University of Stuttgart
Institute of Geodesy

Estimation of River Discharge using SWOT: full catchment coverage with optimal space and time resolution (ERDSWOT)

Principle investigators: MJ Tourian, Nico Sneeuw


Researcher: Siqi Ke

SWOT Science Team Meeting, 27-30 June 2022

GIS

Self-introduction

Siqi Ke

PhD student at the Institute of Geodesy, University of Stuttgart

Institute of Geodesy

+49 (0)711 68584081

siqi.ke@gis.uni-stuttgart.de

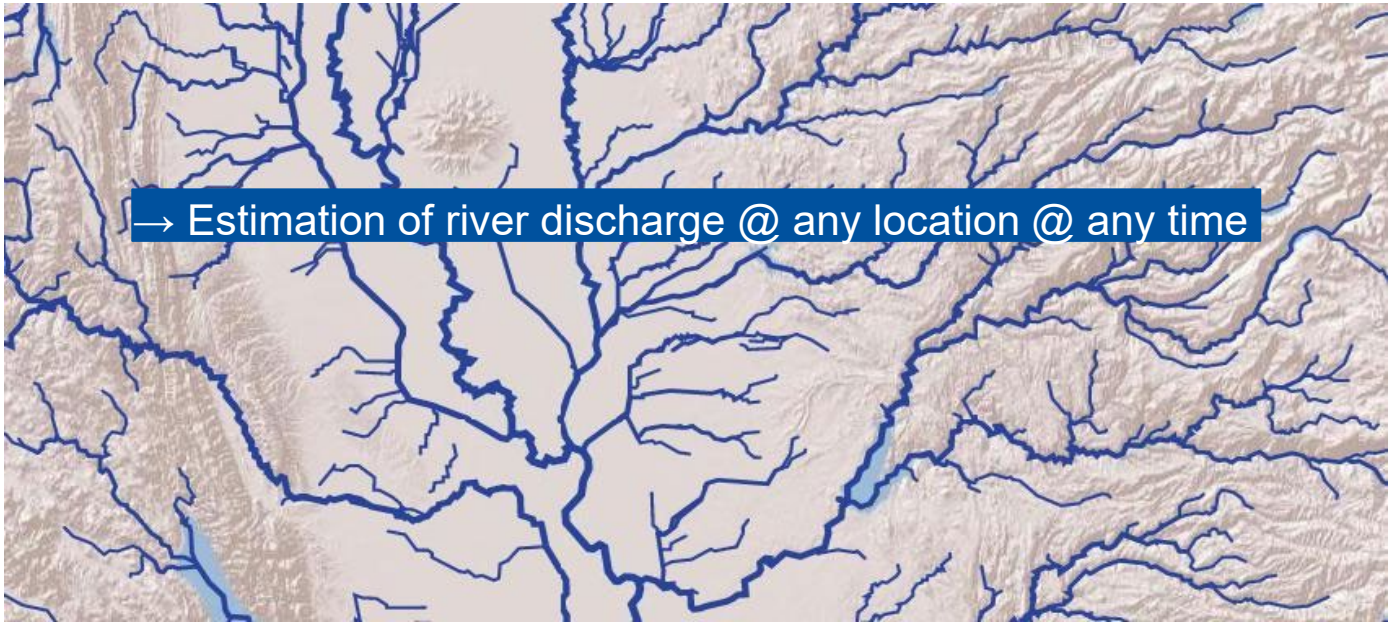
- Main research interest: Hydro-Geodesy (discharge estimation)
- Research Project: ERDSWOT
- Language: Chinese, German, English

2019.Sep	2020.Dec	2021.May	2021.Oct	2022.May
B.Sc. of Engineering in geodesy, University of Stuttgart	B.Sc. of Engineering in navigation, Wuhan University	M.Sc. of Engineering in geodesy, University of Stuttgart	PhD Stuttgart at Institute of Geodesy, University of Stuttgart	Awarding CSC-Scholarship for PhD Study

