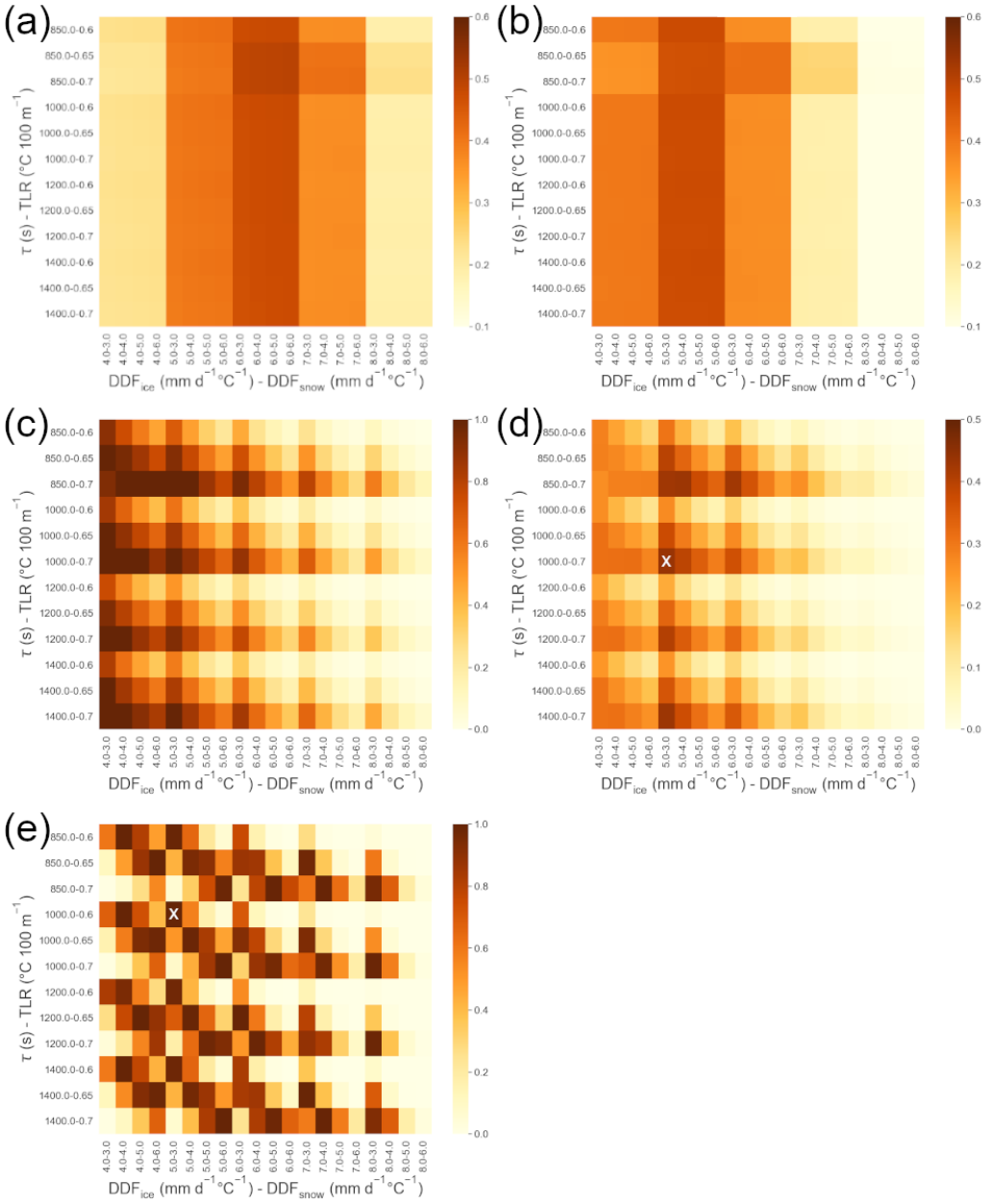

Fig. S1: Heat plots of the PDD calibration showing the skill scores of individual measurements and aggregated model skill. Displayed are skills of (a) S1toS5, (b) Sauto, (c) mass budget of Schiaparelli Glacier, (d) aggregated model skill with calibration Strategy A, and (e) geodetic B_{MSMnc} (Strategy B). The highest performing run is highlighted with a white cross.

