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Multivariate weather prediction with atmospheric analogs: predictors and probabilistic prediction skill for different European regions

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Among the usual methodologies of dynamical or statistical downscaling of climate model, the Analog method appears to be one of the simplest regarding its conceptual nature and its computational costs (Lorentz, 1969). It assumes strong relationships between large scale meteorological variables (predictors) and local weather variables (predictants) so that for two similar large scale situations, the regional consequences on local weather are supposed to be identical. Despite its simplicity, its skill for local scale and/or regional scale prediction is often reported to be very satisfactory. The Analog method has been widely used in Europe to produce precipitation and temperature predictions. For an increasing number of impact studies (e.g. hydrological ones), weather scenarios have to be multivariate and must include additional variables such as wind or radiation. The development of relevant multivariate weather series is however challenging. Weather scenarios have especially to be physically consistent between all weather variables. This issue, which may be critical when relevant hydrological scenarios have to be produced, was to our knowledge fairly not explored.
The Analog method has the ability to easily tackle this problem selecting the same analog date for all the weather predictants and thus insuring automatically the physical consistency. However, the best analogs of a given simulation day are likely to depend on the predictant considered. Achieving physical consistency between variables, which implies optimizing the method in a multivariate approach, therefore a priori requires finding a compromise between the different predictors which would be the best for the different predictant taken separately. For the present study, we use a stepwise Analog method for the probabilistic prediction of regional precipitation, temperature, wind and solar radiation. We explore for 12 regions across Europe the variability and diversity of the most skillful parameterisation of the method in terms of predictors (variable, atmospheric level, shape and size of the geographical domain used for the analogs identification). Predictors are extracted from ERA-Interim reanalyses. Predictants are obtained from the European Climate Assessment and Dataset for precipitation and temperature and derived from high resolution Weather Research and Forecasting model simulations (Tobin et al., 2014) for wind and solar radiation pseudo-observations. We evaluate the method's ability to correctly reproduce the recent past climate of the regions and we discuss how the results vary depending on the target region. We also discuss for each predictant the loss of prediction performances due to the multivariate approach compared to the usual univariate one.

Lorenz, E. N., (1969) Atmospheric predictability as revealed by naturally occurring analogues. J. Atmos. Sci., 26, 636–646.
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