Some Aspects Concerning the SLR Part of ITRF2005

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Motivation

- Significant scale difference between IGN and DGFI ITRF2005 realisations.

- Scale of actual ILRS SLR solutions is not compatible with IGN ITRF2005.

- DGFI uses different strategy for the combination, which results in a different scale and scale rate.

- Evaluation of the scale difference of the two solutions is necessary.

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ITRF2005 - Overview

- For the 1st time: Combination of time series solutions
  of station positions
  - 24 h sessions (VLBI)
    - Weekly (GPS, SLR and DORIS)

   and Earth Orientation Parameters (EOP):
  - Polar motion (x_p, y_p)
  - Universal Time (UT1); only from VLBI
  - Length of Day (LOD)

- 3 ITRF Combination Centres: DGFI, IGN, NRCan

Computation methodology at DGFI

- General concept: Combination on the normal equation level
- Software: DGFI Orbit and Geodetic Parameter Estimation Software (DOGS)
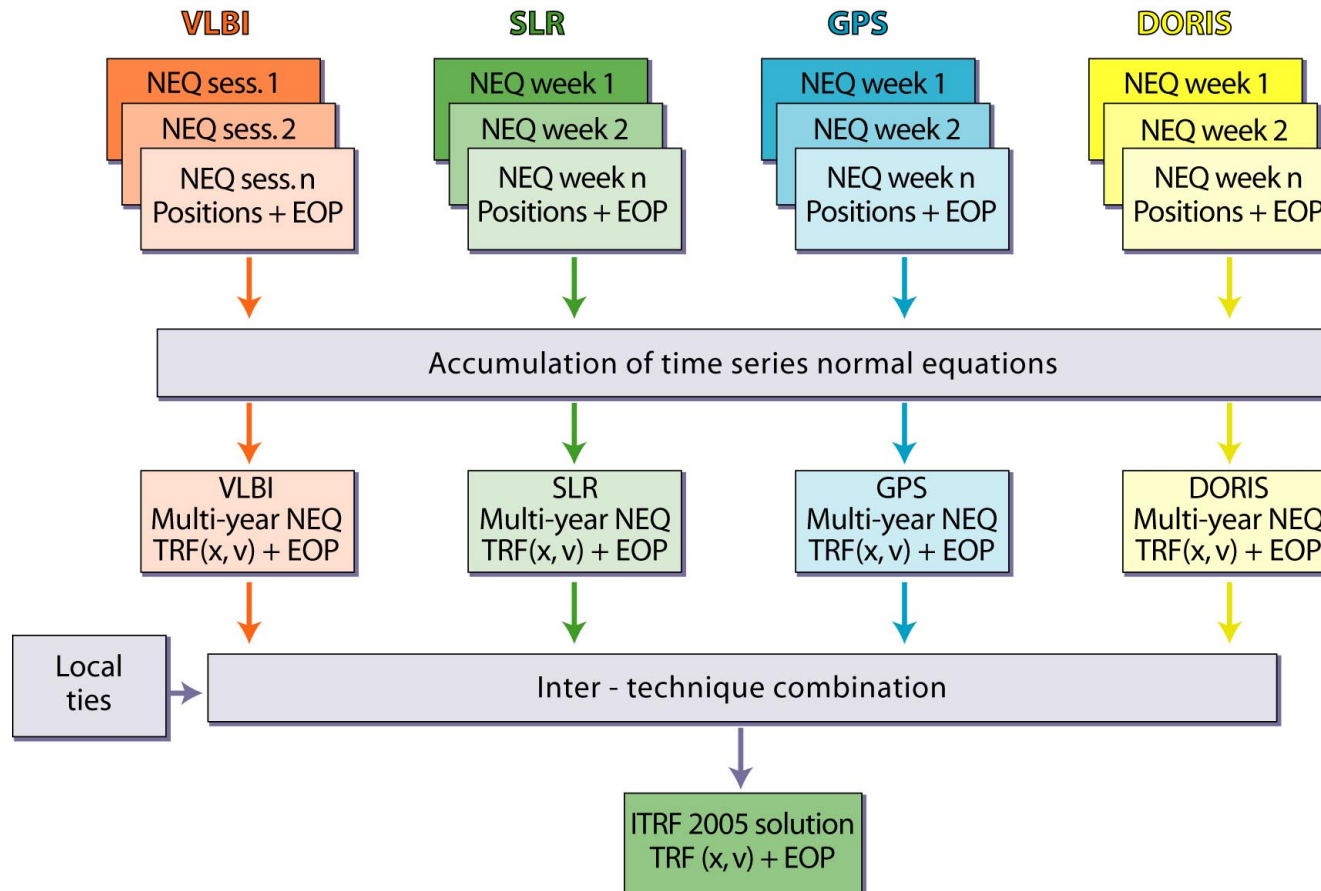
Accumulation of time series NEQ's per technique

- Generation of NEQ's from ITRF2005 input data sets.

- Accumulation of epoch NEQ's per technique.

- Using discontinuities provided by the services.

- Analysis of time series solutions (e.g., nonlinear effects, outliers).

- Equating of station velocities
  for different solution ID's, if they
  are statistically identical.

- The resulting intra-technique NEQ's
 contain station positions, velocities and daily EOP.

Example: GPS station Hofn

Sol ID 1   Sol ID 2
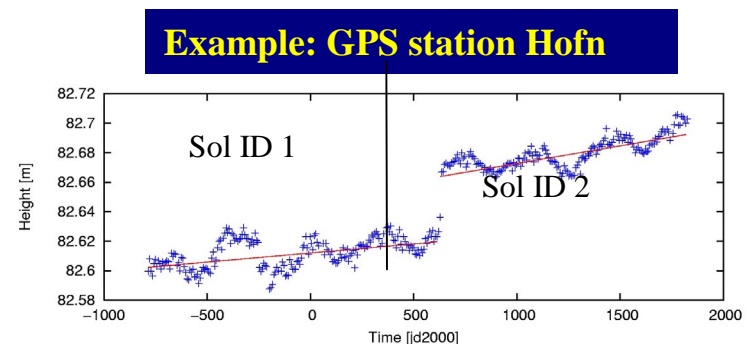
Realization of the geodetic datum

- **Origin**: SLR.

- **Scale**: Weighted mean of SLR and VLBI data.

- **Orientation**: No-Net-Rotation (NNR) conditions w.r.t. ITRF2000 (consistent with BIH1984 definition).

- **Orientation time evolution**: NNR conditions w.r.t. horizontal tectonic motions over the whole Earth by using an Actual Plate Kinematic and Deformation Model (APKIM).

