MONITORING POLAR MOTION BY DORIS TECHNIQUE

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Motivation

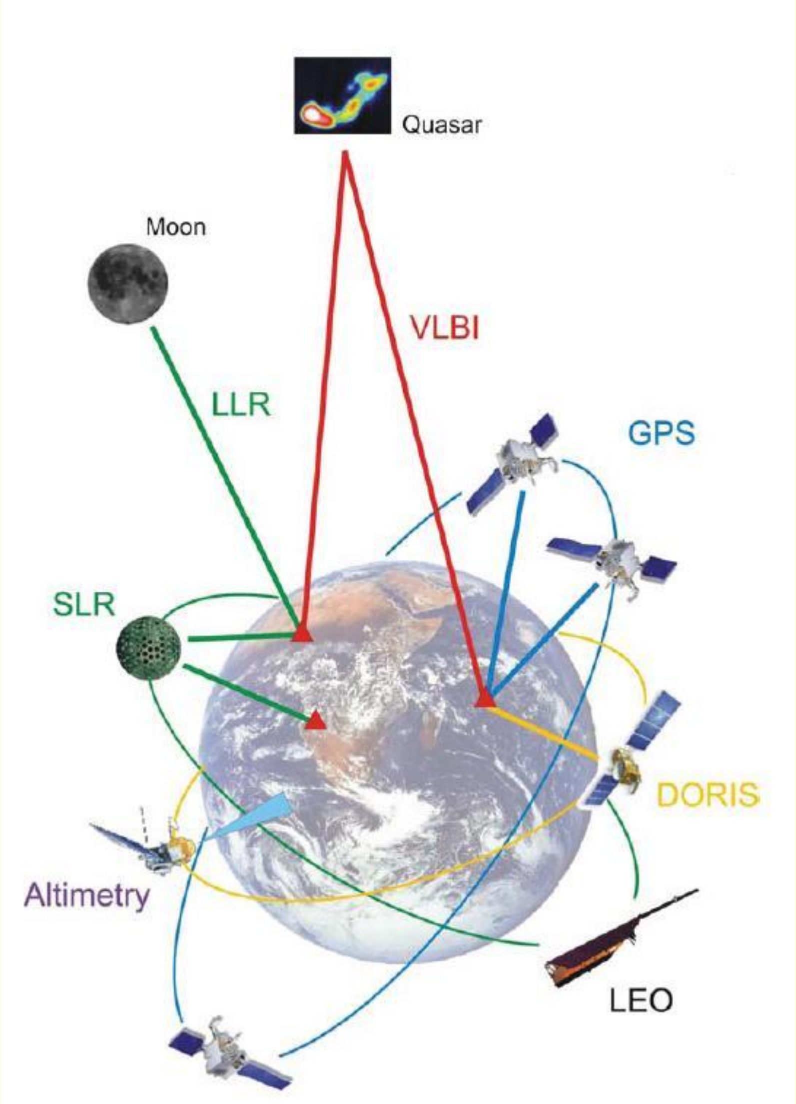
•EOP: by-products of the analyses valuable to assess the accuracy of orbit determinations and terrestrial frame

