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Discussions

Interactive comment on "Evapotranspiration monitoring based on thermal infrared data over agricultural landscapes: comparison of a simple energy budget model and a SVAT model" *by* Guillaume Bigeard et al.

Anonymous Referee #2

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General comments:

The paper explores the application of the Two-Source Energy Balance (TSEB) using TIR data and a SVAT model (SEtHyS) over experimental agricultural sites in Morocco and France, hence different climate and management practices. With regards to application of TSEB, in the model description, it appears they are using most if not all of the original formulations of the Norman et al (1995) model, for example Eq. (9) for partitioning net radiation (Rn) for the soil and canopy elements. However later they state that they adopt a more physically-based Rn divergence model of Kustas and

Norman (1999). Yet in the sensitivity analysis (Table 1) this extinction coefficient for Eq. (9) is retained and evaluated later in Figure 9 which is not consistent with what is stated in the text. While in the references they appear to cite papers that have included new formulations being implemented in the TSEB since the original 1995 paper, they are not included in this paper. The TSEB model has undergone several modifications since it was first presented by Norman et al. (1995). Changes include refinements to the algorithm estimating soil aerodynamic resistance and shortwave and longwave transmittance through the canopy (as they mention in their paper; Kustas and Norman, 2000) and additionally a means for adjusting the Priestley–Taylor formulation for canopy transpiration (Kustas and Norman 1999). Further improvements include incorporating rigorous treatment of radiation modeling for strongly clumped row crops, accounting for shading effects on soil heat flux (Colaizzi et al. 2012a, 2016a,b), and incorporating alternative formulations for computing the canopy transpiration such as Penman–Monteith (PM) or light-use efficiency (LUE) parameterizations (see Colaizzi et al. 2012b, 2014,2016c; Anderson et al. 2008). The later two canopy transpiration formulations are mentioned but not applied in this paper. Alternatively, the SEtHyS is a SVAT model with 22 parameters and so it is unclear why such a comparison is actually being made between a relatively simple but fairly robust thermal-based model and a SVAT having a large number of tunable parameters. It's also unclear why this comparison does not include application of a newly developed and presumably more robust two-source model SPARSE developed by one of the co-authors (Boulet et al., 2015). Additionally, for the sensitivity analysis, the authors do not appear to be aware of the several studies that have already performed sensitivity analyses for key inputs to TSEB. These include two of the papers mentioned in this manuscript. . . Timmermans et al (2007) and Zhan et al. (1996). There is also Li et al (2005) mentioned in the manuscript and then there is the paper by Kustas and Norman (1997) and Kustas et al. (2012). In summary it appears they conduct an analysis with a dated TSEB model without some of the more current refinements and comparing it to a SVAT that has a number of tunable parameters that would be difficult to prescribe over a large area without detailed ground information. There are a significant number of analyses performed making it a long paper and is somewhat diffuse in its focus. While I think the paper has some unique findings, it does not consider some of the main advances in TSEB when evaluating model performance for these agricultural sites. Early season conditions when the canopy is small, the soil is playing a major role in the energy exchange, and there is no discussion of soil roughness effects on the TSEB formulation that has been discussed in the literature (Kustas et al., 2016). Errors in TSEB during senescence will largely depend on how well the green fraction is determined. . .however it should be pointed out that these later stages of vegetation condition are not as important to capture the ET as during the main growing season. While I consider this work as having some merit, particularly the analyses performed with SEtHyS, it seems the authors do not consider to any degree of the advances/refinements made in the TSEB model since Norman et al (1995) and therefore I question how relevant is their analyses and conclusions using the 20+ year old formulations evaluated here in comparison to the more current parameterizations. Based on these shortcomings I do not find the paper suitable for publication in its current form.

Specific comments:

Page 9: It appears the leaf area and green fraction data are very local and may not reflect conditions viewed by the radiometer. This can be a major issue. Is there any indication where they sampled is representative of the radiometer field of view?

Page 9: Eq (15). What values are assumed in the Penman-Monteith equation for computing LEpot?

Page 10: How is the calibration of SEtHyS carried out and what level of calibration is shown in Figure 2 for the SEtHyS model?

Page 10: So the TSEB performance is “sought in its out-of-the box configuration presented in Norman et al (1995)” suggests none of the refinements over the last 20 years are incorporated in this analysis.

Page 10. The 3 parameters identified for study are the Priestley-Taylor coefficient, the net radiation extinction parameter and the fraction of soil net radiation for estimating soil heat flux, G. There is some interdependency here between the amount of canopy net radiation interception and the value of the Priestley-Taylor parameter (Kustas and Norman, 2000). Also for G, refinements of the TSEB include time varying formulation proposed by Santanello and Friedl (2003).

Page 12 line (10): TSEB could be provided albedo inputs from remote sensing. This is something easily done in the model if made available.

Page 12 (line 15): The authors do not seem to be aware of the soil resistance formulation that is sensitive to soil roughness which is discussed in refinements to the TSEB model (Kustas et al., 2016).

Page 12 (Line 30): Its unclear what version of SEtHyS model (1-4 from page 10) is being used in these comparisons.

Page 13 (line 5): The Crow et al (2008) paper actually showed the utility of TSEB in providing an indicator of plant stress for assimilation in a water balance model.

Page 15 Sensitivity analysis to meteorological inputs: It has been long recognized that to apply TSEB regionally requires a way of reducing the need for accurate absolute surface-air temperature differences. This was the motivation for the development of time differencing modeling schemes (Anderson et al., 1997; Norman et al., 2000).

Page 15 Sensitivity analysis to vegetation forcing inputs: The use of micrometeorological measurements close to the canopy height is ill-advised in general due to roughness sublayer effects and so comes as no surprise for the TSEB since the aerodynamic resistances are key to the TSEB calculations. This should be removed

Page 17: Sensitivity analysis to radiative temperature for TSEB: This is well documented and the reason why time differences in radiative temperatures were developed early in the TSEB applications (see Anderson et al., 2004)

Page 17-18: sensitivity analysis to water inputs and soil water content for SEtHyS: This is a major issue with SVAT models. That is why approaches like Crow et al (2008) of combining water balance with remote sensing energy balance is appealing. Moreover, for regional analysis it will be very difficult to acquire irrigation information in a timely manner.

Page 22 (figure 9): These results are related to some extent on the radiation partitioning which the authors appear to have adopted the original formulation of Norman et al (1995) for net radiation extinction and without any clumping effects which row crops tend to have (Anderson et al., 2005).

Page 25 (figure 11): Did the authors consider the fact that extinction of diffuse light through a canopy is quite different from direct and perhaps that is another factor affecting the Priestley-Taylor value?

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