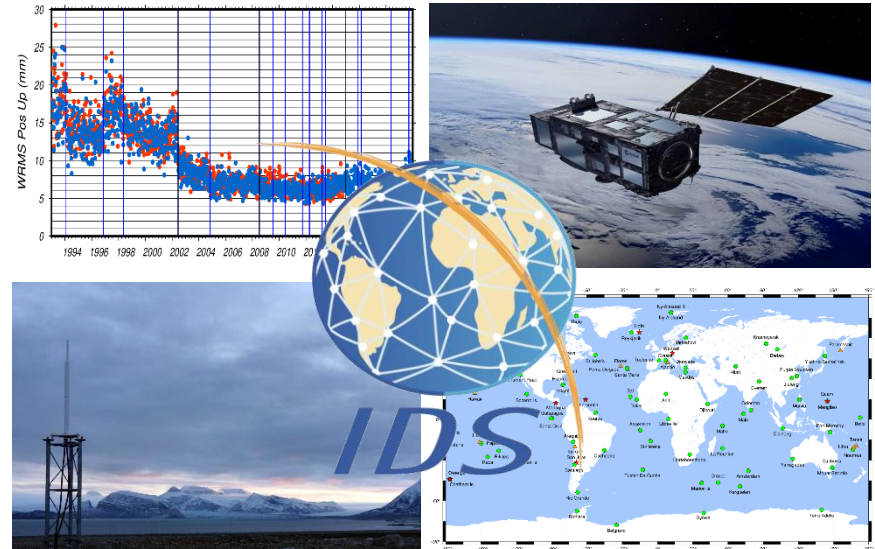


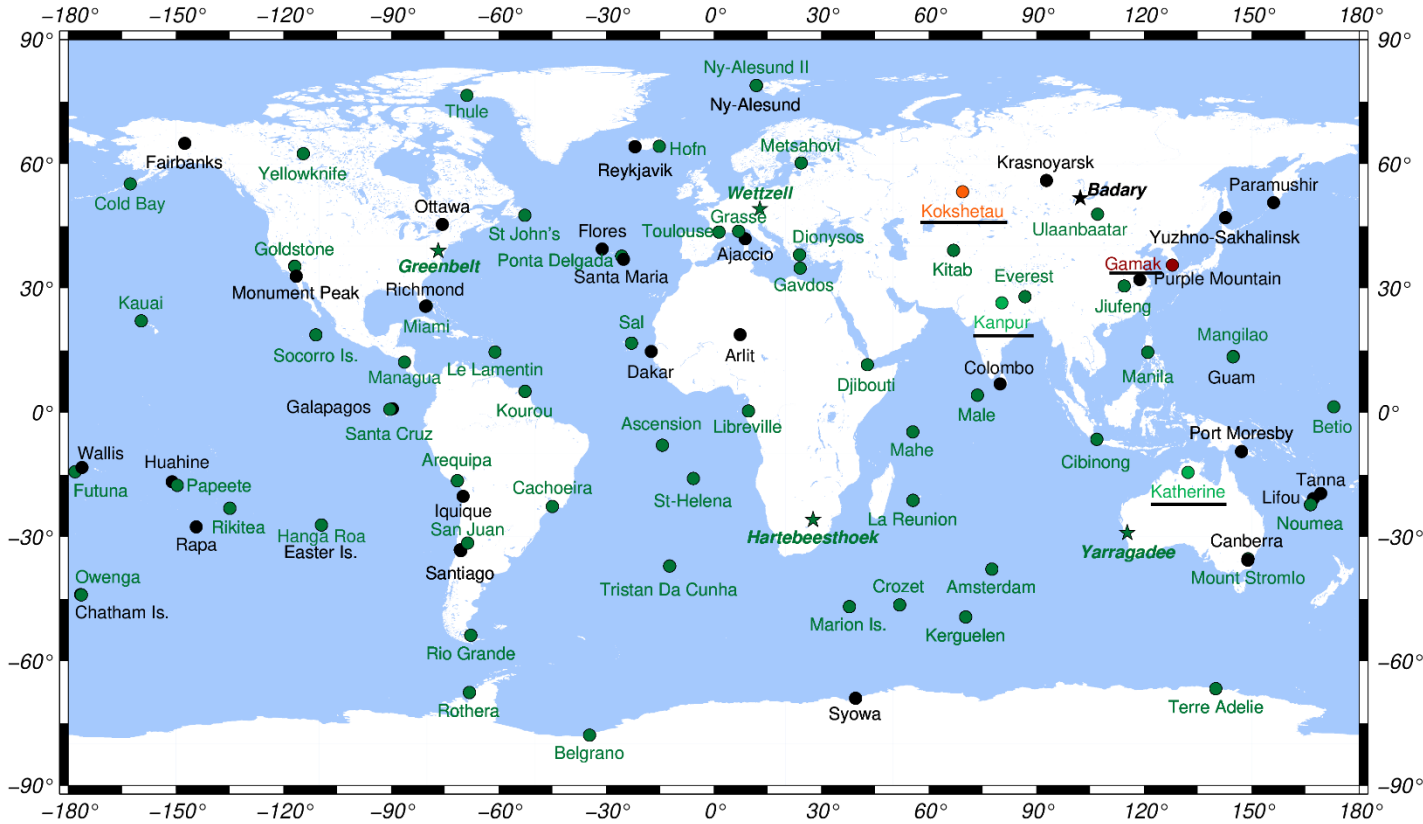
Expected improvements of the DORIS contribution to the next ITRF realization