•Interest of EOP derived from DORIS for IERS combinations

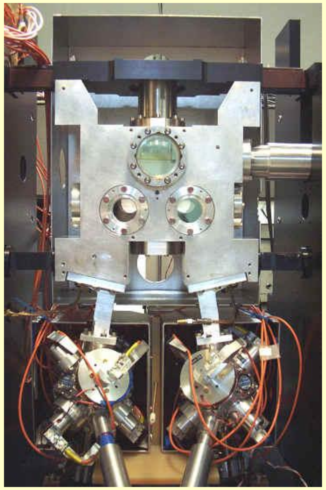
•Multi-technique combinations

IDS Workshop, Lisboa, 21-22 Outobro 2010

Space geodetic techniques



Cold atom gyroscope



Contribution of the various techniques to IERS

The number of stars matches the relative contribution of techniques

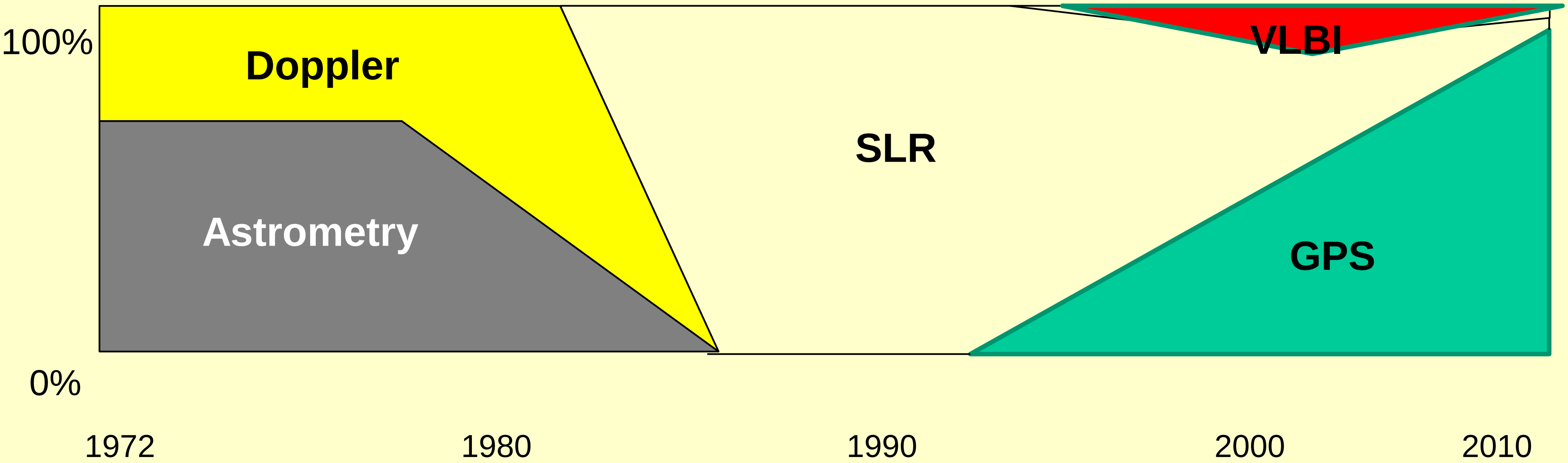
PRODUCTS	LLR	VLBI	SLR	GPS	DORIS
Extragalactic ref. Frame		***			
Tie to solar system	***	*			
Tie to Earth					
Precession-nutation	**	***	*	*	
Universal Time	*	***			
Earth Rotation					
High-frequency UT		***	*	**	
Polar Motion		**	**	***	*
Terrestrial Reference Frame					
Network coverage		*	*	**	***
Long-term geocenter	*	***	**	*	
Tectonic plate motion		***	**	***	***
Densification		*	*	***	**

Techniques evolution for EOP determination

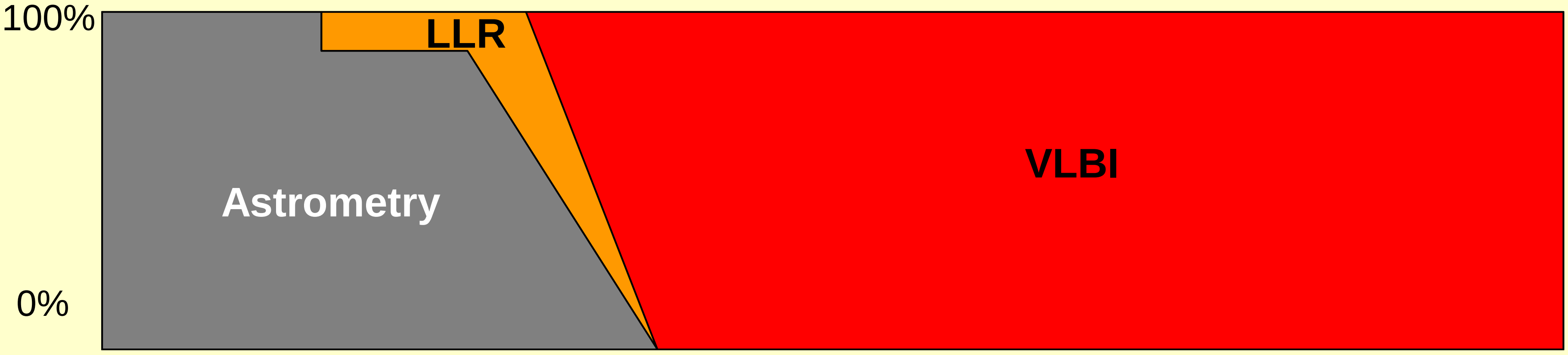
Technique	*since*	*EOP*	*Time Res.*	*Present accuracy*
ASTROMETRY	**1899**	**Pole**	**5 days**	**Pole: 20 mas**
		UT1	**“**	**UT1: 1 ms**
		Nutation	**“**	**Nutation: 40 mas**
DOPPLER	**1972**	**Pole**	**2 days**	**Pole: 10 mas**
LLR	**1969**	**UT0**	**1 day**	**UT0: 0.1 ms**
SLR	**1976**	**Pole**	**3 days**	**Pole: 200 μas**
		LOD	**“**	**LOD: 200 μs/d**
VLBI	**1981**	**Pole**	**7 days**	**Pole: 100 μas**
		Nutation	**“**	**Nutation: 60 μas**
		UT1	**sub-daily - 7 days**	**UT1: 15 μs**
GPS	**1993**	**Pole**	**sub-daily**	**Pole: 40 μas**
		LOD	**“**	**LOD: 25 μs**
DORIS	**1995**	**Pole**	**3 days**	**Pole: 300 μas**

