Galileo Terrestrial Reference Frame (GTRF) - Status update
GRTF is provided under a contract with Spaceopal

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→ THE EUROPEAN SPACE AGENCY

Introduction

As per **EUROPEAN GNSS (GALILEO)** OPEN SERVICE **SERVICE DEFINITION DOCUMENT**:

"The GTRF is a highly accurate realisation of the ITRS. At any time, the alignment between the GTRF and the latest physical realisation of the ITRF is such that the difference between the ITRF and the GTRF coordinates of the ITRF stations/markers used in the realisation of the GTRF is less than 3 cm (2σ). „

Important note:

The current GTRF is based on ITRF/IGS 2020 models except for the Galileo Phase Centre Offsets where Galileo, in contrast to the International GNSS Service (IGS), which decided to adjust the Galileo Phase Centre Offsets (PCO) to compensate the ITRF scale difference, is using the calibrated PCOs published European GNSS Service Centre.

GTRF Generation - Latest realization: GTRF23v01

- The GTRF23v01 was obtained by accumulating (rigorously stacking) all the weekly GTRF combined solutions since 2006 (~650 weeks spanning 15 years)

- GTRF23v01 is aligned to ITRF2020 using the minimum constrains approach over a set of 90 IGS/ITRF sites

- The GTRF23v01 combination process makes use of:

  1. annual and semi-annual signals present in the station position time series were estimated during the stacking, and

  2. Post Deformation (PSD) parametric models were applied to the coordinates of IGS stations that are subject to major earthquakes before stacking the time series.
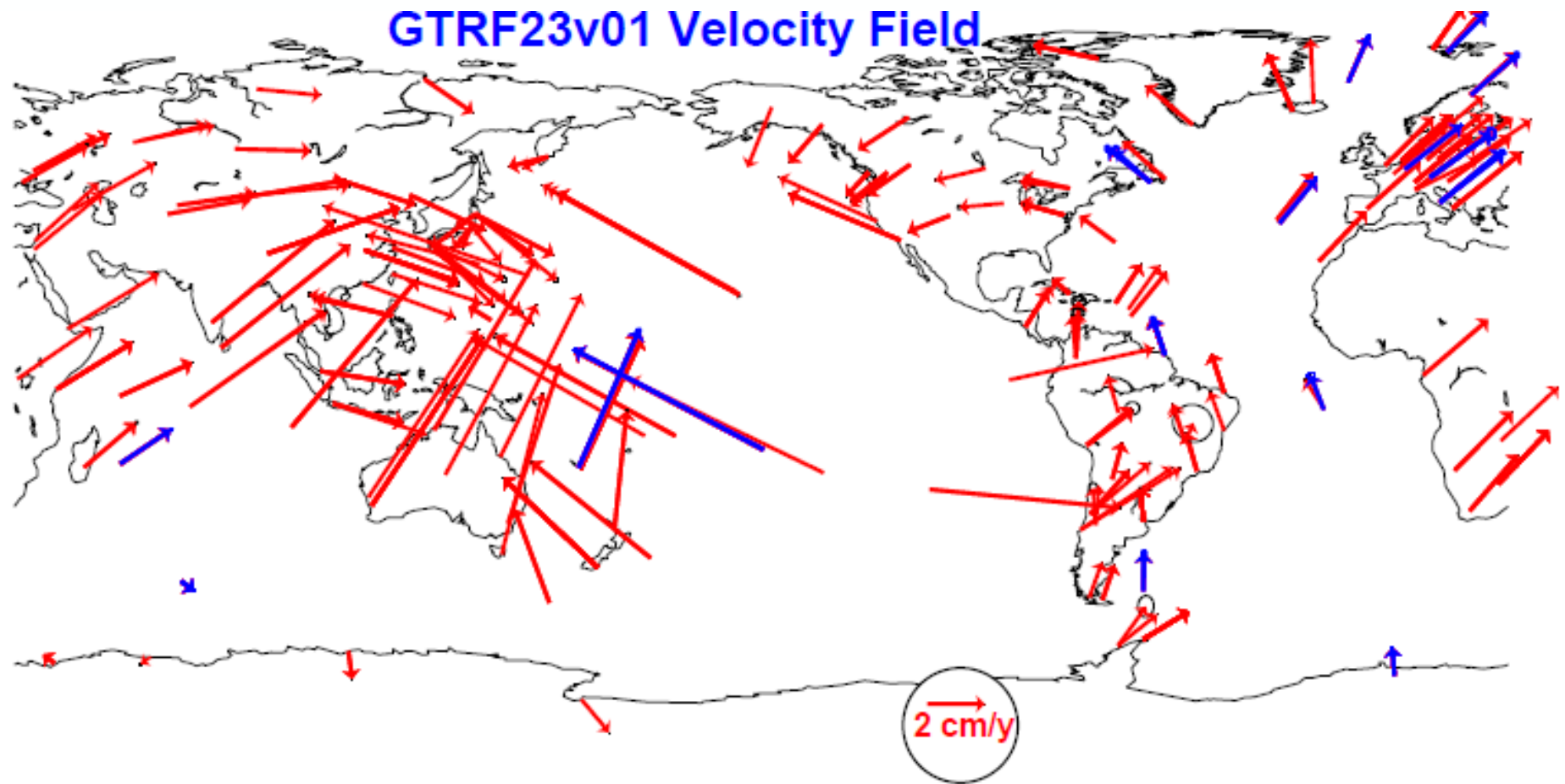
The GTRF Reference Frame Network

