Multi-scale SST-Streamflow connectivity via wavelet complex network techniques

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Introduction

- Streamflow generation is a complex process and often fueled by multiple feedbacks and interactions of hydro-climatological drivers
- Investigation of Sea Surface Temperature (SST)-Streamflow connectivity unravels the large scale climate influences that may have a potential role in modulating local hydrological components
- Integration of wavelets and complex network approach to explore SST-Streamflow connectivity[1,2]

Study area & Data used

- Germany – divided into Alpine, Atlantic and Continental regions based on streamflow regime
- GRDC streamflow data (221 stations) and ERSST v5 data are used in this analysis
- Time period – 1979-2015

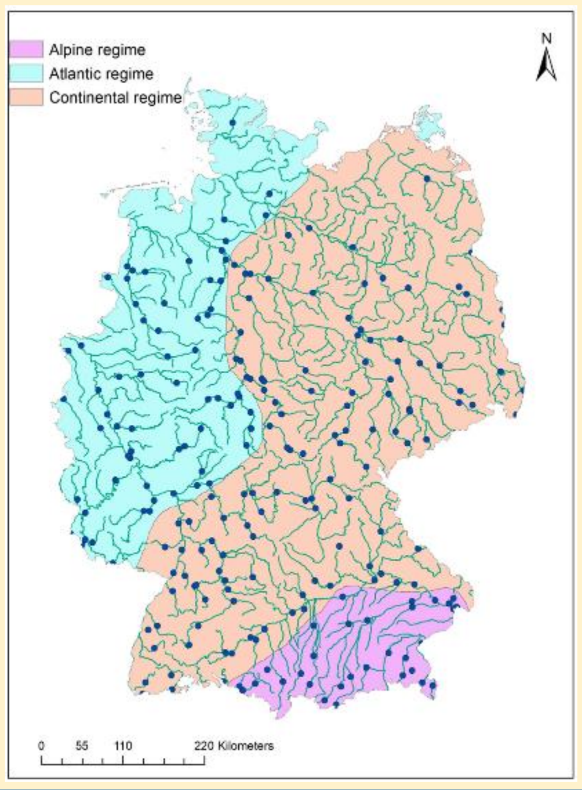


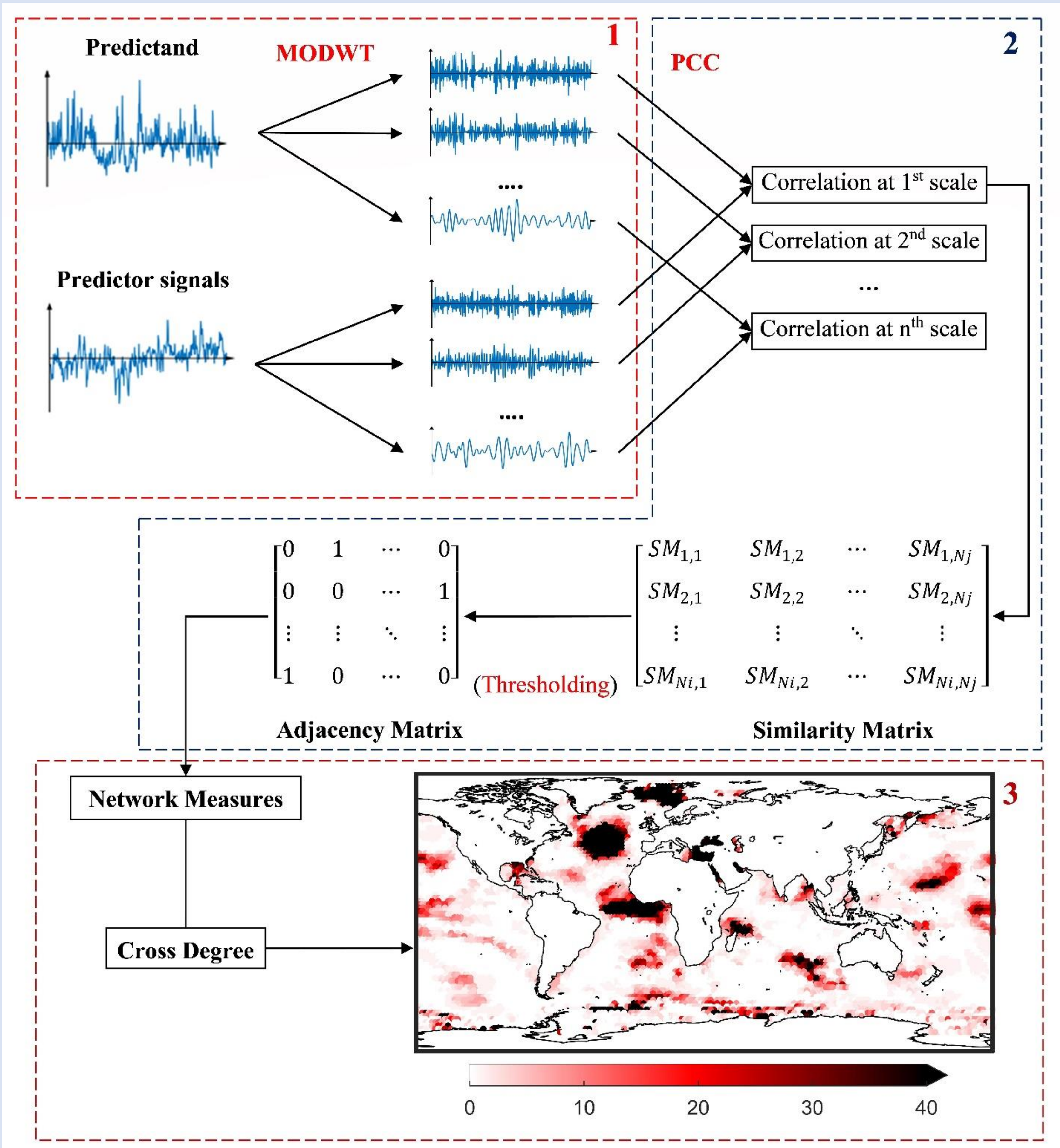
Fig. Spatial representation of gauging stations (marked with dots), streamflow network (blue lines) overlaid by different streamflow regimes of Germany.

Methodology

Step 1 – SST and Streamflow time series decomposed into difference frequency components using Maximal Overlap Discrete Wavelet Transform. Various decomposed frequency signals represented as different time scale anomalies

Step 2 – For every timescale Pearson Correlation Coefficient is employed to quantify the similarity between SST and Streamflow time series. Binary adjacency matrix is developed by fixing the threshold value (99 percentile)

