Supplementary material

Firn cold content evolution at nine sites on the Greenland ice sheet since 1998

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Table S1: Comparison statistics between each station and their respective gap-filling datasets in term of air temperature (Ta), downward shortwave radiation (SW↓), air pressure (P), relative humidity (RH) and wind speed (WS). Subscript 1 and 2 indicates the measurement level.

Station	Gap-filling dataset	Statistic	Meteorological variable							
			Ta_1 (oC)	Ta_2 (°C)	SW↓ (W m^{-2})	P (hPa)	RH_1 (%)	RH_2 (%)	WS_1 (m s^{-1})	WS_2 (m s^{-1})
CP1	CP2	Part of the dataset (%)	4.14	4.14	10.95	10.07	4.14	2.60	3.82	4.06
		RMSE	2.44	2.46	24.53	2.29	3.94	2.55	1.85	1.84
		R^2 (-)	0.96	0.96	0.99	0.92	0.81	0.92	0.62	0.66
CP1	Swiss Camp	Part of the dataset (%)	21.85	17.31	0.00	35.64	15.25	19.42	16.56	17.68
		RMSE	4.32	4.27	-	3.04	7.17	7.32	2.69	2.63
		R^2 (-)	0.85	0.85	-	0.78	0.40	0.42	0.27	0.30
CP1	RACMO2.3p2	Part of the dataset (%)	5.11	11.14	42.06	8.88	19.31	21.67	10.01	11.78
		RMSE	4.36	4.31	51.21	2.29	6.23	5.91	2.50	2.37
		R^2 (-)	0.85	0.85	0.94	0.88	0.51	0.54	0.35	0.40
Dye-2	KAN_U	Part of the dataset (%)	0.00	6.62	4.97	24.38	0.00	24.21	0.00	6.53
		RMSE	-	1.87	58.60	3.37	-	6.53	-	2.59
		R^2 (-)	-	0.97	0.95	0.94	-	0.53	-	0.73
Dye-2	RACMO2.3p2	Part of the dataset (%)	20.22	6.14	25.50	38.02	22.94	14.46	25.77	20.11
		RMSE	2.80	2.76	43.48	2.63	6.19	6.05	1.92	2.14
		R^2 (-)	0.94	0.94	0.97	0.95	0.59	0.54	0.77	0.76
NASA-SE	RACMO2.3p2	Part of the dataset (%)	21.00	18.65	38.72	16.24	37.80	41.34	36.90	40.73
		RMSE	3.43	3.31	46.27	2.74	6.05	5.96	2.19	2.28
		R^2 (-)	0.90	0.91	0.97	0.96	0.53	0.55	0.62	0.52
NASA-U	RACMO2.3p2	Part of the dataset (%)	41.95	44.57	36.58	78.69	41.79	59.61	42.24	44.85
		RMSE	3.42	3.41	42.26	2.60	5.88	5.85	1.69	1.72
		R^2 (-)	0.92	0.92	0.96	0.95	0.60	0.61	0.64	0.66
Saddle	RACMO2.3p2	Part of the dataset (%)	25.39	18.21	29.45	10.53	38.03	38.52	37.45	27.75
		RMSE	3.22	3.21	43.41	1.27	6.17	6.52	2.23	2.27
		R^2 (-)	0.92	0.92	0.97	0.99	0.62	0.60	0.68	0.67
South Dome	RACMO2.3p2	Part of the dataset (%)	29.61	31.04	43.72	86.47	48.78	56.27	38.65	36.12
		RMSE	2.87	2.92	58.69	2.28	7.46	7.80	2.45	2.38
		R^2	0.92	0.91	0.94	0.85	0.51	0.48	0.68	0.70
NASA-E	RACMO2.3p2	Part of the dataset (%)	11.69	16.33	49.03	13.19	35.14	16.56	30.95	23.97
		RMSE	4.60	4.59	53.86	3.97	6.71	6.44	2.69	2.47
		R^2	0.87	0.86	0.93	0.86	0.58	0.60	0.32	0.37
Summit	NOAA	Part of the dataset (%)	6.69	5.64	2.83	0.00	4.07	1.90	9.61	7.16
		RMSE	1.73	1.72	34.16	-	5.62	5.23	1.58	1.25
		R^2	0.98	0.98	0.98	-	0.78	0.78	0.72	0.83
Summit	ETH	Part of the dataset (%)	0.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00
		RMSE	-	-	31.31	-	-	-	-	-
		R^2	-	-	0.98	-	-	-	-	-
Summit	RACMO2.3p2	Part of the dataset (%)	17.45	11.53	21.83	99.79	21.44	17.11	20.12	16.07
		RMSE	4.30	4.23	40.47	5.93	7.60	7.31	1.81	1.78
		R^2	0.90	0.89	0.97	0.34	0.58	0.58	0.60	0.65
Tunu-N	RACMO2.3p2	Part of the dataset (%)	12.39	12.38	32.20	11.74	12.77	25.31	14.63	13.17
		RMSE	3.21	3.19	35.55	2.00	5.68	5.23	1.34	1.37
		R^2	0.94	0.94	0.97	0.97	0.65	0.70	0.61	0.62

