Table S1. Model performance in terms of simulating hourly 2 m water vapor pressure (in hPa) at each AWS on the GrIS (Figure 1). Note that the evaluation were conducted at only SIGMA and PROMICE sites. ME, RMSE, and R^2 are the mean error (the average of the difference between simulated values and observed values), and the coefficient of determination, respectively. Number of observations (OBS) employed for the comparison are also listed.

Sites	ME (hPa)	RMSE (hPa)	R^2	Number of observations
SIGMA-A	0.07	0.36	0.95	18998
SIGMA-B	0.21	0.48	0.94	18541
KPC_U	–0.01	0.44	0.95	26139
SCO_U	–0.16	0.62	0.90	25786
TAS_U	–0.33	0.76	0.84	23263
QAS_L	–0.53	0.88	0.89	23483
QAS_A	–0.42	0.77	0.89	8678
NUK_L	–0.23	0.67	0.92	21933
NUK_U	–0.30	0.63	0.92	20908
NUK_N	–0.23	0.56	0.93	19955
KAN_L	–0.02	0.52	0.94	25518
KAN_M	–0.15	0.59	0.92	20379
KAN_U	–0.05	0.46	0.93	22925
UPE_L	–0.27	0.69	0.92	25409
UPE_U	–0.27	0.56	0.95	23036
Mean value	–0.18	0.60	0.92	

Table S2. Model performance in terms of simulating hourly surface pressure (in hPa) at each AWS on the GrIS (Figure 1). Elevation differences between the reality and NHM-SMAP are indicated together.

Sites	ME (hPa)	RMSE (hPa)	R^2	Number of observations	Elevation difference (m)
SIGMA-A	–2.8	2.9	0.99	18998	4
SIGMA-B	17.4	17.4	0.99	18550	–165
Summit	–7.6	8.9	0.86	13064	44
S-Dome	–4.3	4.4	1.00	11161	20
KPC_U	–5.5	5.6	0.99	26304	23
SCO_U	–23.1	23.2	0.98	26249	176
TAS_U	–2.3	2.6	0.99	23330	1
QAS_L	–12.5	12.6	0.99	26302	85
QAS_A	–13.9	13.9	1.00	9267	104
NUK_L	–7.5	7.6	0.99	26296	26
NUK_U	–13.0	13.1	0.98	20933	85
NUK_N	–8.4	8.5	0.99	23570	46
KAN_L	5.6	5.7	0.99	26303	–74
KAN_M	–7.8	8.0	0.98	21208	49
KAN_U	–3.7	3.7	0.99	24084	20
UPE_L	–7.2	7.3	0.98	25743	34
UPE_U	–8.6	8.7	0.99	26300	77
Mean value	–8.0	8.9	0.98		

Table S3. Model performance in terms of simulating hourly 10 m wind speed (in m s^{-1}) at each AWS on the GrIS (Figure 1).

Sites	ME (m s^{-1})	RMSE (m s^{-1})	R^2	Number of observations
SIGMA-A	–0.5	2.6	0.40	17846
SIGMA-B	1.0	3.2	0.14	17851
Summit	–0.7	2.5	0.54	18825
S-Dome	–2.0	4.0	0.76	10624
KPC_U	0.4	1.7	0.65	25921
SCO_U	–0.2	2.3	0.13	25774
TAS_U	2.5	4.3	0.68	22977
QAS_L	0.2	2.8	0.51	23423
QAS_A	–0.6	2.5	0.59	8481
NUK_L	0.4	2.3	0.52	21808
NUK_U	2.2	3.2	0.64	20807
NUK_N	–0.3	2.4	0.65	19773
KAN_L	0.8	2.4	0.54	25432
KAN_M	–0.1	2.3	0.72	21047
KAN_U	–1.4	2.8	0.78	22660
UPE_L	1.3	3.1	0.44	25051
UPE_U	0.6	2.5	0.69	22906
Mean value	0.2	2.7	0.55	

Table S4. Model performance in terms of simulating hourly downward shortwave radiant flux (in W m^{-2}) at each AWS on the GrIS (Figure 1).

