PROGRAMME OF THE EUROPEAN UNION

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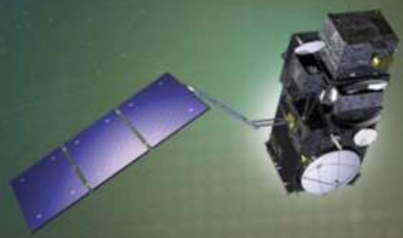

7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

Water level from Sentinel-3A and Sentinel-3B missions

L. Fenoglio, H. Uyanik, J. Chen

University of Bonn, Germany

MOTIVATION

Rivers and coastal-to-land sites are mostly affected by climate changes and are at multi-risks (coastline retreat, flooding storms and river floods)

New missions, new processing, improved accuracy

SAR revised processing and products opens new possibilities for inland, coastal applications

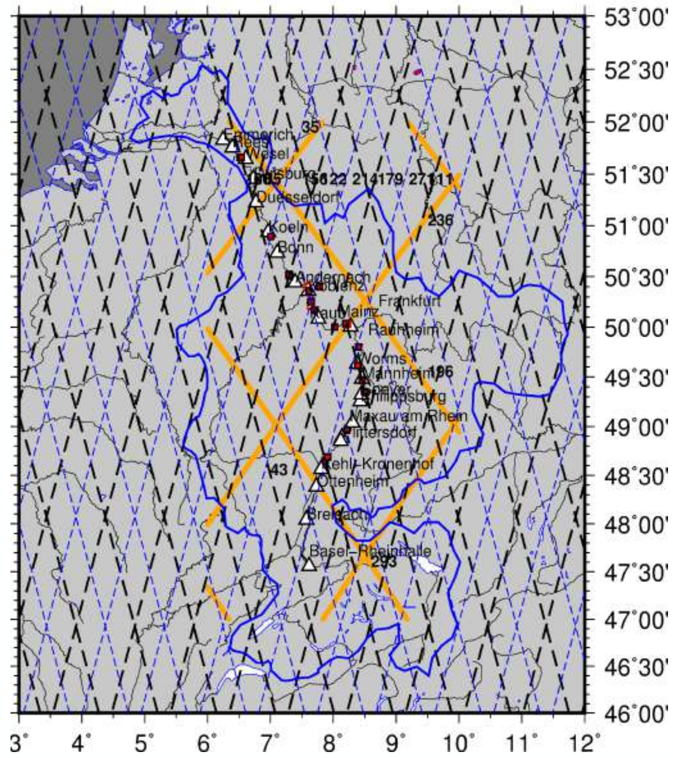

Fig. 1 Rhine catchment

MOTIVATION

Rivers and coastal-to-land sites are mostly affected by climate changes and are at multi-risks (coastline retreat, flooding storms and river floods)

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DETECT B01 in Collaborative Research CRC 1502 DFG will derive river discharge and water storage change from SAR & swath-altimetry for assimilation In hydrological model (https://www.lf.uni-bonn.de/en/research/crc-detect)

GNSS U-Bonn (2 + 10 until march 2023) + 4 Vortex MS for 4 bridges

B01-DETECT RHINE network for Sentinel-3

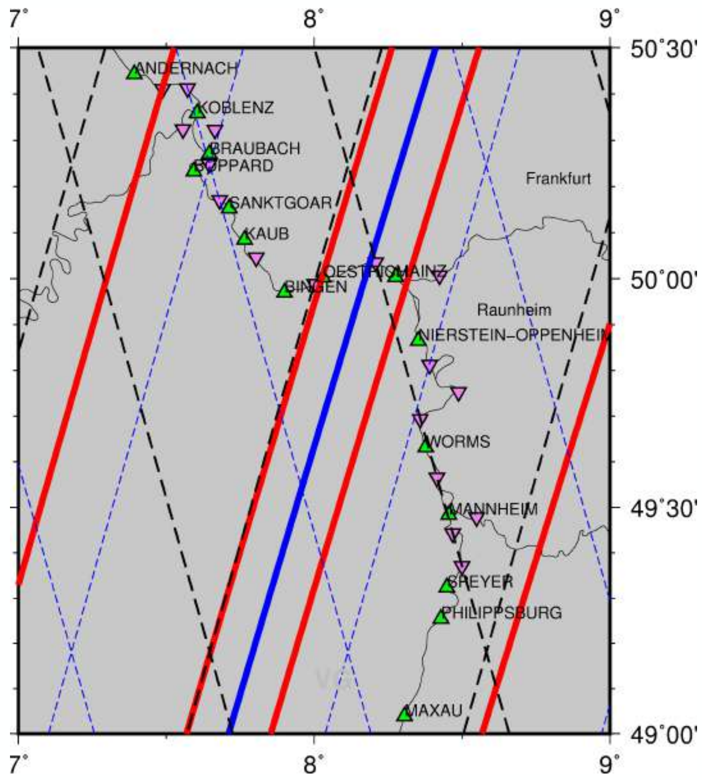

Fig. 2 ROI from SWOT cal/val

MOTIVATION

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B01-DETECT RHINE network for Sentinel-3: **48 VG**, **RG (> 40),** reference **DHHN2016, GCG2016 geoid**