Table S2: Snow pits used for the calibration of the station-derived snow accumulation. SWE are given from the previous summer's horizon.

Station	Date	SWE (mm w.eq.)	Investigators
CP1	11-May-1995	597	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
CP1	11-May-1996	289	
CP1	11-May-1997	475	
CP1	11-May-1998	491	
CP1	26-May-1999	430	
CP1	11-May-2000	467	
CP1	28-May-2001	336	
CP1	8-May-2002	340	
CP1	11-May-2003	471	
CP1	5-May-2008	501	
CP1	9-May-2010	362	
CP1	26-May-2015	356.6	
CP1	17-May-2016	478.4	C. Max Stevens
CP1	17-May-2017	401.72	C. Max Stevens
Summit	11-May-1996	212	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
Summit	11-May-1997	219	
Summit	11-May-1998	153	
Summit	12-May-1999	226	
Summit	11-May-2000	205	
Summit	10-Jun-2001	226	
Summit	10-Jun-2001	256	
Summit	11-May-2002	168	
Summit	11-May-2003	212	
Summit	11-May-2004	245	
Summit	26-Apr-2005	290	
Summit	15-May-2016	246	C. Max Stevens
Summit	29-May-2015	208.9	C. Max Stevens
Summit	28-May-2015	201.4	C. Max Stevens
DYE-2	18-Apr-1999	334	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
DYE-2	12-May-2000	293	
DYE-2	26-May-2002	450	
DYE-2	3-May-2008	341	
DYE-2	16-May-2009	453	
DYE-2	1-May-2010	172	
DYE-2	22-May-2013	217	
DYE-2	1-Oct-2016	60	
DYE-2	24-Apr-2016	313	Achim Heilig
DYE-2	28-Apr-2016	394.7	Achim Heilig
DYE-2	2-May-2016	400.1	Achim Heilig
DYE-2	21-May-2015	312.8	
DYE-2	21-May-2015	283.5	
DYE-2	2-May-2016	304.4	Achim Heilig, Baptiste Vandecrux
DYE-2	12-May-2017	294.3	Achim Heilig
South Dome	22-Apr-1999	549	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
South Dome	15-May-2009	468	
South Dome	27-Apr-2015	677	
Saddle	26-May-2005	408	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
Saddle	3-May-2008	422	
Saddle	22-May-2013	360	
Saddle	24-Apr-2015	435	
Saddle	30-Apr-2015	290	
Saddle	8-May-2017	409.6	Achim Heilig
Saddle	6-May-2016	381.6	C. Max Stevens
Saddle	16-May-2015	347.7	
TUNU-N	28-May-2013	96	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
NASA-SE	26-Apr-2015	445	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
NASA-SE	4-May-2016	590.8	Aleah Sommers
NASA-SE	4-May-2016	620.2	C. Max Stevens
NASA-SE	4-May-2016	624.9	C. Max Stevens
NASA-SE	5-May-2017	695	Achim Heilig
NASA-SE	11-May-2015	548.3	
NASA-E	2-May-2008	133	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
NASA-E	28-May-2013	145	
NASA-U	2-May-2008	230	K. Steffen, J. Box, M. Albert, N. Cullen, R. Huff, J. Weber, S. Starkweather, N. P. Molotch
NASA-U	22-May-2013	281	

