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- towards climate change services

Statistical downscaling of daily precipitation: A two-step probabilistic approach

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Downscaling of climate data is an important issue in order to obtain high-resolution data desired for most applications in meteorology and hydrology and to gain a better understanding of local climate variability. Statistical downscaling transforms data from large to local scale by relating punctual climate observations, climate model outputs and high-resolution surface data.

In this study, a probabilistic downscaling approach is applied on precipitation data from the subtropical mountain environment of the High Atlas in Morocco. The observations were collected within the GLOWA project IMPETUS West Africa. The considered area is characterized by strong NW-SE gradients both of altitude and of precipitation. The method consists of two steps. In order to interpolate between observational sites, the first step applies Multiple Linear Regression (MLR) on observed data taking local topographic information into account. The dependent variable (predictand) is estimated using different explanatory variables (predictors): height, latitude, longitude, slope, aspect, or gradients of height in zonal and meridional direction. For a predictand like temperature, which follows approximately a normal distribution, this method is appropriate. The development of transfer functions for precipitation is challenging, because the empirical distribution is heavily skewed due to many days with marginal or zero amounts and few extreme events. Because an application of MLR on observed values yields partly negative rainfall amounts, a probabilistic approach is utilized. At this, MLR is applied on parameters of a theoretical distribution (e.g. Weibull), which is fit to empirical distributions of precipitation amounts.

In the second step, a transfer function between distributions of large-scale predictors, e.g. climate model or reanalysis data, and of local observations is derived. This is achieved by an equal probability mapping between cumulative distributions functions (CDFs) of large-scale data for recent and future climate conditions and the CDF of observed data. This enables the derivation of a transformation equation to forecast the CDF of the future period at the stations. By combining both parts a future prediction at every point of the investigation area is achieved.