Supplement of Exploring Inter-Model Variability and Its Causes in Antarctic Surface Mass Balance Downscalings of CESM2 with HIRHAM, MAR, and RACMO up to 2100

Benjamin Heurgue

Correspondence: Benjamin Heurgue (benjamin.heurgue@univ-grenoble-alpes.fr)

1 Supplementary

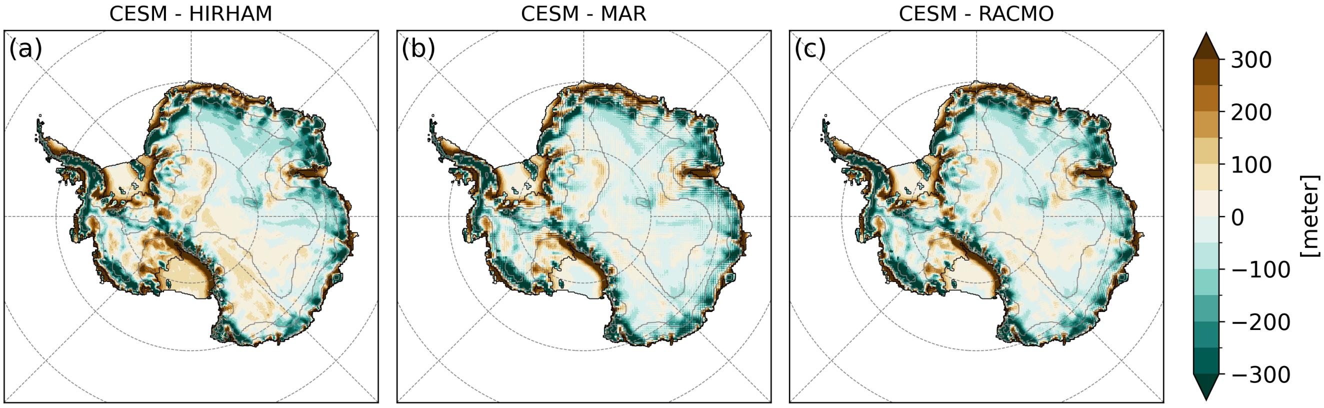

Figure S1. Surface Height differences between CESM and RCMs : HIRHAM (a), MAR (b), and RACMO (c), driven by CESM, in meters.

