Response to Reviewer 1

Below we provide our responses **(in red text)** point-by-point to each comment from the reviewer **(in black text)**. ***Italic texts*** are used to highlight specific changes in the updated manuscript.

General comments:
This paper analyzes the winter meteorological data and surface energy balance (SEB) on a lateral moraine of the Chhota Shigri Glacier in the western Himalaya during 2009-2019, and then explored the effects of cloud cover on winter energy balance and sublimation on that site. In addition, this paper presents long-term glacio- meteorological data in the western Himalayas, which is very important for studying the glacier mass balance changes on the Tibetan Plateau and the surrounding areas. This is an interesting paper, but needs major revisions before can be accepted for publications in TC. I have several comments that the authors should address.

We sincerely thank Reviewer 1 for evaluating our manuscript and giving suggestions to improve the quality of the manuscript. We have responded to your specific comments and outlined the changes that we have made in the revised manuscript. If the reviewers and the editor are satisfied with our responses, we will submit our revised manuscript. Below, we have highlighted (point-wise) the major revisions that we have made in the revised manuscript in response to your main comments:

- We have shortened the meteorological condition section by reducing the texts, figures (part of the figures have been shifted to the supplementary material) and tables in respective sections.
- Reorganized the presentation of meteorological and surface energy balance (SEB) analysis to account for different temporal scales, such as daily, hourly, seasonal, and inter-annual.
- Incorporated a large-scale wind/moisture circulation analysis using ERA5 500 hPa datasets to understand the influence of western disturbances (WDs) on sublimation.
- Sub-hourly and inter-annual correlation analysis, as well as multiple regression analysis of sublimation and meteorological variables, were included. Further, the discussion and interpretation were significantly revised, with a focus on sublimation factors.
- AWS data used in this study, codes for SEB calculation and figures are made open to the global community through open repository with DOI.

Main comments:

1. Introduction: There are some studies discussing the energy balance and mass balance around HK regions and other regions on the Tibetan Plateau in recent years, such as Pamir and Tibet.

Although the authors reviewed some studies, it is relatively simple. The authors should review more recent studies about energy balance and mass balance around the Tibetan Plateau, and pointed out the limitations of these studies.

We acknowledge that we reviewed only a few studies related to glacier surface energy balance (SEB) from the Pamir and Tibet regions in the Introduction section. It is because our main focus is to address the research gaps related to sublimation estimation and its role in glacier mass balance in the Himalaya-Karakoram (HK) region. Therefore, we mainly highlighted the importance of turbulent heat fluxes, understanding gaps for sublimation and its estimation methods used in the HK region and skipped/avoided to discuss findings/gaps related to glacier mass and energy balance.

To make the Introduction section more holistic and inclusive, we have included some of the recent glacier SEB (e.g., Li et al., 2019; Zhu et al., 2020) and sublimation (e.g., Guo et al., 2021) related studies from the Pamir and Tibet regions. Newly incorporated texts in the Introduction read as:

Line No. 41-46:
'However, SEB studies on Tibetan glaciers are relatively more abundant (~17 investigated glaciers/ice-covered sites; Table S1), including direct turbulent heat flux measurements (Yang et al., 2011; Zhu et al., 2018) except in Pamir and Kunlun Mountains (Zhu et al., 2020). Glaciers in the Pamir area are extreme continental type, with cold temperature and low annual precipitation (Li et al., 2019), thus their SEB characteristics are expected to behave differently compared to the majority of HK glaciers which are alpine type, with relatively higher precipitation and temperature.'

Line No. 65-67:
'In the Muji Glacier in northeast Pamir, the cold season's evaposublimation loss is > 70% of the corresponding snowfall (Zhu et al., 2020). In the Qilian Mountains at the August-one Glacier (north-east Tibetan Plateau), evaposublimation loss is lower but accounts for about 15% of annual precipitation (Guo et al., 2021).'

In addition, in Table 4 (revised manuscript) and the sublimation section (Sect. 5.3 and 5.4 in the revised manuscript), we specifically reviewed several studies from the Pamir and Tibet regions, comparing sublimation rates across the HK and Tibetan glacierised regions. Some of the texts are as follows:

Line No. 720-723 (Sect. 5.3):
'Sublimation rates during winter were slightly higher in the Pamir region, e.g., Muztag Ata No. 1 (Zhu et al., 2018) and Muji site (Zhu et al., 2020) compared to the inland/central Tibet region, e.g., Qiangtang No. 1 (Li et al., 2018) and Dongkemadi site (Liang et al., 2018). This is likely

due to the relatively dry atmospheric condition in the Pamire region than the central or eastern parts of Tibet (Table 4; also Liu et al., 2020).'

Line No. 761-776 (Sect. 5.4):

'In the Tibetan Plateau, at the Zhadang Glacier, sublimation loss was 26% of the total annual mass loss (Huintjes et al., 2015a). At the August-one Glacier in the Qilian Mountains, evapo-sublimation accounts for 15% of the annual precipitation, with the major part during winter periods (Guo et al., 2021). In some sites of the Tibetan Plateau, sublimation fraction was considerably higher. For example, in the Muji Glacier in Pamir, cold season's evaposublimation loss was > 70% of the corresponding snowfall (Zhu et al., 2020). In the Kunlun Mountains at Guliya Ice Cap, glacier-wide sublimation loss was ~120% of the winter snowfall, whereas ~50% of the annual snowfall (Zhu et al., 2022). At the Qiangtang No 1 Glacier, inland Tibet, the sublimation and evaporation loss fraction was about 65-169% of the snowfall during 2012-2016 (Li et al., 2018). Such a higher sublimation fraction at the Qiangtang No 1 Glacier during non-melt seasons was associated with high wind speed (~7 m s^{-1}), lower RH (~46%) and low annual precipitation (362-614 mm). This supports that the dry and windy environment fosters sublimation in the HK region. Although there are no sufficient observations available from various parts of the Himalaya or HMA, sublimation fraction to snowfall/annual precipitation is higher in the northwestern part of the HK and western Tibet (e.g., Zhu et al., 2020; Gascoin, 2021). This is likely due to the atmospheric condition of the northwestern part of the HK and western Tibet which is drier than eastern and central Himalaya. Dry atmospheric conditions favor higher sublimation than the wet due to high near-surface humidity gradients.'

2. I do not find how authors calibrate or evaluate their modeled results in this work. The parameters in the energy balance always need to be calibrated by some measured values. For example, the selected surface roughness lengths for momentum, temperature, and humidity, and the different formula of turbulent heat will impact the modeled H and LE. If the modeled results are calibrated, the data will be more credible. Why the author does not select surface temperature to calibrate their model using the iteration method. In this work, the author can deduce that there is no snow cover at the AWS-M site when albedo is smaller than 0.4. This data can also be used to calibrate their modelled values. In addition, it seems that there are few studies about the glacier energy balance which delete G in their model. The AWS-M site remains snow-covered during winter and bare sand/sediment exposed during summer. Whether bare sand below the snow can provide more energy to heat the snow when compared to glacier ice below the snow? Or the author just focuses on the energy feature.

We sincerely acknowledge the concern of Reviewer 1 for the calibration/validation of our SEB calculation, especially the bulk method for turbulent heat flux calculation.

We would like to mention that, in this work, we used the measured surface temperature (T_s; through an infrared radiometer) as an input to calculate the turbulent heat fluxes (H and LE)

following the bulk method; therefore, we cannot compare the simulated T_s and measured T_s to calibrate/validate the bulk methods' performance, which is usually used for evaluating glacier SEB/bulk models.

Concerning the credibility of our SEB and bulk modelling approach, this method has been successfully applied on this glacier in an on-glacier site SEB experiment (Azam et al., 2014a) at 4670 m a.s.l. (~1 km away from the AWS-M; our study site). The SEB model result was validated using the observed surface melt ($r^2 = 0.98$), and also a significant correlation ($r^2 = 0.96$) was observed between the simulated T_s and observed T_s (Azam et al., 2014a).

To incorporate your concern, we tried to validate the sublimation rates using SR-50A data (snow height), which was available for a shorter period (Dec 2009 to Apr 2015). Our plan was to filter snow depth/height (SR-50A) data for periods with no snowfall longer than minimum one week and compare calculated sublimation rates and observed snowpack thickness change over such periods. However, due to inconsistency in the measured precipitation records from the Geonor gauge, the available data for this analysis was only for two years (DJFMA of 2012/13 and 2014/15) (Sect. 3.1). We examined SR-50A data for those two years, but we couldn't find any long enough periods without snowfalls. Figure R1 (below) shows Geonor precipitation data from DJFMA of 2012/13 and 2014/15. Therefore, comparing the SR-50A snow thickness change data to sublimation rates was not appropriate in this case. For the years when Geonor data was not available, we used daily precipitation from the neighbouring Indian Meteorological Department (IMD) Stations: Bhuntar (~50 km) and Manali (~40 km). In those station data also we do not find any long enough period without snowfall (figure not shown here). No daily precipitation data was available from the Keylong, closest IMD station (~60 km) from our study site. There was a possibility to apply the measured/assumed snow density to convert height change into mass loss and compare it with corresponding sublimation loss. However, considering data limitation, we are not in a position to conduct a direct validation of our bulk model.

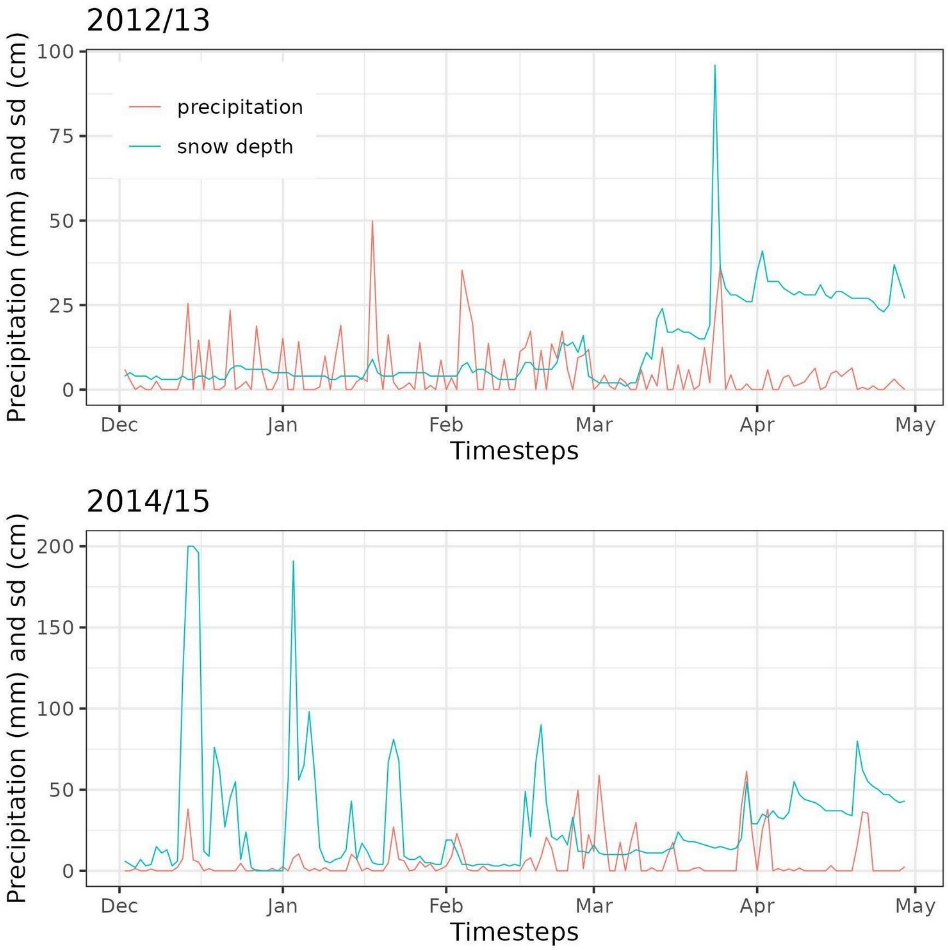


Figure R1. Daily Geonor precipitation (measured at Chhota Shigri glacier base camp at 3850 m a.s.l.) and SR-50A (AWS-M; 4863 m a.s.l.) height change during DJFMA 2012/13 and 2014/15. Data shown only for DJFMA period.

