DORIS AND THE DETERMINATION OF THE EARTH'S POLAR MOTION

D. Gambis, M. Saïl, T. Carlucci

IERS Earth Orientation Centre , Observatoire de Paris, FRANCE

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Overview

- DORIS is one of the techniques supporting the IERS

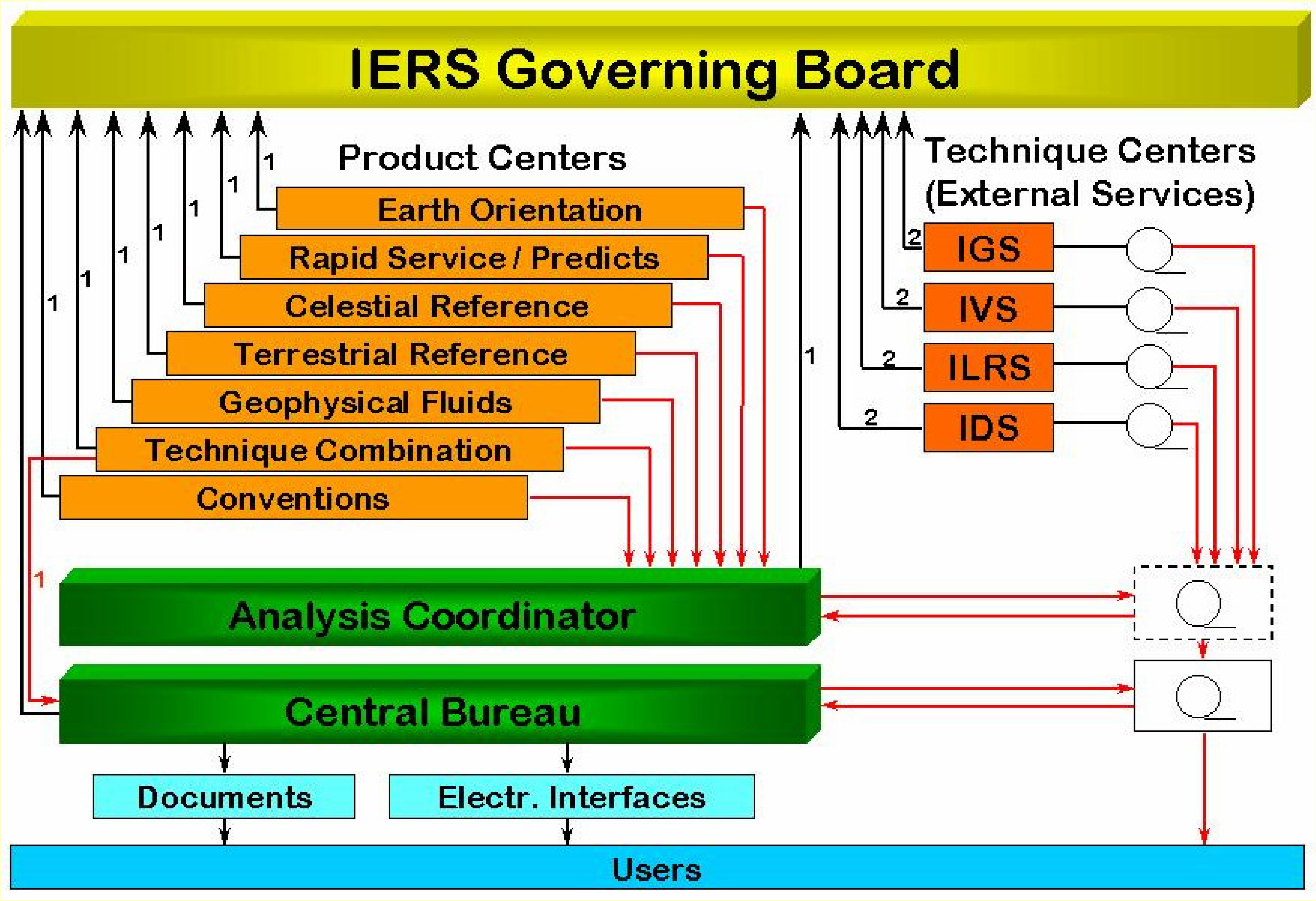
- So far, DORIS EOP not included in the IERS combinations
- Feedback (3-day pole components series weekly available from SOD)

- Improvements
  - DORIS system, number of satellites
  - Analysis, software, data processing strategy
  - Model of forces, SAA..

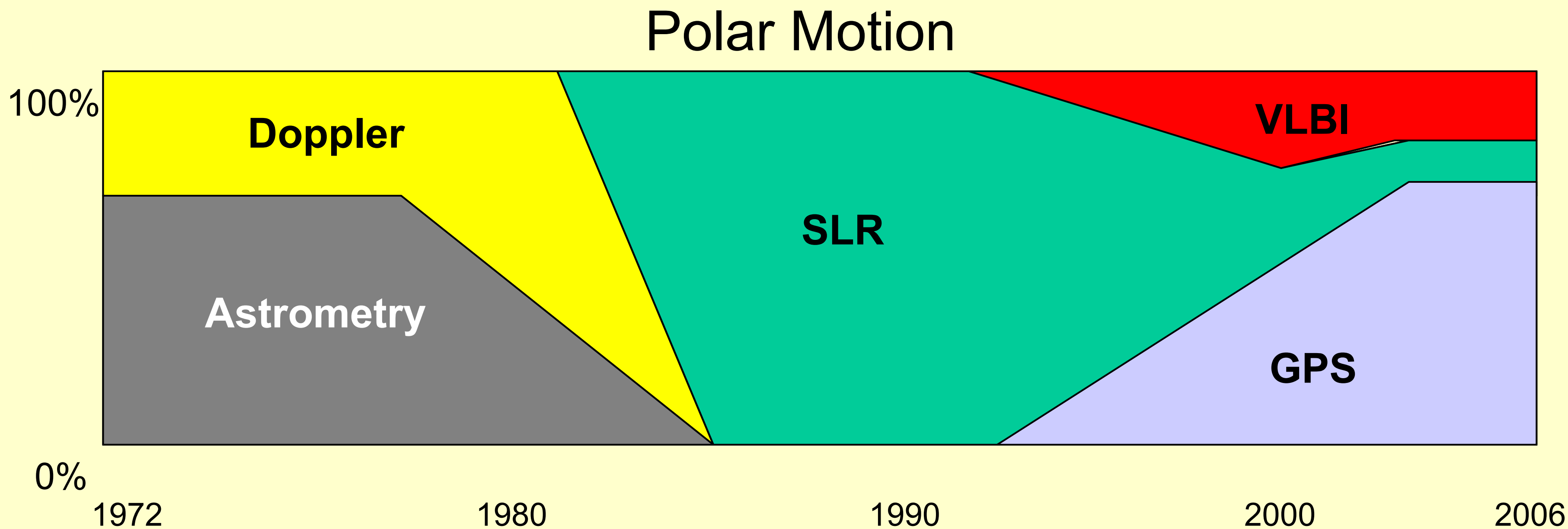
- DORIS EOP Combination
- Use or not of polar motion rates?

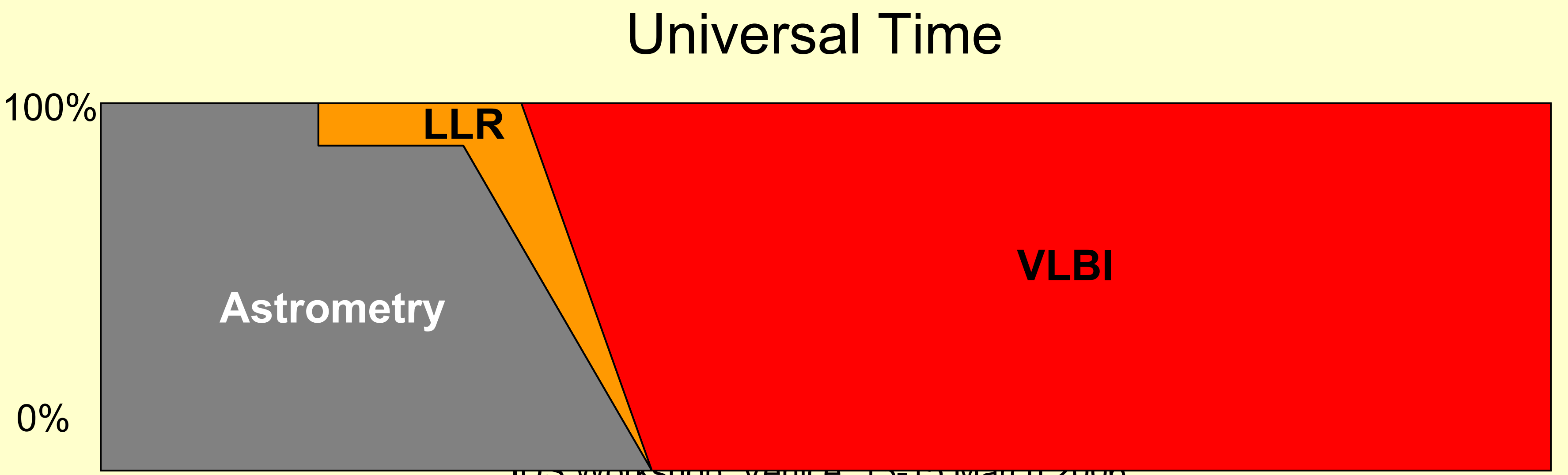
- Another approach: multi-technique combination : Project GRGS/ IERS