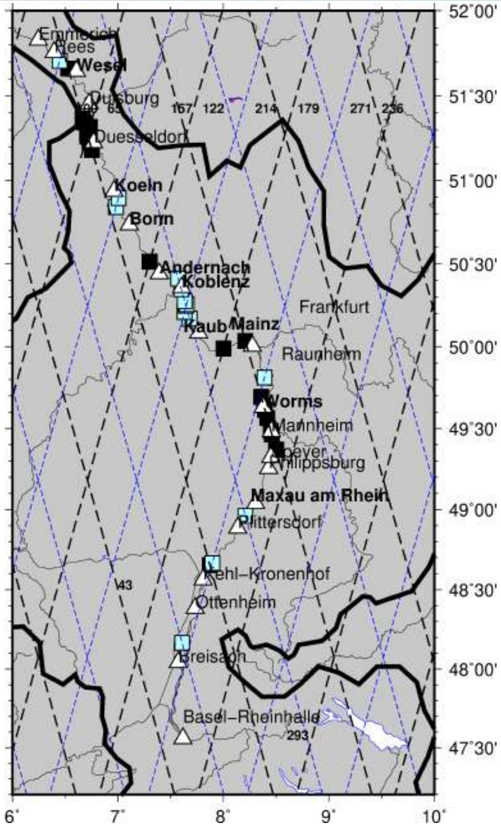


Fig. 3 VG S3A (light blue) and VG S3A (black), gauge (white)

OUTLINE

Data

Sentinel-3A/3B start – Dec 2019 (Copernicus land, 20 Hz **SR_2_LAN___**

Sentinel-3A/3B Thematic Hydrology Product (THP) 20 Hz, Jun–Sept 2022 **SR_2_LAN_HY**

Sentinel-3A/3B start – Sept. 2019 (SARVatore/Earth Console coastal/inland water 80 Hz)

Sentinel-3A/3B Year 2018 FFSAR (CLS SMAP), 80 Hz, 640 Hz

Region

River Rhine

Methods

Virtualpass, TsHydro, revised Virtualpass@NodesReach

Results with : operational LAND, Earth Console SAMOSA+, Thematic Hydrology Product Inland , FF-SAR

Data used

Previous S3VT (6th S3VT)

80Hz SAMOSA+ (Dinardo et al. 2018)

zero-padding + hamming

20Hz SAMOSA2, 20Hz ocog

HYDROCOASTAL Project

20Hz

Zero-padding

No hamming window

Thematic Hydrology Products

Zero-padding

hamming windows

FF-SAR ocog, PTR, multiplePTR

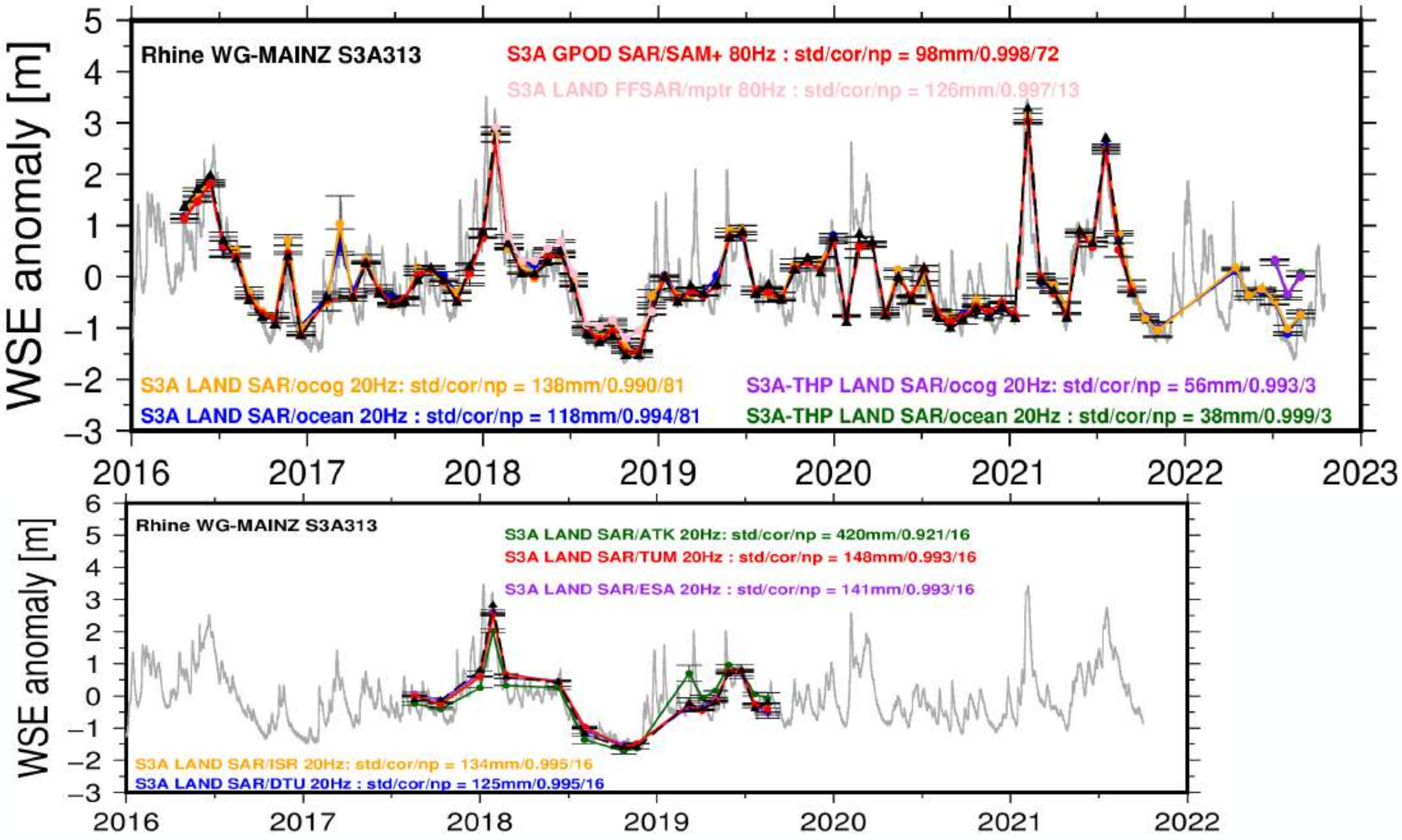


Fig. 4 WSA from S3A pass 157 and orbit 313 in Mainz from LAN product, THP, SAMOSA+ FF-SAR

