# Uncertainty aspects of changes in flood hazard in medium size river catchments for the near future


P. Berg[1], D. Düthmann[2], J. Liebert[3], I. Ott[4], and S. Wagner[4]

(1) IMK-TRO, KIT, Karlsruhe, germany, (2) GFZ, Potsdam, Germany, (3) IWG, KIT, Karlsruhe, (4) IMK-IFU, KIT, Garmisch-Partenkirchen, Germany

Contact: Peter Berg (berg@kit.edu)


Karlsruhe Institute of Technology

## Introduction

The project “Flood hazard in a changing climate” (CEDIM-funded) has the goal to assess whether there is a change in the risk for floods in medium and small size river catchments in Germany for the near future. The project is a collaboration between four institutes: IMK-TRO, IMK-IFU, IWG and GFZ.

The aspect of uncertainty is crucial in this kind of risk assessment. Uncertainties arise from several sources, e.g. model construction and set-up, parameter calibration, natural variability and future scenarios to name a few. The ensemble we have constructed will sample at least some of the range of uncertainties to make a statement on the robustness of our results.
**Figure 1** displays a diagram of the ensemble. A set of two GCM simulations (ECHAM5 and CCCma3) have been down-scaled by two different RCMs, namely CCLM and WRF. A double nesting strategy is used for the downscaling of the GCM data to a 7 km spatial resolution, see **Figure 2**. Three different realizations of the ECHAM5 GCM is used to assess natural variability, and the additional simulation with CCCma3 samples uncertainty due to the GCM.

