GGOS-D: A German Project on the Integration of Space Geodetic Techniques

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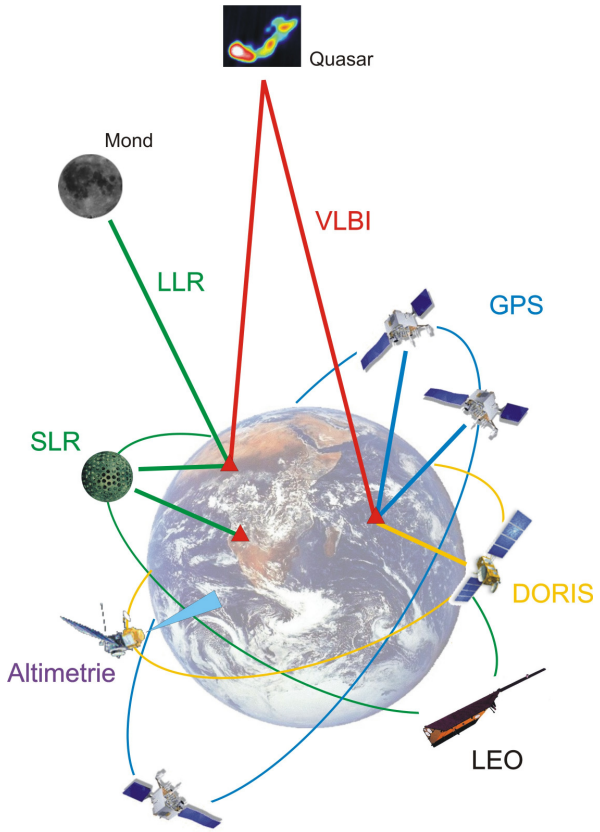
Overview

Integration of space geodetic observations as a basis for a global geodetic-geophysical observing system (GGOS-D)

Observing techniques

- VLBI
- SLR
- GPS
- Low Earth Orbiters (LEO)
- Altimetry

With two independent analysis packages for VLBI, SLR and GPS



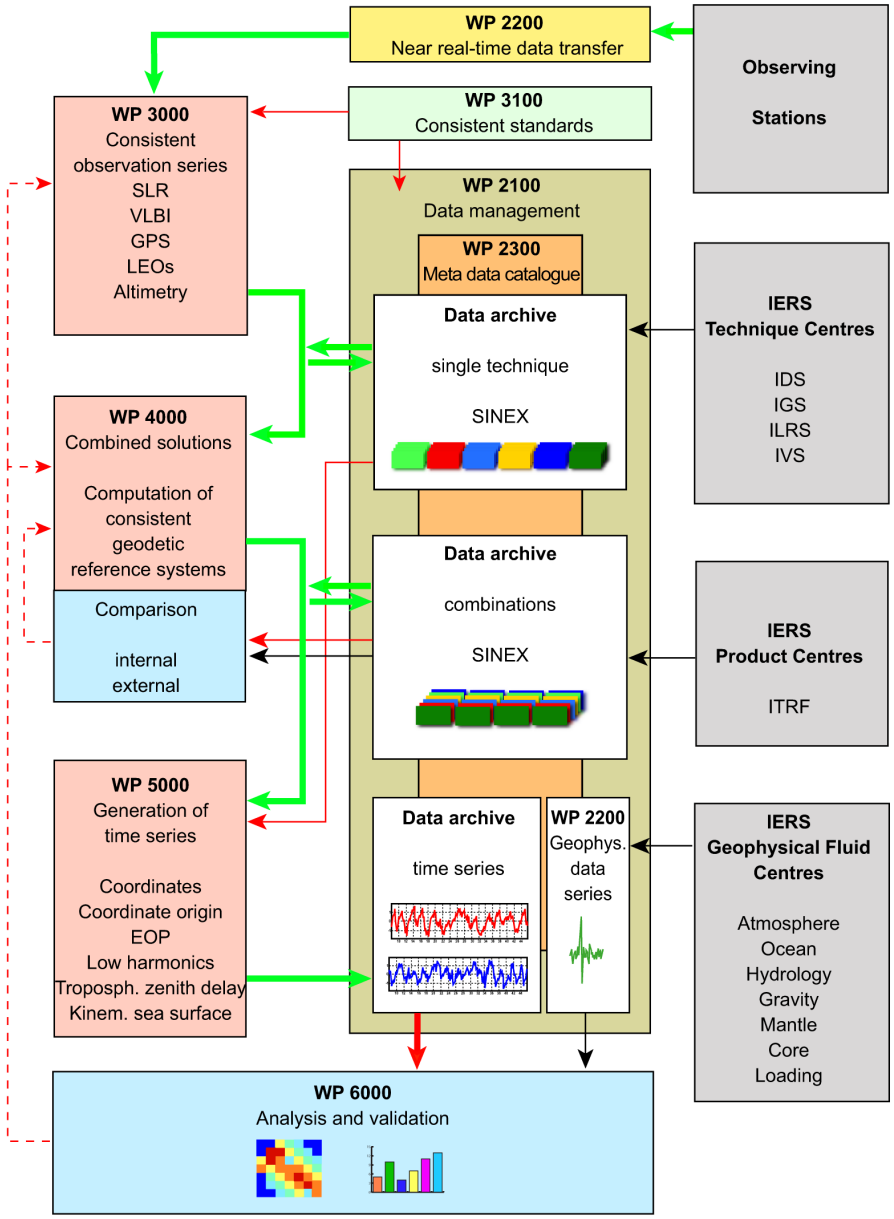
Overview (cont.)

- Data and Information System
- Standards, models and parameters for consistent processing
  - within techniques
  - for combination
- Generation of consistent reference frames through combination
  - quasar positions
  - satellite orbits
  - Earth orientation parameters
  - site coordinates and velocities
  - low degree harmonics of the gravity field
  - sea surface heights
- Generation of consistent time series (incl. Troposphere)
- Investigations of correlations between time series
- Comparisons and validation with external geophysical data

Work Packages

Technique	Work package	Institution	Software	Period
SLR	WP3200	DGFI	DOGS	1984-2006
SLR	WP3200	GFZ	EPOS	1984-2006
VLBI	WP3300	DGFI	OCCAM	1984-2006
VLBI	WP3300	IGGB/BKG	CALC/SOLVE	1984-2006
GPS	WP3400	GFZ	EPOS	1994-2006
GPS	WP3400	GFZ	Bernese V5.0	1994-2006
LEOs	WP3500	GFZ	EPOS	2000-2006
Altimetrie	WP3600	DGFI	DGFI-Software	1992-2006

