



Contribution to ITRF 2020 IDS reprocessing and other activities of GOP analysis center

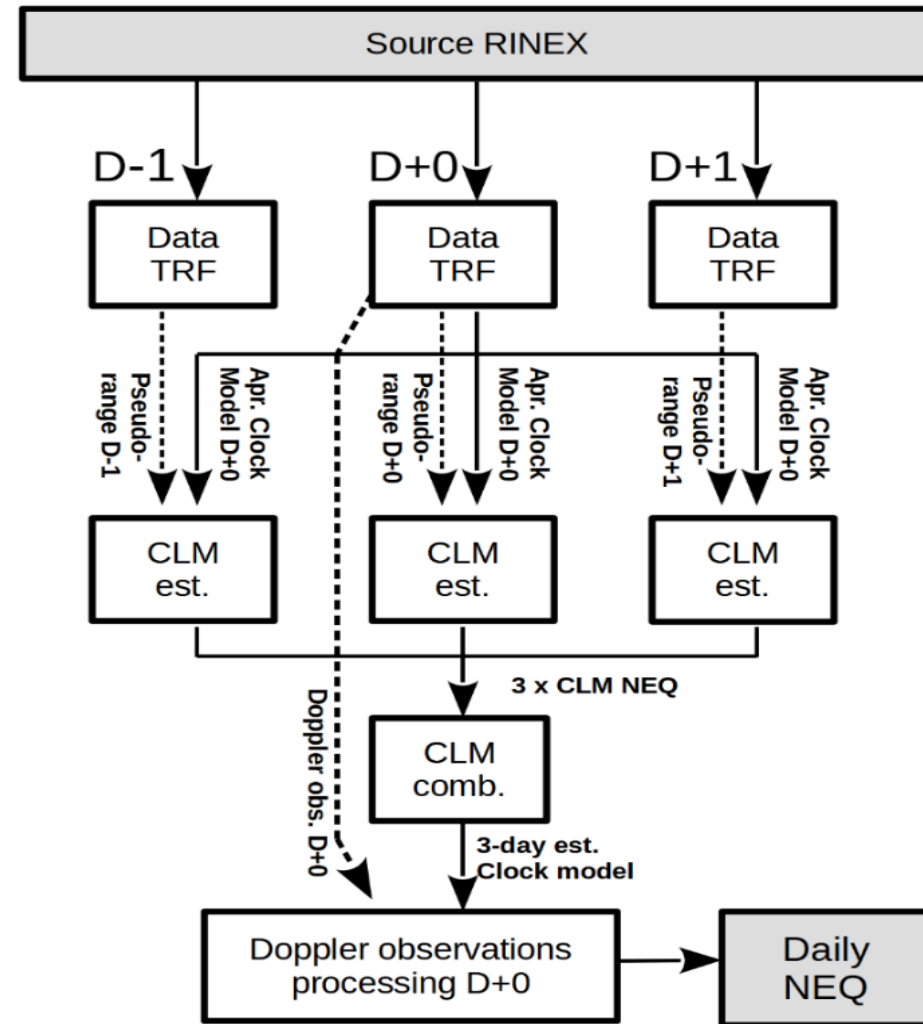
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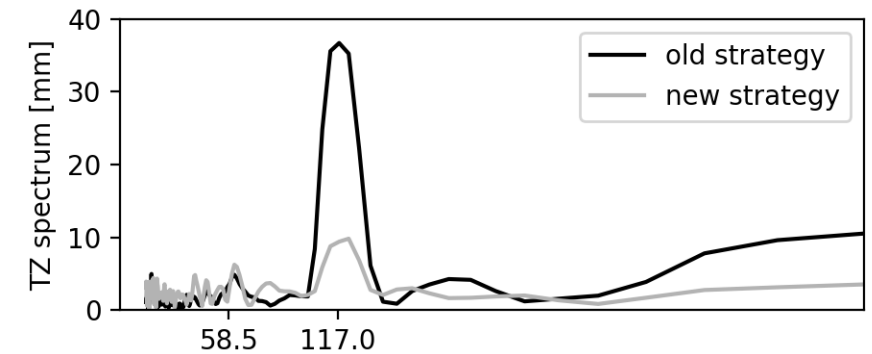
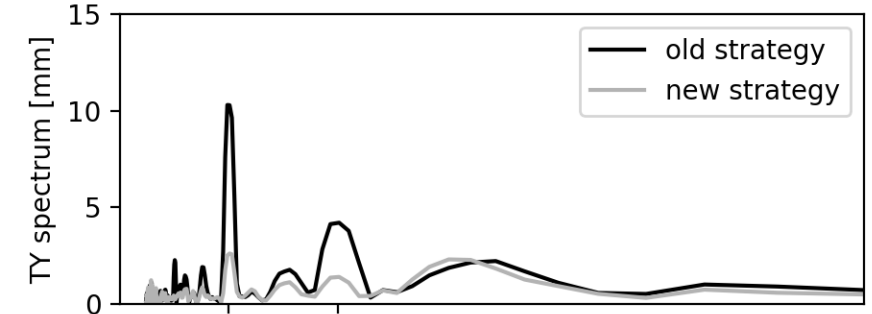
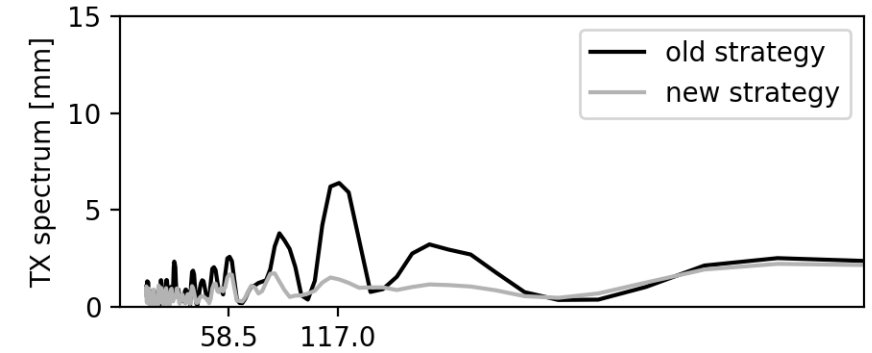
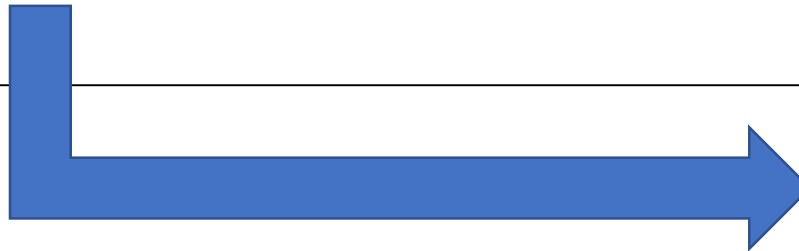
ITRF reprocessing strategy

