Global River Discharges Estimation from SWOT Observations using Data Assimilation and Hydraulic Models

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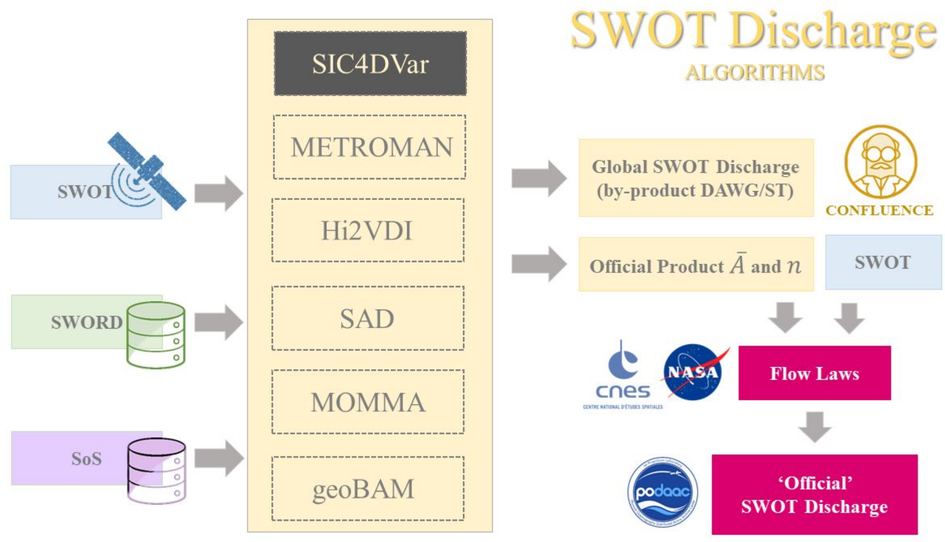
- **Objective :** Estimation of River Discharges from SWOT Observations using Data Assimilation and Hydraulic Models at the Global Scale

- **How :**
  - ➔ Simplify Data Assimilation discharge algorithms (SIC4DVAR Low Cost) and deploy them within Confluence
  - ➔ Provide fine resolution Water Surface Elevation (WSE) and velocity maps on local area with 2D hydraulic models and SWOT data assimilation



SIC4DVar **Full Cost** is dedicated to detailed simulations and discharge estimations of specific rivers of interest. For the Confluence operational platform, a **Low Cost** version has been derived from it. It is implemented in the Confluence operation platform along with 5 other alternative Discharge Algorithms.

SIC4DVar Low-Cost - Bayesian Estimation : Ohio Verification Benchmark

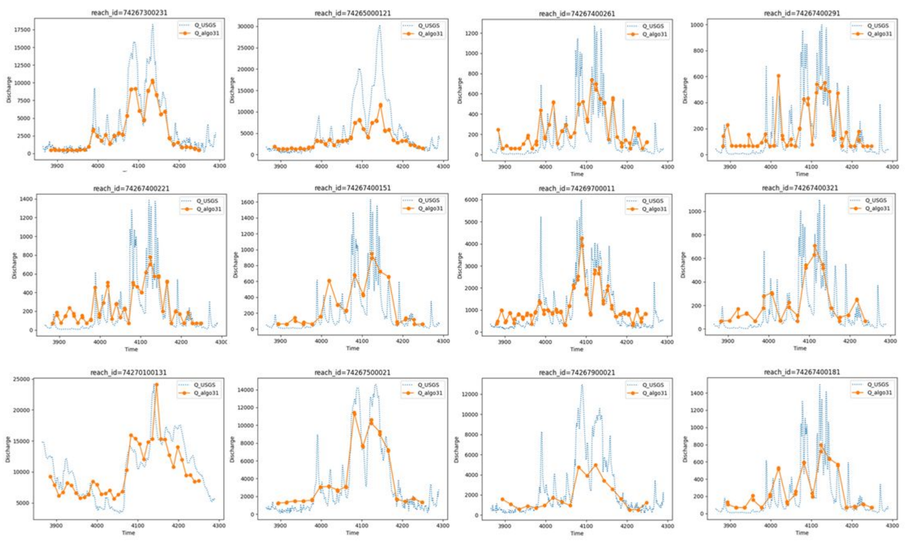
$$\overline{U}^{\,k} = \frac{1}{\sum_{n=1}^{N} \mathcal{L}_n^k} \sum_{n=1}^{N} U_n \mathcal{L}_n^k \rho(U_n)$$

