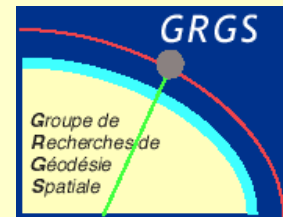


Global combination from astro-geodetic techniques

D. Gambis, T. Carlucci (Obs. Paris)
R. Biancale, J.-M. Lemoine (CNES)
Z. Altamimi, D. Coulot (IGN)



S. Loyer, GPS
Noveltis - Toulouse
L. Soudarin, DORIS
CLS - Toulouse
P. Berio, SLR
OCA - Grasse
P. Charlot, VLBI
Observatoire de Bordeaux
G. Francou, J.C. Marty
Observatoire de Paris, CNES

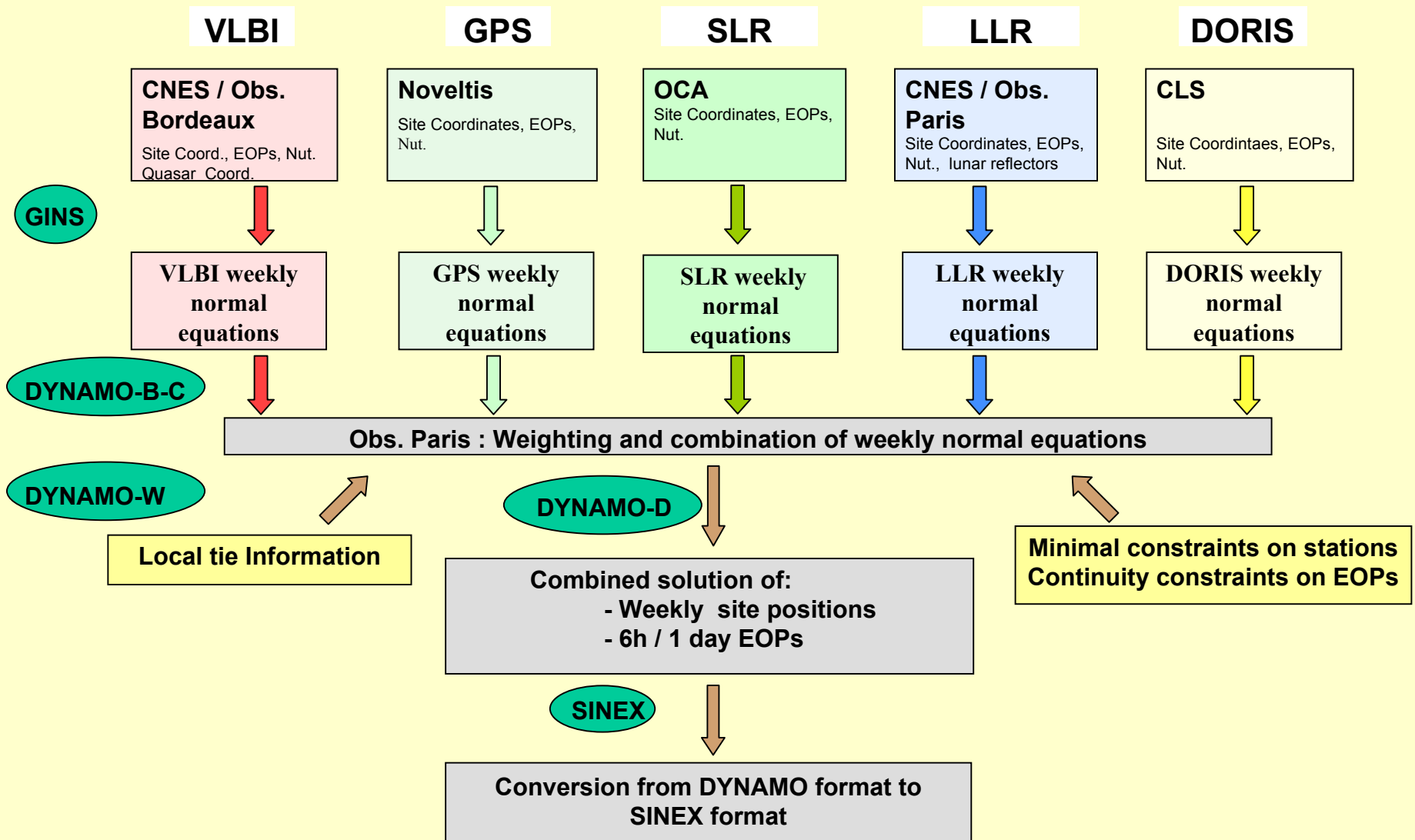
Status of the project

- Since the beginning of 2005, routine determination
- Five geodetic techniques are processed using a single software (GINS)
- Products : Earth Orientation Parameters (Polar motion, UT1, nutation), every 6 hours and weekly station coordinates
- EOP are converted in daily series in SINEX format and made available to IERS in the framework of the IERS Combination Pilot Project
- 29 weeks from January to July 2005 have been analysed

Techniques :

- ✓ GPS : all GPS satellites, stations subset (~60 stations)
- ✓ SLR : Lageos + Lageos2 (~30 stations)
- ✓ DORIS : SPOT-2, -4, -5 and ENVISAT since May (~50 stations)
- ✓ VLBI : only R1 and R4 sessions used (~15 stations)
- ✓ LLR : 2 stations (Grasse and Mc Donald)

