Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
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# DTRF2020-u2023 and first steps towards DTRF2020-u2024

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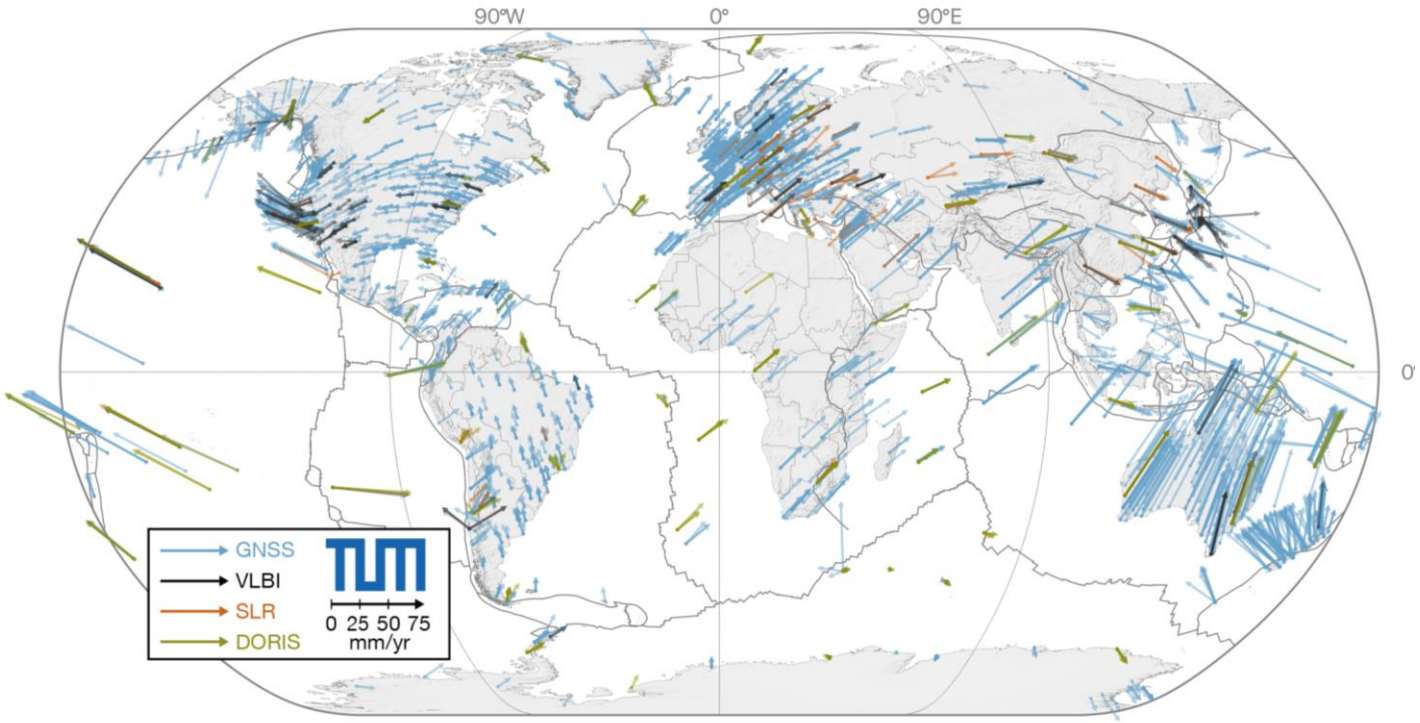
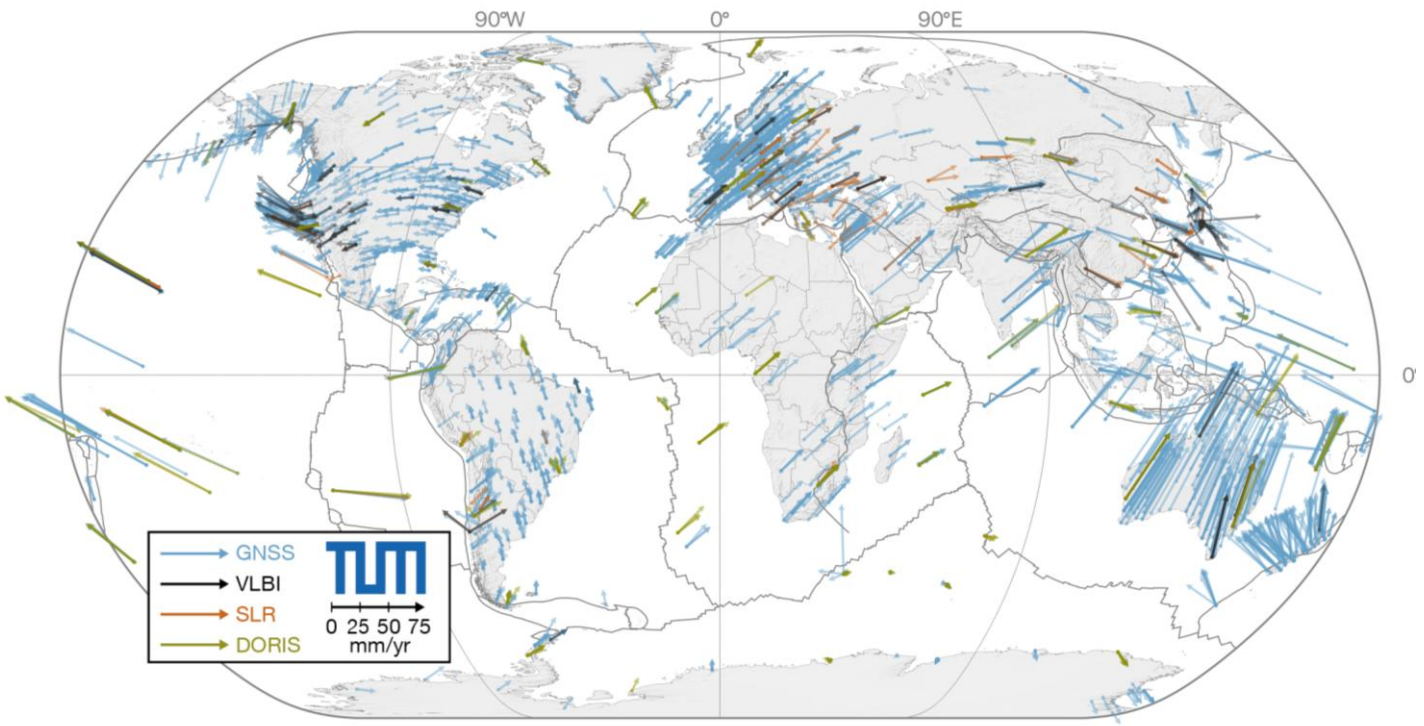



