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An artificial neural network approach for the forecast of ambient air temperature

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Ambient air temperature forecasting is one of the most significant aspects of environmental and climate research. Accurate temperature forecasts are important in the energy and tourism industry, in agriculture for estimating potential hazards, and within an urban context, in studies for assessing the risk of adverse health effects in the general population. The scope of this study is to propose an Artificial Neural Network (ANN) approach for the one-day ahead maximum (Tmax) and minimum (Tmin) air temperature forecasting. The ANNs are signal processing systems consisted by an assembly of simple interconnected processing elements (neurons) and in geosciences are mainly used in pattern recognition problems. In this study the feed-forward ANN models are selected, which are theoretically capable of estimating a measurable input-output function to any desired degree of accuracy. The method is implemented at a single site (Souda Airport) located at the island of Crete in southeastern Mediterranean and employs the hourly, Tmax and Tmin temperature observations over a ten-yearly period (January 2000 to December 2009). Separate ANN models are trained and tested for the forecast of Tmax and Tmin, which are based on the 24 previous day's hourly temperature records. The first six years are used for training the ANNs, the subsequent two for validating the models and the last two (January 2008 to December 2009) for testing the ANN's overall predicting accuracy. The model architecture consists of a single hidden layer and multiple experiments with varying number of neurons are performed (from 1 to 80 neurons with hyperbolic tangent sigmoid transfer functions). The selection of the optimum number of neurons in the hidden layer is based on a trial and error procedure and the performance is measured using the mean absolute error (MAE) on the validation set. A comprehensive set of model output statistics is used for examining the ability of the models to estimate both Tmax and Tmin based on a combination of correlation and difference statistical measures. An insight of the statistically derived input-output transfer functions is obtained by utilizing the ANN weights method, which quantifies the relative importance of the predictor variables. The assessment also includes a seasonal and monthly analysis of the model residuals along with their corresponding distributions. A general remark is that the optimum Tmax ANN architecture contains more hidden layer neurons compared to the Tmin and is related with higher forecasting errors, which is attributed to the increased complexity of estimating the Tmax at the given site. The ANN models in both cases exhibit very good performance and the method can be useful in the field of air temperature forecasting.

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