GRGS organization



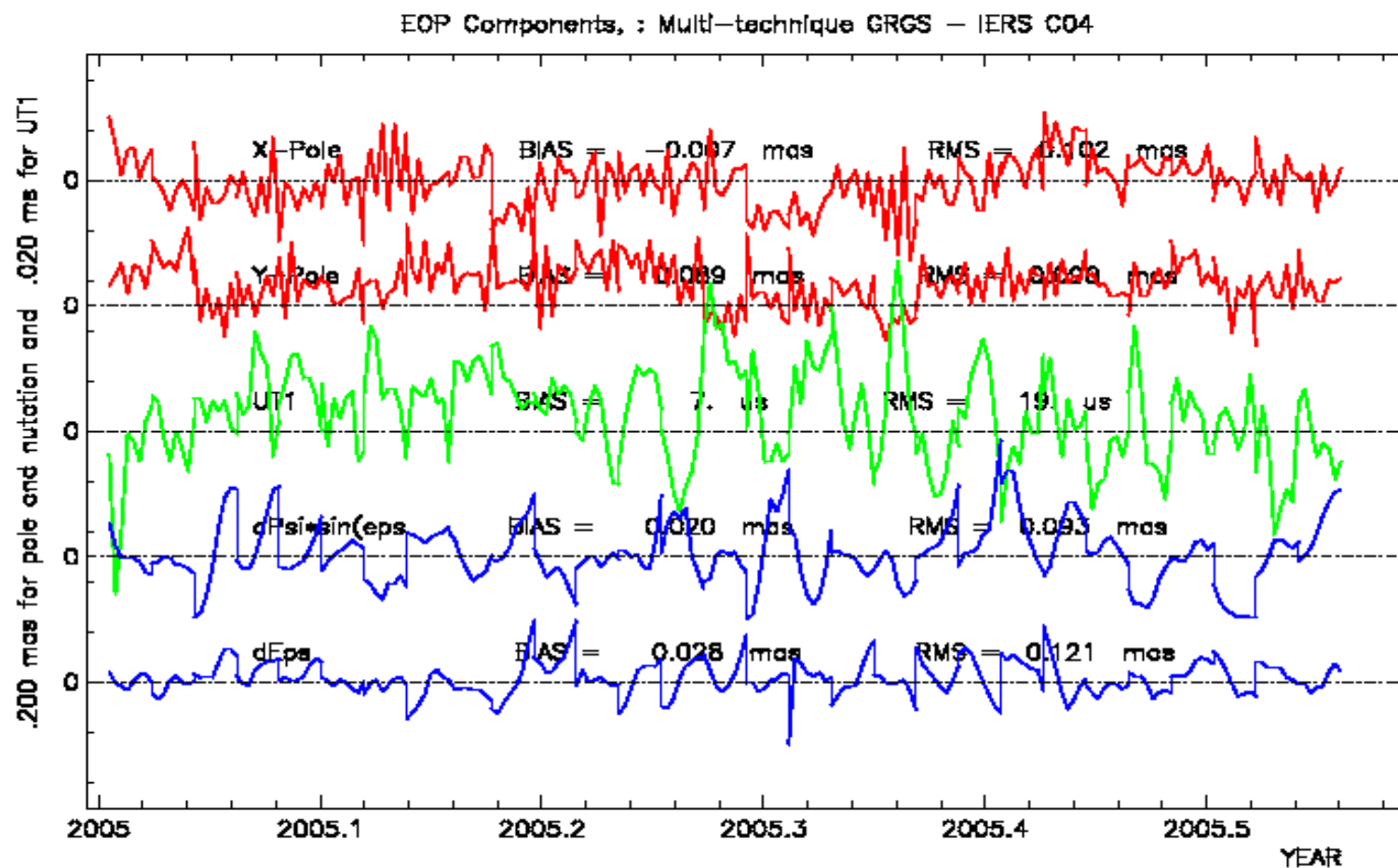
Statistics concerning data

	Number of measurements per week	Mean measurement residuals	Scale factor k Weight= $1/(k.\sigma)^2$
GPS (phase)	~600 000	4.5 mm	1.5
SLR	1500 - 4000	1.0 cm	1.3
DORIS	~100 000	0.40 mm/s	0.7
VLBI	2000 - 5000	1.5 cm	1.0
LLR	0 - 20	11. cm *	4.1

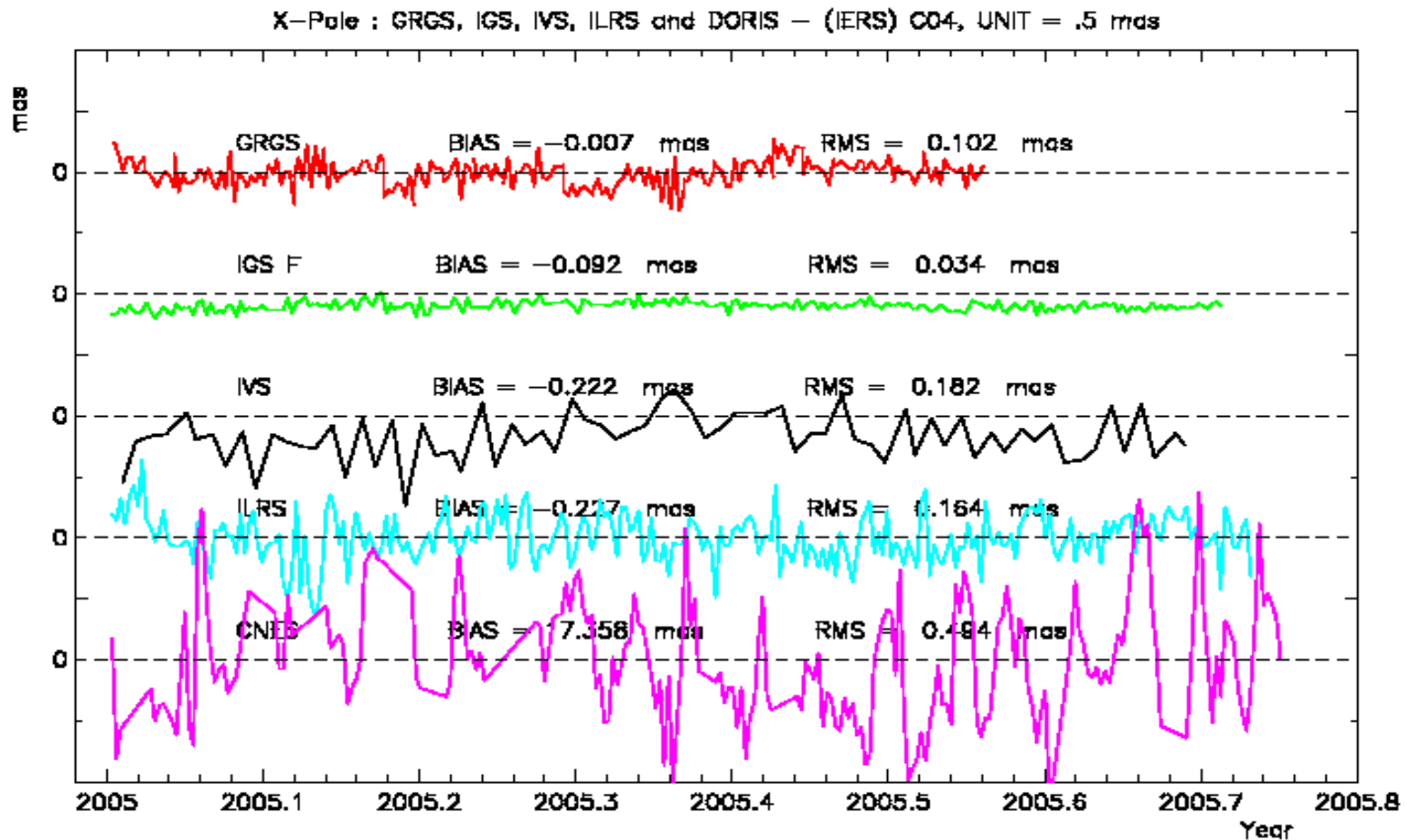
* LLR is processed using NO fitted parameter (libration)

