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

Jonas Olsson[1], Johanna Sörensen[2], Yiheng Du[2], Dong An[2], Peter Berg[1], Erika Toivonen[3], Danijel Belusic[1]

[1]Swedish Meteorolgical and Hydrological Institute
[2]Lund University
[3]Finnish Meteorological Institute

contact: jonas.olsson@smhi.se

Message

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- Local short-duration rainfall extremes in southernmost Sweden appear well reproduced by a high-resolution convection-permitting RCM (HARMONIE-AROME)

- Also general features (spatial distribution, annual cycle) of the precipitation in the region are overall well reproduced by the RCM

- Preliminary climate factors from the RCM are lower than the factors currently used

Overview

- We perform a case study evaluation of 15-min rainfall extremes from 3×3 km² convection-permitting simulations with the HARMONIE-AROME climate model over the Nordic region. The case study focuses 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.

- Selected representative results shown on the following slides include:
  - ✓ Historical performance. Evaluation of reference period simulations, with ERA-Interim boundary, 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.

Material: rainfall data

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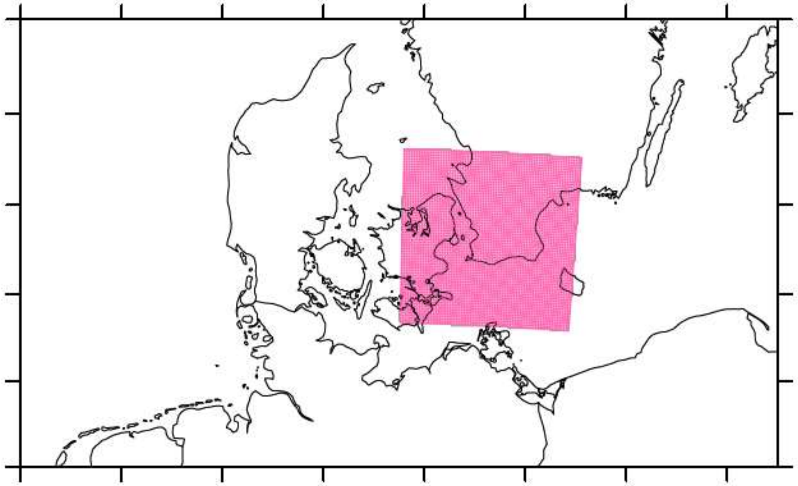
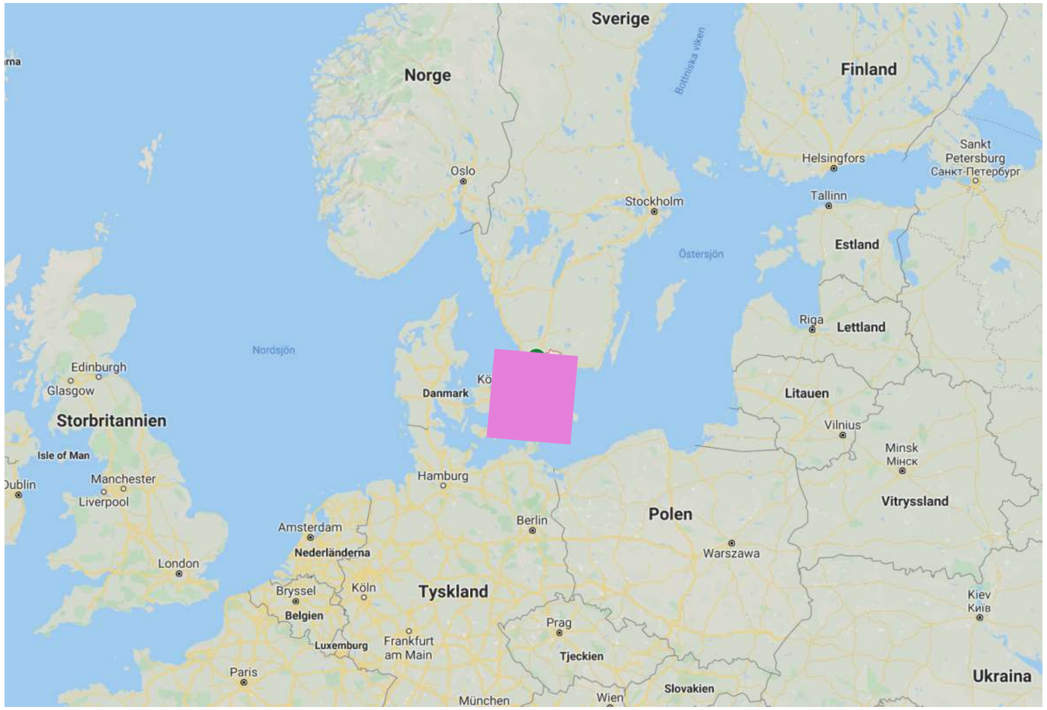
- RCM: High-resolution (15 min, 3 km) simulations by the HARMONIE-AROME climate model with boundaries ERA-interim (1998-2018) and the GCM EC-EARTH RCP85 (1985-2005, 2040-2060, 2080-2100)
- Observations: Time series from high-resolution gauges as well as gridded daily fields in period 1998-2018
- Domain:

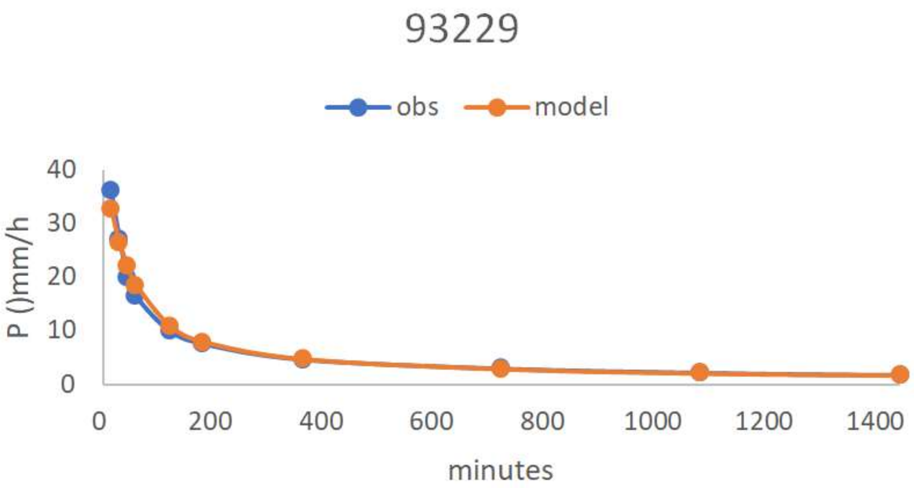


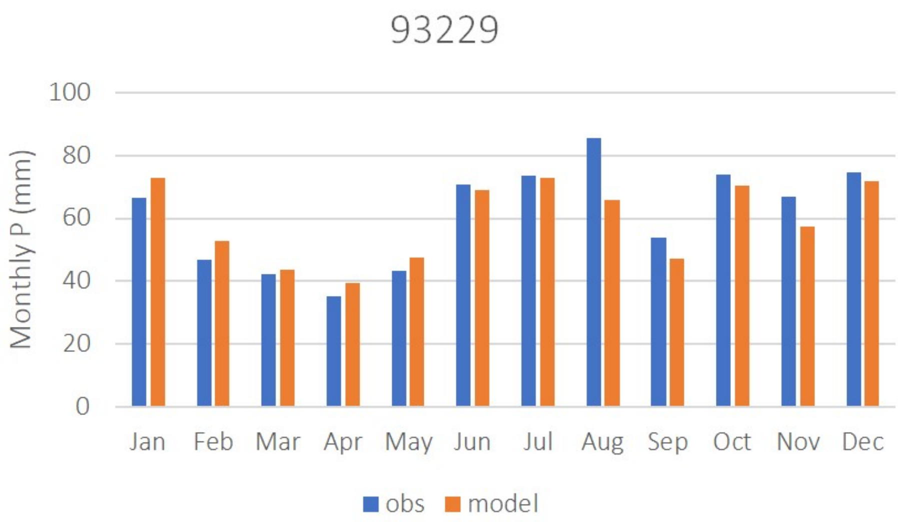


Results: annual maximum and cycle

Average annual maximum (left) and cycle (right) 1998-2018

- obs: gauge in the central part of the domain
- model: HARMONIE-AROME in grid cell covering the station