- Štěpánek et al. paper (Adv. Space Res., in review)
- Compatibility with recent version of IERS conventions
- Compatibility with IDS recommendations
- Improved data preprocessing strategy
- Independency from data supplementary information
- DORIS RINEX processing, including onboard clock estimation
- Improvements in the orbit modeling
- Improvements in the satellite attitude modeling, measured attitude for Jason satellites, attitude information file for T/P
- Improved South Atlantic Anomaly mitigation strategy
- New satellites Saral, Jason-3, Sentinel-3A and Sentinel-3B
- Data downweighting, elevation cut off 12 -> 10 deg
- Improvements in positioning WRMS 0.9-1.5 mm after 2002, around 3 mm after 2008.
- Reduction of Tx, Ty, Tz, Scale variations. Pole estimation improvement

- Clock estimation using pseudorange observations 3- days polynomial (floating interval)
- Transformation Phase to Range rate



- For Jason satellites
- Old strategy (ITRF 2014 repro): nominal attitude for force modeling, CoM corrections
- New Strategy (ITRF 2020 repro): quaternions
- Reduction of draconitic and half draconitic signal in Tx,Ty,Tz
- Periodograms for Jason-2



- **Only for most affected satellites**
- **Jason-1 data not used**
- **SPOT-5 corrected data**
- **Jason-3 – alias names for SAA stations (used only for orbit determination)**

Satellite	Data elimination	Data correction	Alias for SAA stations
Jason-1	YES	NO	NO
SPOT-5	NO	YES (after 2006.0)	NO
Jason-3	NO	NO	YES
Other	NO	NO	NO

- Adjustment of cross track harmonics (constrained $5 \times 10^{-9} \text{ m s}^{-2}$) – reduction of Y_p bias

Cross track 1-per rev	X_p (μas)		Y_p (μas)	
	Mean	Std. Dev.	Mean	Std. Dev.
Not Adjusted	37	648	224	359
Constrained	68	418	89	328
Unconstrained	85	354	-59	503

- After 2008 significant improvement of Pole estimation in comparison to the ITRF 2014 reprocessing
- Corrected error in Hy-2A manoeuvre handling – elimination of outliers in the Pole estimates
- Plots of pole estimates ITRF 2014 and ITRF 2020 reprocessing. Reference: IERS C04 model

