Responses to Comments Made by Reviewer #1:

This manuscript generated a long-time evapotranspiration (ET) dataset, including its three components, for the arid and cold areas of the Tibetan Plateau. The intent of the manuscript is worthy and significant, and the topic generally fits the scope of Earth System Science Data. However, I'm afraid the paper still requires thoroughly editing to reach the level of international publications and before publication is granted. One major concern is that the ET estimation methods were not clear enough, i.e., the MOD16-STM was an existing algorithm, what's your contribution? If introducing soil moisture is, how about the estimates without using soil moisture? Furthermore, the validation is somewhat weird. Particularly the components did not perform any validation or the proposed products did not compare to any existing ET products.

Thank you for your suggestion. We have made a thorough editing of the manuscript. Please check the track change word file. Below is our response to the review`s specific comments. We have introduced the contribution of this paper in the line of 75-100. We developed MOD16-STM at site scale in 2021. However, it is not evaluated at continental scale. This paper upscale the application of MOD16-STM from in-situ scale to the TP regional scale. This is the contribution of this paper. Introducing soil moisture is the contribution of our previous paper, Yuan et al. 2021. We have compared the effects of with and without using soil moisture in that paper. We compared with nearly ten other evapotranspiration products in the revised manuscript. The performance of other existing ET datasets were also evaluated and compared, please see Appendix in our revised version. The longer time coverage is an advantage of our ET dataset. Unfortunately, there are no observations of the ET components until now, only EC observations on the Tibetan Plateau can be used to verify the total ET values or soil evaporation values.

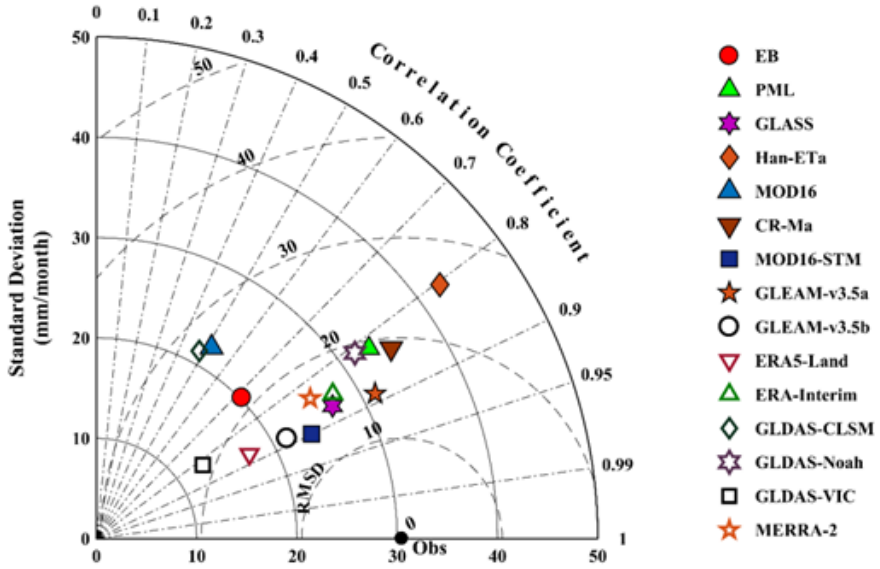

Figure A3 Taylor diagram of the monthly-scale evapotranspiration dataset validated with flux evapotranspiration observations.

Major concerns:

- Introduction section. Although the introduction section was well written, it's unclear why the authors perform this study. I would encourage the authors to directly point out the challenges that the present ET products have, rather than stating a lack of long-term remote sensing ET products (which is not true). Give a clear message to the reader what are the critical problems in the studied topic, why you did the study, and what problem(s) will be solved in the current study.

  Thank you for your suggestion. We agree with the reviewer's suggestions. In the introduction we write that: A considerable variance among the ET products for the TP still exhibit (Peng et al., 2016; Baik et al., 2018; Li et al., 2018; Khan et al., 2018). The Penman–Monteith algorithm has also been used to separately estimate the canopy transpiration (Ec), soil evaporation (Es), and canopy intercepted water evaporation (Ew) (Mu et al., 2011; Zhang et al., 2010) for global land. These ET products perform poorly in TP areas with sparse vegetation or arid to semi-arid climates, as well as in areas with inadequate water supplies. The poor performance of the MOD16 Penman–Monteith model (Mu et al. 2011) in the arid to semi-arid areas of the TP is due to the fact that the algorithm does not take into account the dominant role of the topsoil information (topsoil texture and topsoil moisture (SM)) in controlling the evaporation processes (Yuan et al., 2021). Scientists still have

difficulties to accurately separate and validate the ET components on the TP, even though the total ET estimates are consistent across different products (Lawrence et al., 2007; Blyth and Harding, 2011; Miralles et al., 2016).

