Geophysical Research Abstracts
Vol. 21, EGU2019-14058, 2019
EGU General Assembly 2019
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Inference of complex and spatially distributed braided river channels parameters and inflows discharges by assimilation of historical altimetric time series and forthcoming SWOT data

Pierre-André Garambois, Kevin Larnier, Léo Pujol, Pascal Finaud-Guyot, Amanda Montazem, Jérôme Monnier, Adrien Paris, Sylvain Biancamaria, and Stéphane Calmant

INSA - ICUBE, Fluid Mechanics Team - University of Strasbourg - CNRS, France
(pierre-andre.garambois@insa-strasbourg.fr)

River discharge is an essential physical variable integrating upstream hydrological processes and its inference from multisatellite Water surface (WS) observables remains a challenging question especially when river bathymetry and friction are unknown or poorly known. This is a key issue in view to take advantage of the forthcoming SWOT observations of worldwide rivers wider than 100m with 1 to 4 revisits per 21 days repeat cycle [1] which should bring an unprecedented hydraulic visibility of river flows as defined in [4, 7]. This ill-posed hydraulic inverse problem, with an important identifability issue between effective bathymetry/friction pairs (e.g. [5, 6] among others) is particularly difficult in the case of complex river channel morphologies (e.g. braided rivers, floodplains), and even more in case of multiple lateral flows as for river networks portions.

This contribution, in view of worldwide inferences of river discharges from multisatellites WS observables, presents an extension of the Hierarchical Variational Discharge Inference (HiVDI) algorithm proposed in [6] (DassFlow hydraulic models http://www.math.univ-toulouse.fr/DassFlow) for accounting for complex friction laws and lateral fluxes. It is based on effective and parcimonious hydraulic models taylored in a « satellite reference » from decades of historical altimetric time series on inland waters [3] and water masks [9] and a variational assimilation method [6]. First an effective modeling of braided river portions is proposed following [4] with a distributed friction parameterization depending on hydraulic model state (water depth) enabling to describe altimetric stage-discharge relationships [8]. Next a variational assimilation strategy is tested for infering spatially distributed discharge hydrographs on long river profiles with lateral flows (e.g. confluences, groundwater) and braided flow zones from water surface observations. The capabilities of the method are illustrated on the Xingu and Negro Rivers, two first order Amazone tributaries, with real satelite datasets and SWOT synthetic observations.

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