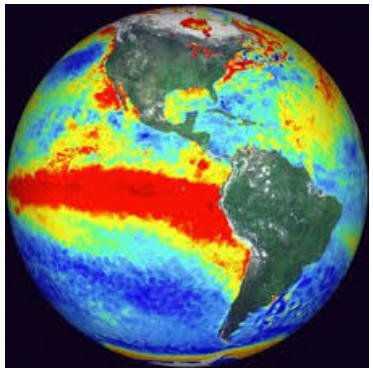
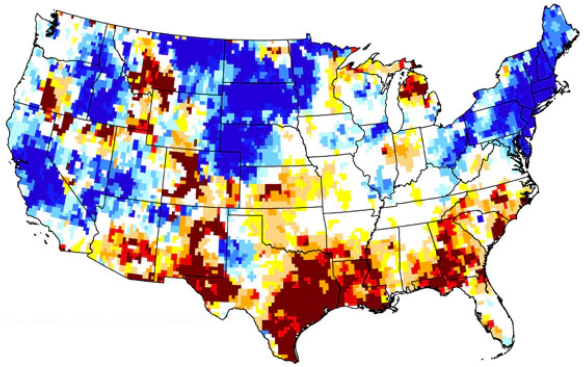




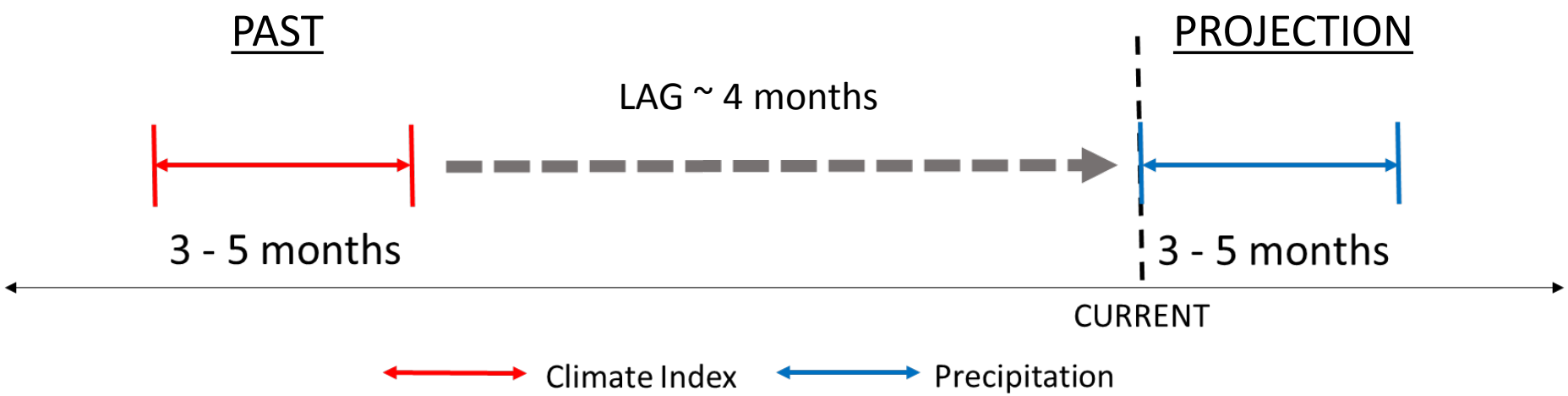
ASSESSING THE RELATIONSHIP BETWEEN LOW-FREQUENCY OSCILLATIONS OF GLOBAL HYDRO-CLIMATE INDICES AND LONG-TERM PRECIPITATION THROUGHOUT THE UNITED STATES

Jason Giovannettone, PhD, PE
Yu Zhang, PhD

Introduction

"Short-" vs. "Long-Window" Correlation

- Past period defined by beginning month and shorter computation window size.
- Past and Projected periods do not overlap.
- Projection period is directly estimated from Past period.
- Correlations are weaker.