GTRF23v01 Network
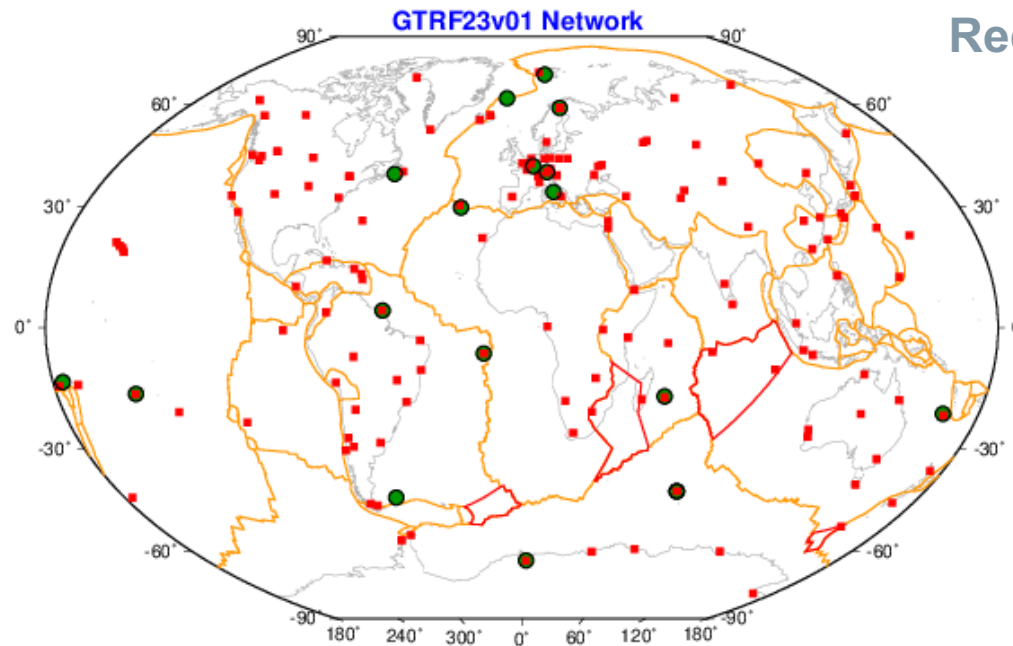
Red squares: ITRF/IGS stations

