

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

Anonymous Referee #2

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General comments:

The study analyses the performance of 10 empirical parametrisations of incoming longwave radiation with original parameters, site-specific fitted parameters and parameters obtained from regression with average climate variables. The calibration and validation data is taken from the AmeriFlux network. Additionally, the study compares the accuracy of outgoing longwave radiation estimates using soil temperature, soil surface temperature and air temperature.

In most parts, the study repeats a similar analysis as other papers (Flerchinger et al., 2009; Juszak and Pellicciotti, 2013; Carmona et al., 2014), which is the comparison of parametrisations of incoming longwave radiation with original and fitted parameters.

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The novelty of the study arises from the site-specific estimation of the parameters using multivariate linear regression. This part is interesting for future studies which do not have longwave radiation data available. As the multivariate linear regression is the new and relevant part of the study, Section 4.4 should be elaborated more and presented in more detail. If this part is emphasised strongly, the paper may be published in HESS after major revisions.

1. The results section mixes methods, results and discussion. The methods should be moved to the methods section, the discussion should be separate and longer to incorporate (i) Which models are best at all sites and when used with parameter estimates from the regression approach? (ii) Are the regressions likely to work outside the USA? (iii) What are possible sources of uncertainty?
2. Most formulas have either not been cited correctly (Table 1 of the manuscript), or the given empirical parameters (Table 2 of the manuscript) were derived for different units of the input variables and can thus not be used with other units and without adjustment. This is a serious issue as it affects the results and conclusions. It should be corrected and all graphs need to be updated. Also some of the conclusions like "Model 8 (Konzelmann et al. (1994)) does not perform very well for some reason." (Line 182) and "Regarding the $L \downarrow$ simulations, the Brunt (1932) and Idso (1981) SMs, in their literature formulations, provide the best performances in many of the sites." (Abstract) may be wrong.
3. Some of the cited literature does not appear in the references.
4. c is used for the clearness index and the cloud cover fraction. Please rename one of them and write the equation to convert them.
5. State in more detail the results of the parameter estimate by regression and provide the formula for the best model including average parameters.

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Specific comments:

Abstract The study described in the manuscript is largely independent of the hydrological model JGrass-NewAge. The authors do not present any results concerning hydrology. Thus, this model should not be central in the first sentences of the abstract.

L13–15 These are really 3 points: (i) original formulation, (ii) site specific calibration, and (iii) parameter estimation based on average site characteristics

L16 Name all variables instead of 'such as'

L21–23 This conclusion may change with correct model formulation. The relative performance of the models should be discussed in more detail in a discussion section.

L29 Remove this sentence.

L31 3 – 100 μ m (1 is still shortwave radiation (Oke, 1987))

L34 Remove 'very expensive', that is relative

L58–59 I do not agree with this major advantage of the current study as compared to the former studies. The empirical formulations of longwave radiation are very simple equations that can be included easily in any model without the need of an open-source tool. Instead, the authors could refer to their parameter estimation approach: 'However, none of the above studies have developed a method to estimate the parameters for any location based on basic site characteristics and ready for practical use by other researchers and practitioners.' More sentences on the added value of this study are needed. What are the research questions?

L68–74 Paragraph not needed

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L77 the 'k' of 'kg' should be lower-case; it would be more intuitive to provide the unit $\text{W m}^{-2} \text{K}^{-4}$ as L is given in W m^{-2}

eq. 3 It should be noted that this equation was proposed by Bolz (1949), and that there are other options that potentially work better (Flerchinger et al., 2009; Juszak and Pellicciotti, 2013). The authors should consider using Unsworth and Monteith (1975), which was recommended in both studies.

L81 c is not the clearness index but the cloud cover fraction (as in line 84)

L87 Related how? Provide equation!

Table 1 I have doubts that all formulas in Table 1 are correct and that the parameters in Table 2 have been adjusted to the units of water vapour pressure (and in some cases radiation). I suggest you check Juszak and Pellicciotti (2013) for adjusted parameters. More specifically please consider:

- Angstrom [1918] does not appear in the reference list. Please provide the correct reference and check the original publication or cite the paper you took the parameters from. Did you adjust the original parameters to match the units in which you computed the radiation and inserted humidity and temperature? I have doubts in the Angstrom case where one original publication computes the radiation in $\text{cal cm}^{-2} \text{min}^{-1}$ (Ångström, 1916). Ångström (1916) also uses e^{Ze} instead of 10^{Ze} .
- Brunt (1932) uses water vapour pressure in millibar not kPa. Did you adjust the parameter Y?
- Swinbank (1963) is clearly used wrongly. The parameters provided in Table 2 do not refer to the clear sky emissivity but to a formula that computes the radiation directly (without $\sigma \cdot T^4$), and in mW cm^{-2} .
- Brutsaert (1975) uses water vapour pressure in millibar not kPa. Please adjust the parameters X and Y.

