

Assessing the Long-Term Stability of the Recent ITRF2020 Solutions

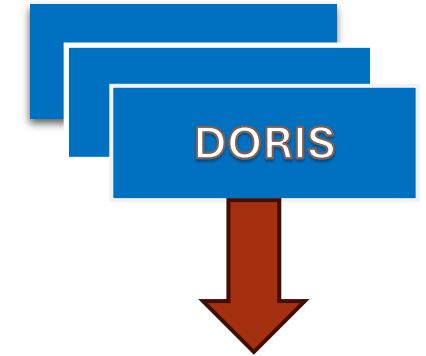
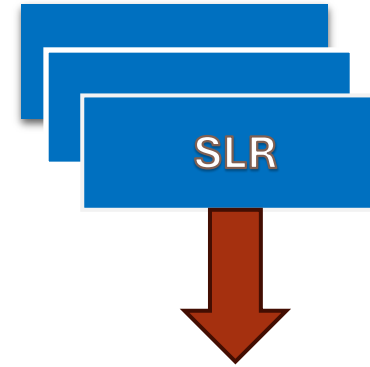
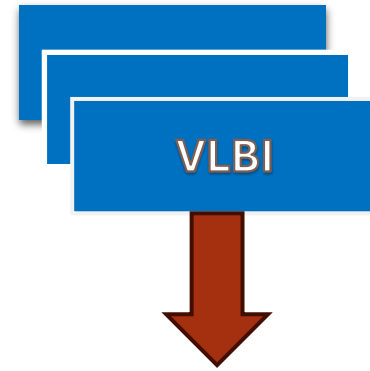
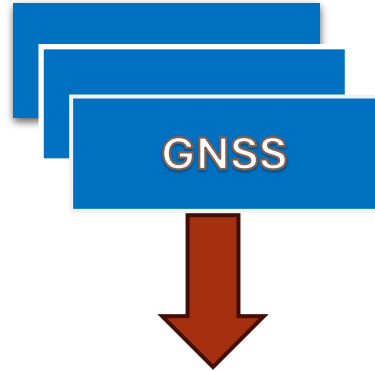
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Outline

- **Overview of recent ITRF solutions**
- **Pairwise Frame Comparison of xTRF2020 solutions**
- **Recovering the CODE repro3 solution with different xTRF2020 solutions**
- **Conclusion**



