Response letter to comments (egusphere-2024-1321)

The following is a point-to-point response to reviewer #1's comments.

We appreciate these comments/suggestions. They would help to significantly improve the quality of this study. Specific revisions and responses to each comment are provided in detail below. Please note that the comments from the reviewer are in ***italics*** followed by our responses in **regular** text.

Response to the comments of Reviewer #1:

Comment 1

The manuscript presents an analysis of six different Potential Evapotranspiration (PET) methods using data from 170 flux sites, with an additional aim to link these analyses to irrigation water requirements (IWR). While the paper extends the dataset size compared to Wouter et al.'s 2019 study, there are significant issues that need addressing before this work can be considered for publication in the HESS journal.

Response: Thank you for your constructive comments. In addition to including more sites in this study, we used a model with physically consistent processes to evaluate common PET methods. We hope the revised manuscript, with a more in-depth analysis about the Irrigation Water Requirement (IWR), will address your concerns.

Comment 2

Clarity of research contribution: The manuscript claims to enhance the understanding and quantification of different PET and IWR estimation methods based on data availability and physical considerations (L23). However, the contribution in terms of IWR is not clearly demonstrated in the results or discussed in the conclusion. It would strengthen the paper to explicitly quantify and discuss the differences and implications of these estimation methods on IWR.

Response: Thank you for your suggestion. Indeed, we overlooked calculating PET after found significant differences within the PET values obtained from these methods. Additionally, because it is very difficult to estimate ETa using these methods, we did not compare the IWR calculated by different PET methods. In the revised version, we will calculate the IWR with the estimated PET by different methods and the observed ETa at each site, and a more detailed analysis of IWR will be presented.

Comment 3

Structure and cohesion: The paper is structured around two main objectives: validating various PET methods and proposing a model for IWR calculation. However, the connection between these objectives is not well articulated, leaving the reader unclear on how they interrelate and support a cohesive thesis. The introduction fails to link these sections logically.

Response: Thanks for your comment. The core of calculating IWR is accurately estimating PET and ETa. This study uses the STEMMUS-SCOPE model, which incorporates physically consistent processes, to calculate ETa and PET, and subsequently IWR. In the revised version, we will reconstruct this section to address this issue.

Comment 4

The conclusion briefly mentions IWR without integrating it into the key findings.

Response: Thank you for pointing out this issue. In the revised version, we will expand on the IWR in the Results, Discussion, and Conclusion sections. Specifically, we will select representative sites to evaluate the effectiveness of the IWR calculated by the STEMMUS-SCOPE model.

Comment 5

Further, the description and justification of the STEMMUS-SCOPE model used are insufficiently detailed. This model is very important as the PET calculated by this model is used as a reference to assess the 6 PET formulas.

Response: Because of the model's structural complexity, we did not provide a detailed introduction and description in this paper. In the revised version, we will provide a clear technical road map (Fig. 1) and include key formulas in the Appendix. Following previous studies that calculate ETa using PET and a water stress factor (WSF), we calculate PET in this study using ETa/WSF.

