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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainties in using remote sensing for water use determination: a case study in a heterogeneous study area in South Africa" *by* L. A. Gibson et al.

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We would like to thank the reviewer for the helpful comments and suggestions. We plan to improve this paper by expanding our introduction in order to state our objectives more clearly and to better place our work within the frame of the literature. We also plan to expand the section on heterogeneity in the revised paper.

Reviewer 2 Comment:

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Interactive Discussion

Discussion Paper

To my opinion, only a small selection of parameters was identified that contribute to the uncertainty of ET (evapotranspiration) computations and no real uncertainty analysis was made using for instance error propagation or Monte Carlo (MC) simulations. You have sensitivity of the model for errors in the estimation of remotely sensed variables such as LST, albedo, NDVI, etc. In addition there is the uncertainty in auxiliary data such as met data, topography, heterogeneity in the area, etc and its mutual interaction among the different variables. This is something that can be identified with a MC approach.

We reply:

We agree with the reviewer that only a small selection of parameters and the effect of uncertainties in these parameters on SEBS-estimated ET was shown in this paper and Monte Carlo simulations would be very useful. However, the intention of this paper was not to exhaustively describe all possible uncertainties or to unpack the SEBS model to display the effect and propagation of uncertainties in ALL parameters (or combinations of parameters) through the SEBS model in the derivation of ET. We wished to highlight those parameters over which the user has some control when using the prepackaged version of SEBS in Ilwis and therefore chose to highlight these.

Reviewer 2 Comment:

I also miss in the introduction the larger frame (reference to literature) on model parameter uncertainty identification (for instance Beven 2006, J. Hydrology) and there is a vast lack of situating the results presented by the authors in the large frame of literature. So I would urge the authors that they put their results in a wider perspective and include some analysis and paragraphs on error retrieval of the model and then zoom in to the results presented in this version of the manuscript. They should at least extend their discussion paragraph.

We reply:

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We agree that we should place this paper better in the context of current literature bearing in mind the objective of the paper which we think was not adequately stated in the introduction. We would like to keep the focus on the SEBS model. In the revised paper we will better formulate our objectives and we will specifically report on where our paper is placed in the literature and will tie this in to our discussion paragraph.

Reviewer 2 Comment:

I would use a more specific title, telling the reader what the paper is really about. This title is to general. Consider next suggestion "Identifying uncertainties in the derivation of evapotranspiration using the SEBS model: a case study in a heterogeneous study area in South Africa.

We reply:

We agree that perhaps the title should change but would suggest "Particular uncertainties encountered in using a prepackaged SEBS model to derive evapotranspiration in a heterogeneous study area in South Africa" as this is more in line with our paper's objectives.

Reviewer 2 Comment:

Some minor things: - Line 10, p6584: "The calculation of ET revealed that the total annual ET calculated using the Surface Energy Balance System (SEBS) model for the study area exceeded the total rainfall for the same area and time period". It is not complementally un-logical in the case that irrigation practice occurs (using water from other and remote parts of the country or deep groundwater).

We reply:

We will expand on this in the introduction section.

Reviewer 2 Comment:

- Line 5, p6588: which products of MODIS are used in this text?

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We reply:

MOD02 and MYD02 refers to MODIS level 1B data (digital numbers). As suggested by reviewer 4, the MODIS and Meteosat SEVERI data products used should have formal citations, brief descriptions and product version numbers to make their content and origin clear.

Reviewer 2 Comment:

- Line 22 p6590: “It can therefore be said that the sensitivity of daily ET to É(T0ôĂĂĂTa) is dependent on the land cover being studied and may also be dependent on the calculated (T0ôĂĂĂTa) itself.” Perhaps more fundamental also on the pixel size (MODIS vs MSG)?

We reply:

We agree and this will therefore be exacerbated in a heterogeneous area. In the revised paper we may tie this into the number of land cover classes present in a MODIS pixel in the discussion section.

Reviewer 2 Comment:

- Equation 2, p6592: how is the quadratic function justified?

We reply:

This is the equation that is used in the SEBS model motivated by Sobrino & El Karraz (2003) from work done by Carlson & Ripley (1997)

Reviewer 2 Comment:

Where are the explanations of variables used in Equation 3? This equation is just one approach of calculating soil heat flux (cfr Basstiaanssen et al, 1998, J Hydrology).

We reply:

It was an oversight to not include the explanations and these will be included in the

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revised paper. We are aware that it is not the only method to estimate soil heat flux; however, it is the method used in the prepackaged SEBS model (Ilwis version) and since when using the prepackaged version, this is the formula used.