Helmert optimal variance
method

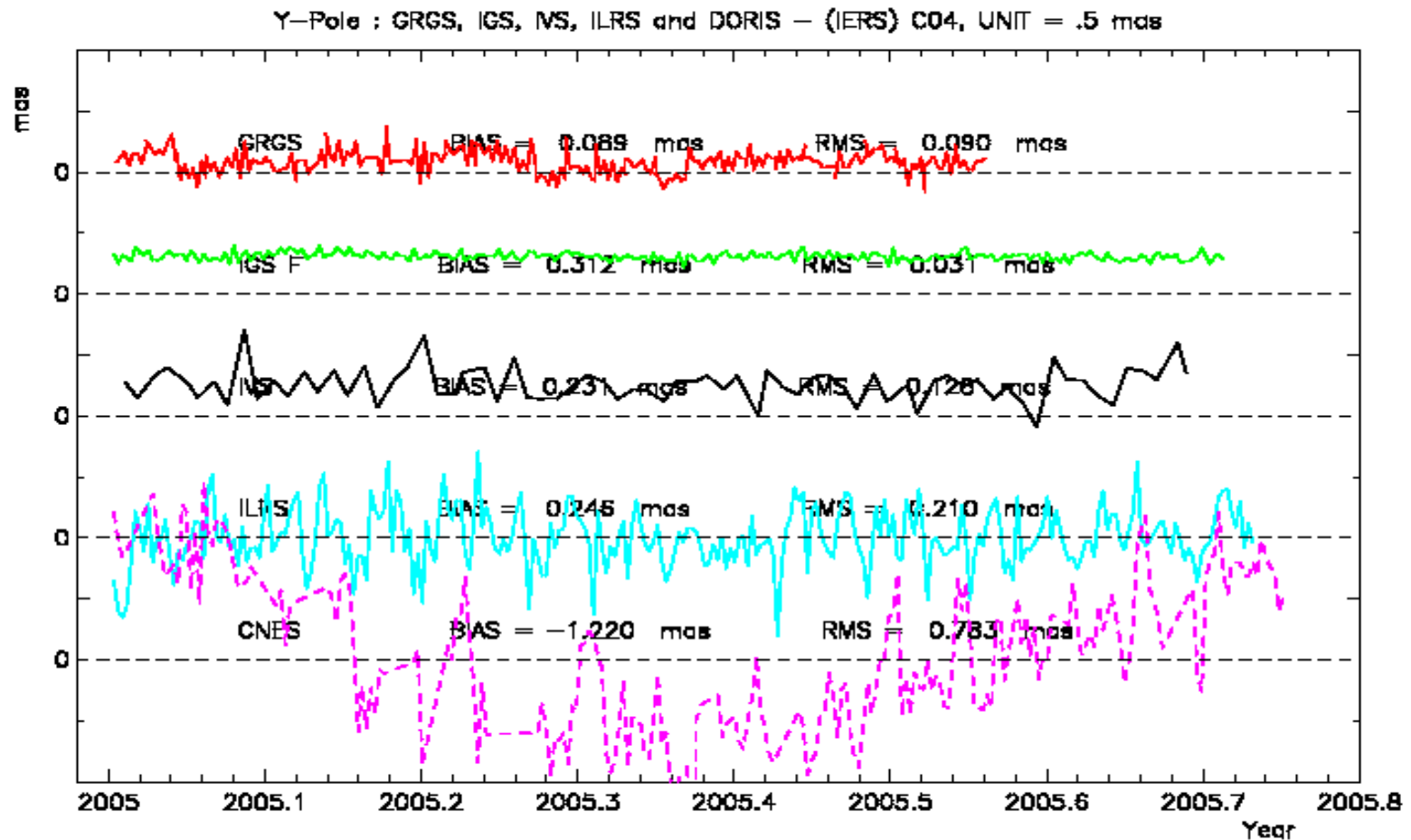
EOP comparison to C04 , weak constraints



