Interactive comment on "Site specific parameterizations of longwave radiation" by G. Formetta et al.

Anonymous Referee #1

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The study evaluates the performance of site-specific parameterizations of longwave radiation. Similar evaluations have already been done by other authors. What's special about this study are two points: 1) The model parameters have been randomly perturbed to analyze their sensitivity. 2) The site-specific model parameters were also estimated with the help of multiple regressions against commonly available local and climatic variables. The results are interesting and definitely worth to be published in HESS after the following comments have been addressed:

The authors thank the reviewer for the prompt revision and the interesting comments and suggestions he made. They definitely improved the quality of the paper. Below we replied one-to-one to each comment.

Q1) *Section 2: Please describe how the last and first hour of daylight was defined.*

A1) We thank the reviewer for the suggestion and we agree with it. We added the following sentence to specify how we computed the first and last hour of daylight.

"The computation of the first and last hour of the day are based on the model proposed in Formetta et al., 20013 that follow the approach proposed in Corripio (2002) equations 4.23-4.25. The sunrise occurs at $t = 12 \cdot \left(1 - \frac{\omega}{\pi}\right)$ and the sunset will be at $t = 12 \cdot \left(1 + \frac{\omega}{\pi}\right)$ where ω is the hour angle. Those equations are based on the assumption that sunrise and sunset occur at the time when the z coordinate of the sun vector equals zero".

Q2) Section 4: There is hardly any discussion of the results. I suggest adding the discussion of the findings in the Result section.

A2) We thank the reviewer for the suggestion. We extended the discussion part as suggested also by reviewer n.2. We added some sentence in the conclusions and some more comments to the results presentation:

“Moreover the Brunt model is able to provide higher performances with the regression model parameters independently of the latitude and longitude classes. For the Idso model the formulation with regression parameter provided lower performances respect to the literature formulation for latitude between [25-30]”.

“Although many studies investigated the influence of snow covered area on longwave energy balance (e.g. Plüss and Ohmura, 1997; Sicart et al., 2006), the SMs do not explicitly take into account of it. As presented in König-Langlo Augstein (1994), the effect of snow could be implicitly taken into account by tuning the emissivity parameter”

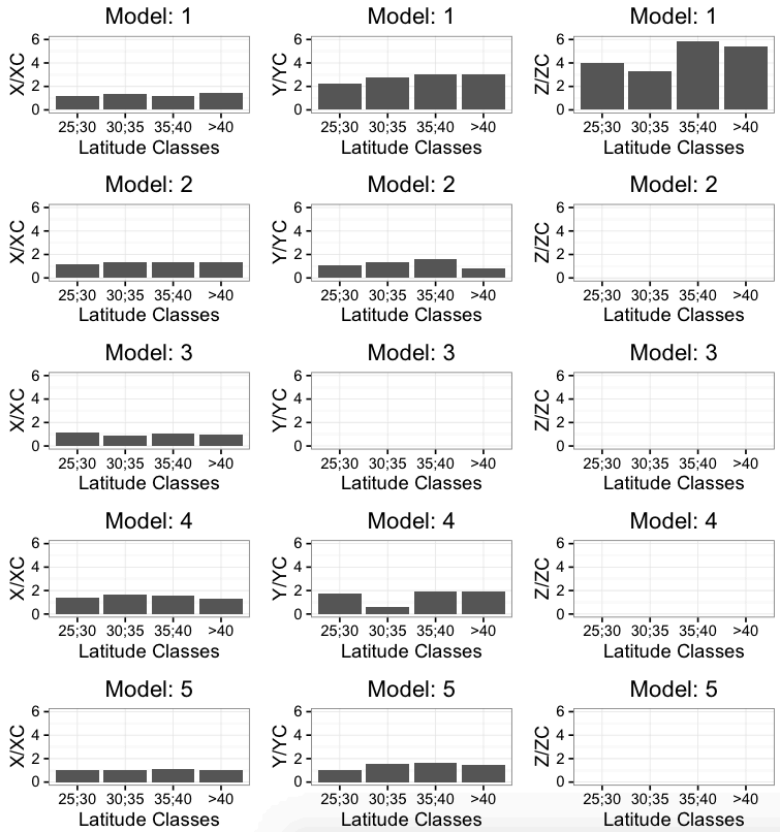
“Finally, the methodology proposed in this paper provides the basis for further developments such as the possibility to: i) investigate the effect different all-sky emissivity formulation, ii) verify the usefulness of the regression models for locations outside the USA; iii) analyze in a systematic way the uncertainty due to the quality of meteorological input data on the longwave radiation balance in scarce instrumented areas."

