Spatial Variability of Long-Term Dependencies in the Precipitation for a Basin-Scale under the Detection of Climate Change

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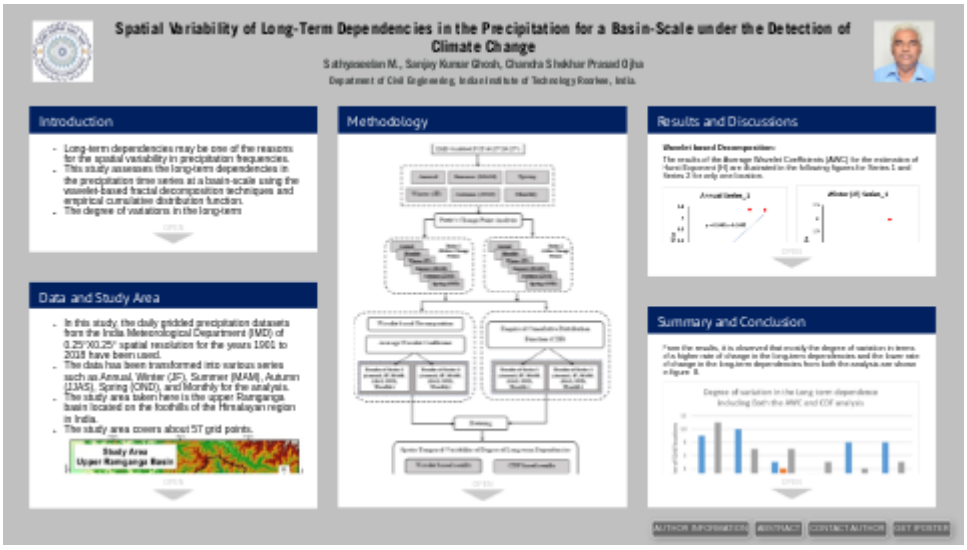
Abstract

Long-term dependencies may be one of the reasons for the spatial variability in precipitation frequencies. This study assesses the long-term dependencies in precipitation time series at a basin-scale using the wavelet-based fractal decomposition technique. The gridded precipitation datasets (0.25deg x 0.25deg) from the India Meteorological Department (IMD) for the year, 1901 to 2018 have been used. In order to find the climate change point (i.e., the year in terms of annual series) from each grid point, the mean-based change point detection is performed. Based on the change points, the input for the wavelet analysis is generated into two series, the series -1 (before change point) and the series – 2 (after change point). The results of the climate change points are different for every location, and the corresponding length of the series also gets changed. In order to handle the non-stationarity associated with the time series datasets, the method of wavelet decomposition is used. The Discrete Wavelet Transform (DWT) based fractal decomposition of time series is performed by taking the Daubechies (db1 to db10) mother wavelet along with the varying scale and translation parameters. Both the results of the series wavelet coefficients are compared using the scaled ratio method and the relative shift in the cumulative distribution functions (CDF). Comparing the time series datasets before and after the change point reveals the significance of long-term dependencies at each location. The results of the spatial variability and its patterns explain the long-term dependencies and their significance at a basin-scale, which may support various scientific studies and development.

Spatial Variability of Long-Term Dependencies in the Precipitation for a Basin-Scale under the Detection of Climate Change



