

## Supplementary Material

### Groundwater rivals aridity in determining global photosynthesis

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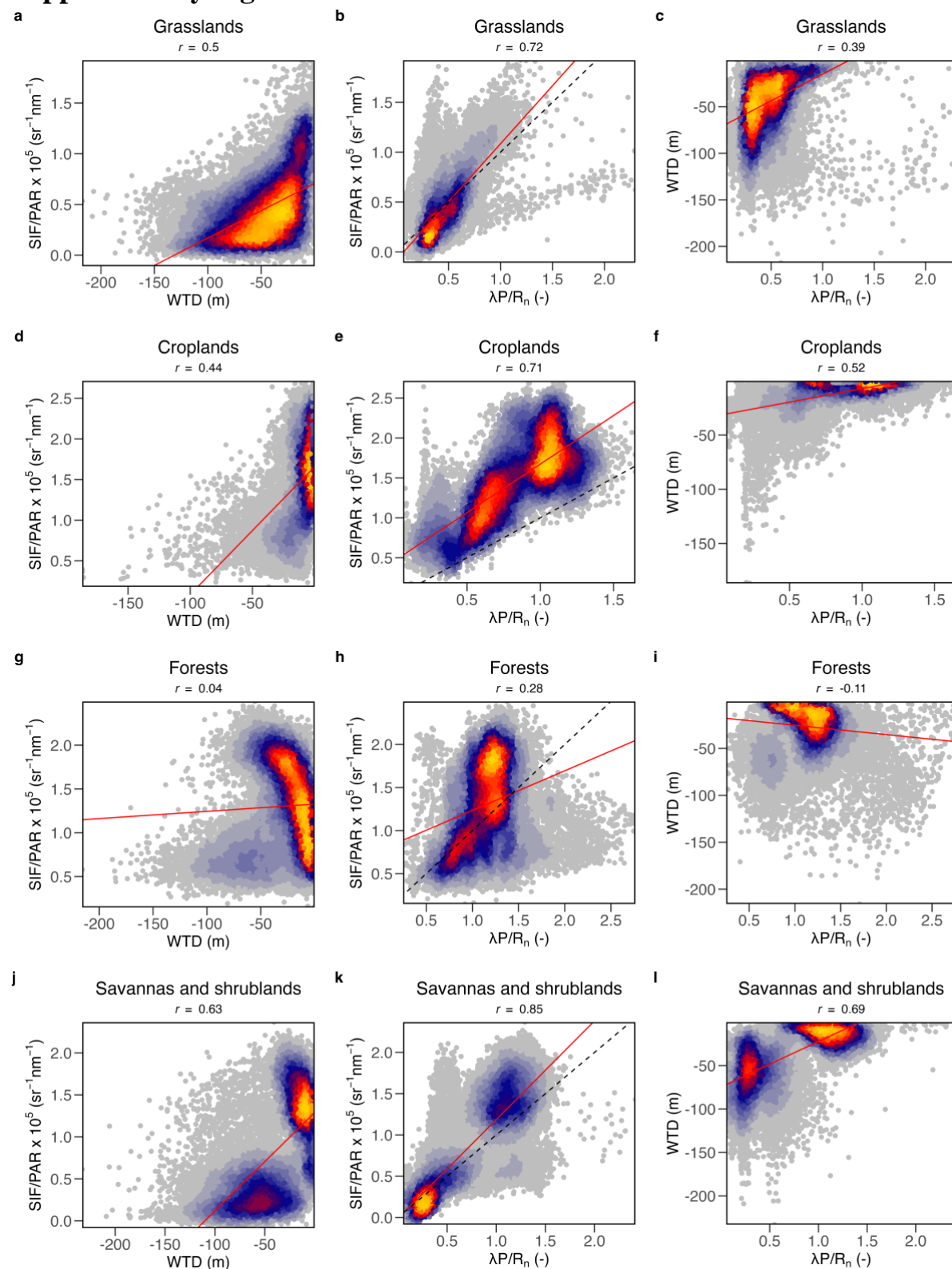