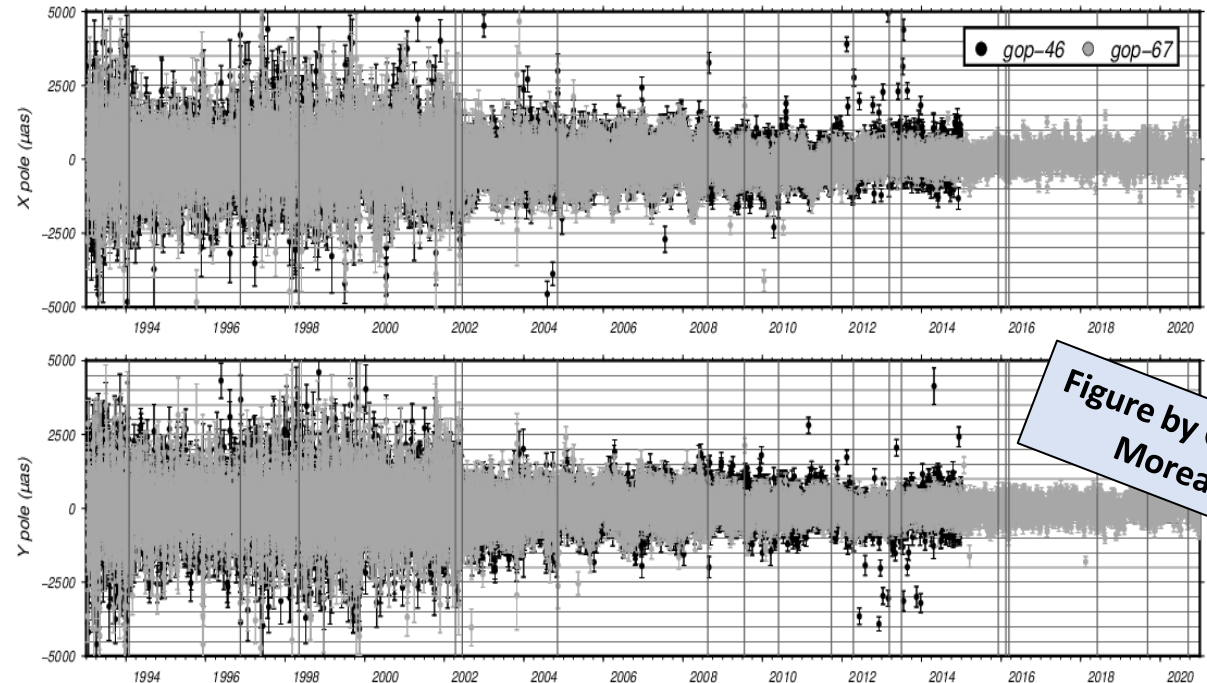


Figure by Guilhem Moreaux

Scale, Tx, Ty, Tz ITRF 2014 and 2020 reprocessing

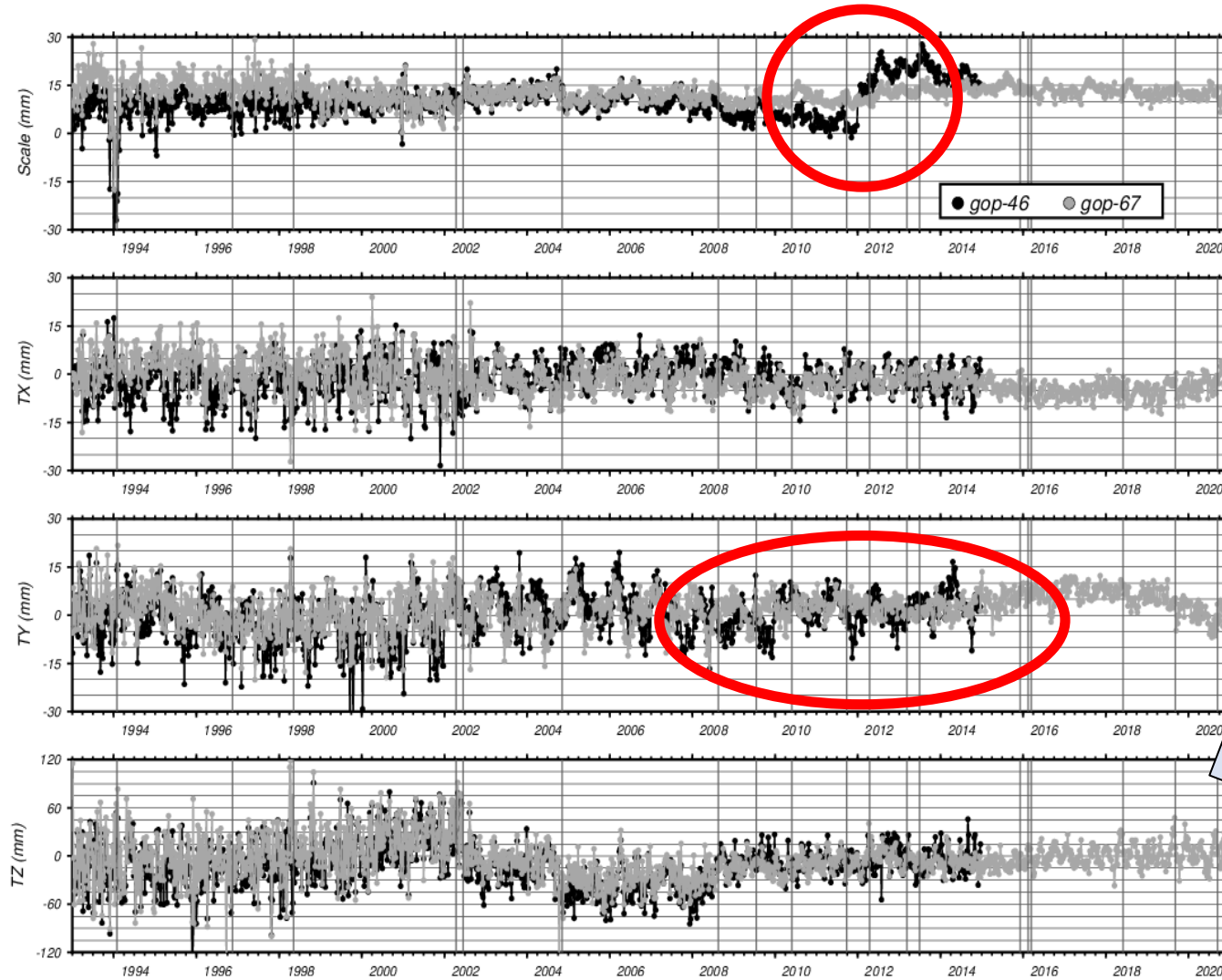


Figure by Guilhem Moreaux

Station WRMS in 2014 and 2020 reprocessing

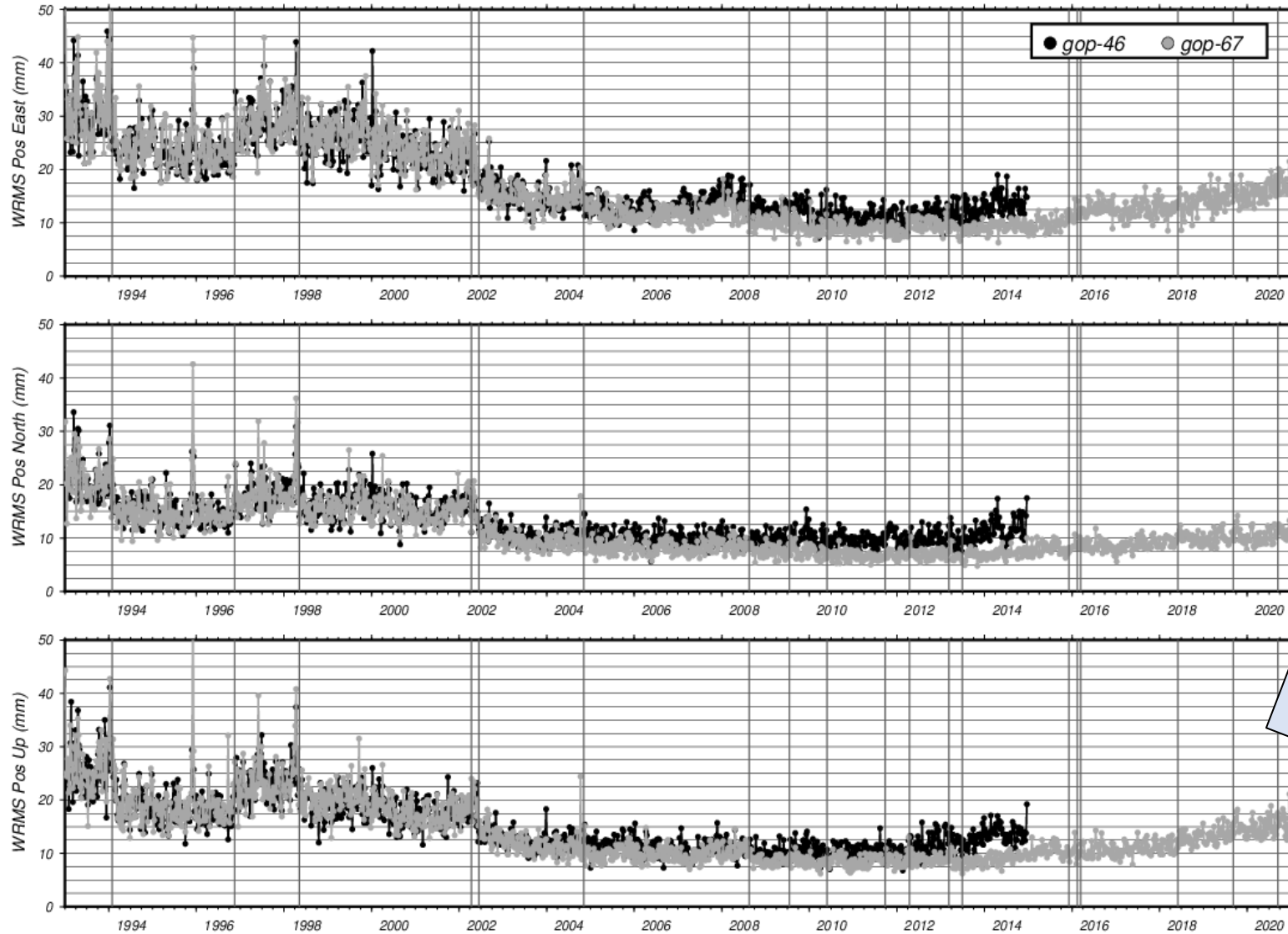
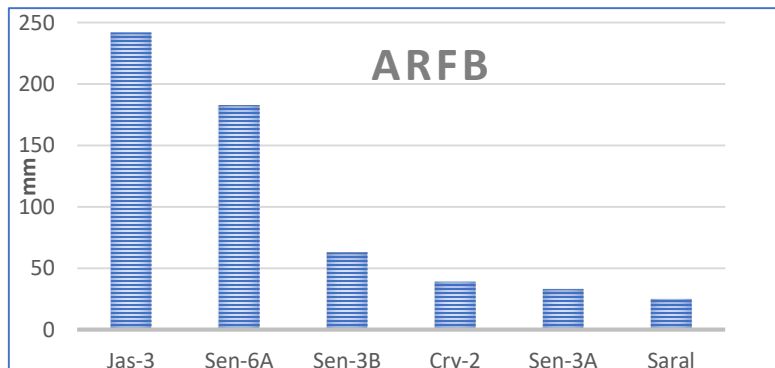


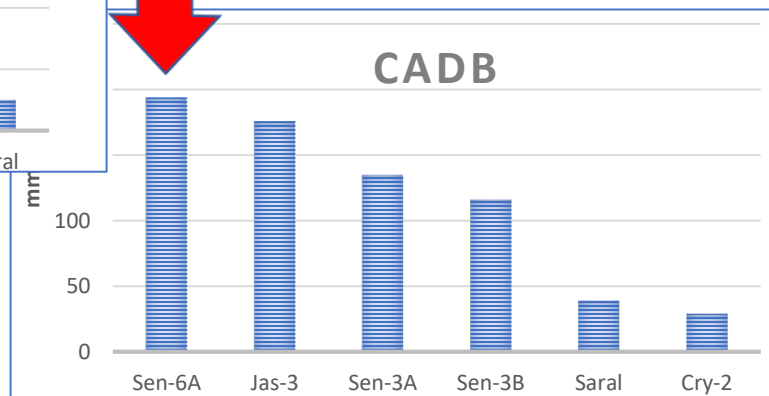
Figure by Guilhem Moreaux

Sentinel-6A

- Launched in late 2020, data from early 2021
- Tests based on 1 year of DORIS data
- Orbit comparison w.r.t. CNES GNSS+DORIS orbit similar to other sats
- Strong SAA effect (the most affected sat. together with Jason-3)
- Special SAA mitigation strategy needed
- Single satellite positioning accuracy comparable to Jason-3
- Higher scale 1.9 ppb w.r.t. ITRF2014 (other sats 0.2-1.21 ppb)
- Impact on the multi-satellite solution, station heights + 1.0 mm



