Geophysical Research Abstracts
Vol. 12, EGU2010-534-1, 2010
EGU General Assembly 2010

High resolution temporal rainfall data generation for climate change studies

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The lack of temporal high-resolution rainfall data is one of the most prominent limiting factors in hydrological and water quality simulations. Most climate change models predict that precipitation patterns will change and that extreme meteorological events are likely to occur more frequently. For climate change studies future climate scenarios are needed which are generally available on daily or six hourly time step. Fine timescale rainfall data of at least 30 minute is required for soil erosion and sediment transport calculations. However, such data are not available for future climate conditions. Therefore it is necessary to develop a disaggregation procedure which is applicable for a wide range of daily and hourly rainfall data.

This study evaluates the generation of high-resolution rainfall data at a point location. We use the coupling of the Hyetos and Cascade approach to disaggregate the daily rainfall data up to 10 minute rainfall intensities. In this study we developed a criteria by dividing the daily rainfall data into four different categories according to their magnitude, i.e. 1-10 mm, 11-25 mm, 26-50 mm and 51-above mm and disaggregate each category according to the following three steps: (1) calculating the Bartlett-Lewis Rectangular Pulse Parameter (BLRP) from historical data, (2) disaggregate the future statistically downscaled data (WETTREG Model) using historical BLRP parameters and Hyetos disaggregation model (disaggregate from daily to hourly); and (3) further disaggregation of hourly data into sub-hourly up to 10 minute rainfall intensity using random multiplicative cascade approach.

The combination of two models, Hyetos and Cascade approach are successfully applied on the complete range of precipitation. We tested this technique on summer and winter precipitation on different amounts for selected stations with varying elevations to cover a range of rainfall pattern. Dividing the rainfall amount into magnitude categories gives us good result for calibration and validation and it also decrease the sum of weighted square error near to zero during calculation of BL parameters in each category. It especially improves the simulation of high rainfall intensities which occurs occasionally. Standard deviation of simulated precipitation is around 78.2% in winter and 88.8% in summer of observed precipitation in the validation mode, variation is around 36.2% in winter and 75.6% in summer and skewness is around 67.2% in winter and 97.2% in summer, respectively.

The generated high resolution rainfall data can especially be used for process based hydrological and soil erosion modeling. This approach is general and can be used for other climate conditions.