RESPONSES TO COMMENTS FROM REVIEWERS #2

Sun et al. provide a valuable estimate of global potential evapotranspiration (PET), which is highly beneficial for various research applications. The authors have taken into account various factors that influence PET estimation and have prepared multiple datasets to derive the PET values. The manuscript is well-structured, with clear method descriptions, data processing procedures, and explanations. Overall, the manuscript could be accepted with some comments to further enhance its quality.

Response: We thank this reviewer very much for the positive comments and the valuable suggestions, which are believed to be very useful for us to improving the study. Seriously according to these suggestions, we have revised this manuscript, and the detailed information could be found below and the revised version.

Major comments:

Comment 1: What are the valid temporal resolutions (e.g., hourly, monthly) for the inputs used in different models (i.e., equations)? Different meteorological datasets have varying temporal resolutions, such as 3-hourly for MSWX and monthly for others. When equations are used to calculate PET and related variables (e.g., D, Rn) to derive PET, it is important to consider whether these equations, as presented in the main text and supplementary materials, are valid for different temporal resolution inputs (e.g., 3-hourly vs. monthly). For example, can the SW equation be applied to different temporal resolution inputs (e.g., hourly or monthly)? It would be helpful to provide information on the validity of the equations for different temporal resolutions of inputs, whenever applicable. Additionally, the SW model was calibrated based on daily inputs (as shown in Figure 3). However, when applying the SW model globally, monthly inputs were used. The question arises whether it is appropriate to use a daily calibrated model for monthly inputs application.

Response: Thank for you recommendations. When calibrating the SW model at the EC sites, the daily inputs was used. However, when applying the calibrated SW model at the globe, the monthly mean inputs was used. For confirming that the monthly inputs could be used to drive the SW model calibrated using the daily inputs, we have re-produce PET based on the daily meteorological variables from MSWX-Past, MERRA-2 and ERA-5, and then compared the new estimates to the original ones PET based on the monthly meteorological variables from the three datasets (Figure R1). Seen from Figure R1, it is not difficult to find that there are no evident differences in the two

PET estimates, expect for April and May with larger ME (around 6 mm) and ubRMSE (around 12 mm) and lower KGE (around 0.4). This implies that the SW model established based on the daily data could be driven using the monthly meteorological variables. Moreover, for stating that the SW model based on the daily data could be applicable at the monthly scale, we have added the related description in the revision, such as "*Considering that the SW model was calibrated with the daily EC measurements, it was necessary to examine whether this model could be applicable at the monthly scale. Therefore, we firstly compared the monthly PET estimated based on the daily and monthly meteorological variables from MSWX-Past, MERRA-2 and ERA-5 (not including CRU TS4.06 mainly due to it with a monthly scale). Various validation metrics showed that there were generally no evident differences in the two PET estimates (Figure S4). That is, the model established with the daily EC measurements could be driven using the monthly meteorological variables.*" **(L312-317)**

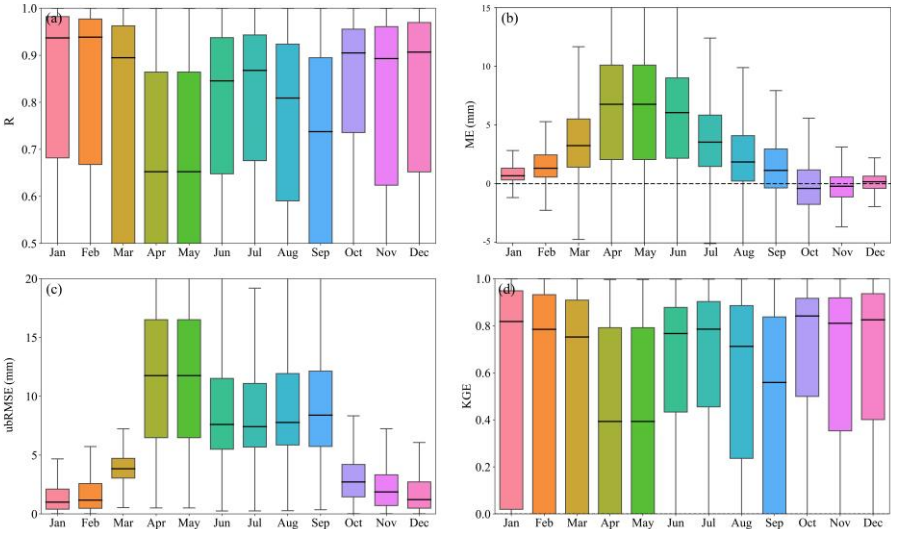

Figure R1: Comparison of the monthly PET estimates based on the daily and monthly meteorological variables. The outer edges of the boxes and the horizontal lines within the boxes indicate the 25th, 75th, and 50th percentiles of the validation metrics.

Comment 2: It would be highly valuable if the authors could provide the datasets that were used to derive PET. This would include the following: EC related datasets, e.g., the original datasets after quality control, selected datasets with no soil water limits, etc; Finally processed canopy height, and/or its source datasets; Land use/land cover, LAI, saturated water content in soil, and the CO_2 concentration. Question for the CO_2 concentration, the seasonal cycle of CO_2 is different among different locations, e.g., between south and north hemisphere, will this affect your PET estimation?

