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Comparison of three statistical downscaling methods for precipitation in the Hérault and Ebro catchments

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The aim of the GICC project "REMedHE" (http://www.remedhe.org) is to evaluate and compare the evolution of water supply capacity under climatic and anthropogenic changes by 2050 on two Mediterranean catchments: the Hérault (South of France) and the Ebro (North East of Spain) catchments. Indeed, the Mediterranean region has been identified as a "hot spot" of climate change, especially for precipitation which is expected to globally decrease while water needs should continue to increase. To perform such a study, it is then necessary to simulate future water flows with hydrological models fed by high-resolution precipitation data representative of the future climate.

To generate high-resolution climate simulations, three different statistical downscaling approaches have been applied. The first one consists in a deterministic transfer function based on a Generalized Additive Model (GAM). The second method involves a Stochastic Weather Generator (SWG), simulating local values from probability density functions conditioned by large-scale predictors. The third approach belongs to the "Model Output Statistics" (MOS) family, in bias correcting the large-scale distributions with respect to the local-scale ones, through the Cumulative Distribution Function transform CDFt approach.

These statistical downscaling models were calibrated and cross-validated using the SAFRAN dataset (for Hérault catchment), a dataset compiled by HydroSciences Montpellier (for Ebro catchment) as local-scale reference and the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis outputs as predictors, over two time periods 1959-1984 and 1985-2010.

Cross-validation analysis shows that the inter-annual variability of the yearly sum of precipitation from GAM is close to that from SAFRAN. However, daily variability and occurrence frequency are badly represented by GAM. On the opposite, SWG and one version of CDFt allow both the inter-annual and the more high-frequency variabilities to be correctly reproduced.

Then, precipitation were simulated over a control time-period (1976-2005) and a future time-period (2036-2065) according to two climate scenarios (RCP4.5 and RCP8.5) and from two General Circulation Models (GCMs): the "Institut Pierre Simon Laplace" (IPSL-CM5A-MR) model and the "Centre National de Recherches Météorologiques" (CNRM-CM5) model. The evolutions of the main statistical properties of precipitation over the two catchments are then analyzed conditionally on the driving GCM and scenario.