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# Can internal climate variability alone explain biases in regional climate simulations?

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Biases in regional climate model (RCM) simulations under present climate have been widely reported, correction methods have been suggested and the robustness of these methods questioned. In parallel, recent studies showed that the importance of internal climate variability has often been underestimated when interpreting climate projections, and that climate change (signal) needs to be differentiated from natural climate fluctuations (noise). This study combines both perspectives and explores whether the differences between meteorological observations and climate simulations can be attributed to climate variability. If the observation and simulation time series actually are two realisations from the same climate system, we consider that the difference between the two is only a random component, whose correction is not possible.

To investigate the importance of climate variability, we adopted a hydrological perspective and considered numerous catchments characteristic of the hydrological regimes in Switzerland. Here the emphasis is on two representative basins: one located in the Alps (183 $km^2$, mean altitude of 2227 masl) and one on the Swiss plateau (231 $km^2$, 700 masl). For both of them we compiled precipitation and temperature time series from station measurements and from the climate models HadCM3Q0-CLM from the ENSEMBLES project for the period 1980-2009. Annual cycles were obtained by spectral smoothing and used for comparing the datasets.

For the alpine catchment, precipitation overestimation by the RCM in winter leads to an inversion of the annual cycle (winter becomes the wettest season instead of summer) and typical precipitation amounts simulated in winter are higher than the observed values of all individual winters of the period 1980-2009. As a consequence, the typical discharge induced by snow-melt, simulated with the conceptual, semi-distributed, hydrological model HBV, is associated with a return period of more than 30 years. Comparison of simulated values with homogenized time series for 1900-2010 confirms that the difference in winter precipitation is too high to be explained by internal variability only. Although the other characteristics of the temperature and precipitation cycles are better resolved, the discharge cycle is distorted by the mismatch between observed and modelled winter precipitation. In contrast, for the low altitude catchment, differences for precipitation and temperature are mostly within the internal variability range and so are the differences for discharge. Although no perfect match between observed and simulated values is obtained, this questions whether bias-correction should be applied here.