Response: We thank this reviewer very much for the suggestions. In fact, all the original datasets could be found in the corresponding websites or the literatures, which have been introduced in details in the paper. We are pleasured to distribute the processed datasets, only if the readers contact us. Additionally, we have also showed a statement in the acknowledgement, such as "*The source code for the model used in this study and input files necessary to reproduce the simulations is available from the authors upon request (sun.s@nuist.edu.cn).*"

Thanks for your comments. For considering spatial differences in CO_2, we have recalibrated the SW model and reproduced PET, PT and PE with the gridded CO_2 dataset (i.e., the monthly CO_2 concentration with a spatial resolution of 1◦ × 1◦ and a time span of 1850–2013 from https://doi.org/10.5281/zenodo.5021361 (Cheng et al., 2022), and the monthly Global CO_2 Distribution product from Japan Meteorological Agency with a spatial resolution of 2◦ × 2◦ and a time span of 1985–2021). The detailed information could be found in the revision.

Comment 3: About SW model:

1) How about you add a concept diagram to show the structure of SW and related equation variables. One example for your reference, Figure 5 in Kochendorfer, J. P. and Ramírez, J. A.: Modeling the monthly mean soil-water balance with a statistical-dynamical ecohydrology model as coupled to a two component canopy model, Hydrol. Earth Syst. Sci., 14, 2099-2120, https://doi.org/10.5194/hess-14-2099-2010, 2010.

2) EQ 1a, should the Cc be removed. Why not the total latent heat doesn't equal the sum of canopy and vegetation latent heat fluxes, but need multiply the coefficients, could you add some explanation?

$\lambda ET = \cancel{C_c} PM_c + \cancel{C_s} PM_s$**?**

3) It would be helpful if the authors could provide an explanation for the calculation of LAIe in EQ2b and clarify the reasoning behind this approach. What is the underlying assumption or basis for this equation? When you calibrate the SW model using EC data with filtering out the rain effects, so most of the LAI should be likely effective (no rain coverage over the leaves), why the LAIe is still calculated in EQ2b (i.e., LAIe is less than LAI when LAI>2)?

When you apply the calibrated SW model for global, the effective LAI should be considered due the reasons of rain. The LAIe should be related to different conditions (e.g., different rainfall intensity) but not considered in the EQ2b.

It seems there is inconsistence. When calibrating SW model using no-rain effects data, but applying effective LAI (i.e., from EQ2) when the rain effects is small. But the same LAIe equation are used for the global application, when under some conditions rain effects may be large. The PET calculation should also include

the maximum ET during rain or after rain events, right?

4) I wonder how to consider the LAIe for PET calculation at EC site level and global grid. How is the SW PET sensitivity to LAIe?

Here I only say rain effects on LAIe, but other factors may also effect LAIe calculations, e.g., snow.

Response: 1) Thanks for your suggestion. The schematic of the Shuttleworth-Wallace (1985) two component canopy model has been shown below (Figure R2) and in the revised manuscript.

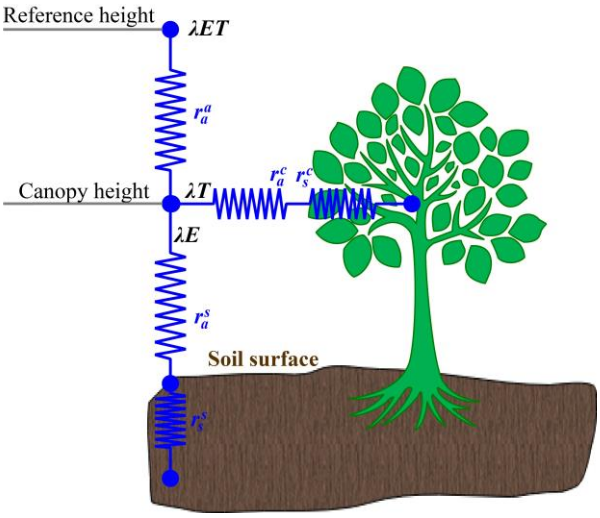

Figure R2: Schematic description of the energy partitioning for a canopy with the SW model.

2) We are sorry that the EQ. 2 confuses you. Now, we have rewritten this equation below and in the revision.

$$\begin{cases} \lambda ET = \lambda Tr + \lambda E & (R1) \\ \lambda Tr = C_c PM_c & (R2) \\ \lambda E = C_s PM_s & (R3) \end{cases}$$