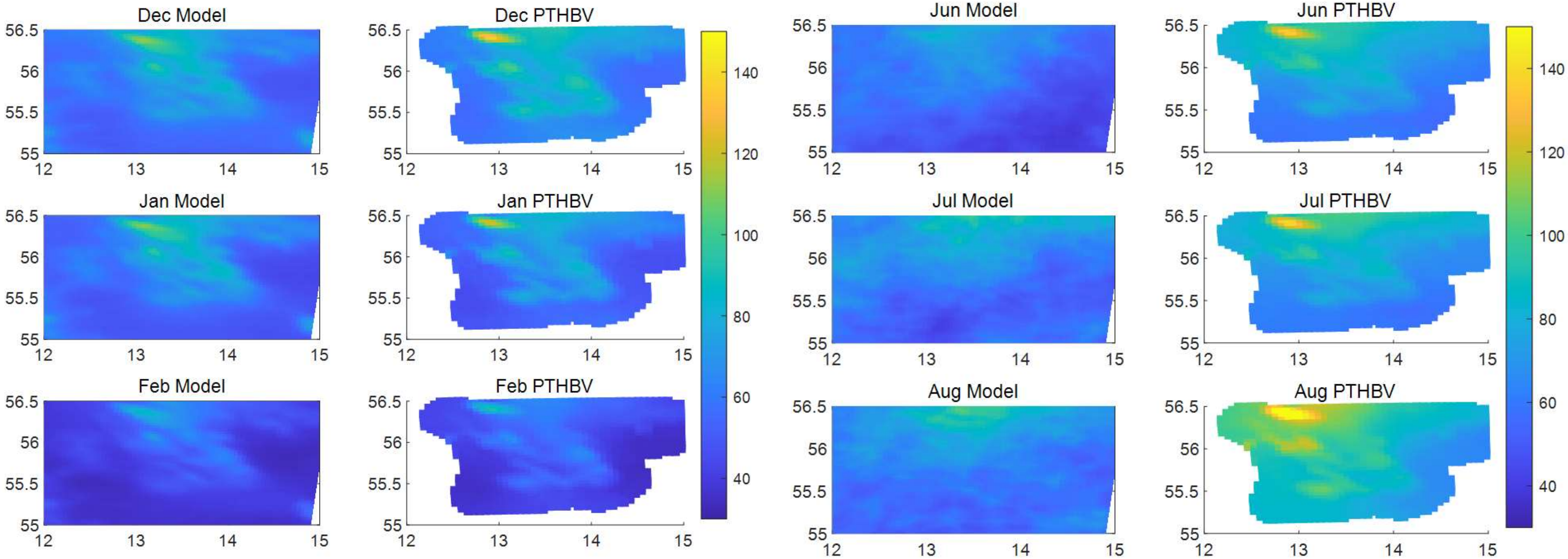




Results: spatial distribution

Spatial distribution in winter (left) and summer (right) 1998-2018

- PTHBV: gridded daily observations
- Model: HARMONIE-AROME



Results: climate factors

Climate factors

- Climate factors represent the future relative increase in short-duration rainfall extremes (increase 10% = climate factor 1.1)
- The ”best estimate” below is based on an ensemble of 12 km EURO-CORDEX projections*
- These results are from only a sub-domain and thus highly uncertain; more comprehensive analysis is underway

	2041-2060	*2081-2100*
HARMONIE-AROME	1.0	1.25
	2041-2070	*2071-2100*
Current ”best estimate”	1.2	1.35

*Olsson, J., Berg, P., Eronn, A., Simonsson, L., Södling, J., Wern, L., and W. Yang (2017) Extreme rainfall in present and future climate, SMHI Climatology No 47, SMHI, 601 76 Norrköping, Sweden, 82 pp (in Swedish).