ITRS Combination Centres

IGN, FRANCE

DFGI-TUM, GERMANY

JPL, USA

ITRF2020

DTRF2020

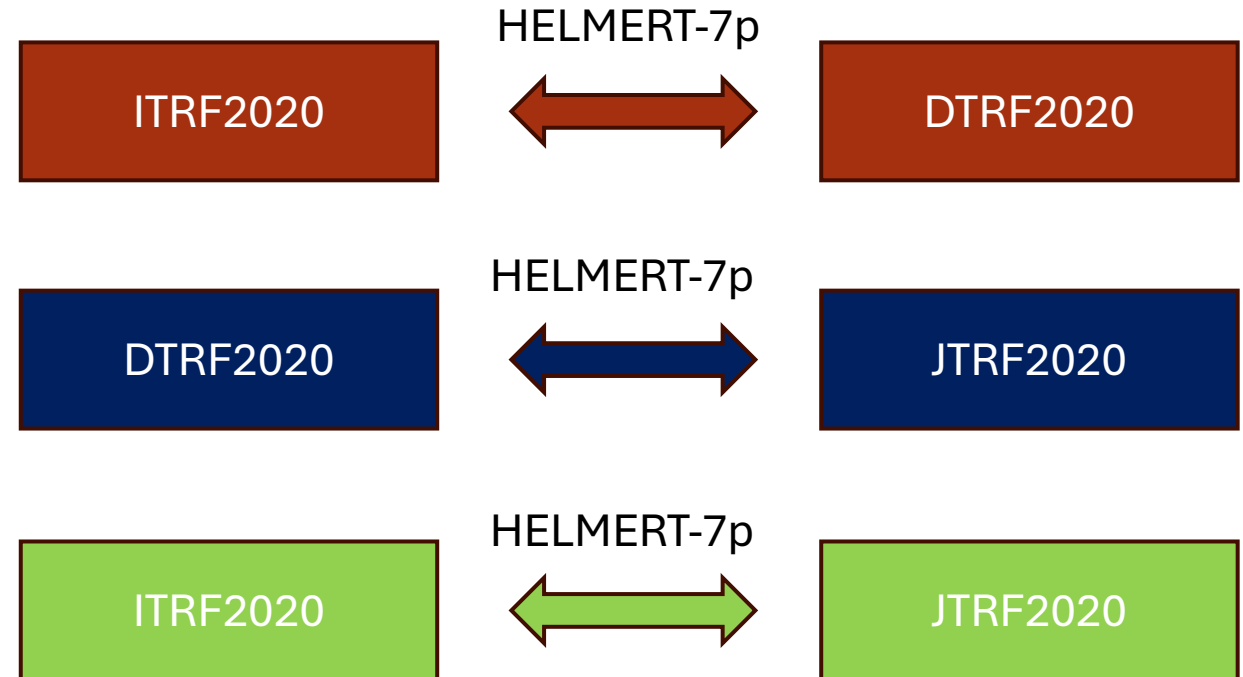
JTRF2020

ITRS realizations	ITRF2020	DTRF2020	JTRF2020
Reduction of Post-seismic deformation	✓	✓	(✓)
Annual / semi-annual signals	✓	—	(✓)
Atmospheric, oceanic and hydrological non-tidal loading (NTL) corrections provided by the Global Geophysical Fluid Center (GGFC)	—	✓	—

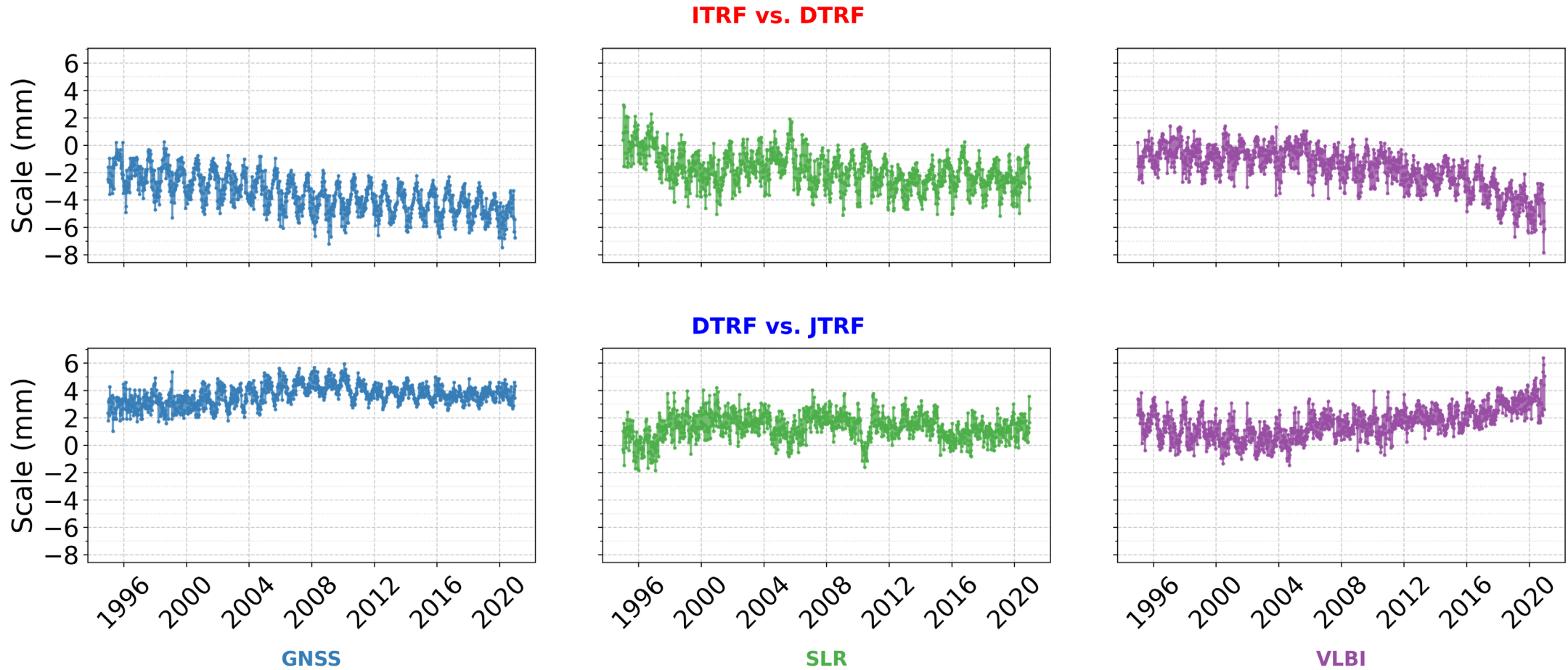
DATUM definition	Origin	Scale	Orientation
ITRF2020	SLR	VLBI/SLR	GNSS/VLBI
DTRF2020	SLR	VLBI/GNSS	GNSS/VLBI
JTRF2020	SLR	VLBI/SLR	GNSS/VLBI

