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Climate-change driven increase in high intensity rainfall events: Analysis of development in the last decades and towards an extrapolation of future progression

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Hydrological extreme events can be triggered by rainfall on different spatiotemporal scales: river floods are typically caused by event durations of between hours and days, while urban flash floods as well as soil erosion or contaminant transport rather result from storms events of very short duration (minutes).
Still, the analysis of climate change impacts on rainfall-induced extreme events is usually carried out using daily precipitation data at best. Trend analyses of extreme rainfall at sub-daily or even sub-hourly time scales are rare.

In this contribution two lines of research are combined: first, we analyse sub-hourly rainfall data for several decades in three European regions.Second, we investigate the scaling behaviour of heavy short-term precipitation with temperature, i.e. the dependence of high intensity rainfall on the atmospheric temperature at that particular time and location.
The trend analysis of high-resolution rainfall data shows for the first time that the frequency of short and intensive storm events in the temperate lowland regions in Germany has increased by up to 0.5 events per year over the last decades. I.e. this trend suggests that the occurrence of these types of storms have multiplied over only a few decades. Parallel to the changes in the rainfall regime, increases in the annual and seasonal average temperature and changes in the occurrence of circulation patterns responsible for the generation of high-intensity storms have been found.
The analysis of temporally highly resolved rainfall records from three European regions further indicates that extreme precipitation events are more intense with warmer temperatures during the rainfall event. These observations follow partly the Clausius–Clapeyron relation. Based on this relation one may derive a general rule of maximum rainfall intensity associated to the event temperature, roughly following the Clausius–Clapeyron (CC) relation. This rule might be used for scenarios of future maximum rainfall intensities under a warming climate.