Validation of spatial variability in downscaling results from the VALUE perfect predictor experiment

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The spatial dependence of meteorological variables is crucial for many impacts, e.g. droughts, floods, river flows, energy demand, and crop yield. There is thus a need to understand how well it is represented in downscaling products. Within the COST Action VALUE we have conducted a comprehensive analysis of spatial variability in the output of over 40 different downscaling methods in a perfect predictor setup. The dowscaling output is evaluated against daily precipitation and temperature observations for the period 1979-2008 at 86 sites across Europe and 53 sites across Germany. We have analysed the dependency of correlations of daily temperature and precipitation series at station pairs on the distance between the stations. For the European dataset we have also investigated the complexity of the downscaled data by calculating the number of independent spatial degrees of freedom. For daily precipitation at the German network we have additionally evaluated the dependency of the joint exceedance of the wet day threshold and of the local 90th percentile on the distance between the stations. Finally we have investigated regional patterns of European monthly precipitation obtained from rotated principal component analysis.

We analysed Perfect Prog methods, which are based on statistical relationships derived from observations, as well as Model Output Statistics approaches, which attempt to correct simulated variables. In summary we found that most Perfect Prog downscaling methods, with the exception of multi-site analog methods and a method that explicitly models spatial dependence, yield unrealistic spatial characteristics. RCM-based MOS methods showed good performance with respect to correlation lengths and the joint occurrence of wet days, but a substantial overestimation of the joint occurrence of heavy precipitation events. These findings apply to the spatial scales that are resolved by our observation network, and similar studies with higher resolutions, which are relevant for small hydrological catchment, are desirable.