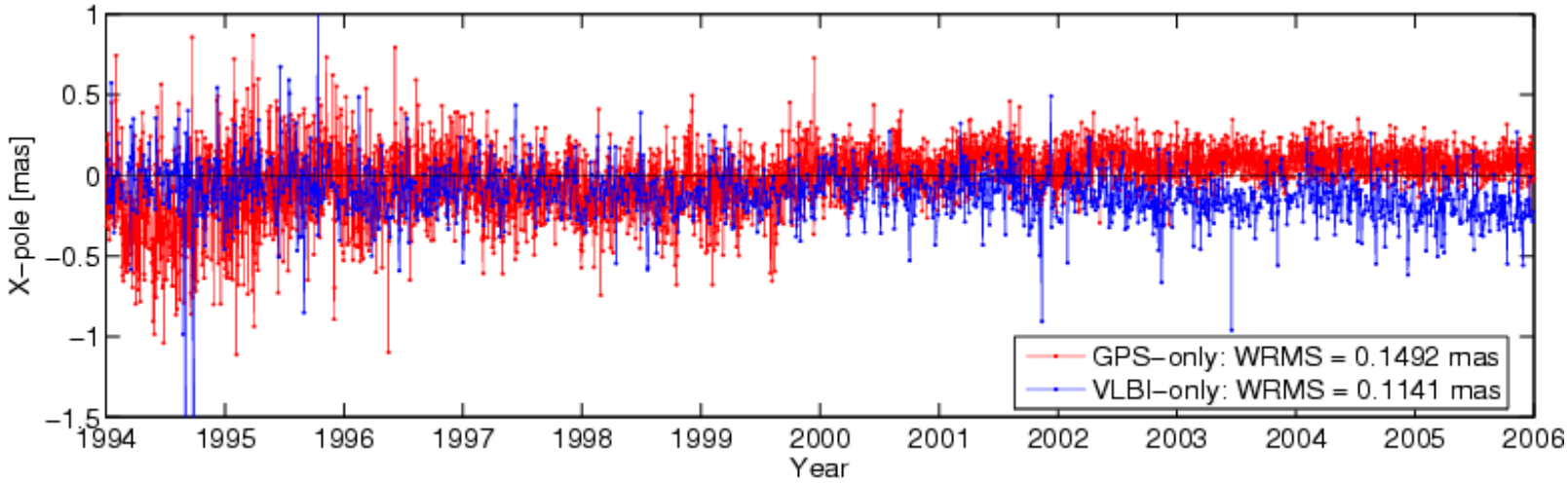
Data Flow

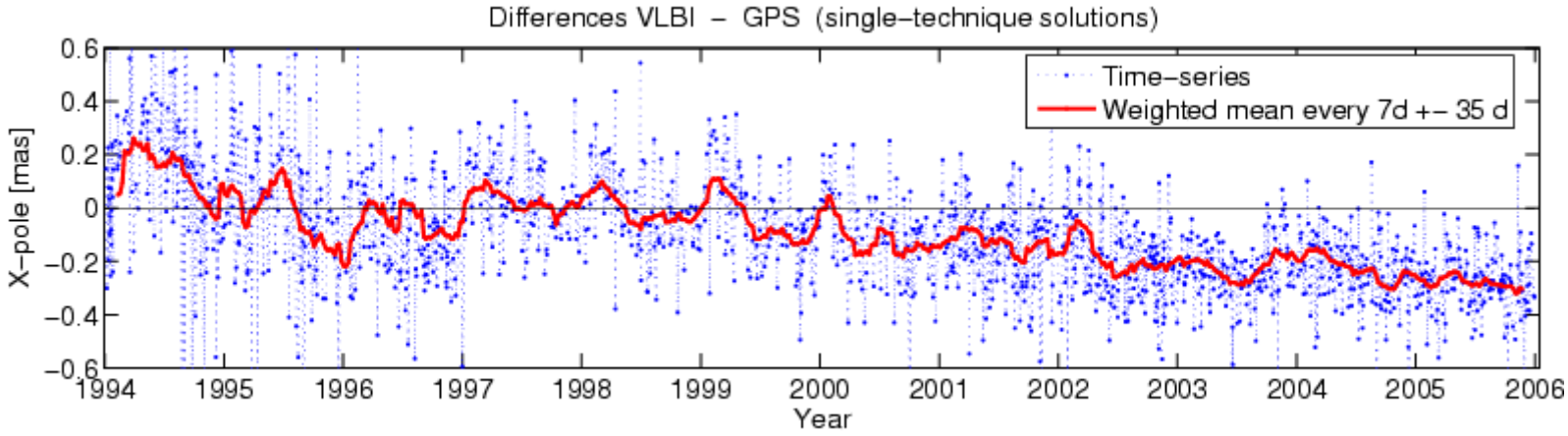

WP 2200
Near real-time data transfer
Observing
Stations
WP 3100
Consistent standards
WP 3000
Consistent
observation series
SLR
VLBI
GPS
LEOs
Altimetry
WP 2100
Data management
WP 2300
Meta data catalogue
Data archive
single technique
SINEX
IERS
Technique Centres
IDS
IGS
ILRS
IVS
WP 4000
Combined solutions
Computation of
consistent
geodetic
reference systems
Comparison
internal
external
Data archive
combinations
SINEX
IERS
Product Centres
ITRF
WP 5000
Generation of
time series
Coordinates
Coordinate origin
EOP
Low harmonics
Troposph. zenith delay
Kinem. sea surface
Data archive
time series
WP 2200
Geophys.
data
series
IERS
Geophysical Fluid
Centres
Atmosphere
Ocean
Hydrology
Gravity
Mantle
Core
Loading
WP 6000
Analysis and validation

Models and Parametrization

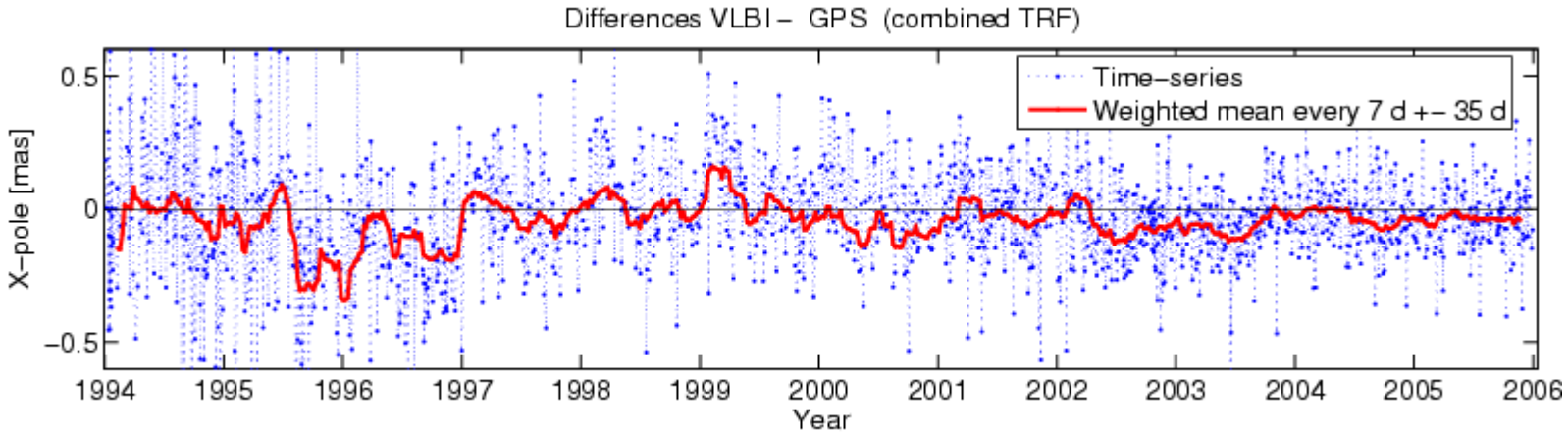
1. Identical models
   * IERS 2003 Conventions
   * hydrostatic zenith delay (from ECMWF)
   * tropospheric mapping function: VMF1
   * thermal deformation (identical implementation)
2. parametrization
   * Station coordinates, EOP, source positions
   * ZWD: 1h intervals as piece-wise linear functions
     At full hours i.e. 17.00, 18.00 ...
   * gradients: piece-wise linear with offsets at session boundaries

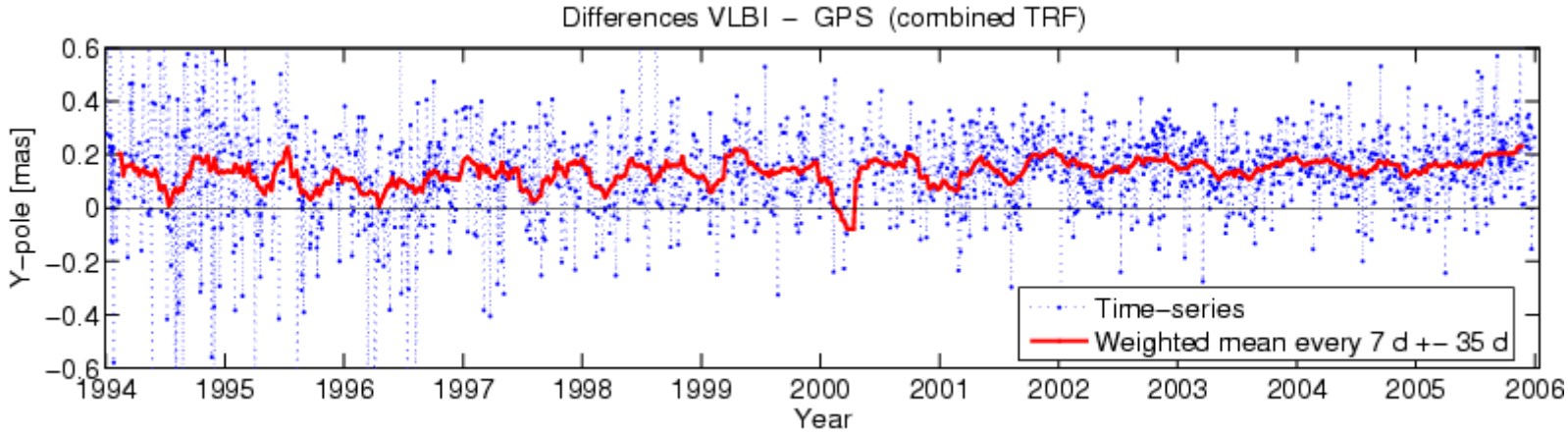
VLBI - GPS


X–pole [mas]
Year
GPS–only: WRMS = 0.1492 mas
VLBI–only: WRMS = 0.1141 mas


Differences VLBI – GPS (single–technique solutions)
X–pole [mas]
Year
Time–series
Weighted mean every 7d +– 35 d