Q3) *Section 4.2: I miss a figure or table, which shows the variability of the site-specific model parameters for the different stations analyzed. This information is necessary in order to judge the sensitivity of the parameters on the different climates. Possibly this is reported in the mentioned supplementary material, which I could not find!*

A3) We thank the reviewer for the comment. We attached the missing file of the table containing the parameters value for each model and station few hours after we read the revision. We agree with the reviewer comment and we added below two figures showing the parameters variability for each model and for classes of latitude and longitude.

Figure 1 shows the ratios between the optimal parameter set and the literature parameter set for each model grouped by latitude classes. In general the parameter ratios vary between 0.3 and 2.0 for most of the model and they do not show great variation across latitude classes except model 1, 8, and 9. The same comments are valid for Figure 2 that shows the ratios between the optimal parameter set and the literature parameter set for each model grouped by longitude classes.

For models 1,8, and 9 the ratios reach the maximum value of 6 and for model 1 and 9 they are lower for the latitude classes [25;30] and [30;35] and higher for latitude classes [35;40] and [>40].”



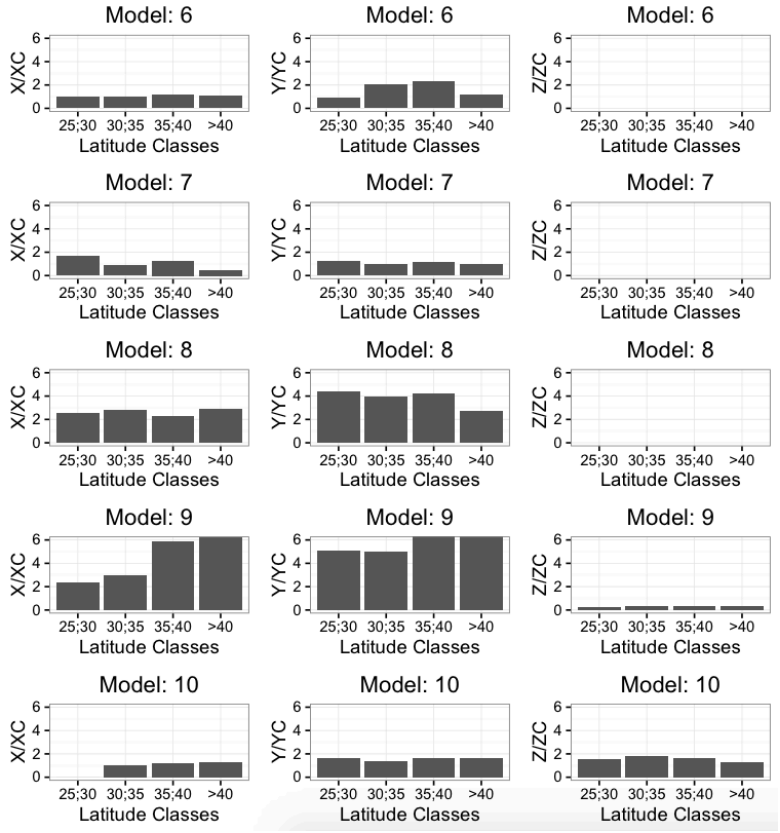
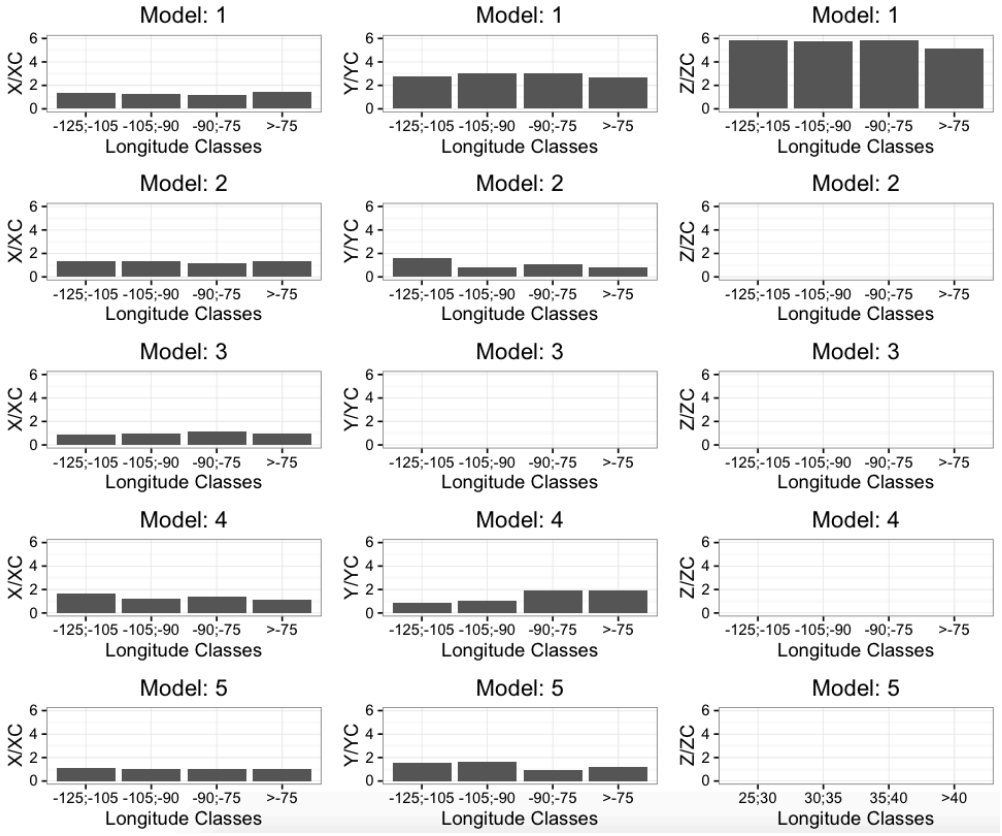