The latest GTRF23v01 is:

- aligned to ITRF2020, is applicable since 05 May 2023
- obtained by a rigorous stacking of 648 weekly GTRF combined solutions
- using minimum constraints approach over a set of 90 IGS/ITRF stations
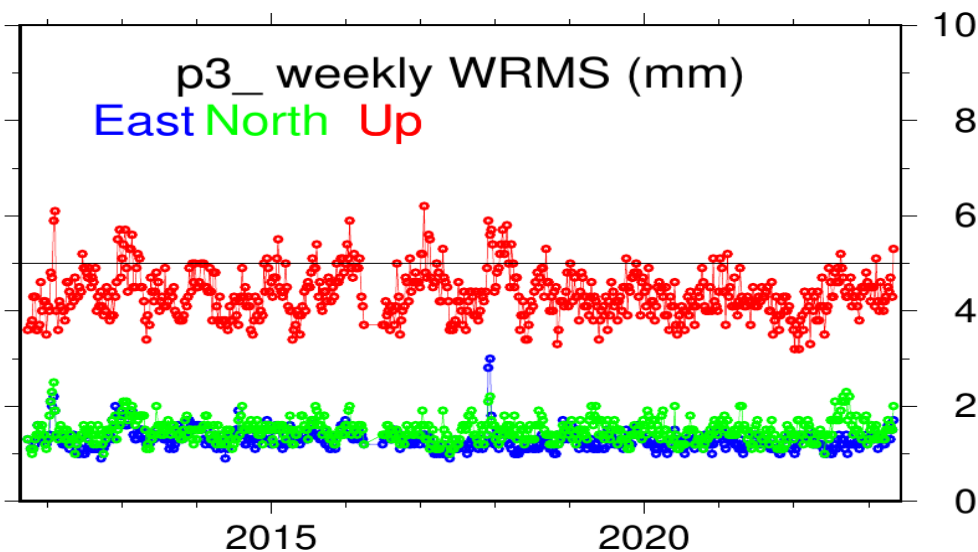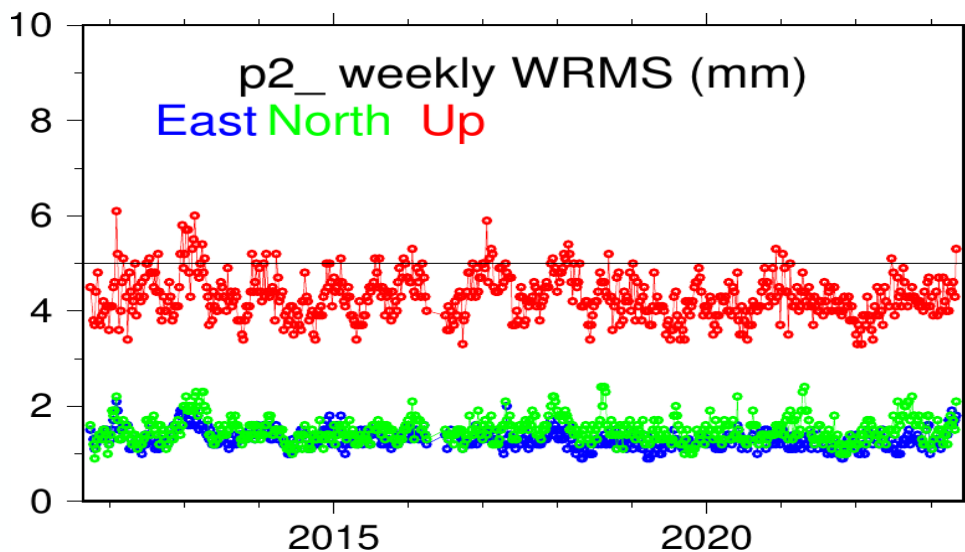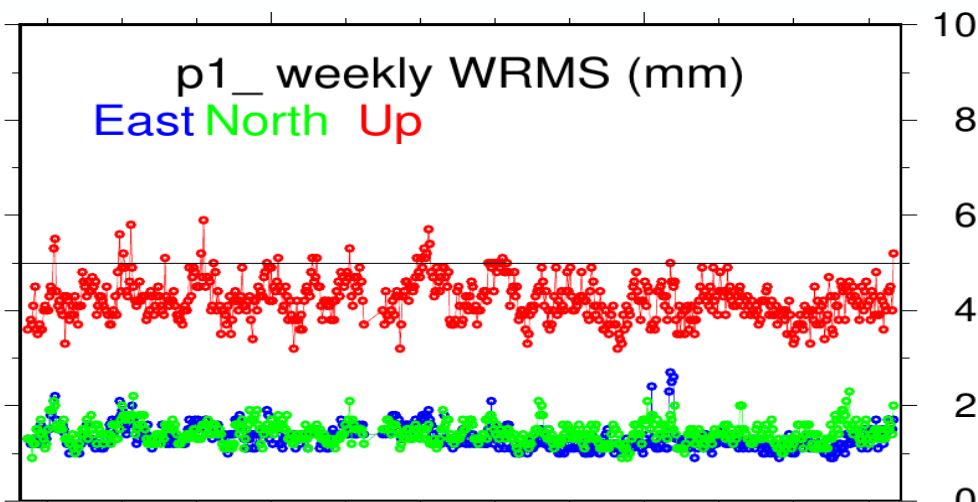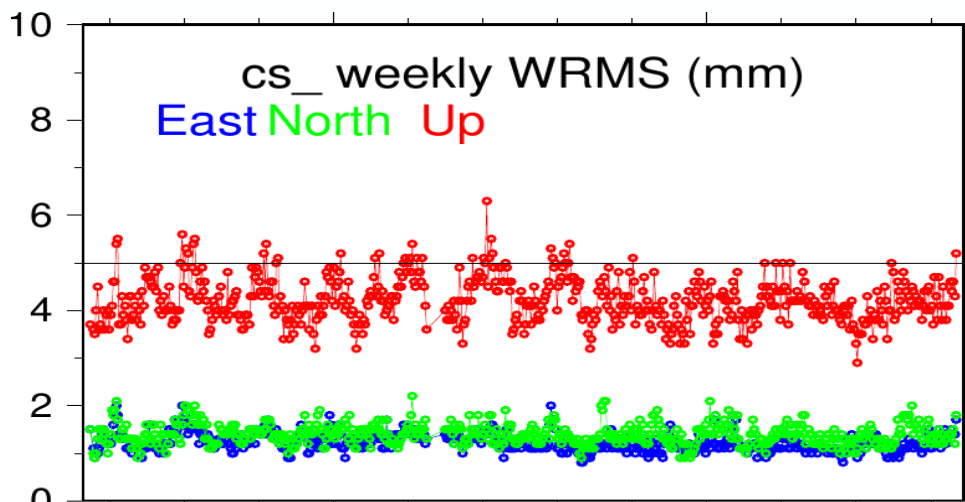
The GTRF23v01 Velocity Field