Contributions of techniques to IERS combined solutions

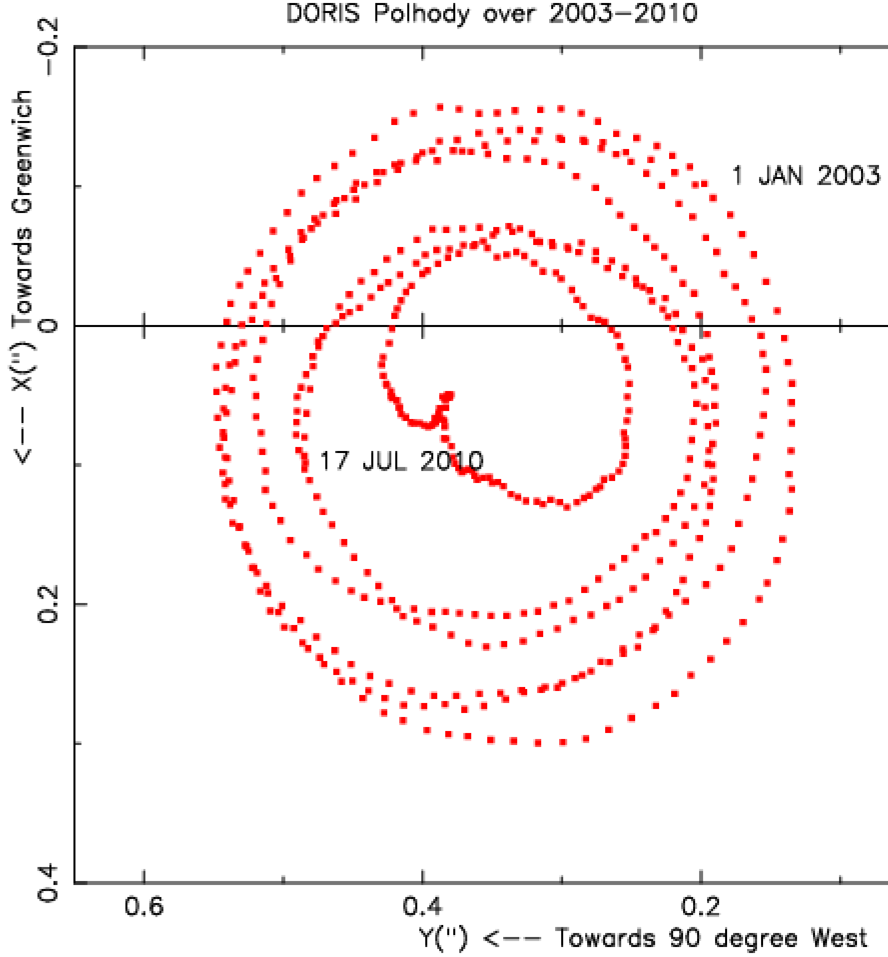
Polar Motion



Universal Time



DORIS polar motion over 2003-2010



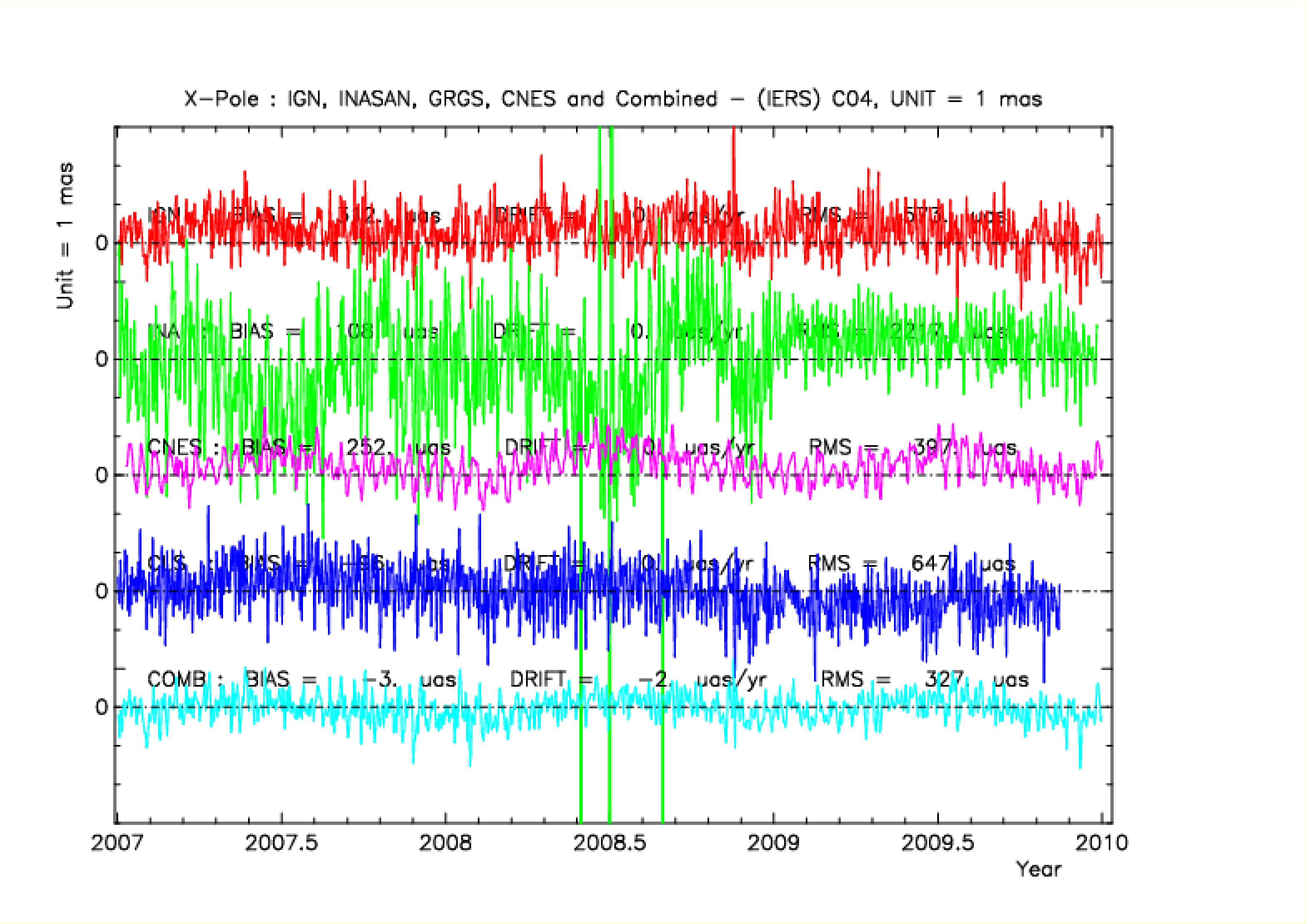
Data analysed

CNES /SOD	Centre National d'Etudes Spatiales, DORIS Orbitography Service (France)
IGN - JPL SINEX	Institut Géographique National (France) and Jet Propulsion Laboratory (USA)
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)