**IDS Analysis Working Group Meeting**
6-7 November 2025, Athens

# DTRF2020-u2023




## Release

- Planned for next week (→ links will become active)
- DTRF website https://dtrf.dgfi.tum.de/en/dtrf2020-u2023/
- Zenodo webpage: https://doi.org/10.5281/zenodo.17432063

## Main characteristics

Secular reference frame computed from a combination of VLBI, SLR, GNSS and DORIS data

- Reference epoch: 2010.0
- Number of parameters: 106,157
- Number of stations: 3663 individual station position solutions (solution numbers)
- Number of EOP: 84,251

# DTRF2020-u2023

## Input data for DTRF2020-u2023

- For VLBI, SLR and DORIS:
  - extension of the DTRF2020 (ITRF2020) input time series by three years 2021.0-2023
  - changes in modelling w.r.t DTRF2020
    SLR: new target signatures and mean RB
    VLBI: gravitational deformation model for 7 more antennas
  - new stations and satellites (DORIS: 3 new stations, 1 new satellite)
  - changing number of ACs (DORIS: plus 1 AC, now 5 ACs)

***Same data as for ITRF2020-u2023***

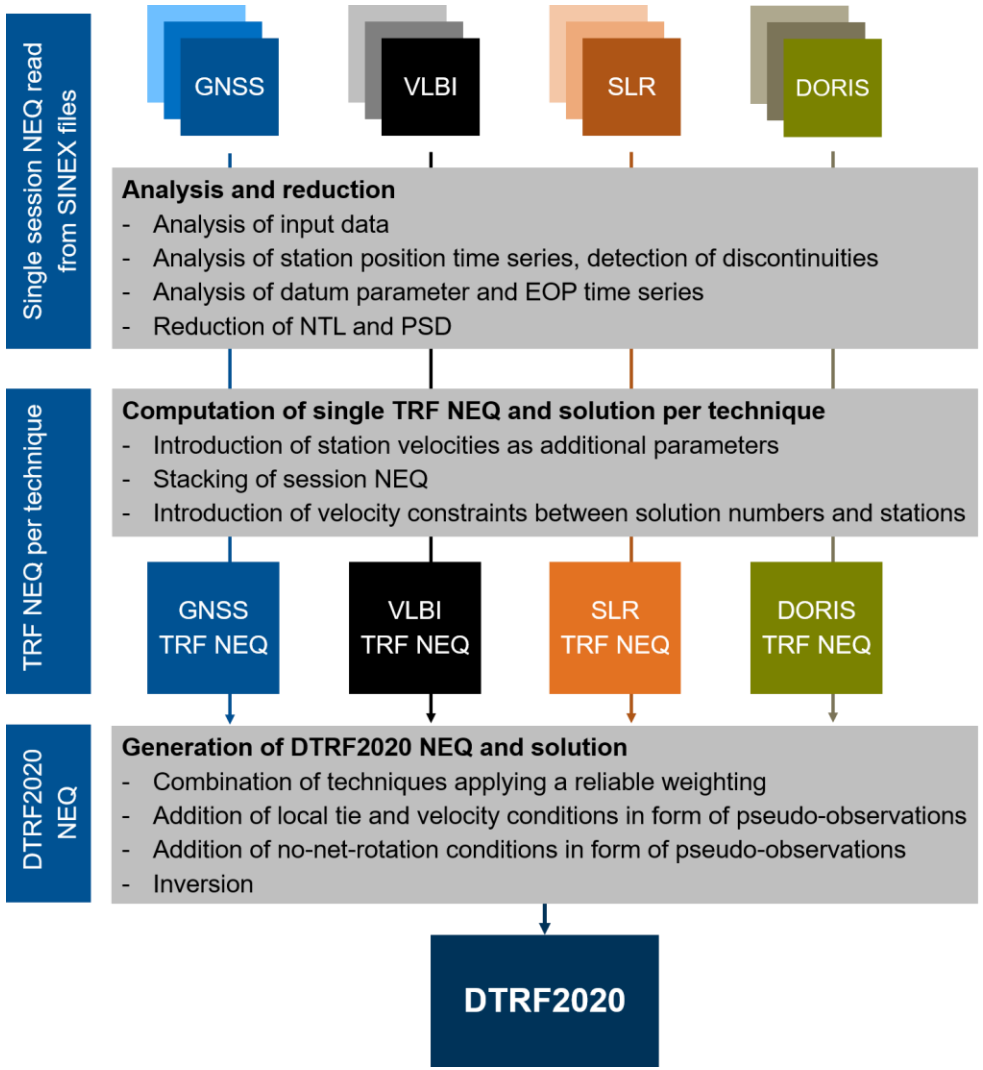
- For GNSS: two series are provided by IGS
  - 2021.0 – Nov. 2022: extension of repro3 series (new antenna PCV)
  - Nov. 2022 – 2023: operational IGS series (different number of ACs)

  } GNSS scale

- Non-tidal loading data (provided by IERS GGFC)

***DTRF2020-u2023 specific***

# DTRF2020-u2023: Computation strategy




- **Two step approach**
  1) Computation of one TRF per technique
  2) Combination of techniques to DTRF2020-u2023
  → Combination **at normal equation (NEQ) level**

