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Global determination of rating curves in the Amazon basin from satellite altimetry

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The Amazonian basin is the largest hydrological basin all over the world. Over the past few years, it has experienced an unusual succession of extreme droughts and floods, which origin is still a matter of debate. One of the major issues in understanding such events is to get discharge series distributed over the entire basin. Satellite altimetry can be used to improve our knowledge of the hydrological stream flow conditions in the basin, through rating curves. Rating curves are mathematical relationships between stage and discharge at a given place. The common way to determine the parameters of the relationship is to compute the non-linear regression between the discharge and stage series. In this study, the discharge data was obtained by simulation through the entire basin using the MGB-IPH model with TRMM Merge input rainfall data and assimilation of gage data, run from 1998 to 2009. The stage dataset is made of $\sim$900 altimetry series at ENVISAT and Jason-2 virtual stations, sampling the stages over more than a hundred of rivers in the basin. Altimetry series span between 2002 and 2011.
In the present work we present the benefits of using stochastic methods instead of probabilistic ones to determine a dataset of rating curve parameters which are hydrologicaly meaningful throughout the entire Amazon basin. The rating curve parameters have been computed using an optimization technique based on Markov Chain Monte Carlo sampler and Bayesian inference scheme. This technique provides an estimate of the best value for the parameters together with their posterior probability distribution, allowing the determination of a credibility interval for calculated discharge. Also the error over discharges estimates from the MGB-IPH model is included in the rating curve determination. These MGB-IPH errors come from either errors in the discharge derived from the gage readings or errors in the satellite rainfall estimates.
The present experiment shows that the stochastic approach is more efficient than the determinist one. By using for the parameters prior credible intervals defined by the user, this method provides an estimate of best rating curve estimate without any unlikely parameter. Results were assessed trough the Nash Sutcliffe efficiency coefficient. Ens superior to 0.7 is found for most of the 920 virtual stations . From these results we were able to determinate a fully coherent map of river bed height, mean depth and Manning's roughness coefficient, information that can be reused in hydrological modeling. Bad results found at a few virtual stations are also of interest. For some sub-basins in the Andean piemont, the bad result confirms that the model failed to estimate discharges overthere. Other are found at tributary mouths experiencing backwater effects from the Amazon. Considering mean monthly slope at the virtual station in the rating curve equation, we obtain rated discharges much more consistent with modeled and measured ones, showing that it is now possible to obtain a meaningful rating curve in such critical areas.