Figure 1: Ratios between optimal and literature parameter set for each model grouped by latitude classes



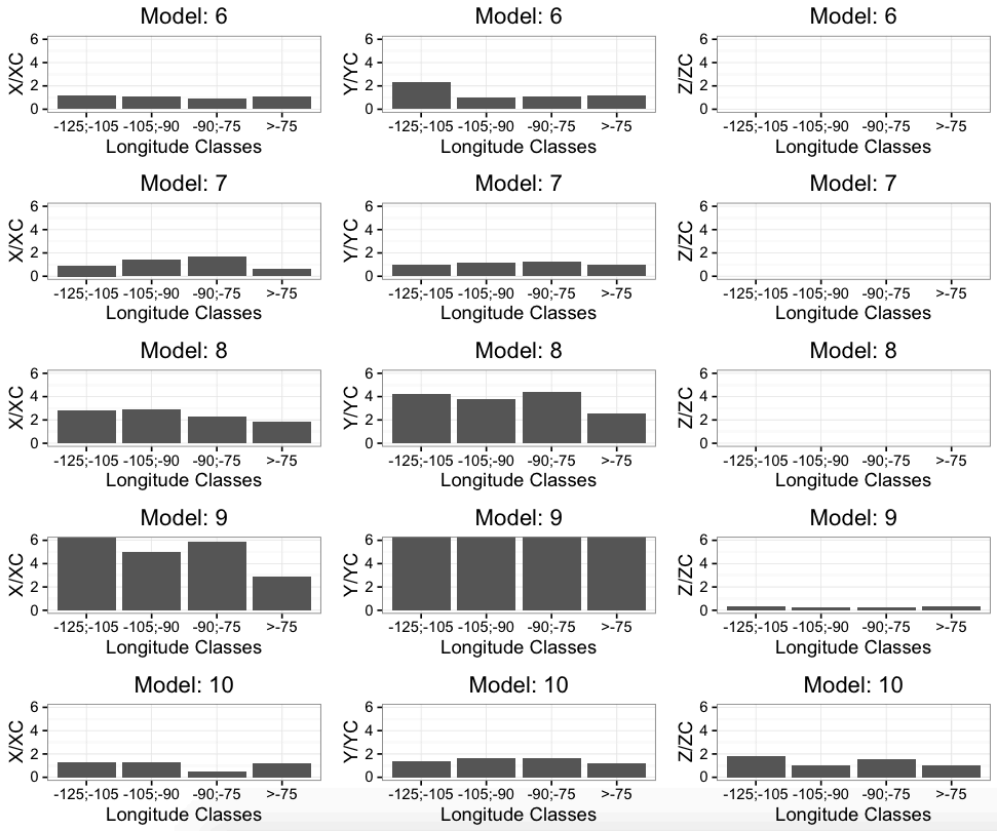


Figure 2: Ratios between optimal and literature parameter set for each model grouped by longitude classes

Q4) *Section 4.3: You write "you start with optimal parameter set". Is done for every station? Moreover, it might be worth mentioning that the all three parameters of model 10 seem to be quite robust.*

A4) Yes, we started with the optimal parameter set for each station analysed and for each model. We added the following sentence to clarify better:

Old sentence: "The procedure was repeated for each parameter of each model"

New sentence: "The procedure was repeated for each parameter of each model and for each station of the analyzed dataset."