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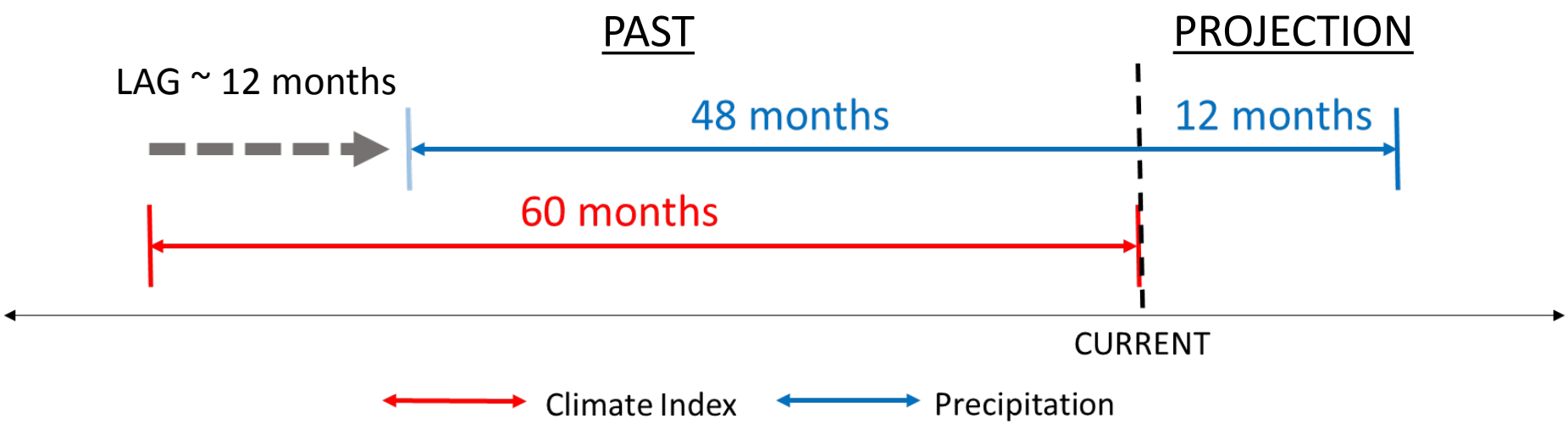
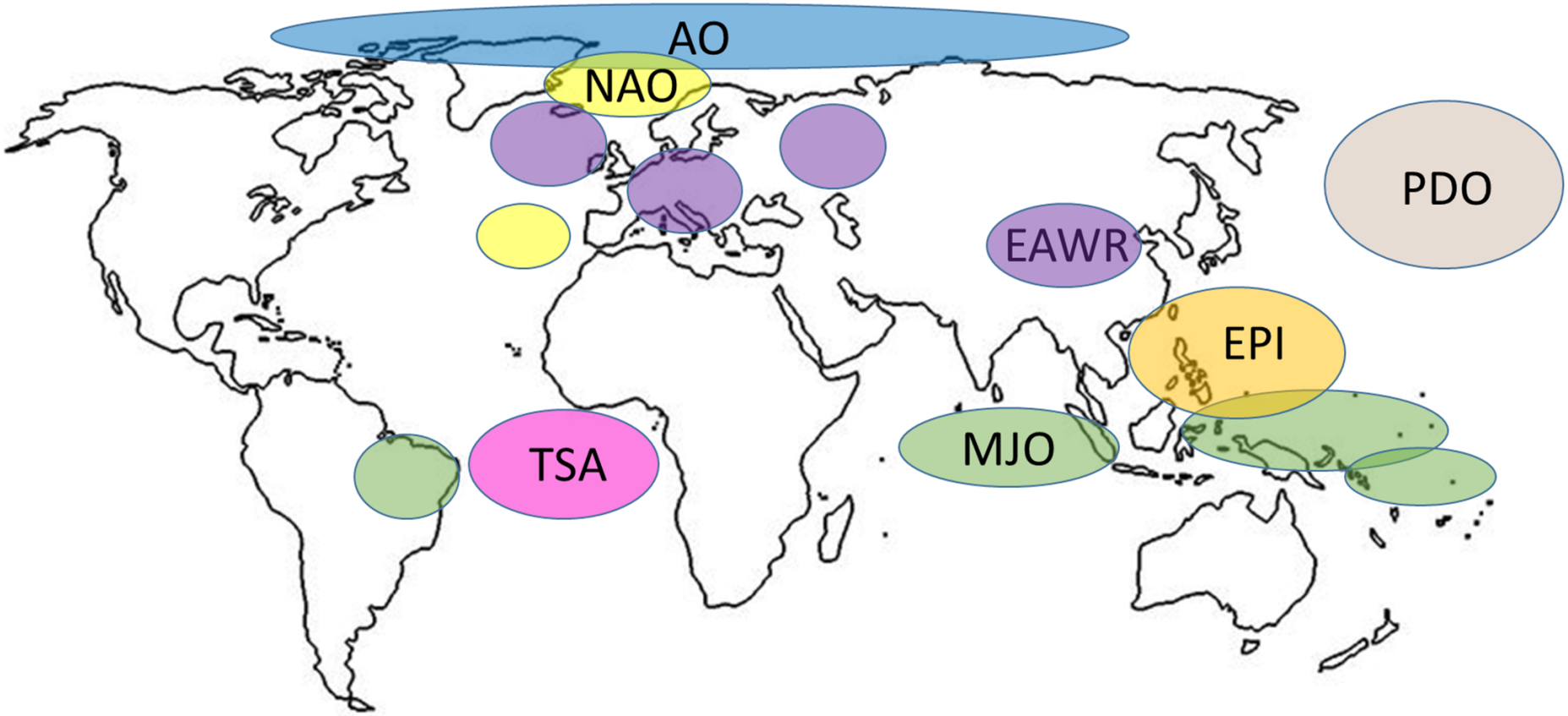