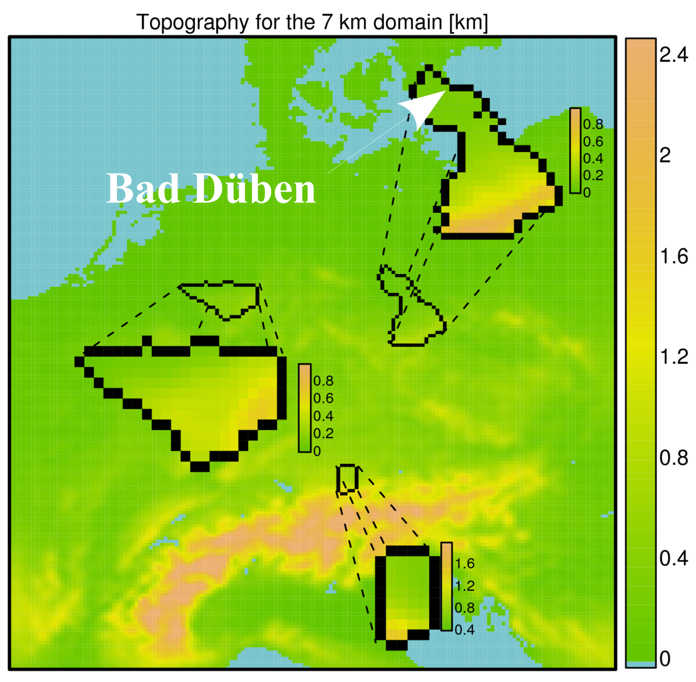


**Figure 2:** RCM 7km domain with the catchments Ruhr (west), Ammer (south) and Mulde (east) emphasized.

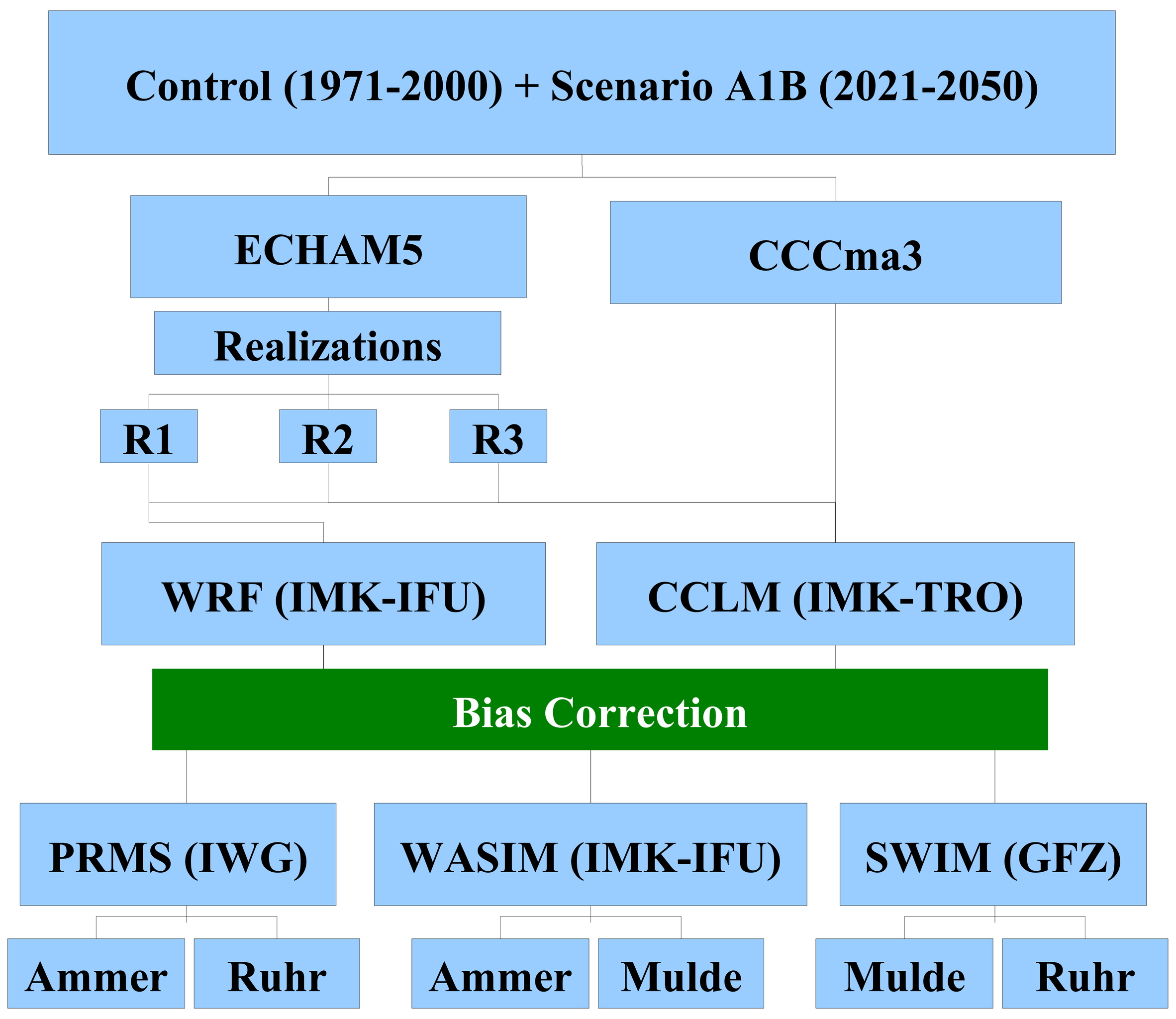


**Figure 1:** Schematic over the ensemble simulation strategy.

## RCM results for Germany

There is a large precipitation bias in most of the RCM simulations for the control period (**Figure3**, left) which shows the need for bias correction. The REMO model [Jacob et al., xxxx] has a significant shift in the precipitation patterns which is not seen in the other two RCMs.

The future precipitation change signal (**Figure 3**, right) varies depending on the RCM, the GCM and the realization used. This emphasizes the importance of using the ensemble method for climate change studies.

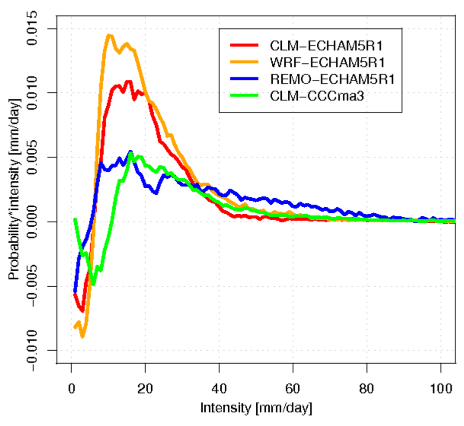


**Figure 4:** Future projected changes for precipitation intensity distribution for different models.

All RCMs and GCMs produce a shift in the precipitation intensity distributions to more extreme behavior (**Figure 4**).

