Hydrol. Earth Syst. Sci. Discuss., 9, C3767–C3771, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C3767/2012/

Hydrology and Earth System Sciences Discussions

Interactive comment on "A dual-pass data assimilation scheme for estimating turbulent fluxes with FY3A data" *by* T. R. Xu et al.

Anonymous Referee #1

Received and published: 13 August 2012

Overview

The study introduces a dual-pass data assimilation scheme to improve turbulent fluxes predictions by using the common land model (CoLM) and assimilating satellite-derived land surface temperature (LST) obtained through the FY3A satellite. Specifically, model prediction of sensible and latent heat fluxes, LST and soil moisture are compared against in situ observation at four sites in China characterized by different land cover. Additionally, sensible heat fluxes are measured both through eddy covariance and a large aperture scintillometer system. Results show that the assimilation of FY3A-derived LST improves the prediction of turbulent fluxes and soil moisture at all sites.

Therefore, the proposed procedure can be used to reduce uncertainties in CoLM predictions.

General Comments

I carefully read the paper by Xu et al. as I'm very interested to understand how the assimilation of land surface temperature can improve not only turbulent fluxes predictions but also soil moisture simulation (my main research topic). I believe the paper is well written, well structured and clear; the language is fluent and precise; and the topic is of interest for the HESS readers. However, I believe that several issues should be addressed before its publication.

1) As clearly stated by the authors in the Introduction section, a large number of studies employing different land surface models, satellite-derived land surface products and data assimilation techniques have been already published in the scientific literature. I am aware that the topic incorporates several issues and a lot of work has to be done to improve our knowledge of the mass and energy balance between the land and the atmosphere. However, the same authors published a similar paper on Journal of Geophysical Research (*Xu et al., 2011b*) by using the same land surface model (CoLM), a similar data assimilation algorithm but different remote sensing and ground experimental observations. I believe that the paper shows enough new material to be published on HESS but I also would like to understand clearly which is the added-value of this paper with respect to the papers already published (not only by the authors).

Specifically, the main novelty of this paper seems to be related to the specific data assimilation scheme that optimizes model vegetation parameters and soil moisture at different temporal scales according to their expected time variability. Theoretically, this scheme seems to improve the data assimilation performance but it should be confirmed through model simulations. I suggest to compare the joint data assimilation scheme as proposed in *Xu et al. (2011a; 2011b)* with the procedure developed in this paper to

HESSD

9, C3767–C3771, 2012

Interactive Comment

effectively understand the benefit (if present) of this new scheme for the prediction of turbulent fluxes and soil moisture.

Moreover, the paper employs for the first time LSTs derived from the FY3A satellite. It would be also interesting to compare different LST products (e.g. by using MODIS) again in terms of CoLM performance.

2) In my opinion, the description of the dual-pass data assimilation scheme should be improved. Seeing the scheme in Figure 1 it seems that the optimization of vegetation parameters and soil moisture is done separately but at each time step for which satellite-LST data are available. However, the optimization of vegetation parameters should be done once per week; for that the scheme in Figure 1 is not clear to me. Moreover, I do not understand how the EnKF can be applied once per week by using the LST observations for the whole week (i.e., seven LSTs if daily data are available). Likely I'm wrong and only one LST per week is assimilated discarding the other observations that are only used to update the model states (i.e., soil moisture). Summarizing, by reading the text it is not clear (at least for me) and it should be revised.

3) The improvement in the prediction of turbulent fluxes and soil moisture seems to be related to the significant model bias. In particular, land surface temperatures and sensible heat fluxes are overestimated and the latent heat fluxes are underestimated by the model (the same happens in *Xu et al., 2011b*). A bias in the forecast model (or assimilated observations) invalidates key assumptions of (bias blind) data assimilation, leading to sub-optimal filter performance (*Dee, 2005*). In general, it is better to address the cause of a model bias, rather than rely on an assimilation to correct it (*Draper et al., 2011*). Data assimilation techniques are designed to correct random errors in the model and rely on the assumption of unbiased background and observations (*Barbu et al., 2012*). Which is the bias between modelled and satellite-derived LST? If the bias (if present) is removed, which is the effect of the assimilation of LST on model predictions? I suggest addressing these aspects in the paper to correctly evaluate the performance of data assimilation.

HESSD

9, C3767–C3771, 2012

4) Finally, I was very interested to see the impact of data assimilation on the modelled soil moisture. In the paper, only one figure is dedicated to this aspect while in situ observations should be available for all the investigated sites. Why are the results for the other sites not shown? A significant bias was also observed in the simulation of soil moisture. Therefore, the same issue as before is valid also for soil moisture.

Furthermore, some additional information on how soil moisture is simulated in the CoLM model would be beneficial to better understand the results. For instance, how many are the soil layers simulated by the model? Which depths? Which equations? ...

Specific Comments/ Technical Corrections (P: page, L: line or lines)

P8511, L1-5: Why are the results only shown in term of RMSE? Please, add also in terms of correlation as it was done for the comparison with LAS measures sensible heat fluxes. The same also applies for soil moisture.

P8512, L22: Why is the evaporation fraction computed from 10:00 to 15:00 and not for the whole day?

P8512, L4: Change "surfer" with "suffer".

P8516, L1-6: These conclusions are too general and should be revised to better delineate the specific issues to be solved in the context of assimilating satellite products in land surface models.

Additional Reference

Barbu, A. L., Calvet, J.-C., Mahfouf, J.-F., Albergel, C., and Lafont, S.: Assimilation of Soil Wetness Index and Leaf Area Index into the ISBA-A-gs land surface model: grassland case study, *Biogeosciences*, 8, 1971-1986, 2011.

Dee, D.: Bias and data assimilation, *Q. J. Roy. Meteorol. Soc.*, 131, 3323–3343, 2005.

HESSD

9, C3767–C3771, 2012

Draper, C., Mahfouf, J.-F., Calvet, J.-C., Martin, E., and Wagner, W.: Assimilation of ASCAT near-surface soil moisture into the SIM hydrological model over France, *Hydrol. Earth Syst. Sci.*, 15, 3829-3841, 2011.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 8493, 2012.