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Statistical downscaling of precipitation: interest of moisture variables

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The interest of moisture variables in statistical downscaling models for precipitation is evaluated using data from different contrasted French hydro-climatic regions. For each region, daily precipitation occurrences and wet-day amounts (predictands)- obtained from the SAFRAN precipitation reanalysis - are estimated from Generalized Linear Models driven by atmospheric variables from ERA40 reanalysis (predictors). The predictor dataset includes dynamical (mean sea level pressure, 700 hPa zonal and meridional velocity) and atmospheric moisture variables (relative humidity, specific humidity at 700 hPa, associated moisture fluxes). Different sets of predictors are considered including dynamical variables alone or combined with moisture variables. A 50-years database is used for the evaluation (1959-2009).

If the significance of dynamical variables is dependent on the region, the influence of moisture variable is fairly homogeneous from region to another. For daily occurrence, inclusion of relative humidity allows for a large increase in explained variance. For daily wet-day amounts, a significant model performance improvement is achieved with each moisture variable and using specific humidity only does not allow for an optimal reproduction of the observed seasonality.

The influence of moisture variables on the time transferability of statistical relationships is also explored. We therefore assess the model ability to reproduce 1/ the inter-annual variations of observed variables and 2/ "observed" trends if any. We also evaluate the stationarity in model performance over the 1959-2009 period. A poor time transferability could suggest a poor model performance. It could also result from temporal non homogeneities in both large scale fields and local meteorological data. In this context, other sets of meteorological and atmospheric data are considered to assess the respective effects of model and data.

The ability of the combined occurrence/wet-days model to reproduce the explained variance in precipitation amounts aggregated over different time scales (relevant for impact studies on water resource) is finally estimated. For all predictor sets, there is a significant increase with time aggregation level, resulting from the large autocorrelation in predictors. For some predictor sets, a large decrease of explained variance is next obtained for large time aggregation levels. This behavior can be especially related to a poor stationarity in model performance.

Results may be different for other climatic contexts. For the studied regions, they are central to the choice of predictor variables in downscaling of daily precipitation. Moisture variables are here expected to make the statistical models more robust for a temporal transferability in a modified climate. Nevertheless, they are not systematically provided by general or regional circulation models.

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