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Linear and Nonlinear Responses of Turkish Extreme Rainfall Oscillations to Large-Scale Atmospheric Circulations

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Investigating the underlying drivers behind the extreme precipitation variability contributes greatly to the ongoing debate on reducing the harmful effects of extreme events such as droughts and flash floods. It is very essential to explore characteristics of the relationship between extreme precipitation and spatially large-scale atmosphere-ocean interaction patterns, which are one of the main factors for the naturally occurred periods of high and low precipitation. Correspondingly, this study aims to search on the type of the relationship (i.e. linear or non-linear) between the anomalies of decadal precipitation extremes in Turkey and some climate indices; Arctic Oscillation (AO), North Atlantic Oscillation (NAO), Southern Oscillation Index (SOI) and Western Mediterranean Oscillation (WeMO). The anomalies in precipitation extremes and climate indices are obtained by means of Quantile Perturbation Method (QPM) considering four climatic seasons and seven sub-regions. Analyses are conducted on 67 different stations including 60 years daily precipitation datasets. The significance of the relation between precipitation extremes and climate indices are examined using single and multiple predictors for both linear and non-linear methods. Spearman's rank order correlation (SROC) and Power Law Regression (PLR) are chosen to test the type of bivariate relationships while Multiple Linear Regression (MLR) and Multivariate Adaptive Regression Splines (MARS) are used to study the type of multivariate relationships. In terms of bivariate relationship, SROC and PLR results are very close to each other, where the correlation coefficient between the SROC and the PLR results is 0.93. However, at approximately 81% of the analyses, MARS shows higher predictive skill than MLR. Furthermore, MARS finds more powerful relations than MLR at 96% of the stations in winter. The analyses with multiple predictors prove that winter extremes are highly related to NAO-SOI pair for most of the country. According to the MARS results, 40% of the stations show statistically significant relationship with this pair at 5% significance level whereas MLR detects significant relationship at only 13% of the stations. Overall, the findings of this study call for using non-linear methods to explore the relationships between precipitation extremes and large-scale atmospheric drivers as the outputs of linear methods may be biased.