



*Supplement of*

## **Relevance of near-surface soil moisture vs. terrestrial water storage for global vegetation functioning**

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Supplementary Information

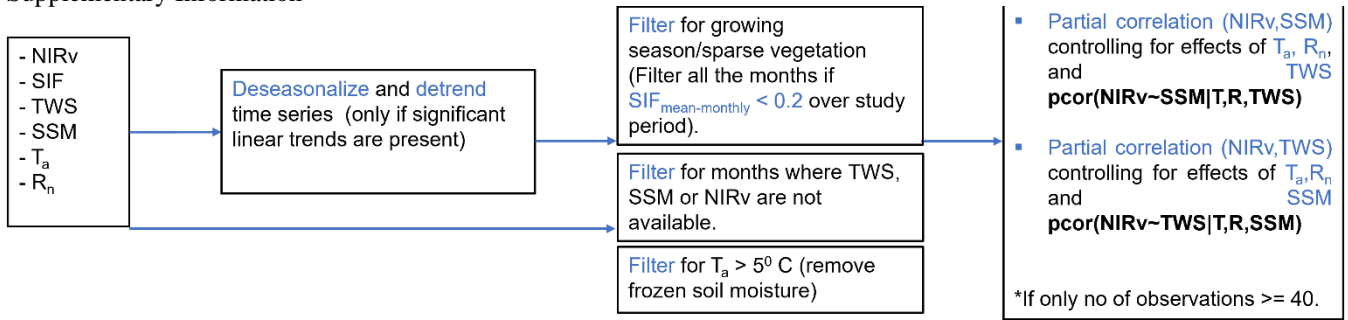


Figure S1: Flowchart of overall data processing and methodology. The input datasets are Terrestrial Water Storage (TWS) Anomalies, Surface Soil Moisture (SSM), Solar Induced Fluorescence (SIF), Near Infrared Reflectance of Vegetation (NIRv), air temperature (T<sub>a</sub>) and Radiation (R<sub>n</sub>).