GTRF23v01 Velocity Field.
Red: IGS/ITRF site
Blue: GSS site

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Final Orbits (PFs vs. CO_ Final)

GGSP Clock Combination
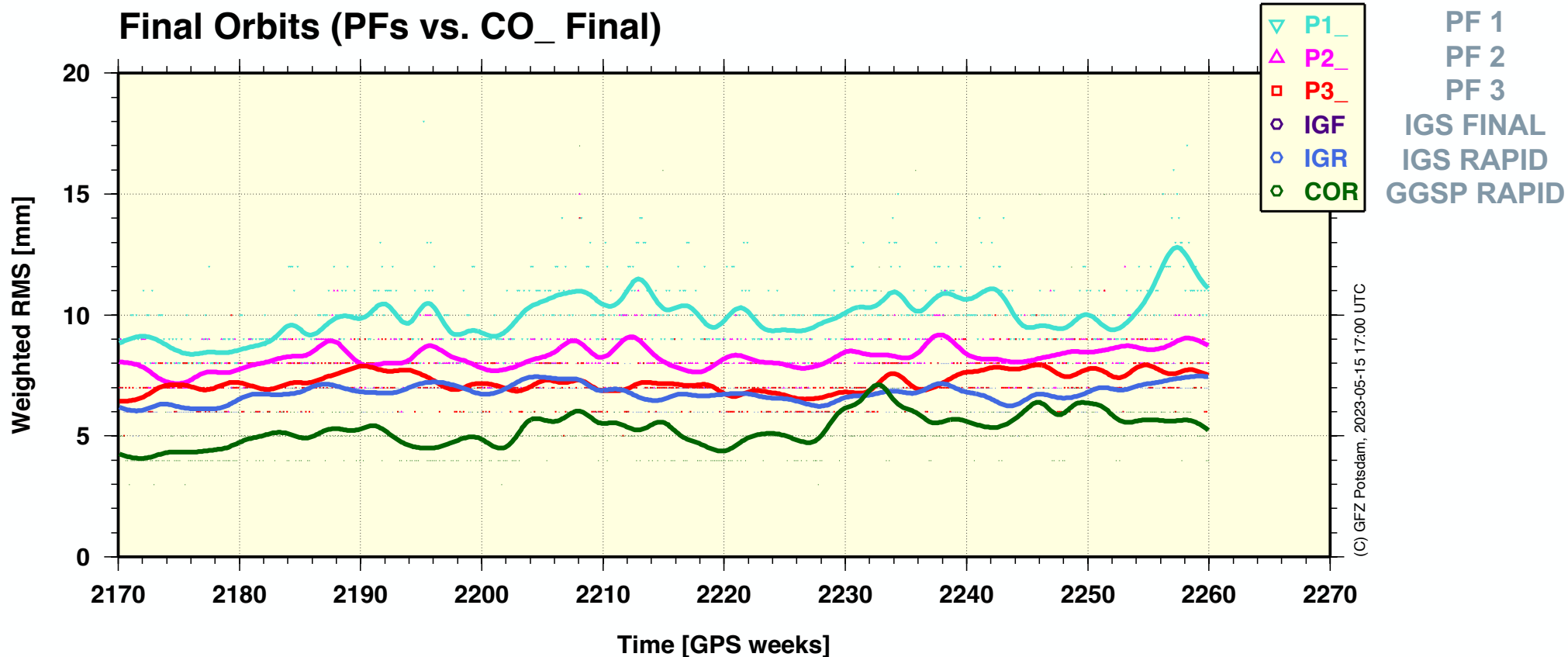
Final Clock SDEV (PFs vs. CO_ Final)

IGR shows 2x higher standard deviation due to model differences.

J2 relativistic clock correction is not applied in IGS.

Legend:
- ▽ P1_ — PF 1
- △ P2_ — PF 2
- □ P3_ — PF 3
- ○ IGF — IGS FINAL
- ○ IGR — IGS RAPID
- ○ COR — GGSP RAPID

Y-axis: Clock SDEV [ns]
X-axis: Time [GPS weeks]

