AOGS 2005

On the Linkage of Large-Scale Climate Variability with Local Characteristics of Daily Precipitation and Temperature Extremes: An Evaluation of Statistical Downscaling Methods

VAN-THANH-VAN NGUYEN[1], TAN-DANH NGUYEN[1] and PHILIPPE GACHON[2]
[1]*McGill University, Montreal, Quebec, Canada*
[2]*Environment Canada and OURANOS Consortium, Montreal, Quebec, Canada*

General Circulation Models (GCMs) have been recognized to be able to represent reasonably well the main features of the global atmospheric circulation but could not reproduce well details of regional climate conditions at temporal and spatial scales of relevance to hydrological impact studies. Hence, there is a need to develop tools for downscaling GCM predictions of climate change to regional scales. Of particular importance for water management purposes are those tools dealing with the linkage of the climate variability to the historical observations of the surface parameters of interest (e.g., precipitation and temperature). If this linkage could be established, then the projected change of climate conditions given by a GCM could be used to predict the resulting change of the selected surface parameters.

In general, two broad categories of downscaling procedures currently exist: dynamical downscaling (DD) and statistical downscaling (SD). DD procedures are mainly based on regional climate models (RCMs) that describe the climate processes using fundamental conservation laws for mass, energy and momentum. DD methods contain thus more complete physics than SD techniques, but require expensive computational costs. On the other hand, SD approaches are relatively fast and much less expensive. Hence, SD methods could be used to develop a large number of different climate realizations and thus could be able to quantify the confidence interval of simulated climate variables. In addition, results of SD methods are more consistent with the local climate conditions since they can directly account for the observed weather data available at the local site.

The main objective of this study is to perform a critical assessment of various existing SD techniques in order to find the most suitable procedure for hydrological impact studies. Of particular interest is the ability of SD techniques to simulate accurately the characteristics of precipitation and temperature extremes. More specifically, the feasibility of two popular downscaling methods, namely the Statistical Downscaling Model (SDSM) and the Stochastic Weather Generator (LARS-WG) Model, were assessed using daily precipitation and temperature extreme data available in the southern Quebec region in Canada for the 1961-1990 period. In general, it was found that both models were able to describe accurately the basic statistical properties of daily temperature extremes at local sites. However, none of these models appears to be able to simulate well the statistical properties of daily precipitation processes. Finally, the LARS-WG is relatively easy for use as compared with the SDSM since it requires a simpler calibration method for parameter estimation.