

The file corresponding to the position of all modifies in the manuscript is the “HESS-2021-131-highlight.pdf”

Referee 1:

1. **Line 76: The references for soil moisture and LAI assimilation are too old, some new references are provided:**

Rahman, A., Zhang, X., Houser, P., Sauer, T., Maggioni, V., 2022. Global Assimilation of Remotely Sensed Leaf Area Index: The Impact of Updating More State Variables Within a Land Surface Model. *Front. Water* 3, 789352. <https://doi.org/10.3389/frwa.2021.789352>

Bonan, B., Albergel, C., Zheng, Y., Barbu, A.L., Fairbairn, D., Munier, S., Calvet, J.-C., 2020. An ensemble square root filter for the joint assimilation of surface soil moisture and leaf area index within the Land Data Assimilation System LDAS-Monde: application over the Euro-Mediterranean region. *Hydrol. Earth Syst. Sci.* 24, 325–347. <https://doi.org/10.5194/hess-24-325-2020>

Xu, T., Chen, F., He, Xinlei, Barlage, M., Zhang, Z., Liu, S., He, Xiangping, 2021. Improve the Performance of the Noah - MP - Crop Model by Jointly Assimilating Soil Moisture and Vegetation Phenology Data. *J Adv Model Earth Syst* 13. <https://doi.org/10.1029/2020MS002394>

Response: These references have been added.

2. **Line 80: References are too old. The four-dimensional variational method (4DVar) assimilation method is also proposed by Bateni et al. (2014) and Xu et al. (2019).**

Bateni, S.M., Entekhabi, D., Margulis, S., Castelli, F., Kergoat, L., 2014. Coupled estimation of surface heat fluxes and vegetation dynamics from remotely sensed land surface temperature and fraction of photosynthetically active radiation. *Water Resour. Res.* 50, 8420–8440. <https://doi.org/10.1002/2013WR014573>

Xu, T., He, X., Bateni, S.M., Auligne, T., Liu, S., Xu, Z., Zhou, J., Mao, K., 2019. Mapping regional turbulent heat fluxes via variational assimilation of land surface temperature data from polar orbiting satellites. *Remote Sensing of Environment* 221, 444 - 461. <https://doi.org/10.1016/j.rse.2018.11.023>

Response: These references have been added.

3. **Line 91: He et al. (2021). assimilated land surface temperature and LAI observations into the 4DVar framework and improves ET and GPP estimates.**

He, Xinlei, Xu, T., Bateni, S.M., Ki, S.J., Xiao, J., Liu, S., Song, L., He, Xiangping, 2021. Estimation of Turbulent Heat Fluxes and Gross Primary Productivity by Assimilating Land Surface Temperature and Leaf Area Index. *Water Res* 57. <https://doi.org/10.1029/2020WR028224>

Response: This sentence have been added.

4. Line 121: Delete the dot after “For instance,”. “Leaf area index” should be “LAI”.

Response: Modified.

5. Line 127: You need to mention the full name of CONUS.

Response: the full name of CONUS has been added in Line 136.

6. Line 421: “spatial simulation” change to “regional simulation”.

Response: Modified.

7. Figure 2 and 5: “ubRMSE” change to “ubRMSD”.

Response: Figure 2 and 5 has been modified as suggested.

8. Line 535: “dry-sub humid” or “sub-dry humid”? Please unify

Response: Modified.

9. Line 536: “bias” change to “BIAS”.

Response: Modified.

10. Figure 10: Remove RMSD results.

Response: Figure 10 has been modified as suggested.

11. Line 576: “RMSD” change to “ubRMSD”.

Response: Modified.

12. Line 692: “bias” change to “BIAS”.

Response: Modified.

13. Line 696: “semi-humid”?

Response: Modified to “sub-dry humid”.

14. Line 733: “HeiHe drainage basin” change to “HeiHe river basin”.

Response: Modified.

15. The data and statistical indices in supplementary materials also need to be updated.

Response: The data and statistical indices in supplementary materials have been updated.

Referee 2:

1. L. 24-27: This sentence is not complete, a verb is lacking. What does "PM" means?

Response: this sentence has been modified and the paraphrase of the “LPJ-PM” has been added.

2. L. 34 (“assimilated GPP”): Are GPP and ET assimilated? I understood that LAI and SM are assimilated, not GPP and ET. Do you mean "The GPP and ET resulting from the assimilation"?

Response: Yes, the “assimilated GPP or ET” has been replaced with "The GPP and ET resulting from the assimilation".

