

***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.***

L. A. Gibson et al.

gibsonl@arc.agric.za

Received and published: 24 November 2010

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 1 Comment: In the methodology section 1) Here you describe the methodol-

C3616

ogy of SEBS. In the text you only deal with the input parameters needed by SEBS to calculate the latent heat. However how one calculates the daily evapotranspiration from that is not mentioned, and should be elaborated. Especially because the algorithms provide a high degree of uncertainty because most of the equations are not physically based.

We reply: We will expand this to show how the instantaneous evaporative fraction is obtained from the simplified energy balance equation and how this is then upscaled to a daily ET value. However, we will not reproduce all the formulae required to do this but will provide the references to them, particularly since these have been previously published in this journal. Particular reference will be made to Su (2002) where the original formulae were published and to Jia et al (2009) where the upscaling of evaporative fraction to daily ET is shown.

Reviewer 1 Comment: In the land surface and air temperature gradient section 2a) You use daily evapotranspiration [mm] instead of latent heat [W/m²]. However in the calculation for the daily evapotranspiration also air temperature is used to calculate the incoming solar radiation. This is not made clear.

We reply: We purposely choose to show daily evapotranspiration in mm instead of representing it as the latent heat in W.m⁻². We want to illustrate how some uncertainties in input data can impact on the estimation of water use and this is best achieved by referring to the daily evapotranspiration result rather than to the energy partitioning results.

The hourly air temperature is used in the calculation of the instantaneous sensible heat flux and therefore in the instantaneous evaporative fraction estimate. Daily average air temperature is used in the upscaling of instantaneous evaporative fraction to daily evapotranspiration. We will make it clear that we are referring to the hourly air temperature in this section. Sensitivity to daily average air temperature could be tested separately.

C3617

Reviewer 1 Comment: 2b) You speak of a 10K retrieval difference between MODIS and MSG. This difference is later used as input for your sensitivity analysis. However the difference between retrievals of other land surface parameters (like emissivity and LAI) is not employed here. You therefore use the difference between 2 different satellite sensors to perform a 1 satellite sensor sensitivity analysis. Please elaborate on this here.

We reply: The alternative sensor was merely used to illustrate the large uncertainty in LST estimation in a heterogeneous environment. Yes, LST will be sensitive to emissivity and other parameters that are used in the split window algorithm that SEBS in Ilwis uses to retrieve LST; however, the purpose of the research is not to determine LST uncertainties but look at what possible uncertainty ranges may be in this environment and assess the impact of this uncertainty on final ET estimation. Therefore the use of a second sensor's LST data was to try to set a realistic uncertainty range in LST in this particular heterogeneous environment and should not be interpreted more deeply than this.

Reviewer 1 Comment: In the Fractional vegetation cover 3) I completely agree with your end result that it is better to use LAI instead of Fc. (mostly because fc saturates well before the ground heat flux comes to an equilibrium. Have you compared ground heat/net radiation measurements for different LAI/fc values?

We reply: No, we did not do this. Given the complexity of the SEBS model, there are many different input parameters and combinations of parameters that could be used in a sensitivity analysis. We plan to expand our introduction to provide better motivation for why we choose to highlight the parameters which we did in this paper. This paper is by no means meant to address every possible sensitivity in the SEBS model and we will make better reference to previous studies in our introductory section particularly to the study by Van der Kwas et al (2009) since this deals with, in particular, arguably the parameter to which SEBS is most sensitive, that is roughness length which we do not deal with in this paper.

C3618

Reviewer 1 Comment: Displacement height 4) In the second last paragraph (p6594) you speak of a maximum vegetation of 2.7 when one has a 2m reference height. However I could not deduct this from the text. I would find it strange in this light that this is concluded when your figure shows that for a displacement height higher than 1.8 you find an instability. Especially as the displacement height is always higher then the vegetation height. Also the effect of LAI in this calculation is not shown. Especially because the LAI has a great effect on the wind speed extinction coefficient and consequently the displacement height.