DGFI

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Station velocities of ITRF2005 (DGFI) solution
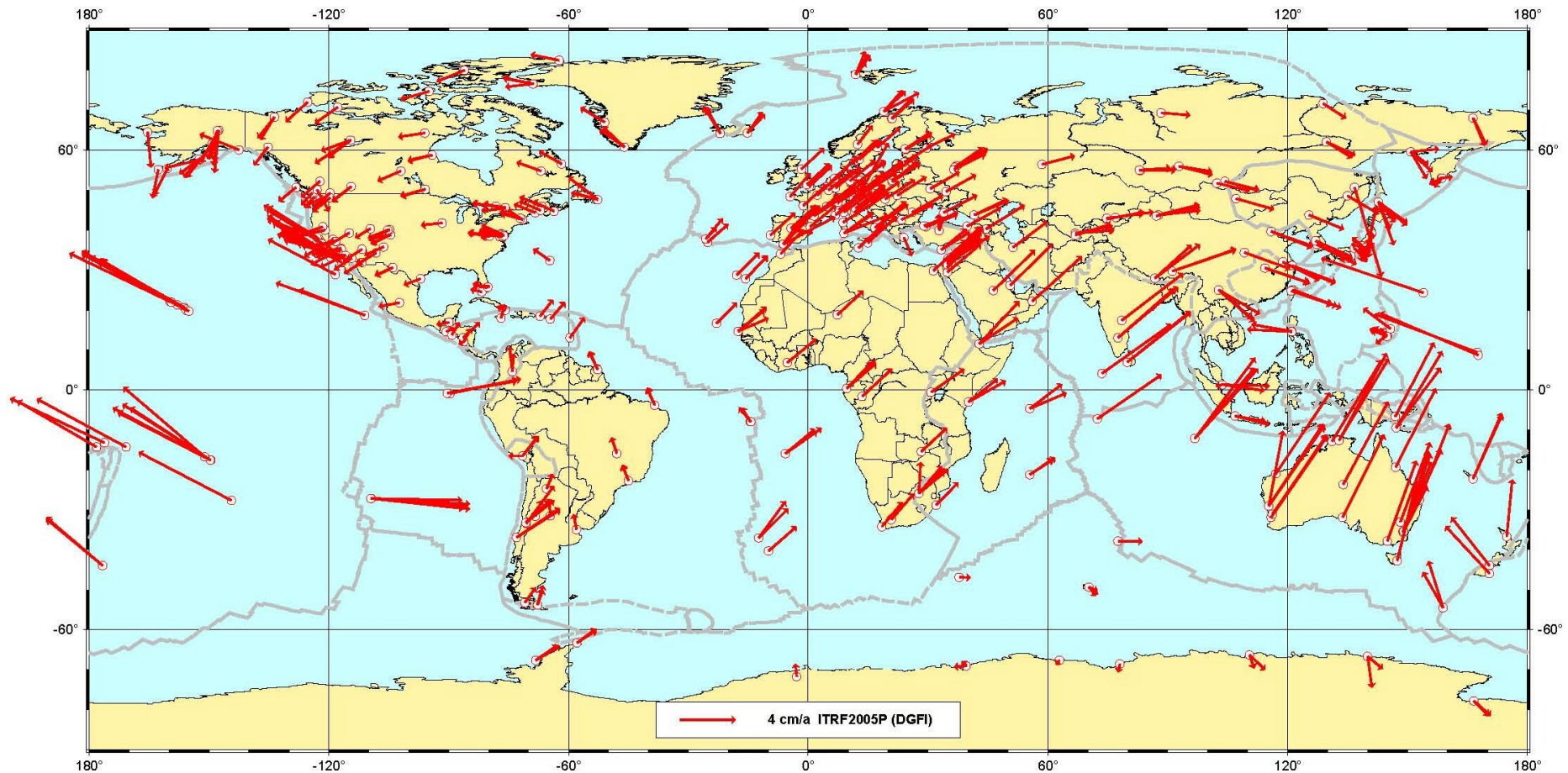
Comparison between IGN and DGFI ITRF2005P solutions (1/2)

RMS differences for „good" reference stations

after 14 parameter similarity transformations

(57 GPS, 25 VLBI, 22 SLR, 40 DORIS)

ITRF2005P DGFI - IGN	Positions [mm]	Velocities [mm/yr]
GPS	0.31	0.14
VLBI	0.79	0.34
SLR	1.82	0.66
DORIS	3.32	1.11

Comparison between IGN and DGFI ITRF2005P solutions (2/2)

Scale differences between IGN and DGFI solutions

(reference epoch: 2000.0)

	SLR		VLBI	
	offset [ppb]	drift [ppb/yr]	offset [ppb]	drift [ppb/yr]
Pure intra-technique solutions (IGN – DGFI)	-0.17 ± 0.06	0.01 ± 0.02	0.16 ± 0.05	0.01 ± 0.02
ITRF2005 P solutions (IGN – DGFI)	**0.86 ± 0.12**	**0.13 ± 0.03**	-0.12 ± 0.06	0.03 ± 0.03

SLR scale difference at epoch 2006.5:
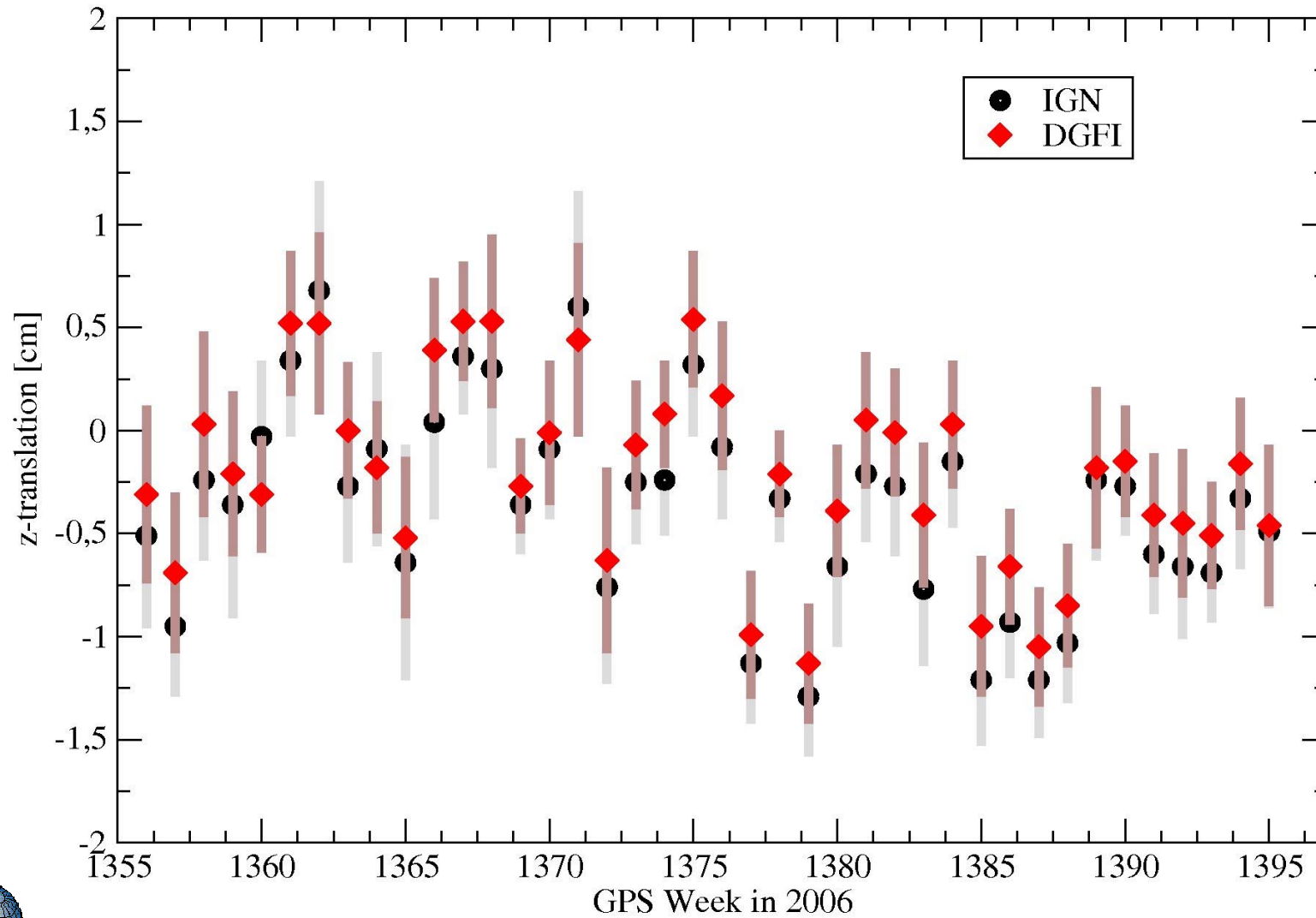
0.86 ppb + 6.5 yrs * 0.13 ppb/yr = **1.7 ppb**