Structure of the International Earth rotation and Reference Systems service (IERS)

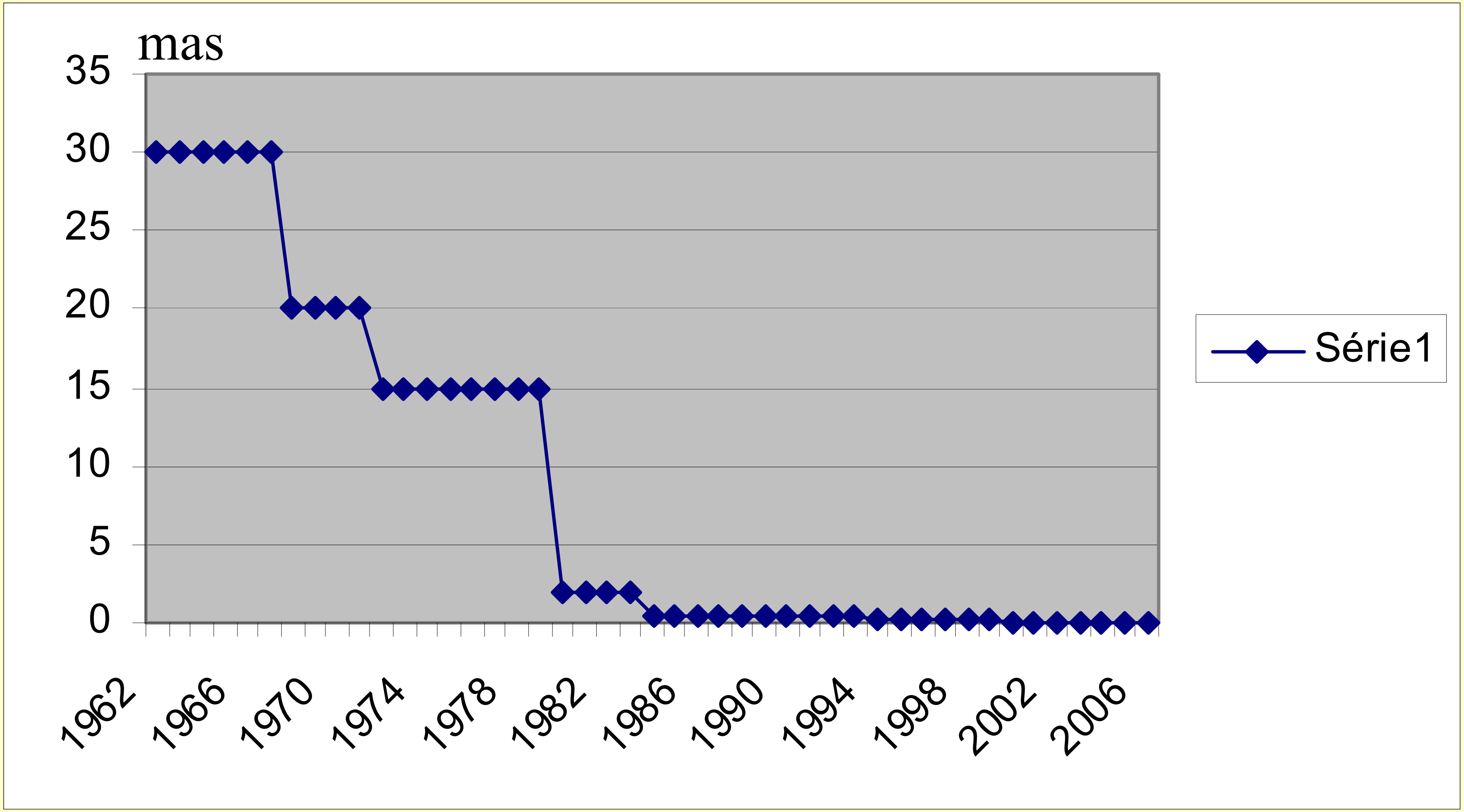


Contributions of techniques to IERS combined solutions





Evolution of the accuracy of the C04 polar motion



Current characteristics of EOP estimates

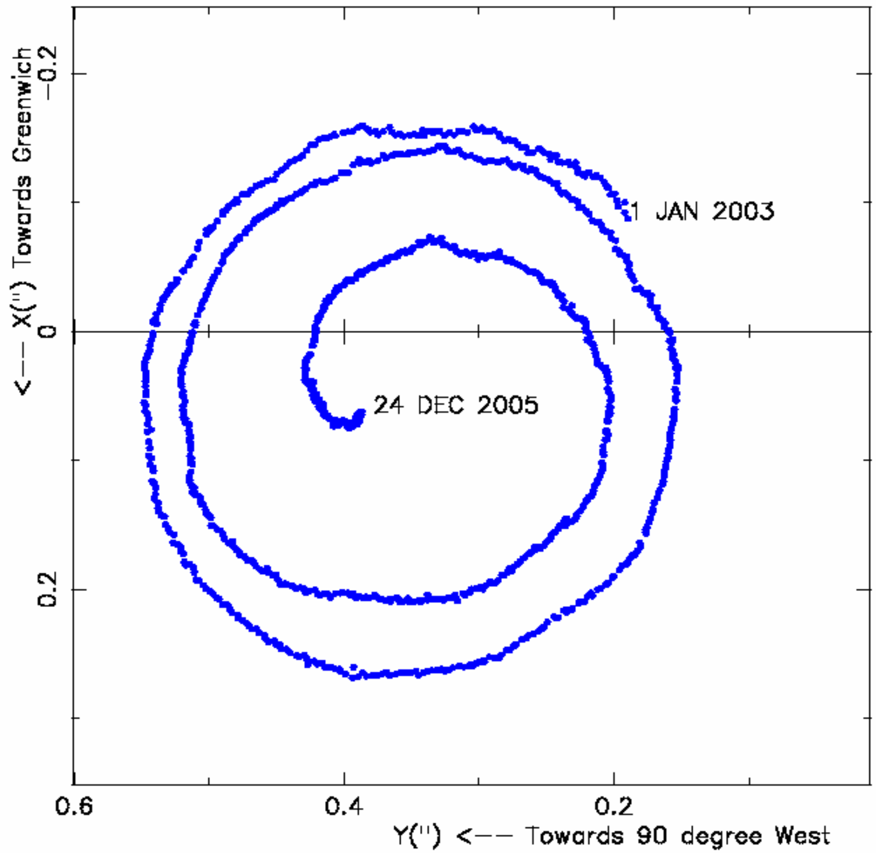
Precision gives an estimation of the stability of various individual solutions

- Polar motion : 50 -100 μas
- Universal Time: 4- 10 μs
- Nutation offsets: 60 μas

Accuracy reflects the real uncertainties of the solutions taking into account the inconsistency of the EOP system with respect to the terrestrial and celestial frames; systematic errors, more critical than precision..

- Polar motion : 150 - 200 μas
- Universal Time: 15 - 20 μs
- Nutation offsets: 60 μas

