Review the IGS Strategy for Precise Point Positioning Applications

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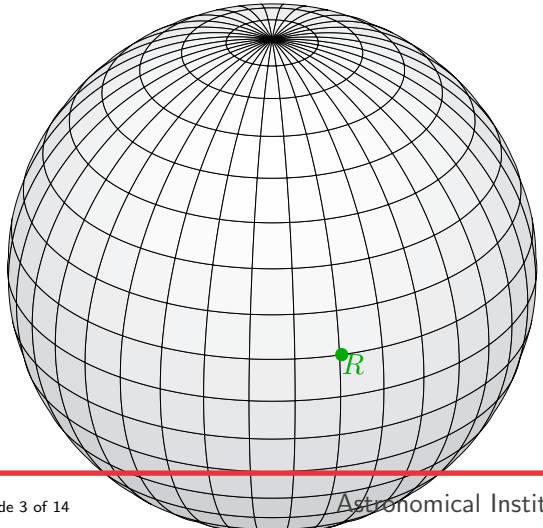
EGU General Assembly 2024
14–19. April 2024, Vienna Austria

The clear theory

Something unexpected

Explanation for the surprise

Illustration of the problem



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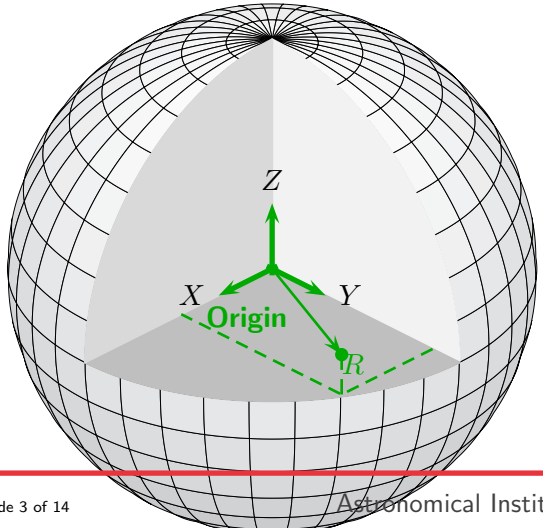

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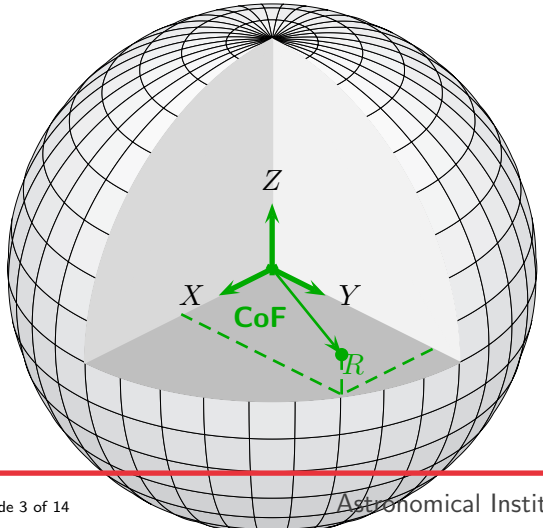

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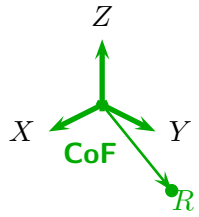

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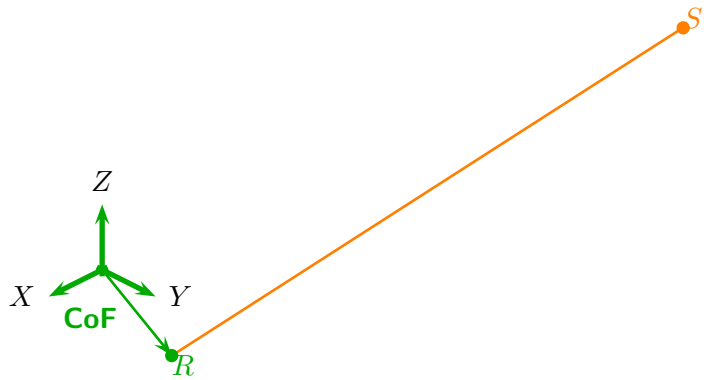

