

Response to Reviewers

We sincerely thank the editor and both reviewers for their careful evaluation and constructive comments. In response, we substantially revised the manuscript. The major changes include:

- (1) reformulating θ within a bounded nonlinear framework in Section 2.3.2;
- (2) adding supplementary analyses (Figures S6–S19; Tables S1–S2) to test robustness, decomposition, and alternative interpretations;
- (3) clarifying the separation of SM and VPD effects and their scale dependence;
- (4) adding sensitivity analyses for atmospheric CO₂ and stand age; and
- (5) improving figure readability and polishing the manuscript throughout.

Below we provide a point-by-point response to each comment.

Response to Reviewer 1

We sincerely thank the referee for the insightful comments on our manuscript. We particularly appreciate the referee's emphasis on the inherent nonlinearity and saturation in the TF–LAI relationship and the implications this has for interpreting θ . In response, we substantially revised the manuscript by reformulating θ within a bounded nonlinear framework, adding supplementary diagnostics and decomposition analyses to distinguish position-dependent saturation from changes in curve shape, and adopting a more cautious interpretation of θ as a large-scale ecohydrological sensitivity metric rather than a direct physiological quantity. These revisions have strengthened both the methodological basis of the study and the interpretation of the results.

Major comment 1

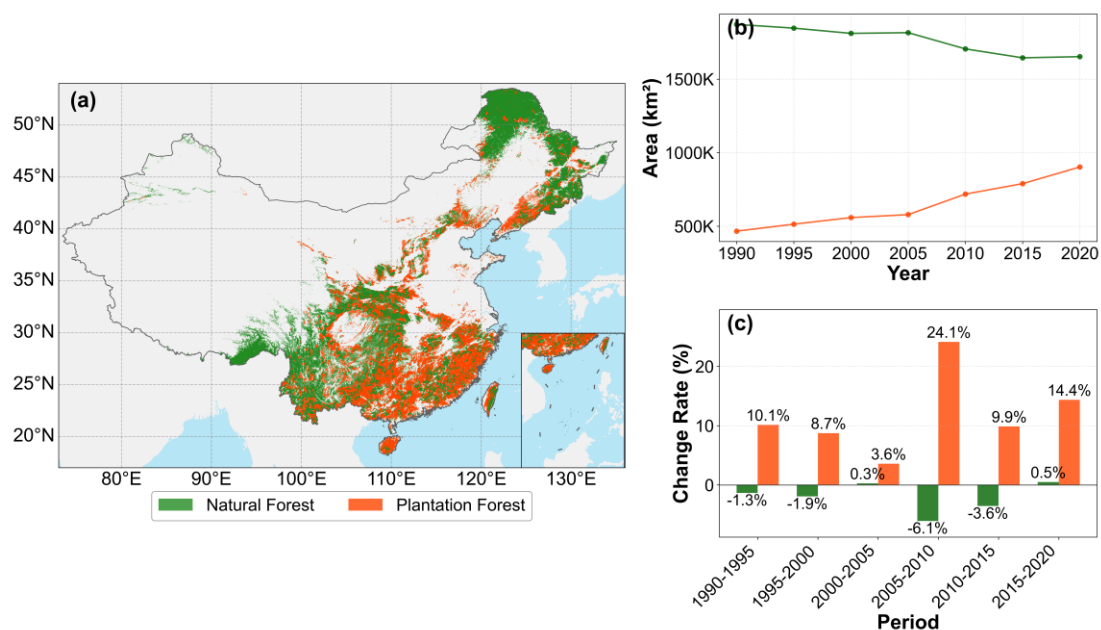
The text in all figures is excessively small, making it difficult to read. This significantly impairs the clarity and accessibility of the data presentation. I strongly recommend enlarging the font sizes (including axis labels, legends, titles, and annotations) and improving the overall figure resolution to enhance readability!

Response

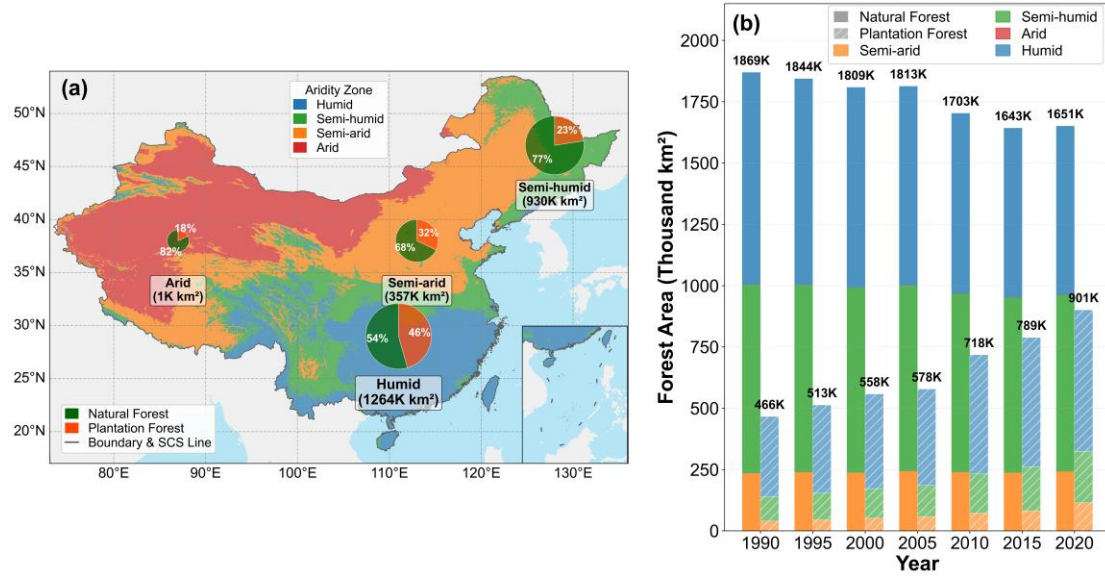
We thank the reviewer for this important comment. We fully agree that figure readability is essential for clear communication of the results. In response, we regenerated and reformatted all figures in both the main manuscript and the Supplementary Material. Specifically, we enlarged the fonts used for axis labels, tick labels, legends, titles, panel labels, and in-figure annotations; increased the export resolution of the graphics; and adjusted the layout and spacing of several multi-panel figures to reduce visual crowding and improve readability. Because this revision mainly concerns figure presentation rather than a localized textual change, the most direct evidence is provided by the revised figures themselves. Representative examples from the revised main text are shown below.

Supporting figure evidence

Representative revised main-text figure: Figure 1



Representative revised main-text figure: Figure 2



Major comment 2

As demonstrated by Wei et al. (2017), the relationship between the transpiration fraction ($TF = T/(T + E_s)$, neglecting interception loss) and LAI is inherently non-linear. Consequently, the θ is expected to diminish with ongoing vegetation greening. Although their study omitted E_i , it robustly illustrates the non-linear response of TF to increasing LAI. This non-linearity arises from biophysical constraints rather than direct influences of VPD or SM.

Specifically, as LAI increases, E_s rapidly approaches its minimum due to enhanced canopy shading, resulting in a substantial decline in the absolute value of $\partial E_s/\partial LAI$. Interception evaporation becomes largely independent of further LAI increases, as it is primarily governed by rainfall patterns (frequency and intensity). T also becomes progressively constrained by available energy or water supply, leading to a marked reduction in $\partial T/\partial LAI$ at higher LAI values.

Under these conditions, $\partial T/\partial LAI$, $\partial E_s/\partial LAI$, and $\partial E_i/\partial LAI$ all approach zero, causing θ to decrease toward zero. These mechanisms indicate that trends in θ may not be driven by shifts in θ in plant water-use strategies, and the effects of VPD and SM on θ are indirect—operating primarily through modulation of absolute transpiration rates rather than directly altering the sensitivity of TF to LAI.

Response

We thank the reviewer for this important and mechanistically insightful comment. We agree that the TF –LAI relationship is inherently non-linear and that saturation and boundary effects may reduce the marginal sensitivity of TF to further greening. In response, we substantially revised both the definition of θ and the interpretation of the results. The most important revision is that we rewrote the calculation of θ in Section 2.3.2 as follows:

“We define the transpiration fraction as

$$TF = \frac{T}{E} \quad (1)$$

Note that $TF \in (0,1)$ is bounded. To explicitly account for the inherent nonlinearity and

saturation in the TF–LAI relationship, we estimated the sensitivity θ as a marginal response under a bounded nonlinear framework.

Within the full period (1990–2020) and within each 11-year moving window, we fit a quadratic model in logit space:

$$z = \text{logit}(TF) = \ln\left(\frac{TF}{1-TF}\right) = a + b(LAI - LAI_{med}) + c(LAI - LAI_{med})^2 \quad (2)$$

Here, LAI_{med} is the pixel-specific median LAI within the same period (median-centering was used to improve numerical stability). Prior to the logit transform, TF was clipped to $[\varepsilon, 1 - \varepsilon]$ ($\varepsilon = 0.005$) to avoid numerical singularities.

We then recovered $TF = 1 / (1 + e^{-z})$ and computed the marginal sensitivity as

$$\theta = \frac{\partial TF}{\partial LAI} = TF(1-TF)[b + 2c(LAI - LAI_{med})] \quad (3)$$

For ease of interpretation, Eq. (7) can be written as $\theta = \underbrace{TF(1-TF)}_{\text{damping}} \times \underbrace{[b + 2c(LAI - LAI_{med})]}_{\eta}$,

in which the damping term reflects boundary effects and η represents the structural sensitivity in logit space.

To separate the position-dependent saturation effect from changes in the shape of the fitted TF–LAI relationship, we evaluated (i) θ_{total} at $LAI = LAI_{med}$, representing the sensitivity under the actual state of each pixel and (ii) θ_{clim} at a fixed reference LAI_{ref} (global median LAI), which removes the influence of shifting along the TF–LAI curve. Additionally, the boundary component was quantified as

$$\theta_{bound} = \theta_{total} - \theta_{clim} \quad (4)$$

We calculated θ at two time scales. (1) The full-period mean θ characterized the average state during 1990–2020. (2) The θ time series characterized decadal changes, generated using an 11-year moving window recorded for the central year (1995–2015), a data processing step that was also used for subsequent trend and attribution analyses.”

This methodological revision directly addresses the reviewer’s concern, because the revised θ is no longer defined as a simple linear slope in raw TF space. Instead, it explicitly incorporates the bounded nature of TF, the nonlinear curvature of the TF–LAI relationship, the position-dependent saturation effect, and the distinction between θ_{total} , θ_{clim} , and θ_{bound} . In other words, the saturation/boundary mechanism raised by the reviewer is now incorporated into the definition of θ itself, rather than being treated only as a qualitative post hoc explanation.

