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Statistical Downscaling of Daily Precipitation Process by Regression Methods

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Climate change will have important impacts on the hydrologic cycle at different temporal and spatial scales. The temporal scales could vary from a very short time interval of 5 minutes (for urban water cycle) to a yearly time scale (for annual water balance computation). The spatial resolutions could be from a few square kilometers (for urban watersheds) to several thousand square kilometers (for large river basins). General Circulation Models (GCMs) have been recognized to be able to represent reasonably well the main features of the global distribution of basic climate parameters, but outputs from these models are usually at resolution that is too coarse (generally greater than 200km) for many impact studies. Hence, there is a great need to develop tools for downscaling GCM predictions of climate change to regional and local or station scales. In recent years, different downscaling methods have been proposed. Of particular importance for hydrological impact studies are those procedures dealing with the linkage of the large-scale climate variability to the historical observations of the daily precipitation process at a local site. 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 local precipitation characteristics. The required linkage can be developed using a wide range of downscaling methods. Two broad categories of downscaling procedures currently exist: dynamical downscaling (DD), based on the modeling of regional climate dynamical processes, and statistical downscaling (SD) methods that relied on the empirical relationships between observed (or analyzed) large-scale atmospheric variables and observed surface environment parameters. In particular, it has been widely recognized that SD methods offer several practical advantages over DD procedures, especially in terms of flexible adaptation to specific study purposes, and inexpensive computing resource requirements. However, several different SD techniques currently exist, but there is no general agreement regarding the choice of the best method. Hence, it is necessary to test different SD methods in order to find the most suitable approach for a particular region of interest. This paper presents therefore a critical assessment of several regression-based SD methods that have been widely used for constructing climate change scenarios for daily precipitations at local sites using GCM grid point information The selected SD techniques include the popular Statistical Downscaling Model (SDSM), the stepwise regression, the weighted least square regression, and the principal component regression. These SD methods were evaluated using the large-scale NCEP re-analysis atmospheric data and the historical daily precipitations available at Dorval Airport station in Quebec (Canada) for the period from 1961 to 1990, of which the first 15 years were used for models' calibration and the remaining 15 years for models' validation. The performance of the selected methods was examined by comparing the statistics of observed data time series to those of 100 simulated time sequences. On the basis of this comparison, the strength and weaknesses of these SD methods are identified and discussed in the present paper.