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*Supplement of*

## **Long-term surface energy balance of the western Greenland Ice Sheet and the role of large-scale circulation variability**

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## Supplementary Materials

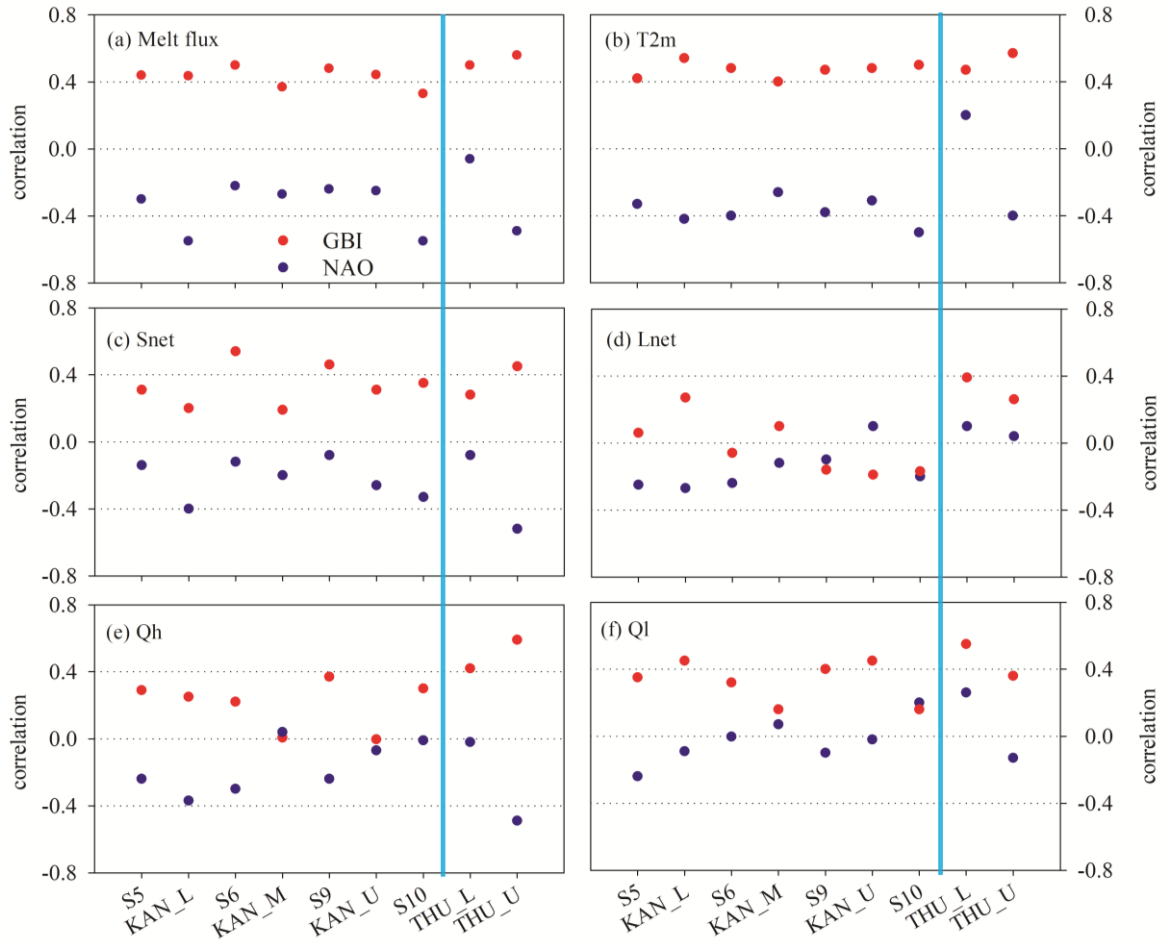


Figure S1. AWS correlations of JJA average SEB components and 2 m temperature (T2m) with GBI (red dots) and NAO index (blue dots).