We then added a dedicated set of supplementary analyses (Figures S6–S13; corresponding to R1–

R8) under this revised framework. These analyses show that the mechanism proposed by the reviewer is indeed valid in part, particularly under TF_E and in high-LAI conditions, where the position/boundary effect contributes substantially to the decline in θ . However, they also demonstrate that this mechanism alone is insufficient to explain the full set of results. First, under the TF_{soil} definition used by Wei et al. (2017), θ increases significantly in both natural and plantation forests, rather than monotonically decreasing. Second, the counterfactual decomposition shows that under TF_{soil} , the shape effect contributes about 51–52% and acts in the opposite direction to the position effect. Third, the η -damping decomposition indicates that changes in θ are not explained by damping alone, because η also changes significantly through time. Fourth, if the TF–LAI curve were truly fixed, θ_{clim} evaluated at a fixed LAI reference should show no systematic trend; however, Figures S10–S13 show significant temporal changes in θ_{clim} and in the fitted coefficients, especially in the low- and mid-LAI strata.

We therefore revised the manuscript in a more cautious way. We now explicitly acknowledge that saturation and boundary compression are an important part of the explanation for θ dynamics, but we no longer interpret changes in θ as a direct or purely physiological shift in water-use strategy. Instead, the revised manuscript frames θ more cautiously as a changing property of the TF–LAI coupling under hydroclimatic forcing, with contributions from both position-dependent saturation and changes in curve shape (i.e., structural sensitivity).

Revised manuscript locations: Section 2.3.2; Section 4.1; Section 4.2.

Revised text excerpt from Section 4.1

[Lines 441–443] The supplementary θ diagnostics further suggest that this nonlinearity cannot be explained solely as a bounded geometric effect of TF; part of the long-term change also reflects shifts in the LAI–TF relationship itself.

Supporting supplementary evidence: Figures S6–S13 (R1–R8), especially Figures S7–S13 for the decomposition, null-model, coefficient-evolution, and LAI-stratified tests.

Major comment 3

This study quantifies the influences of VPD and SM on θ from both spatial gradients and temporal dynamics perspectives. However, VPD and SM operate on distinctly different timescales: VPD fluctuates relatively rapidly compared to SM, and vegetation can respond to these changes over short timescales. For instance, stomata may partially close in response to elevated VPD, leading to quick adjustments in transpiration. In contrast, vegetation responses to changes in SM are typically slower and more gradual, involving physiological acclimation and structural adjustments over longer periods. Furthermore, during the warm growing season under dry soil conditions, VPD can be amplified through land–atmosphere feedback, creating a coupled effect that makes it difficult to disentangle the independent contributions of VPD and SM.

These differences in response timescales and potential feedbacks raise questions about the interpretation of the results presented in the study. I believe this issue warrants further careful consideration and discussion to strengthen the conclusions regarding the relative roles of VPD and SM in driving changes in θ .

Response

We thank the reviewer for this very important and insightful comment. We fully agree that VPD

and SM operate on different timescales and may also become coupled through land–atmosphere feedbacks during warm and dry growing seasons. Without explicitly defining the temporal scale of the analysis and the boundary of interpretation, the relative roles of VPD and SM could indeed be overstated or misinterpreted.

To address this concern, we made substantial revisions at three levels: data timescale definition, analytical framework, and interpretation/discussion. First, we now clarify explicitly in the revised manuscript that all environmental variables used in this study, including LAI, SM, VPD, transpiration, and evapotranspiration, were aggregated to the growing-season scale (April–October), and that θ and its associated coefficients were analyzed using 11-year moving-window series. Accordingly, our analysis is not intended to resolve instantaneous stomatal responses or other short-timescale canopy adjustments. Rather, it is designed to characterize seasonal-to-interannual hydroclimatic controls on θ .

Second, we substantially rewrote the methodological description to distinguish more clearly between the two analytical perspectives. The spatial analysis uses pooled spatial binning to summarize cross-site contrasts under comparable hydroclimatic backgrounds, whereas the temporal analysis uses partial correlation and ridge regression to quantify within-pixel temporal associations after accounting for covariation. We now state explicitly that this framework is intended to assess independent statistical associations and relative dominance under coupled conditions, rather than to claim a complete causal decoupling of SM and VPD.

Third, and most importantly, we revised the Discussion and limitation statements to make the interpretation more cautious. The revised manuscript now states clearly that because SM and VPD may become coupled under warm and dry conditions through drought–heat–atmosphere feedbacks, our results should be interpreted as growing-season to interannual hydroclimatic attribution, not as a direct diagnosis of the speed or mechanism of short-term physiological responses. Consistent with this revision, we also restrained the wording of our conclusions. In addition, to reduce the possibility that the results are driven merely by coupling or redundancy between the two variables, we added relative-contribution metrics and variance inflation factor (VIF) diagnostics. Overall, the revised manuscript now makes the scale of inference explicit and avoids overstating the mechanistic separation of SM and VPD.

Revised manuscript locations: Section 2.1; Sections 2.3.3–2.3.4; Section 4.5.

Revised text excerpt from Section 2.1

[Lines 136–139] All environmental variables were aggregated over the growing season (April–October) for 1990–2020, using only growing-season data and excluding non-growing-season observations. Means were used for state variables (e.g., LAI, SM, Ta, and VPD), whereas cumulative values were used for flux variables (e.g., E, T, and P).

Revised text excerpt from Sections 2.3.3–2.3.4

[Lines 245–250] This approach thus summarized spatial contrasts under comparable hydroclimatic backgrounds using a control-variable logic... the binning analysis characterized cross-site contrasts in θ across the long-term SM–VPD climate space, whereas the partial-correlation and ridge analyses quantified within-pixel temporal associations of θ with SM and VPD.

[Lines 252–281] To investigate the pixel-scale temporal relationships of SM and VPD with θ , we used partial correlation and ridge regression based on the 1995–2015 11-year sliding-window series. This analysis was conducted at two levels. First, for each pixel, we calculated an overall partial correlation coefficient and ridge-regression coefficient based on the full 1995–2015 series... Second, to evaluate

change over time, we performed a secondary sliding-window analysis on the same 1995–2015 series and generated time series of the coefficients themselves... Given the collinearity between SM and VPD, we further employed a ridge regression model... We further calculated the relative contribution (RC) of SM and VPD... To further diagnose multicollinearity between SM and VPD, we also calculated the variance inflation factor (VIF). To quantify temporal changes in θ and in the coefficient series derived from the 11-year moving-window analysis, we estimated trends using the Theil–Sen median slope estimator...

Revised text excerpt from Section 4.5

[Lines 512–515] Because θ , SM, and VPD were analyzed from growing-season aggregates and moving-window series, the results characterize seasonal-to-interannual hydroclimatic controls rather than instantaneous stomatal responses to short-lived atmospheric fluctuations.

Supporting supplementary evidence: Figure S16.

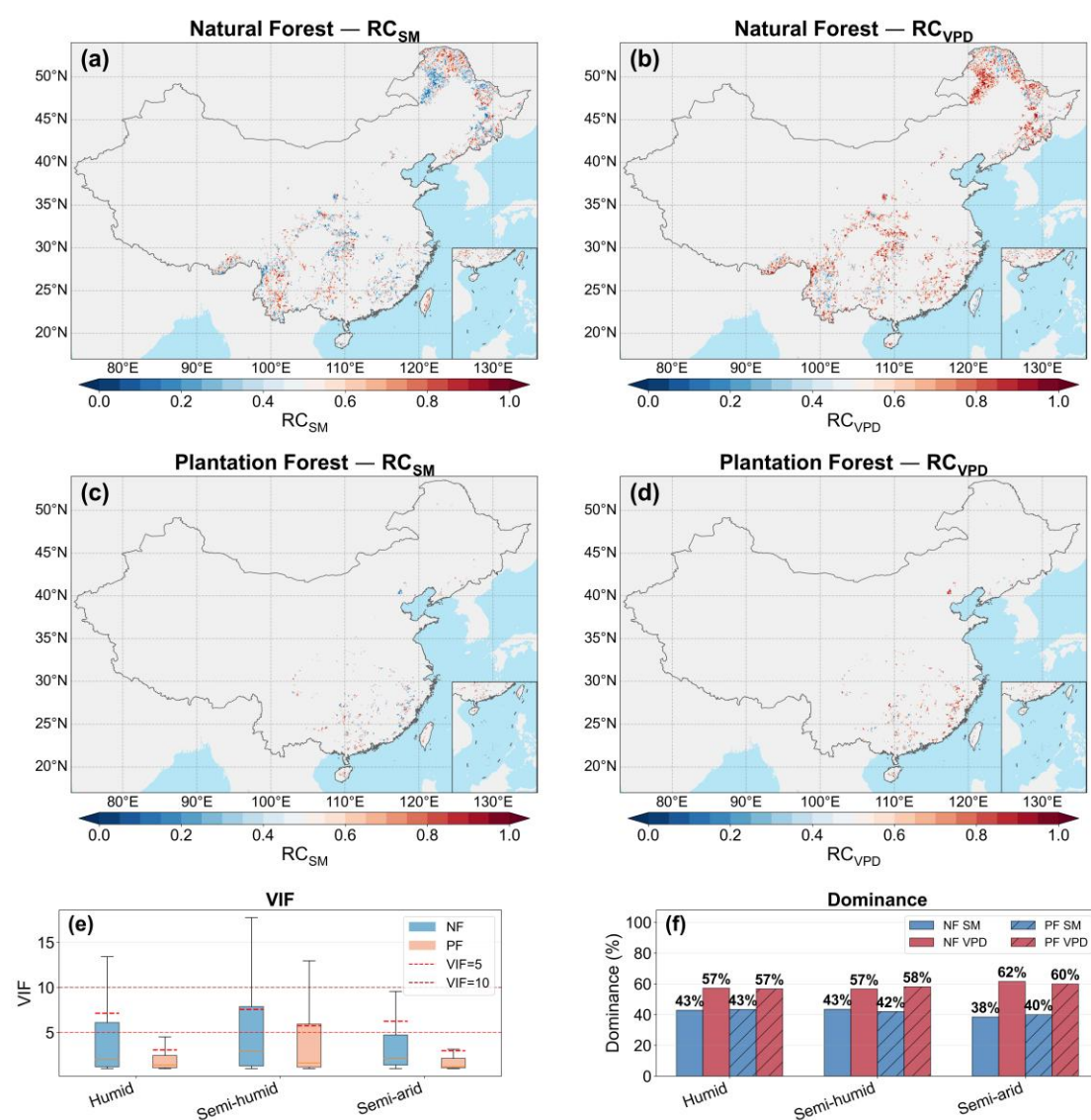


Figure S16. Spatial distribution of the relative contributions (RC) of SM and VPD to θ_{total} , together with variance inflation factor (VIF) and dominance statistics across climatic zones.

