Impact analysis of surface water level and discharge from the new generation of altimetry observations

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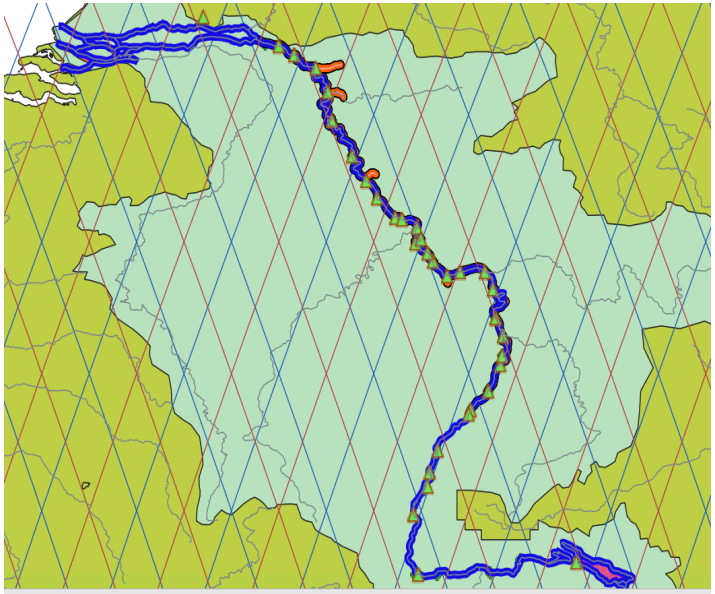
Motivation

Temporal variation of discharge Q

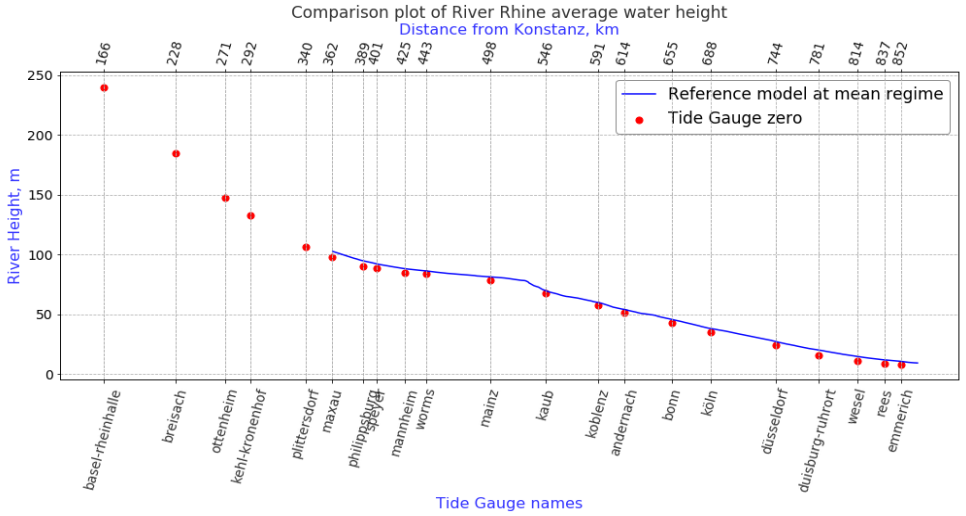
Satellite altimetry
Optical HR images for river width
Sobek 1D hydrodynamic model
In-situ observations

Rhine River



Research questions:

(1) What can we observe (time&space)
(2) Where are the main limitations
(3) New challenges



Approach:

Altimetric - water level
- water slope

- In situ H,Q observations for calibration/validation

- Parameters from Model Configuration: depth

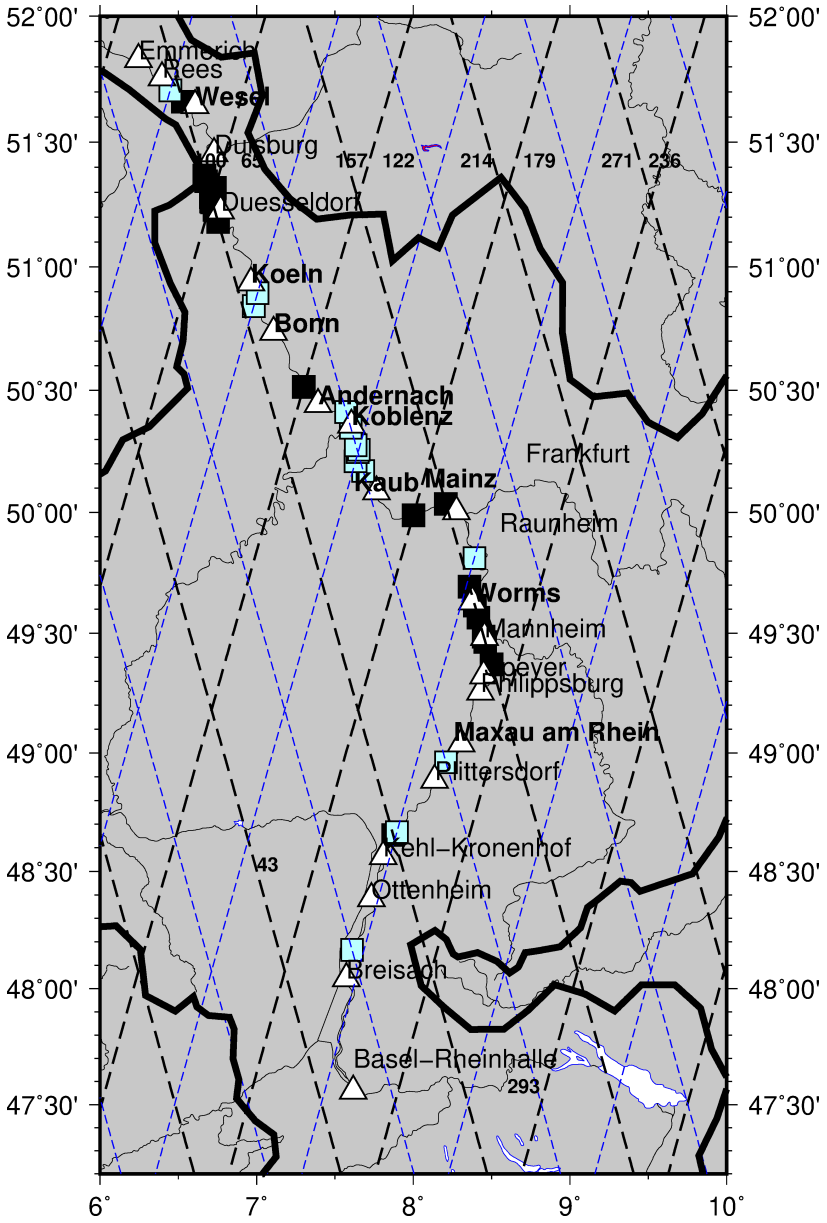
- Methods for altimetric Q :
- -Rating curves,
- -Bjerklies
- -Manning, Metroman

