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A formula for downscaling extreme sub-daily rainfall intensities

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Global warming is associated with an increased rate of evaporation due to higher surface temperatures which also implies a higher hydrological cycle turn-around in a steady-state atmosphere with respect to the water budget. The latter is accompanied with increased atmospheric overturning and more convective activity. In addition, there have been indications of a decreasing area of 24-hr rainfall on a global scale over the last decades, suggesting that rainfall is becoming concentrated over smaller regions. There have also been indications of higher cloud tops. In sum, a consequence of an increased greenhouse effect and modified hydrological cycle is an increased probability for heavy rainfall on local scales and a greater risk of flooding. Changes in risks connected to meteorological and hydrological challenges make it necessary to adapt to new weather statistics. For instance, there is a need to estimate the frequency of heavy downpour and their return levels, both for 24-hr amounts and sub-daily timescales. It is common to account for extreme rainfall by designing infrastructure with the help of intensity-duration-frequency (IDF) curves. One problem is that the IDF curves are based on long records of hourly rainfall measurements that are not widely available. Traditional IDF curves have also been fitted assuming stationary statistics, while climate change implies non-stationary weather statistics. We propose a formula for downscaling sub-daily rainfall intensity based on 24-hr rainfall statistics that is not as limited by data availability nor assumes stationarity. This formula provides a crude and approximate and rule-of-thumb for sites with 24-hr rain gauge data and can be used in connection with downscaling of climate model results. It also represents a way of downscaling rainfall statistics in terms of the time dimension.