3D positioning bias for single sat. solution

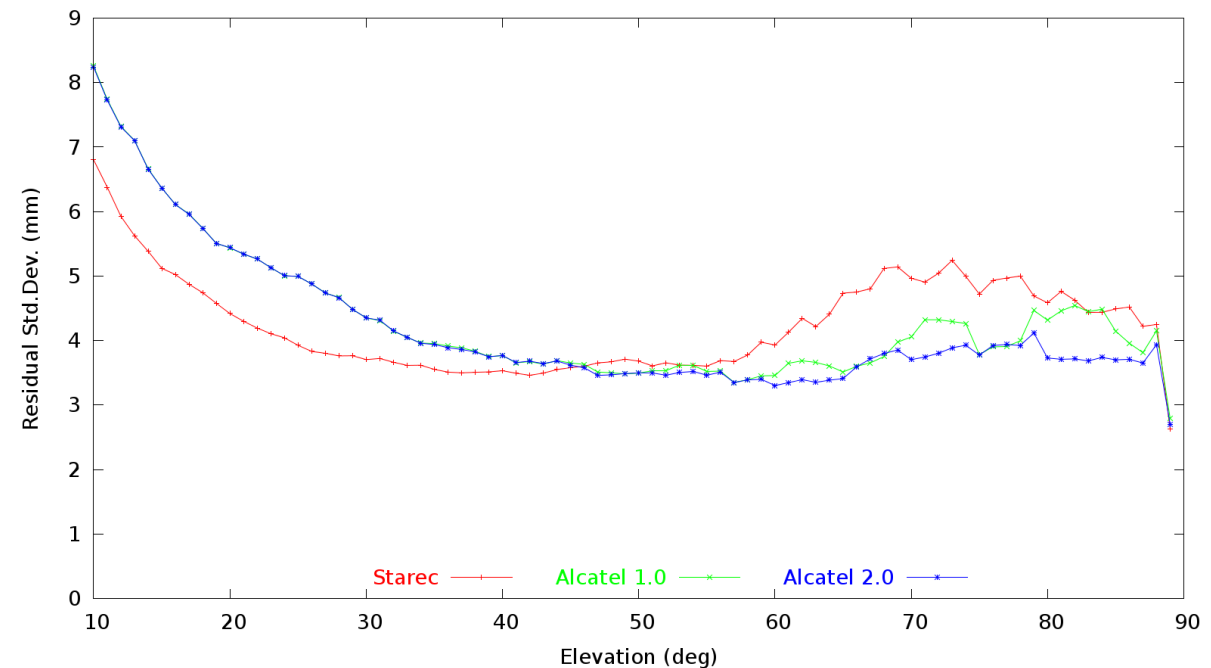
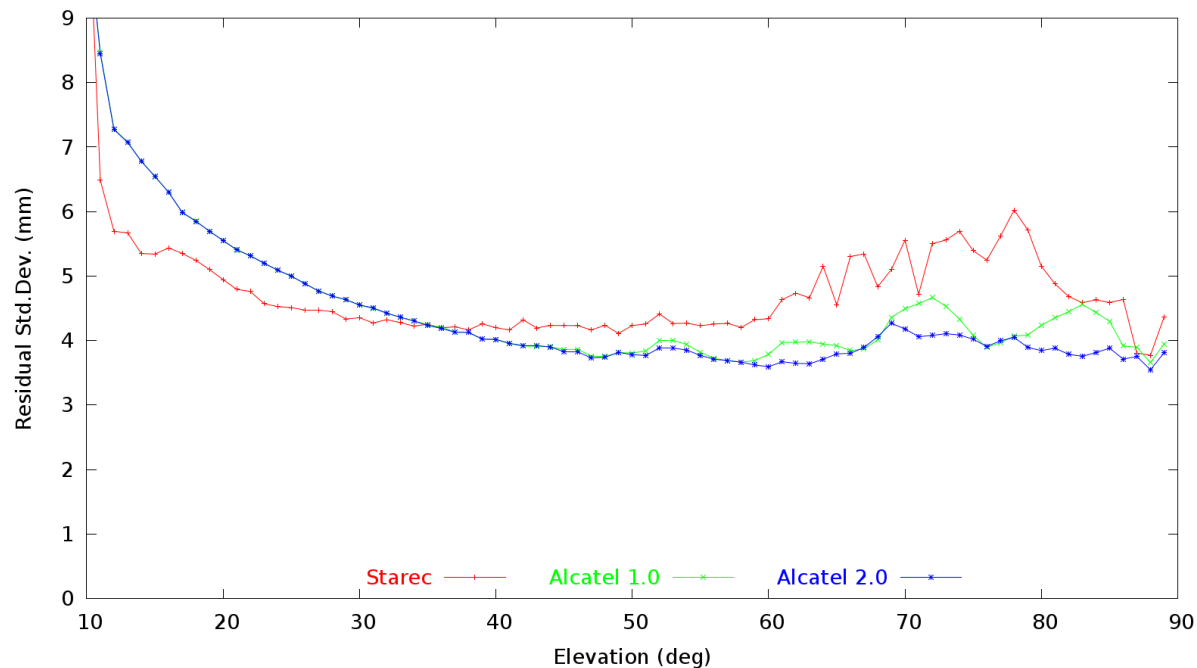