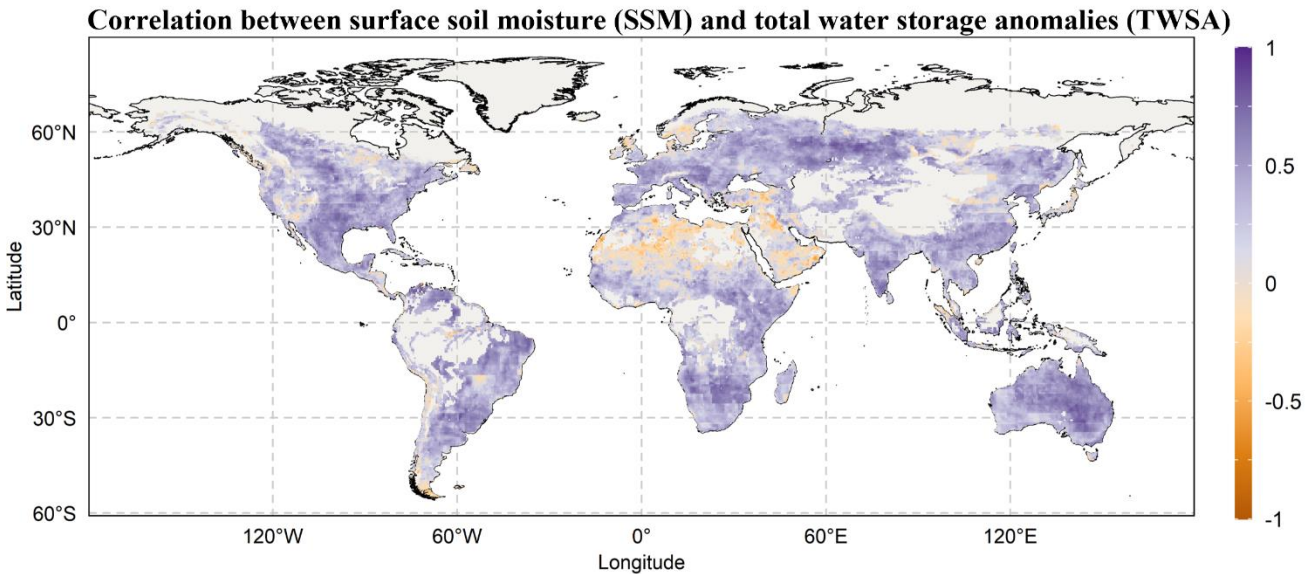


Figure S2: Correlation between surface soil moisture (SSM) from ESA-CCI and total water storage (TWS) from GRACE in growing season months. The purple colour indicates the positive correlation of SSM with TWS while orange