General comment

1. **This paper is a re-submission of a paper previously discussed in HESSD. The authors made a considerable effort to revise the text and the model to meet the reviewers' concerns. The model now has a separated degree-day factor for snow and ice and the description of the model is clearer (but still not entirely clear).**

   Reply: Thanks.

2. **The proposed step-wise calibration method is tested to show how robust it is if applied to different periods and with different hydrograph separation criteria. The method is certainly transferable to other catchments and interesting for the readership of HESS and I recommend publication in HESS after minor revisions.**

   Reply: Thanks.

3. **Before giving some detailed comments hereafter, I would like to point out here that I do not agree with the authors' view that an observed time series can be manipulated such as to "expand the measurement dimension". Information can be extracted from data but the information content of data cannot be increased by any manipulation. Could you please comment on this?**

   Reply: Thank you for this suggestion. We have modified the related concepts in the paper. 'measurement dimension' has been modified as 'signature dimension' in the revised paper.

Detailed comments:

1. Abstract

1. 1. In the abstract, the hydrograph is partitioned according to water sources but then "the hydrological model parameters are grouped by the associated *runoff generation mechanism*"; please use coherent wording according to the very first review of the 1st submission to HESSD. Same holds for section 3, and for the conclusion.

Reply: We have modified the 'runoff generation mechanism' as 'runoff water sources' in the revised paper.

1.2. The abstract does not mention any results, conclusions or outlooks, simply summarizes the method.

Reply: We have expanded the abstract section by adding more details about the results

and conclusions:

"Results show that the proposed calibration approach performed reasonably well. Cross validation and comparison to an automatic calibration method indicated its robustness."

2. Introduction:

2.1. Good literature summary.

Reply: Thanks.

2.2. I do not agree with wording "hydrograph partitioning is another possible way to expand RM". The measurement dimension cannot be expanded otherwise than by adding data; hydrograph partitioning might help to extract the meaningful information pieces and to match them with the corresponding parameter groups. This helps in parameter search since the parameters are not trying to match a piece of information which they are not supposed to simulated. But this does not "add measurements" and the measurement dimension is thus not expanded.

Reply: We have done the related modification in the revised paper by replacing the 'measurement dimension' with the 'signature dimension'. Here this sentence has been corrected as "However, glacier mass data and baseflow data are usually not available in some mountain basins. In these cases, hydrograph partitioning is another possible way to exploit information from available data." in the revised paper.

3. Case study

3.1. I re-iterate my comment: why is the case study qualified as "alpine"? For botany, "alpine" might be a general term referring to any high elevation mountain range, for hydrology, "alpine" refers to my understanding to a hydro-climatic regime with a winter season with snow accumulation and a summer season with melt occurring due to high temperatures; is this the case here? Or do we have a regime where accumulation and melt occur both during the summer as in the Himalaya? On web of science, I could find a single paper mentioning the words "alpine hydrology and Tianshan". Could you not just say why the area has alpine hydrology? Or simply replace alpine area by mountainous area? Namely also on p. 13398 and 13399 where the more general "mountainous area" should be used instead of alpine.

Reply: To the authors' understanding, the term 'alpine' is an alternative word (and short)

for high mountain area. It has no hydrological meaning in this manuscript as referred by the Referee. Thanks for your suggestion. To avoid misunderstanding, we have replaced all the word "alpine" with the word "mountain" or "mountainous" in the revised paper.

4. Method

4.1. I still do not understand how you connect the accumulation and melt of snow with the modis image. The paper says that snow accumulation and potential melt are simulated per subcatchment, I conclude that SWE is also computed per subcatchment. How do you connect this to the area that experiences melt as obtained from the MODIS image? Do you multiply the potential melt (mm/day) with the area that experiences melt? But then, how do you update the SWE? What do you do if your computed SWE is non-zero but the MODIS image does not show any snow pixels? And what if SWE is zero but MODIS shows snow?

Reply: In response to this comment, we have added the below discussion in the revised paper:

"To be noted, snowfall in each subcatchment is calculated according to the daily precipitation and temperature. And snowmelt is simulated using the degree-day method. However, the snow water equivalent in the snow cover zone is not computed. The existing of snow cover in each subcatchment is only determined by MODIS snow image. When the MODIS image indicates the existing of snow cover and meanwhile the daily temperature is higher than 0 ℃, then snowmelt will occur, otherwise, snowmelt will not occur. The identification of snow cover by MODIS image is in accordance with the fact that the partitioning of snowmelt dominant hydrograph is based on MODIS snow products. If the existing of snow cover is determined by snow water equivalent, the temperature parameters to calculate snowfall can have significant effects on the estimation of the degree-day factor for snowmelt. To partly reduce this effect, we calibrate the degree-day factor for snowmelt on the basis of MODIS snow cover products. Although in this way, the water balance of snow cover is not taken into account in the snow cover zone, it should not impact the calibration of the degree-day factor for snowmelt. It's worth noting that snow water balance in the glacier zone is updated by calculation of snow water equivalent where snow cover level should be relatively low."

4.2. The use multi-letter parameter names is banned by HESS.

Reply: Thanks, we have modified all the multi-letter parameter names into subscripts. 'KKA' is corrected to 'K_A', 'KKD' is corrected to 'K_D' and 'WM' is corrected to 'W_M'.

5. Results

5.1. I recommend explicitly commenting on the fact that clearly, the automatic calibration cannot find the solution to the optimization problem, otherwise it *HAS* to find a solution that is better than the step-wise solution. If the automatic solution found by optimizing NSE has a lower NSE or higher RMSE than the manual calibration, this means that the algorithm could not find the optimum.

Reply: In response to this comment, we have added the discussion below in the revised paper:

"The automatic calibration algorithm has run for about 5 weeks (840 hour on a desktop equipped with an Intel Core i7 CPU with 2.8GHz) to obtain the current results. Its performance can increase if the algorithm keeps on running, and even get higher performance than the step-wise calibration method. The comparison here is intending to show that the step-wise calibration method based on hydrograph partition can achieve considerable performance more effectively. The automatic algorithm here treats all the parameters equally during the calibration period. Each parameter should be optimized when searching for the optimal parameter set. This searching algorithm hampers the efficiency of the calibration procedure without identifying the dominant sub-periods for different parameters. In the step-wise calibration method, only parameters that are responsible for the simulation of corresponding hydrograph partition are optimized in each step. And also the calibration of parameter by this method reflects the role of each parameter for the basin runoff generation."

5.2. Again, I do not agree with the wording "Benefitting from the partitioning curves, however, the stepwise calibration method increases the dimension of measurement information to four. The measurement dimension is now equal to the number of parameter groups," The information content of data cannot be expanded by data manipulation. It can only be extracted. Otherwise you would create information.

Reply: In the revised paper, we have revised this sentence as "Benefitting from the

partitioning curves, however, the stepwise calibration method increases the dimension of hydrological signature to four. The signature dimension is now equal to the number of parameter group."

5.3. What means "to extracting index information"?

Reply: it have been corrected as "to extract hydrological signatures".