REFECCT-DETECT - Impact analysis or surface water level and discharge from the new generation altimeter observation

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Motivation

Goal of DETECT-B01 is to improve our knowledge of hydrodynamic processes related to water surface flow by using new space observations. Phase 1 of B01 addresses two research questions: How can we fully exploit the new satellite altimetry missions to derive water level, discharge, and hydrodynamic river processes? Can we separate natural variability from human water use? In this poster we present the current status of B01.

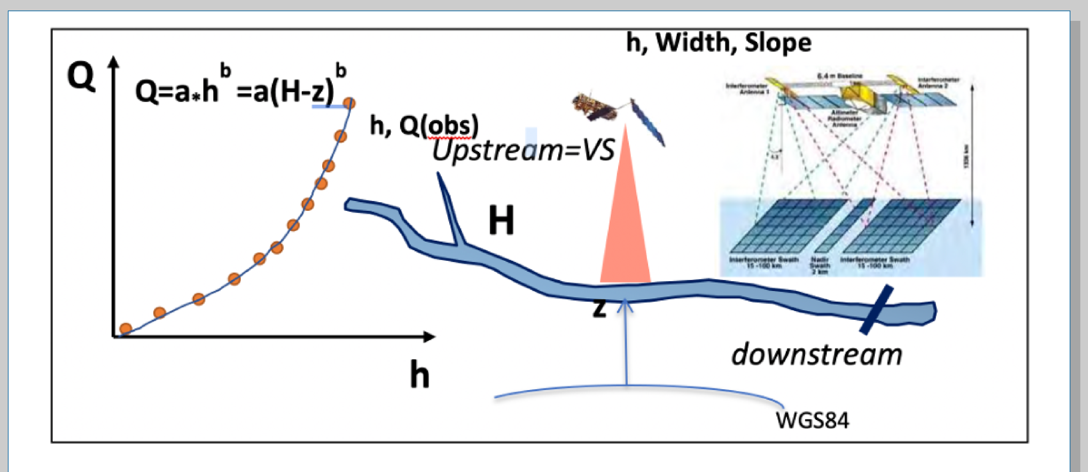

Fig. 1 DETECT Projekt Picture

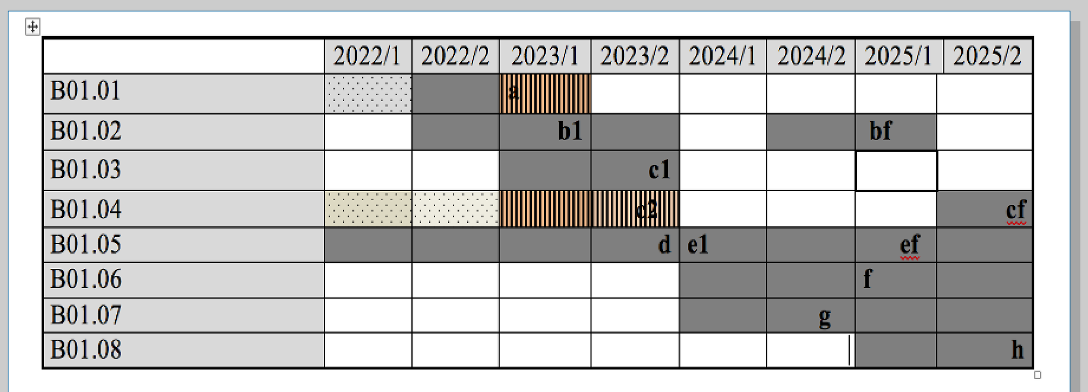

Fig. 2 Gantt of DETECT Status Dec.2022

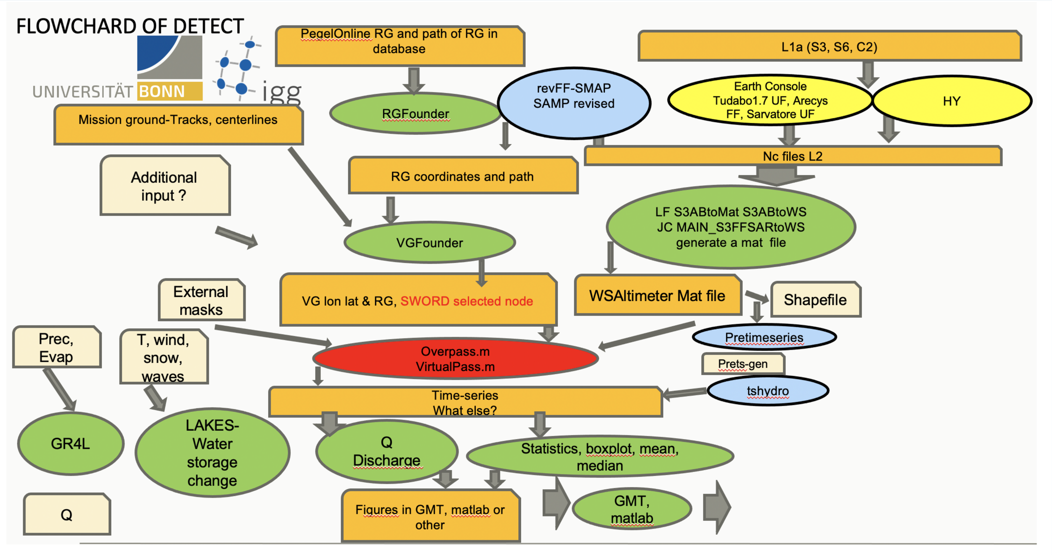