colour indicates the opposite. The non-growing season months are filtered out using the same filtering criteria as described in the methodology.

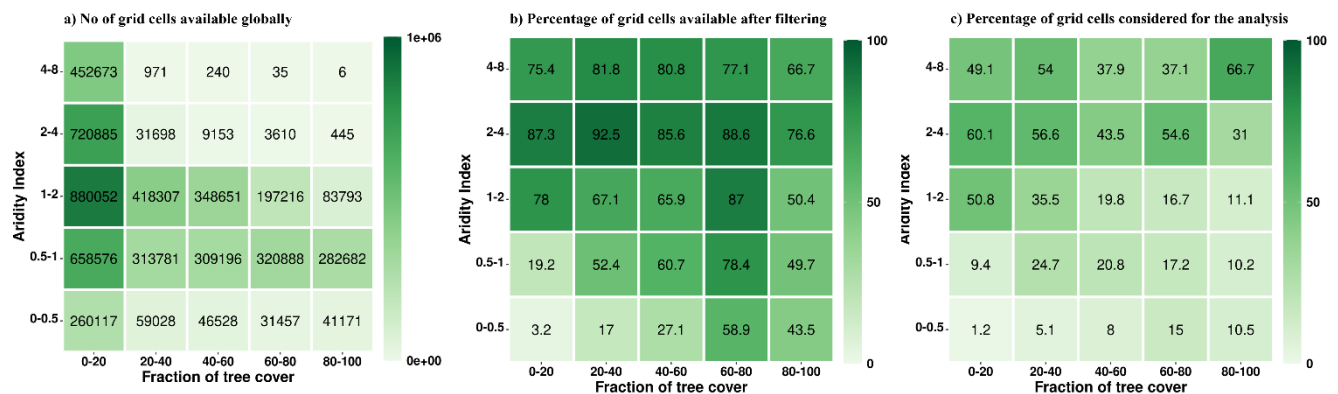
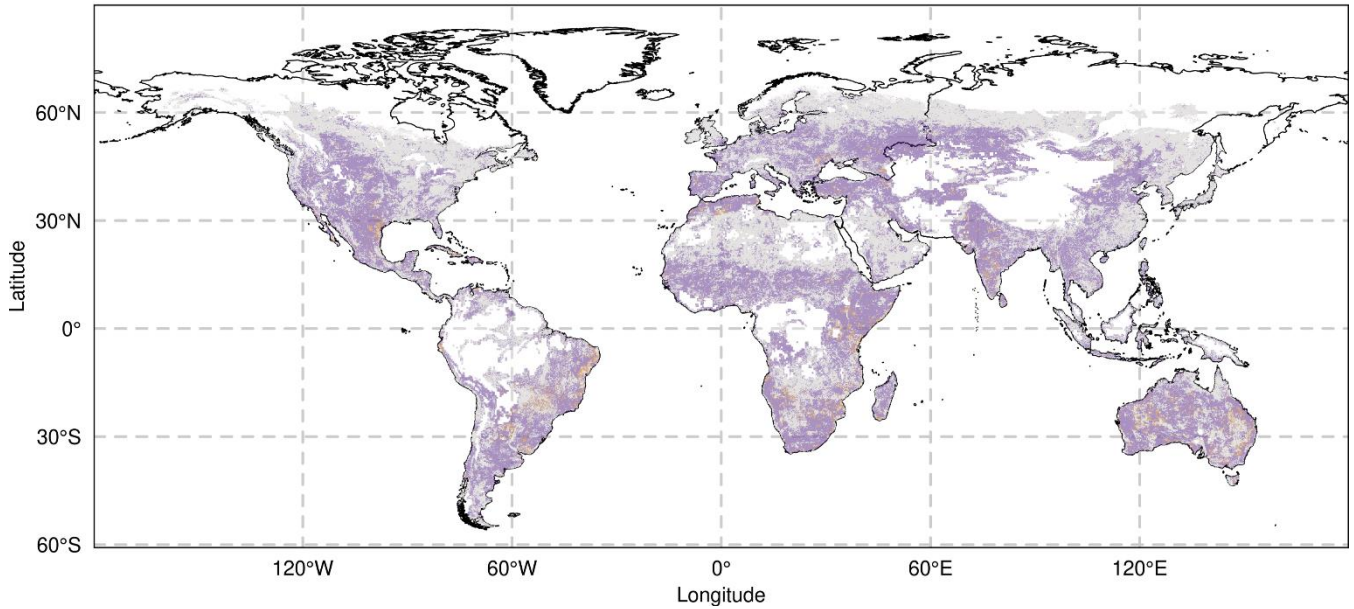
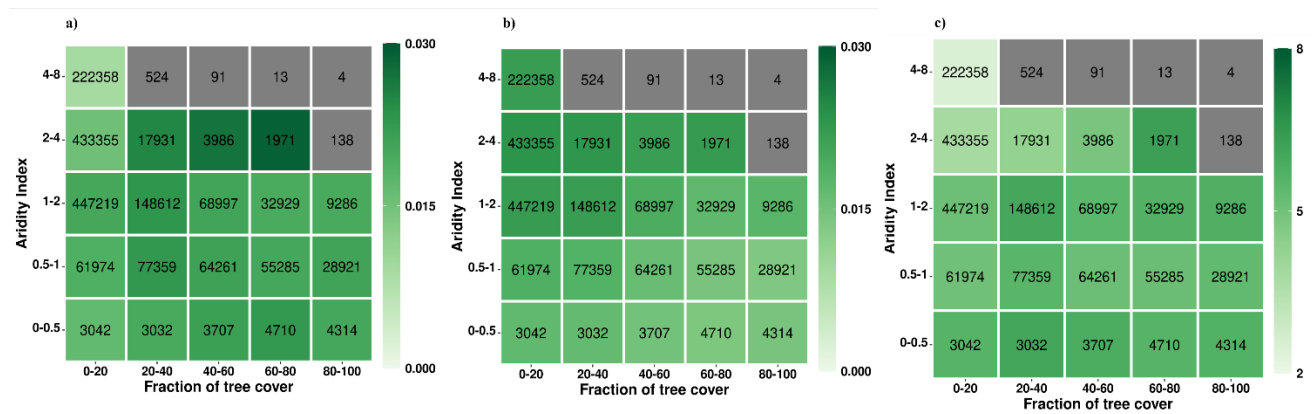


