3	49 ± 1

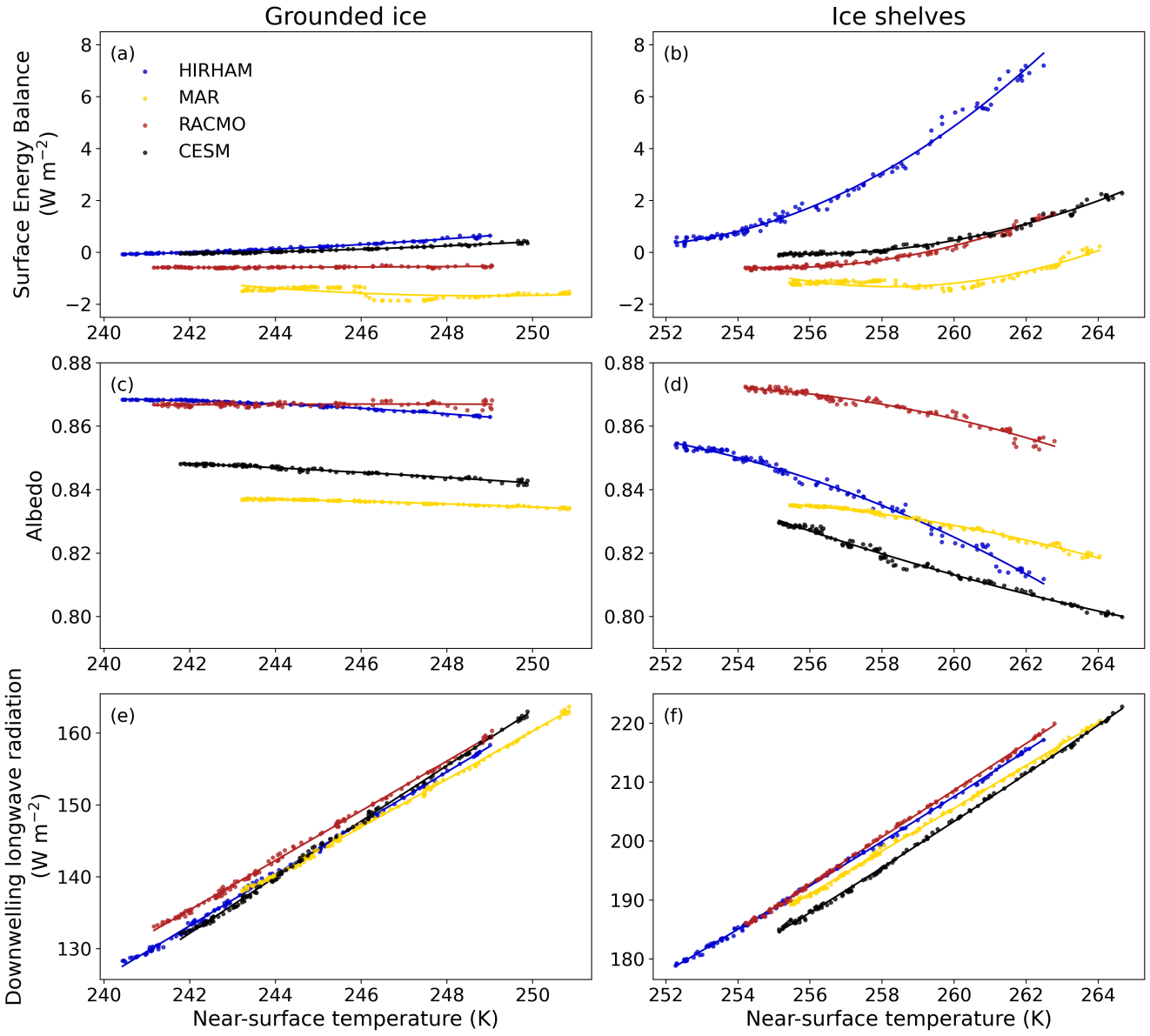


Figure S4. Absolute SEB (W m^{-2}; panels a and b) and albedo (panels c and d) and Longwave Down anomalies (W m^{-2}; panels e and f) as a function of absolute annual near-surface air temperature in K. For the models MAR (yellow), HIRHAM (blue), and RACMO (red) driven by CESM (black) under the SSP5-8.5 scenario. Values are integrated over grounded (left) and floating (right) parts of the ice sheet. A 5-year running mean is applied for clarity.

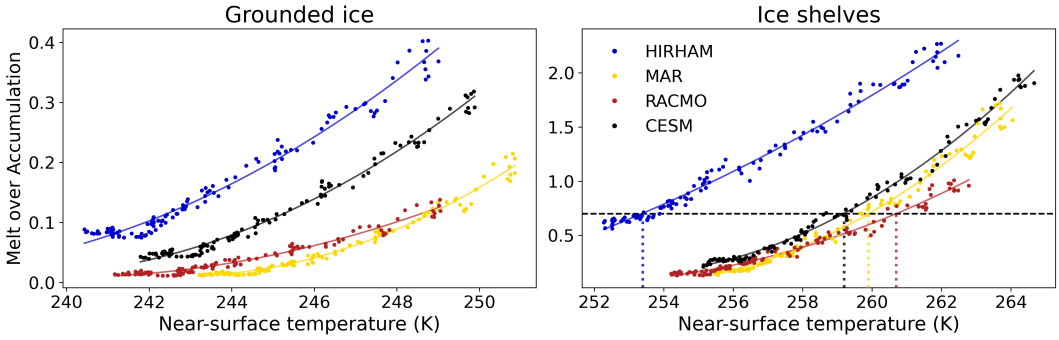


Figure S5. Liquid water (melt + rainfall) over accumulation (snowfall - sublimation) ratio (MOA), as a function of the absolute annual near-surface air temperature in K. For the models MAR (yellow), HIRHAM (blue), and RACMO (red) driven by CESM2 (black) under the SSP5-8.5 scenario. The respective vertical dotted lines indicate the temperature at MOA=0.7, horizontal dotted black line. Values are integrated over grounded (left) and floating (right) parts of the ice sheet. Note that the Y-axis scales differ between grounded and floating ice due to the difference in surface areas. A 5-year running mean is applied for clarity.