Fig. 3 FlowChart Status September 2023

WP B01.01 in 1993- WSE, Q, Storage

In 1993-2009 satellite altimetry observes water surface elevation (WSE) in Low Resolution Mode (LRM), GRDC gives discharge, imagery plus LRM altimetry give storage change. See Pegelonline and GRDC stations in Fig. 4, Q in Fig.5.

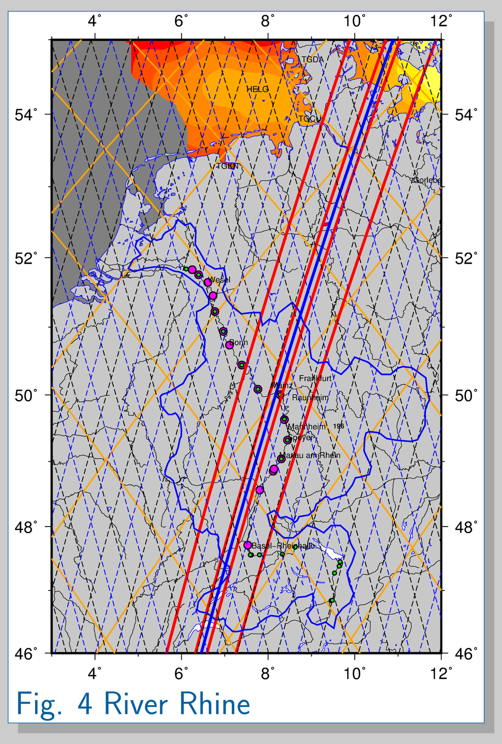

Fig. 4 River Rhine

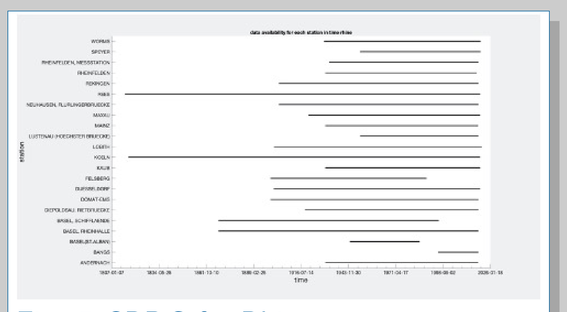

Fig. 5 GRDC for Rhine

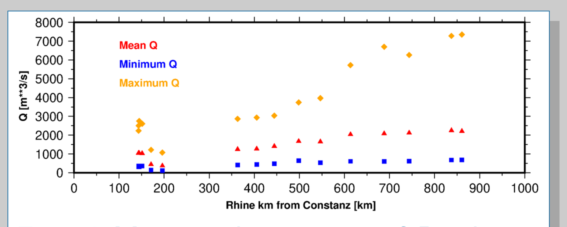

Fig. 6 Mean and extremes of Discharge from GRDC

Bibliography

Fenoglio, L., Dinardo, S., Uebbing, B., Buchhaupt, C., Gärtner, M., Staneva, J., Becker, M., Klos, A., Kusche, J. (2021). Advances in NE-Atlantic coastal Sea Level Change Monitoring from Delay Doppler Altimetry, Adv. Space Res.,68(2), pp. 571–592, doi.org/10.1016/j.asr.2020.10.041.

