(Air)SWOT variational Data Assimilation: identification, sensitivities, and hierarchical models. Method and test Case on the Garonne River (France)

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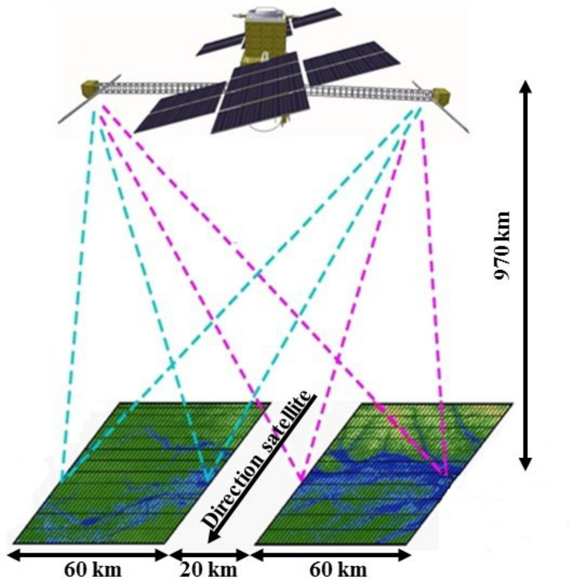
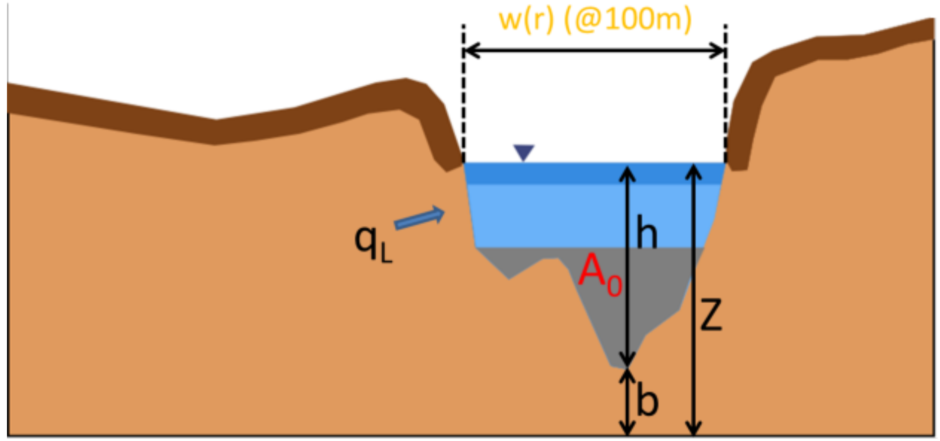
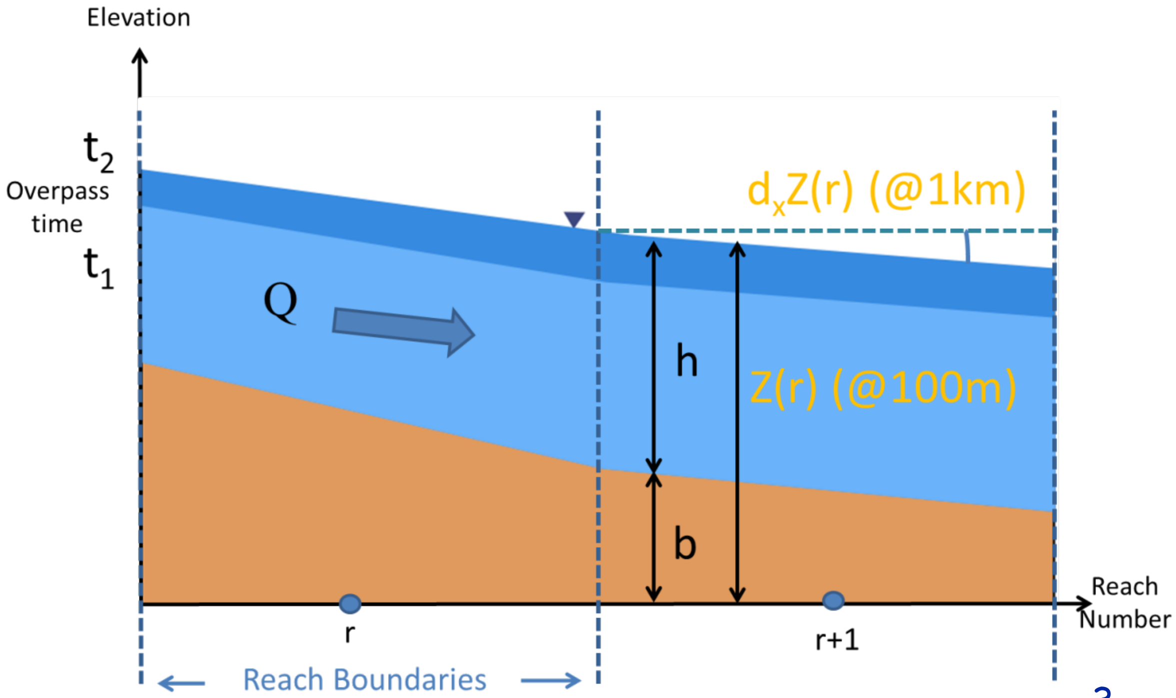
Plan