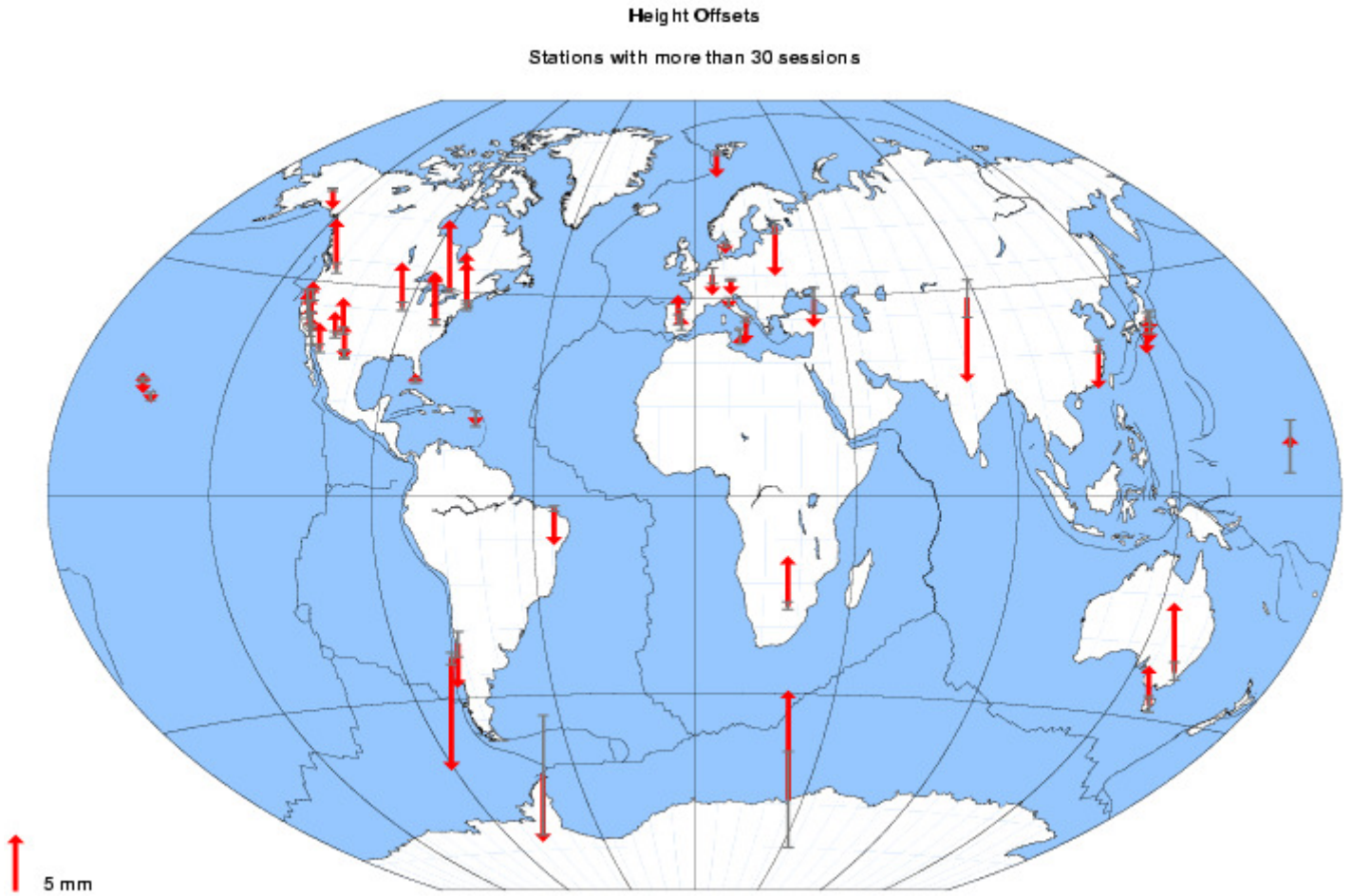
GGOS-D Combined TRF





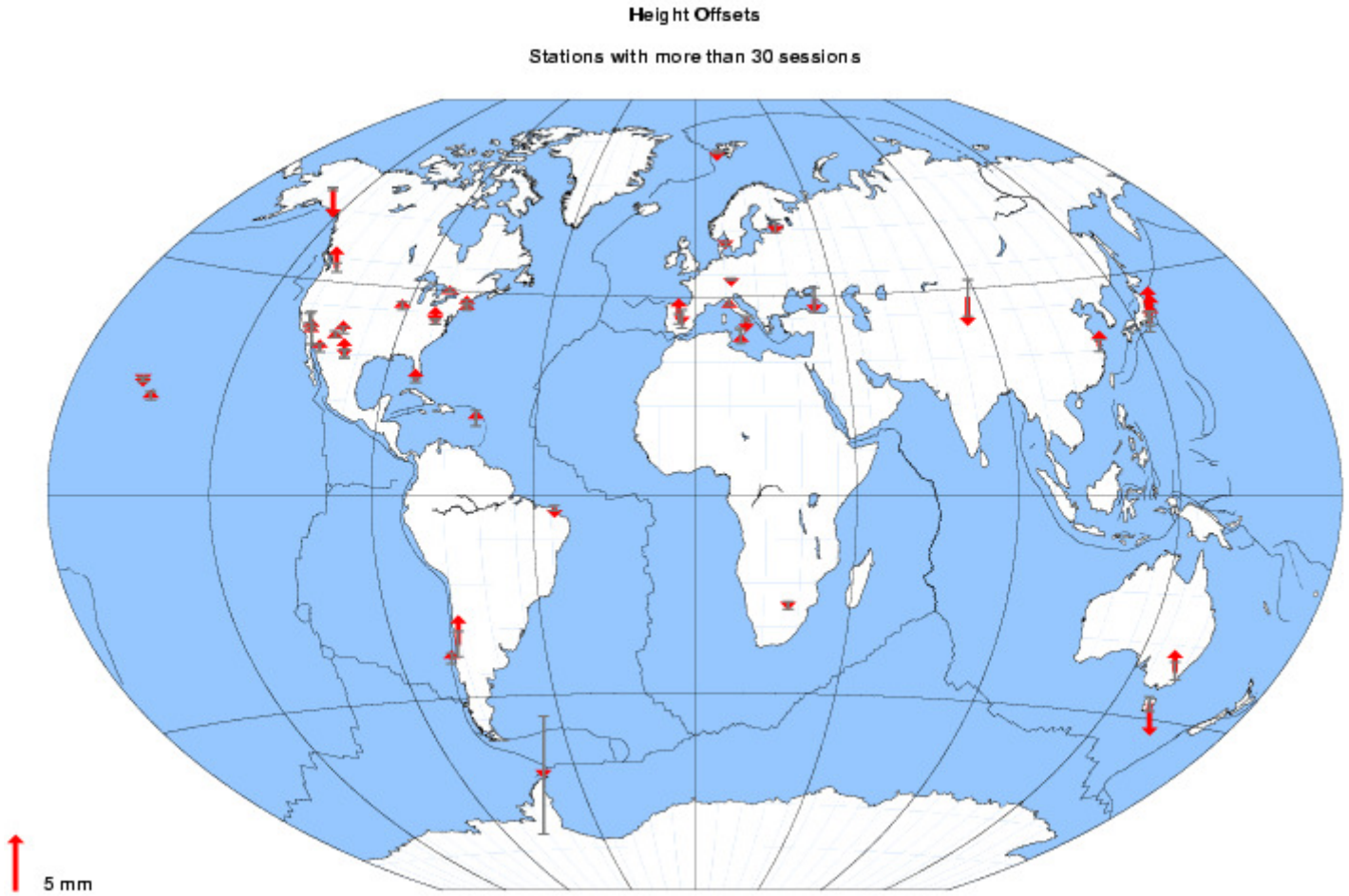
Pole tide: Effects on vertical component