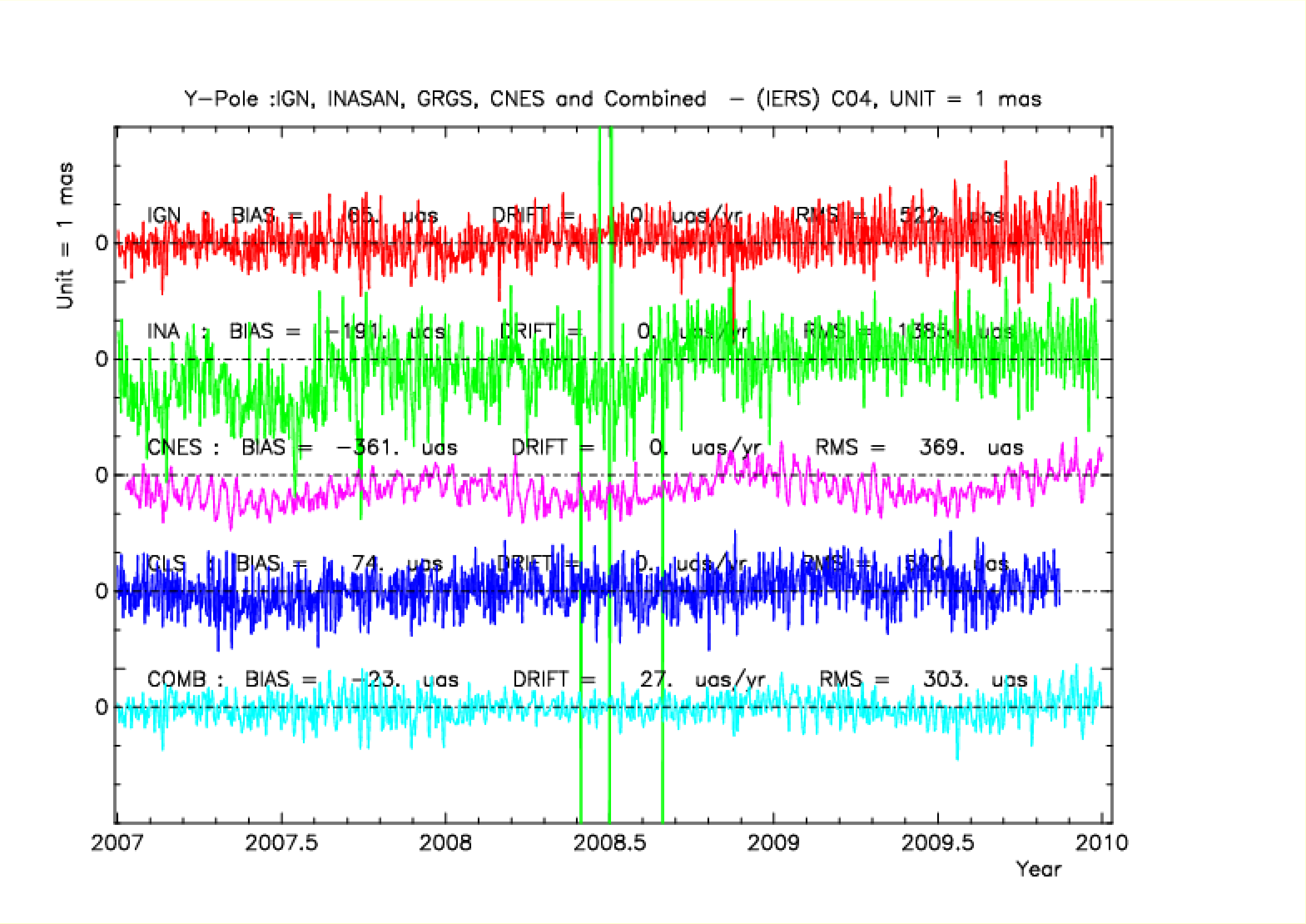
Characteristics of the DORIS solutions

ANALYSIS CENTER	SATELLITES	SOFTWARE	DATA INTERVAL	EOP ESTIMATED
CNES/SOD	SPOT-2, SPOT-4, SPOT-5, TOPEX, ENVISAT, Jason-1 (partly)	ZOOM	1999- 2010	Pole components
IGN-JPL	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX, ENVISAT	GYPSY/OASIS II	1993 - 2010	Pole components Pole and UT1-UTC rates
LEGOS/CLS	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX, ENVISAT	GINS/DYNAMO	1993 - 2010	Pole components using constrains on continuity
INASAN	SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX , ENVISAT	GYPSY/OASIS II	1992 - 2010	Pole components Pole and UT1-UTC rates

