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Exploring potential predictor variables by means of genetic algorithms for thunderstorms forecasting with analog methods

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Analog methods (AMs) rely on the hypothesis that similar situations at the synoptic scale are likely to result in similar local weather conditions. AMs are commonly used for precipitation forecasting or downscaling, but rarely for forecasting convective events. Thus, the selection of the relevant predictor variables has yet to be optimized for forecasting cloud-to-ground lightnings.

The skill of different predictor variables should be assessed, which can turn out to be a cumbersome task if done manually and extensively. Thus, instead of proceeding to a manual assessment of multiple subsets of variables, a global optimization approach was chosen. Genetic algorithms (GAs) were shown to successfully optimize the parameters of the AMs, such as the spatial domain on which the predictors are compared, the selection of pressure levels and lead times of the predictors, a weighting between predictors and the number of analog cases to be provided for each output. GAs can jointly optimize all parameters of AMs and get closer to a global minimum of the cost function by taking into account the dependencies between parameters. Therefore, we propose using GAs to explore the potential skill of many candidate predictors from different datasets and select the most relevant ones, along with the appropriate analogy criteria.

This approach has been applied to NE Italy and Switzerland, where complex orography (Alps chain) provides additional difficulties for forecasting thunderstorms. The predictors were considered in two different contexts: from a short dataset of operational NWP forecasts (ECMWF IFS) and in a perfect prognosis using a long dataset of ERA reanalyses. Although the expert's expertise remains necessary to supervise the selection of predictors, GAs facilitate the exploration of large datasets.