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Geosci. Model Dev., 4, 759-770, 2011
www.geosci-model-dev.net/4/759/2011/
doi:10.5194/gmd-4-759-2011

A pragmatic approach for the downscaling and bias correction of regional climate simulations: evaluation in hydrological modeling

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Abstract. The present study investigates a statistical approach for the downscaling of climate simulations focusing on those meteorological parameters most commonly required as input for climate change impact models (temperature, precipitation, air humidity and wind speed), including the option to correct biases in the climate model simulations. The approach is evaluated by the utilization of a hydrometeorological model chain consisting of (i) the regional climate model MM5 (driven by reanalysis data at the boundaries of the model domain), (ii) the downscaling and model interface SCALMET, and (iii) the physically based hydrological model PROMET. The results of different hydrological model runs set up for the historical period 1971–2000 are compared to discharge recordings at the gauge of the Upper Danube Watershed (Central Europe) on a daily time basis. To avoid "in-sample" evaluation, a cross-validation approach is followed splitting the period in two halves of 15 yr. While one half is utilized to derive the downscaling functions based on spatially distributed observations (e.g. 1971–1985), the other is used for the application of the downscaling functions within the hydrometeorological model chain (e.g. 1986–2000). By alternately using both parts for the generation and the application of the downscaling functions, discharge simulations are generated for the whole period 1971–2000. The comparison of discharge simulations and observations reveals that the presented approaches allow for a more accurate simulation of discharge in the catchment of the Upper Danube Watershed and the considered gauge at the outlet in Achleiten. The correction for subgrid-scale variability is shown to reduce biases in simulated discharge compared to the utilization of bilinear interpolation. Further enhancements in model performance could be achieved by a correction of biases in the RCM data within the downscaling process. These findings apply to the cross-validation experiment as well as to an "in-sample" application, where the whole period 1971–2000 is used for the generation and the application of the downscaling functions. Although the presented downscaling approach strongly improves the performance of the hydrological model, deviations from the observed discharge conditions persist that are not found when driving the hydrological model with spatially distributed meteorological observations.

Citation: Marke, T., Mauser, W., Pfeiffer, A., and Zängl, G.: A pragmatic approach for the downscaling and bias correction of regional climate simulations: evaluation in hydrological modeling, Geosci. Model Dev., 4, 759-770, doi:10.5194/gmd-4-759-2011, 2011.

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Discussion Paper
Published on 08 Jan 2011

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