# Complex Network Approach To Study Extreme Winter Precipitation Events In The United States

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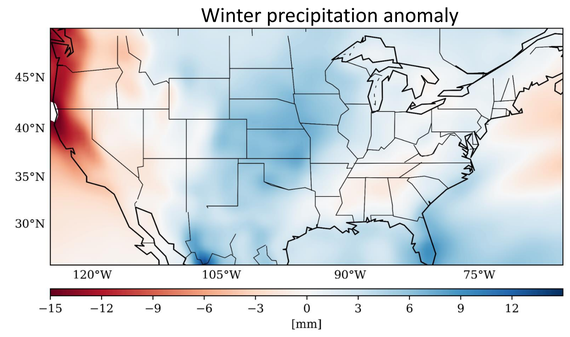
## OBJECTIVE

- Extreme wet winter increased the flood risk in the U.S.
- Spatial dependence of flood events with extreme precipitation is also high in winter[1]
- Influence of El Nino Southern Oscillation (ENSO) on extreme rainfall.




**Data Source**

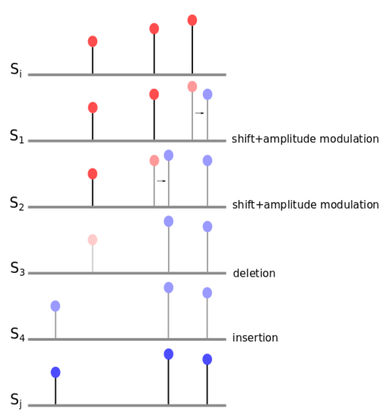
- Daily precipitation:
  - The JRA-55 reanalysis: General Specification and Basic Characteristics[2].
- Climatological variables (Geopotential height, wind):
  - ERA5 hourly data on pressure levels from 1979 to present[3].

## METHODOLOGY

- **Similarity Measure:** *Edit-distance* (ED) is a method to compute distance between two segments by certain operations.
  The distance between two segments $S_i$ and $S_j$ defined as:

$$D(S_i, S_j) = \sum_{(\alpha,\beta)\in C}\{\lambda_0 \|t_i(\alpha) - t_j(\beta)\| + \lambda_k \|L_i(\alpha) - L_j(\beta)\|\} + \lambda_s(|I| + |J| - 2|C|)$$

C is a set of pairs of events (α, β) corresponding to the two different data segments that will be transformed from $S_i$ to $S_j$, t , L are the time and amplitude




- **Network Construction:** We compute the similarity matrix $D_{i,j}$ using ED, by applying a suitable threshold $\tau$ , we obtain the adjacency matrix

$$A_{i,j} = \begin{cases} 1, & D_{i,j} < \tau \\ 0, & D_{i,j} > \tau \end{cases}$$

- **Network Measures:**
  - **Degree:** Computes the number of connection of a node with other nodes in a network.

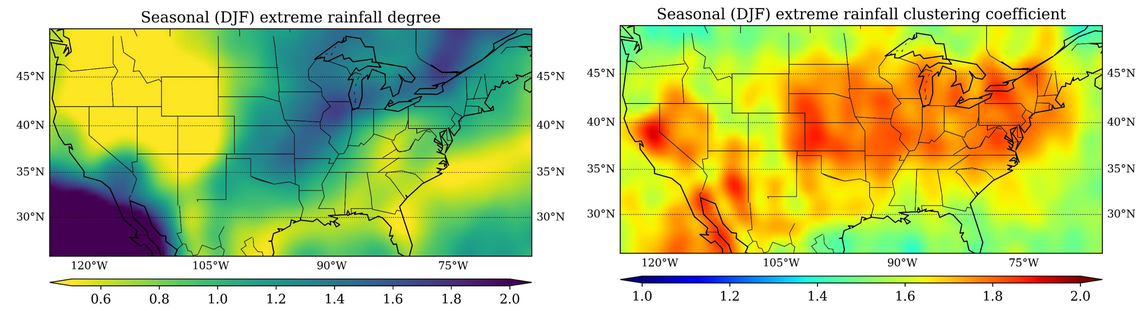
$$K_i = \sum_{j=1}^{N} A_{i,j}$$

  - **Local Clustering Coefficient**: It measures the connectedness between the neighbors of a node.

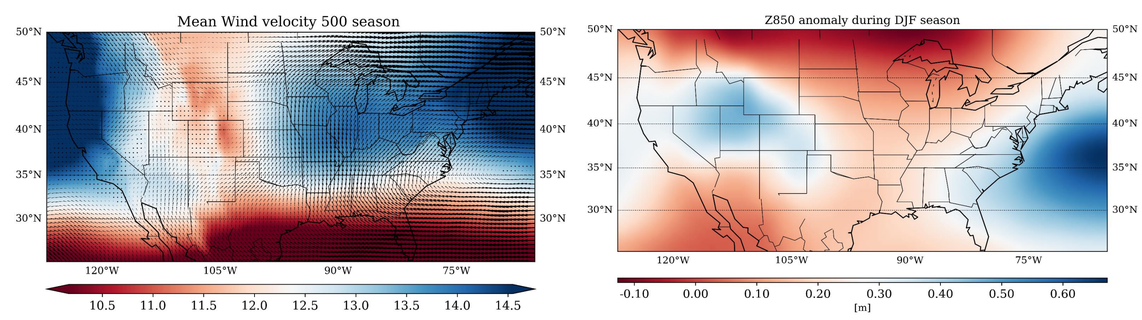
$$LC_i = \frac{\sum_{j,k=1}^{N} A_{ij} A_{jk} A_{ik}}{K_i(K_i - 1)}$$