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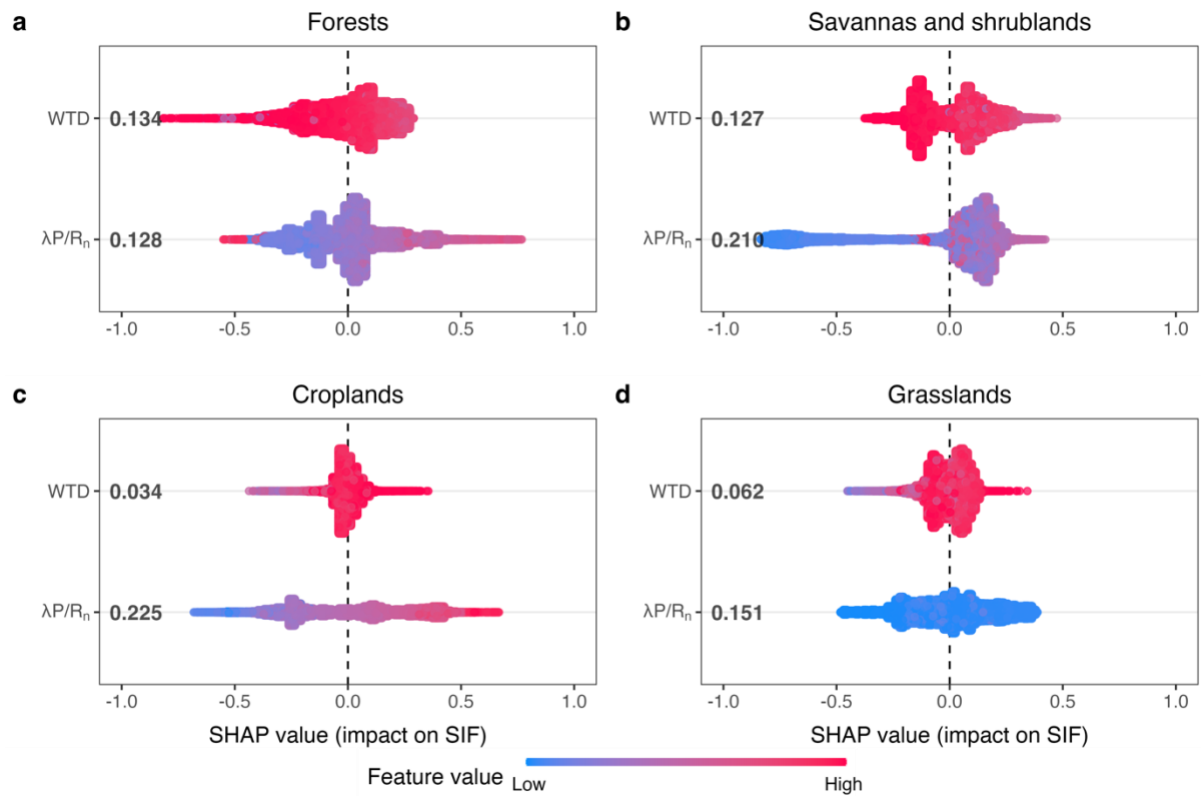
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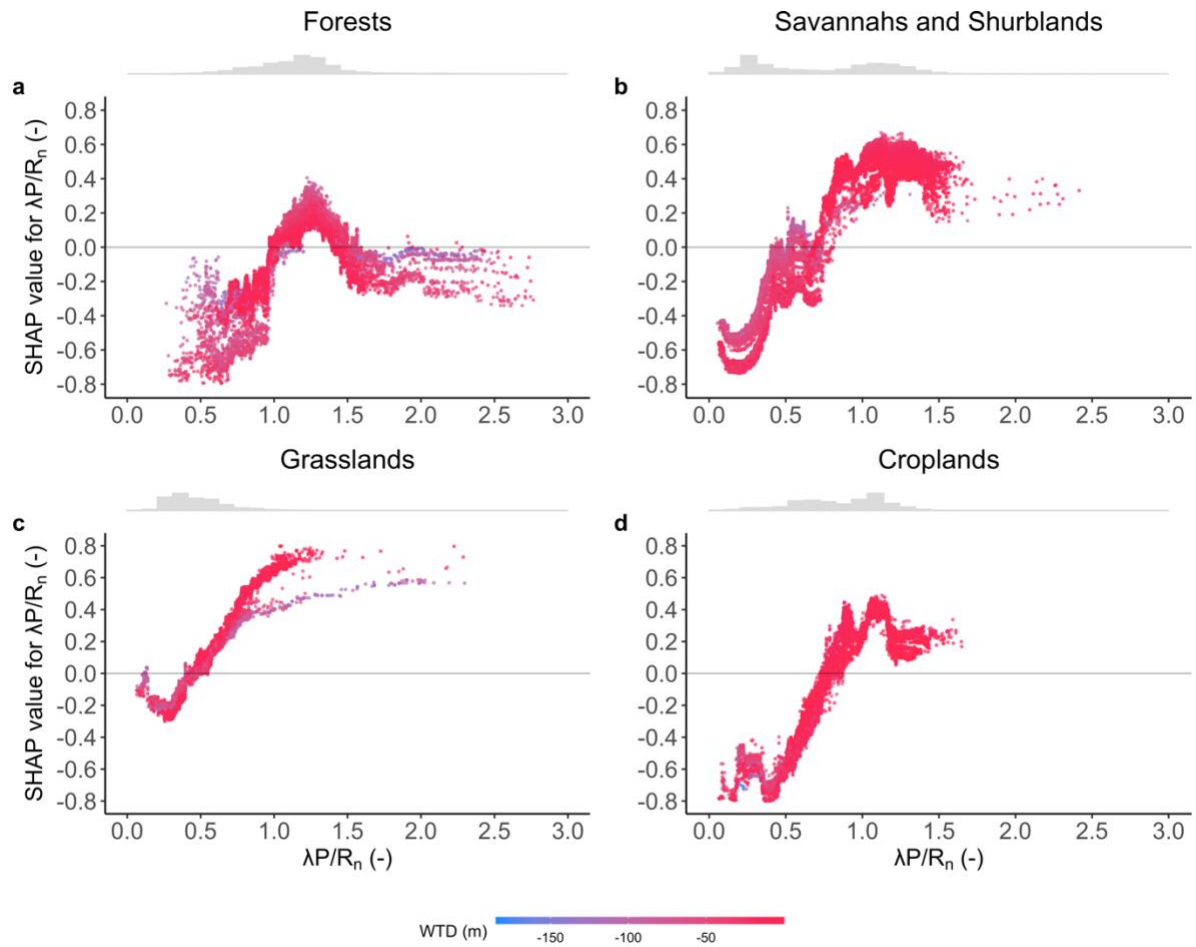
## Supplementary Figures



