Evaluation of xTRF2014 Solutions

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Overview

Introduction and motivation

Description of the processing scheme

Comparison of station coordinates

Comparison of orbits with SLR measurements

Comparing satellite antenna offsets

Comparing polar motion results

xTRF2014 Solutions

- **DTRF2014**
  Deutsches Geodätisches Forschungsinstitut at TU Munich (DGFI-TUM, Germany; Seitz et al. 2016)
  positions+linear velocities

xTRF2014 Solutions

- **DTRF2014** and **DTRF2014L**
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  positions+linear velocities + NT loading corrections

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- **JTRF2014**
  Jet Propulsion Laboratory (JPL, USA; Wu et al. 2015)
  positions every week

Description of the processing scheme

Product availablity:

	GPS	GLONASS
GNSS satellite orbits:	since 1994	since 2002
GNSS satellite clock corrections:		
sampling 30 s:	since 2000	since 2008
sampling 5 s:	since 2003	since 2010

Description of the processing scheme

GNSS Reprocessing in 2015:

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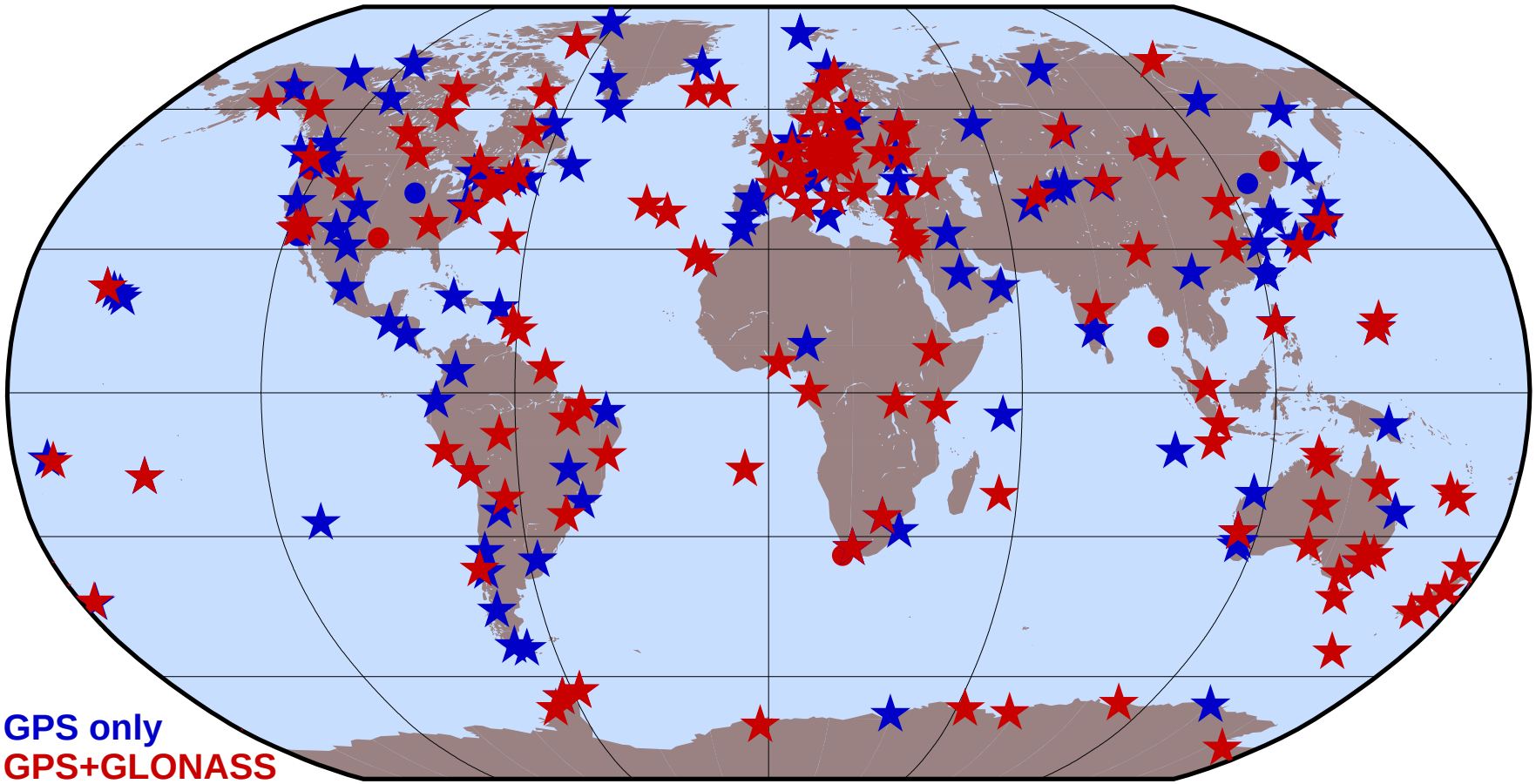
GNSS satellite clock corrections:		
sampling 30 s:	since 2000	since 2008
sampling 5 s:	since 2003	since 2010

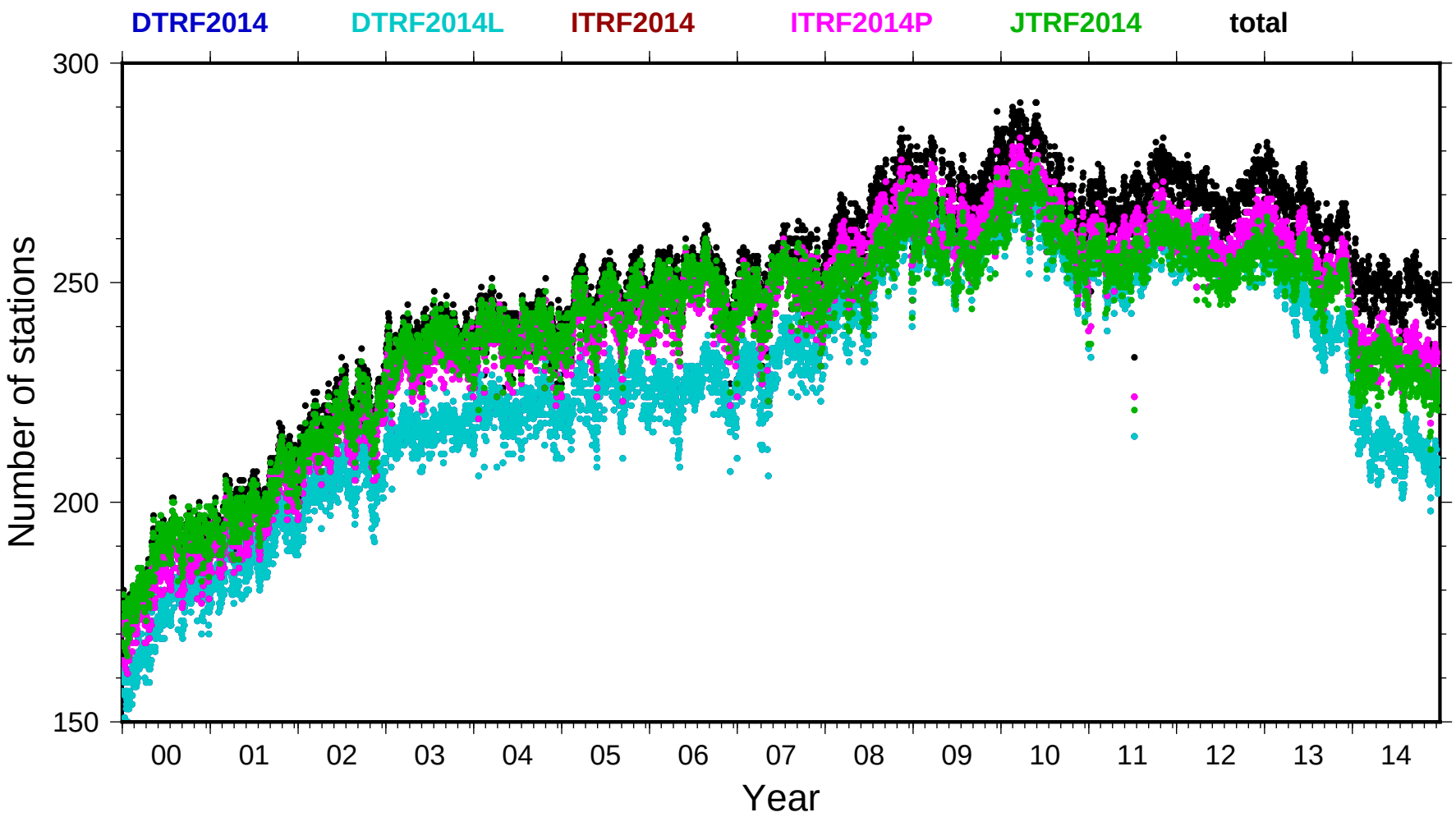
- EGSIEM-repro considers the ECOM2 orbit model.
- The solution is consistent with repro2:
  - IGb08/IGS08.ATX
  - same station selection.

The station network



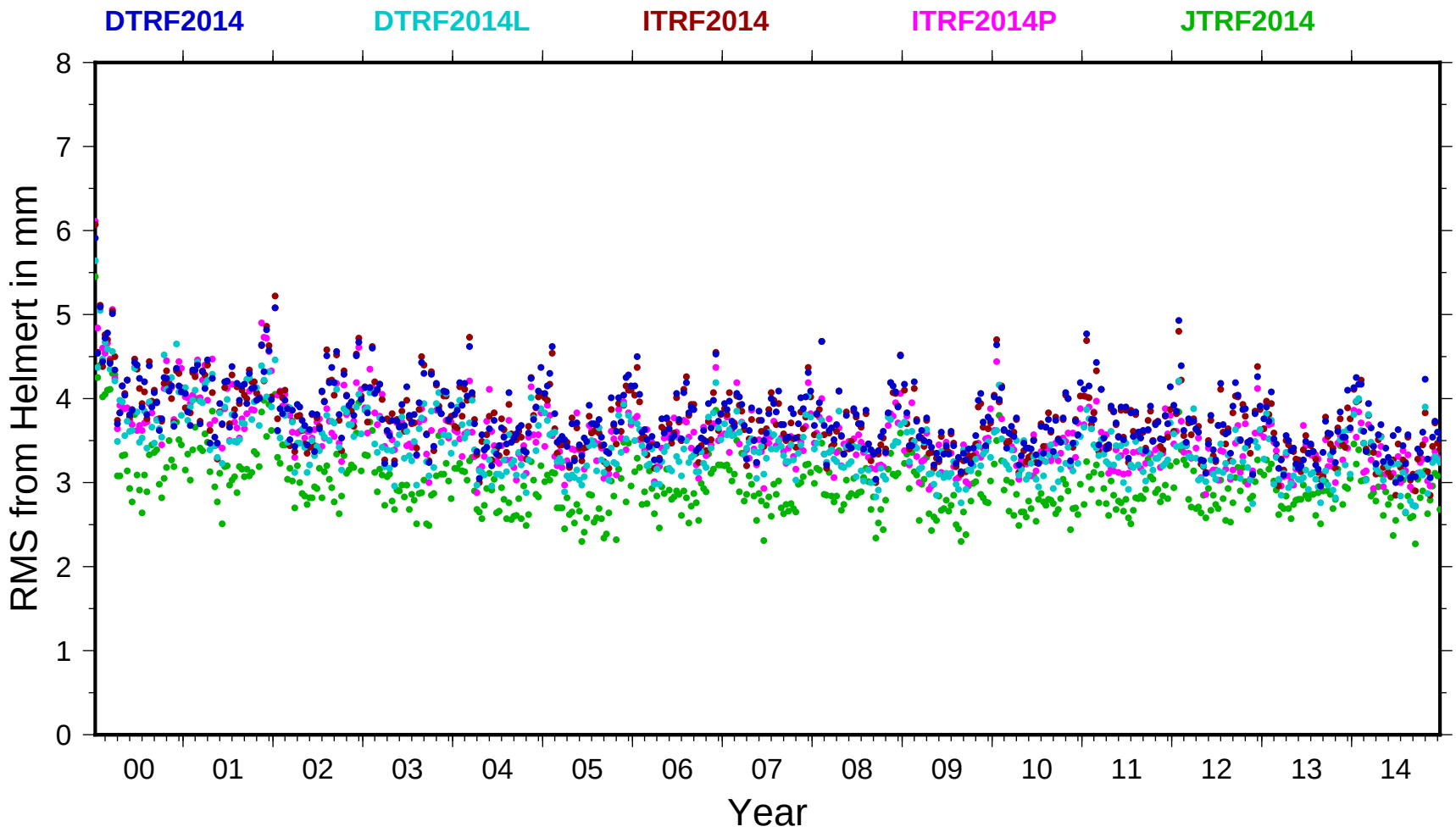
★ given in the DTRF2014 ● other stations **day 12001**

The station network



Comparison of EGIEM solution (IGb08)

RMS (consistency) from a Helmert Transformation



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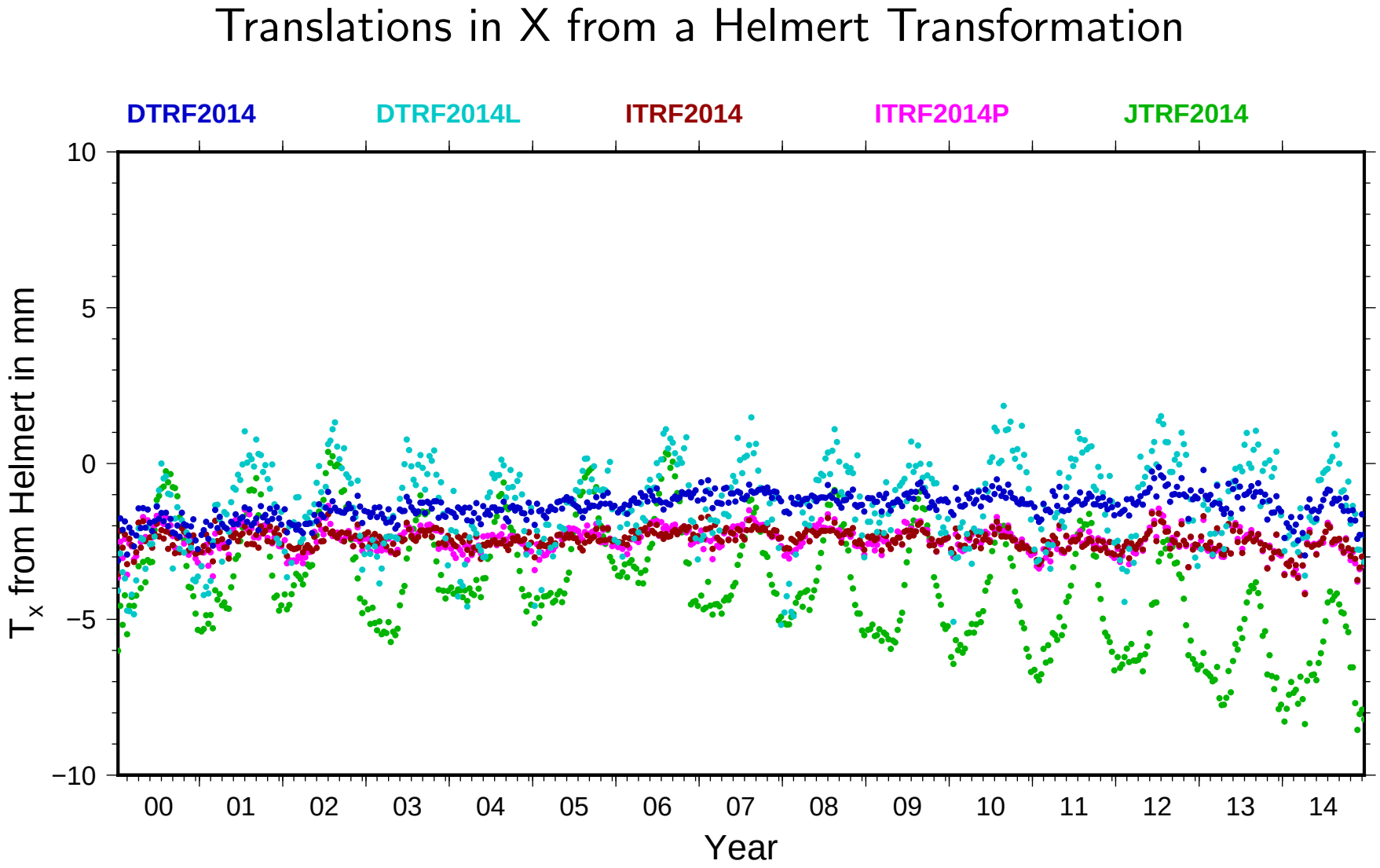

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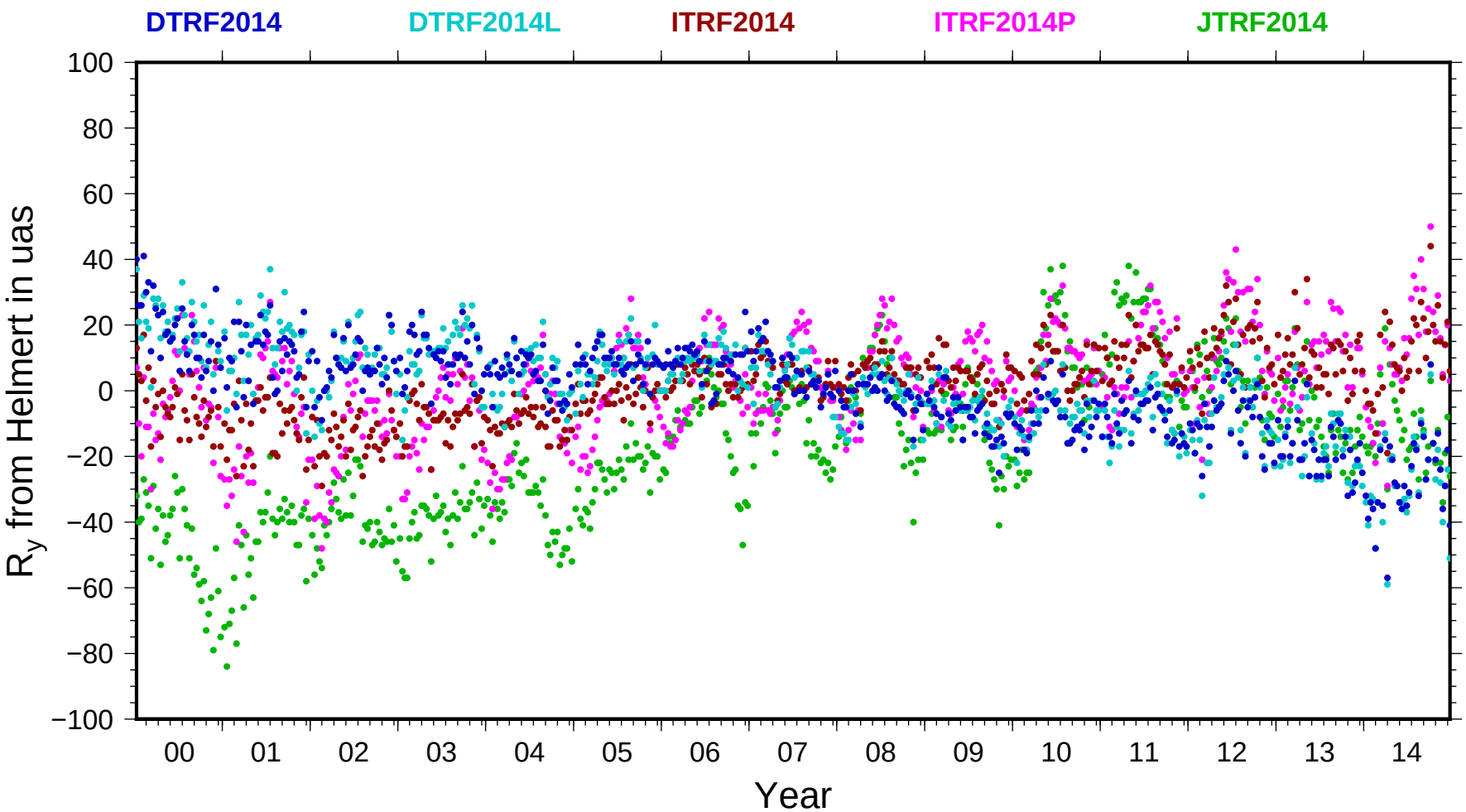

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- Earth rotation parameters (X- and Y-pole offset and rate as well as LOD; 1st UT-values taken from the C04 product), and
- GNSS satellite orbits with 7 dynamical orbit parameters according to the ECOM2 description and three empirical velocity changes of the satellites every 12 hours.

Comparison of station coordinates

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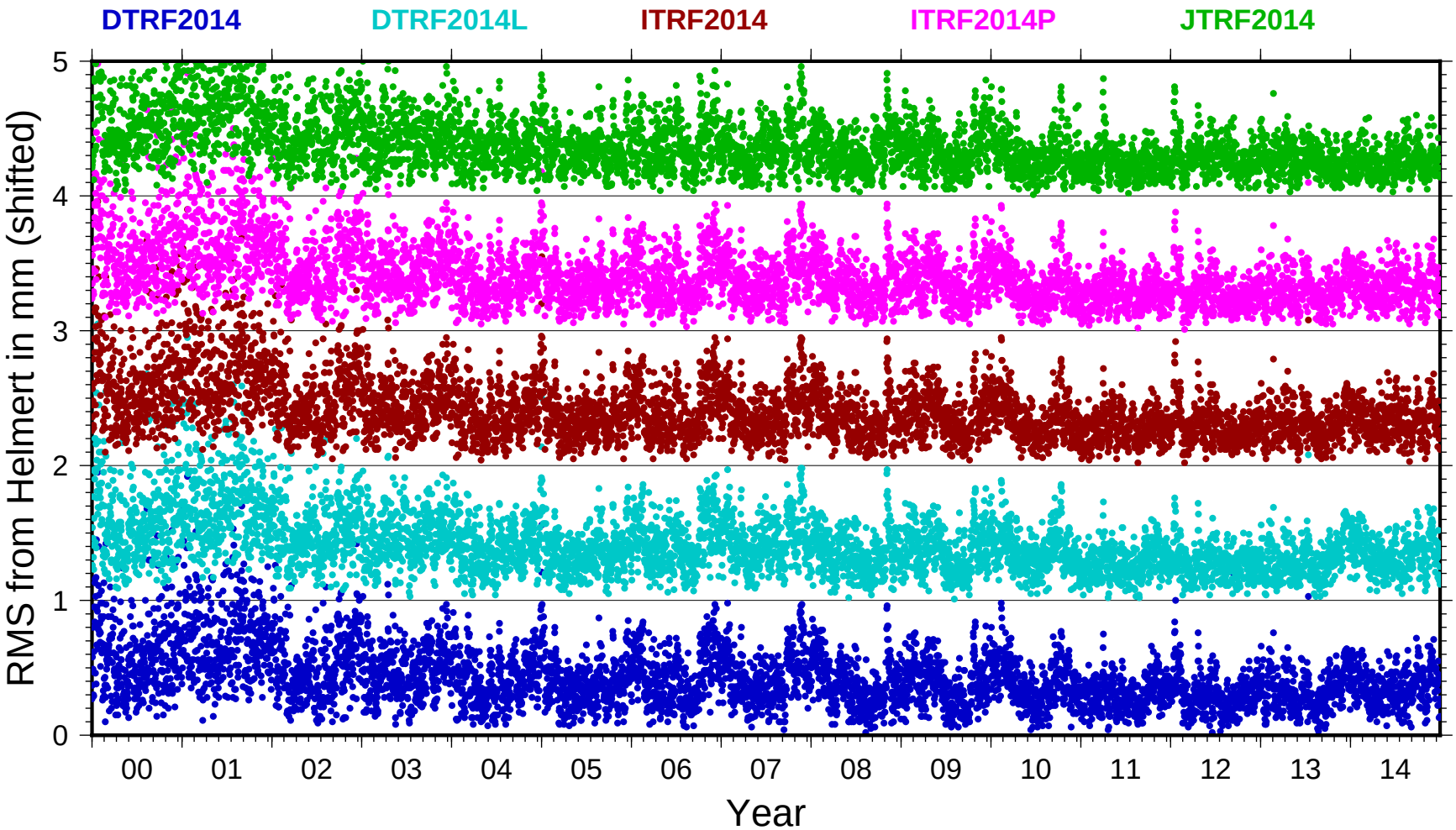
- The transformation and rotation parameters are reflecting the GCC estimates and the orientation from the datum-free solution and are therefore not of interest regarding the consistency between all five reference frame solutions.
- The RMS of the residuals are more interesting because they can be seen as a measure for the distortion of the network geometry introduced by forcing the center of mass into the origin.

Comparison of station coordinates



Comparison of orbits with SLR measurements

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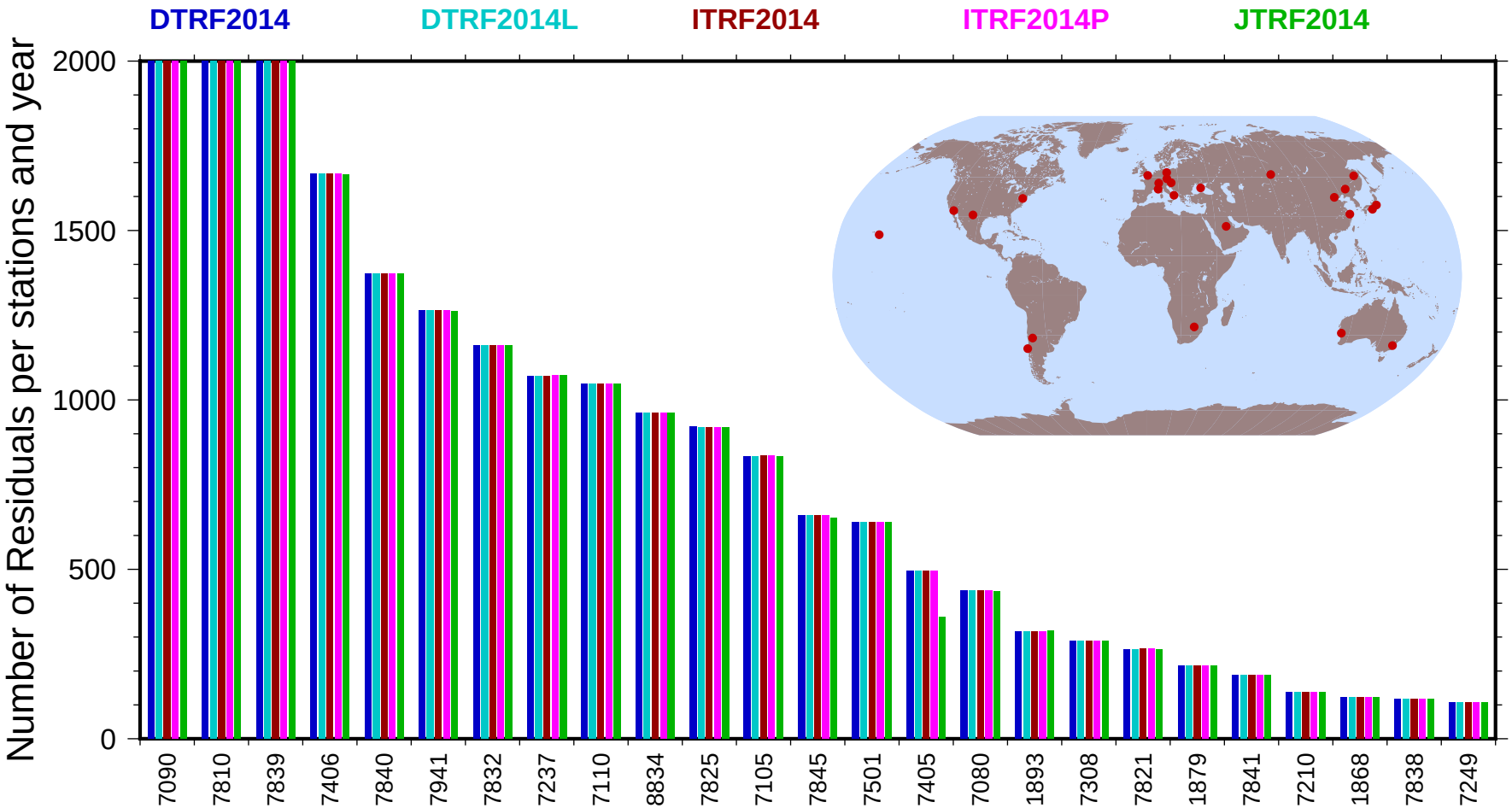
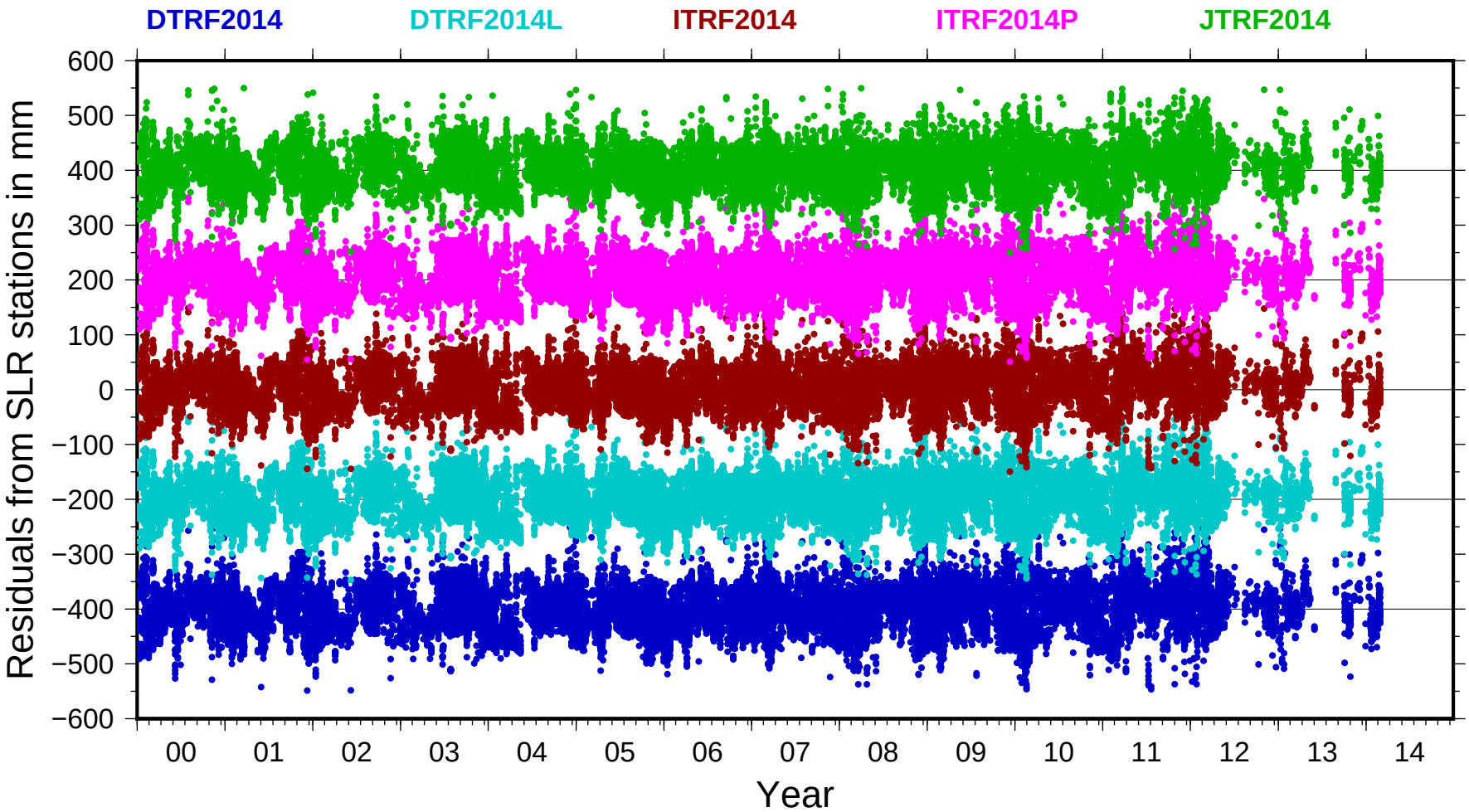
- Station coordinates for the SLR tracking stations have been derived from the five reference frame solutions.
- The GNSS-satellite orbits (with the related ERPs) have been taken from the GNSS microwave solution.
- The SLR measurements are directly confronted with the geometry without estimating parameters).
  (of course the usual corrections for troposphere, relativistic effects, etc. have been applied).