Summary

- Average annual short-duration maxima are well reproduced by the RCM, with only slight underestimation at the shortest durations
- The average annual cycle is well reproduced, although winter precipitation is somewhat overestimated and summer precipitation underestimated by the RCM
- The spatial pattern is well reproduced by the RCMin winter but in summer the pattern is excessively smooth in the model
- Preliminary climate factors estimated from the RCM is lower than the factors currently used
- More comprehensive analysis is being performed and will be reported elsewhere

PS Bonus material: some highly recommended papers are shown on the following slides ☺ →

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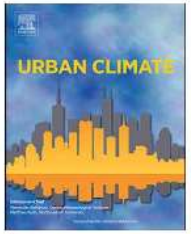

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Towards climate services for European cities: Lessons learnt from the Copernicus project Urban SIS

Lars Gidhagen[a], Jonas Olsson[a,*], Jorge H. Amorim[a], Christian Asker[a], Danijel Belusic[a], Ana C. Carvalho[a], Magnuz Engardt[b], Yeshewatesfa Hundecha[a], Heiner Körnich[a], Petter Lind[a], David Lindstedt[a], Esbjörn Olsson[a], Jörgen Rosberg[a], David Segersson[a], Lena Strömbäck[a]

[a] Swedish Meteorological and Hydrological Institute, SMHI FoUh, 601 76 Norrköping, Sweden
[b] Environmental and Health Administration, Box 8136, 104 20, Stockholm, Sweden

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ABSTRACT

The growing share of Europe's population living in cities makes urban climate change impact assessment and adaptation a critical issue. The urban environment is characterized by its sensitivity to small-scale meteorological, hydrological and environmental processes. These are generally not fully described in climate models, largely because of the models' insufficient spatial resolution. The Urban SIS climate service offers historical and future simulated data downscaled to 1 km × 1 km resolution over selected European metropolitan areas. The downscaled data are subsequently used as input to air quality and hydrological impact models, all made available to users as Essential Climate Variables and Sectoral Impact Indicators through a web portal. This paper presents the Urban SIS climate service and demonstrates its functionality in a case study in Stockholm city, Sweden. Good model performance was attained for intra-city temperature gradients and small-scale precipitation extremes. Less positive results were obtained for large-scale precipitation and hydrology, mainly due to an insufficient domain size in the meteorological and climate modelling, in turn related to the substantial computational requirements. An uncertainty classification approach was developed to aid the interpretation and user application of the data. We hope our lessons learnt will support future efforts in this direction.

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Summertime precipitation extremes in a EURO-CORDEX 0.11° ensemble at an hourly resolution

Peter Berg[1], Ole B. Christensen[2], Katharina Klehmet[1], Geert Lenderink[3], Jonas Olsson[1], Claas Teichmann[4], and Wei Yang[1]

[1]Swedish Meteorological and Hydrological Institute, Folkborgsvägen 17, 610 76 Norrköping, Sweden
[2]Danish Meteorological Institute, Lyngbyvej 100, 2100 Copenhagen, Denmark
[3]KNMI Royal Netherlands Meteorological Institute, Utrechtseweg 297, 3731 GA De Bilt, the Netherlands
[4]Climate Service Center Germany (GERICS), Helmholtz-Zentrum Geesthacht, Fischertwiete 1, 20095 Hamburg, Germany

Correspondence: Peter Berg (peter.berg@smhi.se)

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Abstract. Regional climate model simulations have routinely been applied to assess changes in precipitation extremes at daily time steps. However, shorter sub-daily extremes have not received as much attention. This is likely because of the limited availability of high temporal resolution data, both for observations and for model outputs. Here, summertime depth duration frequencies of a subset of the EURO-CORDEX 0.11° ensemble are evaluated with observations for several European countries for durations of 1 to 12 h. Most of the model simulations strongly underestimate 10-year depths for durations up to a few hours but perform better at longer durations. The spatial patterns over Germany are reproduced at least partly at a 12 h duration, but all models fail at shorter durations. Projected changes are assessed by relating relative depth changes to mean temperature changes. A strong relationship with temperature is found across different subregions of Europe, emission scenarios and future time periods. However, the scaling varies considerably between different combinations of global and regional climate models, with a spread in scaling of around 1–10 % K^{-1} at a 12 h duration and generally higher values at shorter durations.