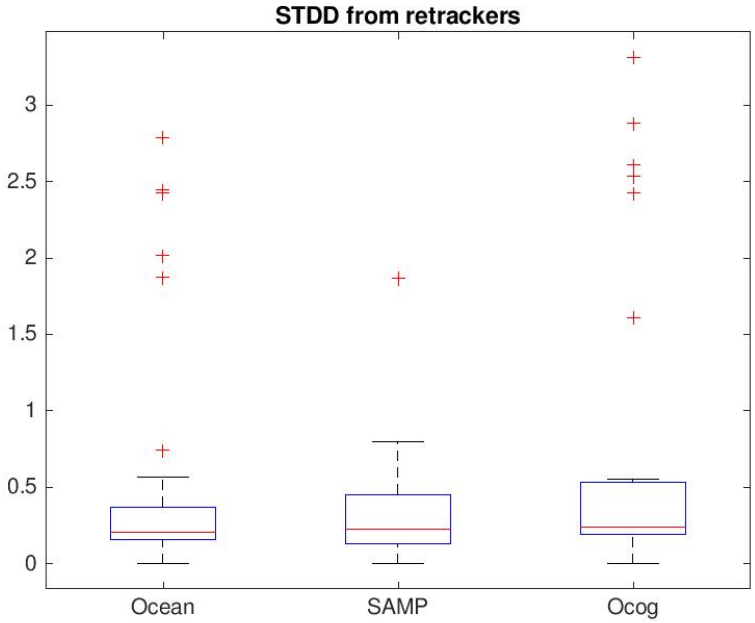
Altimetric discharge

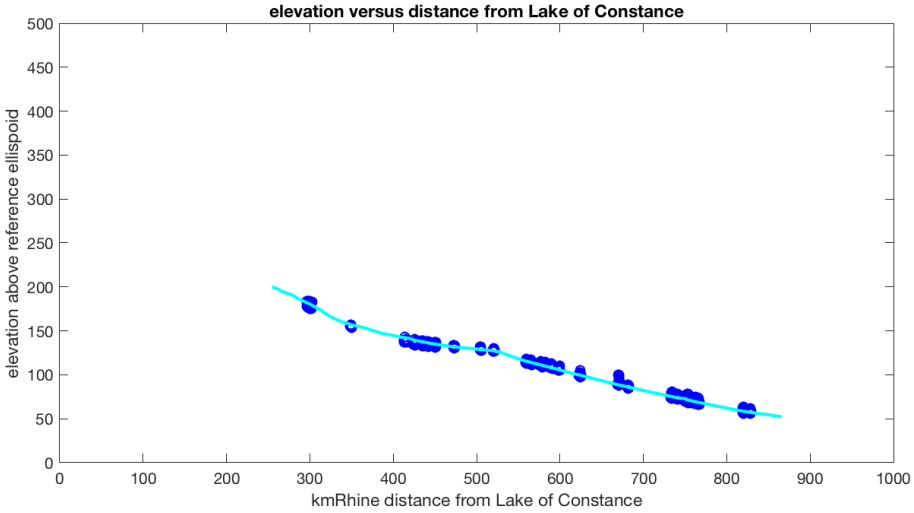
Altimetric Q *vs* modelled Q

Improved heights from SAR and ICESAT-2 satellite altimetry

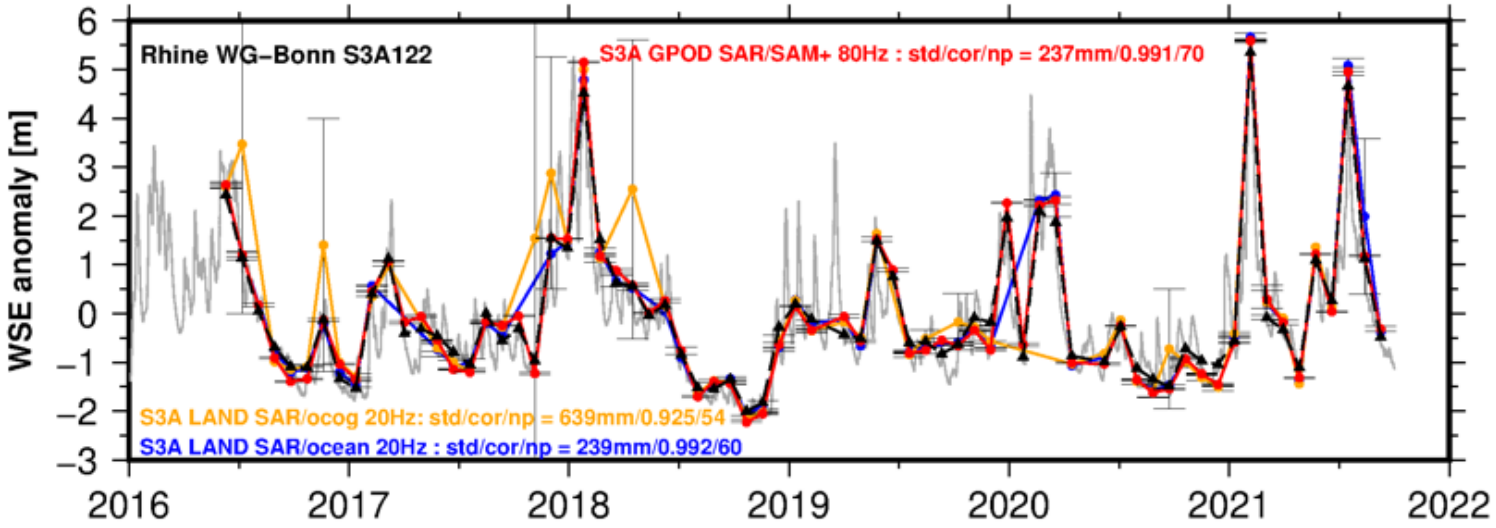
33 Virtual Gauges S3A/B, SAMP+ best

