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Hydrology and Earth System Sciences Discussions

Interactive comment on "Global land-surface evaporation estimated from satellite-based observations" *by* D. G. Miralles et al.

Anonymous Referee #1

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General comments

The paper presents a methodology to derive global land surface evapotranspiration (ET) estimates by using a suite of remote sensing observations. The methodology integrates well known formulations (e.g., the Prisley-Taylor equation) with new ideas about how to exploit available satellite observations (e.g., a module to account for rainfall interception, or a water budget module to ingest precipitation estimates and assimilate soil moisture observations). The final goal is to derive a long time series of ET estimates using the existing satellite products, though only ET estimates for the year 2005 are presented in the paper.

In general, the proposed methodology is well presented, and an effort has been made

to validate the obtained estimates for 2005 with existing tower and ground measurements. As pointed out by the authors, uncertainties in the net radiation are responsible for a large part of the final uncertainty in the ET estimation (specially in non-moisture limiting conditions). Nevertheless, some sort of uncertainty analysis may be an interesting addition in future papers. As in any observation–driven modeling framework, choices for the datasets and the model parameters need to be made, and it would be of interest to see how these choices impact the estimates. A possibility would be to check the sensitivity of the parameterization in an analytical way (see e.g., Fisher, J. B., et al., Global estimates of the land–atmosphere water flux based on monthly AVHRR and ISLSCP-II data, validated at 16 FLUXNET sites, Remote Sensing of Environment (2007), doi:10.1016/j.rse.2007.06.025), or by using different forcing datasets (e.g., Sheffield et al. (2010) Long-Term Estimates of Evapotranspiration for Mexico based on downscaled ISCCP data, J. HydroM., doi: 10.1175/2009JHM1176.1).

Despite the existence of a large body of work characterizing ET from the local to the regional scale, the extension to the global scale requires formulations adapted to the existing global datasets. On going inter-comparisons of the available ET products show still a relatively large spread in their estimates, and the community is still discussing the way forward to exploit effectively the existing satellite observations for global ET estimation. In my opinion, the proposed methodology has the potential to be an important contribution to the field.

The paper is in general well written, but it would benefit from some minor corrections. A few specific suggestions and comments are given below.

Specific comments

Abstract

P8480.L5. This sentence seems confusing. The net radiation does not convey the same information that the surface conductances. For instance, net radiation is also a main driver in Penman-Monteith formulations, which also require surface conductances. Also, it is true that surface conductances cannot be directly estimated from space, but the same applies to the ET. In the same way that we model ET and drive the model with remote-sensing observations, surface conductances are modeled and then driven by e.g. vegetation indexes derived from satellite observations (e.g. Zhang et al. (2010), A continuous satelliteâĂŘderived global record of land surface evapotranspiration from 1983 to 2006, Water Resour. Res., 46, W09522, doi:10.1029/2009WR008800).

Introduction

P8481.L16. The models description is confusing. For instance, some land surface models (off-line and coupled) also use Penman-Monteith formulations. Also, some empirical models use other statistical tools to derive objective non-parametric identification functions, not just machine learning algorithms. The authors are referred to e.g. Kalma et al., Estimating land surface evaporation: a review of methods using remotely sensing surface temperature data, Surv. Geophys., pp. doi:10.1007/s10,712–008–9037–z, or Jimenez et al. (2010) Global inter-comparison of 12 land surface heat flux estimates", JGR, 2010JD014545, in press, for suggestions.

P8481.L28. Better just LandFlux.

P8482.L7. See previous comments for the abstract.

Model methodology

P8483.L15. Adding perhaps "most ABSOLUTE uncertainty". It is true in absolute values, as significant interception loss typically occurs in areas with large ET. But in relative terms (i.e., uncertainty over estimated values) there are other biomes (where interception loss should not be very large) also presenting comparable relative uncertainty (judged as inter-product spread).

P8486.L20. This means that the model needs to be run without assimilation for at least a year. It may help the reader to say this more explicitly. The normalization is done for

each grid cell independently?

P8487.L20. Have other different correlations cut-off values been tested?

P8488.L23. The reader may wonder about the validity of these parameterizations at the global scale, as they seem to have been derived from a case-study in a very specific region in the world.

P8489.L11. It may help the reader to define the Bowen ratio.