DORIS polar motion over 2003-2005



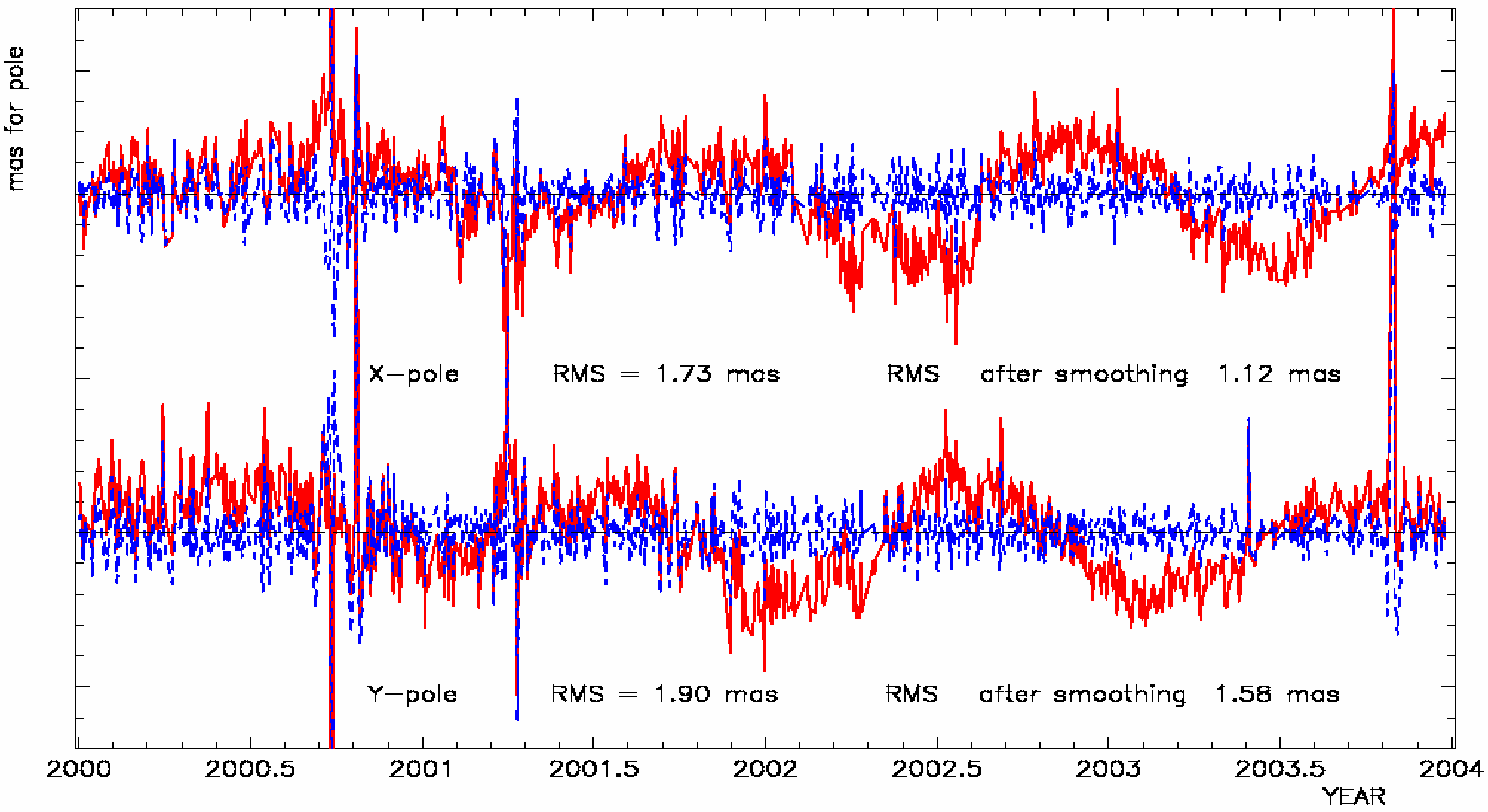
Data analysed

CNES /SOD	Centre National d'Etudes Spatiales, DORIS Orbitography Service (France)
IGN - JPL SINEX	Institut Géographique National (France) and Jet Propulsion Laboratory (USA)
LEGOS - CLS SINEX	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales and Collecte Localisation Satellites (France)
INASAN SINEX	Institute of Astronomy Russian Academy of Sciences (Russia)

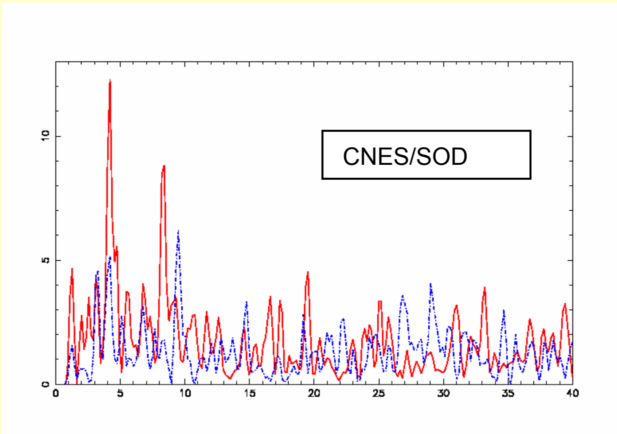
Characteristics of the solutions

ANALYSIS CENTER	SATELLITES	SOFTWARE	DATA INTERVAL	EOP ESTIMATED
CNES/SOD	SPOT-2, SPOT-4, SPOT-5, TOPEX, ENVISAT, Jason-1 (partly)	ZOOM Not SINEX	1999- 2005	Pole components
IGN-JPL	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX, ENVISAT	GYPSY/OASIS II	1993 - 2006	Pole components Pole and UT1-UTC rates
LEGOS/CLS	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX, ENVISAT	GINS/DYNAMO	1993 - 2005	Pole components using constrains on continuity
INASAN	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX , ENVISAT	GYPSY/OASIS II	1992 - 2004	Pole components Pole and UT1-UTC rates

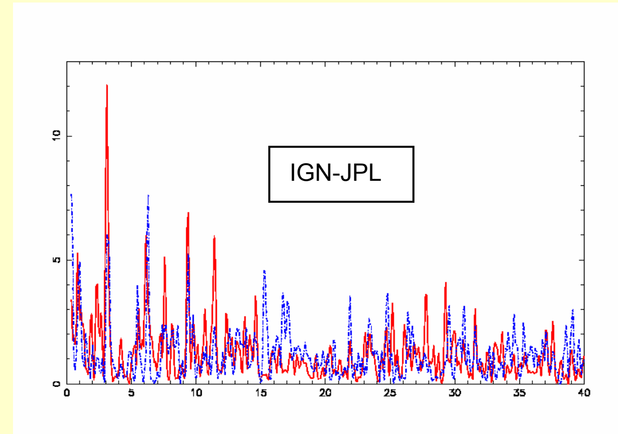
Effect of removing long-term variations



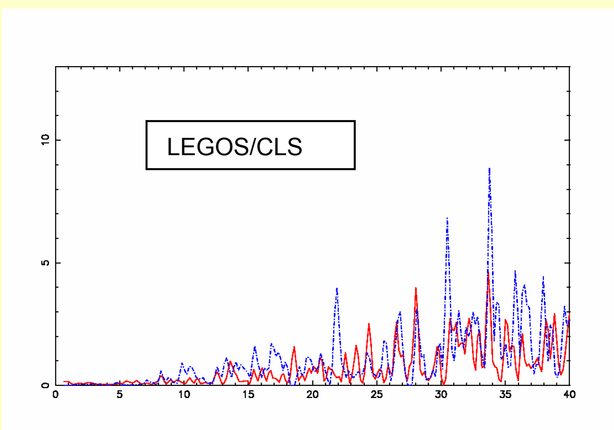
FFT Spectral density of the differences of the various DORIS series with the IERS C04 solution over 2000-2004.



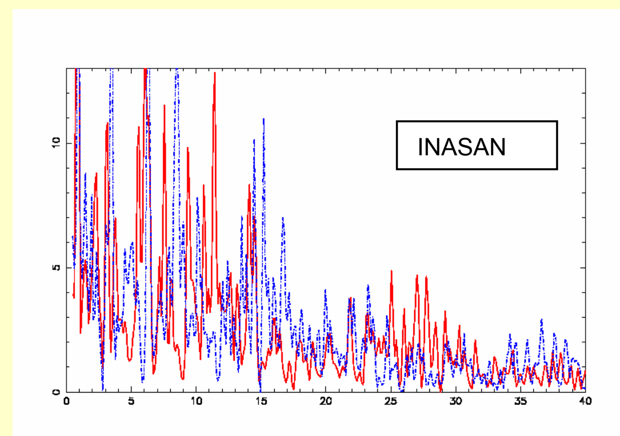
Year 40d 15d 10d



Year 40d 15d 10d



Year 40d 15d 10d



Year 40d 15d 10d

Main significant peaks (in days)