- Monteith and Unsworth [1990] does not appear in the literature list. Please double-check the formula and parameters and provide the correct citation.
- Konzelmann et al. (1994) uses water vapour pressure in Pa not kPa. Please adjust the parameters X and Y.
- Dilley and O'Brien (1998) uses the given formula (Table 1) with the parameters (Table 2) to directly compute the longwave flux, not the emissivity. To get the emissivity, the formula has to be divided by $\sigma \cdot T^4$

Use round brackets for the reference year as in the rest of the manuscript.

L116 No one-sentence paragraph, this sentence can be removed.

Figure 1 How do I_m and I_{top} fit into this schematic? Only those variables are explained later in the text. The 'Modelled longwave radiation' and 'Measured longwave radiation' items in the Verification box are wrongly connected. Is the SWBR always modelled? Does that affect the optimisation process?

L134 Did you try different thresholds? 0.6 seems quite low. Did you verify that you do not include cloudy or partly cloudy observations in the clear sky calibration? If you calibrate ϵ_{clear} at $c = 0.6$, $\epsilon_{all-sky}$ at that condition will be wrong as you compute it from $\epsilon_{all-sky} = \epsilon_{clear} \cdot (1 + a \cdot c^b)$ and $c \neq 0$.

L143–144 Please provide all variables (not 'such as'); altitude is not a climatic variable.

L156 What is N ?

L161–162 Sentence not relevant, remove it.

L166–168 There is also a gradient towards the colder climate. Why did you choose these 24 stations and not all stations?

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Figure 2 Use same index for stations as in Table 4 and make the index bigger so it is readable.

Table 4 How was the climate defined? 'mild' and 'strongly seasonal' do not match the classic categories.

Section 4.1 Update section with correct model implementation and parameters.

Figure 3 Name models in the caption

Figures 4–6, 8–9 Use boxplots instead of barplots to show the variability within the groups and the range of variation. Reorganise the content to have only two Figures: one for clear sky and one for all sky. In both figures, boxes for results of (i) original parameters, (ii) fitted parameters, and (iii) parameters from regression analysis should be next to each other to enable direct comparison. The figures can be arranged in subplots either one per model, or one per latitude / longitude class. Please choose colours that allow black+white printing and consider colour-blind people.

Section 4.2 Update section with correct model implementation and original parameters.

L201–202 This should be moved and discussed in more detail in a discussion section.

L213 Time series from which station? Was the analysis done for all stations?

L206–214 This belongs to the methods section.

Figure 7 Given the methods description, why is the peak not always in the middle of the parameter range? Caption: 'of' is missing an 'f'; describe the meaning of the boxes and the line!

L225–243 This belongs to the methods section.

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Equation 8 Do not use 'a' as it is used for something else in Equation 4

L244–250 Compare also with fitted parameters.

Section 4.4 Update section with correct model implementation and original parameters.

L267–269 This should be moved and discussed in more detail in a discussion section.
How about snow cover? How about the different latitudes?

Conclusions Update section with correct model implementation and original parameters.

Supplementary material Please use the same station IDs as in the manuscript. Please include the detailed results of the parameter regression.

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Technical corrections:

L12 24 instead of twenty-four

L36 put references in brackets

L40 put references in brackets

L51 'They' instead of 'It'

L52 remove 'so'

L64 put reference in brackets

Table 1 caption: units not in italics

L101 space missing before reference

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L104 put references in brackets

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L106 replace ‘;’ with ‘,’

L122 remove brackets from reference

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L158 24 instead of twenty-four

L165 24 instead of twenty-four

L178 1:1 instead of 45 degree

L219 ‘around the’ instead of ‘about’

L231 ‘supplementary’ instead of ‘complementary’

L244 Figure 10 shows something else

L275 24 instead of twenty-four

L284 24 instead of twenty-four

L303 Reformulate ‘In order that’

References

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