

Supplementary information of the Article: The many shades of the vegetation–climate causality: a multimodel causal appreciation

Yuhao Shao ¹, Daniel Fiifi Tawia Hagan ², Shijie Li ³, Feihong Zhou ⁴, Xiao Zou ⁵ and Pedro Cabral ^{6*}

¹ School of Geographical Sciences, Nanjing University of Information Science & Technology, Nanjing 210044, China, yuhaoshao@nuist.edu.cn;

² Hydro-Climate Extremes Laboratory, Ghent University, Ghent, Belgium;

³ Department of Civil and Environmental Engineering, University of Florence, Firenze 50139, Italy;

⁴ Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Nanjing University of Information Science and Technology, Nanjing 210044, China;

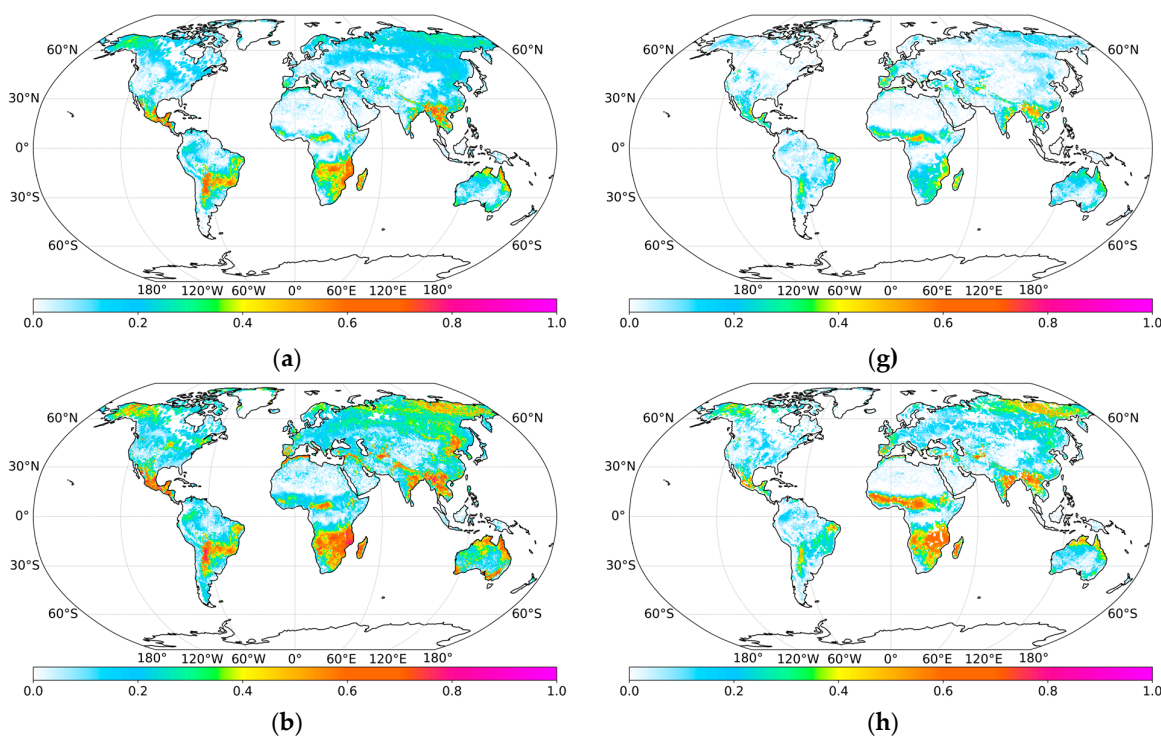
⁵ Tai'an Meteorological Bureau, Tai'an 271000, China;

⁶ School of Remote Sensing and Geomatics Engineering, Nanjing University of Information Science & Technology, Nanjing 210044, China;

* Correspondence: cabral@nuist.edu.cn

Supplementary Materials

The following supplementary information includes results from Kernel Granger Causality (KGC) analysis depicting the influence of temperature (T) on Leaf Area Index (LAI), as well as the reciprocal direction at various degrees of nonlinearity. Additionally, it covers the impacts of T on LAI based on Peter and Clark Momentary Conditional Independence (PCMI) and Liang–Kleeman Information Flow (L-K IF).