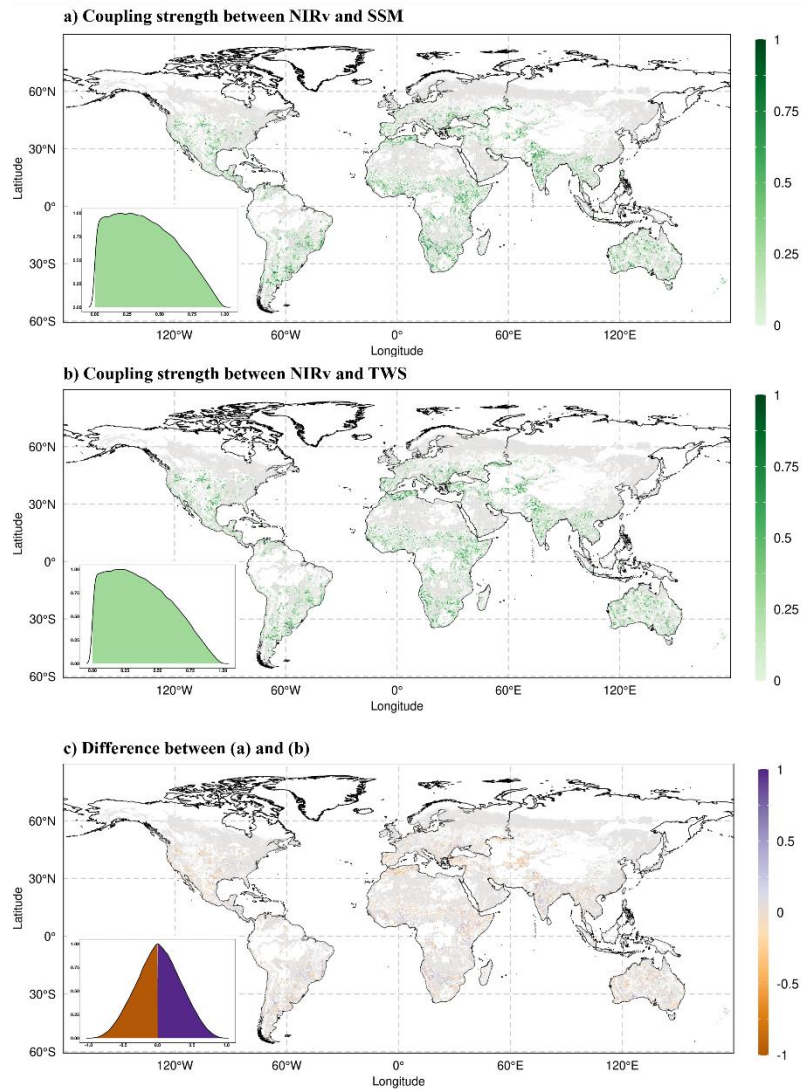
Figure S3: (a) The number of grid cells available globally for different AI-TC classes before implementing any filtering, (b) The percentage of grid cells retained for each AI-TC class after selecting growing season months, removing non-available months, and ensuring a minimum of 40 months are accessible for partial correlation and (c) The percentage of grid cells remaining for each AI-TC class after additional filtering to exclude negative correlations, explicitly focusing on water-limited regions. The percentages are calculated relative to the initial count of grid cells available for each AI-TC class globally (Figure a).



