Response to Anonymous Referee #2

We would like to thank the reviewer for his/her interesting comments and suggestions. We are sure that taking these suggestions into account will significantly improve the clarity and the scientific interest of this paper. We try to address them below in a point-by-point format. The original review is presented in black and the response provided is indicated in red.

The authors used data from over 100 weather stations with different aspect and altitude to develop more accurate long and short-wave radiation estimates from readily-available data such as temperature and geographic features. While I believe this to be a worthwhile task, the manuscript as written is hard to understand, and unclear in its major findings. Consequently, I recommend revisions to the paper before it can be published.

First – it was hard to follow all your descriptions of the various parameters used. I'd suggest putting some of the detail in an appendix section, and simply providing the parameter formulations you ended up using in the main documentation.

Response: The authors acknowledge that the paper should be rearranged to improve its clarity. Your suggestion to put some details in an appendix section will be taken into account. Formulations that are not part of the new model we propose will be put in an appendix. In this appendix will be moved the original Bristow formulation (Eqs. 2 & 3), and the ΔT_{ref} formulations that were used as benchmarks (Eqs. 6, 10 & 11).

Also – I'd like to see clearer comparisons between the new model results and more established methodologies for estimating LW and SW radiation.

Response: In this paper, we already compared the newly developed formulation to the original Bristow and Campbell formulation. It is in our opinion a well-established formulation. If the reviewer meant that LW and SW radiations could be compared to reanalysis data, we provided a detailed answer to this specific issue below.

The use of the KGE criterion is unclear – why not use Pearson correlations directly? If this criterion is indeed superior, please provide explanation of acceptable ranges and max/min values.

Response: The KGE' criterion is somehow similar to the Nash-Sutcliffe efficiency criterion (NSE) as the two criteria are correlated. The range goes from $[-\infty, 1]$, 1 being the best performance that can be achieved; this information will be added to the document.

$$KGE' = 1 - \sqrt{(r-1)^2 + (\omega-1)^2 + (\gamma-1)^2}$$

$$r = \frac{Cov_{so}}{\sigma_s \sigma_o}$$

$$\omega = \frac{\mu_s}{\mu_o}$$

$$\gamma = \frac{\sigma_s/\mu_s}{\sigma_o/\mu_o}$$

Here r is the Pearson correlation criteria (optimum of 1, range $[-1,1]$), ω is the Bias ratio between observations (subscript "o") and simulations (subscript "s") (optimum at 1, range $[-\infty,+\infty]$) and γ is the ratio of the coefficient of variation (optimum at 1, range $[-\infty,+\infty]$). The KGE' is maximized if all subcriteria (r, ω and γ) are equal to 1. The KGE' criterion is superior to the Pearson correlation only as it takes also into account the bias and the variation of the variable.

In addition, it would be useful to see how the provided formulations compare to simply using the nearest weather-station values for LW and SW radiation, or reanalysis datasets – i.e provide some more broad comparisons for your methodology.

Response: The objective behind this paper is to create a distributed simulation of SW and LW radiations over the mountain range. Using the nearest weather station value can be used as a kind of validation (Davos and Weissfluhjoch are the only neighboring stations with very different elevations), but cannot be used as an extrapolation method since the number of stations is small for the whole mountain range.

It is of course possible to compare the simulations to the LSASAF remote sensing products providing SW and LW daily simulations at a 3x3 km spatial resolution. Nevertheless, in this case we think it would be difficult to make a good interpretation of the results without using multiple reanalysis datasets using different downscaling (as the space resolution of reanalysis is often coarse), which would increase the complexity of the paper. We could also think of using part of the parameterization developed here for downscaling coarse grid calculated radiation to finer resolution, but we think it is outside of the scope of the present manuscript.

In the end, it didn't appear that your calibrated models performed much better than the original models. For your conclusion - discuss conditions under which using these more complex formulations would be worthwhile.

Response: The simulations of reference surface temperature indeed do not appear to perform much better than the original models. As said in the discussion, it seems that the errors on longwave simulations have a great impact for high elevation areas. We think that even if this work does not solve completely the problem of simulating radiations in mountain areas, the methods and reflections we had can be useful to the community. This paper could be used as a base for improving longwave radiation modeling in mountains environment when reanalysis data are too coarse.

We think that the method we proposed has the advantage of not being site specific, by being able to be used at large scale (even if there is large differences in elevation). We believe that the formulation could be adapted at other mountain ranges only by calibrating the parameters of the model on observed SW and LW data. If not enough data are available, parameters from the radiation model could be conjointly calibrated with snow and/or with hydrological model parameters.

Specific comments:

P8L14: Semicolon needed

Response: It will be added

P9L18: extra “?”

Response: It will be removed

P9L23: Check this equation, it doesn’t seem correct in the form written, as it equates three measures of effectiveness similarly in the equation, even though one should be maximized, the others minimized.

Response: The equations have been directly taken from the paper from (Gupta et al., 2009; Kling et al., 2012). The KGE’ criterion has to be maximized (maximum value of 1). All the subcriteria from the KGE’ also have an optimal performance for a value of 1. If one (or multiple) subcriteria value is inferior or superior to 1, the whole KGE’ performance decreases.

Table 4: What are JUN, KOP, and SAM? Please define the acronyms and their significance in the table caption (i.e. do these represent high altitude, mid, and low altitude stations?).

Response: JUN, KOP and SAM are the 3 stations used as examples for further analysis (Figure 4, Figure 10 and Table 4). For the sake of clarity, this information will be added to the table caption.

Modifications of the structure of the paper:

1 – Introduction

2 – Datasets

3 – Methods framework

- 3-1 Parameterization of shortwave radiation
- 3-2 Parameterization of Longwave radiations
- 3-3 Humidity parameterization
- 3-4 The reference surface temperature model
- 3-5 The experimental plan

4 – Results

- 4-1 Comparison of the different parameterization
- 4-2 Comparison of two different calibrating methods
- 4-3 Response of a reference surface to the simulated radiative forcing

5 – Discussion

6 – Conclusion