

Supplementary Material

11-year record of wintertime snow surface energy balance and sublimation at 4863 m a.s.l. on Chhota Shigri Glacier moraine (western Himalaya, India)

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Table S1. Radiative and turbulent heat fluxes in the High Mountain Asian (HMA) glacier/snow-covered/debris surfaces. All radiative fluxes are in W m^{-2} . R_{net} corresponds to the sum of S_{net} and L_{net} .

	Glacier/Snow-covered site	Region	Period of observation	Lat ($^{\circ}$)	Long ($^{\circ}$)	Elevation (m)	Surface type	Reference	R_{net} (W m^{-2})	H (W m^{-2})	LE (W m^{-2})
Tibetan Plateau (TP)	Guliya Ice Cap	West Kunlun Mountains, TP	1 Oct 2015 to 30 Sep 2016	81.46	35.26	6000	Ablation zone	Li et al. (2019)	3	12	-11
	Chongche Ice Cap	West Kunlun Mountains, TP	17 Jul to 22 Aug 1987	81.01	35.20	5850	Ablation zone	Takahashi et al. (1989)	44	44	-64
	Urumqi No. 1	Tien Shan, TP	Jun-Aug, 1986-90	86.81	43.12	3840	Ablation zone	Kang and Ohmra (1994)	73	13	-5
	Keqikar Baxi	Southwest Tianshan, TP	16 Jun to 7 Sep 2005	80.09	41.79	4265	Ablation zone	Li et al. (2011)	63	14	-54
	Laohugou No. 12	Western Qilian, TP	1 Jun to 30 Sep, 2010-2015	96.40	39.40	4550	Ablation zone	Sun et al. (2018)	81	8	-13
	Qiyi	Western Qilian, TP	30 Jul to 9 Oct 2011	97.76	39.24	4770	Ablation zone	Wu et al. (2016)	67	28	-21
	Bayi Ice Cap	Qilian Mountains, northern TP	Jun-Sep 2016	98.90	39.01	4800	Ice cap top	Qing et al. (2018)	73	12	-14
	August-one Ice Cap	Qilian Mountains, northern TP	Summer, 2016-2017	98.87	39.02	4820	Ice cap top	Liu et al. (2020) Guo et al. (2018)	61	9	-4
	Parlung No. 4	Southern TP	Annual; 2008-2013	96.92	29.23	4800	Ablation zone	Zhu et al. (2018)	31	11	-21
	Zhadang	Southern TP	Annual; 2008-2013	90.65	30.48	5665	Ablation zone	Zhu et al. (2018)	20	14	-13
	Muztag Ata No. 15	Eastern Pamir, TP	Annual; 2008-2013	75.05	38.23	4400	Ablation zone	Zhu et al. (2018)	8	18	-24
	24 K	Southern TP	Jun to Sep 2016	95.72	29.75	3900	Ablation zone	Yang et al. (2017)	176	-87	-25
	Xiao Dongkemadi	Central TP	7 Oct 1992 to 6 Oct 1993	92.08	33.07	5600	ELA	Liang et al. (2018)	7	12	-6
	Qiangtang No. 1	Inland TP	1 Nov 2012 to 31 Oct 2016	88.70	33.29	5882	Ablation zone	Li et al. (2018)	-7	26	-15
	Guxiang No. 3	South-eastern TP	Jul-Aug, 1965	95.40	29.90	4400	Ablation zone	Wang et al. (1982)	148	63	19
	Xixibangma	South central TP	23 Aug to 11 Sep 1991	85.80	28.45	5700	Ablation zone	Aizen et al. (2002)	28	5	-19
	Muji	Northeastern Pamir, TP	2011-2017	73.74	39.19	4685	Snow/bedrock	Zhu et al. (2020)	25	4	-20
Himalaya	Chhota Shigri	Western Himalaya	8 Jul to 5 Sep 2013	77.51	32.23	4670	Ablation zone	Azam et al. (2014)	187	31	11
	Dhundi	Western Himalaya	13 Jan to 12 Apr 2005	77.13	32.36	3050	Snow/bedrock	Datt et al. (2008)	83	3	-1
	Ganglass, Ladakh	Western Himalaya	1 Sep 2015 to 31 Aug 2017	77.62	34.25	4727	Permafrost	Wani et al (2020)	29	14	13
	Ganja La	Central Himalaya	5 March to 25 May 2018	85.56	28.15	4962	Snow cover	Stigter et al. (2021)	42	14	-8
	Yala	Central Himalaya	9 February to 26 May 2018	85.61	28.23	5090	Glacier, snow cover	Stigter et al. (2018) Stigter et al. (2021)	30	25	-25
	Camp II, Everest	Mt. Everest, Central Himalaya	24 Jun to 31 Oct 2019	86.90	27.98	6464	Snow/bedrock	Matthews et al. (2020)	20	3	-8
	South Col, Everest	Mt. Everest, Central Himalaya	22 May to 31 Oct 2019	86.93	27.97	7945	Snow/bedrock	Matthews et al. (2020)	16	11	-25
	AX010	Central Himalaya	25 May to 25 Sep 1978	86.57	27.69	5080	Ablation zone	Kayastha et al. (1999)	55	8	3
	Pindari	Central Himalaya	13 Jun 2016 to 30 Jan 2018	80.01	30.27	3750	Snow/bedrock	Singh et al. (2019)	76	-10	2
	East Rongbuk	Central Himalaya	1 May to 22 July 2005	86.95	28.04	6523	Ablation zone	Liu et al. (2021)	41	12	-20
	Naimona'nyi	Central Himalaya	Oct 2010 to Sept 2018	81.33	30.45	5950	Glacier-wide	Zhu et al. (2021)	8	12	-16

