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Interactive comment on "Modeling Slope Environmental Lapse Rate (SELR) of temperature in the monsoon glacio-hydrological regime of the Himalaya" *by* Renoj J. Thayyen and Ashok P. Dimri

Anonymous Referee #2

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In this study, the authors analyse the Slope Environmental Lapse Rate (SELR) between several stations in the western Himalayas, and propose a way to deal with the annual cycle of the SELR by using an empirically tuned version of the Clausius-Clapeyron relation. While the objectives of the study are broad and well justified (who wouldn't like to have better temperature estimates for use in impact models?), the presented contribution has too many issues and general applicability problems to justify a publication in TC. One of the major messages of the study (abstract: "*Study suggests moisture-temperature interplay is forcing the seasonal as well as elevation depended variability of SELR*") is very basic and has been the core message of many previous studies with more stations and higher statistical significance (e.g. Kattel et al 2013 for Nepal,

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mentioned in the manuscript). Beside being not mature enough (see discussion below), the modelling aspect of the study has a fundamental shortcoming which is only vaguely discussed by the authors.

Let me pick up some parts of the manuscript to make my point. In the manuscript (P9 L26), they write: "*SELR of section-2M representing the nival- glacier regime is considered important for cryospheric system studies in the Himalaya.*". Later (P12, L27), they state "*SELR modeling is attempted only for valley scale lapse rate (Section-1M) as lapse rate of nival-glacier system (Section-2M) is found to have higher inter-annual variability as discussed in section 4.2 above.*" As a glacier modeller (which I am), I am left with very confusing and contradictory messages here. The glacier lapse rate is important, but since it is complicated I shouldn't attempt to model it? To make things even more confusing, there is another statement in the abstract: "*Inter-annual variations in SELR of the nival- glacier regime is found to be significant while that of the valley scale SELR is more stable. Hence, it is proposed to use the valley scale SELR for glacier melt/runoff studies*." This statement is not backed-up by any evidence, since the authors didn't try to apply their valley model to locations where glaciers and snow *are* found.

I encourage the authors to use the very valuable data presented here to reach higher goals, such as actual application of their method to modelling studies of the glacier melt/runoff. I also encourage them to be much more careful in proof-reading their manuscript before submission next time. There are few things able to annoy a reviewer more than incomplete/inexact figure legends, non-explained variables and acronyms, or typos in the abstract.

Factors influencing the SELR

In the manuscript, the authors explain the difference between the SELR and the free-atmosphere lapse-rate. The correction method they propose to apply, however, is a purely moisture based thermodynamic approach which has in fact nothing to do with the differences between the SELR and and the free-atmosphere. It could have (since the saturation level might be reached by orographic lifting), but this dynamical argument is not quantitatively discussed by the authors. Other reasons why the SELR is different from the the free-atmosphere are:

- differences in incoming radiation
- differences in surface conditions (roughness, albedo), changing the surface energy balance
- dynamical effects (e.g. föhn)
- cold-pools (nighttime inversions)
- etc.

All these effects are playing a role at the monthly time scale too, and can explain (i) why the “valley gradients” and the “nival-glacier” gradients are fundamentally different, and (ii) why the purely thermodynamical approach has to be corrected manually with empirical indexes (Eq. 7, Fig. 8). In fact, I am quite confident that it would be possible to reach the same modelling result as shown in Fig. 9 with a purely statistical approach, since it’s just about adding a correction for the annual cycle to the SELR. The comparatively poor results of the model in simulating inter-annual variability speaks for the necessity for a more complex model.

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Evaluation of the model performance

The authors calibrate their model at one location and apply it to the others. This is already a good idea, but should be extended to a full cross-validation: with cross-validation, you make use of all available data for calibration and validation, and verify the general applicability of your model for future users. If your model only works in one direction, it will probably have issues elsewhere too.

Furthermore, the choice of using correlation as an indicator of model performance is a bad choice. This is best shown in figure 9, upper-right and lower-right plots, where the correlation is good but where the absolute values are way off (model says 8, obs say 6). I would a very different approach for validation, by comparing your model results RMSE with a base method, i.e.: how well does my model perform in comparison to the standard lapse-rate 6 or 6.5 K/Km? How well does it perform in comparison to the average lapse-rate observed at that location, or an average annual-cycle of the lapse-rate? When using the two latter "simple models", the performance of your model can be put into context.

Editorial comments

A non-exhaustive list of issues underlining that authors should take more care of their readers before submission:

- many typographical errors, even in the abstract
- SALR is explained in the abstract but not in the text, DALR is explained nowhere (I know it means “Dry”, but still)
- the formulas are unnecessarily difficult to follow: please be consistent in your

notations (e.g. $\frac{dw_s}{dt}$ is written in several different ways across the chapter) and consider using latex, which is free for everyone to use

- Eq 7: there is no explanation as to what we have to apply the sum to.
- Table 1 and 2: the legends are wrong, as there are both sections presented in each table
- Figure 4: there is no indication as to what the error bars are supposed to represent.
- the text is unnecessary long and contains many repetitions
- As a result of above and (I find) a quite intransparent choice for naming things (i.e. why “Section-1M” and “2M”?), it took me two lectures to get a sparse overview of the data availability.

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