We reply: We disagree that with your statement that “displacement height is always higher than the vegetation height”. According to Brutsaert (1982) on page 116, a number of studies are reported on where the relationship between displacement height (d_0) and canopy height (h_0) is given. The ratio (d_0/h_0) reported on varies from 0.53 to 0.83 with $d_0 = 2/3 \cdot h_0$ being regarded as representative for natural crop covered surfaces. It is possible, according to Brutsaert (1982), for d_0/h_0 to approach unity for very densely placed objects; however, we find no reference to displacement height being reported as being higher than canopy height. SEBS uses the formula $d_0 = 2/3 \cdot h_0$. For clarity, we intend to include the formulation of roughness length, canopy height and displacement height from NDVI and NDVI max in the revised paper. From these formulae it will be apparent how a d_0 of 1.8 equates to a maximum vegetation height of 2.7m since $h_0 = 3/2 \cdot d_0$.

While it is acknowledged that LAI and wind speed extinction coefficient also play a role in this calculation, we would like to state that the main objective of this section was to point out that the type of weather station and the reference height at which wind speed is measured is critical to the correct implementation of the SEBS model (in tall canopies), particularly since we do not find explicit reference to this in other SEBS publications. We make the assumption that some users accessing the prepackaged version of SEBS in Ilwis may not have necessary prior micrometeorological knowledge to realize the importance of the reference height; and we think this should be explicitly

C3619

stated in a publication regarding the use of the SEBS model. We will try to make this clearer in the revised paper.

Reviewer 1 Comment: Heterogeneity of the study area. 5) Figure 7 and the corresponding text are not clear to me. Partly this is because you do not provide the land cover resolution in km for this land cover map. Hence it is not clear to me if you have used multiple MODIS pixels per class, or multiple classes within a single MODIS pixel. Also please define what you mean by mixed pixel effect.

We reply: Please refer to Pg 6595-In 5 where we state that land cover was mapped at 1: 50 000 scale. We will add that the land cover dataset used is the South African National Landcover (ARC-ISCW, 2006) and was mapped from Landsat imagery. We used multiple land cover classes within a single MODIS pixel we will clarify this as well as the mixed pixel effect in the revised paper.

6) Also in the other sections you have provided the sensitivity of the uncertainty in the retrieval and the progression of this retrieval in the daily ET. This is what I miss from the last section.

We reply: We agree that this is lacking. We will demonstrate the sensitivity of spatial resolution in SEBS by comparing SEBS-derived ET from MODIS to SEBS-derived ET from ASTER (Figure 1) for a single date for the two sites shown in the T0-Ta section.

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

C3620

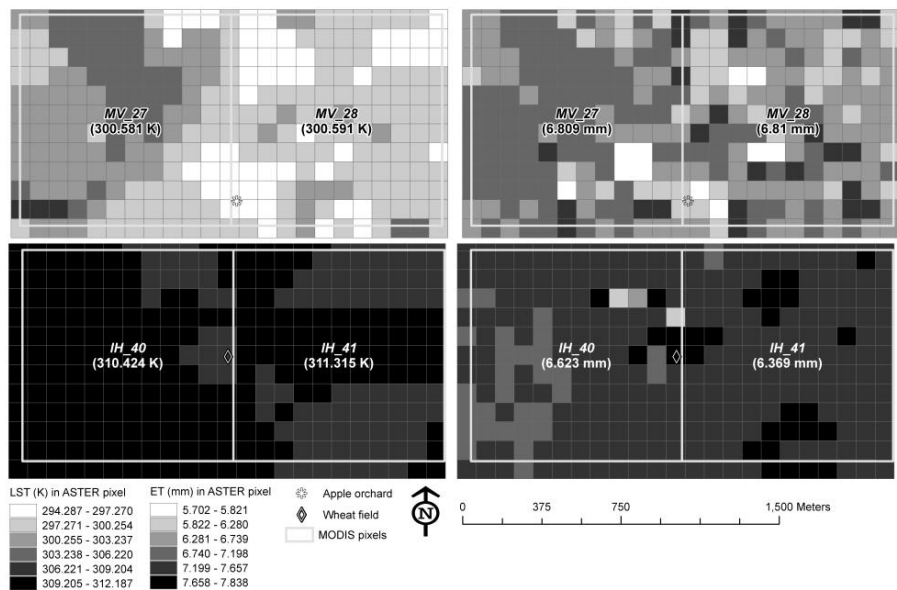


Fig. 1. Comparison of ET and LST for MODIS and ASTER pixels

C3621