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Effects of climate model interdependency and common biases on the uncertainty quantification of extreme rainfall projections

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Climate change impact studies are subject to numerous uncertainties and assumptions. One of the main sources of uncertainty arises from the inherent uncertainty in climate models. Probabilistic procedures based on multi-model ensembles have been suggested in the literature to quantify this uncertainty. However, there are still several challenges in combining multi-model ensembles, e.g. limited number of models, lack of agreement on what is a good model, interdependency of climate projections. Additionally, climate change impact studies often assume that the changes in climate model biases are negligible. This assumption is often used in statistical downscaling methods, and it is rarely validated.

This study investigates the effects of model interdependency and changes in biases on the uncertainty quantification of extreme rainfall projections in Denmark. An ensemble of regional climate models from the ENSEMBLES project is used for this purpose. A Bayesian framework has been developed to quantify the uncertainty in climate model projections. This framework takes into account both the climate model interdependency and the common biases. The interdependency is estimated following an approach based on the eigenanalysis of the climate model errors previously suggested in the literature.

The results show that the climate model projections cannot be considered independent. The information content in the 15-model ensemble analysed may correspond to as little as 5 equivalent independent climate models, depending on the statistic considered. Thus, if the models are assumed independent, the overall uncertainty of ensemble projections will be significantly underestimated. We are currently studying the impacts on the uncertainty of different assumptions of model bias. This study highlights the importance of investigating the underlying assumptions in climate change impact studies, as these may have serious consequences in the design of climate change adaptation strategies.