The primary focus of this work is to estimate sublimation directly derived from *LE*. To analyse and quantify the meteorological variable's sensitivity to sublimation and a possible uncertainty in our bulk model, we conducted a sensitivity analysis of the calculated sublimation (Sect. 5.2), where we perturbed the calculated sublimation by changing meteorological variables (e.g., T_{air} by ± 1°C, T_s by ± 1°C, wind speed (u) by ± 10% and *RH* by ± 10%) and surface roughness lengths (0.0005 m, 0.002 m, 0.003 m and 0.004 m) to evaluate the range of sublimation.

In addition, the bulk method was compared with the direct eddy-covariance method over the snow surface at the Yala Glacier (Central Himalaya, Nepal) to evaluate the performance of the bulk method (Stigter et al., 2018). They found a good agreement between eddy-covariance and bulk method (r^2 = 0.88) in estimating sublimation rates, which shows the reliability of the bulk method over snow surface in the Himalayan site. However, as you also suggested that roughness lengths in the bulk model is very crucial to get an accurate result. Considering this and for better accuracy, we have used the previously calculated snow surface roughness lengths already obtained on this glacier (0.001 m; Azam et al., 2014a), which was calculated using wind measurements at two different levels following a conventional logarithmic profile (e.g., Moore, 1983). These aspects are discussed in Sect. 3.2.2.

Based on the aforementioned discussion, we added a new sentence in the method section (Sect. 3.2.2. revised manuscript) highlighting the limitations of our bulk model validation. The new sentence reads as:

Line No. 233-235:
‘Due to data limitations, direct validation of the bulk model used in this study was not possible, but we trust our results based on Azam et al (2014a)’s bulk model validation on this glacier in 2012/13 and proved to deliver robust results compared to observations. We also conducted a sensitivity analysis of our bulk model including surface roughness lengths.’

Regarding the ground/subsurface heat flux (*G*), we calculated *G* at the AWS-M site following the method proposed by You et al. (2014) and Luce and Tarboton (2010). The diurnal variation of *G* is shown below through a figure (Fig. R2) along with other major energy fluxes. The results show that *G* is negligible about -0.4 ± 4.4 W m^{-2} for DJFMA (2009-2020; n = 73624 half-hourly data points) compared to other energy fluxes. That means there is no significant energy coming from the ground/bare surface. In addition, considering the inadequate measurement of the subsurface heat measurements and relative information of *G* in the HK region (Stigter et al., 2021), we neglected it in our SEB calculation. Also, since we focus on sublimation and its drivers/importance, *G* is beyond the scope of this study.

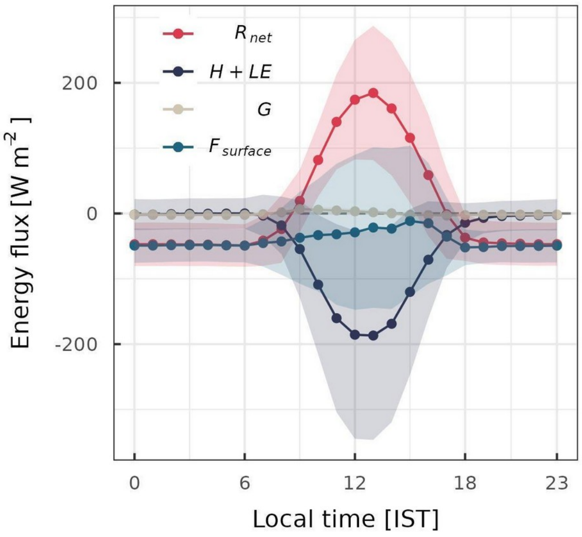


Figure R2. Mean diurnal cycle of *G* (following You et al., 2014 and Luce and Tarboton, 2010) at the AWS-M for DJFMA (2009-2020) along with R_{net}, $H + LE$, and $F_{surface}$.

3. There are so many results in section 4. The author could shorten this section, because some studies have introduced the meteorological data at AWS-M in that glacier (Azam et al., 2016). Are there any special features from your data? Those special features are important. In addition, I hope that the author can discern the timescales for their results, such as diurnal cycle, seasonal cycle, and interannual timescales.

We thank the reviewer for the concern. To incorporate the reviewer's suggestion and shorten the meteorological condition section, we have revised most of the figures in this section. For instance, a part of the figures (e.g., Figure 2, 3, 5C and G, and 6D, 7B in original manuscript) have been shifted to the supplementary material. Table 2 (original manuscript) has also been moved to the supplementary material. Below we present the revised figures (e.g., Figure 2, 3, 5 and 6 in revised manuscript) for your reference. We merged Sect. 4.2 and 4.3 (original manuscript) into a single Sect. 4.1 (revised manuscript). We also reorganized the presentation of meteorological and surface energy balance (SEB) analysis to account for different temporal scales. Such as in Sect. 4.2 (revised manuscript) we presented the diurnal cycle of all meteorological and SEB variables, and seasonal and interannual variation of SEB components in Sect. 4.3 (revised manuscript).

We would also like to mention that Azam et al. (2016) did not focus on the SEB related details, for example, they discussed fewer variables (e.g., T_{air}, *RH*, *u*, S_{in} and S_{out}). T_s, *albedo*, *q* and *CF* were missing in their study, which are important variables to understand SEB characteristics. Furthermore, the meteorological conditions presented by Azam et al. (2016) were based on only four years of datasets (2009-2013), but we updated it using 11-years long datasets in this work (2009-2020).

To discern the timescale of meteorological/SEB characteristics, we have performed the analysis at various temporal scales as suggested by the reviewer. For instance, first, in Sect 4.1 we presented the daily variations and ranges of all meteorological/radiation components. Second, in Sect. 4.2 we presented the diurnal cycle of all meteorological and SEB variables. Third, in Sect. 4.3 we presented the seasonal and interannual variation of SEB components with their statistical correlations. Further, in Sect. 4.6 we analysed sublimation considering various temporal scales, e.g., daily, sub-hourly, seasonal and interannual. Since sublimation and turbulent fluxes are our main interests, we investigated them in Sect. 4.4 and 4.5, focused on the impact of cloud cover in sublimation.

We invite the reviewer to go through the reorganised sections in the revised manuscript.

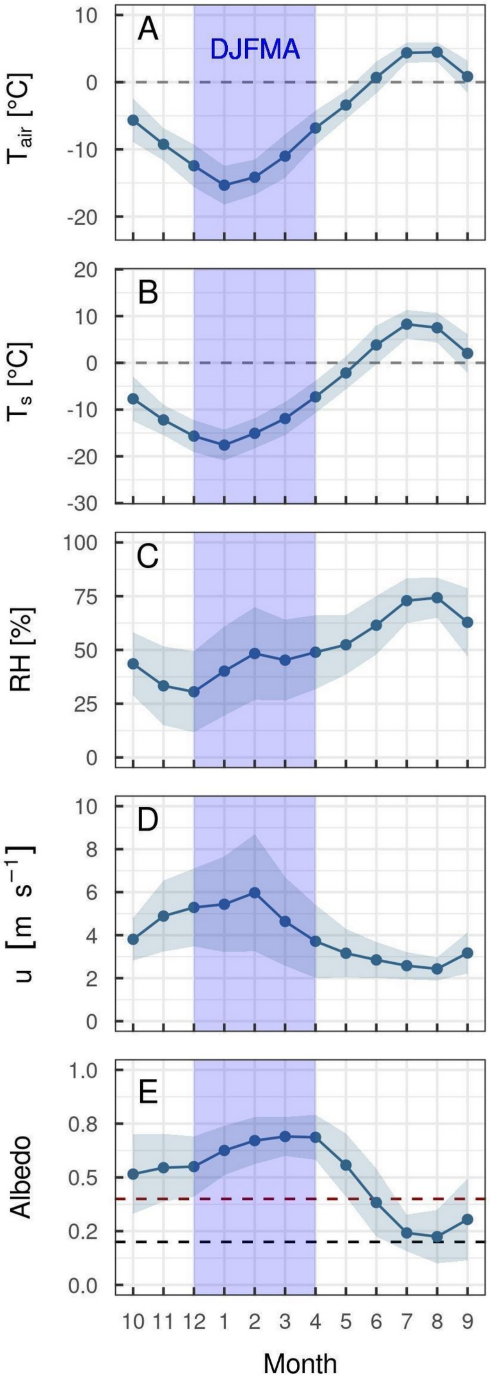


Figure 2 (revised manuscript). Monthly climatology of air (T_{air}) and surface temperature (T_s), relative humidity (RH), wind speed (u) and surface albedo (α_{acc}) at the AWS-M for 2009-2020. DJFMA (1 December to 30 April) period is highlighted with a light blue rectangle in each panel. The shades around the line and scatter points correspond to one standard deviation (SD). Dashed lines in panel E refer to snow-surface albedo (α_{acc} = 0.4; red line) for SEB analysis and bare-surface albedo (α_{acc} = 0.2; black line). Daily values of T_{air}, T_s, RH, u and albedo for the study period are shown in Fig. S2.

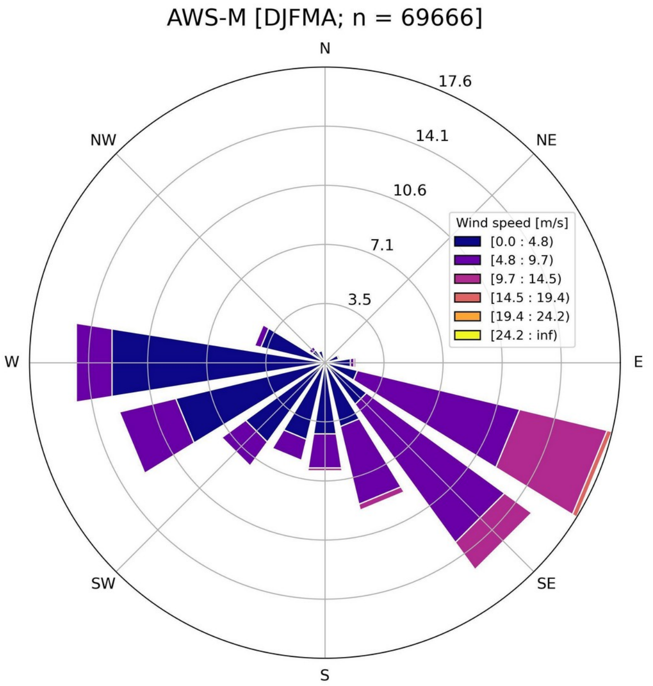


Figure 3 (revised manuscript). Windrose of the AWS-M for DJFMA (2009-2020). The frequency of wind direction is expressed as a percentage based on n = 69666 half-hourly data points.