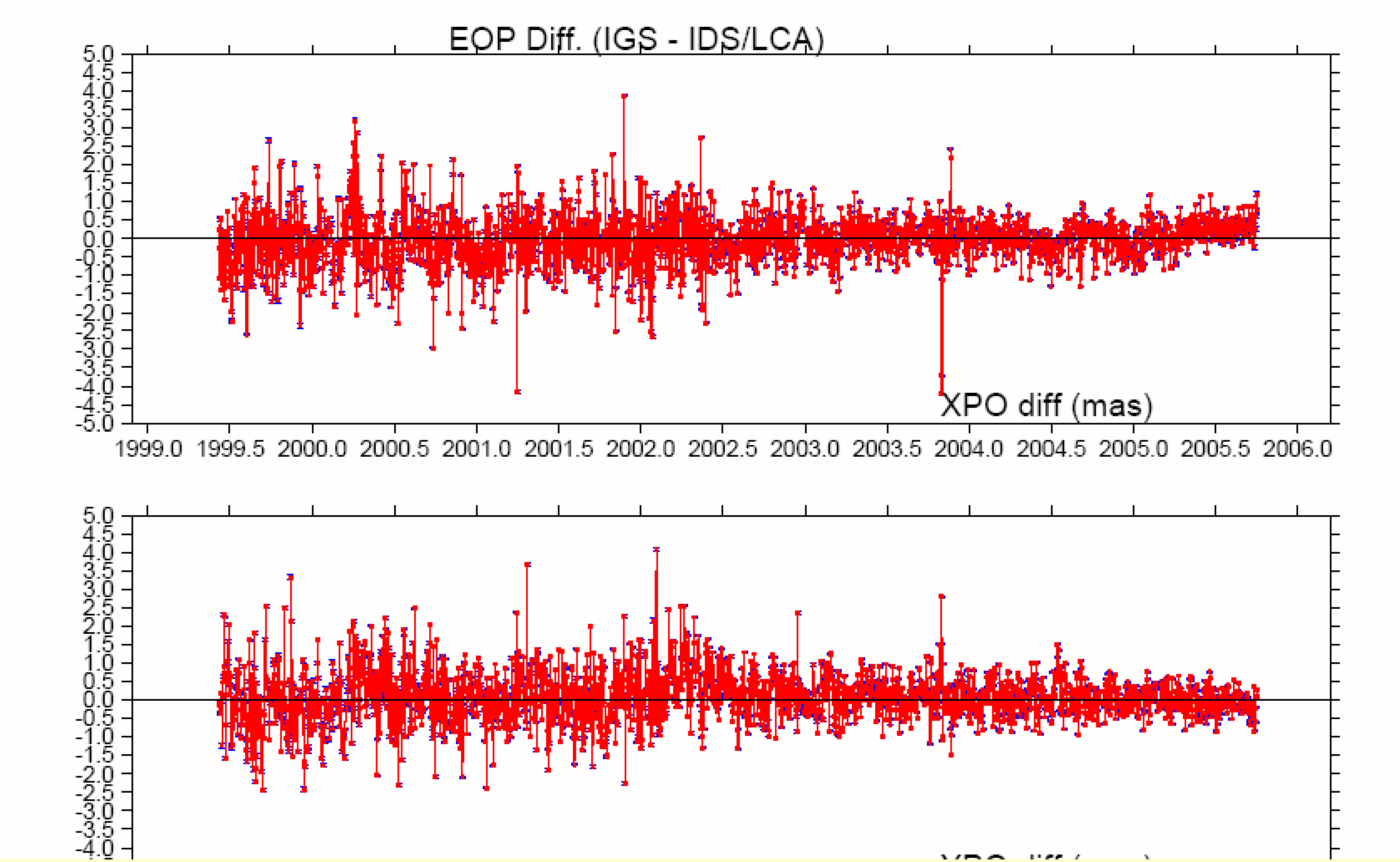
EOP solutions	**X-pole**	**Y-pole**
CNES/SOD	44, 77, 87, 286	38.5, 87, 111
IGN - JPL	32, 39.2, 118, 400	32, 39.2, 118
LEGOS - CLS	11	10.8, 12
INASAN	25.8, 32, 39, 59, 67, 100, 123	43, 57, 107, 123

Scaling factors of the formal errors and weights

Analysis Center	Scaling factor X-pole	Weight in X-pole in percentage	Scaling factor Y-pole	Weight in Y-pole in percentage
CNES/SOD	1.14	33	0.90	32
IGN - JPL	0.58	47	0.78	42
LEGOS/CLS	0.82	7	0.76	5
INASAN	1.02	13	1.16	21

Bias and Root-mean-square (RMS) agreement of the individual solutions and the combined DORIS series over 2000-2004 with respect to the C04 solution

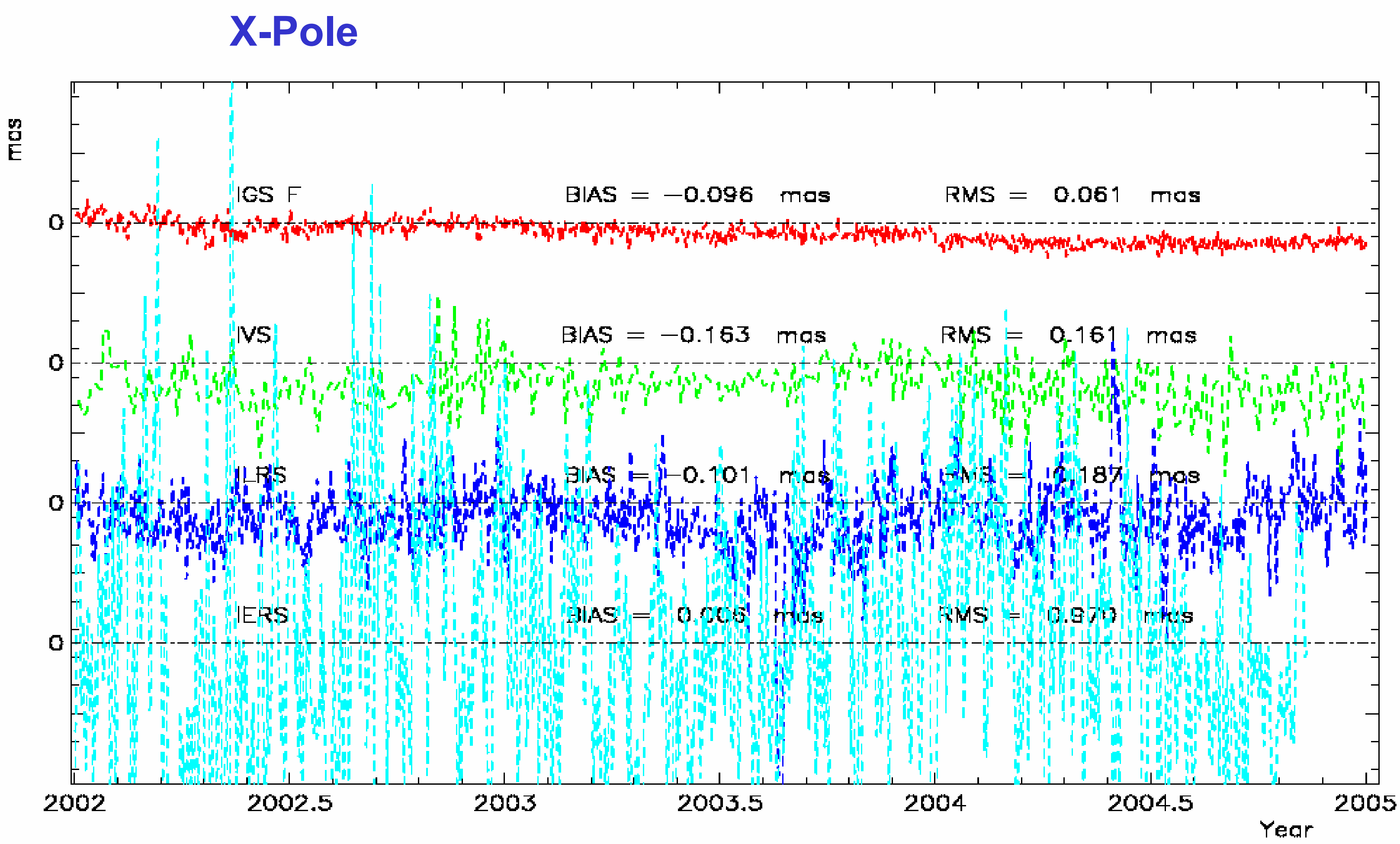
	X-pole bias and sigma (mas)	X-pole RMS (mas)	Y-pole bias and sigma (mas)	Y-pole RMS (mas)
CNES/SOD	0.41 0.04	1.61	0.15 0.04	1.74
IGN-JPL	-0.01 0.04	1.74	-0.24 0.02	0.99
LEGOS/CLS	0.02 0.07	3.47	-0.01 0.07	3.51
INASAN	0.48 0.06	2.83	-0.48 0.04	1.70
COMB (DORIS-IERS)	-0.01 0.03	**1.13 mas**	-0.24 0.02	**0.69 mas**


EOP Diff. (IGS - IDS/LCA)
XPO diff (mas)
1999.0
1999.5
2000.0
2000.5
2001.0
2001.5
2002.0
2002.5
2003.0
2003.5
2004.0
2004.5
2005.0
2005.5
2006.0

