Author response R#1

"The surface energy balance in a cold-arid permafrost environment, Ladakh, Himalaya, India"

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Response to Anonymous Referee #1

Thank you very much for your review and your constructive comments on this manuscript. I hope that the explanation given below, and the changes to the manuscript, will provide an adequate response.

General comments:

Reviewer comments	Author response
- Page 11: When presenting the energy balance equation, the authors use in my opinion a slightly confusing convention related to the flux directions. I would suggest that they use a more common convention very often used in cryospheric research that all fluxes towards the surface are positive and negative away from the surface, because the authors used a different convention often in the paper values are not clearly presented. As an example, in Table 2: the mean value of Sout is given as a negative value and the Min and Max values are given as positive values. The same is the case for LWout.	As suggested, the sign convention for surface energy balance (SEB) components is changed in the revised manuscript.
- Page 11: The authors present as their first objective on page 5: (a) quantify the point Surface Energy Balance (SEB)! When calculating the energy balance from measurements, it is then not clear, why the authors do not use their data to calculate the melt by using their measurements of the snow cover? I understand that they use the model to calculate the melt and also the ground temperatures with their model and use the measured data of snow cover and ground temperature as validation data. However, I have the impression that through this approach the authors mix different steps in the methodology and increase the degree of	Combining this suggestion with that of Rev-2 (Comment: 8) we now use the observed radiation components in the GEOtop as input except LW_{out}. The comparison of observed and Modelled SEB components is treated separately to assess the model reliability. With this we maintain the two step performance evaluation of GEOtop: 1. modelling and comparison of snow depth variations, and 2. near-surface ground temperature variations and compare with the field observations

freedom unnecessarily. First, the authors may simply use all the available data to determine the MEASURED SEB based on the well-known and common approaches and then in a second step they make their model exercise, which is already very well done.	
- Page 22, Table 2: the given albedo values seem to be not reasonable. The authors present for example (taken from Figure 3) measured SWin values in spring (April) of around 300 W m^{-2} and SWout values of 250 Wm^{-2}. A corresponding value of albedo (alpha) would be higher than 0.5. Therefore, the max value of alpha should be higher. Please clarify!	We thank the reviewer for pointing out the error in the calculation of albedo and is now corrected in the revised manuscript. The lower values of mean daily albedo in the previous version of the manuscript were due to wrong averaging (used 24 hr.). Now it is corrected.
- Table S2 in supp. material: I would recommend that you send your data to the Global Energy Balance Archive (see also http://www.geba.ethz.ch and https://www.earth-syst-sci-data.net/9/601/2017/)	Will do so after getting necessary permission from the funding agency.

Specific comments:

Reviewer comments	Author response
1. Page 4, line 83: please cite here a text book such as Oke 1987 or Sellers 1965, because these are well-known facts since starting EB studies.	The references suggested have been added to the revised manuscript.
2. Page 10, line 218: what means 'controlled through parameters' -> please be more specific and explain more in detail.	'Controlled through parameters' here means that the individual processes like surface energy balance or water balance in the GEOtop model can be flexibly controlled separately using the values 1 (on) or 0 (off) in the GEOtop input parameter file. The value equal to 1 means the said process is running and the value 0 means it is turned off. More detail is added in the revised manuscript.
3. Page 10, line 219: please delete s: …mountain regions…	Deleted as suggested in the revised manuscript.

4. Page 11, line 234: replace But with However,	Changed as suggested in the revised manuscript.
5. Page 11, line 240/41: equation (4): why should LWn be only a function of Ts? Please delete the dependencies to Ts in equation, because further down the authors explicitly explain that these variables are not only depending on Ts.	In equation 4, the idea behind showing dependencies was to show that the Eq. 4 is solved in terms of Ts. Yes, the LWn not only depends on Ts through LWout: $LW_{out} = \in_s \sigma T_s^4$ but also on LWin. In the revised manuscript, the sentences have been reformulated. Furthermore, we have stated that only the LE component in Eq. 4 depends on the soil moisture at the surface (θ_w), which combines the surface energy balance with the water balance equation.
6. Page 12, line 257-260: this is strongly dependent on the effective soil conditions, if you have rock surfaces it is completely different from fine sedimentary material. -> please clarify! Please explain in more detail the BATS, which is used here!	The albedo in GEOtop is considered as per the ground surface conditions such as, for the snow-free ground, the albedo varies linearly with the water content of the topsoil layer, and for snow-covered surfaces the albedo is estimated according to the Biosphere Atmosphere Transfer Scheme. In the GEOtop input parameter file, four parameters need to be defined that take care of soil moisture conditions and their effect on albedo. The values of these parameters were taken from the literature and are described in detail in the revised manuscript. Furthermore, the Biosphere-Atmosphere Transfer Scheme (BATS) (Dickinson et al., 1993), is described in detail in the revised manuscript.
7. Page 14, line 296-298: what happens if your surface is bedrock?	If the soil type is bedrock, then in the input parameter file of the model, the parameters specific to bedrock needs to be defined separately.
8. Page 16, line 360: I would also like to see an evaluation of the turbulent heat fluxes!	The observed values of turbulent fluxes are not available for this study. That's why we did not perform an evaluation of the turbulent heat fluxes.

9. Page 17, line 387: delete s: root mean square error	Change made in the revised manuscript.
10. Page 20, Figure 2: would be nice to plot snow height in figure 2 A!	The snow height is added to the Figure 2A in the revised manuscript.
11. Page 21, line 468: what do mean with non-free? clarify!	The word is non-snow period and is corrected in the revised manuscript.
12. Page 22, line 476: please reformulate the following sentence to: …with higher values during summertime and low, relatively stable values during winter…	Changed as suggested in the revised manuscript.
13. Page 22, line 481: please reformulate the following sentence to: …with a thick snow cover during…	Changed as suggested in the revised manuscript.
14. Page 22, line 483: please delete word: values	Deleted as suggested in the revised manuscript.
15. Page 23, Table 2: please control and adapt table 2 according to my comments under General Remarks.	In Table 2, the revised albedo values have been updated.
16. Page 27, Table 3 and page 30 line 615: Fsurf values: please explain the signs of these values? Please also explain the variability of Fsurf in relation to your result outputs of your model? What is the meaning of Fsurf when it is negative and there is no snow? Please clarify!	The **F_{surf}** symbol in the manuscript indicates the latent heat storage in the snowpack due to melting or freezing. During the summertime, when conditions for snow melting are prevailing at the ground surface, the F_{surf} is negative (loss from the system as per revised sign convention) as a result of energy available for melting snow. As per the revised sign convention, the positive F_{surf} (gain to the system) during summertime is the energy used to refreeze the water and represents the freezing flux. Otherwise, the F_{surf} is the soil heat flux for the rest of the time (see Figure 4C).
17. Page 27, line 615: please correct: available	Corrected in the revised manuscript.
18. Page 35, Figure 8: here it is important that most of the energy in Rn is used for melting (particularly in the year 2017) and this should be shown in the figure!	The corresponding snow melt is also shown in the revised figures.

References

Dickinson, R. E., Henderson-Sellers, A. and Kennedy, P. J.: Biosphere-atmosphere transfer scheme (BATS) version 1e as coupled to the NCAR community climate model., 1993.