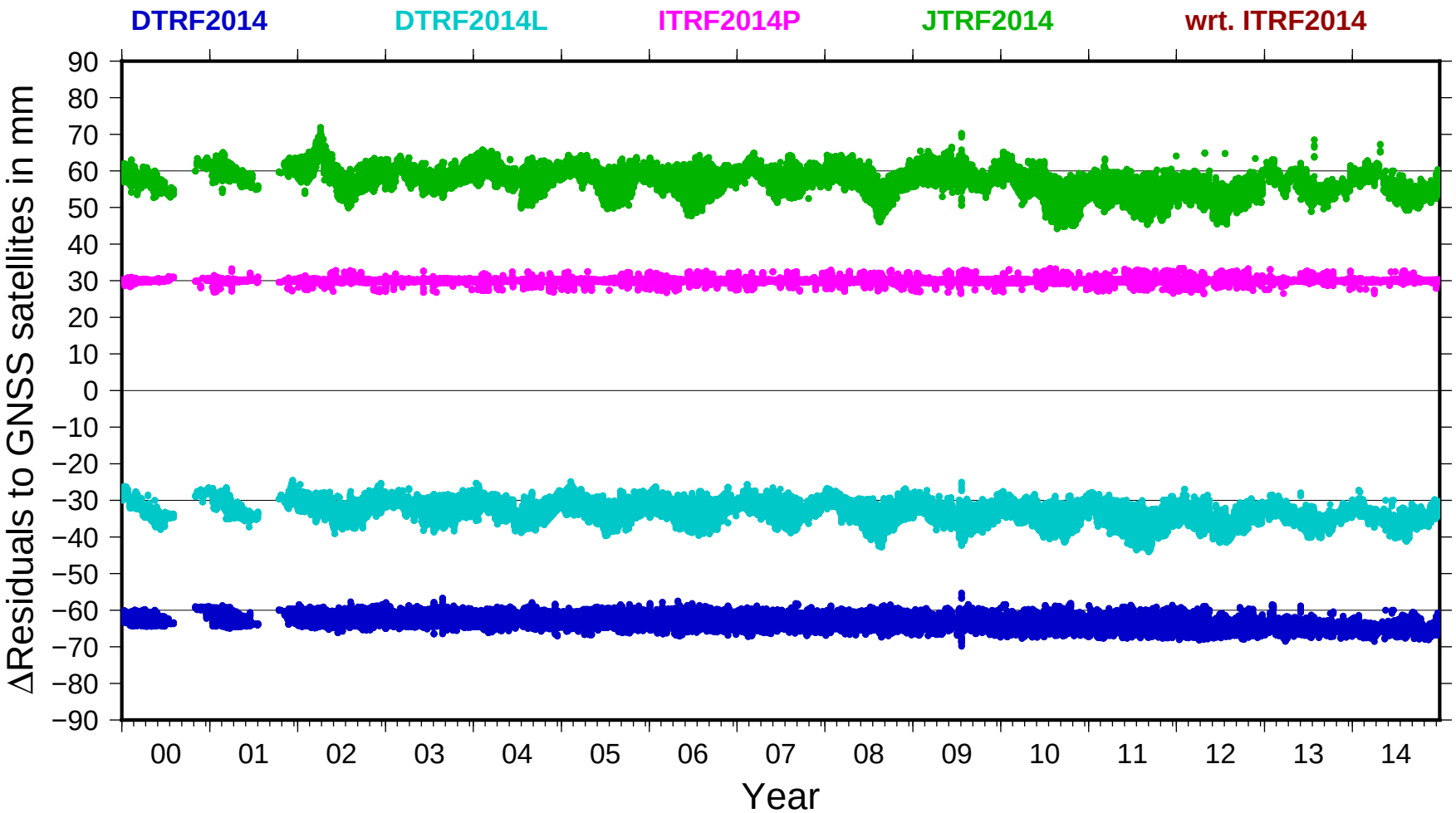
SLR stations tracking GNSS satellites



SLR residuals for G 036 satellite



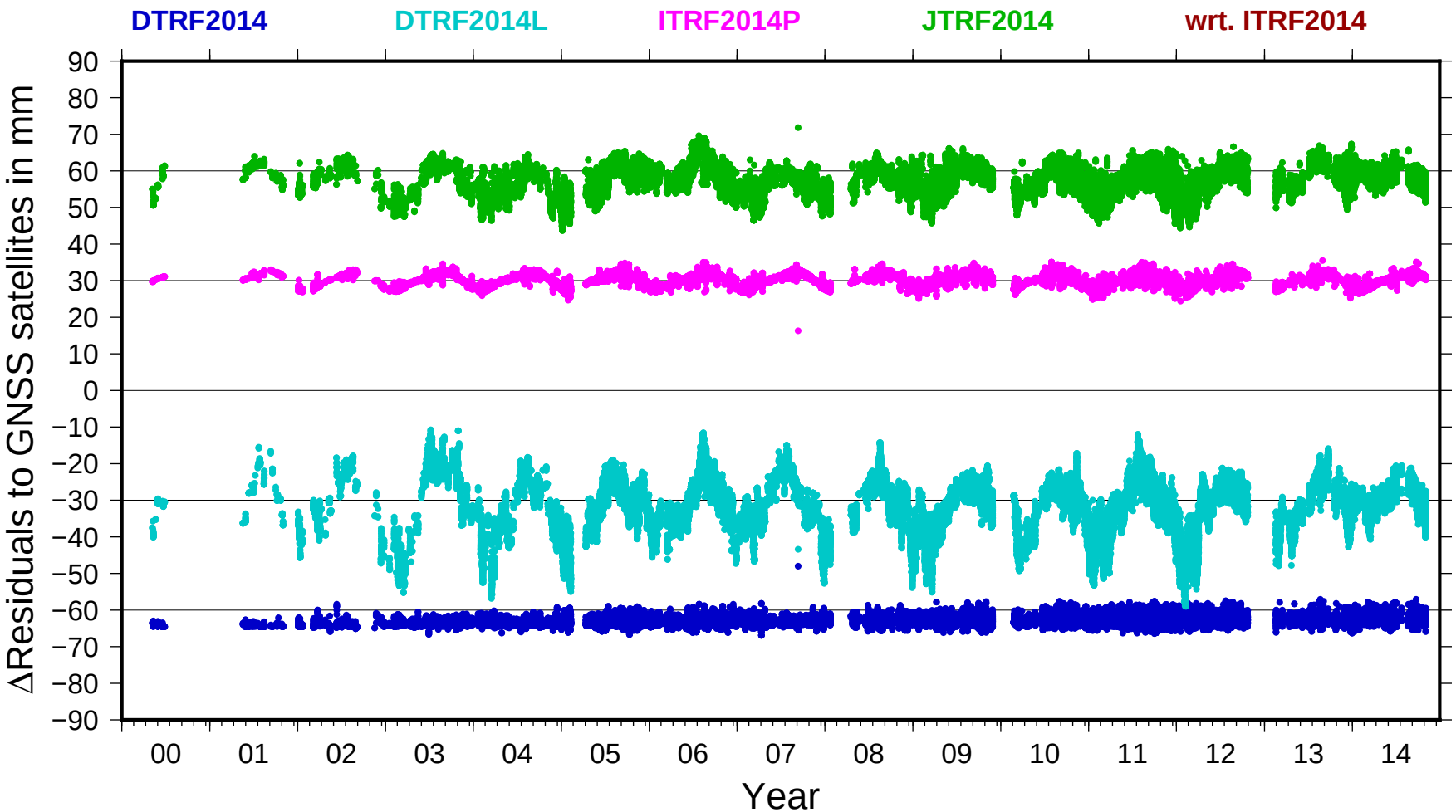
SLR residuals to GNSS satellites per station



a) SLR station: Yarragadee, Australia (number 7090)

The reference ITRF2014 was arbitrary chosen.

SLR residuals to GNSS satellites per station



b) SLR station: Zimmerwald, Switzerland (number 7810)

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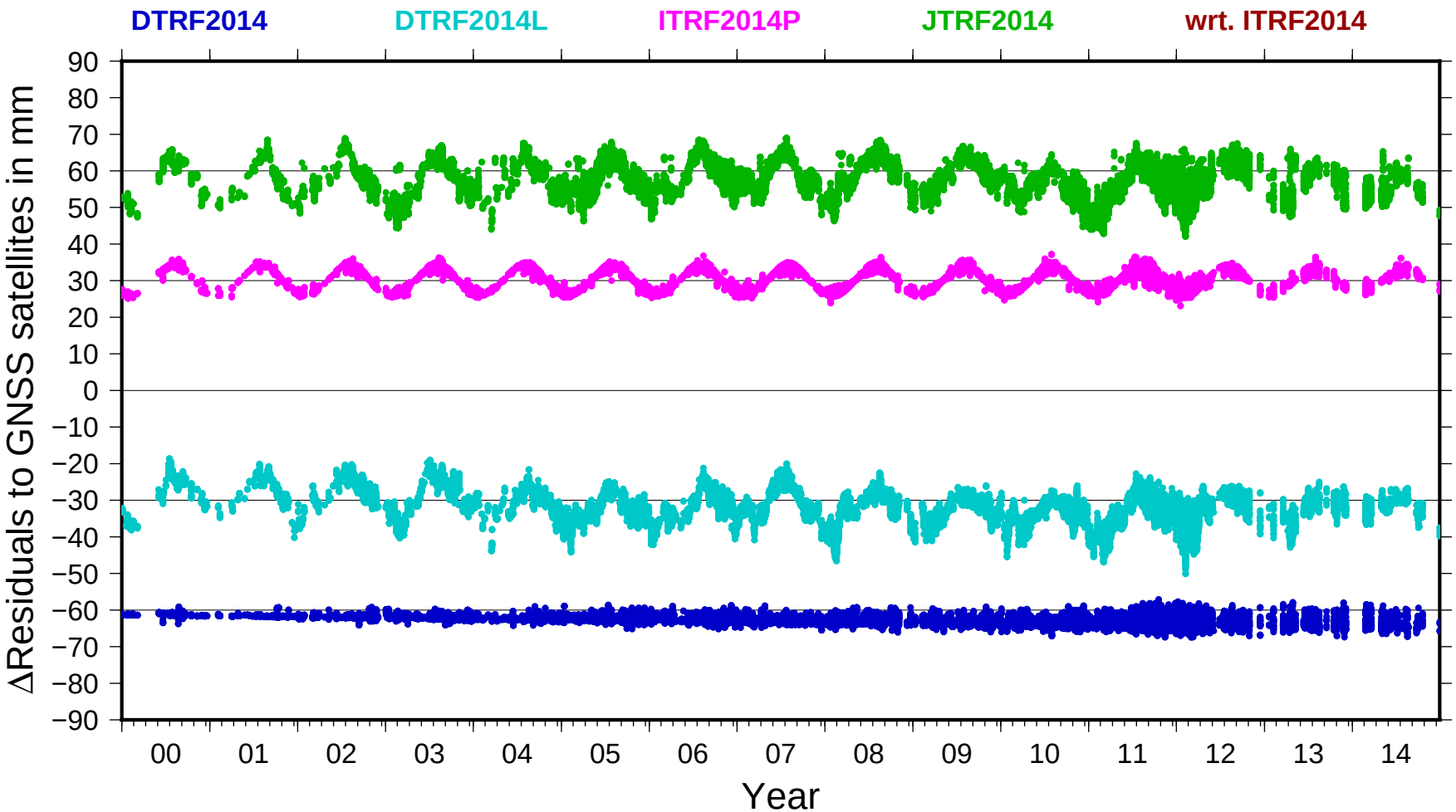
SLR residuals to GNSS satellites per station



c) SLR station: Graz, Austria (number 7839)

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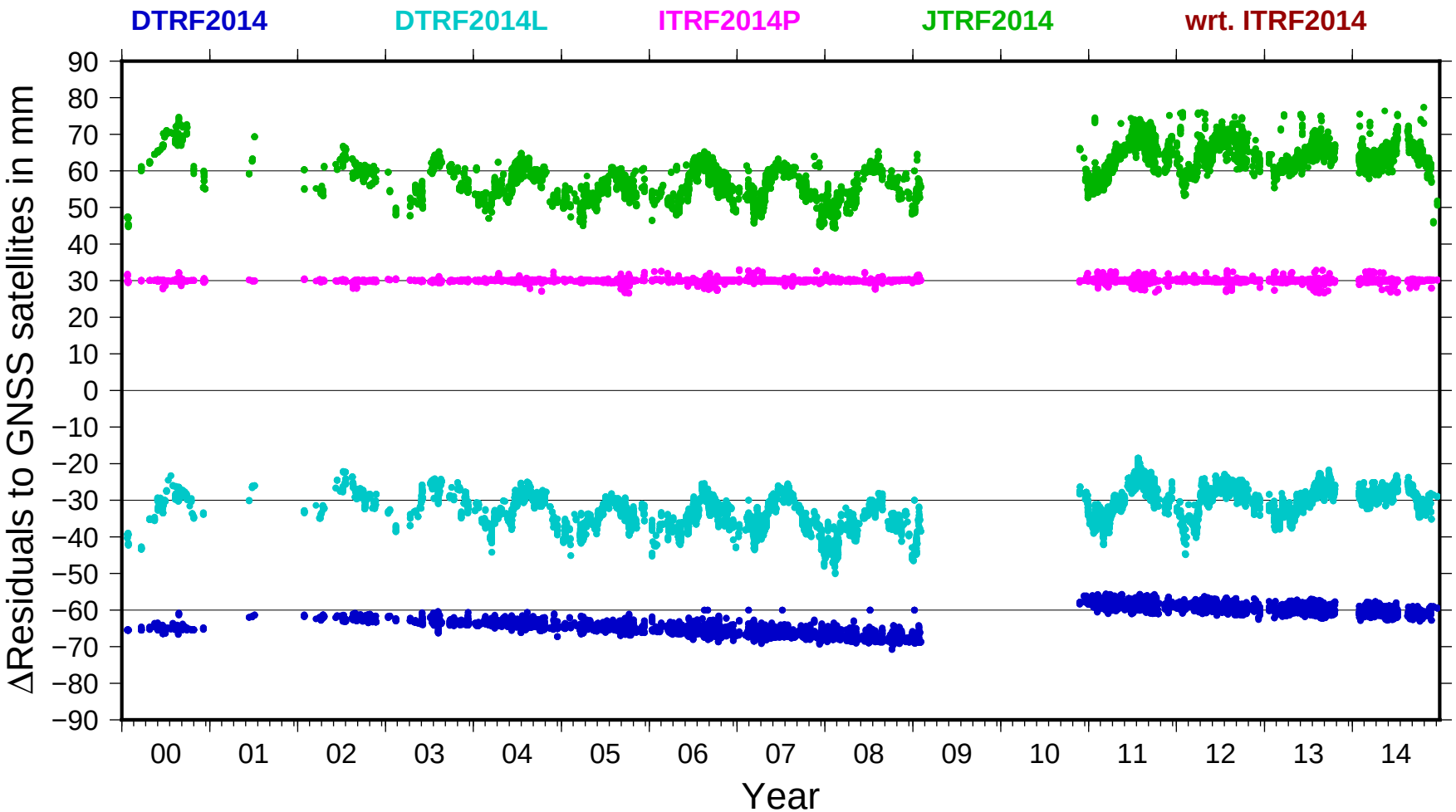
SLR residuals to GNSS satellites per station



d) SLR station: Wettzell, Germany (number 8834)

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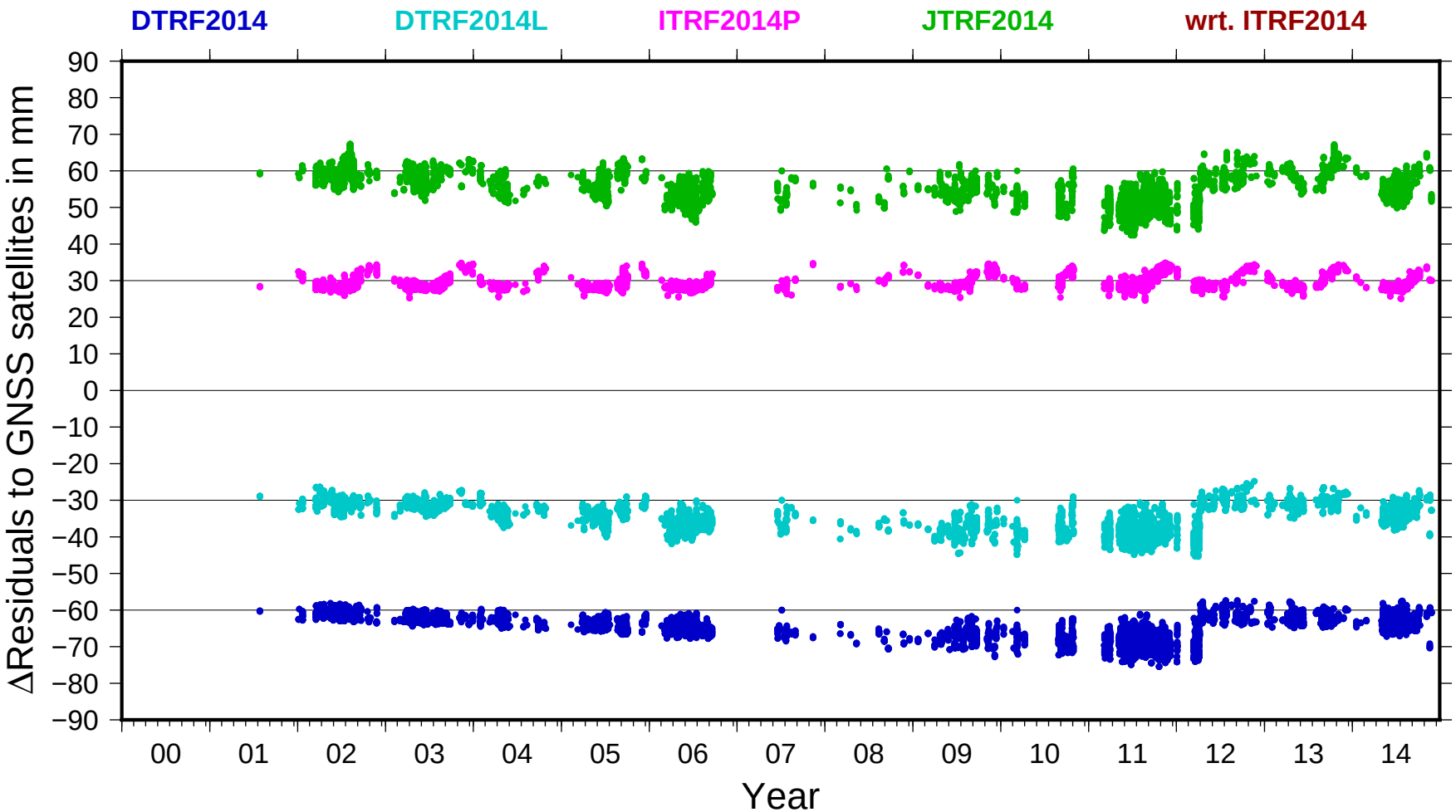
SLR residuals to GNSS satellites per station



e) SLR station: Hartebeesthoek, South Africa (number 7501)

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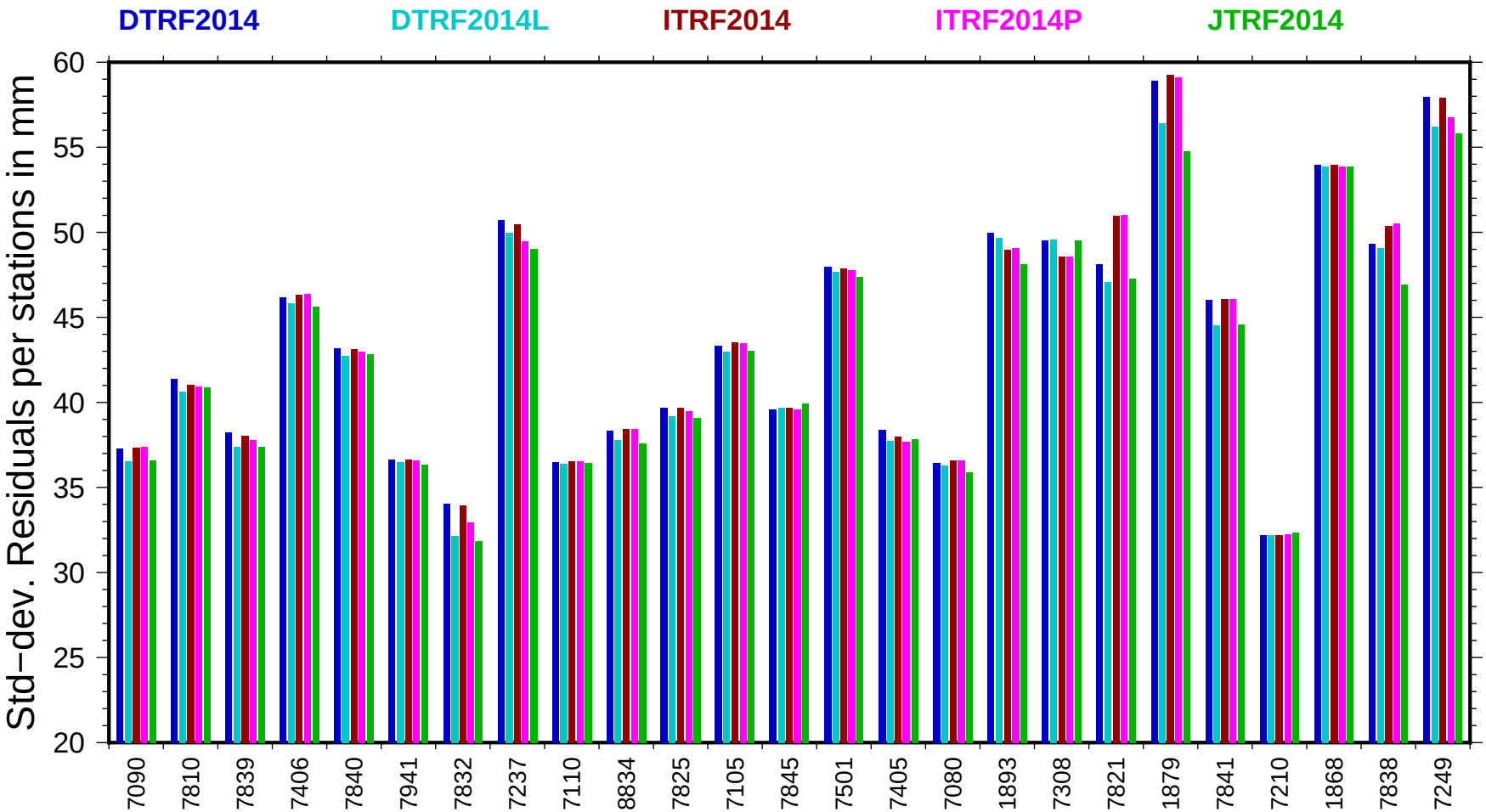
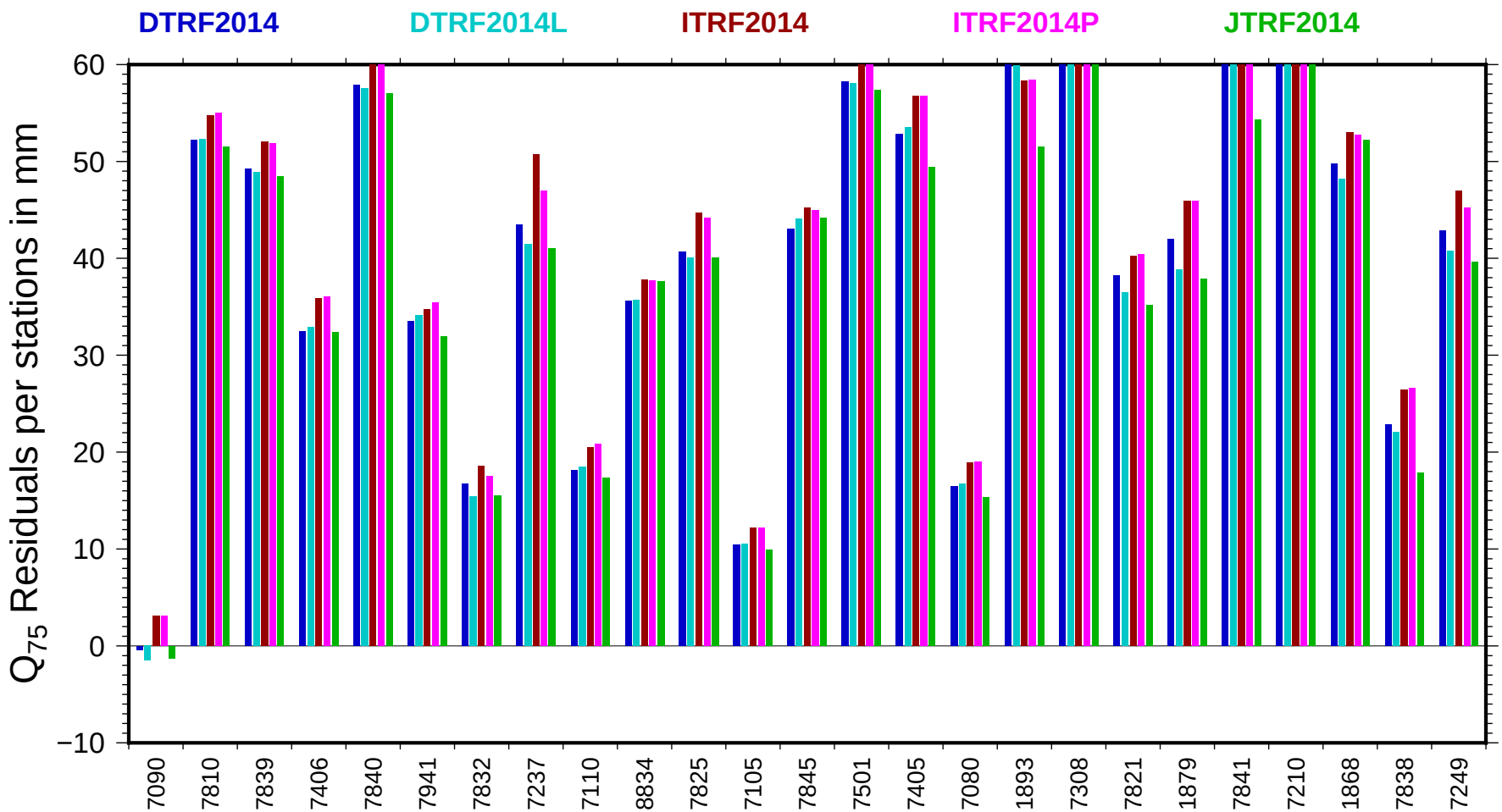
SLR residuals to GNSS satellites per station

Median of all SLR residuals to GNSS satellites



SLR residuals to GNSS satellites per station

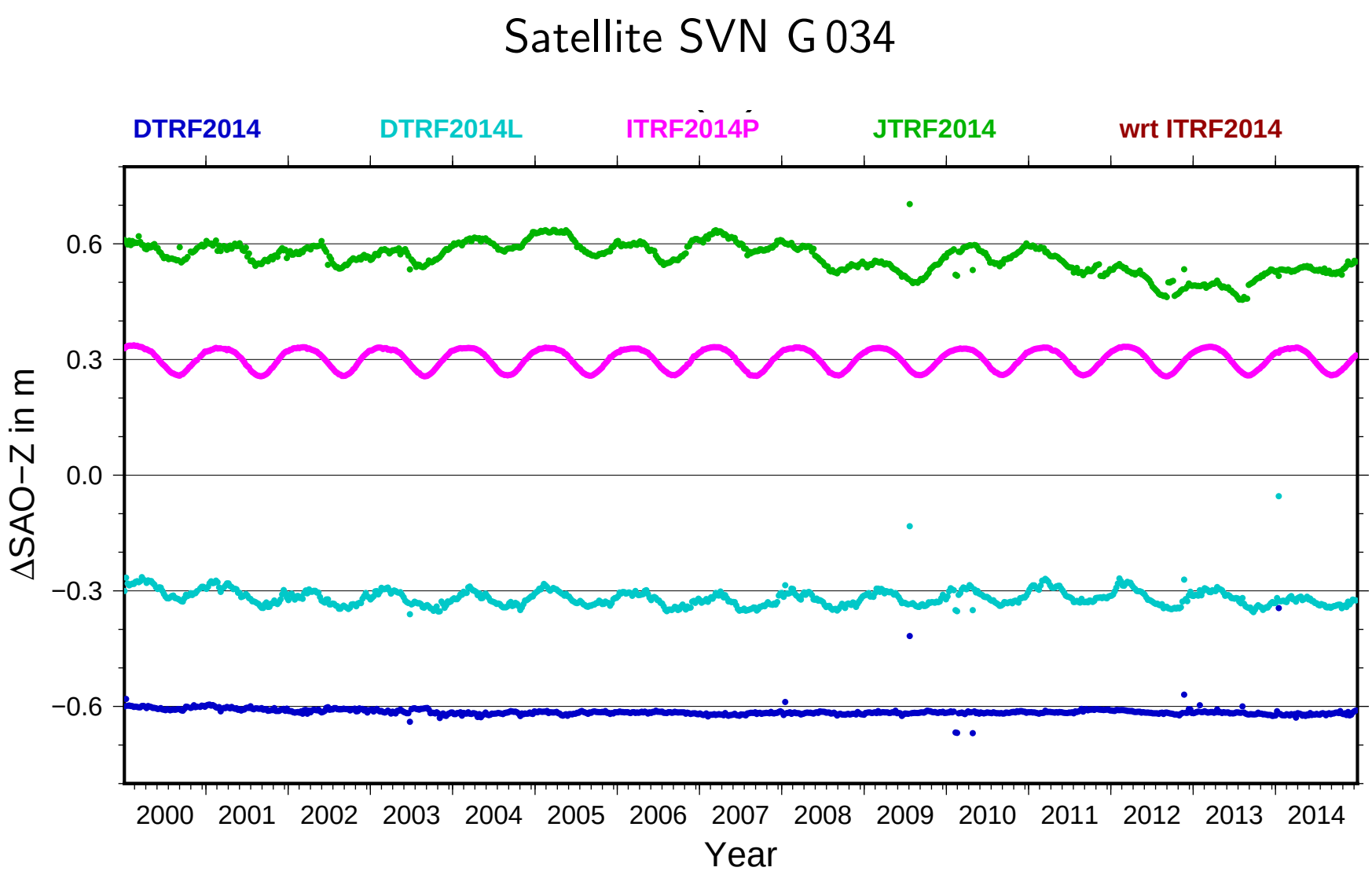
Quantille 75% of all SLR residuals to GNSS satellites



Comparing satellite antenna offsets

- For each solution series a weekly solution was created.
- The verfied set of reference frame coordinates are used for the datum definition that includes even a no scale change condition in order to determine satellite antenna offsets (Z-component only).