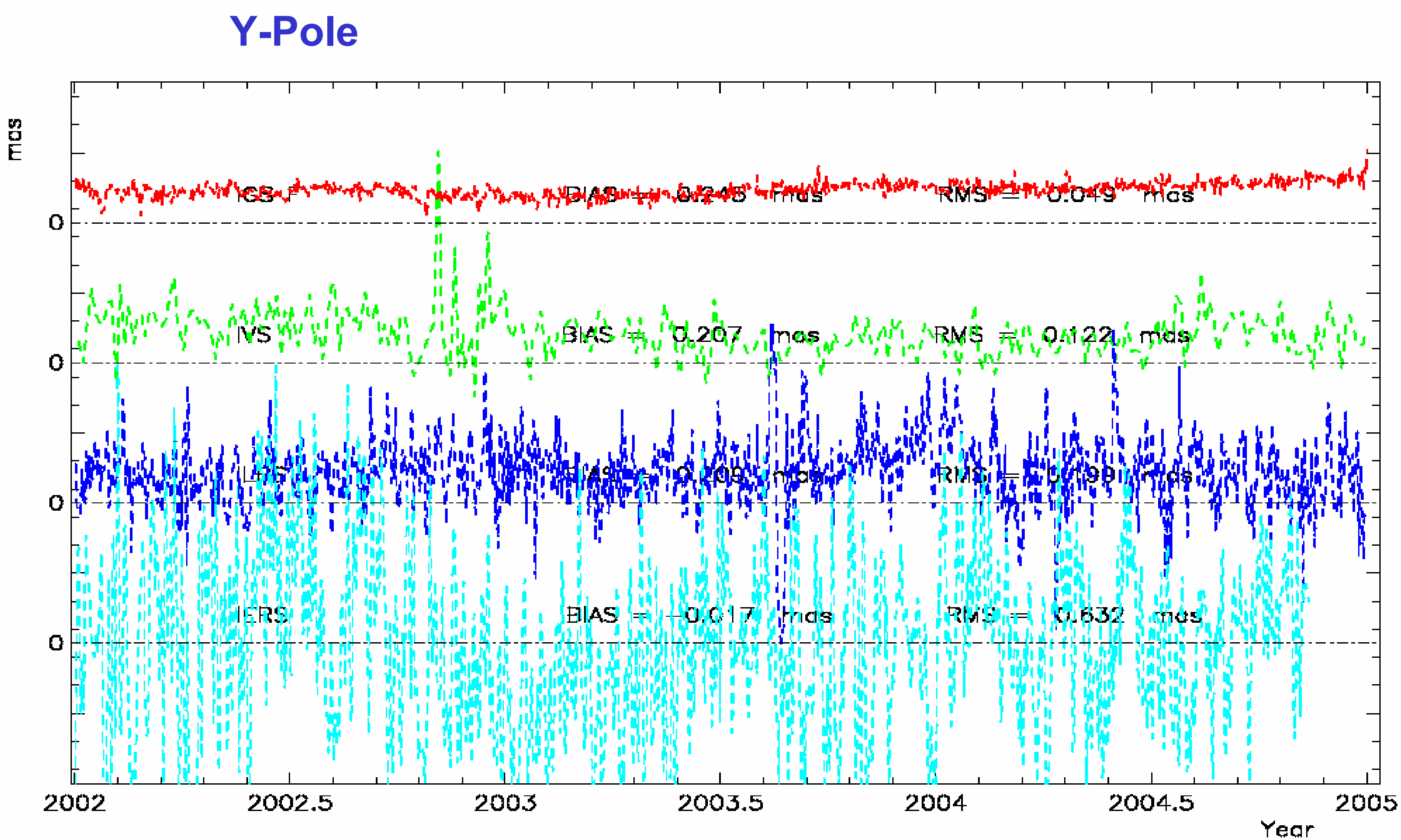
Bias and Root-mean-square (RMS) agreement of the different combined intra-technique solutions series over 2000-2004 with respect to the IERS C04 solution

	X-pole bias (mas)	**X-pole RMS (mas)**	**Y-pole bias (mas)**	**Y-pole RMS (mas)**
IGS	-.09	0.06	.23	0.06
IVS	-.17	0.15	.24	.11
ILRS	-.10	0.19	.18	.19
DORIS(COMB)	-.01	1.13	-.24	.69

Differences combined techniques solutions – IERS C04



Differences combined techniques solutions – IERS C04



Pole rates or not pole rates ?..

PRO

- Valuable quantity PM drift directly comparable to Atmospheric excitation

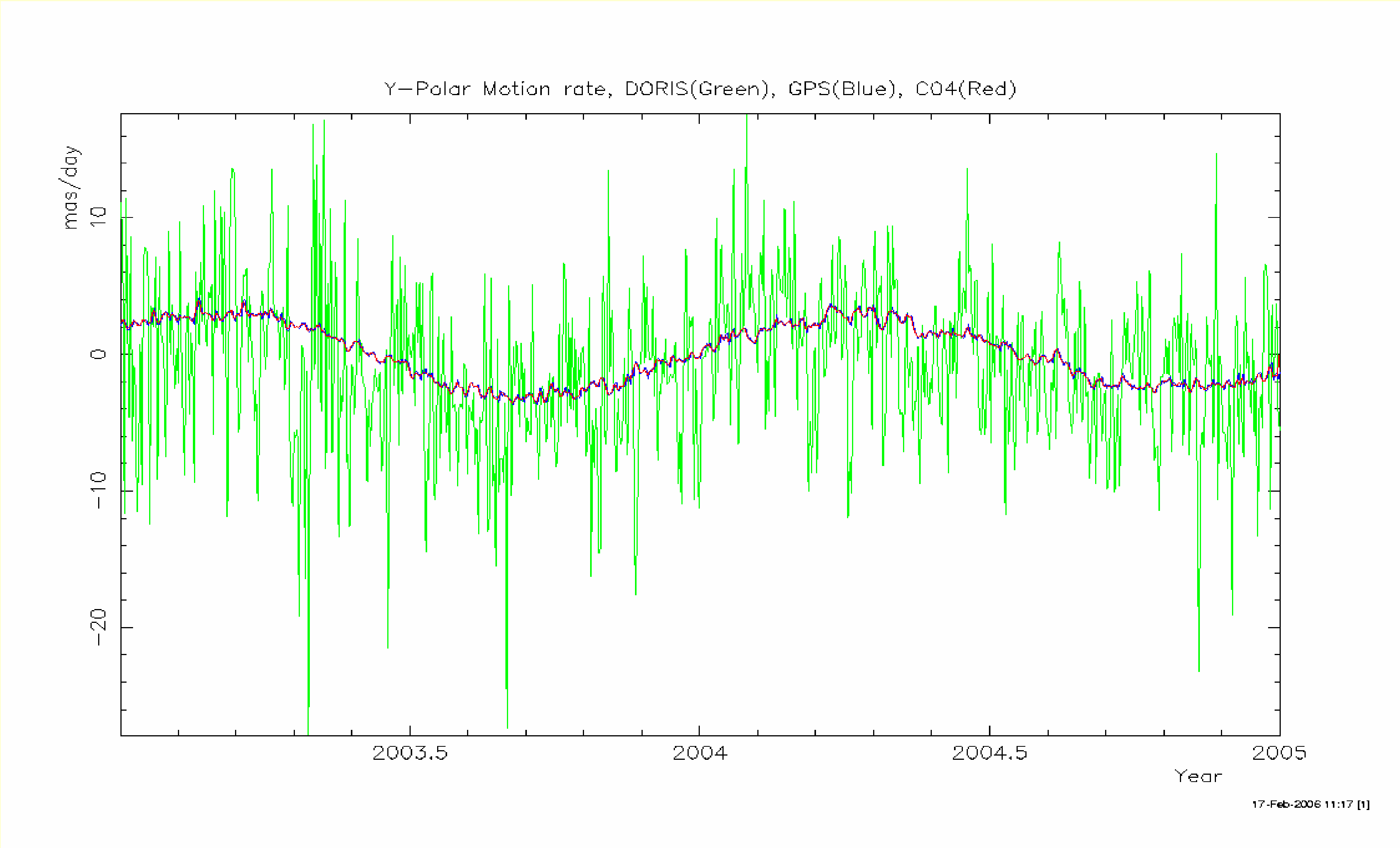
- Improvement of internal consistency

CON

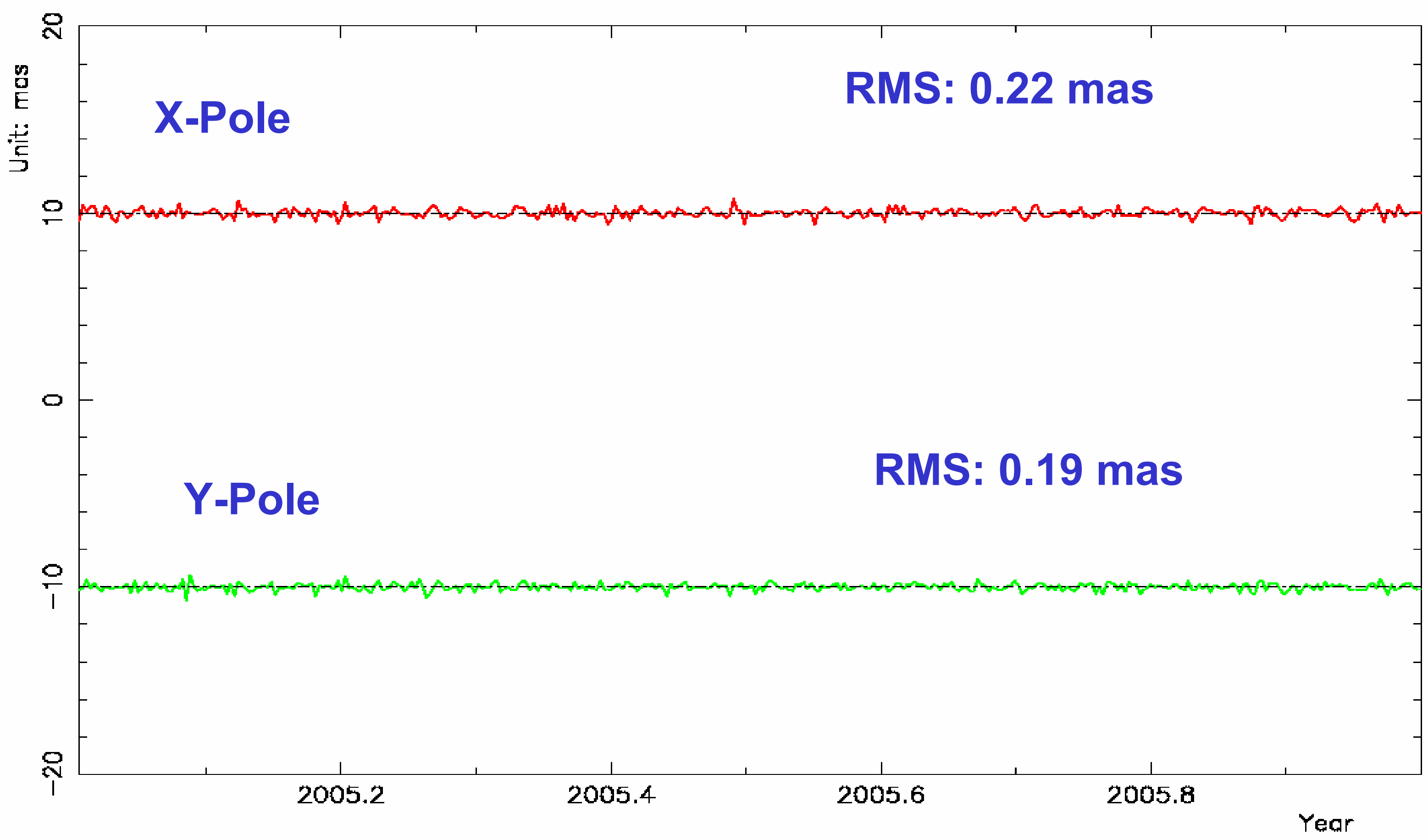
- But correlation PM(t) and drift PM(t) ?

