



Supplement of

The influence of vapor pressure deficit changes on global terrestrial evapotranspiration

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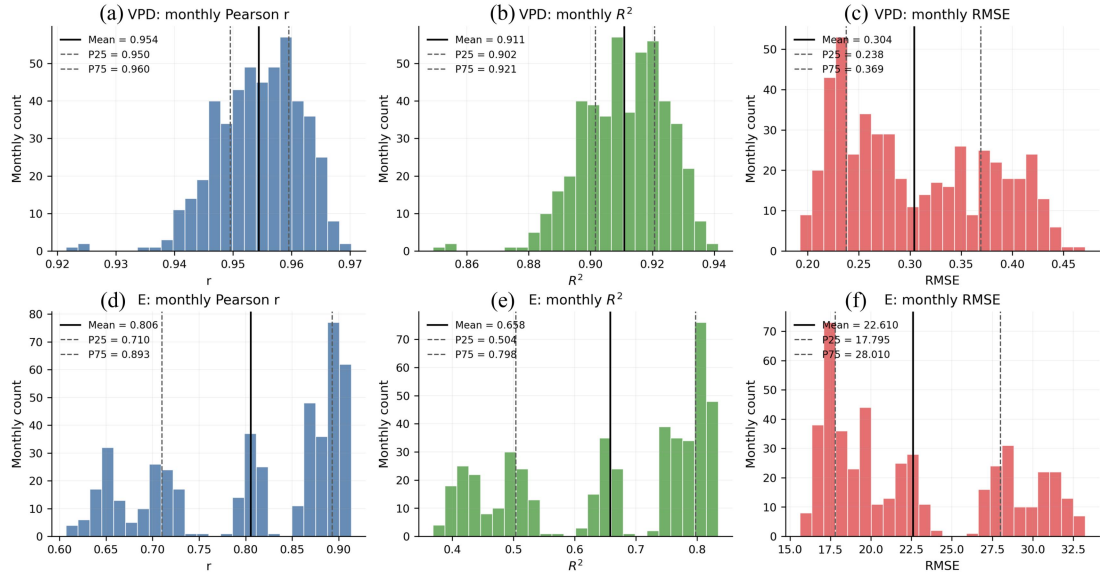


Figure S1. Validation of the reliability of the VPD and E datasets. a-c, spatial distributions of the correlation coefficient (r), coefficient of determination (R^2), and root mean square error (RMSE) between the two VPD datasets. d-f, spatial distributions of r , R^2 , and RMSE between the two E datasets.

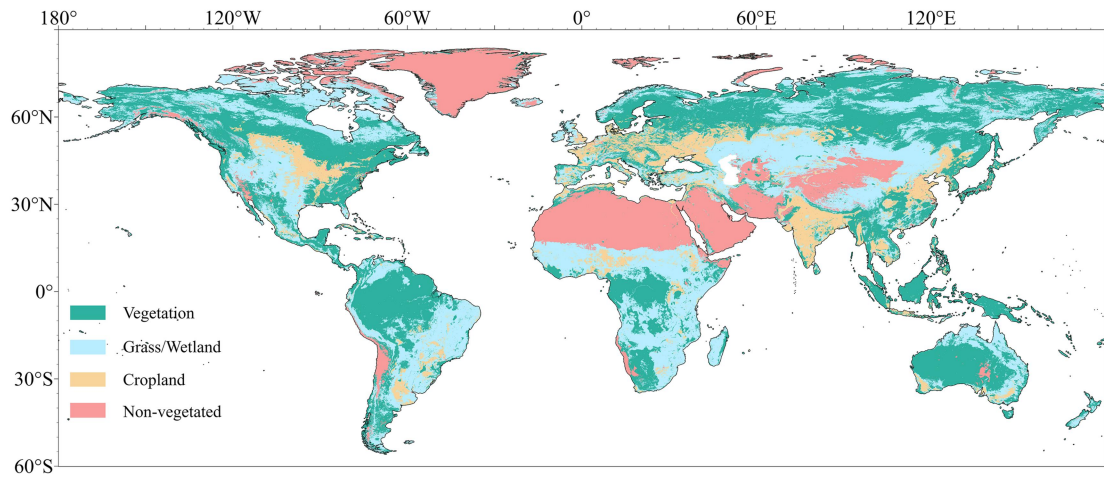


Figure S2. Global distribution of the four major land-use categories aggregated from the original 16 land-cover classes.

