The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
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Review Comment on tc-2022-24

Anonymous Referee #1

Referee comment on "Cloud forcing of surface energy balance from in-situ measurements in diverse mountain glacier environments" by Jonathan P. Conway et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-24-RC1, 2022

Review of "Cloud forcing of surface energy balance from in-situ measurements in diverse mountain glacier environments" by Jonathan Conway et al. #tc-2022-24

General comments:
The authors presented a study on how cloud cover influences the glacier surface energy balance (SEB) in diverse climate settings across the globe based on observed meteorological data from 16 mountain glacier sites. They have compared the results and discussed the differences among 16 sites in terms of cloud's role in controlling local meteorology and SEB and thus glacier surface melt. First, the influence of cloud on the glacier mass balance is an extremely important topic to grow our understanding about physical glacier-atmosphere interactions where the existing community knowledge is poor. Second, this comparative study based on in-situ data from 16 diverse glacier sites is highly welcoming and has potential to increase our knowledge significantly. Finally, such understanding is also helpful to improve the SEB-based regional-wide glacier mass balance models and regional climate models. Based on my knowledge, the work is timely. Dataset selection/filtration steps are well-justified and standard, also methodology section is with strong physical background of the cloud cover estimation equations, etc. Figures are high quality and the statements and conclusions are well supported by the results/figures. Analysis of cloud effects on SEB across 16 sites is one of the unique part and gives a greater knowledge of spatial distribution of such understanding based on observed datasets. Also, I would like to commend the authors for this work which brought together several authors with similar interest and used the unique glacier SEB dataset in a common framework for better understanding the mountain glacier-atmosphere interactions. Also, they have nicely highlighted the future work needed and a need for a common repository of crucial AWS/SEB datasets.

I feel this is an interesting contribution to TC and valuable for the cryosphere community across the globe. The paper is interesting, concise and clearly written, therefore, I do not have many comments/suggestions for the authors as the manuscript is in already good shape. Below you will find some general and minor comments and suggestions that you

might find helpful to improve the quality of the manuscript.

Specific comments:

1. L164: I understand the data scarcity of such high-quality glacier AWS datasets, but don't you think data of 10-days from a month is a bit under-represented the monthly features/statistics? Or how about half a month (15-days) considering limited data for each site, also could be better-justified? If you agree, I do not think it would take much time to consider.

2. In Figure 5, I am a bit surprised to see the overcast cloud fraction in July for CHHO/Chhota Shigri Glacier. It's very small, compared to other Himalayan glaciers (Yala, Mera etc.). However, I am aware that Chhota Shigri area is a monsoon-arid transition zone, where monsoon clouds don't penetrate much (Azam et al., 2014), but such small overcast cloud fraction days are surprising. Or is it due to not having complete-month data in July, as I see in Azam et al. 2014 it starts from 8 July 2013? In that case I believe it is quite under-represented. Otherwise, it is worth putting a small note on the figure caption about this.

3. Section 3.4: How the melt pattern (frequency/amount etc.) gets influenced due to positive Q_L during summer in the Himalayan sites, for example, in Chhota Shigri, Yala, Mera, you get positive Q_L during summer, though it is not a significant amount. Is there any impact of clear-sky/overcast conditions in Q_L overall? Is it worth explaining briefly here?

4. Section 4.2: Although the authors choose to say that there is no relationship or not easy relationship between melt energy (Q_M) CE and latitude/air temperature, but from Figure 12, I think that the relationships are a bit clearer than with altitude or RH or SWin CE. In that case it is worth discussing briefly why there could be a bit clear relation between melt energy (Q_M) CE and latitude/air temperature? Or is it due to the higher latitude sites or maritime influence? Can you comment on this! This brings me to another important point: you should mention which glaciers are maritime/very high-altitude in Table 1, you can create a new column and mark them or find an easy way. This will give a quick idea to the readers and they can correlate better among the diverse climate/sites.

Figure and Table:

Figure 1: Here authors may cite the RGI 6.0 (RGI Consortium, 2017) in the caption, as they have used it in this figure, but I did not see any citation in the reference list. Also, you could mention the background image of this map (Natural Earth?).