International Altimetry Team (2021). Altimetry for the future: Building on 25 years of progress, Adv. Space Res.,68, pp. 319–363, https://doi.org/10.1016/j.asr.2021.01.02

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WP B01.02 WSE from altimetry

Data selection and screening are from the "VirtualPass method" (Fenoglio et al. 2021, Hydrocoastal PVR). SAR altimetry measures water elevation in rivers, accuracy depends on the retracker. The highest accuracy is obtained from the SAMOSA+ (SAMP) retracker and in Fully Focused SAR.

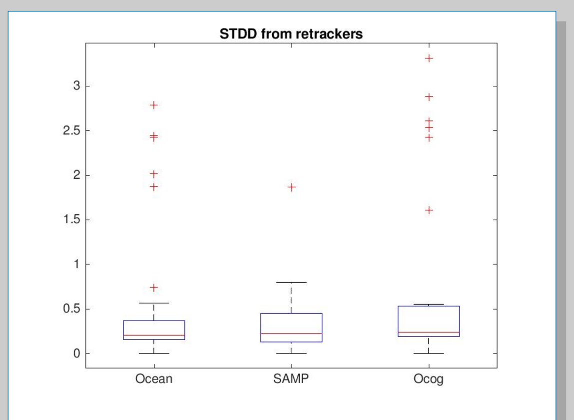

Fig. 7 Stdd of S3 SLA against in-situ

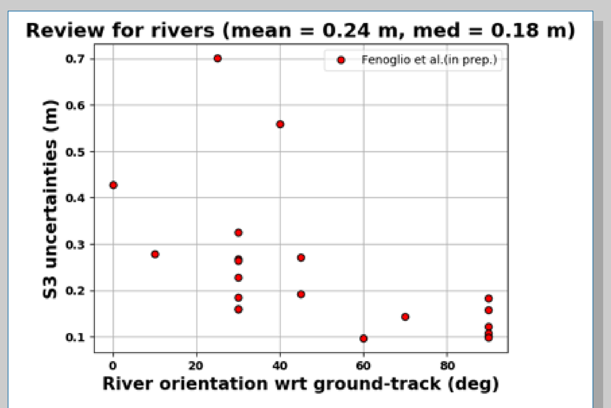