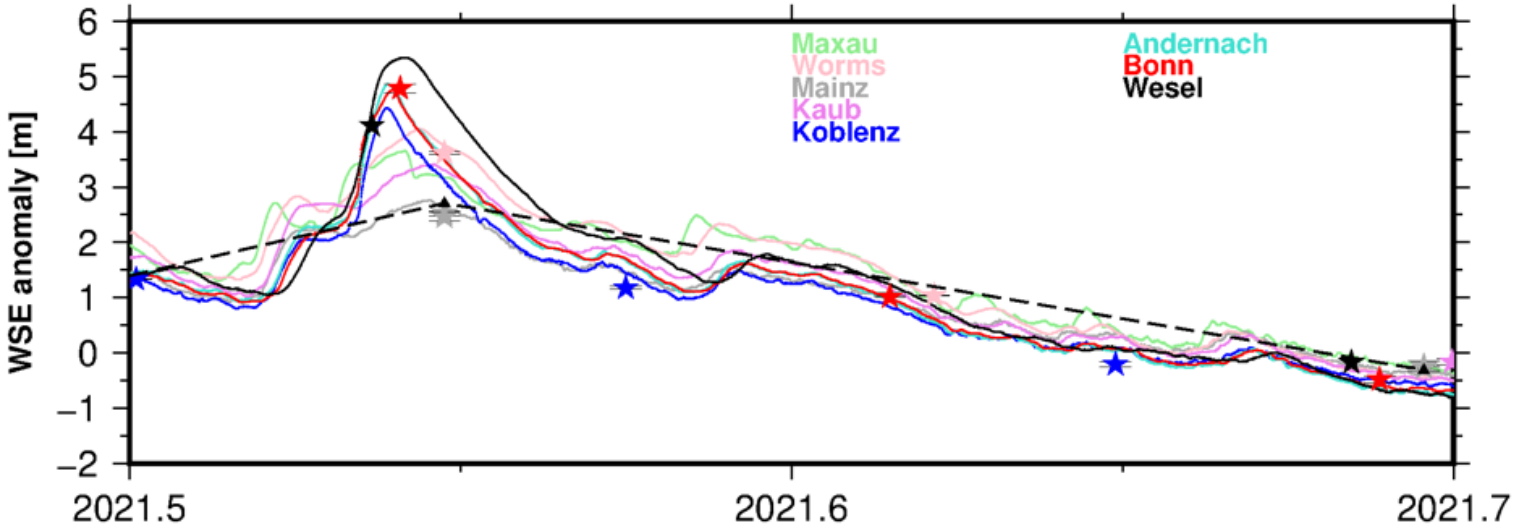




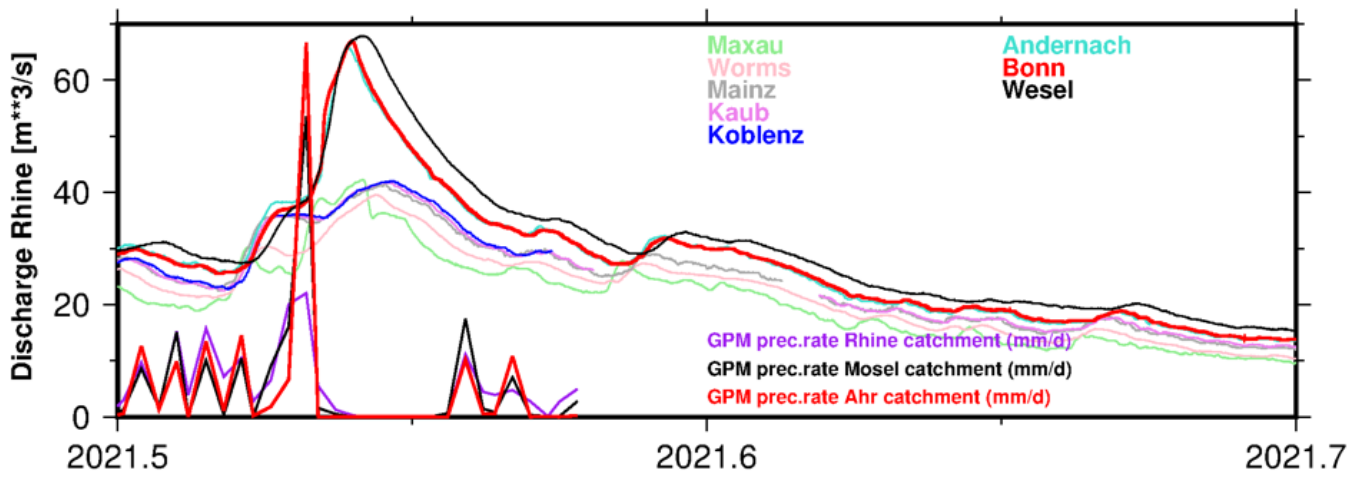


Extreme WSE from nadir-altimetry

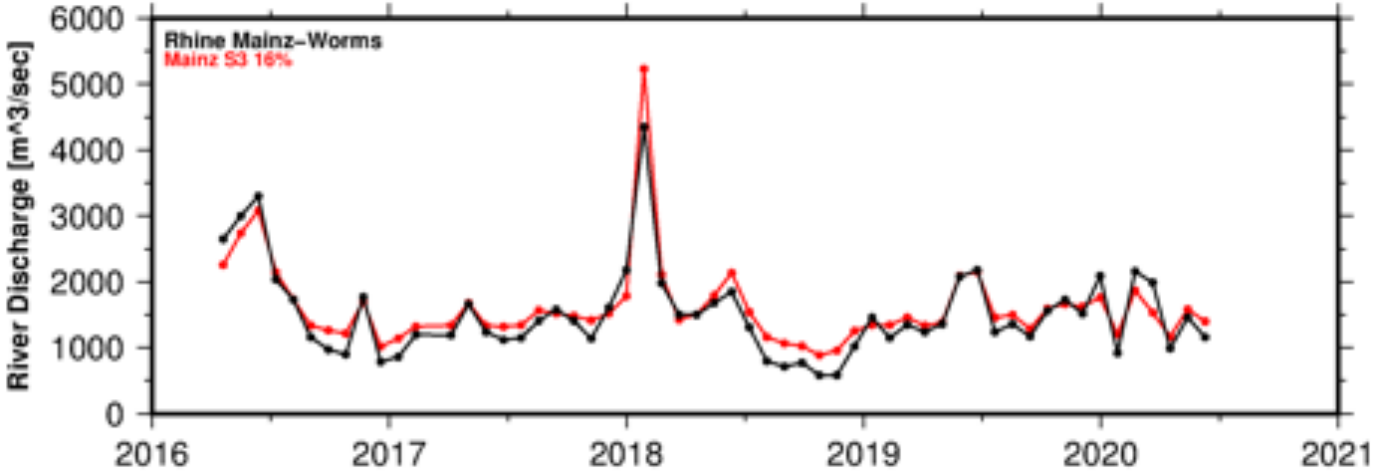




Extreme discharge from nadir--altimetry



$$Q = k_2 W Y^{1.67} S^{0.33}$$

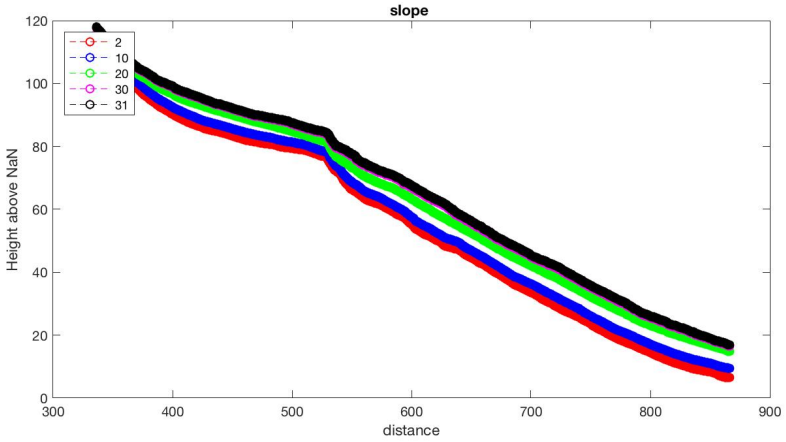