	Mean	RMS
Radial (mm)	-0.3	8.6
Tangential (mm)	-0.7	28.1
Normal (mm)	0.7	36.3

- Solutions with All the satellites and excluding Sentinel-6 and Jason-3
- Station alias rename SAA strategy for Jason-3 and Sentinel-6
- No improvement adding Sentinel-6
- Sentinel-6 Impact expected when GPS clocks introduced in DORIS processing as demonstrated for Sentinel-3A, -3B by Jalabert and Mercier (2018) and Štěpánek et al. (2020)

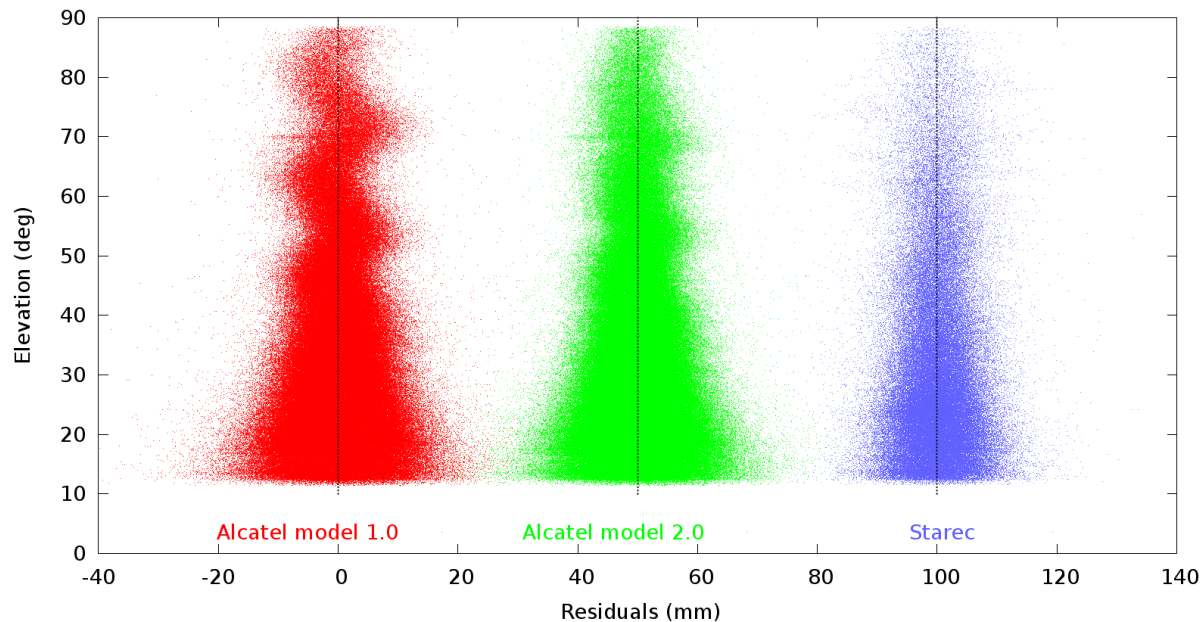
	All –J3,S6	All – S6	All – J3	All
RMS vs. DPOD2014 (3D)	15.3 mm	15.5 mm	15.5 mm	16.3 mm
Repeatability RMS (3D)	12.1 mm	12.4 mm	12.2 mm	12.0 mm
Tx	10.6 ± 2.9 mm	8.1 ± 2.8 mm	7.8 ± 2.6 mm	5.9 ± 2.8 mm
Ty	-1.3 ± 2.4 mm	-0.5 ± 2.3 mm	-0.8 ± 2.3 mm	-0.3 ± 2.5 mm
Tz	2.6 ± 12.9 mm	8.1 ± 11.3 mm	12.7 ± 12.6 mm	12.3 ± 13.5 mm
Scale	4.8 ± 1.5 mm	5.8 ± 1.1 mm	5.0 ± 1.3 mm	6.0 ± 1.3 mm
Xp	0.07 ± 0.41 mas	-0.14 ± 0.44 mas	-0.16 ± 0.40 mas	-0.20 ± 0.45 mas
Yp	0.29 ± 0.38 mas	0.28 ± 0.36 mas	0.20 ± 0.36 mas	0.27 ± 0.40 mas

- Alcatel „2.0“ fits better in some intervals of higher elevation
- Lower residuals for Starec stations at low elevations, but higher at high elevations
- Residuals derived from free-network single-satellite solutions
- Plots for 1994 (left) and 2003 (right), all satellites