Accuracy

48 VGs SAMOSA+ 2016-2021

Effect of orientation with Unfocused SAR on the DETECT-RHINE Network

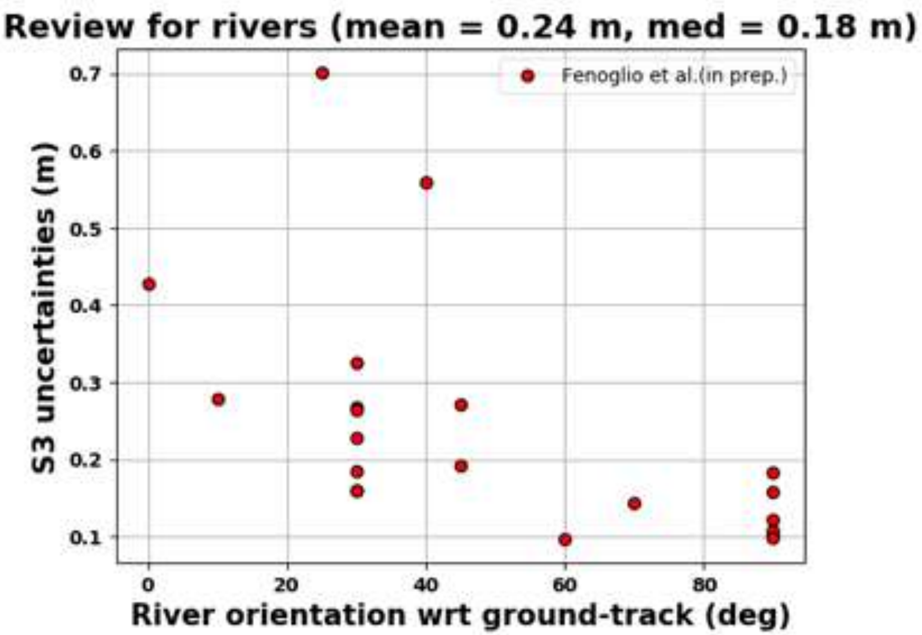
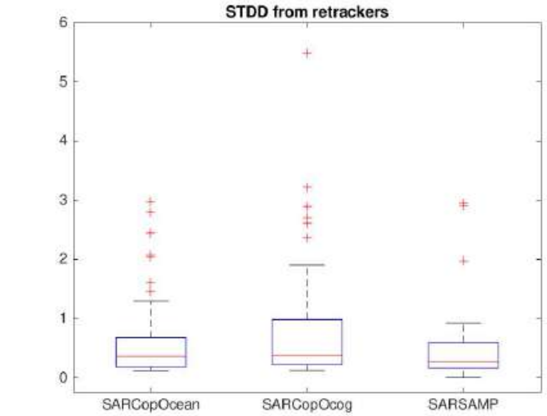
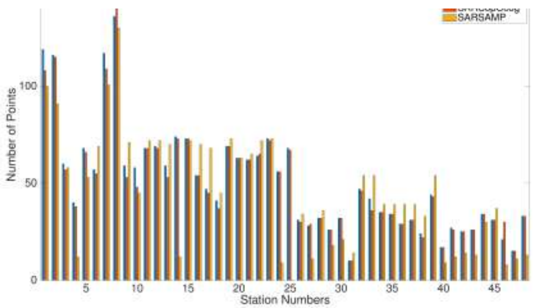


Fig. 5 Accuracy dependence from track orientation relative to river

Accuracy

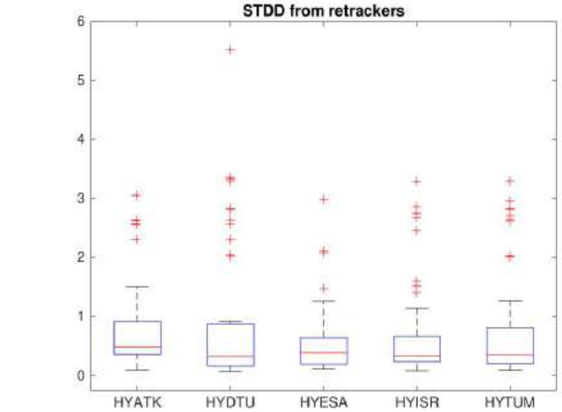
48 VGs **LAND & SAMOSA+** 2016-2021

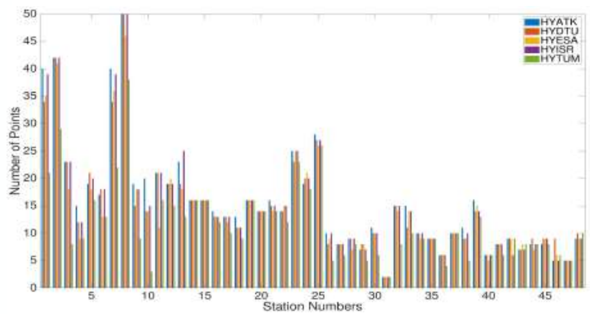




	SARCopOcean	SARCopOcog	SARSAMP
MEDIAN	0.367	0,381	**0,267**
MEAN	0,654	0,847	0,479

