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Defining predictand areas with homogeneous predictors for spatially coherent precipitation downscaling

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Statistical downscaling aims at finding relationships between local precipitation (predictand) and large-scale predictor fields, in various contexts, from medium-term forecasting to climate change impact studies. For distributed hydrological modelling the downscaled precipitation spatial fields have furthermore to be coherent over possibly large river basins. This study addresses this issue by grouping coherent predictand areas in terms of optimised predictor domains over the whole of France, for an analogue downscaling method developed by Ben Daoud et al. (2011).

This downscaling method is based on analogies on different variables: temperature, relative humidity, vertical velocity and geopotentials. These predictor variables are taken from ERA40 at 2.5 degree resolution and local precipitation over 608 climatologically homogeneous zones in France are taken from the Safran near-surface atmospheric reanalysis (Vidal et al., 2010). The predictor domains for each zone consist of the nearest grid cell for all variables except geopotentials for which the optimum domain is sensitive to the predictand location. For large catchments with diverse meteorological influences it is thus beneficial to optimise the predictor domains individually for areas with different influences (e.g. Timbal et al., 2003). The drawback is that different predictor domains may provide inconsistent values between elementary zones. This study therefore aims at reducing the number of different predictor domains by grouping the predictand areas that may use the same predictor domain.

The geopotential predictor domains were first optimised for each of the 608 zones in the Safran data separately. The predictive skill of different predictor domains is evaluated with the Continuous Ranked Probability Skill Score (CRPSS) for the 25 best analogue days found with the statistical downscaling method averaged over 20 years. Rectangular predictor domains of different sizes, shapes and locations are tested, and the 5 ones that lead to the highest CRPSS for the zone in question are retained. The 5 retained domains were found to be equally skillfull with a maximum difference of around 1% of CRPSS on average, and are thus all candidates for clustering predictand zones.

An objective procedure has then been implemented for clustering zones together, based on their sharing a common predictor domain inside their 5 near-optimal domain ensemble. For zones sharing several near-optimal predictor domains, the aim was to minimise the number of disjoint predictand areas. Furthermore solutions that lead to more similar sized areas were preferred. This procedure defines areas with natural spatial coherence and reduces the number of different predictor domains using a procedure based on objective rules, unlike most of studies where this is done either subjectively or arbitrarily. It allowed to reduce significantly the number of independent zones and to identify large homogeneous areas encompassing relatively large river basins. Further developments will address the issue of spatial coherent downscaling for predictand areas that do not share any near-optimal predictor domains.

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