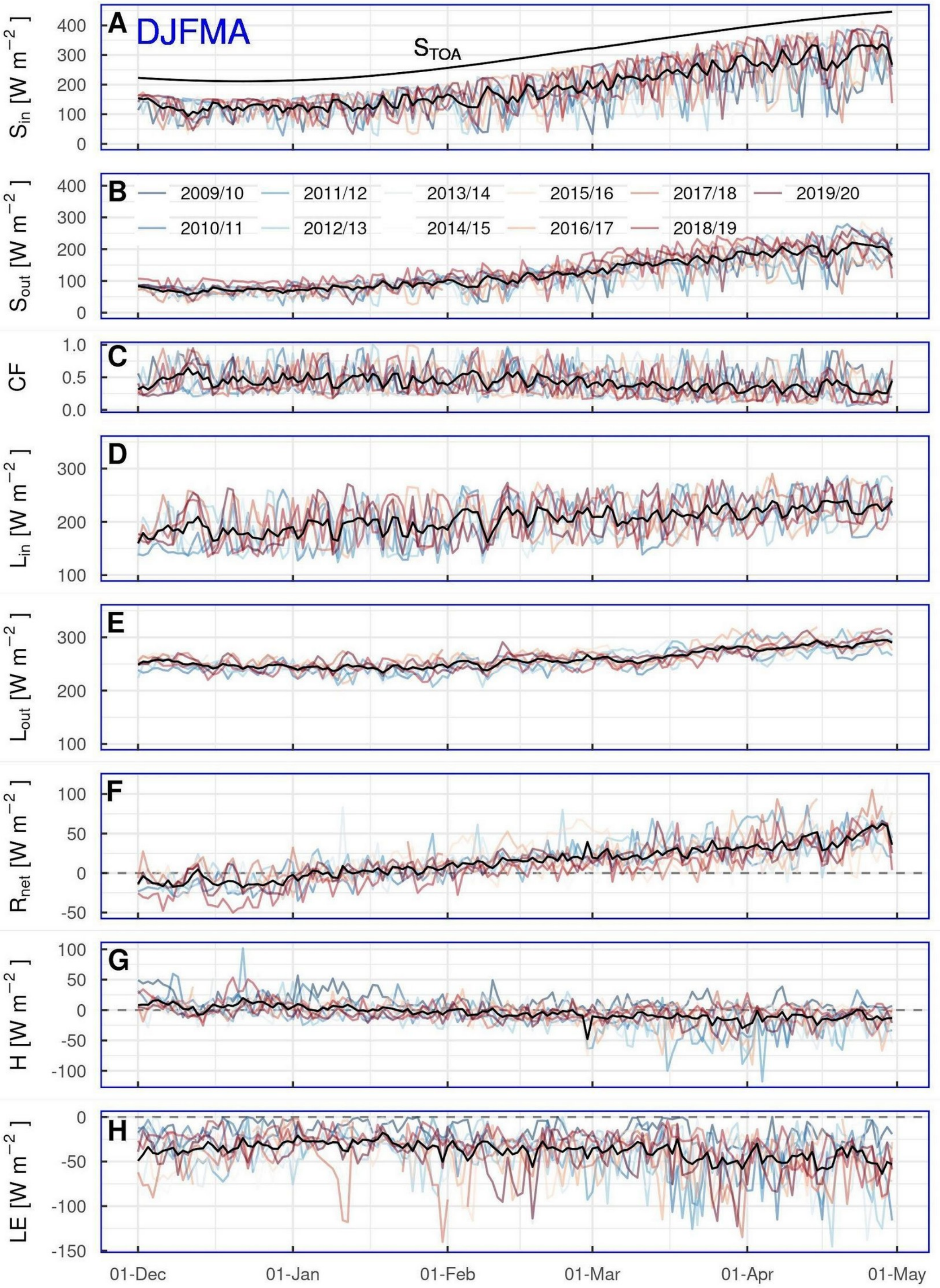


Figure 5 (revised manuscript). The daily mean of short-wave radiation at the top of the atmosphere (S_{TOA}), short-wave incoming (S_{in}) and outgoing (S_{out}), cloud factor (*CF*), long-wave incoming (L_{in}) and outgoing (L_{out}), net radiation (R_{net}), turbulent sensible (*H*) and latent (*LE*) heat fluxes at the AWS-M for DJFMA, 2009-2020. L_{in} and R_{net} start from 1 December 2010. The black line highlights the mean of 2009-2020.

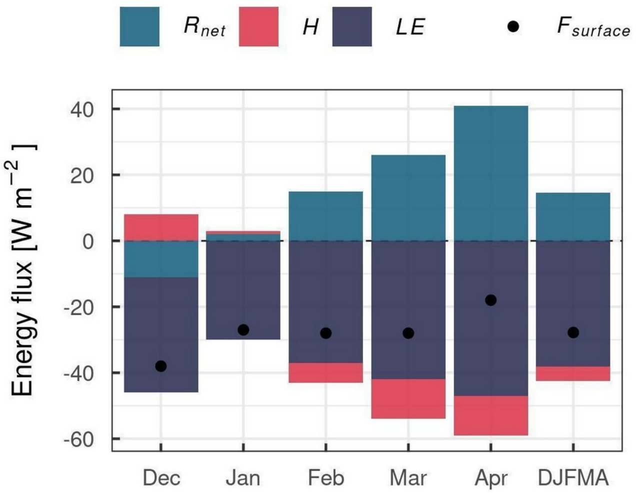
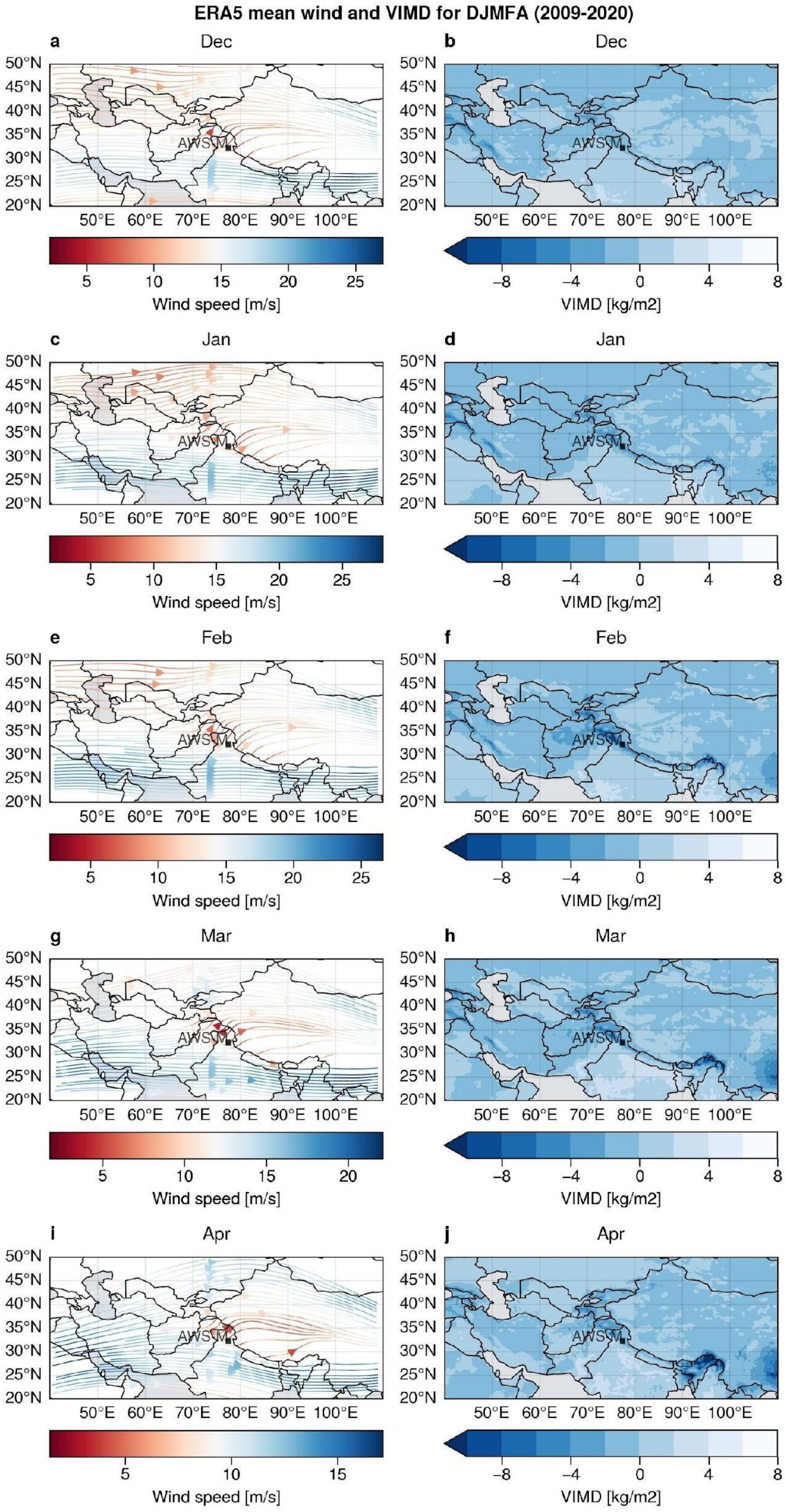


Figure 6 (revised manuscript). Mean monthly energy flux density of R_{net}, H, LE and $F_{surface}$ for DJFMA, 2009-2020.

4. Line 23-25: The author does not discuss the influence of mid-latitude western disturbances on sublimation in the main text. The author can use the Reanalysis data (such as geopotential height and wind fields at 500 hPa or other heights from ERA5 or JRA55) to obtain the direct knowledge of circulation which can impact the sublimation and energy balance.

We thank the reviewer for the suggestion. We acknowledge that we briefly discussed the influence of westerlies on sublimation. However, in this work we intended to keep our analysis as observation data-based as possible, so we did not use any reanalysis dataset to conduct the spatial-scale wind circulation analysis. Therefore, a detailed large-scale analysis of the wind systems is beyond the scope of this study.

However, to incorporate the suggestion we have done a simple atmospheric circulation analysis using horizontal wind (*u* and *v*) and vertically integrated moisture divergence (VIMD) from monthly ERA5 (0.25° grid) data at 500 hPa (Fig. S6 in the revised supplementary, a copy shown below). The figure depicts that, at 500 hPa, horizontal wind and moisture moves from the west and interacts with the western Himalayan relief/region during the DJFMA (2009-2020). We also noted that during the DJFMA months, there is a substantial amount of moisture divergence in the western Himalayan region, which corresponds to increased precipitation. This corroborates our idea that WDs events bring higher moisture and low temperatures into the region, which impede sublimation (discussed in Sect. 4.5 and Sect. 4.6 in revised manuscript). Since the manuscript is already long and our main focus is sublimation using observation (AWS-M) datasets, we would keep this Fig. S6 in the supplementary material.



ERA5 mean wind and VIMD for DJMFA (2009-2020)

Fig. S6 (in supplementary file). Mean horizontal wind (from *u* and *v* components) and vertically integrated moisture divergence (VIMD) at 500 hPa for DJFMA during 2009-2020 based on ERA5 data. ERA5 data was downloaded from the Climate Data Store, ECMWF (https://cds.climate.copernicus.eu). AWS-M location is shown with black square, with a label. Arrows in the wind plots refer to the direction of winds. Plots are generated in Python using several packages, mainly xarray, proplot, matplotlib. Plot template was taken from Lalande et al (2021). Note: the higher negative values (dark blue areas) of VIMD (i.e., large moisture convergence) refers to precipitation intensification in a particular region (https://apps.ecmwf.int/codes/grib/param-db/?id=213).