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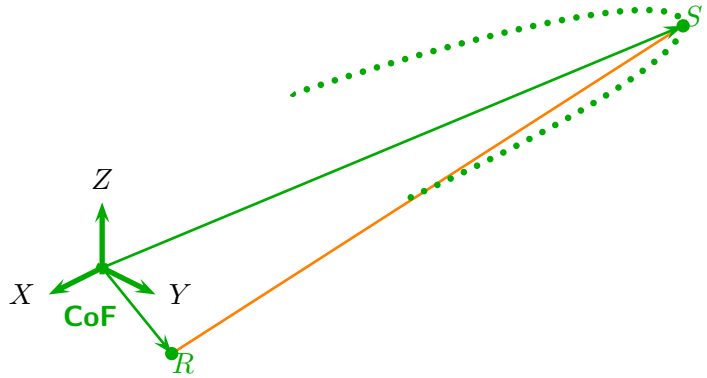

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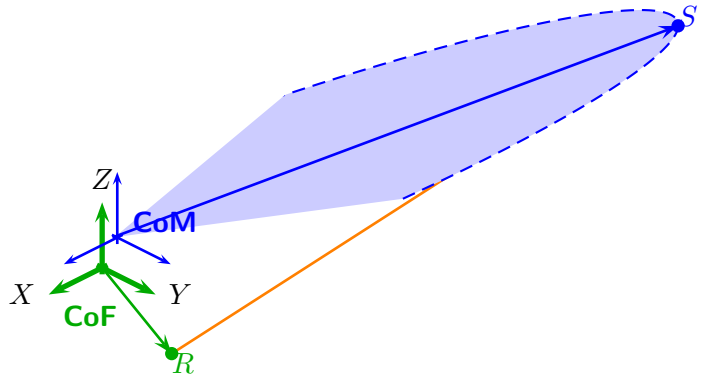

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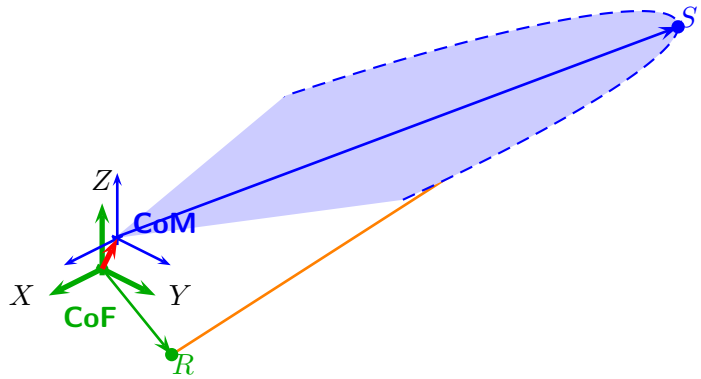


Which reference frames are needed for which purpose?

GNSS station: ITRF (CF-based)

- Earth fixed system with stable origin in time

Satellite positions (for interpolation): ITRF (CF-based)

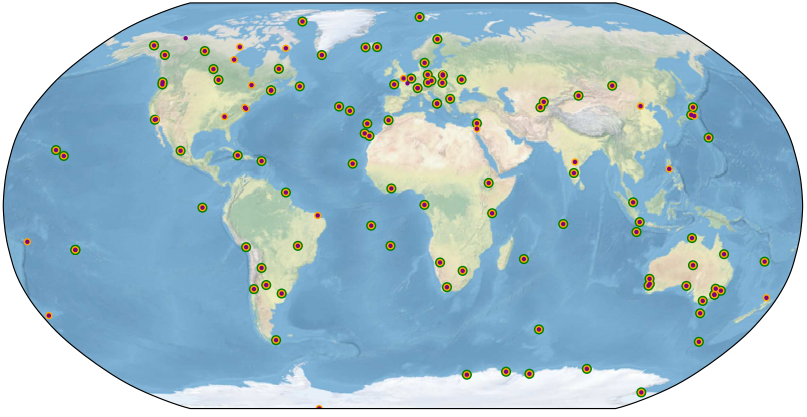
- the same frame as the GNSS stations (for user's convenience)
- realized today in the SP3 orbit product files

Satellite orbits (for orbit modelling): GCRF (CM-based)

- Earth centered system that does not participate in the Earth rotation
- instantaneous center of mass as the origin

We just need a well established ITRF;
GCRF is only needed temporally during the data analysis.

