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Evaluation of a large scale flow routing scheme in the Amazon basin

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This study evaluates the Hydrological Modeling and Analysis System (HyMAP), a global flow routing scheme specially developed to route runoff and baseflow derived from land surface models (LSM) in off-line mode. HyMAP is composed of four modules representing: (1) the surface runoff and baseflow time delays; (2) the interaction between floodplains and rivers; (3) river and floodplain water flow among grid cells; and (4) evaporation from open waters. The relationship between flooded area, water level and storage, as prescribed by the Flexible Location of Waterways (FLOW) method is improved by taking into account river water surfaces in a post-processing procedure. Flow directions, river length and slope are also prescribed on a subgrid-scale basis as provided by FLOW, at a 0.25° spatial resolution. Horizontal water flow in both rivers and floodplains is calculated with the kinematic wave equation, using the Manning equation to compute flow velocity. The daily computation of evaporation from open waters is based on the Penman-Monteith equation. As a first experiment, HyMAP is coupled in off-line mode with the Interaction Sol-Biosphère-Atmosphère (ISBA) to simulate the surface water dynamics in the Amazon basin. The Princeton University 3-hourly atmospheric dataset is used as input to force the system. The model is evaluated over the 1986-2006 period against a large in situ and satellite-based dataset, including water discharge and level, flow velocity and floodplain extent. The model can satisfactorily simulate the water surface dynamics of the Amazon River basin. As a general rule, very good results are obtained in the main rivers while small tributaries showed some limitations in water discharges and levels. Among all stream gauges used in the evaluation process, 39 (or 23% of the total) have Nash-Sutcliffe (NS) coefficients higher than 0.50 and 117 (or 68%) above zero. About 28% of stations have volume errors lower than 15%. Discharges are very well simulated at Óbidos, with NS=0.89. The floodplain extent at the basin scale is well represented with a relative error of 7% and correlation of 0.89. These results indicate non-negligible improvements in comparison to previous studies of the same region. Finally, it is demonstrated that the evaporation from open waters has low impact on the basin water balance and that water is mainly stored in rivers or is in transport at the subgrid-scale.