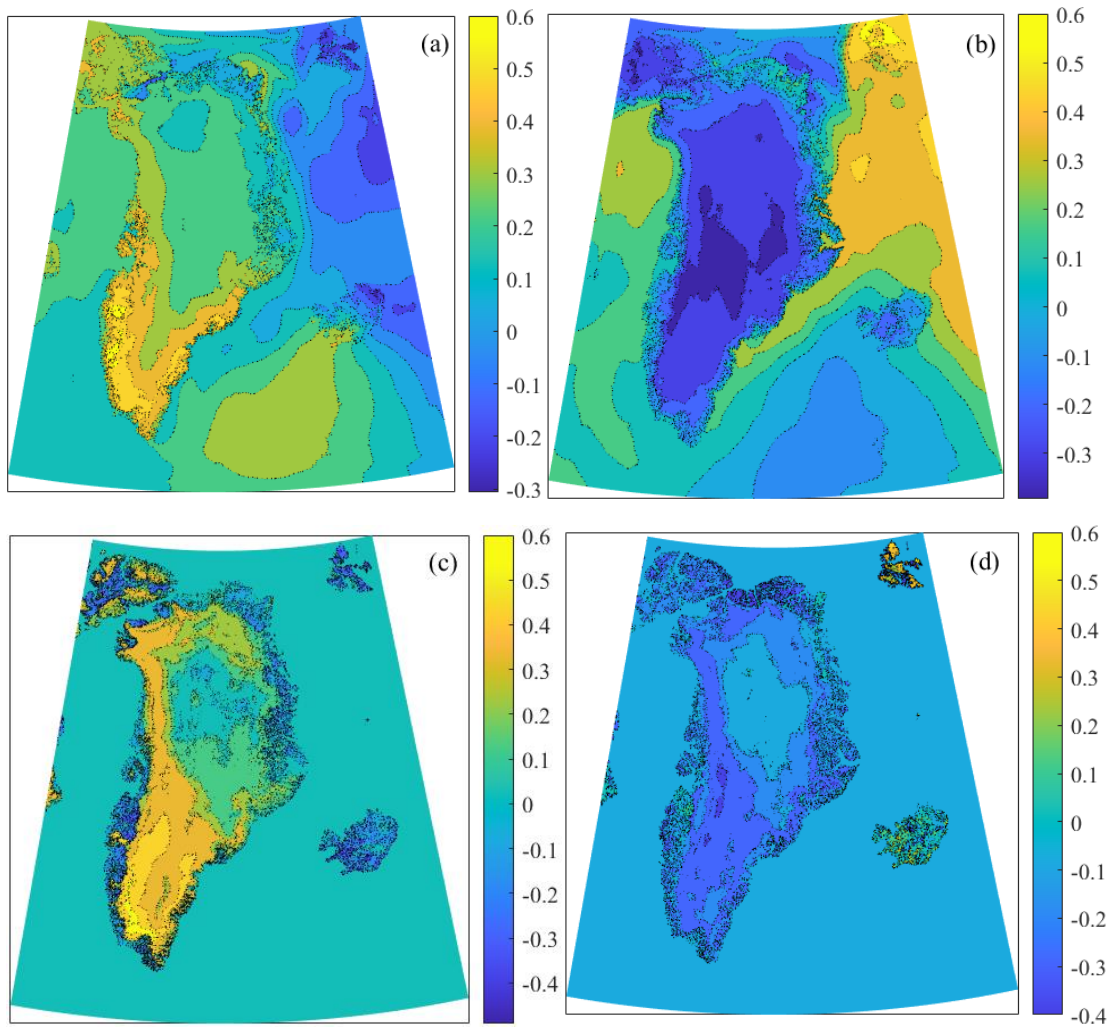


Figure S2. Correlation coefficient fields of 2000~2018 JJA average 2 m temperature (T2m) from RACMO2.3 with (a) GBI and (b) NAO, melt flux from RACMO2.3 with (c) GBI and (d) NAO index.