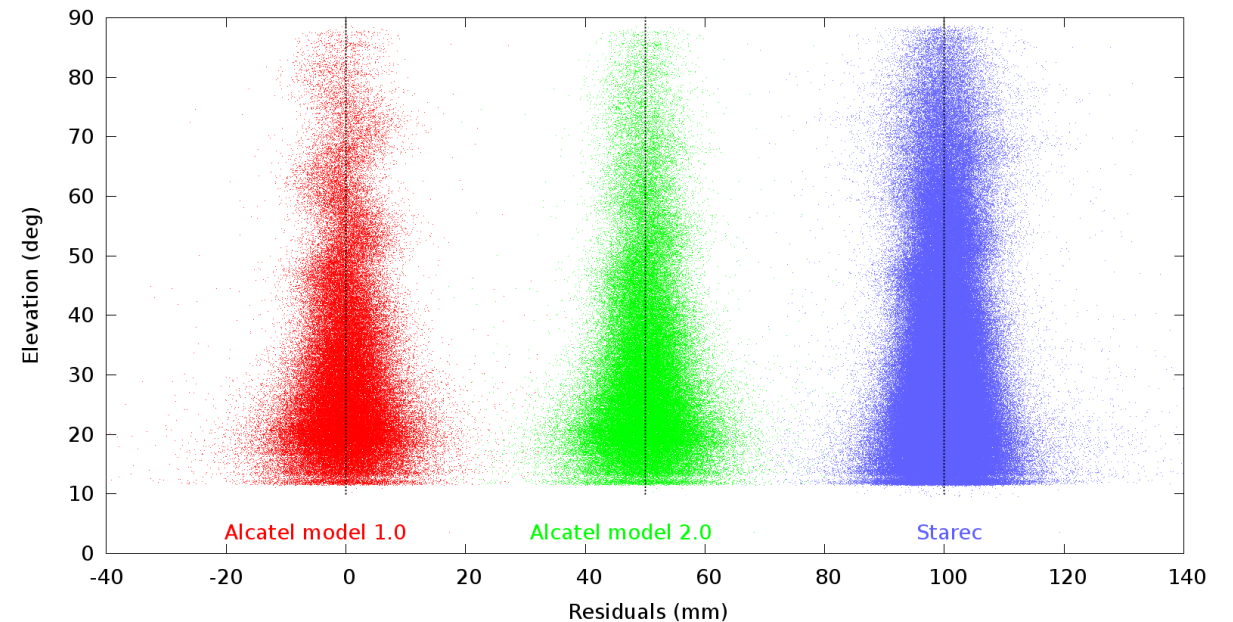


- Residuals for Alcatel (both PCV models) and Starec. *Ascending only*
- Plots for 1994 (left) and 2003 (right), SPOT-2

