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# Sub-daily extreme precipitation under current and future climate conditions from high resolution RCMs

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## Abstract

The increase in extreme precipitation is likely to be one of the most significant impacts of climate change in cities, where short duration extreme precipitation is one of the main causes for severe floods. Hence, reliable information on changes in sub-daily extreme precipitation is needed for the design of robust adaptation strategies.

Some recent studies point towards the fact that the representation of sub-daily extreme precipitation by climate models increases with increasing spatial resolution (Kendon et. al., 2014). This study explores extreme precipitation over Denmark generated by the same regional climate model (RCM) HIRHAM-ECEARTH at different spatial and temporal resolutions. The temporal resolutions 1, 3, 6, 12, 24, and 48 h and the spatial resolutions 8, 11, 25 and 50 km are investigated. For the period 1991 to 2010, the performance of the RCMs is evaluated against two observational datasets: a network of high-resolution rain gauges operated by the Water Pollution Committee of the Society of Danish Engineers and the Danish Meteorological Institute (DMI), usually referred to as the SVK dataset, and the gridded observational dataset Climate Grid Denmark (CGD).

The performance and changes projected in the spatial pattern and the area average Intensity-Duration-Frequency (IDF) curves for 2, 10, and 100 years return periods are evaluated over Denmark. The Partial Duration Series (PDS) methodology is used to extract extreme value series. A threshold corresponding to an average of three annual exceedances is applied. The Generalized Pareto Distribution (GPD) is fitted to the extreme value series using the L-moment approach. In accordance with the approach of Madsen et. al. (2002), we assume a constant regional shape parameter in the GPD over Denmark.

The results show that the RCMs at lower spatial resolution (25 and 50 km) perform similarly to the RCMs at higher spatial resolution (8 and 11 km) at low temporal resolutions, but worse at higher temporal resolutions (see Figure 1). At daily resolution the mean extreme event and shape parameter of the GPD reveals that all the RCMs perform similarly. At hourly resolution the representation of the mean extreme event increases for increasing spatial resolution of the RCMs. In addition, the physical parameterisation of the RCM leads, in general, to more skewed extreme value distributions than the observational dataset for hourly extreme precipitation. This leads to an overestimation of hourly extreme precipitation by the RCMs at 8 and 11 km, which are the models in the so-called grey zone. The biases in the spatial pattern of extreme precipitation change across temporal and spatial resolution.

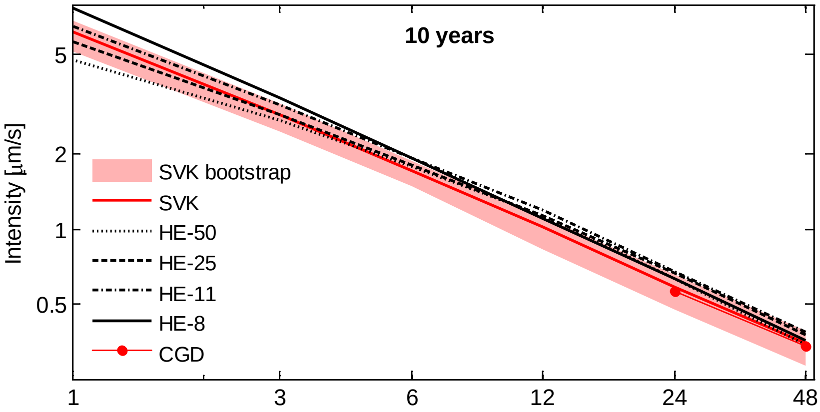


Fig 1: IDF for the 10 years event. Area Reduction Factors (ARF) have been applied to the RCMs to "downscale" the T-year event to point estimates. The shaded area shows the spectrum covered by all the bootstrapping samples from the SVK stations. All the results represent the area average intensity over Denmark.

The changes projected by the RCMs for the period 2081 to 2100 compared to the period 1991 to 2010 depend on the spatial and temporal resolution. The RCMs disagree on the magnitude and spatial pattern of the changes. However, there is agreement on higher changes for higher temporal and spatial resolution (see Figure 2).

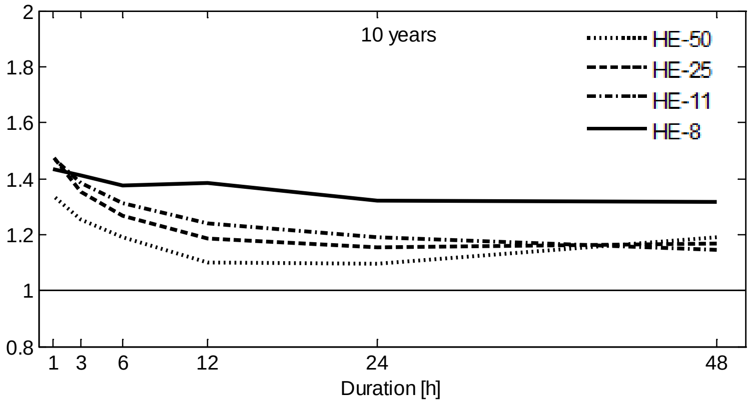


Fig 2: Area averaged changes for the 10 years event estimated from the RCMs for different temporal resolutions.

Overall, the results from this study show that the biases of the RCMs increase and the projected changes decrease for decreasing spatial resolution of the RCMs. This highlights the importance of the spatial resolution of the RCMs and points towards the need for high spatial and temporal resolution RCMs to obtain reliable information on changes in sub-daily extreme precipitation.

## References

Kendon, E. J., Roberts, N. M., Fowler, H. J., Roberts, M. J., Chan, S. C., and Senior, C. A. (2014), Heavier summer downpours with climate change revealed by weather forecast resolution model, Nat. Clim. Chang., 4(7), 570–576, doi:10.1038/nclimate2258.

Madsen, H., Mikkelsen, P. S., Rosbjerg, D., and Harremoës, P. (2002), Regional estimation of rainfall intensity-duration-frequency curves using generalized least squares regression of partial duration series statistics, Water Resour. Res., 38(11), 1239, doi:10.1029/2001WR001125.