EGU2020-7007, updated on 04 Jul 2022
https://doi.org/10.5194/egusphere-egu2020-7007
EGU General Assembly 2020

Short-duration rainfall extremes in very high-resolution climate projections: historical evaluation and future projections

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In general terms, climate adaptation in cities is highly complicated by the very high required spatial and temporal resolution. The high resolution is needed to capture both the full variability of small-scale high-impact weather phenomena and the associated response from the mosaic of land uses and buildings in urban environments. Most commonly available climate model simulations and projections are too spatially coarse (≥10 km) for a proper assessment of many important urban climate impacts.

In terms of water-related impacts, a key issue concerns the reproduction of local short-duration rainfall extremes (cloudbursts) that may cause pluvial flooding. An accurate reproduction of the convective generation of such extremes requires a spatial resolution of at least 5 km, preferably even higher, in convection-permitting regional climate models (CPRCM). Conceivably, estimates of future changes in cloudburst characteristics and associated statistics based on CPRCM simulations will be more reliable than today's estimates based on non-CP RCMs. Because of the extreme computational demand, however, the number of CPRCM simulations made is still rather low and generally limited to small domains and/or short time slices.

But many efforts are currently being made in this direction and the main focus of this presentation will be a case study evaluation of hourly rainfall extremes from 3×3 km² convection-permitting simulations with the HARMONIE-climate model over the Nordic region. The case study will focus on the region around the Öresund strait, that connects southern Sweden and eastern Denmark. This region contains the cities Malmö and Copenhagen that were both hit by heavy cloudburst in the last decade, that caused severe flooding and substantial damage to infrastructure.

The presentation will include different aspects of the simulations and their applicability:

- *Historical performance.* Evaluation of reference period simulations, with both ERA-Interim and GCM boundaries, against high-resolution observations, focusing at the reproduction of short-duration (sub-daily) extremes but also e.g. diurnal cycle and spatial variability.
- *Future changes.* Assessment in terms of climate factors for different durations, return periods and future time horizons. A comparison is made with climate factors estimated from lower-

resolution, non-convection permitting downscalings based on the same GCM projections.
- *End-user practices.* A discussion of what resolution that is needed in order to meet different stakeholders' needs in the light of climate adaptation. The key question is how the output from CPRCM simulations can be processed and interpreted to provide an added value.

Besides the above analyses, two additional related investigations will be presented:

- Lessons learnt from experiments of tailored "urban downscaling" of climate projections down to 1×1 km² and 15 min over selected European urban regions (Stockholm, Bologna, Amsterdam) performed in the Urban SIS project.
- An evaluation of hourly rainfall extremes over selected European countries in a 11×11 km² EURO-CORDEX ensemble, including spatial patterns and temperature scaling of the estimated future changes.