- Bring noise

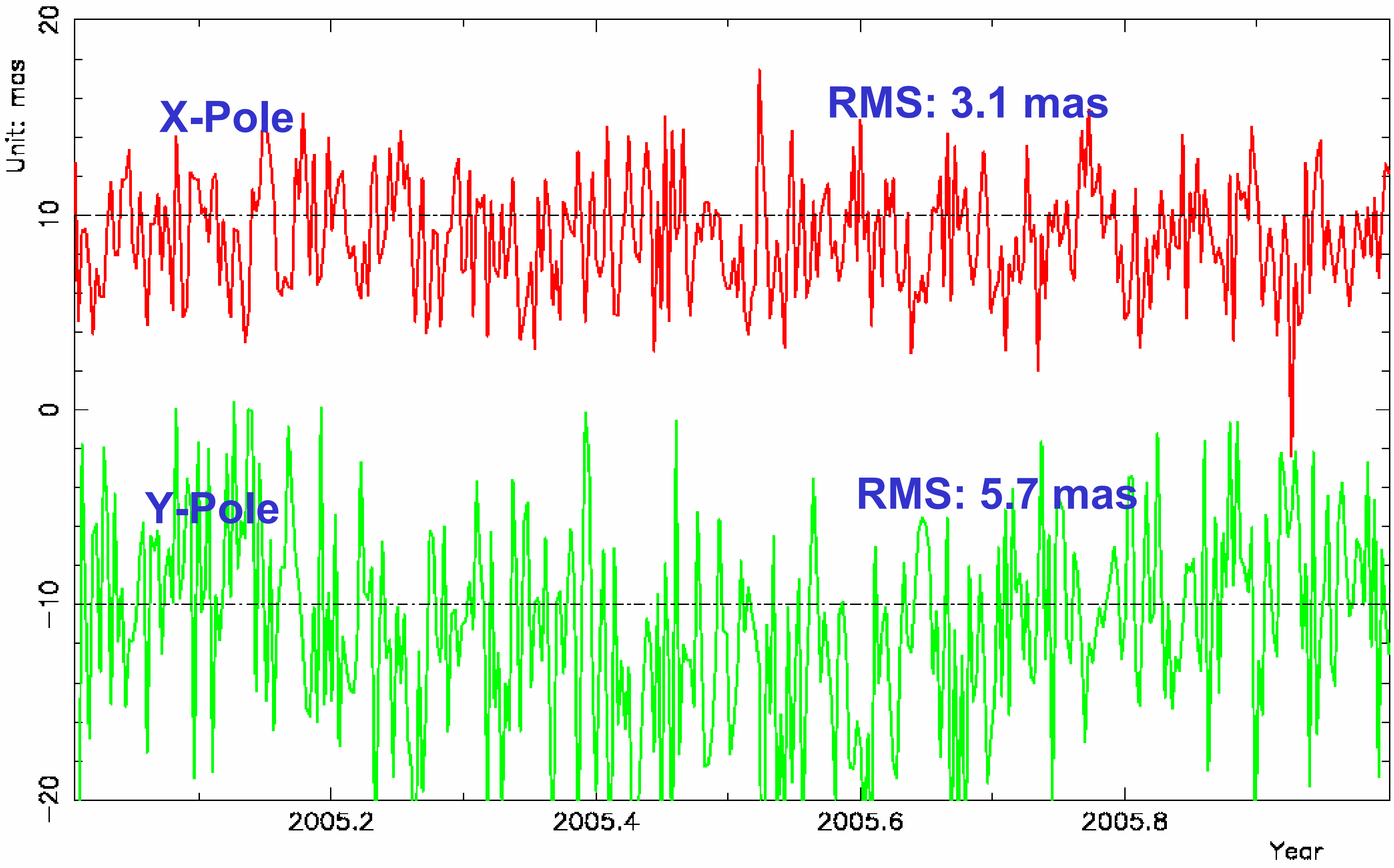
Y-Pole rates GPS (dark blue) and DORIS (green)



Quality of GPS pole rates, closure X(t+1)- X(t) . rate



Quality of DORIS pole rates, closure X(t+1)- X(t) . rate

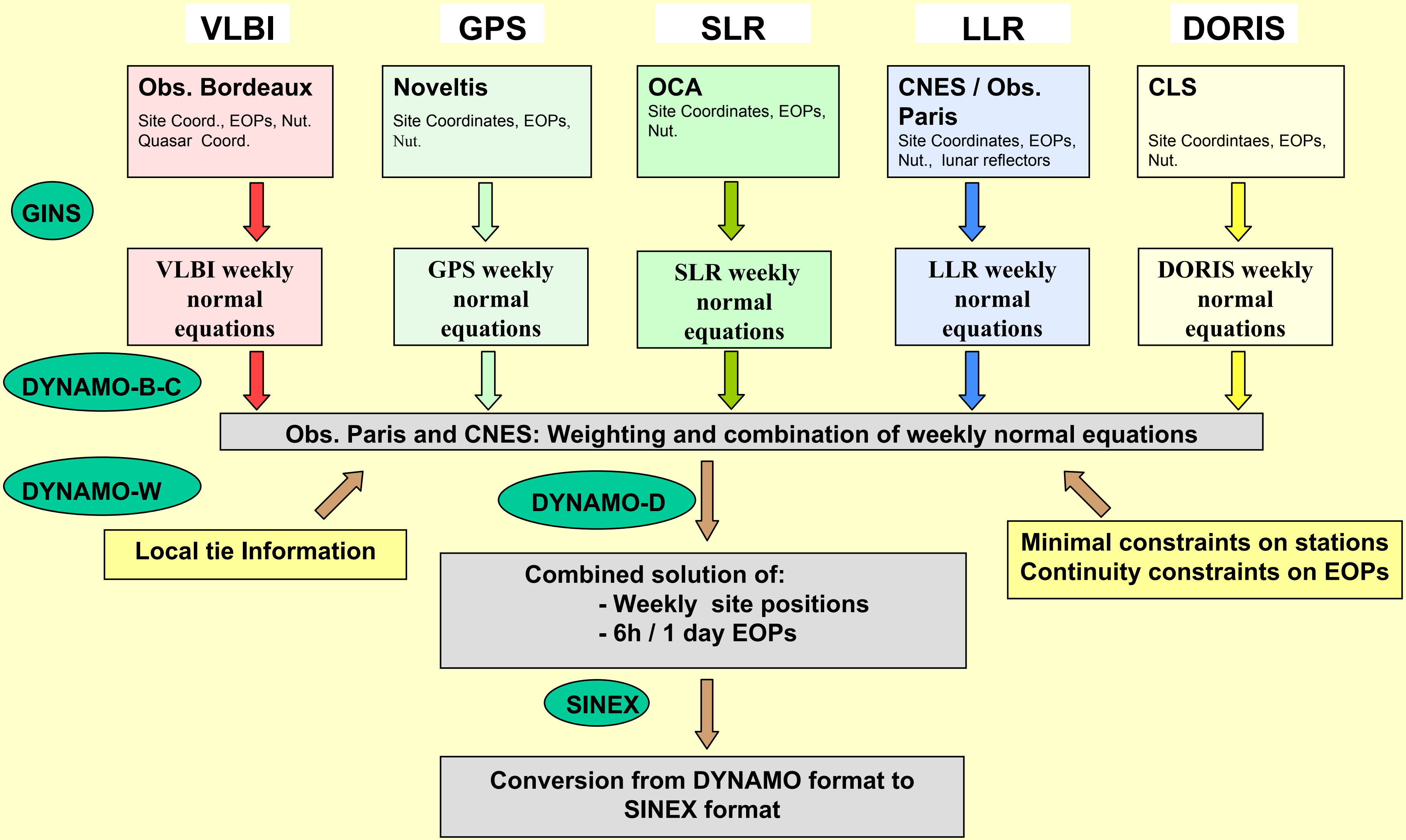


Multi-technique combination
Project “CRC”

