Causality based selection of covariates for non-stationary modeling of extreme precipitation

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Climate change and natural climate variability affect the ocean-atmospheric-land interactions leading to variability in severe weather events such as extreme precipitation. Understanding the causal relationships and the lagged effect between the teleconnection patterns and precipitation would improve the model prediction. In recent years, there has been an increase in the magnitude and frequencies of extreme precipitation, exhibiting non-stationarity. Therefore, this study proposes a framework that includes: i) selection of teleconnections and time-lags using a non-linear Granger causality approach, and ii) developing a Non-Stationary Generalized Extreme Value (NSGEV) model for assessing the extreme precipitation changes using the selected teleconnections as covariates. The proposed methodology considers seventeen teleconnections and is applied to a few case studies. The efficacy of the proposed non-linear causality is brought out in comparison with the linear Granger causality based NSGEV models. Preliminary results suggest that the dominant teleconnections influencing extreme precipitation are selected depending on the geographical location. The selected climate indices as covariates have improved the NSGEV models' performance compared to the stationary model based on corrected Akaike Information Criteria (AICc). Furthermore, the EPs are estimated for various return periods for the NSGEV models and compared with the stationary model. The study's findings will help in adapting better planning, design, and rehabilitation of the water infrastructure and in developing mitigation strategies.