Consistency of satellite antenna Z-offsets



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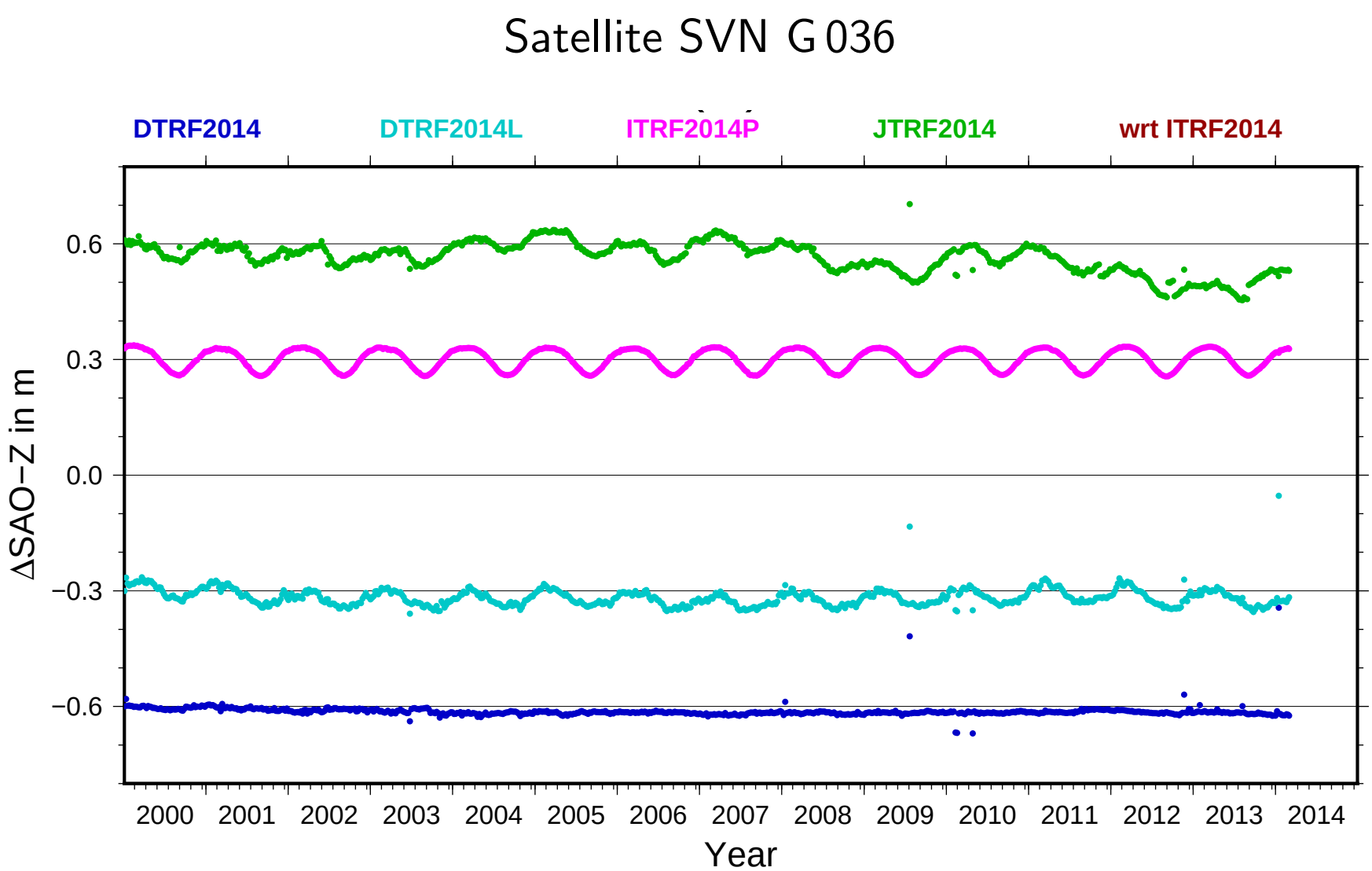

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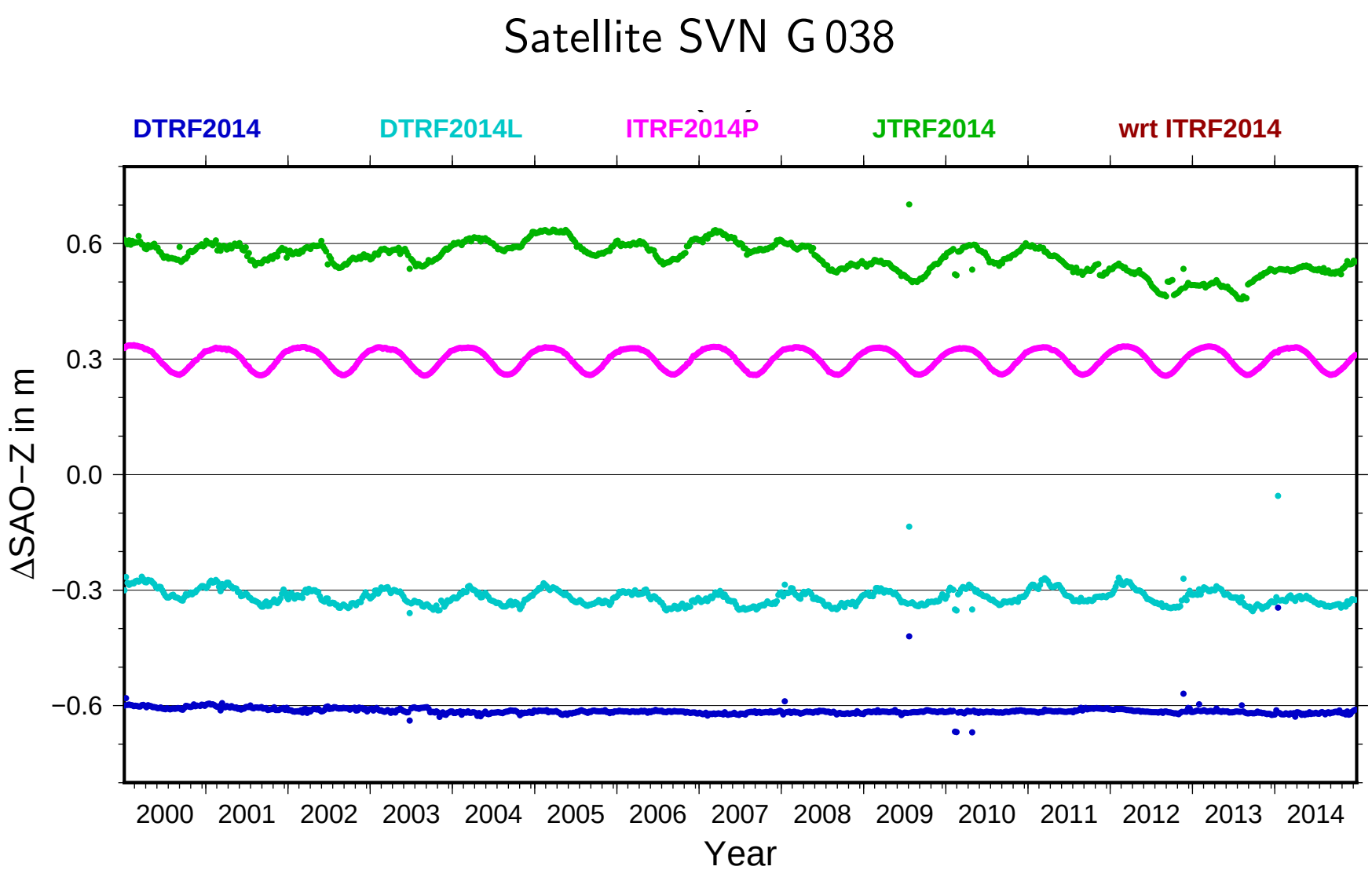

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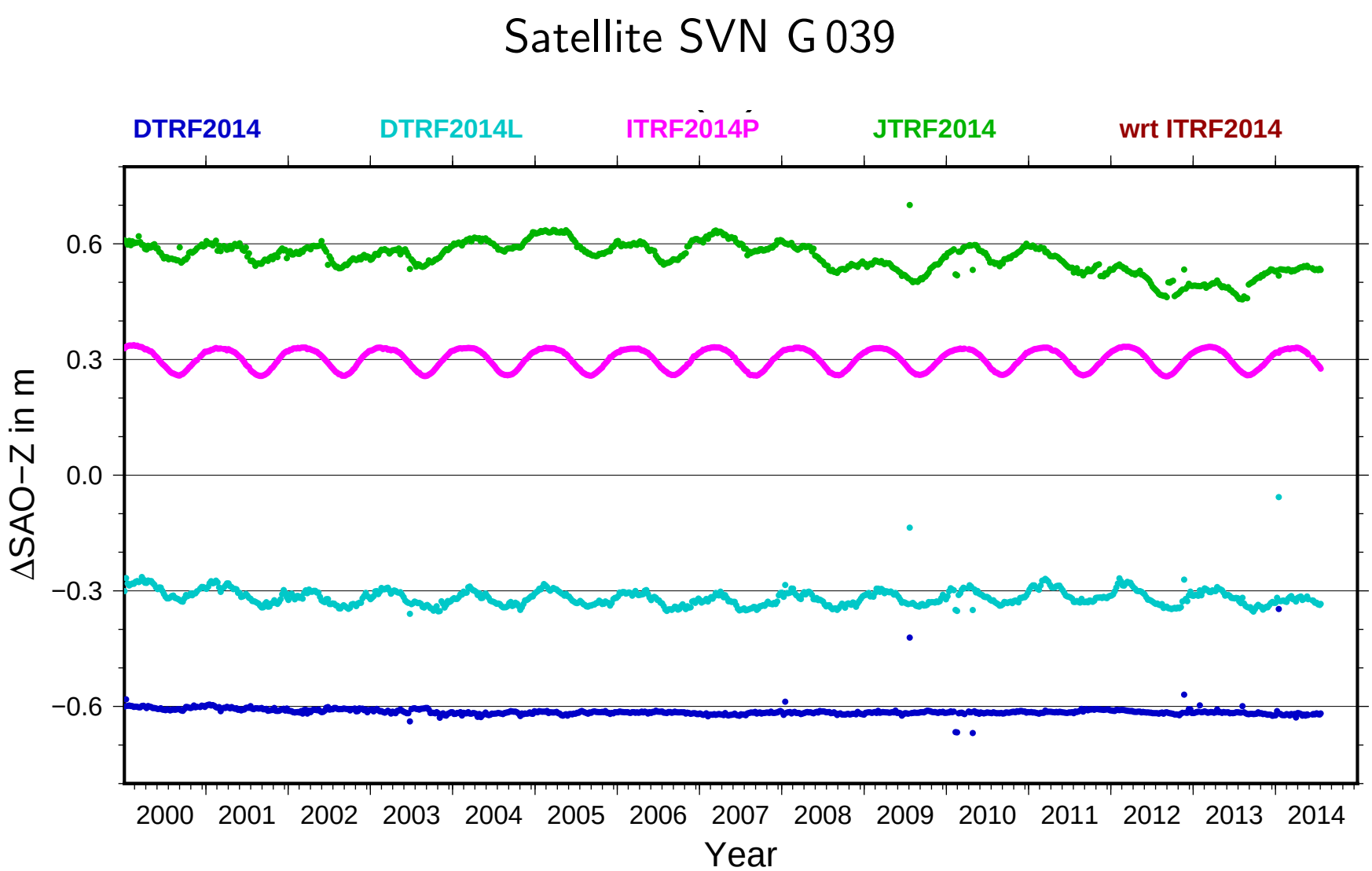

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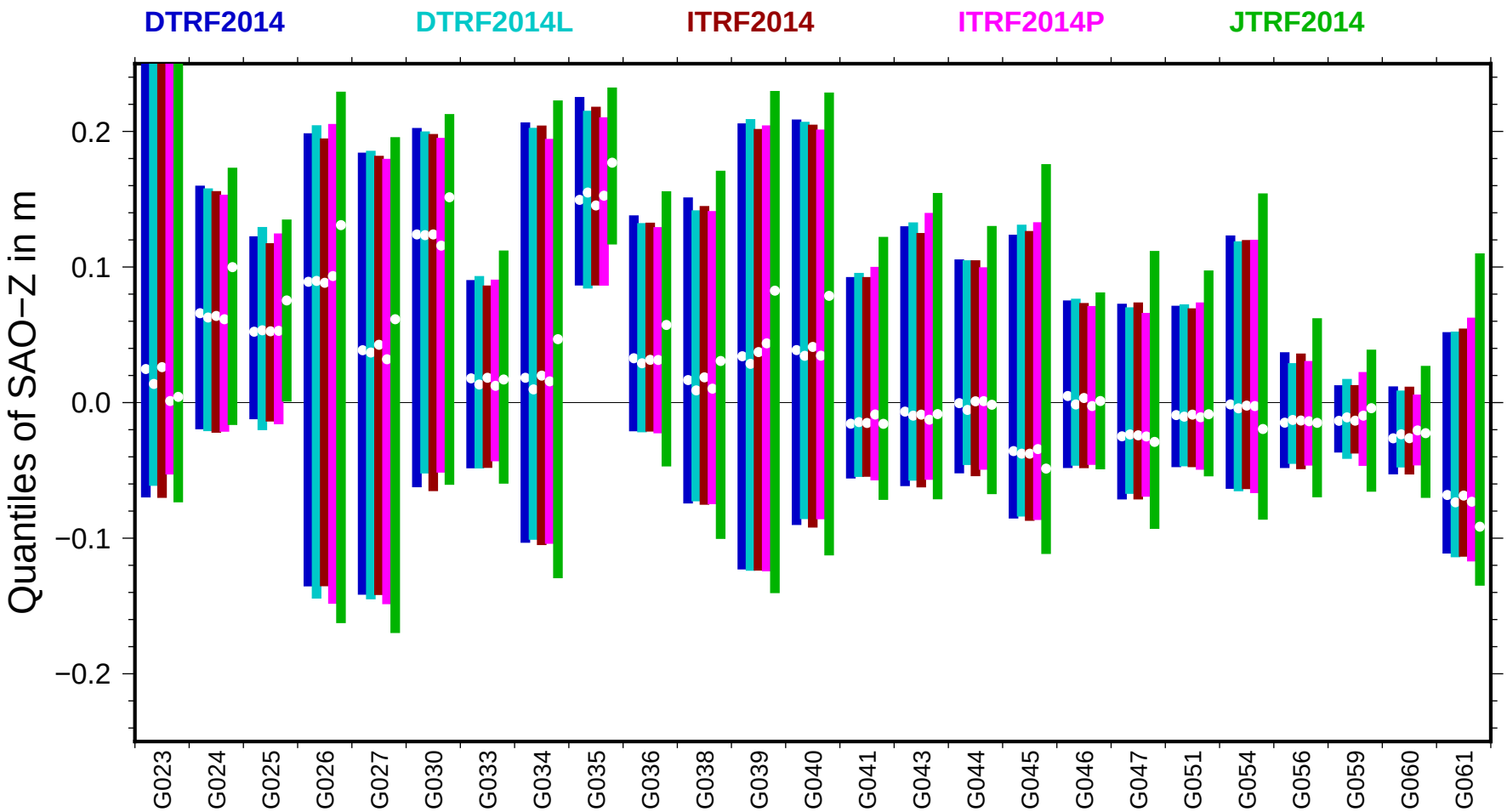
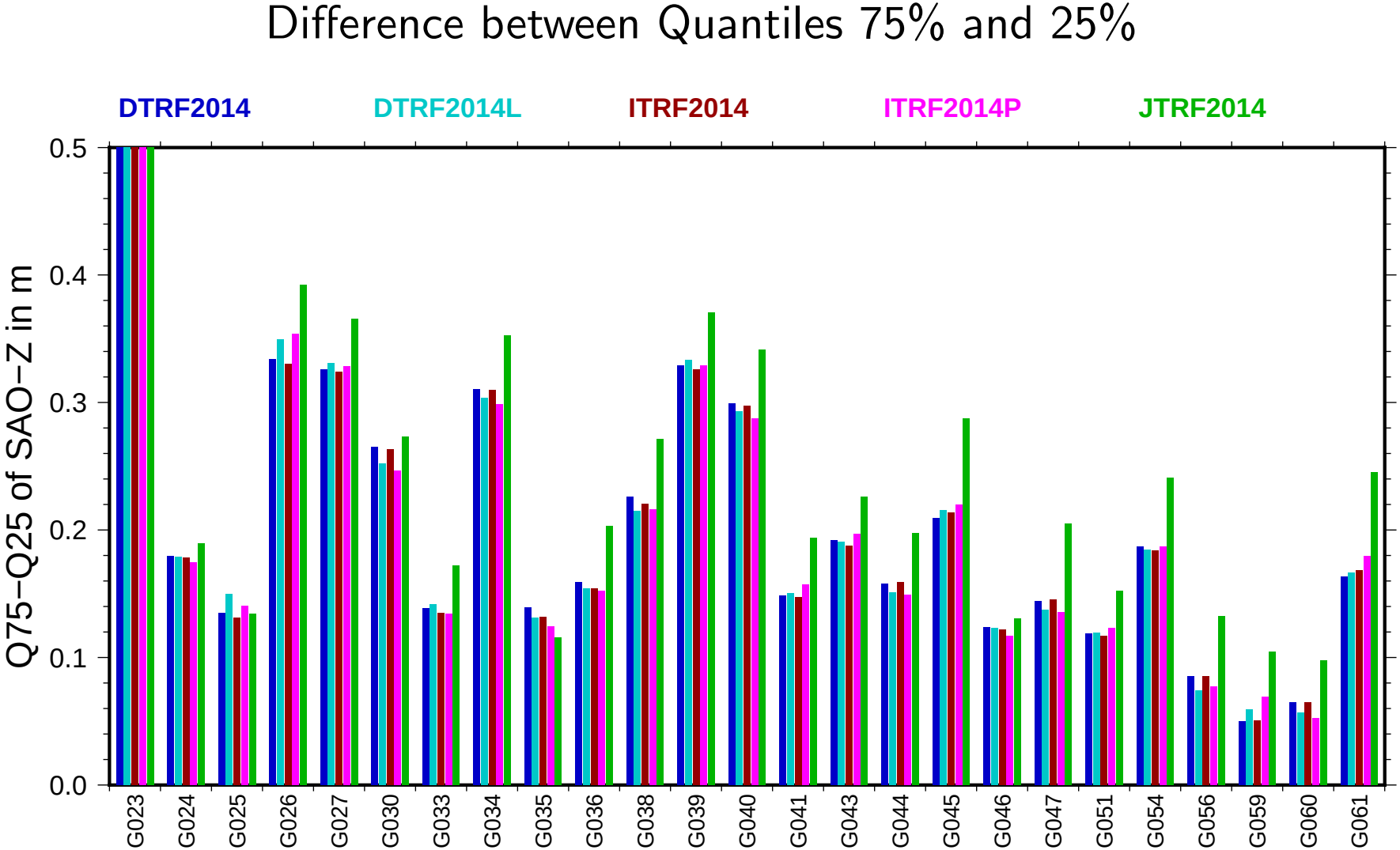
Consistency of satellite antenna Z-offsets

Quantiles 25%, 50% and 75% of the time series



Only satellites with more than 10 years of time series are considered.

Consistency of satellite antenna Z-offsets



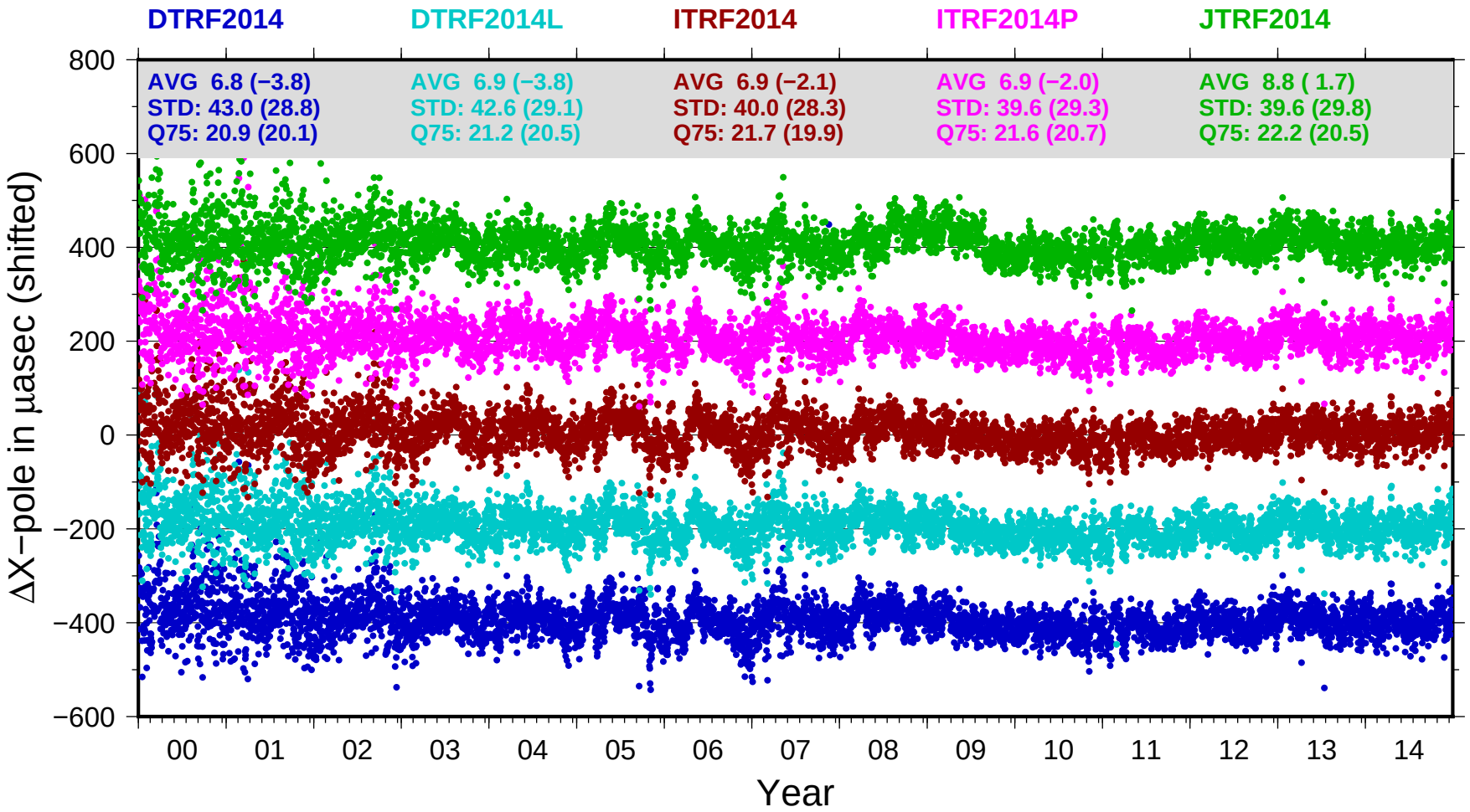
Only satellites with more than 10 years of time series are considered.

Comparing polar motion results

- The polar motion estimates can be compared with the values provided within the respective reference frame solution in order to obtain a measure for the self-consistency.

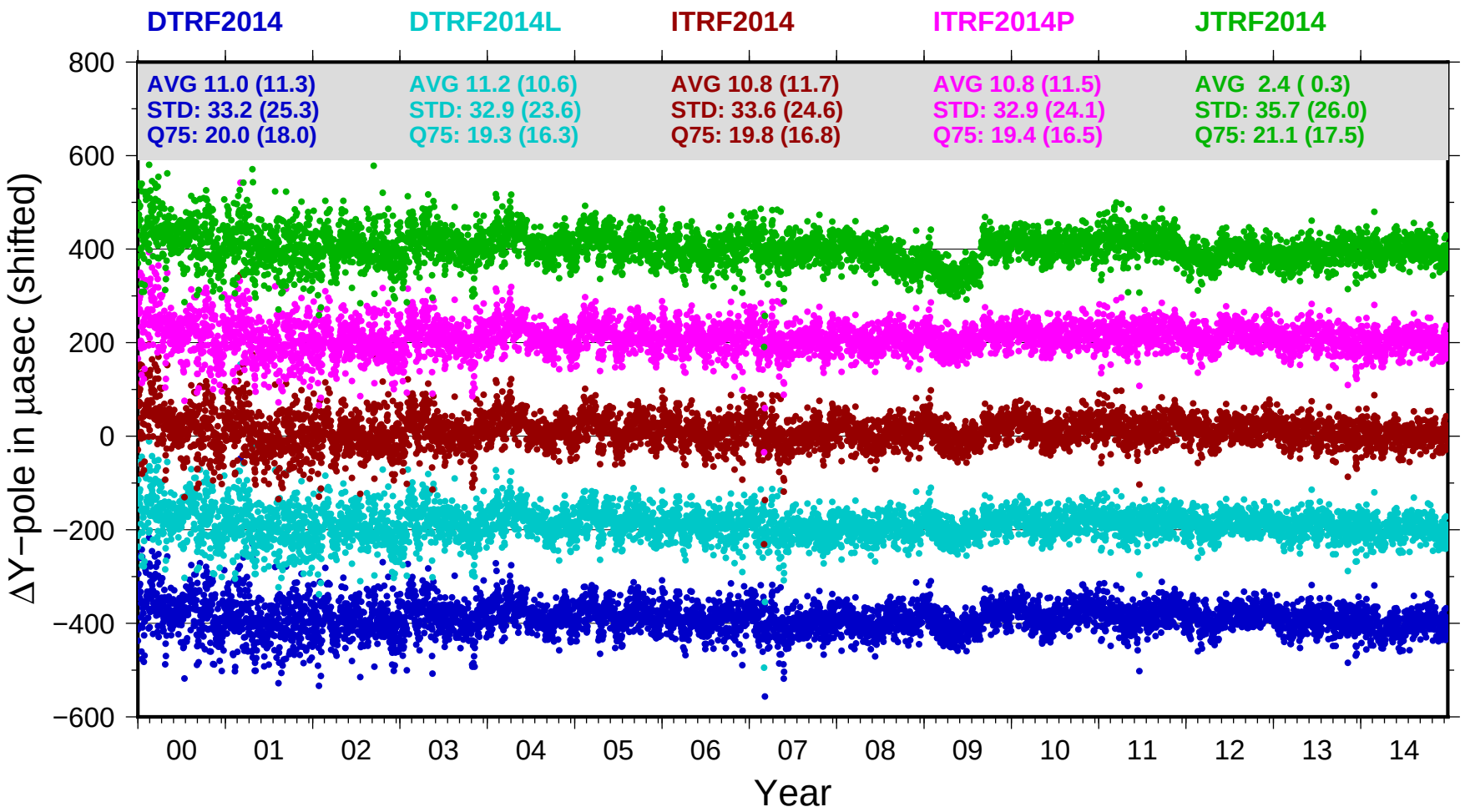
- The polar motion estimates can of course also be directly compared to each other in order to detect differences due to the orientation (stability) of the reference frame solutions.

Consistency of ERP series



Number in brackets are computed from the time interval from epoch 2010.0 onwards.