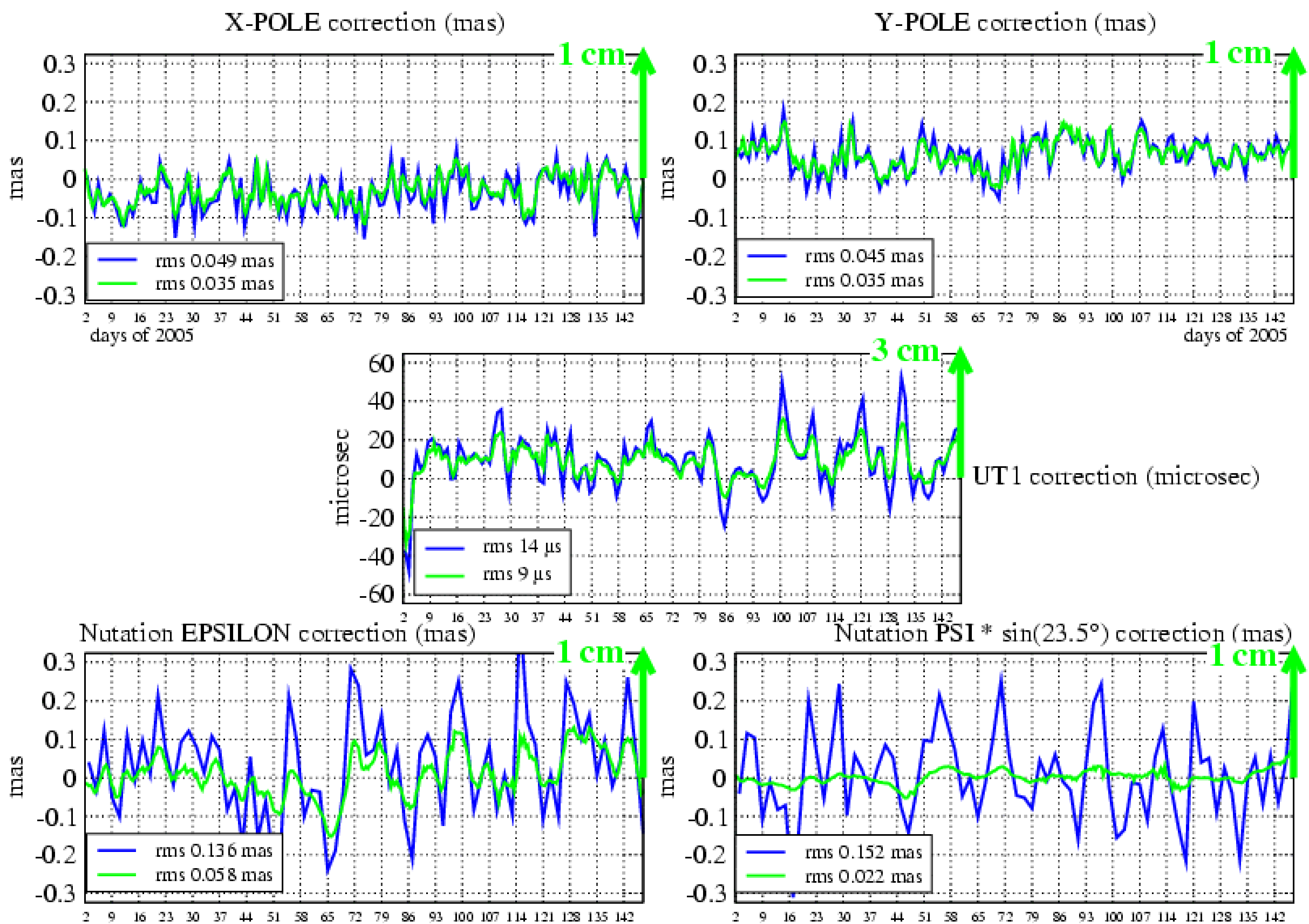
D. Gambis, T. Carlucci (Obs. Paris)
R. Biancale, J.-M. Lemoine (CNES)
Z. Altamimi (IGN)

GPS: S. Loyer
Noveltis - Toulouse
DORIS: L. Soudarin
CLS - Toulouse
SLR: P. Berio, O. Lorrain
OCA - Grasse
VLBI: P. Charlot, G. Bourda
Observatoire de Bordeaux

GRGS organization of the IERS project



Earth orientation parameters : comparison to C04



in blue : daily EOP at 12 UTC

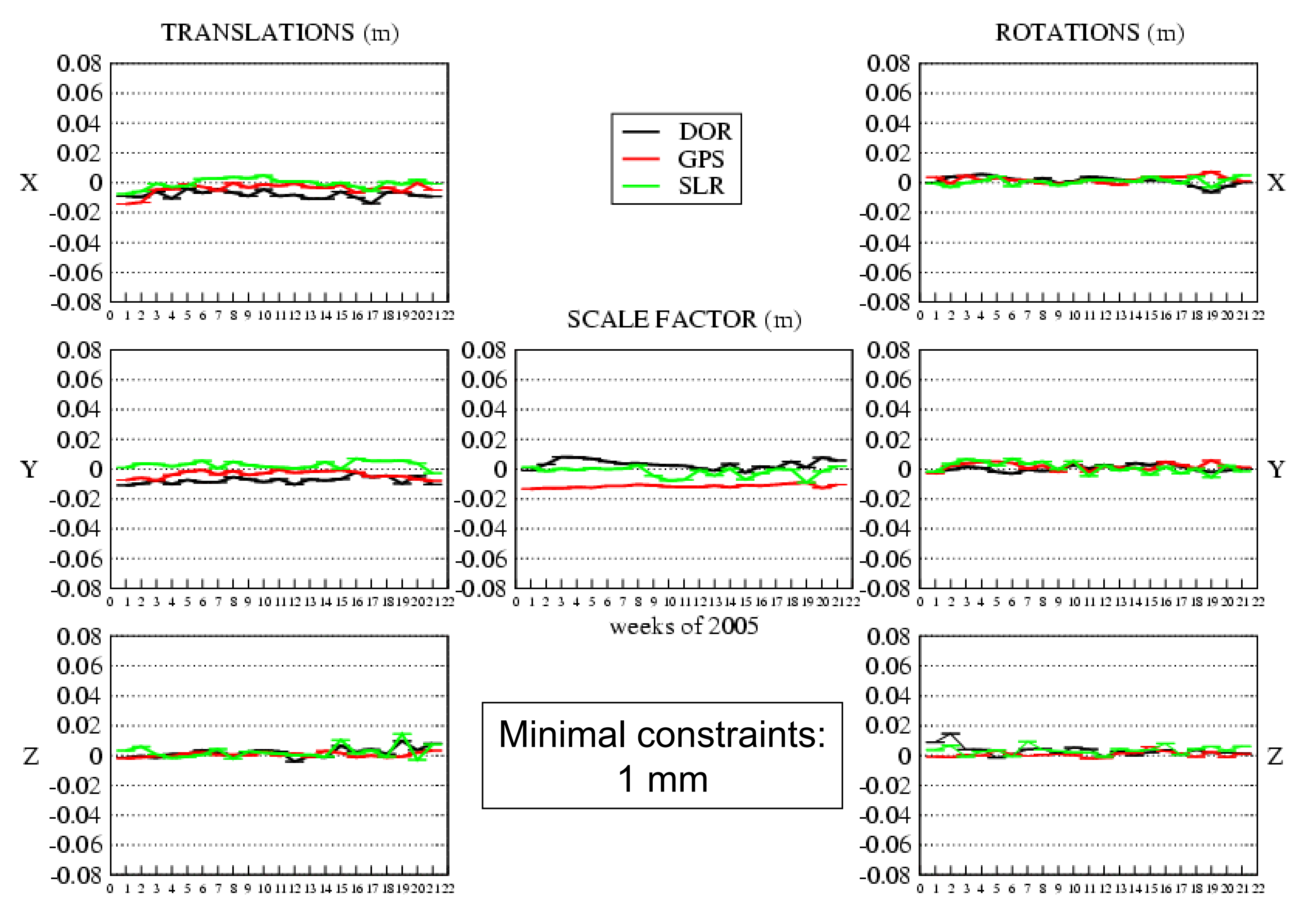
in green between 6-h values

Comparison of various combined series with C04

	Mean			*RMS*		
	Yp (μas)	*Yp (μas)*	*UT1 (μs)*	*Xp (μas)*	*Yp (μas)*	*UT1 (μs)*
IGS	*-88*	*311*		*32*	*30*	
IVS	*-184*	*244*	*1*	*.160*	*.121*	*9*
ILRS	*-234*	*249*		*.160*	*.203*	
DORIS	*-224*	*-23*		*1.44*	*1.49*	
GRGS	*-37*	*62*	*9.3*	*50*	*46*	*14*