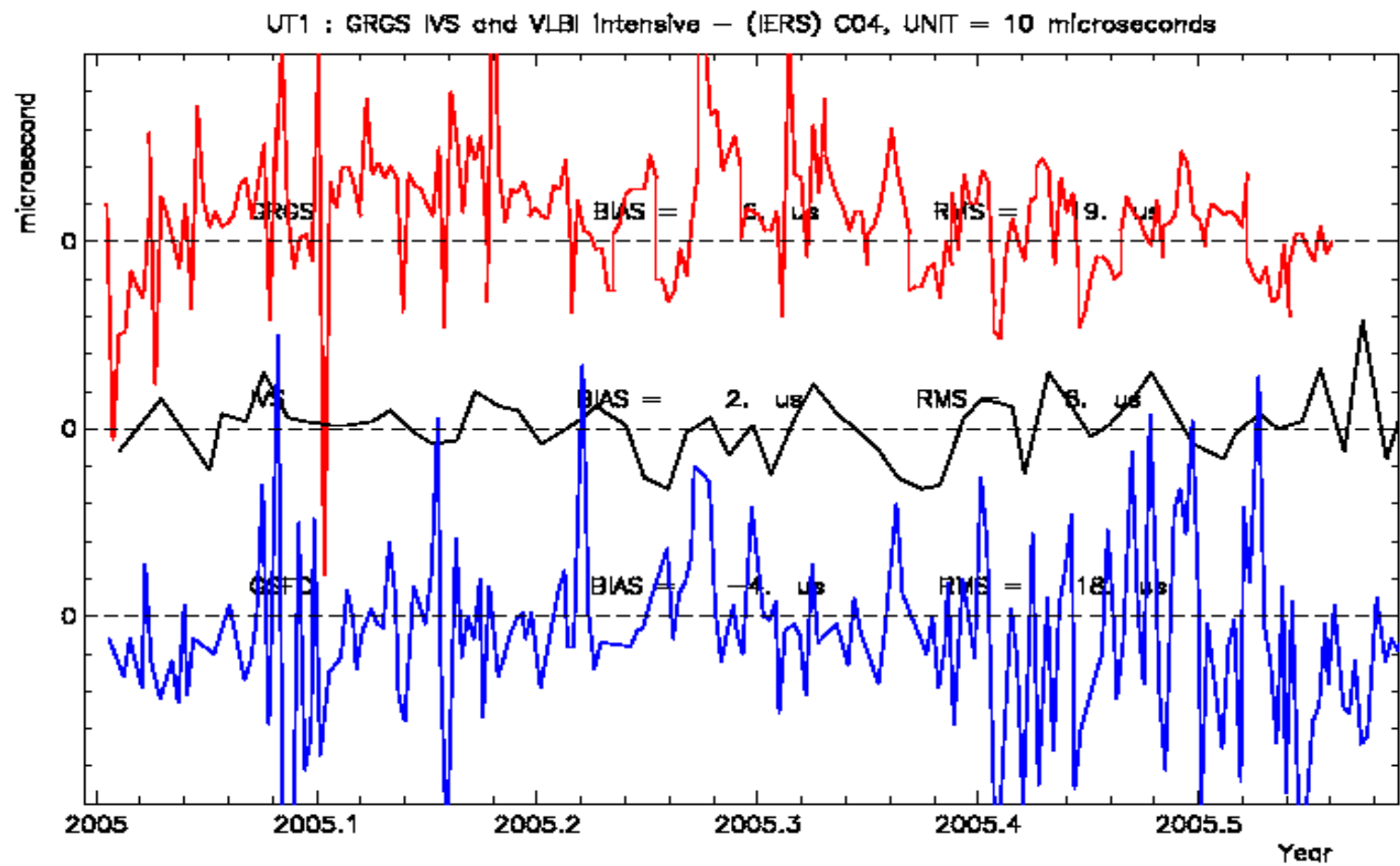
X-Pole: Comparison of individual combined techniques to C04



Y-Pole: Comparison of individual combined techniques to C04



UT1



Comparison of various combined series with C04

Mean

rms

	<i>Xp</i> (μ as)	<i>Yp</i> (μ as)	<i>UT1</i> (μ s)	<i>Xp</i> (μ as)	<i>Yp</i> (μ as)	<i>UT1</i> (μ s)
IGS	-92	311		34	30	
IVS	-222	244	1	182	121	9
ILRS	-227	249		167	203	
DORIS	-224	-23		1440	1490	
GRGS/stations weekly adjusted	-7	89	9.3	102	90	14
GRGS/stations globally adjusted	-37	62	9.3	50	46	14

*Daily
solutions*

*6-hours
solutions
(GRGS)*

constraint of continuity	-31	64	8.8	35	35	8.6
-------------------------------------	------------	-----------	------------	-----------	-----------	------------

Terrestrial reference frame: constraints on station coordinates

Two types of constraints were applied on the weekly station coordinates solutions

✓ Minimal constraints on each different measurement type to remedy for its known deficiency:

Rotations for SLR,

Translations and rotations for VLBI ;