3. L. 38: “than that of SMOS”?

Response: modified.

4. L. 56: “vegetation models”

Response: modified.

5. L. 57: replace “material” by “water, carbon, and energy”.

Response: modified.

6. L. 57: “different conditions accounting for”.

Response: modified.

7. L. 78: delete “Yet”.

Response: modified.

8. L. 92: do you mean “LAI has a lot of impact on”?

Response: Yes, it is. This sentence has modified.

9. L. 112 (“surface SM”): In the text, the same "SM" acronym is used to designate surface soil moisture and root-zone soil moisture. This is very confusing. I suggest you use "SSM" for surface soil moisture, and RZSM for root-zone soil moisture.

Response: This is indeed confusing, and abbreviations related to soil moisture have been refined and unified in the manuscript.

10. L. 120: “root-zone”.
Response: modified.
11. L. 126: “studies show that”?
Response: “We have changed “many studies have proposed” to “many studies showed that”.
12. L. 127: “and soil moisture can improve the simulation of”?
Response: We have made this change as suggested.
13. L. 128-132: Could be replaced by “Over small regions and at high spatial resolution, Xie et al. (2018) and Pan et al. (2019) show that the joint assimilation of soil moisture and leaf area index can improve the accuracy of crop yield estimation using high-resolution satellites products from Sentinel-1 and 2.”
Response: modified.
14. L. 137 (“Interactions Between Soil...”): Delete (written before).
Response: deleted.
15. L. 138 (“LDAS-Model”): LDAS-Monde.
Response: modified.
16. L. 140: are mostly used to implement.
Response: modified.
17. L. 151: “jointly assimilating”
Response: modified.
18. L. 165 (Section 2): This Section is confusing. Where do the atmospheric data used to force the land surface model (e.g. RH) come from? Which atmospheric variables are needed to drive the land surface model? Which variables are assimilated and which variables are analysed? You may refer to Section 3 and Table 2.
Response: Detailed explanation about atmospheric variables, assimilated variables and analyzed variables were added in Line437-447.
19. L. 175 (Table 1, “model coupled from”): do you mean "model corresponding to the coupling of" ?
Response: Yes, it is. The description has been revised as suggested.
20. L. 219: Wfc is not in Eqs. 2.5 and 2.6.
Response: “Wfc” was modified to VWC and the sentence was revised to “VWC is volumetric water content”.

21. L. 221: “wpwp_CH is the canopy height (CH)” what do you mean?
Response: wpwp_CH is the canopy height (CH) adjusted surface soil moisture wilting point and this sentence has been modified.
22. L. 231: Do you mean “The SMAP SSM”?
Response: Yes, and other relative descriptions in this manuscript have been unified as SSM.
23. L. 239: I don't understand the logic of these acronyms. What does "CO" means? "ETjoint" would be more explicit than "ETco". Same for GPP.
Response: “ETjoint, GPPjoint, SMjoint” has been replaced with "ETco, GPPco, SMco", respectively, in the revised manuscript.
24. L. 247 (Figure 1): I would suggest replacing "Scheme 1 (Section 2.2.1)" by "LAI-only". "... 2.2.2)" by SSM-only", "... 2.2.3)" by "Joint LAI and SSM assimilation".
Response: The description has been modified in Figure 1.
25. L. 263: "assimilated GPP and ET results": do you mean "GPP and ET results"?
Response: Yes, it is. We have replaced “assimilated GPP and ET results” with “GPP and ET results”.
26. L. 285: “multiplied by”
Response: modified.
27. L. 290: “assimilated into”
Response: modified.
28. L. 292: “ETpm (see Table 1)”
Response: modified.
29. L. 293: SM was assimilated or ETpm? Not clear.
Response : SSM was assimilated into LPJ-PM. Firstly, the SSM was introduced to into LPJ-PM and ET_{PM} was estimated as a diagnostic variable to assimilated directly with ET_{LPJ} .
30. L. 294: "assimilated ET" or "assimilated surface SM"?
Response : SSM was assimilated into LPJ-PM. The PT-JPL_{SM} sub-model was the observation operator. The ET was the assimilated output. “Assimilated ET” was the ET after assimilation.
31. L. 297 (“observations”): I don't understand. You write, a few lines before, that ET is simulated by LPJ-PM. This is not an observation. Please clarify.
Response : ET_{PM} was estimated as a diagnostic variable to be assimilated directly with ET_{LPJ}, and therefore ETPM is used as an “observation” to compare with other observations.

