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Downscaling precipitation extremes in a complex Alpine catchment

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Climate change is expected to have significant effects on the frequency and intensity of heavy precipitation events. Assessing the impacts of climate change on precipitation extremes is a challenging task. On the one hand, the output of Regional Climate Models (RCMs) is subjected to systematic biases in the case of precipitation, especially in a complex mountain topography, and on the other hand, yet only a few statistical downscaling techniques are known to downscale precipitation extremes reliably.

In this investigation two statistical downscaling approaches were applied to simulate precipitation extremes in the Alpine part of the Lech catchment. The first one, Expanded Downscaling (EDS), is a perfect prognosis approach that is based on regression. EDS has been calibrated and validated using large-scale predictor variables derived from the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis dataset and local station data. The EDS model was then applied to downscale the output of two GCMs (ECHAM5, HadGEM2) for current (1971-2000) and future (2071-2100) time horizons, forced with the SRES A1B emission scenario. The second approach is the Long Ashton Research Station Weather Generator (LARS-WG) which can be characterized as a change factor conditioned weather generator. LARS-WG was calibrated on local station data only and then applied to downscale the output of five different GCM-RCM combinations to meteorological stations. The RCMs have a horizontal resolution of $\sim$25 km and were obtained from the ENSEMBLES project of the European Union. In order to assess precipitation extremes with higher return values, a generalized extreme value distribution was applied to the data. Confidence intervals were calculated by using the non-parametric bootstrapping technique.

The results show that both downscaling approaches reproduce observed precipitation extremes fairly well. Even for very extreme precipitation events such as the 20-year event a good agreement between observation and simulation is obtained. When studying the effects of climate change on precipitation extremes, a wide range of results with both projected increases and decreases in precipitation extremes can be found. However, the number of climate simulations which indicates statistically significant increases is by far larger than that showing decreases. Very robust signals can be found for spring and autumn, in which almost all climate scenarios indicate increases in the intensity of precipitation extremes.