Geophysical Research Abstracts
Vol. 18, EGU2016-2837-1, 2016
EGU General Assembly 2016

What is the benefit of driving a hydrological model with data from a multi-site weather generator compared to data from a simple delta change approach?“

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In 2011 the Swiss national consortium C2SM providednew climate change scenarios were released in Switzerland that came with a comprehensive data set of temperature and precipitation changes under climate change conditions for every a large network of meteorological stations, and for aggregated as well as regions in across Switzerland. These climate change signals were generated for three emission scenarios and three different future time-periods and designed to be used asbased on a delta change factors approach. This data set proved to be very successful in Switzerland as many different users, researchers, private companies, and societal users were able to use and interpret the climate data set. Thus, a range of applications that are all based on the same climate data set enabled a comparable view on climate change impact in several disciplines.
The main limitation and criticism to this data set was the usage of the delta change approach for downscaling as it comes with severe limitations such as underestimatinges changes in extreme values and neglecting changes in variability and changes in temporal sequencesneglecting changes in variability, be it year-to-year or day-to-day, and changes in temporal sequences . lacks a change in the day-to-day-variability. One way to overcome this the latter limitation is the usage of stochastic weather generators in a downscaling context. Weather generators are known to be one suitable downscaling technique, but A common limitation of most weather generators is the absence of spatial consistency rrelation in the generated daily time-series, resulting in an underestimation of areal means over several stations that are often low-biased. refer to one point scale (single-site) and lacks the spatial representation of weather. The latter A realistic representation of the inter-station correlation in the downscaled time-series This is of high particular importance in some impact studies, especially infor any hydrological impact studiesy. Recently, a multi-site weather generator was developed and tested for downscaling purposes over Switzerland. The weather generator is of type Richardson, that is run with spatially correlated random number streams to ensure spatial consistency. As a downside, multi-site weather generators are much more complex to develop, but they are a very promising alternative downscaling technique. A new multi-site-weather generator was developed for Switzerland in a previous study (Keller et al. 2014).
In this study, we tested this new multi-site-weather generator against the “standard” delta change derived data in a hydrological impact assessment study that focused on runoff in the meso-scale catchment of the river Thur catchment. Two hydrological models of different complexity were run with the data sets under present (1980-2009) and under future conditions (2070-2099), assuming the SRES A1B emission2070-2100 scenario conditions. Eight meteorological stations were used to interpolate a meteorological field that served as input to calibrate and validate the two hydrological models against runoff. The downscaling intercomparison was done for We applied 10 GCM-RCM combinations simulations of the ENSEMBLES. In case of the weather generator, that allows for multiple synthetic realizations, we generated for which change factors for each station (delta change approach) were available and generated 25 realizations of multi-site weather. with each climate model projection.
Results show that the delta change driven data constitutes only one appropriate representation compared to theof a bandwidth of runoff projections yielded by the multi-site weather generator data. Especially oOn average, differences between both the two approaches are small. Low and high runoff Runoff values to both extremes are however better reproduced with the weather generator driven data set. The stochastic representation of multiday rainfall events are considered as the main reason. Hence, tThere is a clear yet small added value to the delta change approach that in turn performs rather well. Although these small but considerable differences might questioning the need to construct a multi-site-weather generator with a huge effort, the potential and possibilities to further develop the multi-site weather generator is undoubted.