

Supplementary Materials

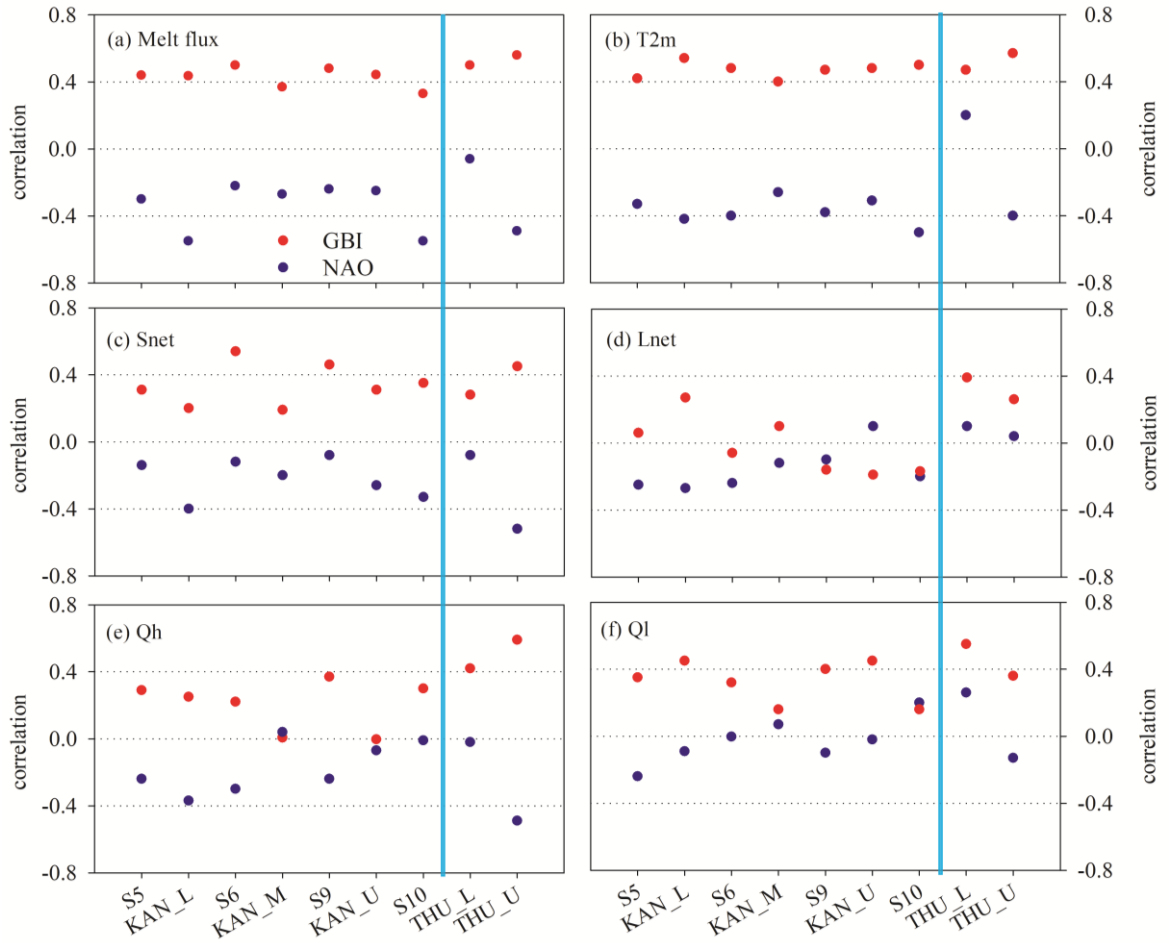


Figure S1. AWS correlations of JJA average SEB components and 2 m temperature (T2m) with GBI (red dots) and NAO index (blue dots).