- **Context of the issue: inversion algorithms for SWOT data**
- **Discharge identification on the Garonne river: preliminary tests**
- **Equifinality problem**
- **Current work: a hierarchy of models for morpho-hydraulics parameters identification**

Context: inversion algorithms for SWOT data, continental hydrology and hydraulics.







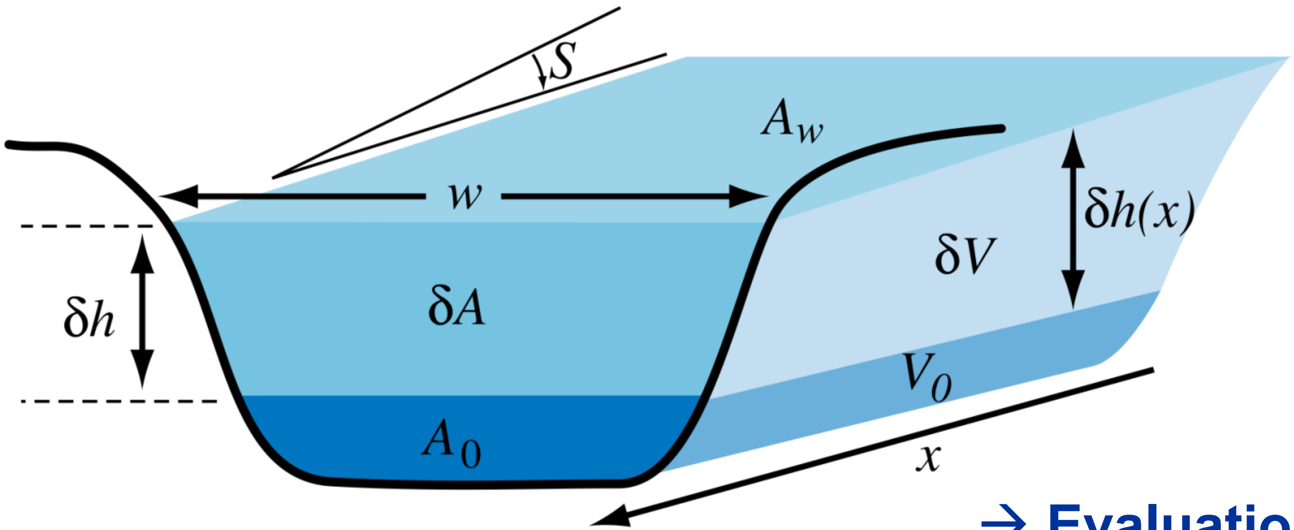
Cartographic data:

-Elevation, width and slope
-Temporal revisits

Cross sectional Manning equation
SWOT observables

Unobserved — Observed — Observed

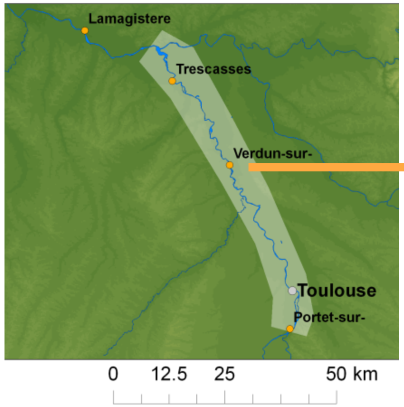
$$Q \approx \frac{1}{n}(A_0 + \delta A)^{5/3} w^{-2/3} (S_0 - \partial_x h)^{1/2}$$

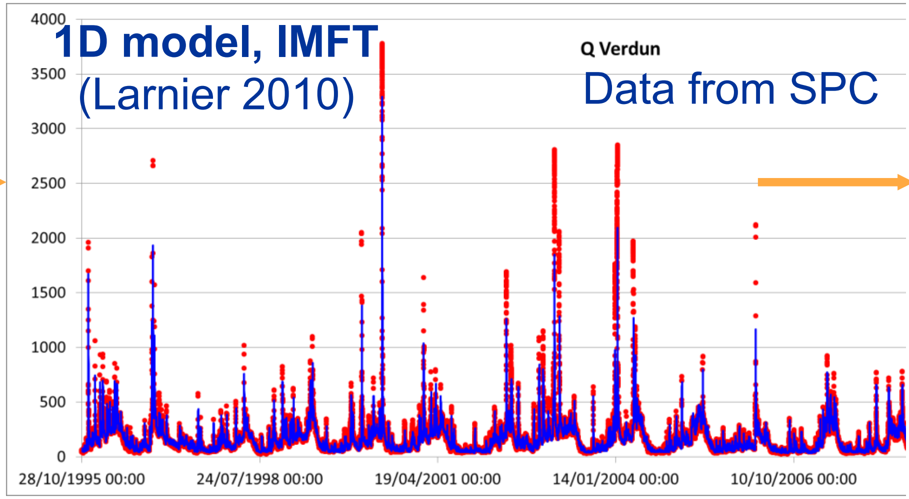


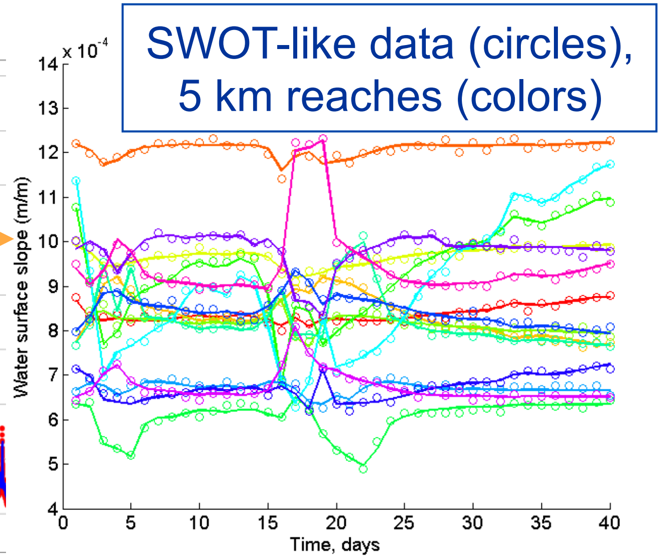
SWOT observables
(Source [Rodriguez 2012])

- → **Evaluation of n and A_0 ?**
- → **n is not constant in time**
- → **downstream averaging distance ?**

Test of a discharge algorithm: upper Garonne river (Toulouse – Malause)