P8490.L1. Any reasons/references to choose the given G/Rn ratios?

P8490.L20. It will help the reader to have a reference supporting this statement, as some ET methodologies do not explicitly model interception loss and use PT equations to estimate the overall ET over wet canopy.

3. Satellite observations

P8492.L26. Even with the care put by the authors to scale GPCP estimates to CMORPH, a discontinuity can be seen in the global map in Figure 5 at 60N over Asia, suggesting very different precipitation regimes from both datasets. Also, later on the authors state as ultimate goal to derive 1983-present estimates, which can obviously not be done with the CMORPH forcing. It may be good to comment on these things, and plans to attack this issue, as the present rest of the model forcings (apart from perhaps also the snow depth) seem adequate for the long term goal.

P8493.L18. As the LPRM product is used in a global context, it may help the reader to mention briefly the investigated regions for the claimed soil moisture accuracy (semi-arid?). We assume that for regions with large vegetation optical depth the same accuracy in the SM product cannot be obtained, which may have an impact in the SM assimilation.

P8493.L20. Any reasons to assign the 60% ratio of herbaceous/tall-canopy ratio?

P8994.L1. As the LPRM started to be presented by citing frequencies, it may be better to give again a frequency rather than the Ka band name.

P8994. L1. In principle the PT equation is governed by the air temperature (Ta) not by the surface temperature (Ts). In fact, the LPRM Ts product is gap-filled with ISCCP Ta, and not the ISCCP-Ts. It could be argued that for daily averages the Ts is a good proxy for Ta, although that may depend on regions and time of the years. The choice of Ts and not Ta, and the gap-filling with Ta and not Ts, needs to be explained/justified.

P8495.L16. The symbol for porosity has already been used for background error variance in the Kalman filter, it may confuse the reader.

P8495.L18. Perhaps “Derivation” instead of “definition”? It may help to mention soil moisture rather than just the symbol.

4. Validation and discussion

P8495.L10. Although details are given in the related table, it may help to give a reference for SCAN here and to point out that stations are only located in US.

P8496.L1. For completeness, the number 0.57 to 0.60 may also be given in the text. Is interesting to see that GLEAM estimates soil moisture better in the second soil layer (r=0.69) than in the first one (r=0.60), even if the assimilation has a larger impact for the first layer. Any thoughts on this?

P8496.L15. As stated in the reference given, the main aims of FLUXNET seem broader than just the carbon fluxes. Adding “water vapor and energy fluxes” may present better the network.

P8496.L27. 50% miss-match in energy closure seems very large, do you have the percentage of stations discarded at hand? Assuming that those numbers have been calculated for all stations, and that they can say something about the quality of the fluxes measured tower, it could have been interesting to add an extra column in Table 3 with the percentage of energy closure.

P8498.L25. It could have been interesting to see some time series for some of the stations (e.g., one station per group) to have examples of how the seasonal variability is captured in the model estimates.

P8498.L28. It may be of interest to put the correlation figures in the context of other published results, making reference to the values presented in the validation of some of the other methodologies with tower measurements.

5. Global application of the model

P8500.L3. Jimenez et al. (2010) may be more appropriate.

6. Conclusions

P8500.L11. Any references to backup this statement? Some researchers argue than is not clear at the moment whether we can estimate better precipitation than ET (even if the precipitation products may seem more mature). Perhaps saying “remains ONE of the biggest” may be less controversial.

P8500.L16. While GCM benchmarking if one of the good reasons to provide ET estimates, the characterization of the water and energy cycle from observations for analysis/attribute studies is (on its own) another important objective.

P8500.L19. A (instead of THE) wide range?

P8500.L23. See previous comments for the abstract. For instance, it could be argued that the proposed herbaceous stress function (driven by a RS estimated optical depth) is not far from a modeled canopy conductance (driven by a RS estimated vegetation index), in the sense of both characterizing observation-driven stress in plant function.

P8502.L3. Possible references for LandFlux-Eval are Jimenez et al. (2010), and Muller et al., Evaluation of global observations-based evapotranspiration datasets and IPCC AR4 simulations, under review, GRL.

Figures

Figure 3. The figure could be simplified by plotting the 4 lines in one plot, as 2 of the lines are repeated in the 2 individual plots. For consistency, use either “herbaceous” or “short vegetation”.

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