Pairwise Frame Comparison

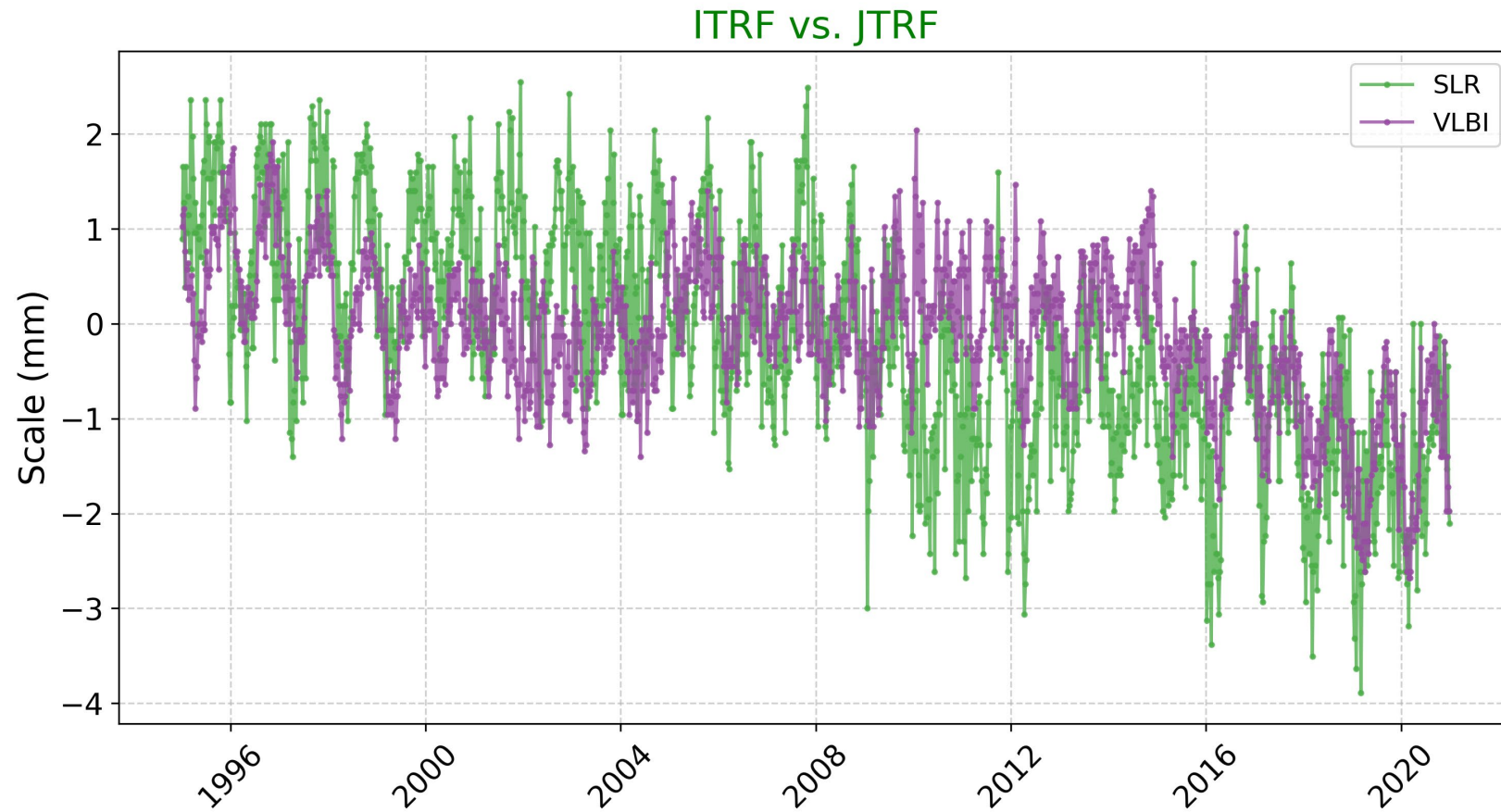
- Dataset description:
 - Weekly coordinate (CRD) time series are extracted from xTRF2020 solutions
 - Time Frame: 1995 to 2020
- Goal: To infer long-term relative stability of the frames in terms of **Scale, Rotation and Translation**



