Geophysical Research Abstracts
Vol. 18, EGU2016-18142, 2016
EGU General Assembly 2016

Identifiability of altimetry-based rating curve parameters in function of river morphological parameters

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Estimating river discharge for ungauged river reaches from satellite measurements is not straightforward given the nonlinearity of flow behavior with respect to measurable and non measurable hydraulic parameters. As a matter of facts, current satellite datasets do not give access to key parameters such as river bed topography and roughness. A unique set of almost one thousand altimetry-based rating curves was built by fit of ENVISAT and Jason-2 water stages with discharges obtained from the MGB-IPH rainfall-runoff model in the Amazon basin. These rated discharges were successfully validated towards simulated discharges (E_{ns} = 0.70) and in-situ discharges (E_{ns} = 0.71) and are not mission-dependent. The rating curve writes Q = a(Z-Z_0)^b*sqrt(S), with Z the water surface elevation and S its slope gained from satellite altimetry, a and b power law coefficient and exponent and Z_0 the river bed elevation such as Q(Z_0) = 0. For several river reaches in the Amazon basin where ADCP measurements are available, the Z_0 values are fairly well validated with a relative error lower than 10%. The present contribution aims at relating the identifiability and the physical meaning of a, b and Z_0given various hydraulic and geomorphologic conditions. Synthetic river bathymetries sampling a wide range of rivers and inflow discharges are used to perform twin experiments. A shallow water model is run for generating synthetic satellite observations, and then rating curve parameters are determined for each river section thanks to a MCMC algorithm.

Thanks to twin experiments, it is shown that rating curve formulation with water surface slope, i.e. closer from Manning equation form, improves parameter identifiability. The compensation between parameters is limited, especially for reaches with little water surface variability. Rating curve parameters are analyzed for riffle and pools for small to large rivers, different river slopes and cross section shapes. It is shown that the river bed elevation $Z_0$is systematically well identified with relative errors on the order of a few %. Eventually, these altimetry-based rating curves provide morphological parameters of river reaches that can be used as inputs into hydraulic models and *a priori* information that could be useful for SWOT inversion algorithms.