It is not difficult to find that the total latent heat (λET) equals to the sum of canopy (λTr) and vegetation latent heat fluxes (λE). In the following text, we will explain why PM_c dose not equal to λTr and PM_s dose not equal to λE. Based on Shuttleworth-Wallace (1985), λTr and λE can be expressed as,

$$\begin{cases} \lambda Tr = \dfrac{\Delta(A - A_{soil}) + \rho c_p D_0 / r_a^c}{\Delta + \gamma(1 + r_s^c / r_a^c)} & (R4) \\ \lambda E = \dfrac{\Delta A_{soil} + \rho c_p D_0 / r_a^s}{\Delta + \gamma(1 + r_s^s / r_a^s)} & (R5) \\ D_0 = D + [\Delta A - (\Delta + \gamma)\lambda ET] r_a^a / \rho c_p & (R6) \end{cases}$$

where D_0 represents the vapour pressure deficit at the canopy source height. Therefore, by introducing EQ. (R6) into EQs. (R4) and (R5) and then EQ. (R1), we can obtain,

$$\begin{aligned}\lambda ET\{[(\Delta+\gamma)r_a^s+\gamma r_s^s][(\Delta+\gamma)r_a^c+\gamma r_s^c]+(\Delta+\gamma)r_a^a[(\Delta+\gamma)r_a^c+\gamma r_s^s]+(\Delta+\gamma)r_a^a[(\Delta+\gamma)r_a^s+\gamma r_s^s]\}\\ =\left(\Delta A_{soil}r_a^s+\rho c_pD+\Delta Ar_a^a\right)[(\Delta+\gamma)r_a^c+\gamma r_s^c]\\ +\left[\Delta(A-A_{soil})r_a^c+\rho c_pD+\Delta Ar_a^a\right][(\Delta+\gamma)r_a^s+\gamma r_s^s]\end{aligned}\tag{R7}$$

If we define

$$\begin{cases}R_a=(\mathit{\Delta}+\gamma)r_a^a & (R8)\\ R_s=(\mathit{\Delta}+\gamma)r_a^s+\gamma r_s^s & (R9)\\ R_c=(\mathit{\Delta}+\gamma)r_a^c+\gamma r_s^c & (R10)\end{cases}$$

and substitute these into EQ. (R7), we can get

$$\begin{aligned}\lambda ET(R_sR_c+R_cR_a+R_sR_a)\\ =[\Delta A(r_a^a+r_a^s)+\rho c_pD-\Delta(A-A_{soil})r_a^s]R_c\\ +\left[\Delta A(r_a^a+r_a^c)+\rho c_pD-\Delta A_{soil}r_a^c\right]R_s\end{aligned}\tag{R11}$$

Based on $R_a+R_s=(\mathit{\Delta}+\gamma)(r_a^a+r_a^s)+\gamma r_s^s$ and $R_a+R_c=(\mathit{\Delta}+\gamma)(r_a^a+r_a^c)+\gamma r_s^c$, we can rewrite EQ. (R11) as,

$$\lambda ET(R_sR_c+R_cR_a+R_sR_a)=PM_sR_c(R_s+R_a)+PM_cR_s(R_c+R_a)\tag{R12}$$

where $PM_s=\frac{\mathit{\Delta}A+[\rho c_pD-\Delta r_a^s(A-A_{soil})]/(r_a^a+r_a^s)}{\mathit{\Delta}+\gamma[1+r_s^s/(r_a^a+r_a^s)]}$ and $PM_c=\frac{\mathit{\Delta}A+(\rho c_pD-\Delta r_a^cA_{soil})/(r_a^a+r_a^c)}{\mathit{\Delta}+\gamma[1+r_s^c/(r_a^a+r_a^c)]}$.

Finally, EQ. (R12) can be rewritten as,

$$\begin{cases}\lambda ET=C_cPM_c+C_sPM_s & (R13)\\ C_c=[1+\dfrac{R_cR_a}{R_s(R_c+R_a)}]^{-1} & (R14)\\ C_s=[1+\dfrac{R_sR_a}{R_c(R_s+R_a)}]^{-1} & (R15)\end{cases}$$

Seen from the derivation above, we could find that PM_c dose not equal to λT and PM_s dose not equal to λE. However, λTr and PM_c (λE and PM_s) exist a certain functional relationship. Because the derivations above can be found in Shuttleworth-Wallace (1985), in the revision we will not provide the complete derivation. However, the related revision has been shown in the revision for more clarity.

3) Maybe this reviewer misunderstands the definition of the effective LAI (*LAIe*) used in this study, mainly due to our uncomplete description of *LAIe*. Here, *LAIe* is the LAI that actively contributes to the surface heat and vapour transfer, and is generally the upper, sunlit portion of a dense canopy (Allen et al., 1998). Therefore, the canopy resistance (r_s^c) is not dependent on LAI rather than *LAIe*. Many studies (Gardiol et al., 2003; Li et al., 2016; Zhang et al., 2016) have showed that the function between r_s^c and *LAIe* can be expressed as $r_s^c=r_{\text{smin}}/LAIe$, when no considering other environmental factors (vapour pressure deficit, air temperature, soil moisture and CO_2 concentration). Due to illumination-induced stomatal closure deeper in the canopy, there exist a complex functional

relationship between LAI and *LAIe* (Gardiol et al., 2003), such as

$$LAIe = \begin{cases} \mathrm{LAI}, & \mathrm{LAI} \leq 2 \\ 2, & 2 < \mathrm{LAI} < 4 \\ \mathrm{LAI}/2, & \mathrm{LAI} \geq 4 \end{cases} \qquad (R16)$$

In this study, the calibrations for the SW PET model were based on the EC observations in days without rain, mainly because the EC system can not observe ET in rainy days. The processing procedure of filtering out rainy days only aims to remove the invalid ET observations and their corresponding climate variables.