Goal

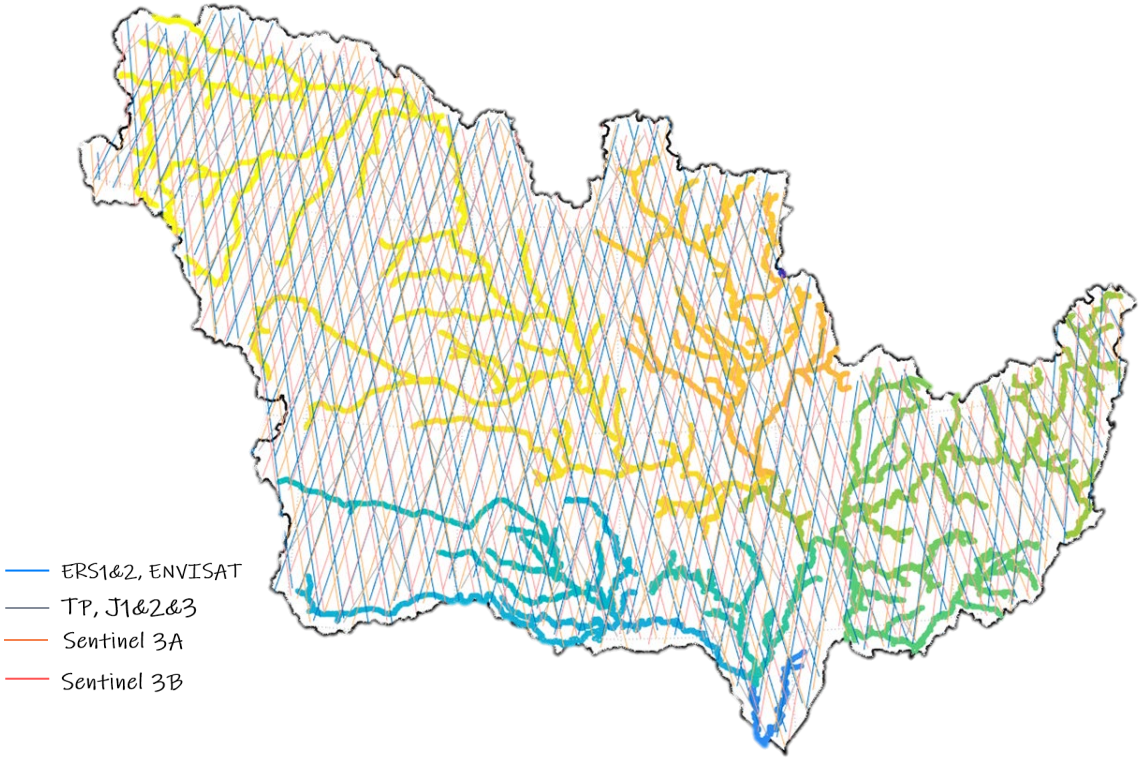
We have:

- SWOT
- Satellite altimetry (water level)
- Satellite imagery (surface area)