Major comment 4

[Line 79-82] The GLEAM4 and SiTHv2 transpiration are generated using semi-empirical modelling approaches that rescale potential evapotranspiration based on a stress factor, which incorporates vegetation optical depth (VOD) and simulated root-zone SM. The only mechanisms through which physiological responses could theoretically be represented are (i) the use of VOD as a proxy for canopy characteristics and (ii) the assimilation of surface soil moisture retrieved from satellite observations (applied only in GLEAM4).

However, the relatively low signal-to-noise ratio in these datasets may introduce substantial uncertainties into the estimated transpiration values. Consequently, it remains uncertain to what extent θ reflects physiological regulation by plants. Given this ambiguity, the interpretation and wording regarding the physiological implications of θ should be considerably more restrained and carefully qualified.

Response

We thank the reviewer for this very important comment. We agree that θ derived from gridded transpiration products such as GLEAM and SiTHv2 should not be over-interpreted as a direct observational measure of instantaneous plant physiological regulation. In response, we revised the manuscript to make the scope of inference more explicit and more cautious. The revised manuscript now frames θ as a large-scale ecohydrological sensitivity metric derived from gridded evapotranspiration products, rather than as a direct measure of stomatal regulation, hydraulic adjustment, or other leaf-/plant-level physiological processes.

Specifically, we restrained the relevant wording throughout the manuscript. First, in the Introduction and Discussion, we revised the text to avoid implying that θ directly represents physiological processes. Second, in Section 2.1, we clarified the distinction between the main analysis and the robustness assessment: all main calculations are based on GLEAM, whereas SiTHv2 and the China terrestrial ecosystem transpiration fraction dataset are used only as cross-product consistency checks, rather than as independent evidence for physiological mechanisms. Third, in the limitation section, we now state explicitly that because θ , SM, and VPD were analyzed from growing-season aggregates and moving-window series, the conclusions apply to large-scale seasonal-to-interannual ecohydrological behavior rather than to direct attribution of instantaneous stomatal responses or any single physiological mechanism.

Under this revised framing, the central result remains the same, but the interpretation is now more restrained: the weakening of θ is interpreted as a large-scale change in LAI–TF coupling under hydroclimatic forcing, rather than as direct evidence of plant-level physiological regulation.

Revised manuscript locations: Section 2.1; Section 4.5.

Revised text excerpt from Section 2.1

[Lines 140–147] To evaluate the robustness of the estimated θ patterns and trends to data-product choice, we additionally used two alternative gridded products for cross-product comparison in supplementary analyses... These two datasets were used only for robustness assessment of θ , whereas all main calculations in the study were based on GLEAM.

Revised text excerpt from Section 4.5

[Lines 512–515] Because θ , SM, and VPD were analyzed from growing-season aggregates and moving-window series, the results characterize seasonal-to-interannual hydroclimatic controls rather

than instantaneous stomatal responses to short-lived atmospheric fluctuations.

Supporting supplementary evidence: Figure S1.

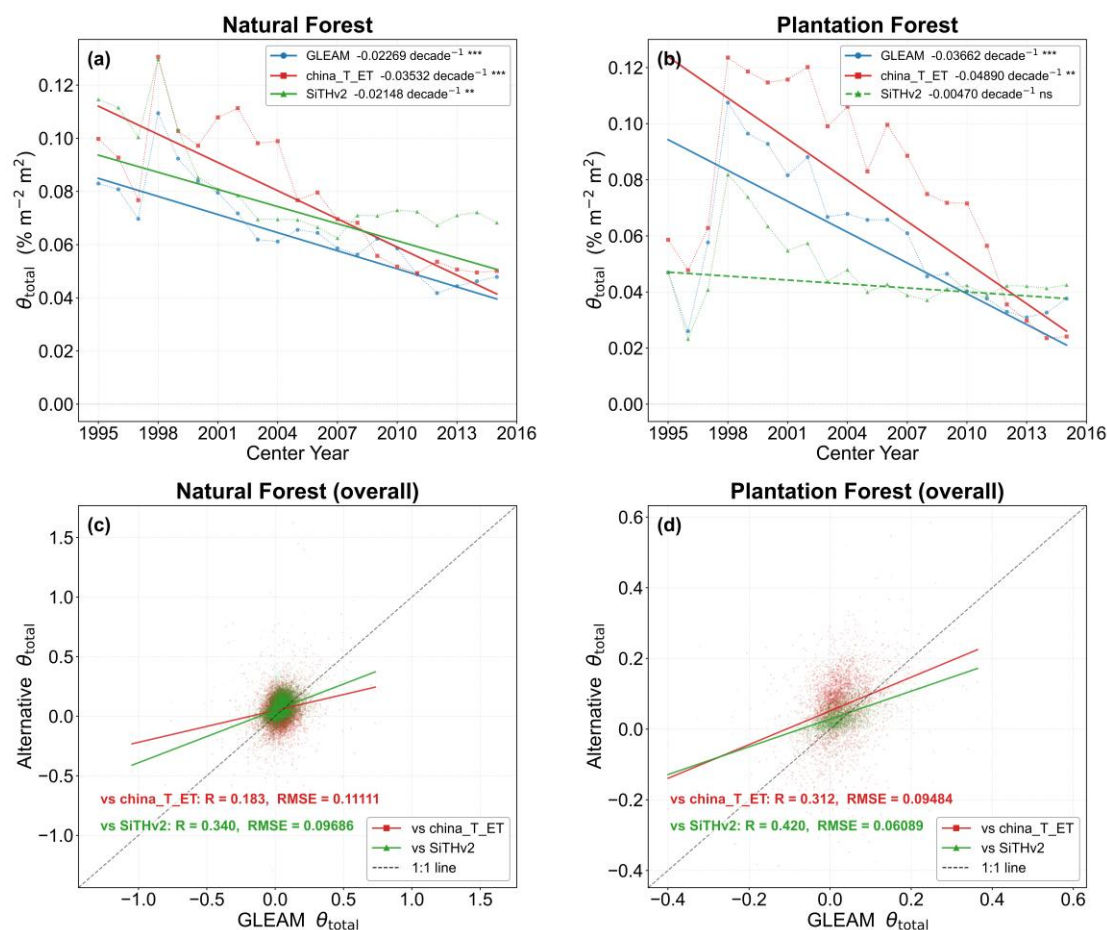


Figure S1. Cross-product robustness check of LAI–transpiration fraction sensitivity (θ_{total}) using three evapotranspiration products.

Major comment 5

[Line 139-143] *The description of GLEAM4 is inaccurate. Its data assimilation is limited to surface soil moisture. Furthermore, the hybrid machine-learning model is implemented solely within the vegetation transpiration module.*

Response

We thank the reviewer for this careful correction. We agree that the previous description of GLEAM was not sufficiently precise. In response, we revised the text in Section 2.1 to make the description more accurate and more tightly limited to the variables actually used in this study.

Specifically, the revised manuscript now states that we extracted transpiration (T), evapotranspiration (E), and soil moisture (SM) from GLEAM v4.2a, and that the SM used in this study refers to the root-zone soil moisture product, rather than surface soil moisture. We also clarified that, in GLEAM, root-zone soil moisture is represented as a vegetation-accessible multi-layer soil profile constrained by assimilated surface observations, rather than as a single shallow soil layer. At the same time, we removed overly broad wording about the full internal implementation of GLEAM, so that the revised text no longer generalizes the complete product architecture beyond what is directly relevant to

the variables used here. In this way, the revised manuscript now describes the published GLEAM variables used in our analysis more accurately and avoids overextending the methodological description of the product itself.

Revised manuscript locations: Section 2.1.

Revised text excerpt from Section 2.1

[Lines 125–133] The main evapotranspiration dataset used in this study was GLEAM v4.2a, from which transpiration (T), evapotranspiration (E), and soil moisture (SM) were extracted. GLEAM separately estimates the major components of terrestrial evaporation and provides both surface and root-zone soil moisture. In this study, SM refers to the root-zone soil moisture product, rather than surface soil moisture... In GLEAM, root-zone soil moisture is represented as a vegetation-accessible multi-layer soil profile constrained by assimilated surface observations, rather than as a single shallow soil layer.

Major comment 6

The methodology employed in this study may be influenced by the strong collinearity between VPD and SM, particularly regarding the application of partial correlation and mediation effect models. To ensure that the findings are robust and not merely artefacts of the chosen methods, it is recommended to provide collinearity diagnostics (e.g., VIF or tolerance levels) to quantify the degree of redundancy between these input variables.

Response

We thank the reviewer for raising this critical methodological concern. We agree that under strong SM–VPD coupling, the interpretation of partial correlation, regression coefficients, and pathway analysis may be questioned if explicit collinearity diagnostics are not provided. In response, we added explicit multicollinearity diagnostics and clarified the analytical framework and interpretation accordingly. We also clarified the interpretation of the pathway analysis, so that the indirect effects mediated through SM and VPD are now interpreted more cautiously as complementary association pathways under coupled hydroclimatic conditions, rather than as a strict causal separation between two fully independent mediators.

First, we substantially rewrote Sections 2.3.3–2.3.4 and clarified that the separation of SM and VPD effects is based on three complementary steps.

(1) At the spatial level, we used pooled spatial binning with a control-variable logic to evaluate $\Delta\theta(\text{VPD}|\text{SM})$ and $\Delta\theta(\text{SM}|\text{VPD})$, so that cross-site contrasts are summarized under comparable hydroclimatic backgrounds.

(2) At the temporal level, we calculated the two partial correlations, $r(\theta, \text{SM}|\text{VPD})$ and $r(\theta, \text{VPD}|\text{SM})$, to quantify independent temporal associations after controlling for the other variable.

(3) Because collinearity can still affect coefficient stability, we further introduced standardized ridge regression to estimate β_{SM} and β_{VPD} , and then calculated relative contributions (RC) from the absolute standardized coefficients to identify the dominant hydrological driver at each pixel. In addition, following the reviewer’s suggestion, we explicitly added variance inflation factor (VIF) diagnostics, which are now shown in Supplementary Figure S16.

Second, to evaluate whether the pathway results were sensitive to mediator specification, we conducted a supplementary comparison of three pathway-model specifications: an SM-only mediator model, a VPD-only mediator model, and the joint SM+VPD model used in the main manuscript. Across

32 driver \times zone \times forest-type units, the direction of VPD-mediated indirect effects was consistent between the single-mediator and joint models in 29 cases (90.6%), whereas the corresponding consistency for SM-mediated effects was lower (22 cases; 68.8%). These results indicate that the main pathway patterns are not purely artefacts of a single model specification, but they also show that SM-mediated indirect effects are more sensitive to collinearity and model structure than VPD-mediated effects. We therefore interpret the pathway coefficients cautiously, as complementary association pathways under coupled hydroclimatic conditions rather than as a strict causal separation of two fully independent mediators.

