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Use of a Neyman-Scott Rectangular Pulses model for downscaling extreme events for climate change projections

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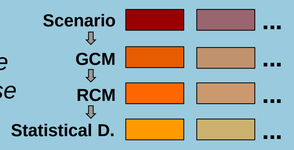
Introduction

In recent years, Weather Generators (WG) have been used in climate change impact studies as a statistical downscaling tool. The Neyman-Scott Rectangular pulses is probably one of the most comprehensive WGs that can be tuned to put emphasis on extreme events.

This study analyses the ability of the NSRP for extreme events and its use as statistical downscaling tool.



Data and Case study

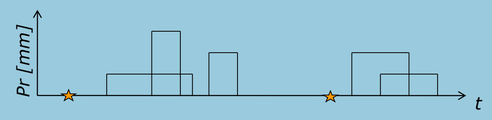
A location in Aarhus (Denmark) has been selected as a case study.

Data used in the analysis:

- Observed daily rainfall for 1981-2010.
- Daily rainfall from 20 RCMs from ENSEMBLES1 from 1951-2100.

Neyman-Scott Rectangular Pulses

This WG is based on a clustering approach, where rainfall is associated with clusters of rain cells making up storm events. The NSRP WG model implemented in the RainSim[2] software has been used in this study.



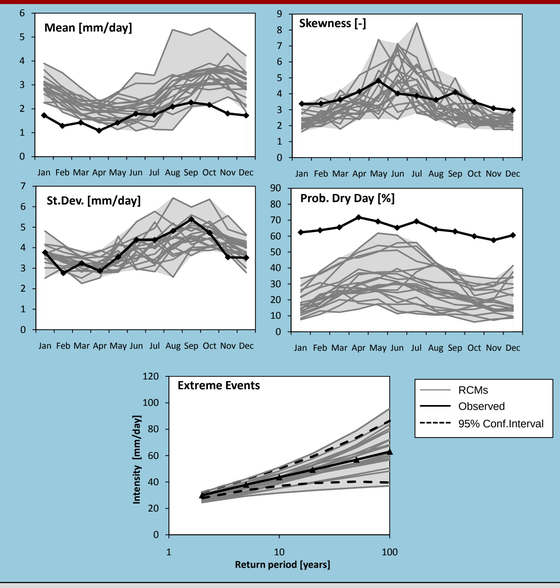
1) Use of NSRP for current climate:

- Statistics form the observed data are used to simulate synthetic time series.

2) Use of NSRP for future climate conditions:

- Statistics for the future climate are estimated using change factors (change of one statistic from the control to the future scenario using the information contained in the RCM).
- The statistics estimated for the future are used to generate synthetic time series.

Current climate – Observations vs. RCMs

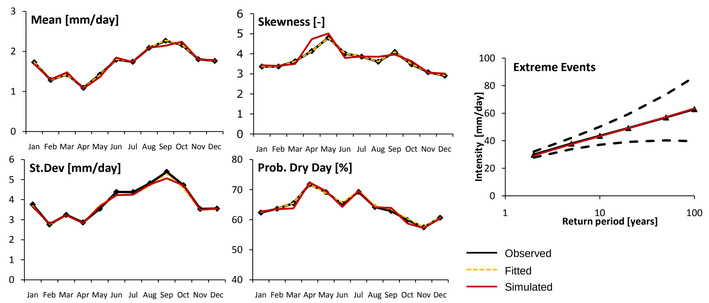


1) NSRP – Current climate

- Observed daily statistics were used to calibrate the NSRP model. During the calibration weights were assigned to each statistic. 1000 years were simulated.

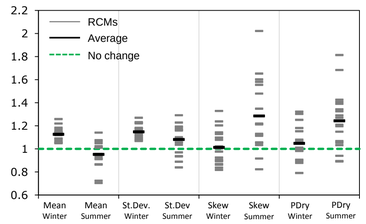
Statistic	Thr. / lag time	Weight
Mean	-	6
St.Dev	-	1
Skewness	-	6
Prob. Dry day	0.2mm	7
Autocorrelation	1	6

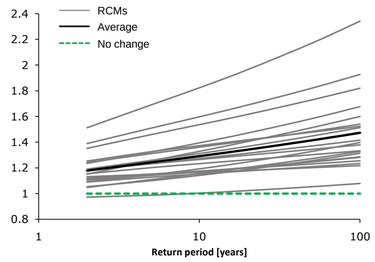
- Statistics from the simulated time series and the extreme events were compared.



2) NSRP – Future climate (2071-2100)

- Firstly, change factors were calculated.
- The same set of statistics and weights as in the use of NSRP for current climate were used to calibrate the WG. 1000 years were simulated.
- The change in extreme events was then estimated using the synthetic time series for the future and current climate.





Conclusions

- RCM projections cannot be used directly in climate change impact studies → Need for statistical downscaling.
- NSRP is able to reproduce adequately observed extreme events.
- Large uncertainty in changes projected by the RCMs, especially in skewness and probability of dry days.
- All RCMs considered in this study point to an increase of extreme events in the future (2071-2100) for this region.
- However, there is large uncertainty in the value of the change, the uncertainty increases for large return periods.

References

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(2) Burton, A., Kilsby, C.G., Fowler, H.J., Cowpertwait, P.S.P., O"Connell, P.E., 2008. RainSim: A spatial-temporal stochastic rainfall modelling system. Environmental Modelling & Software 23, 1356-1369.