IGGB(a) - DGFI

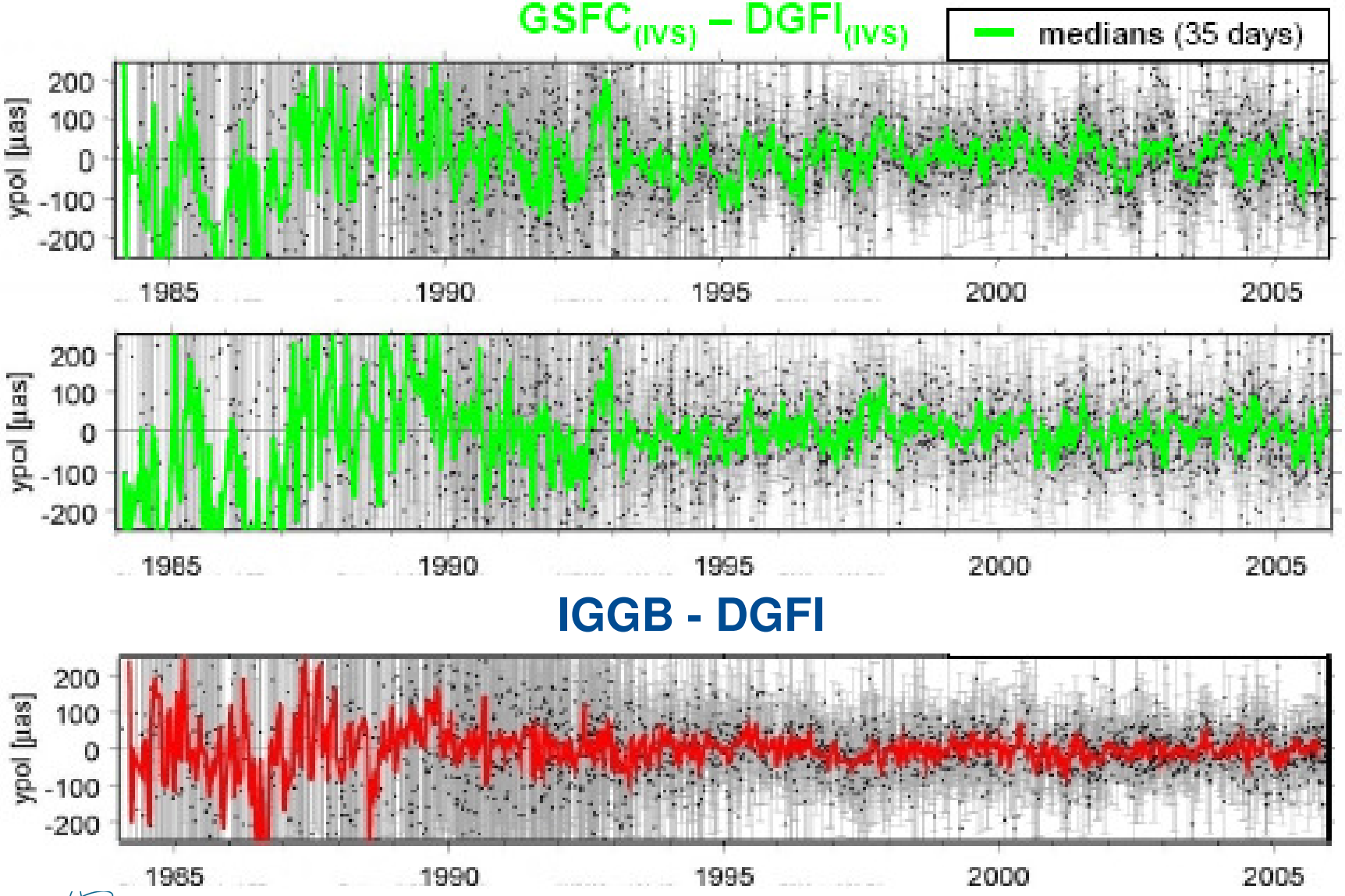


Identical pole tide model

IGGB(b) - DGFI



Pole tide effect on EOP estimates



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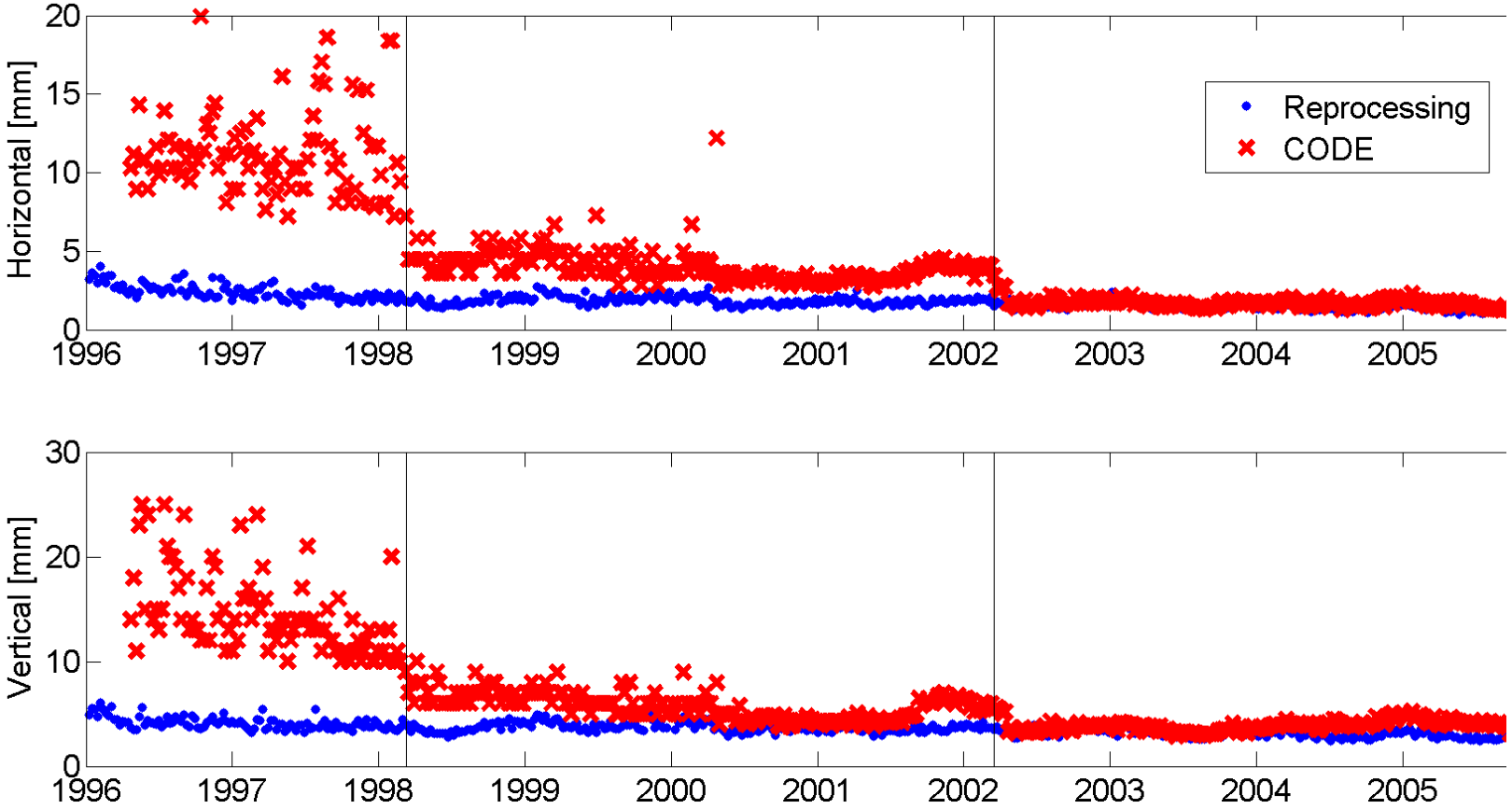
Quality of reprocessed GPS series