Hydro-Climate Indices



* AO = Arctic Oscillation; EAWR = East Atlantic/West Russia pattern; EPI = ENSO Precipitation Index; MJO = Madden-Julian Oscillation; NAO = North Atlantic Oscillation; PDO = Pacific-Decadal Oscillation; TSA = Tropical South Atlantic index

Measures of Correlation

Strength

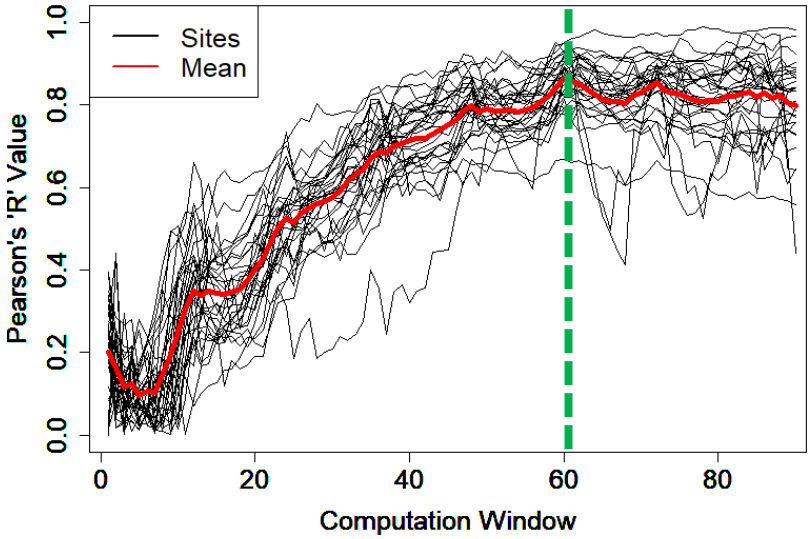
- Correlation strength between all HCIs and precipitation was assessed at each station.
- Pearson's R was used as a measure of correlation strength.
- Only sites having R-values >= 0.60 were considered.

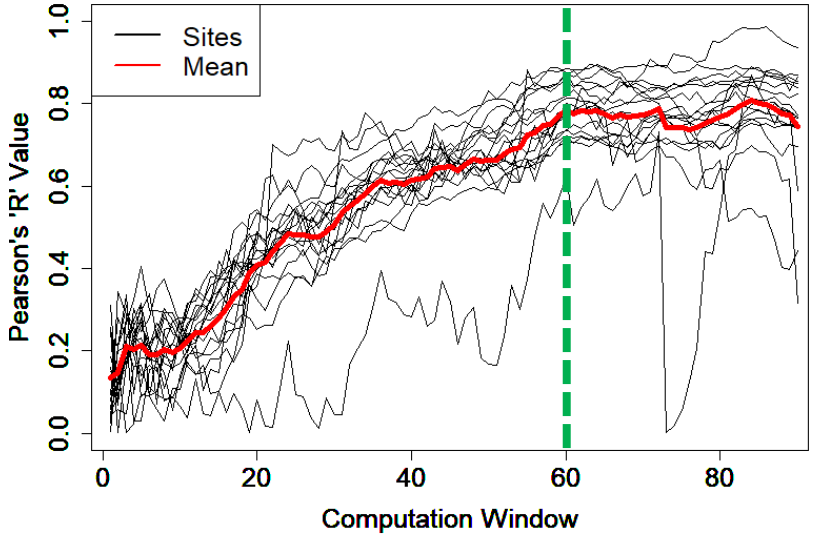
Significance

- Significance was estimated for the HCI with the strongest correlation at each site.
- Bootstrapping technique involved 10,000 randomizations of rainfall to assess the chance of spurious correlation.
- Only sites having p-values <= 0.05 were considered.