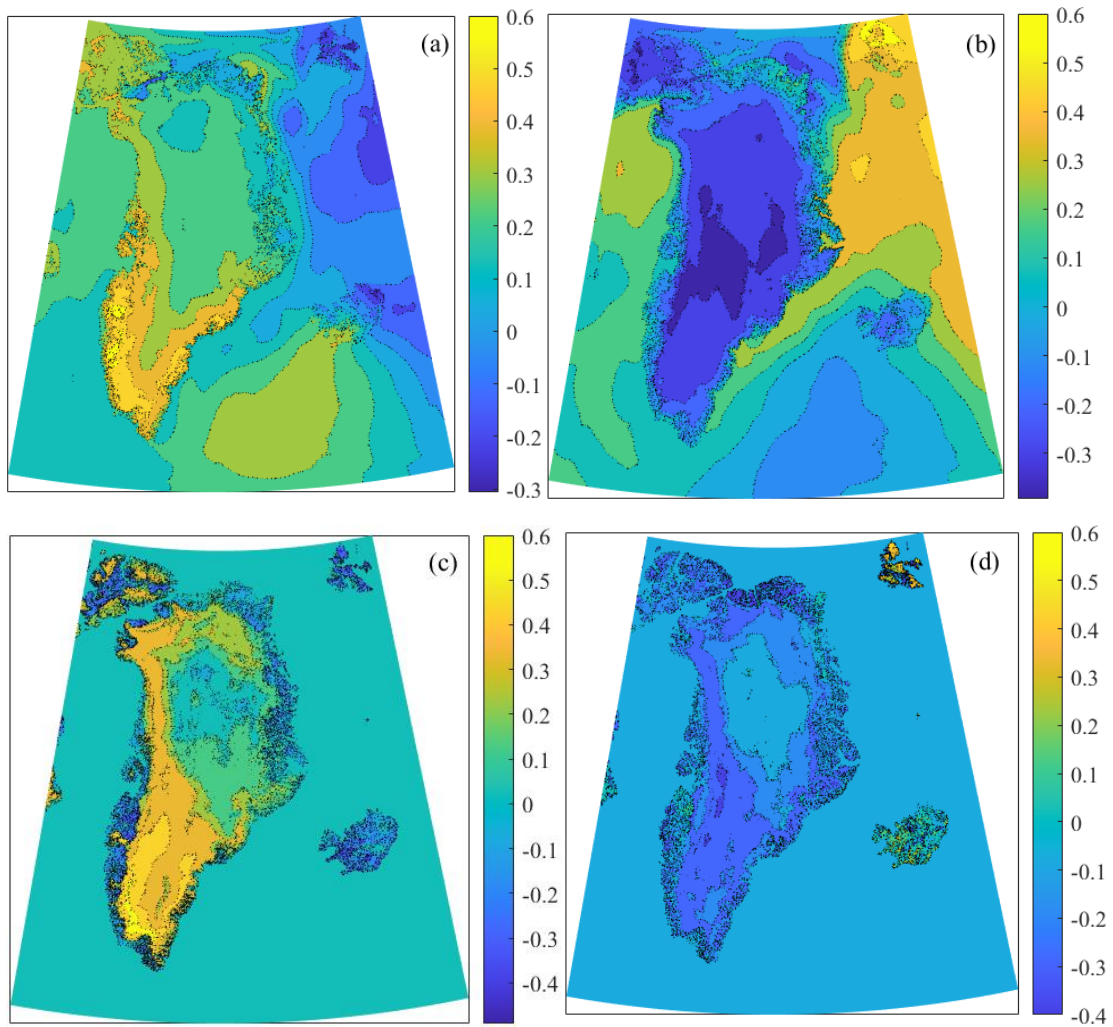


Figure S2. Correlation coefficient fields of 2000~2018 JJA average 2 m temperature (T2m) from RACMO2.3 with (a) GBI and (b) NAO, melt flux from RACMO2.3 with (c) GBI and (d) NAO index.