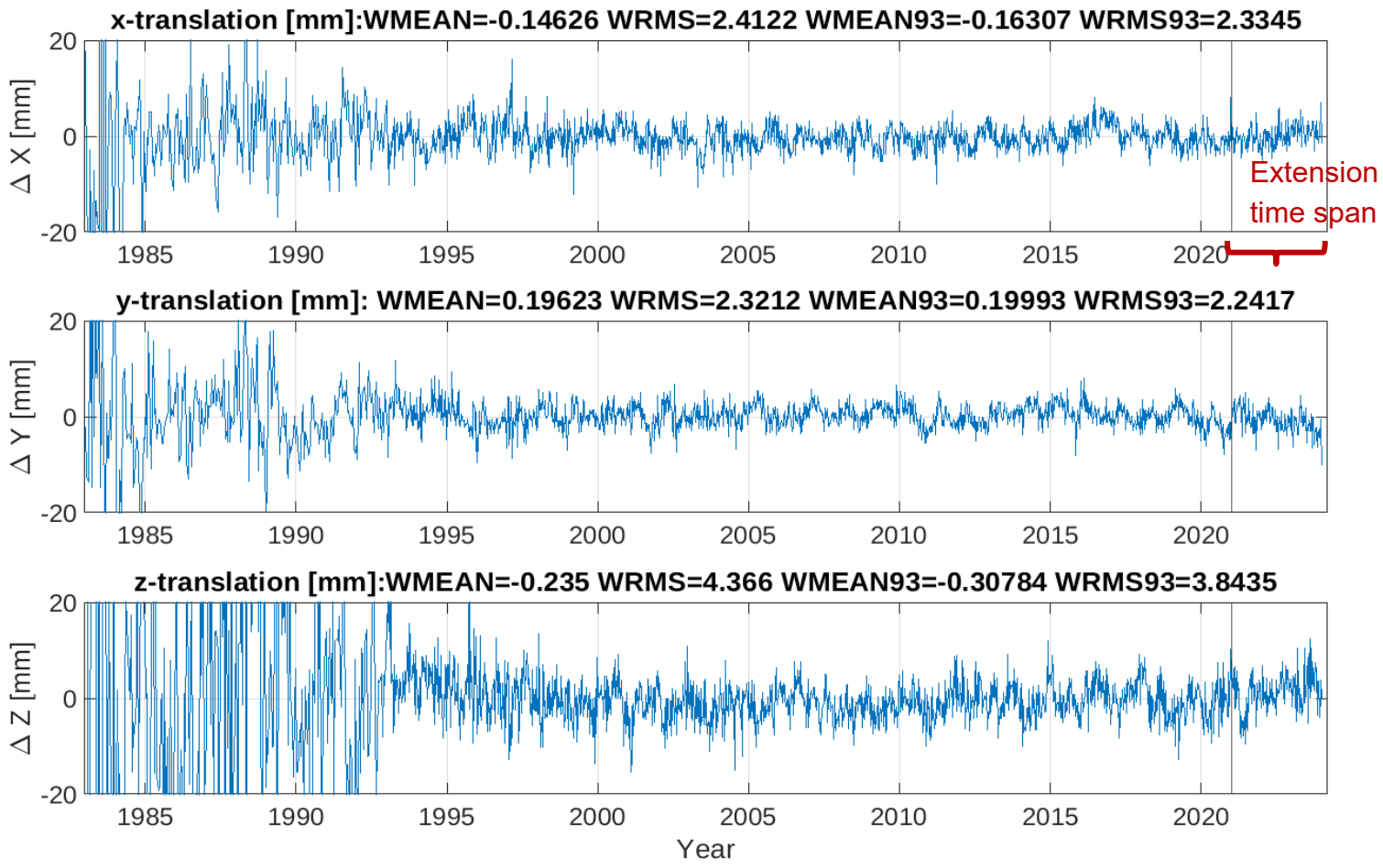
- **Important facts**
  - ✓ **Non-tidal loading (NTL)** displacement corrections reduced at NEQ level for each station
  - ✓ **Post-seismic deformation (PSD)** reduced at NEQ level
  - ✓ **DTRF2020-u2023 scale** is realized from the full input series provided for VLBI and GNSS

- **Further challenge**
  - Stable integration of the VLBI VGOS network (part of step 1)

→ **Reprocessing of all data was necessary** for a consistent application of PSD and new antenna calibrations (GNSS) and the inclusion of formerly reduced stations (DORIS: 3 stations)

