Geophysical Research Abstracts
Vol. 17, EGU2015-5500, 2015
EGU General Assembly 2015

Enhancing Local Climate Projections of Precipitation: Assets and Limitations of Quantile Mapping Techniques for Statistical Downscaling

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The Swiss CH2011 scenarios provide a portfolio of climate change scenarios for the region of Switzerland, specifically tailored for use in climate impact research. Although widely applied by a variety of end-users, these scenarios are subject to several limitations related to the underlying delta change methodology. Examples are difficulties to appropriately account for changes in the spatio-temporal variability of meteorological fields and for changes in extreme events. The recently launched ELAPSE project (Enhancing local and regional climate change projections for Switzerland) is connected to the EU COST Action VALUE (www.value-cost.eu) and aims at complementing CH2011 by further scenario products, including a bias-corrected version of daily scenarios at the site scale. For this purpose the well-established empirical quantile mapping (QM) methodology is employed. Here, daily temperature and precipitation output of 15 GCM-RCM model chains of the ENSEMBLES project is downscaled and bias-corrected to match observations at weather stations in Switzerland.

We consider established QM techniques based on all empirical quantiles or linear interpolation between the empirical percentiles. In an attempt to improve the downscaling of extreme precipitation events, we also apply a parametric approximation of the daily precipitation distribution by a dynamically weighted mixture of a Gamma distribution for the bulk and a Pareto distribution for the right tail for the first time in the context of QM. All techniques are evaluated and intercompared in a cross-validation framework. The statistical downscaling substantially improves virtually all considered distributional and temporal characteristics as well as their spatial distribution. The empirical methods have in general very similar performances. The parametric method does not show an improvement over the empirical ones. Critical sites and seasons are highlighted and discussed. Special emphasis is placed on investigating the effect of bias correction on the mutual dependency between daily temperature and precipitation. The downscaling substantially improves the bivariate distribution of the two variables and does not change their temporal dependence as indicated by the Fourier co-spectrum analysis.

This contribution will advise on the assets and limitations of the related scenario products for use in climate impact research in the alpine environment of Switzerland.