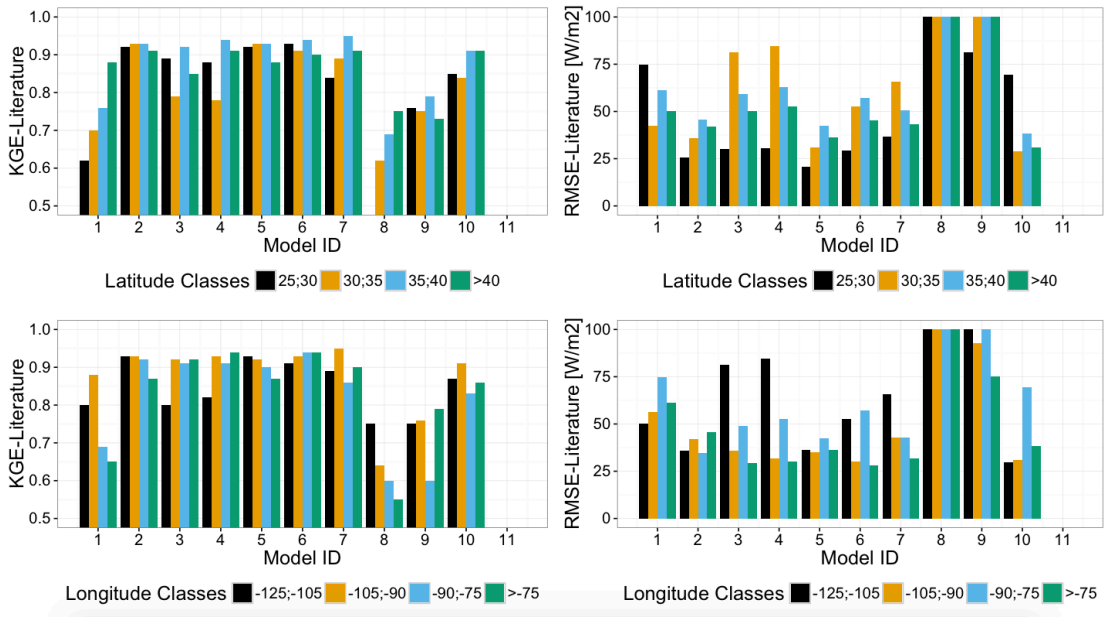
Q5) *Section 4.4: This section is really innovative and therefore its potential needs to be explored more. In practice you often don't have stations nearby, which can be used as a training set. I would like to see how a Ameriflux station in northern Alaska (Arctic) and South America (Tropics) performs with your currently used training set. Is there a specific reason you don't show the*

RMSE for this section? Which models perform best in this section?

A5) We thank the reviewer for the comment but we did not considered the two station he-her is referring to. The station in Alaska was excluded because has many no-values in the time-series of downwelling solar radiation compared to the 24 station we considered. The station in Brazil was not considered because we focused our attention in the North America.

Q6) *As I understand the red bars in Figure 8 represent the same KGE values as the bars in Figure 4. A visual test with model 1 shows a disagreement for latitude class 30;35 and 35;40! Please explain.*

A7) We agree with the reviewer comment and we checked again the script to produce Figure 4. We revised the figure and now it is coherent with Figure 8. Here you can find the new figure 4:



Q6) *Section 4.5: Did take into account the soil was snow covered for some time at some stations. Please discuss the effect of snow an your approach and how it influences your results?*

A6) We thank the reviewer for the question. The model parameterizations do not explicitly take into account of the presence of snow on the soil. We agree with the reviewer suggestion to clarify this aspect and we added the following sentence to state it when we present the models:

“Although many studies investigated the influence of snow covered area on longwave energy balance (e.g. Plüss and Ohmura, 1997; Sicart et al., 2006), the SMs do not explicitly take into account of it. As presented in König-Langlo Augstein (1994), the effect of snow could be implicitly taken into account by tuning the emissivity parameter.”