Seen from definition, the used *LAIe* in this study is independent on rain. However, we agree with the reviewer that when rain happens, the leaves will be covered by rain at a certain time and then the *LAIe* will be smaller compared to the period without rain. Therefore, the corresponding r_s^c decreases, potentially increasing transpiration and then ET. Considering the rainy or snow days to be smaller relative to other days, we believe that such impacts on *LAIe* and then PET may be much limited. Anyway, we have showed the related discussion in this revision, such as "*Considering that this LAI product was based on the 8-day maximum value composite for removing impacts of cloudy days, the LAIe (based on EQ. 3b) was potentially larger than its authentic value due to some leaves covered by rain or snow. Thus, from EQ. 3b,* r_s^c *may be slightly underestimated, leading to an overestimation in PT and PET.*" **(L578-580)**

4) For quantitatively examining impacts of *LAIe* on the PET estimates, we have designed four experiments with *LAIe* increases by 1%, 5%, 10% and 20% at EC site level. Comparison between the original and the new estimates showed that with increases in *LAIe* the PET and PT (PE) would like to increase (decrease), mainly due to r_s^c reductions induced by increased *LAIe* (Figure R3(a1-3)). Furthermore, we have also calculated sensitivity of PET, PT and PE to *LAIe* changes (i.e., PET, PT or PE changes in response to 1% changes in LAIe). Results showed that in response to LAIe increases by 1%, PET (PT) would like to generally increase by 0.4-0.6% (0.4-0.8%) while PE would like to decline by 0.05-0.4% (Figure R3(b1-3)). Moreover, the sensitivity of PET, PT and PE to *LAIe* changes varied among LULC types. Overall, the PET, PT and PE is sensitive to *LAIe* changes. However, we should note the fact that relative to days without rain and snow, the rainy and snow days were usually much smaller, and the rain or snow intercepted by leaves may be evaporated quickly or blown away by wind. Therefore, we believed that the potential uncertainties related to *LAIe* was much limited.

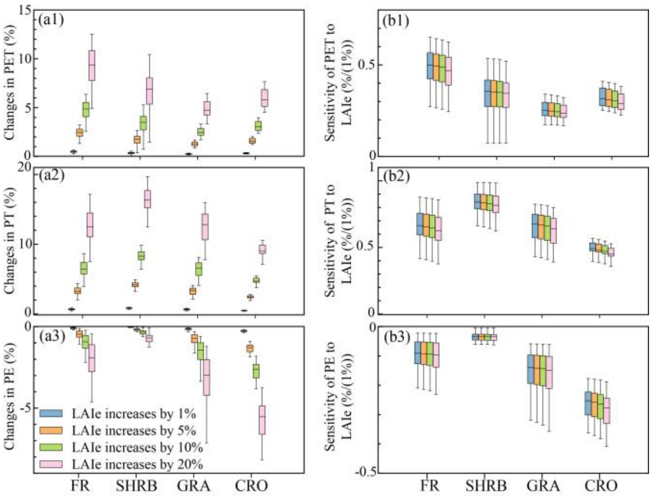

Figure R3: Changes in PET (a1), PT (a2) and PE (a3) with *LAIe* increases by 1%, 5%, 10% and 20%, and sensitivity of PET (b1), PT (b2) and PE (b3) to *LAIe* changes (which represents PET, PT or PE changes in response to 1% changes in *LAIe*)

References:

Allen, R.G., Smith, M., Perrier, A., Pereira, L.S., 1993. Updated reference evapotranspiration definition and calculation procedures, Revision of FAO Methodologies for Crop Water Requirements. 36 pp.

Gardiol, J. M., Serio, L. A. and Maggiora, A. I. D.: Modeling evapotranspiration of corn (Zea mays) under different plant densities. Journal of Hydrology, 217, 188–196, 2003.

Li, X., Kang, S., Li, F., Jiang, X., Tong, L., Ding, R., Li, S. and Du, T.: Applying segmented Jarvis canopy resistance into Penman-Monteith model improves the accuracy of estimated evapotranspiration in maize for seed production with film-mulching in arid area. Agricultural Water Management, 178, 314–324, 2016.

Zhang, B. Z., Xu, D., Liu, Y., Li, F. S., Cai, J. B. and Du, L. J.: Multi-scale evapotranspiration of summer maize and the controlling meteorological factors in north China. Agricultural and Forest Meteorology, 216, 1–12, 2016.

Comment 4: It would be beneficial to have a clear explanation of how PT and PE are calculated differently. Currently, there are no specific equations provided to illustrate the calculations for PE and PT. It appears that PT is derived from PMc, while PE is also derived from PMc. It is important to clarify this distinction and explicitly mention that PT and PE are derived from PMc in the study. Additionally, please review the sentence in line 238 that states "while PMc and PMs are the soil and vegetation latent heat fluxes (W/m2)" to ensure the correct explanation of parameters and variables throughout the equations. Furthermore, it is worth considering the inclusion of discussions on the explicit consideration of plant hydraulics in recent land surface models (e.g., CLM5 in 2019, NOAH-MP in 2021, CoLM in 2022) as it relates to transpiration

simulations. I am interested to know whether the SW model implicitly incorporates plant hydraulics or if there are potential improvements that could be made to the PET estimation by integrating plant hydraulics within the framework of the SW model. Section 4.2 would be an appropriate place to include such discussions.