Table 1: Latitudes and Longitudes digits/decimals are not consistent, some with three decimals and some two. I would have made them two decimals for all sites.

Figure 3: Does the colors mean anything? If yes, you can briefly mention in the caption, else you may remove the colors.

Minor/technical comments:

L57: You could put $T_s \geq 0$ °C or > -0.1 °C in parenthesis.
L58: Please expand: w.e. (water equivalent) within the parenthesis, I see it first appears here in the manuscript.
L70: What do you mean by highly reflective glacier surfaces? Do you mean fresh snow? You may mention a few as e.g.
L71-73: Although the paper by Mandal et al. (preprint in TCD) is still in discussion stage, they showed that sublimation is also considerably reduced (about 2-3 times) due to clouds in the Chhota Shigri Glacier area-one of the sites in your present study.
L99: I think you should expand the abbreviation of AWS here, because it first appears here and removes it from L107.
L105: surface energy balance —> SEB
L107-109: Remove 'balance' after radiation.
L124-125: NORD and CHHO are not expanded here, so it is a bit hard to follow, or can you cite Table 1 somewhere here, so that readers can quickly go to Table 1 and see what these short names refer.
L170: In equation 3, you have not mentioned about the sigma (σ)/ Stefan–Boltzmann constant. As you have mentioned details about all other variables/parameters, I would have mentioned for a bit easy read.
L195: For partly cloudy, isn't it should be $0.2 > N_\varepsilon < 0.8$? Please correct.
L204: Is it important to keep the last part of the sentence 'SWin does not provide meaningful values during the night time'? I would have deleted it because it is relatively understood that SWin is up only during daytime.
L221: Can you cite someone here, as you say 'In studies of net radiation', where they defined CE as the difference between average and clear-sky conditions.
L250: Partial cloud —> partly-cloudy, and elsewhere (e.g., L255, L265 and elsewhere).
L244: In caption, add comma after ε_{cs}
L289: W m-2 —> W m^{-2}
L289-291: Which three sites? It is difficult to identify them easily from 16 sites/legends, can you mention them in parenthesis?
L303: Here you write melt-season, elsewhere it is melt season.
L308: wind climate or wind system?
L341: I would have written clearly: In contrast to the percentage of hours with surface melt. Otherwise, for the general readers it is a bit rethinking what is fraction of time with melt.
L355: Evaporation because of $T_s \geq 0$ °C or > -0.1 °C? You can quickly mention within the parenthesis for easy read for other/general readers.
L403-405: Here I think you should mention the colder and warmer sites, at least a few, in parenthesis. Else, until here the readers have already forgotten which sites are colder/warmer because there are 16 sites across the globe.
L406-407: Is it proper to say it as correlation here? Or would you go with relationship, but again then relationship comes two times. You may find some other words. Cite Figure 12h after the albedo part.
L490: Conclusion does not have any section number. Maybe some formatting issue.
L491: How about, …. and surface energy balance over glaciers from very different...?
L504: Clear-skies.
L515: This sentence is similar to L480. Or you may remove it from L480 and combine it here in the Conclusion.

References:

Azam, M. F., Wagnon, P., Vincent, C., Ramanathan, AL., Favier, V., Mandal, A., and Pottakkal, J. G.: Processes governing the mass balance of Chhota Shigri Glacier (western Himalaya, India) assessed by point-scale surface energy balance measurements, The Cryosphere, 8, 2195–2217, https://doi.org/10.5194/tc-8-2195-2014, 2014.

Mandal, A., Angchuk, T., Azam, M. F., Ramanathan, A., Wagnon, P., Soheb, M., and Singh, C.: 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), The Cryosphere Discuss. [preprint], https://doi.org/10.5194/tc-2021-386, in review, 2022.

RGI Consortium (2017). Randolph Glacier Inventory – A Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Global Land Ice Measurements from Space, Colorado, USA. Digital Media. DOI: https://doi.org/10.7265/N5-RGI-60