Hydrology and
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Discussions

Interactive comment on "Satellite soil moisture data assimilation for improved operational continental water balance prediction" *by* Siyuan Tian et al.

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The study "Satellite soil moisture data assimilation for improved operational continental water balance prediction" by Siyuan Tian et al. develops a data assimilation approach of remote-sensing soil-moisture information for improving the water-balance predictions of the BoM-based implementation of the hydrological AWRA-L model, which is extensively used in Australia for agricultural applications and risk assessment. The novelty of the paper does not lie in the modification of the hydrological model, but in the development of a data assimilation approach. Overall, I think that the paper is well written, and that the topic is relevant for the HESS readers. However, I believe that some critical points developed in the paper should be clarified.

Main concerns: (1) The proposed method very clearly improves the performance of the BoM-based operational AWRA-L model for the prediction of surface (0-10 cm depth) soil moisture, but I am not convinced that this methodology significantly improves the predictions of the model for the other components of the water balance: - Panels b, c and d of Figure 7 suggest that the tested data assimilation methods DA-TC and DA-TCAIR do not improve the open-loop model predictions for the 0-1 m soil moisture, evapotranspiration and streamflow data. Furthermore, in some cases (e.g., 0-1 m modeled soil moisture records for OzNet), the DA-TC and DA-TCAIR outcomes tend to reduce the performance of the original model. - The authors have included a plot showing the observed and modeled streamflow series of one example pixel (Fig. 8) of Australia to justify some of the improvements that the proposed DA-TCAIR methodology may produce in the modelled outputs of the other components of the water balance. In my opinion, this figure only indicates that both the original, model open-loop predictions and the "improved" DA-TCAIR predictions are very poor (i.e., strongly differ from the observed streamflow data) for this example pixel. This is certainly intriguing, since Fig. 7d suggests that, for a very large proportion of the modelled pixels in Australia, there should be a good correspondence between the observed and modelled streamflow data using any of the three tested methodologies (clearly, this is not the case for the Fig. 8 example). This also rises important concerns about the convenience of using the selected example as a representative pixel of the modelled dynamics. - The authors use remote-sensed greenness information (NDVI) of crop fields to justify the better performance of the proposed DA-TCAIR methodology for predicting the "root zone" (0-1 m soil profile) soil moisture. Fig. 9 shows an increased correlation between the crop biomass production (or greenness) and 0-1 m soil moisture for the proposed methodology, but I wonder whether this is an indirect effect of the better prediction of surface (0-10 cm) soil moisture for the proposed method, since (i) the 0-10 cm values are integrated within the modelled 0-1 soil moisture values, and (ii) crops typically concentrate a very large proportion of their roots in the surface (first 15 cm) of the soil profile (see Fan et al. 2016; Field Crops Research, 189: 68-74 for details). An

exploration of the correlation between the vegetation greenness of the crops and the modeled surface (0-10 cm) soil moisture series, and between the modelled series of surface (0-10 cm) and "root zone" (0-1 m) soil moisture would be useful to clarify this point.

(2) The proposed methodology is affected by a strong circularity. The authors apply a method of data assimilation based on the use of remote-sensed surface soil moisture estimations to improve the modeled hydrological components of the water balance of the AWRA-L model, impacting mainly in the outcomes of the surface soil moisture predictions.

Other comments: - The authors apply MODIS NDVI data as a proxy of the vegetation dynamics in the crop fields for some of the analyses. Although NDVI has been very extensively used as a proxy of vegetation cover and production within the last 4 decades, numerous studies indicate that this VI shows considerable limitations to represent accurately the dynamics of vegetation, particularly in drylands. For example, NDVI is strongly influenced by the spatiotemporal variations in soil background reflectance in moderate and low cover areas. In addition, this VI typically shows saturation effects in high biomass areas and is also notably affected by the presence of atmospheric aerosols. Other MODIS VIs (e.g., EVI) may show a better performance for characterizing the vegetation dynamics of the crop fields.

- Fig. 7 lacks statistics. Without statistical testing the authors cannot claim whether there are any differences in the performance of the compared methodologies for soil moisture, evapotranspiration and streamflow prediction.