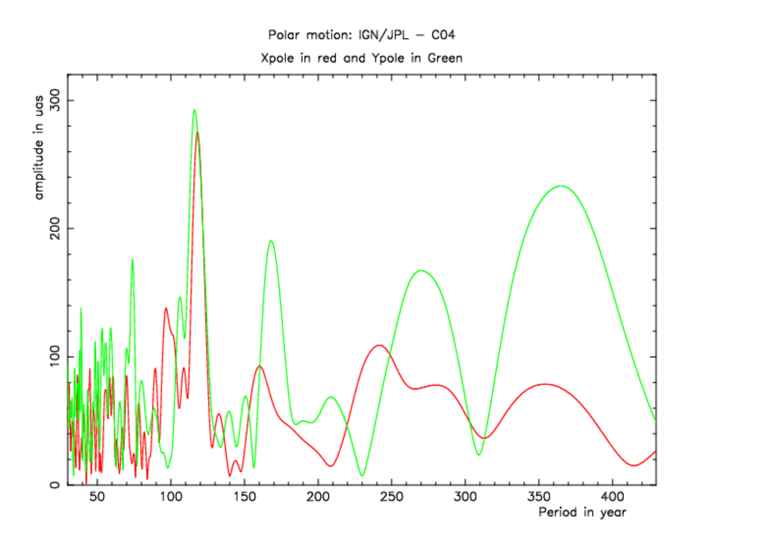
Comparison between different solutions and C04

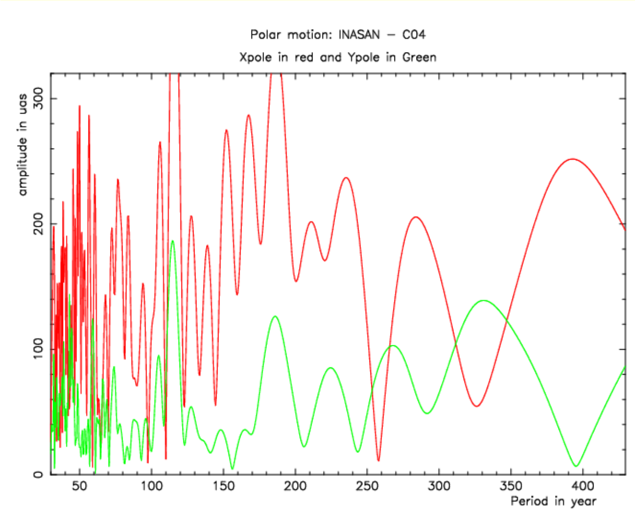


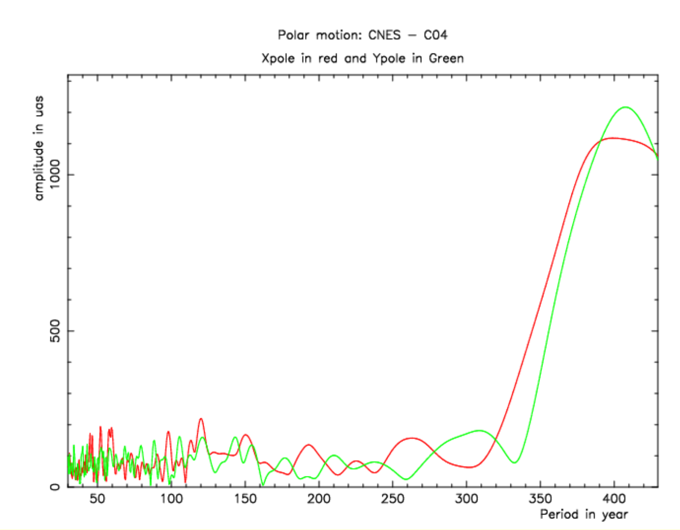
Comparison between different solutions and C04