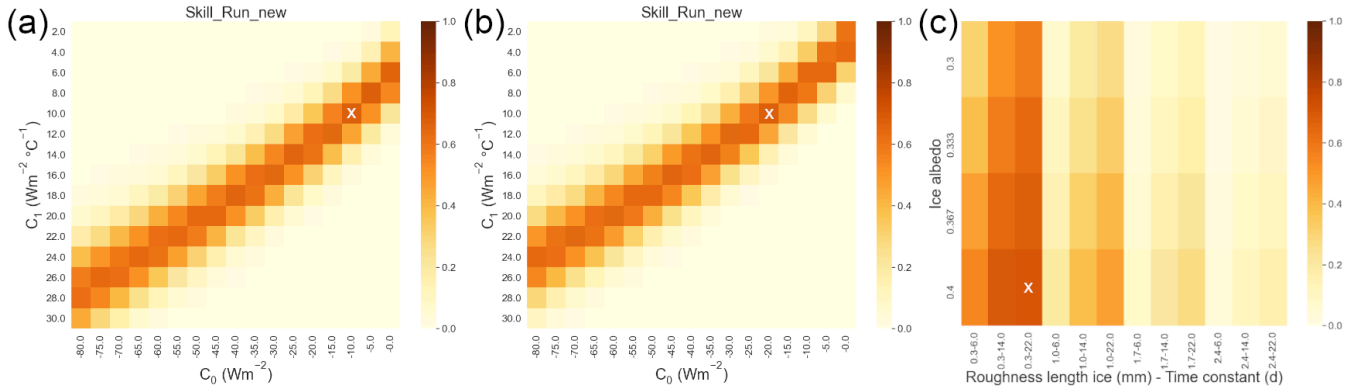

Fig. S2: Heat plots of the model-inherent calibration showing the aggregated model skill for the (a) SEB_Gpot, (b) SEB_G, and (c) COSIPY. The highest performing run is highlighted with a white cross.

