GOP AC report

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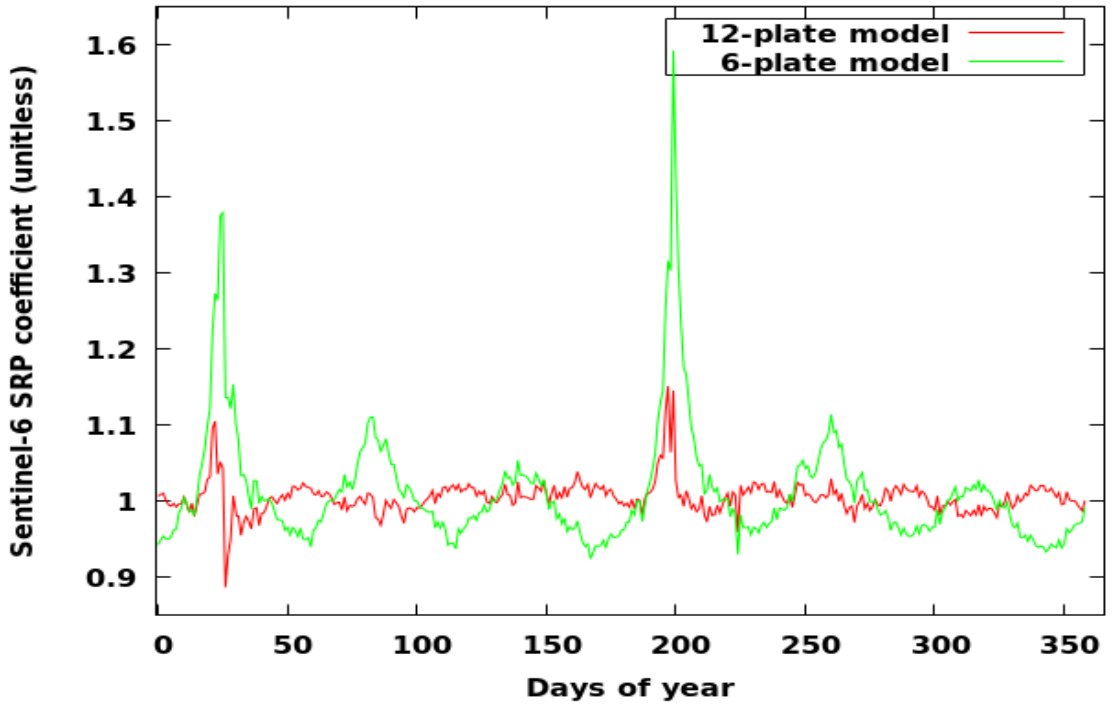
Operational GOP series

- **Operational GOPwd69 and GOPwd70**
  - Differs from GOPwd68 in gravity field model
    - GOPwd68 EIGEN RL04
    - GOPwd69/70 GRGS RL05
  - Differences of GOPwd69 and GOPwd70
    - GOPwd69 all the satellites contribute to the scale
    - GOPwd70 Sentinel-6, Hy-2C and Hy-2A do not contribute to the scale
  - Delivered up to 2025.5
  - Recently LOD included
  - 12 plate macromodel for Sentinel-6 integrated now

Integration of of Sentinel-6 12 plates model

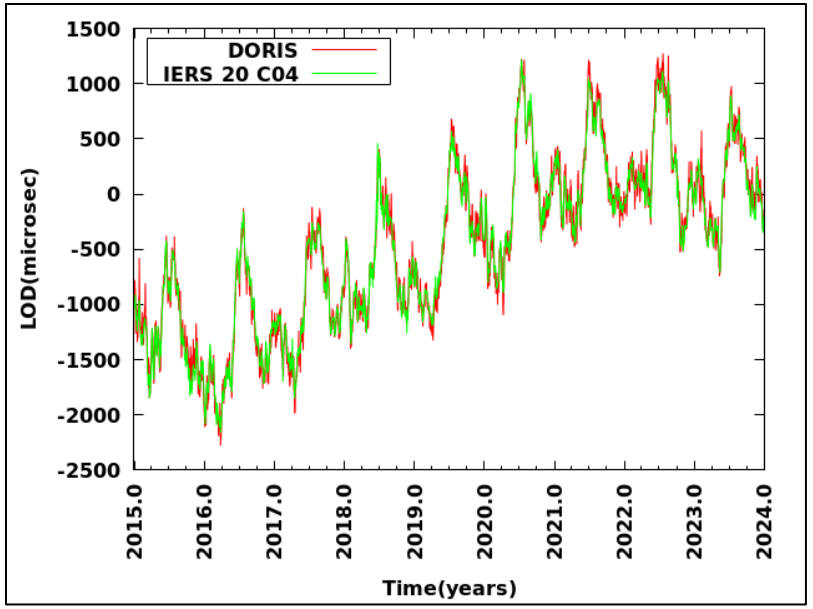
- 12 plates major improvement in the along track, elimination of some outliers
- More stable SRP series