Q7) *Section 5: In the Conclusion section, I miss a focus on the actual results, i.e. the evaluation of the different site-specific parameterizations methods and the performance of the different models. For example, it is not enough to write “A broad assessment of the classic longwave radiation parameterizations clearly shows that the Idso (1981) and Brunt (1932) models are the more robust and reliable for all the test sites, confirming previous results”. First, I don’t “see” this. Please add information based on RMSE or KGE (however this should not be done in the Conclusion section). Second, add the references, which seem to confirm your results*.
A7) We added some comments on the results provided by the Idso and Brunt models, moreover we added the citation of the paper in which this results is confirmed and finally we also commented their performances with the model parameters estimated by the regression models. The new sentence is:

Minor Comments:

Q8): L1: Performance of site specific parameterizations:
A8) We revised according the reviewer suggestion. The new title is: “Performances of site specific parameterizations of longwave radiation”

Q9) L15: for L in SMs
A9) We revised according the reviewer suggestion. The new sentence is:
“to determine by automatic calibration the site-specific parameter sets for L in SMs”

Q10) L29: I guess data also!

A10) We thank the reviewer for the question, but we are not allowed to share data. We provided the website where the ameriflux data are available to download.

Q11) L44: water vapor deficit

A11) We thank the reviewer for the suggestion and we revised the sentence accordingly. The new sentence is:

“To overcome this issue, simplified models (SM), which are based on empirical or physical conceptualizations, have been developed to relate longwave radiation to atmospheric proxy data such as air temperature, water vapor deficit, and shortwave radiation”

Q12) L46: Be consistent - when using L you don’t need to add downwelling or upwelling radiation.

A12) We thank the reviewer for the suggestion. In this row we difined hour notation and we indicate the downwelling longwave radiation with the symbol $L_{\downarrow}$ and the upwelling longwave radiation with the symbol $L_{\uparrow}$. We used this notation consistently in the whole text.

Q13) L49: Instead of old references I suggest to replace it with newer ones, like doi:10.1007/s00704-012-0675-1 and doi:10.1016/j.coldregions.2013.12.004

A13) We thank the reviewer for the suggestions. We added the newest references as he/she suggested and we preferred to keep the old reference as well.

Q14) L53-54: Why show the results only for this study?

A14) We thank the reviewer for the comment. We show the results of this study because our results partially confirm them.

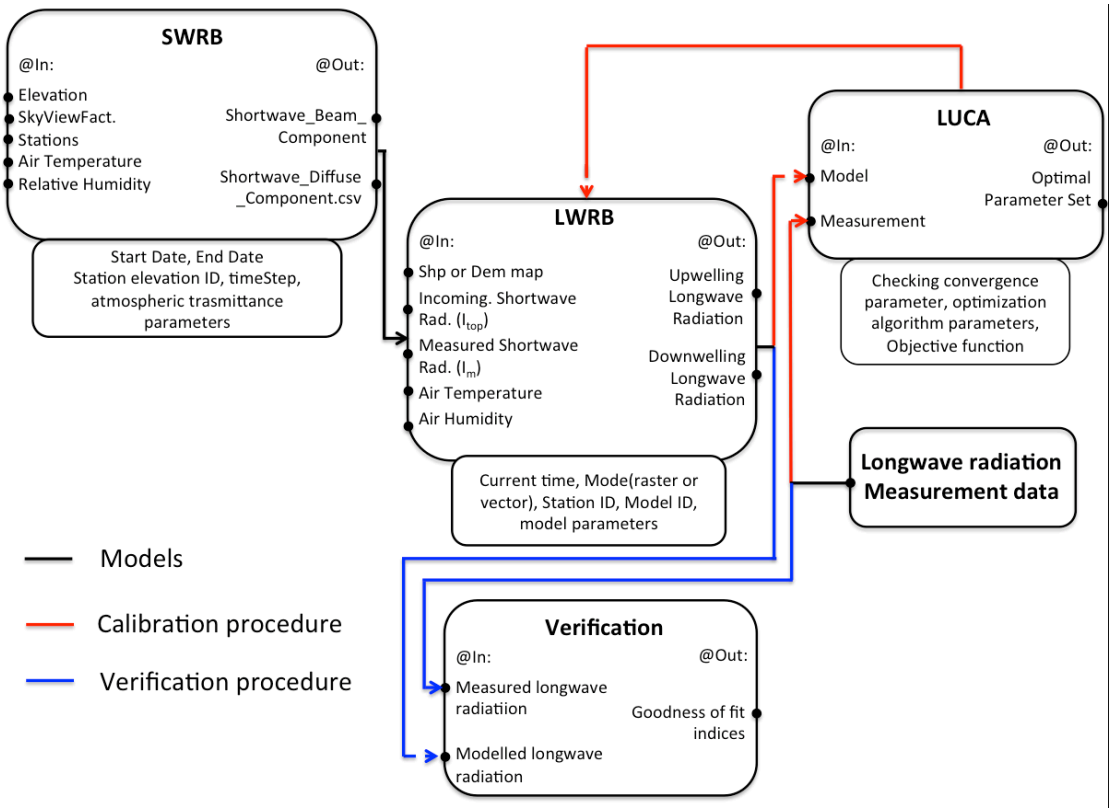
Q15) L77: Delete “near surface” or replace with “screen level”.