Related references:

https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2018MS001500

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020MS002214

Response: Thanks for your suggestions. Now, we have shown the specific equations (EQs. 1b and 1c in the revision) to illustrate the calculations for E or PE and T or PT in this revision. We have corrected the mistake as "*Based on EQ. 1b (EQ.1c),* T_r *(E) can be obtained with* C_cPM_c *(*C_sPM_s*) divide by* λ.", and details could be found in the revised manuscript.

We thank the reviewer very much for providing us the useful references about transpiration simulations. In this study, we employed an empirical model (i.e., Jarvis model) to describe impacts of environmental factors on r_s^c and then transpiration, mainly because this model has relatively simple parameterizations and has been widely and successfully used in many hydrological, ecological, meteorological and agricultural studies. However, it should be noted that this study focuses on PET, evaporation and transpiration rather than their actual values. That is, the soil moisture stress was not considered here (i.e., $F_4 = 1$ within *EQ. 3f*), i.e., no water stress for evapotranspiration process. Through reading the two important references recommended by the reviewer, we found that these two papers focused on improvement of vegetation water stress and root water uptake, and therefore to discuss potential applications for the SW PET model may be beyond of our scope. Anyway, we have to admit that the reviewer provided us a valuable suggestion for our future study, i.e., taking the two literatures as reference to define the water stress factor through incorporating plant hydraulics, and then estimating ET, evaporation and transpiration using our PET estimates.

Comment 5: You have presented the trends of PET, PE, and PT, as well as the contributions of changes in PE and PT to changes in PET. I am curious to know which factors, such as changes in meteorological forcings, contribute to the observed changes in PET, PE, or PT. For instance, could the global temperature increase be a significant driver? Furthermore, it would be valuable to include a discussion on how the phenomenon of Earth greening, such as an increase in LAI, may influence your trend analysis. Consider commenting on the potential impacts of Earth greening on the observed trends in PET, PE, and PT.

Response: Thanks for your suggestion. This manuscript aims to introduce the SW "dual source" PET dataset. The work related to attribution analysis that you mentioned is currently underway, and the preliminary results are listed here (Figure R4). As you mentioned, the global temperature increases and the LAI increases are the main factors affecting potential global evapotranspiration changes. Notably, compared to the dominant factor of TA for changes in PET, the area percentages for the dominant factor of LAI for changes in PT and PE is much larger. This is mainly because of the offset effects between positive contributions of greening to PT and negative contributions of greening to PE. Considering that this paper is mainly about the description of the SW PET dataset, the greening impacts on PET will not be shown in this paper. Actually, just considering the greening impacts on evapotranspiration process (e.g., we have stated its importance in the manuscript, such as "*Recently, with climate change and/or intensified human activities, vegetation has greatly changed on regional and even the global scales (Zhu et al., 2016; Chen et al., 2019), including shifts in vegetation types and vegetation greening (i.e., increases in LAI or other vegetation indices), which have altered the allocation of available water and energy (Zhou et al., 2016, 2018; Sun et al., 2022).*"), the observed LAI was selected an important input to accurately estimate PET.

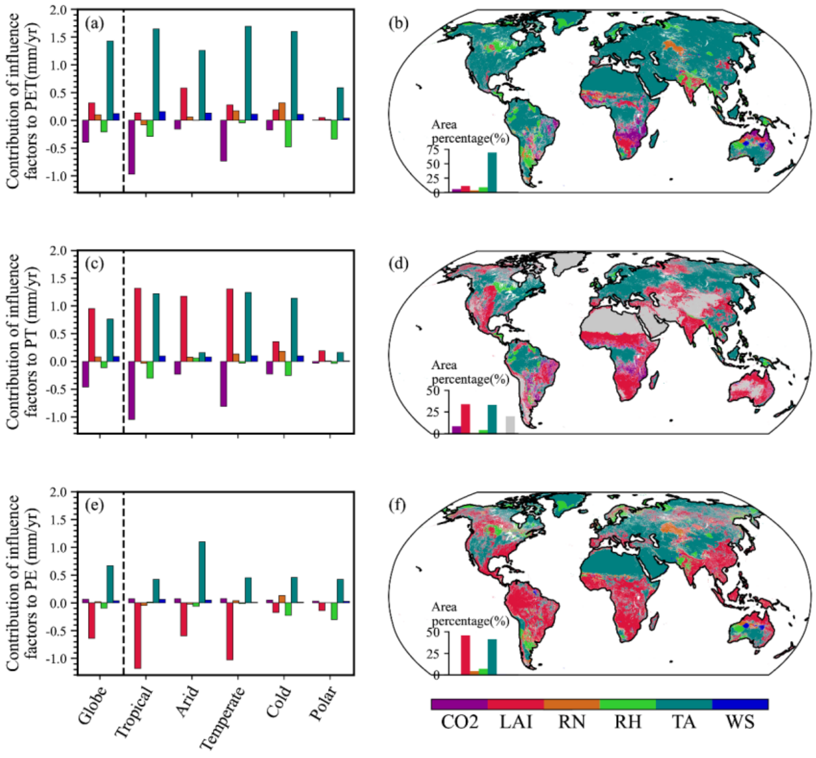

Figure R4: The average contribution of CO_2, LAI, net radiation (RN), relative humidity (RH), temperature (TA), and wind speed (WS) to the global and Köppen-Geiger climate regions annual PET (a), PT (c), and PE (e) trends from 1982 to 2015, and the spatial distribution of dominant factors for annual PET (b), PT (d), and PE (f) trends.