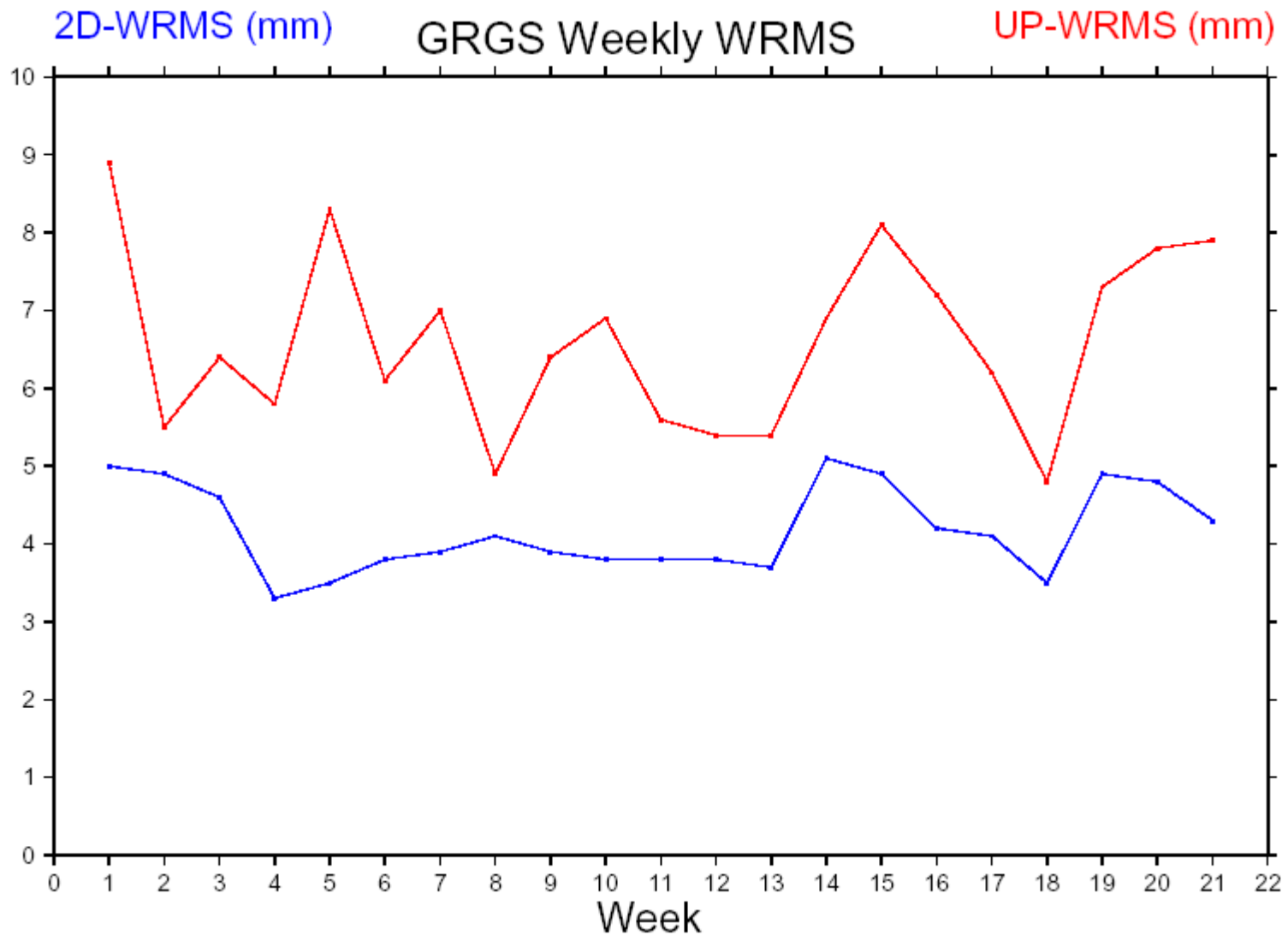
Translations, rotations and scale factor for GPS and DORIS ;

✓ 23 tie constraints between markers applied (from ITRF2000):

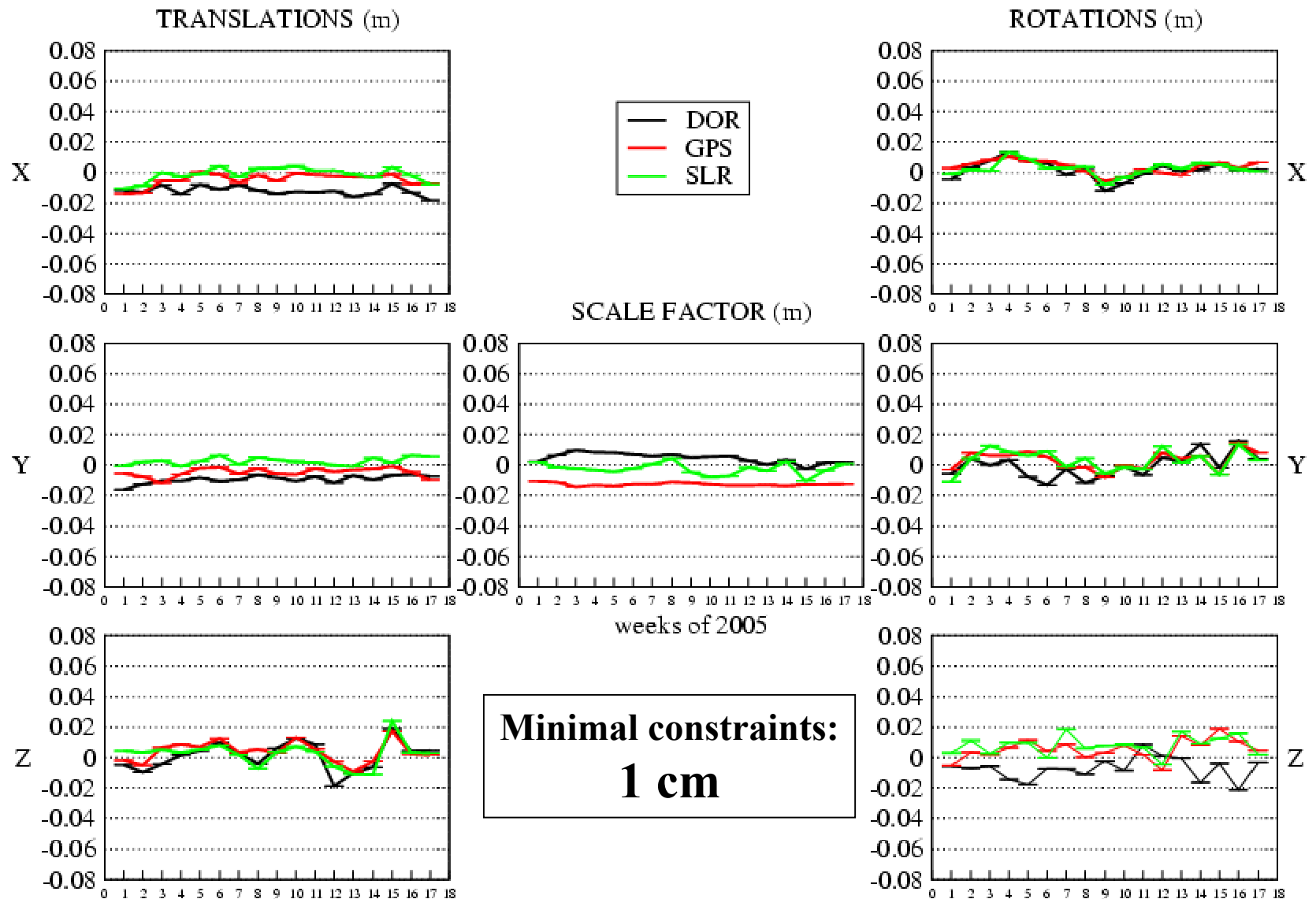
3 SLR-VLBI, 6 SLR- GPS, 6 SLR-DORIS, 1 GPS-VLBI, 7 GPS-DORIS