Computation Window Size

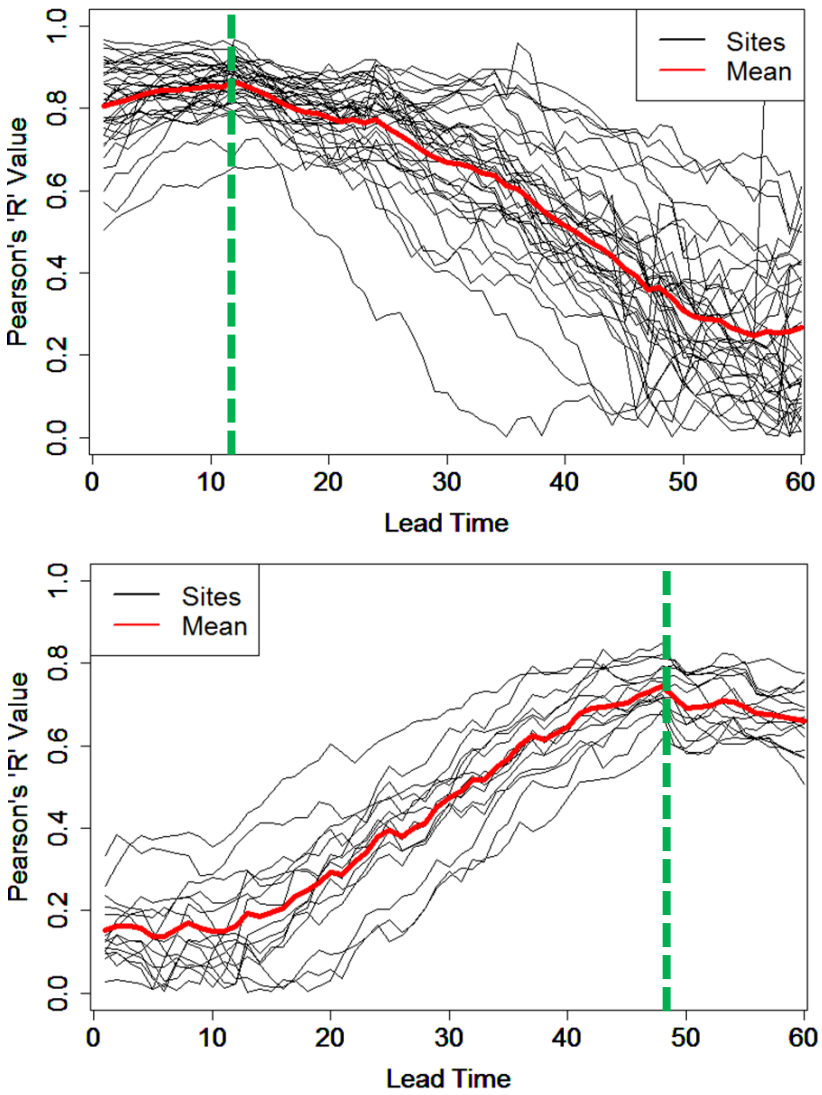
- Computation window sizes ranging from 1 – 90 months were tested.
- Resulting correlation strengths at sites in two states for two different indices that exhibit strong correlation at a lag time = 12 months are shown.
- Both indices exhibit maximum correlation using a window size of approximately 60 months.