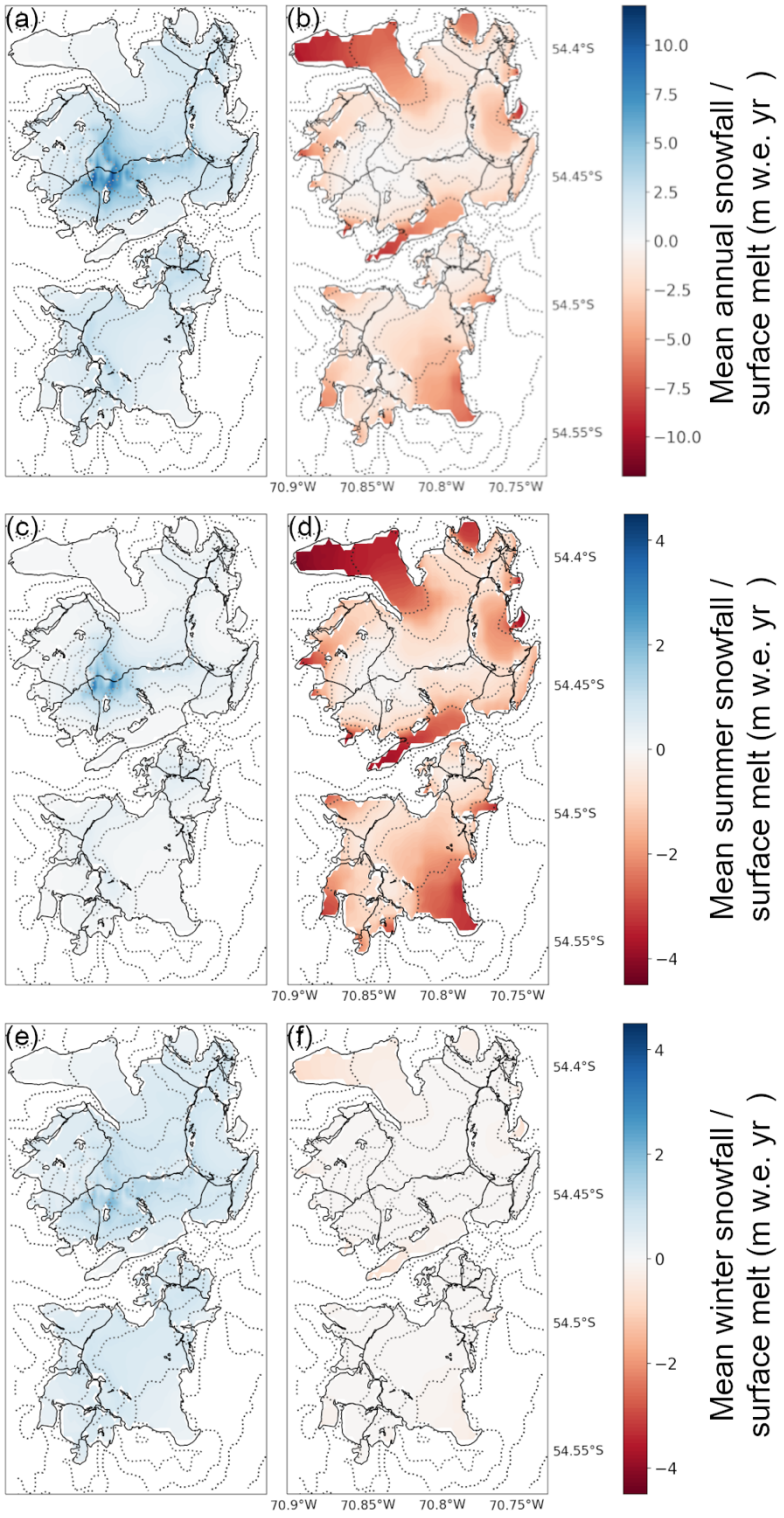

Fig. S3: Mean annual (a, b) and seasonal (c– f) snowfall (a, c, e) and surface melt (b, d, f) from COSIPY.

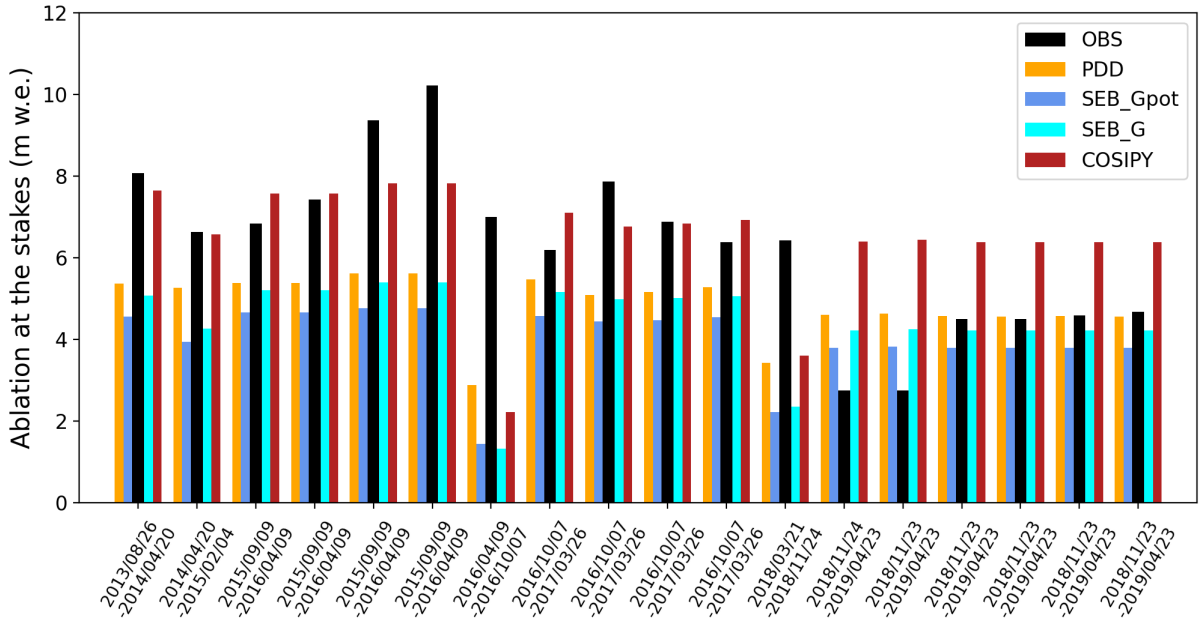

Fig. S4: Comparison of measured against modelled ablation at the individual ablation stakes (S1to5). The observation is displayed in black in the middle between the four models for each measurement period.

