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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Precipitation extremes in a EURO-CORDEX 0.11° ensemble at hourly resolution" *by* Peter Berg et al.

Peter Berg et al.

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We appreciate very much the comments and suggestions, as well as the time and energy spent in reviewing our manuscript. Below are answers to all items raised.

The manuscript of Berg et al. provides a comparison between regional climate model outputs of precipitation and high-resolution observational datasets in Sweden, Germany, Austria, Netherland and France. Overall, the manuscript is well written, the objectives are clear and the results support the goals of the study. Yet, I am puzzled with this submission since to my opinion it does not bring new results. Indeed, the conclusion can be found in the introduction, page 2, line 13-19: "However, RCMs and GCMs

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have shown severe problems with their sub-grid scale parametrisations of convective processes, which affect their ability to reproduce, e.g., the diurnal cycle of rainfall intensity (Trenberth et al., 2003; Fosser et al., 2015; Prein et al., 2015), the peak storm intensities (Kendon et al., 2014), and extreme hourly intensities (Hanel and Buishand, 2010). It is therefore questionable to which extent suchRCMs are capable of describing cloudbursts in present as well as in future climate" Indeed, it is well known that the current generation of CORDEX RCMs includes a convective scheme that is not able to reproduce adequately the small-scale high-intensity rainfall events. Beranová et al. (2018) evaluated the hourly outputs of RCMs and projections for short duration's rainfall have been provided by KyselÃÂą et al. (2012), among others. This is the reason why regional climate models that explicitly reproduce convection are being developed, there is a huge amount of literature presenting this new generation of climate models, see for instance Coppola et al. 2018 or Berthoux et al. 2018 (I believe both should be cited in the text). However, I agree as stated by the authors page 3, line 1 that the convection-permitting simulations are still not widely available, unlike EuroCordex runs. Yet, when reading the manuscript it seems that these convection-permitting simulations are still not available for research purpose, when several studies have already been produced with these types of model (see Berthoux et al. 2018, Reszler et al. 2018). It can be somewhat misleading to the reader not familiar with climate models.

We agree on many of the raised points; there are earlier studies that have addressed deficiencies in the sub-daily precipitation of parameterized models for different regions and statistics, and the reviewer provides references to additional studies that will be included in the revised version. What separates the current study from earlier ones is (i) the novel method of evaluation with national data sets of extreme precipitation statistics, (ii) the spatial analysis for part of the data sets in (i), (iii) a larger set of state-of-the-art paramaterized RCMs with intercomparison of the models, (iv) identification of which time-scales (duration) that are better captured with these models and can with high confidence be used for climate change assessments, and (v) analysis of the sensitivity to a changing

climate. Points (i), (ii), (iv) and (v) are readily applicable to future evaluations of convection permitting simulations.

We believe that these points are already well described in the current manuscript, as also noted by other reviewers. We will clarify the point about the convection permitting simulations being available in the research community, and include the suggested references.

Specific comments: Since the study focuses on the summer season, the title should say it. In various regions such as south France, the maximum intensity events are occurring in the autumn, not during summer.

That is a very good point. We do not have the resources to redo our analysis for this paper since the calculation are quite time consuming, but will mention this unfortunate cut-off for the Mediterranean climate in the revised manuscript. Thank you for the references which we will also include.

Page 4, line 6: Rajczak and Shär 2017 analyzed daily model outputs

The line does states that: "Rajczak and Shär (2017) analysed heavy and extreme daily precipitation intensity..."

Page 3 section 2.1: it should be clearly stated here that the 9 simulations all include a parametrized convection scheme.

We will add this in the manuscript to make this very clear.

Page 13, lines 9: it is not clear which threshold is used in the GP model for future time periods. As explained page 7, lines 7-14, a precipitation threshold is defined for each grid point to have 3 events on average per year. Which value is used for the future time period? the threshold value yielding 3 events per year in present climate ? The authors should provide, at least in the text, the ranges of threshold values obtained for the different grid points/regions.

We treat the different time periods separately, so the threshold is unique for each time-slice and therefore also different for historical and future projections. At 1h duration the thresholds range from about 1 to 30 mm/h across land regions of Europe and across all models for the historical period, with domain median values of about 3 to 7 mm/h. The largest changes are towards the end of the century in RCP8.5 where the domain median values increase by between 13 and almost 50% across the models. At 12h duration, the thresholds range from about 0.5 to 10 mm/h and medians between 1.4 to 1.8 mm/h. The change under RCP8.5 range from 14 to almost 50%, similar to the 1h duration. We will include this information in a comprehensible way in the revised text.

Page 15, line 13-15: it is very good that the authors talk about data availability in the discussion. It should be stressed also that the different data sets they used are probably not homogeneous at all: some rely on observed precipitation, some rely on a mixture of observed precipitation and simulations from a climate model (Germany) and some rely on a weather generator (France). Further work should try to homogenize these data sets prior to the evaluation of climate models, or the discrepancies between data set could induce an artificial bias in the evaluations. Due to different sources of data, is it very likely that the spatial patterns of the different datasets cannot be compared in a robust way.

We agree, and already touch upon this in the discussion in Section 5, but will explicitly mention the issue of homogeneity between methodologies to allow more direct comparisons.

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