Large-scale estimation of river bathymetry using a global river model and satellite altimetry

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Satellite altimetry has played an increasing role in monitoring river processes. Its observation is more accurate but temporally and spatially sparse, compared with global river routing models. Hence, the integration of satellite altimetry and river routing models is expected to help improving model performance and better understanding river processes.
A river bankfull depth (RBD), one of the dominant topographic parameters in the models, is difficult to observe directly from satellites because electromagnetic waves reflect on the water surface. The currently prevalent RBD dataset was produced by an empirical equation as a function of the runoff amount. Previous studies showed that this dataset has a considerable errors.
Here, we developed a new method to estimate RBD efficiently on a large scale by integrating a global river routing model (CaMa-Flood) and a satellite altimetry dataset (Hydroweb, http://hydroweb.theia-land.fr). It consists in updating the original CaMa-Flood RBD based on the assumption that the discrepancy in water surface elevation between the model outputs and Hydroweb data is entirely due to RBD inaccuracy. Then, we validated the method under the framework of an observing system simulation experiment. It was confirmed that RBD would be improved even if there were uncertainties on observed runoff. We also clarified the conditions where the RBD estimation was susceptible to the uncertainty of runoff.
Finally, we adapted the method with real data from Hydroweb in the Amazon river basin. The updated RBD can represent local topographic variability and is generally deeper in downstream areas and shallower in upstream ones than the original RBD. This update in the model parameter reduced the overestimation of inundation ratio by at most 20% when it was validated with a SAR observation. This improvement will be significant for realizing more accurate flood estimation.

Keywords: River Bathymetry, Global River Model, Satellite Altimetry