# DTRF2020-u2023 origin

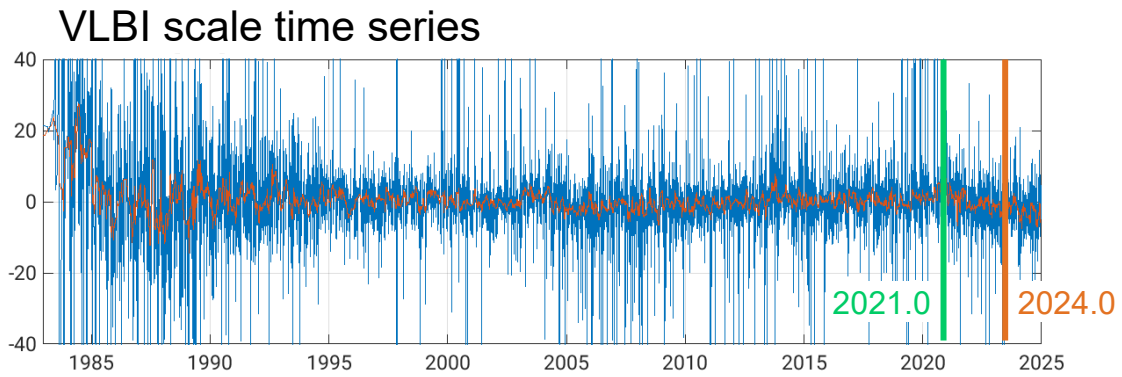
## SLR translation time series

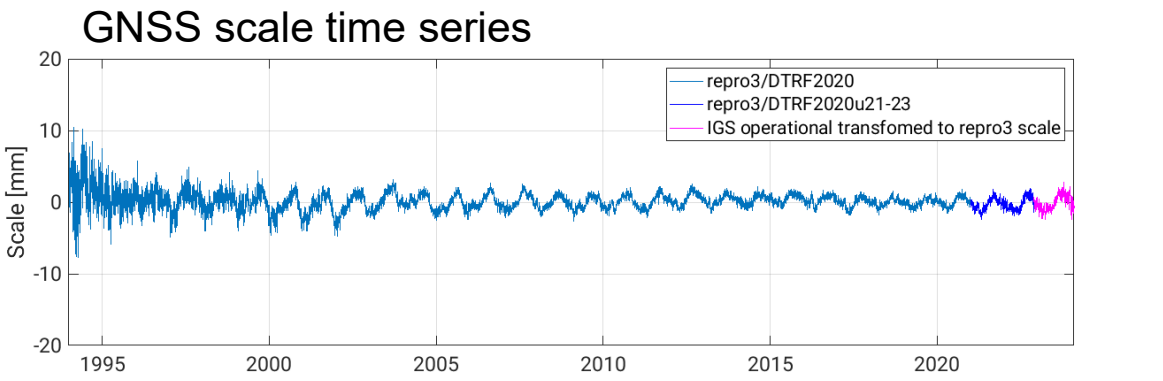


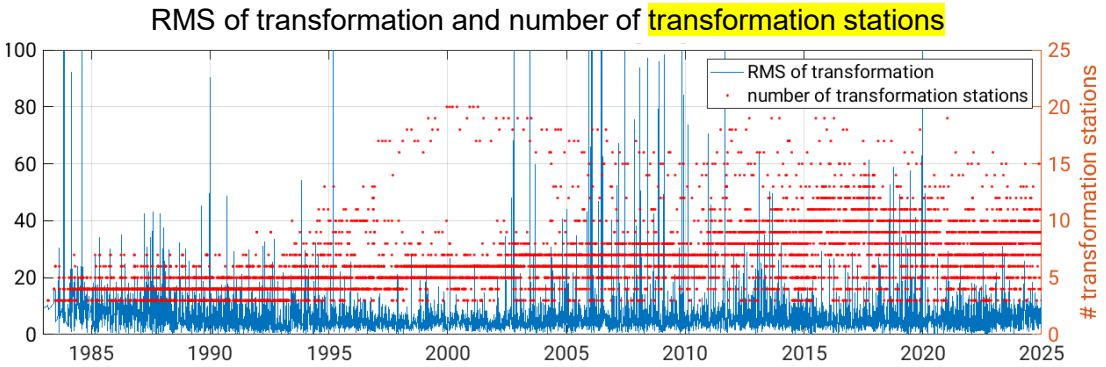

→ Very stable translation time series for the time span when LAGEOS2 is included starting in 1993

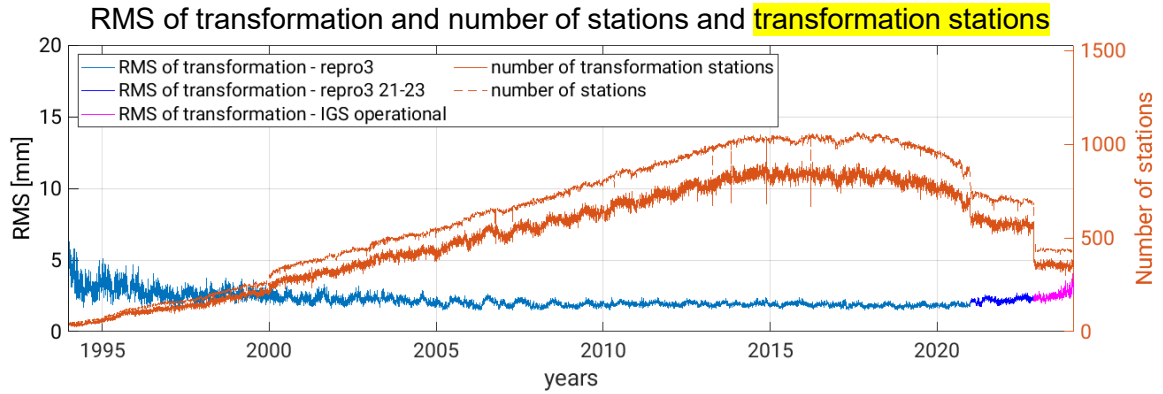
# DTRF2020-u2023 scale

## VLBI and GNSS intrinsic scale time series




→ Small drift in 2021-2023, probably due to the increasing number of stations on the southern hemisphere

→ Periodic signals: draconitic GNSS signal and its harmonics. The annual signal is widely reduced by NTL corrections.