To further confirm the influence of WDs in sublimation, we have discussed the relationship based on observed datasets in Sect. 4.5 (revised manuscript) and also in Sect 4.6 (revised manuscript). Therein we used AWS-measured *u*, *RH*, *CF* and Geonor precipitation during the possible WDs events. We kept the analysis figure in supplementary material (Fig. S5 in the revised supplementary file; a copy shown below) because this is a short discussion supported by minimal analysis. From Fig. S5A we discern that strong winds (more than 10 m s^{-1}) often bring higher moisture (greater than 60-70% *RH*) during DJFMA and subsequent precipitation. We also note that higher precipitation events were associated with strong *u* (Fig. S5B) implying that those events were likely driven by WDs at the study site.

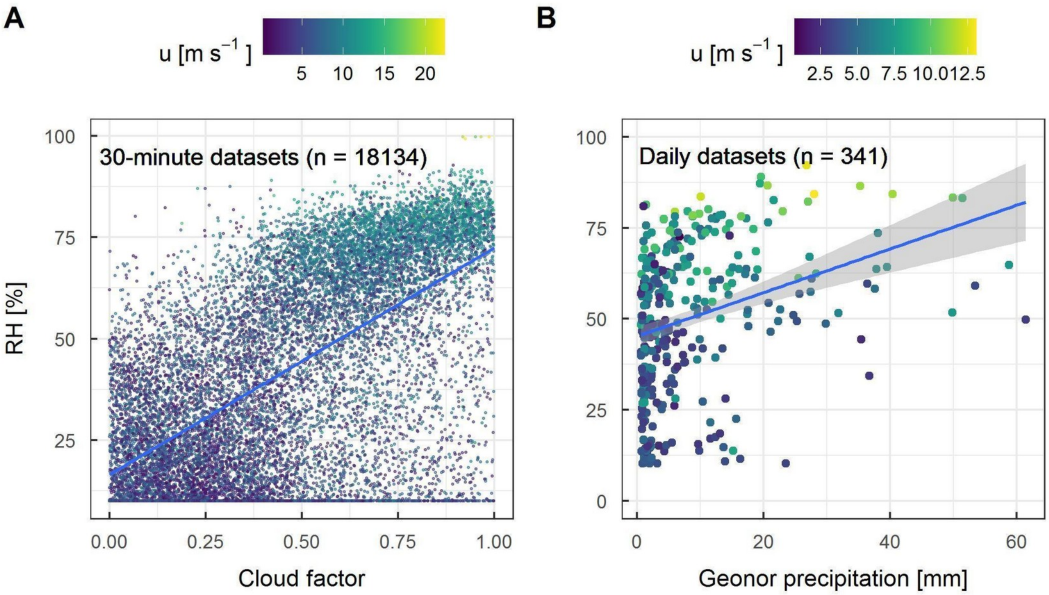


Fig. S5 (in supplementary file). (A) Relationship between relative humidity, wind speed and cloud factor, and (B) relative humidity, cloud factor and precipitation. The number of data points is mentioned on the respective panel. Precipitation was recorded at the glacier base camp at 3850 m a.s.l.

In addition to the large-scale wind/moisture circulation analysis (Fig. S6), we incorporated a literature review of large-scale circulation analyses on the influence of WDs over the western Himalayan region during the winter months. Newly added texts read as:

Line No. 498-505 (Sect. 4.5):
'WDs events are most dominant during winter months around the Chhota Shigri region as observed based on the ERA5's horizontal wind fields and vertically integrated moisture divergence datasets at 500 hPa from 2009 to 2020 (Fig. S6). Zhu et al. (2021) and Liu et al. (2020) investigated the impact of WDs in the western Himalayan region using a large-scale circulation analysis based on ERA5's geopotential height and wind fields at 500 hPa and ERA Interim's atmospheric datasets (precipitation, vertically integrated water vapour transport and specific humidity), respectively. Both studies indicated that during the winter months in the western Himalaya and western Tibetan regions, WDs storm activities transport a significant amount of moisture and influence the precipitation.'

Line No. 555-559 (Sect. 4.6):
'Large-scale circulation studies based on moisture/source tracking approach confirms that the synoptic activity of WDs in the western Himalayan region during winter months intensifies not only the upper-troposphere disturbances (higher precipitation) but also their thermal structure through baroclinic processes (Baudouin et al., 2021; Canon et al., 2015). Thus, very strong and cold winds, with higher moisture through WDs impedes sublimation in the region.'

5. The author examines the role of cloud cover on SEB and turbulent heat fluxes based on clear-sky conditions and overcast conditions. However, this can be finished by using just two years of data. The relationship between CF and sublimation is small (Table 4). Thus, CF (or Sin) is not the main factor causing the interannual changes in sublimation in winter during 2009-2020. I strongly recommend that authors analyze the factors which control the interannual changes in sublimation in winter during 2009-2020 through correlation analysis. The author can explain interannual changes in sublimation from the view of energy balance. And the author should analyze the relationships between RH and sublimation, between albedo and sublimation, between Sin and sublimation, between Sout and sublimation, between Lin and sublimation, Lout and sublimation between D and Tair, between D and Ts, and between D and RH. I guess that albedo is an important factor that contributes to the interannual changes in sublimation by changing Ts. The concrete results are depending on your further analysis.

We agree with Reviewer 1 that CF/S_{in} is not the main factor for sublimation. Therefore, we did not use such statements anywhere in the manuscript. However, we did write as: *'Cloud cover, on the other hand, has a significant impact on the primary meteorological variables, particularly* S_{in}, T_s *and* q_s*.'* in Line No. 536-537. The observation was based on (i) the correlation coefficient (r) analysis (Fig. 10; Sect. 4.5 in revised manuscript), (ii) difference in LE magnitude in clear-sky and overcast conditions (Sect. 4.4 in revised manuscript) and interannual correlation of sublimation and meteorological variations (Sect. 4.6 in revised manuscript; Table S4).

Concerning the main factors of sublimation, we note that sublimation is governed by a combined effect of different meteorological variables, primarily the vertical moisture ($q – q_s$) and temperature ($T_{air} – T_s$) difference/gradients, wind speed and the state of the surface boundary layer (stability). This is supported by multiple regression and variance analysis presented in Table 3 (revised manuscript; shown below). The multiple linear regressions analysis showed $q – q_s$, $T_{air} – T_s$, u and T_s together are the best sublimation predictors in clear-sky conditions (95%), overcast conditions (89%) and for all-data (without *CF* filter; 92%). Considering two combined predictors, q - q_s and u explains the highest variance (> 80%) in sublimation for clear-sky, overcast and all-data conditions. However, individually, sublimation did not show strong correlation with any meteorological variables (Fig. 10 in revised manuscript, a copy below) except $q – q_s$, $T_{air} – T_s$, T_s and q_s which are the direct variables. All these correlation coefficients were based on half-hourly datasets for the daytime (between 09:00 and 16:00 IST).

Indeed, albedo is an important variable in sublimation, with a stronger correlation in clear-sky conditions (r = -0.29; Fig. 10 below). In overcast conditions, however, albedo has little impact on sublimation (r = -0.02).

Considering your suggestion, we developed an interannual correlation analysis based on cumulative sublimation and meteorological variables (n = 11 years; Table S4; a copy below). Inter-annual correlation analysis showed T_s (r = 0.85; p < 0.01) correlates the highest with cumulative sublimation, followed by S_{in} (r = 0.79; p < 0.05) and *RH* > 80% (r = -0.76; p < 0.01). This suggests that on an interannual scale, high T_s (through higher S_{in}) and low near-surface moisture conditions supports sublimation.

Overall, we find that near-surface temperature ($T_{air} – T_s$) and moisture gradient ($q – q_s$), along with wind speed, were important factors in sublimation, while cloud cover shapes the meteorological variables. We have revised our discussion following the arguments presented above. We would like to invite the reviewer to go through over the revised manuscript sections (particularly Sect. 4.5, 4.6 and 5.1) for the meteorological factors of sublimation.

Below we highlighted the concluding sentences in different sections regarding the main sublimation factors:

Line No. 507-509 (Sect. 4.5):
'Overall, we noted that at sub-hourly scale near-surface moisture availability (through q - q_s) plays a bigger role in determining LE magnitude, with the combined effects from several meteorological variables, particularly q_s, T_s and u.'

Line No. 535-537 (Sect. 4.6):

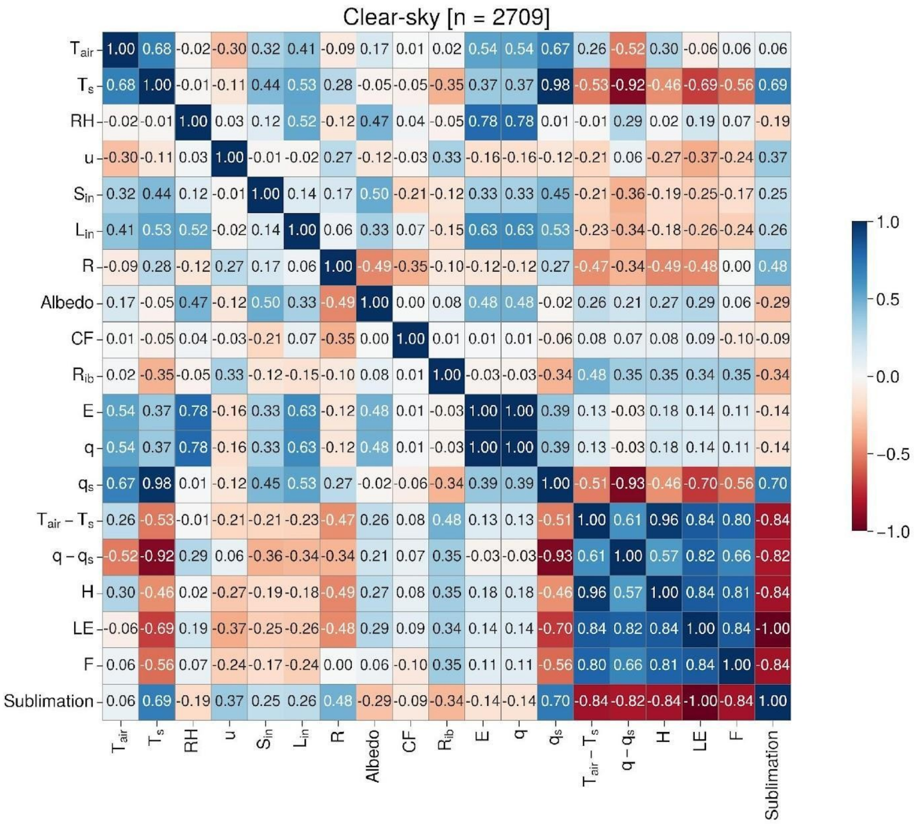
'This suggests that on an interannual scale, high T_s (through higher S_{in}) and low near-surface moisture conditions supports sublimation. Cloud cover, on the other hand, has a significant impact on the primary meteorological variables, particularly S_{in}, T_s and q_s.'

Line No. 663-665 (Sect. 5.1):

'Overall, we conclude that near-surface moisture availability (through q - q_s) plays a major role in governing LE magnitude at the AWS-M at different temporal scales, while moisture availability was influenced and conditioned by a number of meteorological variables, notably S_{in}, u, q_s, and T_s.'