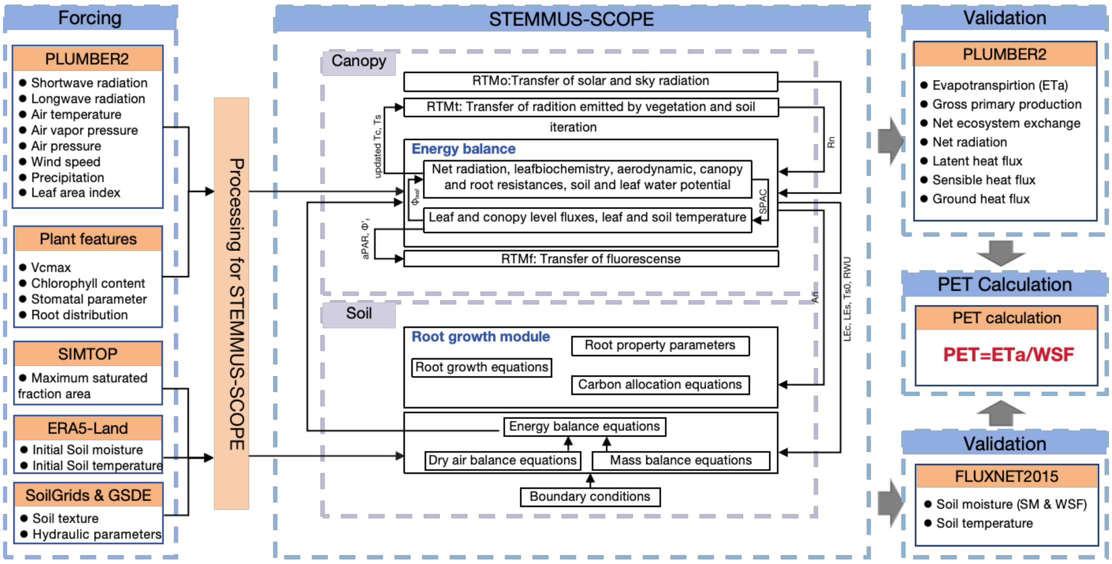

Figure 1: Technology road-map to generate the data in this study.

Comment 6

Then I am curious about how this model works, if it works better than 6 PET formulas, and how accurate/uncertain this model is. However, this information is largely ignored in this paper.

Response: This study primarily uses model-estimated PET to evaluate other commonly used PET models. Regarding model accuracy, some results at the site scale have already been published (Wang et al., 2021; Tang et al., 2024). As for the simulation results at the 170 sites, we plan to publish it in another paper (is under reviewing by Scientific Data). This is also why we did not elaborate much on the model operation and validation in this paper. This pater only focuses on the usage of the datasets that has already been published on Zenodo (Wang et al., 2024). Overall, the model well simulated Rn, LE, H, GPP, and SM globally and the seasonal variations of fluxes were also captured. Some key figures (Fig. 2 and 3) will be presented in the revised version and are as follows.