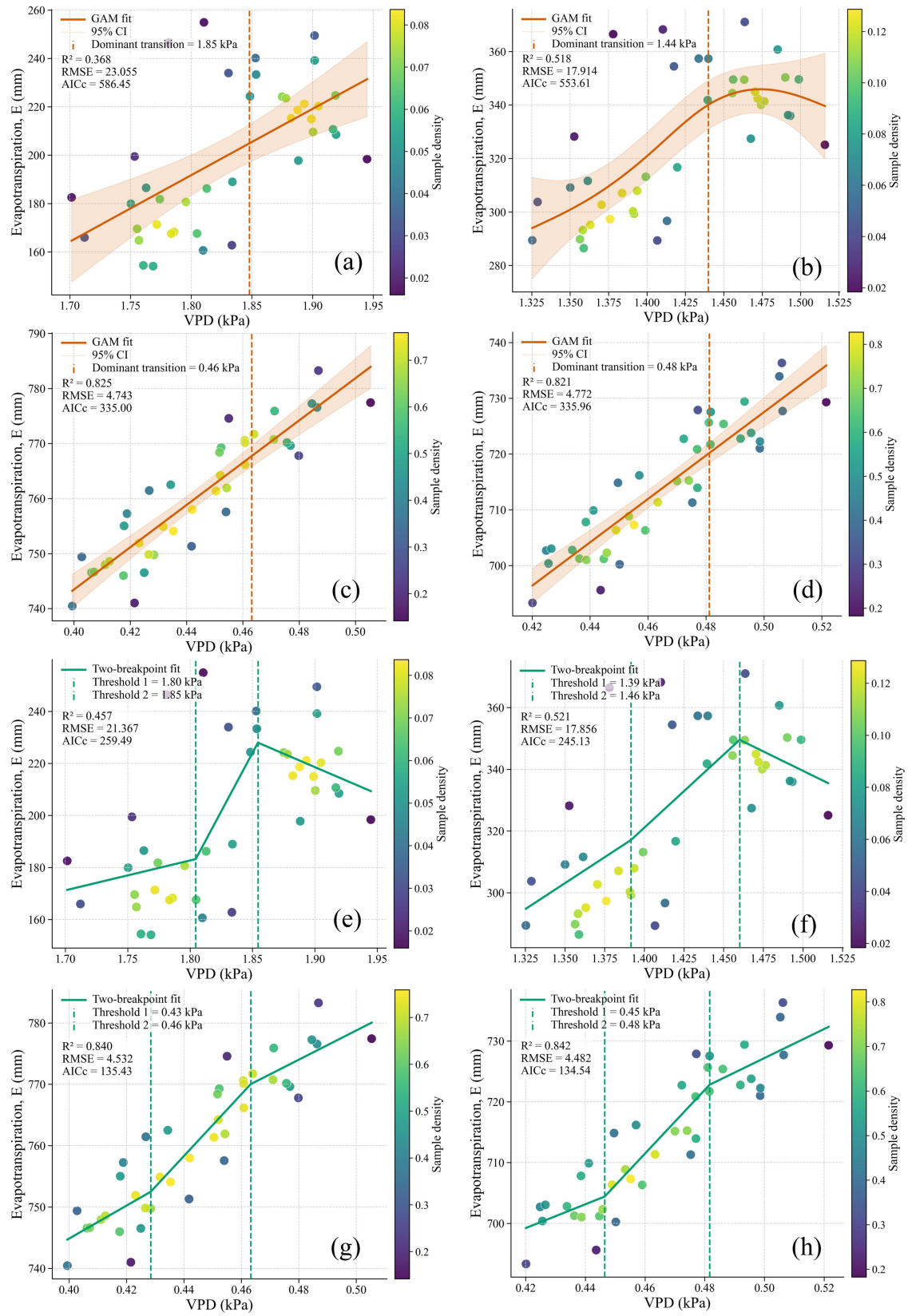


Figure S3. Nonlinear threshold responses of terrestrial evapotranspiration to vapor pressure deficit across AI-based aridity zones. Panels a–d show the GAM-based nonlinear responses of terrestrial evapotranspiration (E) to vapor pressure deficit (VPD) in the arid, semi-arid, humid, and

semi-humid aridity zones, respectively. Panels e–h show the corresponding two-breakpoint piecewise fits for the same four aridity zones in the same order. In each panel, points represent annual area-weighted mean observations for the corresponding aridity zone, with color indicating sample density. Solid curves denote the fitted nonlinear relationships, and shaded areas in the GAM panels indicate the 95% confidence intervals of the fitted responses. Vertical dashed lines indicate the estimated threshold locations, defined as the dominant transition point for the GAM and as the two fitted breakpoints for the two-breakpoint piecewise model. Together, these results illustrate the aridity-zone-dependent nonlinear response of E to VPD and provide a robustness check for the threshold estimates reported in the main text.

