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Discharge and bathymetry estimations of rivers from SWOT like data

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We present an inverse method enabling to estimate the discharge and an effective bathymetry of rivers observed by altimetry only, in particular from the forthcoming SWOT mission (NASA-CNES et al., 2021). First an original reading of the inverse problem is proposed in terms of wave propagations through “identifiability maps”. Next dedicated low complexity systems are derived to obtain simple (algebraic) relations between the three critical flows unknowns: the discharge Q(x,t), an effective bathymetry b(x) and the corresponding friction parameter (Manning-Strickler) K(x;h) (h the water depth). Next an advanced Variational Data Assimilation (VDA) formulation based on the complete physics (Saint-Venant’s equations) is elaborated. The resulting Hierarchical Variational Discharge Inference (HiVDI) algorithm turns out to be robust and relatively accurate passed the assimilation of a hydrological cycle ($\sim$ 1 year variations, considered as a “learning period”).
Next, given the identified parameters (b(x), K(h)) during this “learning period”, the low complexity systems enable to estimate Q(x,t) in real-time.
Numerical results on numerous river datasets are analysed in detail; SWOT-like measurements may be provided by the instrument simulator.

References

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[3] "DassFlow: Data Assimilation for Free Surface Flows", open-source computational software. Mathematics Institute of Toulouse, INSA, CNRS, CNES, CS corp. http://www.math.univ-toulouse.fr/DassFlow