The experiment setup



Network of 120 IGS stations as used by CODE rapid solution.

The experiment setup

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- three one-day solutions are connected to a long-arc solution
  - day 180 to 189 of year 2023
  - extraction of the middle day
  - datum definition: NNR+NNT condition on a verified set of stations in IGS20 frame

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- one-day orbit solution
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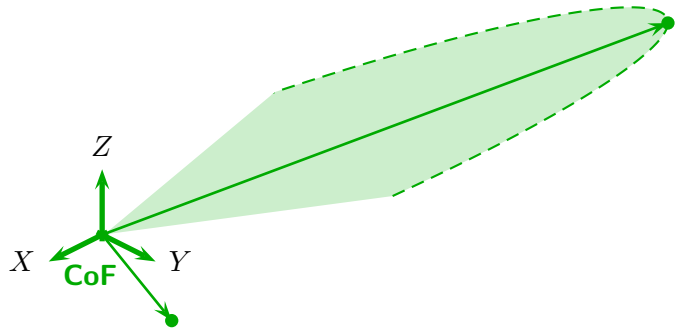
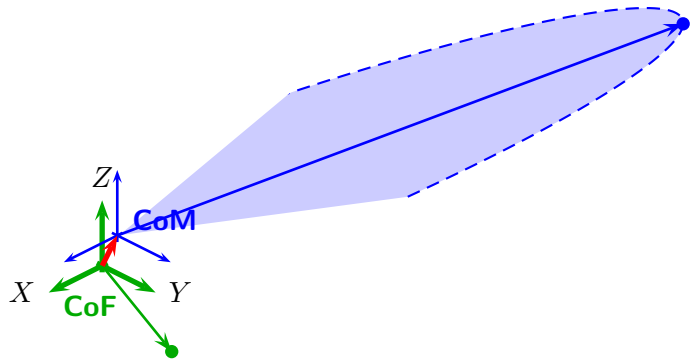
- three one-day solutions are connected to a long-arc solution
  - day 180 to 189 of year 2023
  - extraction of the middle day
  - datum definition: NNR+NNT condition on a verified set of stations in IGS20 frame
- back substitution of the receiver and satellite clock parameter
  - day 180 to 189 of year 2023
  - geometry from the three-day long-arc solution is introduced

The experiment setup: Solution CoF



The experiment setup: Solution CoM



Comparing the CoF- and CoM-based solutions

Station coordinates (in IGS20 frame):

- no significant transformation parameters
- agreement: RMS of differences (without transformation parameters) $< 0.5\,\mathrm{mm}$

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Satellite positions (in GCRF incl. geocenter vector):

- agreement: RMS of differences (with transformation parameters) $\approx 5 \ldots 7\,\mathrm{mm}$

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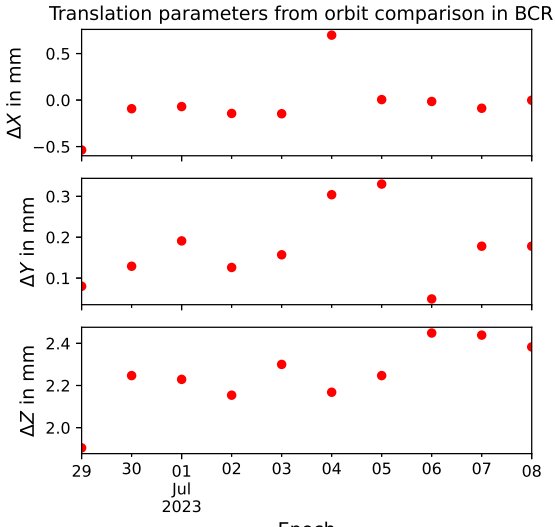