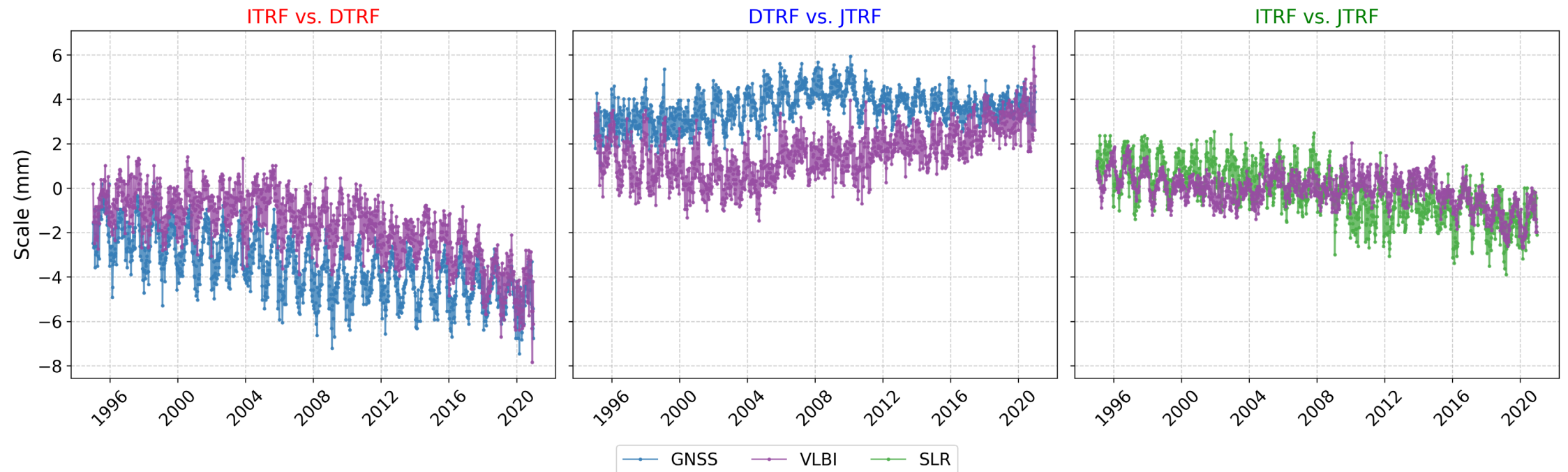
Long-Term Stability of frames: SCALE



Long-Term Stability of frames: SCALE



Long-Term Stability of frames: SCALE



Long-Term Stability of frames: SCALE

- In the middle of the time series a scale offset of ~ 2.1 mm is observed between GNSS and VLBI in the pairwise frame comparisons of **ITRF2020 \leftrightarrow DTRF2020** and **DTRF2020 \leftrightarrow JTRF2020**.
- In contrast, the **ITRF2020 \leftrightarrow JTRF2020** comparison shows a high level of consistency among GNSS, SLR, and VLBI scales at the level of about 0.1 mm.