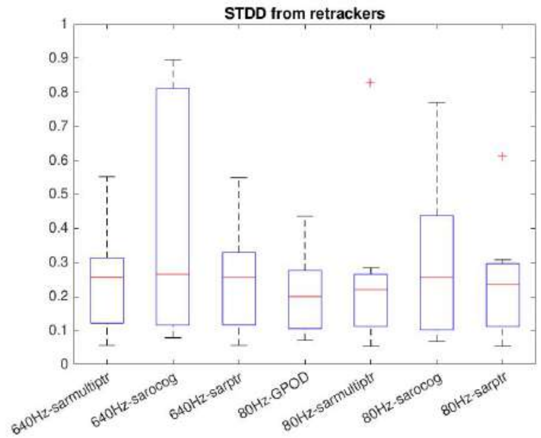
48 VGs **ESA Hydrocoastal** 2016-2021





	ATK	DTU	ESA	ISR	TUM
MEDIAN	0.494	**0,324**	0,394	0,338	0,354
MEAN	0,813	0,926	0,671	0,691	0,795

8 VGs **FF-SAR** CLS SMAP 2018



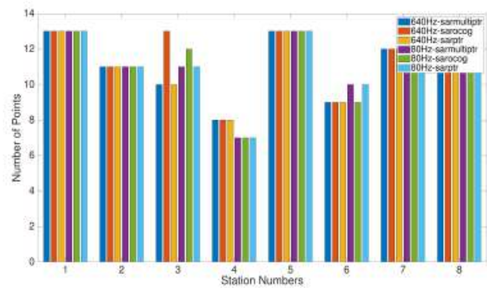
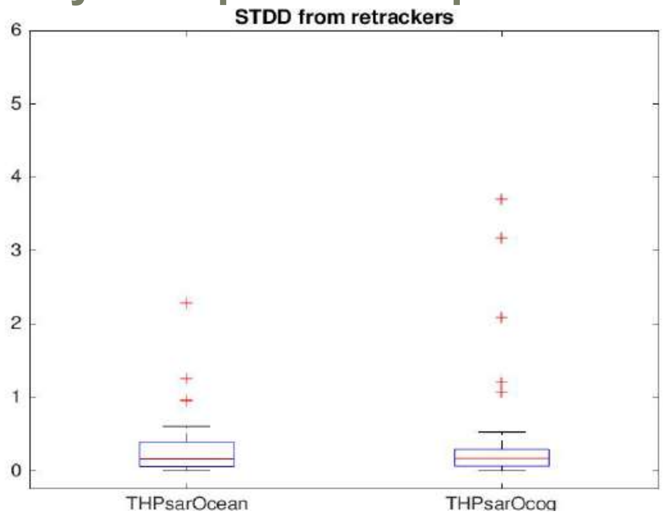


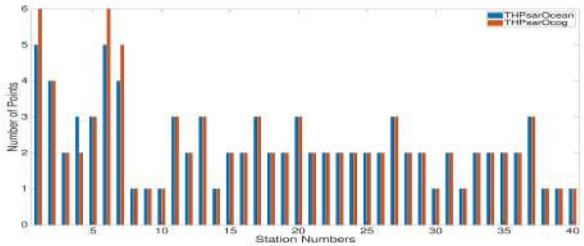
Fig. 6 Accuracy for 3 case studies

	640Hzsarm ultiptr	640Hzsaroco g	640Hzsa rptr	80HzGP OD	80Hzsar multiptr	80Hzsaroc og	80Hzsar ptr
MEDIAN	0,256	0,266	0,256	**0,201**	**0,221**	0,256	0,236
MEAN	0,249	0,794	0,251	0,209	0,260	0,304	0,244

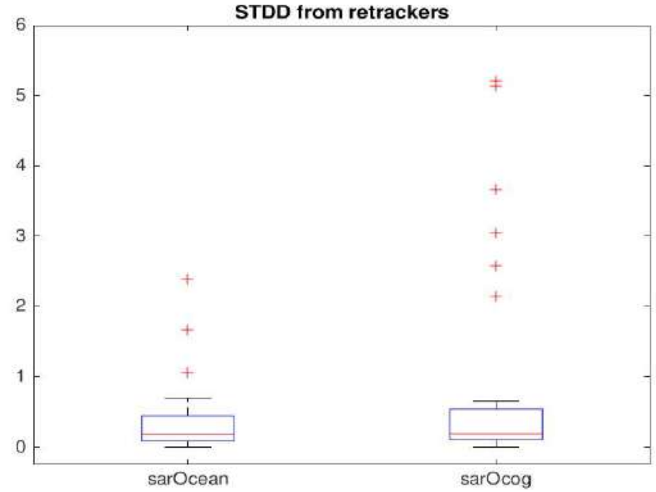
Accuracy: comparison of products STDD op. S-3 LAND products (right) against S-3 THP products (left)

