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Why does my design rainfall change over time? A dynamical downscaling experiment to reconstruct changes in sub-hourly precipitation extremes at the centennial scale

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Design rainfall values are required in many applications in hydrologic engineering including urban hydrology. They are derived in the framework of extreme value statistics based on observed precipitation time series with high temporal resolution. The vast majority of these time series cover at best around 30 years fulfilling most criteria to perform statistical analyses. However, this approach assumes stationarity, i.e., we cannot draw any conclusions regarding changes over time in extreme precipitation intensities. However, current guidelines like, e.g., the European Standard EN 752 ("Drain and sewer systems outside building") requests that "the potential effects of climate change should be considered" in urban hydrologic design projects. From a few studies that explore centennial scale time series, we know that sub-hourly precipitation extremes are subjected to multi-decadal oscillations, which suggests that precipitation extremes change as a consequence of climate variability and climate change. The latter is also supported by most recent findings in the IPCC 5th Assessment report which states that "extreme precipitation events will *very likely* become more intense and more frequent by the end of this century". In order to address both climate variability and climate change to understand changes in precipitation extremes over time, we suggest a dynamical downscaling experiment on centennial time scales, starting from the end of the little ice age to the near present. Hence, the 20th Century Reanalyses dataset (1850-2014) is used to drive the Weather Research and Forecasting (WRF) Model for the domain of Central Europe with 30 km resolution. From this long-term dynamical downscaling experiment, 10min precipitation intensities are compared to two corresponding observed time series which cover the period 1931 to 2017. Due to a mismatch in scales, a direct comparison is not possible. Instead, we compare how anomalies of quantiles computed for precipitation extremes in consecutive subsets of 15 years change over time. Downscaled changes in anomalies match the corresponding observed anomalies very well ($r = 0.85$ and $r = 0.92$, respectively). This holds also true for the pronounced increase in anomalies in the last decades. In the last years, however, this increase declined in both modelled and observed time series. One of the observed time series even suggests a slight decrease in extreme precipitation. While it is clear that such approach is not capable of reliably reconstructing single convective events due to the coarse grid size and the fact that better reanalyses data are available at least for the last decades, the results suggest that we can reliably reconstruct changes in sub-hourly precipitation extremes, even by elaborating this minimal dynamical downscaling approach. In the future, dynamical downscaling experiments should be designed in a way that better addresses changes in sub-hourly precipitation in order to support practical requirements in urban hydrology.