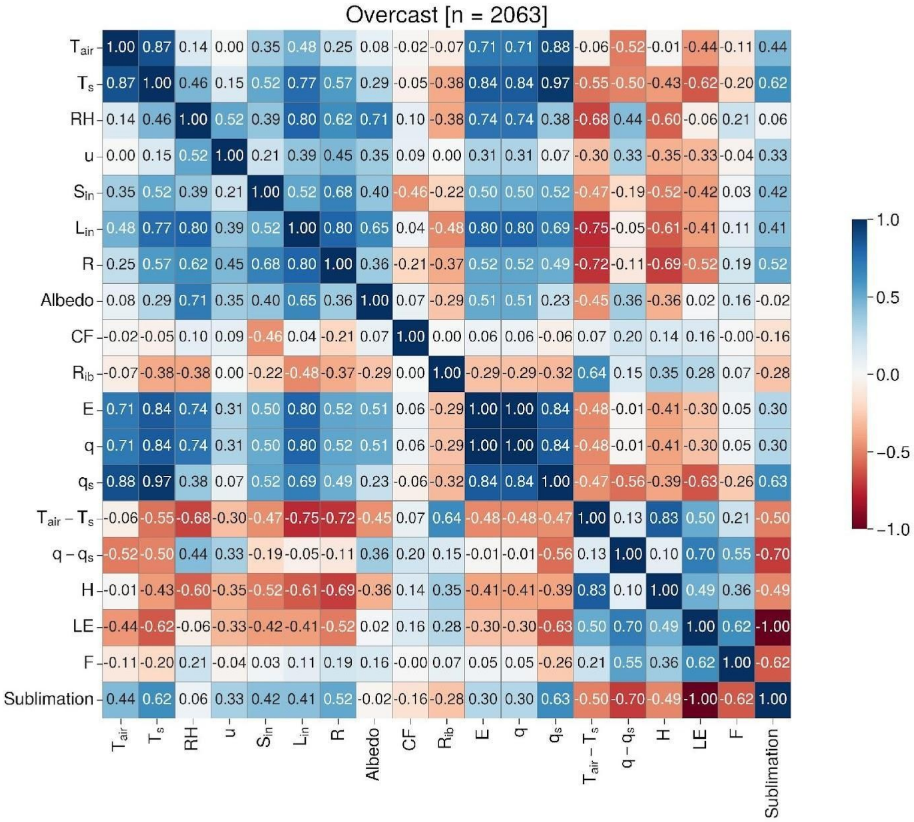
Table 3 (in revised manuscript). Summary of the multiple linear regression analysis (k-fold (k = 10) cross-validation) of sublimation rate and combined meteorological variables. Total n = 13217, 2708 and 2063 half-hourly data points for all-data, clear-sky and overcast conditions, respectively, between 09:00 and 16:00 IST for DJFMA (2009-2020). The *p*-value of r^2 was always < 0.001.

Variable	**r^2 cross-validation**		
	All-data	**Clear-sky**	**Overcast**
T_s, u	0.53	0.69	0.44
T_{air}, u	0.10	0.17	0.30
q, u	0.03	0.15	0.15
q_s, u	0.58	0.71	0.47
u, T_{air}-T_s	0.58	0.75	0.29
u, q-q_s	0.86	0.85	0.84
q, u, T_{air}	0.26	0.21	0.34
q, u, T_s	0.79	0.82	0.71
q_s, u, T_{air}	0.77	0.90	0.51
q_s, u, T_s	0.59	0.71	0.48
T_{air}-T_s, q-q_s, u	0.92	0.95	0.89
T_{air}-T_s, q-q_s, S_{in}	0.85	0.85	0.67
T_{air}-T_s, q-q_s, L_{in}	0.84	0.85	0.67
T_{air}-T_s, q-q_s, R_{net}	0.85	0.86	0.70



Clear-sky [n = 2709]

	T_{air}	T_s	RH	u	S_{in}	L_{in}	R	Albedo	CF	R_{ib}	E	q	q_s	$T_{air} - T_s$	$q - q_s$	H	LE	F	Sublimation
T_{air}	1.00	0.68	-0.02	-0.30	0.32	0.41	-0.09	0.17	0.01	0.02	0.54	0.54	0.67	0.26	-0.52	0.30	-0.06	0.06	0.06
T_s	0.68	1.00	-0.01	-0.11	0.44	0.53	0.28	-0.05	-0.05	-0.35	0.37	0.37	0.98	-0.53	-0.92	-0.46	-0.69	-0.56	0.69
RH	-0.02	-0.01	1.00	0.03	0.12	0.52	-0.12	0.47	0.04	-0.05	0.78	0.78	0.01	-0.01	0.29	0.02	0.19	0.07	-0.19
u	-0.30	-0.11	0.03	1.00	-0.01	-0.02	0.27	-0.12	-0.03	0.33	-0.16	-0.16	-0.12	-0.21	0.06	-0.27	-0.37	-0.24	0.37
S_{in}	0.32	0.44	0.12	-0.01	1.00	0.14	0.17	0.50	-0.21	-0.12	0.33	0.33	0.45	-0.21	-0.36	-0.19	-0.25	-0.17	0.25
L_{in}	0.41	0.53	0.52	-0.02	0.14	1.00	0.06	0.33	0.07	-0.15	0.63	0.63	0.53	-0.23	-0.34	-0.18	-0.26	-0.24	0.26
R	-0.09	0.28	-0.12	0.27	0.17	0.06	1.00	-0.49	-0.35	-0.10	-0.12	-0.12	0.27	-0.47	-0.34	-0.49	-0.48	0.00	0.48
Albedo	0.17	-0.05	0.47	-0.12	0.50	0.33	-0.49	1.00	0.00	0.08	0.48	0.48	-0.02	0.26	0.21	0.27	0.29	0.06	-0.29
CF	0.01	-0.05	0.04	-0.03	-0.21	0.07	-0.35	0.00	1.00	0.01	0.01	0.01	-0.06	0.08	0.07	0.08	0.09	-0.10	-0.09
R_{ib}	0.02	-0.35	-0.05	0.33	-0.12	-0.15	-0.10	0.08	0.01	1.00	-0.03	-0.03	-0.34	0.48	0.35	0.35	0.34	0.35	-0.34
E	0.54	0.37	0.78	-0.16	0.33	0.63	-0.12	0.48	0.01	-0.03	1.00	1.00	0.39	0.13	-0.03	0.18	0.14	0.11	-0.14
q	0.54	0.37	0.78	-0.16	0.33	0.63	-0.12	0.48	0.01	-0.03	1.00	1.00	0.39	0.13	-0.03	0.18	0.14	0.11	-0.14
q_s	0.67	0.98	0.01	-0.12	0.45	0.53	0.27	-0.02	-0.06	-0.34	0.39	0.39	1.00	-0.51	-0.93	-0.46	-0.70	-0.56	0.70
$T_{air} - T_s$	0.26	-0.53	-0.01	-0.21	-0.21	-0.23	-0.47	0.26	0.08	0.48	0.13	0.13	-0.51	1.00	0.61	0.96	0.84	0.80	-0.84
$q - q_s$	-0.52	-0.92	0.29	0.06	-0.36	-0.34	-0.34	0.21	0.07	0.35	-0.03	-0.03	-0.93	0.61	1.00	0.57	0.82	0.66	-0.82
H	0.30	-0.46	0.02	-0.27	-0.19	-0.18	-0.49	0.27	0.08	0.35	0.18	0.18	-0.46	0.96	0.57	1.00	0.84	0.81	-0.84
LE	-0.06	-0.69	0.19	-0.37	-0.25	-0.26	-0.48	0.29	0.09	0.34	0.14	0.14	-0.70	0.84	0.82	0.84	1.00	0.84	-1.00
F	0.06	-0.56	0.07	-0.24	-0.17	-0.24	0.00	0.06	-0.10	0.35	0.11	0.11	-0.56	0.80	0.66	0.81	0.84	1.00	-0.84
Sublimation	0.06	0.69	-0.19	0.37	0.25	0.26	0.48	-0.29	-0.09	-0.34	-0.14	-0.14	0.70	-0.84	-0.82	-0.84	-1.00	-0.84	1.00



Overcast [n = 2063]

	T_{air}	T_s	RH	u	S_{in}	L_{in}	R	Albedo	CF	R_{ib}	E	q	q_s	$T_{air} - T_s$	$q - q_s$	H	LE	F	Sublimation
T_{air}	1.00	0.87	0.14	0.00	0.35	0.48	0.25	0.08	-0.02	-0.07	0.71	0.71	0.88	-0.06	-0.52	-0.01	-0.44	-0.11	0.44
T_s	0.87	1.00	0.46	0.15	0.52	0.77	0.57	0.29	-0.05	-0.38	0.84	0.84	0.97	-0.55	-0.50	-0.43	-0.62	-0.20	0.62
RH	0.14	0.46	1.00	0.52	0.39	0.80	0.62	0.71	0.10	-0.38	0.74	0.74	0.38	-0.68	0.44	-0.60	-0.06	0.21	0.06
u	0.00	0.15	0.52	1.00	0.21	0.39	0.45	0.35	0.09	0.00	0.31	0.31	0.07	-0.30	0.33	-0.35	-0.33	-0.04	0.33
S_{in}	0.35	0.52	0.39	0.21	1.00	0.52	0.68	0.40	-0.46	-0.22	0.50	0.50	0.52	-0.47	-0.19	-0.52	-0.42	0.03	0.42
L_{in}	0.48	0.77	0.80	0.39	0.52	1.00	0.80	0.65	0.04	-0.48	0.80	0.80	0.69	-0.75	-0.05	-0.61	-0.41	0.11	0.41
R	0.25	0.57	0.62	0.45	0.68	0.80	1.00	0.36	-0.21	-0.37	0.52	0.52	0.49	-0.72	-0.11	-0.69	-0.52	0.19	0.52
Albedo	0.08	0.29	0.71	0.35	0.40	0.65	0.36	1.00	0.07	-0.29	0.51	0.51	0.23	-0.45	0.36	-0.36	0.02	0.16	-0.02
CF	-0.02	-0.05	0.10	0.09	-0.46	0.04	-0.21	0.07	1.00	0.00	0.06	0.06	-0.06	0.07	0.20	0.14	0.16	-0.00	-0.16
R_{ib}	-0.07	-0.38	-0.38	0.00	-0.22	-0.48	-0.37	-0.29	0.00	1.00	-0.29	-0.29	-0.32	0.64	0.15	0.35	0.28	0.07	-0.28
E	0.71	0.84	0.74	0.31	0.50	0.80	0.52	0.51	0.06	-0.29	1.00	1.00	0.84	-0.48	-0.01	-0.41	-0.30	0.05	0.30
q	0.71	0.84	0.74	0.31	0.50	0.80	0.52	0.51	0.06	-0.29	1.00	1.00	0.84	-0.48	-0.01	-0.41	-0.30	0.05	0.30
q_s	0.88	0.97	0.38	0.07	0.52	0.69	0.49	0.23	-0.06	-0.32	0.84	0.84	1.00	-0.47	-0.56	-0.39	-0.63	-0.26	0.63
$T_{air} - T_s$	-0.06	-0.55	-0.68	-0.30	-0.47	-0.75	-0.72	-0.45	0.07	0.64	-0.48	-0.48	-0.47	1.00	0.13	0.83	0.50	0.21	-0.50
$q - q_s$	-0.52	-0.50	0.44	0.33	-0.19	-0.05	-0.11	0.36	0.20	0.15	-0.01	-0.01	-0.56	0.13	1.00	0.10	0.70	0.55	-0.70
H	-0.01	-0.43	-0.60	-0.35	-0.52	-0.61	-0.69	-0.36	0.14	0.35	-0.41	-0.41	-0.39	0.83	0.10	1.00	0.49	0.36	-0.49
LE	-0.44	-0.62	-0.06	-0.33	-0.42	-0.41	-0.52	0.02	0.16	0.28	-0.30	-0.30	-0.63	0.50	0.70	0.49	1.00	0.62	-1.00
F	-0.11	-0.20	0.21	-0.04	0.03	0.11	0.19	0.16	-0.00	0.07	0.05	0.05	-0.26	0.21	0.55	0.36	0.62	1.00	-0.62
Sublimation	0.44	0.62	0.06	0.33	0.42	0.41	0.52	-0.02	-0.16	-0.28	0.30	0.30	0.63	-0.50	-0.70	-0.49	-1.00	-0.62	1.00

Figure 11 (in revised manuscript). Pearson's correlation coefficient (*r*) matrix of various meteorological and SEB components at the AWS-M in clear-sky and overcast conditions between 09:00 and 16:00 IST, 2009-2020. Number (n) of half-hourly data points are shown on top of the panels.