All the above contents inform readers that challenges of present ET products faces and the critical problems in the TP ET studies. Because, MOD16-STM may provide us with a high chance to accurately estimate ET`s components. That's why we use the model to estimate ET for the TP region.

- Method section. The authors use a two source PM equation. However, they did not sperate r_s and r_c (Eqs. 1 to 3). In fact, these two resistances as well as resistance for wet canopy (interception) are estimated using different methods in MOD16, but they were estimated in the same way in this study. In addition, the input datasets have different temporal scales and how did you deal with the problem (or model simulation at what kind of temporal scale)? It is also unclear how the estimates were validated. For example, at half-hour or daily scale? How to match the EC tower data with the pixel?

  Sorry for the mistake in eq.1. 'rs' in eq 1 should be 'rc'. We have corrected it in the new version. Hereby, we did not estimate resistance in the same way. We parameterized the evaporation resistance r_s in the Es for different soil moisture in the different soil texture (Equation 15). Meanwhile, the estimated CL parameter value of r_c was calibrated at grassland and taken as 0.0038 in the original MOD16 model for Ec over the Tibetan Plateau.

  The daily and 8-day model-driven data were averaged over the temporal scale to be monthly datasets. We use pre-processed input data at monthly temporal resolution to calculate the ET.

  The results of the long time series simulations are validated by comparing pixels corresponding to the latitude and longitude of flux site with EC measurements. EC hourly measurements have been averaged to monthly values before the evaluation.

- Results section. I'm somewhat confused by the results shown in figure 5, particularly the ET and its component in forest land. The ET can be high as greater than 700 mm, but the Ec looks like only around 150 mm. Could you show some published data to justify the estimates? Moreover, how accurate is the Ei comparing to the other results (e.g., Zheng's product)? In section 3.4, could you show some

comparisons between your estimates and the other products (e.g., using plots)?

Thank you for your suggestion. There is no forest site on the TP. There is no publicly available data for the observations of ET component. This is why we cannot verify the ET model over the forest. In addition, if you look at the following figure, it shows that the forest land only covers a very small area of TP and most of the forest land is around the margin of the TP border. Hereby, ET of the TP forest is not an important issue. We also validated other existing ET datasets, please check the revised Appendix material.

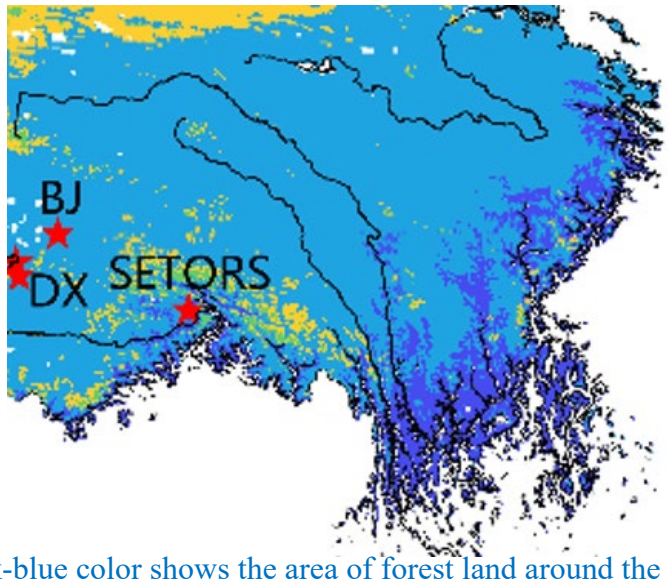

Figure 1, dark-blue color shows the area of forest land around the southeastern border of TP.

- Discussion section. In 4.2, insightful discussion is missing. For example, in ET estimation, a lot of empirical coefficients were used, did they cause any uncertainty?

We added the following paragraph to discuss the issues associated to empirical coefficients: Although the MOD16 model directly estimates ET, avoiding the process of calculating sensible heat. The empirical coefficients for the different soil textures were redefined. There are still some empirical parameters (e.g., CL, the mean potential stomatal conductance per unit leaf area) that can increase the uncertainty of the simulation results. Therefore, it is necessary to parameterize these empirical parameters according to physical processes to reduce the uncertainty of the simulation results in future studies. The influence of the physical processes of deeper soil water and heat transfer on the resistance should be considered. The MOD16-STM algorithm has a great dependence on higher-

precision soil moisture products. Most areas of the TP are covered by permafrost and seasonally frozen soil. It is difficult to grasp the SM conditions during the soil freezing and thawing period. Therefore, it is necessary to use observations during the soil freeze-thaw period to verify the applicability of the model.