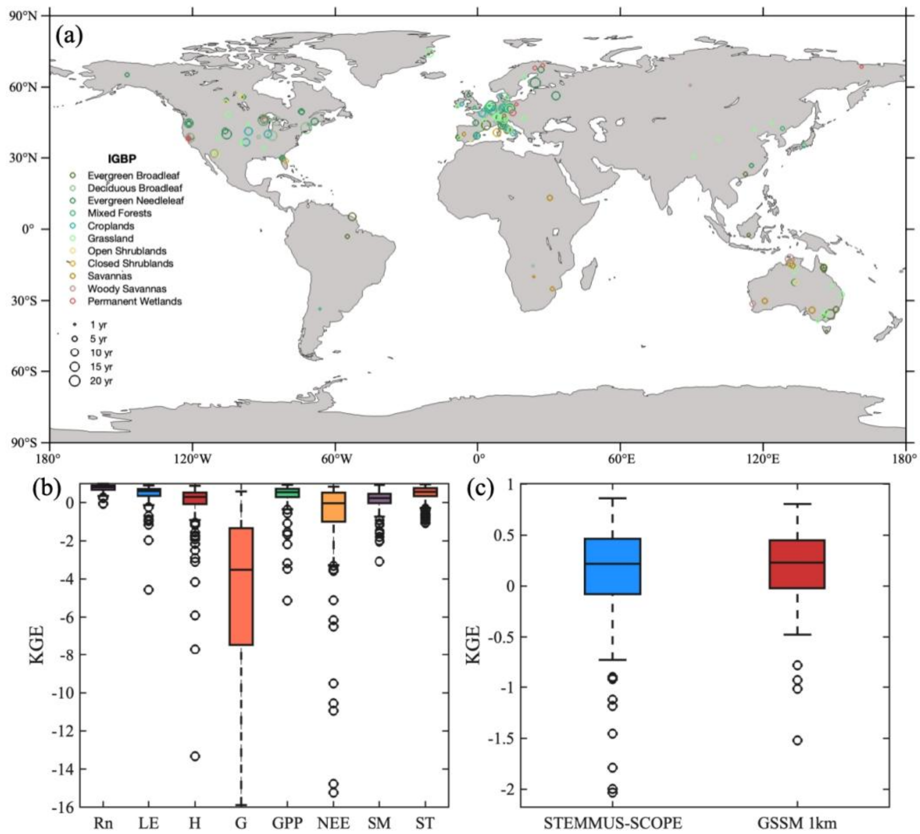

Figure 2. (a) Global distribution of PLUMBER2 sites; (b) Performance (Kling–Gupta efficiency, KGE) of STEMMUS-SCOPE (box plots) for the validation set of observations; (c) Performance (KGE) of STEMMUS-SCOPE and GSSM 1km (box plots) for the validation set of observations. The box plots show (from top to bottom) the maximum, 75th percentile, median, 25th percentile, and minimum. The whiskers extend to the most extreme data points not considered outliers, and the outliers are plotted individually using the ‘○’marker symbol.

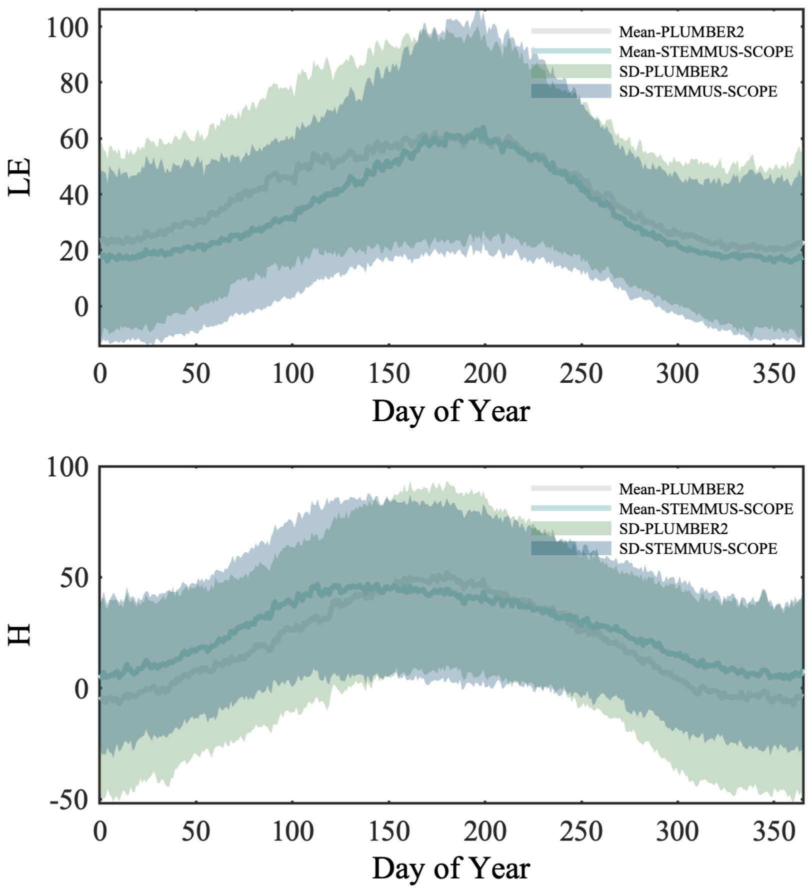

Figure 3. Time series of modeled and observed daily LE and H for 170 sites. (The solid line represents the mean daily values of 170 sites, and the shaded area indicates the standard deviation of these 170 sites)

Comment 7

Terminology and definitions: What is the meaning and definition of plant water requirement? It appears once in the title and twice in the abstract, and then disappears in the rest of the text. Is plant water requirement equal to PET, ET0, or IWR? A precise definition of each term at the outset, and consistent usage throughout the paper, are necessary to ensure clarity and professionalism.