Figure S1: Initial runs used to calculate the density on June 1998 at NASA-U, Saddle, South Dome, NASA-E, Summit and Tunu-N. a-f) Surface forcing data. g) Simulated firn density. h) Firn density profile at the start (blue) and end (red) of the preliminary run.

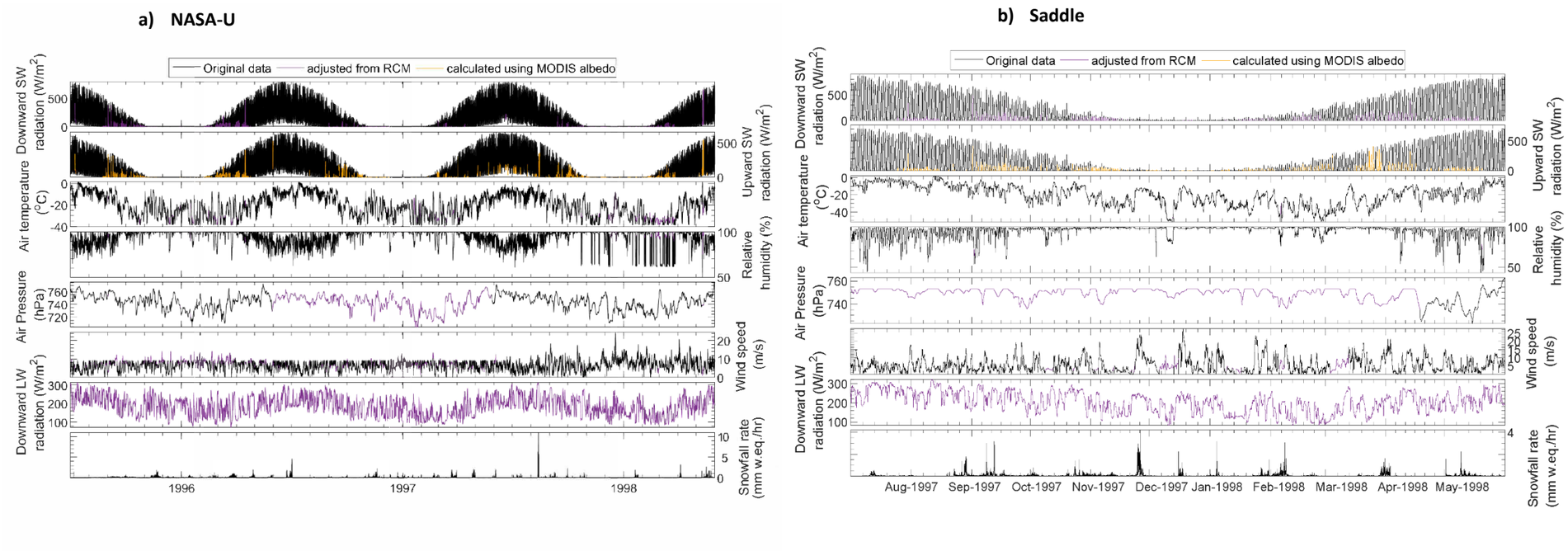
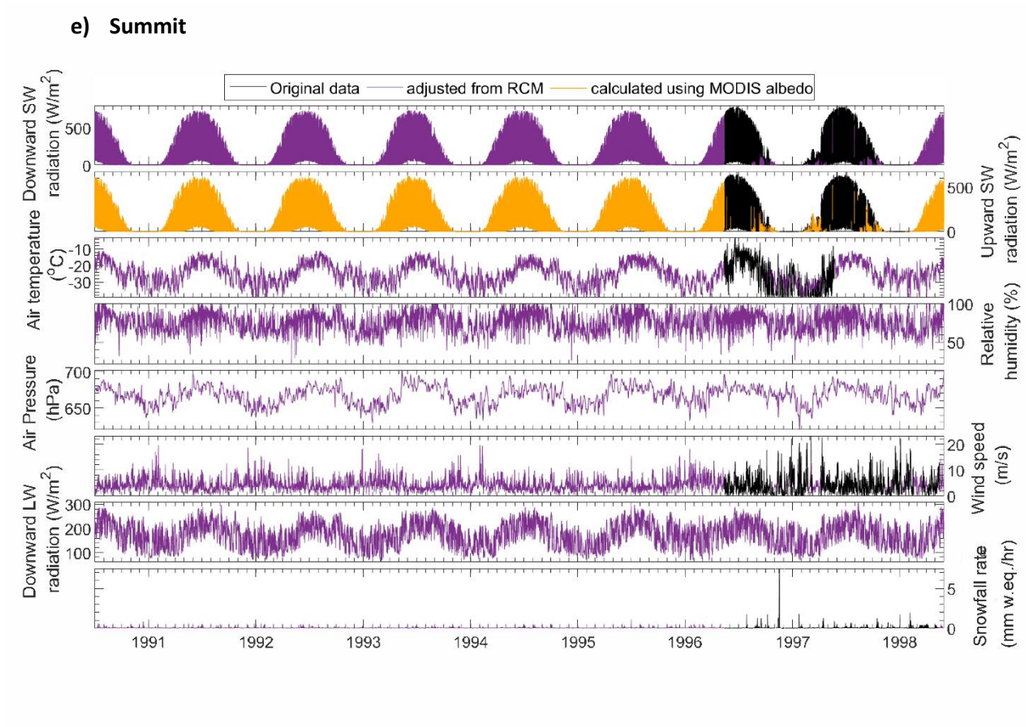
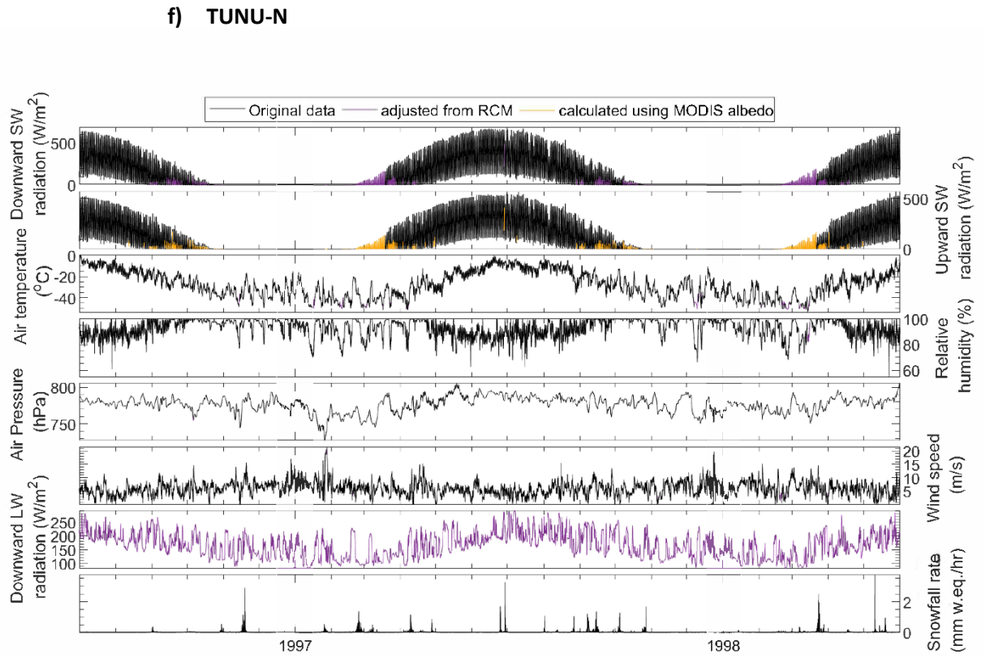
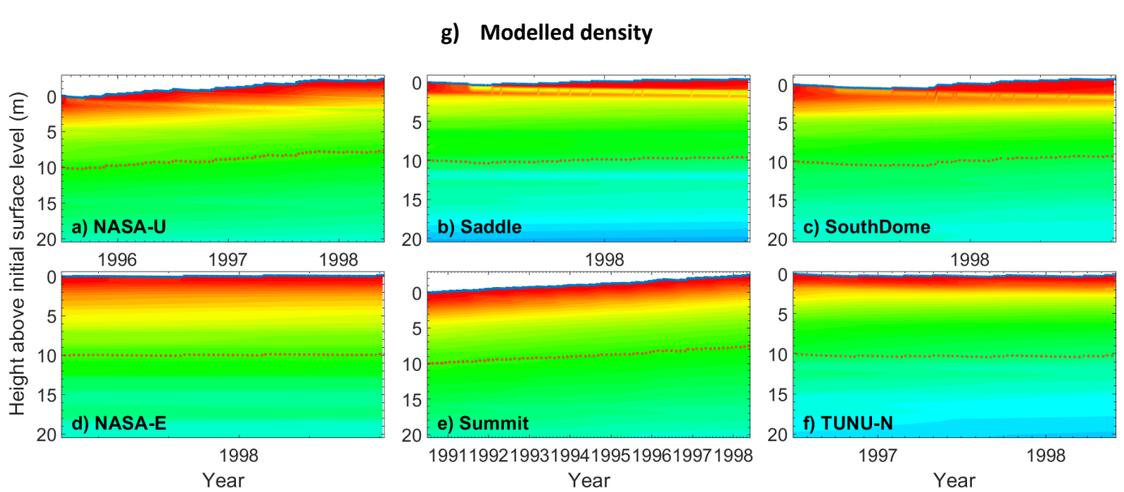