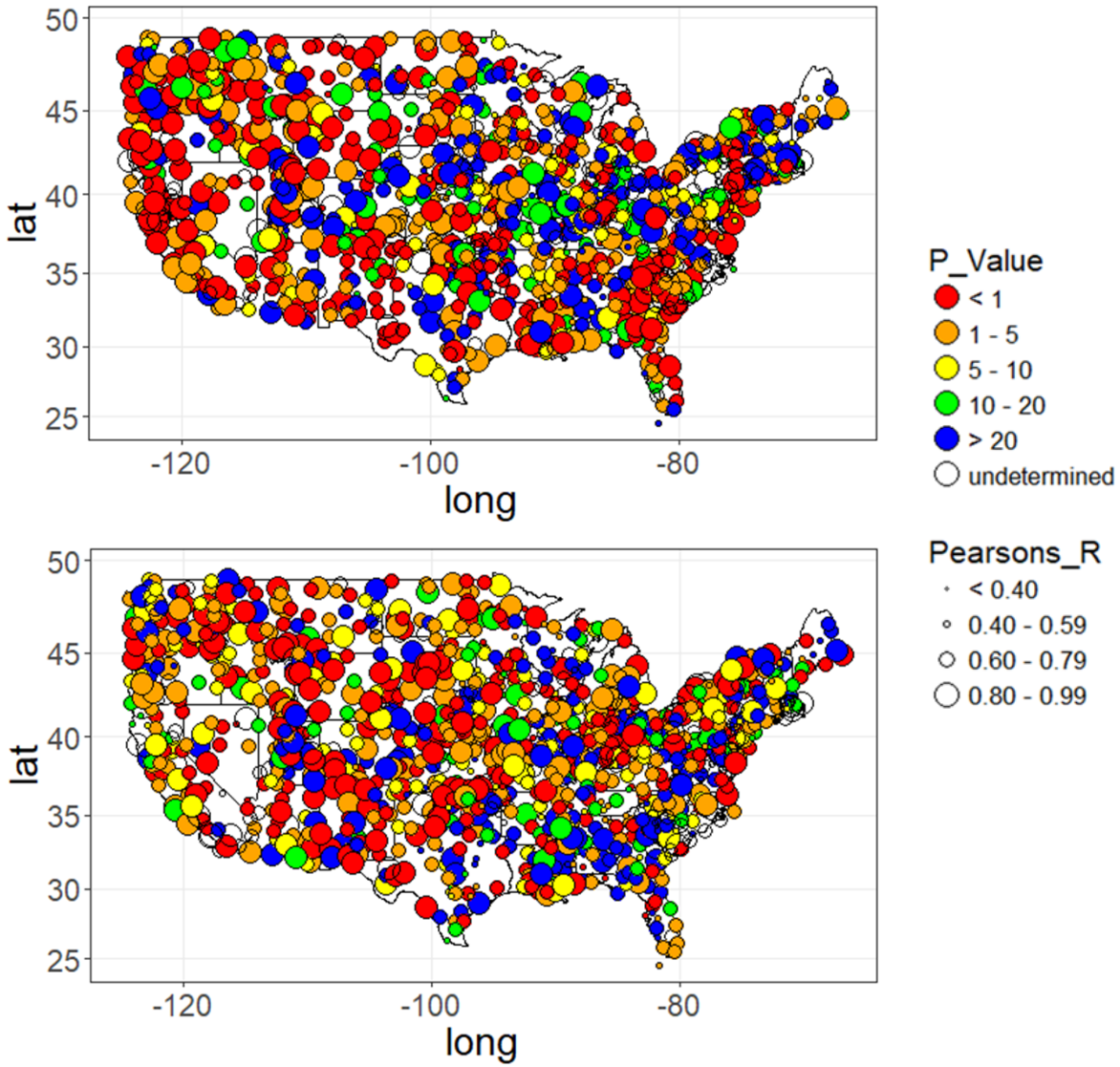
Lag Time

- Lag times ranging from 1 – 60 months were tested.
- Resulting correlation strengths at sites in one state showing strong correlation with two indices at lag times = 12 & 48 months, respectively, are shown.
- Both indices exhibit maximum correlation using the lag times that are shown.