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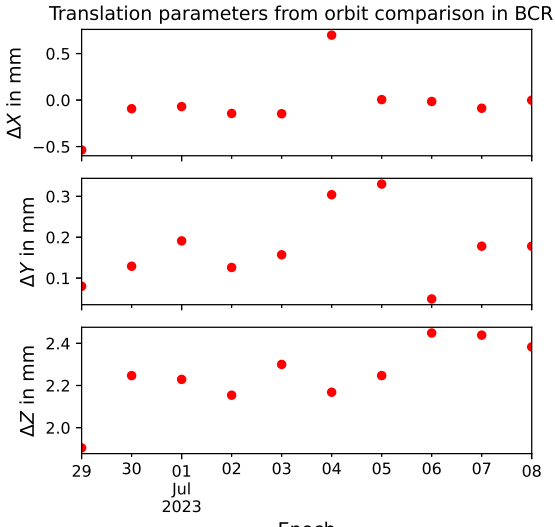


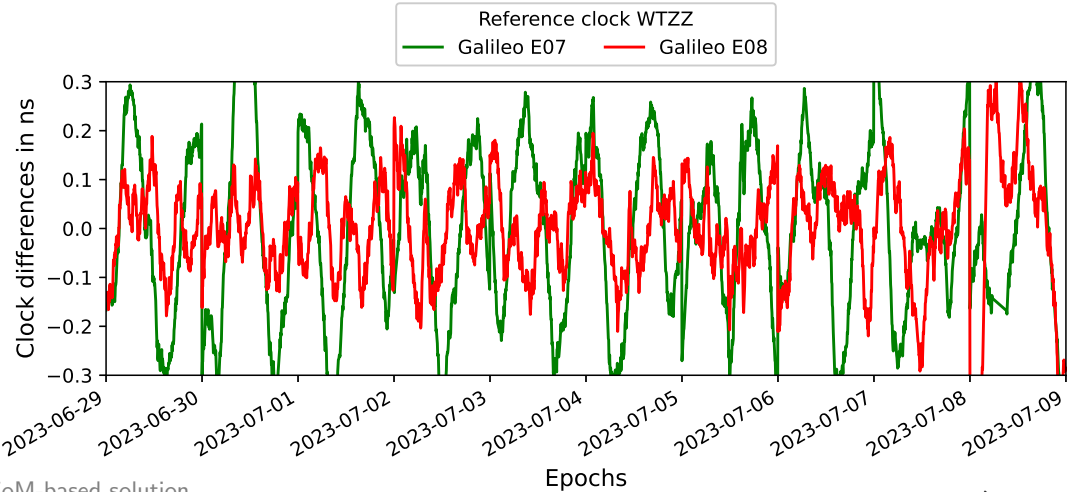
Geocenter correction applied:

- X-component: $0.5\,\mathrm{mm}$
- Y-component: $3.2\,\mathrm{mm}$
- Z-component: $3.2\,\mathrm{mm}$