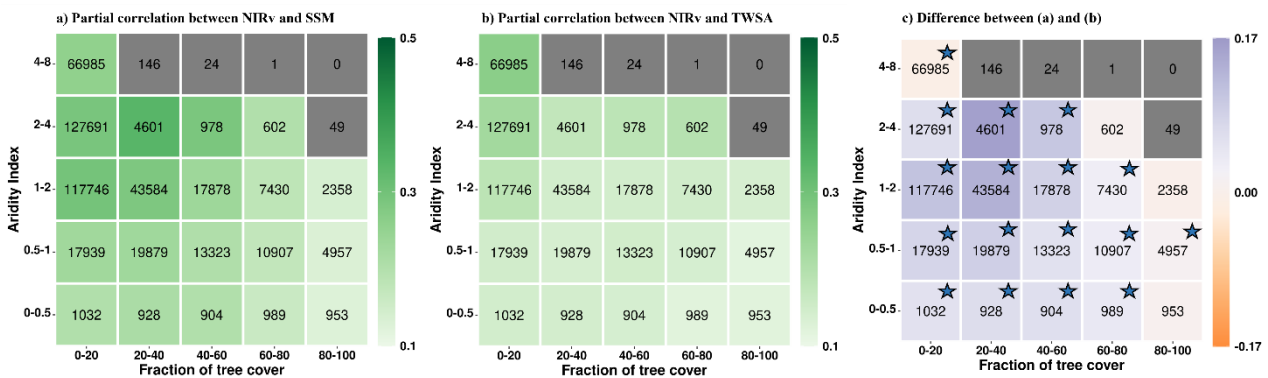
**Figure S4:** The purple color denotes instances where the entire confidence interval of the partial correlation between NIRv and Total Water Storage (TWS) falls outside the entire confidence interval of the partial correlation between NIRv and Near-Surface Soil Moisture (SSM). In some grid cells (orange color), the confidence interval for NIRv ~ TWS falls within the bounds of NIRv ~ SSM during growing season months. The 95% confidence intervals were computed using a full bootstrapping methodology, applying 1000 repetitions in each grid cell.