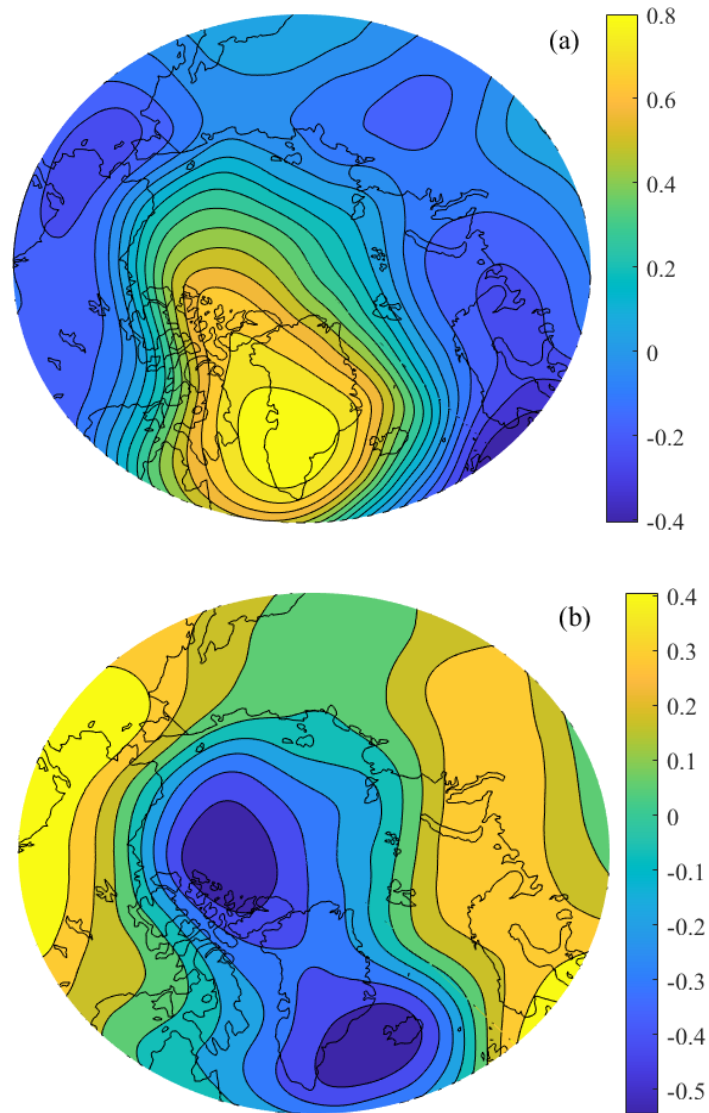


Figure S3. Regression fields of 2000~2018 JJA 500hpa geopotential height regressed with GBI (a) and NAO (b) index. The color bars show the correlation coefficient  $R$ .

Table S1. Annual surface energy fluxes ( $W m^{-2}$ ) at the nine AWS locations, SEB values of  $L_{out}$ ,  $Q_h$ ,  $Q_l$ ,  $G$  and  $M$  are derived from the SEB model while  $S_{in}$ ,  $S_{out}$  and  $L_{in}$  are from observations

Flux	S5	KANL	S6	KANM	S9	KANU	S10	THUL	THUU
$S_{in}$	124	129	146	141	146	146	155	108	113
$S_{out}$	-75	-79	-89	-98	-109	-117	-125	-74	-84
$S_{net}$	49	50	57	43	37	29	31	34	29
$L_{in}$	238	240	240	226	219	217	201	231	222
$L_{out}$	-277	-276	-274	-263	-258	-250	-237	-264	-256
$L_{net}$	-39	-36	-34	-36	-38	-33	-36	-33	-34
$R_{net}$	10	14	23	6	-1	-4	-6	2	-5
$Q_h$	32	22	18	15	10	10	6	20	16
$Q_l$	-4	-6	-2	-5	-1	-4	-1	-6	-2
$G$	-1	6	-1	1	3	5	6	2	2
$M$	-37	-36	-39	-17	-11	-6	-5	-17	-11

Table S2 Root Mean Squared Error (RMSE), mean bias (MB) and correlation coefficient (R) between daily AWS observations and ERA-Interim (EI), ERA5 (E5), RACMO2.3 (RAC) at KAN\_L

Variable	AWS	EI			E5			RAC					
		E5	RAC	MB	RMSE	R	MB	RMSE	R	MB	RMSE	R	
$S_{in}$	129	119	117	135	23.4	34.5	0.98	12	21	1.00	6	10	1
$S_{out}$	79	44	41	81	32	23.4	0.96	38	56	0.80	2	21	0.95
$Q_h$	22	8	-6	30	14	18	0.12	28	44	0.29	8	12	0.46
$Q_l$	-6	-6	-17	-4	1.2	9	0.14	23	19	0.23	2	4	0.79
$M$	-36	~	~	-38	~	~	~	~	~	~	1.6	12	0.97
Alb (-)	0.70	0.64	0.74	0.74	0.1	0.27	0.5	0.06	0.2	0.6	0.02	0.13	0.78
$T_{2m}$	266.0	266.0	267.5	265.4	1.7	6.9	0.92	1.5	2.8	0.99	0.3	0.6	0.99

Table S3 Root Mean Squared Error (RMSE), mean bias (MB) and correlation coefficient (R) between daily AWS observations and ERA-Interim (EI), ERA5 (E5), RACMO2.3 (RAC) at KAN\_M