A15) We thank the reviewer for the suggestion and we revised accordingly,

deleting “near surface”.

Q16) Table 1: The Monteith and Unsworth (1990) is missing in the Reference section, but I guess you mean Unsworth and Monteith (1975) anyway.
A16) We thanks the reviewer for the suggestion and we added the missing citation:
“John Lennox Monteith and MH Unsworth. Principles of Environmental Physics . Butterworth-Heinemann,1990.”

Q17) L103-105: Please reformulate. I suggest to make two sentences.
A17) We thank the reviewer for the suggestion. We splitted the sentence in two and the revised sentence is:
“Is well known that surface soil temperature measurements are only available at a few measurement sites. Under the hypothesis that difference between soil and air temperatures is not too big, it is possible to simulate L↑ using the air temperature (Park et al., 2008). ”
Q18) Figure 1: “incoming Radiation” in the LWRB box is confusing. Please replace with “Incoming Shortwave Radation”.
A18) We thank the reviewer for the suggestion and we revised the figure accordingly. The new figure is presented below:



Q19) L134: Why 0.6. Did you also test other thresholds?

A19) We thank the reviewer for the comment. We tested other thresholds and the one we selected offered a good compromise in effectively detecting clear sky day and in obtaining a time series long enough to be used for calibration purpose.

Q20) L164: Could you please add some information about the used longwave instruments its measurement uncertainties.

A20) The longwave radiation is measured with Eppley Pyrgeometer and the uncertainty is ± 3 W/m2 on average. This information is valid for many stations but some of them changed instrument during the time.

Q21) L182-183: The reason is that the Konzelmann model was calibrated for the Greenland ice sheet, which has a totally different climate than you stations.

A21) We thank the reviewer for the comment and we modified the sencente according his/her suggestion:

New sentence: “Model 8 (Konzelmann et al. (1994)) does not perform very well for many of the stations likely because the model parameters were estimated for the Greenland where the ice plays a fundamental role on the energy balance.”

Q22) L225: For better understanding please link this part to the former section by changing the first sentence to: The just performed calibration procedure to estimate: : :
requires: : :
A22) We thank the reviewer for the comment and we modified the sentence according his/her suggestion:
New senetence: “The just performed calibration procedure to estimate the site specific parameters for $L\downarrow$ models requires measured downwelling longwave data.”

Q23) L232: The URL is invalid: I suggest to add this information also to the supplementary material.
A23) We thank the reviewer for the suggestion and we are going to update the link and submit the regression R script in the supplementary material.

Q25) L244: figures (8) and (9)
A25) We thank the reviewer and we revised the typo according his suggestion.

References

König-Langlo, G., & Augstein, E. (1994). Parameterization of the downward long-wave radiation at the Earth's surface in polar regions. *Meteorologische zeitschrift, NF 3, Jg. 1994, H. 6*, 343-347.

Sicart, J. E., Pomeroy, J. W., Essery, R. L. H., & Bewley, D. (2006). Incoming longwave radiation to melting snow: observations, sensitivity

and estimation in northern environments. *Hydrological processes*, *20*(17), 3697-3708.

Plüss, C., & Ohmura, A. (1997). Longwave radiation on snow-covered mountainous surfaces. *Journal of Applied Meteorology*, *36*(6), 818-824.