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Evaluation of the probability distribution of the future change in extreme precipitation

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This study examines future (2081-2100) projections of precipitation extremes over the Rhine catchment area. Future changes in extreme multi-day precipitation sums will influence the probability of floods in the Rhine basin. The aim of this study is to quantify uncertainties in the future change of precipitation extremes and to test if these future changes in extremes differ from the changes that could be expected from natural climate variability. The projections of the changes in precipitation extremes depend on the Regional Climate Model (RCM), the driving Global Climate Model (GCM) and the emission scenario. Due to these model uncertainties, credible high resolution climate scenarios for impact studies require an ensemble of RCM simulations driven by multiple GCMs. In this study an ensemble of five RCMs, driven by two GCMs is compared with an ensemble of 13 GCMs (all driven by IPCC SRES A1B emission scenario). Since high resolution RCM projections were not available from all 13 GCMs, the GCM outputs were post-processed to the (sub)catchment scale using a delta change approach. This approach uses climate responses of the GCM to modify an observed (1961-1995) precipitation time series. Changes in temporal means as well as in temporal variability are taken into account. Further, time series resampling was applied to extend an observed 35 year time-series to 3000 year time-series to be able to take extreme events with return periods up to 1000 years into account. Within the five-member RCM ensemble and the 13-member GCM ensemble the spread in the change of multi-day precipitation extremes is quite similar for return periods between 10 and 1000 years. Therefore a probability distribution for extreme precipitation events was constructed by combining the results for the five RCM and 13 GCM simulations. To be able to distinguish the climate change signal from natural variability for extreme precipitation, we compared the RCM and GCM ensembles to a large 17-member ensemble of a single GCM used in the ESSENCE project. The spread in the change in extreme precipitation projected by the different RCMs and GCMs is comparable to the spread generated by the 17-member ESSENCE ensemble which is entirely due to natural variability. This is an interesting result from which we conclude that natural climate variability is an important factor for studying the future (anthropogenic) change in precipitation extremes. We will briefly touch on what RCM/GCM experiments are needed to be able to fully distinguish anthropogenic effects from natural variability.