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Hydrology and Earth System Sciences Discussions

Interactive comment on "A Bayesian approach to estimate sensible and latent heat over vegetation" *by* C. van der Tol et al.

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Both reviewers acknowledge the importance of our paper, but also highlight a number of shortcomings. These shortcomings all relate to the presentation of the work, especially the description of the methodology and the discussion of the results.

The reviewers pointed out that we had not presented the methodology in an entirely clear and unambiguous way. This is a relevant comment. We think the method is useful for a wider audience. We show that for three different land cover types (a vineyard, a maize crop and a forest) in two different climates, the Bayesian approach gives better estimates of sensible and latent heat flux than traditional methods. The method can easily be implemented and used in many applications. We realise that the Bayesian approach is not (yet) commonly applied in hydrology, and that a clear presentation is

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necessary. For this reason we have revised the paper and rewritten major parts of the text, in particular to better explain the methods used. The general message and most of the specific comments of the reviewers have been very helpful.

The reviewers did not comment on specific parts of the methodology or of the results. Hence, we have not revised the model nor did we reconsider the data that were used.

Response to specific comments of Reviewer 1:

"My major comments are:

- The major problem with the paper is that it is written rather sloppily. When reading the paper, I get the impression that the writing has been done in a rush, to get the paper written by a deadline. - For example, the introduction immediately starts by referring to equations 1, 2, and 3,which are explained in a later section. This does not read easy and should be rewritten."

We have removed all references to equations from the introduction section.

"- Page 2339, line 24-25: In the paper by Reichle, soil moisture is not retrieved from microwave remote sensing. In this paper, a synthetic experiment is performed, in which modeled soil moisture is converted into brightness temperature using a radiative transfer model. These are then used in a synthetic data assimilation study. This should be corrected."

The paper by Reichle indeed concerns synthetic data instead of measured data. We have corrected this. We have also included an explanation of the concepts of the Bayesian approach in the introduction section.

"- Page 2341, line 14-19: I do not agree with the statement that there are seven unknowns in the Penman equation. Besides the conductances, all variables in this equation are usually measured. Either I understand it wrong, or this should be further explained. - In general, the explanation on the Bayesian approach is rather unclear. For somebody (like me) who has not yet applied this, this is very difficult to understand.

HESSD

6, C656–C661, 2009

Please provide more explanation."

We agree with the reviewer's comment. We have now included a better description of the Bayesian approach in Sect. 2.3. In this section we explain, for example, why all variables in the energy balance are considered as unknowns.

"Minor comments:

- Abstract, line 4-5: weather stations on the ground. Please rephrase." Done

"- Page 2344, line 1: does "squiggly" mean a tilde? This also comes back on page 345, line 23." The squiggly symbol is the tilde above a variable. In the revised version, we explain that the tilde $\sim$ is used to indicate an a priori value, whereas the $\hat{}$ is used to indicate a posterior value.

"- Page 2346, line 16: What is a "contact temperature" ?" We have rephrased this. For this site, surface temperature was measured with small Negative Temperature Coefficient termistors (NTC) attached to needles (referred to as 'contact temperatures' in this paper).

Response to specific comments of Reviewer 2:

"General comments This paper uses Bayesian approach over vegetation to derive land surface energy budget quantities (sensible and latent heat flux). For each comparison time, the remote sensing derived quantities are compared to point surface in situ observations of the energy fluxes. The paper then claims that the level of agreement between the two methods is adequate to support the notion that the ASTER data can be used to derive these quantities in this region. "

We do not mention ASTER data in the paper. This paper only deals with data from field campaigns: Barrax, the Sonning experiment and Eagle.

"The paper is lacking in depth and detail as to the methodology used and depends on numerous references with little explanation as to the applicability of the reference.

HESSD

6, C656–C661, 2009

There is no background given by which to judge as to whether the level of agreement is adequate for advancing the state of knowledge. It is suggested that more background material and information on specific methodology be provided."

Similarly to Reviewer 1, the reviewer points out that more explanation is needed about the methodology. In the revised manuscript, we focus on explaining the Bayesian approach in more detail, as well as the methodology that we have chosen.

"Despite some of the above drawbacks, this paper does demonstrate that reasonable results were obtained for a limited number of cases thereby giving additional credibility to a methodology and capability of the research team. That capability and methodology could be made even more credible if more information is given against which these results could be evaluated. For Bayesian approach over a vegetation to get the information of sensible and latent heat flux is a valuable work for land surface energy budget and therefore the subject of the paper is worth to be published."

"Specific comments The title: “A Bayesian approach to estimate sensible and latent heat over vegetation” change to“A Bayesian approach to estimate sensible and latent heat fluxes over the vegetation area”"

We have changed the title into: “A Bayesian approach to estimate sensible and latent heat over vegetated land surface”, because the method should also work for a partially vegetated surface.

"Page 2338, line 11: First paragraph - It is shown that the Bayesian approach yields more accurate estimates of sensible and latent heat flux than traditional methods. Why more accurate estimates?"

See our response to Page 2340, line 2, below

"Page 2338, line 15: “the Earth’s surface energy balance” is “the land surface energy balance”" This has been corrected

"Page 2339, line 1: Only SU? Please add some references." We have added two more

HESSD

6, C656–C661, 2009

references

"Page 2339, line 14: the sentence “Aerodynamic and surface resistances are particularly difficult to estimate” have to change following:” It is difficult to estimate the aerodynamic and surface resistances” Pay attention to the English expression."

We do not understand this comment. We think that the sentence was out of place in the introduction. In the revised version of the manuscript, we have moved the sentence to Sect. 2.1, where we explain the energy balance.

"Page 2340, line 2: Your mentioned improve estimates of sensible and latent heat. But from the fig. 3, 4 and 5, I do not find the good results. How to say improve?"

Figures 3, 4 and 5 show that the lowest root mean square error is consistently found for the Bayesian approach. In other words, the Bayesian approach is better than the other two approaches. We do not claim that the results are perfect, only that they improve when we apply the Bayesian approach. One can obtain much better results by calibrating the model against (part of) the measurements, but this is exactly what we want to avoid. The flux data are available because we work with data from field campaigns. However, in many applications, in particular those making ample use of remote sensing products, these data are not available. Therefore, in this paper we are trying to ascertain, whether we can predict the fluxes if we do not have flux measurements. The conclusion is that the best results are obtained with the Bayesian method. In the revised manuscript, we phrase this more clearly.

"Page 2340, line 17:Where do you get the energy balance equation? Add the reference." Done

"Page 2340, line 18: Delete the “received by the surface”" Done

"Page 2352: The results part. This part need the refined statement. It looks too long to express your main points." We have rewritten this section, to stress the main conclusions. Especially the part about night time fluxes was too long.

HESSD

6, C656–C661, 2009

"Figures: Unified coordinate system. For example in fig 3, x and y, you have to use same scale. If x=300, then y=300. Please mark them." The scales have already been the same; this can be seen from the diagonal 1:1 lines. Only the ticks at the y-axis had 100 Wm-2 intervals, whereas the ticks at the x-axis had 200 Wm-2 intervals for reasons of legibility. In the revised version, we consistently use ticks at intervals of 100 W m-2.

"The overall quality of the English is not quite good enough. Please have it looked over by a native speaker." There are near-native English speakers among the authors, who have gone through it again, and made some amendments. However, we cannot find any sections where the English could in any way have caused the reader to misunderstand the theory, methodology or the interpretation of the results.

Christiaan van der Tol and Anne Verhoef, on behalf of all authors

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 2337, 2009.