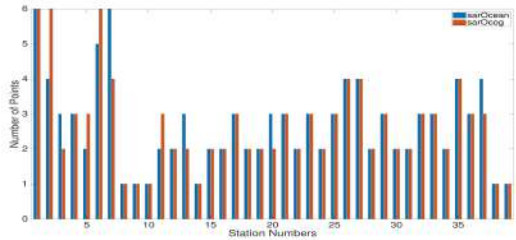
40 VG





	THPsarOcean	THPsarOcog
MEDIAN	**0.165**	0.171
MEAN	0.338	0.485





	sarOcean	sarOcog
MEDIAN	**0.176**	0.190
MEAN	0.354	0.826

Fig. 7
Accuracy for LAND and THP LAND

Accuracy: comparison of evaluation methods

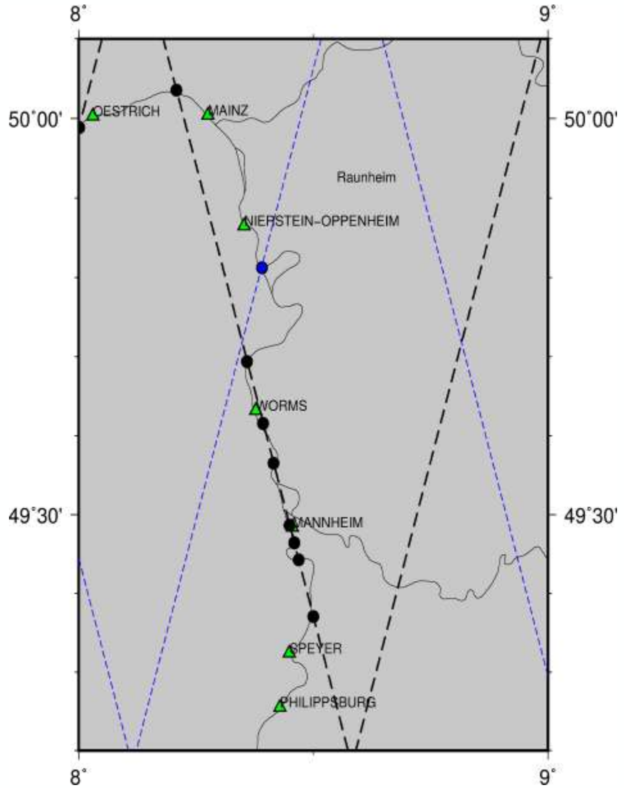


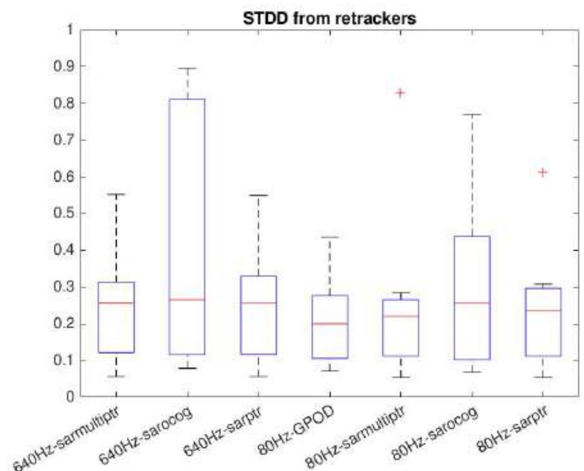
Fig. 9 . S3A (black) with the 8 VG from Mainz to Spyer. S3B (blue) and gauge (green)

8 VG

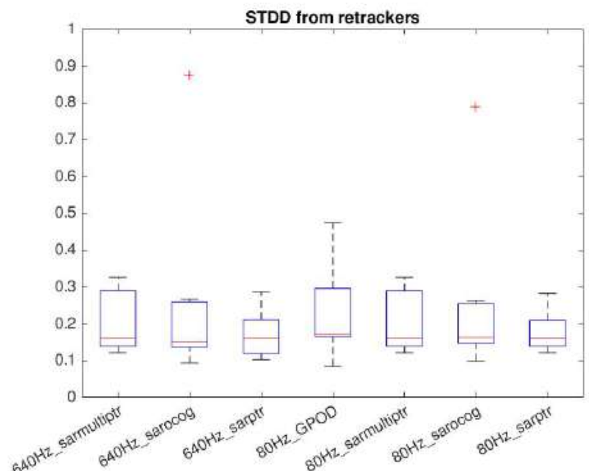
S-3 FF-SAR CLS SMAP, USAR SAMOSA+ *on the Mainz-Speyer line*

Time-series @VG: Virtualpass & tsHydro methodology

Fig. 8 Accuracy for case FF-SAR using 2 methods



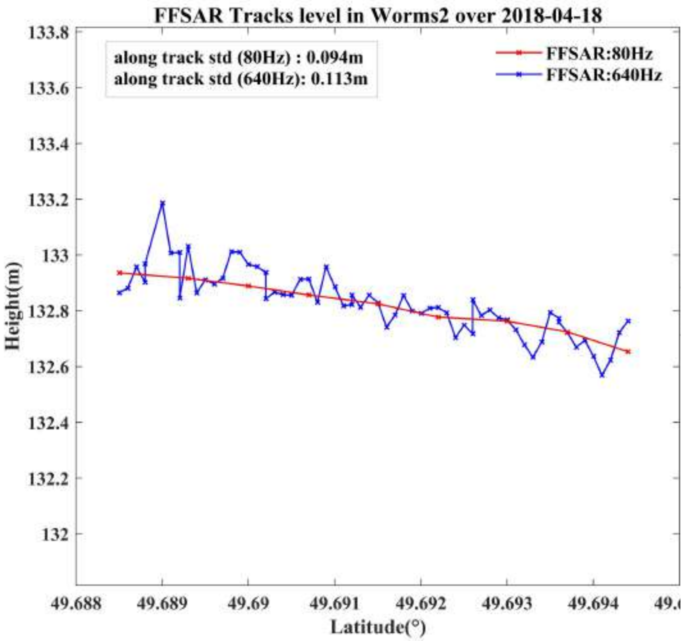
	640Hz-sarmultiptr	640Hz-sarocog	640Hz-sarptr	80Hz-GPOD	80Hz-sarmultiptr	80Hz-sarocog	80Hz-sarptr
MEDIAN	0,256	0,266	0,256	**0,201**	0,221	0,256	0,236
MEAN	0,249	0,794	0,251	0,209	0,260	0,304	0,244