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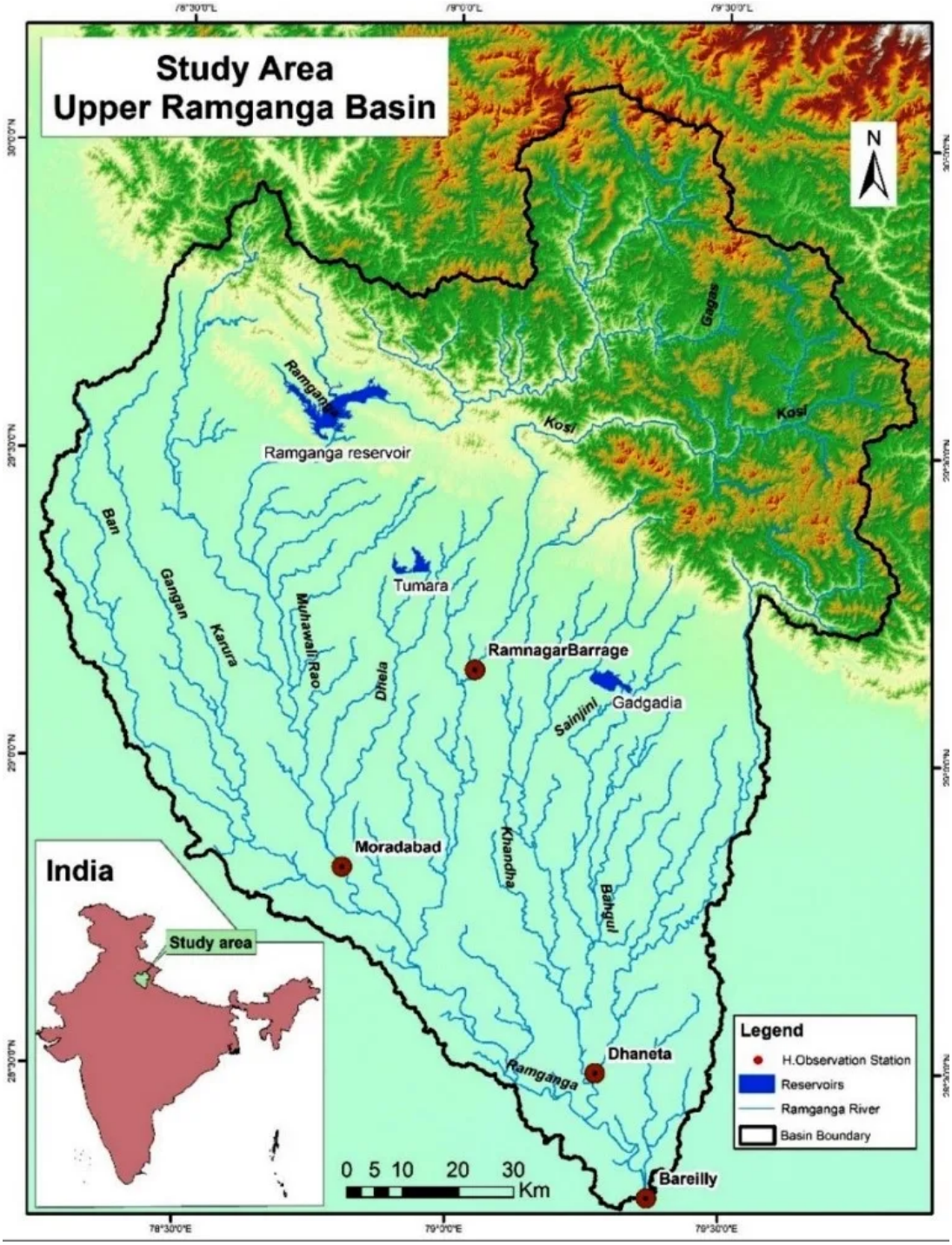
PRESENTED AT:

INTRODUCTION

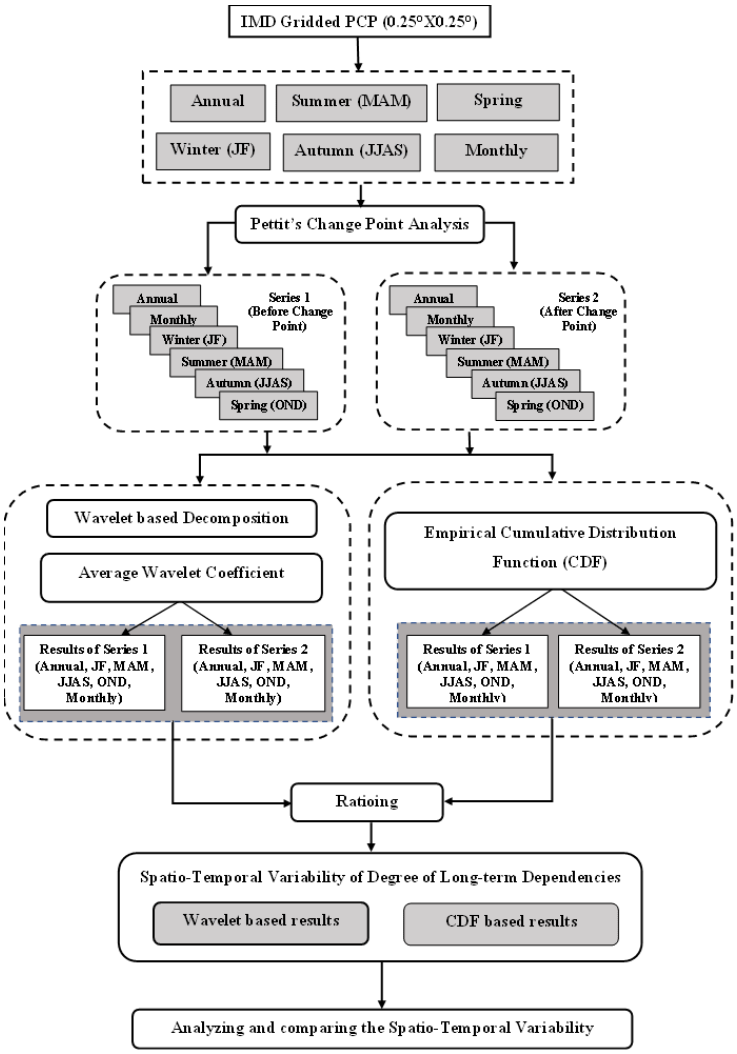
- Long-term dependencies may be one of the reasons for the spatial variability in precipitation frequencies.
- This study assesses the long-term dependencies in the precipitation time series at a basin-scale using the wavelet-based fractal decomposition techniques and empirical cumulative distribution function.
- The degree of variations in the long-term dependencies in the precipitation provides an understanding of climate change happenings and their impacts at the basin or regional scale level.

DATA AND STUDY AREA

- In this study, the daily gridded precipitation datasets from the India Meteorological Department (IMD) of 0.25°X0.25° spatial resolution for the years 1901 to 2018 have been used.
- The data has been transformed into various series such as Annual, Winter (JF), Summer (MAM), Autumn (JJAS), Spring (OND), and Monthly for the analysis.
- The study area taken here is the upper Ramganga basin located on the foothills of the Himalayan region in India.
- The study area covers about 57 grid points.



METHODOLOGY



RESULTS AND DISCUSSIONS

Wavelet based Decomposition:

The results of the Average Wavelet Coefficients (AWC) for the estimation of Hurst Exponent (H) are illustrated in the following figures for Series 1 and Series 2 for only one location.