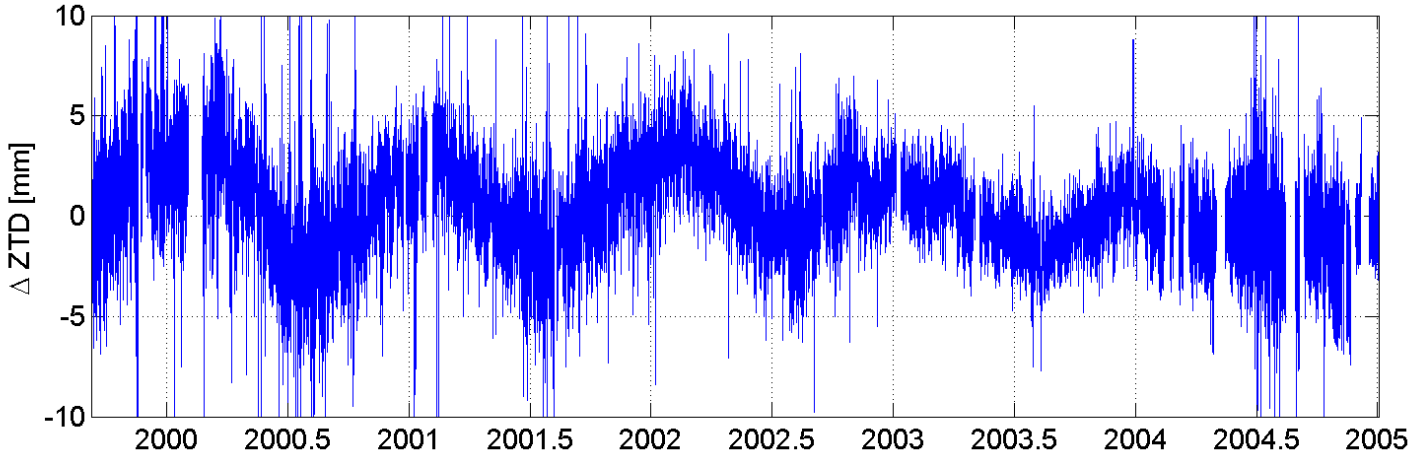
GGOS-D GPS Reprocessing (Bernese)



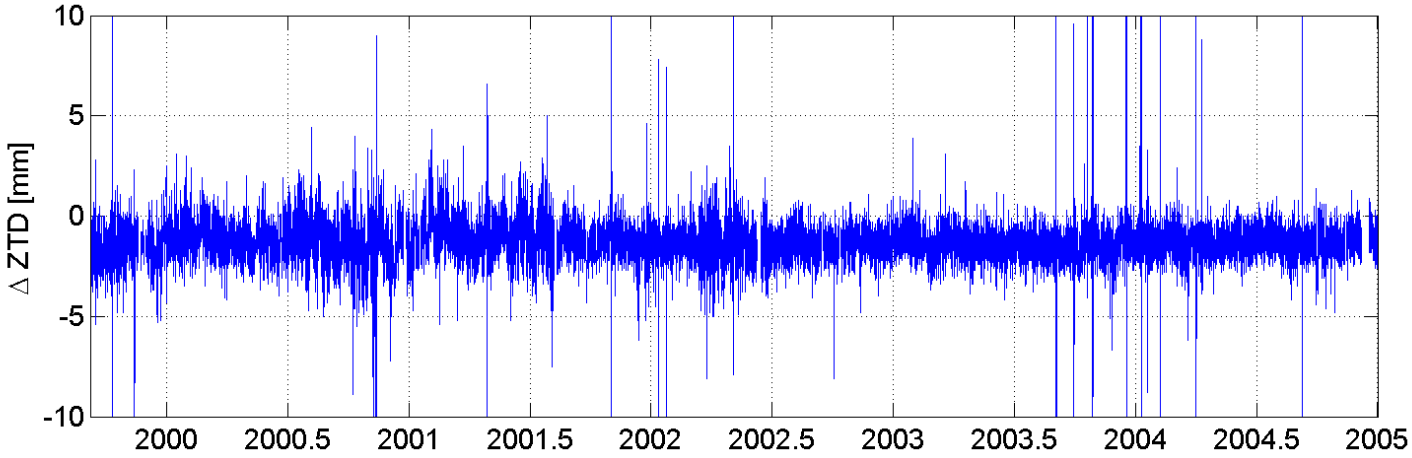
GGOS-D GPS Reprocessing (EPOS) in preparation

Troposphere results

Troposphere Ny Alesund (NYAL/NYA1)