Fig. 8 Samples in compared time-series

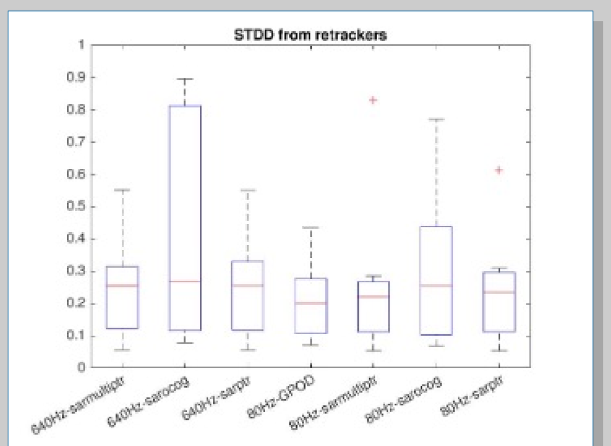

Fig. 9 Boxplot accuracy

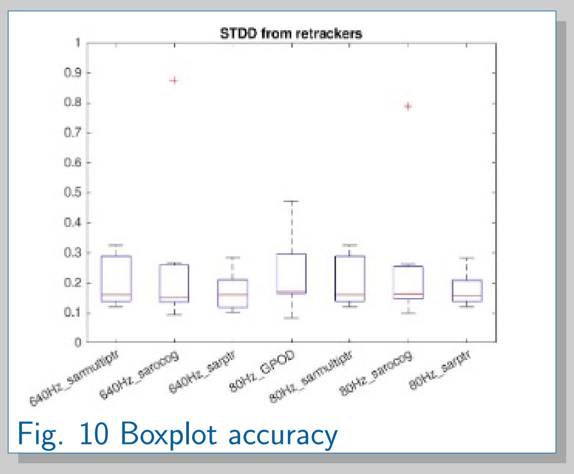

Fig. 10 Boxplot accuracy

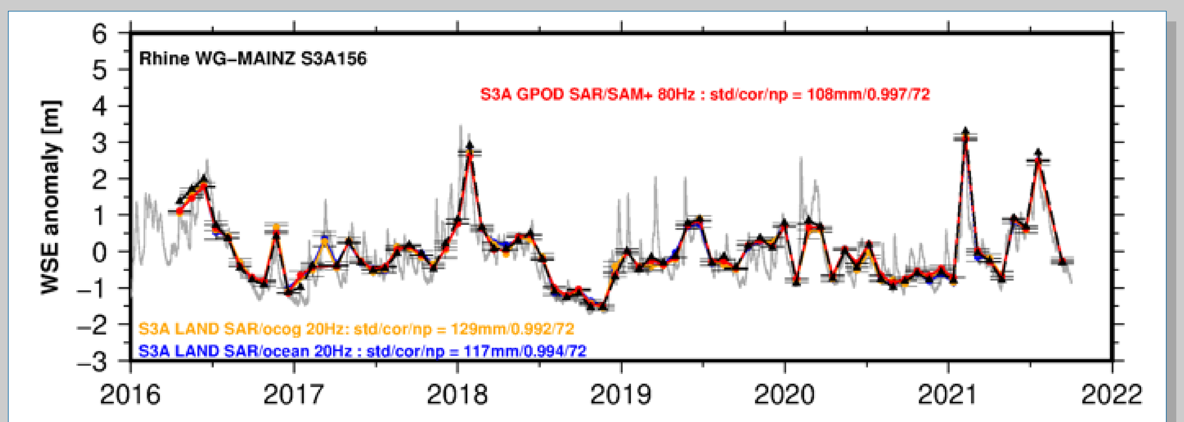

Fig. 11 VirtualPass method for S3A SLA in Mainz

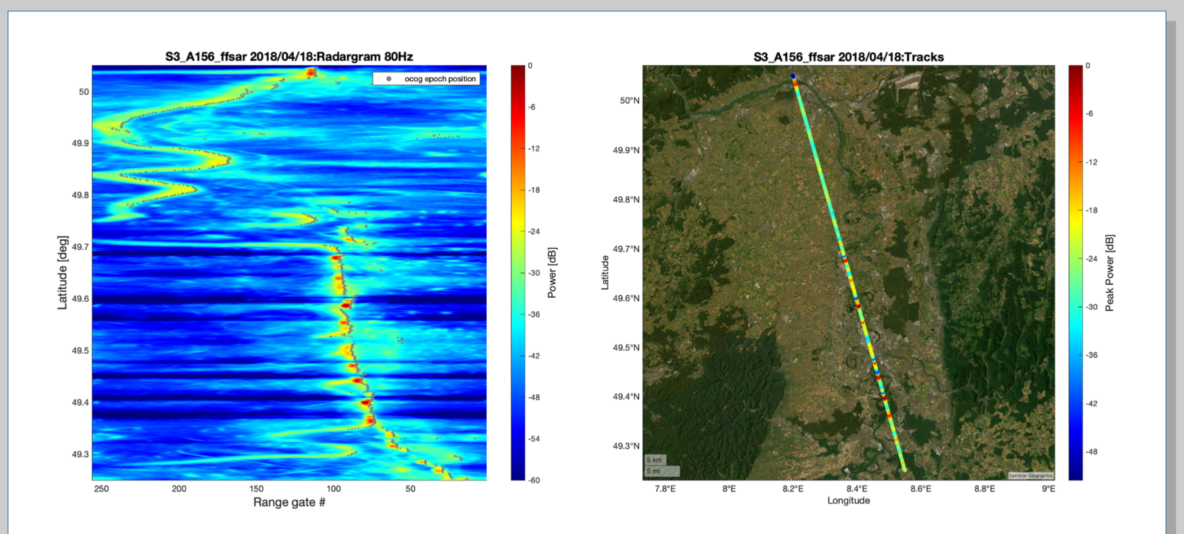

Fig. 12 Radargramm in FFSAR

First analysis of SWOT L2 LR SSH products

We validate in the Lake of Geneva SWOT-nadir and -karin, Sentinel-3 and Sentinel-6 FFSAR processed against gauge St.Prex in 2023. We use SWOT L2 NALT IGDR 1.0 and L2 LR SSH 1.1 Expert Products. Time-series of SWOT-karin are made averaging all data in the swath. All other data are averaged along-track.