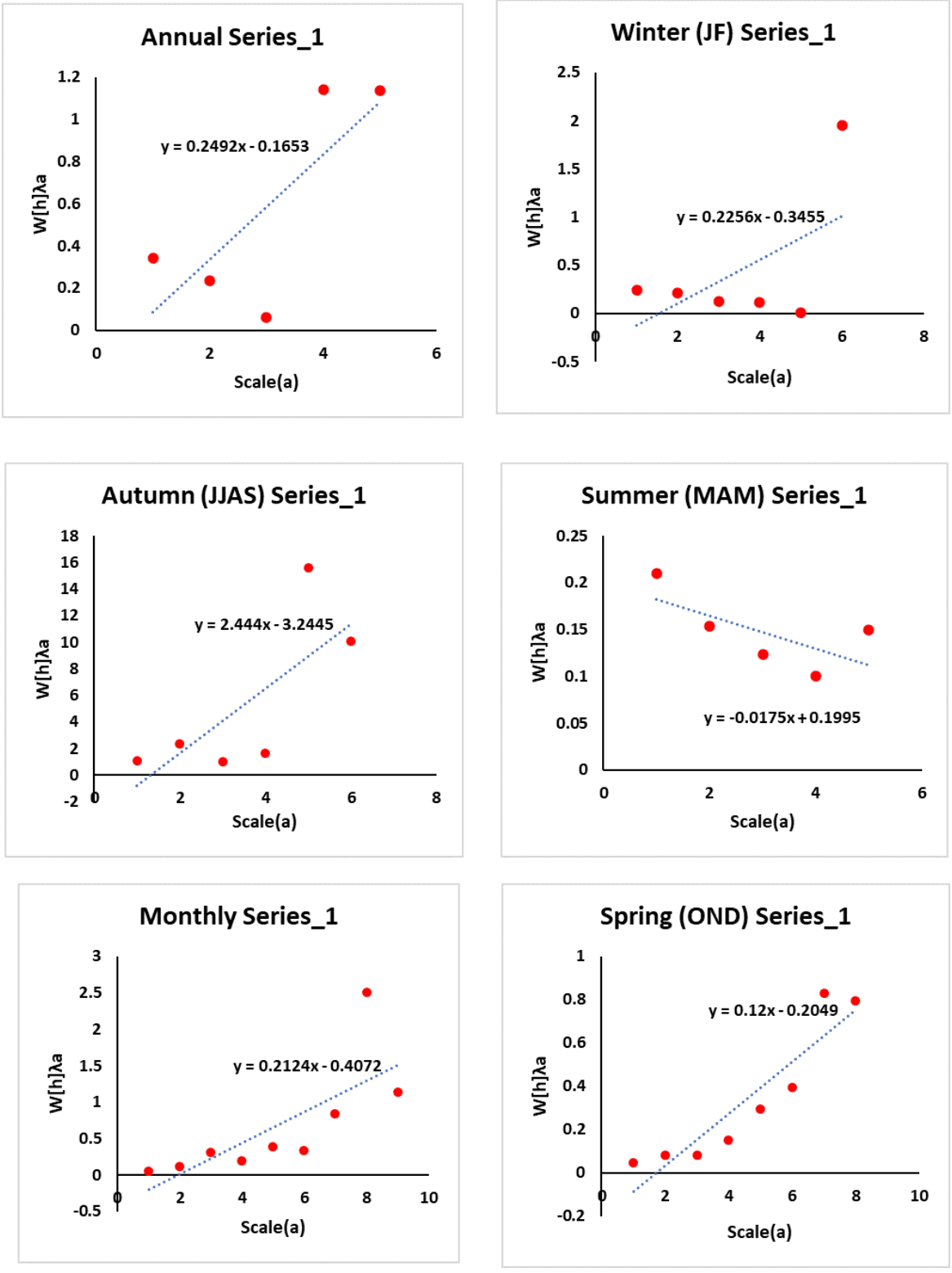


Figure 3. Showing the AWC for station 9. and Series 1.