(C) GFZ Potsdam, 2023-05-15 17:00 UTC
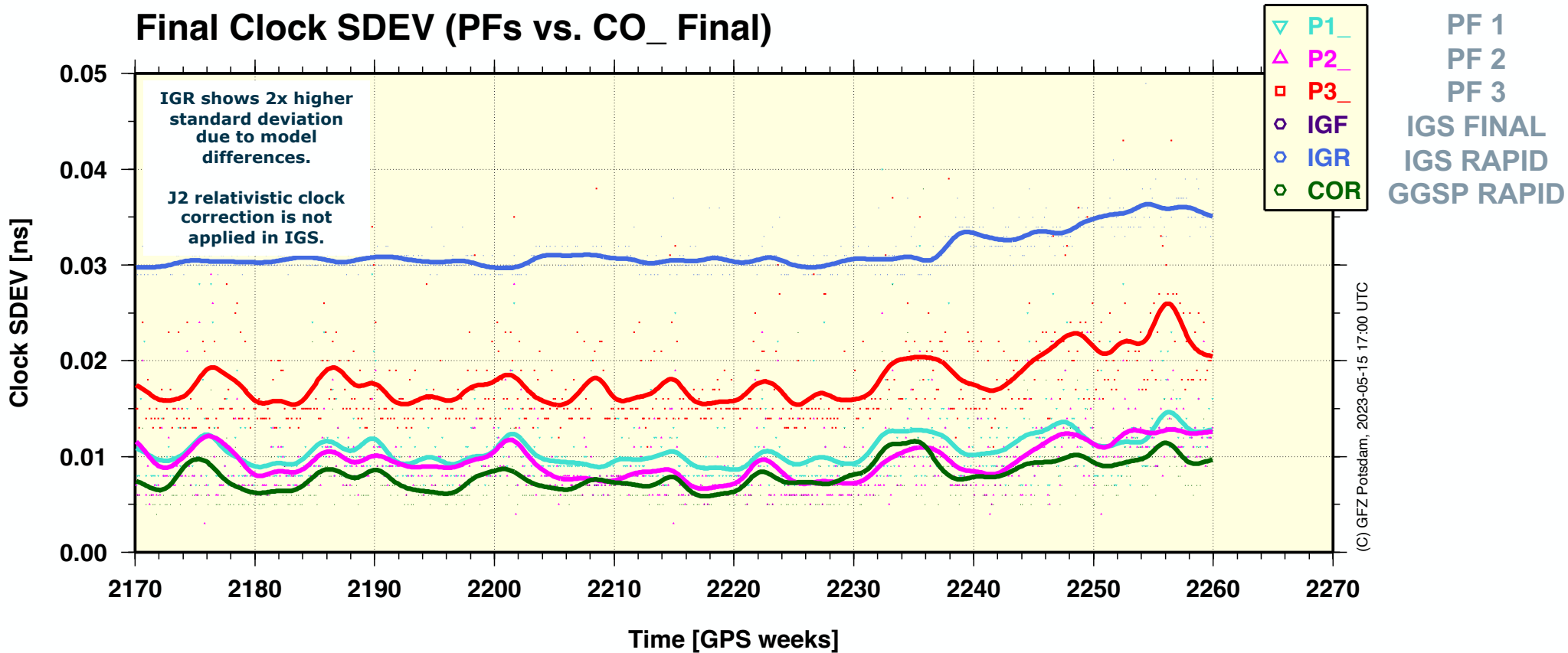
GRSP Orbit accuracy
Standard deviation SLR Residuals