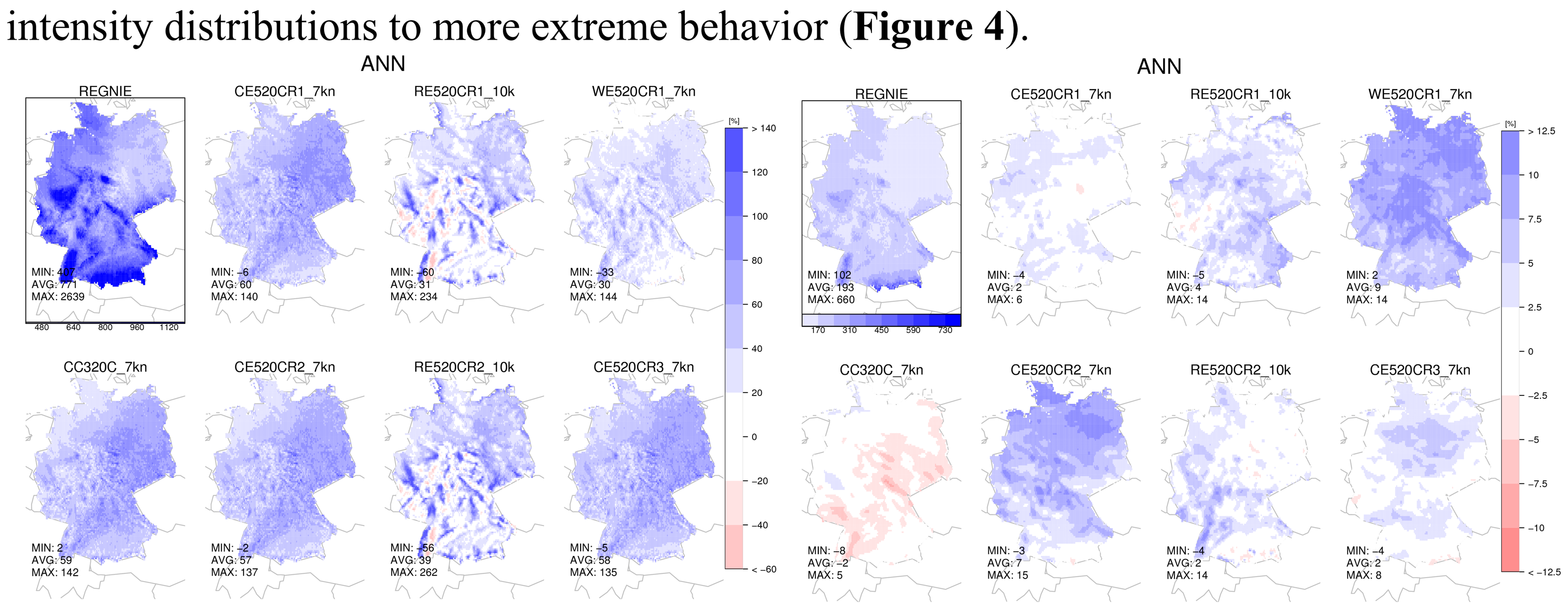


**Figure 3:** Future projected changes for precipitation (left) and temperature (right).

## Hydrological model results for Mulde

The simulated discharge at Bad Düben shows a considerable dependence on the RCM model used for the downscaling, but also on the hydrological model and the realization of the ECHAM5 model used (**Figure 6**). This emphasizes also the importance of enlarging the ensemble at every level of the model chain. Note that the RCM forcing data for these simulations were bias corrected to have the same mean values as the observations, and the differences between the simulations are due to differences in the temporal structure of the time-series.