Guilhem Moreaux (CLS), Frank Lemoine (NASA),
Hugues Capdeville (CLS), Petr Štěpánek (GOP),
Michiel Otten (Positim), Samuel Nahmani (IGN),
Arnaud Pollet (IGN) and Patrick Schreiner (GFZ)





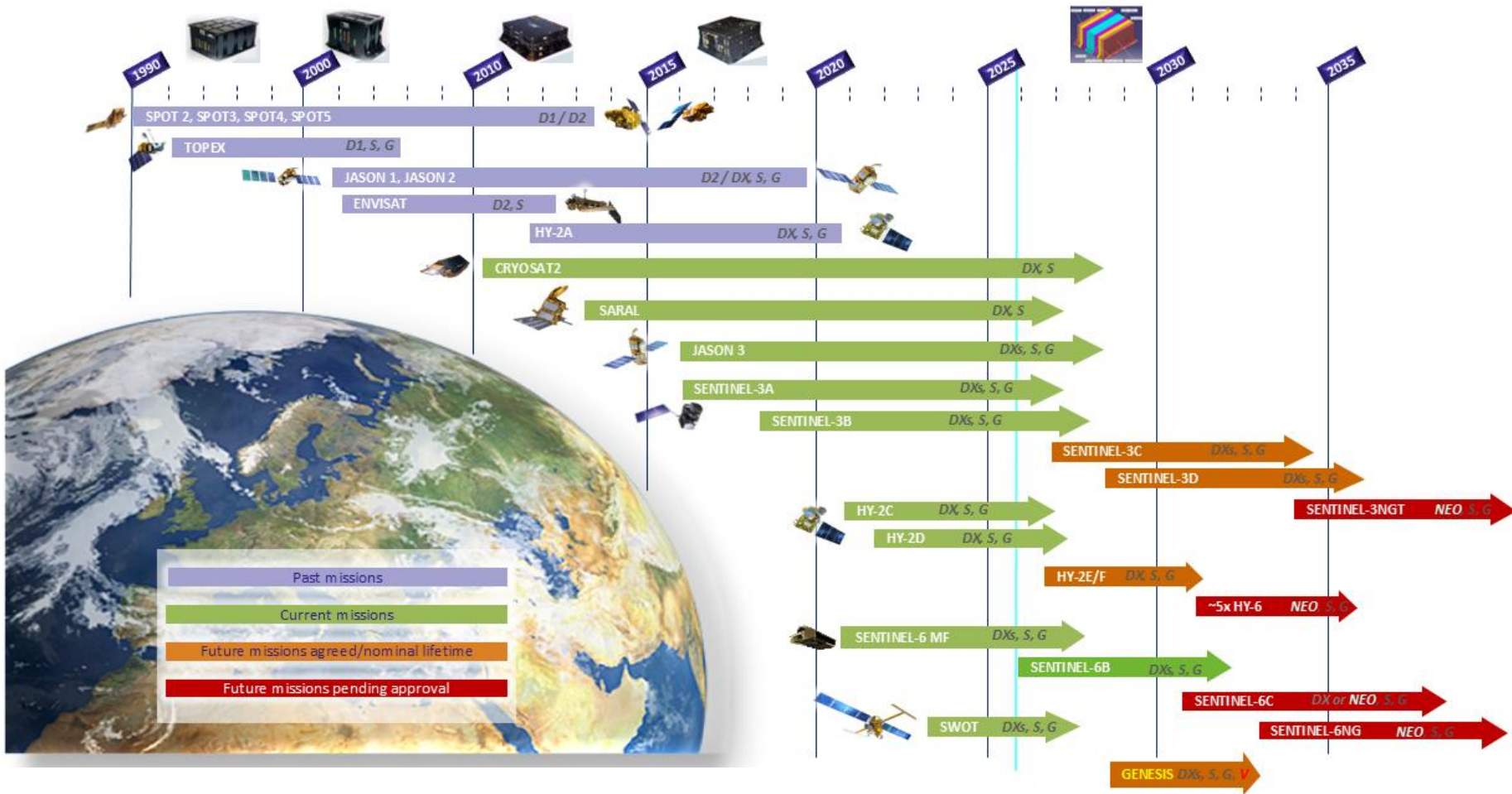
The DORIS Station Network



@2026.0: 61 operational sites with 4 four-technique sites.
@2026.5: 63 - Kanpur (India, GNSS), Katherine (Australia, GNSS/VLBI).
@2027.0: 64 - Kazakhstan (Kokshetau or Karaganda, GNSS).
@2028.0: 65 - Gamak (South Korea, GNSS/SLR).



DORIS Constellation



Six satellites to be launched in the next five years.
All equipped with the latest generation of DORIS receivers enable to track seven beacons simultaneously.



