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An estimation of future changes in winter precipitation and raindays over Greece: a statistical downscaling approach based on artificial neural networks

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The main objective of the present study is the construction of a statistical downscaling model based on artificial neural network approach, in order to find empirical relationships between large-scale variables and observational winter precipitation and raindays over Greece. The empirical functions derived were then used for the estimation of the future changes of the selected parameters in the study area, with the aid of the data from a general circulation model.

Gauge daily precipitation data from 22 stations evenly distributed allover the Greek region for the period 1958-2000 were employed. Also, for the purpose of downscaling winter precipitation and raindays, large–scale circulation predictors from the NCEP/NCAR reanalysis database were used, for several geopotential levels (1958-2000). Moreover, daily surface specific humidity and raw precipitation data for a 24-point grid set were considered over Greece with the same resolution and for the same time period.

Aiming on the simplest configuration of the statistical model, in order to avoid overfitting, but getting the most optimal and stable results, it was concluded on a trial and error basis, that the best results were obtained with only one hidden layer with twelve (12) nodes. Furthermore, experimentation showed that the ideal spatial window for the circulation based predictors is 0^o – 32.5^oE and 30^oN – 55^oN. The ANN model is then trained for the years 1958-1978 + 1994-2000 consisting one period (calibration period) while the intermediate years 1979-1993 were used for the validation of the model results (validation period). Seven sets of predictors were primarily applied in

the downscaling model and the results were evaluated using four performance criteria. It was found that two sets of predictors a) the circulation-based 500hPa and b) its combination along with surface specific humidity and raw precipitation data were the most efficient predictor in generating local scale precipitation and raindays series in the Greek area.

On a next step, the data for the atmospheric general circulation model (HadAM3P-Hadley Center), both for the control run period (1961-1990) and the future scenario period (2071-2100), were applied to the statistical model for the estimations of the future changes in the examined parameters.

The simulated time series were evaluated against observational data and the downscaling model was found efficient in generating winter precipitation and raindays with high correlation coefficient for the largest percentage of the stations under study. The temporal evolution of the estimated variables was also well captured. Generally, the use of the combined predictor attributed to the improvement of the simulated results. Subsequently, the present day and future changes on precipitation conditions were examined using the HadAM3P data to the statistical model. The downscaled climate change signal for both precipitation and raindays was partly similar to the signal from the HadAM3P direct output: a decrease of the parameters is predicted over the study area. However, the amplitude of the changes was different.

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