Table S4 (in supplementary file). Interannual correlation coefficient (*r*; n = 11) between cumulative sublimation (S_c) and primary meteorological variables for 2009-2020. '*' refers to $p < 0.05$.

	RH > 80%	T_s	T_{air}	*u*	***RH***	S_{in}	***CF***
S_c	-0.76*	0.85*	-0.15	-0.10	-0.50	0.79*	0.56

6. Discussion: I sometimes feel confused about the sentences in the discussion. Take section 5.3 for example. The author said that sublimation during the summer- monsoon season was lower, which could be due to the ISM-driven warm and moist atmosphere in the southern slope of the HK region. However, sublimation is higher at very high altitudes despite high summer-monsoon humidity, e.g., East Rongbuk Glacier site (6523 m a.sl.). What is the main point of the author? When author compared their study with other studies, the author should note the spatial and temporal scales. Some studies used the glacier-wide values, while others used point values. Some studies used the low-altitude values, while others used the high- altitude values. Some studies used the annual values, while others used winter values. These data with different scales are incomparable. The author should select these data carefully.

We thank you for the comment. We rephrased the respective sentence in the revised manuscript. Now it reads as:

Line No. 729-733:
'Sublimation rate during the summer-monsoon season, in general, was lower than that during winter (Table 4), which could be due to the warm and moist atmospheric conditions driven by the ISM. Despite high summer-monsoon humidity, sublimation is higher at very high altitude sites, such as the East Rongbuk Glacier site (6523 m a.sl.). At very high altitudes, this is most likely due to strong winds and low air vapour pressure.'

Regarding the heterogeneous spatial and temporal scale of the comparison, we would like to highlight that sublimation is poorly investigated and understood across the HK region as compared to general glacier SEB studies. Therefore, available datasets are heterogeneous from the spatial and temporal scale point of view. For example, only a single study in the Himalaya (Stigter et al., 2018) and a few in Tibet (Guo et al., 2021; Zhu et al., 2020) have discussed sublimation in detail. Also, in some of the studies meteorological values are not clearly defined or shown (e.g., in Dongkemadi Glacier in central Tibet; Liang et al., 2018). Furthermore, most studies in the HK and Tibet regions have focused exclusively on the summer season, considering the importance of summer SEB in melt modeling. Therefore, it is extremely hard to make an exhaustive comparison with consistent spatial or temporal scale based on limited available studies. This is the main reason for selecting all available studies and compare their values to draw a general overview of sublimation rates across HK and High Mountain Asia (HMA).

To clearly highlight the differences in spatial and temporal scales of existing sublimation studies, we added one sentence in the revised manuscript in the respective section (Sect. 5.3). It reads as:

Line No. 715-718:
'The existing sublimation studies in the HK and HMA are not uniform in terms of spatial and temporal scales, which makes it difficult to compare sublimation and associated processes consistently. However, it is worthwhile to recall these existing sublimation datasets for comparison, not to conduct a thorough and rigorous comparison, but to qualitatively address the sublimation process in the region.'

Considering your suggestion, we have revised the respective Table (Table 3 in revised manuscript) and texts slightly for a consistent/similar comparison of the sublimation rates based on available studies. We would like to invite the reviewer to go through the revised comparison section.

Minor comments:

Line 32: wind-driven transport can cause accumulation in some sites.

The sentence was framed from the ablation point of view. However, to give this sentence a bit more ablation perspective, we have revised it and now reads as:

Line No. 32:
'..wind-driven transport/erosion—lead to the loss of snow and ice mass..'

Line 121-123: How do you get albedo in the night? Thus, what is your surface albedo threshold value in the night which is used to discern snow or bare-ground?

We filtered the snow-covered period based on the daytime surface albedo (α_{acc}) ≥ 0.4. We revised the sentence for clarity and now it reads as:

Line No. 32:
'We filtered the snow-covered period for SEB based on the daytime surface albedo threshold value above 0.4 at the AWS-M (the mean bare-ground/snow-free surface albedo was < 0.25 for July-August; 2009-2020).'

Line 153: Please explain the physical significance of Fsurface. If Fsurface is larger than 0, does melt occur at that time?

We revised the respective section and included a dedicated sentence mentioning the physical significance of residual energy ($F_{surface}$). The sentence reads as:

Line No. 172-174:
'When $F_{surface}$ is larger than 0 W m^{-2} (towards positive), it will direct towards the surface/snowpack and warm it up until it reaches at melting point (T_s = 0°C), and then surplus $F_{surface}$ will cause melting (Hock, 2005).'

Line 209-210: Can you analyze the difference between infrared measured Ts and Ts derived from Lout? Please list the figure. Is the emissivity of bared-ground similar to that of snow cover? This is important for the author to calculate Ts from Lout.

We have calculated the difference between infrared measured T_s and T_s derived from L_{out} (shown in Table R1, below). The requested comparison figure is presented below (Fig. R3). L_{out}-based T_s was derived using the Stefan-Boltzmann equation for the snow surface, with emissivity of 1 (following Hock and Holmgren, 2005; Wagnon et al., 2003). We observed the least root mean square error (RMSE = 0.23°C) and mean absolute error (MAE = 0.06°C) for emissivity = 1. We also observed that as emissivity decreases, RMSE and MAE increase considerably (Table R1).

We would also like to point out that we derived T_s from L_{out} only to compare it to the measured T_s. We did not use this L_{out}-based T_s in any of our SEB/sublimation calculations, therefore it has no impact on our results.

Table R1. Comparison of RMSE and MAE for different snow emissivity.

Emissivity	r^2	**RMSE [°C]**	**MAE [°C]**
1	0.99	0.23	0.06
0.99	0.99	14.09	14.08
0.98	0.99	27.39	27.37
0.97	0.99	39.98	39.95

Considering your above comment, we have revised the respective sentence in the revised manuscript and now it reads as:

Line No. 222-224:
'T_s was directly used from the measurement by an infrared radiometer (Table 1). The correlation between infrared measured T_s and T_s derived from L_{out} (using Stefan-Boltzmann equation for the

snow surface with emissivity of 1 following Hock and Holmgren, 2005) was $r^2 = 0.99$ ($p < 0.001$) with RMSE = 0.23°C.'

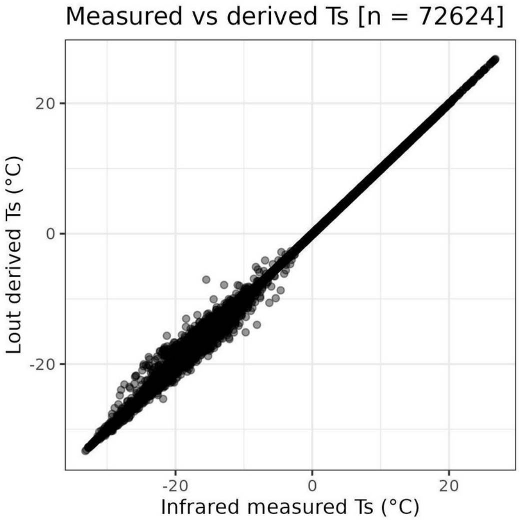


Figure R3. Comparison of half-hourly values of the infrared measured T_s vs L_{out}-based T_s at the AWS-M site.

Line 312-313: Which components in Rnet are more important in playing an essential role in governing the turbulent fluxes? And the author should indicate the timescale.

On an interannual scale, S_{in} showed stronger indirect relationship with *LE* and *H* (r = -0.80 and -0.61, respectively; $p < 0.05$) than L_{in} (r = -0.36 and -0.39, respectively; not significant). Whereas, in half-hourly scale, in clear-sky conditions, S_{in} and L_{in} both have shown a nearly similar impact on *LE* (r = -0.25, -0.26 and 0.29, respectively). In overcast conditions, impact of S_{in} and L_{in} equally rises (r = -0.42 and -0.41). These analyses are further discussed in Sect 4.3 and Sect. 4.5 in the revised manuscript.

We have highlighted the timescales of our analysis in the respective sentence and sections. The revised texts read as:

*Line No. 420-421 (**Sect. 4.3. Seasonal and interannual variation of SEB components**):*
'S_{in} showed a stronger indirect relationship with LE and H (r = -0.80 and -0.61, respectively; $p < 0.05$) than L_{in} (r = -0.36 and -0.39, respectively; not significant).'

*Line No. 506-507 (**Sect. 4.5. Turbulent heat fluxes under different cloud conditions**):*
'At sub-hourly scale, neither R_{net} nor S_{in} and L_{in} can adequately explain turbulent fluxes in both overcast and clear-sky conditions (r = < 0.50; Fig. 11).'

Line 313-314: I can not understand this sentence.

We have removed this sentence in the revised manuscript.

Line 325: What do you mean about the different colors of lines in Figure 6?

The different colour lines in Figure 6 (original manuscript) define different years from 2009/10 to 2019/20. In the revised manuscript, we have combined both Fig. 5 and 6 (original manuscript) into a single figure (Figure 5 in revised manuscript) and it contains a legend for all coloured lines. A copy of the revised figure (Figure 5) is shown under your main comments no. 3 (above).

Line 359. Please add the "in the daytime" in the title of section 4.5.

Revised it as suggested.

Line 363-364 Why precipitation is higher in February and March than in January and April? High precipitation always means high cloud cover. This is different from your results of CF.

We thank the reviewer for the question and concern. In Fig. 8 (in revised manuscript, a copy shown below), we showed that February was the second cloudy (overcast) month, which is consistent with February having the second highest precipitation amount (24% of winter; Table S3 in revised manuscript). In January, more hours were cloudy, but only accounted for 19% of the total winter precipitation. This could be partly explained by the average moisture content in January (0.8 g kg^{-1}) which was ~30% lower than in February (1.1 g kg^{-1}) (see Table S3 in revised manuscript). In addition, it should be worth mentioning here that Fig. 8 is based on n = 8191 half-hourly data points, which was extracted from n= 23903 half-hourly data points following clear-sky ($CF < 0.2$) and overcast ($CF > 0.8$) filters. Night values were neglected in Fig. 8 because our *CF* calculation is based on S_{in} data which was unavailable during night. Since, we do not have the cloud information from night and transition hours (for 16 hours), it is difficult to understand and correlate the precipitation value with cloud cover.

In addition, in-situ precipitation data from the Geonor station was available only for five discontinuous hydrological years, therefore only five years of precipitation data is not sufficient to discern the relationship between cloud cover/fraction and precipitation intensity in the region.