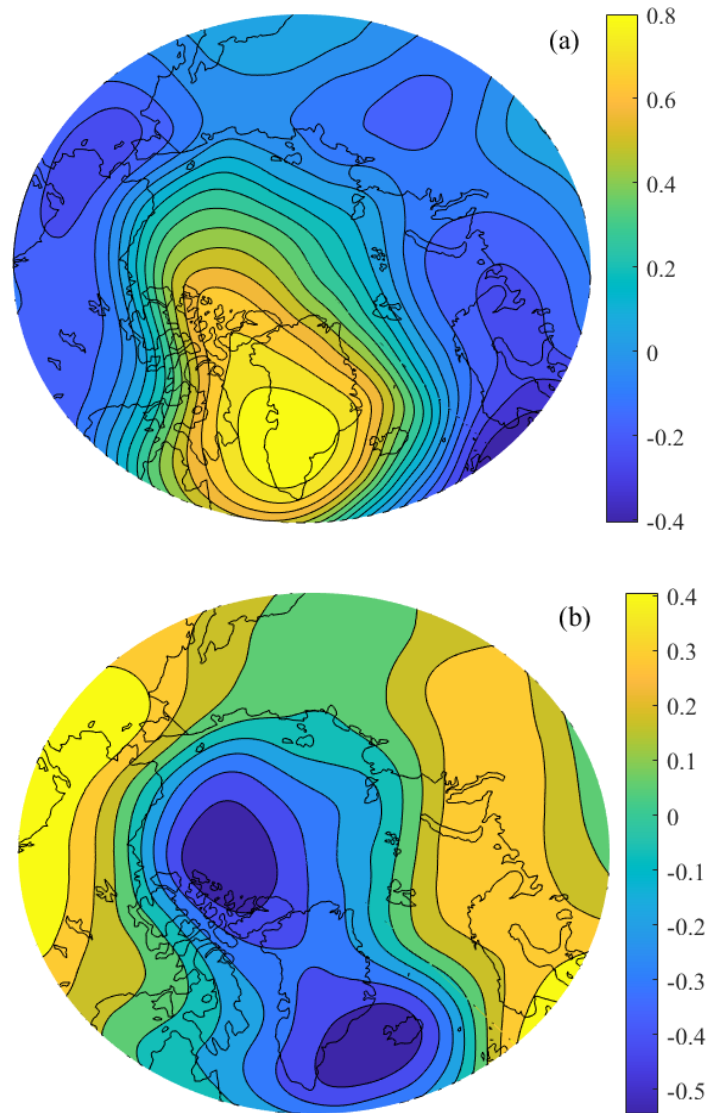


Figure S3. Regression fields of 2000~2018 JJA 500hpa geopotential height regressed with GBI (a) and NAO (b) index. The color bars show the correlation coefficient R.

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					
		EI	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	3.2	23.4	0.96	38	56	0.80	2	21	0.95
Q_{h}	22	8	-6	30	14	18	0.12	28	44	0.46	8	12	0.09
Q_{l}	-6	-6	-17	-4	0	9	0.04	23	19	0.23	-2	4	0.79
Alb (-)	0.70	0.64	0.74	0.74	0.06	0.27	0.6	0.04	0.2	0.5	0.	0	0.78
$T_{2\text{m}}$	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					
		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
Alb (-)	0.78	0.22	0.85	0.82	0.56	0.58	0.68	0.07	0.14	0.2	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					
		MB	RMSE	R	MB	RMSE	R	MB	RMSE	R			
S _{in}	146	138	142.5	144	45.3	63	0.97	3.5	7	0.9	2	6.7	1
S _{out}	117	107	120	118	35.8	47	0.98	3	10	0.9	1	5	0.99
Q _h	10	7.12	25	19	2.88	8.7	0.20	15	14	0.84	9	10	0.83
Q _l	-4	-6.9	-3.1	-4.5	2.9	3.3	0.95	0.9	5.4	0.75	0.5	4.6	0.78
Alb (-)	0.83	0.21	0.85	0.87	0.62	0.6	0.31	0.02	0.05	0.5	0.04	0.06	0.69
T _{2m}	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					
		MB	RMSE	R	MB	RMSE	R	MB	RMSE	R			
S _{in}	108	115	104.4	117	31.1	47.9	0.97	3.6	15.8	0.99	6	19.8	0.99
S _{out}	74	74	58	80	40.7	63.3	0.89	16	26	0.99	4	10.7	0.99
Q _h	20	0.2	2.6	16.5	18.8	22.8	0.25	17.4	26	0.1	3.5	15	0.25
Q _l	-6	-1.5	-7.3	-2.1	3.5	7.6	0.57	1.3	9	0.4	4	6.7	0.7
Alb (-)	0.67	0.64	0.62	0.77	0.03	0.13	0.66	0.05	0.16	0.65	0.03	0.08	0.8
T _{2m}	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 _{in}	113	86	103	114	30.9	48	0.98	10	15	0.99	1	6.7	0.99
S _{out}	84	64	63	86	45.7	69	0.94	21	32	0.98	2	10	0.99
Q _h	16	0	6	20	16	19	0.20	10	15	0.40	4	7	0.80
Q _t	-2	-2	-6	-0	0.4	4	0.50	4	7	0.55	2	4	0.70
Alb (-)	0.80	0.63	0.77	0.83	0.17	0.27	0.39	0.03	0.13	0.12	0.03	0.08	0.74
T _{2m}	260.0	259.0	259.0	261.0	1.1	3.3	0.97	0.9	3.3	0.96	1	1	0.99