⟹ **1.1 cm difference in SLR station heights !**

ITRF2005 scale compared to SLR(ILRSA solution)

IGN and DGFI solutions w.r.t. ILRSA weekly solutions
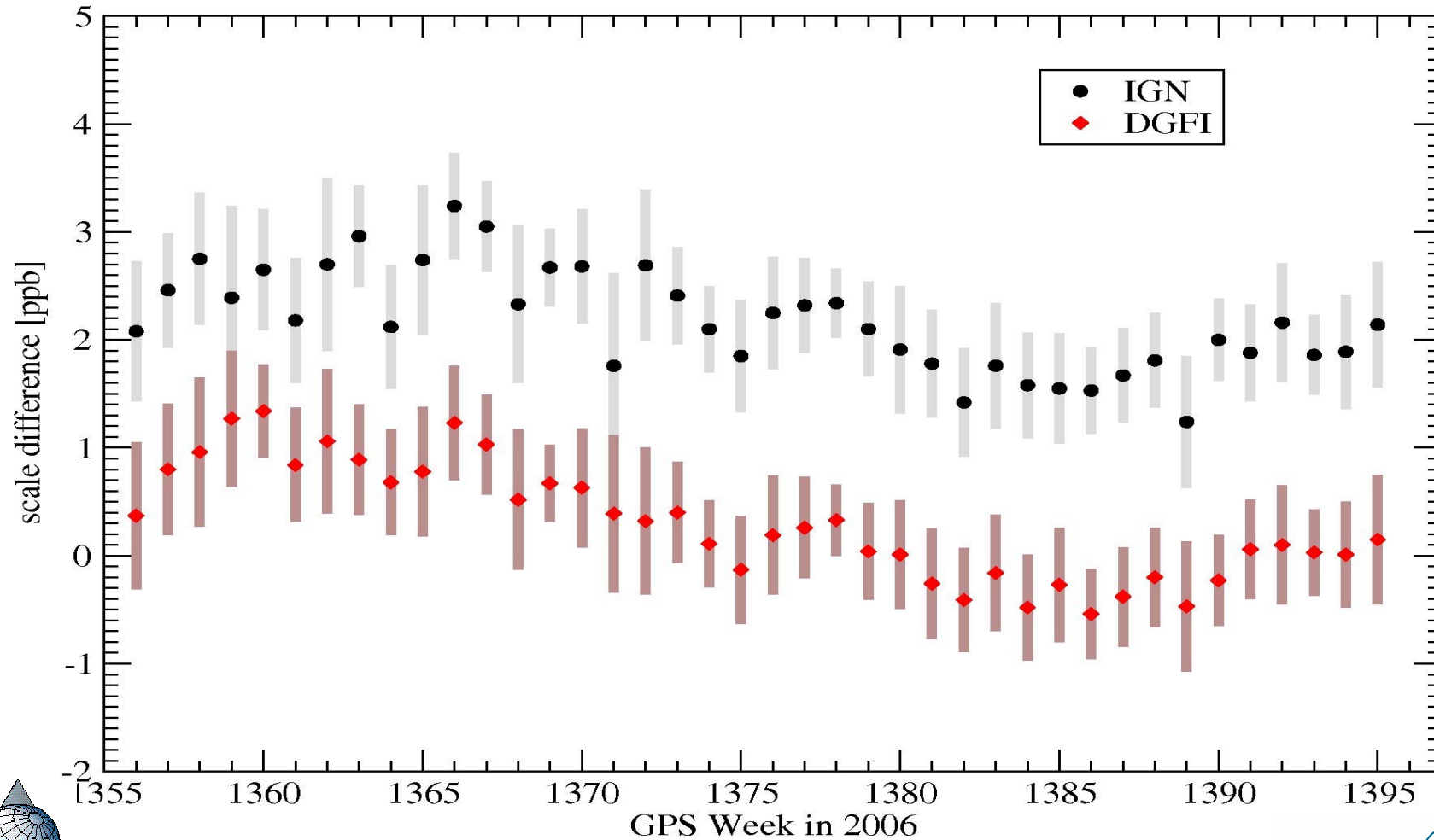
ITRF2005 z-translation compared to ILRSA

Investigations on SLR and VLBI scale of ITRF2005

- Transformation of SLR and VLBI solutions w.r.t. GPS.

- Selection of „good" co-location sites.

- Adding local ties to GPS station positions (identical networks).

- „Indirect" comparison of SLR and VLBI scale via GPS.

- The down weighting of the Australien sites and Tahiti resulted in a scale difference of 0.8 ppb between SLR and VLBI (same weighting as IGN solution)