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

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

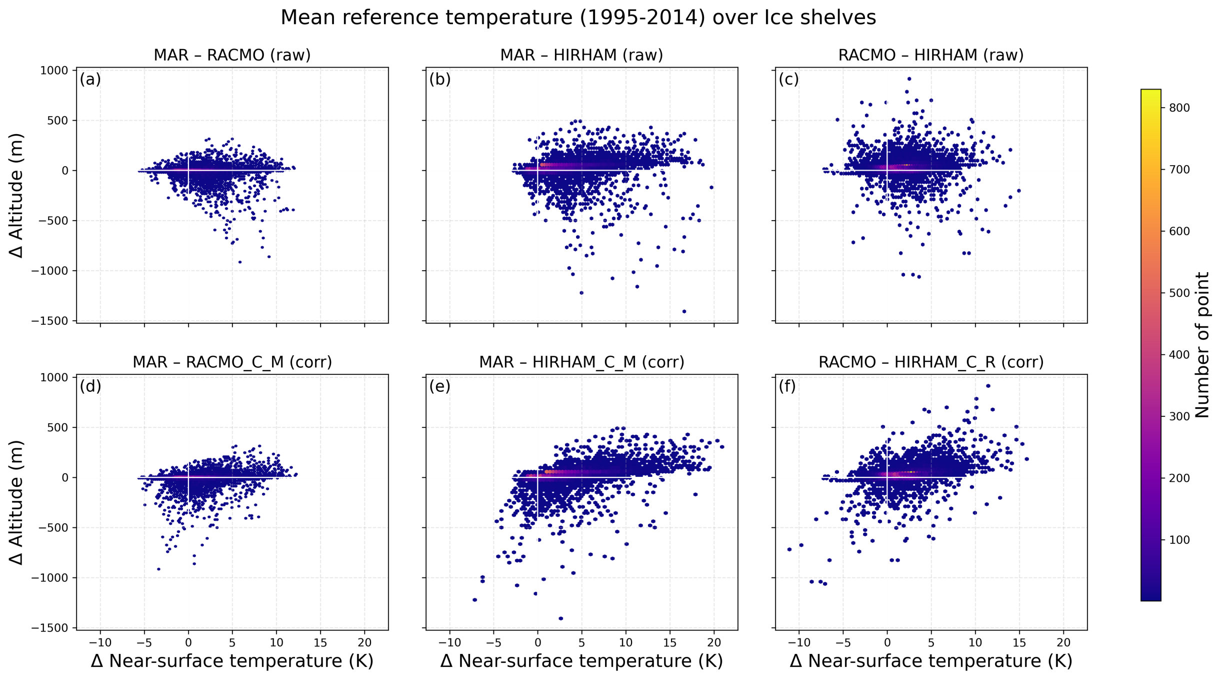

Figure S2. Scatter plots of ice-shelf altitude differences as a function of the reference-period (1995–2014) mean near-surface air temperature in K) between MAR and RACMO (a), MAR and HIRHAM (b), and RACMO and HIRHAM (c). Temperature-difference panels (d), (e), and (f) were corrected using a lapse rate 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

