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Evaluation of Bias-Correction Procedures for Adjusting RCM Simulations for Hydrological Impact Studies at the Catchment Scale

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Regional climate models (RCM) are increasingly used in hydrological climate-change impact studies. However, the use of RCM simulations is challenging due to the potential for considerable biases. Several bias-correction methods have been developed to adjust RCM climate variables, ranging from simple scaling approaches to rather sophisticated methods employing probability mapping or weather generators. The basic assumption when applying any of these methods is that the correction algorithm and its parameterization for current climate conditions is also valid for future conditions.

This contribution provides an overview of available bias-correction methods and introduces a new linear approach to correct biases in RCM climate variables. The analysis of these methods was based on simulations of 11 RCMs driven by different global climate models (GCMs). Several bias-correction procedures were used to correct for deviations in the RCM-simulated temperature and precipitation data. We were especially interested in the performance of bias-correction methods for future scenario simulations. Since this cannot be evaluated directly, we used a differential split-sample approach to evaluate the correction methods with respect to future changed conditions. 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.

Improvement of raw RCM temperature and precipitation was achieved with all bias-correction approaches. Most methods were able to correct the daily mean values, but there were clear differences in their ability to correct other statistical properties such as standard deviation or percentiles. The differential split-sample test of the bias-correction methods resulted in a large spread and a clear bias for some of the methods during the validation period. Simulated streamflow characteristics were sensitive to the quality of driving input data and simulations driven with bias-corrected RCM variables had more narrow variability bounds and fitted observed values better than simulations forced with raw-RCM climate variables.