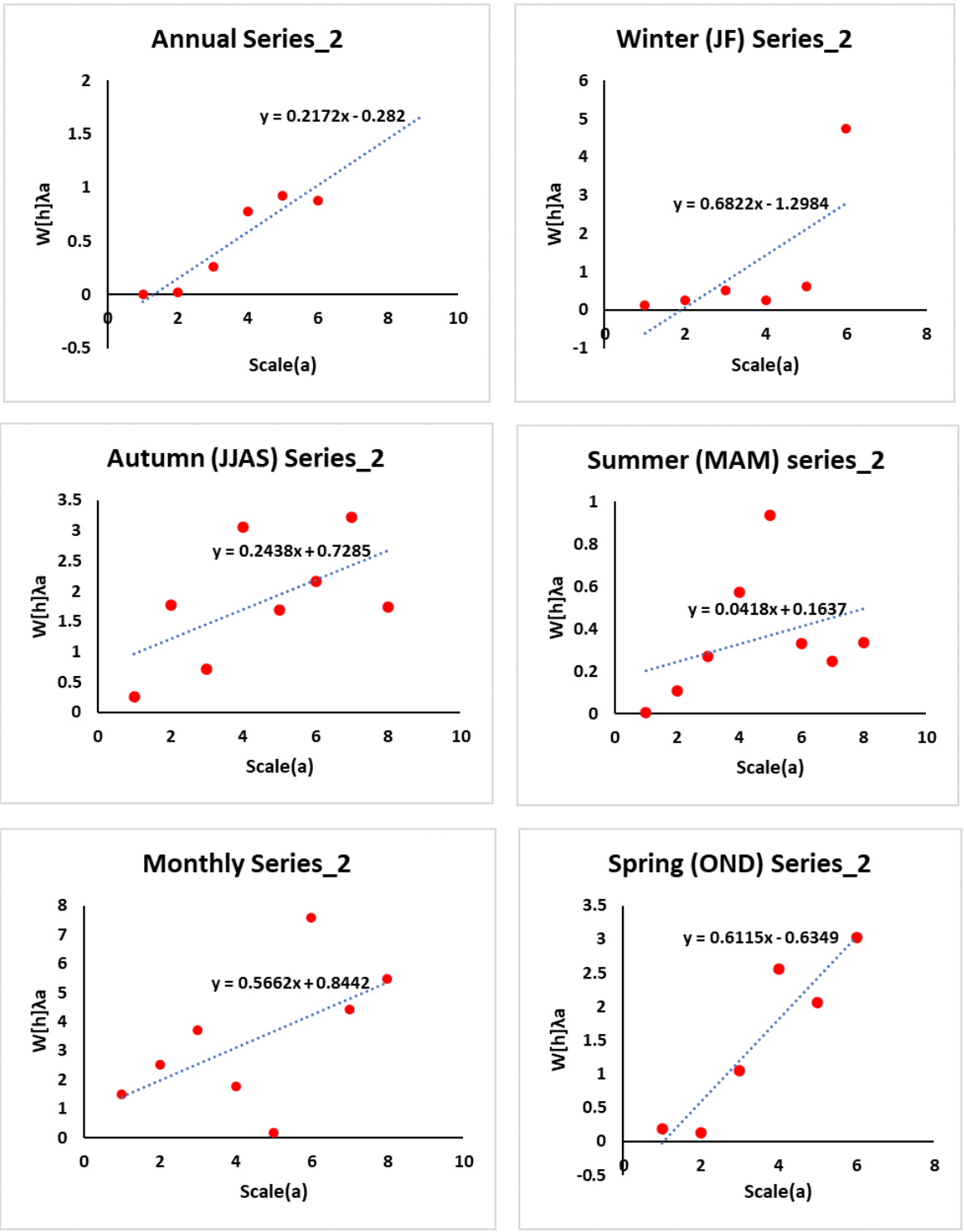


Figure 4. Showing the AWC for station 9 and Series 2.

Based on the values of the AWC slopes, the Hurst coefficients (H) are calculated. This is a representation of the long-term dependencies in the non-stationary condition.

The ratioing is applied on the AWC based values of series 1 and series 2 and the spatial variability of the degree of long-term dependencies are mapped as shown in figure 5.