Table S2. The number of days below snow-surface albedo threshold ($\alpha_{acc} = 0.4$ in this study) in each year and corresponding dates. The data period is DJFMA, 2009-2020.

Year	No. of days $\alpha_{acc} < 0.4$	$\alpha_{acc} < 0.4$ dates
2009/10	-	-
2010/11	-	-
2011/12	16	1-6 Dec, 18 Dec, 22-23 Dec, 26-31 Dec (2011), 1 Jan 2012
2012/13	-	-
2013/14	9	1-2 Dec, 4-5 Dec, 16-19 Dec (2013), 3 Jan 2014
2014/15	1	11 Dec 2014
2015/16	-	-
2016/17	30	1-24 Dec, 30 Dec (2016), 16-20 Apr 2017
2017/18	18	13-23 Jan, 1-5 Feb, 29-30 Apr (2018)
2018/19	-	-
2019/20	-	-
Total	74	-

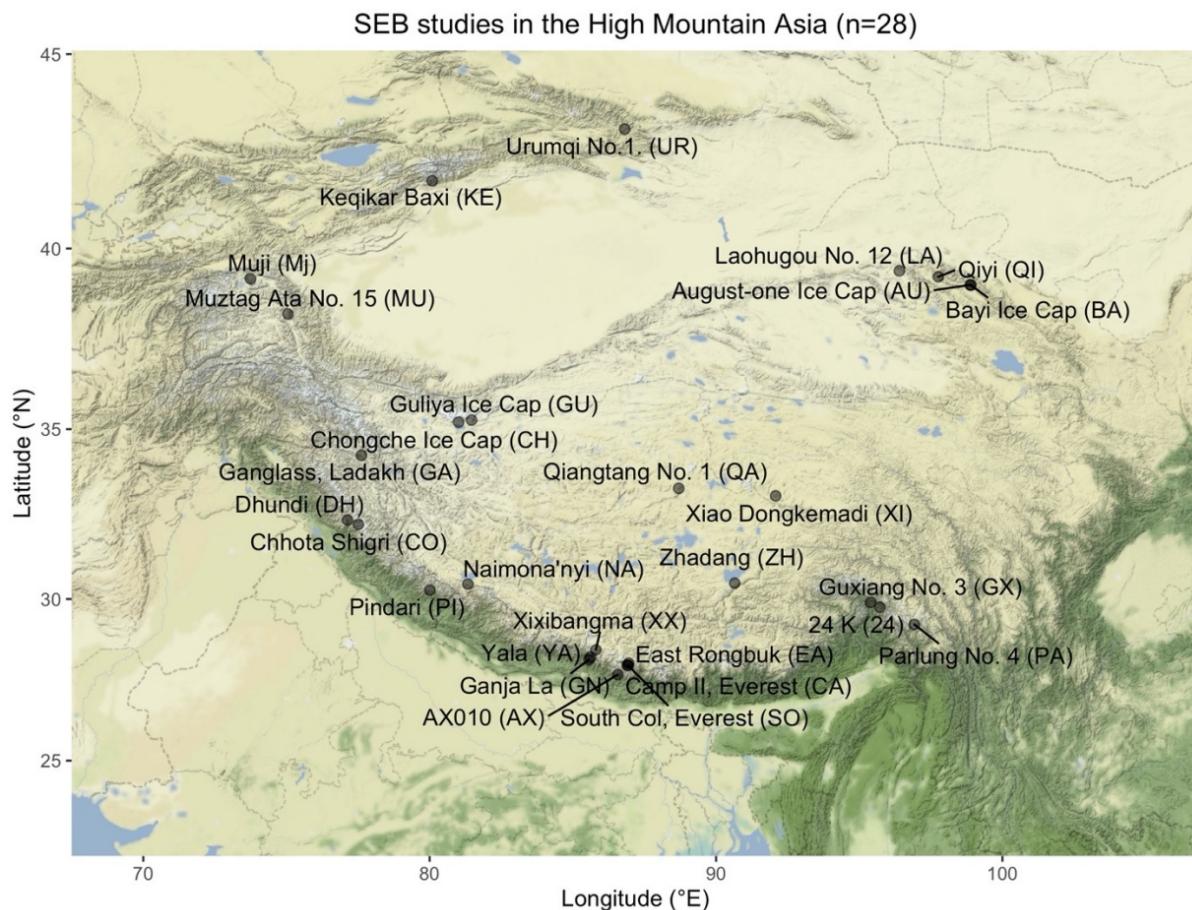


Fig. S1. Location of the existing glacier/snow-cover SEB sites across HMA (listed in Table S1). The background is the Stamen terrain map. The figure is generated using the ‘ggmap’ package (Kahle and Wickham, 2013) in the R environment.