Consistency of ERP series



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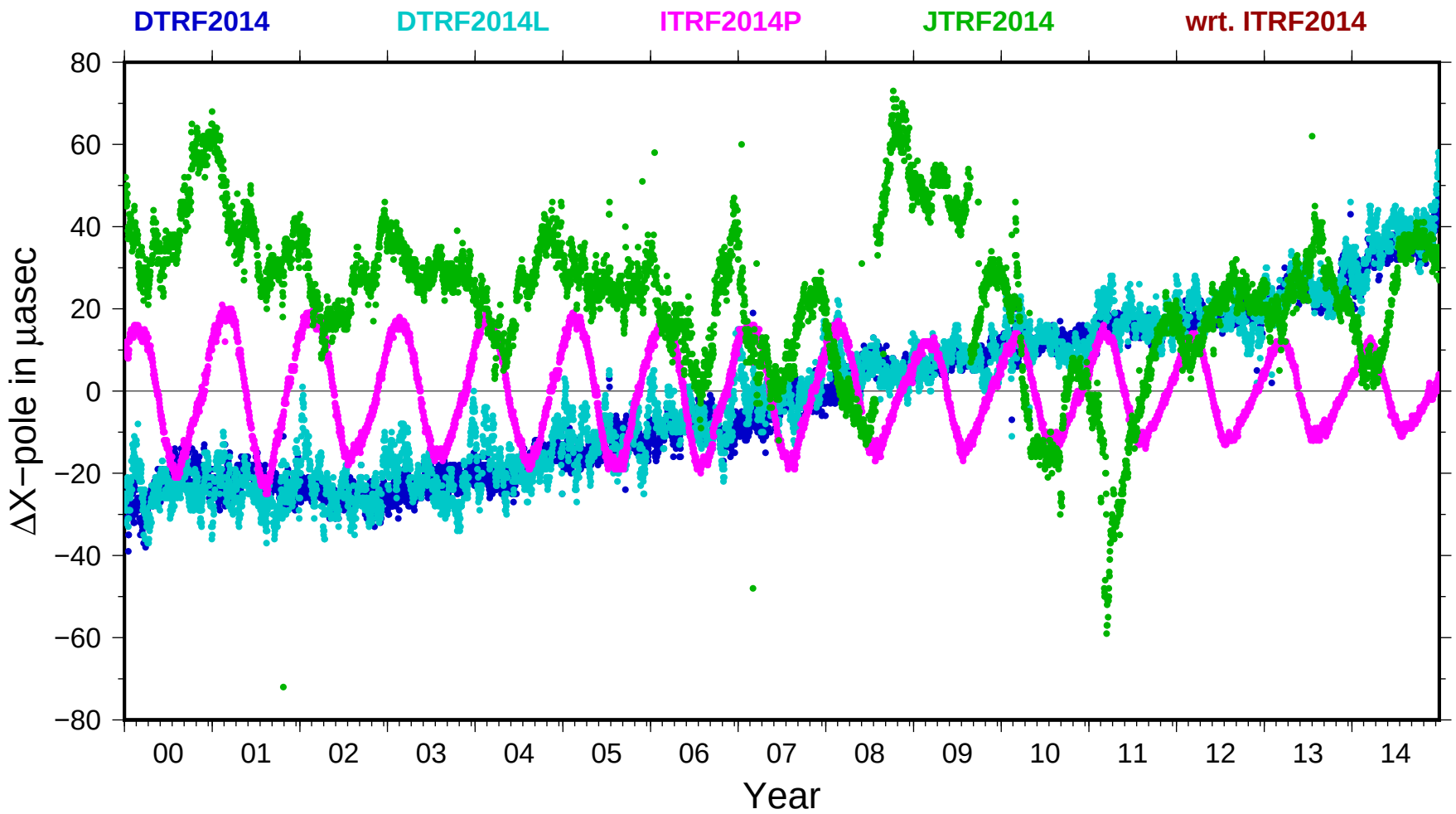

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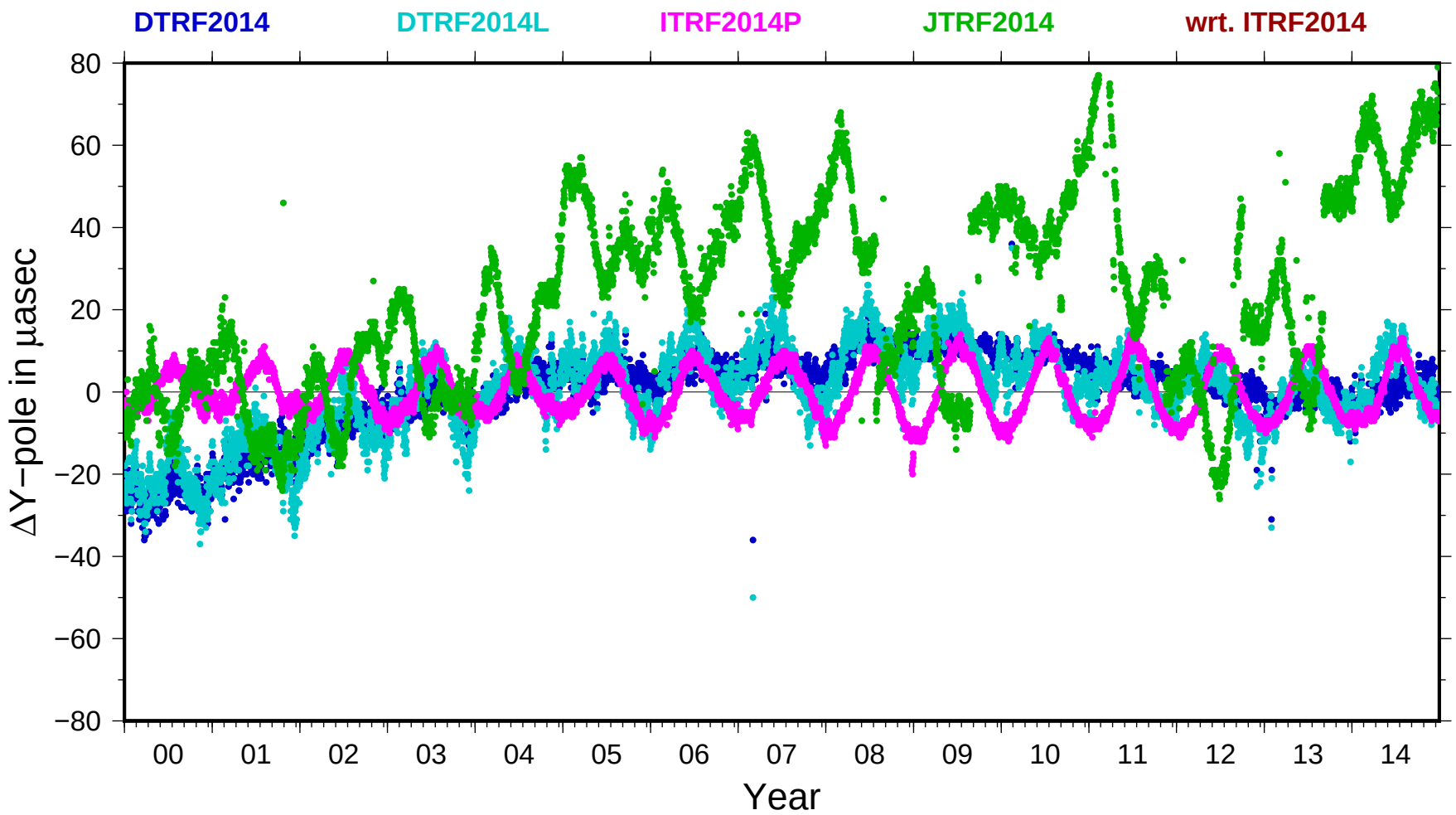

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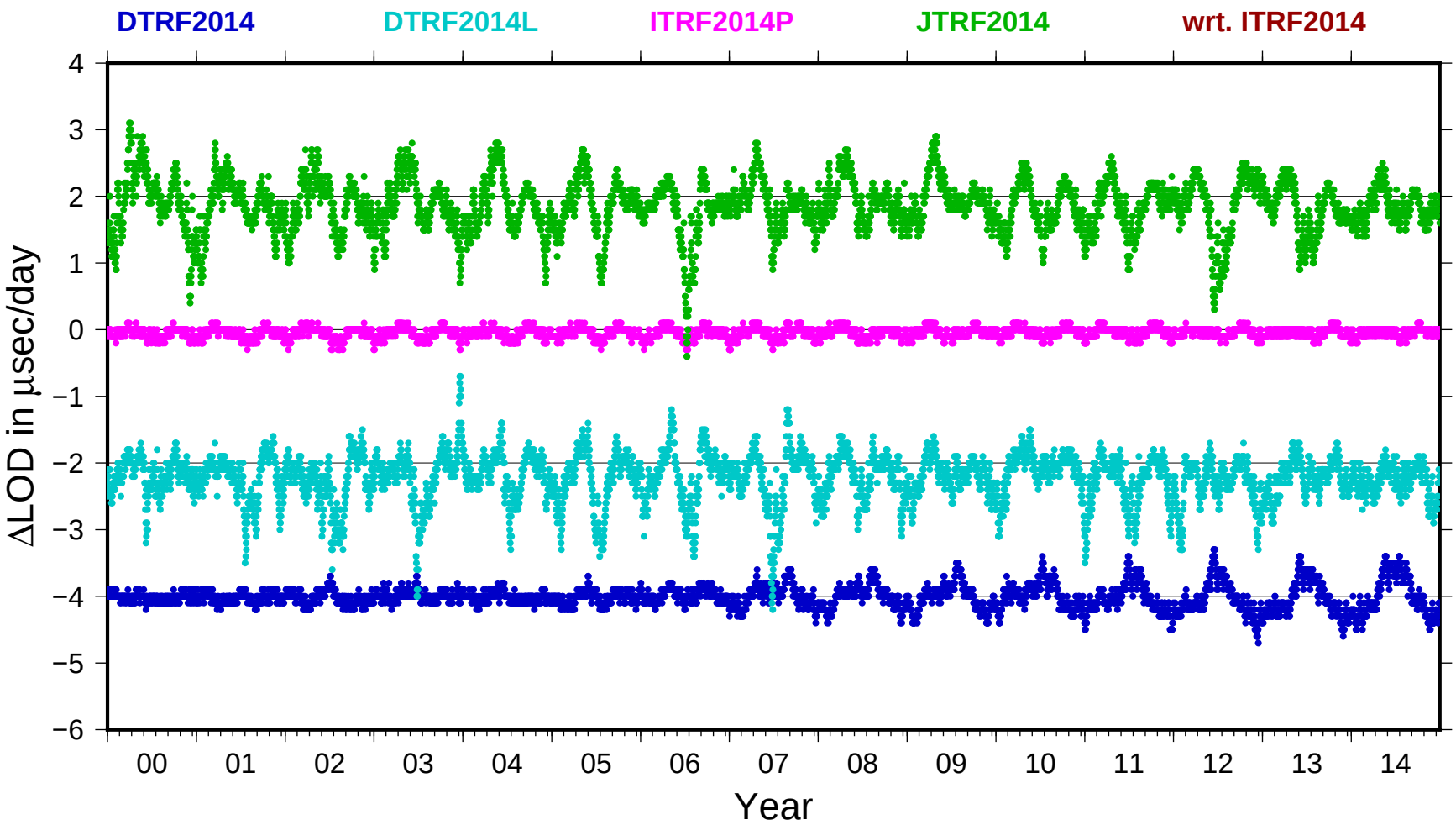

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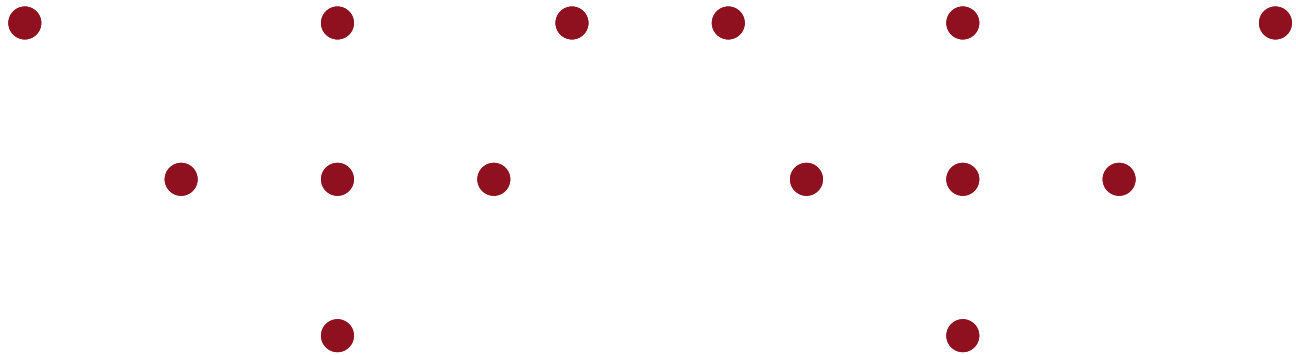
Evaluating the long-term stability



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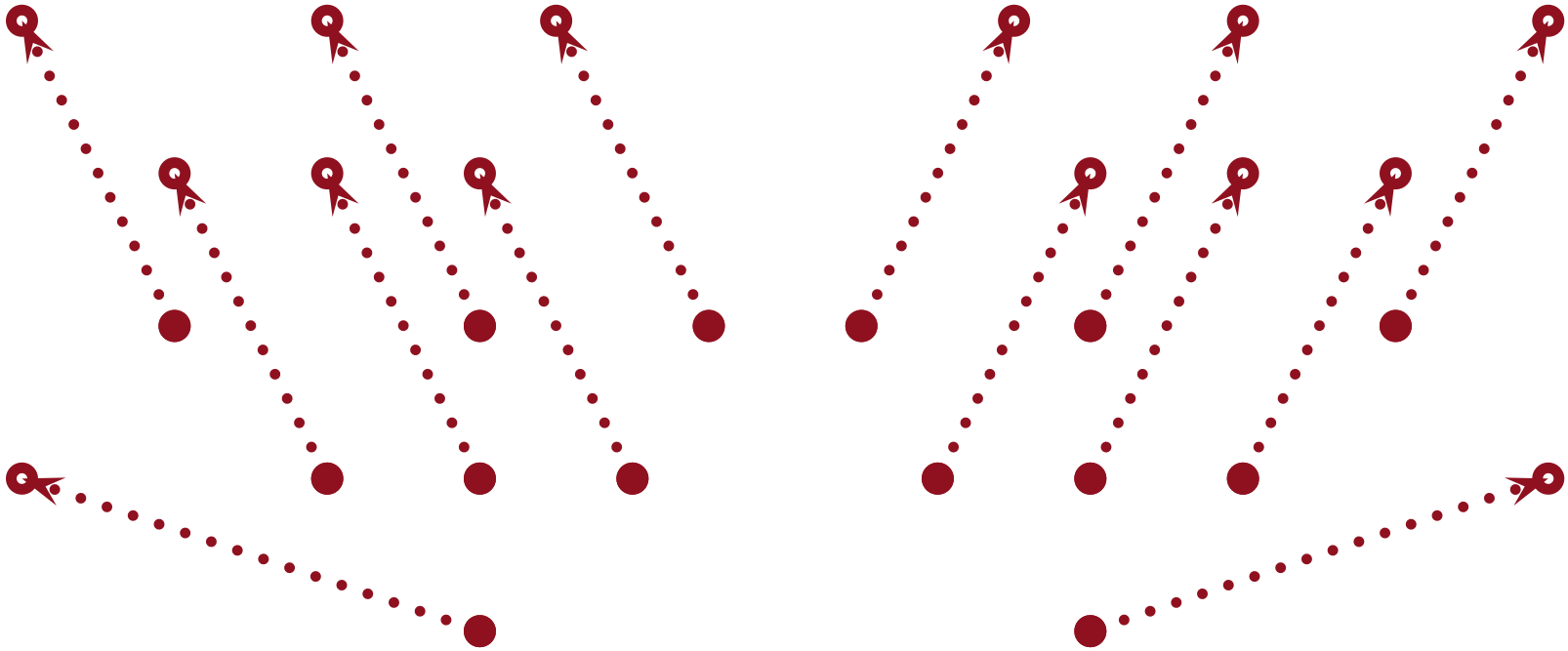

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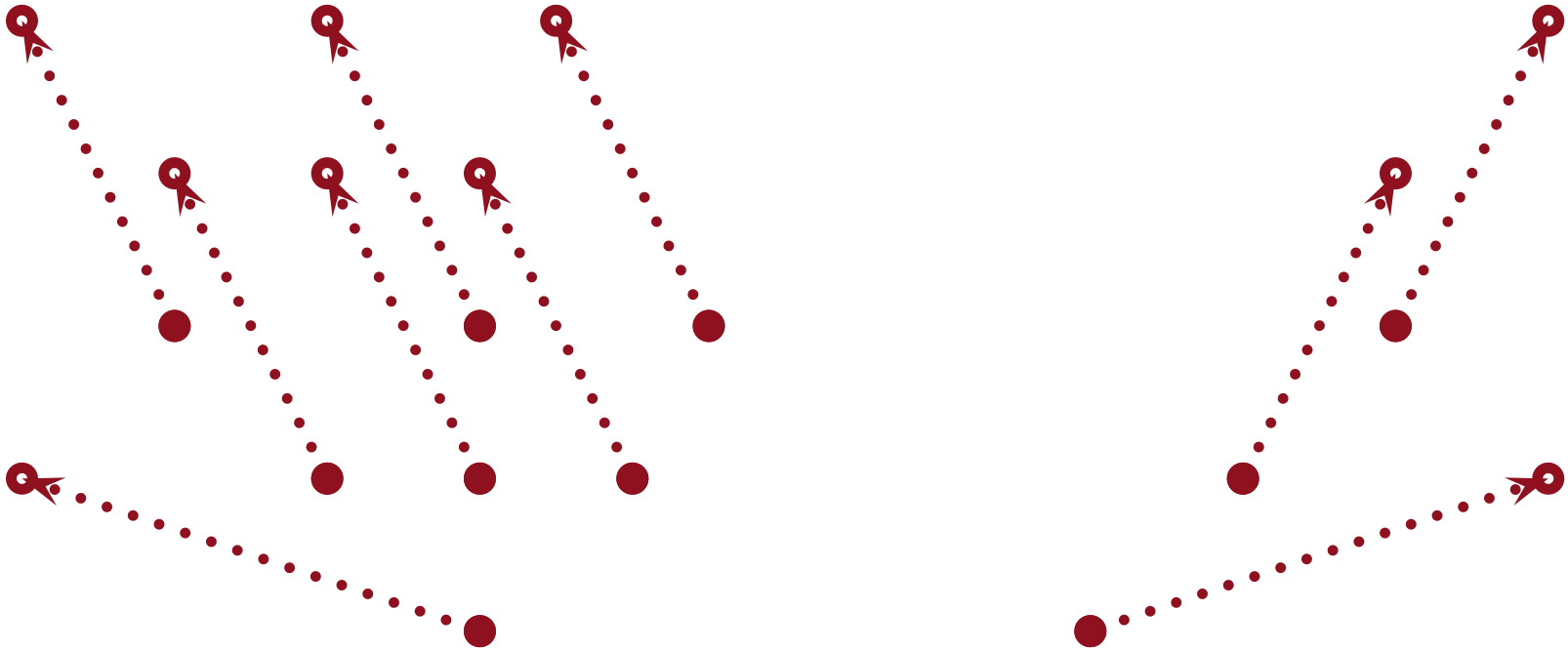

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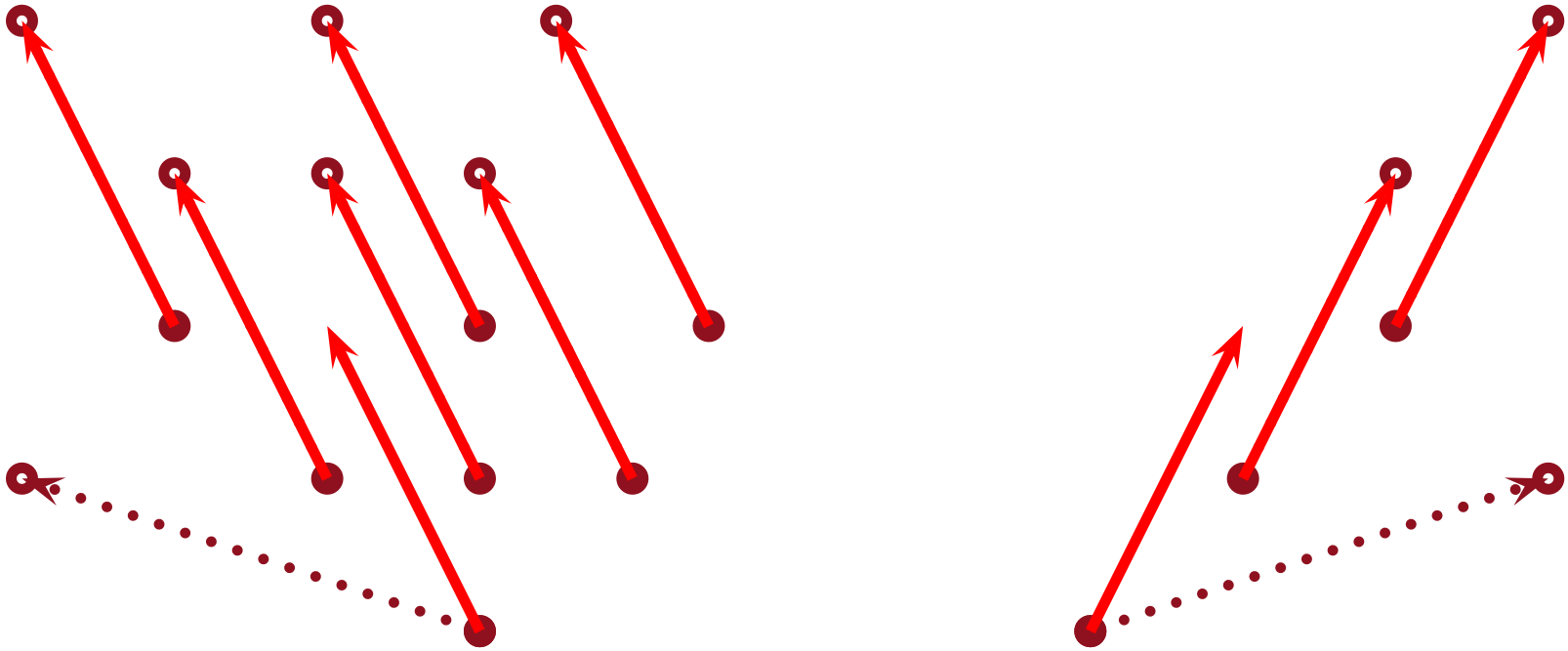

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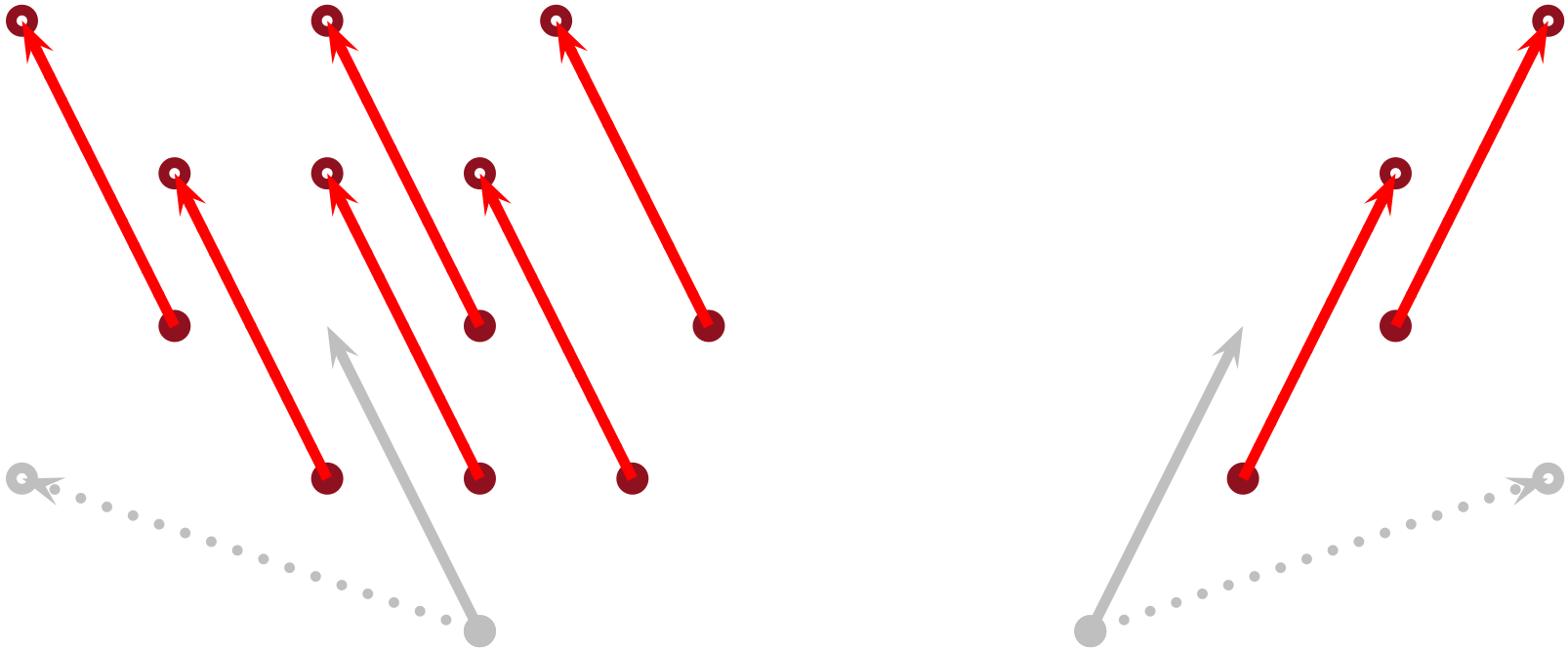

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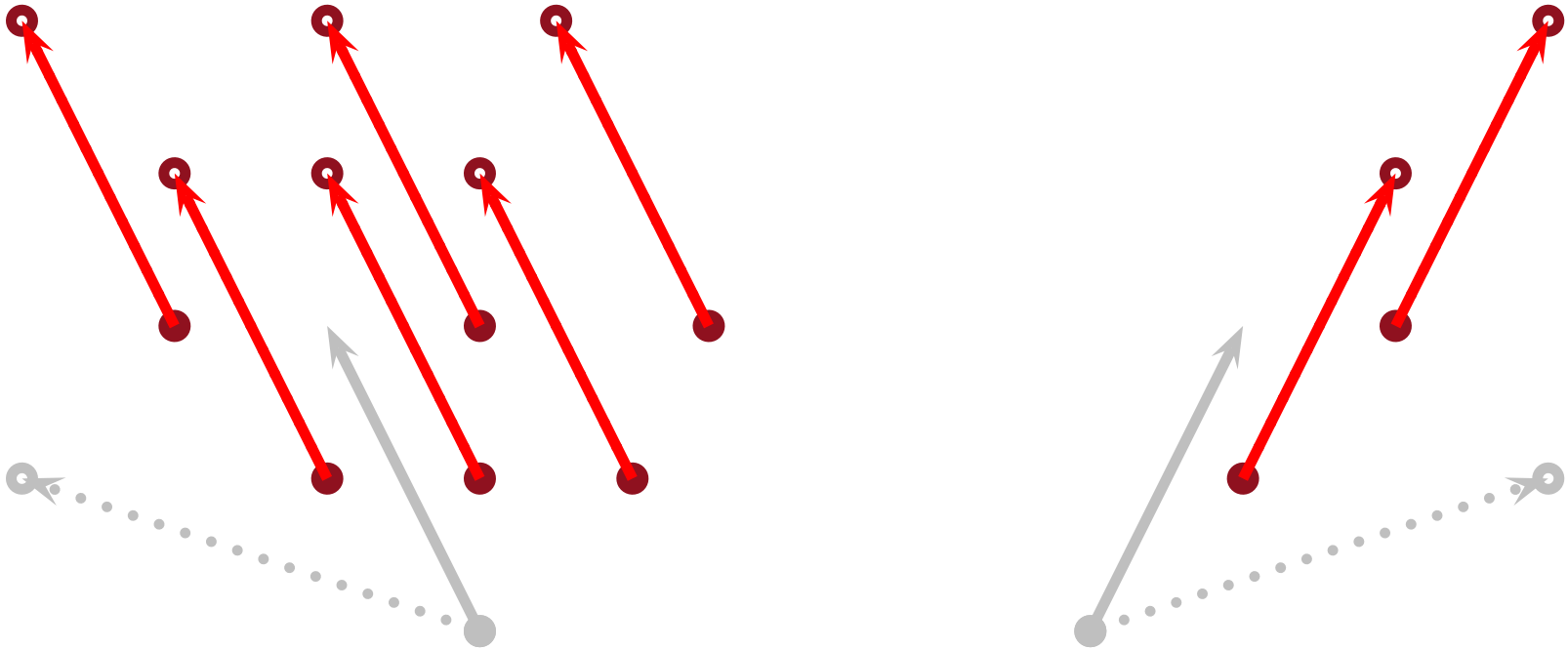

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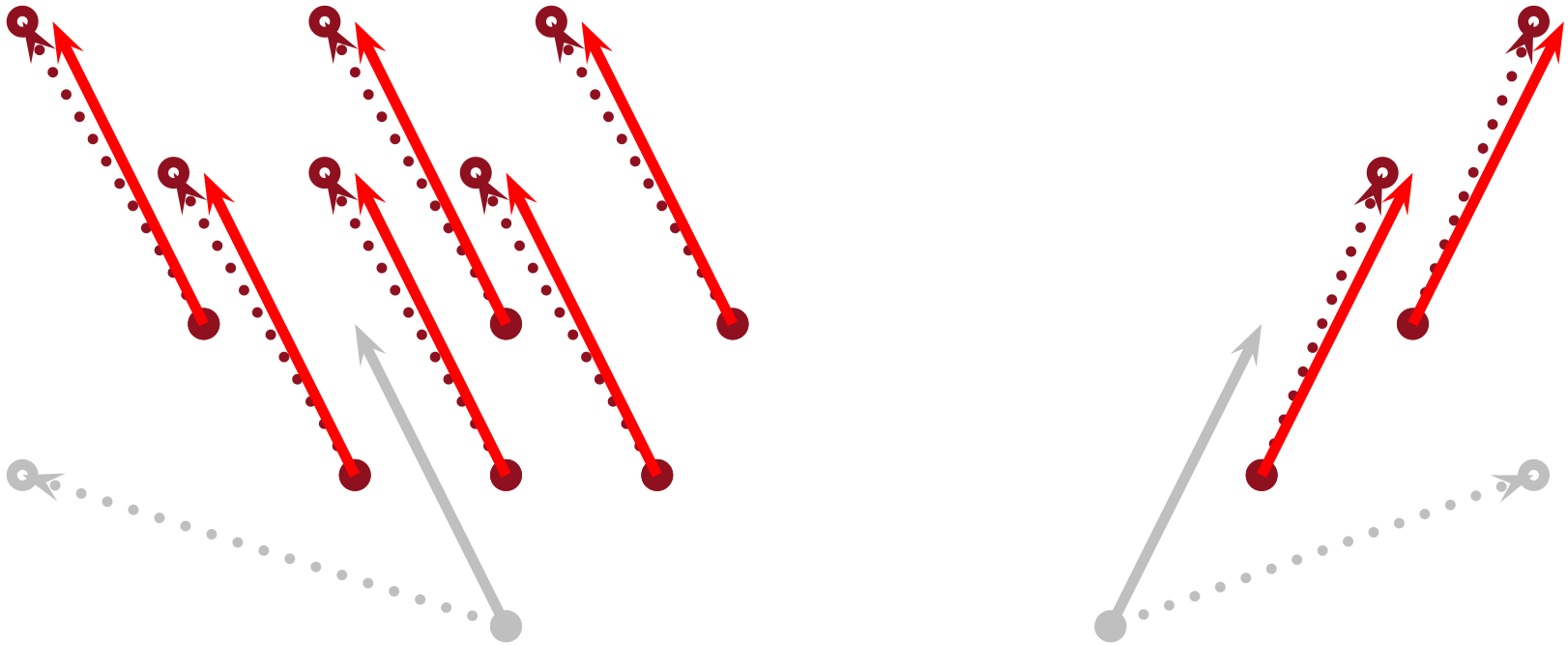

- The NNR-Nuvel1A model is assumed to be free of rotations.
- The there are no rotations the reference frame solution wrt. the NNR vector field it is supposed to be a NNR-reference frame solution.
- The there are constant rotations thee NNR condition either in the reference frame solution or in the NNR-Nuvel1A model is not sattisfied.