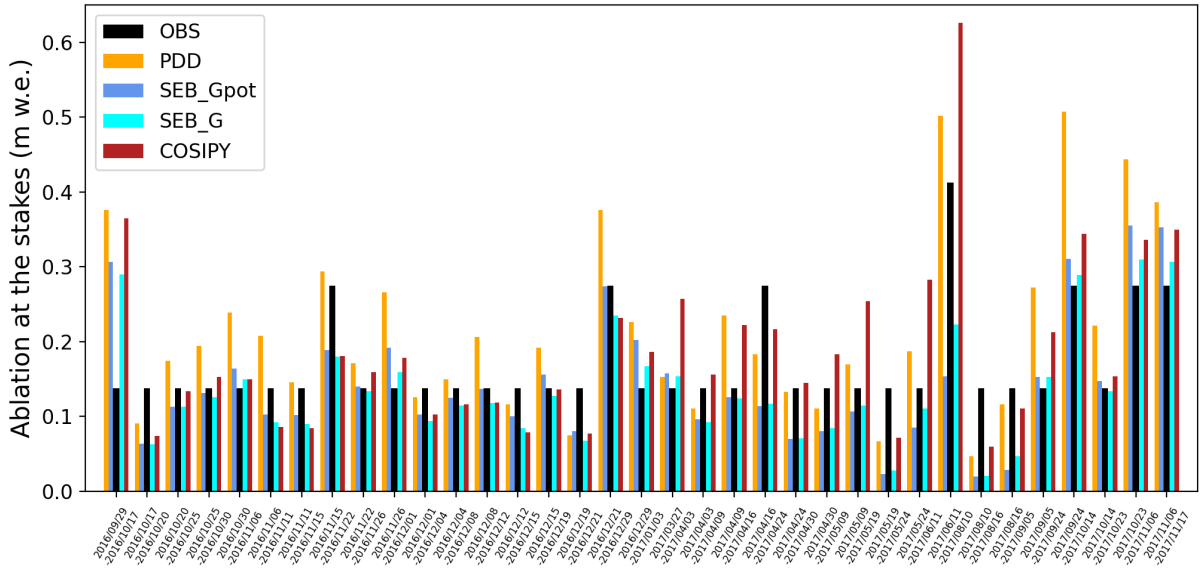

Fig. S5: Comparison of measured against modelled ablation at the automatic ablation sensor (Sauto). The observation is displayed in black in the middle between the four models for each measurement period.

Table S1: Statistical performance of input variables compared to observations at the AWS location (daily resolution). Given are the mean model bias (MMB), the root mean square error (RMSE) and the Pearson correlation (*r*). MMB and RMSE are given in the respective variable's unit.

	Quantile Mapping			ERA5 direct	Radiation model		OPM
	T	*RH*	*PRES*	*U*	*G*	*Gpot*	*RRR*
MMB	-0.06	-12.68	-0.26	-1.26	2.37	30.97	-1.51
RMSE	0.76	14.02	1.70	1.75	40.69	55.22	5.43
r	0.95	0.72	0.99	0.76	0.78	0.70	0.63

Table S2: Ice flux through the flux gate for the periods 2000-2013 and 2000-2019.

Period	Mean velocity (m day^{-1})	Mass flux (km^{-3} yr^{-1} i.e.)	Uncertainty (km^{-3} yr^{-1} i.e.)
2000-2013	0.18	0.0209	± 0.0044
2000-2019	0.19	0.0206	± 0.0036

Table S3: Comparison of specific and surface MB (m w.e. yr^{-1}) using Strategy A and B for the glaciers in the study site (> 3 km^2). For both strategies the best, minimum and maximum estimate are given. B_{MSMnc} gives the massif-wide annual average MB excluding glaciers with major calving losses. The asterisk marks lake termination.

