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## **Supplementary Materials**

**Table. S1.** Relative anomalies (%) of the 2080-2099 NET energy flux and SEB components compared to the 1980-1999 results, on 1980-1999 MSK<sub>melt</sub>, for different future MAR runs.

	NET	SW <sub>net</sub>	LW <sub>net</sub>	SHF	LHF
MAR-CAN <sub>45</sub>	143,60	23,85	-6,05	86,22	-68,78
MAR-CAN <sub>85</sub>	313,48	42,94	-18,67	211,79	-198,37
MAR-NOR <sub>26</sub>	72,01	10,85	-2,01	39,89	-8,95
MAR-NOR <sub>45</sub>	91,70	13,32	-3,52	46,42	-17,55
MAR-NOR <sub>60</sub>	127,02	16,45	-6,98	60,42	-42,42
MAR-NOR <sub>85</sub>	205,45	22,25	-14,64	104,52	-85,46



**Fig. S1. (a)** Daily melt and bare ice extents  $(10^4 \text{ km}^2 \text{ day}^{-1})$  on the GrIS based on daily melting rate higher than 7.5 mmWE day<sup>-1</sup>, and daily melt (Gt day<sup>-1</sup>) from the 1980-1999 MAR-CAN<sub>histo</sub>, 2080-2099 MAR-CAN<sub>45</sub> and MAR-CAN<sub>85</sub> simulations. **(b)** Daily near-surface (TAS) and surface (STT) temperatures (°C) from the same MAR simulations, on the maximum bare ice extent of the 1980-1999 MAR-CAN<sub>histo</sub> simulation. **(c)** The same as **(b)**, but for the daily surface albedo. **(d)** The same as **(b)**, but for the monthly snowfall (SF) and rainfall (RF) (Gt month<sup>-1</sup>).



**Fig. S2. (a)** SEB components anomalies (W m<sup>-2</sup>) from the GrIS according to the near-surface temperature anomalies (°C) for the MAR simulations forced by CMIP5 GCMs, with regressions drawn in solid lines. All the anomalies are related to the 1980-1999 average outputs provided by MAR forced with the same forcing fields. For a given year of simulation, the daily SEB components and near-surface temperatures where a daily melt greater than 1 mmWE day<sup>-1</sup> occurs have been annually averaged on the GrIS according to the occurrence of the daily melt events. (b) The same as (a), but for the MAR simulations forced by the ERA-INTERIM and ERA-40 reanalyses, with the regressions from (a) drawn in dashed lines.



**Fig. S3. (a)** Annual cloud optical depth (COD) anomalies over the GrIS according to the annual near-surface temperature anomalies (°C), for the MAR simulations forced by the reanalyses and the CMIP5 GCMs. All the annual anomalies are related to the 1980-1999 average outputs provided by MAR forced with the same forcing fields. **(b)** The same as **(a)**, but for the annual shortwave downward flux (SWD) anomalies (W m<sup>-2</sup>) according to the annual longwave downward flux (LWD) anomalies (W m<sup>-2</sup>) over the GrIS.



**Fig. S4. (a)** Summer (June-July-August) near-surface temperature (°C) from the MAR-CAN<sub>histo</sub> run over the 1980-1999 period. **(b)** Summer anomalies (°C) of the MAR-CAN<sub>85</sub> near-surface temperature compared to **(a)**. **(c)** The same as **(a)**, but for the MAR-NOR<sub>histo</sub> near-surface temperature. **(d)** The same as **(b)**, but for the MAR-NOR<sub>85</sub> anomalies to **(c)**. **(e)** Summer wind speed (m s<sup>-1</sup>) simulated by MAR-CAN<sub>histo</sub> over 1980-1999, with average wind direction as vectors. **(f)** Summer anomalies (in standard deviation) of the MAR-CAN<sub>85</sub> wind speed compared to **(e)**. **(g)** The same as **(a)**, but for the MAR-NOR<sub>histo</sub> wind speed. **(h)** The same as **(f)**, but for the MAR-NOR<sub>85</sub> anomalies to **(g)**.



**Fig. S5. (a)** Summer (June-July-August) snowfall (SF) anomalies (mmWE yr<sup>-1</sup>) of the 2080-2099 MAR-CAN<sub>85</sub> simulation over the GrIS, compared to the 1980-1999 MAR-CAN<sub>histo</sub> simulation. The equilibrium line altitude (ELA) of the 1980-1999 MAR-CAN<sub>histo</sub> and 2080-2099 MAR-CAN<sub>85</sub> simulations are drawn in solid green line and solid blue line, respectively. **(b)** The same as **(a)**, but for the summer rainfall (RF) anomalies (mmWE yr<sup>-1</sup>). **(c)** The same as **(a)**, but for the summer near-surface temperature (TAS) anomalies (°C) on MSK<sub>melt</sub>. **(d)** The same as **(a)**, but for the summer surface temperature (STT) anomalies (°C) on MSK<sub>melt</sub>. **(e-h)** The same as **(a-d)**, but for the 2080-2099 MAR-NOR<sub>85</sub> anomalies to 1980-1999 MAR-NOR<sub>histo</sub>.



**Fig. S6. (a)** Summer (June-July-August) surface albedo of the 1980-1999 MAR-CAN<sub>histo</sub> simulation over the GrIS. (b) Summer surface albedo anomalies of the 2080-2099 MAR-CAN<sub>85</sub> simulation compared to (a). (c) The same as (a), but for the 1980-1999 MAR-NOR<sub>histo</sub> simulation. (d) Summer surface albedo anomalies of the 2080-2099 MAR-NOR<sub>85</sub> simulation compared to (c).



**Fig. S7. (a)** Surface albedo anomalies according to the near-surface temperature anomalies (°C) over MSK melt, for the MAR simulations forced by the reanalyses the CMIP5 GCMs, with regression drawn in sold black line. All the anomalies are related to the 1980-1999 average outputs provided by MAR forced with the same forcing fields. **(b)** the same as **(a)**, but for the anomalies of cumulated daily snowfall extents  $(10^6 \text{ km}^2 \text{ yr}^{-1})$  on MSK<sub>melt</sub>, based on significant snowfall higher than 1 mmWE day<sup>-1</sup>. **(c)** The same as **(b)**, but for the anomalies of cumulated daily rainfall extents  $(10^6 \text{ km}^2 \text{ yr}^{-1})$  on MSK<sub>melt</sub>, based on significant rainfall higher than 1 mmWE day<sup>-1</sup>.