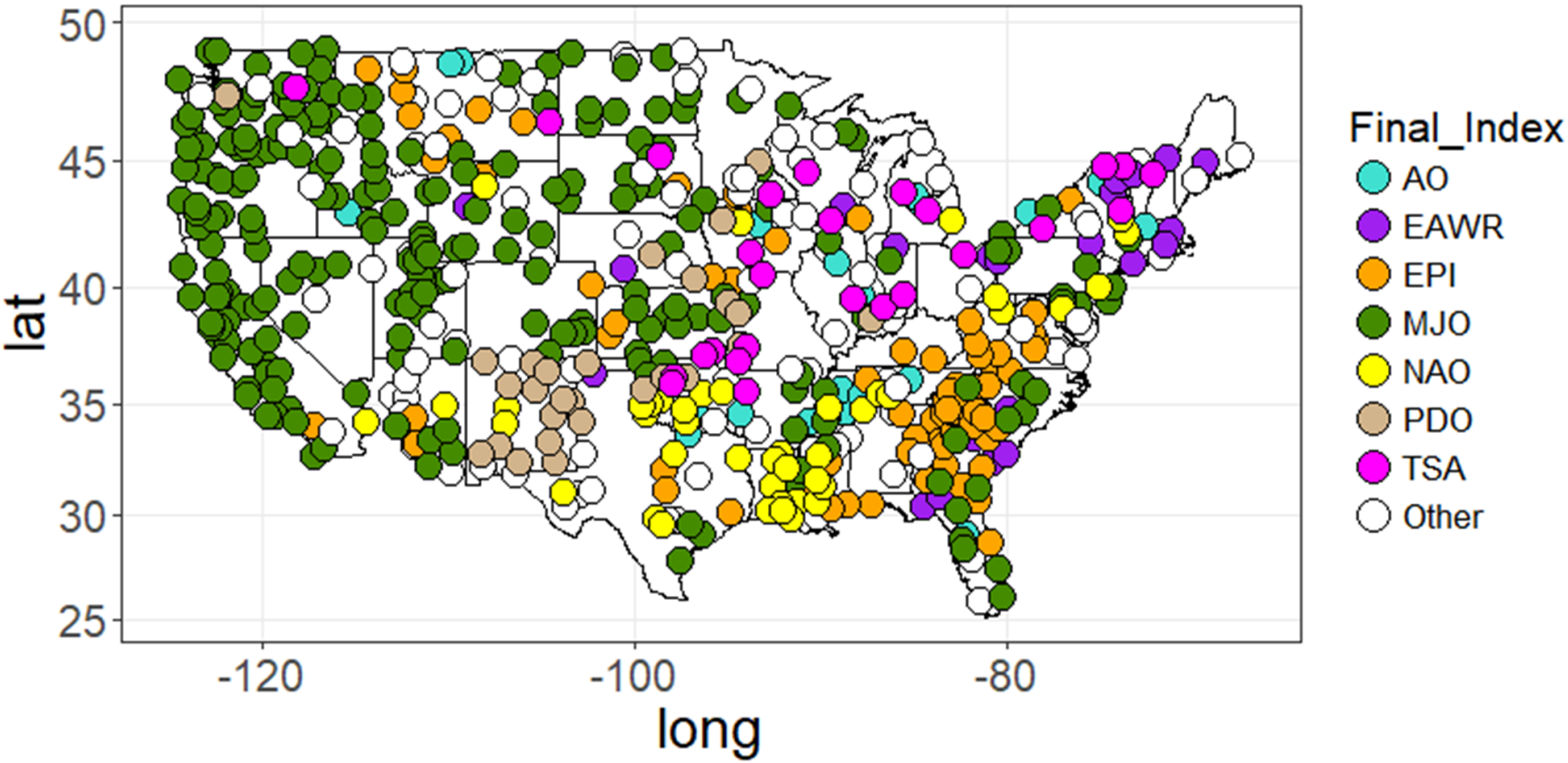


Results: Lag = 12, 48 months

- Correlation strength and significance were tested for two lag times: 12 and 48 months, respectively.
- Red and orange circles represent high significance.
- Large circles represent high correlation strength.
- Only sites exhibiting both were considered in the final results.