Sites	ME (W m^{-2})	RMSE (W m^{-2})	R^2	Number of observations
SIGMA-A	–13.5	60.2	0.86	8077
SIGMA-B	–9.4	72.6	0.80	8069
Summit	–9.1	75.9	0.88	10945
S-Dome	52.6	112.3	0.82	10556
KPC_U	–28.6	56.0	0.90	11443
SCO_U	0.6	69.0	0.88	10972
TAS_U	–9.6	88.9	0.81	8588
QAS_L	16.6	96.5	0.83	11229
QAS_A	–3.8	103.7	0.81	3962
NUK_L	2.2	90.8	0.83	8384
NUK_U	–10.5	82.8	0.87	8341
NUK_N	4.4	84.5	0.86	9534
KAN_L	–17.1	127.3	0.70	10837
KAN_M	–16.4	73.0	0.88	8510
KAN_U	–39.4	81.3	0.91	10467
UPE_L	–0.7	78.5	0.83	11007
UPE_U	–7.0	65.0	0.88	11061
Mean value	–5.2	83.4	0.84	

Table S5. Model performance in terms of simulating hourly downward longwave radiant flux (in W m^{-2}) at each AWS on the GrIS (Figure 1). Note that the evaluation were conducted at only SIGMA and PROMICE sites.

Sites	ME (W m^{-2})	RMSE (W m^{-2})	R^2	Number of observations
SIGMA-A	–24.3	36.6	0.71	18353
SIGMA-B	–14.4	31.6	0.72	18440
KPC_U	–14.3	28.3	0.74	26066
SCO_U	–17.0	28.3	0.78	26221
TAS_U	–20.5	32.7	0.66	23107
QAS_L	–19.8	30.2	0.80	26216
QAS_A	–21.4	32.5	0.76	9209
NUK_L	–21.7	32.0	0.80	21835
NUK_U	–13.6	28.6	0.78	20827
NUK_N	–21.3	15.0	0.77	23441
KAN_L	–13.0	28.1	0.76	26155
KAN_M	–10.7	28.5	0.75	21140
KAN_U	–11.7	29.8	0.71	23962
UPE_L	–22.2	35.8	0.72	25562
UPE_U	–13.9	29.8	0.77	26225
Mean value	–17.3	29.9	0.75	

Table S6. Model performance in terms of simulating hourly snow/firn/ice surface temperature (in ºC) at each AWS on the GrIS (Figure 1). Note that the evaluation were conducted at only SIGMA and PROMICE sites.

Sites	ME (°C)	RMSE (°C)	R^2	Number of observations
SIGMA-A	2.3	4.7	0.91	19007
SIGMA-B	3.2	4.9	0.91	18551
KPC_U	2.6	4.8	0.93	26139
SCO_U	1.1	4.3	0.82	26235
TAS_U	1.7	3.2	0.82	23316
QAS_L	0.4	2.2	0.87	26301
QAS_A	0.0	2.6	0.90	9264
NUK_L	0.4	2.7	0.88	21944
NUK_U	–0.3	2.7	0.90	20920
NUK_N	0.1	2.8	0.89	22793
KAN_L	1.1	3.2	0.90	26284
KAN_M	1.0	3.5	0.91	21184
KAN_U	0.9	3.3	0.93	24039
UPE_L	2.0	4.5	0.85	25747
UPE_U	1.0	3.3	0.92	26291
Mean value	1.2	3.5	0.89	

Table S7. Model performance in terms of simulating hourly snow and ice albedo at each AWS on the GrIS (Figure 1). Note that the evaluation were conducted at only SIGMA and PROMICE sites.