Geocenter motion model from ITRF2020

`https://itrf.ign.fr/ftp/pub/itrf/itrf2020/...`
`ITRF2020-geocenter-motion.dat`

Comparing the obtained satellite clock corrections



CoM-based solution

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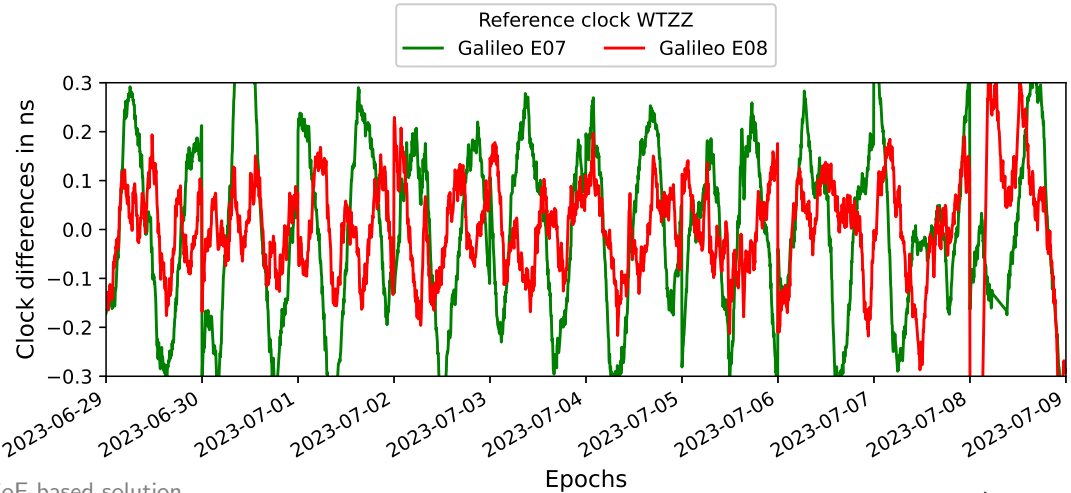

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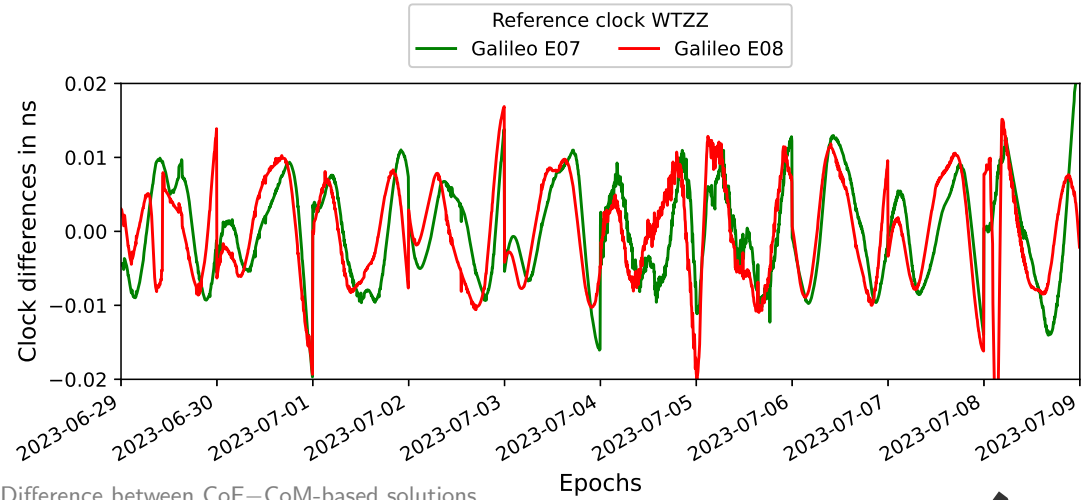

Difference between CoF−CoM-based solutions

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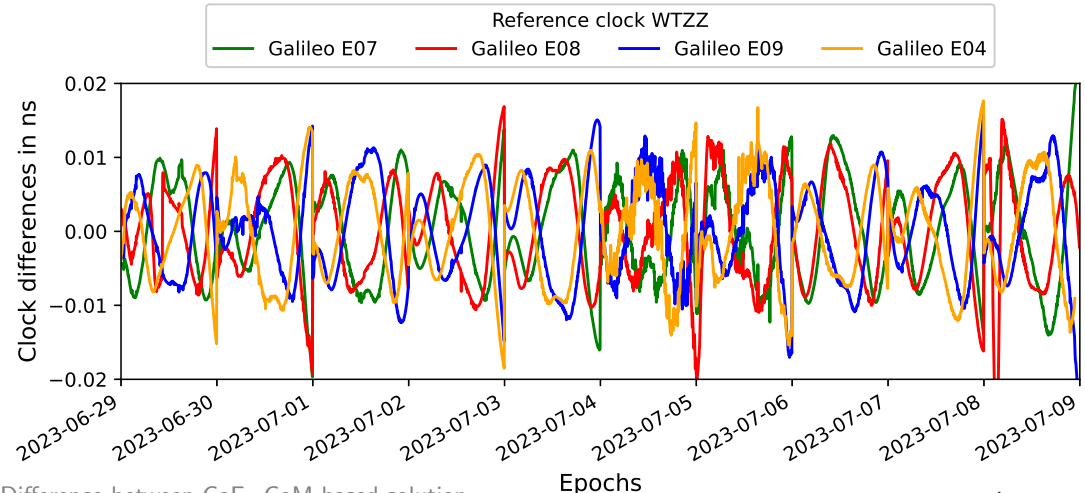