**Figure S5:** Standard deviation of anomalies of (a) NIRv (b) SSM and (c) TWS across varying aridity class and tree cover fraction classes for growing season months only.



**Figure S6: Partial correlation of NIRv with (a) surface soil moisture (SSM),  $\rho_{cor}$  (NIRv-SSM) (b) total water storage anomalies (TWS),  $\rho_{cor}$  (NIRv-TWS), and (c) difference between (a) and (b) in dry months. In this analysis, the identification of dry months was based on selecting those months corresponding to the lowest 10th percentile of surface soil moisture, while also considering only grid cells, where over 100 monthly observations were available after filtering. Furthermore, only grid cells having positive correlation during growing season months were considered for dry months analysis. Additionally, all the grid cells having a negative partial correlation between NIRv and SSM or NIRv and TWS have been filtered out in this map.**



**Figure S7: Similar to Figure 2, but only considering the grids cells that are considered in the dry months.**

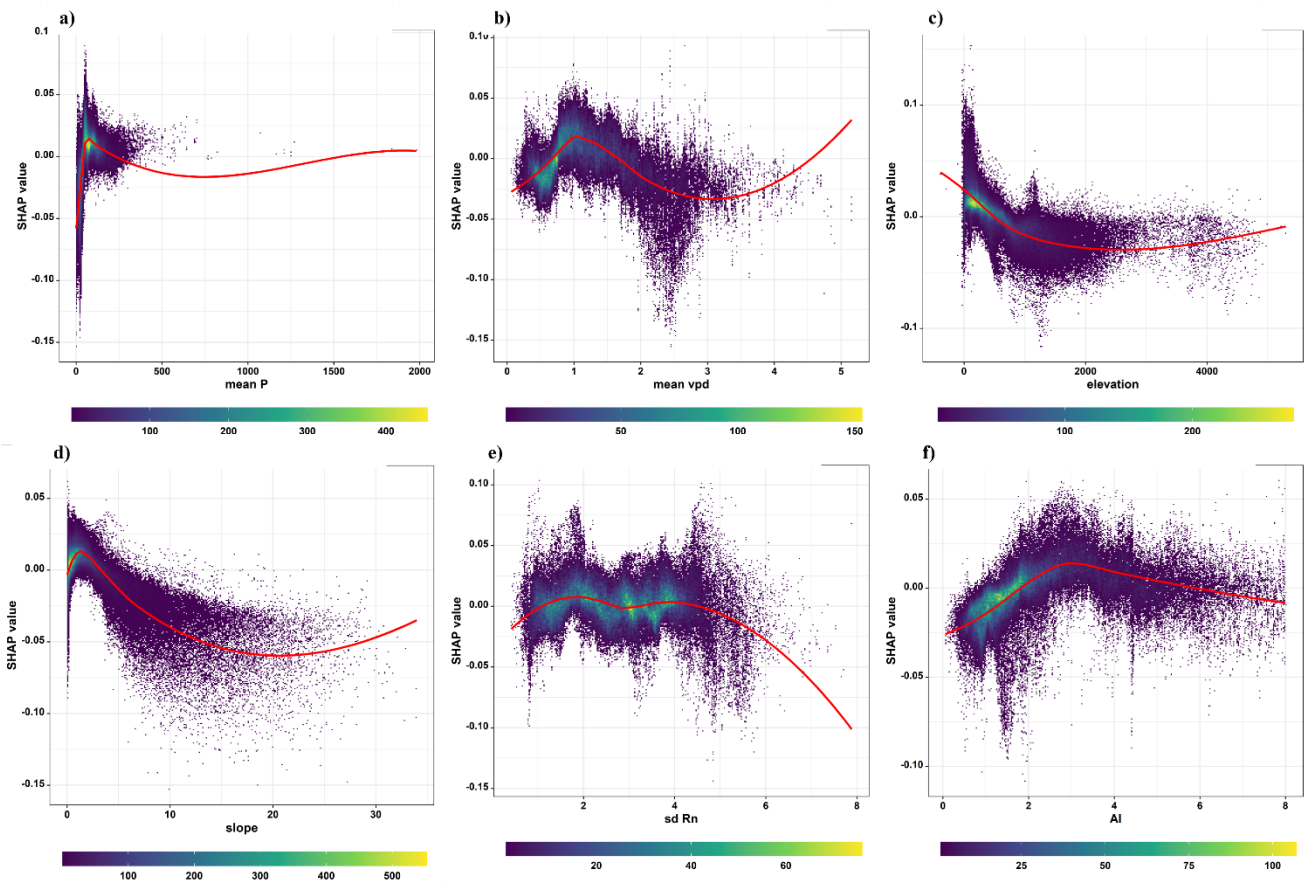


Figure S8: SHAP dependence plot (SHAP value vs value of predictor) for the predictors, (a) mean P, (b) mean vpd, (c) elevation, (d) slope, (e) variability of net radiation (sd Rn), and (f) aridity index. These predictors rank 4<sup>th</sup> to 9<sup>th</sup> in the SHAP importance plot out of 15 predictors in SHAP analysis.