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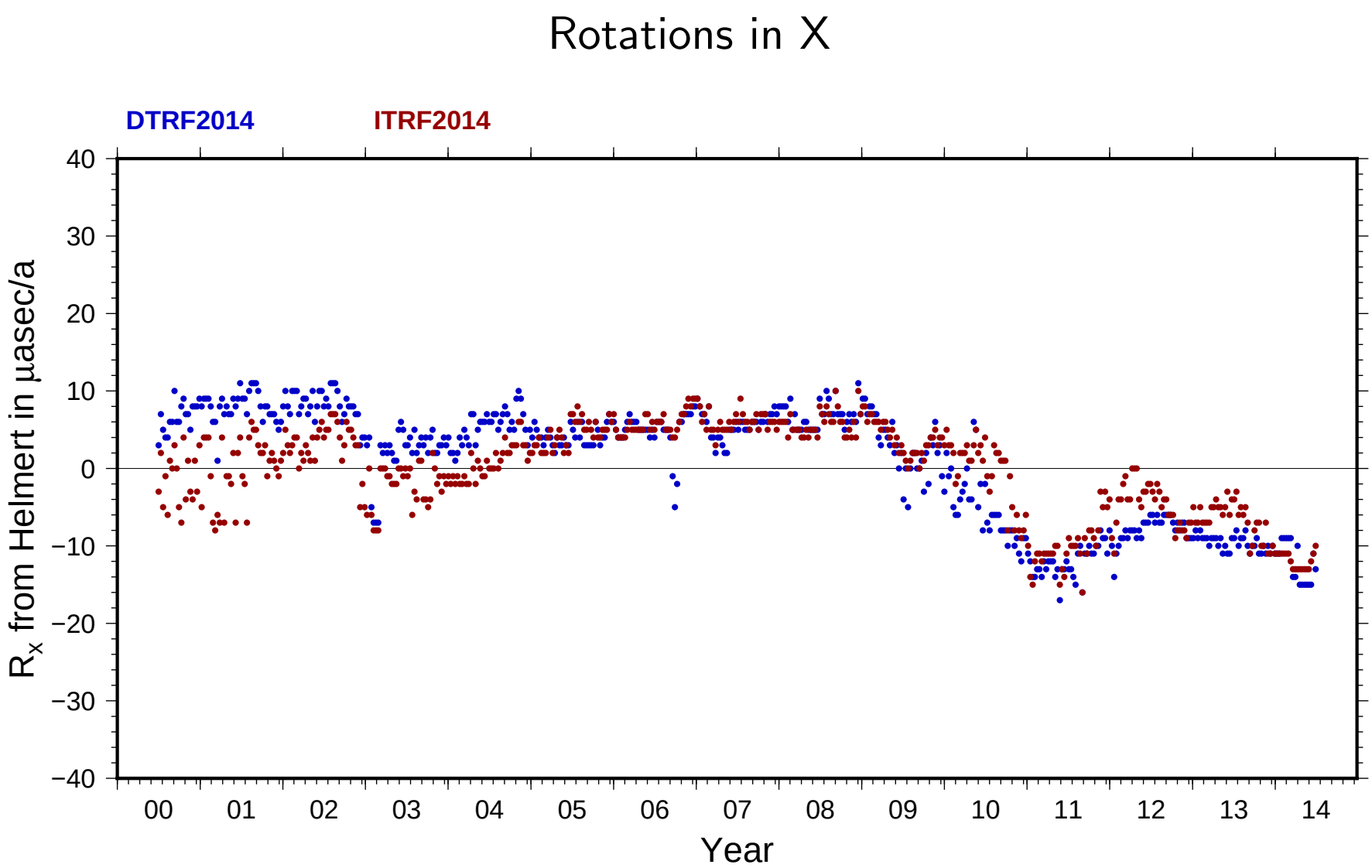

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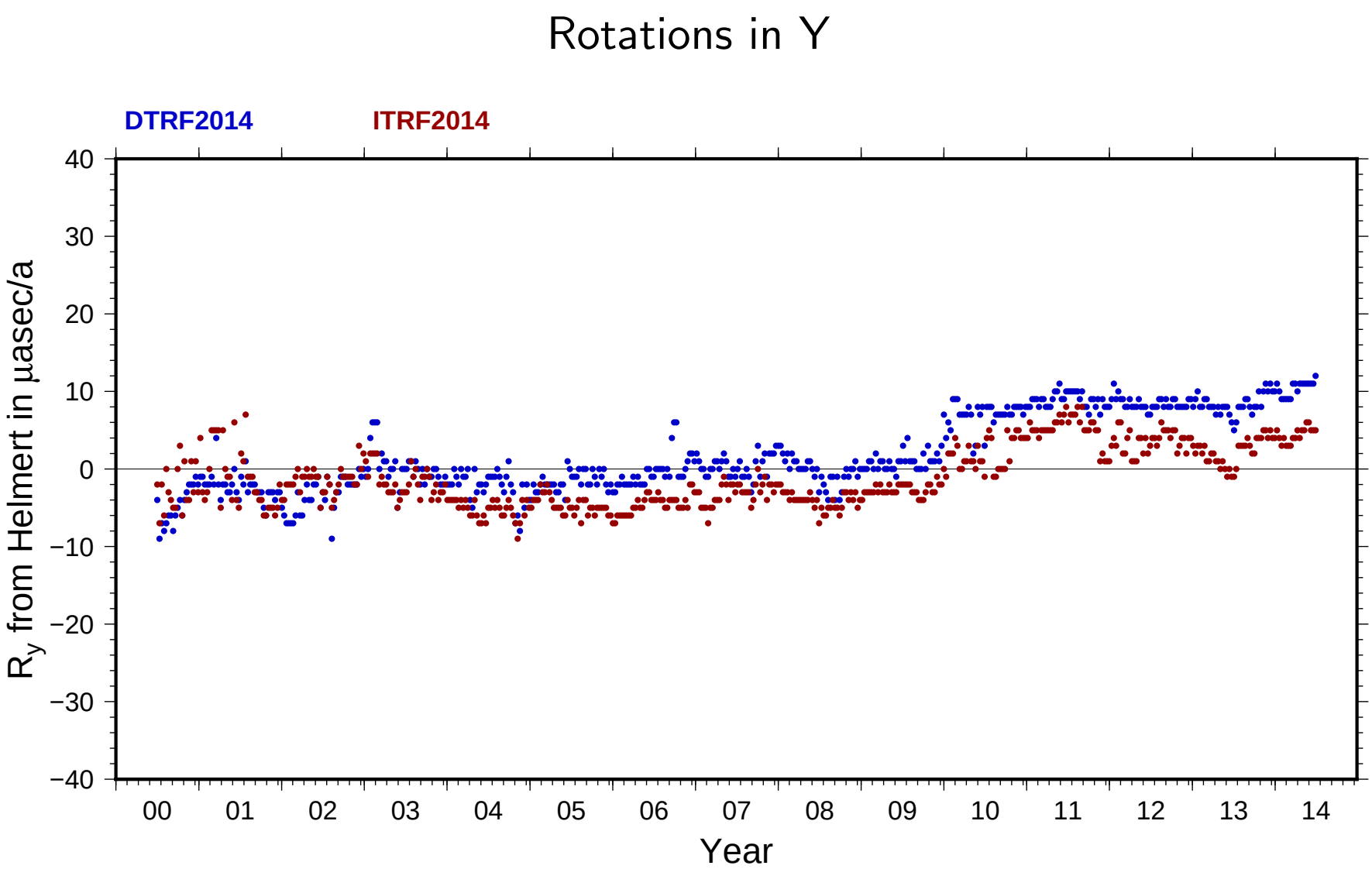

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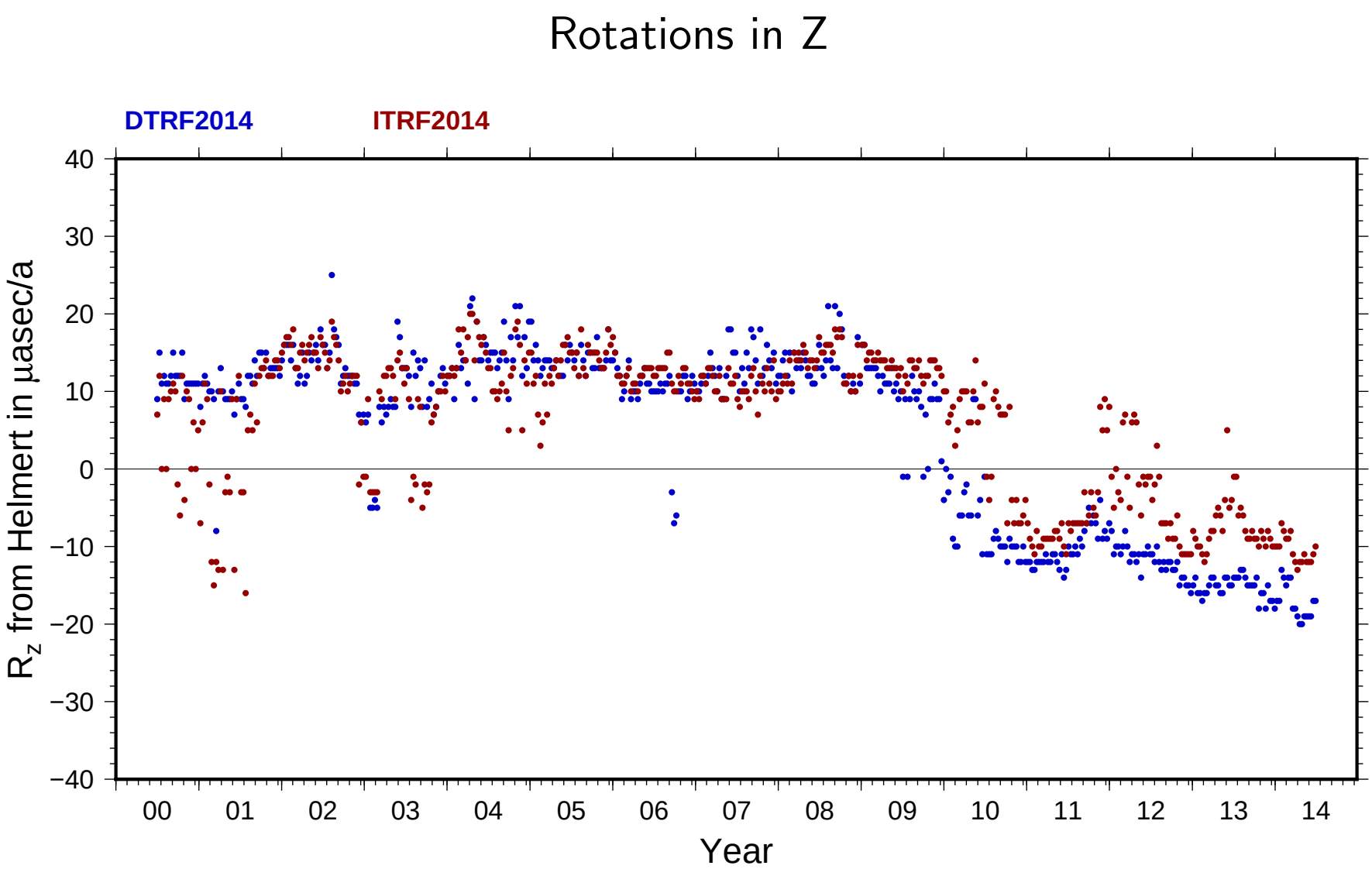

Acknowledgment

We are grateful to the groups providing their reference frame solutions and accomplishing information used for this evaluation study, namely

- Z. Altamimi (IGN, France),
- C. Abbondanza (JPL, USA) as well as
- M. Bloßfeld and M. Seitz (DGFI-TUM, Germany).

THANK YOU
for your attention

Publications of the satellite geodesy research group:

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

xTRF2014 Solution Characterization

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  DOGS-CS: combination of normal equations

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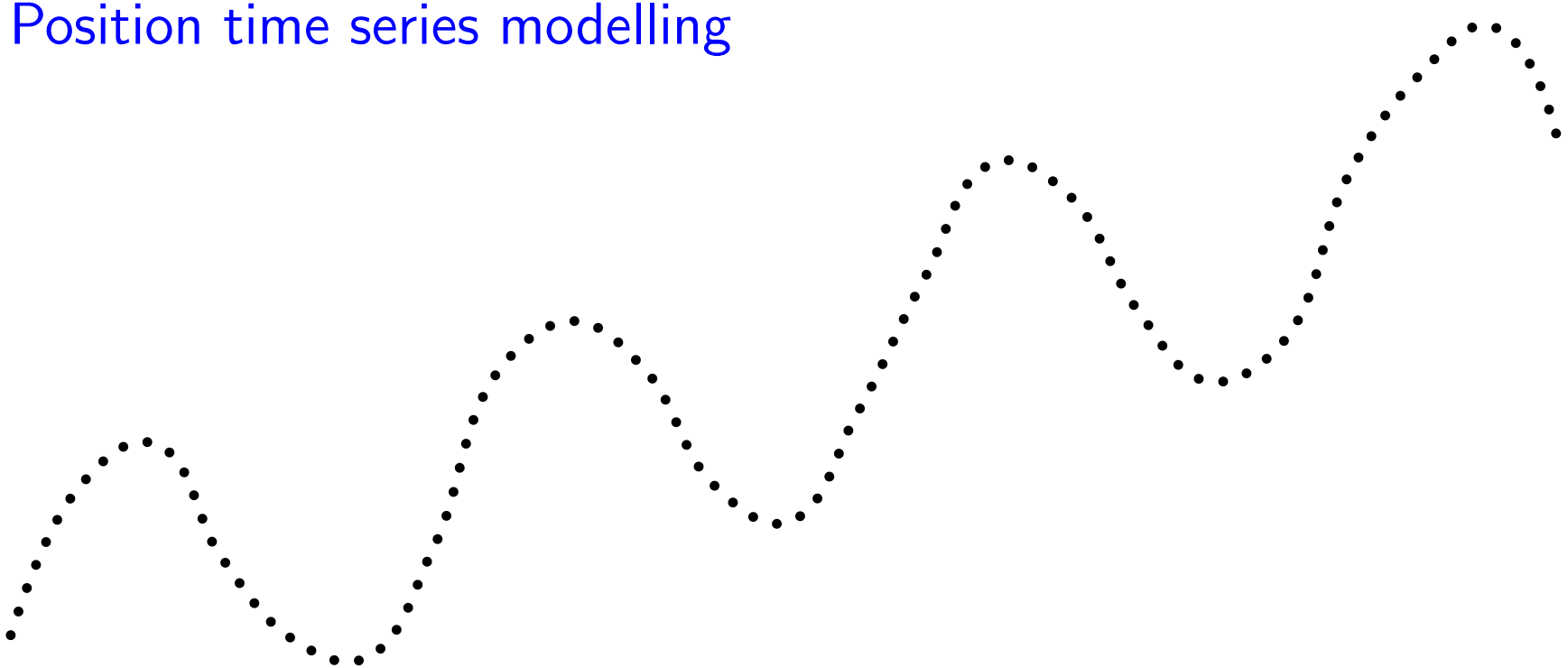
  Jet Propulsion Laboratory (JPL, USA; Wu et al. 2015)
  CATREF+KALMAN: combination of solutions

xTRF2014 Solution Characterization

Position time series modelling



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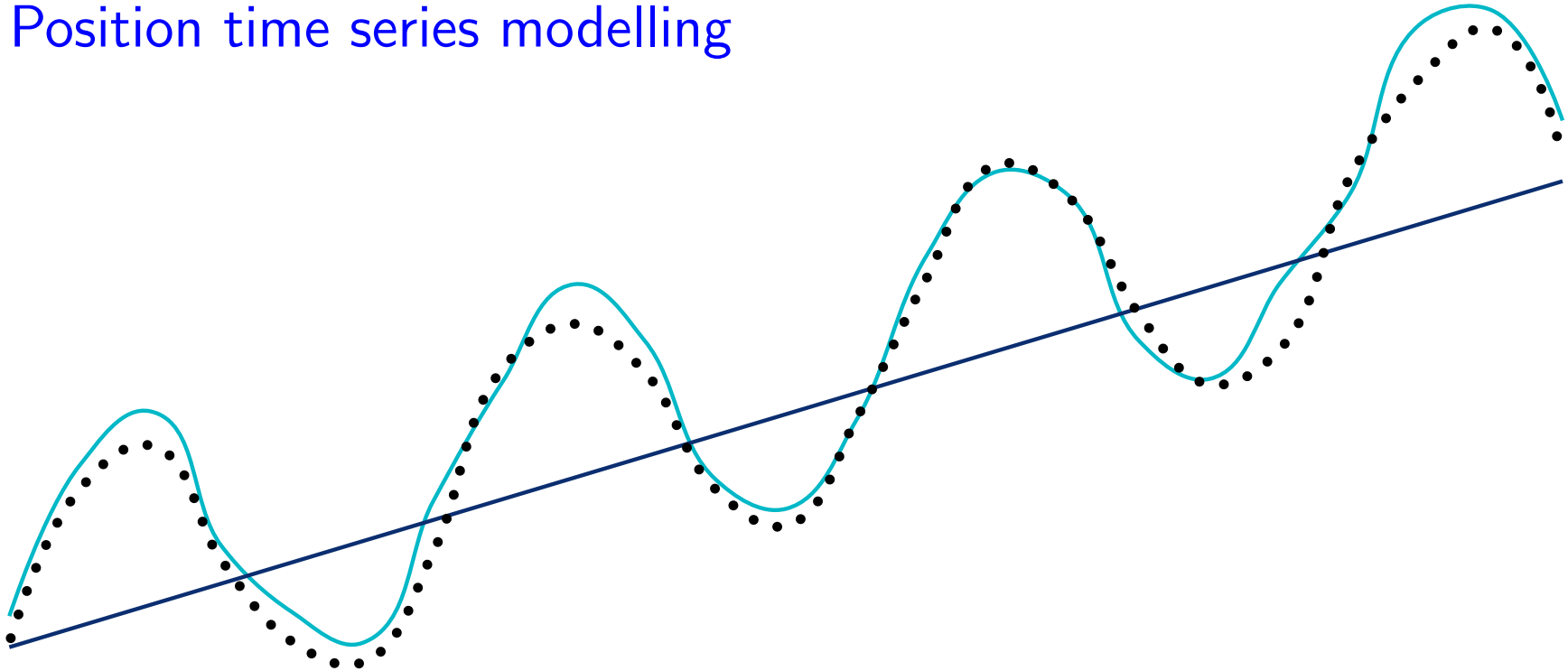
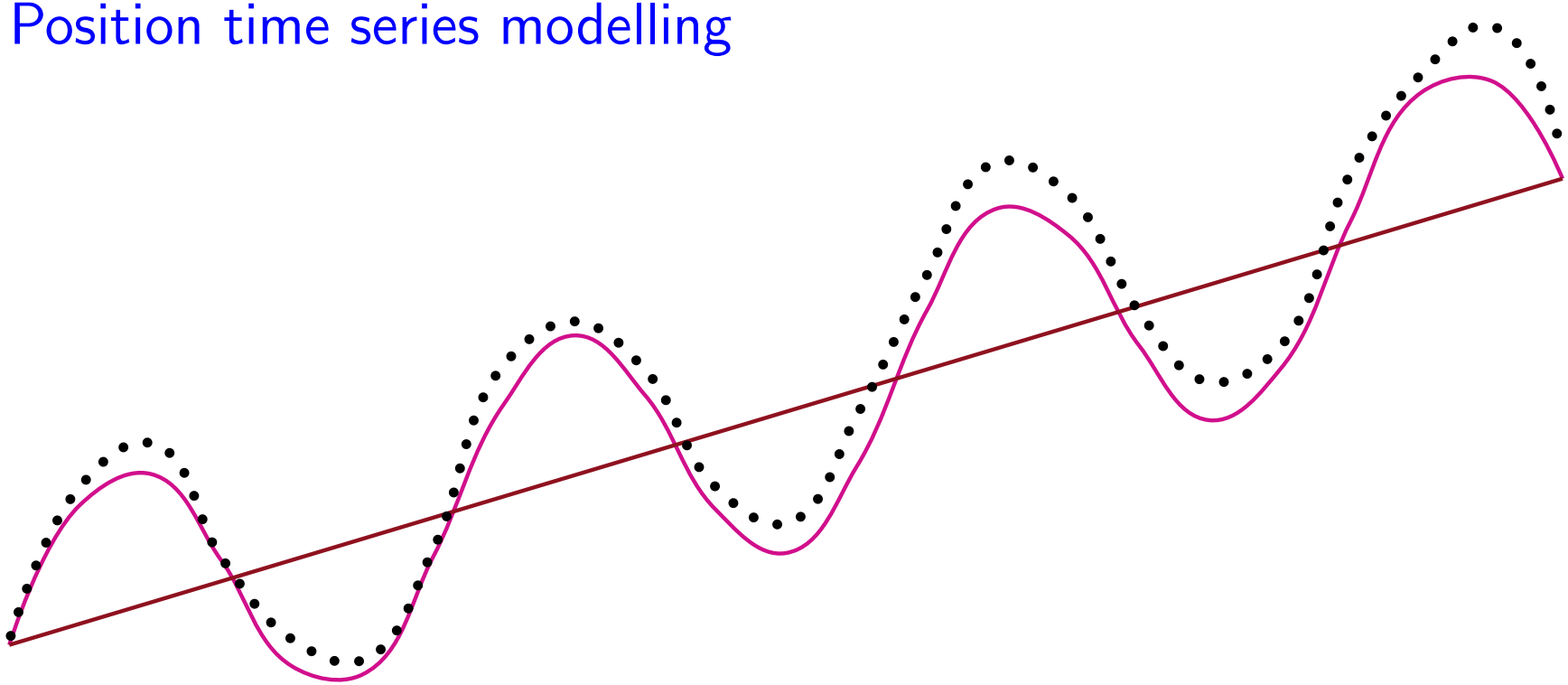


- DTRF2014: linear velocities and external geophysical models

xTRF2014 Solution Characterization

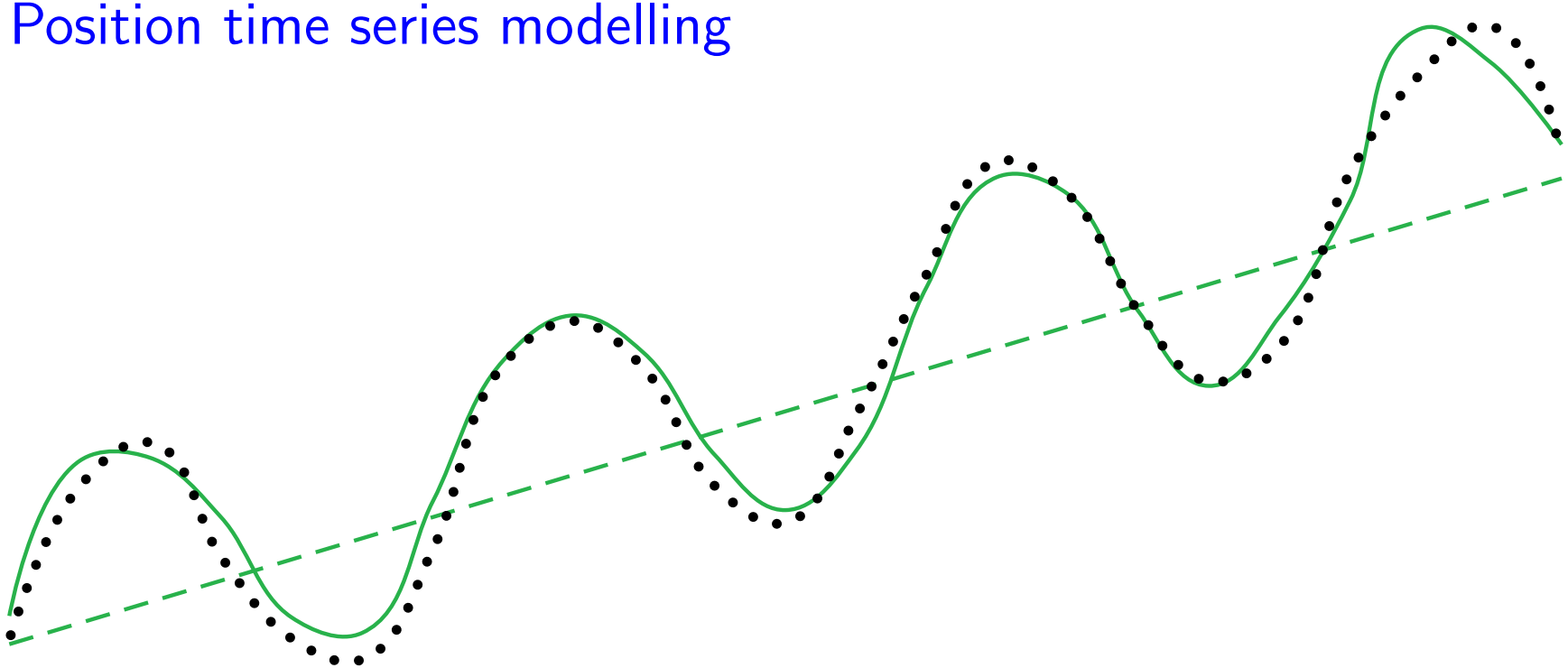
Position time series modelling



- DTRF2014: linear velocities and external geophysical models
- ITRF2014: linear velocities and empirical periodic functions

xTRF2014 Solution Characterization

Position time series modelling



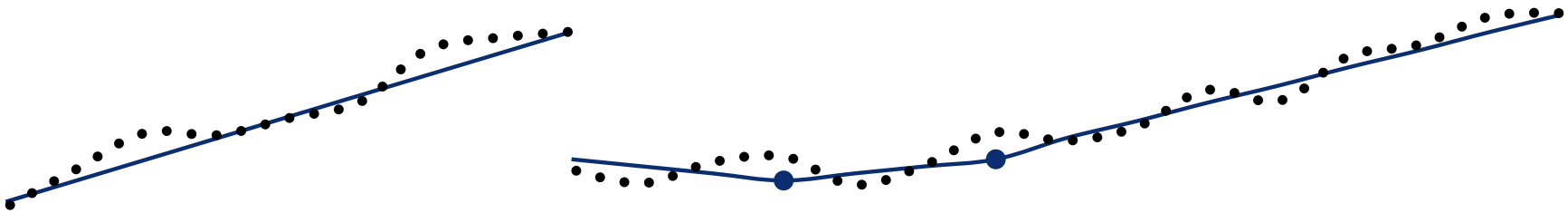
- DTRF2014: linear velocities and external geophysical models
- ITRF2014: linear velocities and empirical periodic functions
- JTRF2014: filter based on epoch-to-epoch changes

xTRF2014 Solution Characterization

Handling of Earthquakes

xTRF2014 Solution Characterization

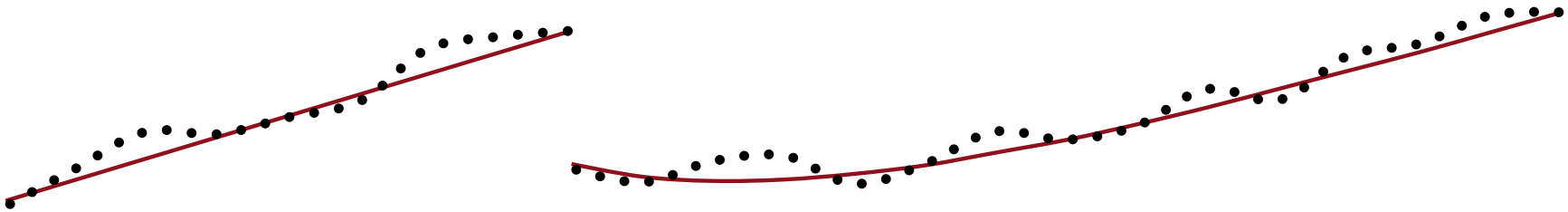
Handling of Earthquakes



- DTRF2014: a sequence of linear velocities

xTRF2014 Solution Characterization

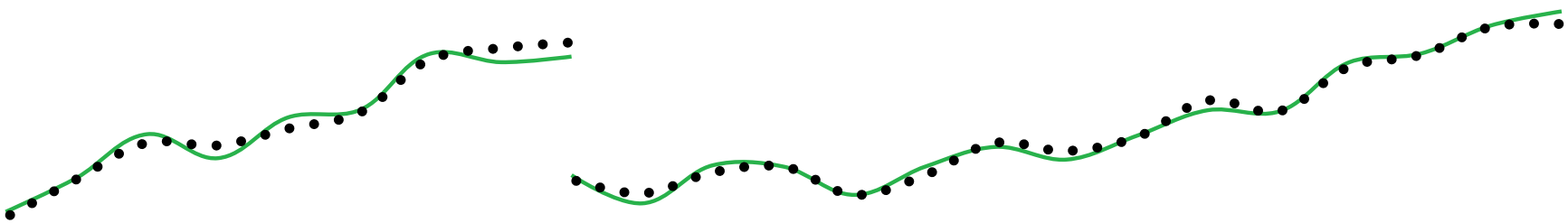
Handling of Earthquakes



- DTRF2014: a sequence of linear velocities
- ITRF2014: empirical deformation models (PSD)

xTRF2014 Solution Characterization

Handling of Earthquakes



- DTRF2014: a sequence of linear velocities
- ITRF2014: empirical deformation models (PSD)
- JTRF2014: filter based on epoch-to-epoch changes

xTRF2014 Solution Characterization

- **DTRF2014**
  Geophysical modeling of the position time series: e.g., use of geophysical models for non-tidal loading effects (NT-L)
  - \+ good approximation of the regularized station position by considering NT-L
  - – global models do not cover regional effects; limited accuracy of the models

xTRF2014 Solution Characterization

- **DTRF2014**
  Geophysical modeling of the position time series: e.g., use of geophysical models for non-tidal loading effects (NT-L)

- **ITRF2014**
  Advanced mathematical modeling of the position time series: e.g., approximation of post-seismic deformation (PSD) via empirical models
  - \+ PSD models help to avoid discontinuities
  - – estimated annual signals may contain non-geophysical contributions

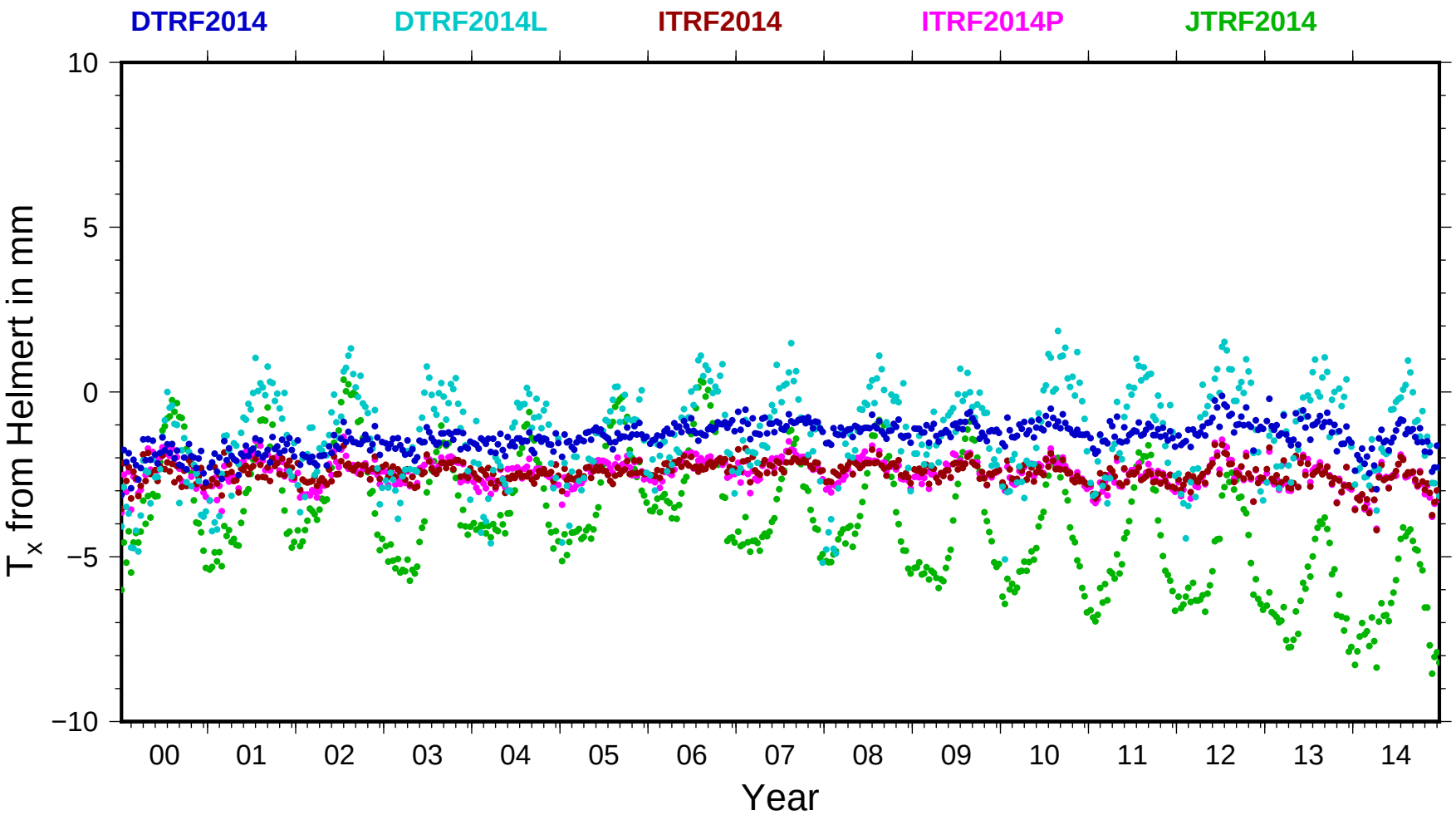
xTRF2014 Solution Characterization

- **DTRF2014**
  Geophysical modeling of the position time series: e.g., use of geophysical models for non-tidal loading effects (NT-L)