			Strategy A		Strategy B	
Name/ID	Area (km^2)	specific MB (m w.e. yr^{-1})	best	min max	best	min max
Conway* 133	8.46	-0.18	1.50	1.22 1.50	0.89	0.89 1.16
Schiaparelli* 136	24.78	-0.79	-0.51	-0.79 -0.51	-1.10	-1.39 -1.01
Schiaparelli_FG 136	22.73	-0.63	-0.64	-0.95 -0.64	-1.29	-1.46 -1.19
138*	3.29	-0.52	1.35	1.08 1.35	0.76	0.75 1.02
Lovisato* 139	13.37	-1.30	0.83	0.52 0.83	0.19	0.04 0.35
Emma 142	7.31	-0.20	0.13	-0.23 0.18	-0.63	-0.74 -0.49
144	3.78	-0.74	-0.13	-0.46 -0.04	-0.81	-0.89 -0.71
149	3.86	-0.65	0.15	-0.24 0.31	-0.56	-0.66 -0.37
152	3.53	-0.32	0.98	0.64 1.09	0.26	0.25 0.54
157	3.60	-0.09	0.54	0.17 0.67	-0.15	-0.20 0.06
Pagels 159	18.59	-0.45	0.08	-0.29 0.19	-0.64	-0.76 -0.49
B_{MSMnc}	77.19	-0.51	0.16	-0.16 0.20	-0.51	-0.58 -0.45

Table S4: Comparison of specific and surface MB (m w.e. yr^{-1}) from the four different models for the glaciers in the study site (> 3km^2). For every model the best, minimum and maximum estimate are given. B_{MSMnc} gives the massif-wide annual average MB excluding glaciers with major calving losses. The RMSE is weighted by area and calculated from the land-terminating glaciers only as well as including Schiaparelli cut along the flux gate as a land-terminating glacier. Asterisk marks lake termination.

Name/ID	Area (km^2)	Specific MB (m w.e. yr^{-1})	PDD		SEB_Gpot		SEB_G		COSIPY	
			best	min max	best	min max	best	min max	best	min max
133 Conway*	8.46	-0.18	0.47	0.19 0.57	0.42	0.38 0.62	0.46	0.43 0.63	1.04	0.86 1.04
136 Schiaparelli*	24.78	-0.79	-1.05	-1.46 -0.65	-0.75	-0.90 -0.62	-0.81	-0.94 -0.70	-1.25	-1.44 -1.25
136 Schiaparelli_FG	22.73	-0.63	-1.23	-1.54 -0.92	-1.08	-1.16 -0.99	-1.10	-1.20 -1.00	-0.76	-0.98 -0.76
138*	3.29	-0.52	1.46	1.24 1.63	1.89	1.85 1.93	1.77	1.72 1.85	1.97	1.87 1.97
139 Lovisato*	13.37	-1.30	0.85	0.57 1.09	1.23	1.16 1.31	1.17	1.08 1.25	1.09	0.97 1.09
142 Emma	7.31	-0.20	-0.35	-0.80 -0.16	-0.30	-0.37 -0.20	-0.24	-0.34 -0.13	-0.41	-0.66 -0.41
144	3.78	-0.74	-0.84	-1.19 -0.57	-0.82	-0.89 -0.71	-0.68	-0.77 -0.56	-0.82	-1.03 -0.82
149	3.86	-0.65	-0.57	-0.95 -0.37	-0.50	-0.56 -0.34	-0.56	-0.64 -0.40	-0.74	-0.99 -0.74
152	3.53	-0.32	0.17	-0.21 0.25	-0.05	-0.08 0.23	0.08	0.03 0.30	0.35	0.11 0.35
157	3.60	-0.09	0.14	-0.21 0.32	0.40	0.34 0.49	0.33	0.26 0.43	0.35	0.16 0.35
159 Pagels	18.59	-0.45	-0.49	-0.90 -0.29	-0.40	-0.47 -0.28	-0.47	-0.56 -0.35	-0.69	-0.94 -0.69
B_{MSMnc}	77.19	-0.51	-0.43	-0.77 -0.18	-0.29	-0.36 -0.22	-0.32	-0.41 -0.21	-0.46	-0.66 -0.46
RMSE			0.18	0.18 0.43	0.18	0.17 0.28	0.18	0.18 0.27	0.30	0.30 0.43
RMSE incl. Schiaparelli_FG			0.39	0.27 0.64	0.31	0.27 0.35	0.32	0.28 0.37	0.25	0.25 0.40