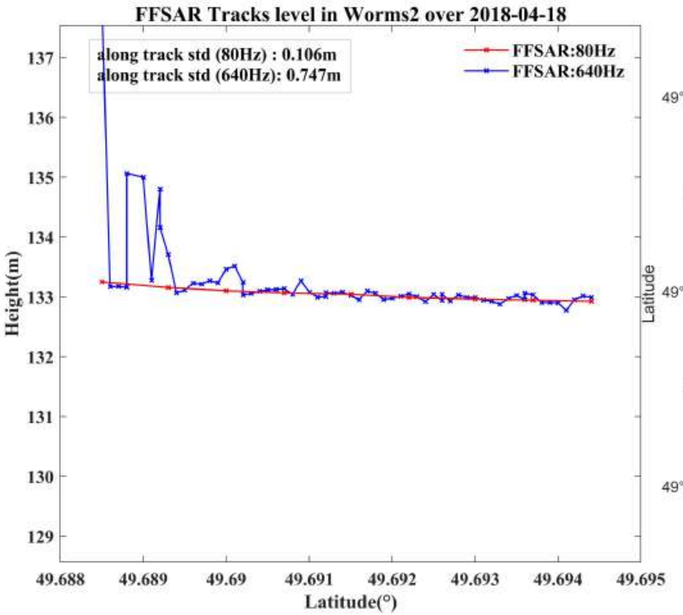


640Hz_sarmultiptr	640Hz_sarocog	640Hz_sarptr	80Hz_GPOD	80Hz_sarmultiptr	80Hz_sarocog	80Hz_sarptr
0,161	**0,150**	0,161	0,172	0,161	0,163	**0,160**
0,390	0,258	0,171	0,228	0,390	0,252	0,178

8 VGs FF-SAR CLS SMAP

FF-SAR in 2018-04-18





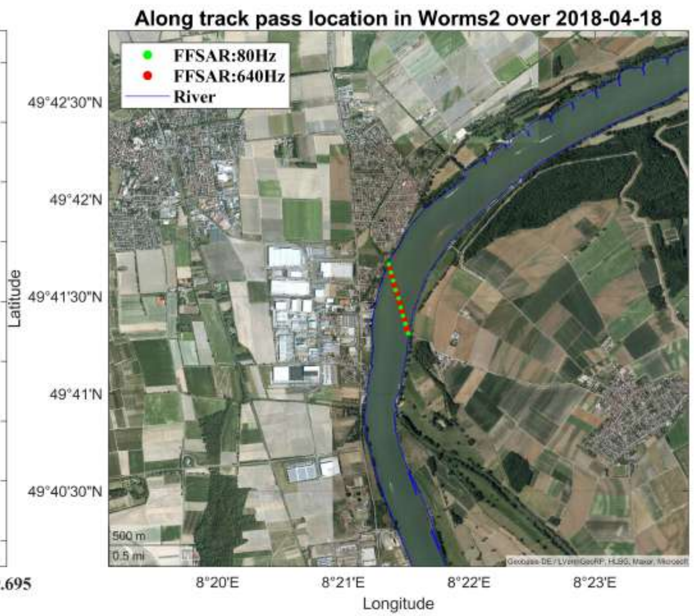
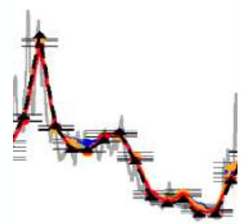


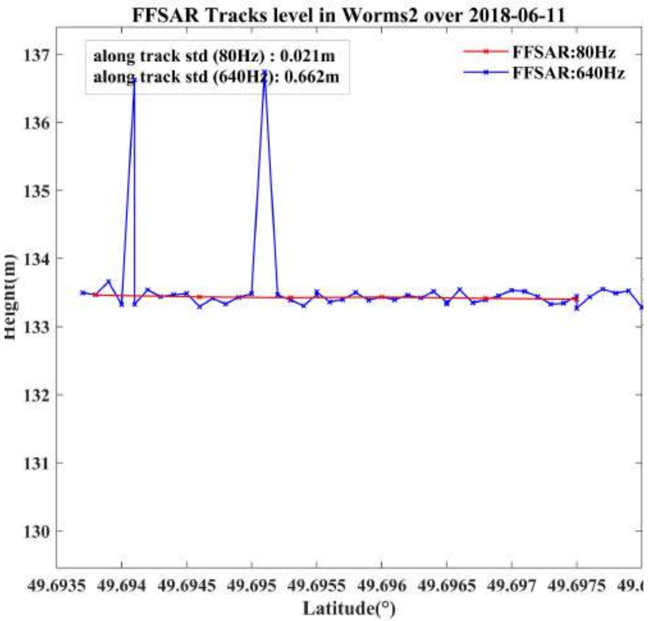
Fig. 10 Water Surface Anomaly (WSA) from FF-SAR with mptr (left) and ocog (right)

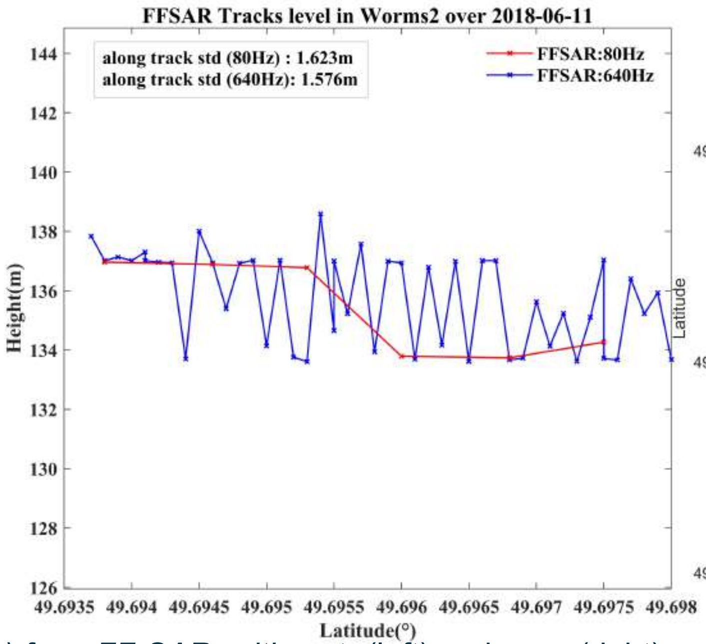
WSH from **retracker multiptr** has smaller noise than from retracker ocog



