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Inferring river properties with SWOT like data

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Inverse problems in hydraulics are still open questions such as the estimation of river discharges. Remotely sensed measurements of hydrosystems can provide valuable information but adequate methods are still required to exploit it. The future Surface Water and Ocean Topography (SWOT) mission would provide new cartographic measurements of inland water surfaces. The highlight of SWOT will be its almost global coverage and temporal revisits on the order of 1 to 4 times per 22 days repeat cycle [1]. Lots of studies have shown the possibility of retrieving discharge given the river bathymetry or roughness and/or in situ time series. The new challenge is to use SWOT type data to inverse the triplet formed by the roughness, the bathymetry and the discharge.
The method presented here is composed of two steps: following an inverse formulation from [2], the first step consists in retrieving an equivalent bathymetry profile of a river given one in situ depth measurement and SWOT like data of the water surface, that is to say water elevation, free surface slope and width. From this equivalent bathymetry, the second step consists in solving mass and Manning equation in the least square sense [3]. Nevertheless, for cases where no in situ measurement of water depth is available, it is still possible to solve a system formed by mass and Manning equations in the least square sense (or with other methods such as Bayesian ones, see e.g. [4]). We show that a good a priori knowledge of bathymetry and roughness is compulsory for such methods. Depending on this a priori knowledge, the inversion of the triplet (roughness, bathymetry, discharge) in SWOT context was evaluated on the Garonne River [5, 6]. The results are presented on 80 km of the Garonne River downstream of Toulouse in France [7]. An equivalent bathymetry is retrieved with less than 10% relative error with SWOT like observations. After that, encouraging results are obtained with less than 10% relative error on the identified discharge.

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