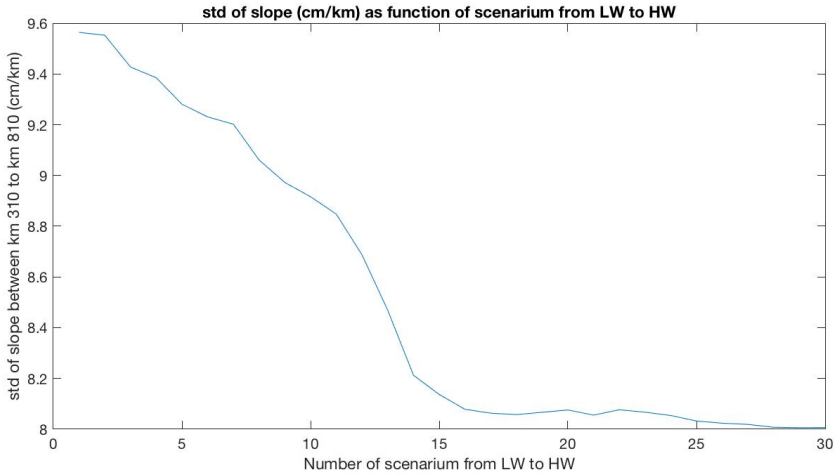
$$Y = f(H_{alti}) = H_{alti} - H_0$$

$$S_{alti} = \frac{H_{altiWorms} - H_{altiMainz}}{L_{river}}$$

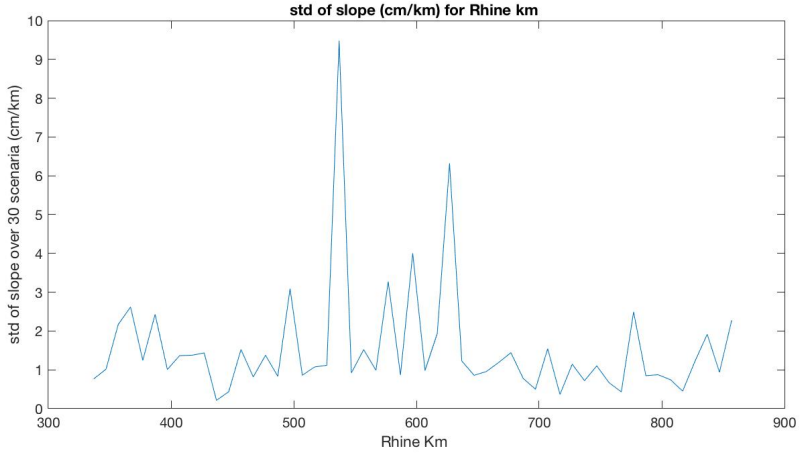
The river slope challenge

1.7 cm/km mission requirement for the SLOPE, stdd of slope per scenaria (right)