FF-SAR in 2018-06-11

8 VGs FF-SAR CLS SMAP





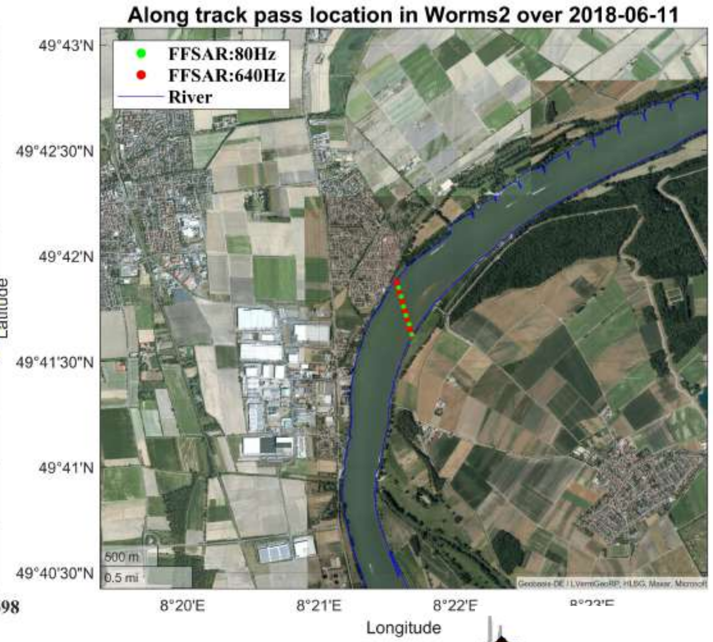
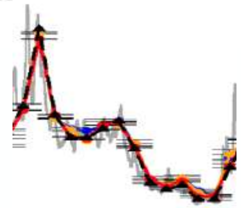


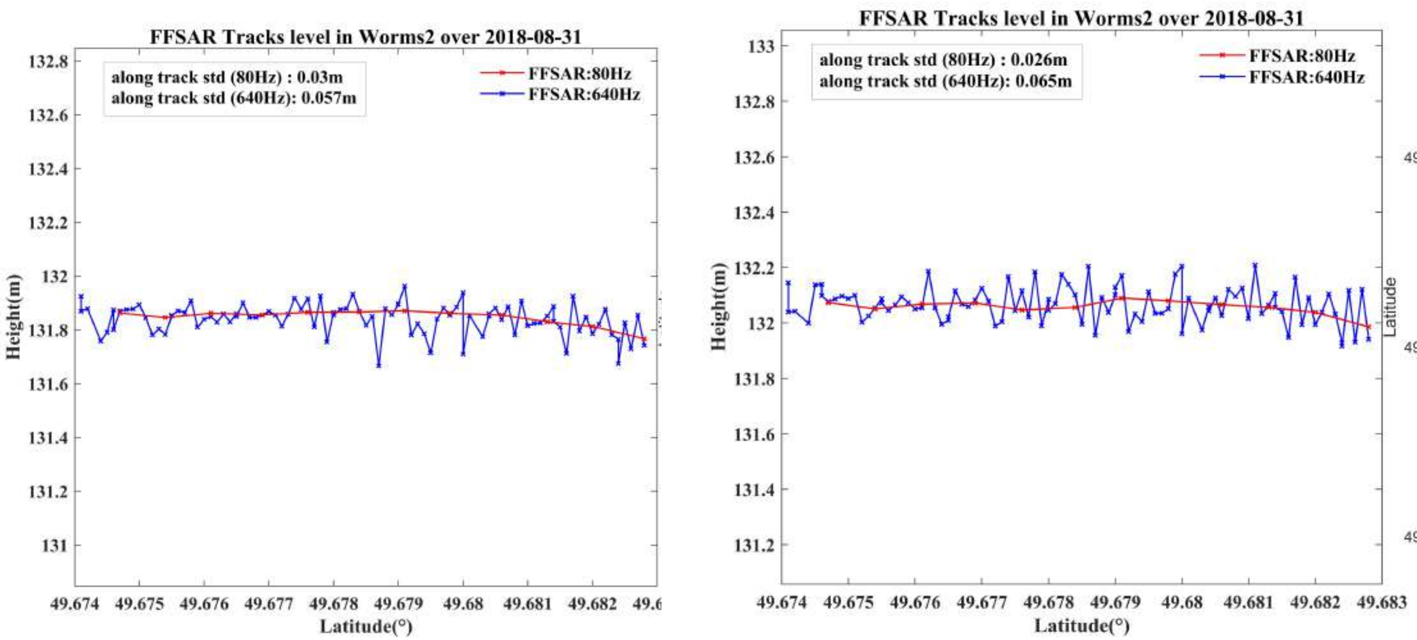
Fig. 11 Water Surface Anomaly (WSA) from FF-SAR with mptr (left) and ocog (right)



WSH from **retracker multiptr** has smaller noise than from retracker ocog

FF-SAR in 2018-08-31 mptr (left) and ocog (right)

8 VGs FF-SAR CLS SMAP



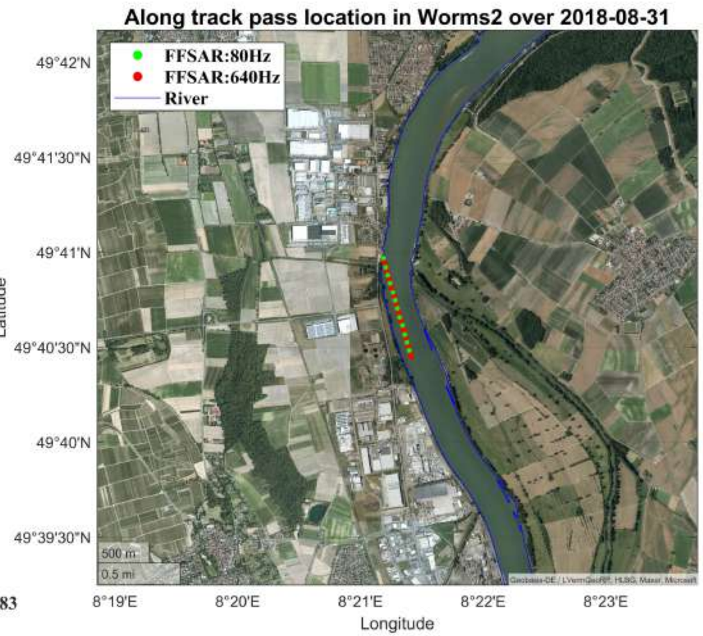
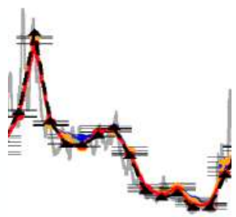