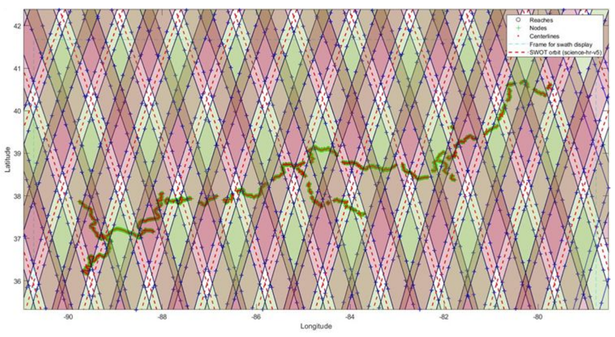
Posterior PDF (with different options)

Gejadze et al. 2022

$$Var(U^k) = \frac{1}{\sum_{n=1}^{N} \mathcal{L}_n^k} \sum_{n=1}^{N} \left(U_n - \overline{U}^{\,k}\right)^2 \mathcal{L}_n^k \rho(U_n)$$

N : The ensemble size





-SWOT-like observations.
-SWOT temporal frequency and spatial distribution.
-Realistic representation of the errors.
-Test Cases: 215 River reaches.
-Sets of reaches (from 2 to 10).
-16 USGS stations

T2D-EnKF state-parameter dual Estimation in 2D: Garonne case study

T2D-EnKF is dedicated to detailed **2D simulations** that provide **Water Surface Elevation maps** of specific rivers of interest. It assimilates heterogeneous data: in-situ observations and remote sensing data such as SWOT products at nodes and reaches and Sentinel1-derived water extents. The assimilation of SWOT-derived WSE maps is a perspective.

T2D-EnKF state-parameters dual analysis

$\mathbf{x}_c^{a,i} = \mathbf{x}_c^{f,i} + \mathbf{K}_c \left(\mathbf{y}_c^{o,i} - \mathbf{y}_c^{f,i}\right)$ with the control vector

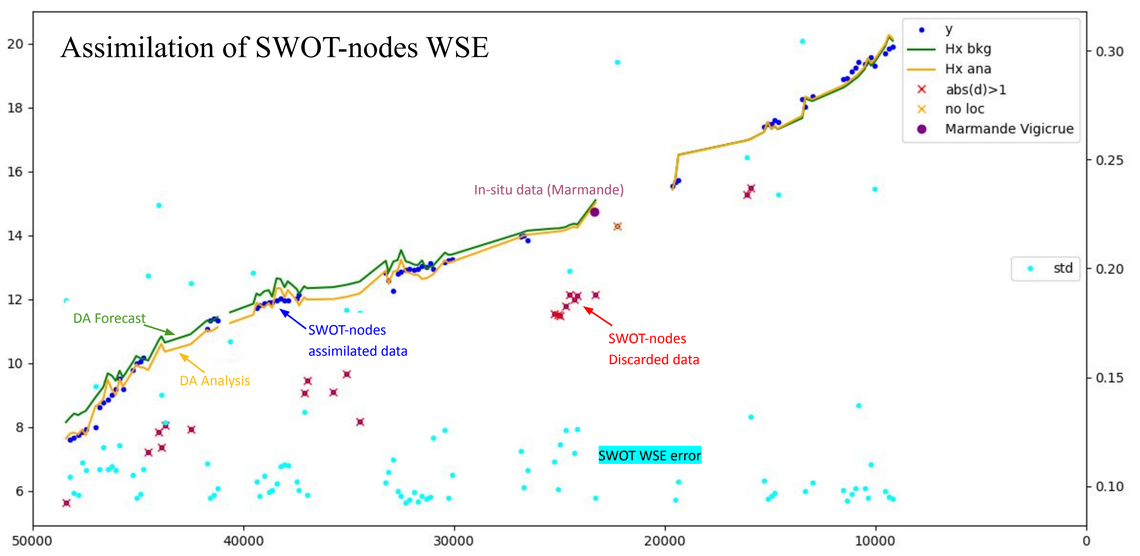
$$\mathbf{x}_c^{a,i} = \left[\left(\boldsymbol{K}_{s_k}\right)_c^{a,i} \text{ with } k \in [0,6],\ \mu_c^{a,i},\ (\delta \boldsymbol{H}_k)_c^{a,i} \text{ with } k \in [1,5]\right]$$

