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Disentangling natural and forced components of extreme rainfall hazards over Europe

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There is mounting evidence that human-made climate changes do project onto the natural modes of climate variability. As a result, hydro-climatic extreme events have become more intense and more frequent in the last decades. Yet, unraveling the role of climate change and climate variability in the occurrence of extreme events remains poorly known. Such information is critical to assess and manage disaster risks and improve adaptation and mitigation strategies to decrease the damages and costs to society. This study seeks to tease out the impact of anthropogenic climate change from natural climate variability on daily extreme rainfall events at 263 stations in Europe over an approximately century-long period from 1925 to 2015. The decadal oscillations of daily extreme rainfall in different seasons are determined using the quantile perturbation method and then tested for the presence of nonstationarity. The attribution analysis of significant extreme rainfall events based on the Monte Carlo method is performed by comparing the occurrence probability under natural forcing alone and under natural plus anthropogenic forcings. The results reveal a climate change footprint in the decadal oscillations of extreme rainfall, with significant upward trends ranging between 27% and 56% of the continental area in different seasons. From a spatial point of view, western Europe characterized by strong upward trends is the most hazardous region of the continent to extreme rainfall events. We also find that the extreme rainfall events under climate change have become twice as frequent as under natural forcing. The attribution of human-caused climate change to significant extreme rainfall events over Europe varies with seasons and is in the range of 35-52%.