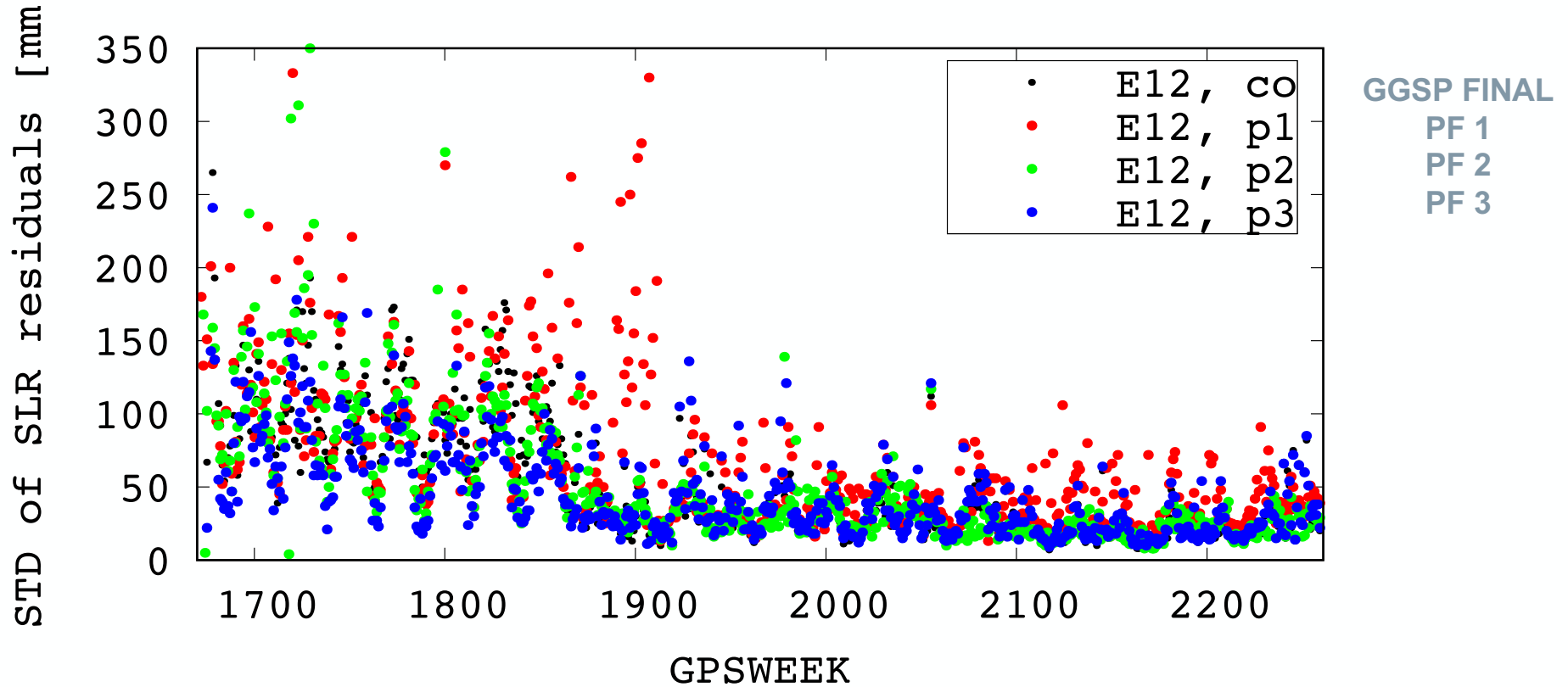

Notice improvement thanks to improved modelling starting week 1873

GTRF Validation

A GTRF validation is carried out on a weekly basis.

Weekly GRSP solution are compared vs different Reference Frames.

Example for week 2260 in table below:

```
                              #sites    North [mm] East [mm]  Up [mm]
                              ------    ---------- ---------  -------
IGS20        RMS / COMPONENT    82         2.04      2.10      5.48      IGS ITRF 2020 realisation

IGS23P2260 RMS / COMPONENT     129         0.85      0.77      3.02      IGS Weekly Solution

GTRF23V01   RMS / COMPONENT    179         2.27      1.91      5.48      GTRF23v01
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Conclusions

- GTRF is a state of art realisation of the ITRS for Galileo

- GTRF23v01 is rigorously aligned to ITRF2020 over the 14 parameters

- GTRF is updated on a yearly basis taking into account linear and nonlinear station motions

- GTRF has the same high accuracy as the ITRF, but it is more frequently updated

- The current GTRF is based on ITRF/IGS 2020 models except for the Galileo Phase Centre Offsets where Galileo uses the calibrated PCOs provided on the European GNSS Service Centre

Thank you very much for your attention

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