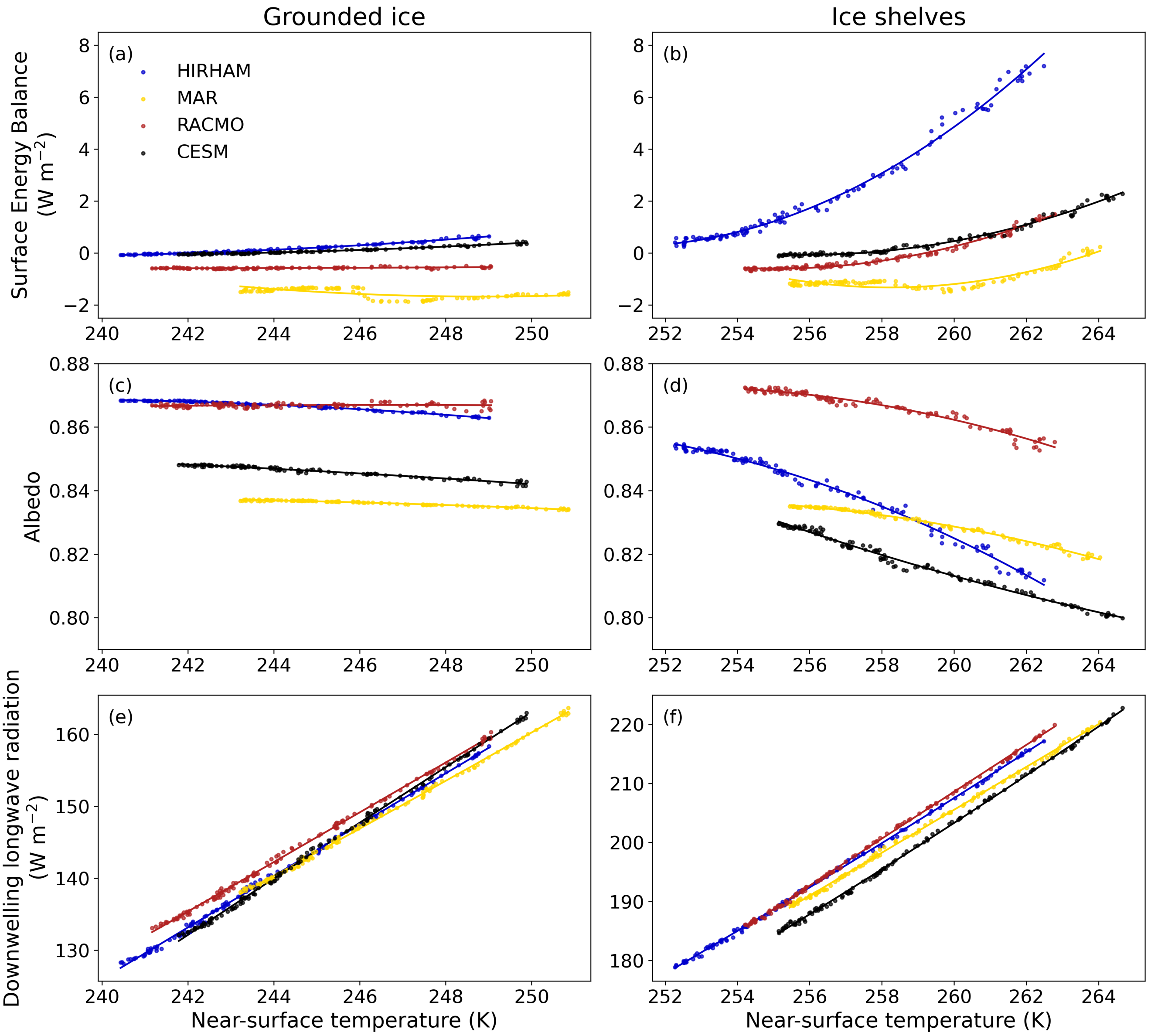

Figure S3. Absolute SEB (W m^{-2}; panels a and b) and albedo (panels c and d) and Longwave Down anomalies (W m^{-2}; panels e and f) as a function of absolute annual near-surface air temperature in K. For the models MAR (yellow), HIRHAM (blue), and RACMO (red) driven by CESM (black) under the SSP5-8.5 scenario. Values are integrated over grounded (left) and floating (right) parts of the ice sheet. A 5-year running mean is applied for clarity.

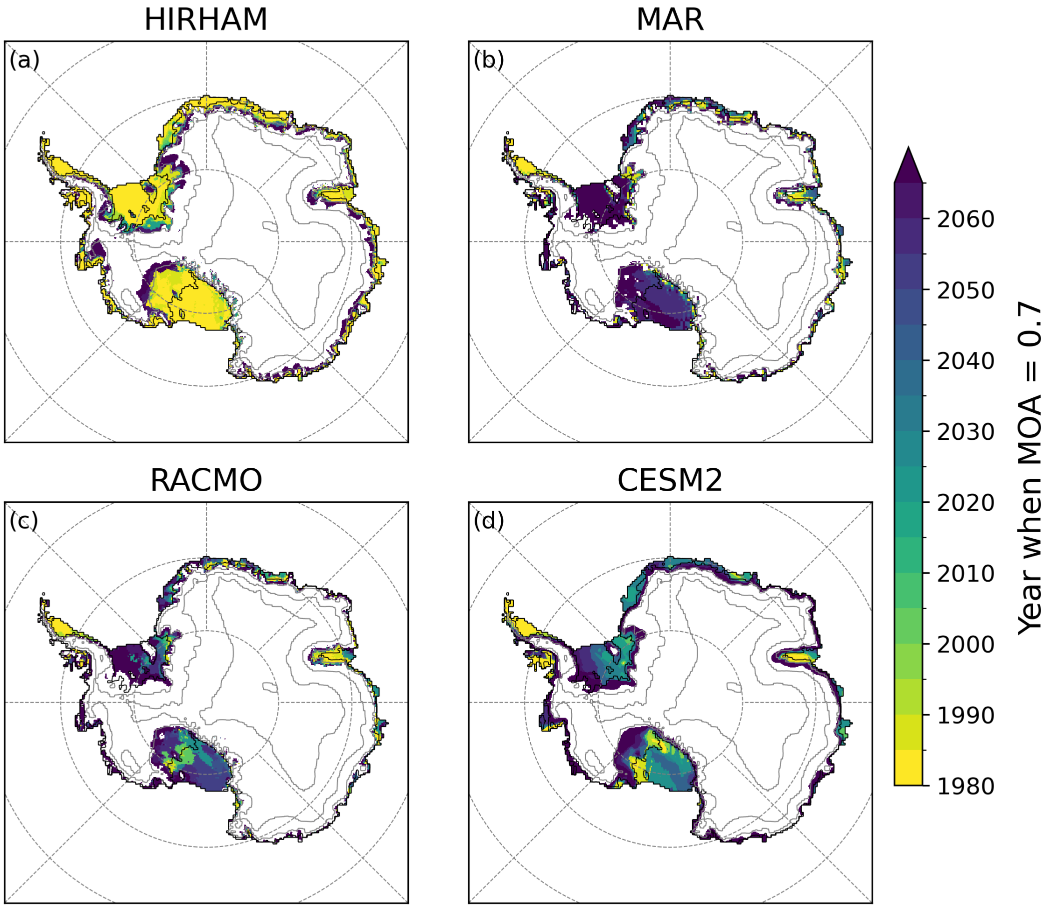

Figure S4. Corresponding year, at each grid point, when the Melt-over-Accumulation ratio reaches the threshold of 0.7 (MOA = 0.7). For HIRHAM (a), MAR (b), RACMO (c), and CESM (d) under the SSP5-8.5 scenario. MOA values are calculated using a 5-year running mean.

Figure S5. 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.

References

Magand, O., Frezzotti, M., Pourchet, M., Stenni, B., Genoni, L., and Fily, M.: Climate variability along latitudinal and longitudinal transects in East Antarctica, Annals of Glaciology, 39, 351–358, https://doi.org/10.3189/172756404781813961, 2004.