Geophysical Research Abstracts
Vol. 14, EGU2012-4264, 2012
EGU General Assembly 2012

Validity of Differently Bias-Corrected Regional Climate Model Simulations for Streamflow Simulations under Changing Climate Conditions

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The direct application of Regional Climate Model (RCM) simulations in hydrological climate-change impact studies can be questionable due to the potential risk for considerable biases. Several bias correction approaches - ranging from simple scaling to rather sophisticated methods - have been developed to help impact modelers coping with the various problems linked to biased RCM output. The main disadvantage of any of these correction procedures is their underlying assumption of stationarity: the correction algorithm and its parameterization for current climate are expected to also be valid for future climate conditions. Whether or not this presupposition is actually fulfilled for future conditions cannot be evaluated - given our lack of time machines. Nevertheless, systematic testing of how well bias correction procedures perform for conditions different from those used for calibration can be done by applying a differential split-sample as proposed by Klemeš ["Operational testing of hydrological simulation models", Hydrological Sciences Journal 31, no. 1 (1986): 13-24].

This contribution summarizes shortly available bias correction methods and demonstrates their application using the example of an ensemble of 11 different RCM-simulated temperature and precipitation series. We then applied a differential split-sample test which enabled us to evaluate the performance of different bias correction procedures under changing climate conditions with only a limited amount of data (30-year records). Furthermore, we evaluated the different correction methods based on their combined influence on hydrological simulations of monthly mean streamflow as well as spring and autumn flood peaks for five meso-scale catchments in Sweden under current (1961-1990) and future (2021-2050) climate conditions.

This differential split-sample test resulted in a large spread and a clear bias for some of the correction methods during validation based on an independent data set. More sophisticated higher-skill correction methods such as 'distribution mapping' performed relatively well also during the validation period, whereas the simpler, and more widely used, 'delta change' and 'linear scaling' approaches resulted in the largest deviations and least reliable projections for changed conditions. Therefore, we question the use of these methods in future climate-change impact studies despite the simplicity in applying them and recommend using higher-skill bias correction methods.