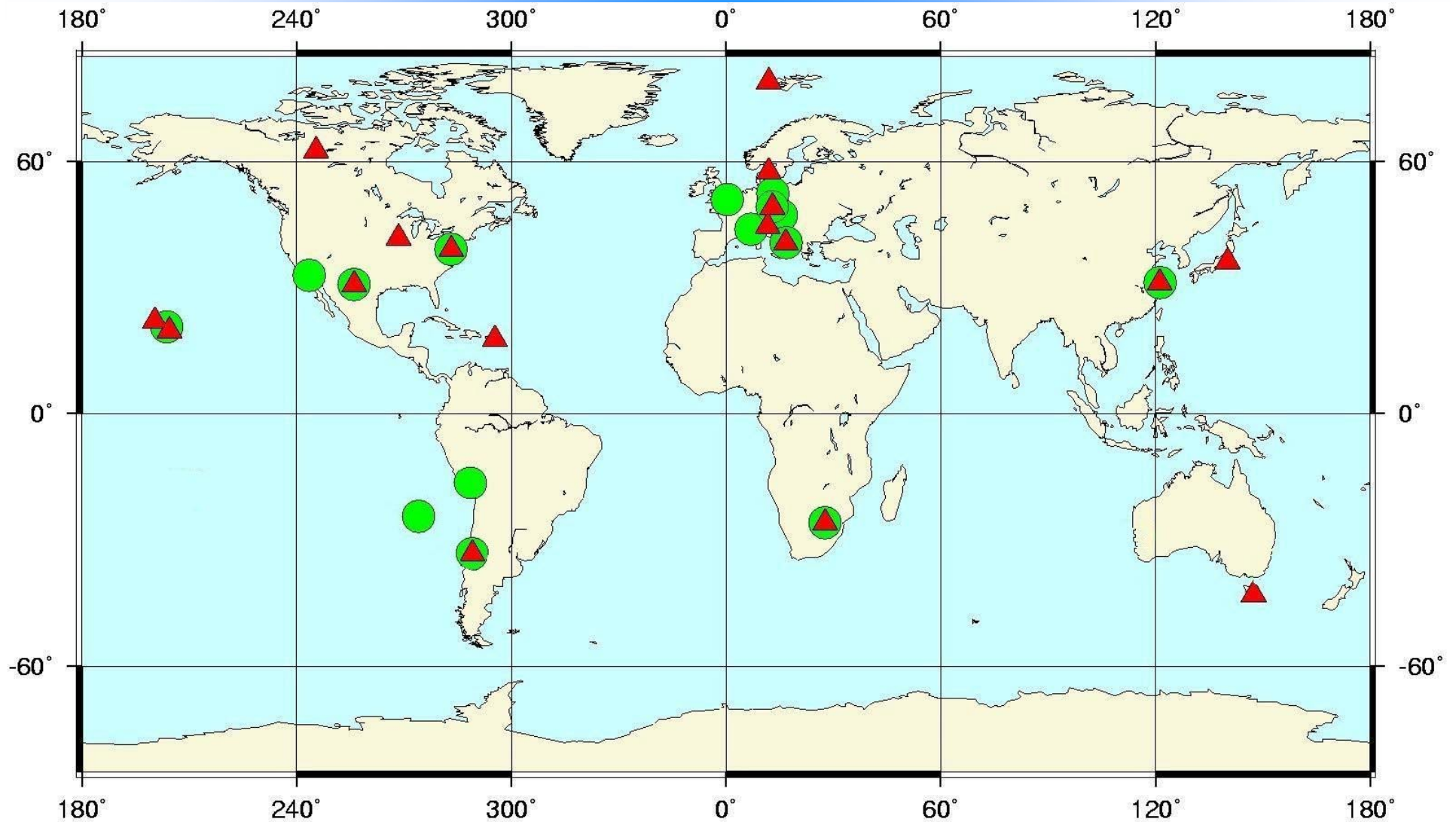# Investigations on SLR and VLBI scale of ITRF2005
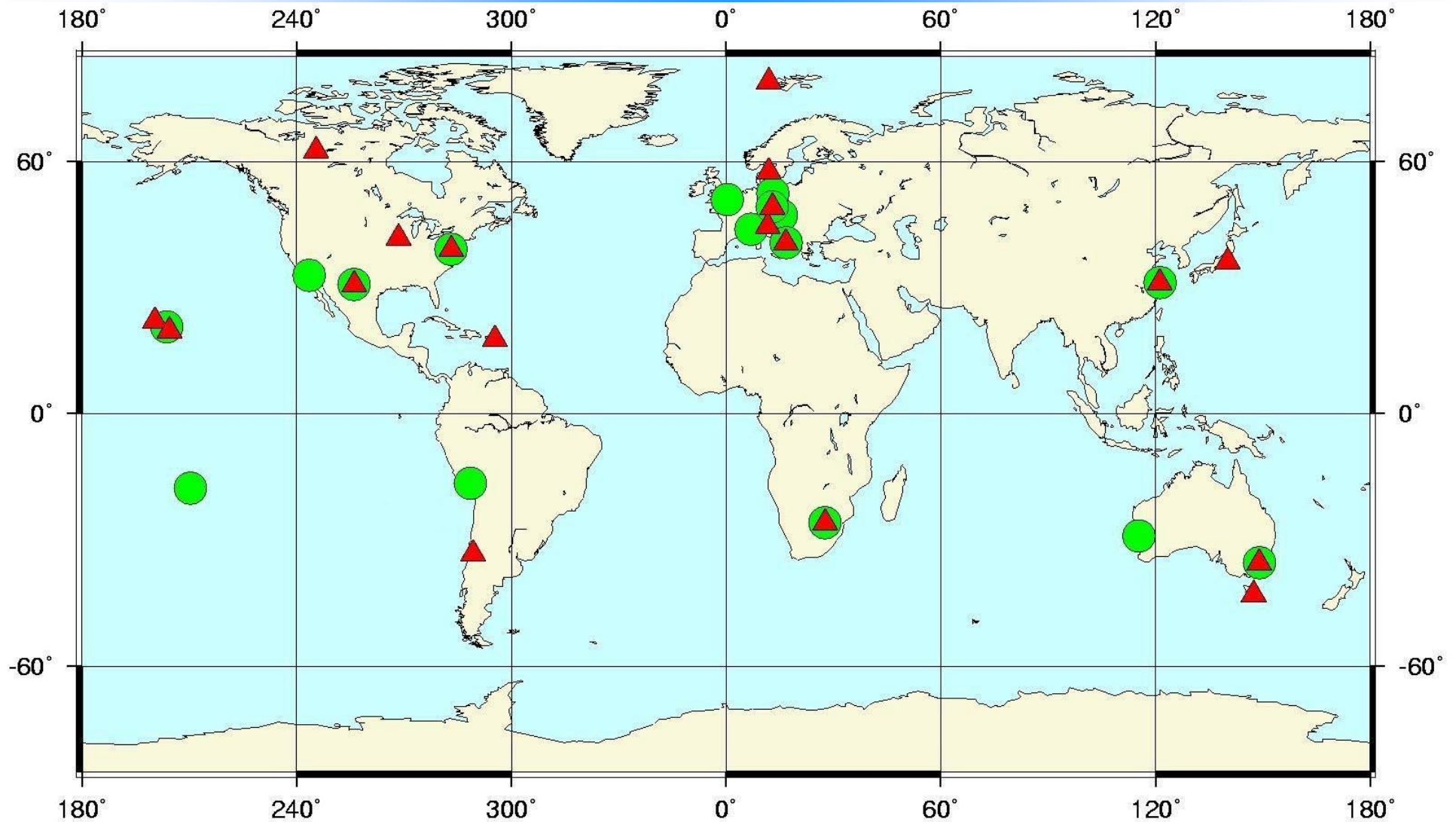
Co-location sites   ▲ **GPS – VLBI (18)**   ● **GPS – SLR (16)**

Investigations on SLR and VLBI scale of ITRF2005
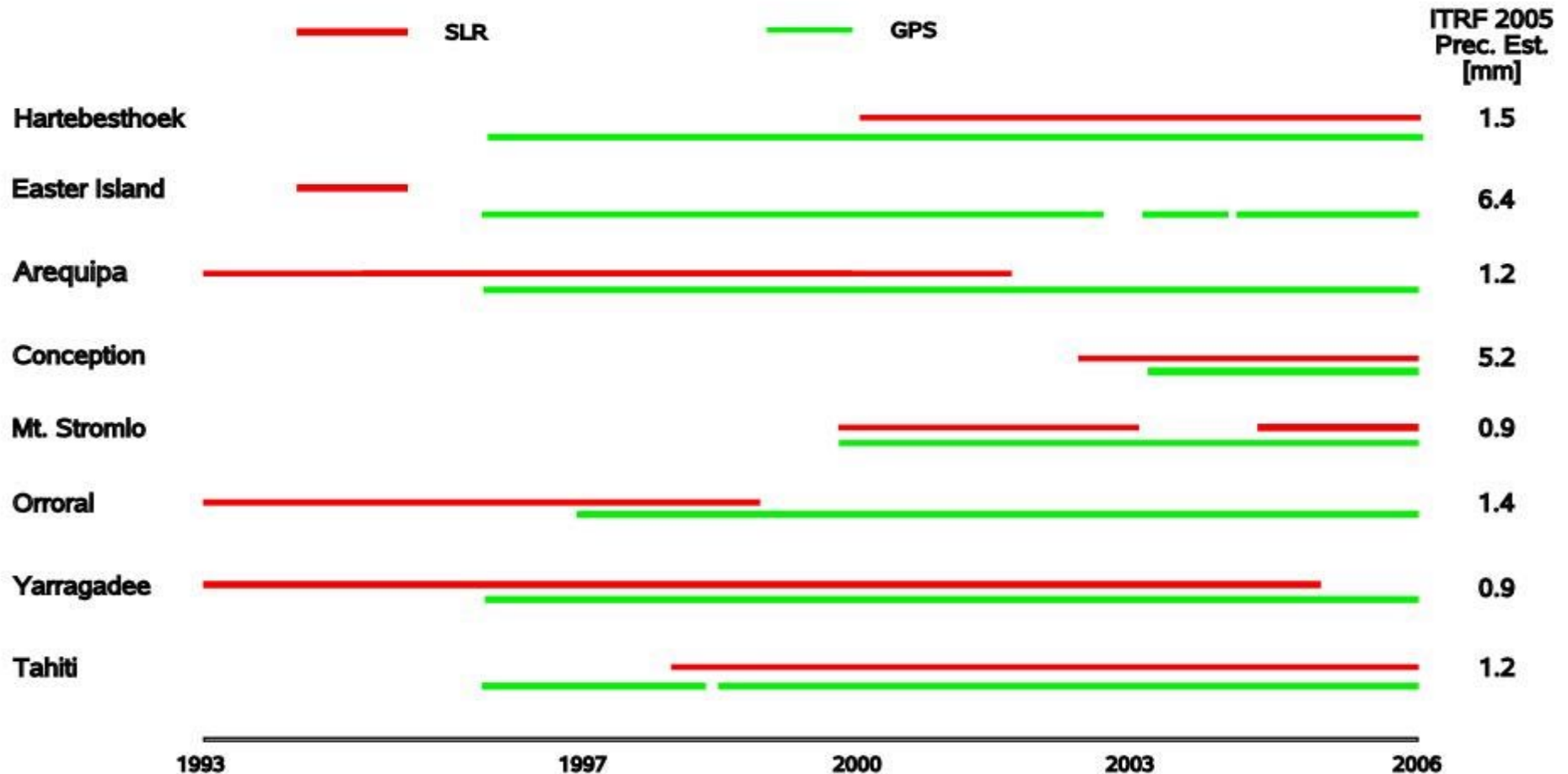
Co-location sites   ▲ **GPS – VLBI (18)**   ● **GPS – SLR (16)**