Difference between CoF−CoM-based solution

Satellite clock corrections do absorb the Geocenter correction

From the satellite clock differences
the related geocenter vector is extracted:

- X-component: $0.7\,\mathrm{mm}$
- Y-component: $3.5\,\mathrm{mm}$
- Z-component: $2.6\,\mathrm{mm}$

Geocenter correction applied:

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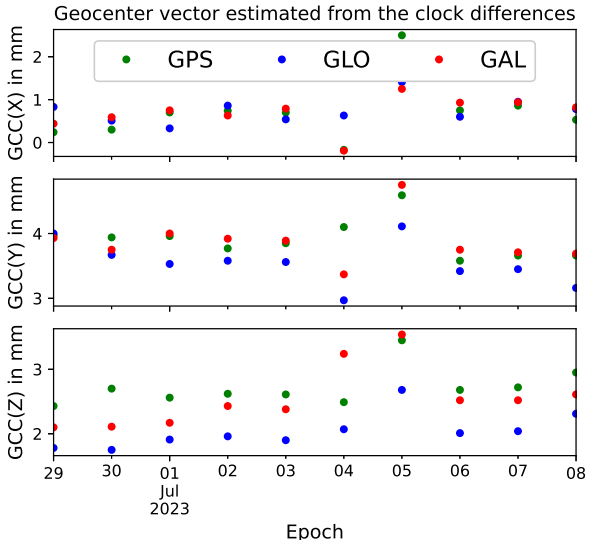

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Conclusions

- If a center of mass correction for the Geocenter vector introduced in the GNSS orbit determination it is completely absorbed by the co-estimated satellite clock corrections.

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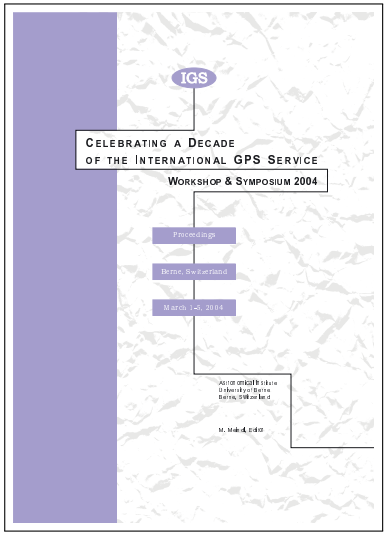
Conclusions

- If a center of mass correction for the Geocenter vector introduced in the GNSS orbit determination it is completely absorbed by the co-estimated satellite clock corrections.
- The orbits realize a center of mass system in the GCRF independent from introduced vector. GCRF is just a temporary frame realized during the data processing.
- For PPP one has to be careful regarding the consistency.
- Any PPP solution has to end up in the ITRF (CF-based frame).

IGS Workshop 2004



Recommendations:

- All IGS satellite clocks should be in ITRF center of network. . . .

  extract from Recommendation 2.10 – IGS Reference Frame Maintenance

- The PPP realization of ITRF using IGS products . . .

  extract from Recommendation 2.11 – IGS Reference Frame Maintenance

THANK YOU

for your attention

Publications of the satellite geodesy research group:

http://www.bernese.unibe.ch/publist