Figure S1: continued.







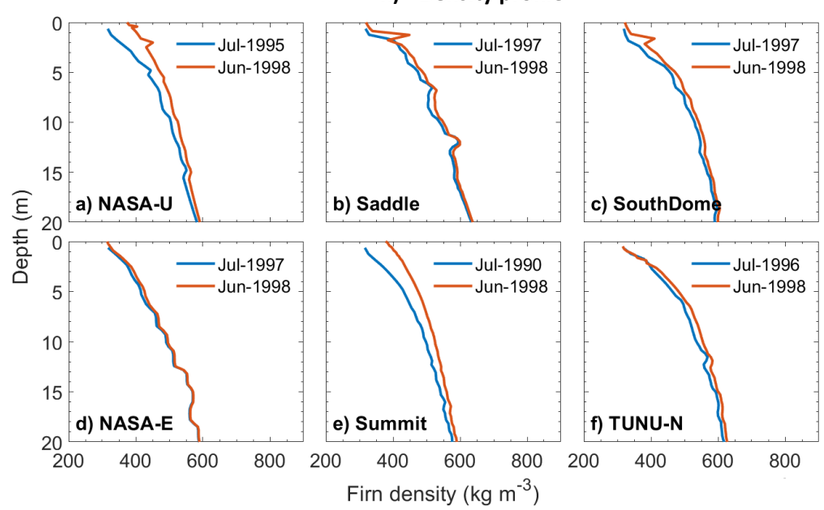


Figure S2: Surface energy balance and calculated melt. Surface energy fluxes are positive towards the surface.

