Advances on the integration of spatial altimetry data into the automatic calibration of hydrological models

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The need for more accurate spatio-temporal predictions of water availability in a changing climate has motivated the development of several satellites dedicated to measure the global water balance components in the last decades. In particular, the radar altimetry, firstly developed to measure ocean level changes, has revealed to be a useful tool for the understanding of the water cycle in ungauged and poorly gauged areas where in situ data are scarce or nonexistent. This study presents an optimization procedure for the automatic calibration of hydrological models based exclusively on spatial altimetry data. This means that observed water discharge is not required used as the target of the calibration procedure. The technique is based on the minimization of biases between discharges computed by the MGB-IPH hydrological model and by stage-discharge relations (h×Q models) derived from the combination of spatial altimetry data and modeled discharges at virtual stations. The study area is the Branco River basin, located in the Northern Amazon basin. Spatial altimetry data provided by the ENVISAT satellite at four virtual stations are used in the optimization process for the 2002-2006 period. Eleven scenarios are evaluated. They differ from each other by the nature of the data used to guide the optimization process (spatial altimetry and water discharge), by the objective functions to be minimized and by the equation used to relate stage and discharge. Optimal simulated discharges at the daily time step are evaluated at the Caracarai station with the Nash-Sutcliffe (NS), NS for the logarithms of stream flow (LNS) and relative error (RE) coefficients. For scenarios using spatial altimetry data, NS varied from 0.66 to 0.94, LNS from 0.61 to 0.95 and RE from 0.18 to 0.73. For scenarios with observed discharges, the best coefficients are 0.94, 0.96 and 0.16, respectively. Zero-flow river depths derived from the h×Q models are compared to ADCP measurements. Absolute differences vary from 0.04m to 1.10m, according to the scenario.

Keywords: Automatic calibration, spatial altimetry, hydrological model, rating curve, ENVISAT, MGB-IPH, MOCOM-UA, Amazon basin