Specific comments:

- Line 68. What did you mean by using "the remote nature of the TP"? Line 77-99. It mentioned that "It is also difficult to separate and validate the ET components effectively." Maybe a comprehensive validation of the ET components is needed to prove that this challenge has been overcome in this dataset. Otherwise, the product does not solve the problem mentioned in the introduction section: "Interestingly, there are significant differences in the global and regional contributions of the Es, Ec, and Ei even if the total ET estimates are consistent across different products (Lawrence et al., 2007; Blyth and Harding, 2011; Miralles et al., 2016)."

  (1) "The remote nature of the TP" was changed to 'complex environment of the TP'.

  (2) I think the reviewer also agree that a full comprehensive ET components validation is not possible for the TP region. There is no ET components observation at all. In the MOD16-STM model development paper, Yuan et al. 2021, we have innovated a method how to verify and enhance ET components at site scale. We assume that the land cover is bare soil in winter, eddy covariance only observes soil evaporation, hereby, we use winter data to optimize the rs to enhance the soil evaporation equation. Then the enhanced soil evaporation equation was fixed and applied to the summer time. The observed canopy transpiration was assumed to be EC measured ET minus the soil evaporation calculated by the MOD16-STM. The observed canopy transpiration was then used to calibrate C_L and rc. These two steps make us believe that the ET components estimation is reliable.

- Figure 1. It is better to use different color for each panel. Where are these data from?

  Thank you for your suggestion. We have modified the caption of figure1 in the revised manuscript as: Figure 1. Maps of the (a) topography (STRM), (b) climate zones (FAO aridity index), (c) land cover types (MCD12C1), and (d) soil textures

(HWSD) in the study area. The red dots indicate the flux site locations.

- Line 82-83. "The MOD16 algorithm is also used to separately estimate…" may be better.

  Thank you for your suggestion. We have modified the sentence in the revised manuscript as: The MOD16 algorithm is also used to separately estimate the canopy transpiration (Ec), soil evaporation (Es), and interception (Ew) (Mu et al., 2011; Zhang et al., 2010).

- The authors claim that the new ET product exhibited acceptable performance on the TP based on nine flux towers. Overall, it is agree well with the flux tower ET (Figure 3j), but overestimation occurred at lower ET rates and underestimation at larger ET rates (obviously in Figures 3d, e, f, i). It is better to give some explanation and make insightful discussion (or improvement).

  Thank you for your suggestion. The overestimation at lower ET rates may be due to the fact that r_s is underestimated and ET is overestimated. Conversely, underestimation occurred at larger ET rates in summer, probably because the soil was close to saturation and r_s was overestimated leading to an underestimation of Es.

- Is it necessary to use a question for a section title?

  We have modified the sentence in the revised manuscript as: 2.2 Generate a long-term series of monthly ET products

- I'm quite confused by using the MOD16-STM. What does STM mean (or abbreviation for what)?

  Thank you for your suggestion. The full name of STM is "soil texture model". We explain it in the revised manuscript.

- In the following paragraph, the writing style of T* was varied. Please unify them.

  Thank you for your suggestion. "*T**" was used everywhere in the new manuscript now.

- Although the 18 ET products are proved with accept accuracy, they show a large uncertainty in both trends and averaged ET on the TP. To compare their performances on the TP, it is suggested to compare the averaged ET from these products to the EC measurements (i.e., monthly and annual scales) and water balance method.

  Thank you for your suggestion. We add two new figures to compare the ET products. Please check figure A3, A4 in the Appendix.

- Be careful when using “very”, for example Lines 37, 63, 277, 361, etc.

  In the manuscript, we replaced "very" with "quite".

- Figure 4. It is unclear which data is observation and which is observation.

  Thank you. We have modified the caption of figure 4 in the revised manuscript as: Figure 4 Time series variations in the MOD16-STM simulated ET (blue solid line with ‘*’ marks) and flux-tower-observed ET (red circles) at (a) SETORS, (b) Arou, (c) HB, (d) QOMS, (e) DX, (f) NAMORS, (g) BJ, (h) SH, and (i) NADORS.

- Figure 5. What does Ew mean?

  “Ew” means soil and canopy intercepted water evaporation.

- Figure 10. The legends include CR-Ma, while it is not shown in the figure.

  Thank you. This is a mistake. We have indicated which line is CR-Ma in the figure.

- It seems the conclusion is too long.

  Yes, we have made the conclusion part short and concise. Please check the track change file.