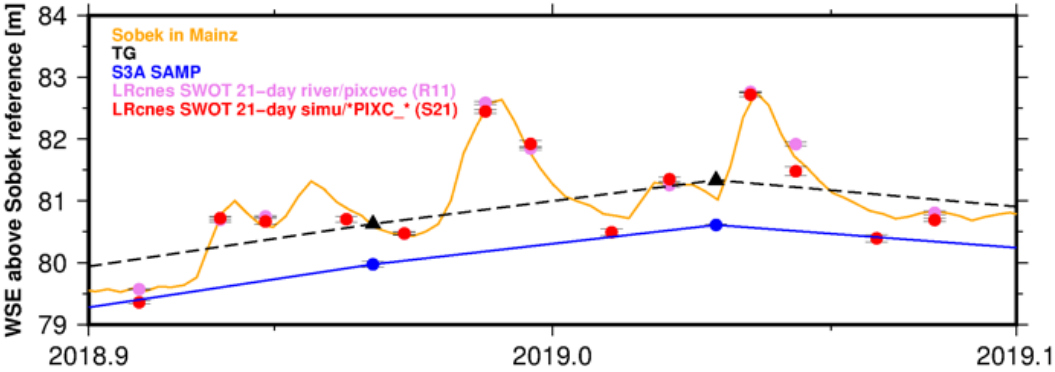




stdd of slope per scenaria

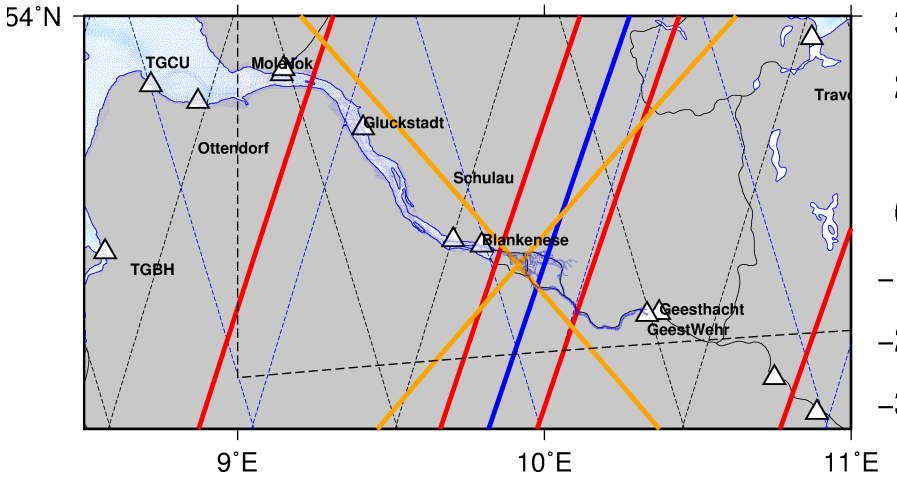


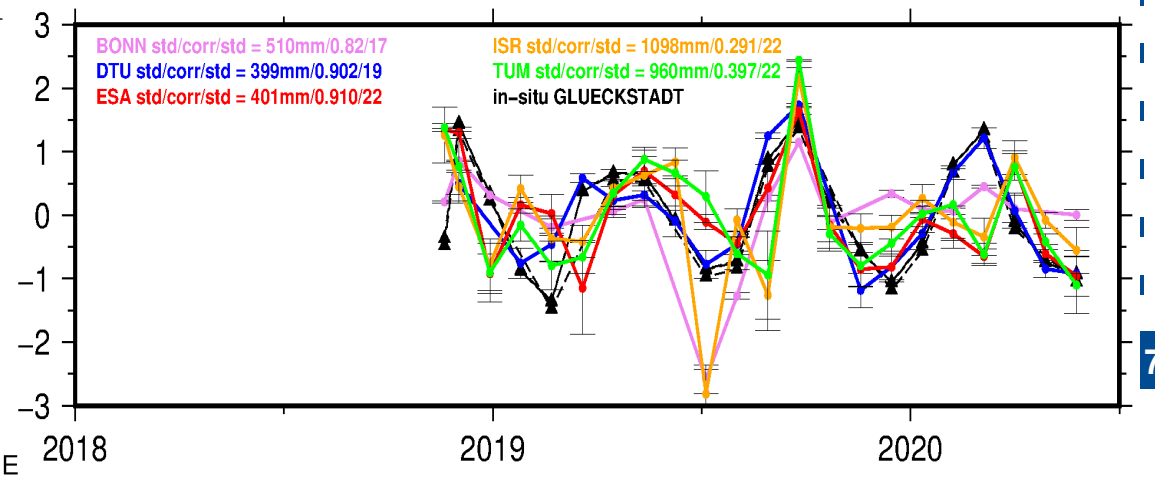
stdd of slope along the Rhine river

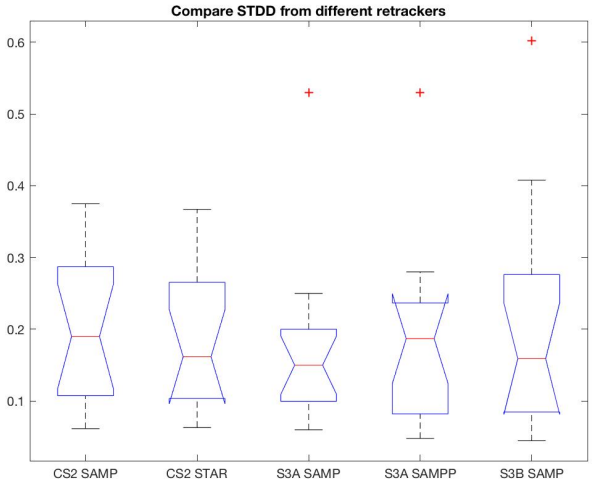


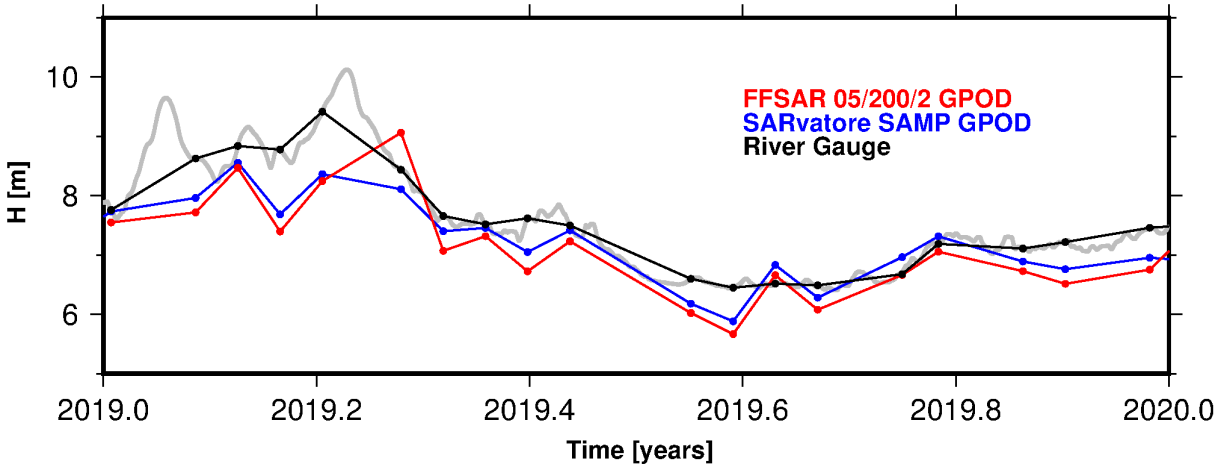
continuous slope meas, in SWOT

Estuary : higher dynamics







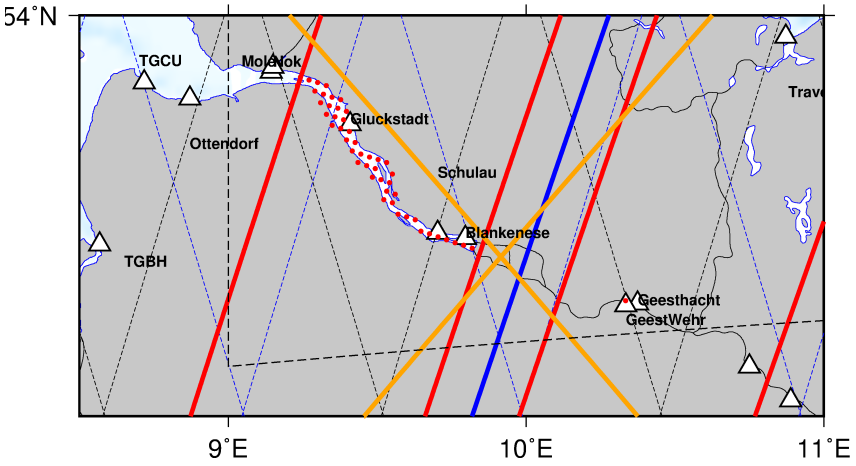


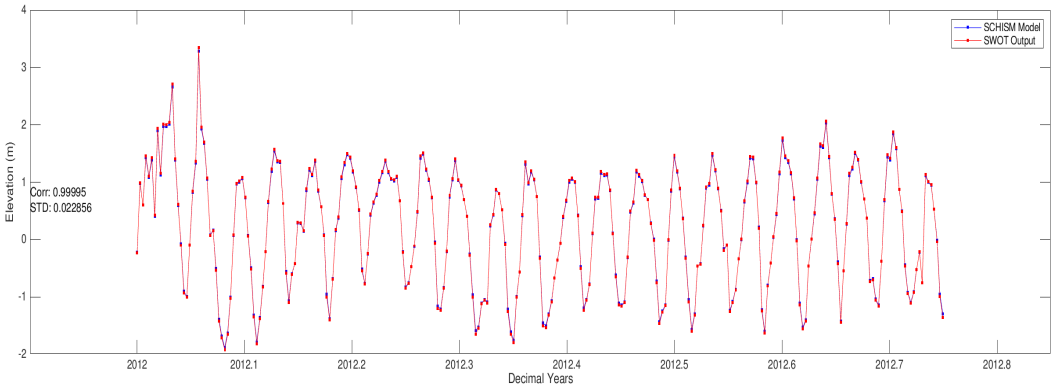
Coastal accuracy

Estuarine accuracy

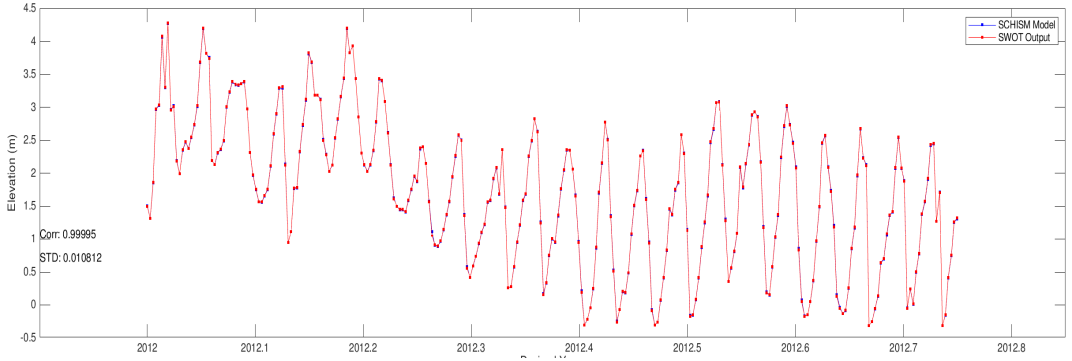
The estuary challenge

Estuary : higher dynamics





With SWOT simulated points



SWOT from SCHISM HR and in-situ data at first and last point of the SWOT simulation (JPL Ocean Simulator)

Significance of findings

- **In rivers: accuracy up to 10 cm** in **water height** of **altimetric radar,** alternative to official products. Best H_{alti} accuracy with GPOD-SAM+
- Rhine River Q mainly controlled by **water level** and **water slope, slope determination is a new challenge in satellite altimetry and in SWOT**
- **In estuary:** limitation of nadir-altimeters (higher dynamics in tidal river, HR needed)
- In Elbe estuary and tidal river: interaction of tides and discharge, higher temporal and spatial sampling needed
- Outlook:
  - **Q f**rom **physically-based methods** based on hydraulic equations (simple: Bjerklie and less approximated Metropolis-Manning (Durand et al. 2016).
  - Consider auxiliary information for **Q, e.g. r**iver fluvial geomorphology (depth, bed roughness, floodplain characteristics)
  - De-tide not stationary analysis in estuary
  - SWOT altimetry

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