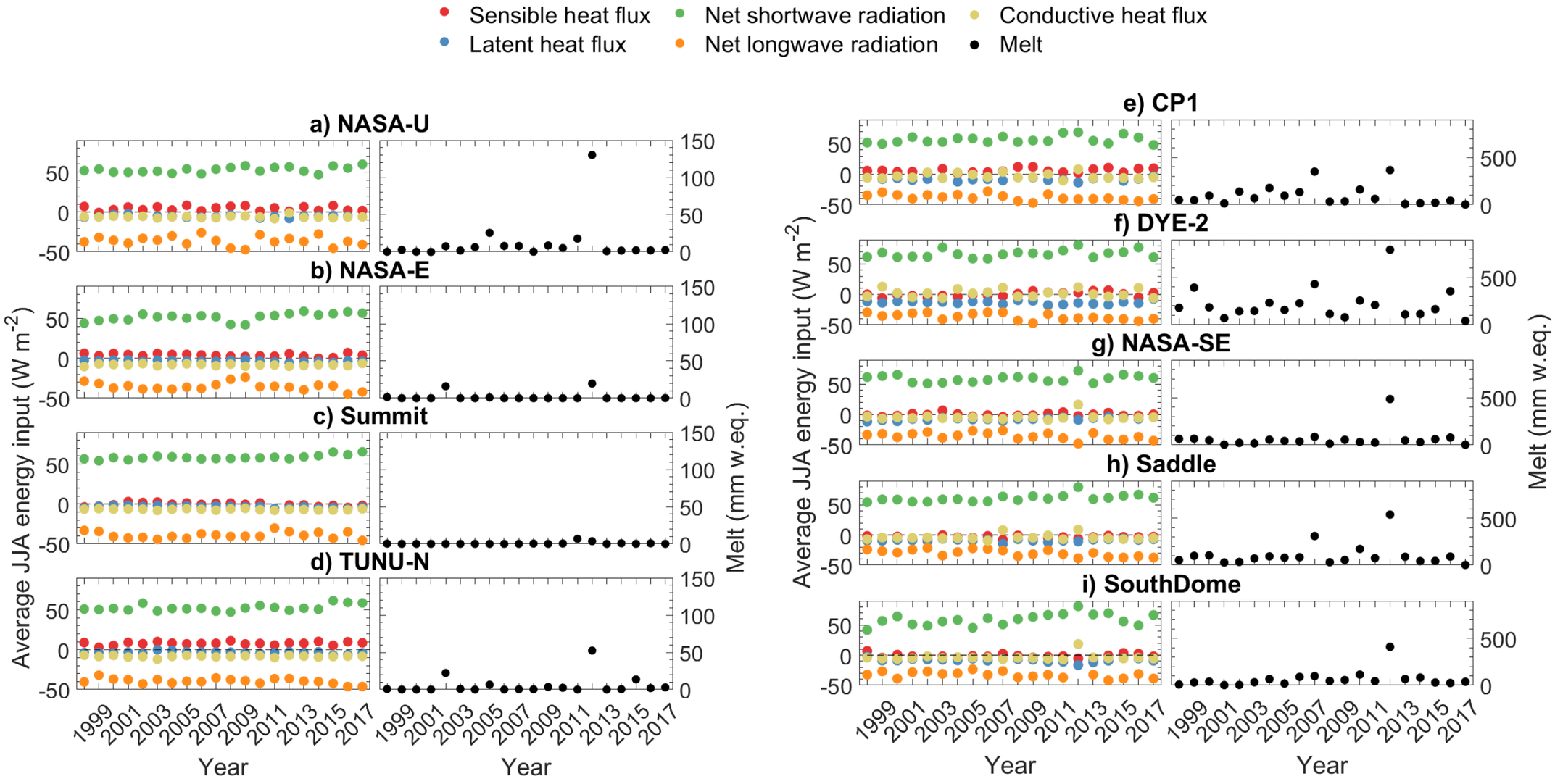


Figure S3: Observed and simulated density profiles

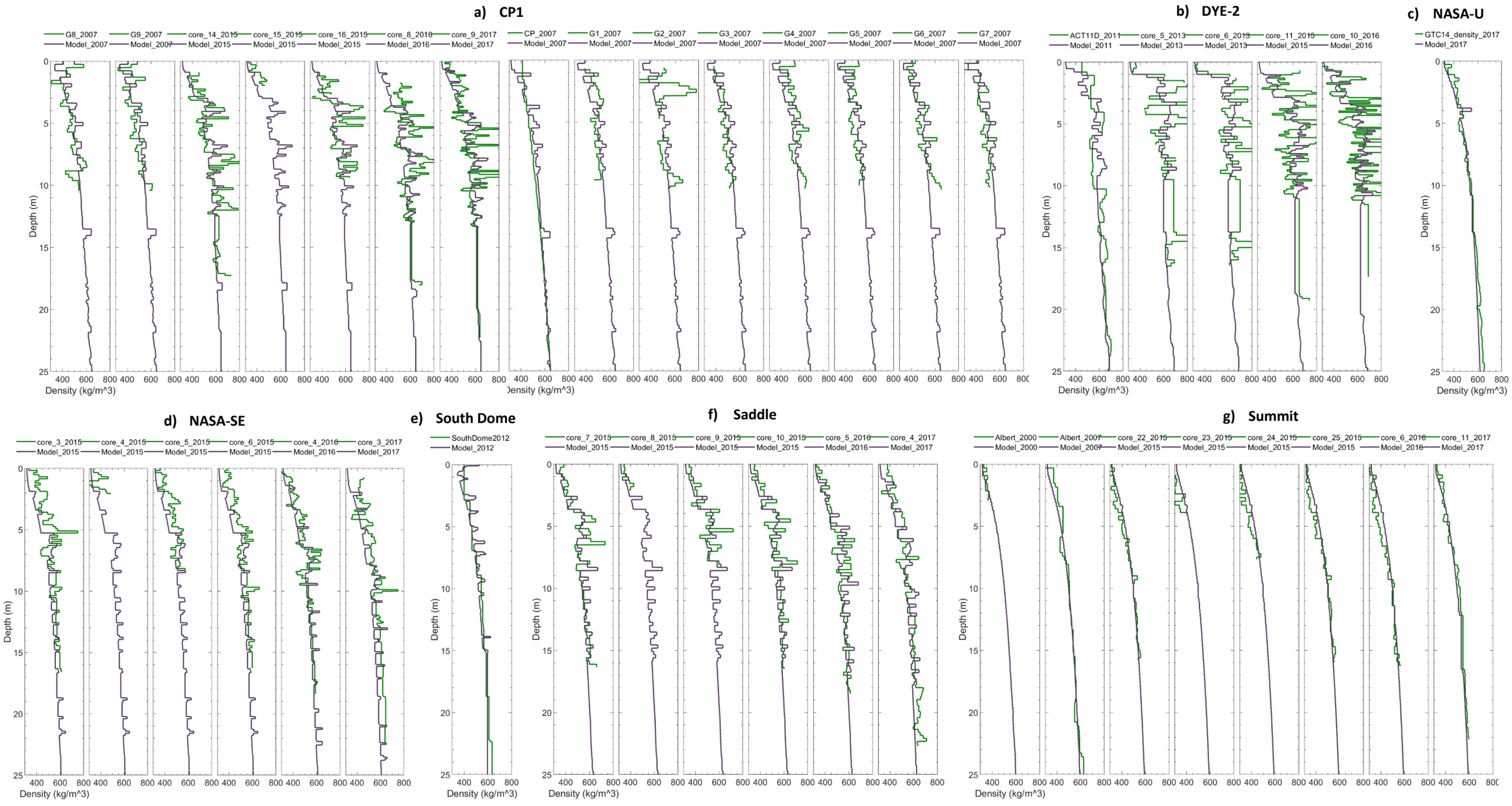


Figure S4: Scatter plots of observed and simulated firn temperature. Sensor #1 is the one closer to the surface and #10 the deepest.