Geophysical Research Abstracts
Vol. 12, EGU2010-1935-1, 2010
EGU General Assembly 2010

Statistical downscaling of climate scenarios for hydrological impact analysis in Austrian basins

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Projections about future climate in Europe are available from a number of General Circulation Models (GCMs) and Regional Climate Models (RCMs). Future estimates of precipitation and temperature can be used for driving hydrological models that give information about availability of water resources. However, a direct application of these data in Austrian mountainous basins is not feasible because of apparent biases, which are caused by local variability due to orographic effects. This local variability is poorly represented in the relatively coarse resolution of even the most detailed RCMs. On the other hand, it has been shown that GCMs and RCMs yield reliable results for regional patterns in pressure distributions, as measured by the 500 hPa geopotential heights. In Austria - at the intersection of Atlantic, Mediterranean and Continental climate influences - the regional pressure distributions exert a strong control on the local weather. A statistical downscaling approach is used for establishing a relationship between indices derived from historic simulations of regional pressure distributions and observed local precipitation and temperature data. For example, the probability of a certain amount of local daily precipitation can be modelled with an exponential distribution, which parameters are strongly dependent on the regional wind direction. Two approaches are tested for estimating the parameters of the statistical model: (1) Fourier Analysis and (2) Artificial Neural Network. Both approaches are calibrated with the Maximum-Likelihood method. The statistical relationships are subsequently used for obtaining precipitation and temperature estimates from predicted pressure distributions of future climate scenarios. Here, the basic assumption is that the statistical relationships are unchanged under future climate. An evaluation with independent data shows that the proposed downscaling method is able to reproduce the statistical properties of precipitation and temperature also in unusually wet, dry, and warm periods. The downscaled climate data are input to hydrological models that are employed in various Austrian studies for climate change impact assessment.