Investigations on SLR and VLBI scale of ITRF2005

Occupation of Southern Hemisphere Collocation Sites

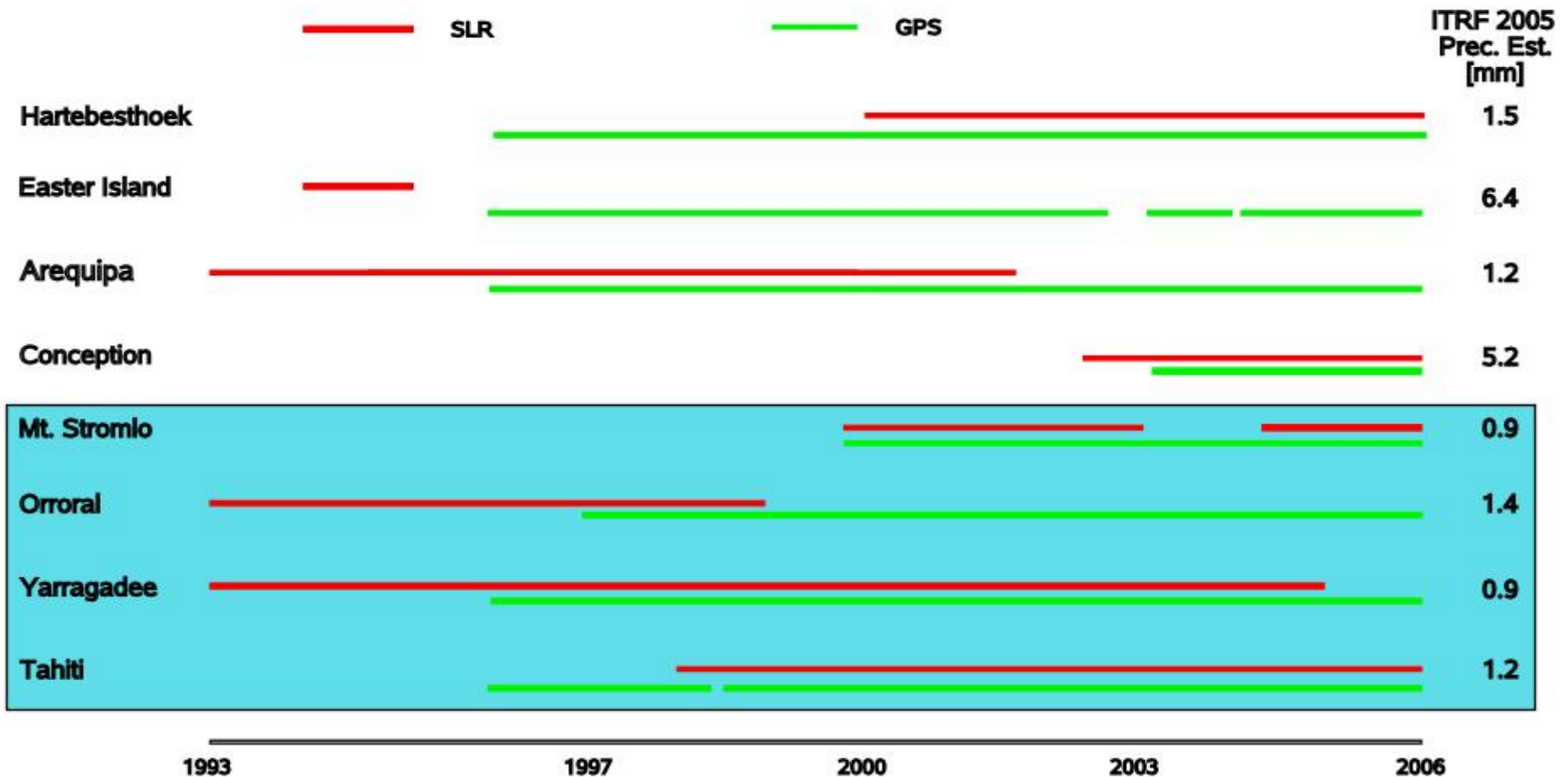