32. L. 300-301 (“it is proven”): Who proved that?

Response : The article of Li et al, 2020. We have added this citation at the end of this statement.

33. L. 314: FPCda is undefined. Please define this term here.

Response : FPCda was the assimilated FPC in LAI assimilation scheme. The definition was added in Line 266.

34. L. 315: Is "assimilated" the right word? This is confusing.

Response : This sentence was modified to “the ETjoint was generated using ET_{LAI} and ET_{PM}”.

35. L. 316: "ETco, GPPco, SMco": what does "co" means? Do you mean "ETjoint, GPPjoint, SMjoint"?

Response : “co-“ means “joint” or “jointly”. “ETjoint, GPPjoint, SMjoint” has been replaced "ETco, GPPco, SMco", respectively, in the revised manuscript.

36. L. 331: What does "Tan-Tracker" mean? Is "TAN" an acronym?

Response : Tan-Tracker is a dual-pass data-assimilation system in which both CO₂ concentrations and CO₂ fluxes are simultaneously assimilated (Tian et al.,2014). A brief explanation has been added in Line 319-320.

Tian, X., Xie, Z., Cai, Z., Liu, Y., Fu, Y., & Zhang, H. (2014). The Chinese carbon cycle data-assimilation system (Tan-Tracker). Chinese science bulletin, 59(14), 1541-1546.

37. L. 372: “squared correlation coefficient”.

Response : We have changed “correlation coefficient” to “coefficient of determination”.

38. L. 375: interms of “R” or “R2”?

Response : R²

39. L. 377: SD or NSD?

Response : NSD

40. L. 379 (“in the figure”): which Figure? Figure 10?

Response :in the Taylor chart.

41. L. 428 (“LAI maps”): Which maps? Was this evaluation done in this study?

Response : the references was added in Line 420-421.

42. L. 440: delete “Both”and replace “was” by “were”.

Response : modified.

43. L. 456: “were resampled”.
Response : modified.
44. L. 481-482: Not clear. it seems that "x" is lacking. When you write " $y = 0.92 + 21.66$ ", do you mean " $GPP_{co} = 0.92 GPP_{obs} + 21.66$ "?
Response : It have been modified as suggested.
45. L. 485 (Figure 2): Too many subfigures. a,b,c,d appear 4 times! Should be split into 3 Figures, one for R2, one for BIAS, and one for ubRMSD. Part of them could be moved to a Supplement.
Response : These subfigures have been divided into separate figures.
46. L. 485 (Figure 2 caption): The SQUARED correlation coefficient
Response : modified.
47. L. 499 (Figure 4 labels): Shurbland our shrubland?
Response : modified.
48. L. 509: "assimilated" or "estimated"?
Response : It is GPPjoint.
49. L. 524 (Figure 5): Same as for Figure 2. Too many subfigures. a,b,c,d appear 4 times! Should be split into 3 Figures, one for R2, one for BIAS, and one for ubRMSD. Part of them could be moded to a Supplement. The SQUARED correlation coefficient.
Response : These subfigures have been divided into separate figures.
50. L. 539 (“assimilated ET”): Do you mean "the ET values resulting from the assimilation"?
Response : Yes, it is. We have modified the text accordingly.
51. L. 571: “SM assimilation” or “SSM assimilation”?
Response : We have clarified that it should be SSM assimilation.
52. L. 590 (Figure 9): The two subfigures should have exactly the same y axis.
Response : Figure 9 has been modified as suggested.
53. L. 602 (Figure 10): Please indicate that ubRMSD refers to the dashed green lines. The ET_{smap} and ET_{smos} labels and dots should be placed outside the Taylor diagram.
Response : Figure10 has been modified as suggested .
54. L. 610 (ET_{smap} is better): This is not true for forests. For forests, ET_{smos} is closer to A than ET_{smap}.
Response : Exactly, ET_{SMAP} performed better than ET_{SMOS} for most PFTs, except forest (Line 770). This may be due to the influence of deep soil moisture in forest type.

55. L. 694 (LAI daily output): LAI products are affected by cloud coverage. Cannot be daily. Is it available every 8 days as mentioned elsewhere?

Response : In our assimilation system, the 8-day average of GLASS LAI were used as observations for each day for assimilation (Line 580-581).

56. L. 725 (72000 mm/yr): Where does this number comes from? Units are wrong.

Response : modified.

57. L. 788: "irrigated site".

Response : modified.