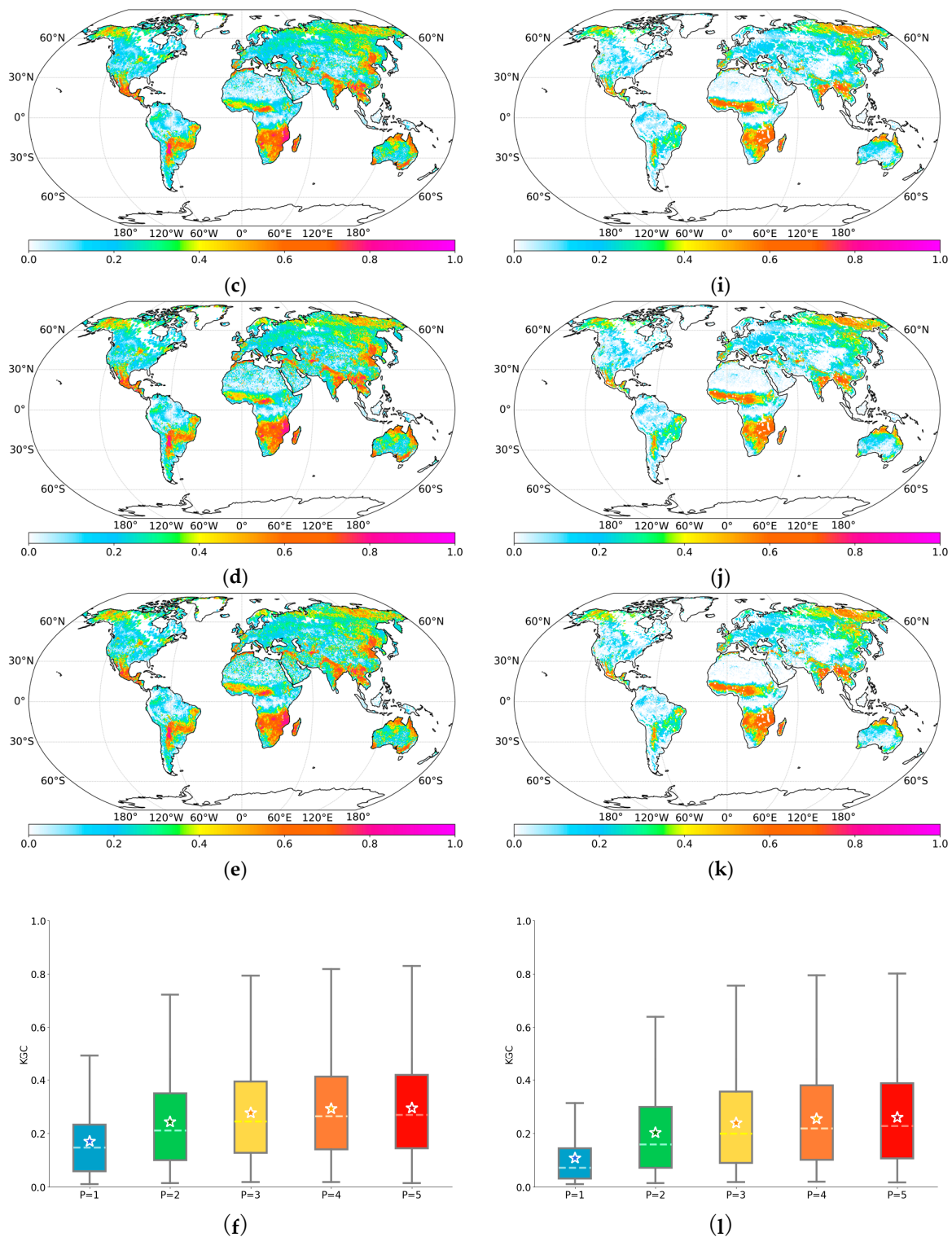


Figure S1. The Kernel Granger Causality (KGC) results between LAI and T, the results of KGC from T to LAI are shown from (a) to (e), while the results from LAI to T are shown from (g) to (k), representing the results of parameter P equal to 1: (a) and (g), 2: (b) and (h), 3: (c) and (i), 4: (d) and (j) and 5: (e) and (k). The statistical boxplot of KGC results for the relationships of (f): T→LAI and (l): LAI→T across different degrees of nonlinearity, indicated by the parameter P, which ranges from 1 to 5.