IDS Analysis Centers

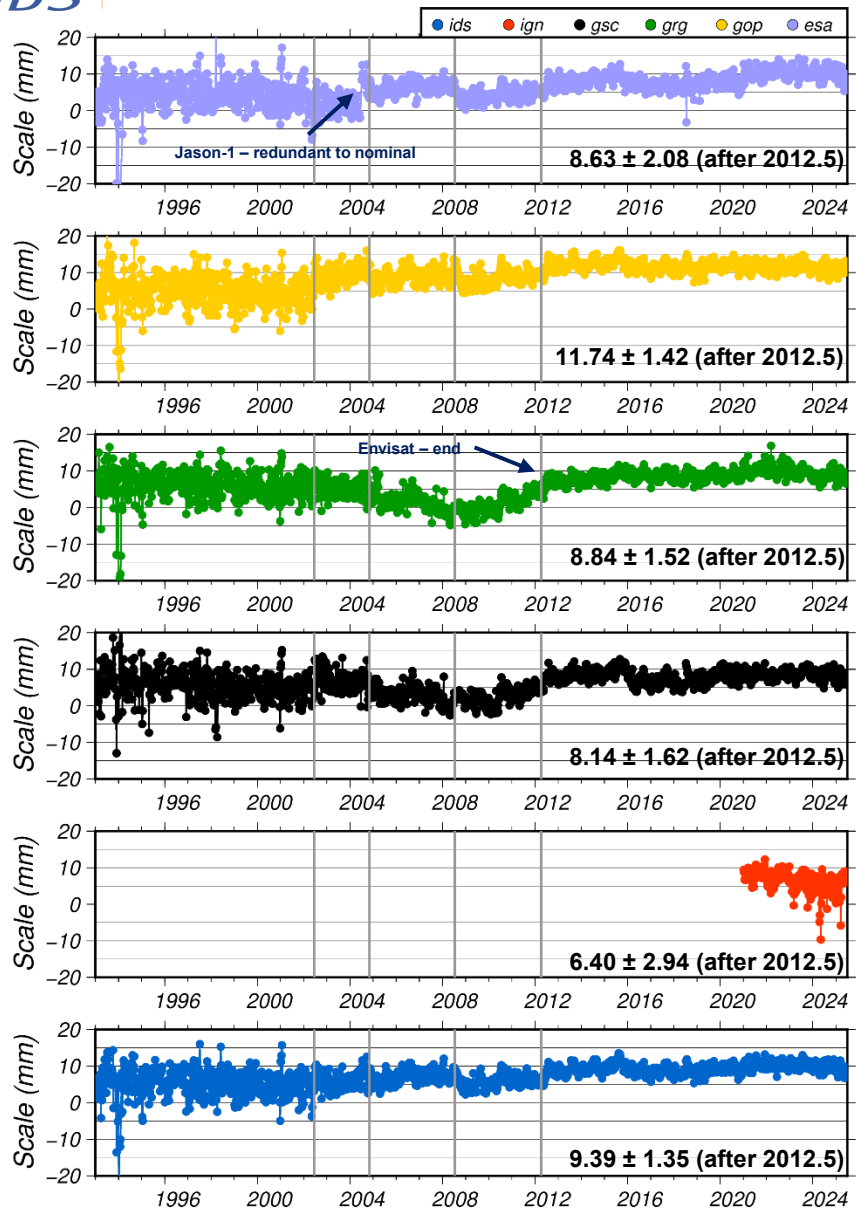
AC	Software	Solution Type	EOPs	ITRF2014	ITRF2020	ITRF20XX
ESA	EPNS	NEQ	offset+rate+LOD	X	X	X
GOP	BERNESE	COV	offset+rate+LOD	X	X	X
GRG	GINSDYNAMO	COV	offset	X	X	X
GSC	GEODYN	NEQ	offset	X	X	X
IGN	GIPSY-OASIS GIPSY-X	NEQ	offset	X		X
GFZ*	EPOS-OC	NEQ	offset+LOD			X
IDS	CATREF	COV	Offset+LOD			

*under evaluation

IDS contribution to the next ITRF realization may be based on 6 IDS AC solutions from 6 different software packages.



IDS ACs & Combined Scales w.r.t. ITRF2020-u2023



Have a mean offset of about 8 to 12 mm.

May be impacted by a few events related to the time evolution of the DORIS satellite constellation.

