Intercomparison of discharge estimation methods From synthetic river surface observations from space (SWOT like data)

Study rationale going forward: Defining the investigation plan

by

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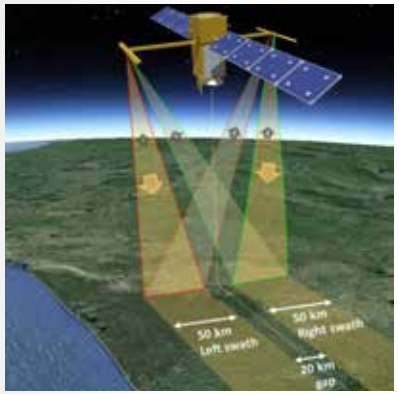
SWOT science team, June 2018, Montreal,

Discharge algorithm working group

Outline

- Hydraulic Inverse problem(s) from river surface observables
- Scientific goal and motivations for a benchmark
- Inversion methods proposed
- Defining an Intercomparison method and plan?
- Conclusion/Perspectives

What is river hydraulic parameters inversibility with SWOT data?



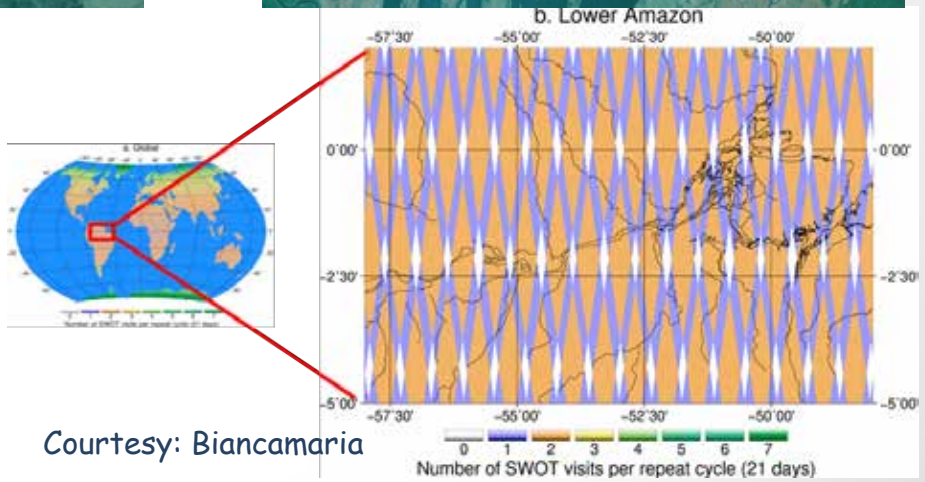

Garonne river (Toulouse, France)


Congo River (Border of Congo and RDC)

Challenging points:

Unobservable river bathymetry?

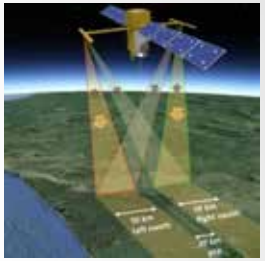
Link between basal friction an topography?



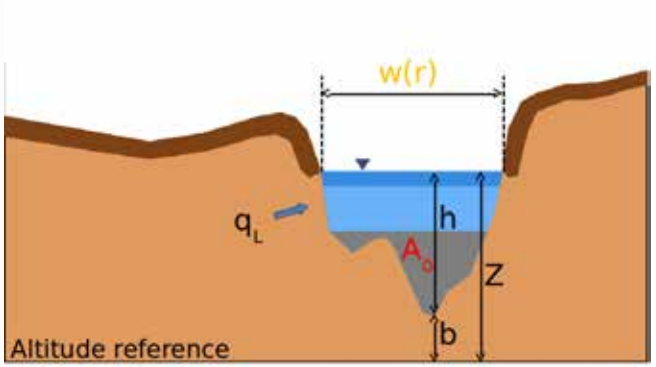
Courtesy: Biancamaria

Tanana River (Alaska, US)

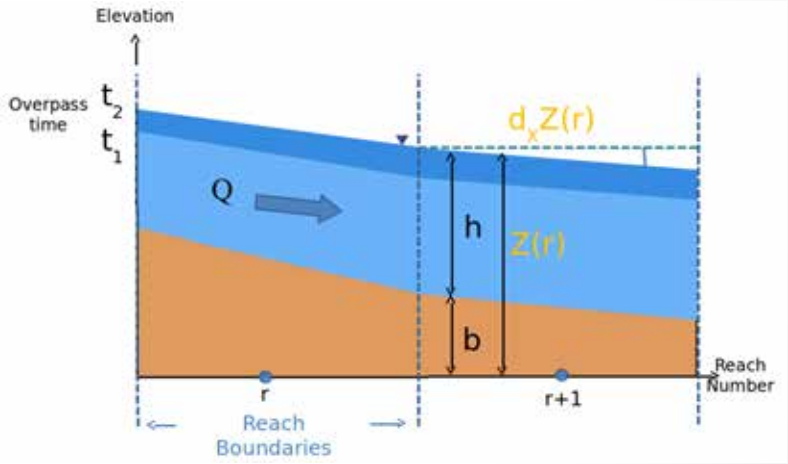
Local Hydraulic inverse problems given the observability of river flow surfaces in a SWOT context



- Reach averaged SWOT obs. (Z, W, Slope) + temporal revisits
- **Challenging points:** Unobservable river bathymetry? Link between basal friction and topography?