SPOT-2 residuals from 1994, Ascending

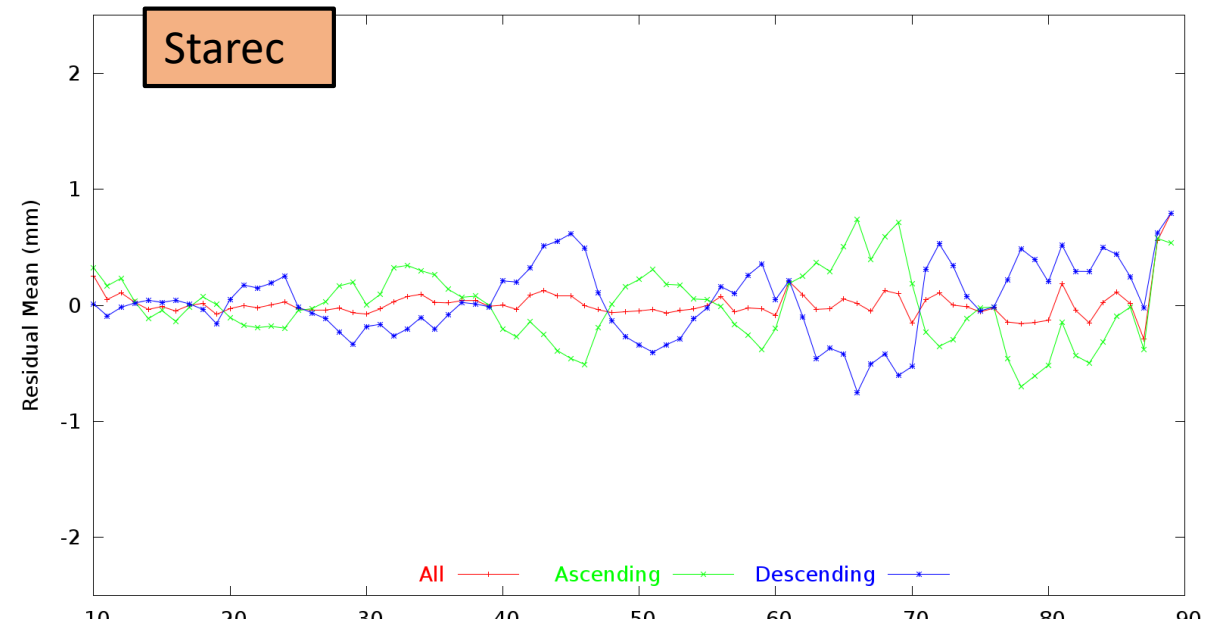
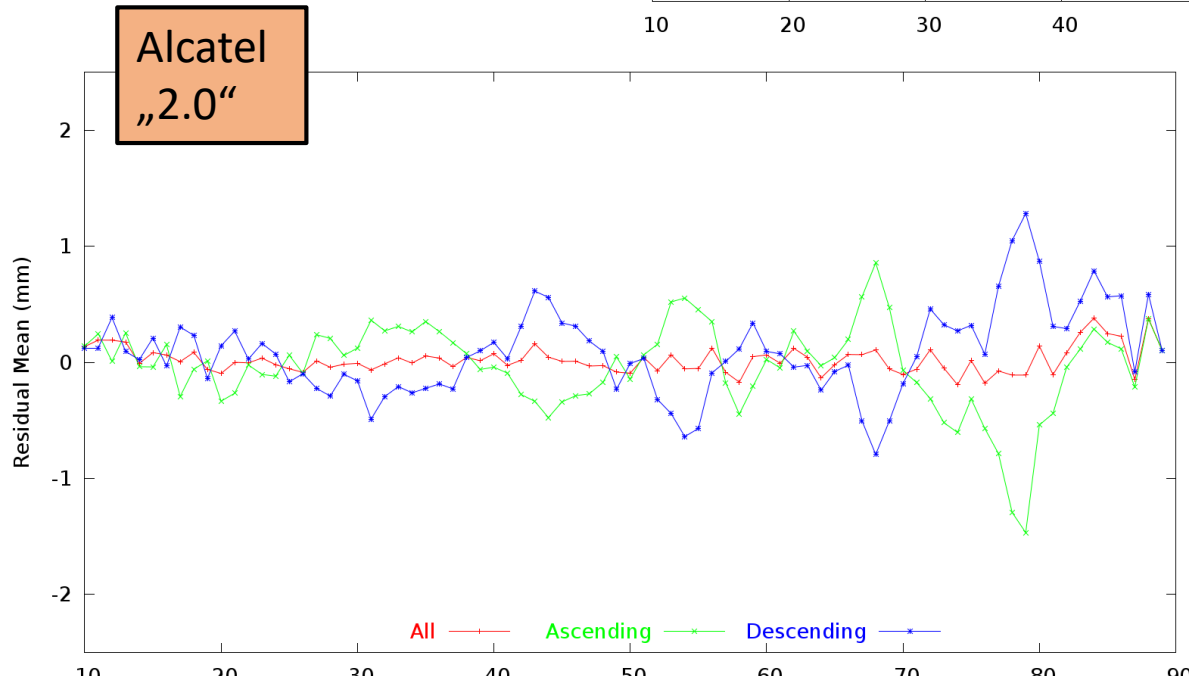
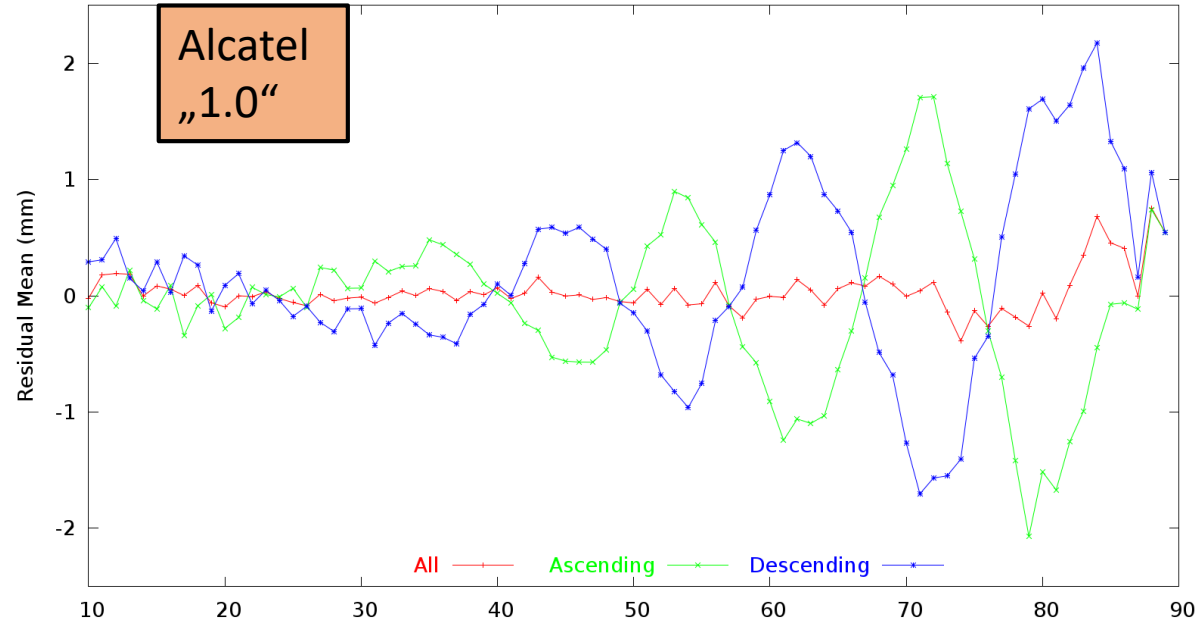


SPOT-2 residuals from 2003, Ascending





Residual mean per elevation. All, ascending, descending



- **introduction of GPS clock for Sentinels – extension for Sentinel-6A, possibly included in GOP operational solutions (cooperation with TUM)**
- **Understanding of Ty drift reported by IDS combination center in our recent solutions**
- **Possible cooperation with AIUB on DORIS/GNSS combinations using Bernese GPS software (initial discussions)**
- **Continue with Sentinel-6A testing. Use of quaternions, when available**
- **Start with Hy-2C and Hy-2D processing**
- **Differences in ascending/descending DORIS residuals – could be used for ground Antennae PCV tuning?**



Special thanks to Guilhem Moreaux (CLS, IDS combination center) for his feedback

Thanks for the attention !