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Comment on hess-2022-379

Anonymous Referee #1

Referee comment on "Improving regional climate simulations based on a hybrid data assimilation and machine learning method" by Xinlei He et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-379-RC1, 2022

This study proposed a hybrid data assimilation and machine learning framework to integrate in-situ and remotely sensed-based soil moisture observations and remotely sensed leaf area index (LAI) into the Weather Research and Forecasting (WRF) model. The ensemble Kalman filter (EnKF) approach is used to update the leaf biomass and specific leaf area by assimilating the remotely sensed LAI. A machine learning surrogate model is used to integrate soil moisture profile observations and remote sensing soil moisture product to estimate the three-layer soil moisture. In general, the hybrid framework coupled with the WRF model can improve the simulation of air temperature, specific humidity, wind speed, and precipitation, etc. in the Heihe River basin (HRB). In addition, the hybrid model can highlight the oasis-desert effect and improve the simulation of regional wind speed and precipitation. These results contribute to understanding regional climate and land-atmosphere interactions in the HRB with an advanced WRF model. The entire manuscript meets the scope of this journal. However, several points in the manuscript need to be addressed. So I suggest a minor revision is needed before publication.

Major comments:

- The authors need to emphasize the advantages of the hybrid framework coupled with the WRF model compared to the previous Noah-MP model. This includes the innovative aspects of the study objectives, content, and results.
- Although the advantages of hybrid modeling are obvious, the authors still need to explain why ML methods were constructed to estimate soil moisture instead of directly assimilating SMAP soil moisture. In addition, the uncertainties in the estimation of soil

moisture from the hybrid model need to be discussed.

Minor comments:

- How to match the spatial resolution of different datasets to the WRF system, for example, land cover data with a spatial resolution of 30 m, while WRF is set to 3 km.
- The MODIS LAI is the most widely used remote sensing product. Describe why GLASS LAI can be used for assimilation instead of using other products.
- The values of WRF (DA-ML) simulated LAI, 1.12, 1.05, 1.49, and 0.33, are obviously lower than the values drawn in Figure 2, especially at cropland. Another question is that the LAI of WRF (DA-ML) in Figure 2 is a little larger than the LAI of GLASS, not lower.
- If the horizontal coordinate in Figure 3 is Julian Day Number, its starting value should be clearly marked. Furthermore, after 200 days in the midstream, the simulation of soil moisture from the WRF (DA-ML) is hard to capture the observed peak values.
- Line 252: The reliability of ETMap should be described.
- Line 265: In the validation work, air temperature and specific humidity simulations and observed heights need to be listed.
- Figure 6 and 7: The standard deviation of the observations is missing at Hulugou station.
- Figures 9 and 10 show the Mean vertical profile of differences in air temperature and specific humidity between the WRF (DA-ML) and WRF (OL) during the growing season in 2015 in the midstream and downstream oasis. However, the vertical profile locations are unclear even though the rectangle has been marked in Figure 8. And I want to confirm the mean vertical profile of Figures 9 and 10 should be marked as a line or a rectangle area.
- Line 403: “The height is about 650hPa”. Can hPa be converted to m?
- Line 417: “Driven by background northerly winds, more watervapor fluxes from the midstream oasis region were carried to the upstream region”. This conclusion is hardly obtained from the Figure 13.
- The size of the horizontal and vertical coordinates in Figure 13b and c are too small.