



*Supplement of*

## **Persistent La Niñas drive joint soybean harvest failures in North and South America**

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**Table S1. Conditional independence claims for local causal diagram**

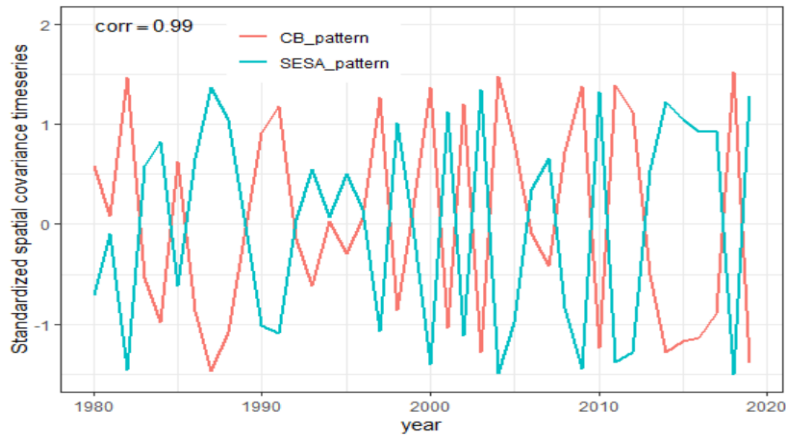
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| <ul style="list-style-type: none"> <li>• <math>SM_{spring} \perp Heat_{summer} \mid \{SM_{summer}\}</math></li> <li>• <math>SM_{spring} \perp yield_{anomaly} \mid \{SM_{summer}, Heat_{summer}\}</math></li> <li>• <math>RF_{summer} \perp Heat_{summer} \mid \{SM_{summer}\}</math></li> <li>• <math>RF_{summer} \perp yield_{anomaly} \mid \{SM_{summer}, Heat_{summer}\}</math></li> </ul> |
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Where (“ $\perp$ ”) implies statistically independent given (“ $\mid$ ”) the conditioning set  $W = \{\dots\}$ .

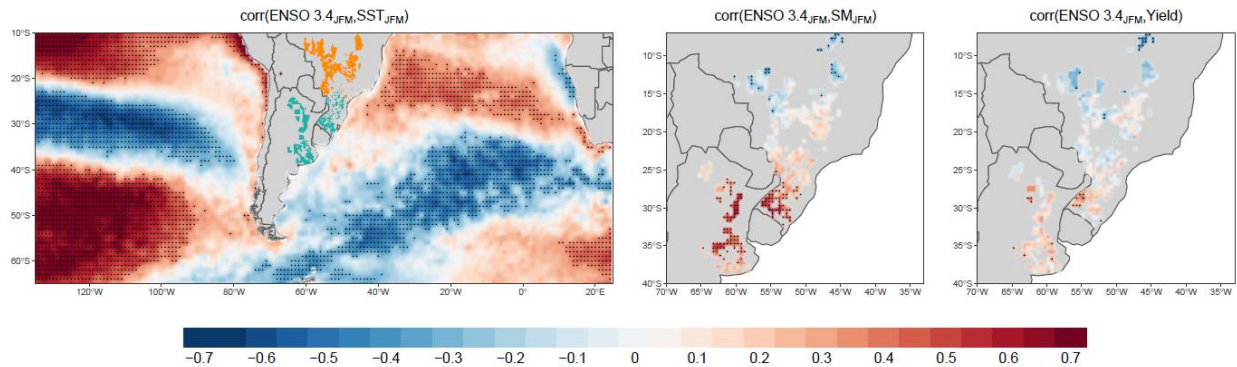
**Table S2. Conditional independence claims for remote causal diagram**

