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Spatial artefacts in distributed quantile-mapped climate scenarios

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The provision of user-friendly and directly applicable climate scenarios is an essential part of climate services, but is challenged by a number of well-known limitations of the underlying climate model data. These limitations especially relate to the coarse resolution (that does often not match the spatial scale required by climate impact assessments) and to systematic biases of the raw model output (which would be inherited by subsequent impact models if not corrected for). Numerous post-processing methodologies have been developed in recent years that transfer coarse-resolved climate model data to finer spatial scales and/or to bias correct raw model data. In the frame of the upcoming generation of Swiss reference climate scenarios (CH2018; www.climate-scenarios.ch) an empirical quantile mapping (QM) approach is employed to provide transient bias-corrected scenarios of several meteorological variables at Swiss stations and on a high-resolution grid based on the EURO-CORDEX regional climate projections.

QM has previously been shown to perform well compared to other downscaling and bias correction approaches. However, certain caveats and limitations remain that both climate scenario providers and climate scenario users need to be aware of. One of these potentially critical issues concerns the modification of the raw climate model's change signal by QM. Such a modification can be meaningful in case of intensity-dependent model biases that would lead to different mean biases in a present-day reference and a future scenario period. Here we present an example for a systematic modification of raw temperature change signals by QM that is strongly connected to the topography of the region of interest. This case potentially reveals a statistical artefact caused by the purely empirical distribution-based correction approach of QM. The systematic modification consists of an elevation-dependent amplification or attenuation of raw climate model temperature changes. It concerns both the station-based QM product and the high-resolution QM-based grid and generally lacks a physical explanation. The interpretation of QM-based climate scenarios in a spatial context is hampered by these artefacts, and elevation-dependent warming signals in QM-based products need to be carefully evaluated.

This contribution presents a summary of the issue, and also discusses potential future adjustments of the QM methodology in order to circumvent the adverse effect on temperature change signals.