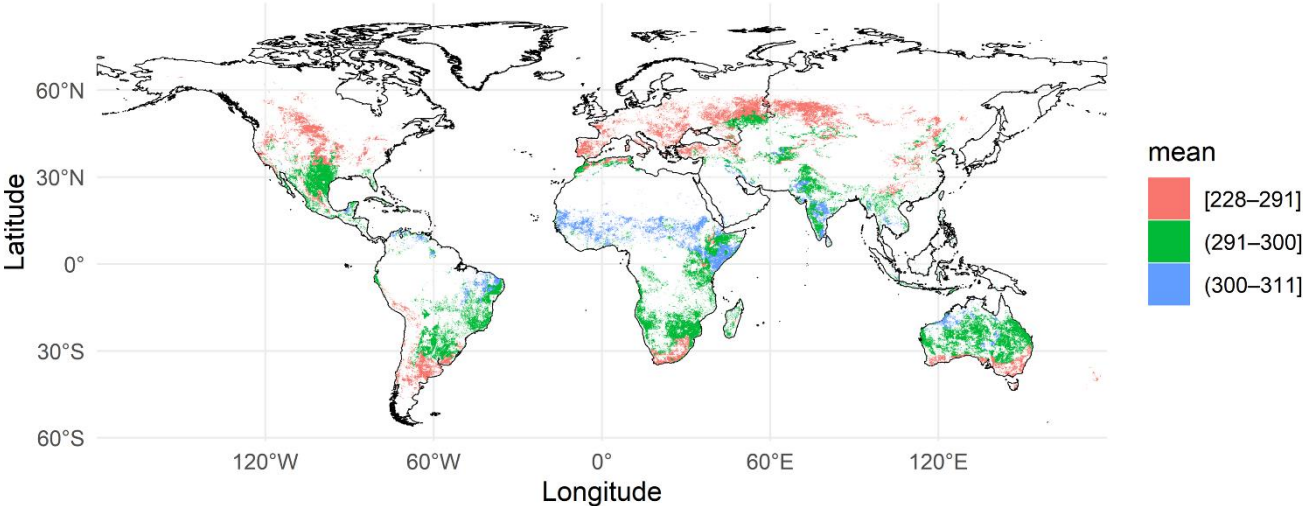
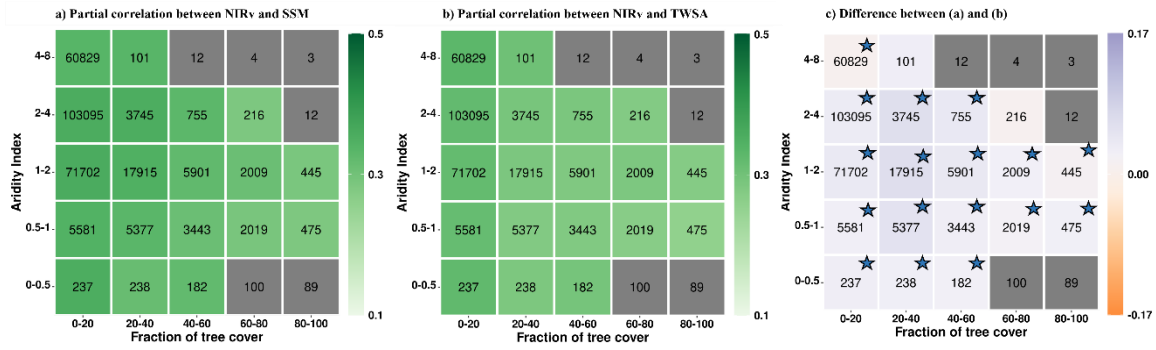
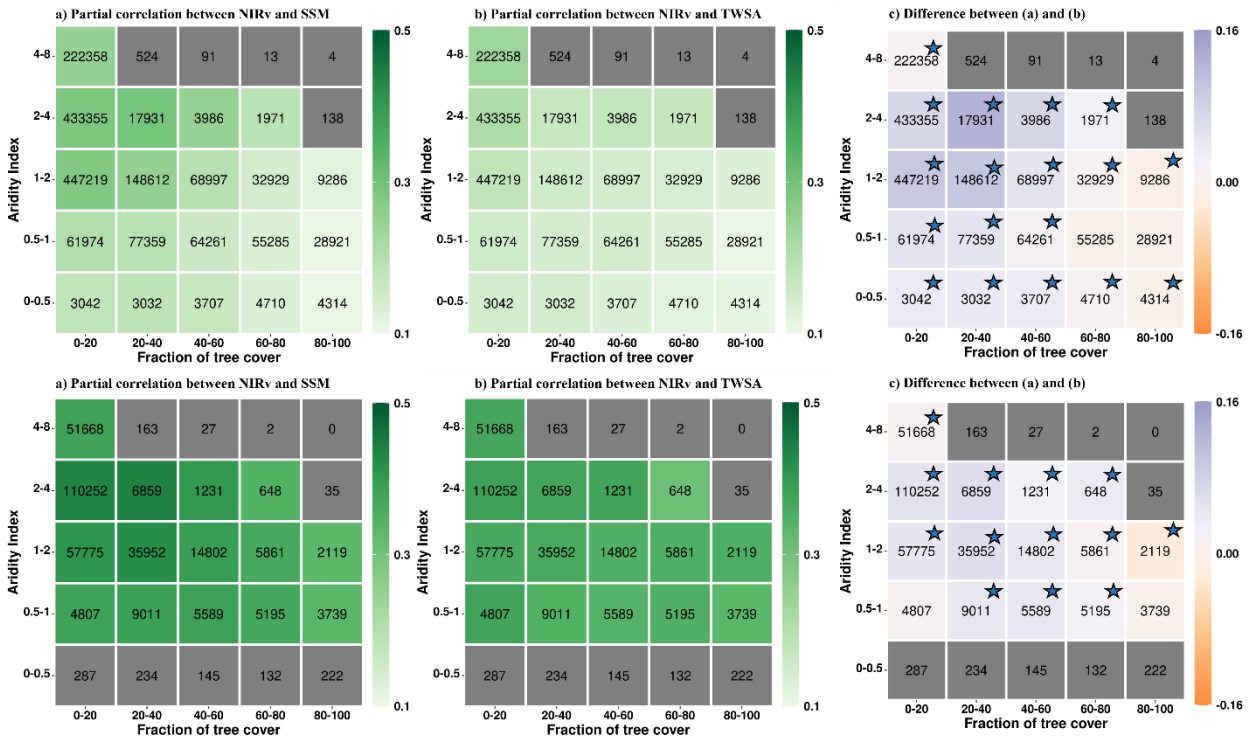