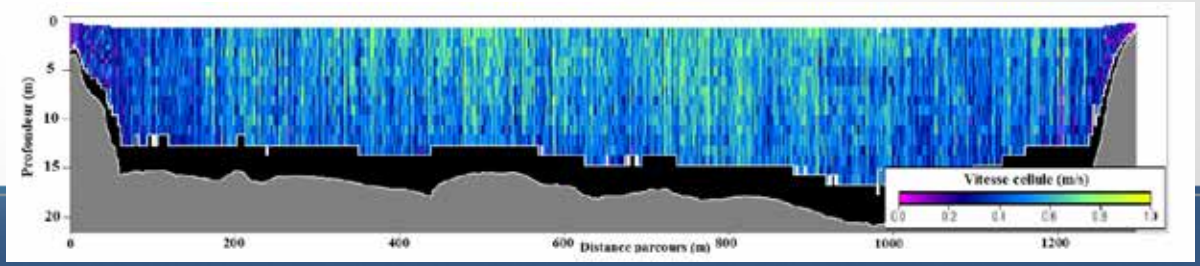
Case of single thread channels



→ Underconstrained and ill-posed inverse problems

→ Tiplet (Q, A0, K) « Equifinality » (e.g., Aronica et al. 1998, Roux and Dartus 2008, Garambois and Monnier 2015, Brisset et al. 2016, 2018, Oubanas 2018, Larnier et al. subm., among others)

A real velocity profile, Rio Negro at Novo Airão in 12/15 (ADCP Measurement) – Source Paris 2015



Scientific goal and motivations for a benchmark

- **The estimation of the discharge is more or less challenging depending on the space-time observations density (and nature!), the prior information quality and the measurement errors**

- **Few low complexity methods proposed based on: steady flow models, hydraulic geometries, empirical power laws. Intercomparison on 19 rivers** (cf. Durand et al. 2016)**, variable accuracy and not robust**

- **A benchmark of data assimilation methods was proposed during SWOT ST 2016 (cf. talk "Approaches to DA Intercomparison",** Andreadis, K., Biancamaria, S. , Garambois P.-A., Gejadze, I., Malaterre, P.-O., Monnier, J., Oubanas, H., Ricci, S., Roux, H.)

- **Goal of the present study: Asses the inference capabilities of several inverse methods (either based on Saint-Venant equations or empirical models) based on SWOT data**

Scientific goal and motivations for a benchmark

- **Context of the study:**
  - 5 inversions methods proposed (BAM, DassFlow, Filtering, Metroman, SIC)
  - 32 river portions of O(10) to O(100km) in length
  - Various hydrological and geomorphological contexts, hydraulic complexities
  - Daily “SWOT like” observables
  - Some cases out of the scientific requirements (river width < SWOT detection capacity…)

- **Given a first guess on discharge, bathymetry and roughness** (Q_0, b_0, K_0) **“SWOT like” observables (evenly spaced in time, various spatial samplings)**
  → **How is discharge inferable?** (Formulate more precise questions)

5 forward and inverse modeling paradigm proposed

BAM (UMASS) - Bayesian Metropolis – hydraulic geometries

DassFlow (IMT-ICUBE) - 1D Saint-Venant, variationnal, hierarchical

MetroMan (OSU) - Metropolis Manning equation

SAD (JPL) - Filtering method

SIC4DVar (G-eau) - 1D Saint-Venant, variationnal

Possible Questions/Axes for this study

- **How is discharge inferable?** (Formulate more precise questions)

→ Who solve which inverse problems – parameters, hypothesis?

→ What information on discharge identifiability can be gained from this intercomparaison – specific problems brought by 30 rivers with daily observables?

→ Extensive presentation of all parameters/hypothesis of each algorithms hypothesis is needed – accuracy is not robustness.

- **Which Physical Criteria/discharge signal features matter - Cost functions for assessment ?** (RMSE, NASH, Volume, Nash(f(Q)), Kling-Gupta, others ?)

- The present investigations consist in finding « best possible performances » expectable (interpolation capacities in a **non blind context**, good first guesses), predictive?

- From questions we will formulate, prepare a plan of inversions and result analysis

- Others questions/ideas : …

Towards discharge products?

- Is it possible to build a « discharge product » from the current state of those researches – robustness?
- **For which reasons is a SWOT discharge allowed to have « poor performances »?**
- Meaning of an aggregation of various estimates from different methods - (K,A0) on the worldwide river reaches seen by SWOT?
- Crucial point of uncertainty estimation in case of an aggregation for the « basic » discharge product, **is a standrard deviation attribute needed**?
- Real data errors?
- Real samplings, observation errors, gaps?
- **Blind testing on very few, well designed (goals) test cases** – need for a third party to produce test cases (with SWOT simulator?)
- Discussion: …