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Comparison of stochastic MOS corrections for GCM and RCM simulated precipitation

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In order to assess to what extent regional climate models (RCMs) yield better representations of climatic states than general circulation models (GCMs) the output of the two model types is usually directly compared with observations and the value added through RCMs has been clearly demonstrated. RCM output is often bias-corrected and in some cases bias correction methods can also be applied to GCMs. The question thus arises what the added value of RCMs in this setup is, i.e. whether bias-corrected RCMs perform better than bias-corrected GCMs.

Here we present some first results from such a comparison.
We used a stochastic Model Output Statistics (MOS) method, which can be seen as a general version of bias correction, to estimate daily precipitation at 465 UK stations between 1961-2000 using simulated precipitation from the $RACMO_2$ and CCLM RCMs and from the ECHAM5 GCM as predictors. The MOS method uses logistic regression to model rainfall occurrence and a Gamma distribution for the wet-day distribution. All model parameters are made linearly dependent on the predictors, i.e. the simulated precipitation. The fitting and validation of the statistical model requires the daily, large-scale weather states in the RCM and GCM to represent the actual, historic weather situation. For the RCMs this is achieved by using simulations driven by reanalysis data; $RACMO_2$ is just driven at the boundaries, whereas in CCLM the circulation within the model domain is additionally kept close to the reanalysis through spectral nudging. For the GCM we have used a simulation nudged towards ERA40. The model validation is done in a cross-validation setup and is based on Brier scores for occurrence and quantile scores for the estimated probability distributions.

The comparison of the validation skills for the two RCM cases shows some improved skill if spectral nudging is used, indicating that on daily timescales RCMs can generate internal variability that needs to be kept in mind when designing and validation downscaling methods. A major outcome of the study is that the corrected GCM-simulated precipitation yields consistently higher validation scores than the corrected RCM-simulated precipitation. Taken at face value this seems to suggest that in a setup where the simulated precipitation is post-processed there is no clear added value of using an RCM. However, due to the different ways of controlling the atmospheric circulation in the RCM and the GCM simulations, such a strong conclusion cannot be drawn. Yet, the study demonstrates how challenging it is to demonstrate the value added by RCMs in this setup.