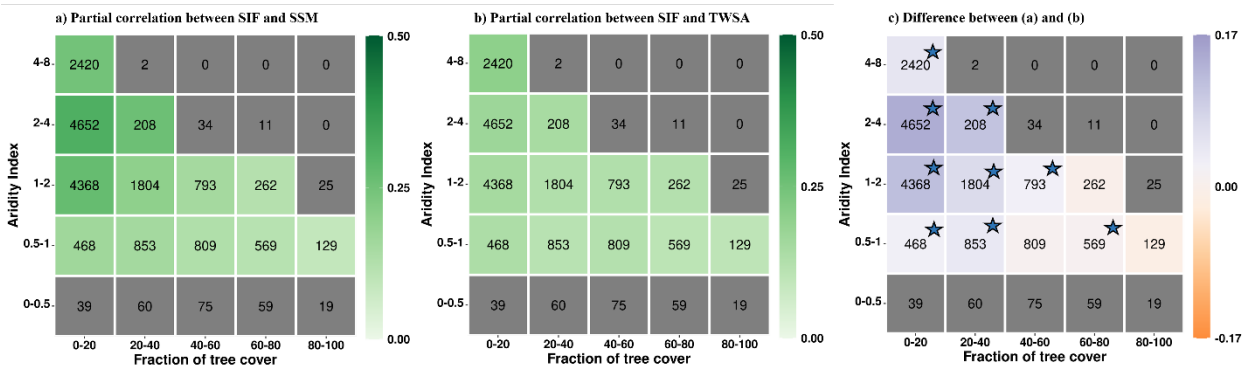
Figure S9: Mean air temperature ( $T_a$ ) (K) in during growing season of grid cells considered for attribution analysis.



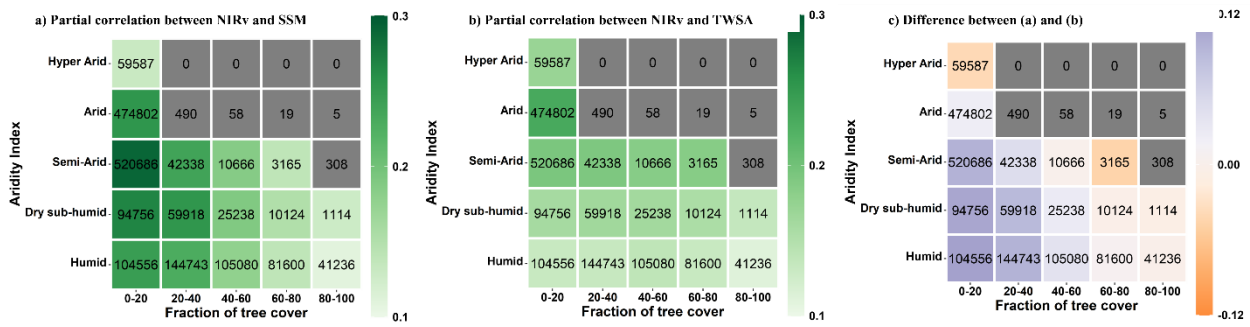
**Figure S10:** Similar to Figure 2, but considering only the grid cells that exhibit both significant ( $p < 0.005$ ) and positive partial correlation during growing season months.



**Figure S11:** Comparison of partial correlation of NIRv (upper portion) with (a) SSM, (b) TWS, (c) diff (a) and (b) in for growing season months (d) SSM, (e) TWS and (f) diff (d) and (e) for dry season months. The growing season months are defined based on an elevated threshold, requiring the mean-monthly SIF to be greater than 0.5 for the presented heatmaps, unlike threshold of 0.2 presented in Figure 2.



**Figure S12: Partial correlation of SIF with (a) SSM, (b) TWS, (c) diff (a) and (b) in for growing season months. Note that the partial correlation between SIF and water storages are done at 0.5 degrees compared to the partial correlation of NIRv with water storages at 0.05 degrees.**



**Figure S13: Partial correlation of NIRv with (a) SSM, (b) TWS, (c) diff (a) and (b) in for growing season months for different formulation of aridity index (AI).**