Third, we also revised the Results and Discussion to make the interpretation more robust and more cautious. Rather than relying on any single method as decisive evidence, the revised manuscript now emphasizes that partial correlation, ridge regression, RC, VIF, dominance statistics, and the supplementary mediator-specification comparison together provide a mutually supporting diagnostic framework. These revisions strengthen the robustness and interpretability of the manuscript.

Revised manuscript locations: Section 2.3.3; Section 2.3.4; Section 2.3.5; Results Section 3.2.3.

Revised text excerpt from Section 2.3.3

[Lines 238–247] To assess the relative roles of SM and VPD in the spatial differentiation of θ , we applied a pooled spatial-binning analysis... This approach thus summarized spatial contrasts under comparable hydroclimatic backgrounds using a control-variable logic.

Revised text excerpt from Section 2.3.4

[Lines 267–275] Given the collinearity between SM and VPD, we further employed a ridge regression model, $\theta = \beta_{SM} \cdot SM + \beta_{VPD} \cdot VPD$, to more robustly quantify their relative contributions to θ . By introducing an L2 regularization term, ridge regression stabilizes coefficient estimates under multicollinearity. The regression was performed on standardized time series, and the resulting coefficients (β_{SM} and β_{VPD}) directly reflect the relative strengths of the SM and VPD effects. We further calculated the relative contribution (RC) of SM and VPD as $RC_{SM} = |\beta_{SM}| / (|\beta_{SM}| + |\beta_{VPD}|)$ and $RC_{VPD} = |\beta_{VPD}| / (|\beta_{SM}| + |\beta_{VPD}|)$, to determine the dominant hydrological driver at each pixel. To further diagnose multicollinearity between SM and VPD, we also calculated the variance inflation factor (VIF).

Revised text excerpt from Section 2.3.5

[Lines 291–295] Because SM and VPD may remain correlated under coupled hydroclimatic conditions, the pathway coefficients were interpreted as complementary association pathways rather than as a strict causal separation of two fully independent mediators. This interpretation was further evaluated using a supplementary mediator-specification comparison based on SM-only, VPD-only, and joint pathway models (Figure S19).

Revised text excerpt from Results Section 3.2.3

[Lines 386] RC and VIF supported the robustness of this interpretation (Figure S16).

Revised text excerpt from Section 3.3

[Lines 412–416] A supplementary mediator-specification comparison showed that the direction of

VPD-mediated indirect effects was generally more robust across single-mediator and joint models than that of SM-mediated effects, whereas SM-mediated pathways were more sensitive to model specification under SM–VPD coupling (Figure S19).

Supporting supplementary evidence: Figure S16 and Figure S19.

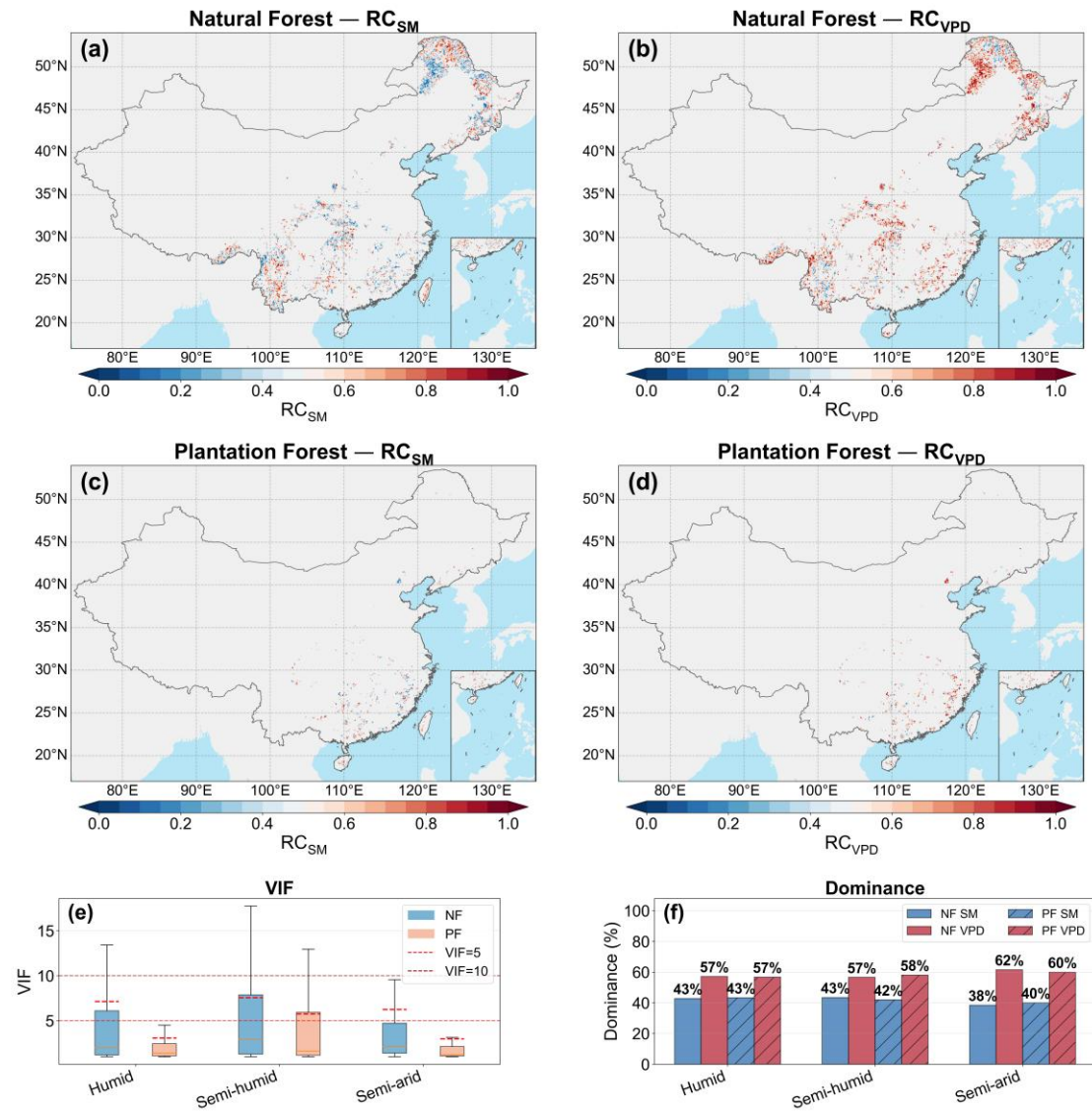


Figure S16. Spatial distribution of the relative contributions (RC) of SM and VPD to θ_{total} , together with variance inflation factor (VIF) and dominance statistics across climatic zones.

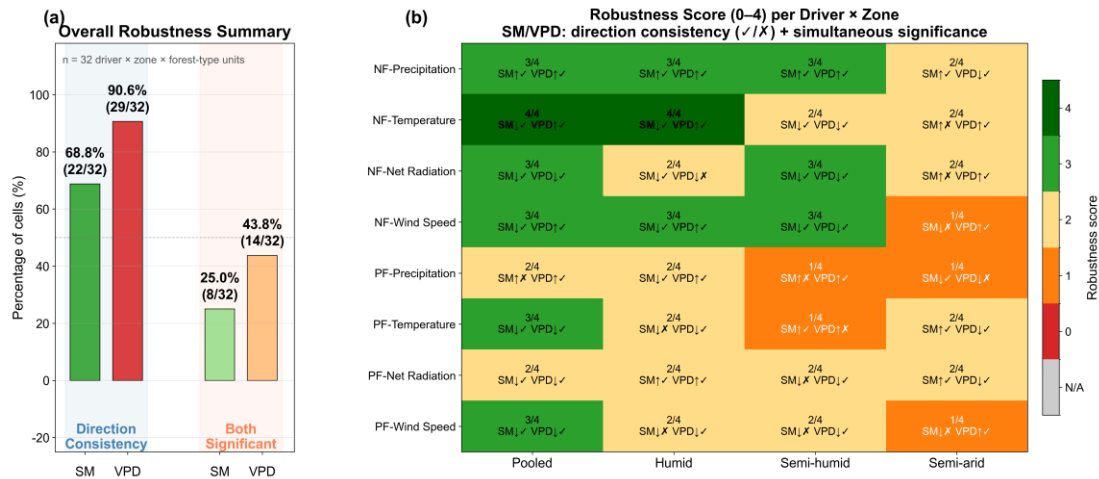


Figure S19. Robustness of pathway indirect effects to mediator specification.

Major comment 7

The Discussion section is currently characterised by excessive reiteration of the results. I recommend streamlining this section to enhance clarity and conciseness. Additionally, the manuscript would be significantly strengthened by a dedicated discussion on methodological limitations, which is essential for a nuanced interpretation of the findings.

Response

We thank the reviewer for this important suggestion. We fully accepted this point and substantially revised and reorganized the Discussion section. The revision had two main goals: to reduce repetitive restatement of the Results and to add a more explicit discussion of methodological limitations, so that the Discussion becomes more concise, clearer, and more interpretively balanced.

First, we restructured the Discussion into several more focused themes: (1) nonlinear hydroclimatic regulation of θ , (2) long-term weakening of the LAI enhancement effect on TF, (3) temporal changes in the roles of SM and VPD, (4) contrasting responses of natural and plantation forests, and (5) implications and limitations. During this revision, we removed or compressed passages that mainly repeated the Results section and instead strengthened the discussion of mechanisms, scale dependence, and links to previous studies. As a result, the revised Discussion is now more focused on what the findings mean, rather than restating what the findings are.

Second, following the reviewer's recommendation, we added and strengthened a dedicated Implications and limitations section. In this section, we now state explicitly several major limitations of the study: (1) a nationwide long-term in situ benchmark for θ trends is not yet available, so the present study relies on cross-product robustness rather than site-based validation; (2) because θ , SM, and VPD were analyzed using growing-season aggregates and moving-window series, the inference applies to seasonal-to-interannual controls rather than instantaneous stomatal responses; (3) because the analysis is based on gridded transpiration/evapotranspiration products, the results are more appropriately interpreted as large-scale ecohydrological patterns than as direct evidence of a single physiological mechanism; and (4) rising CO₂ and stand age may act as background modifiers of θ , but they do not overturn the main interpretation of hydroclimatic control. We believe these revisions substantially improved the Discussion by moving it away from simple result repetition and toward a more explicit interpretation under clearly stated methodological boundaries.

Revised manuscript locations: Section 4.1; Section 4.2; Section 4.5.

Revised text excerpt from Section 4.1

[Lines 441–443] The supplementary θ diagnostics further suggest that this nonlinearity cannot be explained solely as a bounded geometric effect of TF; part of the long-term change also reflects shifts in the LAI–TF relationship itself (Figures S6–S13).

