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Evaluation of monthly precipitation downscaling methods accuracy for the assessment of climate change impacts on droughts

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It is generally accepted that the increasing concentrarion of greenhouse gases in the atmosphere will very likely lead to the change of climate. Globally averaged mean evaporation, temperature, and rainfall intesity will probably increase in response to increased consentrations of greenhouse gases (IPPC, 2001). General circulation models (GCMs) are the main tools today for simulating present and future climate conditions. However in regional climate schemes they appear restrictions and large descrepancies are detected among models. Ordinary aproaches to bridging the scale gap is downscaling methodologies, both statistical and dynamical. In this study, various statistical 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 CGCM2 and the ECHAM5, as well as outputs of a Regional Climate Model (RCM) were applied for the downscaling of monthly precipitation and 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 km x 10 km. K-means clustering was performed to the historical data for the formation of six clusters for precipitation. A new hybrid statistical downscaling methodology (Tzabiras et al., 2010) is applied 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. Artificial Neural Network (ANN) models are also developed for the downscaling grid precipitation using as inputs the GCM outputs. Finally, the Regional Climate Model (RCM) outputs have been used for the spatial interpolation with Inverse Distance Weighted (IDW) technique and multivariate splines in a comparative study of their potential in projecting observed precipitation values. All models have been developed for Oct.1960-Sep.1990 period and verified for the Oct.1990-Sep.2002 period. Various statistics (Mean Average Error (MAE), Root Mean Square Error (RMSE), Coefficient of Efficiency (CI), Index of Agreement (IA) and Persistence Index (PI) have been used for the evaluation 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 intercomparison analysis of models for the two periods indicated the accuracy and reliability of the new hybrid statistical downscaling method against ANN models and spatial interpolation techniques of RCM output. Nevertheless, ANN approach satisfactorily simulates the observed precipitation and constitutes a more efficient method for SPI index estimation in opposition with the spatial interpolation methods based on the RCM output.