# DTRF2020-u2023 and DTRF2020

## Transformation parameters between DTRF2020-u2023 and DTRF2020

| | GNSS | | VLBI | | SLR | | DORIS | |
|---|---|---|---|---|---|---|---|---|
| | offset [mm] | rate [mm/yr] | offset [mm] | rate [mm/yr] | offset [mm] | rate [mm/yr] | offset [mm] | rate [mm/yr] |
| **Tx** | -0.45 | -0.05 | 0.31 | -0.07 | -0.04 | 0.01 | -1.41 | -0.00 |
| **Ty** | -0.95 | -0.11 | -1.33 | -0.08 | -0.05 | -0.07 | -0.35 | -0.14 |
| **Tz** | -0.29 | 0.00 | -0.84 | 0.04 | -0.10 | 0.01 | -0.47 | 0.06 |
| **Scale** | 0.00 | 0.00 | 0.16 | 0.00 | 0.72 | -0.06 | 0.89 | 0.09 |
| **Rx** | 0.48 | 0.06 | 0.52 | 0.06 | 0.31 | 0.05 | -0.35 | 0.11 |
| **Ry** | -0.21 | -0.02 | 0.85 | -0.06 | 0.04 | 0.00 | -0.38 | -0.02 |
| **Rz** | -0.06 | 0.06 | -0.47 | 0.04 | 0.62 | 0.02 | -0.86 | 0.14 |

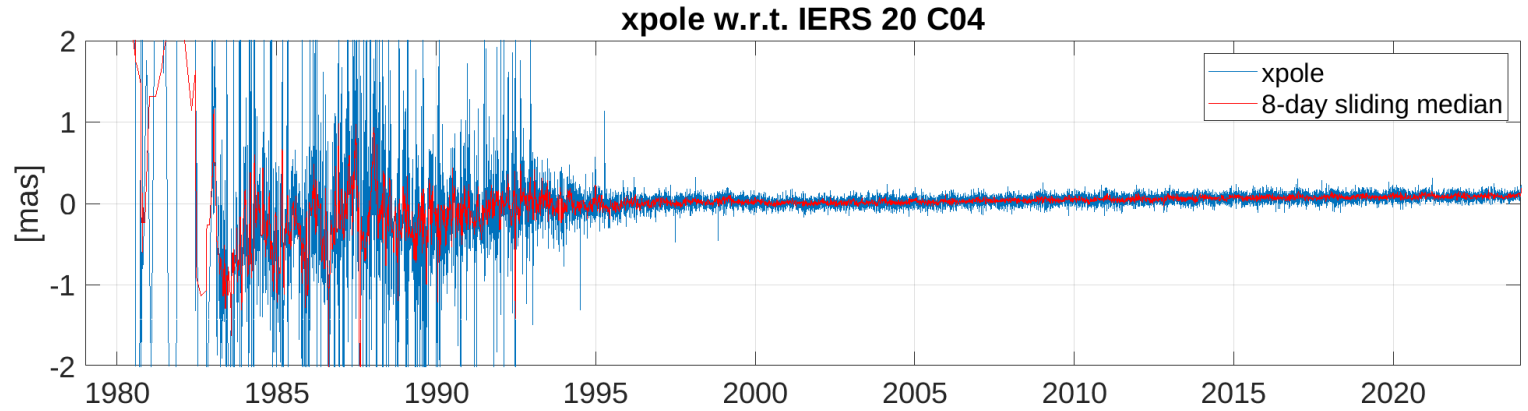
→ Transformation parameters between DTRF2020 and DTRF2020-u2023 are very small