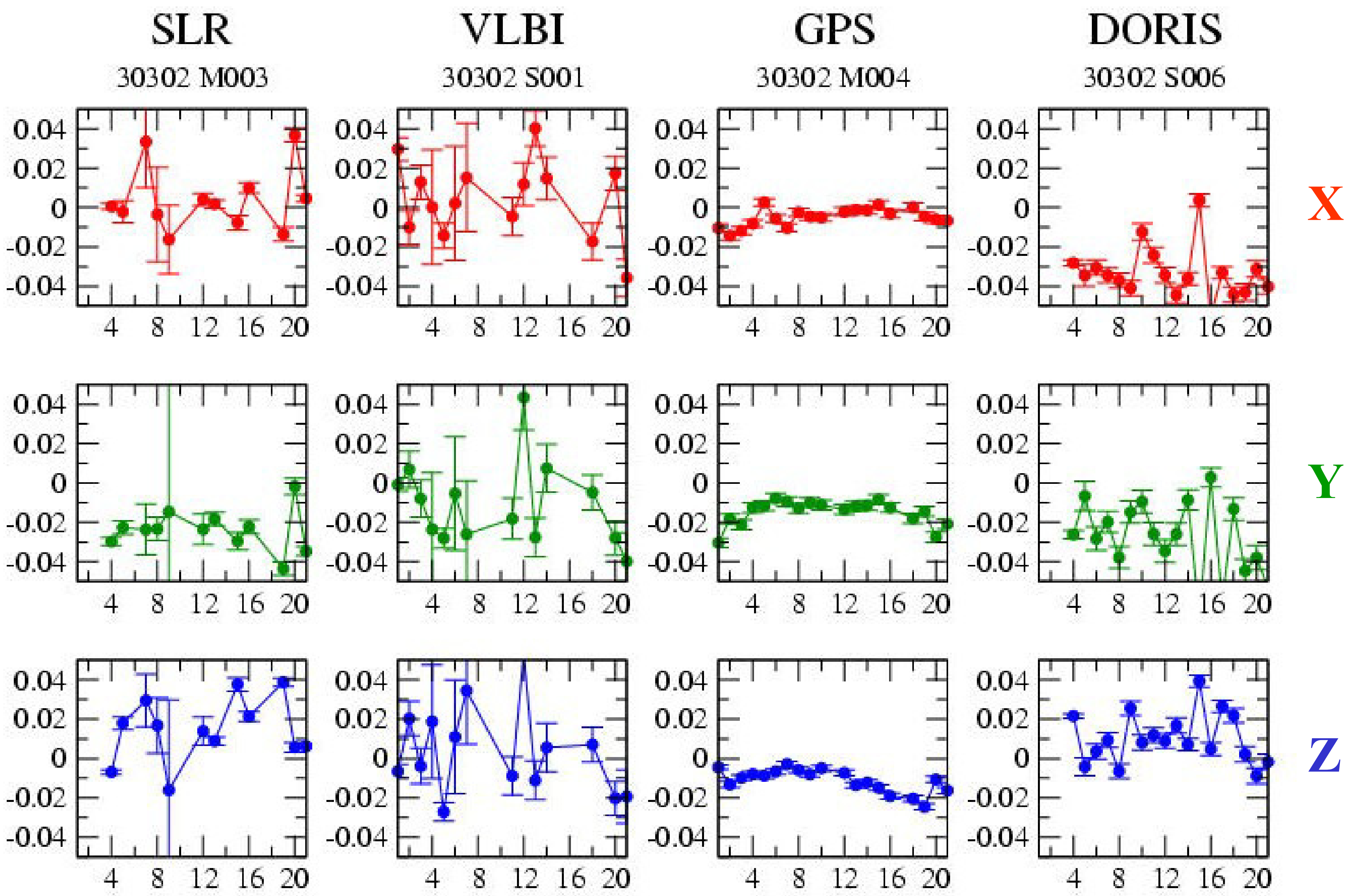
Daily solutions

Reference frame solution : 7-parameter transform wrt ITRF2000

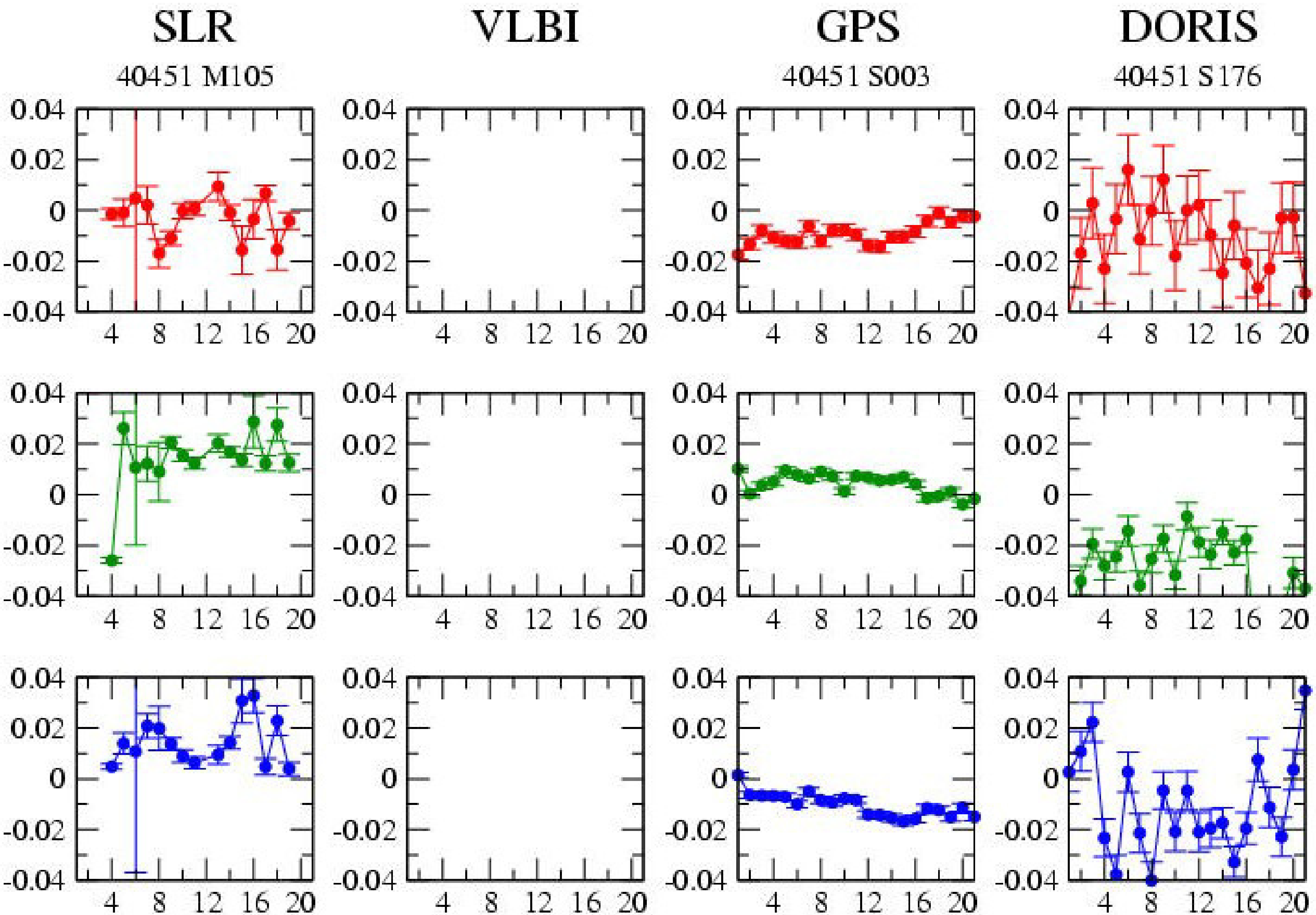


Minimal constraints:
1 mm

Reference frame solution : results for colocated site 30302



Reference frame solution : results for colocated site 40451



Conclusions

- Combination of four DORIS independant series

- Precision of the DORIS combined polar motion is .9 mas and .6 mas respectively for X and Y-pole.

- Accuracy takes into account the inconsistency between reference frames and EOP not better than 1 mas

  $$\text{Inaccuracy}^2 = \text{precision}^2 + \text{Systematic error}^2$$

- A lot of systematic variations affect the accuracy, orbit model deficiency
- Polar motion accuracy : external check of the POD quality

- Pole rates estimation do not improve the quality of the PM series

- New multi-technique analysis approach including DORIS

« CRC » GRGS project