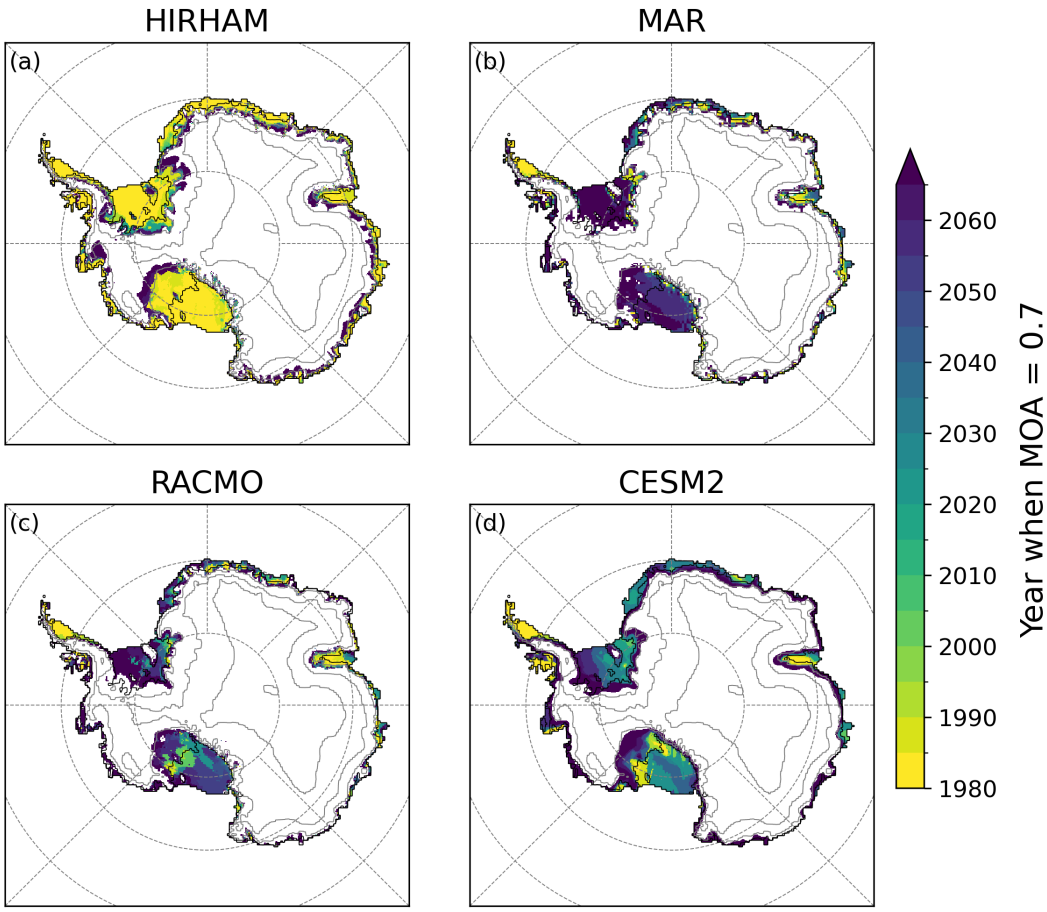


Figure S6. Corresponding year, at each grid point, when the Melt-over-Accumulation ratio reaches the threshold of 0.7 (MOA = 0.7). For HIRHAM (a), MAR (b), RACMO (c), and CESM (d) under the SSP5-8.5 scenario. MOA values are calculated using a 5-year running mean.

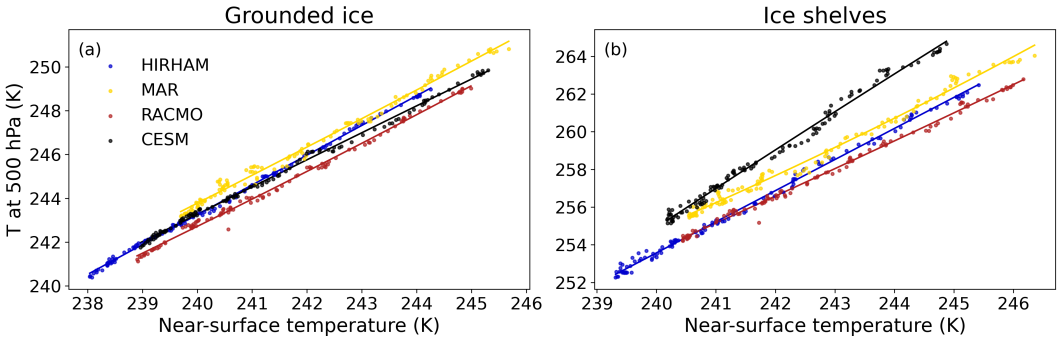


Figure S7. Near-surface temperature (K) as a function of the temperature at 500 hPa (K). For the models MAR (yellow), HIRHAM (blue), and RACMO (red) driven by CESM (black) under the SSP5-8.5 scenario. Values are integrated over grounded (left) and floating (right) parts of the ice sheet. A 5-year running mean is applied for clarity.

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