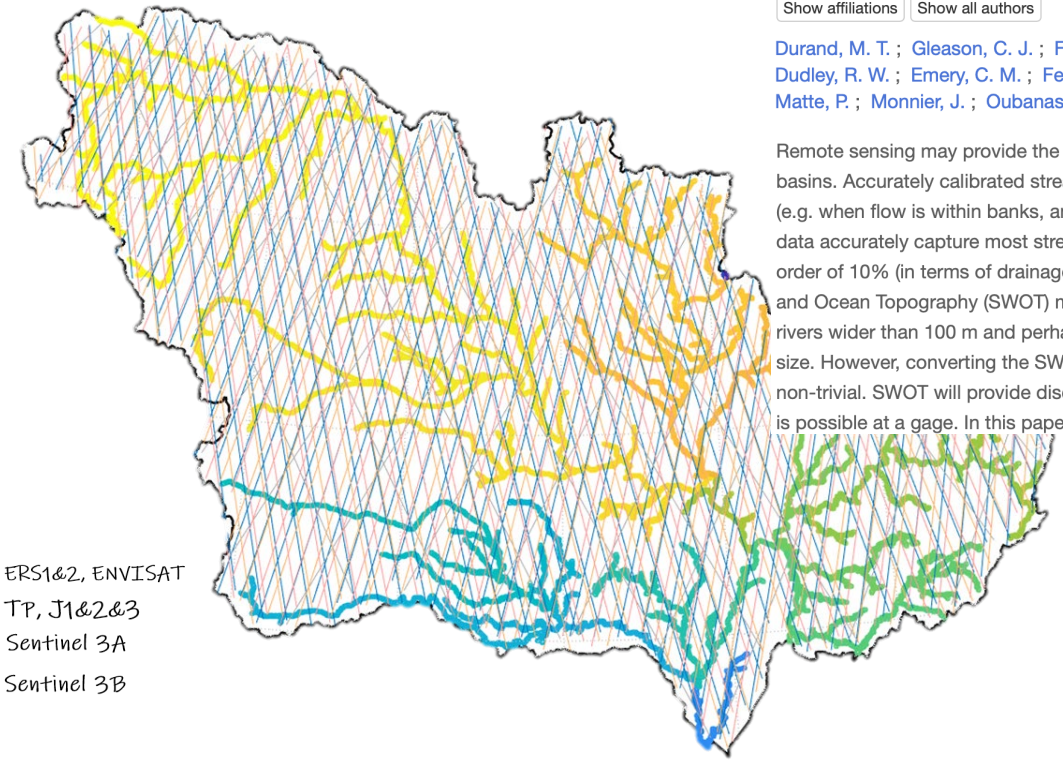


Approach 1: Full-catchment river water level time series

Approach 1: Full-catchment river water level time series



Approach 2: Generation of an ensemble of discharge time series



A global framework for SWOT discharge

Show affiliations | Show all authors

Durand, M. T. ; Gleason, C. J. ; Frasson, R. P. M. ; Pavelsky, T. ; Allen, G. H. ; Bates, P. D. ; Dudley, R. W. ; Emery, C. M. ; Fenoglio-Marc, L. ; Garambois, P. A. ; Hossain, F. ; Larnier, K. ; Lin, P. ; Matte, P. ; Monnier, J. ; Oubanas, H. ; Pan, M. ; Rodriguez, E. ; Schaperow, J. ; Tarpanelli, A. ; ...

Remote sensing may provide the key to one of the longest-standing problems in hydrology: ungaged basins. Accurately calibrated stream gages are accurate to within 10% or better under most conditions (e.g. when flow is within banks, and rating curves are kept up to date). Publicly available stream gage data accurately capture most streamflow into the ocean, but coverage for smaller tributaries is on the order of 10% (in terms of drainage area) for basins 50,000 km^2 in size. The forthcoming Surface Water and Ocean Topography (SWOT) mission will vastly expand measurements of global rivers, measuring rivers wider than 100 m and perhaps as small as 50 m, corresponding to nearly all basins 50,000 km^2 in size. However, converting the SWOT measurements of height, width and slope into river discharge is non-trivial. SWOT will provide discharge for all SWOT-observed rivers, but at lower accuracy than what is possible at a gage. In this paper, we describe how the SWOT discharge data product will be

Discharge algorithms:

- geoBAM
- MetroMan
- SAD
- Hi2VDI
- MOMMA
- SIC4DVar

GIS

Approach 3: EnKF based discharge estimation over entire river network

$$Q(t,x) = [q^{(1)}(t,x)\ q^{(2)}(t,x)\ \dots\ q^{(n)}(t,x)]$$

$$Q(t,x) = \Phi\, Q(t-dt,x-dx)+e$$

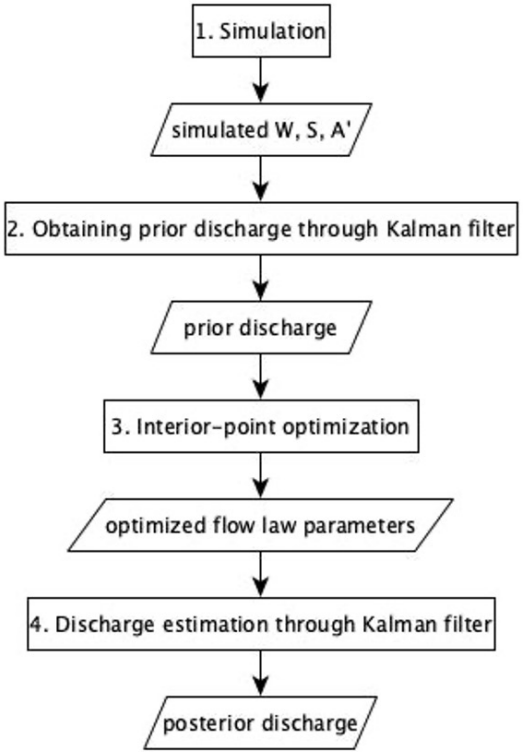
$$Y(t,x) = H\, Q(t,x) + v$$

ensemble of discharge values

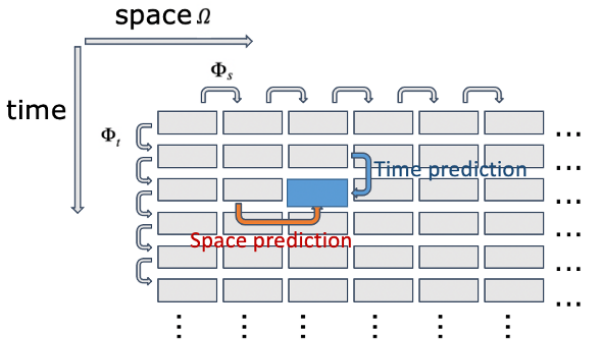
→ Assimilated river discharge at full catchment scale

