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Using Distributed Precipitation in TOPMODEL approach for Large-Scale Basins

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Generalized Circulation Models (GCMs), representing physical processes in the atmosphere, ocean, cryosphere and land surface, are the most advanced tools currently available for simulating the global climate system. In the past decade, GCM modeling using large-scale runoff routing models (RRMs) has received special attention. TOPMODEL is a hydrological model based on variable source area assumption. Its main parameter is the topography index derived from a digital elevation model. This study has the objective to apply a modified GIS-based TOPMODEL approach as a RRM and to carry out stream discharges simulation and predictions using a climate projection. Three large-scale basins were selected, the Amazon basin (7.05 million km^2), the Yangtze basin (1.72 million km^2) and the Brahmaputra basin (1.73 million km^2). The global topographic data was extracted using ETOPO5 data, from the National Geophysical Data Center (NGDC), National Environmental Satellite (NOAA). Basins boundaries and stream networks were acquired from Global Runoff Data Center (GRDC) and Global Drainage Basin Database (GDBD), respectively. The climate observed daily data were obtained from the Intergovernmental Panel on Climate Change (IPCC). For daily data model calibration, time series for the Amazon data encompass the period from 1990 to 1995. For the Yangtze basin the period of data used corresponds to the 2004 year and for Brahmaputra basin from 1990 to 1991. The Penman method was used to estimate evapotranspiration. For discharge predictions the climate projection data (MRI AR4, A1B scenario, 20 km mesh resolution) was obtained from KAKUSHIN program which has the objective to establish a probabilistic global warming projection by using both GCM and an earth system model with intermediate complexity (EMIC), combined with advanced statistical techniques. The original TOPMODEL approach was utilized in a cell-to-cell framework, therefore, the spatial distributed rainfall data from GCMs could be used. However, the redistribution of local saturation deficits was carried out according to the original approach. It implies that the model uses the mean saturation deficit and the local topographic index for redistribution. This approach saves computational time for the reason there is no necessity to calculate the water balance for each cell in the grid. A routine was implemented to compute the distances from the outlet to each cell in order to routing the flow using a velocity parameter. Monte Carlo simulations were used to find the best set of parameters according to the Nash-Sutcliffe coefficient. The simulations using the new TOPMODEL distributed approach were compared to the original one. The results show that the modified TOPMODEL approach produced better results than the original TOPMODEL approach (Figure 1).

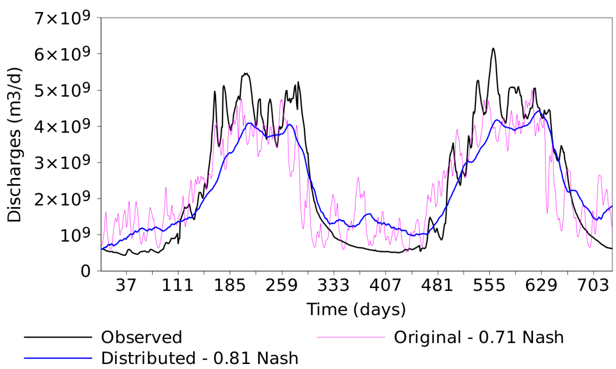

Figure 1: Brahmaputra basin simulations.