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Intensity changes in future extreme precipitation: A statistical event-based approach.

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Short-lived precipitation extremes are often responsible for hazards in urban and rural environments with economic and environmental consequences. The precipitation intensity is expected to increase about 7% per degree of warming, according to the Clausius-Clapeyron (CC) relation. However, the observations often show a much stronger increase in the sub-daily values. In particular, the behavior of the hourly summer precipitation from radar observations with the dew point temperature (the Pi-Td relation) for the Netherlands suggests that for moderate to warm days the intensification of the precipitation can be even higher than 21% per degree of warming, that is 3 times higher than the expected CC relation. The rate of change depends on the initial precipitation intensity, as low percentiles increase with a rate below CC, the medium percentiles with 2CC and the moderate-high and high percentiles with 3CC.

This non-linear statistical Pi-Td relation is suggested to be used as a delta-transformation to project how a historic extreme precipitation event would intensify under future, warmer conditions. Here, the Pi-Td relation is applied over a selected historic extreme precipitation event to 'up-scale' its intensity to warmer conditions. Additionally, the selected historic event is simulated in the high-resolution, convective-permitting weather model Harmonie. The initial and boundary conditions are alternated to represent future conditions.

The comparison between the statistical and the numerical method of projecting the historic event to future conditions showed comparable intensity changes, which depending on the initial percentile intensity, range from below CC to a 3CC rate of change per degree of warming. The model tends to overestimate the future intensities for the low- and the very high percentiles and the clouds are somewhat displaced, due to small wind and convection changes. The total spatial cloud coverage in the model remains, as also in the statistical method, unchanged.

The advantages of the suggested Pi-Td method of projecting future precipitation events from historic events is that it is simple to use, is less expensive time, computational and resource wise compared to a numerical model. The outcome can be used directly for hydrological and climatological studies and for impact analysis such as for flood risk assessments.