Current interest

Estimation of river discharge using a mass-conserved Kalman filter approach relying on simulated SWOT observations



- Joint prior from time and space process models



: discharge of a reach Ω

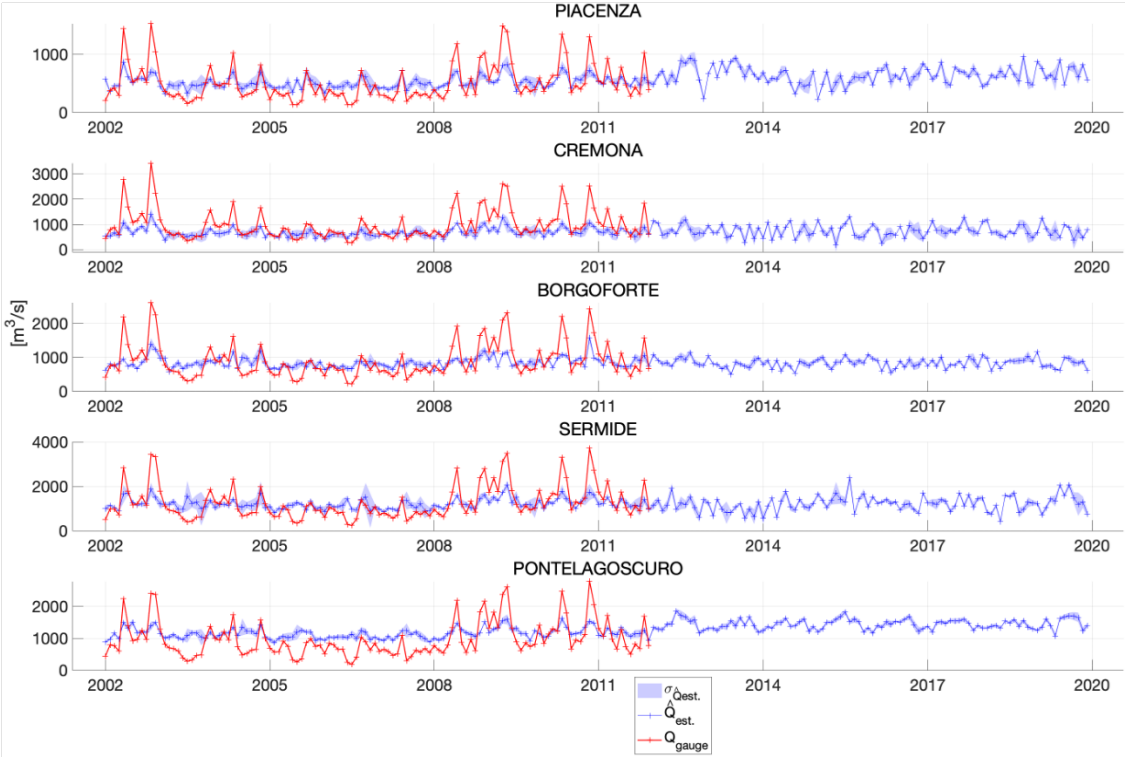
Φ_s : transition matrix in space domain

Φ_t : transition matrix in time domain

- Mass conservation condition as observation equation
- For posterior discharge: recalculated discharge by optimized flow law parameters as additional observations

Results of monthly discharge estimates in river Po

Comparison of monthly discharge in gauge stations in time series



	Correlation	NSE
PIACENZA	0.44	0.19
CREMONA	0.44	0.18
BORGOFORTE	0.45	0.20
SERMIDE	0.44	0.20
PONTELAGOSCURO	0.44	0.17

University of Stuttgart
Institute of Geodesy

Thank you!

Siqi Ke

e-mail siqi.ke@gis.uni-stuttgart.de
phone +49 (0) 711 685-84081
www.gis.uni-stuttgart.de

University of Stuttgart
Institute of Geodesy
Geschwister-Scholl Str. 24D