	ITRF2020 \leftrightarrow DTRF2020			DTRF2020 \leftrightarrow JTRF2020			ITRF2020 \leftrightarrow JTRF2020		
	GNSS	VLBI	SLR	GNSS	VLBI	SLR	GNSS	VLBI	SLR
Mean	-3.49	-1.35	-2.14	3.65	1.41	1.35	0.19	0.01	-0.07
Median	-3.51	-1.28	-2.2	3.64	1.34	1.4	0.13	0	-0.06
RMS	3.75	-1.8	2.53	3.73	1.4	1.69	0.95	0.67	1.2

* Scale factor in mm/km multiplied by semi major axis of the Earth \rightarrow values in mm

Recovering the CODE repro3 solution with different xTRF2020 solutions

- Using normal equations (NEQs) generated for the CODE contribution to IGS repro3 are solved based on the xTRF2020 solutions,
- All stations with coordinates per day extracted from xTRF2020 solutions are used for minimum constraint solutions applying NNR/NNT conditions,
- Reference frame stations are verified by residuals of a Helmert transformation. Stations exceeding a residual limit in the North, East, Up components of <15/15/30> mm are not used for the datum definition.
- The resulting station coordinate time series (CRD), satellite orbits (ORB), Earth rotation parameters (EOP), and **geocenter coordinates (GCC)** are used to compare xTRF2020 solutions **reflecting** the consistency of the different reference frames solutions.

GCC ↔ Translation from xTRF2020 Comparison

➤ Dataset description:

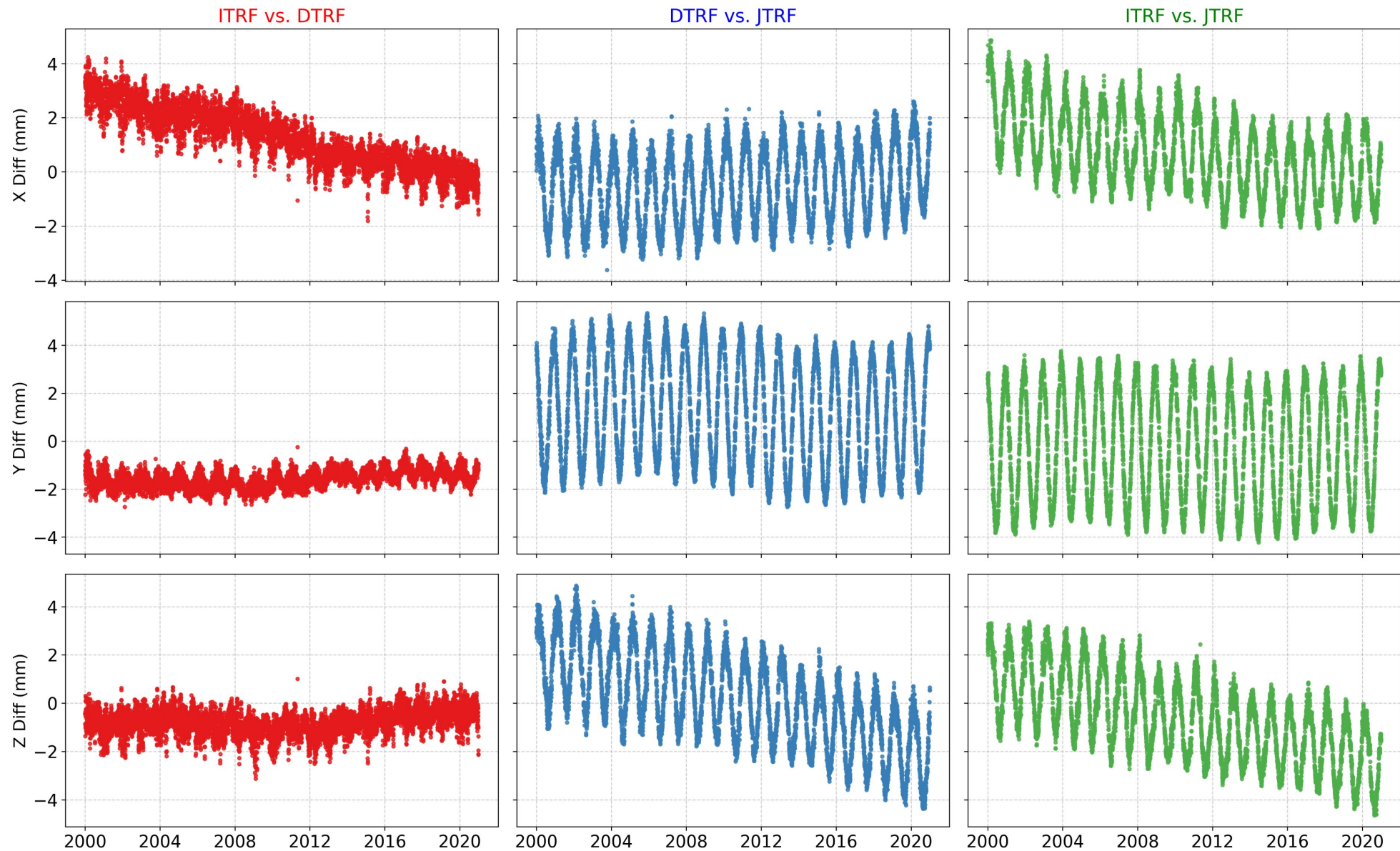
- Coordinate (CRD) time series for each day are extracted from xTRF2020 realizations and used
- Time Frame: 2000 to 2020