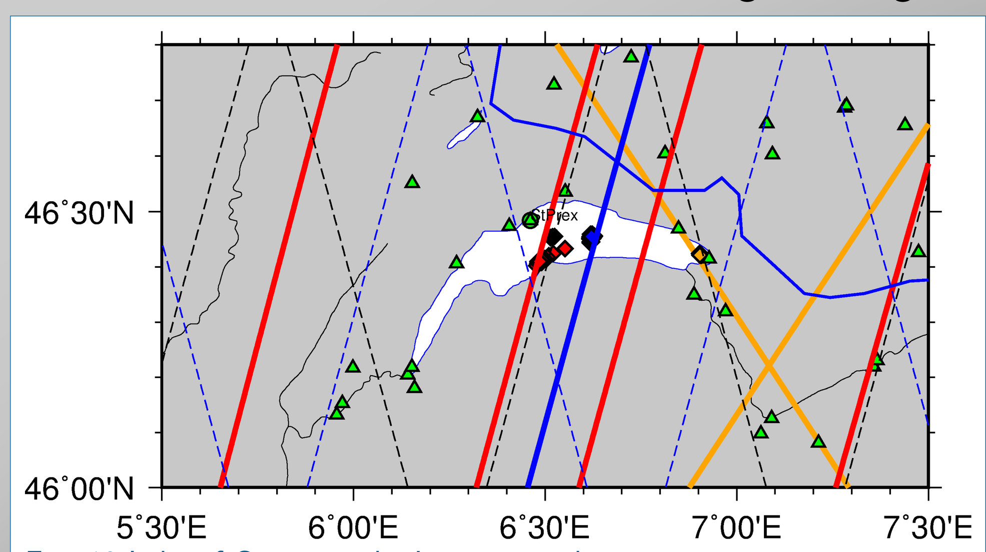

Fig. 13 Lake of Geneva with altimeters and gauges

The SWOT-karin agrees with gauges, with 2 cm and 60 points. SWOT-nadir accuracy is 5 cm with 67 points. For Sentinel-3 and Sentinel-6 the STDD is 7 and 2 cm with 4 and 7 points (Figs. 14).