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| <ul style="list-style-type: none"> <li>• <math>ENSO_{summer} \perp SM_{spring} \mid \{ENSO_{spring}\}</math></li> <li>• <math>ENSO_{summer} \perp NP/SA_{pattern} \mid \{ENSO_{spring}\}</math></li> <li>• <math>ENSO_{summer} \perp Yield_{anomaly} \mid \{SM_{summer}\}</math></li> <li>• <math>ENSO_{spring} \perp SM_{summer} \mid \{ENSO_{summer}, SM_{spring}, NP/SA_{pattern}\}</math></li> <li>• <math>ENSO_{spring} \perp Yield_{anomaly} \mid \{SM_{summer}\}</math></li> <li>• <math>SM_{spring} \perp NP/SA_{pattern} \mid \{ENSO_{spring}\}</math></li> <li>• <math>SM_{spring} \perp Yield_{anomaly} \mid \{ENSO_{spring}, SM_{summer}\}</math></li> <li>• <math>NP/SA_{pattern} \perp Yield_{anomaly} \mid \{ENSO_{spring}, SM_{summer}\}</math></li> </ul> |
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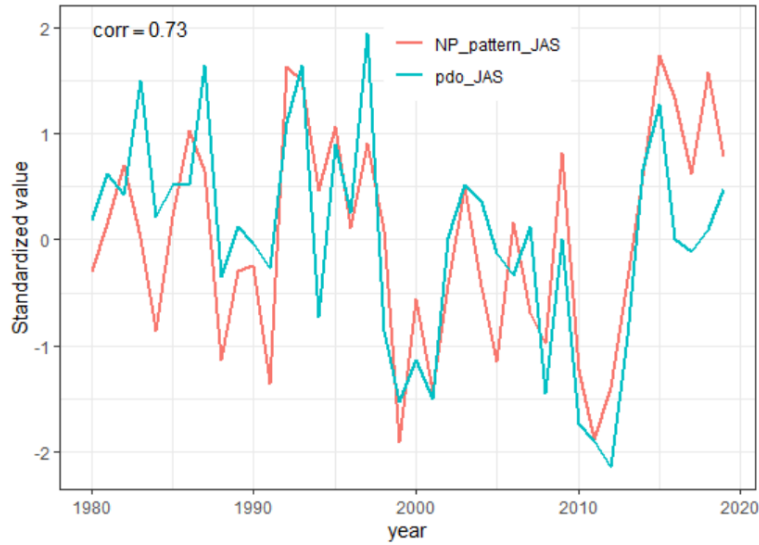
Where (“ $\perp$ ”) implies statistically independent given (“ $\mid$ ”) the conditioning set  $W = \{\dots\}$ .



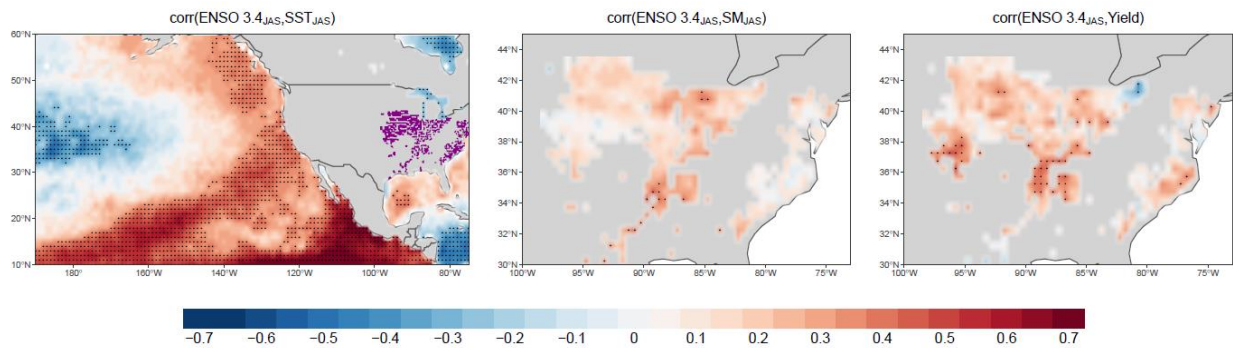
**Figure S1. Spatial covariance timeseries based on highlighted SST correlation pattern for SESA and CB regions.**



**Figure S2. Correlation maps for same-season JFM ENSO 3.4 index against austral summer SST (JFM), soil moisture (JFM) and yield anomaly in CB and SESA.**



**Figure S3. PDO index (dataset source: Huang et al., 2017) averaged over JAS and NP pattern averaged over JAS. Correlation between the two time-series is statistically significant.**



**Figure S4. Correlation maps for same-season JAS ENSO 3.4 index against boreal summer SST (JAS), soil moisture (JAS) and yield anomaly in the US.**

## References

Boyin Huang, Peter W. Thorne, Viva F. Banzon, Tim Boyer, Gennady Chepurin, Jay H. Lawrimore, Matthew J. Menne, Thomas M. Smith, Russell S. Vose, and Huai-Min Zhang (2017): NOAA Extended Reconstructed Sea Surface Temperature (ERSST), Version 5. NOAA National Centers for Environmental Information. doi:10.7289/V5T72FNM. Obtain at NOAA/ESRL/PSD at their website <https://www.esrl.noaa.gov/psd/> [9/5/2022].