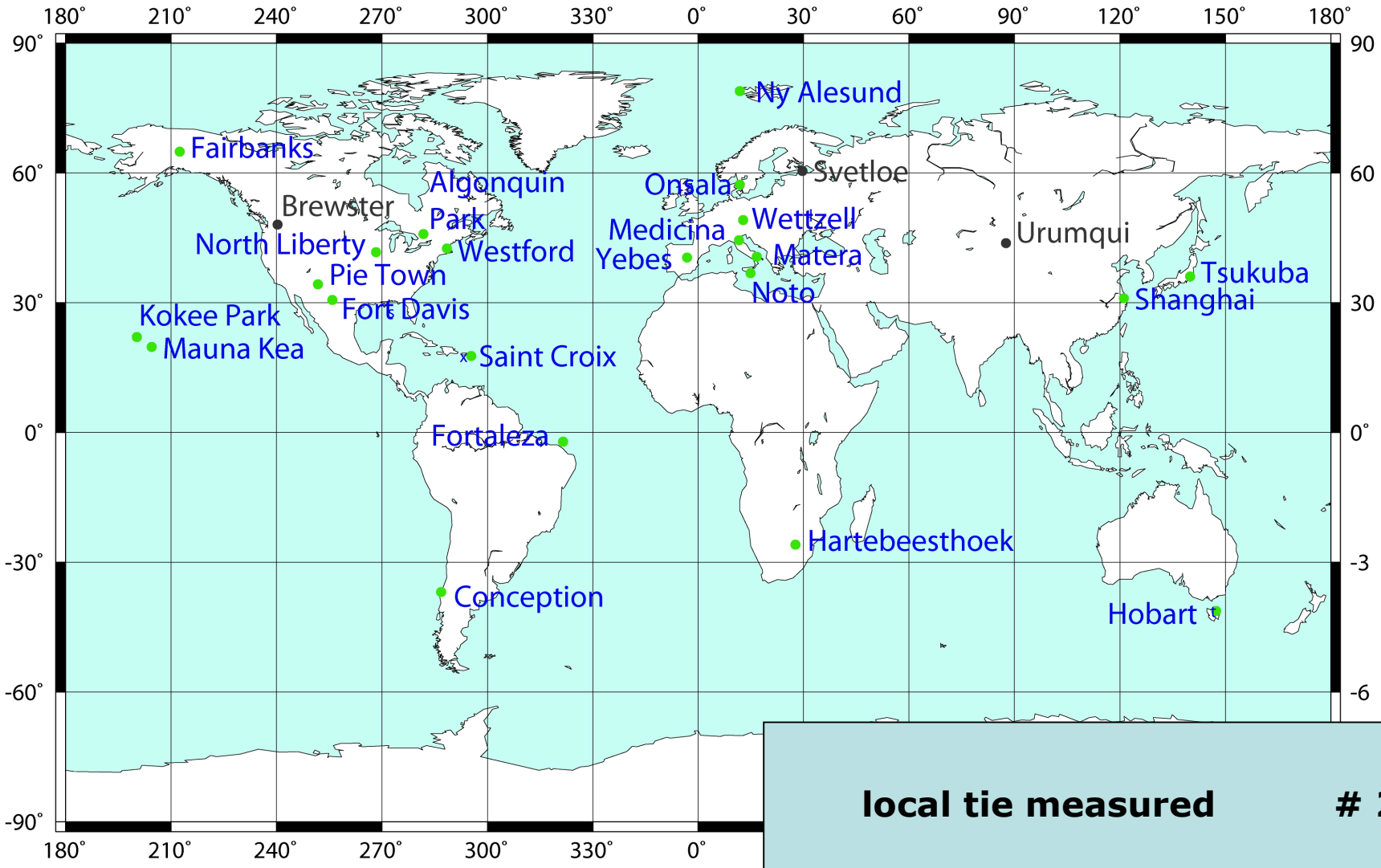


IGS



GGOS-D

Daily Combination of VLBI and GPS



local tie measured	**# 22**
local tie not measured	**# 3**

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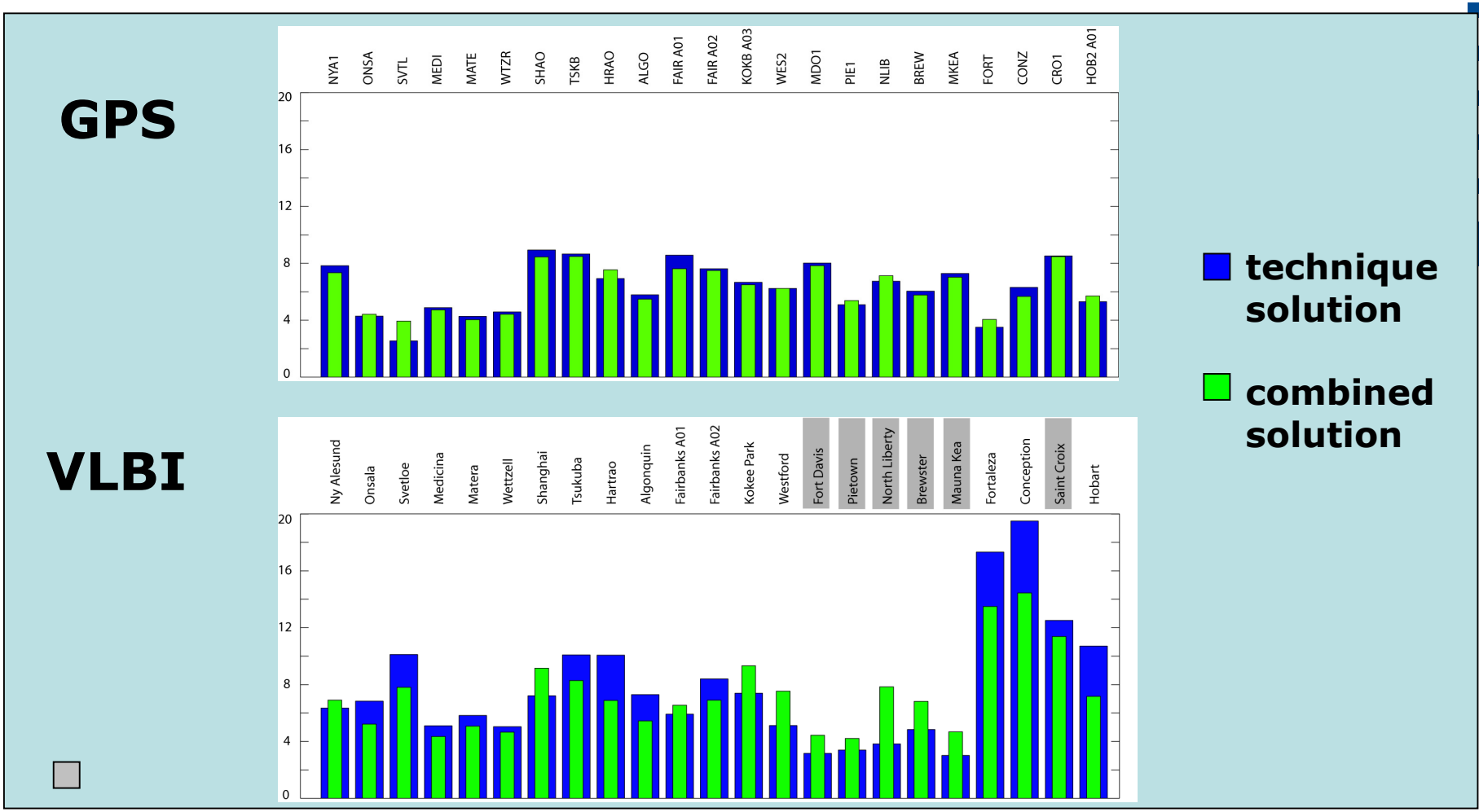
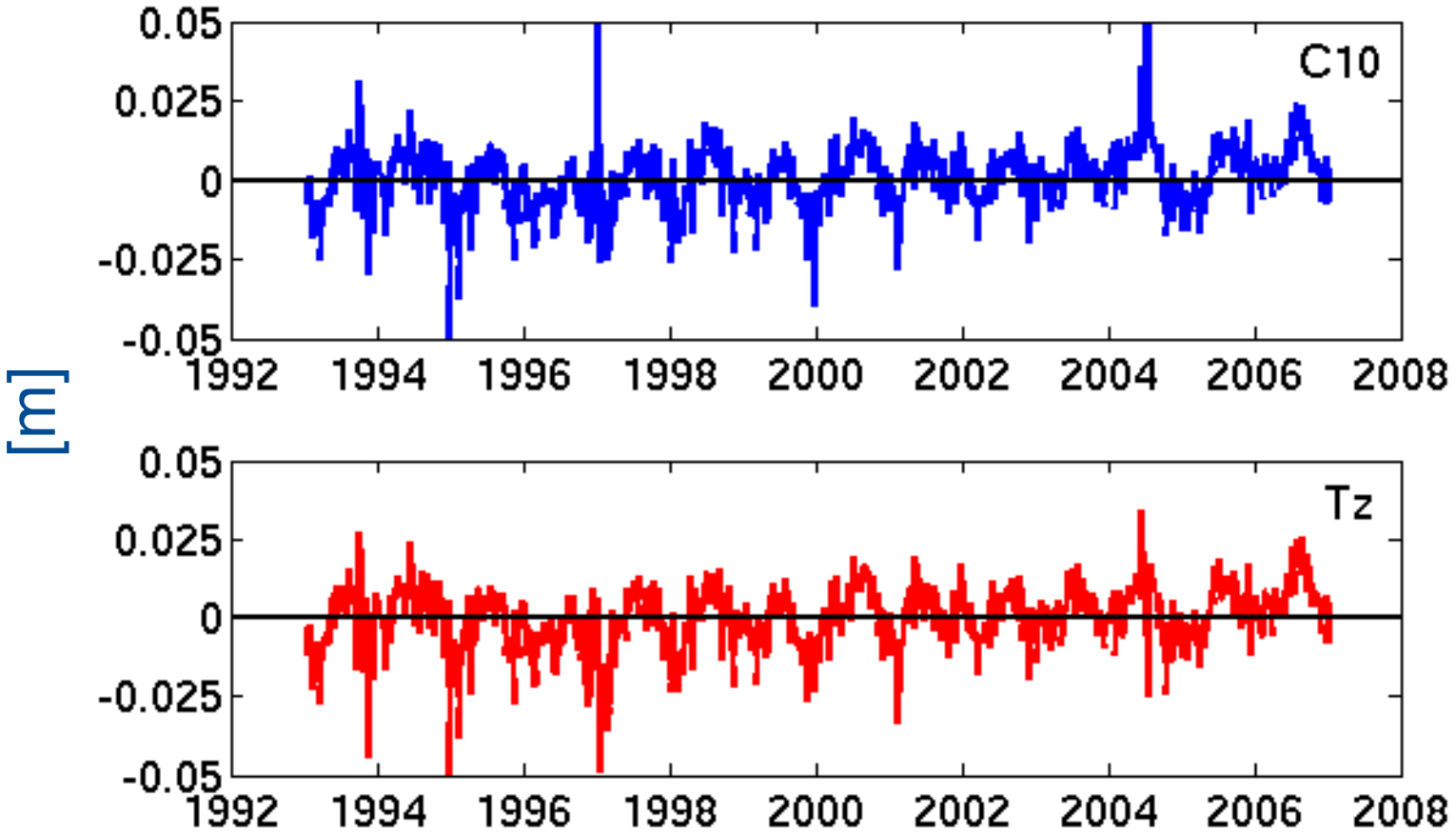
Repeatabilitiy of station heights [mm]

