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Impact of the bias correction and downscaling aspects of quantile mapping on simulated climate change signal: a case study over Central Italy

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Quantile mapping (QM) is a widely used post-processing technique employed to connect climate model simulations to impact studies. This technique relies on transfer functions established on observed and simulated climate variables over a common period (calibration period) and then used to adjust the whole simulation. Depending on the simulation-observation spatial scale mismatch, QM can be used in two different configurations. The first one is to employ only the bias correction (BC) aspect of QM, establishing transfer functions with observations aggregated at the simulation scale. The second configuration includes a statistical downscaling (SD) aspect as well, when the reference (observed) product remains point-scale. Another important issue with QM, and other post-processing techniques, is its impact on the climate change signal (CCS) of a simulation (e.g. statistics difference between 2071-2100 and 1971-2000 periods).

In this work, we compare the alteration of the simulated CCS by QM between the BC and the BC+SD configurations over a study area covering Central Italy. In the BC configuration QM is applied on each member of a five-RCMs ensemble from the ENSEMBLES project (25 km horizontal resolution). Grid-cell-wise correction function is derived from E-OBS observed dataset, having the same resolution of RCMs grid. In the BC+SD configuration, QM is used to adjust and downscale RCMs results (from the former five simulations plus additional three EURO-CORDEX simulations with 12.5 km resolution) towards representative point-wise observational sites belonging to the Marche Region Civil Protection network. In both the configurations, different statistical moments of annual and seasonal temperature and precipitation CCS were assessed before and after the application of a daily-based empirical QM. Further, we studied CCS alteration as a function of the calibration period observed to simulated variance ratio regarded as factor controlling QM tendency of altering original changes. Finally, by using a multi-model ensemble approach, the influence of QM over the inter-model spread of historical and future simulations was investigated.

QM BC configuration is found consistently affecting temperature original CCS mostly in Summer season. The ratio of observed to simulated variance can be regarded as factor significantly controlling QM impact in both the configurations, mainly for the temperature. Finally, in both the configurations, QM strongly reduced temperature inter-model spread in the two temporal segments and only lightly for precipitation.