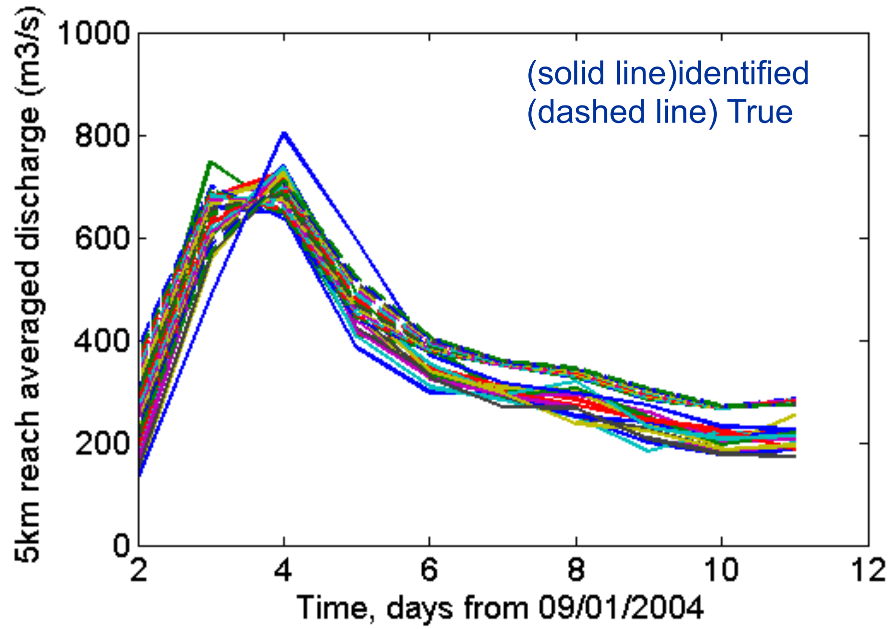


First guess (A_0, n), SWOT obs (w, Z, $d_x h$)

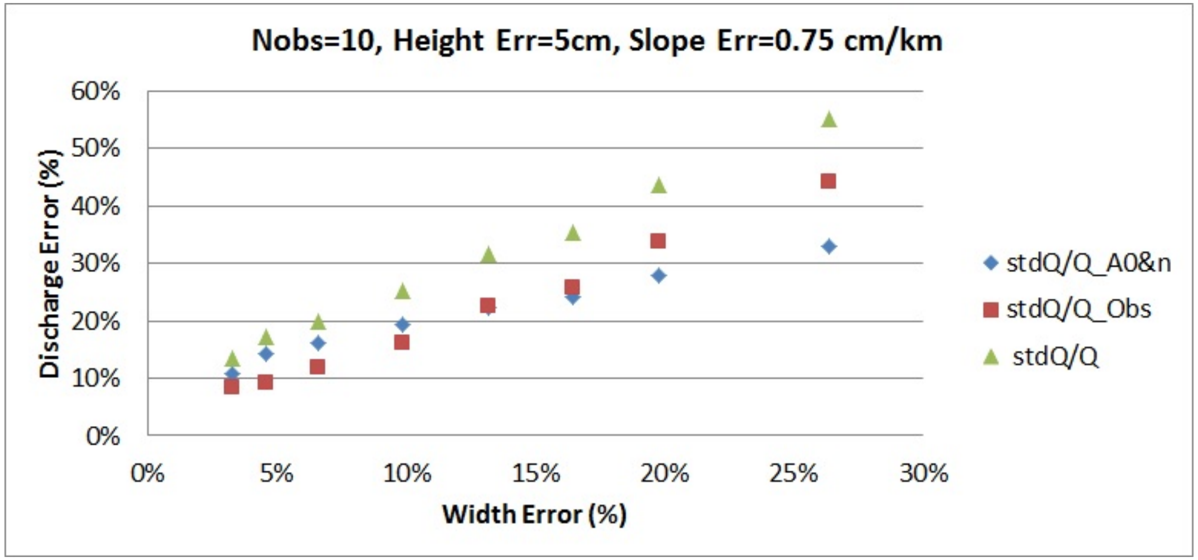
Mass and Manning equations
+
Metropolis algorithm (MCMC)