- **ITRF2014**
  Advanced mathematical modeling of the position time series: e.g., approximation of post-seismic deformation (PSD) via empirical models

- **JTRF2014**
  Advanced mathematical modeling of the position time series: e.g., weekly estimation of station coordinates
  - \+ good approximation of the regularized station position
  - − uncertainty of geodetic datum; difficult extrapolation

Comparison of EGIEM solution (IGb08)



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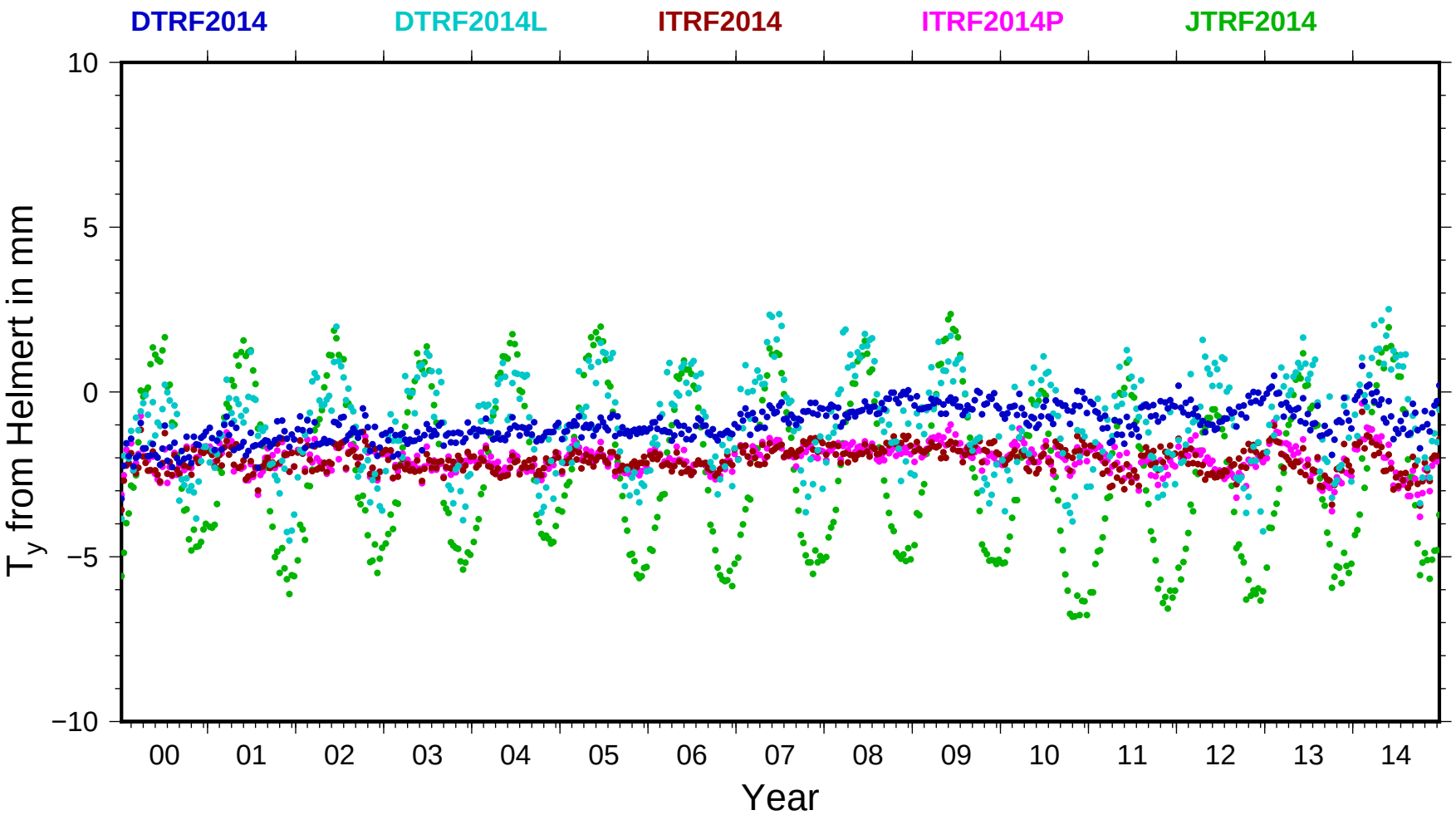
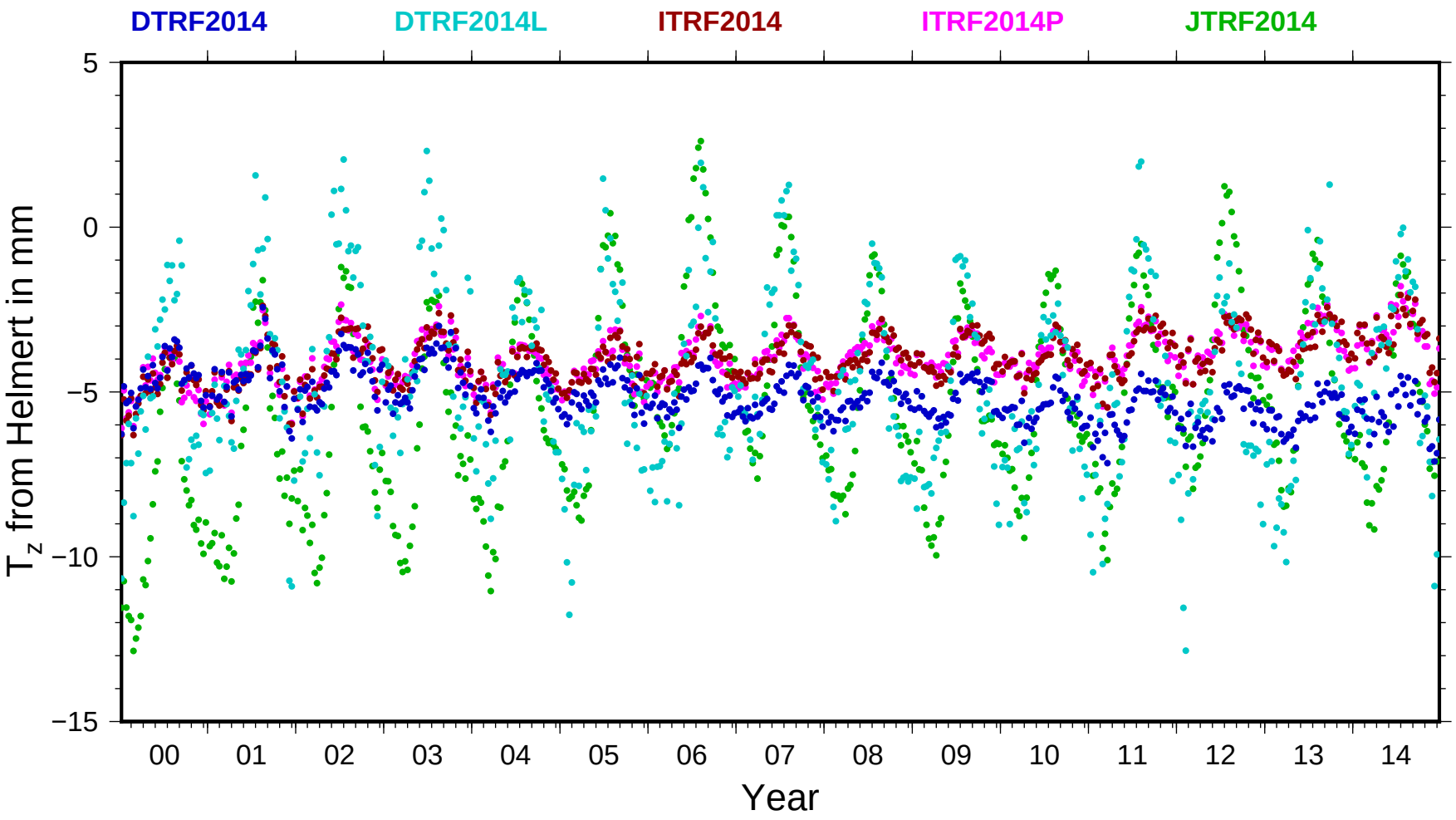


Comparison of EGIEM solution (IGb08)



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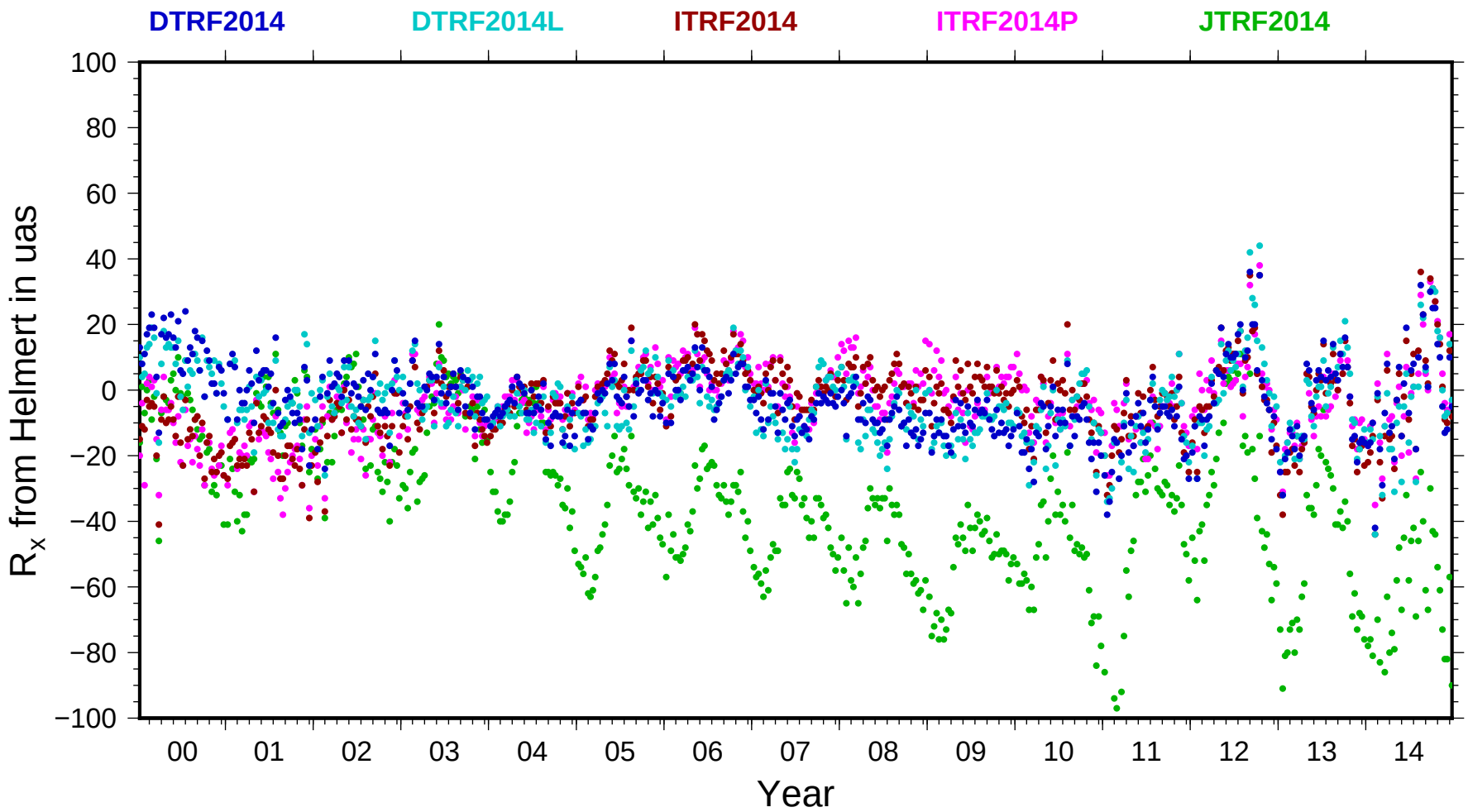
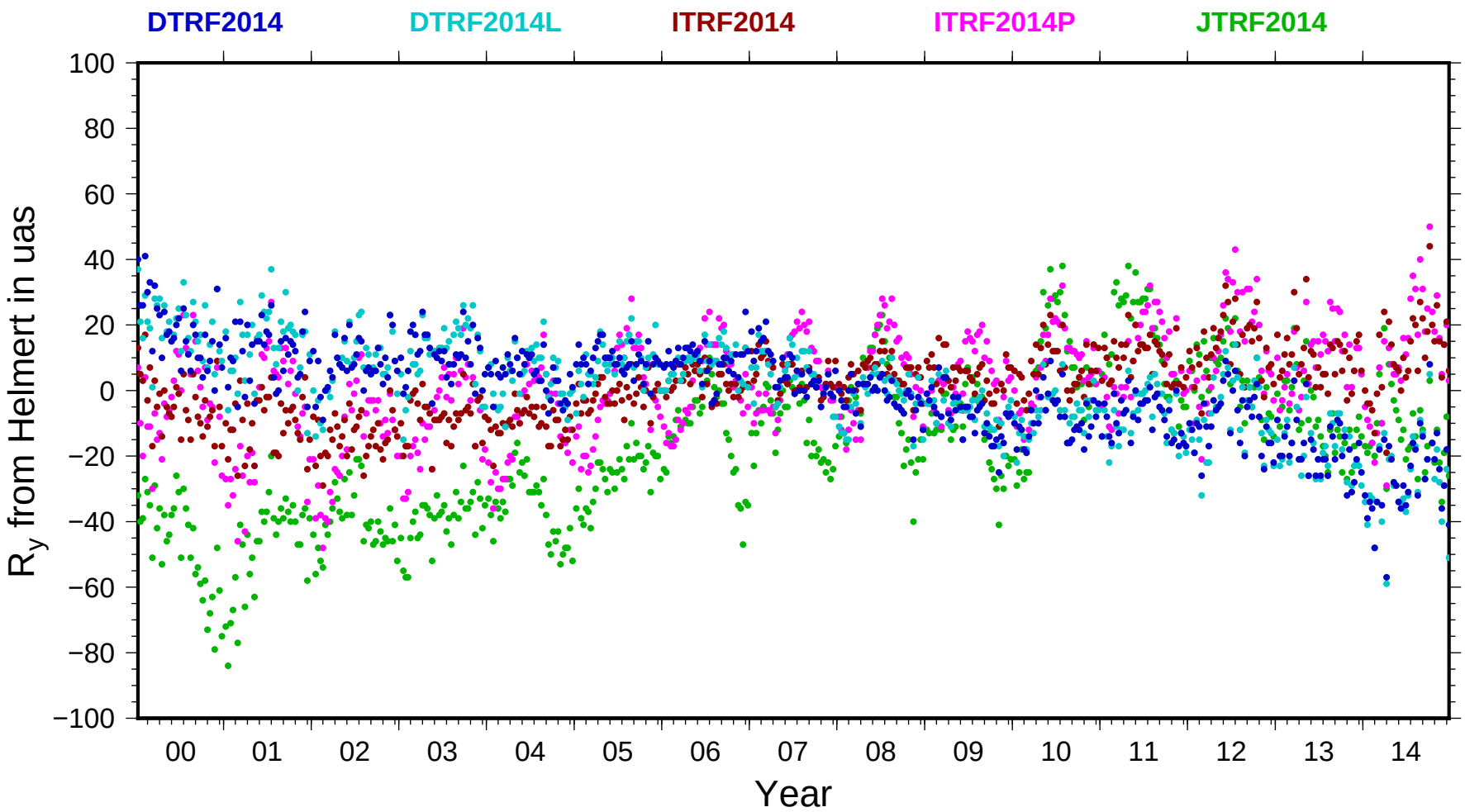
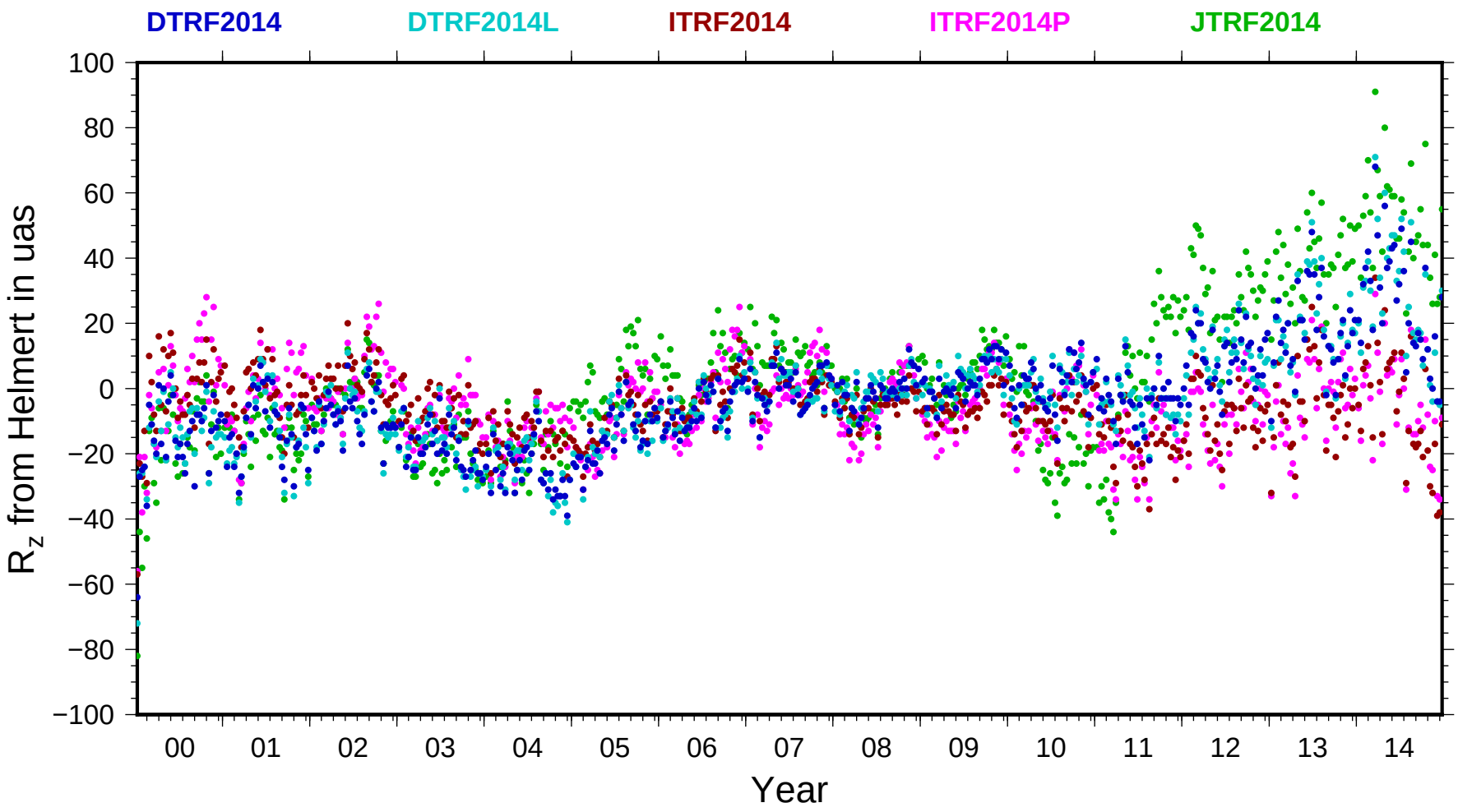


Comparison of EGIEM solution (IGb08)



Comparison of EGIEM solution (IGb08)



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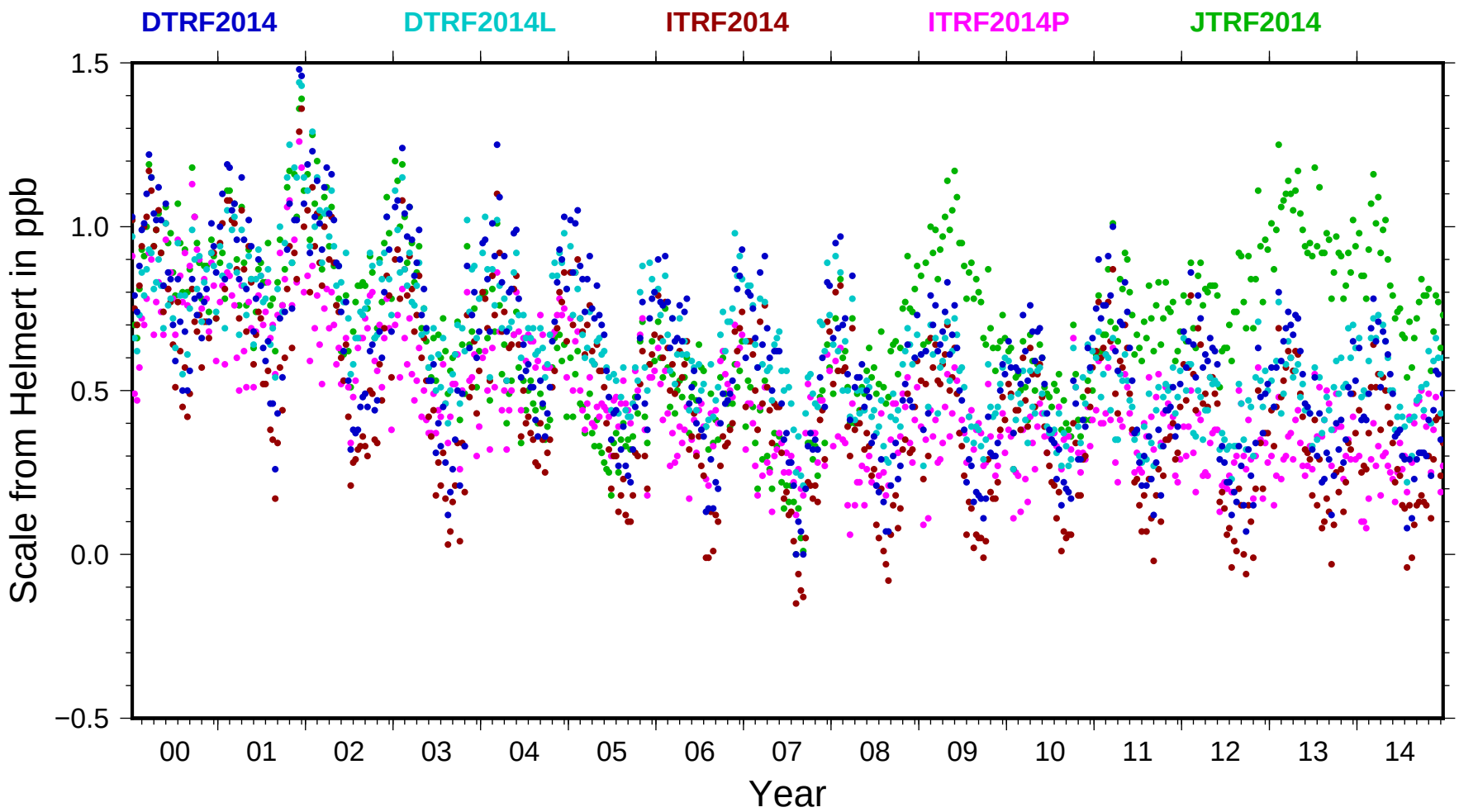
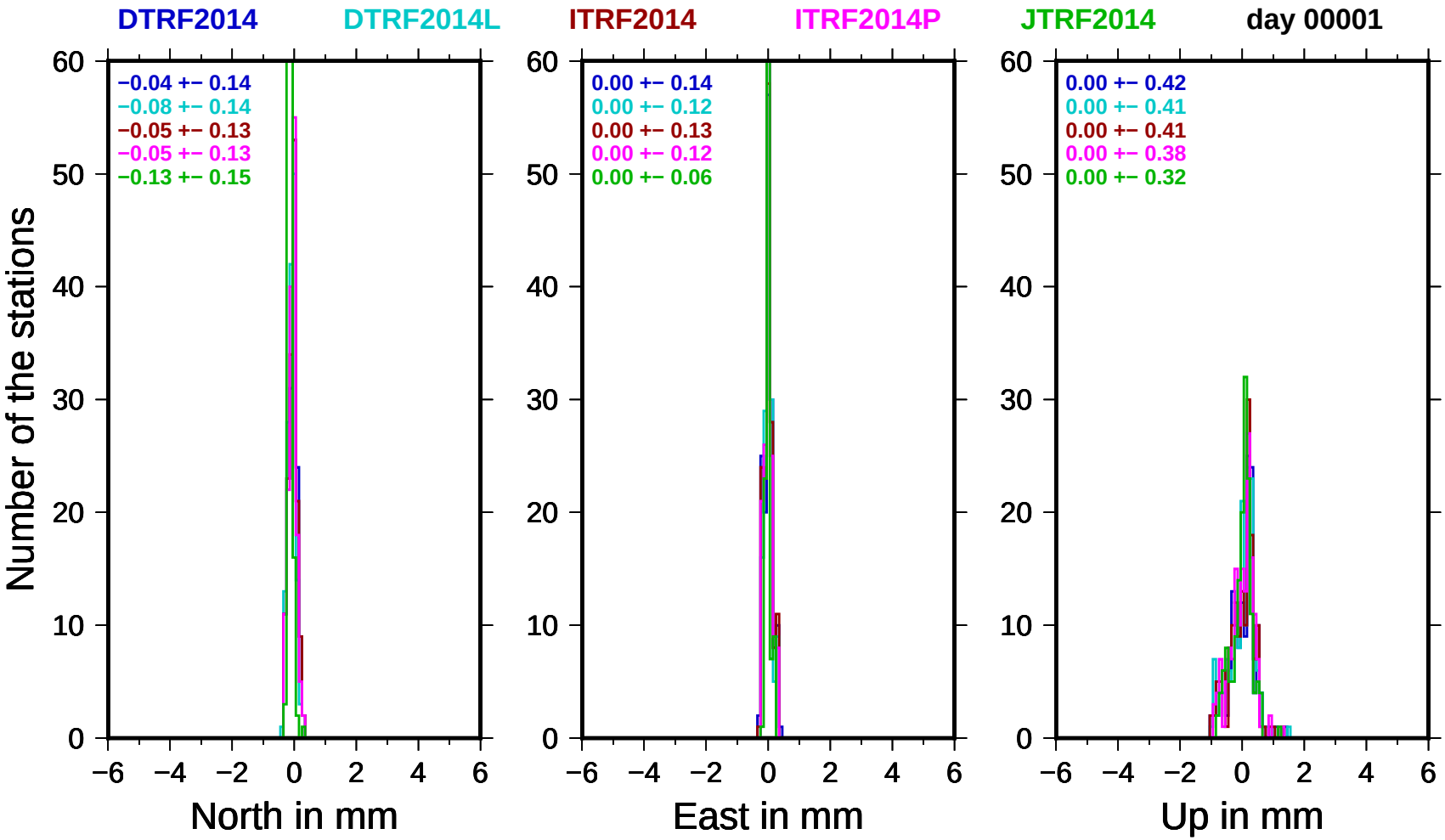
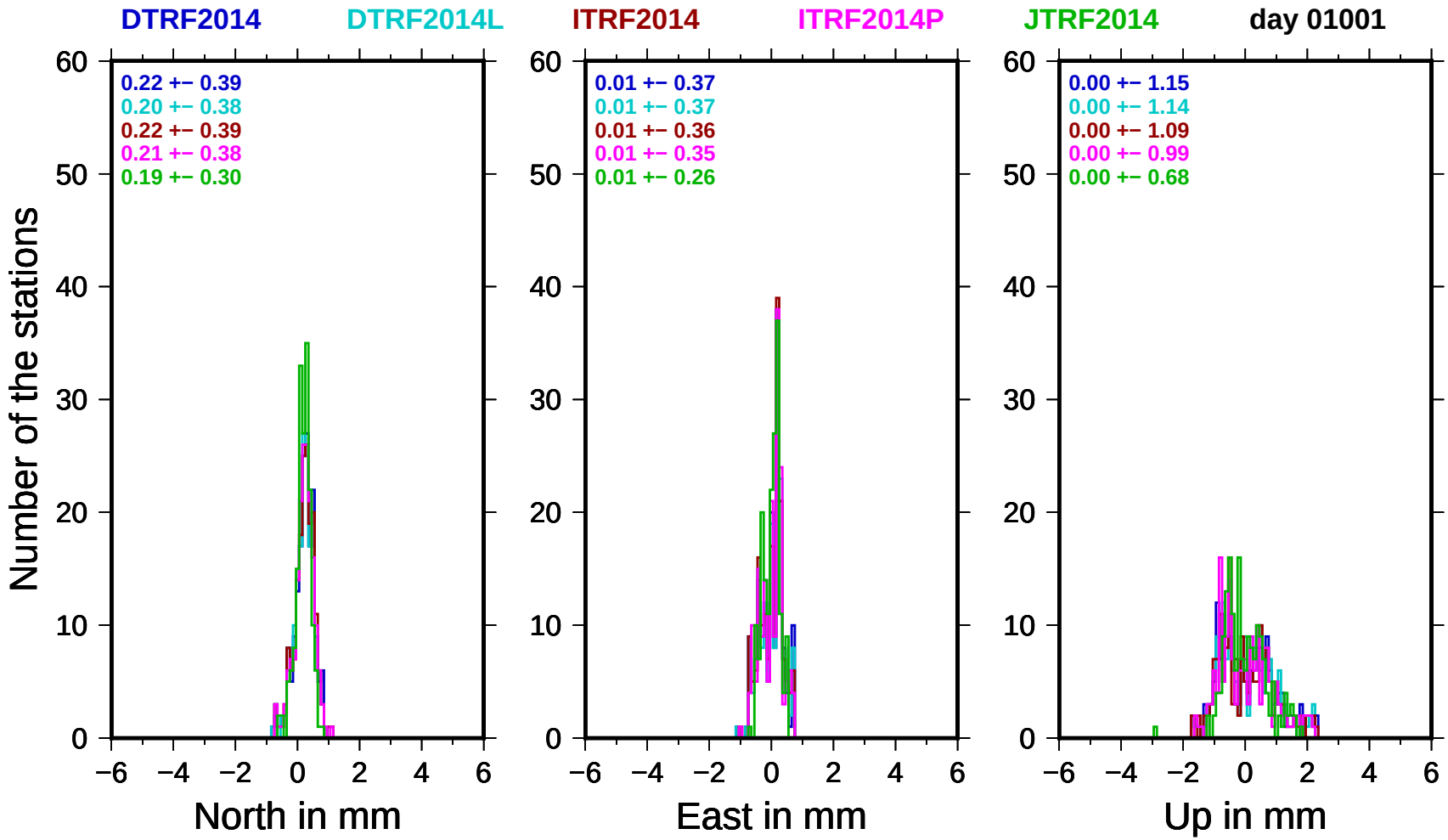