Revised text excerpt from Section 4.2

[Lines 462–464] Together, these results suggest that CO₂ rise and stand development may act as background modifiers of θ , while the dominant large-scale patterns remain primarily associated with hydroclimatic variability.

Revised text excerpt from Section 4.5

[Lines 508–515] Several limitations should remain explicit. A nationwide in situ benchmark for θ trends is not yet available... In addition, because θ , SM, and VPD were analyzed from growing-season aggregates and moving-window series, the results characterize seasonal-to-interannual hydroclimatic controls rather than instantaneous stomatal responses to short-lived atmospheric fluctuations.

Supporting supplementary evidence: Figure S1, Figure S16, Figure S17, and Figure S18

Specific Comments Line 15–16

There is a conceptual mismatch in grouping forest types with reanalysis products like GLEAM and ERA5-Land. Furthermore, the sliding window approach is a temporal analysis framework, whereas partial correlation, ridge regression, and mediation models are statistical inference methods.

Response

We thank the reviewer for this careful comment. We agree that the original abstract conflated different conceptual levels. Forest-type maps are used to identify the natural-forest (NF) and plantation-forest (PF) samples, whereas GLEAM and ERA5-Land are gridded data products used to derive evapotranspiration and hydroclimatic variables, respectively; these should not be grouped as if they were the same type of input. We also agree that the sliding-window procedure serves as a temporal analysis framework, whereas partial correlation, ridge regression, and pathway analysis are inferential methods and should not be presented at the same conceptual level.

In response, we revised both the abstract and the analytical framework in the main text. In the abstract, we removed the previous list of analytical methods and no longer present sliding window, partial correlation, ridge regression, and pathway analysis as a single parallel sequence. We also rewrote the study-description sentence so that forest-type maps are presented specifically as the basis for identifying NF and PF, while GLEAM-derived variables and ERA5-Land data are described according to their respective data roles. In the main text, we clarified the roles of the different analytical components: pooled spatial binning is now presented as the approach for characterizing spatial contrasts along the joint SM–VPD gradient; sliding-window partial correlation and ridge regression are described as the temporal attribution framework based on the 11-year moving-window series; and pathway analysis is presented separately as the method used to decompose the indirect effects of macroclimate change on θ through local hydrological pathways. These revisions make the hierarchy among sample definition, data sources, temporal framework, and inferential methods much clearer.

Revised manuscript locations: abstract

Revised text excerpt from abstract

[Lines 13–16] Using forest-type maps to identify natural forests (NF) and plantation forests (PF), together with GLEAM-derived evapotranspiration variables and ERA5-Land hydroclimatic data from 1990–2020, we quantified the spatiotemporal patterns of θ and evaluated the relative roles of soil moisture (SM) and vapor pressure deficit (VPD).

Specific Comments Line 75–79

References of these sentences?

Response

We thank the reviewer for pointing this out. We agree that the original sentence was under-referenced and that some of its wording was overly specific relative to the supporting literature. In response, we revised and tightened this passage and added appropriate references. In the revised manuscript, the text is now restricted to two aspects that can be more directly supported: (1) the national-scale spatial distribution of natural and planted forests in China, and (2) the more general characteristics of planted forests relative to natural forests, namely that planted forests are more often younger, structurally simpler, dominated by single-species or even-aged stands, and managed more intensively. We removed several more specific statements from the original version, such as the explicit reference to deep-rooted species and the itemized listing of management practices, because these were not as directly supported by national-scale references.

Revised manuscript locations: Introduction

Revised text excerpt from introduction

[Lines 71–76] China's forests now comprise extensive natural and planted forests. Natural forests are concentrated mainly in the mountainous regions of northeastern and southwestern China, whereas planted forests are more widespread in eastern, central, and southern China (Cheng et al., 2024b). Compared with natural forests, planted forests in China are more often younger, structurally simpler, and dominated by single-species or even-aged stands under more intensive management (Cheng et al., 2024a; Farooq et al., 2021)

Specific Comments Line 123

This dataset, ..., was produced by machine learning algorithm ...

Response

We thank the reviewer for this careful correction. We agree that the original sentence was awkward in structure and not ideally phrased. In response, we rewrote the sentence in a more standard academic form to state clearly that the dataset was derived from Landsat imagery and extensive forest inventory samples using machine-learning classification. This revision improves both grammatical clarity and conciseness.

Revised manuscript locations: Section 2.1

Revised text excerpt from Section 2.1.

[Lines 117–119] This dataset was derived from Landsat imagery and extensive forest inventory samples using machine-learning classification and was resampled to 0.1° resolution to match the

hydroclimatic datasets.

Specific Comments Line 188

Please clarify the identities of the left and right bars in panel (b). It is currently unclear what variables or groups these bars represent.

Response

We thank the reviewer for this helpful suggestion. We agree that the identities of the left and right bars in the original Figure 2b were not sufficiently clear. In response, we revised Figure 2 further. In addition to adding pie charts in panel (a) to show the NF/PF fractions within each climatic zone, we also clarified panel (b) through the bar position, hatch pattern, and caption text. In the revised figure, for each year, the left solid stacked bar represents natural forest (NF), whereas the right hatched stacked bar represents plantation forest (PF). The bar colors indicate the contributions from the different climatic zones (humid, semi-humid, semi-arid, and arid), and the value above each pair of bars indicates the total national forest area for that year. These revisions make the identities of the grouped bars and the plotting logic in panel (b) much clearer.

Revised manuscript locations: Section 2.2.1.

Revised text excerpt from Figure 2

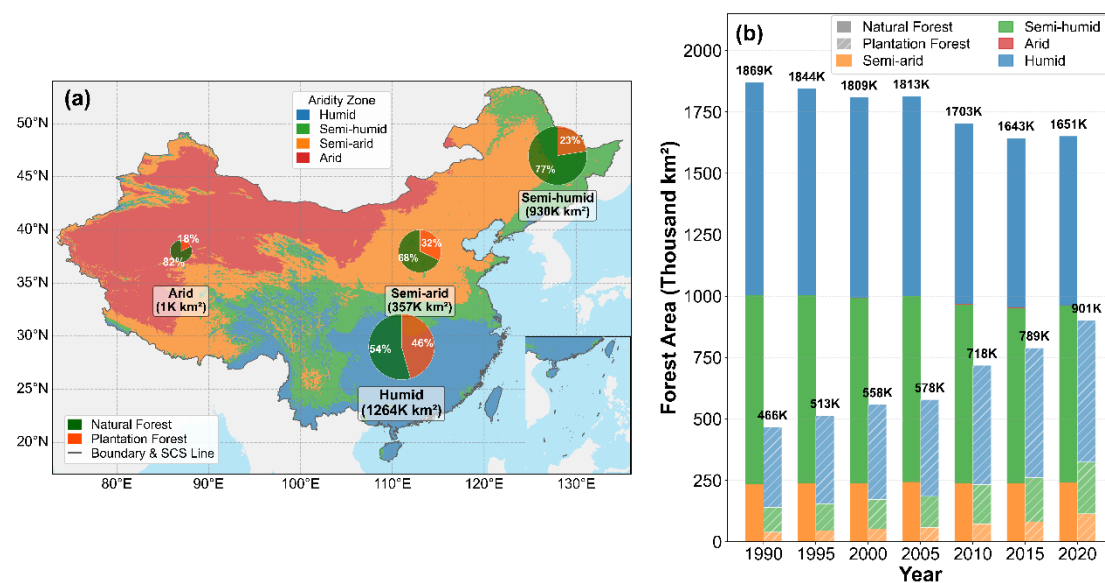


Figure 2. Spatiotemporal distribution and composition of forests in different climatic zones in China from 1990 to 2020. (a) Spatial distribution of the four climatic zones (humid, semi-humid, semi-arid, and arid) in China; the pie charts show the total forest area within each zone and its composition of natural forest (green) and planted forest (orange). (b) Dynamic changes in forest area in each climatic zone from 1990 to 2020. For each year, the left solid stacked bar represents natural forest (NF), and the right hatched stacked bar represents plantation forest (PF). Bar colors indicate the forest area contributed by different climatic zones. The value at the top of each year indicates the total national forest area, and labels with “K” denote 10^3 km².

Specific Comments Line 214–216

The temporal scales of transpiration and evapotranspiration used for the calculations are not

specified. Please clarify whether these analyses were conducted on a daily or monthly basis.

Response

We thank the reviewer for pointing out this ambiguity. We agree that the original text did not clearly specify the temporal scale used for calculating TF and θ . In the revised manuscript, we now state explicitly that T and E were first aggregated from daily data to annual growing-season totals (April–October), while LAI was represented by the corresponding annual growing-season mean. TF was then calculated from these annual growing-season quantities, and θ was estimated from the annual growing-season TF–LAI relationship within the full period and within each 11-year moving window. We further clarify that the analyses in this section were therefore conducted at the annual growing-season scale rather than at the daily or monthly scale.

Revised manuscript locations: Section 2.1 and Section 2.3.2

Revised text excerpt from Section 2.1.

[Lines 136–139] All environmental variables were aggregated over the growing season (April–October) for 1990–2020. Means were used for state variables (e.g., LAI, SM, Ta, and VPD), whereas cumulative values were used for flux variables (e.g., E, T, and P).

Revised text excerpt from Section 2.3.2

[Lines 207–211] In this study, T and E were first aggregated from daily data to annual growing-season totals (April–October), and LAI was represented by the corresponding annual growing-season mean. TF was then calculated from these annual growing-season quantities, and all subsequent θ analyses were therefore conducted at the annual growing-season scale rather than at the daily or monthly scale.

Specific Comments Line 273–279

The section 'Trend Analysis and Testing' should be integrated into Section 2.3.4, as the latter mentions trend analysis but lacks a detailed explanation.

Response

We thank the reviewer for this helpful suggestion. We agree that the original structure was not ideal: Section 2.3.4 already referred to trend analysis of the coefficient series, but the actual description of the trend estimator and significance test was placed later in a separate subsection (“Trend analysis and testing”). To address this concern, we integrated the content of the former Section 2.3.6 into Section 2.3.4. In the revised manuscript, after introducing the partial-correlation and ridge-regression framework, we now describe directly how trends in the coefficient series and related θ time series were estimated using the Theil–Sen slope and evaluated using the variance-corrected Mann–Kendall test. This revision makes the logic of the temporal attribution section more complete and improves the internal consistency of the Methods section.

Revised manuscript locations: Section 2.3.4 and Section 2.3.5

Revised text excerpt from Section 2.3.4

[Lines 276–281] To quantify temporal changes in θ and in the coefficient series derived from the 11-year moving-window analysis, we estimated trends using the Theil–Sen median slope estimator. Trend significance was assessed using the Mann–Kendall (MK) test (two-tailed, $\alpha = 0.05$).