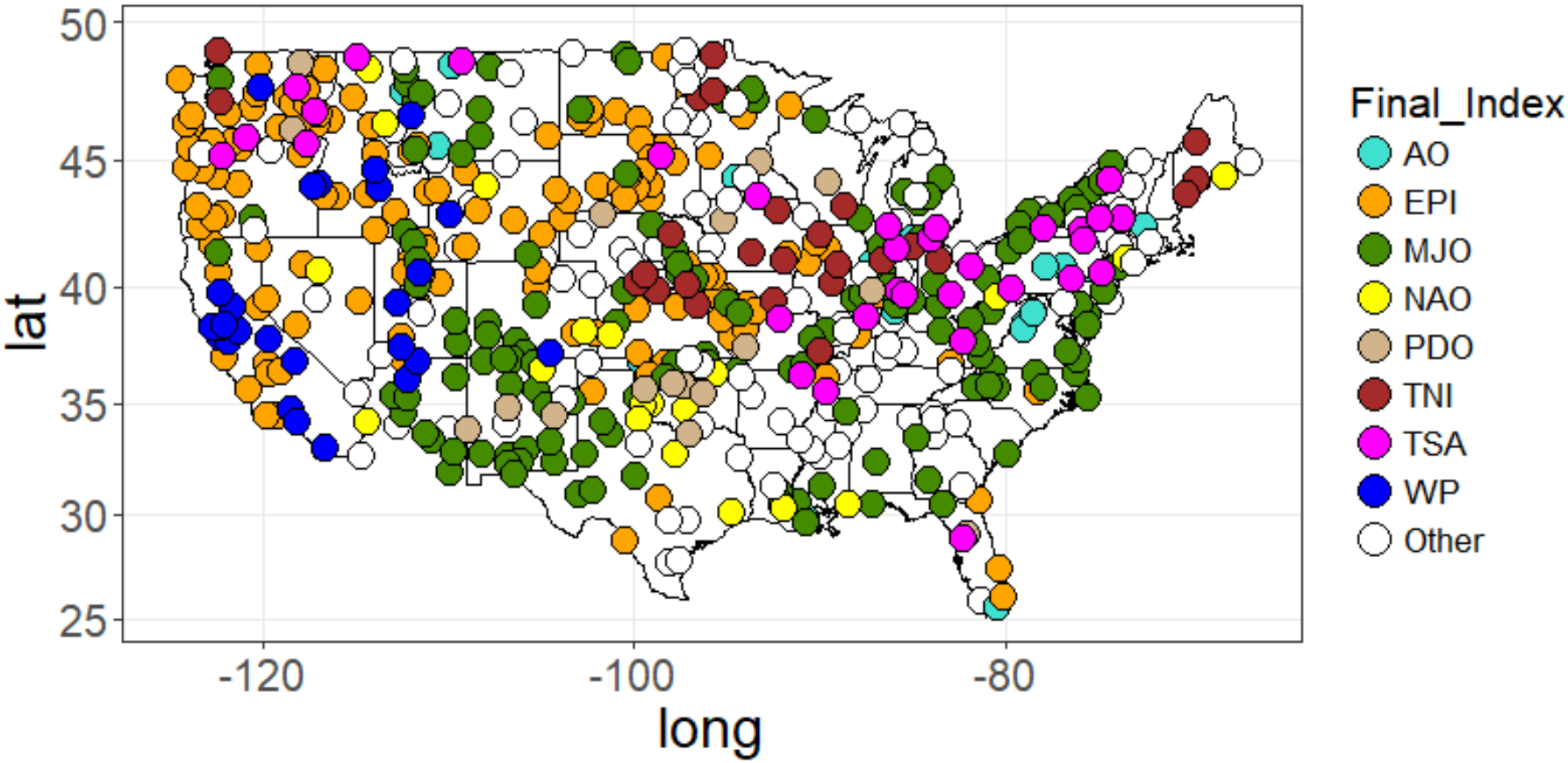


Results: Lag = 12 months



- Only sites having a correlation strength (R) > 0.60 and significance (P_value) <= 0.05 are shown. Seven dominant HCI's were identified.

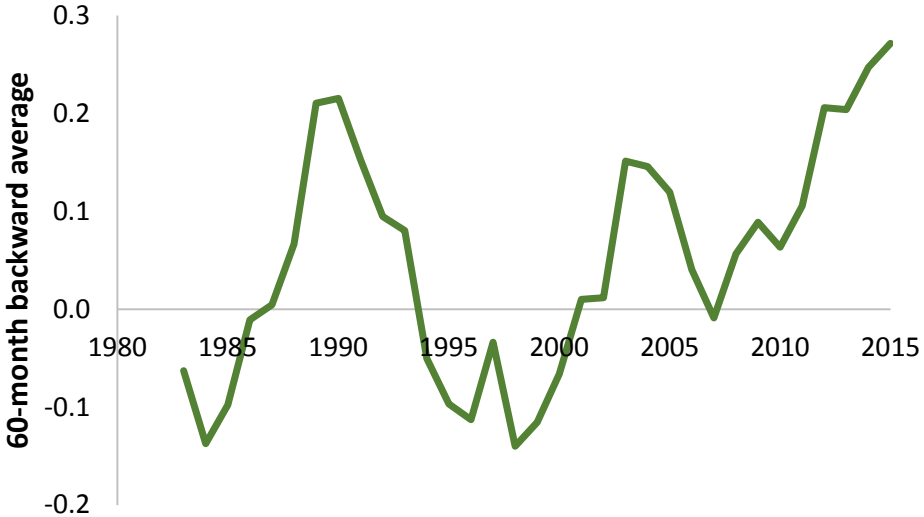
Results: Lag = 48 months

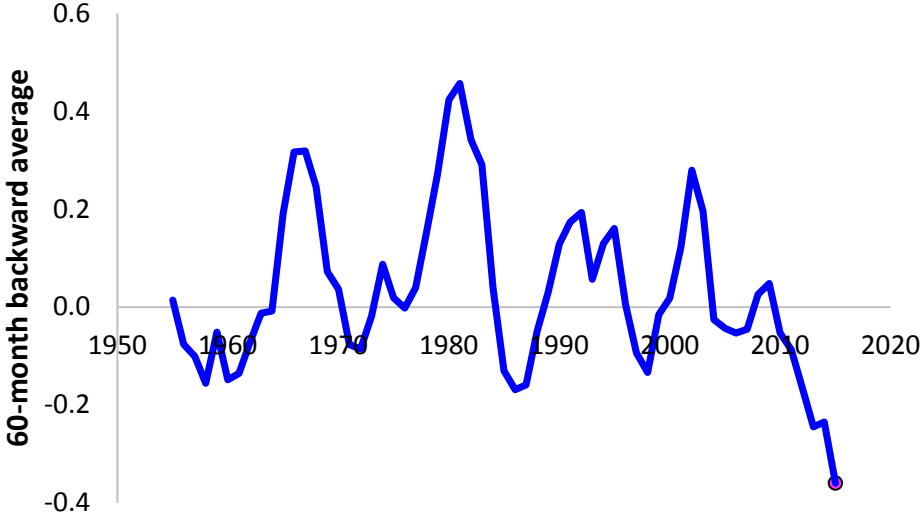


- Only sites having a correlation strength (R) > 0.60 and significance (P_value) <= 0.05 are shown. Eight dominant HCI's were identified.