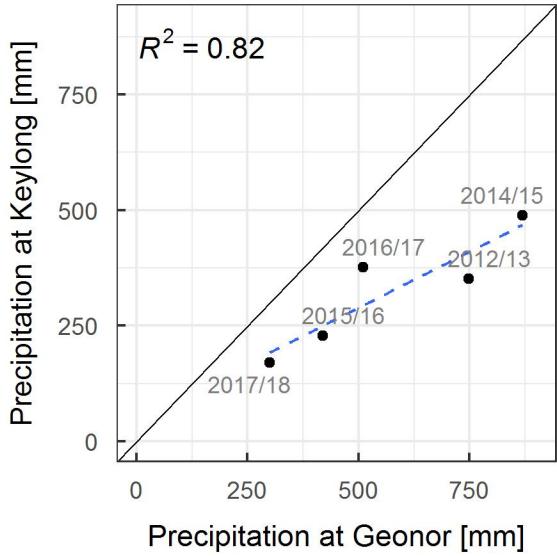


Fig. S2. Comparison of DJFMA precipitation recorded at the Geonor/base camp station (3850 m a.s.l.) and IMD's Keylong station (3119 m a.s.l.). Both stations are ~60 km away. Keylong data is taken from: <https://weathershimla.nic.in/en-IN/climatedata.html>. DJFMA precipitation is the sum of records between December and April of each hydrological year. Five years data are available for Geonor; years are shown on top of the respective data points. Also shown is the 1:1 line. This figure illustrates a strong correlation between Keylong and Geonor precipitation ($R^2 = 0.82$); however, the RMSE is 274 mm.