Are quite stable since mid-2012 (lie in a range of ± 2.50 mm, trend of about 0.11 mm/yr for IDS).

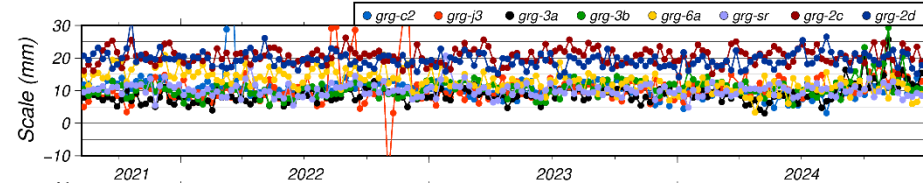


IDS Scale Improvements

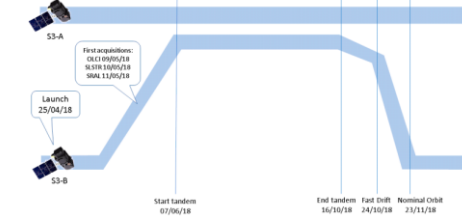
To improve the overall stability and to reduce the mean offset of the scale, the IDS ACs may:

- Mitigate the impact of the SAA by estimating the behavior of the DORIS USO using GPS clocks for Sentinel-3A, Sentinel-3B, Sentinel-6A, Sentinel-6B (IDS Working Group "Integrated Clock Correction Strategies for DORIS", see poster T4-p6).
- Review the CoM-CoP vectors, CPO of onboard antennas (see for example poster W1-p4).
- Review the contribution of each DORIS mission to the scale of the multi-satellite solutions.