Identification of (A_0, n)… Hence Q

Algorithm from [Durand et al., 2013]



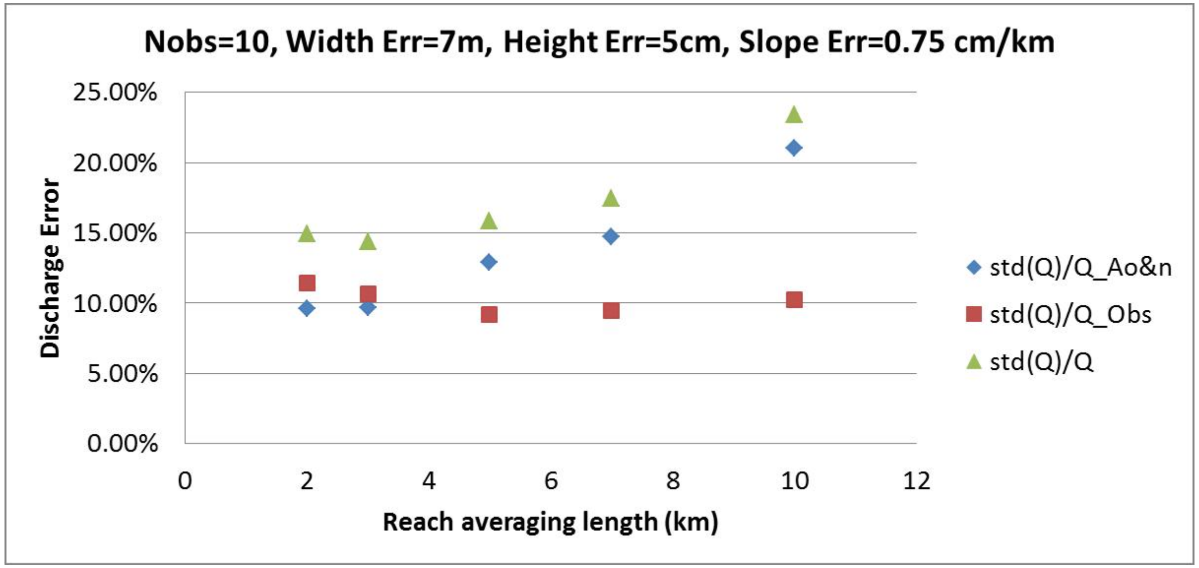
Sensitivity of discharge uncertainty upper Garonne river (Toulouse – Malause)



[Garambois and Roux 2013]
Blog: swotdawg.wordpress.com

Discharge identifications with different noise levels (e.g. width)