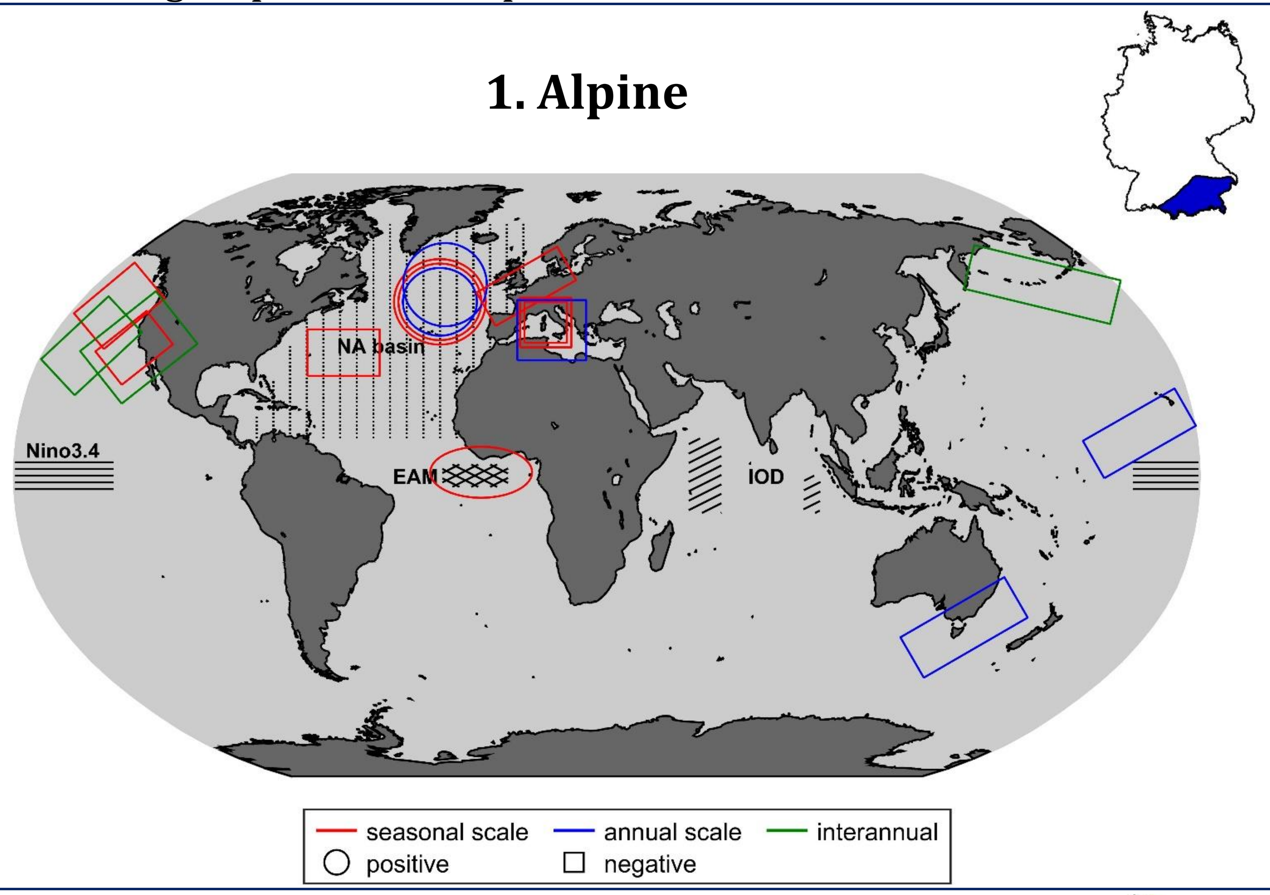
Step 3 – Network (adjacency matrix) topology is evaluated using Cross Degree network measure



Results & Discussion

The climate network (SST→ Streamflow) on the globe showed the number of stations in streamflow regions connected with the SST grids, i.e., the number of significant connections that each SST grid possess at a specific timescale.