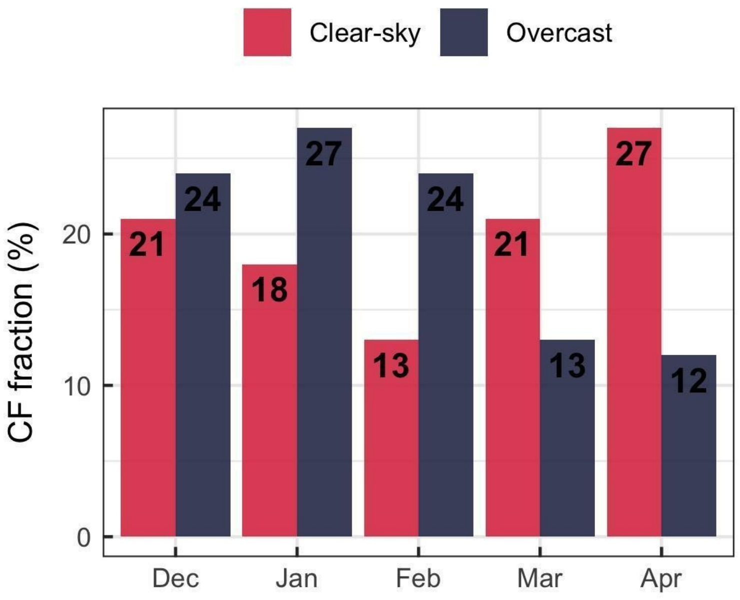


Figure 8 (in revised manuscript). Monthly fraction of clear-sky (CF ≤ 0.2) and overcast (CF ≥ 0.8) conditions at the AWS-M. Fraction percentage is calculated from n = 5810 clear-sky and n = 2381 overcast observations from total n = 23903 half-hourly values between 09:00 and 16:00 IST (DJFMA, 2009-2020).

Line 376: 3 times lower?

We modified the sentence and now reads as:

Line No. 465-466:
'In clear-sky, the mean daytime H was -66 W m^{-2} which is three times more negative than that in overcast conditions (-21 W m^{-2}).'

Line 423: 145 ± 25 mm w.e. a-1?

Revised it as suggested.

Section 4.7: There is no section 4.7.2 in this part. The author can merge section 4.7 and section 4.7.1 as one part.

Thanks for the suggestion. We have merge it and renamed the section as:

'4.6 Sublimation and its relationship with meteorological variables'

Line 451-452: I can not agree with the author, because we can not find that low Tair (-5°C and -10°C) corresponds to high Ts (0°C and -10°C) for the same time. From figure14b, we can only find that sublimation was the larger when Tair ranged between -5°C and -10°C (compared to Tair in other values). This is similar to the Ts. Thus, the content in Line 451-452 is not correct.

Thanks for catching this issue. This sentence has been corrected and now reads as:

Line No. 551-553:
‘Sublimation was the largest when T_{air} *ranged between -5°C and -10°C and also when* T_s *ranged between 0°C and -10°C (Fig. 12; Fig. 13B and C). Whereas, sublimation was considerably lower when moisture availability was higher,* T_s *was significantly lower, with very strong u (Fig. 12; Fig. 13).’*

To show this observation clearly, we made two more meteorological clusters (i.e., $T_s > -10$°C and $T_s < -10$°C) in the existing Fig. 12 (in revised manuscript, a copy shown below). From Fig. 12 (bottom panels) it is clear that sublimation was almost half when $T_s < -10$°C compared to $T_s > -10$°C. This is also evident in Fig. 13 (in revised manuscript, a copy shown below).

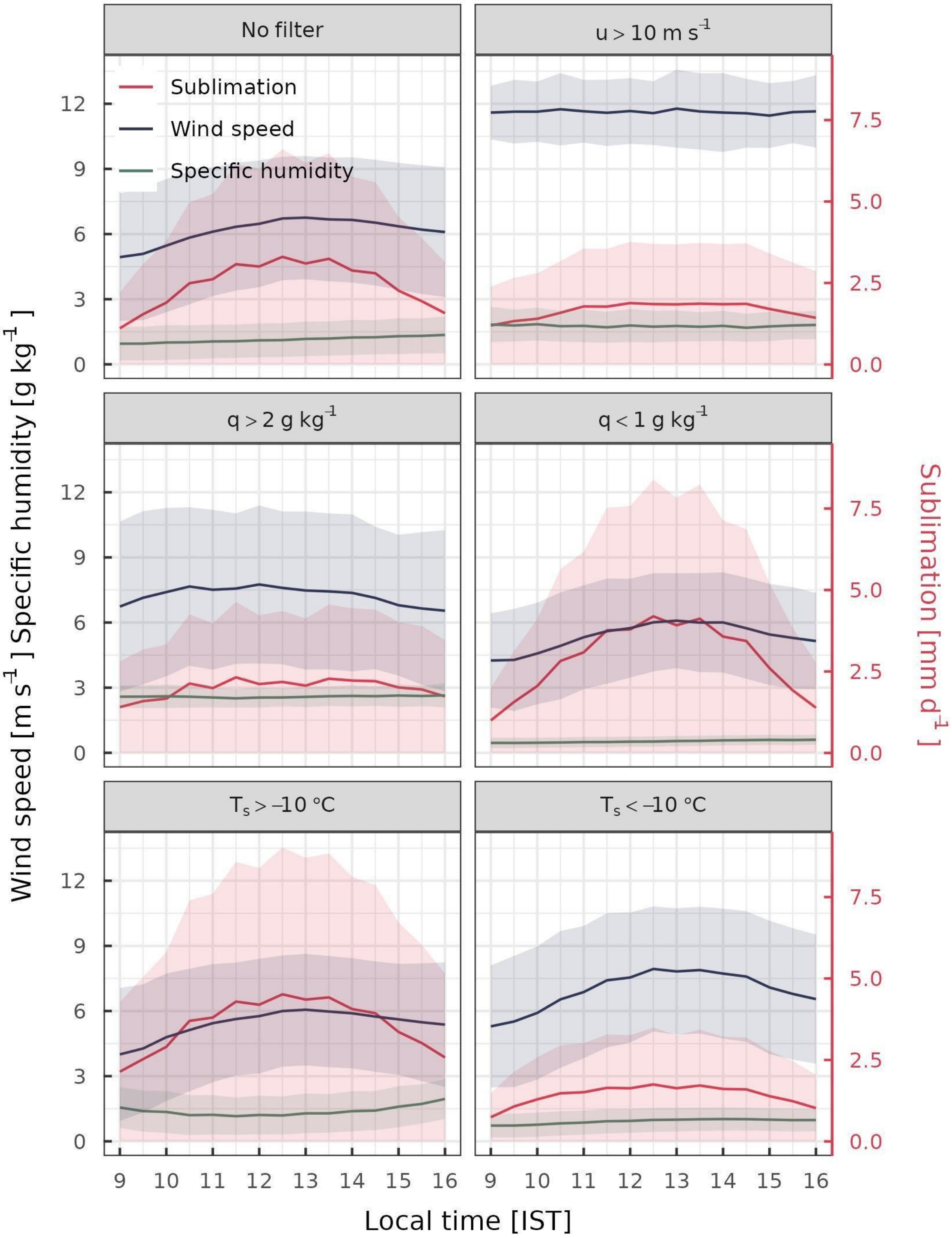


Figure 12 (in revised manuscript). Half-hourly daytime (09:00-16:00) records of sublimation (red), wind speed (blue) and specific humidity (green) at the AWS-M for different clusters: no filter, u > 10 m sec^{-1}, q > 2 g kg^{-1}, < 1 g kg^{-1}, T_s > -10°C and T_s < -10°C. Data period: DJFMA, 2009-2020. Number of data-points n=30257, 2347, 12295, 9762, 10552 and 12734 for no filter, u > 10 m sec^{-1}, q > 2 g kg^{-1}, < 1 g kg^{-1}, T_s > -10°C and T_s < -10°C, respectively.

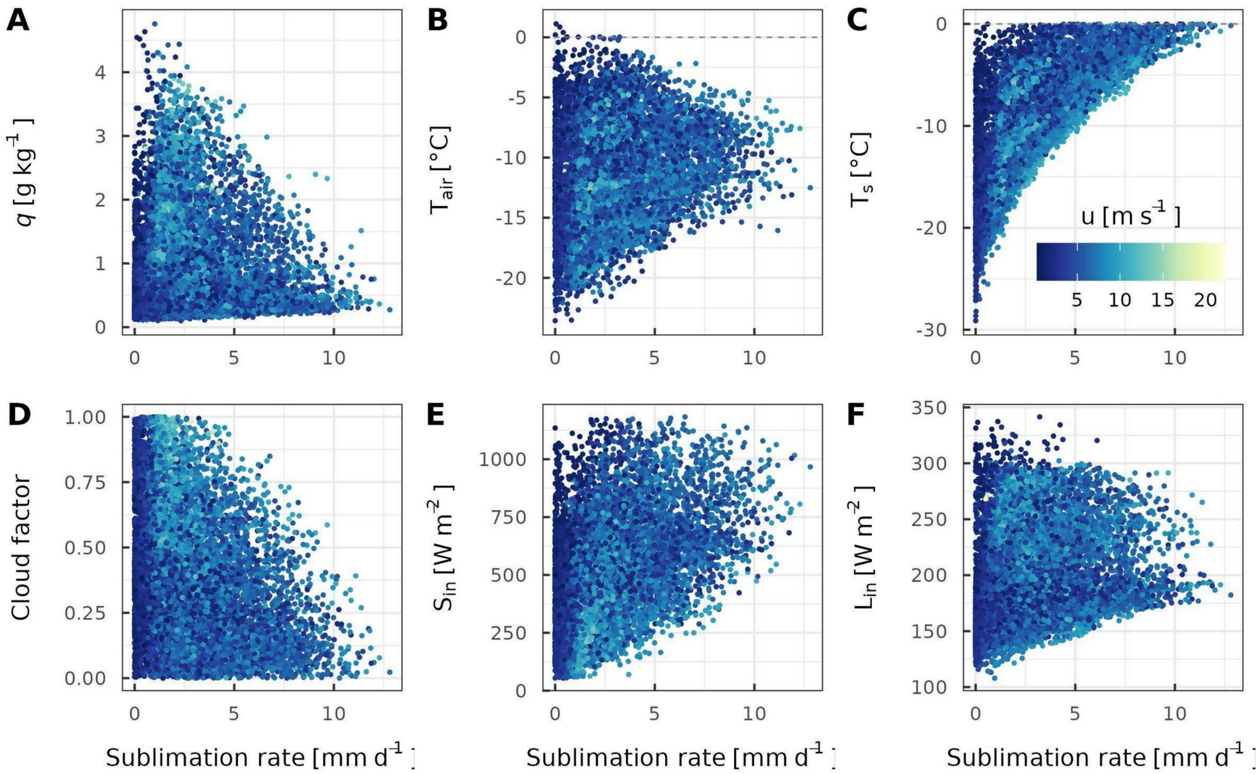


Figure 13 (in revised manuscript). Scatter plot of u, q, T_{air}, T_s, CF, S_{in} and L_{in} against sublimation rate at the AWS-M. The colour of the data points refers to the measured wind speed (u). Total n = 14088 half-hourly data points between 09:00 and 16:00 IST for DJFMA (2009-2020).

Line 480-481: What is your timescale?

Our analysis is based on half-hourly *LE* datasets, however for a longer/seasonal perspective, we averaged it for daily, monthly, and seasonal (DJFMA) timescale as well. In the current section (Sect. 5.1 in revised manuscript), we have discussed *LE* from an overall/holistic perspective to summarise the factor controlling *LE* at the AWS-M site.