## RESULTS

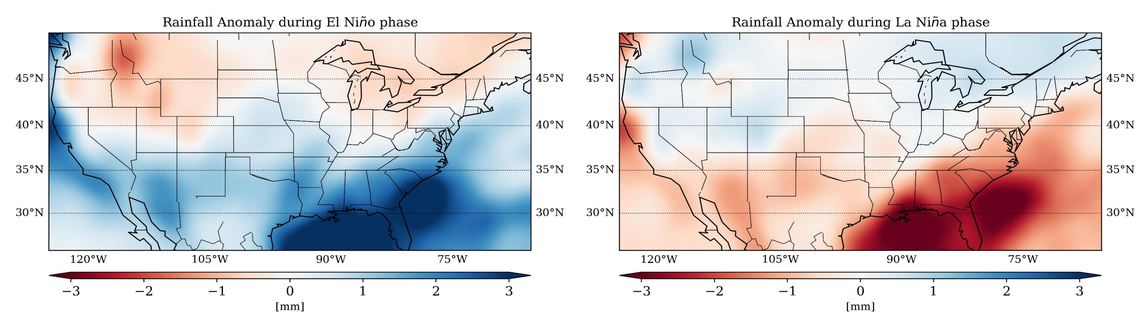
- Network measures of extreme winter precipitation



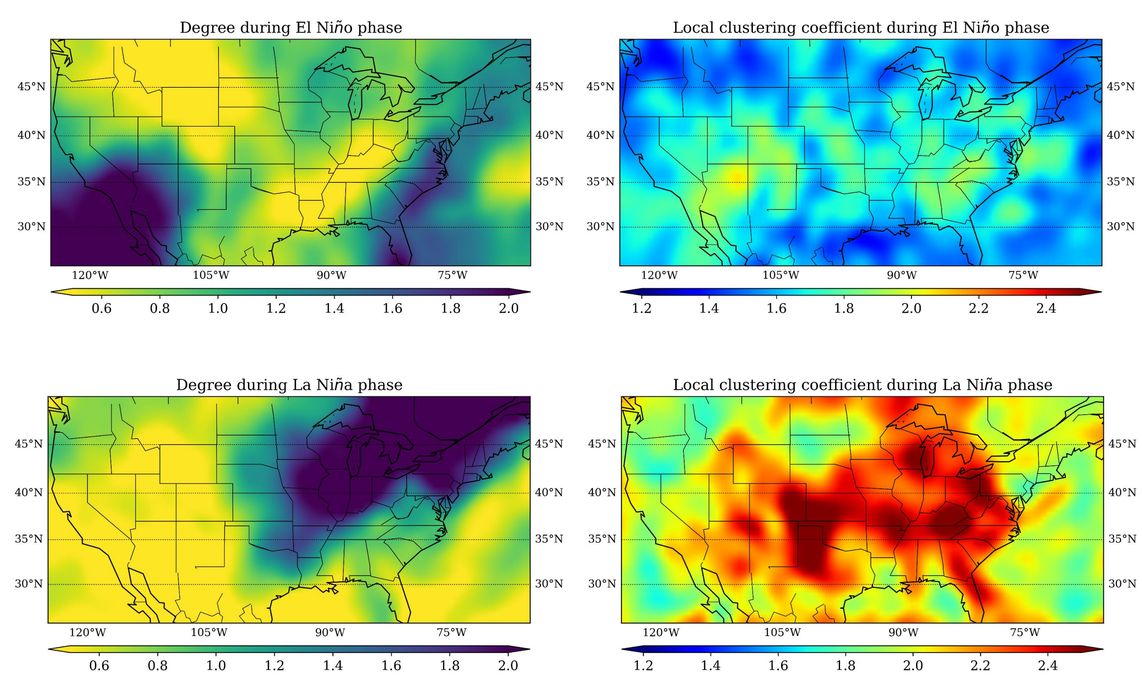

- Atmospheric Circulation during winter season




- Precipitation Anomaly during ENSO




- Network measures during ENSO




**Discussion:**

- We apply a special kind of similarity measure to study the occurrence and intensity of extreme rainfall in the U.S.
- We also study the influence of ENSO on U.S. winter precipitation.
- We mainly investigate the connectedness of grid points (**degree**) and the structural property of our network (**local clustering coefficient**) for extreme rainfall.

[1]Brunner et. al. GRL 2020
[2]Kobayashi et. al. 10.2151/jmsj.2015-001
[3]Hersbach et. al. Rmets 2020

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