Minor comments:

Comment 1: In the introduction, the authors mentioned different types of models to calculate the PET, and give examples for each type model (e.g., Penman-Monteith). It would be great if the authors can also provide the equations for these example models in the supplementary, so the readers can better compare them. Also please provide the information about the common temporal resolutions of the inputs for these models, hourly or daily or, …

Response: Thanks for your suggestion. The typical PET models have been added in the revised supplementary materials (i.e., Table S1 in the revision), and please see below.

Table R1: Some typical PET models

Proposed by	Equation	Timescale
Dalton (1802)[a]	$PET = (0.3648 + 0.07223u)(e_s - e_a)$	Monthly
Thornthwaite (1948)[b]	$PET = 16N_m(10T_{mean})$	Monthly
Turc (1961)[c]	$PET = 0.013[N_{mean}/(T_{mean} + 15)](R_n + 50)$	Daily/Monthly
Hargreaves and Samani (1985)[c]	$PET = 0.0145K_{RS}R_e(T_a + 17.8)T_d^{0.5}$	Daily/Monthly/Yearly
Penman (1948)[d]	$PET = \dfrac{\Delta H + \gamma(e_s - e_a)f(u)}{\Delta + \gamma}$	Daily
Monteith (1965)[d]	$PET = \dfrac{\Delta(R_n - G) + [\rho c_p(e_s - e_a)]/r_a}{\Delta + \gamma(1 + r_s/r_a)}$	Daily
Allen et al. (1998) (FAO-56 Penman-Monteith)[d]	$PET = \dfrac{0.408\Delta(R_n - G) + \gamma u(e_s - e_a)[900/(T_{mean} + 273)]}{\Delta + \gamma(1 + 0.34u)}$	Hourly/Daily/Monthly

Note: [a], [b], [c] and [d] represent mass-transfer-based, temperature-based, radiation-based, and combination PET models, respectively. T_d are differences in the maximum (T_{max}) and the minimum (T_{min}) temperatures, i.e., $T_d = T_{max} - T_{min}$. K_{RS} is empirical coefficient fitted to R_{ds}/R_e versus T_d data. $f(u)$ is a function of wind speed. r_s represents surface or canopy resistance, while and r_a represents aerodynamic resistance.

Comment 2: In the supplementary, where is "EQ. S7a", should be EQ S4a?. Bold the titles of "The ERA-5 D" and "The MERRA-2 D"

Response: Thanks. We have corrected this mistake. The titles of "ERA-5D" and "MERRA-2D" have been bolded.

Comment 3: Lang et al has another dataset from the webpage:

https://langnico.github.io/globalcanopyheight/, what is the difference between this version of data and the Lang data you used in your study. Should this new data better than what the Lang data you used. You may add some discussion of this. It seems that the canopy height is temporally static, but the LULC changes yearly. How to make the consistence for each year's LULC's canopy height for a given grid if LULC changes happens.

Response: Thanks for your suggestion. The data you mentioned is indeed more novel, high-resolution, and covers a wider range than the Lang data used in this study. It was updated in May 2020, when our global vegetation height data production work was completed. For quantifying impacts of different canopy height data on our PET estimates, we have used this new canopy height data to re-estimate PET (named as PET_{new}) during 1982-2015 in 3 FR and 3 SHRB plots (Figure R5), and then compared the two PET estimates (represented as (PET_{new} – PET in this study) divided by PET in this study). Overall, the different canopy height datasets could cause differences in the PET and its two sub-components estimates, but we should note that the differences of the three variables were generally between -6% and 6%, especially for the FR plots generally between -1% and 1%. This suggested that the differences in PET and its two sub-components induced by different canopy height datasets were limited. Moreover, when producing PET, we have used four canopy height datasets for decreases uncertainties. Meanwhile, considering uncertainties related to the canopy height datasets, the related discussion was also shown in the manuscript, such as "*The reconstructed global vegetation canopy height also has limitations, which may raise from (1) uncertainties in the retrieval algorithms and remote sensing data (Simard et al., 2011; Wang et al., 2016; Potapov et al., 2020; Lang et al., 2021, 2022), (2) neglecting the spatial differences in CRO and GRA heights and using an alternative specific value, and (3) not considering the inter-annual changes in the FR and SHRB canopy heights and the intra-annual cycle in the CRO and GRA heights. These limitations undermine the accuracy of the PET estimates.*" **(L585-589)**

To make the consistence for each year's LULC's canopy height for a given grid if LULC changes happens, we obtained the canopy height at a grid with LUCC using the mean height from the four nearest neighboring grids with the same LULC. Now, we have added the related description in this revision, such as "*In the grid with LULC changes in a certain year, its new h value was assigned as the mean h value of its four nearest neighboring grids with the same LULC.*" **(L234-236)**