Reviewer 2 Comment:

- Line 20, p6591: "At AQUA overpass, when the soil of the field validation site is shaded, there is a much better agreement between field validation (approximately 3–15% of net radiation) and the SEBS results (approximately 5% of net radiation) for soil heat flux." Why is that? Because shadow may create a false idea of the pixel being covered by vegetation? In other word, the model acts as if this pixel is composed of vegetation? Suggestions?

We reply:

Yes, we believe this is the case and will add it to the revised text.

Reviewer 2 Comment:

Line 1, p6593: The question remains then how much vegetation cover affects the ET outcome of the model? Is this sentence "Fractional 5 vegetation cover is calculated outside of SEBS and care should be taken in the choice of formula as the variation in ET as a function of fc has been demonstrated" not forcing an open door?

We reply:

We believe that Figure 4 and text on line 25 Pg 6592 demonstrates this. Since the fractional vegetation cover formula is one of the choices the user of the prepackaged SEBS in Ilwis has, we think it is worth highlighting the effect the choice of formula had in our particular study area. Although it is not mentioned in the paper (and it can be included in the revised paper), the fractional vegetation cover may also be used to weight roughness length literature values (Su, 2002) and then used as an input into the SEBS model. Since we did not use roughness length from the literature and rather used the empirically derived formulations for aerodynamic parameters, the impact of

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this was not measured here.

Reviewer 2 Comment:

Also the sentence “The uncertainty in the calculation of the sensible heat flux introduced by uncertainties in displacement height and the height of wind speed measurement should be carefully considered and addressed since errors in the calculation of the sensible heat flux will be propagated through the model and eventually influence the final ET calculation.” on Line 20p6594? How large are the errors one can expect?

We reply:

We would like to change this sentence to “The uncertainty in the calculation of the sensible heat flux introduced when the displacement height approaches the height of wind speed measurement should be carefully considered and addressed since errors in the calculation of the sensible heat flux will be propagated through the model and eventually influence the final ET calculation as demonstrated in this study, in Figure 5. “ In addition, the sensitivity of sensible heat flux to d0 will be shown on Figure 5 and will be included in the text.

Reviewer 2 Comment:

- Check the manuscript to be sure that numbers and units are separated with a white space (cfr line 4, p6594); - Avoid the multiple use of the word “opportunity” in l25p6596, 13p6597, 18p6597. - References cited in the text should be ordered chronological and then alphabetical.

We reply:

These editorial changes are noted.

Reviewer 2 Comment:

- I can recommend next paper of Verstraeten et al. (2008) in Sensors since it reviews some methods for retrieving ET and soil moisture at different observation scales and

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also includes a small discussing on error analysis and uncertainty. It probably gives you some other references that you can consult and/or cite.

We reply:

Thank you.

Reviewer 2 Comment:

- So as to conclude: what kind of specific (not general) advice can you give readers when they want to use SEBS with respect to errors and uncertainty?

We reply:

We have reported on the sensitivities of SEBS-estimated daily evapotranspiration to various parameters for our particular study area and shown how daily evapotranspiration estimates fluctuate as a result of these uncertainties. We would not like to make generalizations regarding the magnitude of errors produced by uncertainties in the input data, as the dependence on study area and the interaction of various input parameters in the model was not the objective of this study. However, users should consider which input parameters can be calculated outside of the prepackaged version of SEBS and a decision as to which is the most appropriate methodology should be taken.

We would like to conclude by offering the users of the prepackaged version of SEBS in Ilwis the following advice: 1) Since SEBS is sensitive to the T0-Ta gradient, care should be taken when estimating T0 in a topographically diverse area as retrievals are less accurate in this setting. In particular, SEBS should not be used in mountainous areas with coarse resolution sensors since the heterogeneity of the LST cannot be captured at the appropriate scale (note that this will be shown in the revised paper under the added heterogeneity section). 2) Care should be taken when selecting a fractional vegetation cover formula as this should be appropriate for the study area, especially if NDVI min and max values need to be defined. In particular, it is advised that if a LAI product is available at the appropriate scale, that it be used to estimate fractional vegetation

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cover according to the formula by Choudhary (1987). In addition, the accurate retrieval of fractional vegetation cover may be more critical if it is also used to weight literature values of roughness height. 3) The reference height of the weather station should be considered in relation to the canopy height of the study area. In an area where field crops with a low canopy height predominate, the use of an agrometeorological weather station is appropriate. However, where tree crops and natural vegetation with a canopy height exceeding 2.7m are found, weather stations which measure wind speed at 10 m are appropriate. 4) The scale at which the evapotranspiration results are required must be considered in relation to the choice of sensor and therefore pixel resolution and the heterogeneity of the study area. When working at a catchment scale a coarse resolution sensor may be appropriate, as reported by McCabe and Wood (2006). However, for farm or field scale results a higher pixel resolution will be required to detect inter-field or inter-farm variations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 6581, 2010.