→ 15% width error max acceptable
→ SDT requirement

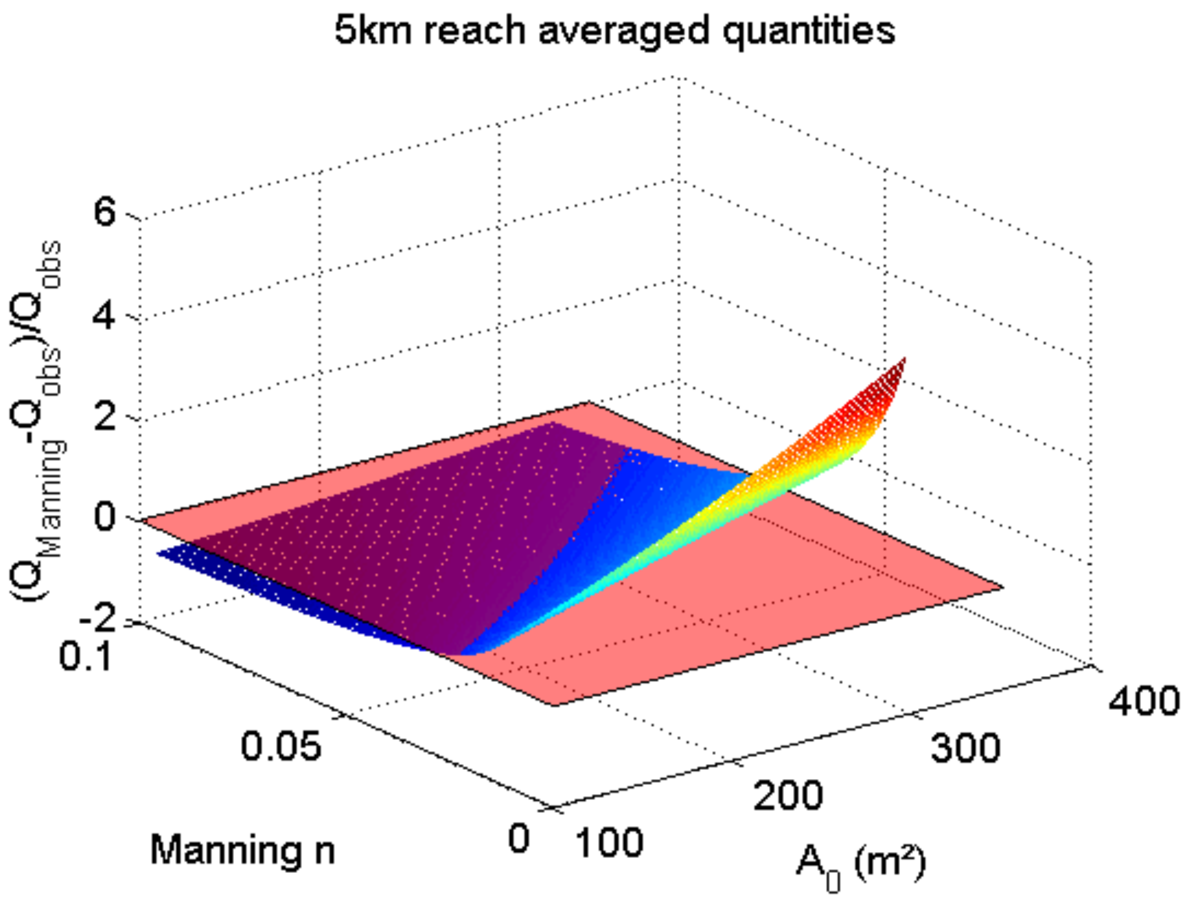


How to define a reach ?

→ Reach > 5km no representative of the hydraulic behaviour of the Garonne river

→ If not global uncertainty dominated by uncertainty due to A_0 and n

Roughness (n)/geometry (A_0): equifinality



[Garambois and Monnier 2013]
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Forward Manning discharge given different (A_0,n) for the Garonne river

A_0 and n are embedded in the friction slope term which is non linear.

→Infinity of (A_0,n) solutions.

- **NB: Sensitivities of each parameter with Dassflow possible**
- **But does not imply indentifiability of a unique (A_0,n)**

A hierarchy of models for morpho hydraulic parameter identification

Parameters and river discharge identification with SWOT like data:

Manning equation, LISFLOOD-FP + Kalman filter

[Durand et al. 2010, 2013] [Biancamaria et al.2011], [Yoon et al. 2012]).