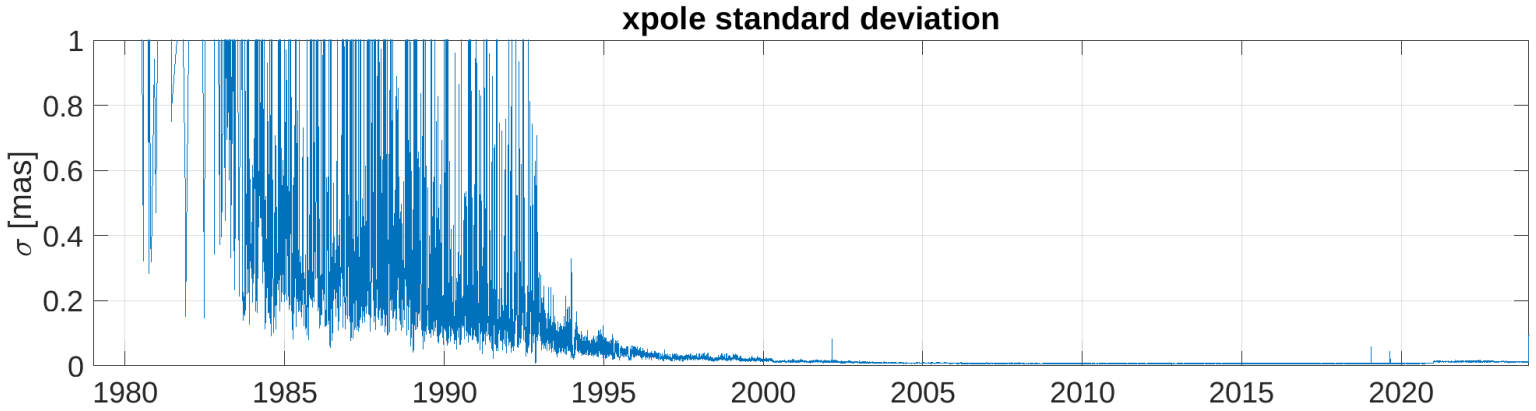
→ RMS of transformation

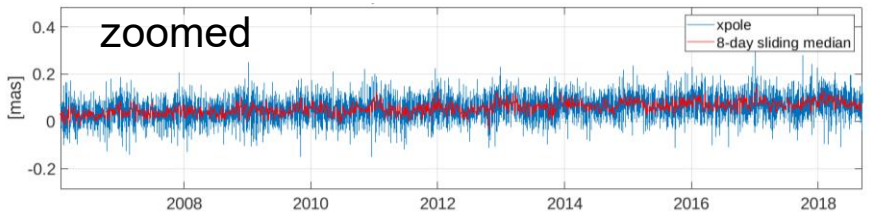
- GNSS, SLR, VLBI: below 0.7 mm and 0.04 mm/yr
- DORIS: 1.6 mm and 0.1 mm/yr