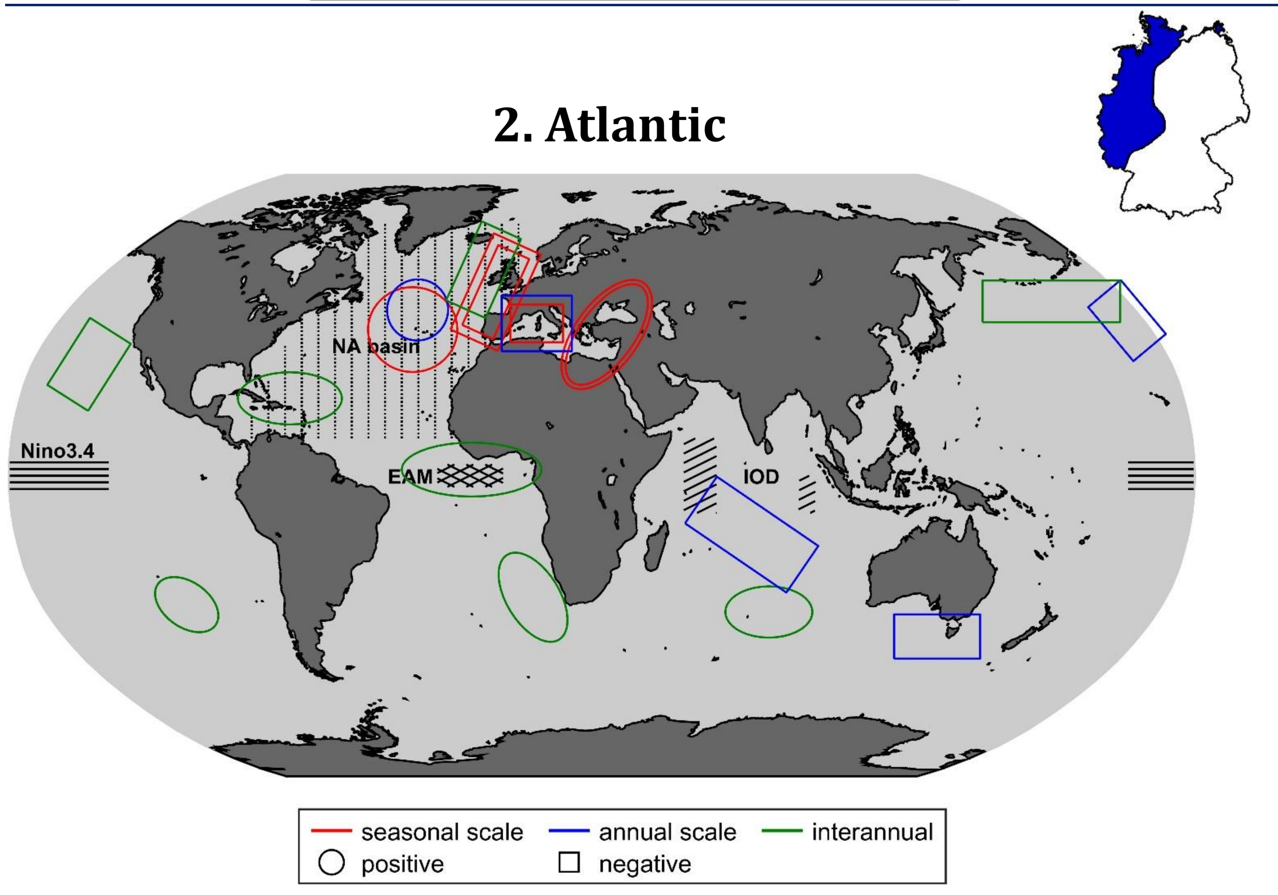
1. Alpine



SST spatial pattern→Alpine

- South of Greenland region exhibit positive connections with Alpine streamflow region at finer timescales
- .At these timescales, eastern U.S. coast and regions around European coast has negative connections
- Above regions resembles the characteristics of North Atlantic SST tripole like pattern[3]

