### Status report of the IDS AAC at GFZ

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# 1 Hardware Environment

- GFZ POD Group is located in Oberpfaffenhofen
- Implemented the DORIS processing environment also at GFZ in Potsdam

#### **Computation levels:**

- Cluster (Potsdam)
  - CPU/GPU cluster
  - Main processing facility
- HPC (Potsdam)
  - Future evaluation
  - Future archive
- HPC (Oberpfaffenhofen)
  - · Current evaluation and archive
  - Future backup



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# 2 Suite of Processed Satellites



We have extended the suite of processed DORIS missions to all altimetry satellites (10).

Other satellites:

- SPOT 2,3,4,5
  - Planned
  - Internal coordination
- HY-2A,-2C,-2D
- SWOT
  - Data availability?

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# 3 Orbital Fit

- Software: EPOS-OC (capable of processing and simulating all four techniques)
- Results for Sentinel-3A/-3B/-6A MF (DORIS-only)
- Post fit residuals
  - DORIS: 0.38-0.42 mm/s
  - SLR: 0.69-0.79 cm

		Ser	Sentinel-3A		Sentinel-3B		Sentinel-6A (MF)	
		RMS	No. Obs.	RMS	No. Obs	RMS	No. Obs.	
SLR <sup>(1)</sup>	[cm]	0.75	271′387	0.79	154′355	0.69	53′404	
DORIS <sup>(1)</sup>	[mm/s]	0.41	16′212′601	0.42	9'820'344	0.38	3′963′499	

 Current and future orbit versions are available via ISDC: <u>ftp://anonymous@isdcftp.gfz-potsdam.de</u>

(1) See also Schreiner et al., 2023

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# 4 External Orbit Comparison (1)

- External orbit comparison with the CPOD-QWG<sup>(2)</sup> combined orbit solution
- GFZ values for the maximum mission duration until Dec. 2021
- CLS/GRGG and GSFC values according to CPOD RSR-23 (Jan-Dec. 2021)<sup>(2)</sup>
- GFZ: DORIS (DORIS+SLR values are quite similar)
- CLS/GRGG: DORIS
- GSFC: DORIS+SLR

		Radial [cm]	Transverse [cm]	Normal [cm]
S3A	GFZ <sup>(1)</sup>	0.82	1.88	1.48
	CLS/GRGG <sup>(2)</sup>	1.00	2.72	2.04
S3B	GFZ <sup>(1)</sup>	0.80	1.96	1.65
	CLS/GRGG <sup>(2)</sup>	0.98	2.68	2.14
S6A	GFZ <sup>(1)</sup>	0.75	2.24	1.55
	CLS/GRGG <sup>(2)</sup>	0.78	2.50	2.60
	GSFC <sup>(2)</sup>	0.54	1.84	1.76

(1) See also Schreiner et al., 2023

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(2) (GMV, 2022)





# 4 External Orbit Comparison (2)

- Orbit comparison against the combined orbit solution
- Regional West-East pattern visible
- GRGG solution shows similar pattern in CPOD RSR-23 analysis (GMV, 2022)
- Adaption of the used gravity field model or parameterization might be needed
- GFZ GPS based orbits do not show such a pattern



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# 4 External Orbit Comparison (3)



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## **5 TRF Results**

- We computed single-satellite weekly regional reference frame solutions based on the DORIS-only orbit solution
- Solved for station positions and ERPs (X-/Y-pole and LOD)
  - Only 1m constraint
- Iterative NNR station network finder
  - Strength of the condition equivalent to 1mm
- Combined solution
  - Combination on normal equation level
- 5.1 Helmert Parameters
- 5.2 ERPs
- 5.3 Station coordinates



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## **5.1 Helmert Parameters**

- Translation shows minor differences in the millimeter level
- Scatter of
  - Tx and Ty similar
  - Tz GFZ smaller
  - the scale. similar
- Investigations on S3A scale drift ongoing
- Rotation in Rz visible



Compare: Schreiner et al., 2023

	<b>Tx</b> [ <i>mm</i> ]	<b>Ty</b> [ <i>mm</i> ]	<b>Tz</b> [ <i>mm</i> ]	<b>Rx</b> [ <i>mm</i> ]	<b>Ry</b> [ <i>mm</i> ]	Rz [mm]	Scale
Comb. <sup>(1)</sup>	$3.36 \pm 1.75$	$1.80 \pm 2.53$	0.87 ± 3.94	$-1.71 \pm 1.00$	2.59 <u>+</u> 1.61	$-6.57 \pm 1.30$	$-2.61 \pm 1.79$
IDS 16 2015-2021 <sup>(2)</sup>	$-3.85 \pm 2.09$	6.39 <u>+</u> 2.89	$-1.75 \pm 10.31$	-	-	-	$10.60 \pm 1.64$
						(1) See also Sch	nreiner et al., 2023
						(2) Compare Mo	reaux et al 2022



