Geophysical Research Abstracts,
Vol. 11, EGU2009-12828, 2009
EGU General Assembly 2009

Uncertainty in climate change impacts on droughts using a statistical downscaling method

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Climate change will affect the hydrology of a region through changes in the timing, amount, and form of precipitation, evaporation and transpiration rates, and soil moisture, which in turn affect also the drought characteristics in a region. Droughts are long-term phenomena affecting large regions causing significant damages both in human lives and economic losses. The most widely used approach in regional impact studies is to combine the output of the General Circulation Models (GCMs) with an impact model. Although this approach is quite realistic there are inherent uncertainties about the details of regional climate changes. The outputs of Global Circulation Model CGCMa2 were applied for two socioeconomic scenarios, namely, SRES A2 and SRES B2 for the assessment of climate change impact on droughts. In this study, a statistical downscaling method has been applied for monthly precipitation. The methodology is based on multiple regression of GCM predictant variables with observed precipitation and the application of stochastic timeseries models for the treatment of the residuals (white noise). The methodology was developed for the base historical period (1960-1990) and validated against observed precipitation for the basin of Lake Karla in Thessaly for the period (1990-2002). The validation indicated the accuracy of the methodology and the uncertainties introduced (propagated) by the downscaling procedure in the estimation of a meteorological drought index the Standardized Precipitation Index (SPI) at multiple timescales. Subsequently, monthly precipitation and SPI were estimated for two future periods 2020-2050 and 2070-2100. Comparison of the drought indices timeseries calculated from observed and downscaled meteorological parameters indicated the accuracy, reliability of the downscaling method and the uncertainty introduced in climate change studies.