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Spatiotemporal statistical downscaling method with uncertainty for climate change impact assessment on droughts

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Climate change impact assessment requires spatial and temporal scales at which impacts take place. The outputs of the current general circulation models (GCMs) and regional climatic models (RCMs) cannot be used for analysis at local extent due to their coarse resolution. Downscaling methods and spatial interpolation techniques are employed in this study to downscale mean monthly precipitation over the region Thessaly, Greece. The outputs of Global Circulation Models CGCMa2 and the ECHAM5 were applied for two socioeconomic scenarios, namely, SRES A2 and SRES B2 for the assessment of climate change impact on droughts. Observations from 79 precipitation stations for the period October 1960 to September 2002 were used. Ordinary kriging was employed for the spatial distribution of precipitation data into 128 grids of 10 x 10 km. K-means cluster analysis was performed to the historical data for the formation of six clusters for precipitation. The downscaling methodology is based on a generalized multiple regression (GMLR) of GCM predictor variables with observed cluster precipitation and the application of stochastic timeseries models for the treatment of the residuals (white noise) in clusters. The GMLR models used large-scale predictor parameters of GCMs output such as minimum Surface Temperature (STmin) and Geopotential Thickness 500-1000 hpa (GZ500-1000). The accuracy of precipitation downscaling for the base period (1960-1990) was quite low and the regression coefficient between downscaled and observed grid precipitation was between 0,29 and 0,58. A MPAR(2) multivariate autoregressive model was developed for the simulation of the residuals between GMLR projections and observed data. Using the time series models 100 synthetic timeseries of precipitation were reproduced in each grid. Various statistics (Mean Average Error (MAE), Root Mean Square Error (RMSE), Coefficient of Efficiency (CI), Index of Agreement (IA) and Persistence Index (PI)) were used for the comparison of downscaled with the observed grid precipitation and the calculated drought Standardized Precipitation Index (SPI) for the development base period (1960-1990) and the validation period (1990-2002). The comparison analysis for the two period indicated the accuracy, reliability of the downscaling method and the uncertainty introduced in climate change studies.