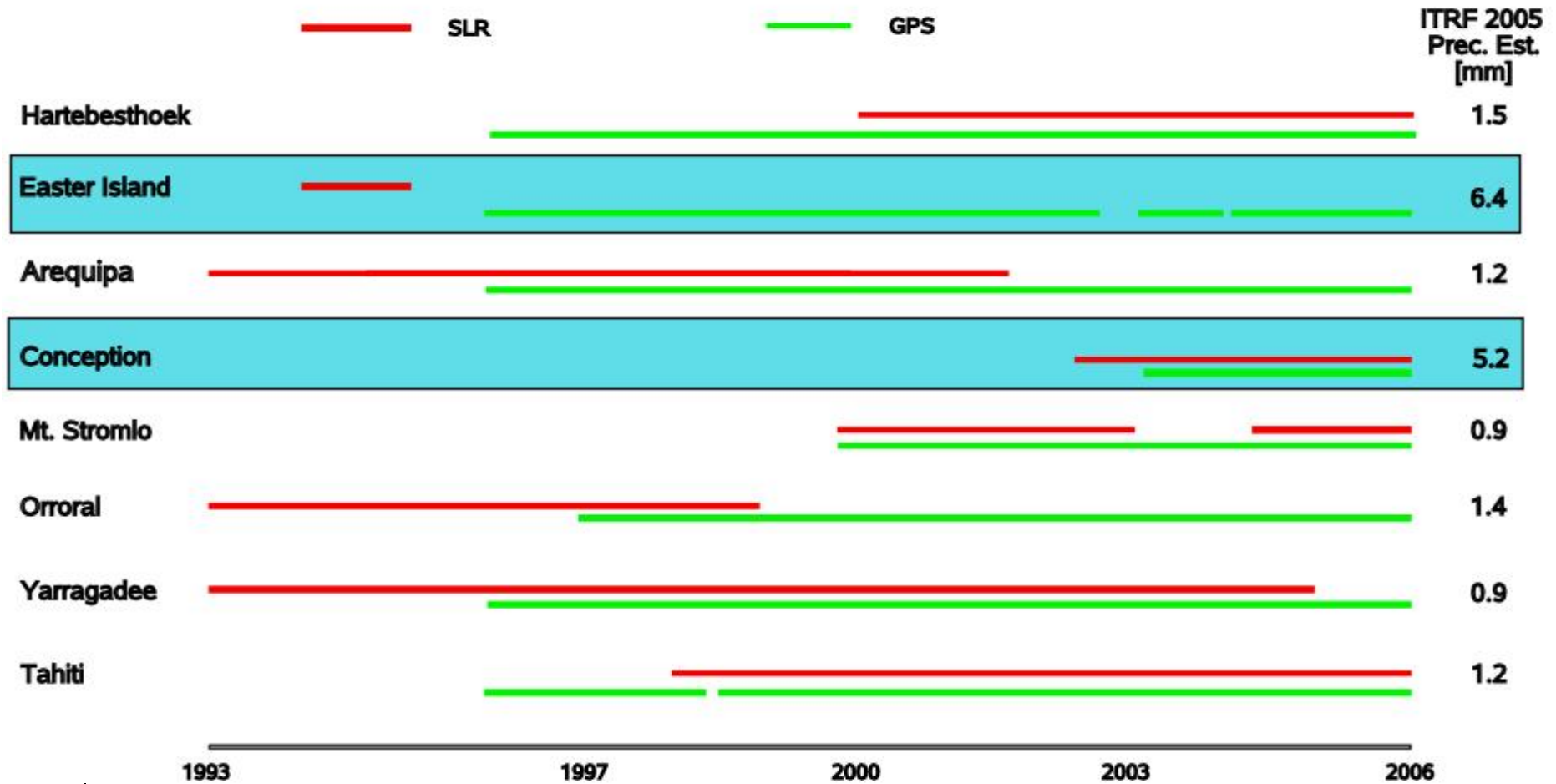# Investigations on SLR and VLBI scale of ITRF2005
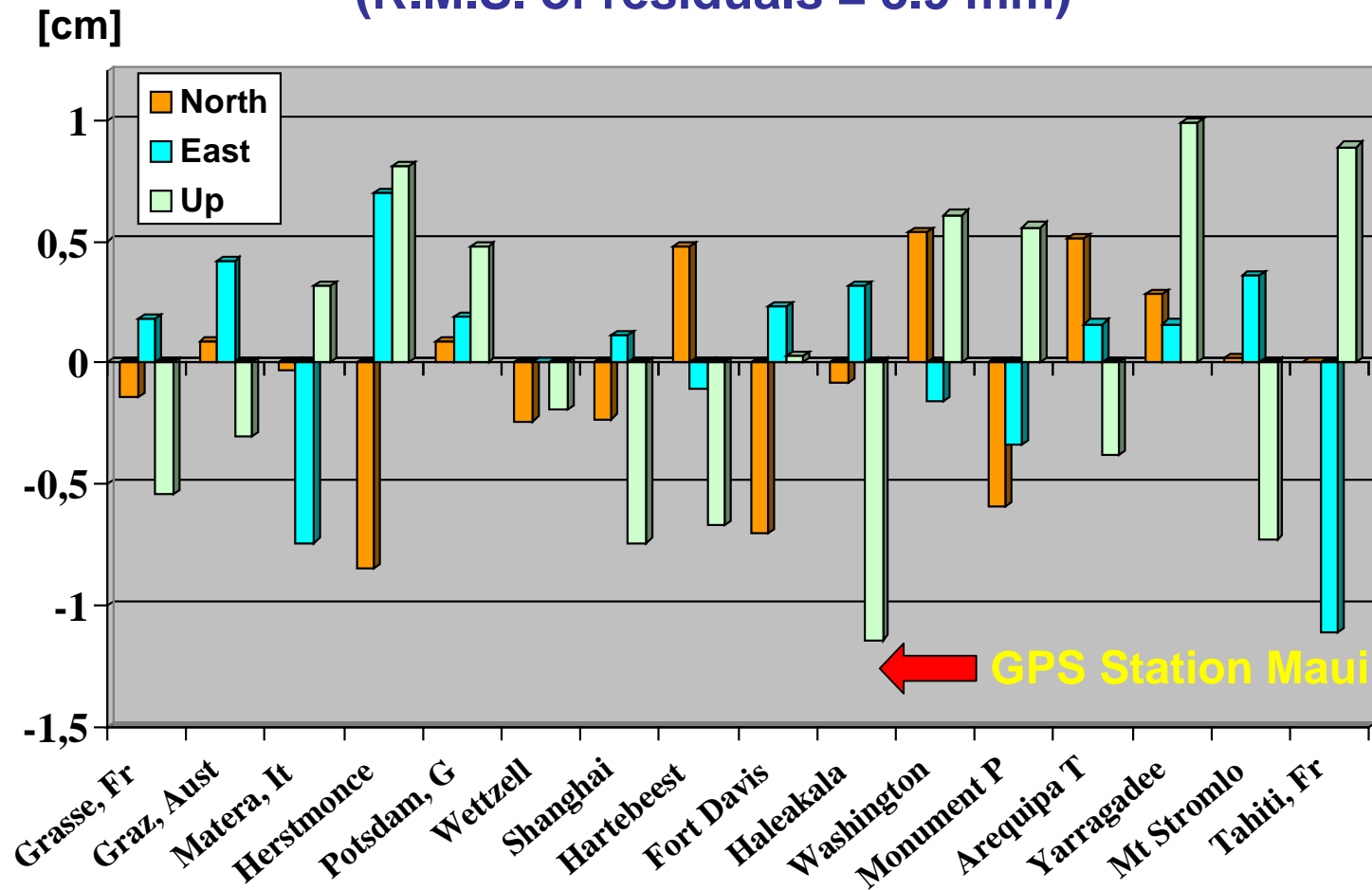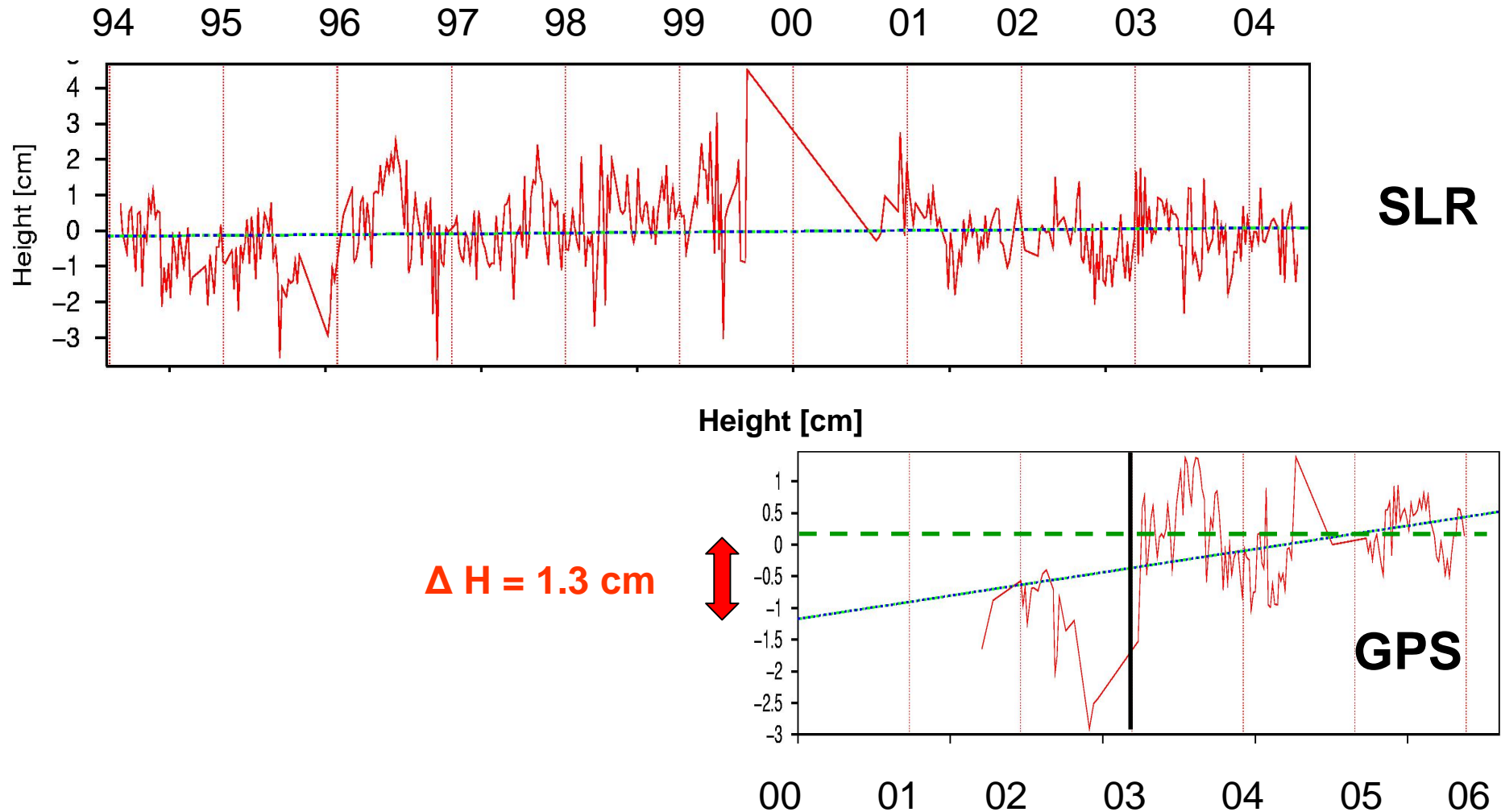