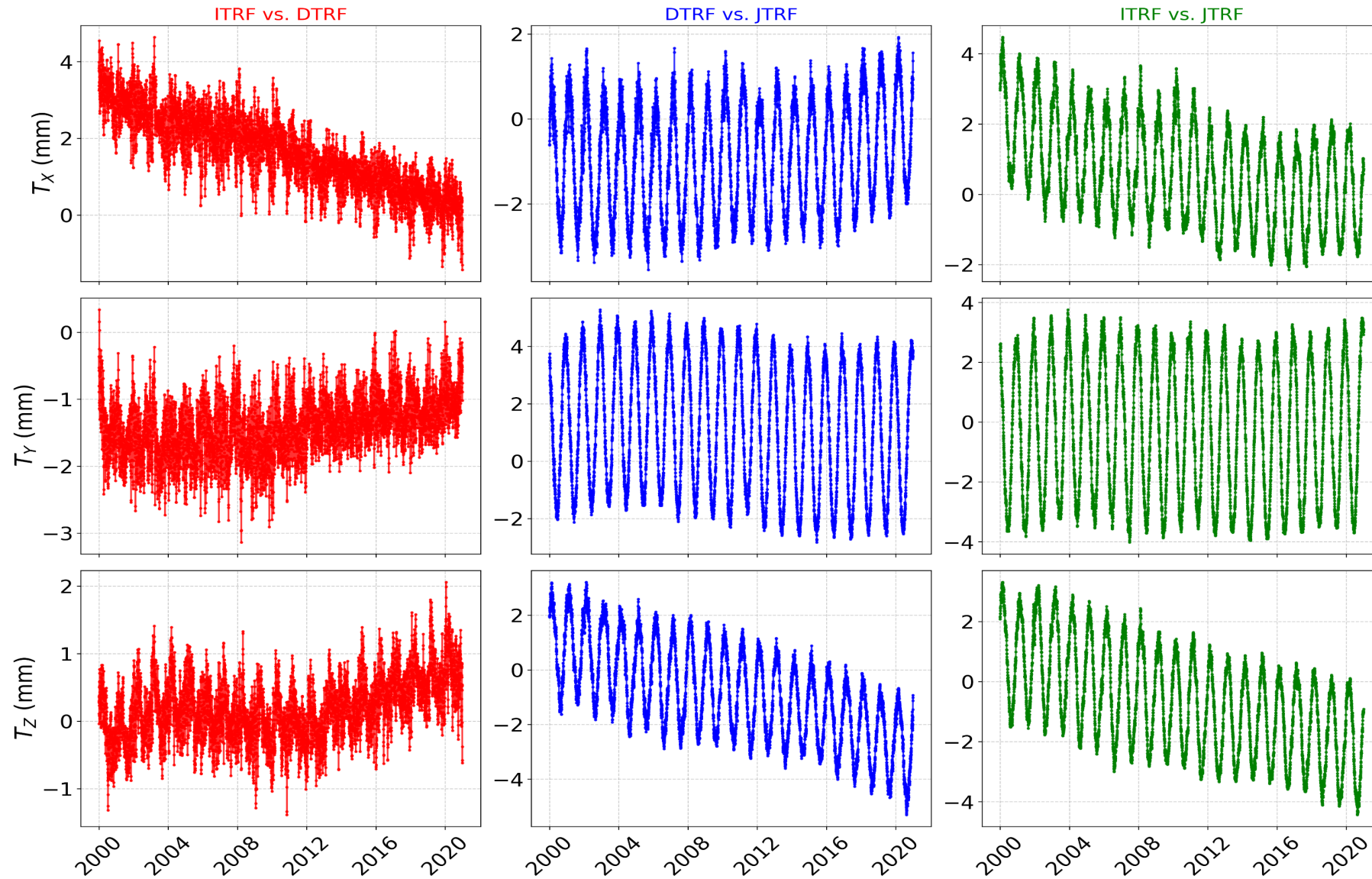
- Goal: To infer long-term relative stability of the frames in terms of **Scale, Rotation and Translation**