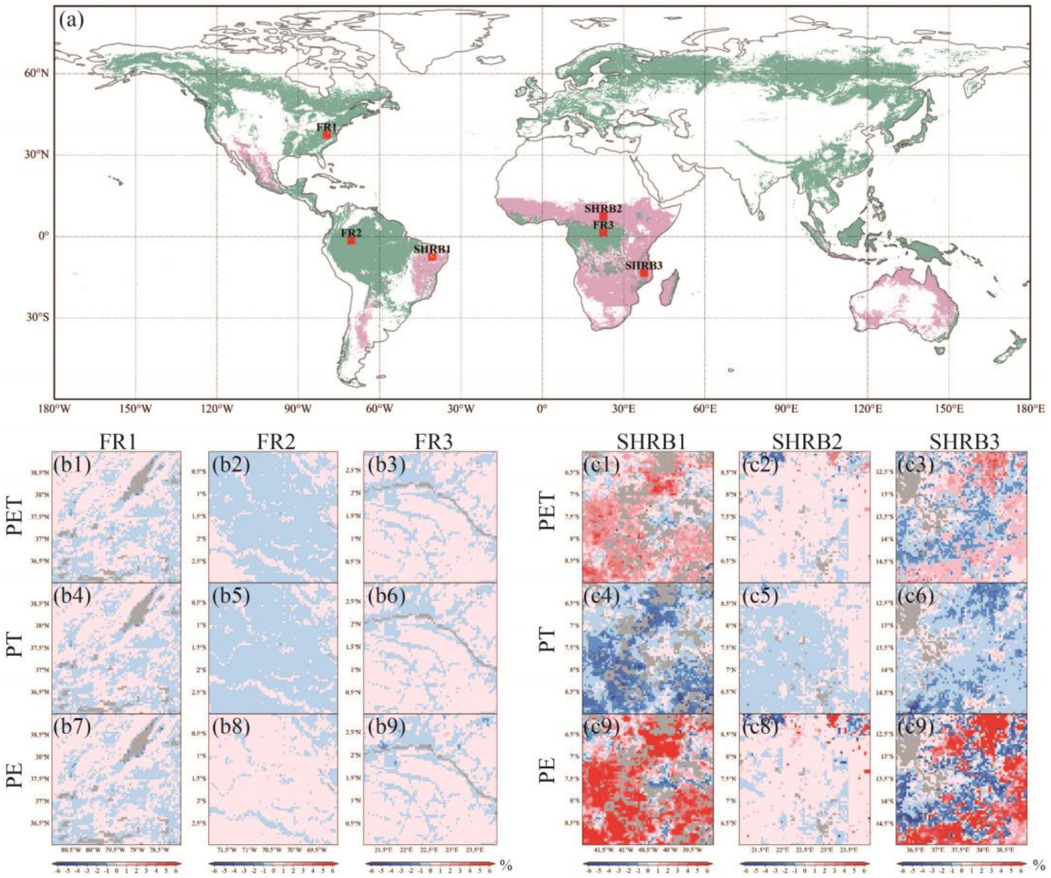

Figure R5: Spatial distribution of 3 FR and 3 SHRB plots (a), and differences in PET (b1-3 and c1-3), PT (b4-6 and c6-6) and PE (b7-9 and c7-9)

Comment 4: L230, r_{smin} should be defined when it first appears.

Response: Thanks. The definition of r_{smin} has been added where it first appears.

Comment 5: How are the averages of PET, PE, PT are calculated based on grid average or area average? Please mention it in the text.

Response: The averages of PET, PE, and PT are estimated based on the area-weighted method. For clarity, the method has been mentioned in this revision.

Comment 6: Check the Figure 8, the colors for scatters and PE PT lines are not consistent.

Response: Thanks for pointing out the mistake. The mistake has been corrected, and please see below or this revision.

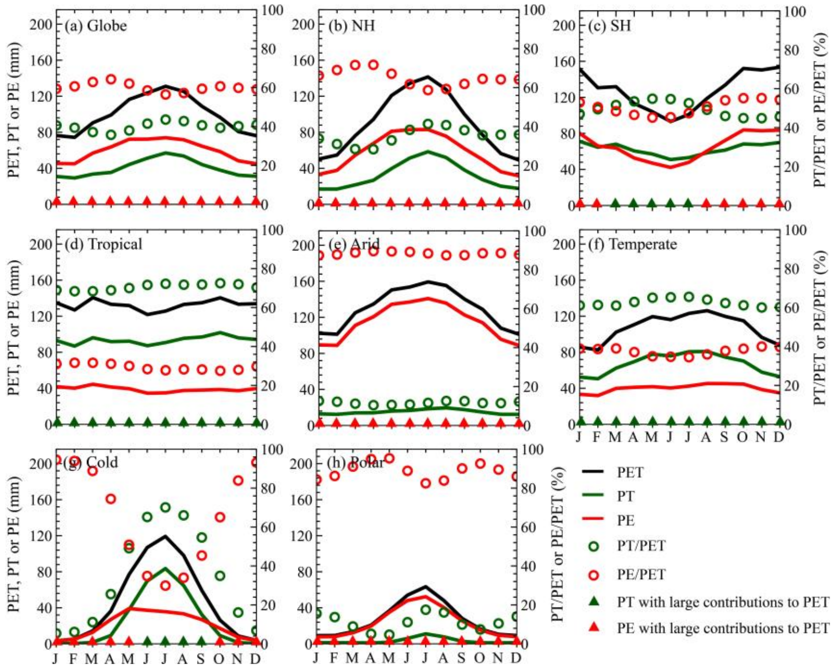

Figure R6: Climatological monthly PET, PE, PT, PE/PET and PT/PET averaged over the globe, each hemisphere, and each KG climate region.