To reduce potential bias caused by temporal autocorrelation, the MK statistic was variance-corrected. The same trend-analysis framework was applied consistently to all moving-window-derived time series used in the temporal attribution analysis.

Revised text excerpt from Section 2.3.5

[Lines 295–297] The trends of P, Ta, Rn, WS, SM, VPD, and θ used in the pathway analysis were all estimated using the same Theil–Sen and variance-corrected Mann–Kendall framework described above.

Specific Comments Line 320

The 'hump-shaped' pattern described by the authors is not readily apparent in Figure 4a.

Response

We thank the reviewer for this helpful comment. We agree that the previous term “hump-shaped” was too strong a characterization of the pattern shown in Figure 4a. The figure more directly supports the presence of a relative high- θ region along the joint SM–VPD gradient, with lower θ values toward both ends of the gradient, rather than a visually sharp or symmetric “hump” in a strict geometric sense. In response, we removed the phrase “hump-shaped” from the revised manuscript and replaced it with a more direct and cautious description. The revised text now states that θ was relatively high under intermediate SM and moderate-to-high VPD conditions, whereas lower values occurred toward both the wet/low-VPD and dry/high-VPD ends of the gradient. This revision makes the wording more consistent with what is actually shown in Figure 4a,b and avoids overinterpreting the visual pattern.

Revised manuscript locations: Section 3.2.1

Revised text excerpt from Section 3.2.1

[Lines 331–334] Pooled binning analysis showed that θ varied nonlinearly along the joint SM–VPD gradient in both forest types, with relatively high values occurring under intermediate SM and moderate-to-high VPD conditions, and lower values toward both the wet/low-VPD and dry/high-VPD ends of the gradient (Figure 4a,b).

Specific Comments Line 458-459

The phrase 'non-linear trend of increasing' is ambiguous.

Response

We thank the reviewer for pointing this out. We agree that the phrase “non-linear trend of increasing” was ambiguous and did not clearly convey the intended meaning. In the revised manuscript, we removed this wording and replaced it with a more explicit mechanistic description. The revised text now states that, when soil water becomes limiting or atmospheric demand becomes too strong, stomatal regulation increasingly constrains transpiration to avoid hydraulic damage, so the marginal gain in transpiration per unit increase in LAI declines. This wording is clearer and more consistent with the cited literature.

Revised manuscript locations: Section 4.1

Revised text excerpt from Section 4.1

[Lines 434–438] Once soil water becomes limiting or atmospheric demand becomes too strong, stomatal regulation increasingly constrains transpiration to avoid hydraulic damage, so the marginal gain in transpiration per unit increase in LAI declines (Novick et al., 2016; Grossiord et al., 2020; McDowell et al., 2022).

Response to Reviewer 2

We sincerely thank the reviewer for the careful evaluation and constructive comments. We have revised the manuscript substantially in response to these concerns. In particular, we clarified the definition of soil moisture and its depth representation in GLEAM, expanded the methodological description of how the relative roles of SM and VPD were separated, added supplementary analyses for atmospheric CO₂ and stand age, revised the discussion to better explain scale dependence and methodological limitations, improved Figure 2, corrected the variable error, and polished the English throughout the manuscript. Our point-by-point responses are provided below.

Comment 1

One of my main concerns is that whether in situ observations could be used to calculate the transpiration sensitivity and examine their temporal evolution. Then, the declining trend of transpiration sensitivity estimated could be validated using in situ observations.

Response

Thank you for this important suggestion. We agree that a direct validation of θ and its temporal evolution using long-term in situ observations would substantially strengthen the manuscript. In the revised version, we have now clarified this point explicitly and have framed the limitation more cautiously.

At present, however, a nationwide forest in situ benchmark suitable for this purpose is not available. Specifically, we are not aware of a long-term observational network across China's forests that can simultaneously provide (i) continuous multi-year records, (ii) reliable partitioning of transpiration versus total evapotranspiration and related components, and (iii) matched information on LAI dynamics and stand development. For this reason, we cannot currently validate the 1990–2020 decline in θ directly with a consistent nationwide in situ dataset.

Instead of overstating the evidence, we have now made this limitation explicit in the revised manuscript and strengthened the robustness assessment through cross-product comparison. Besides the main GLEAM-based analysis, we additionally used two independent gridded products (SiTHv2 and the China terrestrial ecosystem transpiration fraction dataset) to re-estimate θ and compare both the temporal trajectories and the pixel-level agreement among products. These new results are presented in Supplementary Figure S1.

Although this approach does not replace direct site-based validation, it provides an independent product-level consistency check under currently available data conditions. We have therefore revised the manuscript to state clearly that the reported evidence should be interpreted as a robust large-scale and product-consistent pattern rather than a formally validated nationwide in situ benchmark.

We have also added a clearer limitation statement in the Discussion to emphasize that θ , SM, and VPD were analyzed using growing-season aggregates and moving-window series, so the inference pertains to seasonal-to-interannual hydroclimatic controls rather than instantaneous stomatal responses.

Revised manuscript locations: Section 2.1; Section 4.5.

Revised text excerpt from Section 2.1

[Lines 140-147] To evaluate the robustness of the estimated θ patterns and trends to data-product choice, we additionally used two alternative gridded products for cross-product comparison in

supplementary analyses ... These two datasets were used only for robustness assessment of θ , whereas all main calculations in the study were based on GLEAM.

Revised text excerpt from Section 4.5

[Lines 508-512] A nationwide in situ benchmark for θ trends is not yet available because long-term observations that simultaneously resolve transpiration partitioning, LAI dynamics, and stand development remain too sparse across China's forests. We therefore evaluated robustness through cross-product consistency rather than direct site-based validation.

Supporting supplementary evidence: Figure S1.

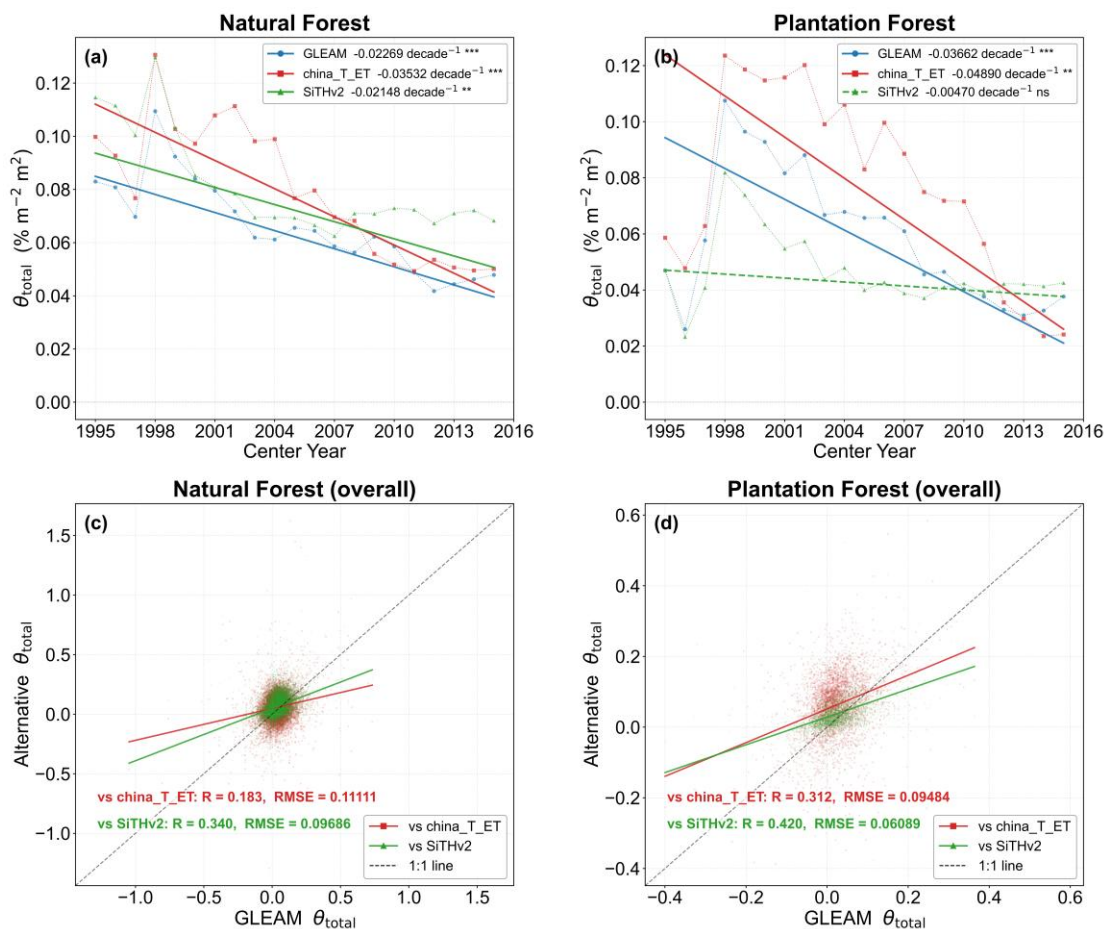


Figure S1. Cross-product robustness check of LAI-transpiration fraction sensitivity (θ_{total}) using three evapotranspiration products. Panels (a, b) compare the spatial-mean θ_{total} time series in NF and PF; panels (c, d) show the pixel-level agreement between GLEAM and the alternative products.

Comment 2

Another main concern pertains to the tight correlation between the two key variables: atmospheric demand (vapor pressure deficit, VPD) and soil demand (soil moisture, SM). An explicit clarification is needed regarding how to quantitatively separate their respective contributions. The descriptions in Section 2.3.3 and Section 2.3.4 are still not clear.

Response

Thank you for this important comment. We agree that SM and VPD are often tightly coupled

at the growing-season scale, and that a simple bivariate relationship is not sufficient to separate their respective roles in shaping θ . In the revision, we therefore rewrote Sections 2.3.3–2.3.4 to clarify the analytical logic and added an explicit multicollinearity diagnostic.

More specifically, our separation is based on three complementary steps rather than on a single statistic. First, at the spatial level, we used pooled spatial binning to calculate $\Delta\theta(\text{VPD}|\text{SM})$ and $\Delta\theta(\text{SM}|\text{VPD})$. The former compares θ between high- and low-VPD groups within comparable SM backgrounds, whereas the latter compares θ between high- and low-SM groups within comparable VPD backgrounds. This control-variable logic is intended to summarize cross-site contrasts under comparable hydroclimatic conditions.