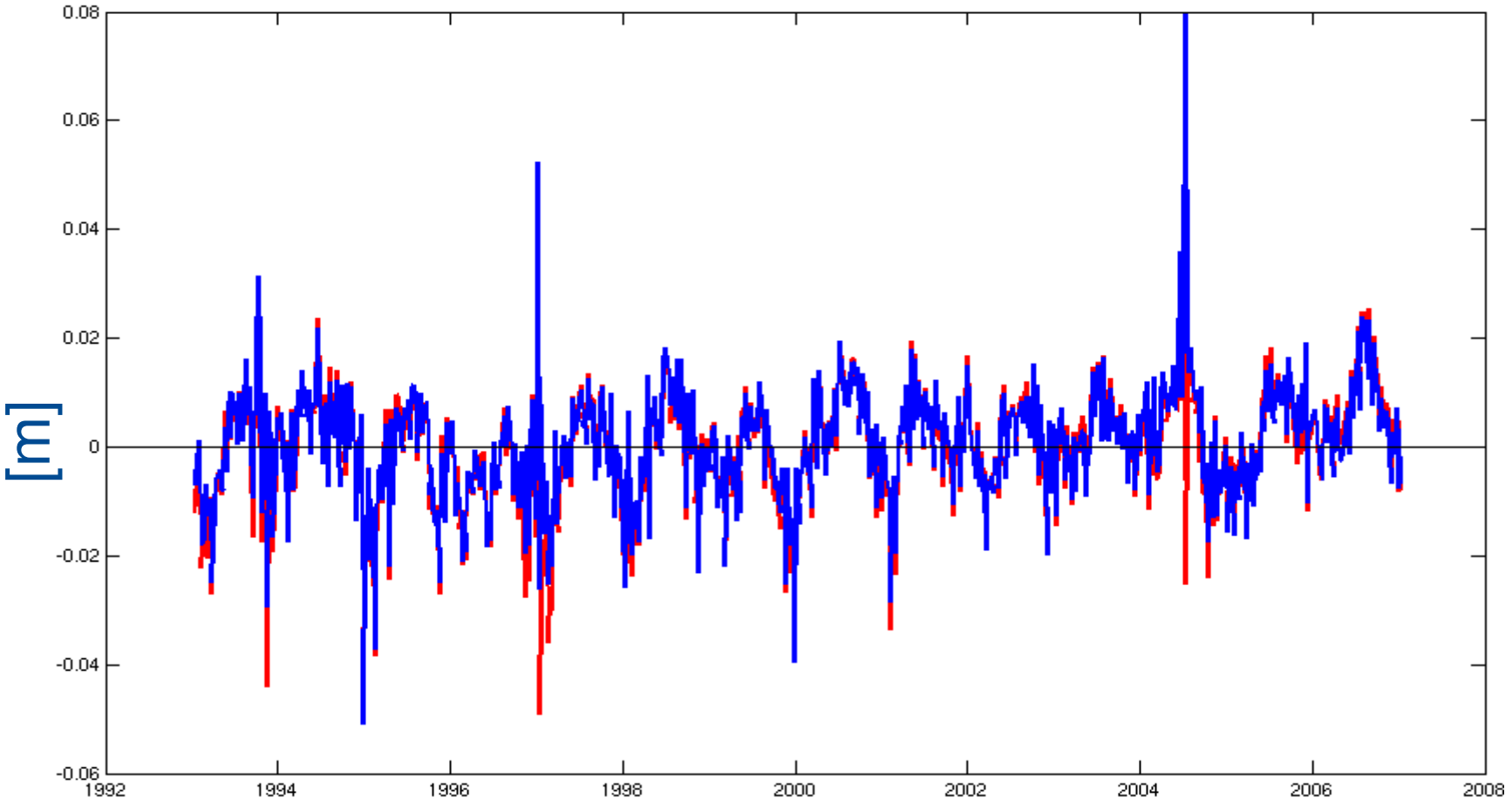


SLR Solution



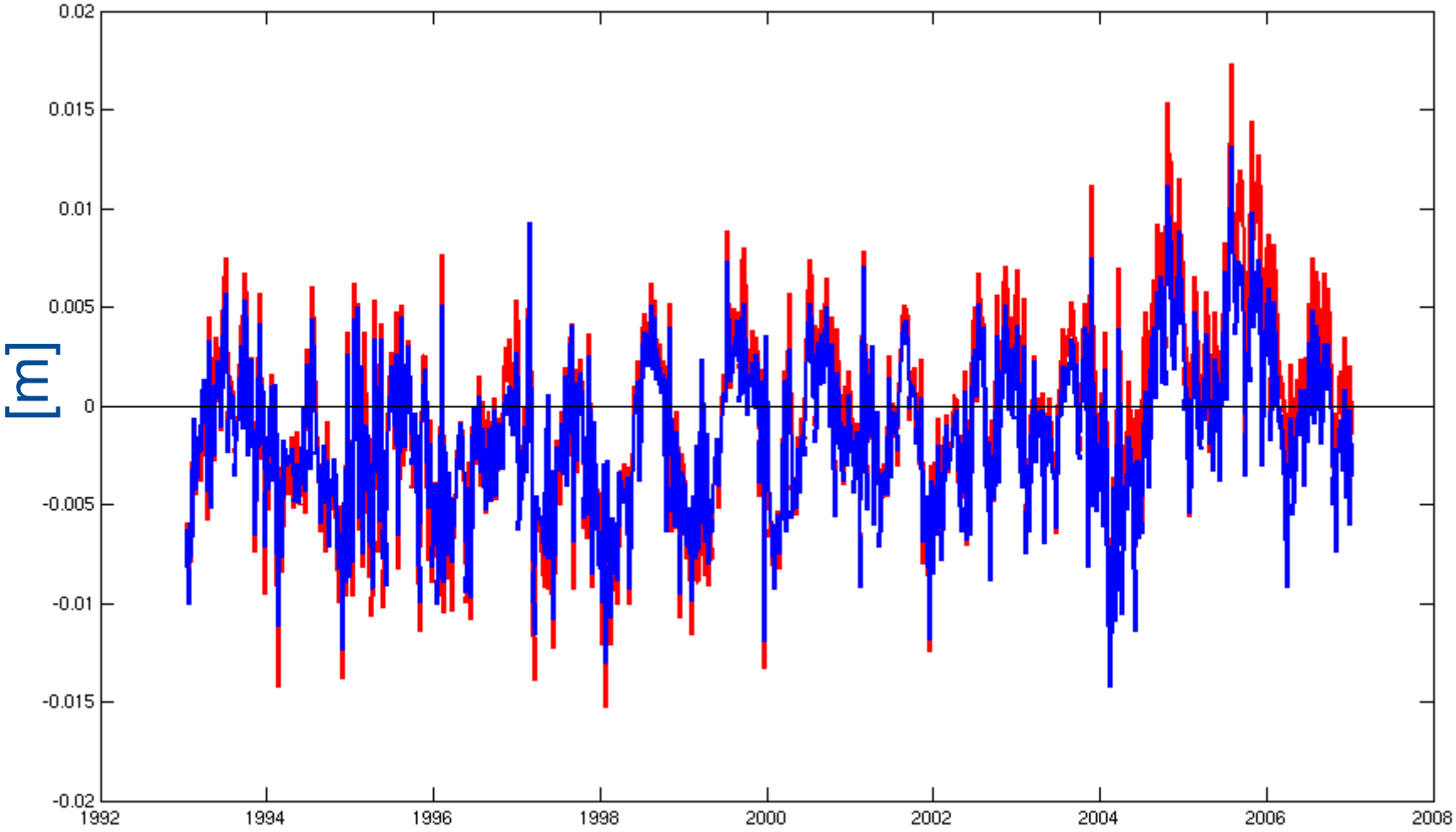
SLR Solution

C_{10} (blue) – Tz (red)



SLR Solution

C_{11} (blue) – Tx (red)



