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Challenges and Opportunities in the Detection of Trends in Subdaily Heavy Precipitation in the United States

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Increasing empirical evidence has been showing that, over the last decades, the frequency of daily heavy precipitation has risen in some regions of the United States (U.S.); less evidence has instead been presented at subdaily resolutions. In this study, we describe the challenges and opportunities associated with the detection of trends in subdaily heavy P in the U.S. using Version 2 of the Hourly Precipitation Data (HPD) from the National Climatic Data Center (NCDC). This dataset comprises records from 1897 gages, which we found to be affected by several issues preventing their use in trend studies, including long periods with missing observations, changes of instruments, and different signal resolutions (largely, 0.254 and 2.54 mm). Despite this, after proper checks, we were able to identify 370 gages with ≥40 years of statistically homogenous data in 1950-2010 that cover the U.S. with a good density. To improve the ability to detect trends, we designed a framework that quantifies the degree to which the observed over-threshold series above a given empirical q-quantile are consistent with stationary count time series with the same marginal distribution and serial correlation structure as the observations. We also applied the false discovery rate test to account for spatial dependence and multiplicity of the local tests. Analyses were performed for the signals aggregated at Δt = 1, 2, 3, 6, 12, and 24 h and for q = 0.95, 0.97, and 0.99, finding that most gages exhibit increasing trends across all Δt's and that their statistical significance increases with Δt and decreases with q, but only for $\Delta t \geq 2$ h. This might indicate that the physical generating mechanisms of precipitation have changed in a way that leads to larger accumulations over durations >1 h but similar intensities within 1 h. An alternative possible explanation for these outcomes is instead that the coarse signal resolution (2.54 mm) reduces the power of the test for trend detection as Δt decreases. Investigating these issues will be the subject of our immediate future work.