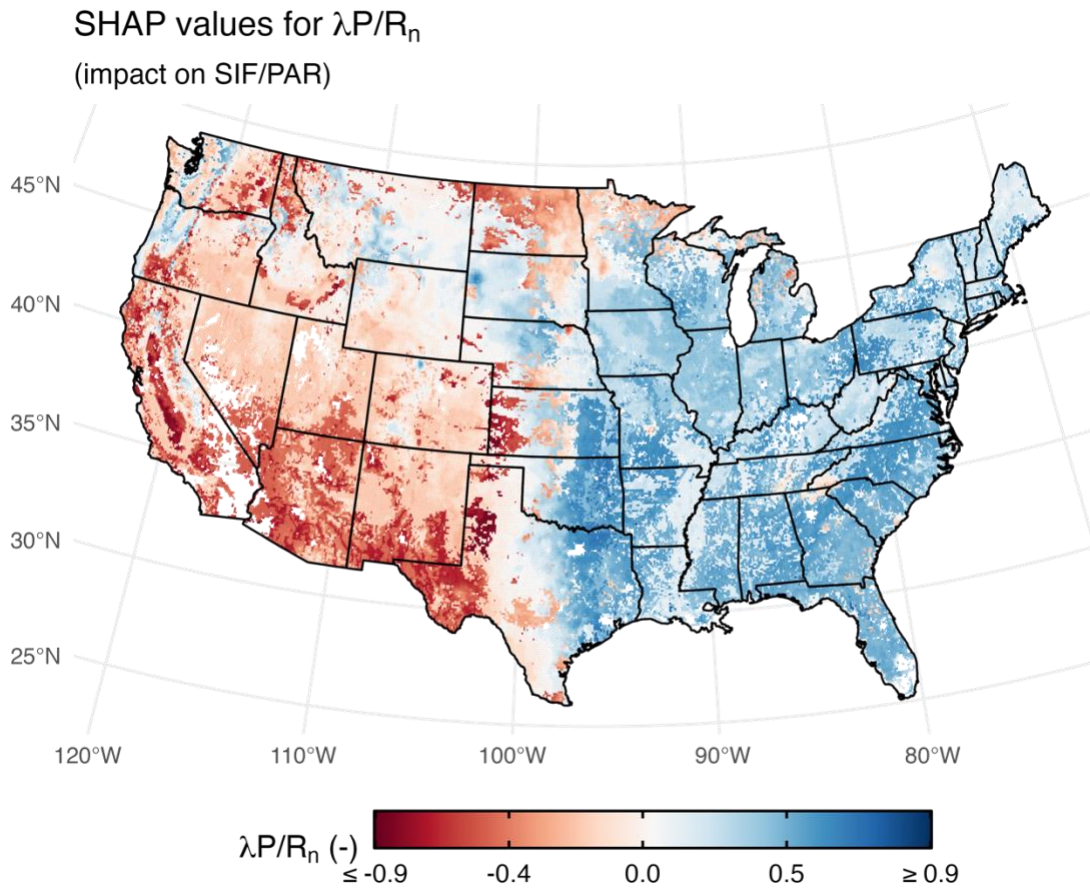
**Supplementary Fig. 1 | Pearson correlation coefficients between features and with the target variable in the Extreme Gradient Boosting models for the USA. a-c, Grasslands. d-f, Croplands. g-i, Forests. j-l, Savannas and shrublands. Red line: linear regression line between modelled and observed data. Dashed black line:  $y = x$  line.**



