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# Partitioning internal variability and model uncertainty components in a multireplicate multimodel ensemble of hydrometeorological future projections

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A simple and robust framework was proposed by Hingray and Mériem (2013) for the partitioning of the different components of internal variability and model uncertainty in a multireplicate multimodel ensemble (MRMME) of climate projections obtained for a suite of statistical downscaling models (SDMs) and global climate models (GCMs). It is based on the quasi-ergodic assumption for transient climate simulations. Model uncertainty components are estimated from the noise-free signals of each modeling chain using a two-way ANOVA framework. The residuals from the noise-free signal are used to estimate the large and small scale internal variability (IV) components associated with each considered GCM/SDM configuration. This framework makes it possible to take into account all runs and replicates available from any climate ensemble of opportunity.

This quasi-ergodic ANOVA framework was applied to the MRMME of hydrometeorological simulations produced for the Upper Durance River basin (French Alps) over the 1860-2100 period within the RIWER2030 research project (http://www.lthe.fr/RIWER2030/). The different uncertainty sources were quantified as a function of lead time for projected changes in temperature, precipitation, evaporation losses, snow cover and discharges (Lafaysse et al., 2013).

For temperature, GCM uncertainty prevails and, as opposed to IV, SDM uncertainty is non-negligible. Significant warming and in turn significant changes are predicted for evaporation, snow cover and seasonality of discharges. For precipitation, GCM and SDM uncertainty components are of the same order. Despite high model uncertainty, the non-zero climate change response of simulation chains is significant and annual precipitation is expected to decrease. However, high values are obtained for the large and small scale components of IV, inherited respectively from the GCMs and the different replicates of a given SDM. The same applies for annual discharge. The uncertainty in values that could be experienced for any given future period is therefore very high. For both discharge and precipitation, even the sign of future realizations is uncertain at a 90% confidence level.

These findings have important implications. As for GCM uncertainty, SDM uncertainty cannot be neglected. The same applies for both components of internal variability. Climate change impact studies based on single SDM realizations are likely to be no more relevant than those based on single GCM runs (or small ensembles). When they are intended to provide information for climate change adaptation, they may lead to poor decisions. In the present case, it would be better to adapt to IV of precipitation than to the precipitation decrease obtained from the mean climate change response of simulation chains.

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