	Number	Discrepancy
No tie	23	36 mm
Ties applied	23	8 mm

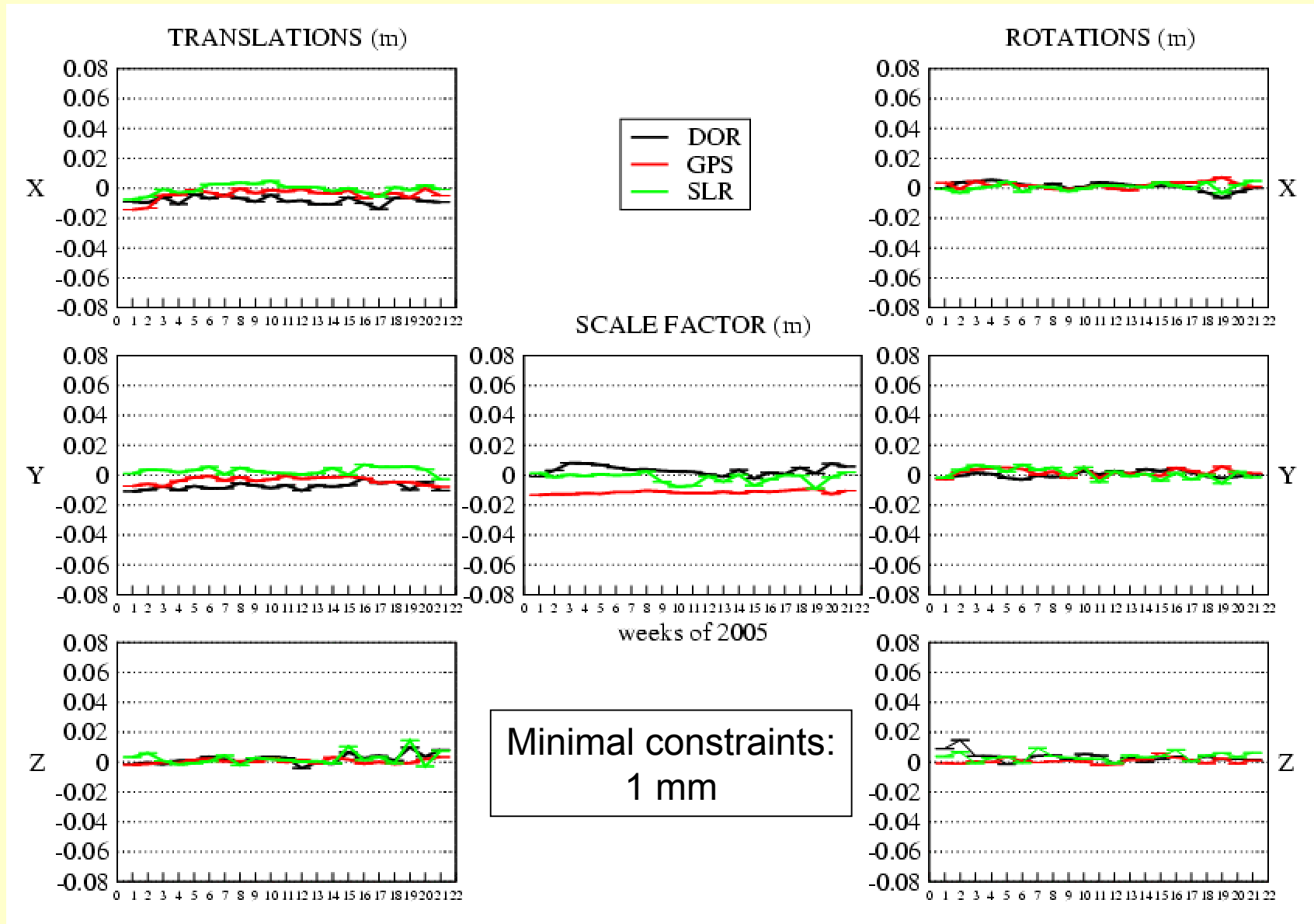
Reference frame repeatability (from Altamimi)



Reference frame solution : 7-parameter transform wrt ITRF2000



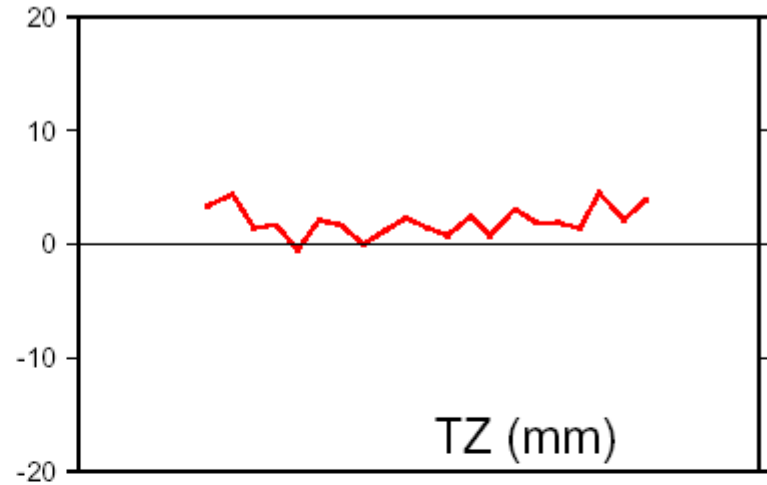
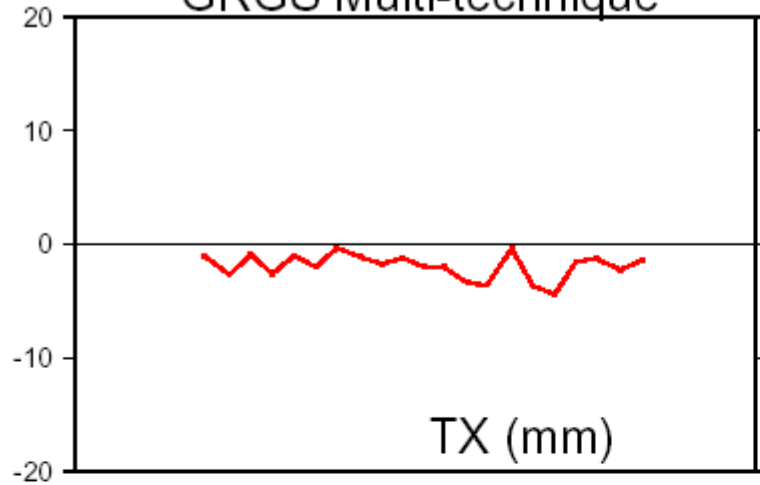
Reference frame solution : 7-parameter transform wrt ITRF2000