Take advantage of mission tandem phases:
 Topex/Jason-1, Jason-1/2, Jason-2/3, Sentinel-3A/3B, Sentinel-6A/6B.

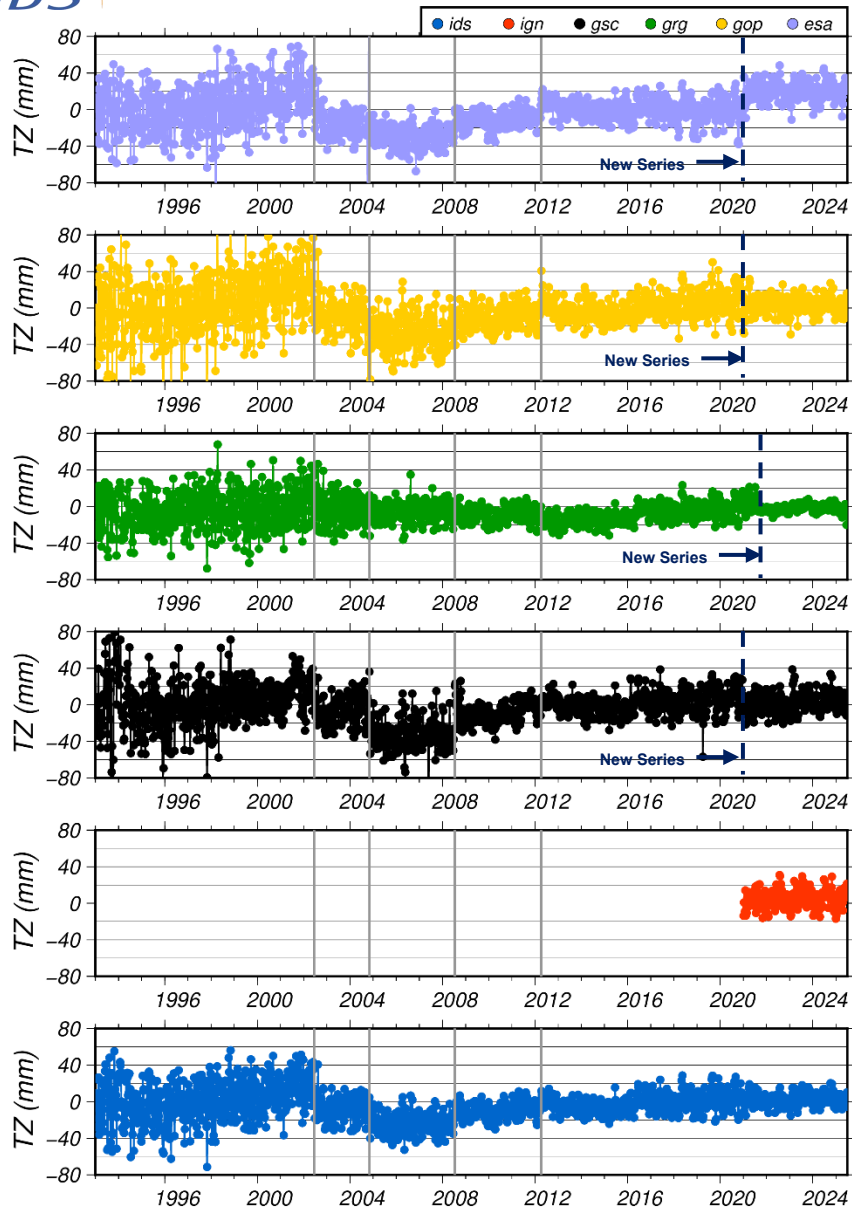


Scale wrt DPOD2020 v4.1 of the GRG 56 single satellite solutions (Cryosat-2, Jason-3, Sentinel-3A, Sentinel-3B, Sentinel-6A, Saral, HY2C, HY2D).