# DTRF2020-u2023 EOP

## Terrestrial pole parameters: x-pole w.r.t. IERS 20 C04



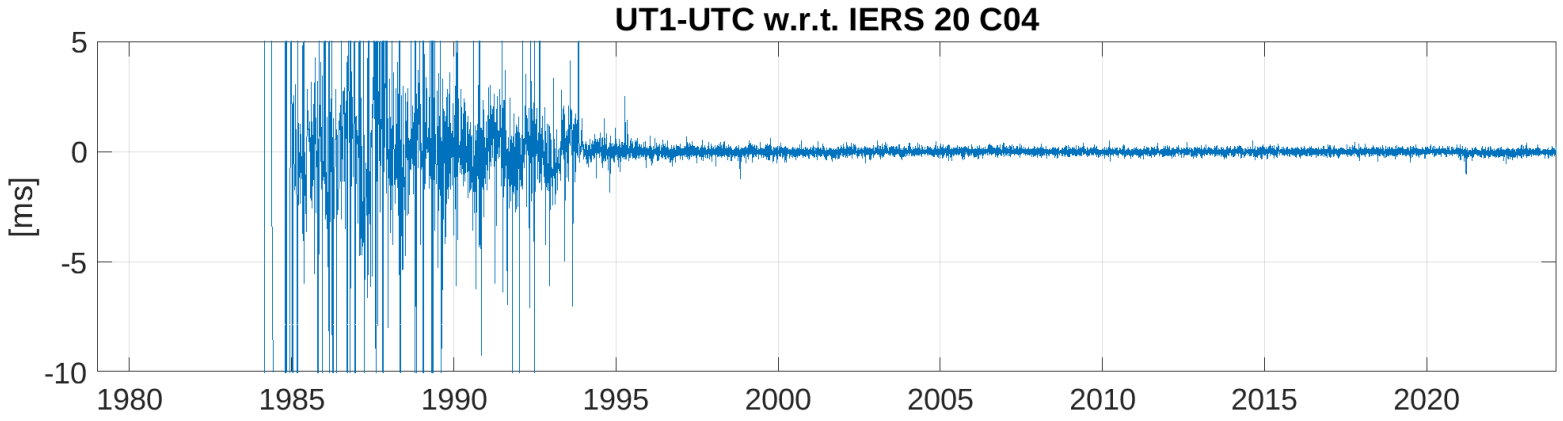



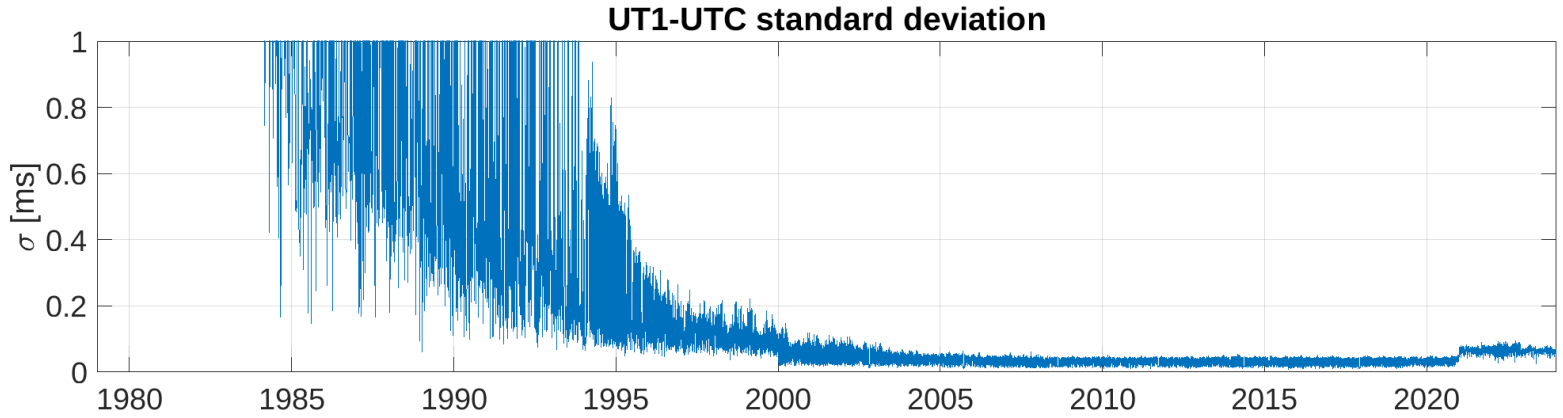




- → Very stable terrestrial pole time series
- → Small differences to IERS 20 C04 estimated consistently to ITRF2020
- → The same holds for y-pole and the pole rates
- → Annual signal results from a different handling of seasonal signals in DTRF2020-u2023 (NTL reduced) and ITRF2020-u2023 (annual, semi-annual and draconitic signal parameterized)

# DTRF2020-u2023 EOP

## Terrestrial pole parameters: UT1-UTC w.r.t. IERS 20 C04




- → Very stable UT1-UTC time series
- → Small differences to IERS 20 C04
- → Increased standard deviations for time span of the extension series 2021-2023 possibly due to the changing number of contributing ACs (new weighting strategy?)

# DTRF2020-u2023 Release Content

- **SINEX files of DTRF2020-u2023** per technique with full variance-covariance matrix
- **EOP file of DTRF2020-u2023** in IERS 20 C04 format
- **NTL corrections in [x,y,z] and [North,East,up]** applied in DTRF2020-u2023 as time series per station
- **PSD corrections in [x,y,z]** as time series per station affected by a significant post-seismic deformation up to epoch 2031-01-01
- **Station position residual time series**
- **SLR translation time series** with respect to DTRF2020-u2023

# DTRF2020-u2023 Application

## Implementation of DTRF2020-u2023

- **Linear station position model (SINEX files)**

$$x_{t_i} = x_{t_0} + v * (t_i - t_0)$$

- Adding **PSD model** series to stations affected by earthquakes provides station positions including the post-seismic deformation