Sites	ME	RMSE	R^2	Number of observations
SIGMA-A	0.02	0.07	0.04	3150
SIGMA-B	0.07	0.15	0.06	3250
KPC_U	0.09	0.13	0.06	4451
SCO_U	0.22	0.27	0.09	5297
TAS_U	0.15	0.24	0.10	3627
QAS_L	0.32	0.41	0.12	6415
QAS_A	0.15	0.25	0.03	2252
NUK_L	0.27	0.32	0.13	4501
NUK_U	0.20	0.25	0.09	4752
NUK_N	0.23	0.33	0.12	5352
KAN_L	0.19	0.23	0.16	6003
KAN_M	0.17	0.25	0.12	4571
KAN_U	0.08	0.11	0.07	5967
UPE_L	0.11	0.17	0.19	5136
UPE_U	0.15	0.22	0.10	5243
Men value	0.16	0.23	0.10	

Table S8. Model performance (on-line version of NHM-SMAP) in terms of simulating JJA hourly 2m air temperature at each AWS on the GrIS (Figure 1).

Sites	ME (°C)	RMSE (°C)	R^2	Number of observations	Elevation (m)
SIGMA-A	–0.1	1.5	0.83	5894	1490
SIGMA-B	1.1	1.7	0.87	5446	944
Summit	–0.1	3.5	0.67	5772	3208
S-Dome	0.2	2.2	0.80	4521	2901
KPC_U	–1.2	2.0	0.79	6624	870
SCO_U	–1.7	2.6	0.57	6122	980
TAS_U	2.6	3.2	0.41	4414	570
QAS_L	1.4	2.3	0.45	4273	290
QAS_A	–1.4	2.3	0.48	1992	1010
NUK_L	0.1	1.7	0.53	5351	550
NUK_U	–0.7	2.0	0.67	5308	1130
NUK_N	–0.3	1.5	0.74	3227	920
KAN_L	0.1	1.2	0.76	5960	680
KAN_M	–0.8	1.9	0.80	5097	1270
KAN_U	–1.5	2.5	0.81	6618	1840
UPE_L	–0.1	1.7	0.62	6360	220
UPE_U	–0.6	1.4	0.87	5044	940
Mean value	–0.2	2.1	0.69		