Occupation of Southern Hemisphere Collocation Sites

Investigations on SLR and VLBI scale of ITRF2005

Occupation of Southern Hemisphere Collocation Sites

Comparison of SLR and GPS solutions

Station position residuals at 16 co-location sites
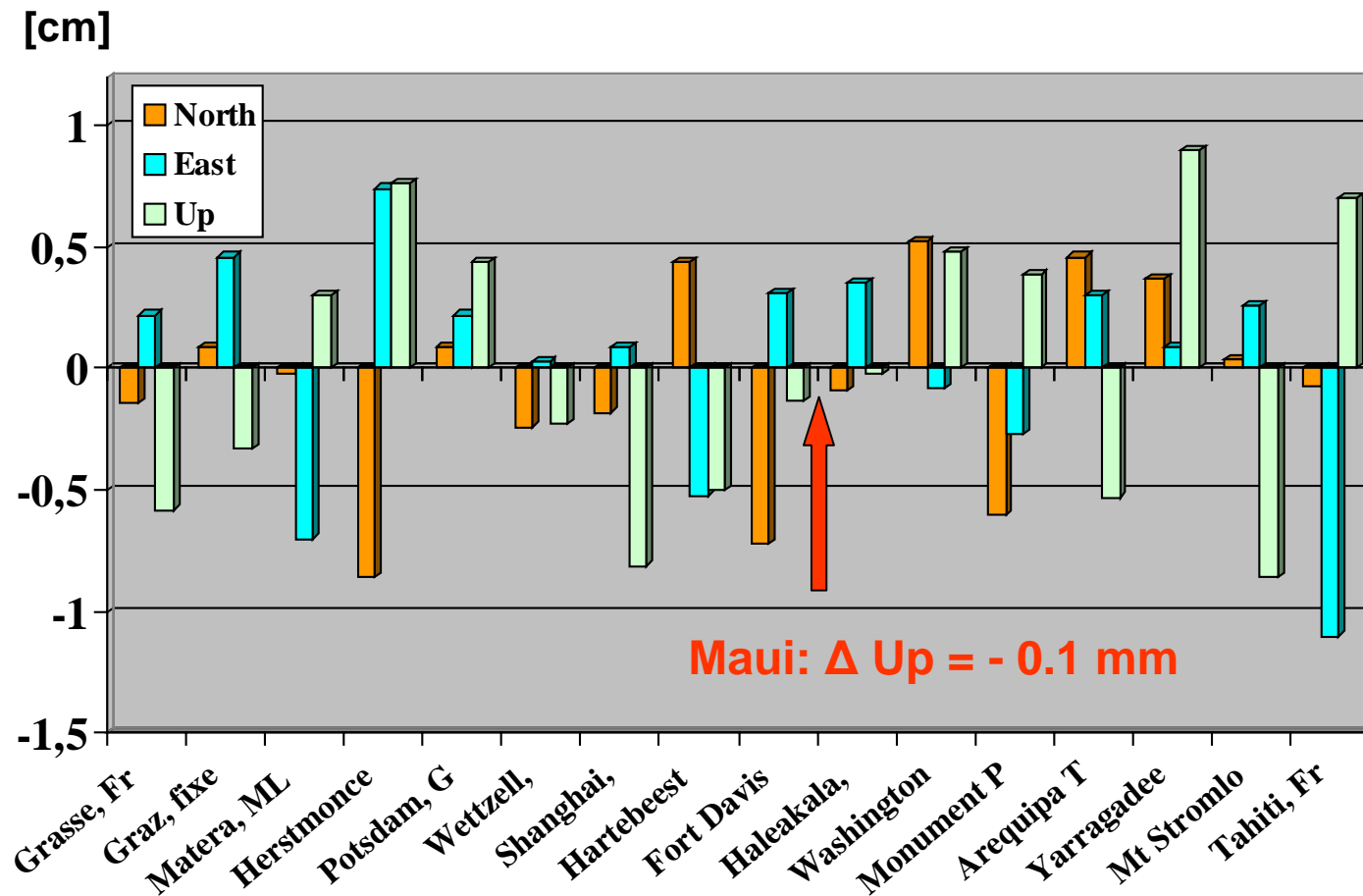
(R.M.S. of residuals = 3.9 mm)

Position time series for co-location site Maui

Comparison of SLR and GPS solutions

Station position residuals at 16 co-location sites
(R.M.S. of residuals = 3.6 mm; orig. 3.9 mm**)**

Maui: Δ Up = - 0.1 mm

Scale between SLR and VLBI

	Δ Scale offset [ppb]	Δ Scale drift [ppb/yr]
SLR - VLBI	0.40 ± 0.42	0.04 ± 0.10
SLR – VLBI *	**0.26 ± 0.41**	**0.03 ± 0.09**

*** : Discontinuity for GPS station Maui introduced**

Some remarks:

- The scale difference between SLR and VLBI is obtained „indirectly"
  via similarity transformations w.r.t. the GPS network.

- The estimated scale differences are very small and not significant.

- Much effort was made to select the „best" co-location sites
  w.r.t. quality and spatial distribution.