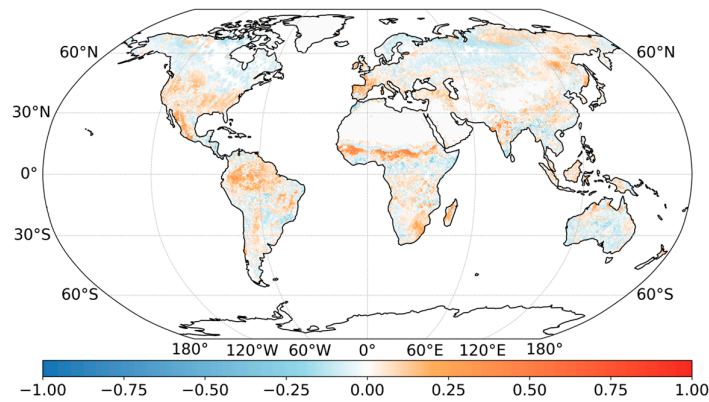


Figure S2. The global distribution of the causal effects from T to LAI based on the Peter and Clark Momentary Conditional Independence (PCMCI), which shows the influence of T to LAI with a time lag of one month.

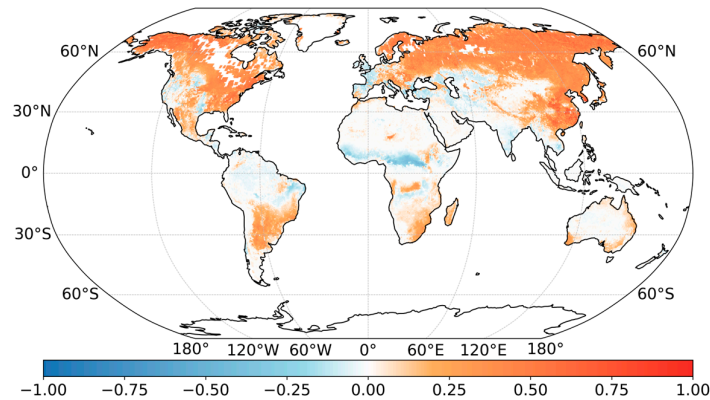


Figure S3. The global Liang-Kleeman Information Flow (L-K IF) from T to LAI. Red colours indicate positive IF rates and blue colours indicate negative IF rates. All results are computed at a 5% statistical significance. White regions are statistically insignificant regions or masked out due to the absence of vegetation.

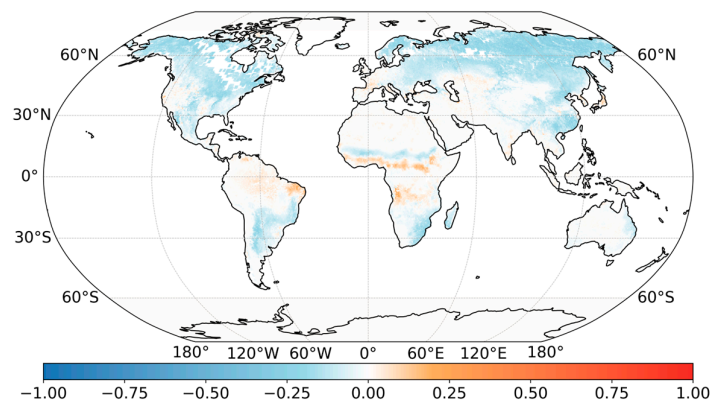


Figure S4. The global Liang-Kleeman Information Flow (L-K IF) from LAI to T considering the influence of evapotranspiration (ET). Red colours indicate positive IF rates and blue colours indicate negative IF rates. All results are computed at a 5% statistical significance. White regions are statistically insignificant regions or masked out due to the absence of vegetation.