Response: Thank you for your comment. In this study, plant water requirements means the IWR. Incorporating Reviewer #2's comments, we plan to use "plant water deficit" instead of "irrigation water requirement". And a clear definition of plant water deficit will be provided in the revised version.

Comment 8

Introduction: The introduction is not well-organized with convincing logical lines, which leads to your research questions. In the whole paragraph from L44 to Line L52, there is no one reference to support your description, which is not a professional way *of academic writing. For example, in the sentence "Across various research endeavors, semi-empirical methods and process-based models have demonstrated noteworthy prolificacy in ET0 estimation by leveraging the limited climatic variables as inputs.", references are needed to demonstrate "Across various research endeavors".*

Response: Thank you for your suggestion. We acknowledge that the current Introduction section overly emphasizes the computation of PET and neglects its role in calculating IWR. In the revised version, we will reorganize this section to focus on the calculation of IWR first. And we will explain the significance of PET for IWR and highlight the issues associated with current PET methods.

Comment 9

Figures: The figure 1 and 3 suffer from low resolution. The width of the bars in Figure 3 should be the same.

Response: The resolution of figure 1 and 3 have been improved and the font size of figure 3 are enlarged. The width of the bars in Figure 3 are also be keep consistent.

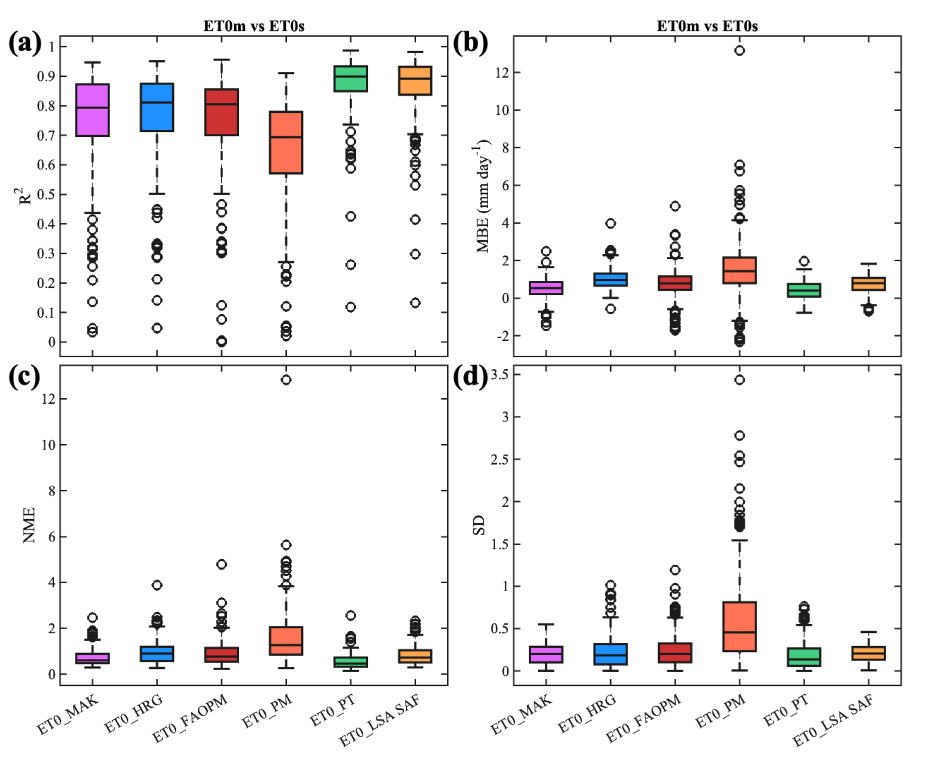

Figure 4. The (a) Coefficient of determination (R^2), (b) Mean bias error (MBE, in mm day^{-1}), (c) Standard deviation (SD), and (d) Normalized mean error (NME) between calculated daily potential evapotranspiration ($ET0_m$) using different formulas and modeled daily potential evapotranspiration ($ET0_s$) by STEMMUS-SCOPE at 170 flux sites.

