

Comment on hess-2021-131

Anonymous Referee #1

Referee comment on "Simulating carbon and water fluxes using a coupled process-based terrestrial biosphere model and joint assimilation of leaf area index and surface soil moisture" by Sinan Li et al., Hydrol. Earth Syst. Sci. Discuss.,
<https://doi.org/10.5194/hess-2021-131-RC1>, 2021

The paper by Li et al. proposes using a four-dimensional variational assimilation method (PODEn4DVar) with soil moisture (SM) and leaf area index (LAI) observations for calculating the evapotranspiration (ET) and gross primary production (GPP). The paper is rich in content but there are a lot of confusions. Therefore, major revisions are required before proceeding with your paper.

As you said, the spatial scale mismatch between the ground observed footprint size and satellite-derived footprint size were the vital factors affecting assimilation performance. The spatial resolution of assimilated GLASS LAI data is 5 km, and thus the resolution of ET and GPP estimates is 5 km. The spatial footprint of EC measurement of ET and GPP is at most about 100-500 m. Hence, there is a mismatch between the footprint of model estimates (5 km) and field EC measurements (100 m). Larger spatial representation mismatches can lead to completely wrong conclusions, especially on heterogeneous surfaces. Perhaps you discussed it in the manuscript, but such uncertainty will strongly change the result.

Lines 47: Maybe it should be "GLASS LAI"?

Lines 73: "ENKF" or "EnKF", please unify.

Lines 74: There have been many applications of four-dimensional variational method (4DVar).

Lines 165: What does this equation mean? What are the constraints of SM on ET?

Lines 170, 179, 180: Confusing expression! Do you assimilate ET in the manuscript?

Lines 187: The flow chart of the LPJ-VSJA assimilation program is complicated and needs to be simplified. What are "section 3.1.1" and "section 3.2" in the Figure 1?

Lines 196: RMSD and ubRMSD have similar meanings, maybe you only need to keep one.

Lines 216: Observation errors should be defined based on the errors of instruments measuring LAI. Why did you choose arbitrary values for LAI observation errors?

Lines 217: "(R, RMSD, BIAS,)" remove the comma.

Lines 229: What is the time step and spatial resolution of the model running?

Lines 301: I can't find ubRMSD in the Taylor diagram of Figure 10

Lines 318: Please add the reference about Liu et al. (2018). You should add the download URL about Heihe data.

Liu, S., et al., 2018. The Heihe Integrated Observatory Network: A Basin-Scale Land Surface Processes Observatory in China. *Vadose Zone Journal* 17, 180072.
<https://doi.org/10.2136/vzj2018.04.0072>

Lines 337: You should add download URLs for LAI, SM, and other remote sensing data.

Lines 367: The spatial resolution of MODIS ET is 1km, and the spatial resolution of GLASS ET is 5km. To be consistent, have you resampled?

Lines 387: You should mention Figure 3 in the description.

Lines 395: The unit format is not uniform, you need to double check. "g C/m²/mon" or " g C m⁻² mon⁻¹ ", please unify. The x-axis in Figure 3 and 6 is confusing, or you can express it in years.

Lines 408: Over cropland, the data assimilation scheme tends to generally underestimate GPP. What is the reason for the underestimation?

Lines 411: "Fig.4", Full name or abbreviation? please check carefully!

Lines 413: There are a lot of up-scaled ET and GPP products (Jung et al., 2009, 2020) that can be used for regional validation.

Jung, M., et al., 2009. Towards global empirical upscaling of FLUXNET eddy covariance observations: validation of a model tree ensemble approach using a biosphere model. *Biogeosciences* 6 (10), 2001–2013.

Jung, M., et al., 2020. Scaling carbon fluxes from eddy covariance sites to globe: synthesis and evaluation of the FLUXCOM approach. *Biogeosciences* 17, 1343–1365. <https://doi.org/10.5194/bg-17-1343-2020>

Lines 504: The X-axis label is the same as the y-axis label in the Taylor chart.

Lines 516: The full name should be used the first time you use it (NSD).

Lines 548: In column A, GPP is low in the tropics and high in arid regions?

Figure 13: The TC method has been used to quantify uncertainties of gridded datasets. The TC method can only calculate uncertainty based on three (ET/GPP) products. How did you calculate the five (ET/GPP) products?

Lines 579: "Except for MODIS, GLASS, and LPJ-DGVM (0–60 mm month⁻¹), the σ of other products was generally between 0–20 mm month⁻¹." This is hard to see in Figure 14.