Comparison of station coordinates



Comparison of station coordinates



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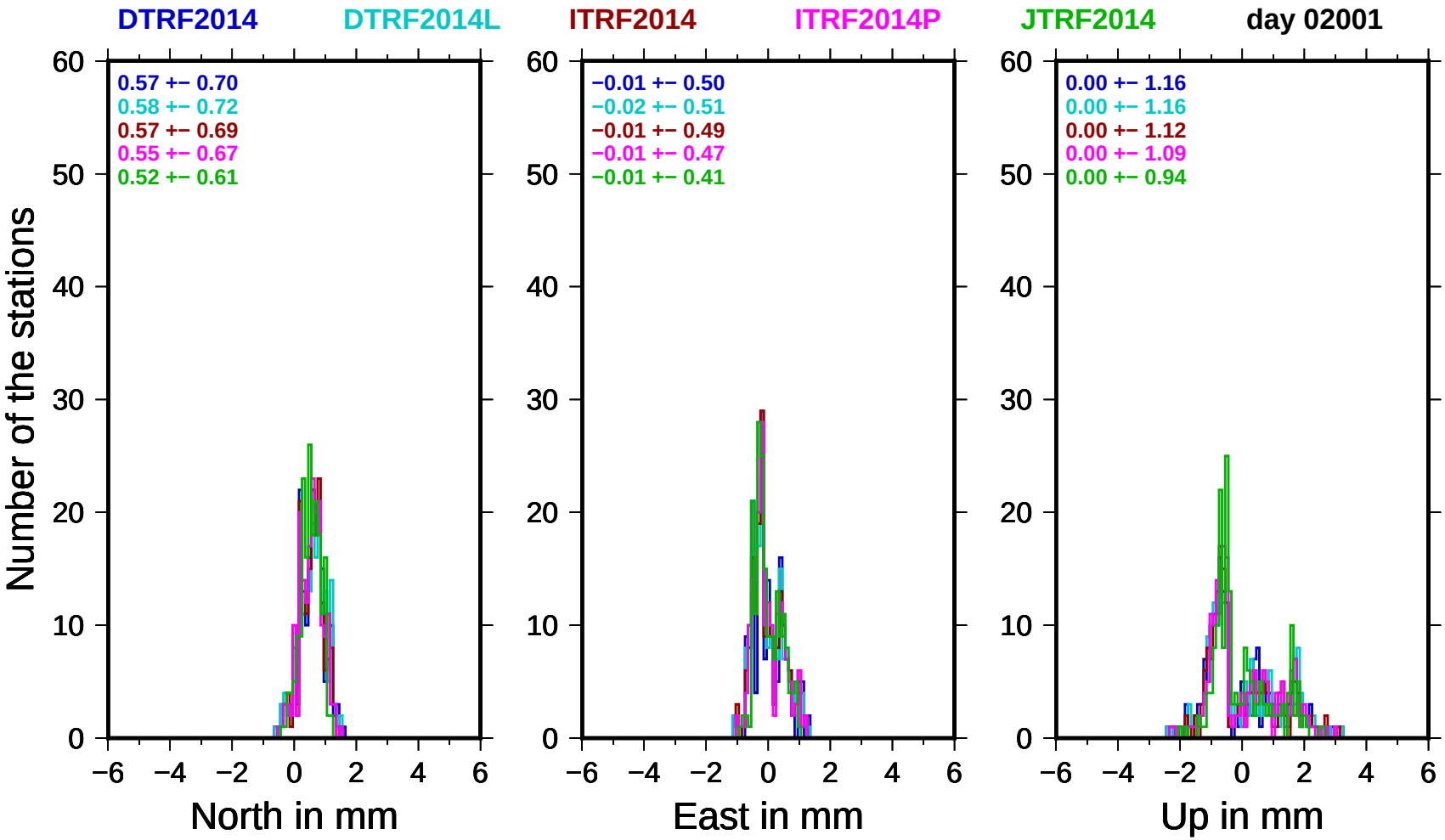
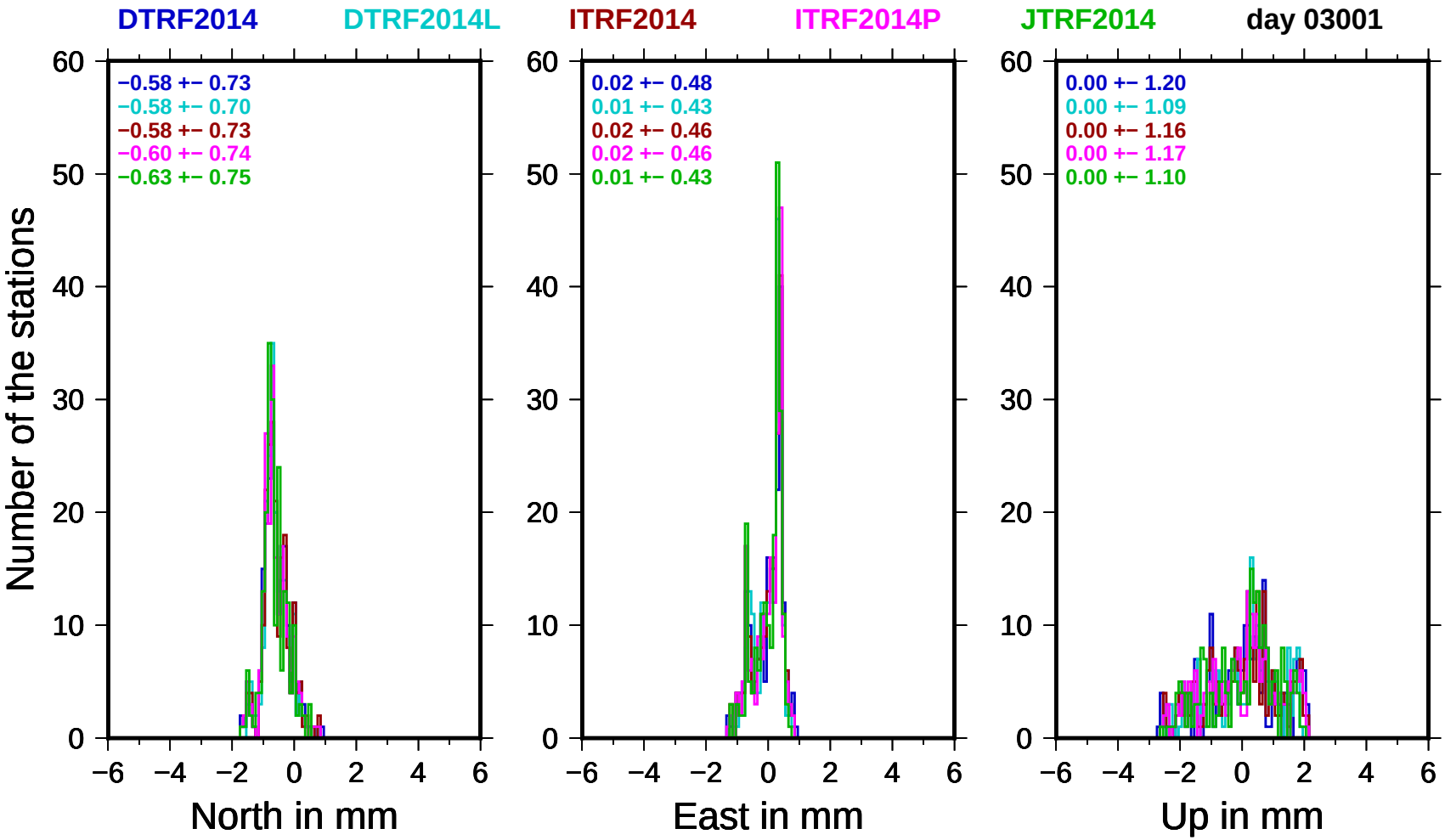


Comparison of station coordinates



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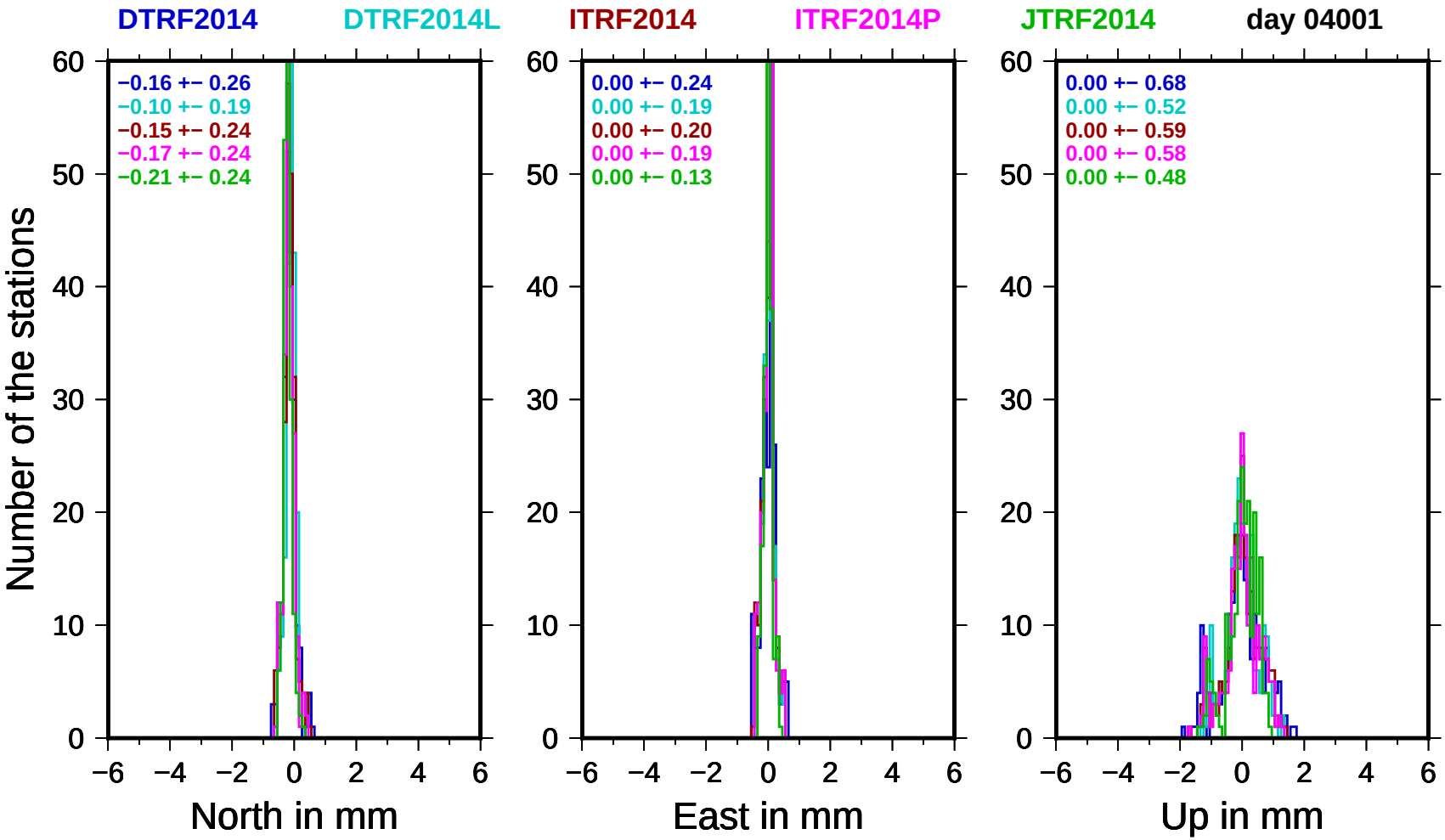

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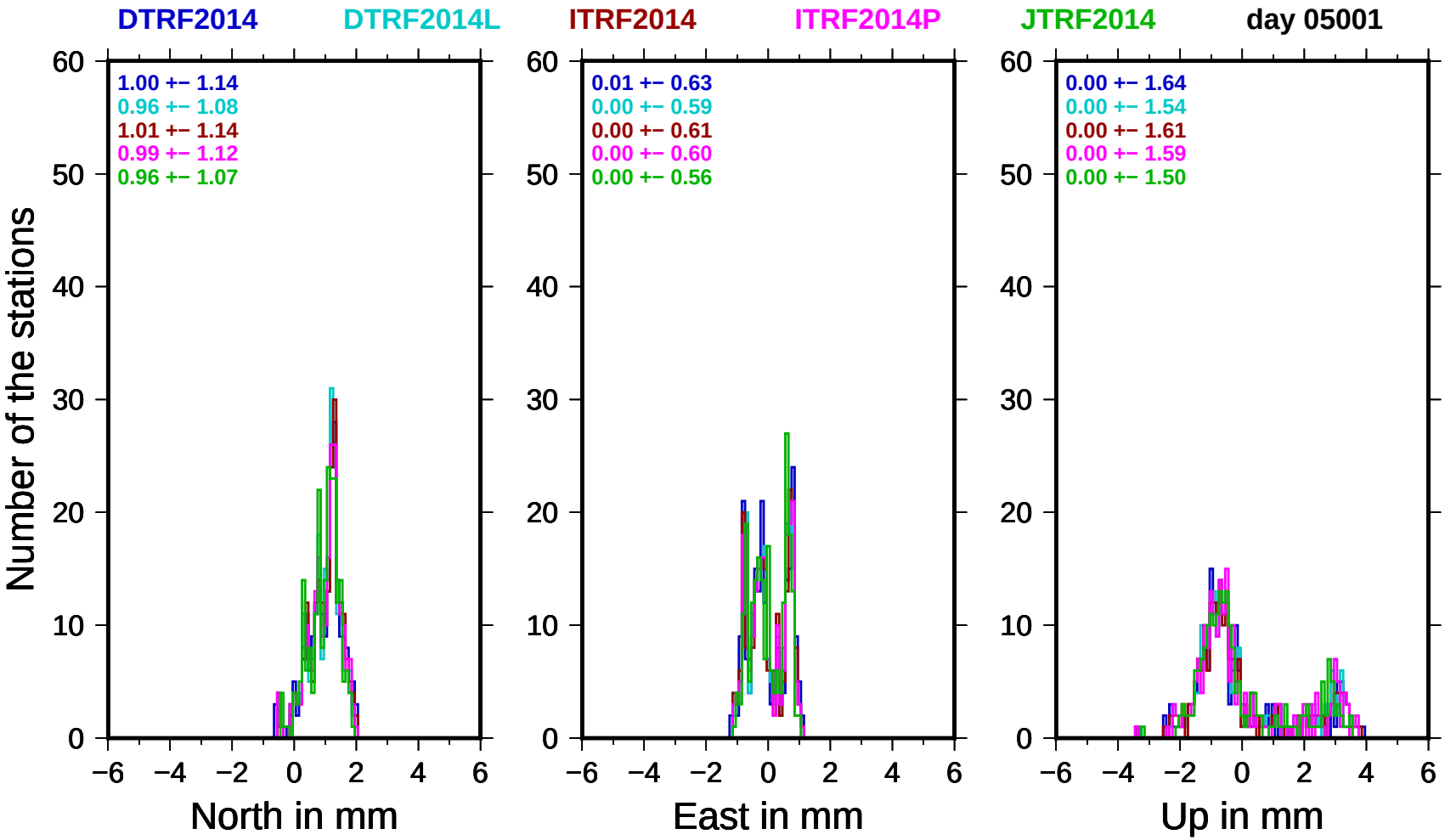

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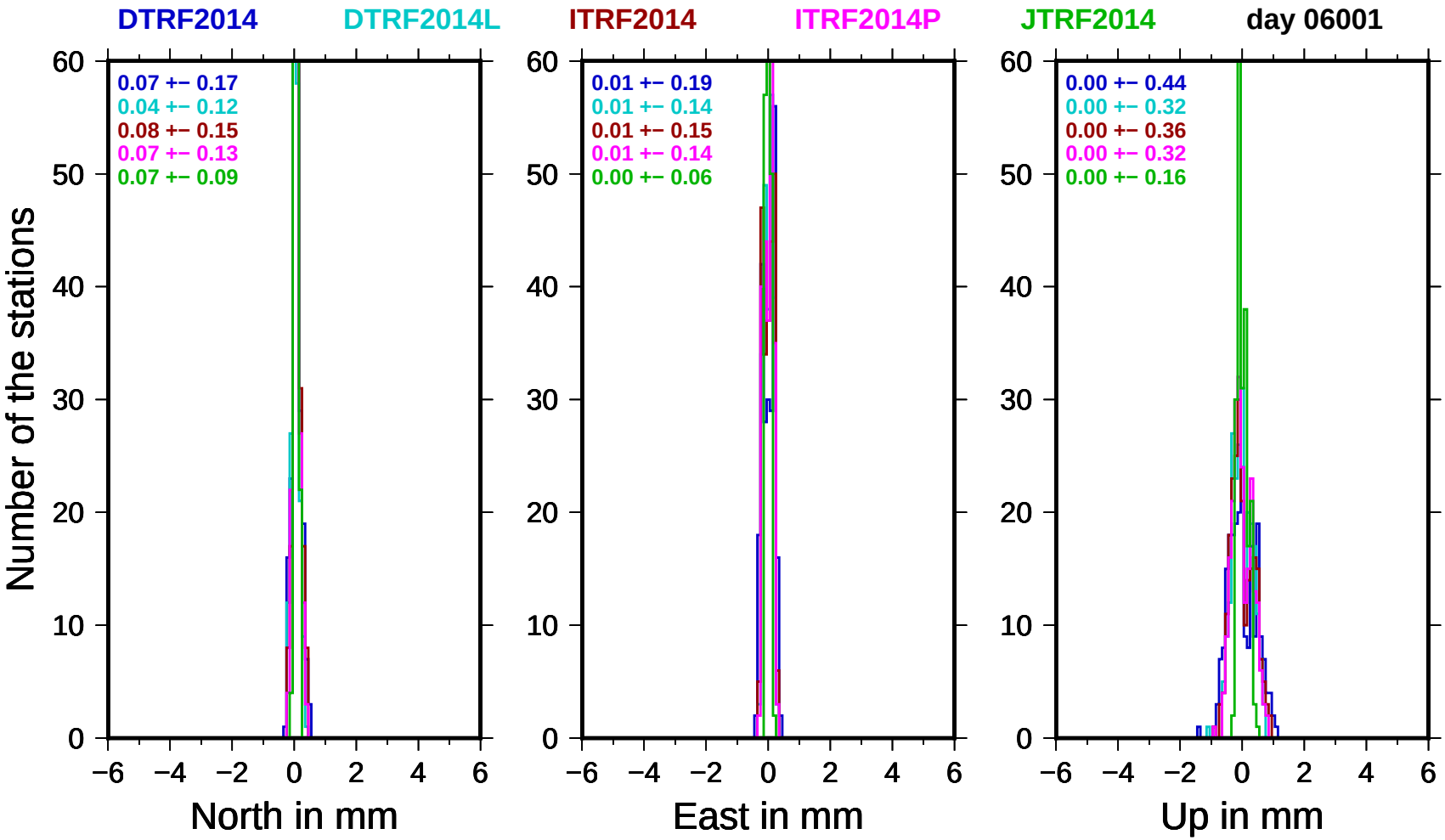

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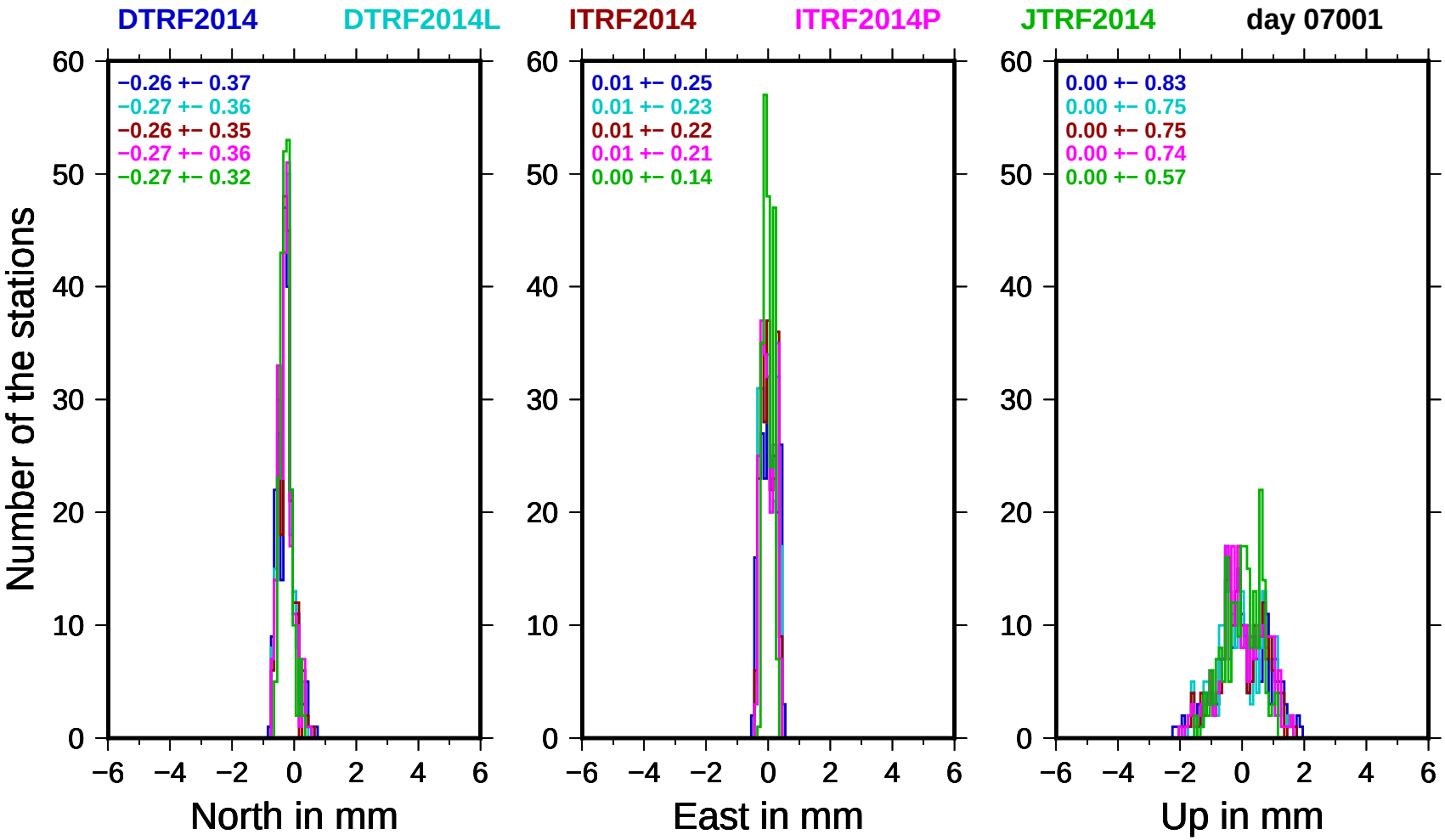

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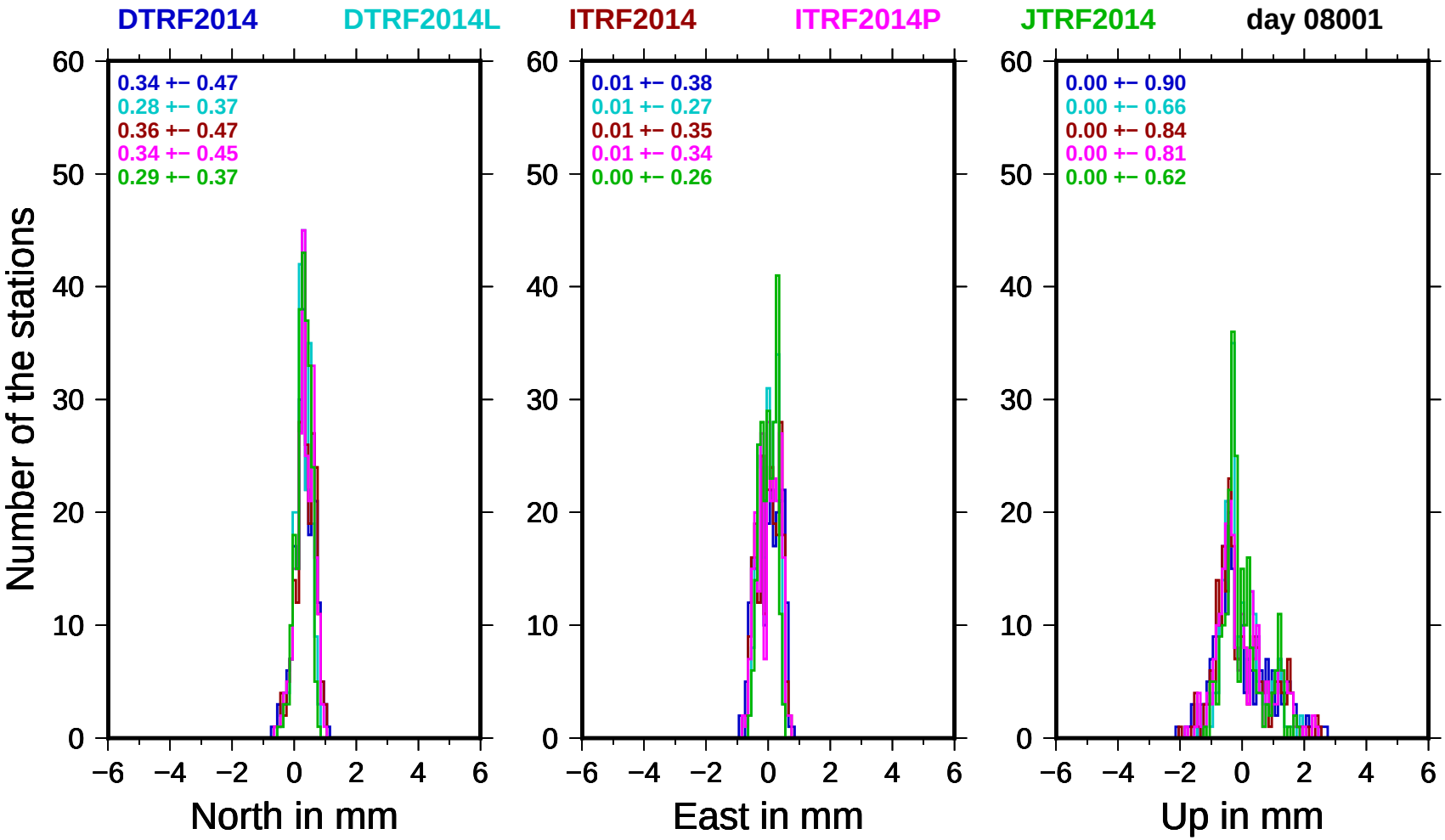

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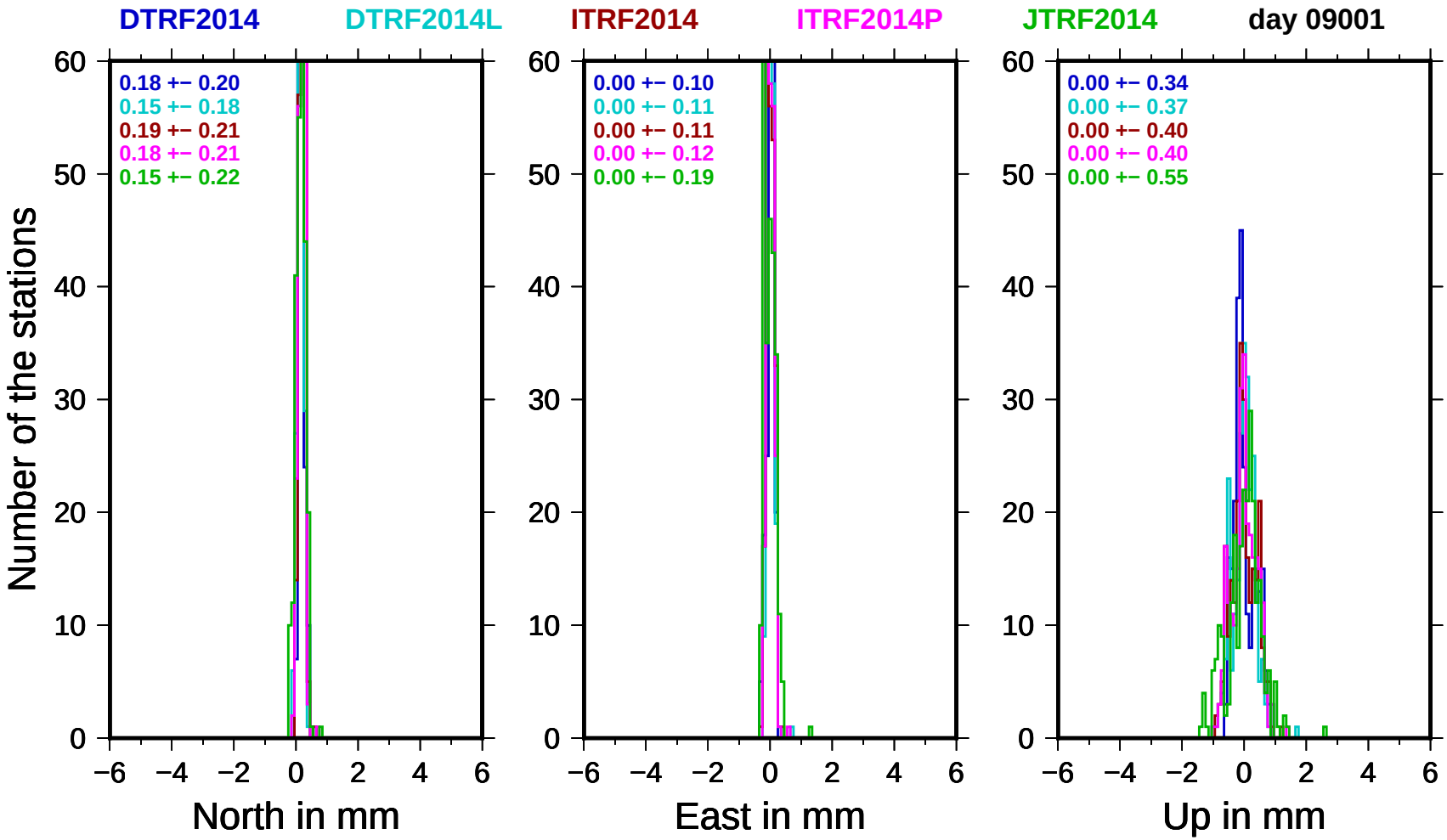

