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A Comprehensive Assessment of Trends in Subdaily Heavy Precipitation in the U.S.?

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Theoretical arguments and modeling experiments suggest that heavy precipitation is expected to intensify in a warmer climate. These projections have been supported by observational evidence at the daily scale, whereas the lack of long-term subdaily records has limited the ability to conduct analyses at shorter durations. In this study, we address this research gap using the Hourly Precipitation Data (HPD) from the National Climatic Data Center (NCDC). Due to the presence of relatively large periods with missing observations, we first implement a procedure to reconstruct probable missing zeros using the Analysis of Record Calibration (AORC) hourly gridded product. After the reconstruction, we identify 1404 gages with more than 75% (median of 94%) of complete records in the period 1979-2019 that cover the continental U.S. with good density. We then perform trend test analyses on the hourly observations where, at each gage, (1) independent events are identified, (2) peak-over-threshold series above the 90th, 95th, and 99th quantiles are extracted, and (3) trend tests are performed on the annual frequency and mean intensity of the POT series. After accounting for field significance, we find that hourly heavy precipitation exhibits statistically significant trends that are increasing for the frequency (+1% - +2% every year) but decreasing for the intensity (-0.4 mm/h - -1.8 mm/h every 10 years). This is true in most of the country, except for some areas in the Southwest and South regions. Analyses repeated with the signals aggregated at 2, 3, 6, 12, and 24 hours lead to similar patterns, although a lower number of statistically significant trends is found as the duration increases. Overall, the statistical evidence of the trends is higher when focusing on the frequency rather than the intensity of heavy precipitation, and it is reduced when considering higher quantiles likely because of the lower test power. The results of this study are useful for the validation of climate and atmospheric models and the incorporation of nonstationarities due to global warming in intensity-duration-frequency curves of extreme precipitation used for infrastructure design.