**Supplementary Fig. 2 | SHAP summary plots using global data.** **a-d**, SHAP summary plots, which show the effect of different predictors on each model outcome. Each dot corresponds to the interannual mean of an individual pixel from global datasets. The average SHAP value, displayed to the left of each plot near the name of each predictor, represents the mean contribution of that predictor. The colour of a dot indicates the magnitude of each predictor at that location. The  $x$ -axis position of a dot represents the local SHAP value of the predictor, i.e. how a predictor affects the outcome of the model (i.e. SIF/PAR). Overlapping dots at an  $x$ -coordinate denote higher density, suggesting similar effects across multiple points. WTD: water table depth, P/R<sub>n</sub>: moisture index. **a**, Forests (evergreen and deciduous, needle-leaved and broadleaved, and mixed forests). **b**, Savannas and shrublands (savannas and woody savannas, open and closed shrublands). **c**, Croplands. **d**, Grasslands.



**Supplementary Fig. 3 | SHAP dependence plots of  $\lambda P/R_n$  versus its SHAP value along WTD gradients across plant functional types.** SHAP dependence plot show how a specific predictor affects model outcomes while accounting for interaction effects between predictors. Each dot represents the long-term mean of an individual pixel from global datasets. The colour of a dot indicates the magnitude of the moisture index at that location. WTD: water table depth,  $\lambda P/R_n$ : moisture index. **a**, Forests (evergreen and deciduous, needle-leaved and broadleaved, and mixed forests). **b**, Savannas and shrublands (savannas and woody savannas, open and closed shrublands). **c**, Grasslands. **d**, Croplands. Grey histograms on top of each panel depict marginal density plots for  $\lambda P/R_n$ .



**Supplementary Fig. 4 | Spatial representation of SHAP values for  $P/R_n$  across the continental United States.** SHAP values illustrate the effect of  $P/R_n$  on SIF/PAR. Positive SHAP values suggests that WTD has a positive impact on SIF/PAR (blue points), thus meaning that groundwater is supporting additional photosynthetic activity. Conversely, negative SHAP values indicate that the WTD value has a negative effect on SIF/PAR in that specific pixel (red points).

**Supplementary Table 1 | Performance of Extreme Gradient Boosting (XGB) models**

<b>Plant functional types</b>	<b><math>R^2_{\text{train}}</math></b>	<b><math>R^2_{\text{test}}</math></b>	<b><math>\text{RMSE}_{\text{train}}</math></b>	<b><math>\text{RMSE}_{\text{test}}</math></b>
<i>USA</i>				
Forests	0.55	0.49	0.32	0.34
Savannas and shrublands	0.84	0.82	0.24	0.26
Grasslands	0.67	0.64	0.18	0.18
Croplands	0.69	0.66	0.27	0.29
<i>World</i>				
Forests	0.21	0.2	0.48	0.48
Savannas and shrublands	0.32	0.31	0.47	0.47
Grasslands	0.27	0.27	0.35	0.35
Croplands	0.38	0.36	0.35	0.36