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Hydrological validation of statistical downscaling methods applied to climate model projections

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Abstract Understanding the impacts of climate change projections on the hydrological cycle is a great challenge for the hydrometeorological community. The RIWER 2030 project aims at evaluating the impacts of climate change on two French watersheds with major issues of water management. Climate change impact studies use a mixture of GCM, RCM and downscaling methods to generate local watershed climate input time-series for hydrological models to generate streamflow time-series. This modelling chain is rather complex and each step can strongly impact hydrological projections. Before using such a chain, we consider that downscaling methods must be validated on past observations. This paper aims to assess the ability of downscaling methods and hydrological models to reproduce past climate and hydrological observed series and trends. Three downscaling methods (based on analog approaches) were applied on a reanalysis of atmospheric pressure fields over the 1953–2002 period to generate climate time-series. Then, downscaled precipitation and temperatures were coupled to two hydrological models (lumped and semi-distributed) to generate streamflow time-series. Downscaling methods performances were assessed on precipitation and temperatures at different spatial and temporal scales. Hydrological model simulations were also used for a complete assessment on potential evapotranspiration, snow water equivalent and streamflows. The results show a relatively good ability of downscaling methods to reproduce climate observations and to yield good hydrological simulations. However, low flows depend strongly on downscaling methods and hydrological model performance. Downscaling methods are sometimes not able to reproduce an observed trend, which is highly questionable when used for climate change impact studies.

Key words analog methods; statistical downscaling; rainfall–runoff models; past climate validation