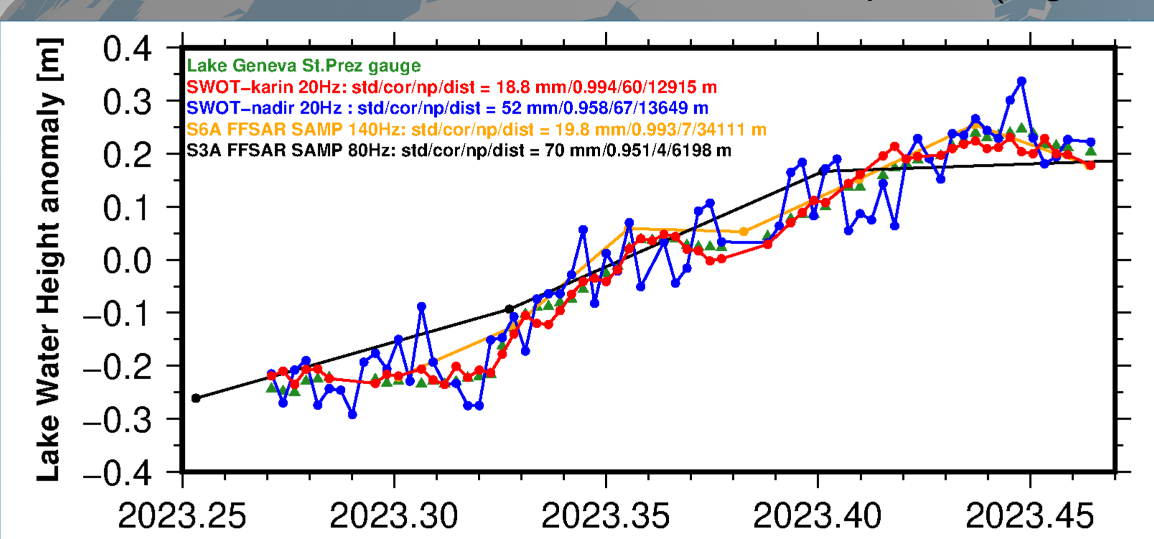

Fig. 14 Altimetry against St. Prex gauge in lake of Geneva

WP B01.03 Q from SSH, Slope, W

River slope is derived from nadir-altimeters from two river crosses. Depth and width are derived from digital terrain model (DTM) and from water height. The discharge Q is then derived from slope, depth and width from the Bjerkley equation (Q=kWYS), for pre-defined k and exponents (synthesis) or estimating k (conductance coeff.) and three exponents (analysis).

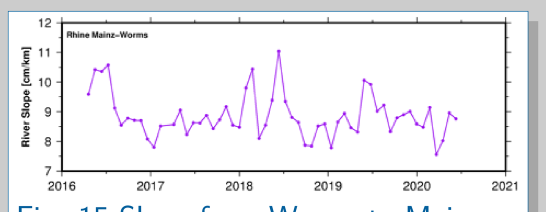

Fig. 15 Slope from Worms to Mainz

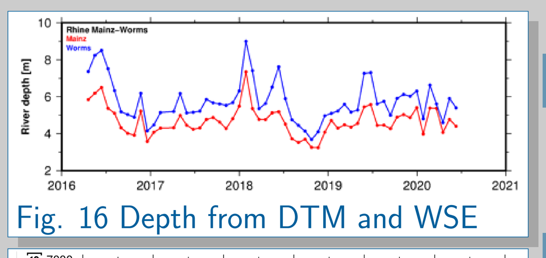

Fig. 16 Depth from DTM and WSE

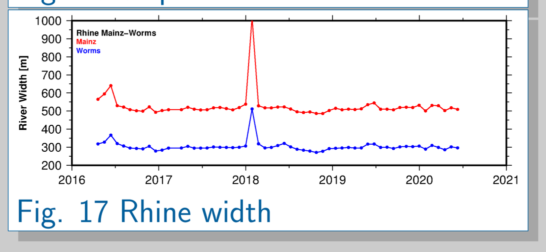

Fig. 17 Rhine width

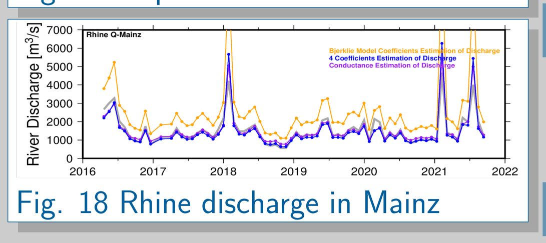

Fig. 18 Rhine discharge in Mainz

WP B01.04 WSC from SSH and imagery

Water Storage change in lakes is derived from water extent and WSE from satellite imaging and altimetry. SWOT is validated against in-situ and DTM. Open questions are:

- is FFSAR better than SAR for nadir-altimetry?
- can SWOT monitor the rivers to lakes connection ?