Comment 7: For the calibration of r_{smin}, it would be helpful to know the range of variation among the 10 r_{smin} values for each specific plant functional type (PFT) site.

Response: Thanks for your suggestion. For obtaining the first 10 best r_{smin} values, the method of Hu et al. (2009) was used in this study, and the highest *KGE* was used as the criteria. Therefore, we believe that the first 10 best r_{smin} values should be close. Through checking the range (reflected by the standard deviation) of variation among the 10 r_{smin} values for each site (Table R2), we could find that the standard deviation does be much small at each site. Therefore, we think that it is not necessary to show the range the range of variation among the 10 r_{smin} values for each site, because the first 10 highest *KGE* correspond to the first 10 best r_{smin} and the range should be small.

Table R2: Standard deviation of the 10 r_{smin} values for each site

GLASS-GLC types	Names	Standard deviation	GLASS-GLC types	Names	Standard deviation	GLASS-GLC types	Names	Standard deviation
CRO	US-Bo1	0.33	FR	DE-Obe	0.17	SHRB	ES-Lma	0.60
CRO	IT-CA2	0.26	FR	DE-Tha	0.31	SHRB	AU-TTE	0.23
CRO	US-CRT	0.49	FR	DK-Sor	0.29	SHRB	SD-Dem	0.17

CRO	US-Twt	0.52	FR	FI-Hyy	0.31	SHRB	AU-Dry	0.15
CRO	BE-Lon	0.28	FR	FR-Pue	0.39	SHRB	AU-DaS	0.52
CRO	DE-Kli	0.27	FR	IT-Col	0.37	SHRB	AU-Cpr	0.30
CRO	FR-Gri	0.24	FR	IT-Lav	0.21	GRA	AU-Sam	0.20
CRO	US-ARM	0.28	FR	IT-PT1	0.22	GRA	US-Aud	0.34
CRO	DE-Geb	0.45	FR	IT-Ren	0.21	GRA	PT-Mi2	0.19
CRO	US-Ne1	0.33	FR	IT-Ro2	0.17	GRA	ES-VDA	0.13
CRO	US-Ne2	0.40	FR	IT-SRo	0.38	GRA	HU-Bug	0.32
CRO	US-Ne3	0.41	FR	NL-Loo	0.36	GRA	US-Fpe	0.27
CRO	MSE	0.27	FR	RU-Fyo	0.37	GRA	CN-Du2	0.26
FR	AU-Cow	0.46	FR	US-Blo	0.31	GRA	CN-Du3	0.33
FR	AU-Ctr	0.20	FR	US-Me2	0.30	GRA	RU-Ha1	0.41
FR	CA-Qcu	0.17	FR	US-NR1	0.33	GRA	US-ARb	0.37
FR	DE-Bay	0.19	FR	US-Syv	0.22	GRA	US-ARc	0.37
FR	FHK	0.22	FR	FR-Hes	0.31	GRA	CN-HaM	0.29
FR	AU-Lox	0.38	FR	GDK	0.52	GRA	IT-Tor	0.15
FR	AU-Rob	0.36	FR	TMK	0.20	GRA	US-LWW	0.42
FR	AU-Tum	0.13	FR	TSE	0.32	GRA	AT-Neu	0.44
FR	AU-Wom	0.22	FR	US-Moz	0.36	GRA	AU-Rig	0.20
FR	BE-Vie	0.20	FR	US-SP1	0.11	GRA	AU-Emr	0.17
FR	BR-Sa3	0.28	FR	US-SP2	0.20	GRA	US-AR2	0.11
FR	CA-Gro	0.12	FR	US-SP3	0.17	GRA	CN-Cng	0.26
FR	CA-Qfo	0.37	SHRB	US-KS2	0.21	GRA	US-Goo	0.22
FR	CA-SF1	0.39	SHRB	IT-Noe	0.29	GRA	US-AR1	0.26
FR	CA-SF2	0.17	SHRB	CA-SF3	0.43	GRA	DE-Gri	0.28
FR	CA-TP1	0.41	SHRB	ES-Amo	0.35	GRA	AU-Stp	0.20
FR	CA-TPD	0.38	SHRB	AU-RDF	0.17	GRA	US-SRG	0.19
FR	DE-Hai	0.31	SHRB	US-Ton	0.20	GRA	US-Wkg	0.45
FR	DE-Lkb	0.21	SHRB	BW-Ma1	0.21	GRA	US-Var	0.24