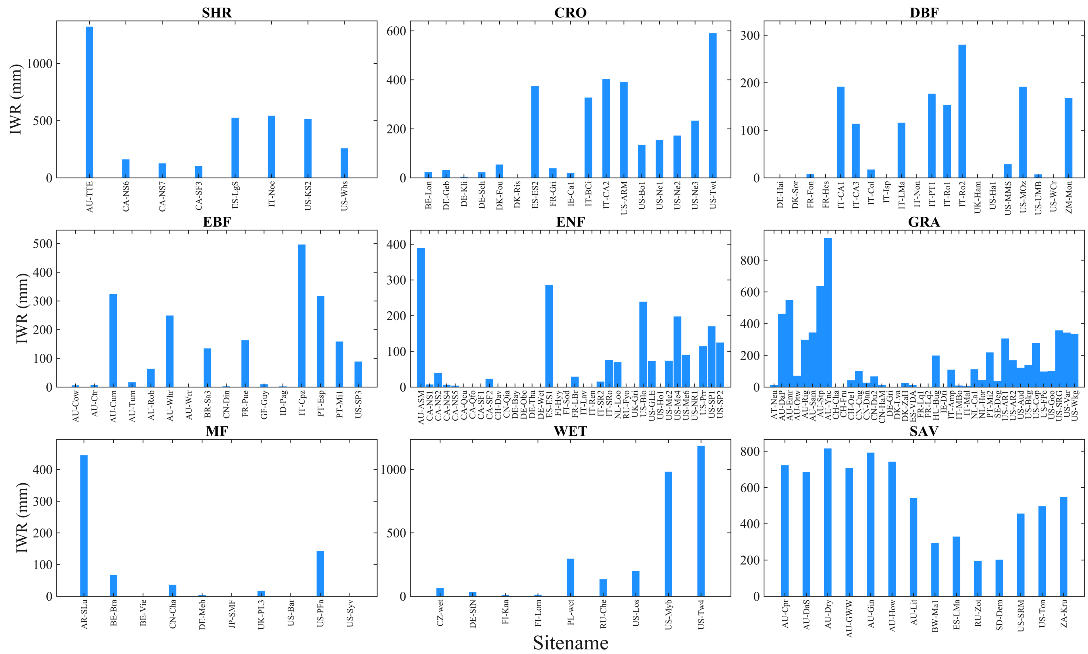

Figure 5. The calculated irrigation water requirement (IWR) by STEMMUS-SCOPE for different vegetation types at 170 flux sites.

Comment 10

Summary: The manuscript could have potential but requires significant revisions for research questions, narrative flow, and overall manuscript presentation, particularly in defining and integrating its key components—PET and IWR estimation. I recommend a thorough restructuring to better align this journal's expectations.

Response: Thank you again for your comments on the structure and key components of this manuscript. I hope its readability would be significantly improved with above-mentioned modifications and the revised version could be reconsidered by you.

References:

Wang, Y. et al. Integrated modeling of canopy photosynthesis, fluorescence, and the transfer of energy, mass, and momentum in the soil–plant–atmosphere continuum (STEMMUS–SCOPE v1.0.0). Geoscientific Model Development 14, 1379-1407 (2021). https://doi.org/10.5194/gmd-14-1379-2021

Tang, E. et al. Understanding the effects of revegetated shrubs on fluxes of energy, water, and gross primary productivity in a desert steppe ecosystem using the STEMMUS–SCOPE model. Biogeosciences 21, 893-909 (2024). https://doi.org/10.5194/bg-21-893-2024

Wang, Y. et al. STEMMUS-SCOPE for PLUMBER2: A Physically Consistent Dataset Across the Soil-Plant-Atmosphere Continuum (v1.0.3). Zenodo, (2024). https://zenodo.org/records/11323245.