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Changing precipitation in western Europe, climate change or natural variability?

Emma Aalbers (1,2), Geert Lenderink (1), Erik van Meijgaard (1), Bart van den Hurk (1,2)

(1) Royal Netherlands Meteorological Institute (KNMI), De Bilt, Netherlands (emma.aalbers@knmi.nl), (2) Institute for Environmental Studies, VU University Amsterdam, the Netherlands

Multi-model RCM-GCM ensembles provide high resolution climate projections, valuable for among others climate impact assessment studies. While the application of multiple models (both GCMs and RCMs) provides a certain robustness with respect to model uncertainty, the interpretation of differences between ensemble members – the combined result of model uncertainty and natural variability of the climate system – is not straightforward.

Natural variability is intrinsic to the climate system, and a potentially large source of uncertainty in climate change projections, especially for projections on the local to regional scale. To quantify the natural variability and get a robust estimate of the forced climate change response (given a certain model and forcing scenario), large ensembles of climate model simulations of the same model provide essential information. While for global climate models (GCMs) a number of such large single model ensembles exists and have been analyzed, for regional climate models (RCMs) the number and size of single model ensembles is limited, and the predictability of the forced climate response at the local to regional scale is still rather uncertain.

We present a regional downscaling of a 16-member single model ensemble over western Europe and the Alps at a resolution of 0.11 degrees (∼12km), similar to the highest resolution EURO-CORDEX simulations. This 16-member ensemble was generated by the GCM EC-EARTH, which was downscaled with the RCM RACMO for the period 1951-2100.

This single model ensemble has been investigated in terms of the ensemble mean response (our estimate of the forced climate response), as well as the difference between the ensemble members, which measures natural variability. We focus on the response in seasonal mean and extreme precipitation (seasonal maxima and extremes with a return period up to 20 years) for the near to far future. For most precipitation indices we can reliably determine the climate change signal, given the applied model chain and forcing scenario. However, the analysis also shows how limited the information in single ensemble members is on the local scale forced climate response, even for high levels of global warming when the forced response has emerged from natural variability.

Analysis and application of multi-model ensembles like EURO-CORDEX should go hand-in-hand with single model ensembles, like the one presented here, to be able to correctly interpret the fine-scale information in terms of a forced signal and random noise due to natural variability.