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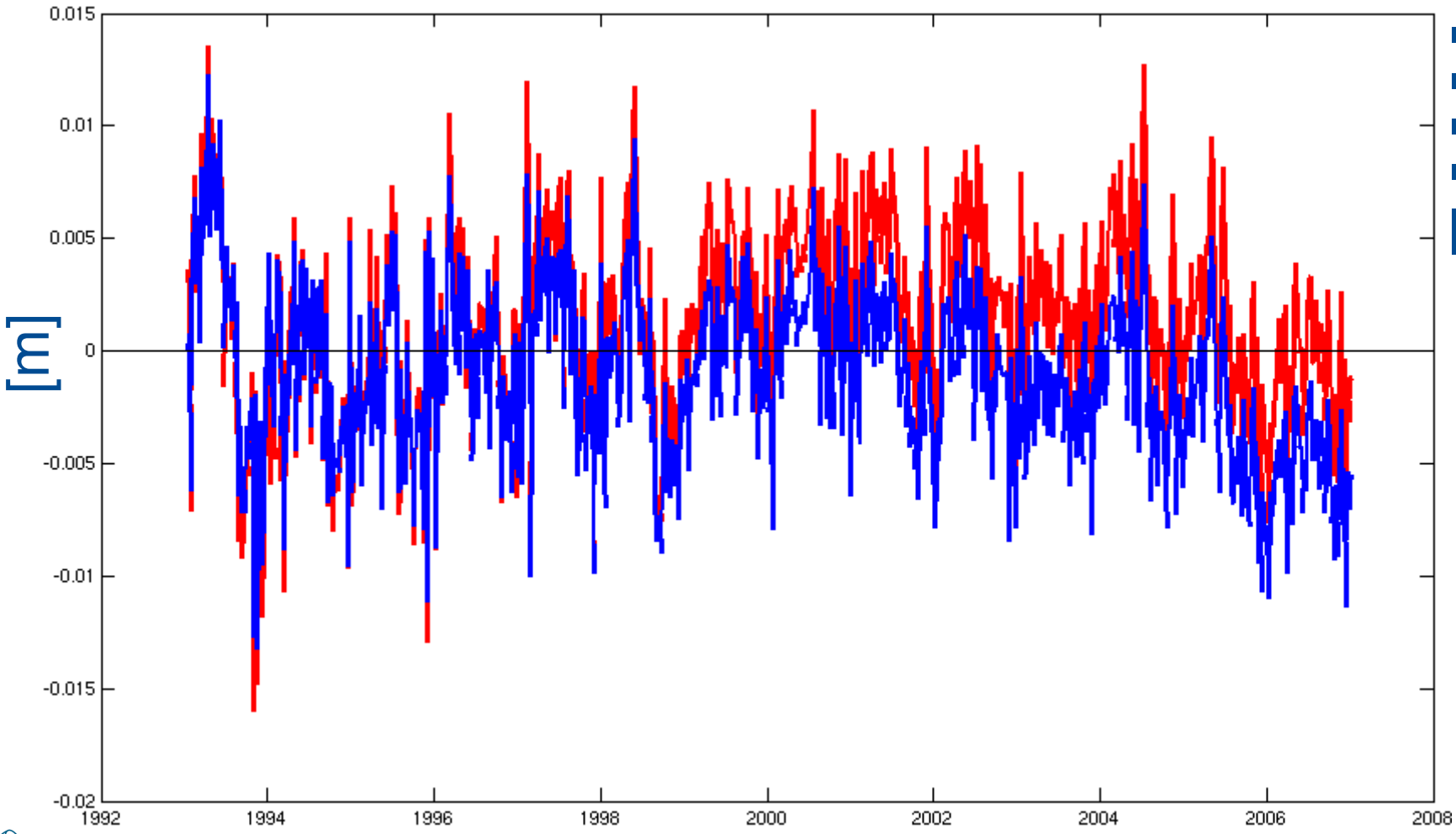
SLR Solution

S_{11} (blue) – Ty (red)

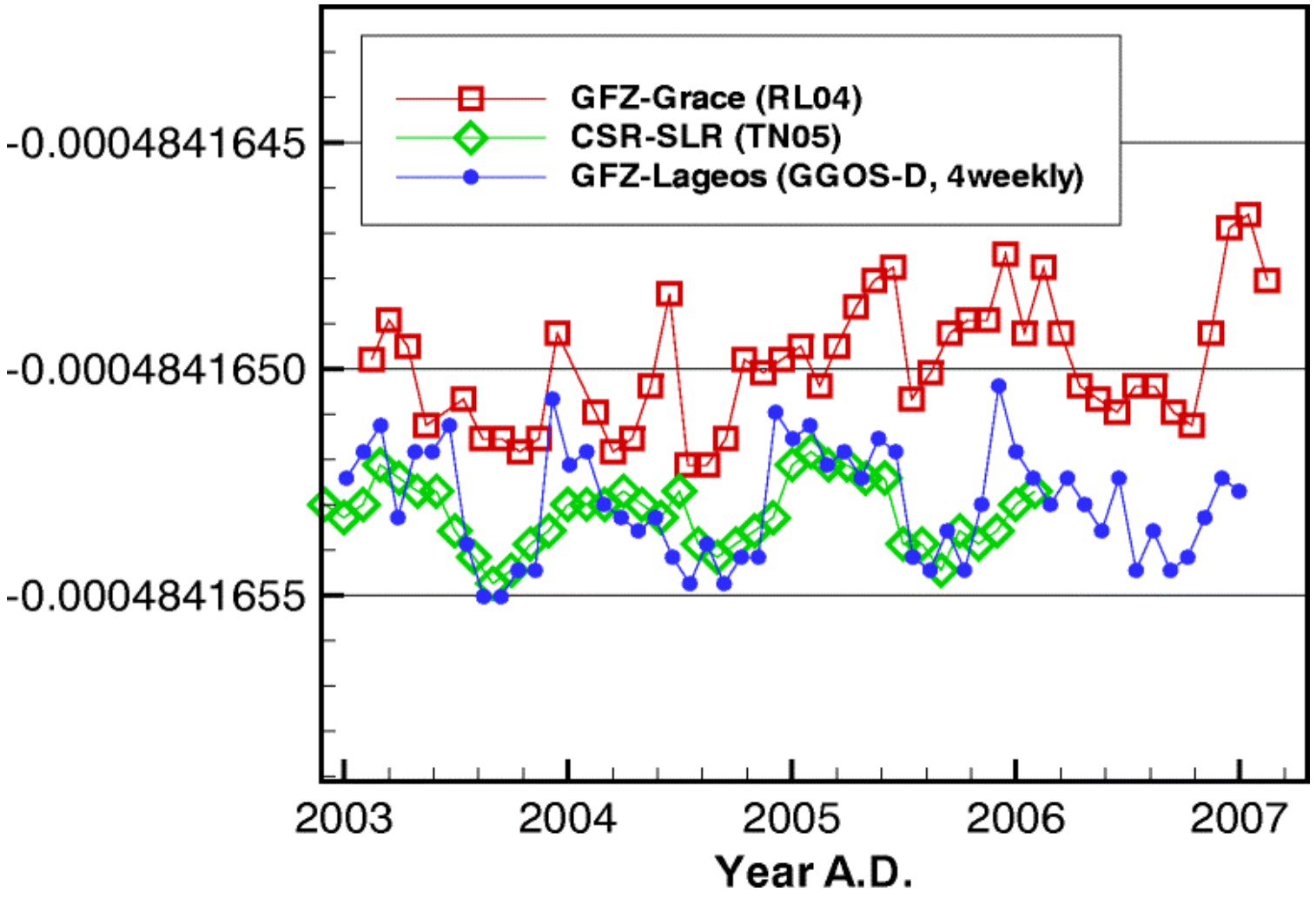


SLR and Integrated processing

Constellation	SLR	Integrated
satellites	Lageos 1 / Lageos 2	GPS / CHAMP / GRACE
observations	SLR normal points (ILRS)	GPS ground (IGS and GFZ networks) GPS SST (CHAMP, GRACE) K-Band (GRACE) SLR normal points (ILRS), low-weighted accelerations, thruster firings
estimated parameters	station coordinates low-degree harmonics (n,m $\leq$ 2) polar motion, UT1 auxiliary parameters	station coordinates low-degree harmonics (n,m $\leq$ 2) polar motion, UT1 auxiliary parameters
fit of orbits	RMS of laser residuals: 1 cm	RMS of laser residuals : 4 cm RMS of GPS phase residuals: 0.5 cm

SLR and Integrated processing

C_{20} Time Series



Altimetry

- Computation of variations of harmonic coefficients up to degree and order 2 completed
- Effect of atmosphere not yet corrected for