

Statistical Significance of Trends in the Extremes of Monthly Precipitation Over the US

Salil Mahajan, Gerald R. North, R. Saravanan
Department of Atmospheric Sciences, Texas A&M University
&
Marc G. Genton
Department of Statistics, Texas A&M University

Abstract (Presentation)

Extreme events of precipitation have a potential of impacting our social and economic activities. Observational studies suggest that there has been an increase in extremes of weather in the past decades, but it is difficult to assess their statistical significance as the real world provides just one realization of the stochastic behavior associated with precipitation variability. In this study, a stochastic model of monthly precipitation over the US was created to generate numerous realizations. These simulations were used to establish the statistical significance of the observed trends in the extremes using the Monte-Carlo scheme. The stochastic model incorporated log-normal density function to represent the skewed nature of the density function of precipitation, and also accounted for spatial correlation of precipitation among the climate regions. It is found that accounting for spatial correlation improves the stochastic model to better estimate the confidence limit bounds for the Monte-Carlo test. It is also seen that the log-normal density function accounts aptly for the skew-ness associated with monthly precipitation when averaged over spatial scales of climate regions. Monthly precipitation from various Global climate Models (GCMs) integrations of the 20th century was also analyzed. The similarity of the density function of monthly precipitation to the log-normal distribution is also exhibited coherently in all the GCM integrations. Furthermore, the similarity in the density functions of monthly precipitation of the real world data and the GCM integrations is remarkable, implying that precipitation is simulated reasonably well by the GCMs.

A marginally statistically significant upward trend in the extremes of monthly precipitation over the US is observed over the past century in one of the precipitation datasets. GCM integrations of the 20th century were also subjected to the Monte-Carlo tests. No statistically significant trends in the extremes of monthly precipitation were observed in most of the GCM integrations. However, GCM integrations of the 21st century, widely display statistically significant upward trends, implying a role for anthropogenic forcing in the systematic increase of extremes of precipitation.