Reference frame systematics (from Z Altamimi / IGN)

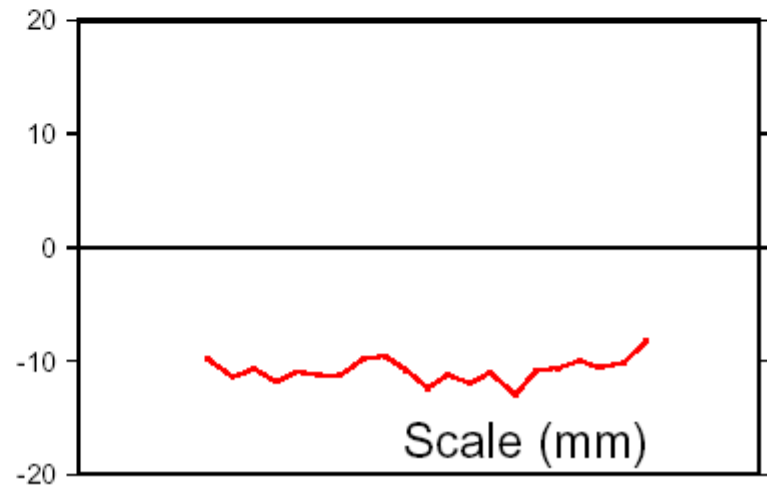
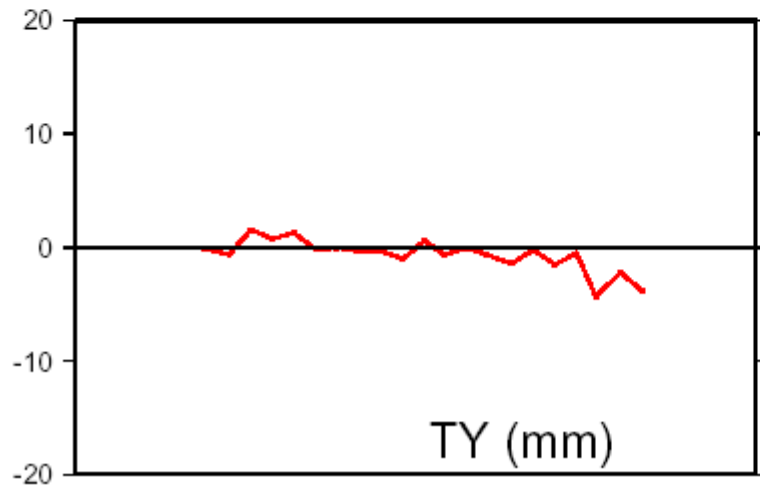
GRGS Multi-technique