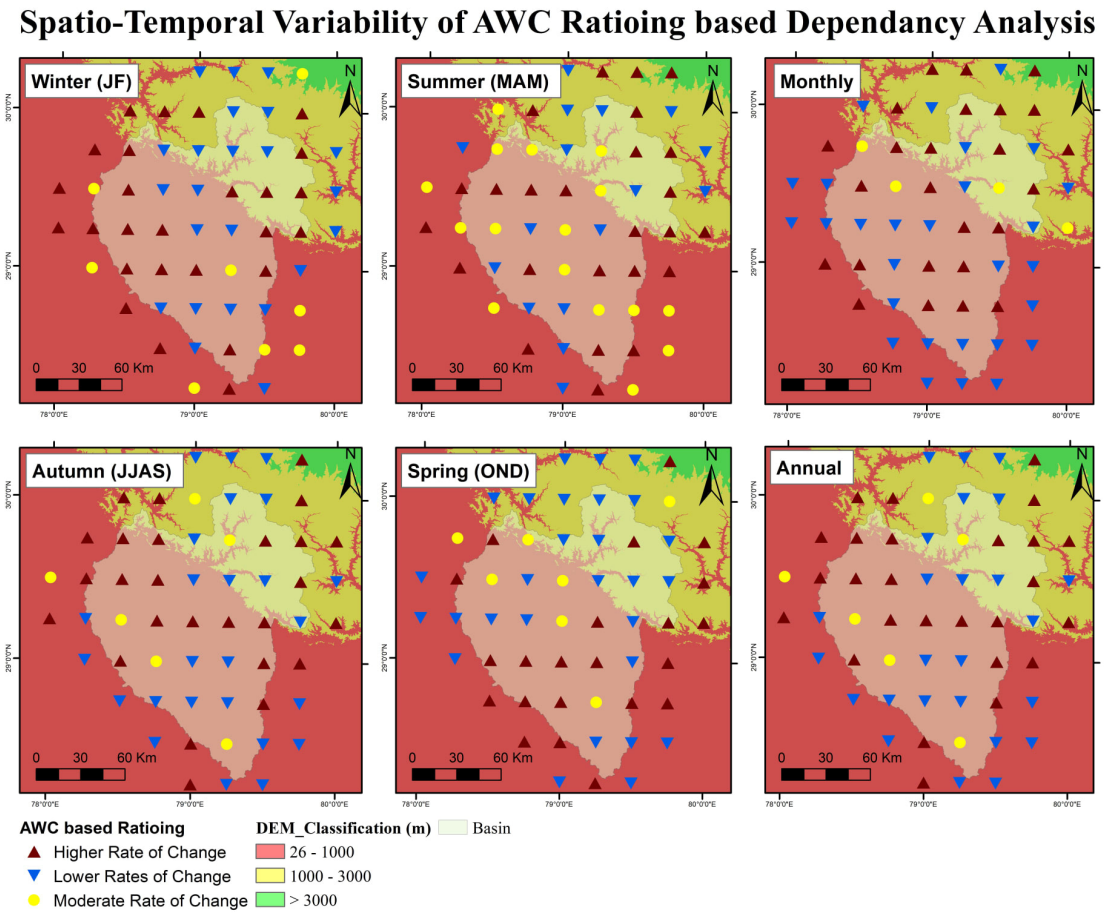


Figure 5. Spatial variability of the Long-term dependencies based on the AWC and ratioing.

Empirical Cumulative Distribution Function (ECDF)

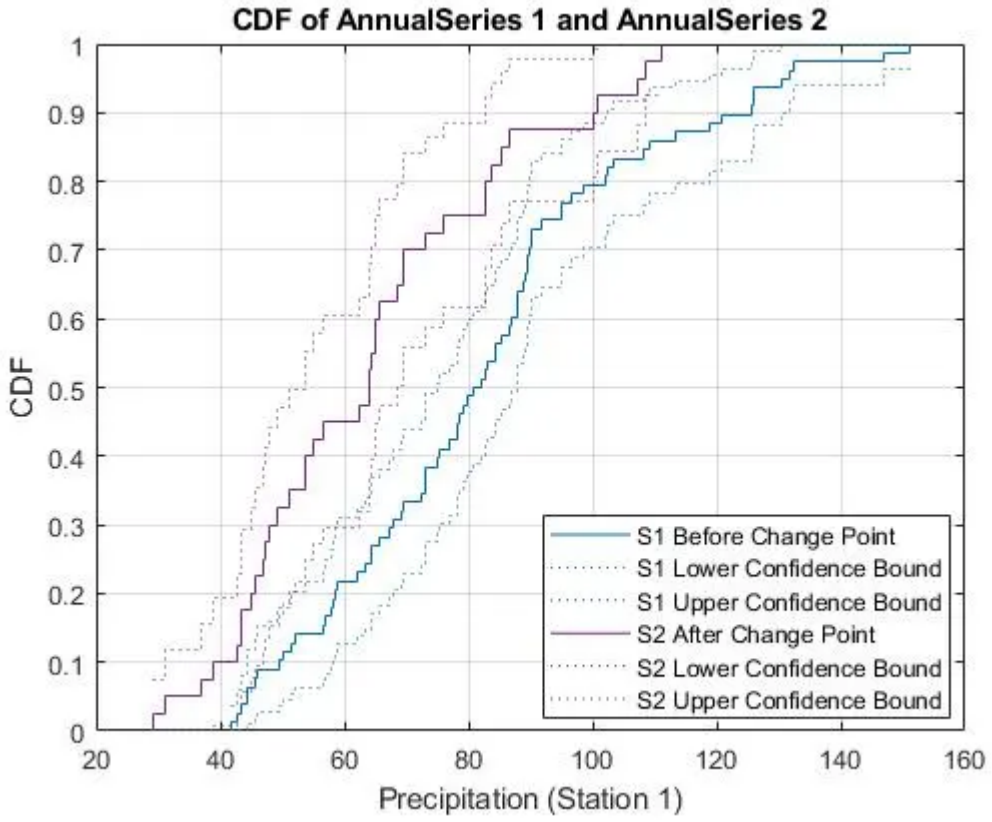


Figure 5. CDF for the Station 1 Annual Series 1 and Annual Series 2.