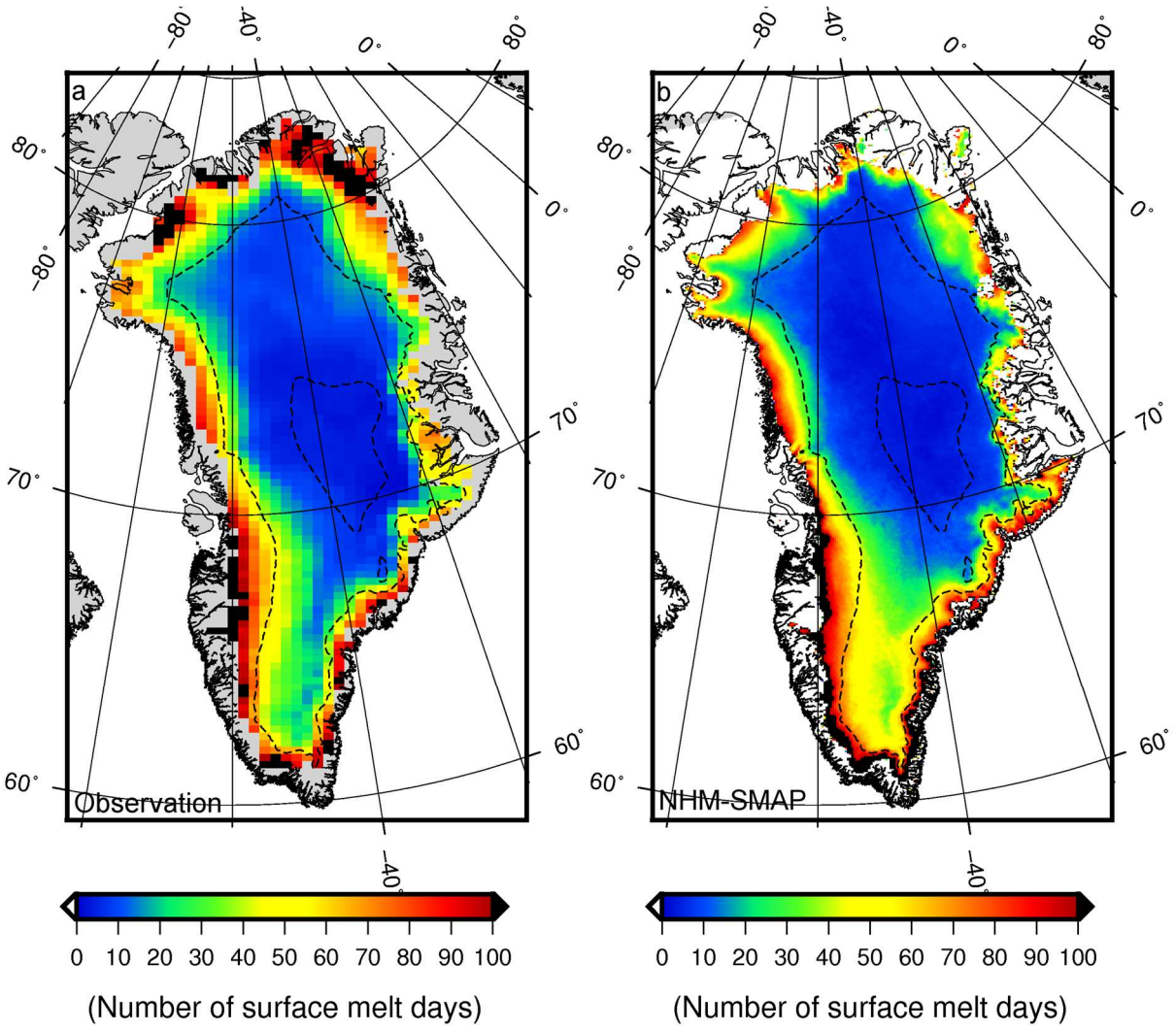

Figure S1: (a) Observed and (b) simulated number of the GrIS surface melt days in 2012. Observation data are from Mote (2014).

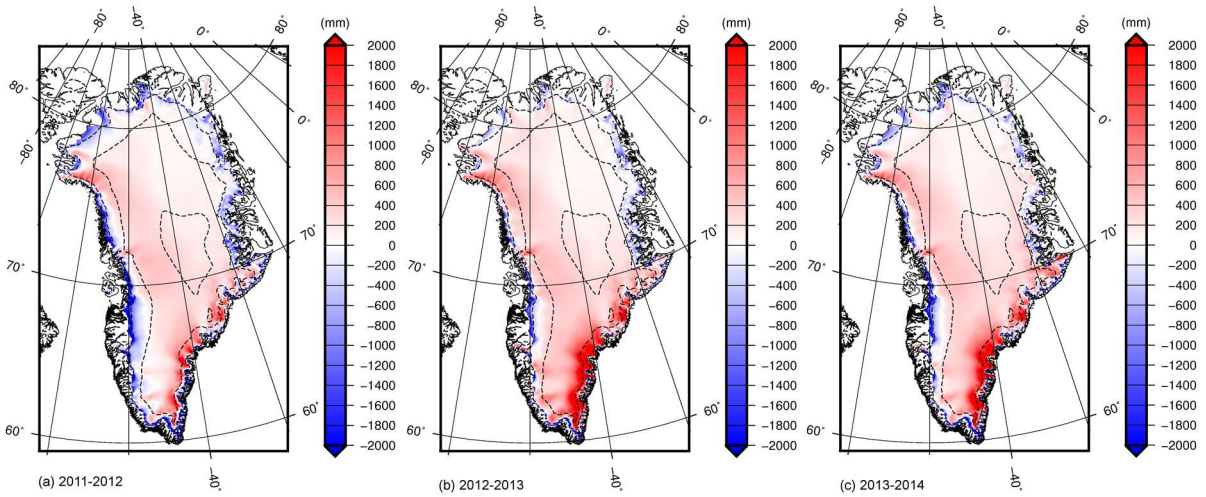

Figure S2: The NHM-SMAP simulated accumulated GrIS SMB (in mm) during the (a) 2011-2012, (b) 2012-2013, and (c) 2013-2014 mass balance years (September to August).