Variable	AWS	EI			E5			RAC					
		E5	RAC	MB	RMSE	R	MB	RMSE	R	MB	RMSE	R	
$S_{in}$	141	117	140	140	33.3	46.6	0.98	1	20	0.99	1	13	1
$S_{out}$	98	78	118	99	15.4	34	0.93	20	44	0.92	1	11.5	0.99
$Q_h$	15	8.1	27	26	6.9	16	0.14	12	17	0.54	11	16.8	0.57
$Q_l$	-5	-6.6	-7	-4.5	1.6	9	0.5	2	8.9	0.4	0.5	3.6	0.85
$M$	-17	~	~	-16.6	~	~	~	~	~	~	5.3	13	0.96
Alb (-)	0.78	0.52	0.85	0.82	0.16	0.28	0.68	0.07	0.14	0.7	0.04	0.06	0.92
$T_{2m}$	261.3	265.6	263.1	262.1	4.3	8	0.91	1.8	2.8	0.99	0.8	1.3	0.99

Table S4 Root Mean Squared Error (RMSE), mean bias (MB) and correlation coefficient (R) between daily AWS observations and ERA-Interim (EI), ERA5 (E5), RACMO2.3 (RAC) at KAN\_U

Variable	AWS	EI	E5	RAC	EI			E5			RAC		
					MB	RMSE	R	MB	RMSE	R	MB	RMSE	R
S <sub>in</sub>	146	138	142.5	144	45.3	63	0.97	3.5	7	0.9	2	6.7	1
S <sub>out</sub>	117	107	120	118	35.8	47	0.98	3	10	0.9	1	5	0.99
Q <sub>h</sub>	10	7.12	25	19	2.88	8.7	0.20	15	14	0.84	9	10	0.83
Q <sub>l</sub>	-4	-6.9	-3.1	-4.5	2	3.3	0.95	1	5.4	0.75	0.5	4.6	0.78
M	-6	~	~	-8	~	~	~	~	~	~	1.4	4.5	0.94
Alb (-)	0.83	0.61	0.85	0.87	0.2	0.6	0.31	0.02	0.05	0.5	0.04	0.06	0.7
T <sub>2m</sub>	257.3	266.4	258.8	258.3	9.1	10	0.94	1.5	2.7	0.9	1	1.2	0.99

Table S5 Root Mean Squared Error (RMSE), mean bias (MB) and correlation coefficient (R) between daily AWS observations and ERA-Interim (EI), ERA5 (E5), RACMO2.3 (RAC) at THU\_L

Variable	AWS	EI	E5	RAC	EI			E5			RAC		
					MB	RMSE	R	MB	RMSE	R	MB	RMSE	R
S <sub>in</sub>	108	115	104.4	117	31.1	47.9	0.97	3.6	15.8	0.99	6	19.8	0.99
S <sub>out</sub>	74	74	58	80	40.7	63.3	0.89	16	26	0.99	4	10.7	0.99
Q <sub>h</sub>	20	0.2	2.6	16.5	18	22.8	0.25	17	26	0.1	3	15	0.25
Q <sub>l</sub>	-6	-1.5	-7.3	-2.1	3	7.6	0.57	2	9	0.4	4	6.7	0.7
M	-17	~	~	-13.9	~	~	~	~	~	~	2.4	11.9	0.95
Alb (-)	0.67	0.64	0.62	0.77	0.04	0.13	0.66	0.05	0.16	0.65	0.03	0.08	0.8
T <sub>2m</sub>	262.8	260.3	260	261.7	2.5	4.8	0.93	2.8	6	0.94	1.1	2.7	0.96

Table S6 Root Mean Squared Error (RMSE), mean bias (MB) and correlation coefficient (R) between daily AWS observations and ERA-Interim (EI), ERA5 (E5), RACMO2.3 (RAC) at THU\_U

Variable	AWS	EI	E5	RAC	EI			E5			RAC		
					MB	RMSE	R	MB	RMSE	R	MB	RMSE	R
S <sub>in</sub>	113	86	103	114	30.9	48	0.98	10	15	0.99	1	6.7	0.99
S <sub>out</sub>	84	64	63	86	45.7	69	0.94	21	32	0.98	2	10	0.99
Q <sub>h</sub>	16	0	6	20	16	19	0.20	10	15	0.40	4	7	0.80
Q <sub>l</sub>	-2	-2	-6	-0	0.4	4	0.50	4	7	0.55	2	4	0.70
M	-11	~	~	-12	~	~	~	~	~	~	2.6	14	0.95
Alb (-)	0.80	0.63	0.77	0.83	0.1	0.27	0.39	0.03	0.13	0.52	0.03	0.08	0.74
T <sub>2m</sub>	260.0	259.0	259.0	261.0	1.1	3.3	0.97	0.9	3.3	0.96	1	1	0.99