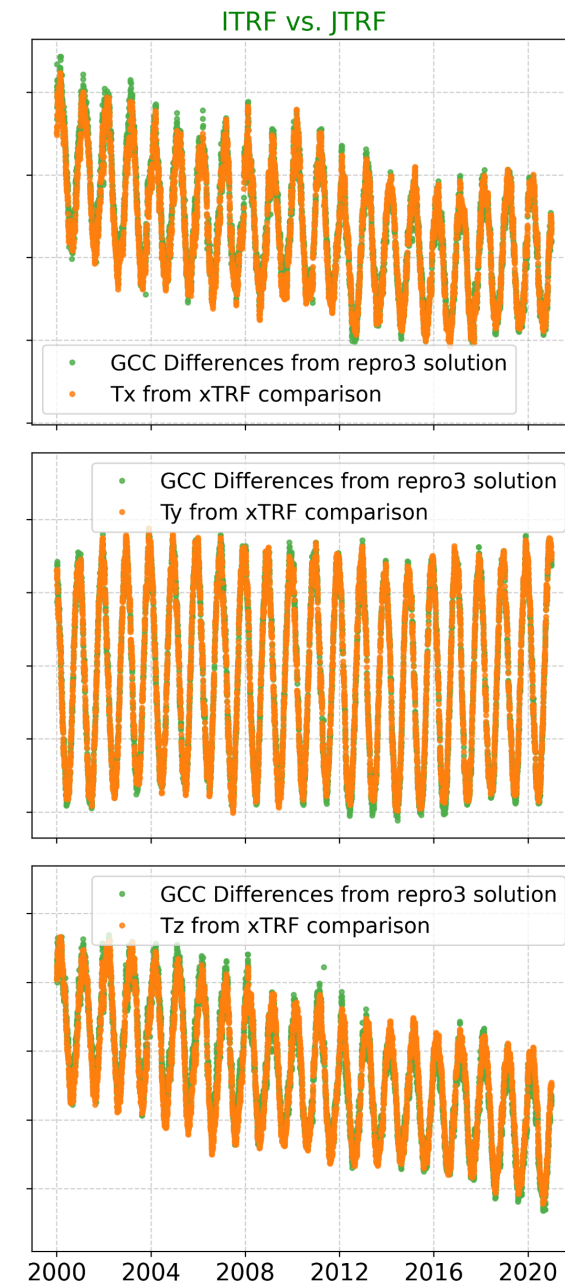
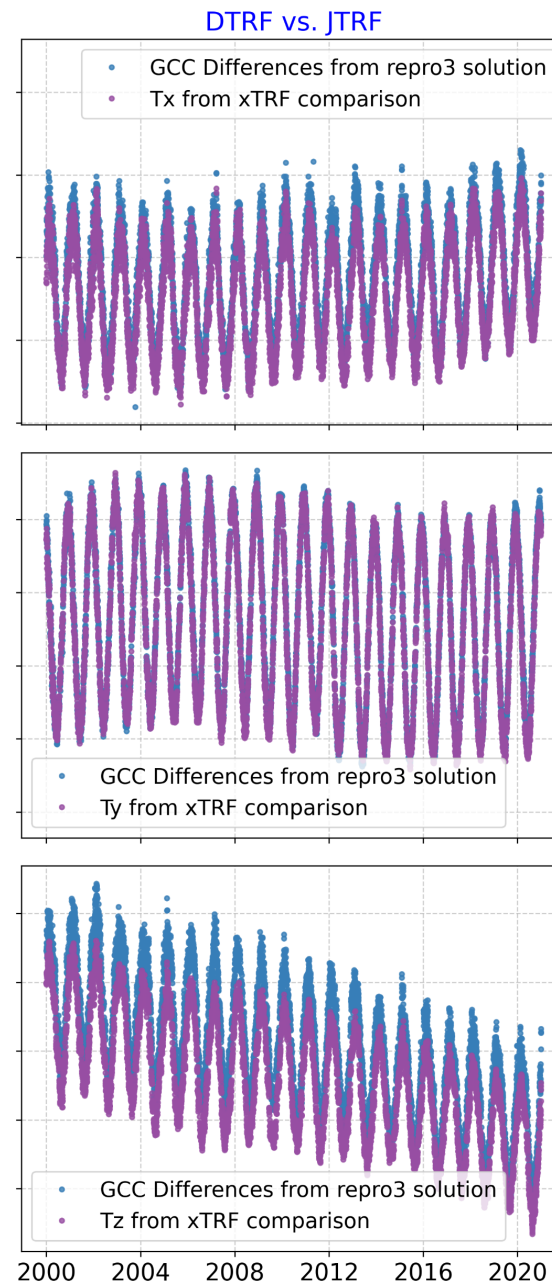
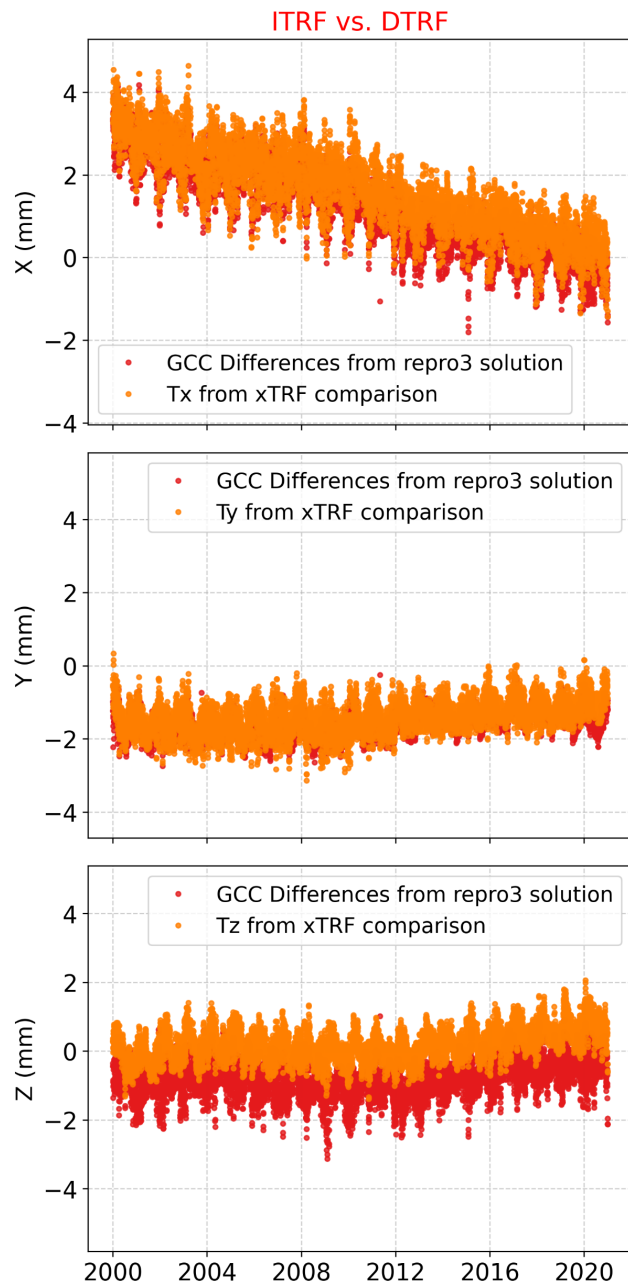


GCC Differences from repro3 solution



Helmert Translation Parameters - GNSS





Summary:

- We directly compared the coordinate sets for the four space geodetic techniques in the xTRF2020 solutions using a set of Helmert transformations.
 - Given the definition of scale realisation in DTRF2020, How can we explain the scale discrepancy between GNSS and VLBI?
- We have done GNSS solutions based on NEQs with the datum definition from the various xTRF2020 solutions.
 - As shown with the example of the relation between the estimated geocenter coordinates with the translation parameters the results agree with the expectations.

Future Work:

- To also incorporate the SLR measurements with GNSS satellites to verify the consistency of the coordinate sets between the techniques in the xTRF2020 solutions.