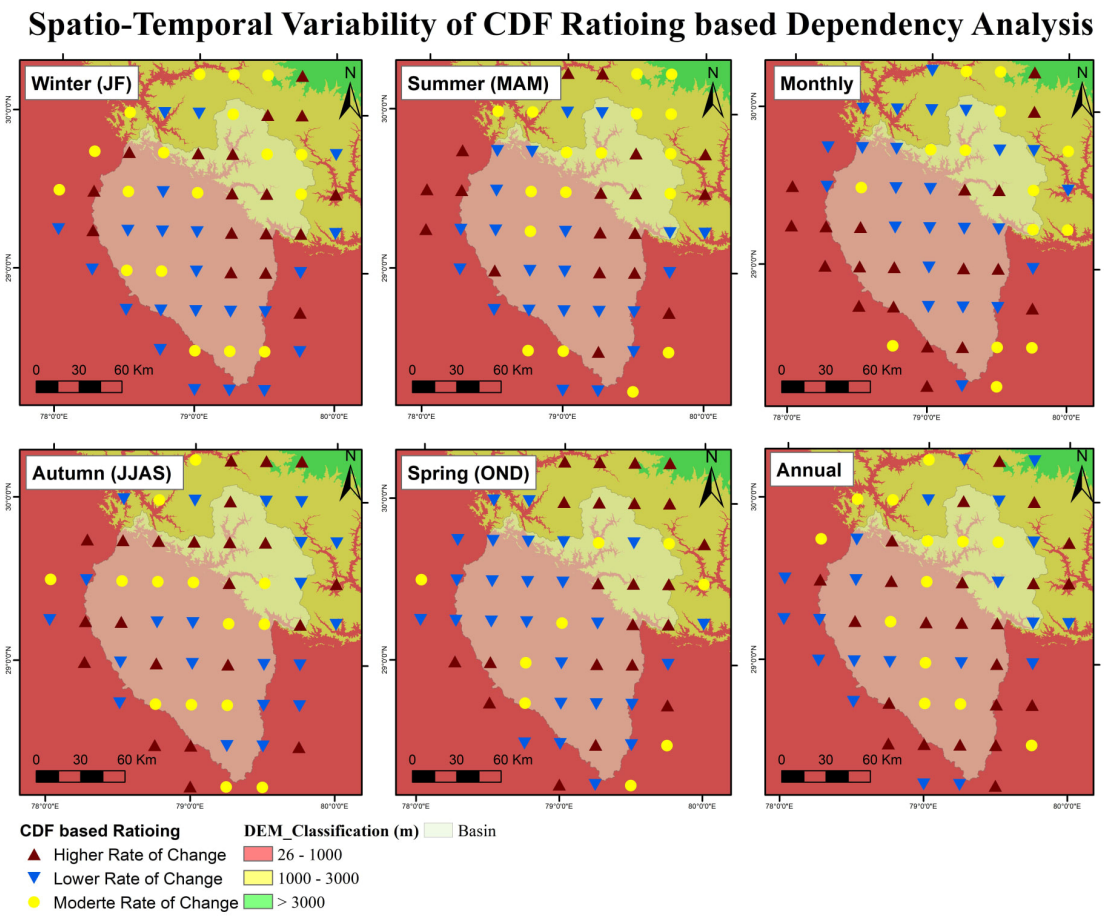


Figure 7. Spatial variability of the Long-term dependencies based on the CDF and ratioing.

SUMMARY AND CONCLUSION

From the results, it is observed that mostly the degree of variation in terms of a higher rate of change in the long-term dependencies and the lower rate of change in the long-term dependencies from both the analysis are shown in figure 8.

