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Observed change in extreme daily rainfalls in the French Mediterranean

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In spite of a relatively dry mean climate, the Mediterranean regions in Southern France use to experience heavy rainfalls over short durations - typically a few minutes to one day. Here we examine long-term trends in the historical record of extreme precipitation events occurring over the French Mediterranean area, where many long homogeneous time-series are available. Extreme events are considered in terms of their intensity, frequency, extent and precipitated volume.

Changes in intensity are analysed via an original statistical approach where the annual maximum rainfall observed at each measurement station are aggregated into a univariate time-series, according to their statistical dependence. This procedure substantially enhances the signal-to-noise ratio. The mean intensity increase is significant and estimated at +22% (+7% to +39% at the 90% confidence level) over the 1961-2015 period. Given the observed warming over the considered area, this increase is consistent with a rate of about one to three times that implied by the Clausius-Clapeyron relationship.

Changes in frequency and other spatial features are investigated through a Generalised Linear Model. Changes in frequencies for events exceeding high thresholds (about 200mm in one day) are found to be significant, typically near a doubling of the frequency, but with large uncertainties in this risk ratio. The area affected by severe events and the water volume precipitated during those events also exhibit significant trends, with an increase by a factor of about 4 for a 200mm threshold, again with large uncertainties.

All diagnoses consistently point toward an intensification of the most extreme events during the last decades. We argue that the diagnosed trends can hardly be explained without invoking the human influence on climate.