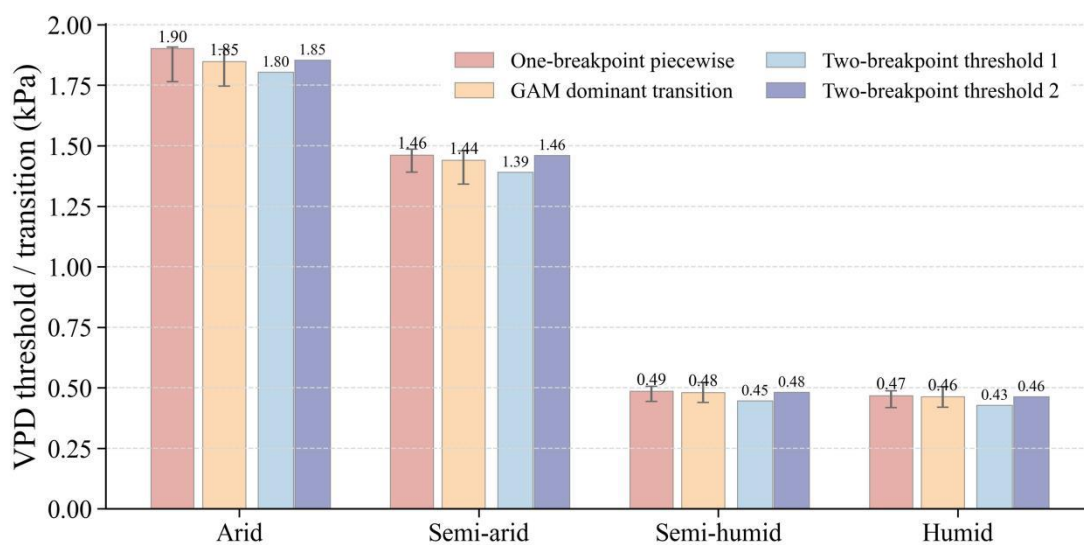


Figure S4. Comparison of VPD threshold estimates derived from different models across AI-based aridity zones. Bar plots compare the estimated VPD thresholds or transition points among the one-breakpoint piecewise model, the GAM-derived dominant transition, and the two-breakpoint piecewise model across the four aridity zones (arid, semi-arid, semi-humid, and humid). For the two-breakpoint model, the first and second breakpoints are shown separately to illustrate the potential multi-stage structure of the nonlinear VPD–E relationship. Error bars for the one-breakpoint piecewise model and GAM indicate the 95% bootstrap confidence intervals of the corresponding threshold estimates. This figure highlights the consistency in threshold magnitude across models, while also showing that threshold values systematically decrease from dry to humid aridity backgrounds.

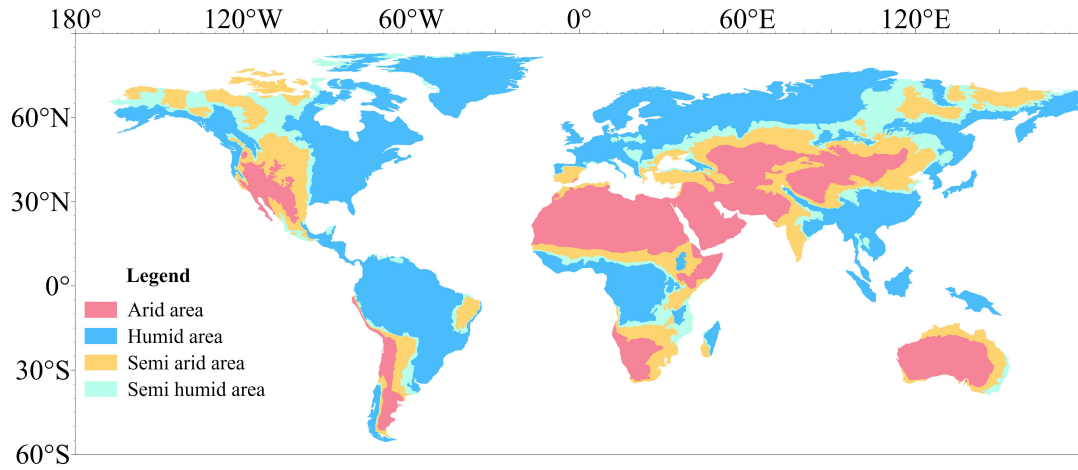


Figure S5. Global AI-based aridity zones classified by aridity index (AI). The map classifies global land areas based on the aridity index ($AI = P/PET$), where P is mean annual precipitation and PET is mean annual potential evapotranspiration. According to the commonly used UNEP classification, hyper-arid, arid, semi-arid, semi-humid, and humid regions are defined by $AI < 0.03$, $0.03 \leq AI < 0.20$, $0.20 \leq AI < 0.50$, $0.50 \leq AI < 0.65$, and $AI \geq 0.65$, respectively. In this figure, the hyper-arid class is merged into the arid class; therefore, the “Arid area” in the legend corresponds to $AI < 0.20$.