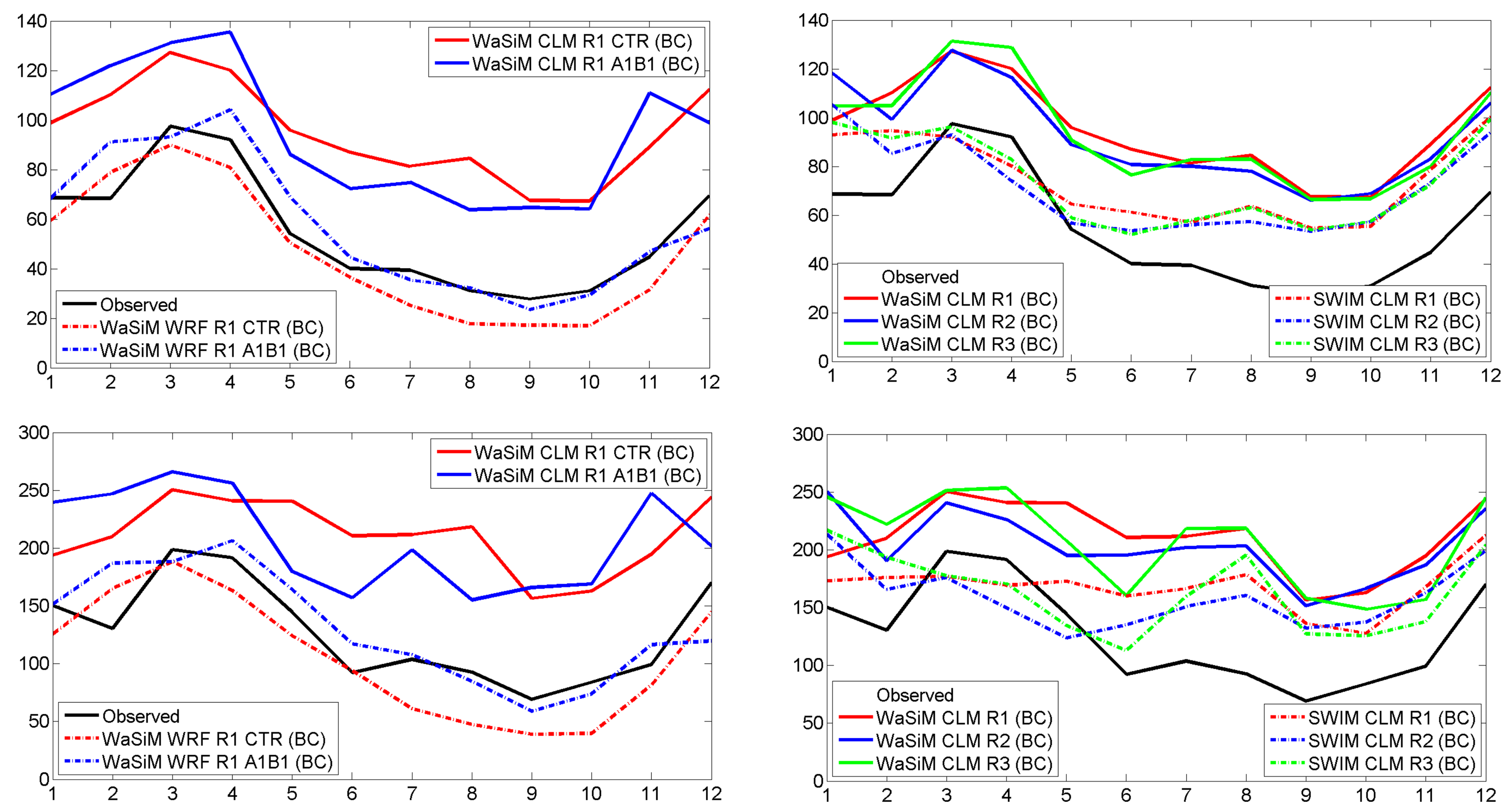


**Figure 6:** Results for mean (top) and maximum (bottom) discharge for Bad Düben in the Mulde catchment.

## Bias correction

The hydrological models are sensitive to bias in the climate models. In many previous studies there has been a strong emphasis of bias correcting the mean values of precipitation and temperature, with the effect of worsening the tails of the distributions. In this project we correct for the full distributions of precipitation and temperature, while also accounting for uncertainties in the observations.

A quantile mapping method [Berg et al., 2010] is used to force the modeled distribution to fit with the observed (REGNIE and PIK data), see **Figure 5**. This is performed using daily data with calculated transfer functions for each month of the year.

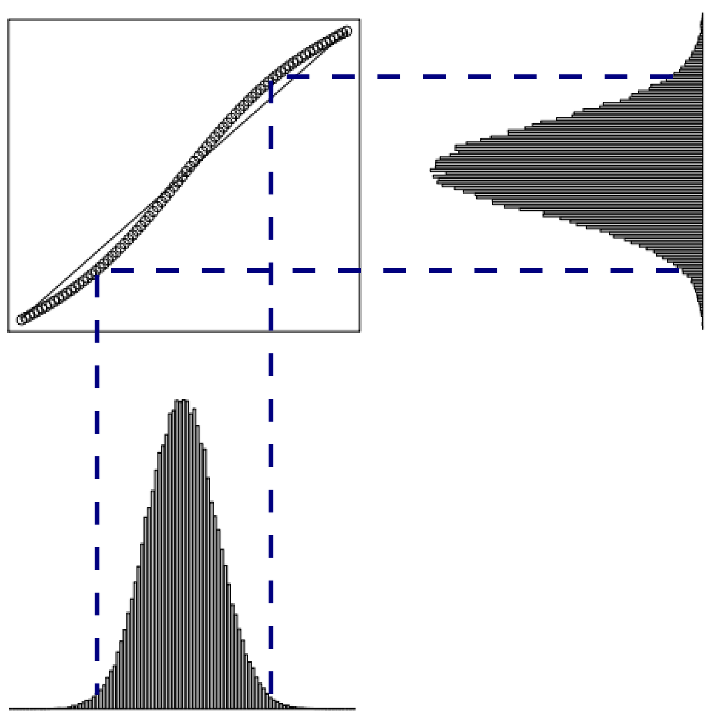

**Figure 5:** Schematic on how the bias correction is applied to a histogram to transform it into a target (observed) histogram.

## Conclusions and outlook

The large inter-model differences for GCMs, RCMs and hydrological models emphasizes the need for using an ensemble approach to assess uncertainties in future climate projections.

Even though bias correction of the RCM simulations have been carried out, there is still a significant difference between the hydrological simulations carried out with different realizations of the ECHAM5 GCM.

The results for the hydrological modeling was so far only presented for two models in one catchment. More robust results will be possible when the full ensemble of models have been used for all three catchments.

## References


Berg, Duethmann, Feldmann, Liebert, Wagner, Assessing uncertainties in observations and RCM bias correction, submitted to International Journal of Climatology 2010.