Fig. 12 Water Surface Anomaly (WSA) from FF-SAR with mptr (left) and ocog (right)

WSH from **retracker multiptr** and from **retracker ocog** have similar noise (3cm)



Merging of VGs for river monitoring - over 500 km and in 2 months

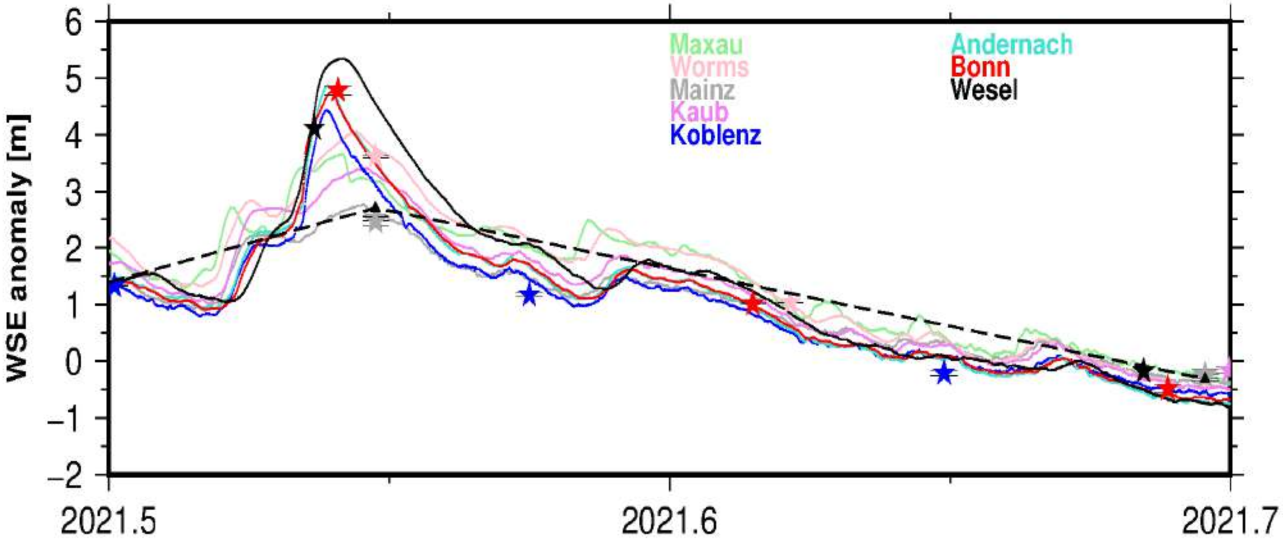
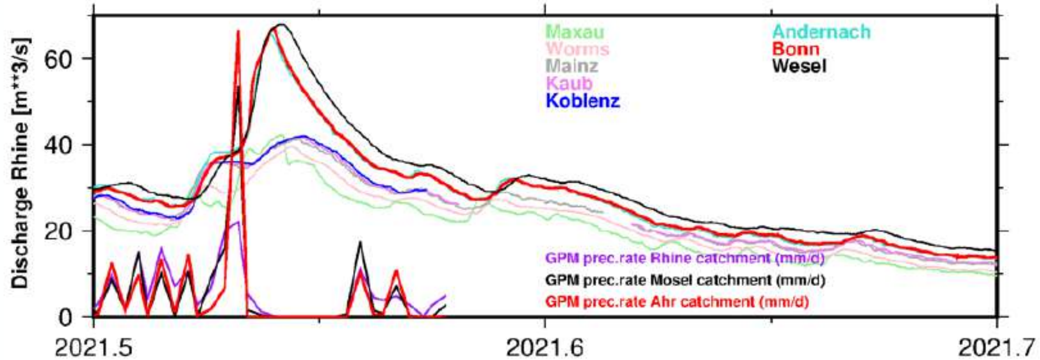


Fig. 13 Rhine high water July 2021 from Sentinel-3 (stars) and in-situ gauges (lines)

Fig. 14 Discharge from in-situ (lines) and precipitation (bottom)



CONCLUSION

An assessment of the Water Surface Height (WSH) provided in the Hydrology Thematic products was performed over the river Rhine.

The **accuracy** is estimated by comparison with in situ gauges, the **noise level** of the WSH is estimated by computing the topography variation over consecutive 20/80/640 Hz measurements.

With THP, accuracy has increased (11 cm vs 5 cm). and the **noise level** decreased (only 3 obs. pro VS).
Noise reduction is due to **zero-padding** (better range resolution) and hamming window processing already recognized by using SAMOSA+ (Dinardo 2019, Fenoglio et al., 2020).

With FF-SAR (SMAP/CLS), accuracy has increased and the **noise level** is decreased at 80 Hz (> 2 cm)
Accuracy of FF-SAR and SAMOSA+ are siimilar (for 8 VS, median is 22-20 cm or 15-17 cm method-depending).

Thanks for your attention

Low water in Lorch am Rhine, 5th August 2022