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### 5.2 ERPs

Comparison of the derived ERPs with the EOP 14 C04

- Standard deviation of the pole coordinate differences of the combined solution similar to IDS16
- ~150µas Y-Pole offset visible for all solutions

	X-pole [µas]	<b>Υ-pole</b> [μas]	LOD [ <i>µs</i> ]
S3A <sup>(1)</sup>	$-77.40 \pm 187.26$	$-140.88 \pm 172.00$	$0.03 \pm 22.30$
S3B. <sup>(1)</sup>	8.64 <u>+</u> 231.91	$-180.19 \pm 197.26$	0.00 <u>+</u> 39.39
S6A. <sup>(1)</sup>	172.96 <u>+</u> 179.76	$-177.95 \pm 170.17$	$0.02 \pm 28.65$
Comb. <sup>(1)</sup>	$-15.64 \pm 182.75$	$-148.24 \pm 152.58$	$0.00 \pm 19.23$
IDS 16 2015-2021 <sup>(2)</sup>	$18.88 \pm 192.05$	5.38 ± 171.69	-

(1) See also Schreiner et al., 2023

(2) Compare Moreaux et al., 2022

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# **5.3 Station Coordinates**

- Station North and Up component repeatability on similar level as IDS 16 solution
- IDS 16 2015–2021<sup>(2)</sup> mean and std. of WRMS: East: 11.31  $\pm$  1.90 mm / 8.22  $\pm$  1.09 mm / 10.38  $\pm$  1.82 mm
- Open:
  - Up component: Frequency shift stations Syowa tech. prob.
  - SAA Effect: Arequipa, Cachoeira

Mean standard deviation of all station coordinate differences to a priori

	East [mm]	North [mm]	Up [mm]
S3A <sup>(1)</sup>	24.4 <u>+</u> 5.4	$13.1 \pm 2.0$	13.7 <u>+</u> 6.0
S3B. <sup>(1)</sup>	22.8 <u>+</u> 6.2	$13.2 \pm 3.9$	14.2 <u>+</u> 4.9
S6A. <sup>(1)</sup>	57.7 <u>+</u> 7.6	16.1 ± 3.3	23.6 <u>+</u> 6.9
Comb. <sup>(1)</sup>	22.6 <u>+</u> 8.8	$12.0 \pm 1.9$	13.2 <u>+</u> 6.1



Mean height difference for combined solution compared to  $\mbox{DPOD14}^{(1)}$ 



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# 6 Conclusion and Outlook

#### More information:

ASR Special Issue (Schreiner et al., 2023) EGU Presentation (Reinhold et al., 2023) Monday, 24 Apr, 15:25–15:35 (Schreiner et al., 2023) Friday, 28 Apr, 08:30-10:15 EGU Poster (Reinhold et al., 2023), (Neumayer et al., 2023)

#### **Conclusion:**

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- Processed DORIS orbits show good agreement in external comparison
- Derived TRF solutions show comparable results to other combined solutions

#### **Outlook:**

 Processing of SPOT satellites is checked -SWOT data?

- Validate products in cooperation with the IDS CC
- How to reach IDS AC status?

- SAA GPS-USO implementation with EPOS-OC
- Operational GNSS tie point processing with EPOS-OC
- DORIS station outages -> JSON / API?



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### References

- *GMV (2022). Copernicus POD Regular Service Review Jan. Dec. 2021. URL:* <u>https://sentinels.copernicus.eu/documents/247904/4599719/GMV-CPOD-RSR-0023 v1.1 Copernicus POD Regular Service Review Jan Dec 2021.pdf</u>
- GMV (2023) Copernicus POD Regular Service Review Jan. Dec. 2021. URL: <u>https://sentinels.copernicus.eu/documents/247904/4599719/GMV-CPOD-RSR-</u> <u>0027 v1.0 Copernicus POD Regular Service Review Jan Dec 2022+-+QWG.pdf</u>
- Moreaux et al. (2022) The international DORIS service contribution to ITRF2020. DOI: <u>https://doi.org/10.1016/j.asr.2022.07.012</u>.
- Schreiner et al. (2023) On precise orbit determination based on DORIS, GPS and SLR using Sentinel-3A/B and -6A and subsequent reference frame determination based on DORIS-only. DOI: <u>https://doi.org/10.1016/j.asr.2023.04.002</u>.



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