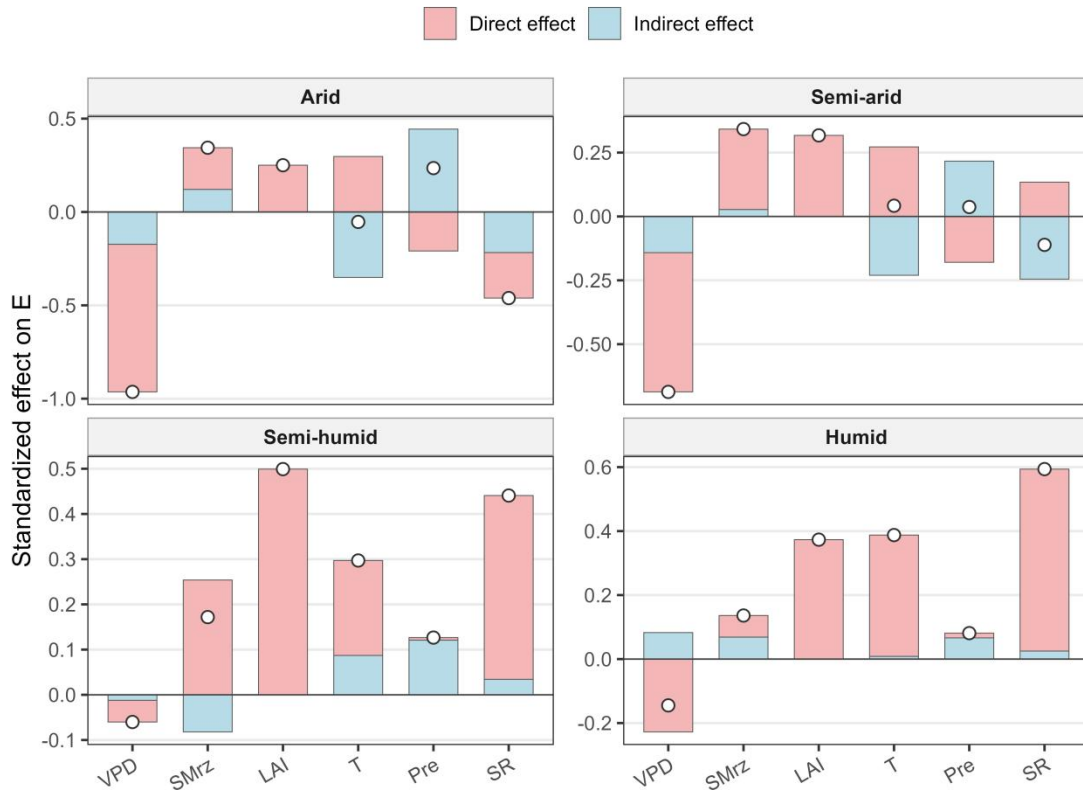


Figure S6. Decomposition of direct, indirect, and total effects on evapotranspiration across AI-based aridity zones. The figure shows the standardized effects of each predictor on E in the full aridity-zone-specific SEMs. Panels show results for (a) arid, (b) semi-arid, (c) semi-humid, and (d) humid regions. Pink bars represent direct effects, and blue bars represent indirect effects mediated

through other variables in the SEM. White circles represent total effects, calculated as the sum of direct and indirect effects. The y-axis shows the standardized effect on E. VPD, vapor pressure deficit; SMrz, root-zone soil moisture; LAI, leaf area index; T, air temperature; Pre, precipitation; SR, surface solar radiation; E, evapotranspiration.

Table S1. Comparison of restricted and full SEMs across AI-based aridity zones.

Climate zone	Restricted SEM	Restricted SEM <i>P</i> value	Residual VPD–LAI association in restricted SEM	Restricted SEM AIC	Full SEM AIC	Δ AIC	Full SEM status
	Fisher's C						
Arid	14.17	0.001	$P = 0.0008$	3504.21	3494.89	–9.32	Saturated
Semi-arid	8.52	0.014	$P = 0.0141$	4189.57	4185.46	–4.11	Saturated
Semi-humid	8.57	0.014	$P = 0.0137$	4000.04	3995.88	–4.15	Saturated
Humid	33.08	<0.001	$P < 0.001$	3546.01	3518.48	–27.53	Saturated

Table note. The restricted SEM excluded the direct statistical association between VPD and LAI, while the full SEM retained this association. The residual VPD–LAI association was identified from directed-separation tests of the restricted SEM. Δ AIC was calculated as $AIC_{full} - AIC_{restricted}$. Negative Δ AIC values indicate lower AIC values for the full SEM. After retaining the residual VPD–LAI association, the full SEMs became saturated models, leaving no remaining independence claims for Fisher's C tests. Therefore, Fisher's C statistics are reported only for the restricted SEMs. VPD, vapor pressure deficit; LAI, leaf area index; SEM, structural equation modeling; AIC, Akaike information criterion.