IDS ACs & Combined Geocenter w.r.t. ITRF2020-u2023



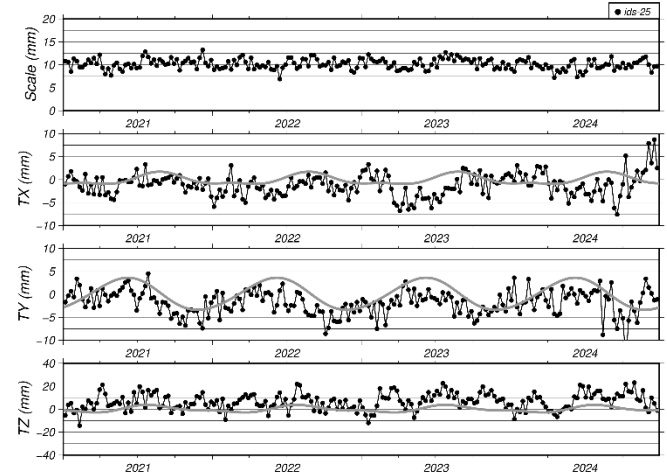
- May be impacted by a few events related to the time evolution of the DORIS satellite constellation,
- May contain draconitic (118-day) and sub-draconitic (59-day) signals, since modeling the nonconservative forces acting on these satellites is very challenging as
- Each DORIS satellite is unique,
- The DORIS satellites are at low altitudes (800-1.400 km).



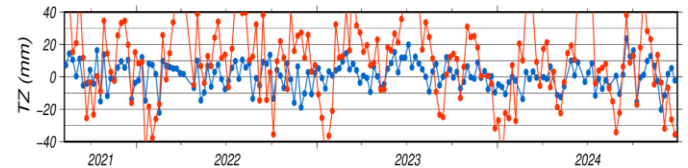
IDS Geocenter Improvements

The quality of the DORIS geocenter may benefit from:

- ❑ Reviewing the contribution of each DORIS mission.
- ❑ Using more detailed or retuned satellite macromodels.
- ❑ Generalizing the use of quaternions rather than an attitude model.
- ❑ Estimating daily constant accelerations.
- ❑ Revisiting the estimation of solar radiation pressure coefficients during higher solar activity.
- ❑ Analyzing mission tandem phases.



Geocenter and scale of the IDS CC solution for the ITRF2020-u2024 (black) wrt ITRF2020-u2023. ITRF2020 geocenter model is shown in grey.



Z-translation wrt ITRF2020-u2023 of the Jason-3 GRG solutions: **with** and **without** daily normal constant accelerations.