Stochastic estimation of the Kalman gain with Ne members:

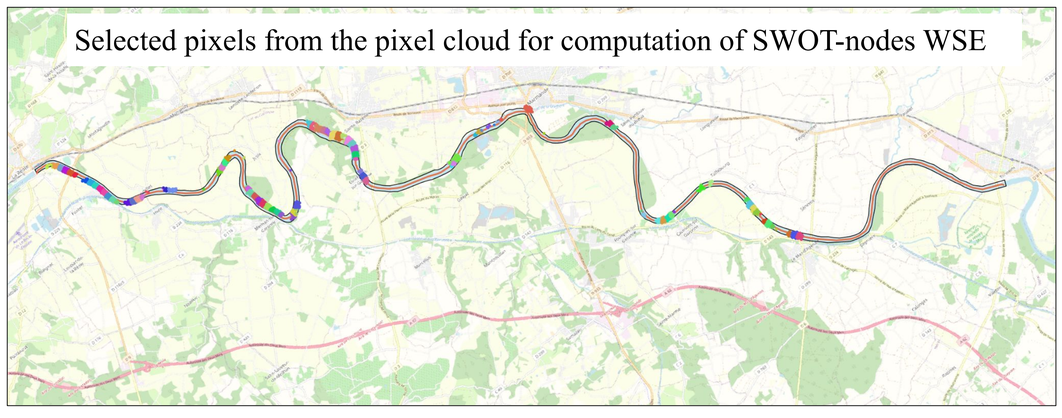
$$\mathbf{P}_c^{\mathbf{x},\mathbf{y}} = \frac{1}{N_e} \mathbf{X}_c^T \mathbf{Y}_c \in \mathbb{R}^{n \times n_{obs}}$$

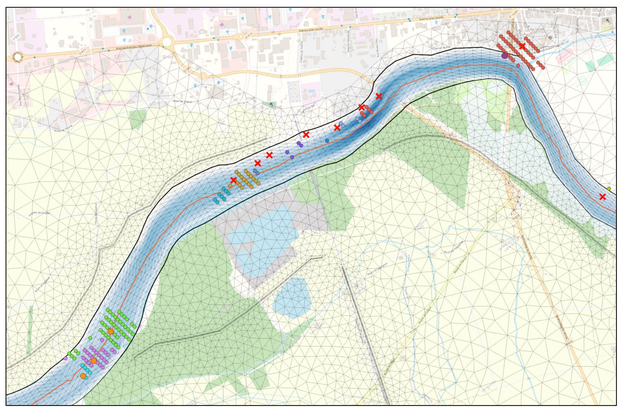
$$\mathbf{P}_c^{\mathbf{y},\mathbf{y}} = \frac{1}{N_e} \mathbf{Y}_c^T \mathbf{Y}_c \in \mathbb{R}^{n_{obs} \times n_{obs}}$$

Nguyen et al. 2021, Nguyen et al. 2022



- Garonne Test Cases Jan-Feb 2021 flood event
- SWOT-like observations from SWOT-HR+RiverObs
- SWOT temporal frequency and spatial distribution of swath 42, 113, 291
- Realistic representation of the errors
- 3 Vigicrue stations, 6 Sentinel-1 overpasses





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- Floods on the Indian Rivers through discharge Estimation of SWOT data (FIRES) : Indu Jayaluxmi – Indian Institute of Technology Bombay (CEFIPRA)

Collaborations with funded SCO projects 2021-2024 :
- Flood Detection Alert and Mapping Digital Twin FloodDAM-DT (Space Climate Observatory-CNES/IDEAS-JPL/NASA)