Lageos-1 range biases

Range Bias Comparison
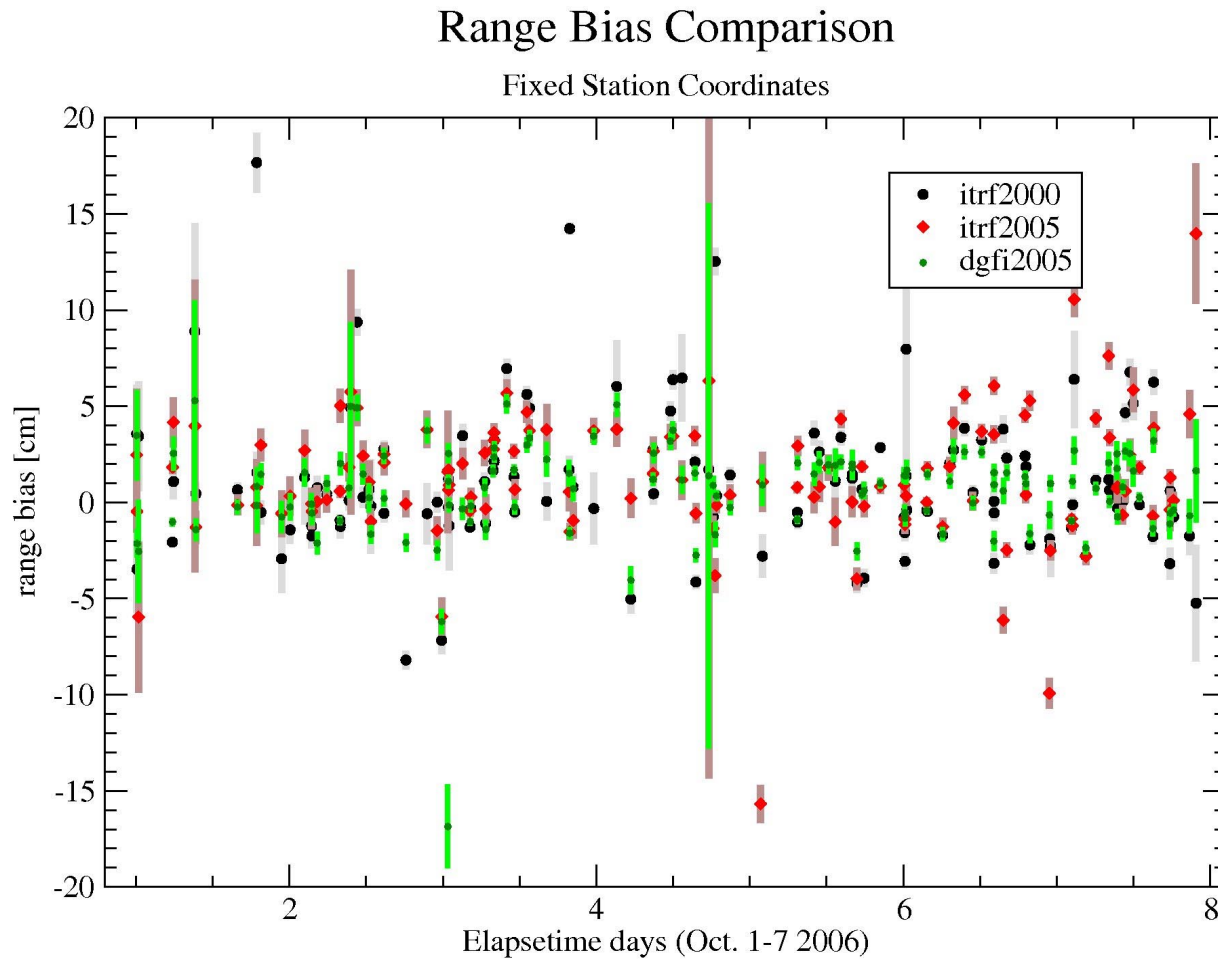
Lageos-1 orbit fit with fixed station coordinates, Oct.1-7 2006
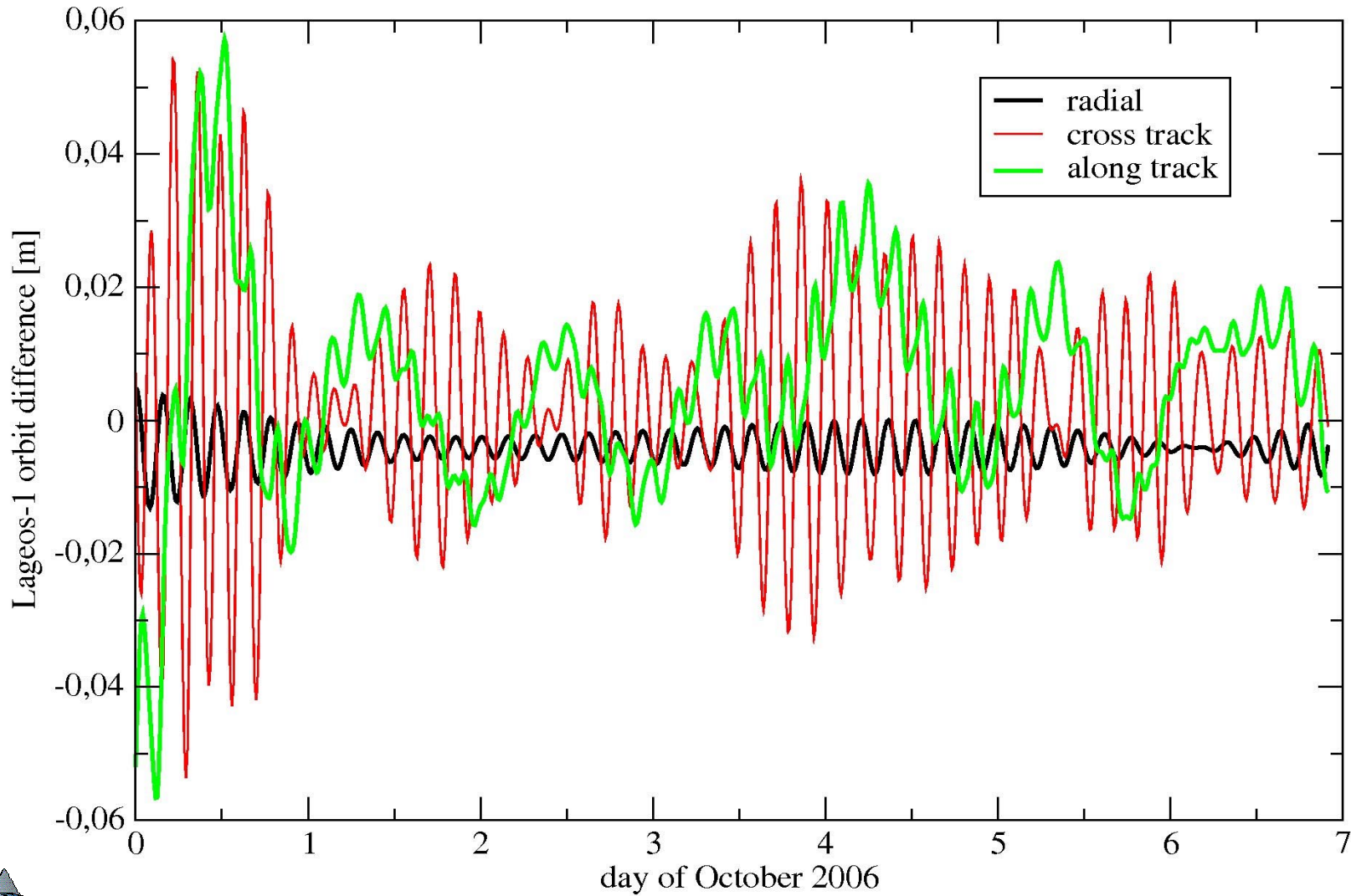
Conclusions

- Good agreement of IGN and DGFI intra-technique solutions.

- The combined ITRF2005P solutions of IGN and DGFI show significant differences for the scale of the SLR network (Δ scale = 0.84 ppb + 0.13 ppb/yr).

- This discrepancy is most likely caused by a different combination procedure and the handling of local ties.

- IGN and DGFI solution differ w.r.t. the scale realization:
  - DGFI: Mean of SLR and VLBI data (both scales agree).
  - IGN: Based on VLBI (SLR and VLBI scales differ significantly).

- Key issues are further studies on the SLR and VLBI scales and on the integration of different techniques.

DGFI

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