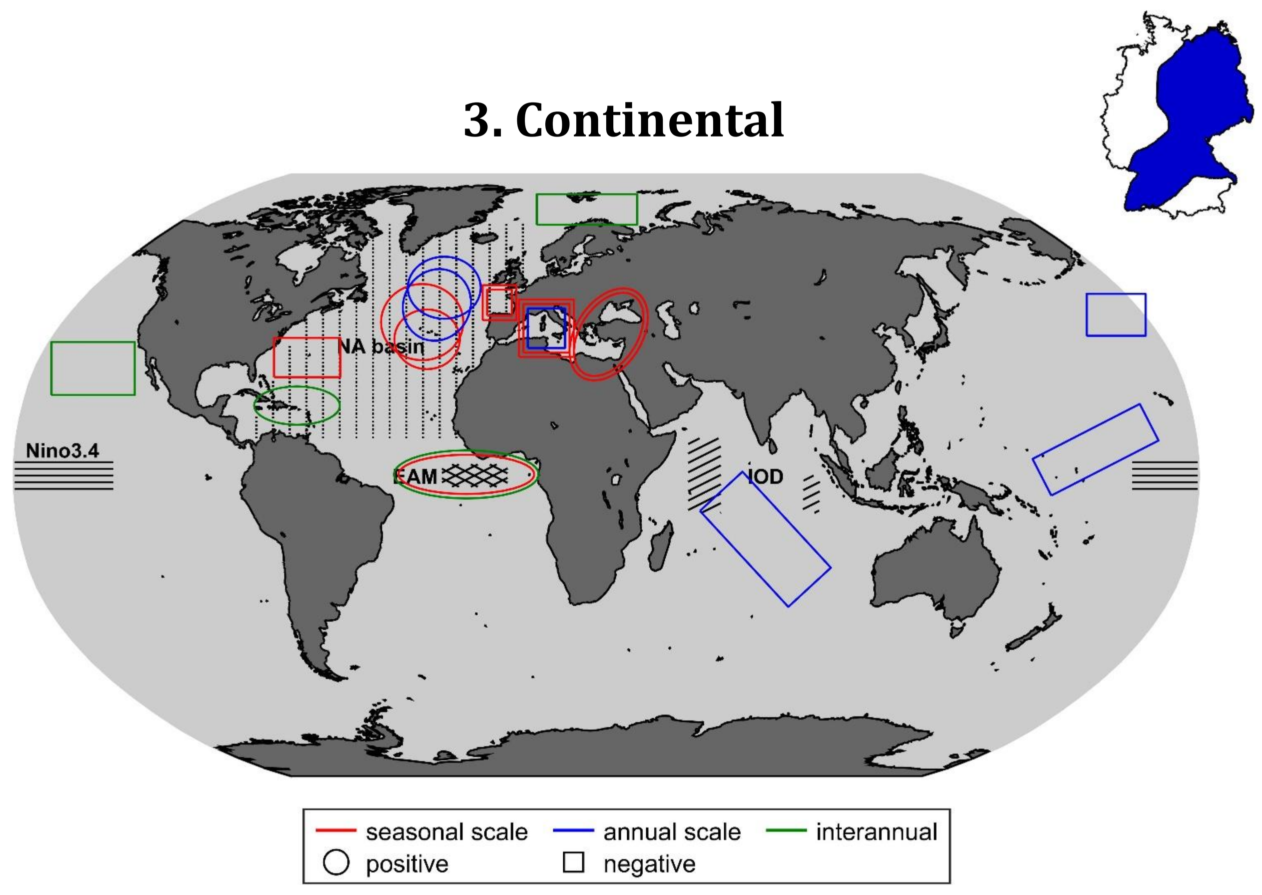
2. Atlantic



SST spatial pattern→Atlantic

- Characteristics regions of NA SST tripole like pattern is not robust especially U.S. east coast region is not appeared
- Spatial patterns in the eastern Mediterranean Ocean and Black Sea at seasonal scale maybe exist due to the interlinking connection with Northern Atlantic Oscillation (NAO).
- Equatorial Atlantic region at inter-annual timescale resembles Equatorial Atlantic Mode/Atlantic Nino[4]
- The presence of central North Pacific regions may also be due to the interannual ties between North Pacific and North Atlantic basins that may influence North America and European climate altogether[5]

3. Continental



SST spatial pattern → Continental

- Central North Atlantic region is persistent up to the annual scale similar to the Alpine region, with the latitude ranges up to subtropics
- Presence of eastern Mediterranean Ocean and Black Sea similar to the Atlantic region
- North Atlantic SST tripole like pattern regions include the negative U.S. east coast, positive south of Greenland and negative connection around the European coast[3]
- Equatorial Atlantic region at interannual scale is also present similar to Atlantic region
- Continental pattern comprises the characteristics of both Atlantic and Alpine regions

Conclusions

- SST-streamflow connectivity helps evaluate local hydrology
- Cross degree spatial patterns resembling North Atlantic SST tripole-like region, Equatorial Atlantic Mode identified for different streamflow regions at consistent timescales
- Prediction of streamflow using the identified connections may be the possible trajectory of this current research

Take-home message

Unravelling SST-streamflow connectivity and understanding physical mechanism underneath the connection helps evaluate local hydrology at future climatic conditions

References

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