We want to better understand:

1) The sensitivity and identifiability of hydraulic parameters,

2) the sensitivity of discharge estimation to model assumptions

3) the sensitivity of discharge estimation to SWOT errors

Current work:

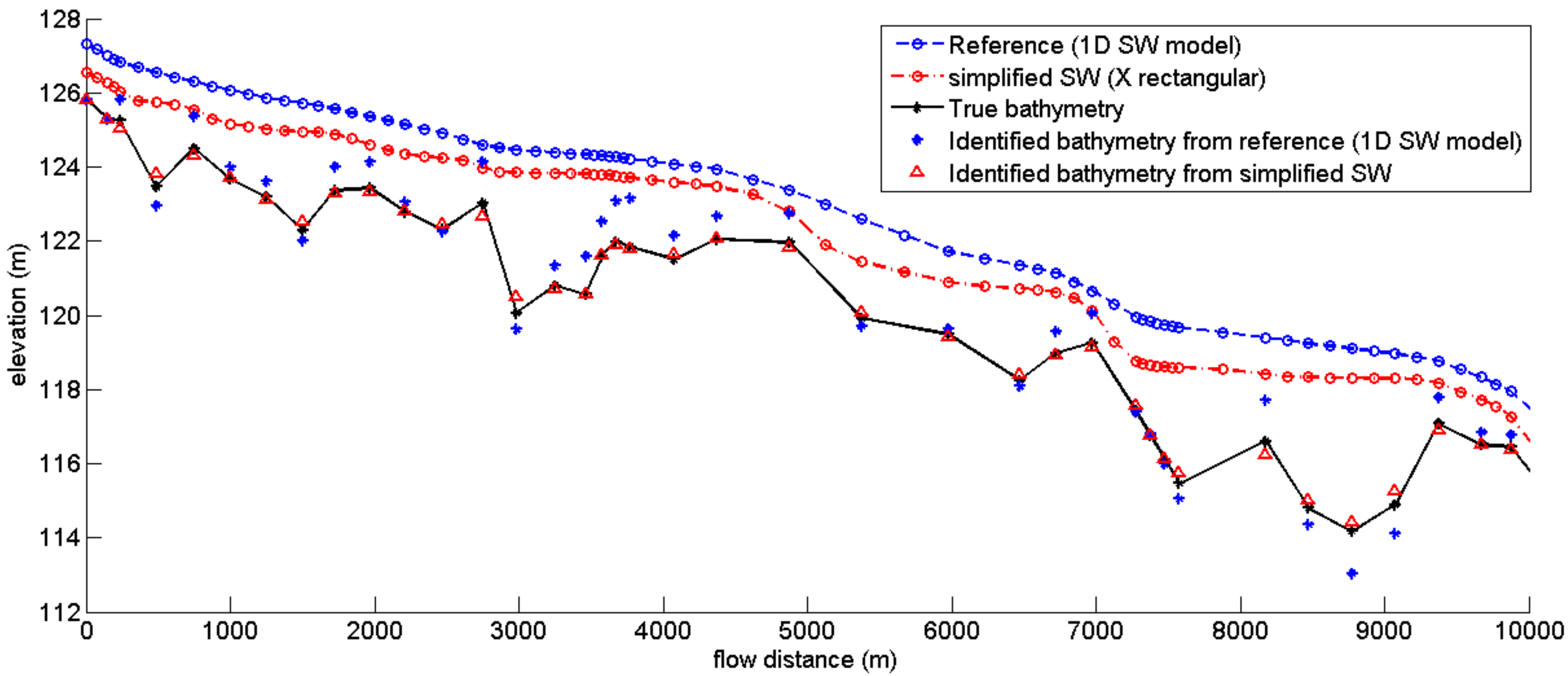
Elaboration/assessment of a model hierarchy with variational data assimilation and uncertainty reduction.

Hierarchical models:

- "0.5D" Permanent and uniform flow,
- 1D Gradually varied flow
- 2D unsteady flow including sensitivity, calibration-identification: DassFlow software. To be assessed with SWOT-like data and bathymetry.

A rough river topography identification

SWOT observables (w, Z, $d_x h$) + 1 depth observation



[Garambois and Monnier 2013]

→ Toward an iterative hierarchical model for uncertainty reduction ?

Under progress at IMT - INSA