Hydrol. Earth Syst. Sci. Discuss., 6, S720–S725, 2009
www.hydrol-earth-syst-sci-discuss.net/6/S720/2009/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Evaluation of the Surface Energy Balance System (SEBS) applied to ASTER imagery with flux-measurements at the SPARC 2004 site (Barrax, Spain)" *by* J. van der Kwast et al.

J. van der Kwast et al.

Received and published: 19 June 2009

The authors would like to thank the referee for the comments.

General comments of referee #2: "The research makes an exploration on how to effectively estimating evapotranspiration based on the SEBS over the highly heterogeneous Barrax using ASTER remote sensing observations. The SEBS model is one of the best models developed over last decade for accurately estimating daily ET. With a sound base of physics, this model has been successfully applied by many researchers. The author also evaluates two scenarios of the SEBS model with distributed flux measurements at the landscape scale. What is a significant advance from previous works should be shown explicitly."

Author's response: The innovation of this contribution is the use of SEBS, footprint analysis and in-situ measurements to quantify the effects of homogeneous and heterogeneous land cover in flux estimates. Given the quality of the SPARC 2004 data, the details of analysis presented here are significantly higher than comparable analysis done previously. Furthermore the paper discusses scale issues related to the footprint of measurements and resolution of remote sensing data. The paper discusses why fluxes modelled by SEBS do not always agree with in-situ measurements and how this can be improved.

General comments of referee #2 (continued): "In this investigation, analysis of two Scenarios, model sensitivity and the result of evapotranspiration based on the SEBS model are presented, but the main purpose of this paper is not described clearly in abstract."

Author's response: The abstract will be changed into: "Accurate quantification of the amount and spatial variation of evapotranspiration is important in a wide range of disciplines. Remote sensing based surface energy balance models have been developed to estimate turbulent surface energy fluxes at different scales. The objective of this study is to evaluate the Surface Energy Balance System (SEBS) model on a landscape scale, using tower-based flux measurements at different land cover units during an overpass of the ASTER sensor over the SPARC 2004 experimental site in Barrax (Spain). First a sensitivity analysis has been performed in order to investigate to which variable the sensible heat flux is most sensitive. Taking into account their estimation errors, the aerodynamic parameters (hc, z0m and d0) can cause large deviations in the modelling of sensible heat flux. The effect of replacement of empirical derivation of these aerodynamic parameters in the model by field estimates or literature values is investigated by testing two scenarios: the Empirical Scenario in which empirical equations are used to derive aerodynamic parameters and the Field Scenario in which values from field measurements or literature are used to replace the empirical calculations of the empirical scenario. The Field Scenario only resulted in a small improvement, compared

HESSD

6, S720–S725, 2009

Interactive Comment

to the Empirical Scenario, where the footprints of the measurements contain a homogeneous land cover. The Field Scenario can even worsen the result in the case of heterogeneous footprints, by creating sharp borders related to the land cover map. In both scenarios modelled fluxes correspond better with flux measurements over uniform land cover compared to cases where different land covers are mixed in the measurement footprint. Furthermore SEBS underestimates sensible heat flux especially over dry and sparsely vegetated areas, which is common in one-source models."

General comments of referee #2 (continued): "Moreover, the description of the ground data is incomplete and the cause of the bias is also insufficient explored."

Author's response: A more elaborate description of the ground data is outside the scope of the paper. The authors believe that sufficient information on the ground data is given for the objectives of the paper. For more detailed information on the ground data we refer to Su, Z., Timmermans, W., Gieske, A., Jia, L., Elbers, J. A., Olioso, A., Timmermans, J., Van Der Velde, R., Jin, X., Van Der Kwast, H., Nerry, F., Sabol, D., Sobrino, J. A., Moreno, J., and Bianchi, R.: Quantification of land-atmosphere exchanges of water, energy and carbon dioxide in space and time over the heterogeneous Barrax site, Int. J. Remote Sens., 29, 10 5215–5235, doi:10.1080/01431160802326099, 2008. 1168, 1170, 1171

The bias, i.e. underestimation of sensible heat flux, especially at higher values is common in one-source models. Sites that are characterized by a sparse vegetation cover under dry conditions have typical conditions where these models have difficulties in deriving the sensible heat flux.