$$x_{t_i} = x_{t_0} + v * (t_i - t_0) + \Delta x_{\mathrm{PSD}}$$

- Adding **NTL referring to CM** provides station positions referring to an instantaneous CM realized as the mean origin of DTRF2020-u2023 plus geocenter variations as provided by the NTL models

$$x_{t_i} = x_{t_0} + v * (t_i - t_0) + \Delta x_{\mathrm{PSD}} + \Delta x_{\mathrm{NTL(CM)}}$$

- Adding **NTL referring to CF** provides station positions including the local NTL variations and referring to DTRF2020 origin (mean CM)
- Adding **SLR translation time series** provides station positions referring to an instantaneous CM as sensed by SLR

$$x_{t_i} = x_{t_0} + v * (t_i - t_0) + \Delta x_{\mathrm{PSD}} + \Delta x_{\mathrm{NTL(CM)}} + \Delta x_{\mathrm{Tran}}$$

# Summary

## DTRF2020-u2023 shows good results in terms of

- long-term stability of datum parameter series → also already seen for DTRF2020-u2024
- the accuracy and consistency of EOP series
- the agreement with DTRF2020
- DTRF2020-u2024 is planned to be finished by end of 2025

## xTRF updates in practice

**PROs:**

- yearly updates provide a constant availability of high-accuracy, up-to-date xTRFs
- reprocessing effort for technique services is strongly reduced
- time series analysis is reduced to extension series and formerly reduced stations

**CONs:**

- reprocessing of xTRF is necessary – at least partly – to consider for model changes (e.g., GNSS PCV) and to include stations formerly reduced due to short time spans → computational effort stays high
- discontinuities at the start epoch of extension series in some station time series and in the formal errors of estimated parameters (mainly due to a changing number of ACs)