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Extreme precipitation events increasing in the San Francisco Bay Area, CA, USA between 1890 and 2010

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We have analyzed precipitation distribution across the San Francisco Bay Area (SFBA) in northern California, USA, using detailed records that span more than a century, to assess nonstationarity in the occurrence of extreme events. The primary goal of this study is to more accurately characterize trends in extreme precipitation events for 1 hour to 60 day durations over the past 120 years. As Earth's climate continues to warm, scientists, water managers, and water users need to understand how the hydrologic cycle is being changed, and how these changes will impact aquatic, ecologic, and human systems. Larger scale regional studies that include the SFBA have inconsistent results, and are not yet reliable sources for local management entities. Relationships between event magnitude and mean annual precipitation (MAP) in the SFBA are commonly calculated using results from a study based on data from 1906 to 1956. This study uses observations from the past 120 years with hourly records at 210 stations and daily records at 429 stations. We apply a Pearson Type III probability distribution for quantifying precipitation event depth-duration-frequency, and assess changes in these characteristics for events having a wide range of intensities. We employ a Bayesian framework with a Markov Chain Monte Carlo algorithm to show that storm event magnitude and frequency are increasing, with the largest events increasing the most. In several large urban areas, we see storm magnitudes increasing between 7 and 40%. Part of this increase can be attributed to an increase in MAP, but much of the change results from a concentration of a greater fraction of annual precipitation into a smaller number of larger events. We also present initial results illustrating greater increases in extreme event magnitude relative to MAP in urban areas. Results from this study demonstrate the nonstationarity in SFBA precipitation records, and propose new empirical relations for estimating storm magnitude based on MAP. However, if changes are continuing, these results may understate the size of upcoming events.