LOD estimation

- The LOD annual weighted mean varies for the years between -22 μs to 39 μs. The weighted std. dev. reaches values around 83 microseconds in the average (cross track OPR amplitudes constraints 5×10^{-9} m/s^2)
- Peer reviewed paper in final stage of development, to be submitted soon

Year	Weighted mean [μs]	Weighted standard deviation [μs]
2015	39.1	91.2
2016	-20.8	66.4
2017	-0.8	84.0
2018	21.4	88.6
2019	4.4	86.5
2020	-22.4	85.1
2021	38.7	83.8
2022	35.6	85.3
2023	11.9	69.7



Strategies for GS Days

- Motivation: develop different processing strategy for Geomagnetic storm days
- During GS days, many observations are flagged invalid, which lowers data yield. However, the residuals of the remaining valid data change little because the bad measurements are filtered out.
- Drag estimation strategy may be changed for GS days
- Special GS strategy is effective in particular for G5 storm categories (2024) as Kp ≥ 8+. [G5 Days- 084, 131, 132, 284, 285]

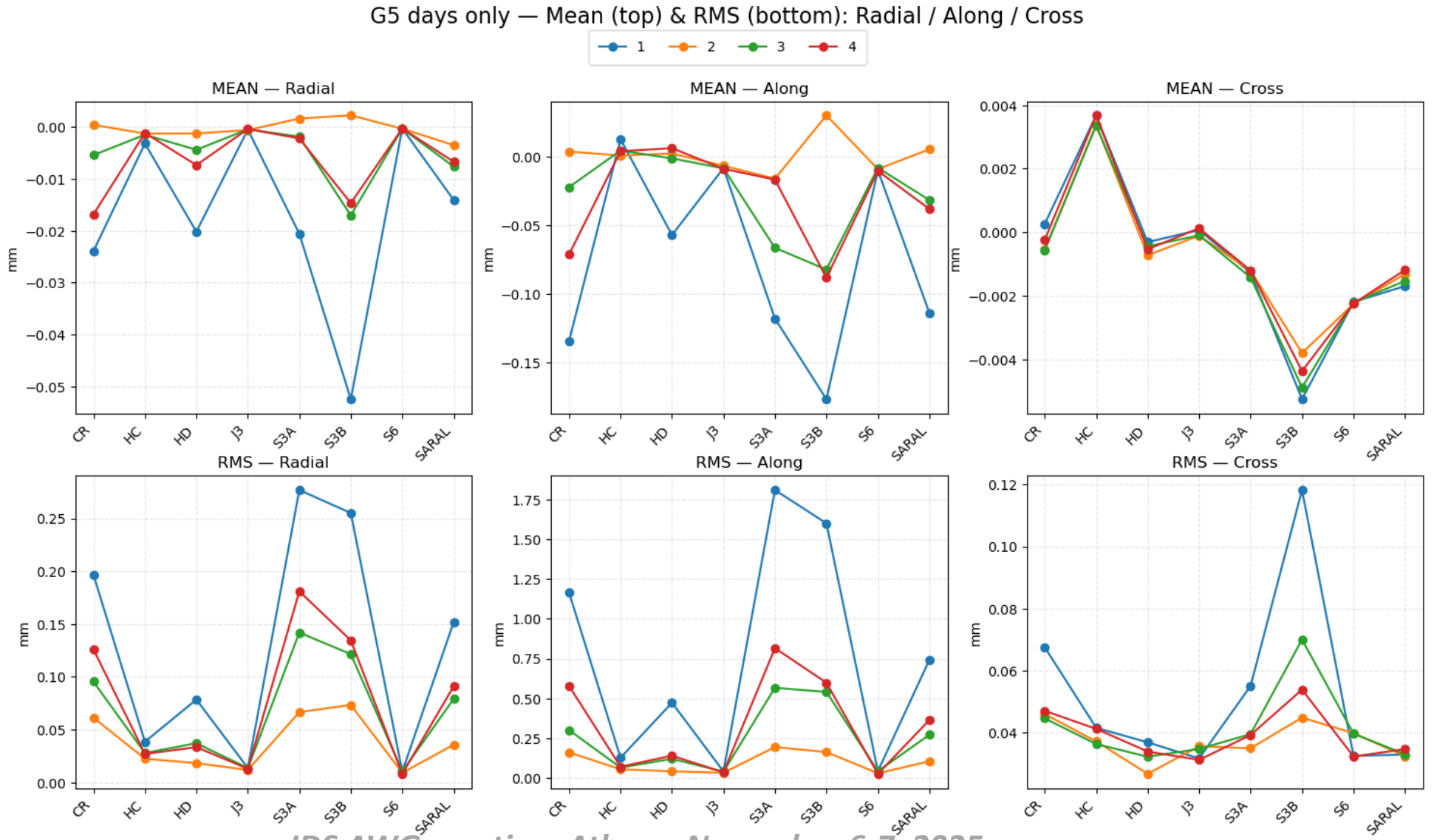
Version	Drag relative constraints	Data elimination criterion			
		Residuals < σ (sigma) multiplication by	Residuals < constant	Pass symmetry ratio	Min number of observations per pass
1	1 (0.5)*	3.5	50 mm	3	12
2	6 (3)	3.5	50 mm	3	12
3	1 (0.5)	5	100 mm	Not applied	2
4	6 (3)	5	100 mm	Not applied	2

