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Generation of Regional Climate Ensembles Using Atmospheric Forcing Shifting

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One of the main challenges in climate change research is improving knowledge about how regional climates may change in the next decades. Reliable information about changes of the mean climate state and extreme events such as heavy precipitation and dry spells are required for the water and risk management as well as for the development of adaptation and mitigation strategies.

High-resolution ensembles are used to perform studies on the variability and change of regional climate and to assess the uncertainty of regional climate model (RCM) projections. In this study, we present Atmospheric Forcing Shifting (AFS) as an innovative ensemble generation technique and address the question how AFS affects the results of the regional climate simulations. Furthermore, the influence of synoptic conditions on the effect of AFS and the benefit of AFS for the generation of RCM ensembles are discussed.

AFS is realised by introducing small shifts to the atmospheric fields derived from global data (here: ERA40 reanalyses) to each direction by 25 and 50 km, respectively. The shifted fields drive COSMO-CLM simulations for Europe with a horizontal resolution of 50 km. Besides the reference simulation, eight shifting scenarios are included into the RCM ensemble. The effect of AFS on 2m temperature and precipitation is studied for Central Europe and the period from 1980 to 1984. This includes the quantification and validation of the ensemble spread in comparison to the E-OBS dataset and COSMO-CLM simulations driven by different global climate models (GCMs).

The investigation of the mean annual cycle and spatial distribution indicates that the effect of AFS on precipitation is larger and more heterogeneous than on 2m temperature. In summer, the ensemble variability is larger than in winter which is likely to be related to the frequency of synoptic conditions. Furthermore, AFS affects the probability distribution of 2m temperature and precipitation, including their extremes. Consequently, AFS may provide a suitable method to improve the statistics of extreme events.

The next step is to generate an RCM ensemble with a resolution of 7 km for past (1971-2000) and future (2011-2040) decades using AFS and different GCMs. Based on the results, change signals of the mean climate state as well as of the likelihood and variability of extreme events will be determined.