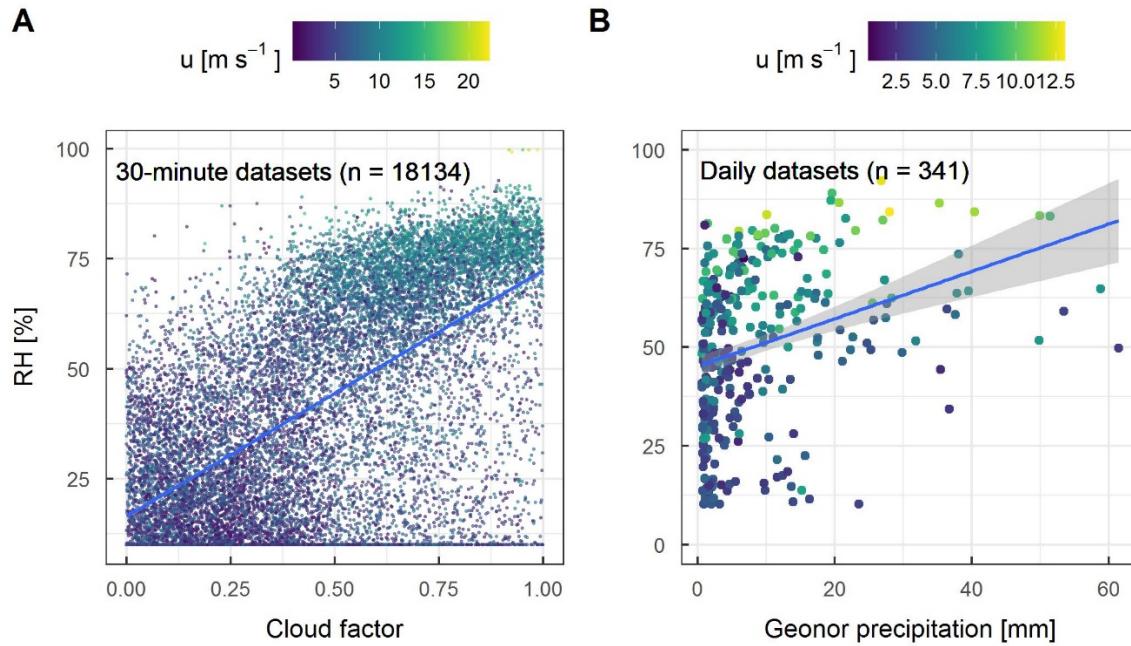


Fig. S3. (A) Relationship between relative humidity, wind speed and cloud factor, and (B) relative humidity, cloud factor and precipitation. The number of data points is mentioned on the respective panel. Precipitation was recorded at the glacier base camp at 3850 m a.s.l.