Second, at the temporal level, we calculated the two pixel-wise partial correlations $r(\theta, \text{SM}|\text{VPD})$ and $r(\theta, \text{VPD}|\text{SM})$, which quantify the independent temporal association of each variable with θ after controlling for the other. Third, because collinearity may still affect coefficient stability, we complemented the partial-correlation analysis with standardized ridge regression to estimate β_{SM} and β_{VPD} , and then calculated their relative contributions (RC) from the absolute standardized coefficients to identify the dominant hydrological driver at each pixel.

To further assess whether collinearity was severe enough to overturn the inference, we added variance inflation factor (VIF) diagnostics. Supplementary Figure S16 shows that VIF values are generally in the low-to-moderate range, indicating that the covariation between SM and VPD does not invalidate the main ridge-regression pattern. We therefore revised the Results section to state more explicitly that VPD still explains a slightly larger share of the present spatial pattern of θ , whereas the relative role of SM strengthens over time in many regions.

We also now state more clearly that these analyses are complementary rather than redundant: the binning analysis describes cross-site spatial contrasts, whereas the partial-correlation and ridge analyses quantify within-pixel temporal attribution and its evolution. In this sense, our goal is not to fully 'decouple' SM and VPD with a single model, but to evaluate their relative roles across statistical scales using mutually supporting diagnostics.

Revised manuscript locations: Sections 2.3.3–2.3.4; Section 4.3.

Revised text excerpt from Sections 2.3.3-2.3.4

[Lines 245-275] This approach summarized spatial contrasts under comparable hydroclimatic backgrounds using a control-variable logic ... the partial-correlation and ridge analyses quantified within-pixel temporal associations of θ with SM and VPD ... Given the collinearity between SM and VPD, we further employed a ridge regression model ... We further calculated the relative contribution (RC) of SM and VPD ... To further diagnose multicollinearity between SM and VPD, we also calculated the variance inflation factor (VIF).

Revised text excerpt from Section 4.3

[Lines 466-470] Partial correlation, ridge regression, and pathway analysis consistently indicate that the hydroclimatic controls on θ have changed over time ... VPD still explains a slightly

larger share of the present spatial pattern of θ , as also supported by the dominance statistics and multicollinearity diagnostics (Figure 7; Figure S16).

Supporting supplementary evidence:

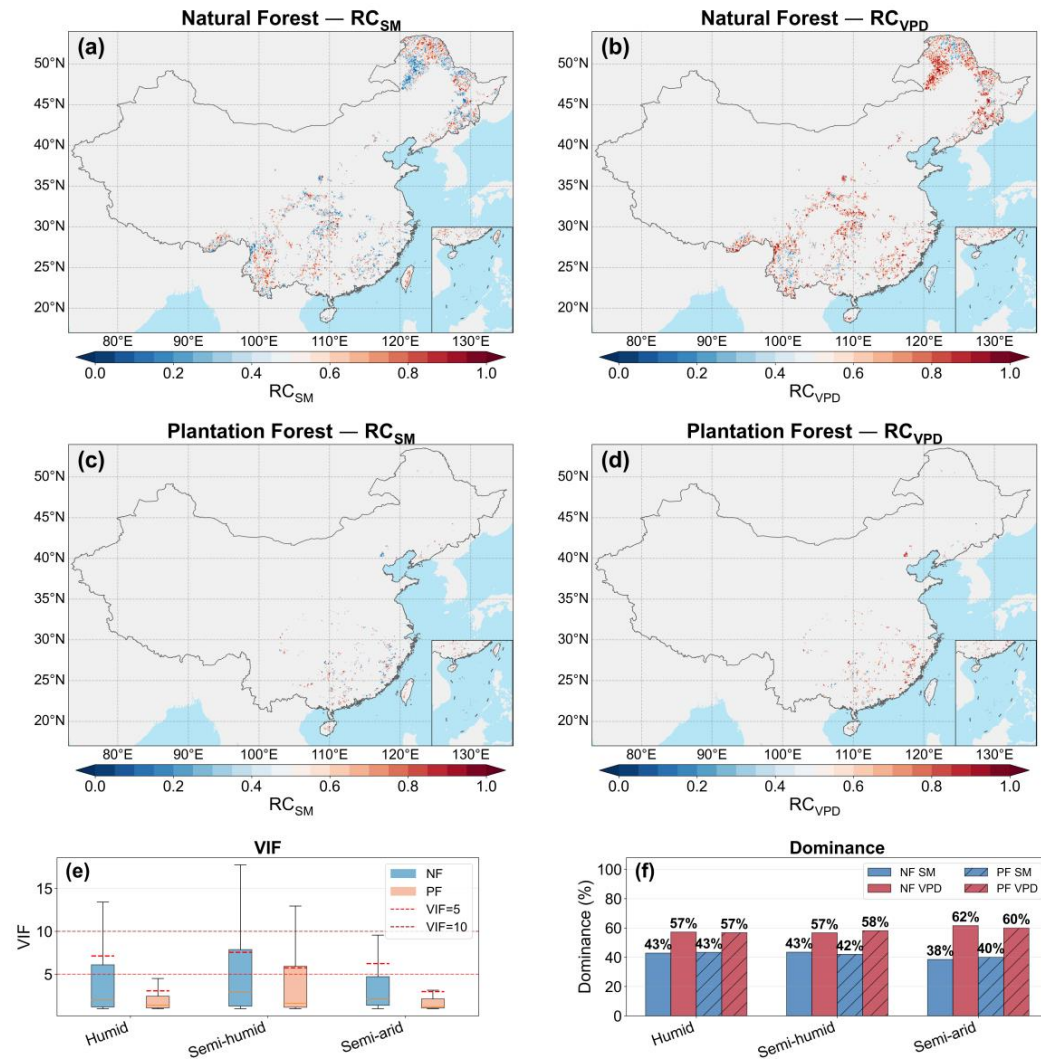


Figure S16. Spatial distribution of the relative contributions (RC) of SM and VPD to θ_{total} , together with variance inflation factor (VIF) and dominance statistics across climatic zones.

Comment 3

The other concern is that this study did not consider the effect of forest age, which should be addressed. In addition, rising atmospheric CO₂ concentrations have an important effect on forest water use efficiency (Section 4.2), but it is not considered in the present manuscript.

Response

We thank the reviewer for this helpful suggestion. We have now considered the potential effects of stand age and rising atmospheric CO₂ in the revised manuscript, but we treat them as supplementary sensitivity analyses rather than core variables in the main analytical framework. The main reason is that

this study focuses on the hydroclimatic controls of θ . Over our study domain, CO₂ behaves much more like a temporally coherent background forcing than a spatially heterogeneous driver comparable to SM or VPD, whereas stand age can modulate θ indirectly through stand structure, rooting depth, canopy roughness, and interception. To address this concern, we added the corresponding auxiliary datasets in Section 2.1 and clarified in the objectives that we examined whether atmospheric CO₂ and stand age altered the main interpretation. We also expanded the Discussion and added Figure S17, Figure S18, Table S1, and Table S2 to the Supplementary Material. These results show that CO₂ rise is better interpreted as a temporally coherent background modifier, while the higher θ in NF than in PF persists after age stratification, and including stand age does not overturn the main interpretation of the relative roles of SM and VPD.

Revised manuscript locations: Objectives; Section 2.1; Section 4.2.

Revised text excerpt from Objectives

[Lines 108–109] We further assessed robustness through cross-product comparison and examined whether atmospheric CO₂ and stand age altered the main interpretation.

Revised text excerpt from Section 2.1

[Lines 148–155] To assess whether long-term changes in θ may also be modulated by non-hydroclimatic background factors, we further compiled several auxiliary datasets ... These auxiliary datasets were resampled to 0.1° resolution and used only to assess whether CO₂ and stand age materially altered the observed θ patterns and trends. They were not included in the main analytical framework, in which the focus was on hydroclimatic controls.

Revised text excerpt from Section 4.2

[Lines 450–462] Rising atmospheric CO₂ may also have contributed to this decline ... the supplementary analyses are more consistent with interpreting CO₂ as a temporally coherent background forcing rather than a spatially heterogeneous driver of θ ... the age-stratified results show that the higher θ in NF than in PF persisted across age groups, and including stand age did not overturn the broad interpretation of the relative roles of SM and VPD, although the magnitude of change was heterogeneous across forest types and climatic zones (Figure S18; Table S2).

Supporting supplementary evidence: Figure S17, Figure S18, Table S1, and Table S2.

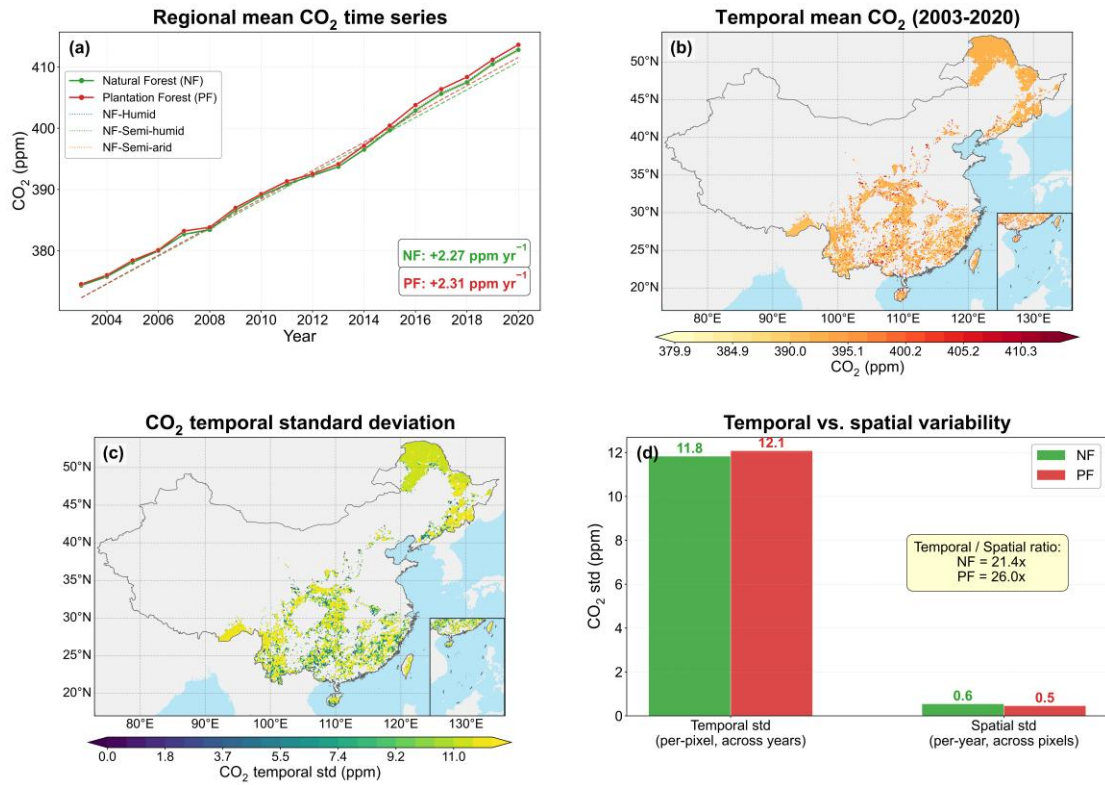


Figure S17. Spatiotemporal characteristics of atmospheric CO₂ concentration over Chinese forests (2003-2020) and the rationale for excluding CO₂ from the main pathway model.