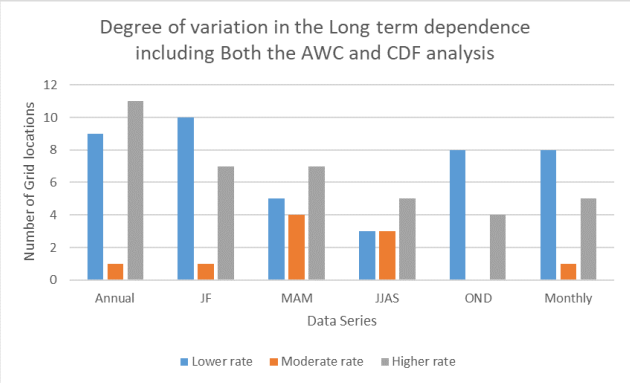


Figure 8. Degree of variation in the long-term dependencies based on both the analysis.

These spatial variabilities in the degree of long-term dependencies provide an understanding of climate change and may support the various scientific studies, resource management, and development.

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ABSTRACT

Long-term dependencies may be one of the reasons for the spatial variability in precipitation frequencies. This study assesses the long-term dependencies in precipitation time series at a basin-scale using the wavelet-based fractal decomposition technique and empirical Cumulative Distribution Function (CDF). The gridded precipitation datasets (0.25° x 0.25°) from the India Meteorological Department (IMD) for the year 1901 to 2018 have been used. In order to find the climate change points from each data series, Pettit's change point method is used. Based on the change points, the input for both methods is generated into two series, the series -1 (before change point) and the series – 2 (after change point). In order to handle the non-stationarity associated with the time series datasets, the method of wavelet decomposition and the continuous CDFs are used. The Discrete Wavelet Transform (DWT) based decomposition is performed by taking the Daubechies (db1 to db10) mother wavelet along with the varying scale and translation parameters. The Average Wavelet Coefficient (AWC) method estimates the Hurst exponent (H) for analyzing the long-term dependencies. Also, using the ratio approach, the means of the CDFs for the original data series are constructed and compared. The results of both the series wavelet coefficients are compared using the ratio method, and the relative shifts in the CDFs are mapped. Then, the results of the spatio-temporal variability patterns at different classes such as higher, moderate, or lower rates of change explain the degree of long-term dependencies and their significance at each location in a basin-scale, which may support various scientific studies and related resources management and development activities.

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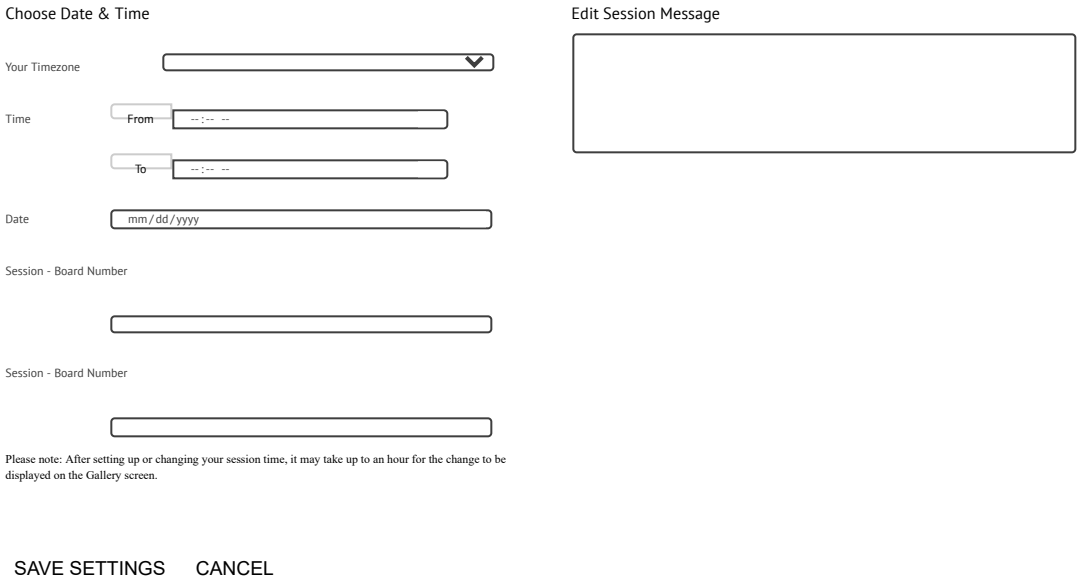

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