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Hydrologic and Hydrodynamic Modelling of the Amazon Basin using TRMM Rainfall Estimates

Rodrigo Cauduro Dias de Paiva (1), Diogo Costa Buarque (1), Walter Collischonn (1), Mino Sorribas (1), Daniel Gustavo Allasia (1), Carlos André Bulhões Mendes (1), Carlos Eduardo Moreli Tucci (1), and Marie-Paule Bonnet (2)

(1) Instituto de Pesquisas Hidráulicas – IPH/UFRGS, Porto Alegre, Brazil (rodrigocdpaiva@gmail.com), (2) IRD – Institut de Recherche pour le Développement, LMTG,Toulouse, France

To minimize risk to extreme hydrological events it is necessary to act preventively by improving understanding of the natural system and through reduction of vulnerability and uncertainty through the prediction of weather, climate and hydrology. Forecast systems based on hydrological models are one of the main tools to achieve these goals. In the case of the Amazon, hydrological modelling is an enormous challenge because of its size, limited data, regional climatic diversity and particular hydraulic features which include low gradients, back-water effects and extensive inundated areas. However, uncertainties in rainfall arising from limited ground-level measurements and low raingauge density, impose severe difficulties, particularly in parts of the drainage basin lying outside Brazil. Rainfall estimation by remote sensing using satellite-derived data from the Tropical Rainfall Measuring Mission (TRMM) is a possible means of supplementing raingauge data, having better spatial cover of rainfall fields. This study describes the large-scale hydrological model developed for the whole Amazon River basin, named MGB-IPH, which is expected to be used in the future as part of a hydrological forecasting system, and reports on the use of such model with rain fields obtained from TRMM 3B42 algorithm. The MGB-IPH is a distributed, physically-based model in which river basin is discretized into several catchments and each catchment is divided in Hydrological Response Units (HRUs). The HRUs are usually defined using a combination of soil types and land cover maps. The model uses physical based equations to simulate the hydrological processes, such as the Penman Monteith model for evapotranspiration.. River routing is done either using the Muskingum-Cunge method or a full hydrodynamic model, or a combination of both. The hydrodynamic model uses the full Saint Venant equations, a simple floodplain storage model and GIS based parameters extracted from Digital Elevation Models, and is capable of simulating backwater effects and seasonally flooded floodplains. Applying the model to the whole Amazon basin required development of several pre-processing tools to generate the necessary data for the hydrodynamic model, based on relatively poor information. Using the SRTM DEM with 15" resolution (approximately 500 m) we derived information about river cross-sections, floodplain extent, flood volume, and water slope. The model is able to generate results of streamflow and water level at thousands of places in the Amazon basin, and we compared these results to observed data at several points. Although TRMM under-estimates rainfall in regions with more marked relief, such as the transition region between the Amazon and the Andean regions of Peru, Ecuador and Colombia, resulting in an underestimation of discharge in parts of those regions, the model showed to be able to well reproduce observed hydrographs in Amazon River and main tributaries. In general, comparisons of model results with discharge observations at several locations throughout the basin showed that model performance was good and the use of TRMM 3B42 as input data is encouraging.