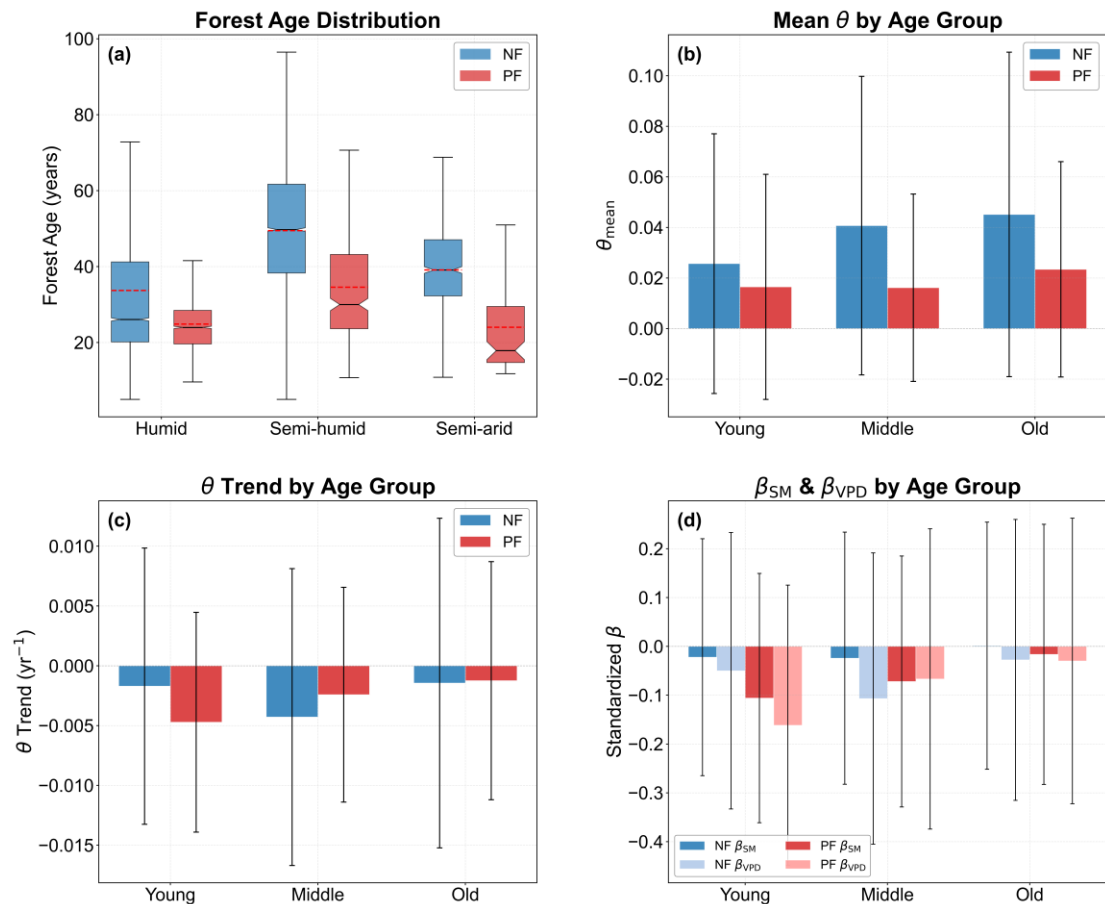


Figure S18. Comparison of LAI–transpiration fraction sensitivity (θ) between natural forests (NF) and (PF) after stand-age stratification.

Comment 4

Section 2.1: Please clarify the soil depth for the soil moisture data used in this study.

Response

We thank the reviewer for pointing this out. We have clarified in Section 2.1 that the SM used in this study is not surface soil moisture, but the GLEAM root-zone soil moisture product. We also added an explanatory sentence stating that this variable represents a vegetation-accessible multi-layer root-zone soil profile constrained by assimilated surface observations, rather than a single shallow soil layer.

Revised manuscript locations: Section 2.1.

Revised text excerpt from Section 2.1

[Lines 127-133] GLEAM separately estimates the major components of terrestrial evaporation and provides both surface and root-zone soil moisture. In this study, SM refers to the root-zone soil moisture product, rather than surface soil moisture ... In GLEAM, root-zone soil moisture is represented as a vegetation-accessible multi-layer soil profile constrained by assimilated surface observations, rather than as a single shallow soil layer.

Comment 5

As shown in Eq. 1-4, VPD is mainly affected by air temperature and relative humidity, why was relative humidity not considered as one of climate factors in the analysis?

Response

We thank the reviewer for this important question. In the revised manuscript, we now distinguish more clearly between the variables used to calculate VPD and the variables included in the pathway analysis. RH is explicitly used in the calculation of VPD, so its effect on atmospheric water demand is already embodied in VPD. If RH and VPD were both included as parallel predictors in the subsequent pathway analysis, their interpretations would overlap and the model would become more redundant. We therefore retained RH in the VPD calculation and added an explicit statement in Section 2.3.5 that RH was not included separately because its effect on atmospheric water demand is already represented by VPD.

Revised manuscript locations: Section 2.3.1; Section 2.3.5.

Revised text excerpt from Section 2.3.1

[Lines 194-195] To calculate VPD, we used directly observed meteorological parameters, including air temperature (T_a , °C), relative humidity (RH, %), and air pressure (P_a , hPa).

Revised text excerpt from Section 2.3.5

[Lines 287-288] RH was not included separately because its effect on atmospheric water demand is already represented by VPD

Comment 6

Line 102: The aridity index framework was used to divide the study area to three climatic zones. But there are four climatic zones (Lines 182-184, Fig. 2) although the arid zone was excluded from the analysis (Lines 185-187).

Response

We thank the reviewer for catching this inconsistency. We have revised the wording to distinguish clearly between the geographic classification and the statistical-analysis domain. The revised manuscript now states consistently that the AI framework divides China into four climatic zones for mapping and descriptive comparison, whereas the subsequent statistical analyses are restricted to the humid, semi-humid, and semi-arid zones because forest samples in the arid zone are too sparse.

Revised manuscript locations: Objectives; Section 2.2.1.

Revised text excerpt from the Objectives

[Lines 98-101] We first used the aridity index (AI) framework to characterize the climatic background across four climatic zones and then focused the statistical analyses on the humid, semi-humid, and semi-arid zones to ensure comparability.

Revised text excerpt from Section 2.2.1

[Lines 174-179] Based on the 1990-2020 multi-year mean AI, China was divided into four climatic zones ... This four-zone classification was used as the geographic framework for mapping and descriptive comparisons. Because forest samples in the arid zone were extremely sparse, subsequent statistical analyses were restricted to the humid, semi-humid, and semi-arid zones

Comment 7

Figure 2: It is better to add the fraction of NF and PF for different climatic zones in Fig. 2a.

Response

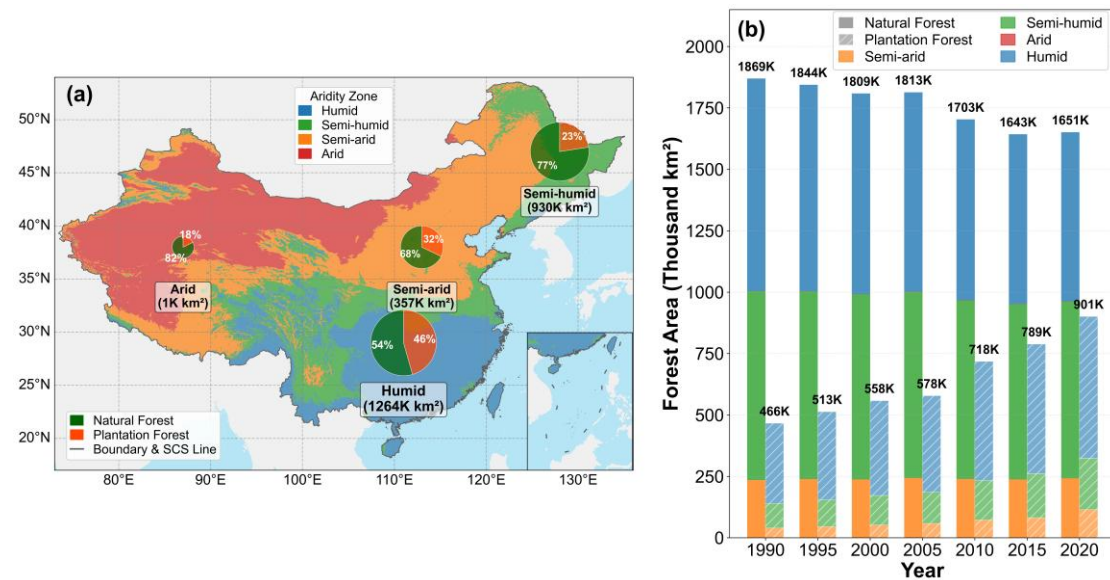
We thank the reviewer for this helpful suggestion. We have revised Figure 2a by adding pie charts for each climatic zone to show the total forest area and its composition of natural forest (NF) and planted forest (PF). The figure caption has also been updated accordingly. This revision makes the zonal composition of NF and PF more transparent and easier to compare visually.

Revised manuscript locations: Figure 2 caption.

Revised figure caption

[Lines 181-184] Figure 2 ... (a) Spatial distribution of the four climatic zones ... the pie charts show the total forest area within each zone and its composition of natural forest (green) and planted forest (orange).

Revised main-text figure: Figure 2a now includes pie charts showing the NF/PF composition in each climatic zone.



Comment 8

Line 550: the wrong variable “ β_{VPD} ”

Response

We thank the reviewer for pointing out this error. In the revised manuscript, the section corresponding to the original Line 550 has been rewritten, and the incorrect variable no longer appears at that location. Furthermore, we have meticulously checked the entire manuscript (including all text, equations, and captions) to ensure that no similar errors exist and that the symbols β_{SM} and β_{VPD} are used consistently throughout.

Comment 9

Proofreading of the manuscript needs to be polished by a native English speaker before the submission.

Response

We thank the reviewer for this valuable suggestion. Before resubmission, the entire manuscript was professionally proofread and polished by a native English speaker to improve grammar, wording, clarity,

and overall readability. A language-editing certificate is provided with the revised submission.

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- 收费单价: 0.55元/单词
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