Geophysical Research Abstracts
Vol. 14, EGU2012-4754, 2012
EGU General Assembly 2012

Optimising predictor domains for spatially coherent precipitation downscaling

S. Radanovics (1), J.-P. Vidal (1), E. Sauquet (1), A. Ben Daoud (2), and G. Bontron (2)

(1) Irstea, UR HHLY Hydrology and Hydraulics Research Unit, Lyon, France (sabine.radanovics@irstea.fr), (2) Compagnie Nationale du Rhône, Lyon, France

Relationships between local precipitation (predictands) and large-scale circulation (predictors) are used for statistical downscaling purposes in various contexts, from medium-term forecasting to climate change impact studies. For hydrological purposes like flood forecasting, the downscaled precipitation spatial fields have furthermore to be coherent over possibly large basins. This thus first requires to know what predictor domain can be associated to the precipitation over each part of the studied basin. This study addresses this issue by identifying the optimum predictor domains over the whole of France, for a specific downscaling method based on a analogue approach and developed by Ben Daoud et al. (2011).

The downscaling method used here is based on analogies on different variables: temperature, relative humidity, vertical velocity and geopotentials. The optimum predictor domain has been found to consist of the nearest grid cell for all variables except geopotentials (Ben Daoud et al., 2011). Moreover, geopotential domains have been found to be sensitive to the target location by Obled et al. (2002), and the present study thus focuses on optimizing the domains of this specific predictor over France.

The predictor domains for geopotential at 500 hPa and 1000 hPa are optimised for 608 climatologically homogeneous zones in France using the ERA-40 reanalysis data for the large-scale predictors and local precipitation from the Safran near-surface atmospheric reanalysis (Vidal et al., 2010). The similarity of geopotential fields is measured by the Teweles and Wobus shape criterion. The predictive skill of different predictor domains for the different regions is tested with the Continuous Ranked Probability Score (CRPS) for the 25 best analogue days found with the statistical downscaling method. Rectangular predictor domains of different sizes, shapes and locations are tested, and the one that leads to the smallest CRPS for the zone in question is retained. The resulting optimised domains are analysed for defining regions where neighbouring zones have equal or similar predictor domains and identifying which French river basins contain zones associated with different predictor domains, i.e. are exposed to different meteorological influences.

The above analysis will be used (1) to extend the statistical downscaling method of Ben Daoud et al. (2011) to the whole of France and (2) to develop it further in order to achieve spatially coherent forecasts while preserving the predictive skill on the local scale.

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