* Jason orbit satellites

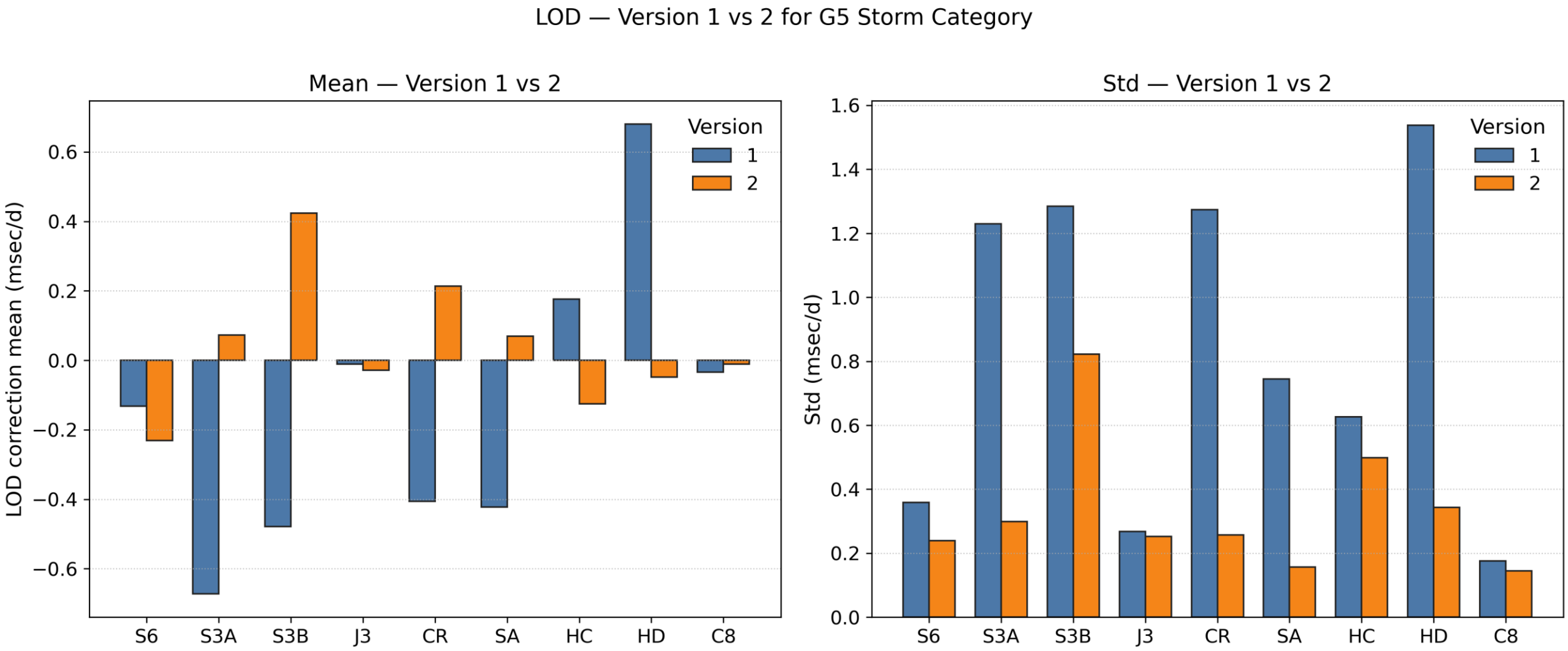
1 – Standard solution.
2 – Combination of both strategies: weaker drag constraints and less strict observation elimination criteria.
3 – Only the weaker drag-constraint strategy
4 – Only the less strict observation-elimination strategy.

