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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Downscaling future precipitation extremes to urban hydrology scales using a spatio-temporal Neyman–Scott weather generator" *by* H. J. D. Sørup et al.

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We very much appreciate the thorough review that has been performed of our manuscript and we will as well as possible answer the questions raised. We acknowledge that the focus and extent of the study is ambitious, and obtaining the fine balance in the manuscript where the right amount of details is reported to make "everything add up" without overloading the reader with details of minor relevance has been a difficult exercise.

Page C1063, first paragraph: As is mentioned the study very much depends on hourly

RCM data and the use of a weather generator is exactly chosen to be less dependent on the RCM's bias and fit to present observations. The two ENSEMBLES data sets used in hourly resolution are obtained through direct contact to the groups who produced them: the RACMO-ECHAM through KNMI as mentioned in the acknowledgements and the HIRHAM-ECHAM through DMI who is co-authoring the paper. This last point will be added to the acknowledgements. The four high resolution RCMs come out of a research project and Mayer et al. (2015) is indeed only the validation of the reference runs against observations. However, this reference is used, as it is the same models with the same configurations and grids which are run under the two RCP scenarios used in the present study.

Page C1063, first paragraph: We will add a small discussion to the manuscript on the reliability of hourly RCM data along with a discussion of the use of change factors to be less dependent on this reliability.

Page C1063, second paragraph: The paper's focus on extremes and their change in the future is indeed important and validation of methods also. The weather generator as such, as well as the individual measures used to describe the extremes, are all validated in literature as referenced in the manuscript. For the novelty of using the weather generator with abundant data on very small scale we lack instruments for thorough validation. As the observational data set is very unevenly distributed and lacks data in many points for extensive periods we do not expect the weather generator data and the observational data to fit each other perfectly. What we expect is merely an approximate fit (but for the parameters, not only the average rainfall). Thus, we do not expect that a Kolmogorov-Smirnov test (or the like) would give any positive result if applied on any of the points in the model as we do not expect the extremes to happen at the exact same spatial locations as in the original data set.

Page C1063, second paragraph and page 1065 fourth paragraph: We acknowledge that Figure 5 does not provide enough information to discuss the fit of the model and will replace it with a figure showing the density plots of the normalized errors for the

different parameters, to highlight that the density is higher near the 1:1 line of the present Figure 5 and to guide the discussion on how accurate (unbiased) the model is and on how large the variance therefore is.

Page C1063, second paragraph and page 1065, comment starting with 2576, 11: With respect to Figure 6 it was not convincing that the model is site specific. Again, the differences between the observational data set and the weather generator output should result in differences and Figure 6 shows that we have the same trends. Also, here we lack rigorous statistics to describe what would constitute an adequate fit given the above mentioned differences in the data set and expectations.

This study is very much a proof of concept of the fact that we are able to use a weather generator for a purpose it was not developed for in an area where we need methods to generate finer resolution time series data for possible future climates. Answers to the more specific questions.

Page C1063, second last paragraph: Whether the manuscript would have been better told in two parts is not a discussion we want to open up at this stage. We believe that the scientific value of having it all together serves a purpose and, hence, we have collected the results into the present manuscript.

Page C1063, last paragraph: Applying change factors directly to time series is definitely an easy solution but also a solution, which we believe will result in unrealistic time series, as we know that the mean changes and changes to extremes are not necessarily the same. Especially in the summer months we expect less rainfall on average but an increase in the extreme amounts and independently on the change factor relationship chosen, this would result in either too much rainfall in total or too small extremes in general. The weather generator methodology is an approach adopted in an attempt to overcome these issues and produce time series that are realistic in more aspects than just extremes or just mean rainfall.

Page C1064, second paragraph: The term “change factor” is indeed used ambiguously

in the manuscript, and we will change on of the uses for something just as appropriate. Page C1064, third paragraph: The naming of the weather generator in the manuscript is interesting. As we see it the fact that it is a (ST)NSRP weather generator is important and described in the methodology but the same kind of study could just as well have been carried out with other spatio-temporal weather generators where relevant properties of rainfall are described and thus we believe that the generic WG for weather generator is well justified as naming convention in the manuscript.

Page C1064, fourth paragraph: The observational data are treated as stationary in this manuscript and no climate trend is identified within the observational period for this study event though there could potentially be one as pointed out by Gregersen et al (2013). We do not believe that this causes any major effects on the resulting model, as the area is very homogeneous with respect to the input data.

Page C1064, line starting with 2568, 7 and 2571, 3 and 4: We will change the manuscript order to avoid discussions on aspects that are not presented adequately beforehand. Page C1064, line starting with 2567 and 2571, 5: The core components of the weather generator and the calculations of appropriate change factors have been developed by the Newcastle group (Burton et al.) and as such we do not wish to reproduce their findings here. The first issue is really well described in several papers and will be thoroughly referenced to guide the reader for the best places to obtain this information. The second issue is described in another Burton et al. (2010) paper than the one referenced, hence the confusion; this will be corrected in the manuscript.

Page C1064, line starting with 2570, 21: We will add a section discussing the calibration and simulation times of the WG. In general the calibration can be cumbersome, but the simulation is very swift (even though the actual “writing to text files” part can take time if many hundreds of points are included in the simulation).

Page C1064, line starting with 2568, 12: Whether intensity and duration are correlated in general is an interesting issue that we do not discuss in this manuscript. However,

IDF curves do not say anything about the actual event lengths and about their mean intensities. A 1 hour maximum value might well originate in a much longer event where the 3 or 6 hour maximum values were not extreme. And on the rain cell level where the weather generator operates the picture is even more unclear, particular since the extremes are the product of multiple cells overlapping in time and space. Hence, it is not a discussion we believe will enhance the manuscript and we do not plan to incorporate it in the manuscript.

Page C1064, line starting with 2568, 25: As the CGD data set is only used to compute monthly means for the application area we believe that the length of data is not a problem for this study.

Page C1065, line starting with 2574, 1: The unconditional spatial correlation is thoroughly described in Mikkelsen et al. (1996). The word 'unconditional' reflects that the methodology takes into account that the events at the compared stations are actually happening at the same time and that all the events registered at times where both stations were working but only registered at one station are also weighed into the correlation.

Page C1065, line starting with 2575, 6: The fitting is a bit unstable but within small realistic bounds and mostly for the parameter that controls the time at which the first cell arrives after a storm is initiated. All the results show that cells arrive more or less immediately after the start of the event. The results between different realizations of the weather generator (WG1-10) show clearly that this fitting behaviour does not influence the results to any extent.

Page C1065, line starting with 2577, 1: The 100 year event shown in Figure 7 is a product of an extrapolation of data using a PDS approach and a GPD model. As such there is no direct link to the discrepancies observed in Figure 5 and as we will replace Figure 5 with a more appropriate one this picture should be clearer with the new Figure 5.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 2561, 2015.