



## Comment on **essd-2021-114**

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Referee comment on "Long-term energy balance measurements at three different mountain permafrost sites in the Swiss Alps" by Martin Hoelzle et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-114-RC2>, 2022

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The manuscript presents meteorological and energy balance data collected at three high-altitude sites belonging to the Swiss PERMOS network. The dataset is unique and of wide interest. I really wish to thank the authors for sharing this golden dataset. The manuscript is well written and organized and almost ready for publication. I only have one major comment and few minor issues listed below.

1. In the results and discussion sections, temporal trends of many parameters (air temperature, snow height, snow cover duration, radiation, ...) are presented. I recommend the use of Mann–Kendall nonparametric test to test trends significance and Sen-slope to estimate trend values and uncertainties, rather than linear regression. I suggest including either in the text or in the figures (e.g. fig3 and fig8) trend values, uncertainty, and significance.

Minor and technical points

I share the comment of reviewer 1 regarding figures: axis and labels size are often too small

The relevance of interplay between surface energy balance and surface cover is outlined in many sentences of the introduction (e.g. p2 l23, p3 l7, ...). I found it a bit difficult to understand Schiltorn surface characteristics. Is it "fine-grained debris of sandy and silty material" (p4 l22)? Corvatsch surface is a "coarse blocky rock glacier" (p4 l5); Stockhorn surface is "medium-size debris, fine-grained material, and outcropping bedrock" (p5 l5). Am I right? Maybe a table summarising site characteristics (elevation, mean snow depth or duration, surface characteristics, ...) could be of help?

p3 l27: " ... as long-term monitoring stations, the data have some larger gaps, which could only partly be filled." -> maybe " ... as long-term monitoring stations; the data have some larger gaps, which could only partly be filled."

p3 l29: Maybe "Data are stored ... CR1000) and are directly ... " could be better?

p4 l16: "Today, only few perennial snow patches can be found, which have been shrinking considerably as a consequence of the warm 1980s and 1990s (Imhof et al., 2000)." Is this sentence really needed?

p4 l29: typo: "2000.In addition"

p5 l10: typo: "MeteoSwiss fro the"

p5 l21 fl1: I find the use of the notations  $Q_s$  and  $Q_s$  (shortwave radiation) and  $Q_s$  (snow heat flux) potentially misleading. I suggest using something like  $Q_{sw}$  for radiation and  $Q_s$  for snow to avoid the risk of confusion

p6 l13: "T0 is the mean absolute air temperature between ... ". is there a word missing here? T0 is the mean absolute air temperature "difference" between ....?

p6 l23 fl1 (4) and p7 fl1 (7): I imagine  $q_a$  is calculated from relative humidity measurements at 2m. What about  $q_s$ ?

p8 l4-7 & l20: What is the influence of the choice of using constant snow density values (220 kgm<sup>-3</sup>) on the computation of  $Q_S$  and  $Q_M$  and thus on the partitioning of all energy fluxes (e.g. fig 7 and p12 l16-20)? Can you comment on that?

p8 fl1 (11): Did you use constant  $k$  values? which ones? Which is the  $\hat{\alpha}z$  range used for the calculation?

p8 l24-26: will it make sense to add, for example in table 2, a column indicating a summary of missing data (% of NA) for all variables at the 3 sites?

p9 l2-4: What does this mean? variable1@site1 is gapfilled using correlations like variable1@site1 ~ variable2@site1? "Energy balance variables" means also gapfilling wind speed with air temperature? can you clarify this? The results of this procedure are not included in table 2 right? Is there any reference to this in section 3.2?

p9 l13: "Snow height data was" ... isn't "data" always plural? -> were corrected?

p9 l16: which "top of atmosphere radiation value" was used?

p9 l21: "In addition, site specific processing steps were performed for the different variables." that are the ones presented @l22 and l28?

p9 l23-25: snow height multiplication factors: all factors are <1. Does this mean that at Schiltorn, Stockhorn, and Murtel snow height is always lower than corresponding reference stations or vice versa? Can you comment on this? Wind erosion? Secondly, correction factors were used to gapfill missing snow data at the three sites or to systematically correct all snow data at the three sites? I imagine the first one. right? maybe you can specify it.

p9 l28: "Level 2 data were ..." -> "Level 2 shortwave incoming radiation data were corrected ... with shortwave outgoing radiation" Am I right? Secondly, I imagine this procedure was adopted to correct QSin data during or right after snowfalls. Correct? How did you flag snowfall events and how did you define the time window when the correction is needed (how many hours after snowfall)? Did you find a nice way to flag the records when the QSin sensor is "obscured" by snow and thus the correction needs to be applied?. Lastly, I imagine alpha stands for albedo.

p9 l29: Longwave incoming radiation correction: systematically? all data?

p10 l7 "available" .. what do you mean by that? originally available or after gapfilling? are there remaining gaps after the gapfilling procedure presented at p9? if yes it could be relevant to insert this information somewhere (see comment p8 l24-26)

p10 l22 and p12 l6-l14: how was the warming rate computed? I recommend the use of Mann-Kendall nonparametric trend test and Sen-slope estimator of trend.

p10 l23: "for the periods in winter" what does this mean?

p10 l25: "maximum snow height": is this the absolute maximum of the time series or the mean of yearly maximum values? I think that the latter is more informative.

p10 l25: increasing and decreasing snow height trends are significant? see the previous comment regarding trend estimation

p10 fig3: also the significance of these trends needs to be tested with Mann–Kendall nonparametric trend test and Sen-slope estimator of slopes of trend. Modify fig3 accordingly inserting p values and some measure of uncertainty around the trend values

p11 l7: albedo values: are mean albedo values computed using all days? (both snow and snow-free periods)? Are these differences caused by differences in snow cover duration or driven by albedo differences of the ground/rock surface spectral properties related to granulometry and/or lithology?

p11 l9: "... the following values were measured ..." maybe " ... the following mean values were observed ... "

p11 l13-14: radiation components trends: see previous comments on significance.

p11 l25 and l28 fig6 and fig7 legend: use the same notation used in fla1:  $Q_s$ ,  $Q_r$  ...

p11 l26 "The share" maybe "the partitioning"?

p11 l30: influence of snow cover on energy fluxes is more than "also" of importance. I think it is the main driver of the seasonal course you are describing.

p11 l31: "... snow is impacting the incoming shortwave radiation by its high albedo ... " snow albedo impacts net radiation rather than incoming shortwave radiation.

p11 l32 "available atmospheric energy" why not simply "available energy"?

p12 l3: typo: (r-2)

p12 l13: typo ... by (MeteoSwiss)

p12 l16: "increase in cloudiness". If the significance of radiation trends is confirmed (see comment p11 l13-14), it is a very interesting point strongly related to the EDW discussion @p13 l3-l10. Do you have any other references or observations available? (MeteoSwiss data?). Can you exclude instrumental drift?

p12 l18 "... the strong spatial differences between them are significant." This part of the sentence is unclear.

p12 l24-26 and fig8 I recommend the use of Mann-Kendall nonparametric trend test and Sen-slope estimator of trend rather than linear regression.

p14 l11 "The data is available on different data platforms". Isn't this a repetition of l9?

p12 l21: typo "... see (Scherler ..."

p26 fig8, p27 fig9, p28 fig10 and p 29 fig11 captions: check typos sites-dates ()

p32 table3: second-last row. typo "height"