mm



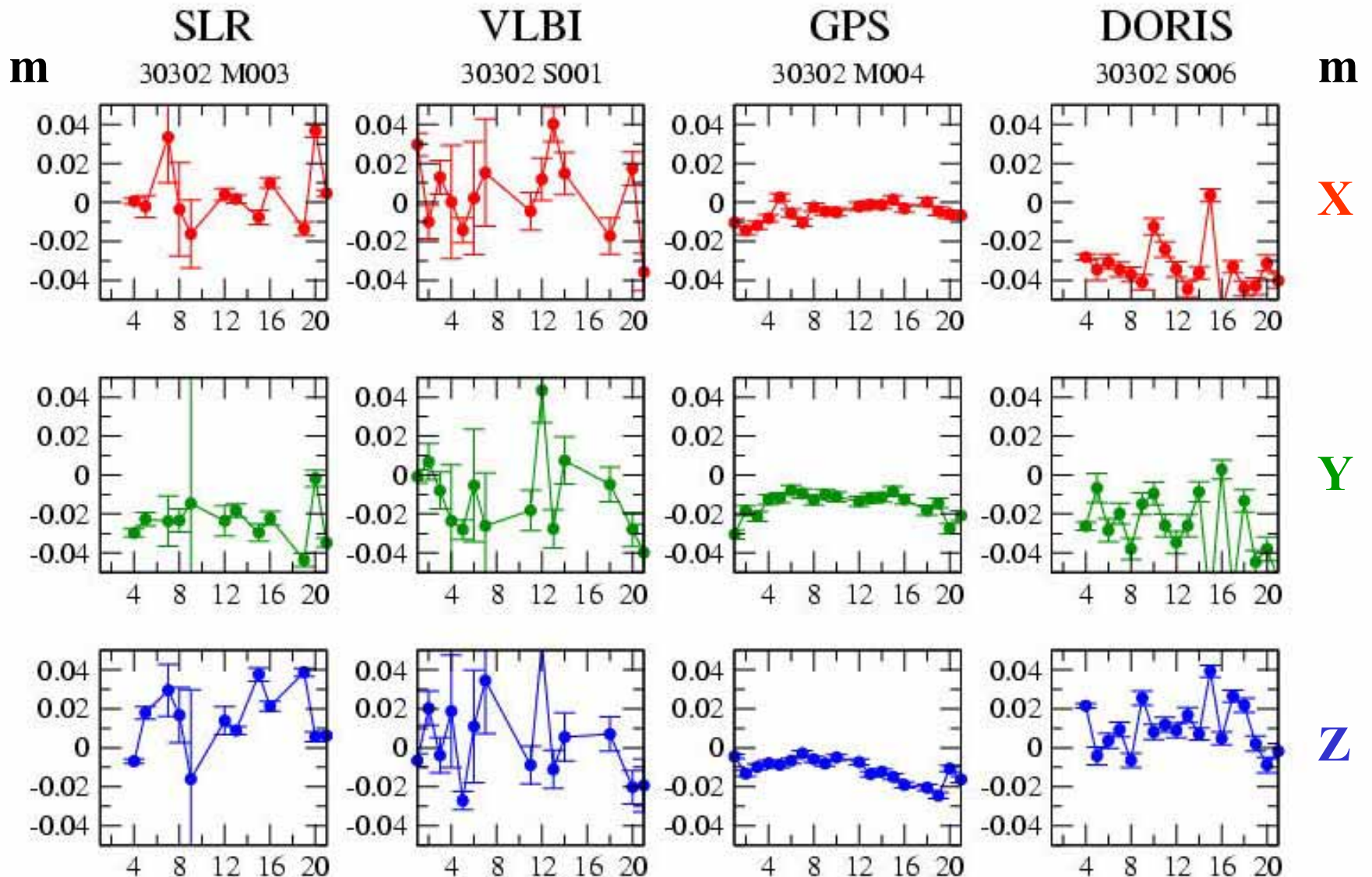
mm

mm



mm

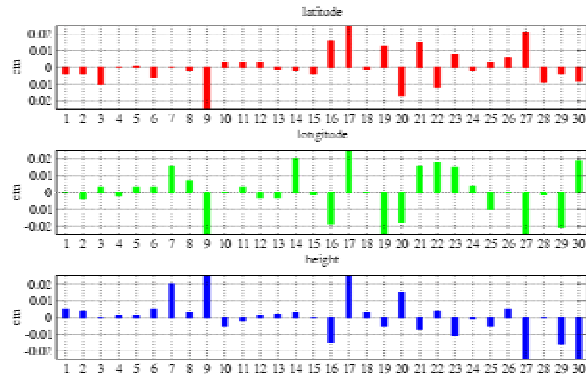
Reference frame solution : results for colocated site 30302 in meters



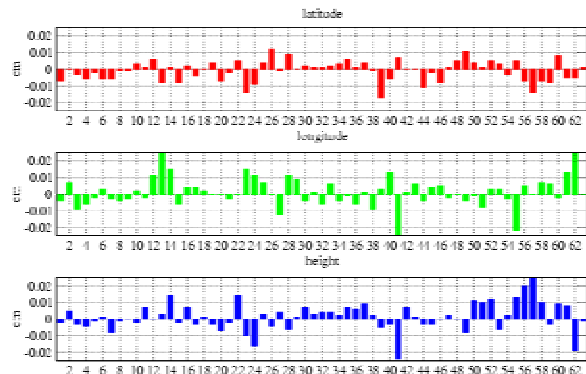
Reference frame solution : mean solution wrt ITRF2000

	SLR/LLR	DORIS	GPS	VLBI
3-D difference with ITRF2000	0.69 cm	2.48 cm	0.98 cm	1.81 cm

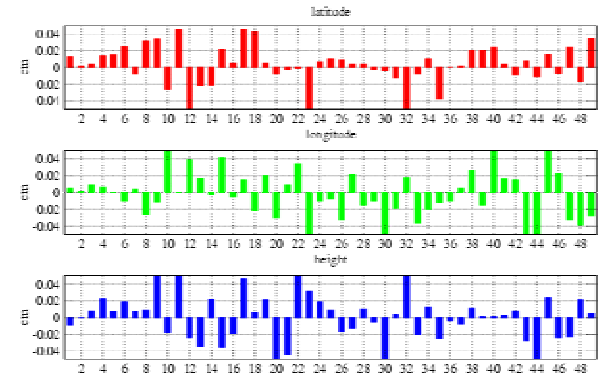
SLR stations : comparison to ITRF-2000



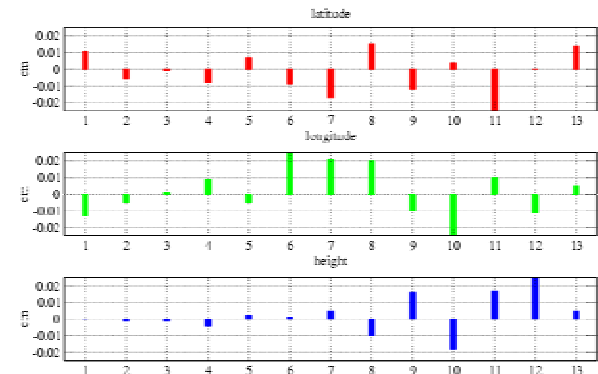
GPS stations : comparison to ITRF-2000



DORIS stations : comparison to ITRF-2000



VLBI stations : comparison to ITRF-2000



Conclusions and prospects

Combination process in GRGS is now working routinely

Good quality of solutions

Role of constraints in EOP

- On continuity between successive weeks

Role of constraints in TRF

- Minimal

- Local ties associated to ITRF2000

Need to improve the data processing of each technique

LLR

Estimation of additional parameters (e.g. libration)

GPS:

- ✓ Use of double differences with integer ambiguities resolution
- ✓ Antenna phase center correction

DORIS

- Introduction of JASON with SAA correction
- Center of phase fit per satellite

VLBI

Comparison with MODEST software

Use of tropospheric corrections per site using dry and wet delays from 6h ECMWF grids (for all techniques)

Decrease of time latency to less than 8 weeks for the combined products

Search for an optimal strategy concerning constraints

(EOP continuities, minimal for stations and local ties)

The objective is to be fully operational mid-2006