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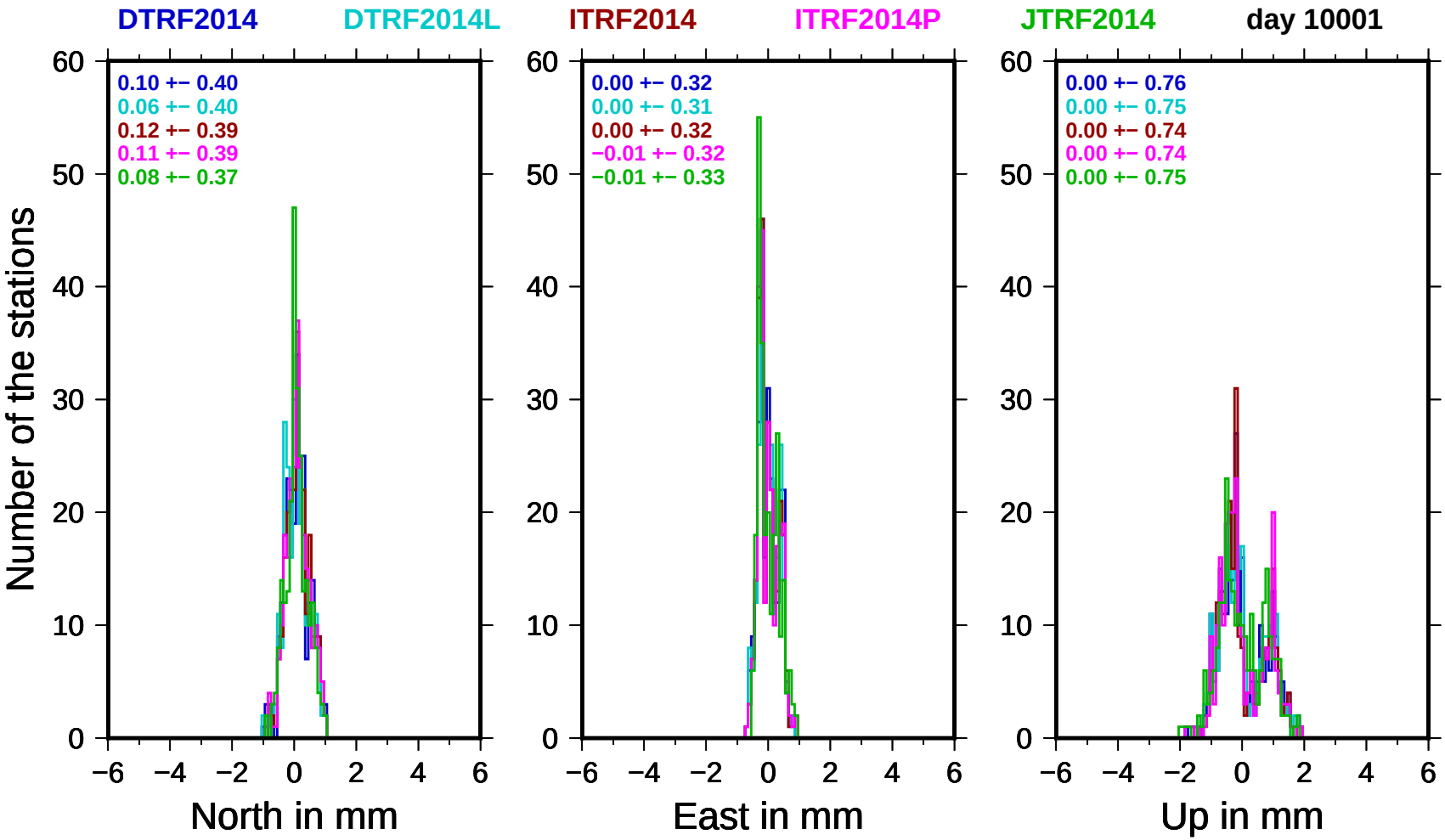

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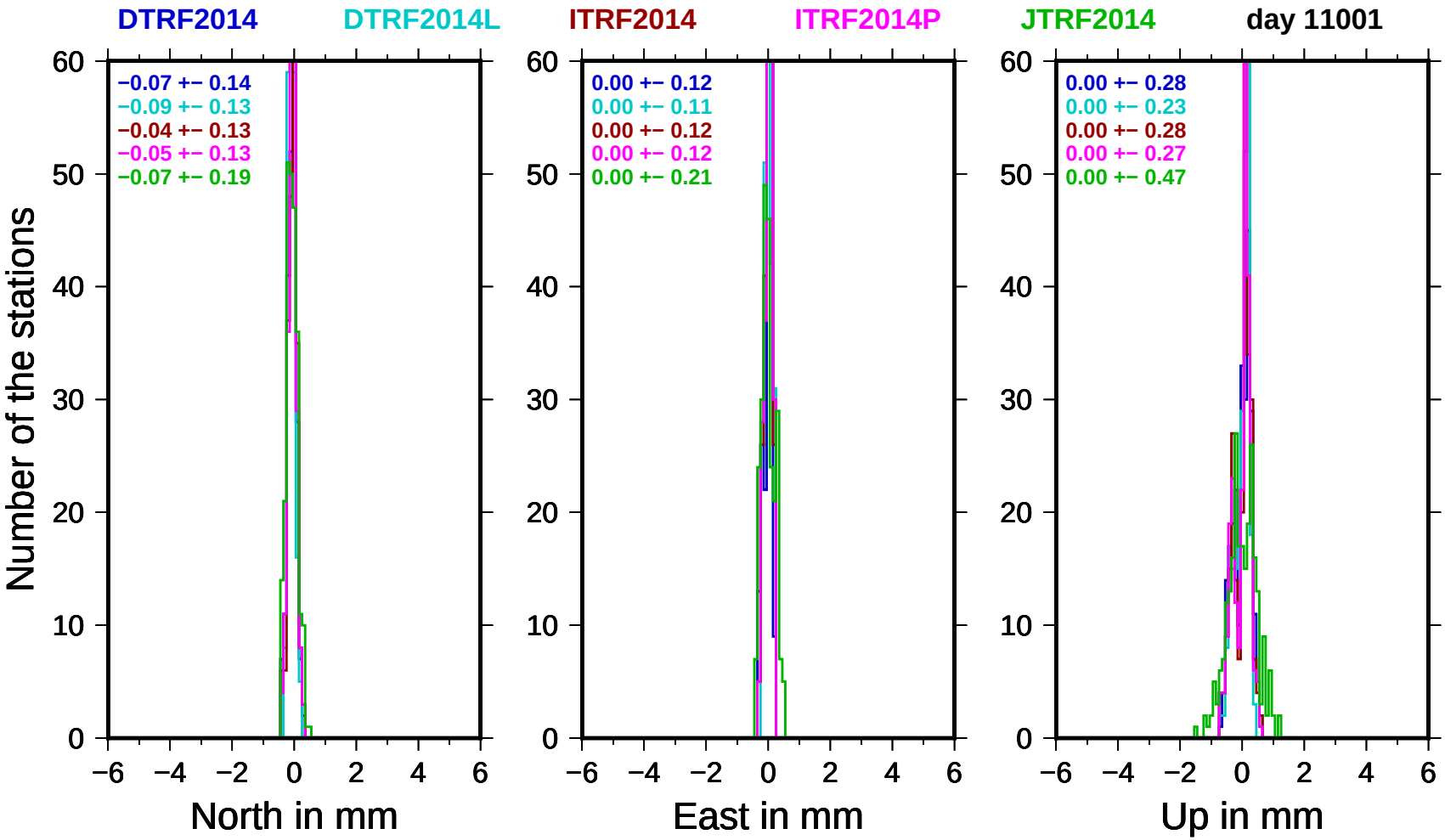

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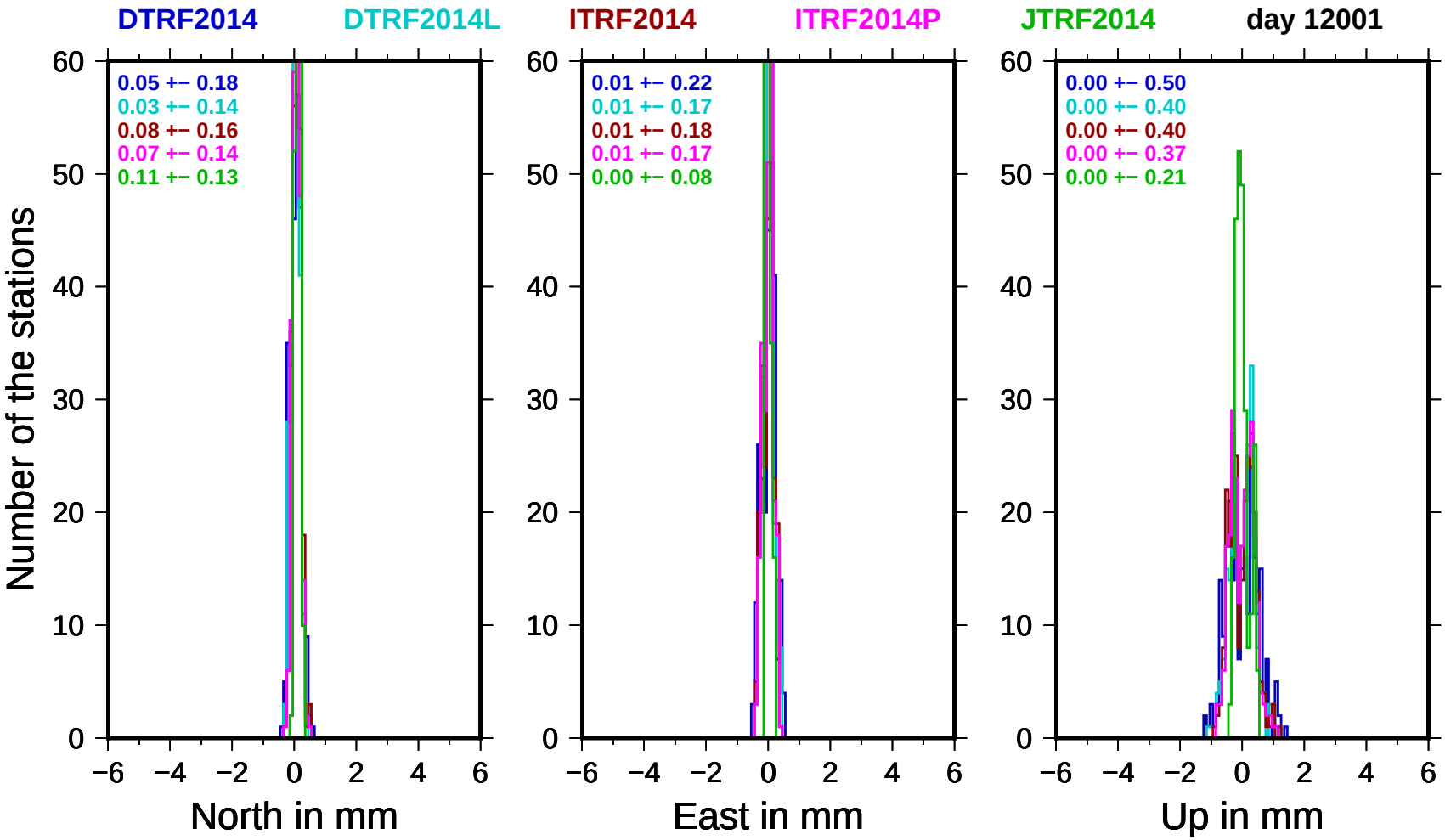

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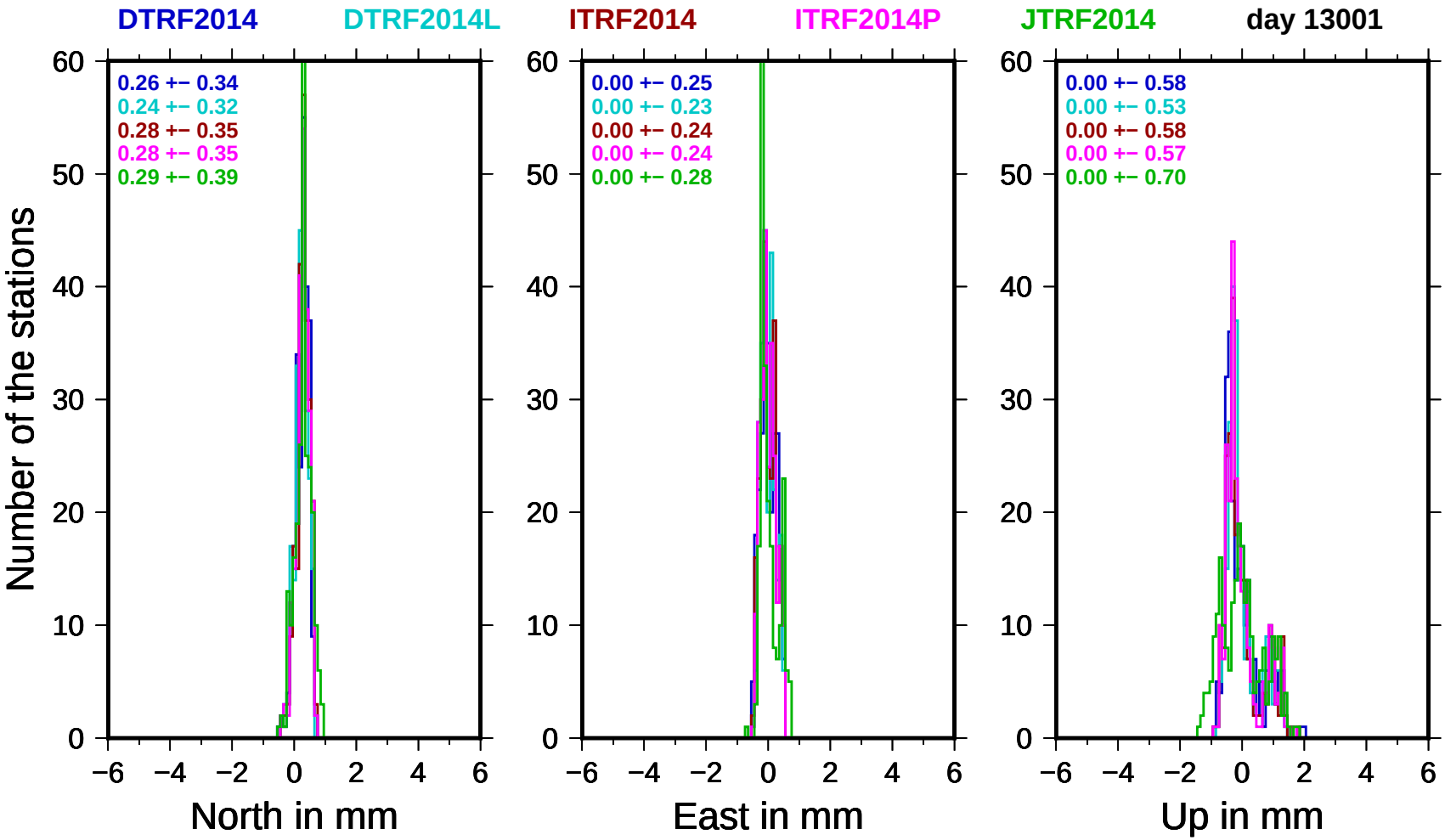
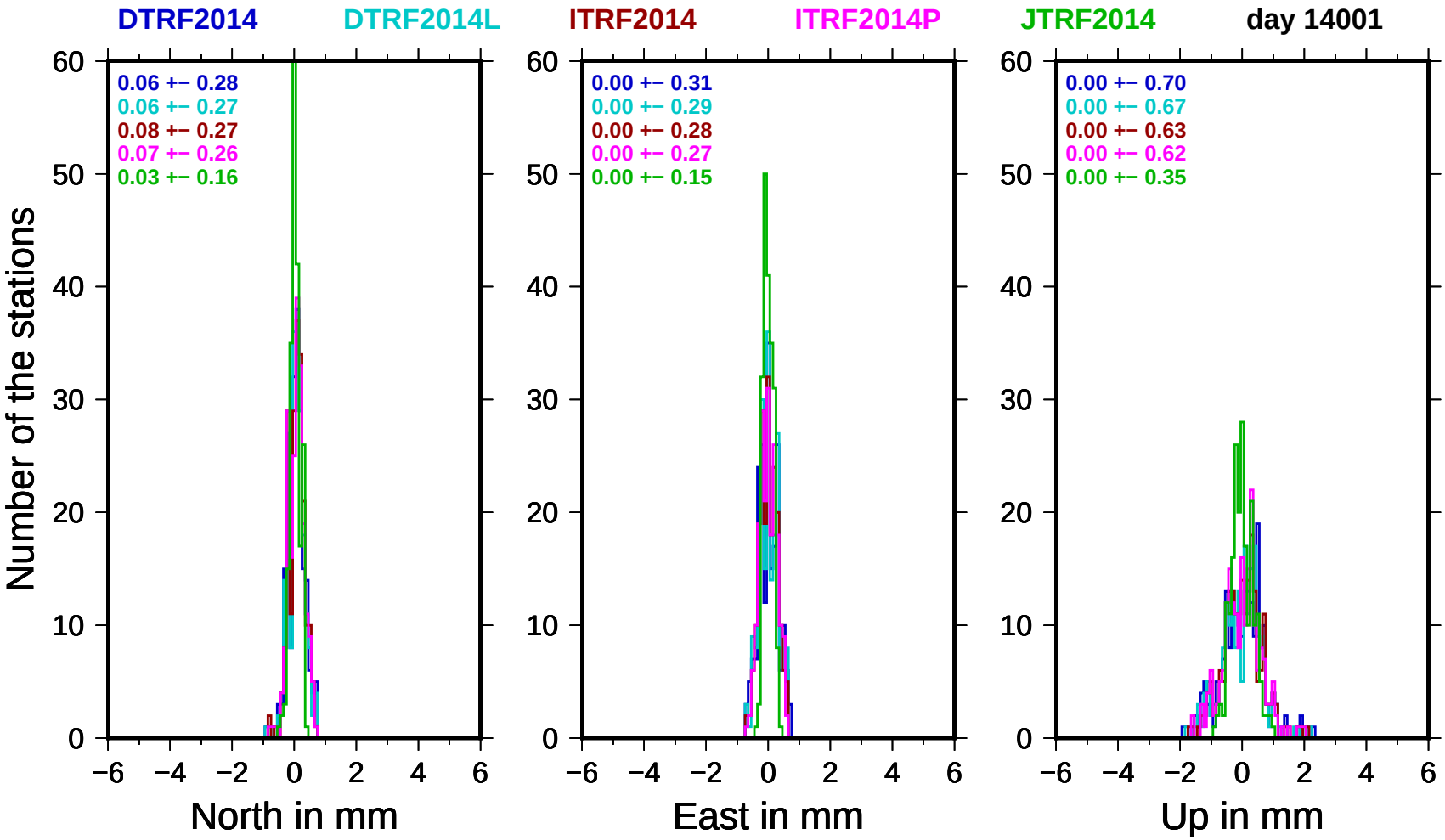
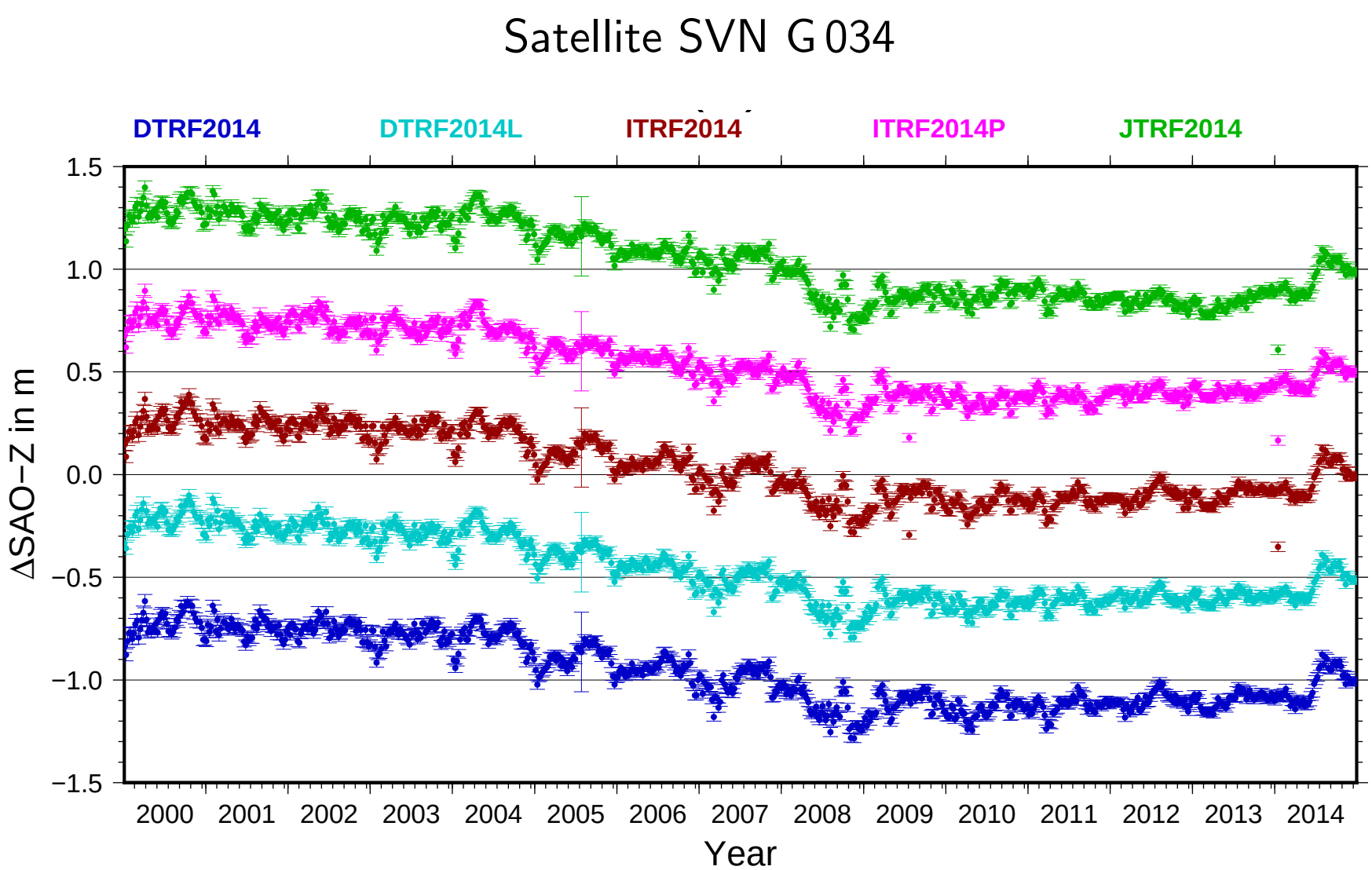


Comparison of station coordinates



Estimated satellite antenna Z-offset series



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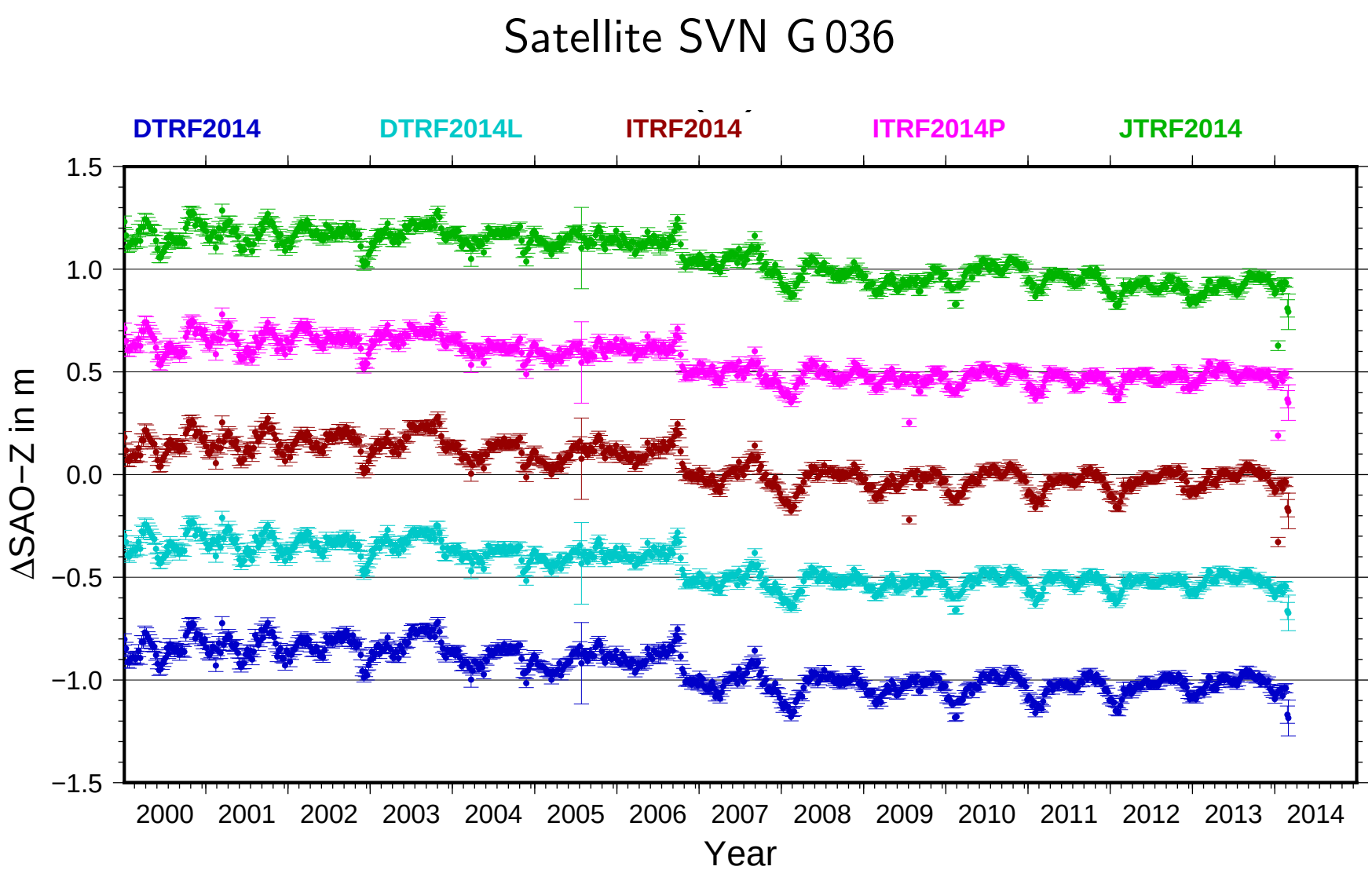
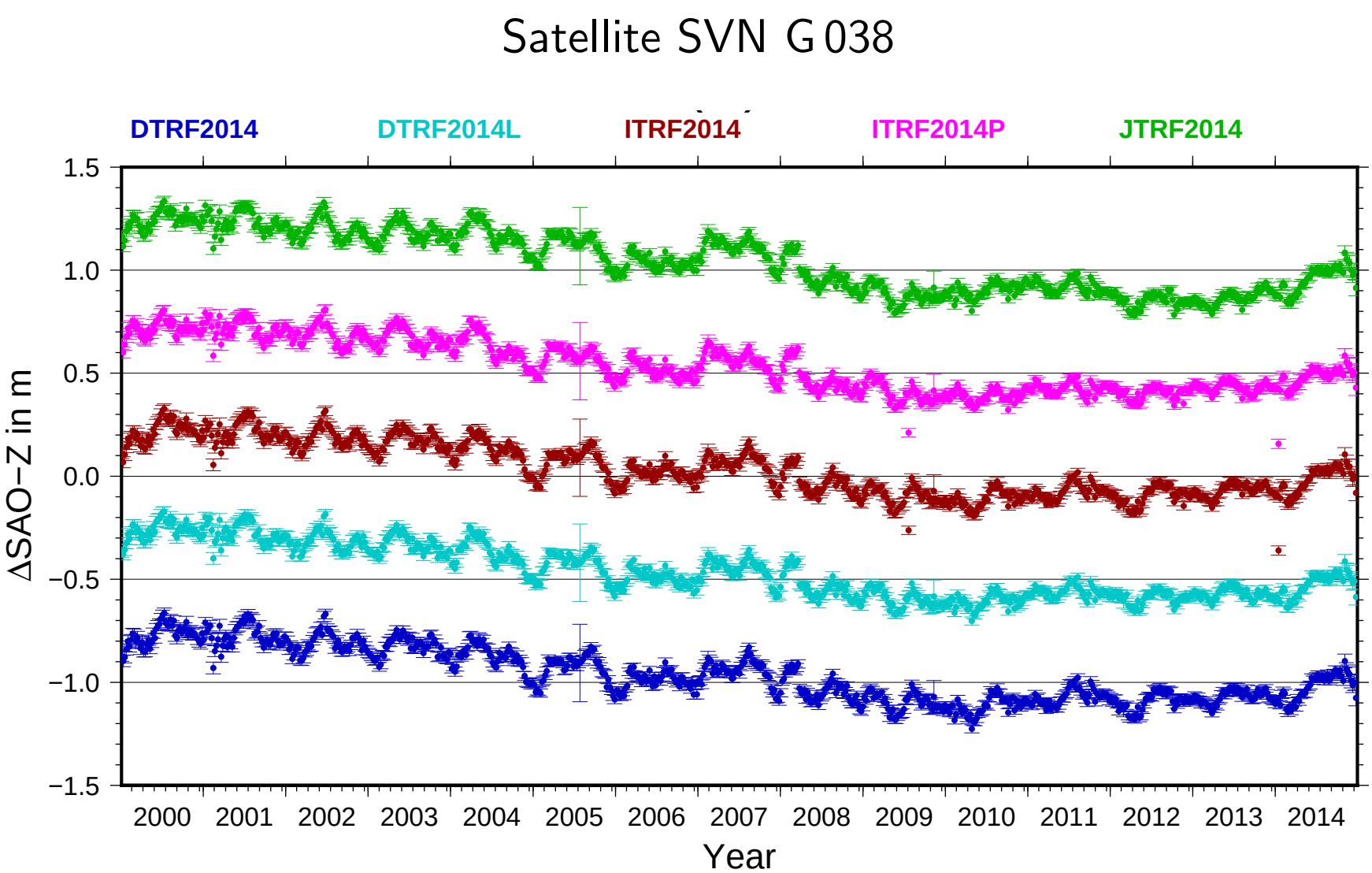


Estimated satellite antenna Z-offset series



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