Other comments:

Comment 1: P1166L15-18: "Accurate quantification of the amount of evapotranspiration and its spatial distribution is important in research in fields of hydrology, agronomy and meteorology. This information aids in precision irrigation, determining crop water stress and water use of vulnerable ecosystems, and predicting weather and climate

HESSD

6, S720–S725, 2009

Interactive Comment

change." References needed to support your sentences.

Author's response: The following references will be added: Climate/meteorology: (Avissar and Pielke 1989), Ecosystem: (Moran 2004), Agronomy:/irrigation (Anderson et al. 2003). The full references can be found at the end of this discussion.

Comment 2: P1166L25-26, "Conventional SVATs are based on point measurements and give only reliable results at the local scale. These models cannot be upscaled to larger areas because of the heterogeneity of land surfaces and the dynamic nature of heat transfer processes." I do not think this is proper here. More and more works are based on the SVAT model with satellite remote sensing to upscale larger and heterogeneity areas.

Author's response: The author's will modify these lines by explaining that we aim at independent estimates of fluxes at the relevant scale which can be used to validate results of other SVATs

Comment 3: The author should do explain the SEBS algorithm more detailed not just about the roughness length.

Author's response: The authors have the opinion that a more detailed description of the SEBS model is not appropriate here and not necessary for understanding the objectives of the paper. In the paper, we refer to publications in which the model is described in detail.

Comment 4: P1171L3, "After atmospheric correction", the authors do not show how the atmospheric are corrected?

Author's response: It will be added that MODTRAN is used for the atmospheric correction, using a standard atmosphere.

Comment 5: P1171L5-7, "Surface temperature and surface emissivity are retrieved from a temperature-emissivity separation (TES) algorithm (Gillespie et al., 1999) using all five atmospherically corrected TIR bands." The authors do not present how to

HESSD

6, S720–S725, 2009

Interactive Comment

estimate the surface temperature and emissivity based on TES algorithm.

Author's response: ASTER Level 2 products for which TES was applied have been used. Sobrino et al. (2007) found errors less than 1.5 K for the level 2 products of the Barrax site. Full reference is included at the end of this discussion.

Comment 6: P1173L13-16, "The output of the SEBS model consists of the spatial distribution of net radiation (Rn), soil heat flux (G0), sensible heat flux (H), latent heat flux (LE) and evaporative fraction (lambda) at the moment of satellite overpass (18 July 2004, 11:00:29 UTC) (Fig. 2)." The authors do not show how the heat fluxes are calculated.

Author's response: See response to comment 3. The derivation of the fluxes are already described in e.g. Su (2002).

Comment 7: P1177L6-7,"These parameters are empirically derived from their relationship with NDVI (Eqs. 1, 2 and 3) and are correlated." How do the authors correct these parameters?

Author's response: No corrections were performed, It was assumed that default values are appropriate for the study area.

Comment 8: A catering plot is more suitable to express the correlation between field observations and modeled surface parameters rather than Table 4.

Author's response: In case purely measured values are compared versus modelled values, such as is the case with the canopy heights a graph might be better. Here however, also z0m and d0 are shown, which are not really measured but derived from canopy height using standard assumptions (Brutsaert, 1982) or tabular data. Therefore, for these parameters we feel it is more appropriate to show their values in a tabular form.

References:

HESSD

6, S720–S725, 2009

Interactive Comment

Anderson, M.C., Kustas, W.P., & Norman, J.M. (2003). Upscaling and downscaling - A regional view of the Soil-Plant-Atmsophere continuum. Agronomy Journal, 95, 1408-1423

Avissar, R., & Pielke, R.A. (1989). A parameterization of heterogeneous land surfaces for atmospheric numerical models and its impact on regional meteorology. Monthly Weather Review, 117, 2113-2136

Moran, M.S. (2004). Thermal infrared measurements as an indicator of plant ecosystem health. In: "Thermal Remote Sensing in Land Surface Processes", ed. D.A. Quattrochi, and J. Luvall, Taylor and Francis., CRC Press. Boca Raton, Florida, USA pp. 257-282

Sobrino, J.A., Jimenez-Munoz, J.C., Balick, L., Gillespie, A.R., Sabol, D.A., & Gustafson, W.T. (2007). Accuracy of ASTER level-2 thermal-infrared standard products of an agricultural area in Spain. Remote Sensing of Environment, 106, 146-153

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 1165, 2009.

HESSD

6, S720–S725, 2009

Interactive Comment