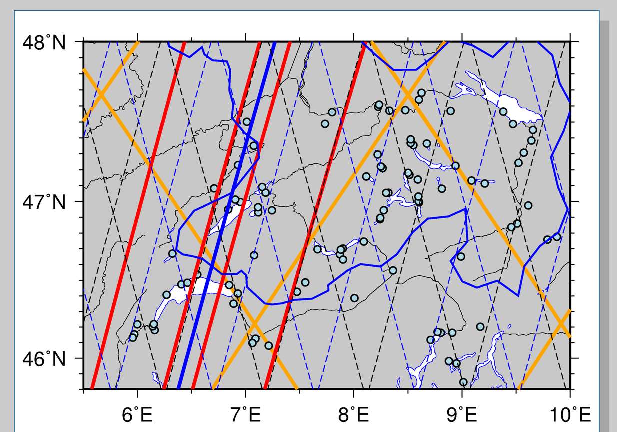

Fig. 19 CH database subset

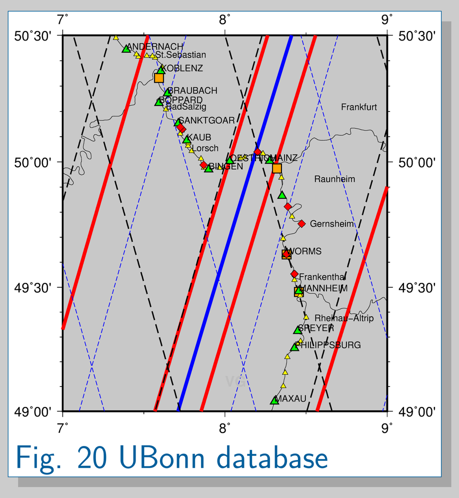

Fig. 20 UBonn database

WP B01.05 Cal/Val for SWOT

SWOT cal/val phase is from April to July 2023, 1-day repeat with the Rhine covered every day for 500 km (1 min). Eight Rasperry PI reflectometry have ben installed at Vortex stations between Mannheim and Koblenz. Others have been installed.

In Fig. 21 the WSE anomalies are measured by Vortex. Fig.22 shows the WSE absolute height of the Vortex compared to the WSE from ships levelling via GNSS (Fixierung). Differences between estimated heights are at cm level.

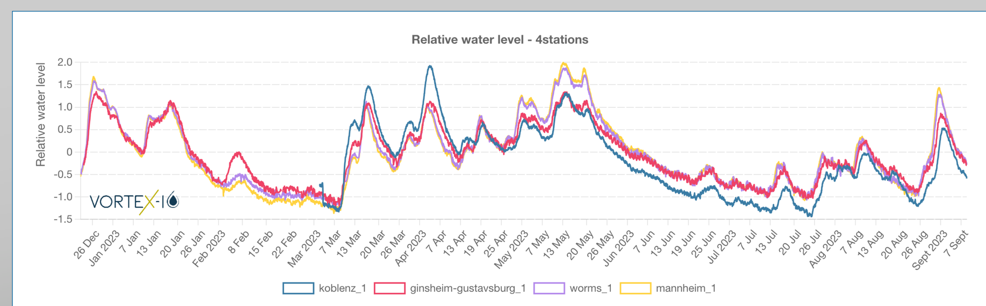

Fig. 21 Vortex4x

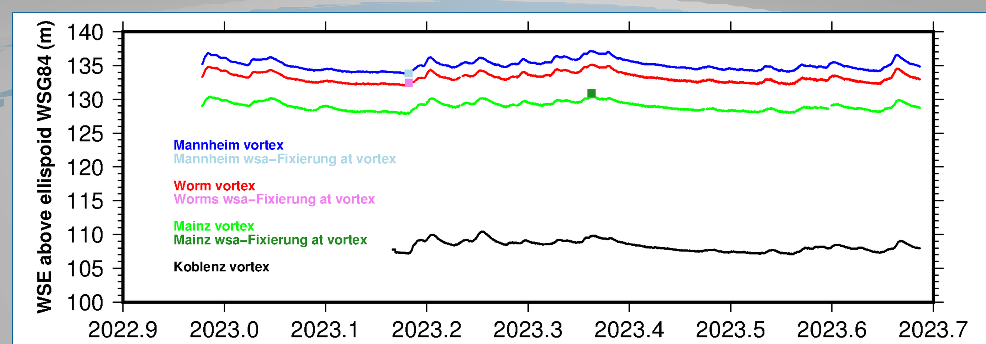

Fig. 22 Ellipsoidal heights comparison

WP B01.06 Operator TO BE generated

- evaluate Q from Prec and ET (GR4L model)
- evaluate Q from existing outputs of land model (comp)
- construct operators OPER-Q and OPER-WSTO

Conclusions

- Geodetic validation of nadir-altimetry WSE in cal/val region with cm-level absolute and relative accuracy
- less than 10 cm accuracy in WSE with SAR altimetry SAMOSA+
- discharge 15 % wrt in-situ
- best accuracy of WSE from SWOT-karin in Lake of Geneva (2 cm)

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