Line 544: Do you want to say that sublimation during the summer-monsoon season was lower than that during winter?

Yes. We revised it for a better read.

Line No. 729-731:
‘Sublimation rate during the summer-monsoon season, in general, was lower than that during winter (Table 4), which could be due to the warm and moist atmospheric conditions driven by the ISM’

Line 545-547: The studies of Mölg et al. (2012) and Li et al. (2018) are in the south and central Tibet, respectively. They do not study the glaciers in the northern slope of the HK region.

Thanks for pointing this out. Previously we missed to cite the SEB studies which are from the northern slope of the Himalaya, for example, on Naimona'nyi and East Rongbuk glaciers (e.g., Zhu et al., 2021; Liu et al. 2021). We revised the sentence and now reads as:

Line No. 733-735:
‘The high moisture from ISM also impacts Tibetan glaciers, particularly those located in the northern slope of the Himalaya (Zhu et al., 2021; Liu et al., 2021) and central Tibet (Mölg et al., 2012; Li et al., 2018).’

Line 547-548: Can you explain the phenomenon that you found in these sentences?

In this sentence, we did not intend to discuss any phenomenon, but to point out (from the existing studies) that sublimation rates in the central Himalaya are relatively higher during post-monsoon and pre-monsoon (for example in Yala and Mera glaciers; Table 4 in revised manuscript).

Although near-surface moisture (*RH*) is relatively higher in the central Himalaya during post-monsoon and pre-monsoon (because it is close to the Bay of Bengal) than in winter season. The sublimation rates are comparatively higher (Table 4; Yala and Mera glaciers). We assume that this is because of the high altitude location (for Yala it was > 5300 m a.s.l. and for Mera it was >5300 m a.s.l. and > 6500 m a.s.l.), where strong wind or snow blowing could have increased sublimation considerably.

We have revised the respective sentences and now reads as:

Line No. 735-741:
‘In the Nepalese central Himalaya, we note a higher sublimation value of 2.4 and 1.8 mm d^{-1} *on the Yala Glacier during the post- and pre-monsoon seasons (Table 4). Litt et al. (2019) also reported a significantly higher sublimation rate of 7.1 and 1.9 mm* d^{-1} *during the post- and pre-monsoon on the Mera Glacier. Such higher sublimation rates on the Yala and Mera glaciers are unique, particularly during post- and pre-monsoon seasons when air vapour pressure/specific humidity is higher than that of winter season (Shea et al., 2015; Perry et al., 2020). Nevertheless, such higher sublimation can also be partially attributed to snow*

blowing/redistribution at such high-altitude sites (Barral et al., 2014; Wagnon et al., 2013; Huintjes et al., 2015b).'

Line 548-549: I do not find that the moisture content is relatively higher during post- and pre-monsoon on the Mera Glacier than that in winter in Table 5. And the altitudes are significantly different between the post- and pre-monsoon periods.

We have now updated Table 4 (in revised manuscript, a copy shown below) with *RH* and wind speed values for the Yala and Mera glaciers for the pre- and post-monsoon seasons. Table 4 shows *RH* for Yala and Mera glaciers are considerably higher (~70%) in pre-monsoon and close to 50% in post-monsoon (Litt et al., 2019).

Post-monsoon sublimation rate was not available for 6543 m a.s.l. AWS site from the Mera (Litt et al., 2019). So, to keep it consistent, now we have used the Mera Glacier sublimation rates from a single site: 5360 m a.s.l. where both pre- and post-monsoon seasons' sublimation rates are available. Updated Table 4 shown below:

Table 4 (in revised manuscript). Compilation of sublimation rate across the HMA region. '*' refers to the evaporation values. Do' refers to the same method as in the row immediately above.

Site	**Altitude (m a.s.l.)**	**Region**	**Period of observation**	**Season approx. to Chhota Shigri**	**Surface**	**Method**	***S* (mm d^{-1})**	**RH (%)**	**u (m)**	**Reference**
Tibetan Plateau										
Zhadang	5665	Nyainqentanglha Shan	1 October to 31 May, 2008-2013	Winter	Glacier-wide	Bulk-aerodynamic	0.5	44	3.6	Zhu et al. (2018)
Muztag Ata No. 15	4400	Eastern Pamir	1 October to 31 May, 2008-2013	Winter	Glacier-wide	Do	0.7	42	6.4	Zhu et al. (2018)
Parlung	4800	Southeast TP	1 October to 31 May, 2008-2013	Winter	Glacier-wide	Do	0.4	64	3.4	Zhu et al. (2018)
Muji	4685	Northeast Pamir	1 October to 31 May, 2011- 2017	Winter	Glacier-wide	Do	0.5	50	4	Zhu et al. (2020)
Qiangtang No. 1	5882	Inland TP	1 October to 31 May, 2012-2016	Winter	Glacier-wide	Do	0.4	46	6.8	Li et al. (2018)
Guliya Ice Cap	6000	Kunlun Shan	1 October to 31 May, 2015-2016	Winter	Glacier-wide	Do	0.3	67	7.9	Li et al. (2019)
Dongkemadi	5600	Central TP	7 October 1992 to 4 May 1993	Winter	Glacier ELA	Do	0.2	-	4.3	Liang et al. (2018)
August-one	4817	Qilian Mountains	Jan-May, Oct-Sept, 2016-2020	Winter	Glacier	Do	0.4	68	6.9	Guo et al. (2021)
Himalaya										
Pindari	3750	Central Himalaya	December 2016 to February 2017	Winter	Medial moraine	Monin-Obukhov theory	~0.3	55	1.2	Singh et al. (2020)
Yala	5350	Central Himalaya	15 October 2015 to 20 April 2017	Winter	Glacier/ ablation zone	Eddy-covariance	1	~40	~2.5	Stigter et al. (2018)
Yala	5330	Do	1 October to 15 November, 2012-2017	Post-monsoon	Glacier/ ablation zone	Bulk-aerodynamic	2.4	~49	~1.8	Litt et al. (2019)
Yala	5330	Do	10 May to 5 June, 2012-2017	Pre-monsoo	Glacier/ ablation	Do	1.8	~77	~1.9	Do

				n	zone					
Mera	5360	Do	1 October to 15 November, 2013-2016	Post-monsoon	Glacier/ablation zone	Do	1.9	~46	~2.8	Do
Mera	5360	Do	10 May to 5 June, 2013-2016	Pre-monsoon	Glacier/ablation zone	Do	3.3	~72	~2.3	Do
Lirung	4250	Do	26 September to 12 October 2016	Post-monsoon	Glacier debris	Eddy-covariance	1.8-2.8*	~60	~3	Steiner et al. (2018)
South Col, Everest	7945	Do	22 May to 31 October 2019	Summer-monsoon	Ice-rock surface	Bulk-aerodynamic	~0.8	~60	6.3	Matthews et al.(2020)
East Rongbuk	~6500	Do	28 April to 2 May 2008	Pre-monsoon	Glacier	Lysimeter	1.9	-	-	Yang (2010)
East Rongbuk	6523	Do	1 May to 22 July 2005	Summer-monsoon	Glacier	Bulk-aerodynamic	0.05-1.2	60	4.2	Liu et al. (2021)
Xixibangma	5900	Do	23 August to 29 September 1991	Summer-monsoon	Glacier	Calculated	0.02	36	5.9	Aizen et al. (2002)
Naimona'nyi	5543	Do	1 October 2010 to 31 May 2018	Winter	Glacier-wide	Bulk-aerodynamic	0.6	34	5.5	Zhu et al. (2021)
Chhota Shigri	4670	Western Himalaya	1 Dec 2012 to 29 Jan 2013	Winter	Glacier/ablation zone	Do	0.8	44	4.9	Azam et al. (2014a)
Chhota Shigri	4863	Do	1 December to 30 April, 2009-2020	Winter	Seasonal snow on moraine	Do	1.1	43	5	This study

Line 550-551: What is the cause for the differences that the authors found in this sentence?

Thanks for pointing this out. Here we compared our study (for DJFMA) with wet/moist season's sublimation rates without any data/analysis from this study site. Therefore, we have removed the sentence from the revised manuscript.

Line 553-555: I cannot understand what you want to say.

We revise it, as:

Line No. 741-744:
'Overall, dry air, low atmospheric pressure and high wind speeds are suitable conditions for sublimation, as reported from various high-altitude sites in the HMA (Matthews et al., 2020; Litt et al., 2019; Stigter et al., 2018; Zhu et al., 2018) and everywhere in the world (Wagnon et al., 1999; Cullen et al., 2007; Fyffe et al., 2021)'

Line 560-564: These sentences have no relationship with the title 'Sublimation fraction to winter snowfall and its importance'.

Thanks for this suggestion. We have removed the sentences from the respective paragraph and revised it.

Line 569: Why sublimate is higher in the northwestern part of the HK than that in the other parts of the HK region?

It is because the atmospheric conditions of the northwestern part of the HK, as well as the west Tibet, are very dry and arid compared to other parts of the HK, such as the Eastern or Central Himalaya, where climate is more humid and monsoon precipitation is higher. Dry air and low atmospheric pressure create a steep near-surface moisture gradient, which fosters strong sublimation. To clarify this in the revised manuscript, we incorporated a dedicated sentence for this, and it reads as:

Line No. 771-776:
'Although there are limited observations available from various parts of the Himalaya or HMA, the available findings show sublimation fraction to winter/annual snowfall/precipitation is higher in the northwestern part of the HK and western Tibet (e.g., Zhu et al., 2020; Gascoin, 2021). This is likely due to the atmospheric condition of the northwestern part of the HK and western Tibet which is drier than eastern and central Himalaya. Dry atmospheric conditions favor higher sublimation than the wet due to high near-surface humidity gradients.'

Line 579-580: Such a higher sublimation fraction? You mean that the sublimation fraction is higher on Qiangtang No 1 Glacier than other glaciers on the TP. Have you compared the meteorological data at the Qiangtang No. 1 Glacier to that on other glaciers?

In this section we did not compare meteorological conditions of different glaciers. We intended to limit our discussion on the sublimation fractions and its variation across the region. In other glacier/areas, sublimation fraction was comparable (between ~16% and ~60%) and not very much contrasting, except at the Qiangtang No 1 Glacier which where sublimation fraction is 65-169%. Therefore, to briefly discuss the contrasting conditions at Qiangtang No 1, we presented the meteorological conditions (wind speed, *RH* and snowfall values from Table 3 in Li et al., 2018) in the discussion. This comparison briefly points out the contrast, which we thought to be interesting for the readers.

Line 610-611: This result disagreed with your description in section 5.4. Sublimation fraction to winter snowfall is higher on Qiangtang No 1 Glacier than that on Chhota Shigri Glacier.

Thanks for pointing this out. We revised the sentence and now reads as:

Line No. 807-809:
'The cumulative DJFMA sublimation was 145 ± 25 mm w.e. a^{-1}, corresponding to 16-42% of the fraction of winter snowfall at the AWS-M site, which is relatively higher than that observed in

other studies across the HK region, with considerable interannual variations and lower than a few of the Tibetan sites.'

Line 620: There are more than 10 published works about Chhota Shigri Glacier. However, the meteorological data for that glacier is still not open to scientists in the world.

We have uploaded AWS-M data used in this study in Zenodo along with the codes used in SEB calculation and generating the figures. The citable open-access link (https://doi.org/10.5281/zenodo.6609605; Mandal et al., 2022) is now provided in the revised manuscript.

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