Station Position WRMS wrt cumulative solution

Time period: 1993.0-2025.5

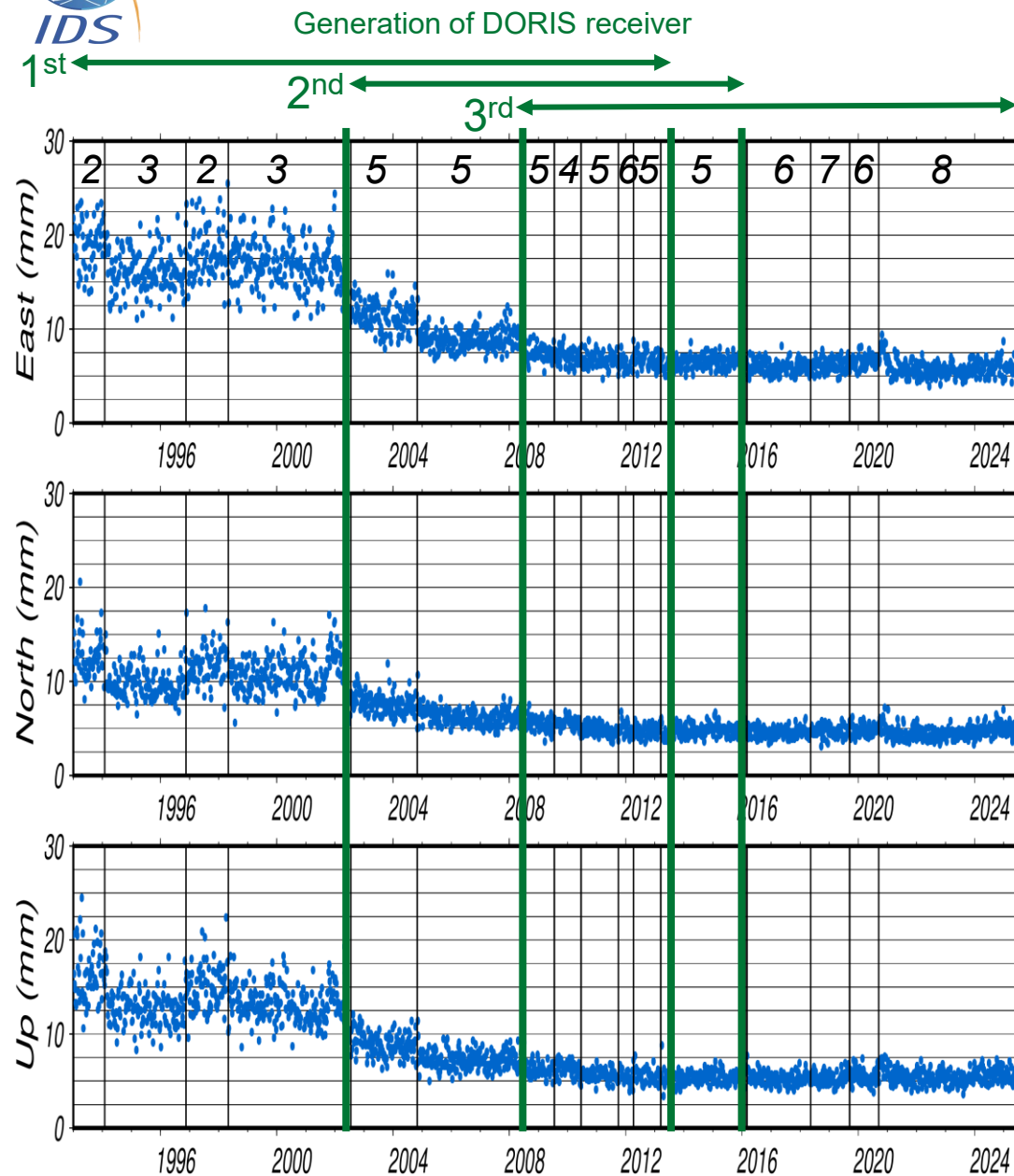
Nb of satellites

Time Period	East [mm]	North [mm]	Up [mm]
1993.0-2022.5	17.1 ± 2.6	10.9 ± 2.1	13.7 ± 2.4
2002.5-2008.5	9.9 ± 1.8	6.8 ± 1.2	7.9 ± 1.3
2008.5-2015.9	6.7 ± 0.8	5.0 ± 0.7	5.7 ± 0.8
2015.9-2021.0	6.2 ± 0.8	4.8 ± 0.6	5.5 ± 0.7
2021.0-2025.5	5.7 ± 0.7	4.6 ± 0.6	5.5 ± 0.7

Results improved:

- When more satellites are available.
- With missions with different inclinations.
- With the evolution of DORIS receiver capabilities.

Positioning of SAA stations may also be improved with new SAA mitigation strategies.

