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Meteorological Time Series Reconstruction via Artificial Neural Network.

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The climate system has a very complex and non linear behaviour for which consistent and robust mathematical models are needed, for example the use of artificial neural network models, since they allow the modelling of non-linear dynamic problems. The aim of the present work is the application of robust procedures for reconstruction and homogenisation of air temperature (extreme and monthly), insolation, precipitation and humidity relative time series. In fact, the natural motivation of this work is to describe or characterise regional Earth's Climate, improving stochastic methodologies to predict rainfall, insolation and air-surface temperature extremes as a function of time; how far other components of the climate system are alternatives (NAO, ENSO, and other climate proxies) to recovering the time series. The selected series consist of twenty two monthly time series recorded in the period 1956 – 2000 at twenty two weather stations in Portugal. Time series is a special case of symbolic regression we can use ANN to explore the spatiotemporal dependence of meteorological attributes as a function of space-time on inputs for computer simulations. It is very well-known that a common problem in numerical climate characterization is the spatiotemporal processing (integration or interpolation) of data from different types and different origins or accuracies (the space-time *change of support problem*).). The *Artificial Neural Network* approach using *Empirical Bayesian Updating* seems to be an important tool for the propagation of the related weather information to provide practical geostatistics solution of uncertainties associated with the interpolation, capturing the spatiotemporal structure of the data. The basic idea is to import the entire posterior distribution from

other locations allowing prediction of unsampled *weather parameters* using spatial related sampled *information*. The practice of ANN has been recognized recently as a promising way of making predictions on time series, detecting irregular behaviour. In effect, we determine the embedding dimension (number of past observations) of the time series attractor (delay time that determine how data are processed) and uses these number to define the network's architecture (Input Data ⇒ Pre-Process); physically, the attractor is the object to which the time series in a phase space (space in which each point describes the state of a dynamical system as a function of the non-constant parameters of the system) is attracted to (Pre-Process ⇒ Neural Network); meteorological attributes can be accurately predicted by the spatiotemporal ANN model architecture: designing, training, validation and testing (Neural Network ⇒ Post-Process); the best generalization of new data is obtained when the mapping represents the systematic aspects of the data, rather capturing the specific details (e.g., noise contribution) of the particular training set. The evaluation of the error function (Post-Process ⇒ Output Data). The analysis of extreme meteorological events in Continental Portugal by means of the *Artificial Neural Network* approach using *Empirical Bayesian Updating* indicates that a clear change in their frequency has occurred during the period of time under study. This suggests that natural variability of the climate system could be the cause of the recent changes, although anthropogenic forcing due to increasing greenhouse gas concentrations cannot be disregarded as well. This methodology produces mean squared errors less than those associated to the temporal interpolaton using ARIMA or cubic splines, once the time series have a considerable number of consecutive missing values.