Mean & RMS for G5 (2024)

- **Strategies improve accuracy in all components w.r.t the CNES reference multitechnique orbits.**

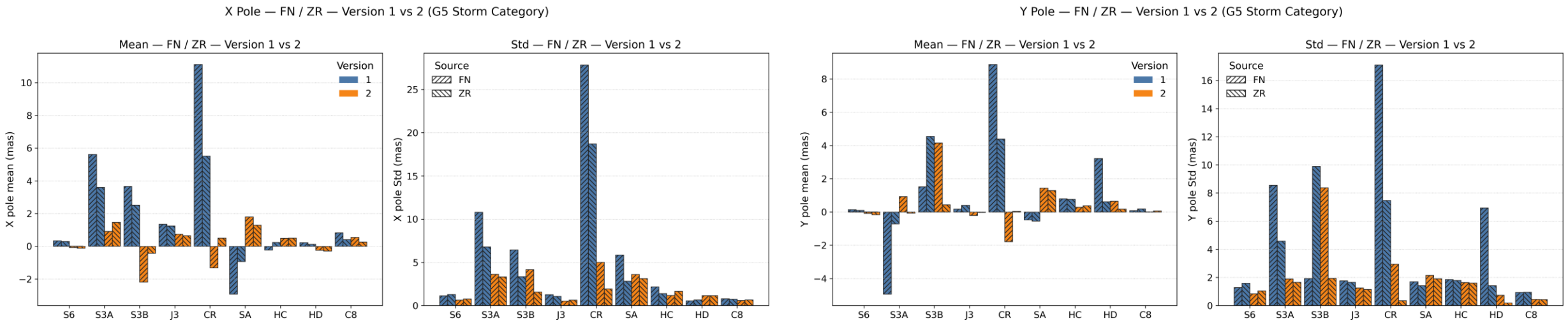


LOD Improvement (2024)



- Using the modified (Version 2), the variance of LOD corrections decreases by 40–80%, while the mean drifts are reduced by ~60% across satellites during G5 storm days.

X & Y Pole Improvement (2024)



ERP component	Avg. reduction in mean	Avg. reduction in Std
X-pole	21.6% improvement	25.9% improvement
Y-pole	22.9% improvement	24.3% improvement

- Version-2 & ZR gives the best ERP quality during geomagnetic storms. It delivers ~22% lower ERP bias and ~25% lower variability on average, improving ERP reliability under extreme space weather.

Cross track bias adjustment in the GOP time series (experimentally)

- **Motivation: reduce Tz variations as reported by GRG AC**
- **Result: No improvement, but degradation**
- **Needs: discuss with GRG AC, a priori constraints? Verify the procedure**

multi-sat solution	GOPwd70	GOPwd70 + cross track bias
Tx (mm)	-2.7±1.9	-2.9±1.9
Ty (mm)	3.9±2.7	4.1±2.6
Tz (mm)	-1.6±8.3	-1.3±20.2
Scale (mm)	16.0±1.0	15.9±1.1
Xp (mas)	-0.05±0.31	-0.04±0.32
Yp (mas)	-0.04±0.28	-0.04±0.28

Tz (mm)	Sen-3A	Sen-3B	Cryosat	Hy-2C	Hy-2D	Jason-3	Sen-6A	Saral
GOPwd70	17±24	0±32	4±43	-5±12	0±14	8±26	2±14	-23±17
GOPwd70 + cross track bias	72±39	52±61	61±45	-226±133	8±68	31±65	36±86	22±53

Future prospects

- **SWOT – to be experimentally included in the solution**
- **Special preprocessing strategy for SAA stations**
- **Development of Bernese/DORIS version compatible at the NEQ level with recent Bernese GNSS version – cooperation with BKG an University Bern. First step of full integration of DORIS to Bernese soft. (recently only Bernese/DORIS experimental version derived from official Bernese)**
- **Clock correction integration for Sentinel-6, experimental solution with clock corrective models for all Sentinels**

Thanks for your attention !