

## ***Interactive comment on “Spatial pattern evaluation of a calibrated national hydrological model – a remote sensing based diagnostic approach” by Gorka Mendiguren et al.***

**Anonymous Referee #2**

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Major comments:

Mendiguren et al. studied the importance for a hydrological model simulation to reproduce similar spatial patterns as those of remote sensing data. Their modified version of the DK-model provides a simulated evaporation result that has more similar spatial features found in the remote sensing based ET. Generally, I read the paper with great interest. The paper fits very well within the stated scope of journal. I consider that the evaluation of spatial patterns of model simulation result is still quite novel and rarely done in common hydrological model practices. However, there are still some major issues to be addressed before this manuscript is being accepted for publication.

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The authors present an improved model in which remote sensing derived data were used for parameterizing vegetation parameters. They claim that the improved model provides better results as it has more similar spatial patterns as those of remote sensing data. However, it seems that the benchmarking of simulation results is limited to the evaporation flux only (especially its spatial pattern). I suggest performing more evaluation and comparison to the ‘original’ and ‘improved’ model simulation results, particularly to their discharge and groundwater head results.

In addition, I feel that the presentation, writing and structure of the paper must be upgraded. Often, there is no clear gap/interval between paragraphs. There are paragraphs and sentences do not flow with their previous ones. These make the paper difficult to read and understand in quite a lot of places. Moreover, in the Introduction section, I hardly find any sentences related to the actual or the main objective of the study (which is to evaluate spatial patterns of a model simulation result?). I also think that the presentation and structuring of the Methods section must be improved. Furthermore, I recommend to have separated sections of Results and Discussion. Please also see some suggestions in the following minor comments.

Minor comments:

Page 1, lines 13-15: “The main hypothesis of the study is . . . .” I suggest rephrasing this sentence. Moreover, I could not find this hypothesis in the Introduction section.

Page 1, lines 26-28: Using your modified version of the DK-model, did you get any improvements on your discharge and groundwater head simulation results?

Page 2, lines 21-24: I suggest including some references about the applications of using satellite data for assessing groundwater as well (e.g. Rodell et al., 2009, <http://dx.doi.org/10.1038/nature08238>; Sutanudjaja et al., 2013, <https://doi.org/10.1016/j.rse.2013.07.022>; Richey et al., 2015, <http://dx.doi.org/10.1002/2015WR017349>). I guess that they are relevant for your study as you use the DK-model that simulates groundwater head dynamics. I am also

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curious how the improvement that you introduced (based on remote sensing data) affects groundwater head simulation.

Page 3, lines 1-3: Could you please elaborate more with what you meant by the “eminent risk” here? Some references will be helpful.

Page 3, lines 14-16: Could you please elaborate more with what you meant by the “diagnostic approach”?

Page 3, lines 26-27: Neglecting biases/differences in the absolute values is a quite brave assumption. Could you please provide some justification behind it? Why?

Page 3, line 30: This should be “Sections 2.2 and 2.3”.

Section 3: Please consider to reorganize the structure (sub-sections) of Section 2. I found that it is quite difficult to understand and follow the sequence of each step of your methods.

Page 4, lines 10-11: You have discharge and groundwater head measurement data. Could you please evaluate the results of your improved model to these data?

Page 4, line 19: “TSEB can successfully be applied with a single LST observation, . . . .” This sentence is not clear for me. What do you mean by “single LST observation”?

Equation 1: Please put the reference to this equation. Moreover, it will be very helpful if you include the unit or the dimension for every variable. Example: NDVI [-]; LAI [-]; VH [unit: m]

Page 5, line 1: “. . . MODIS band number.” Please be more specific with these “band numbers”.

Equations 2 and 3: Please put the reference to these equations (e.g. as you introduced the reference for Equation 4).

Page 5, line 10: Please include the dimension/unit for the parameters alpha and beta.

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I guess they are dimensionless.

Page 5, line 18: This sentence does not flow well with the ones before it.

Page 5, line 21: Could you please elaborate more with what you meant by the “highest quality pixels”?

Page 5, line 27: I miss the explanation why you have to calculate “Fraction of Green”? For what purpose?

Page 5, line 27 to Page 6, line 9: Please rewrite this part. I hardly follow it. And can you please justify this assumption to the reality?

Page 6, line 10: This sentence does not flow well with the ones before it.

Equations 7 and 8: What is the difference between “Net Radiation” and “netRad”. If they are the same, please be consistent with your variable names. Please also include the dimension/unit.

Page 6, lines 22-23: I hardly understand this sentence.

Page 6, lines 24-32: “Data from three eddy covariance (EC) flux towers is used as a reference to perform a sensitivity analysis and calibration of some of the vegetation parameters of the TSEB.” I guess that the methods for sensitivity analysis and calibration are given in the Section 2.4? Please consider to reorganize Section 2 so that all your method steps are presented in a logical sequence.

Section 2.3: It makes more sense to put this Section 2.3 directly after Section 2.1.

Page 7, lines 8-9, Equation 9: Why did you have to substitute LAI with NDVI?

Equations 11 and 12: Please put some references.

Page 8, line 1: “. . . perturbation with respect to a change in model performance.” What is your model performance objective function? RMSE? NSE? KGE?

Page 8, line 5: How did you choose these four parameters?

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Equation 13: What is the best value of SEOF? 0? Please clarify.

Section 3: I recommend to have separated sections for Results and Discussion.

Section 3.1: Sensitivity analysis: Can you please explain more about how you perturb your model input data? What is their range for the maximum and minimum values of each variable?

Page 8, line 14: How did you choose these four parameters? Based on your sensitivity analysis (Fig. 3)? How?

Section 3.1: TSEB calibration: How realistic is your calibrated TSEB result map (including its spatial pattern)? Did you compare it to other studies (e.g. to MODIS, GLEAM, etc.)?

Figures 5, 6 and 7: Please use the same and consistent legend (color and values) for all figures so that they can easily be compared.

Page 9, lines 25-28: "The main aim of TSEB . . ." It seems that the sentences do not flow with their previous ones.

Figure 8: How did you normalize all three maps? What was the motivation to normalize these three maps?

Figure 10: Please improve the caption for Fig. 10. What does the color mean here?

Page 10, line 16: MIKE-SHE = DK-model?

Page 11, lines 1-15: Please rephrase the sentences in these lines. This seems a very important finding in your result. I guess that this result appears very dependent on your choice to use Equation 11 (Page 7, line 19). I am wondering how you derive this equation, particularly their factor 12 and constant 0.2? Can we implement this equation for other study areas, e.g. to other climate regions (e.g. tropical areas).

Page 12, line 27 to Page 13, line 16: I suggest starting a new subsection for this part.

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Others:

Figure 1: For the figure on the right, what do the numbers (1 to 6) stand for?

Figure 2: Please indicate the pixel (row 100, column 84) in Fig. 1.

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