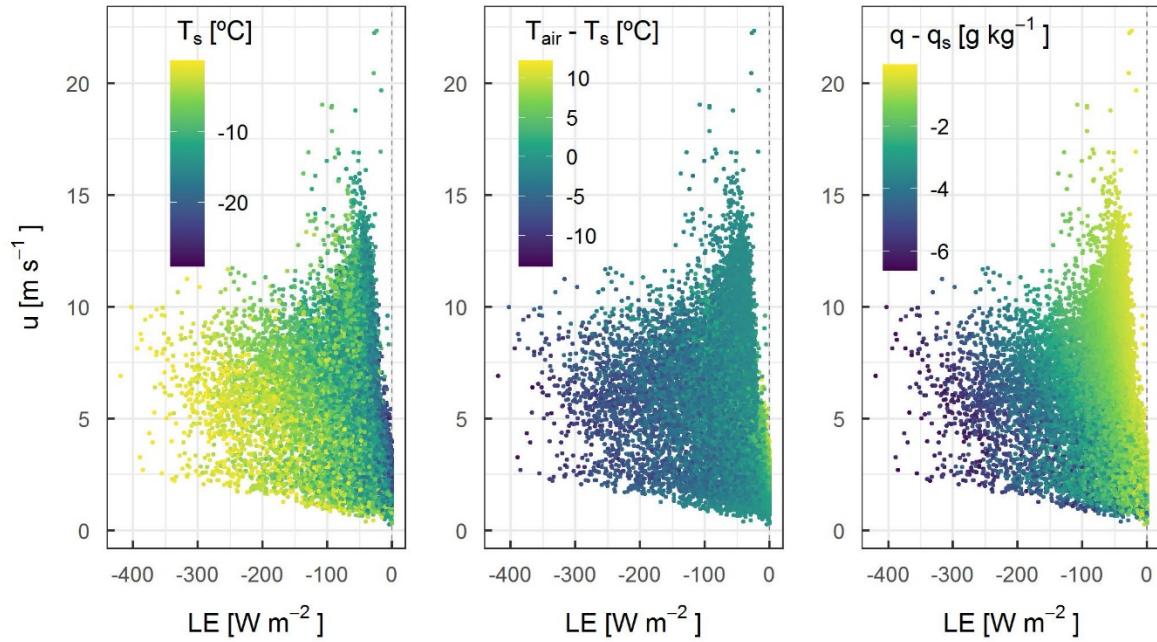


Fig. S4. Relationship of LE with u , T_s , $T_{air} - T_s$ and $q - q_s$ over the study period for DJFMA, 2009–2020. The half-hourly data points are used ($n = 13217$) between 09:00 and 16:00 IST.

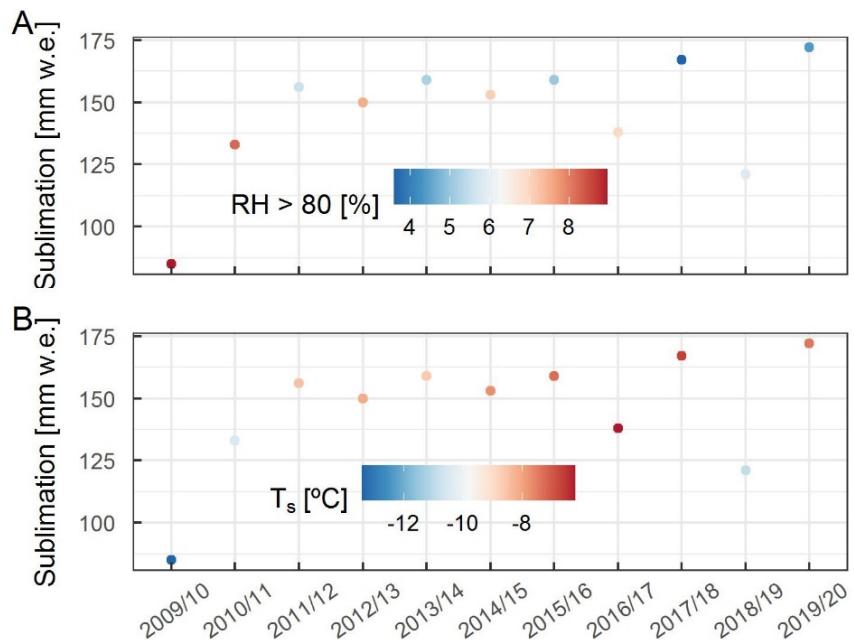


Fig. S5. Relationship between cumulative sublimation and $RH > 80\%$ and T_s at the AWS-M for DJFMA, 2009–2020. RH and T_s are for the daytime between 08:00 and 16:00 IST.

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