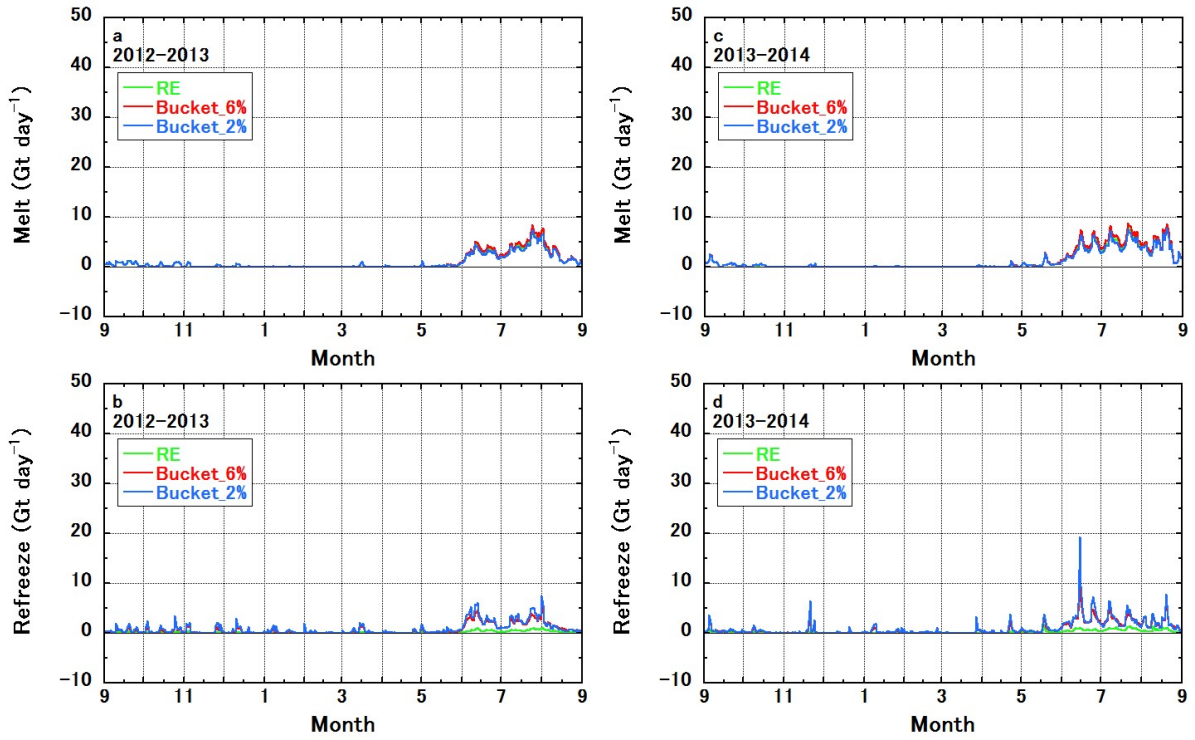

Figure S3: Sensitivity to the choice of vertical water movement scheme of the simulated top 30m integrated (a and c) melt and (b and d) refreeze for the GrIS during the (a and b) 2012-2013 and (c and d) 2013-2014 mass balance years. RE indicates the default setting for vertical water movement in snow and firn based on the Richards equation; Bucket_6% and Bucket_2% are alternative settings based on simple bucket schemes with irreducible water contents of 6 % and 2 % of the pore volume.