Low-Frequency Oscillations

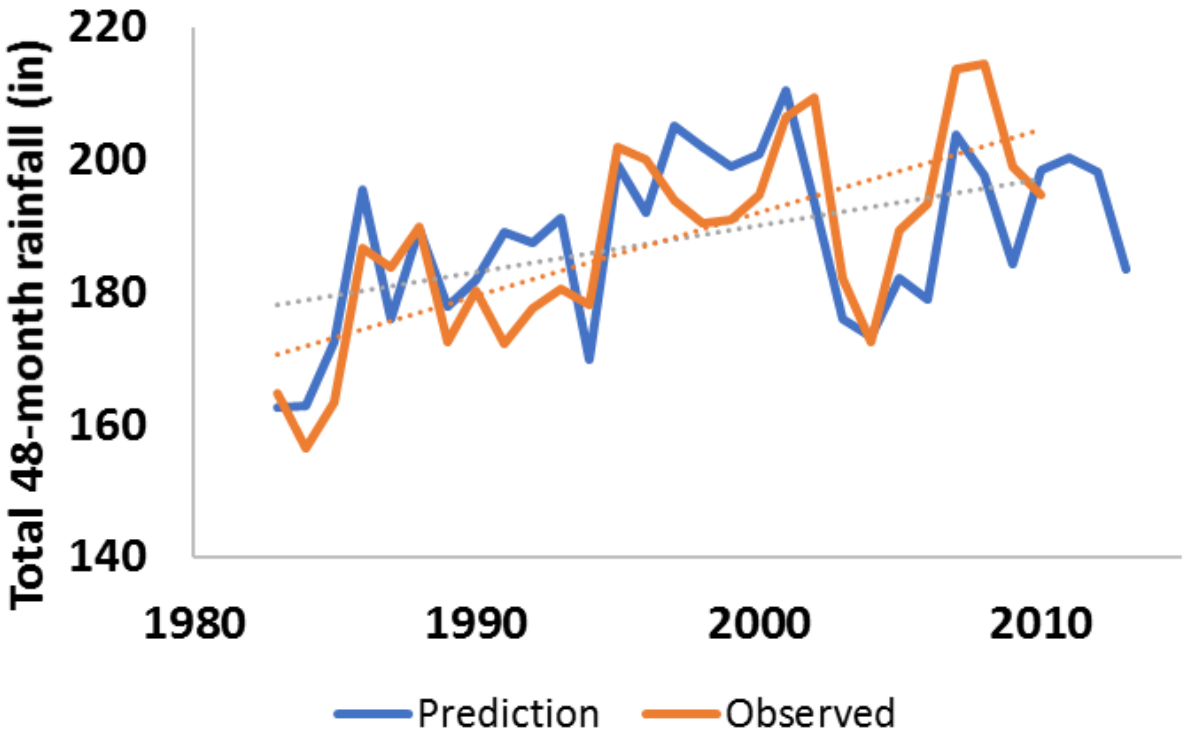
- MJO is a major component of intra-seasonal variability in the tropics with a recurrence interval of 30 – 60 day.
- Lower-frequency oscillations are also present (e.g., ~10 years).
- WP pattern also exhibits a lower-frequency oscillation of approximately 10 – 12 years.





Results: Norfolk, VA (48 months)

- MJO was used to recreate historical long-term precip at Norfolk, VA.
- Majority of local max and min values are captured.
- ~55% of the increasing trend in precip is accounted for by the MJO.



Conclusions

Question? Can Hydro-Climate Indices (HCI's) be used to forecast regional rainfall in the United States on annual or longer time scales?

Conclusions

- 7 HCI's were found to have strong and significant predictive capabilities at an annual time scale.
- 8 HCI's were found to have strong and significant predictive capabilities at time scales of 48 months.
- Most influential indices include:
  - Madden-Julian Oscillation (MJO)
  - ENSO Precipitation Index (EPI)
  - North Atlantic Oscillation (NAO)
  - Pacific-Decadal Oscillation (PDO)
  - Tropical South Atlantic Index (TSA)

Future Study

- What are the mechanisms of correlation between precipitation and HCI's?
- How can these correlations be used to inform future water allocation & water resources management?
- Can HCI's be used to predict the onset and persistence of a drought or an extended wet period?
- What are the impacts of climate change on each HCI? Can this information be used to estimate the impacts of climate change on precipitation in other regions?
- Do similar correlations exists for temperature, stream flow, hurricane/tropical cyclone formation, etc.?

Questions

- For more information about obtaining a copy of the **Hydro-FIT software**, please contact Jason Giovannettone at jpgiovannettone@hydrometriks.com.
- Reference 1: Giovannettone, J., Copenhaver, T., Burns, M., and Choquette, S. (2018). "A statistical approach to mapping flood susceptibility in the Lower Connecticut River Valley Region." *Water Resour. Res*., 54, 7603-7618. https://doi.org/10.1029/2018WR023018
- Reference 2: Giovannettone, J. G., and Zhang, Y. (2019). "Identifying strong signals between low-frequency climate oscillations and annual precipitation using correlation analysis." *Accepted by Int. J. Climatol.*