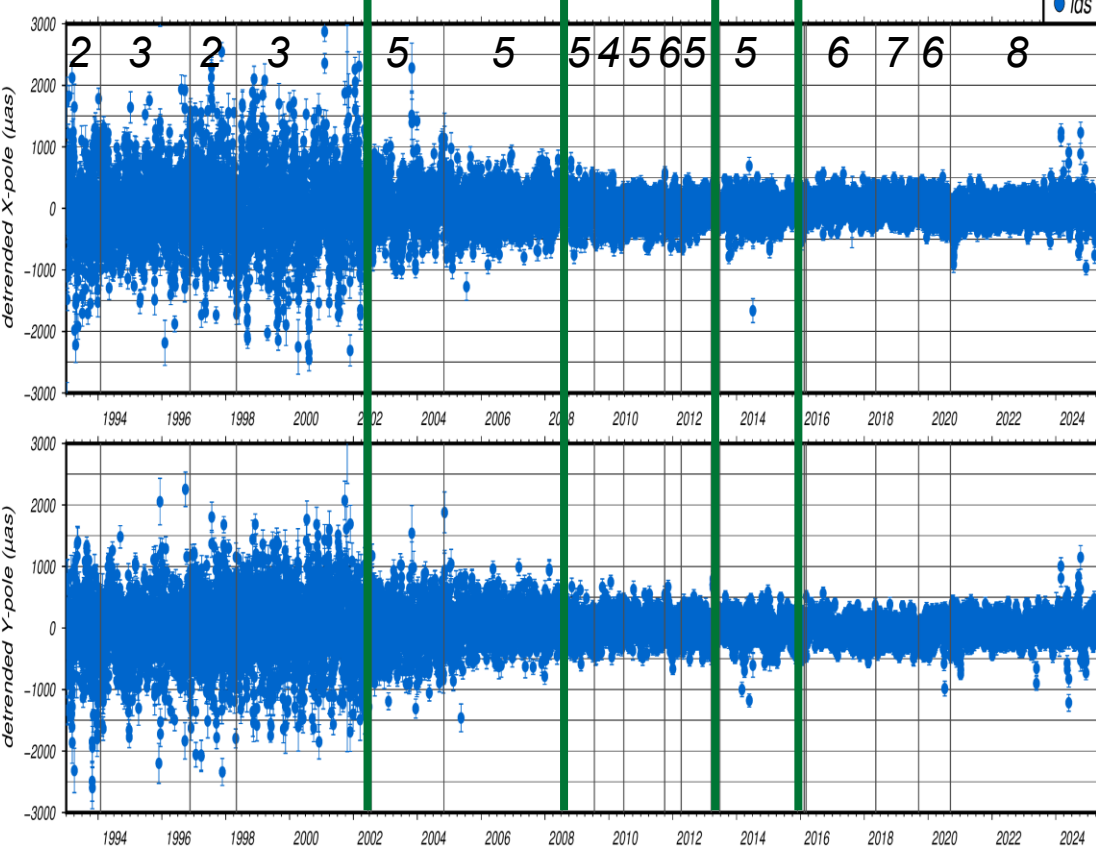




ERP Residuals wrt IERS C04

Time period: 1993.0-2025.5

Generation of DORIS receiver



Nb of satellites

Time Period	X-pole [μs]	Y-pole [μs]
1993.0-2022.5	-0.2 ± 649.6	-4.9 ± 573.9
2002.5-2008.5	2.1 ± 327.5	1.4 ± 314.0
2008.5-2015.9	-1.3 ± 203.8	0.0 ± 193.5
2015.9-2021.0	-1.6 ± 169.1	-0.6 ± 162.3
2021.0-2025.5	2.4 ± 189.2	-0.2 ± 183.3

Results improved:

- When more satellites are available.
- With the evolution of DORIS receiver capabilities.

Results may be improved with a new selection of IDS AC contributors.

Forthcoming combined LOD starting early 2024.



The IDS contribution to the next ITRF realization

Will be improved in terms of scale, origin, station positioning and EOPs thanks to:

- New missions** (six over the next five years).
- New DORIS ground stations** (two in 2026, one in 2027 and one in 2028).
- New ACs** (six in overall soon).
- More detailed and tuned satellite macromodels.**
- New SAA mitigation strategies** (using connections between GNSS receivers and DORIS USOs).
- The review of the satellite contributions to the multi-satellite solutions.**
- Use of satellite tandem phases.**