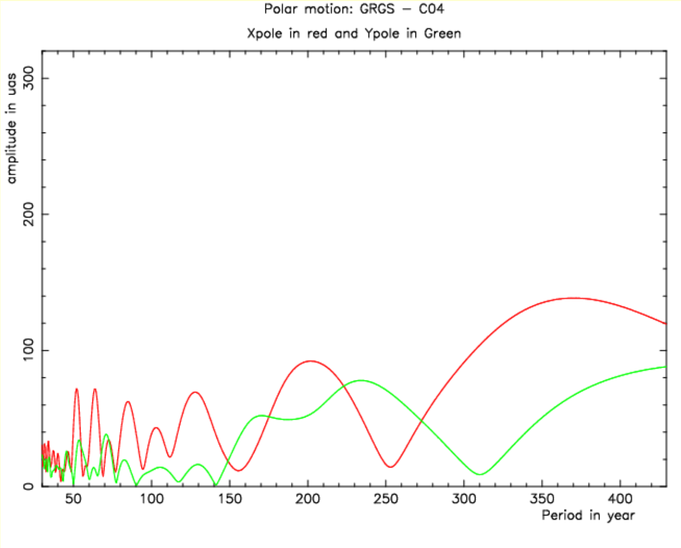


Systematic periodic effects

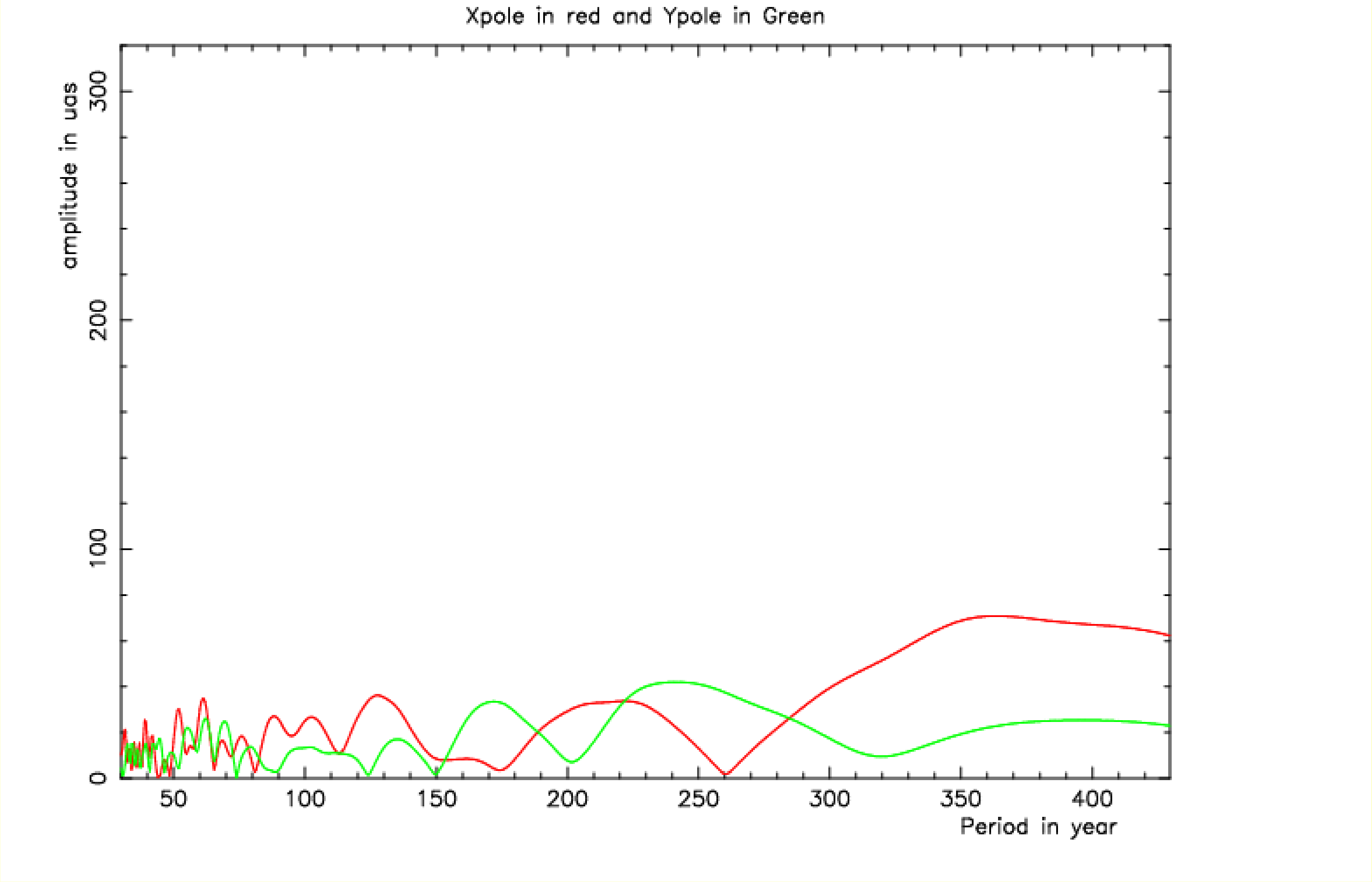




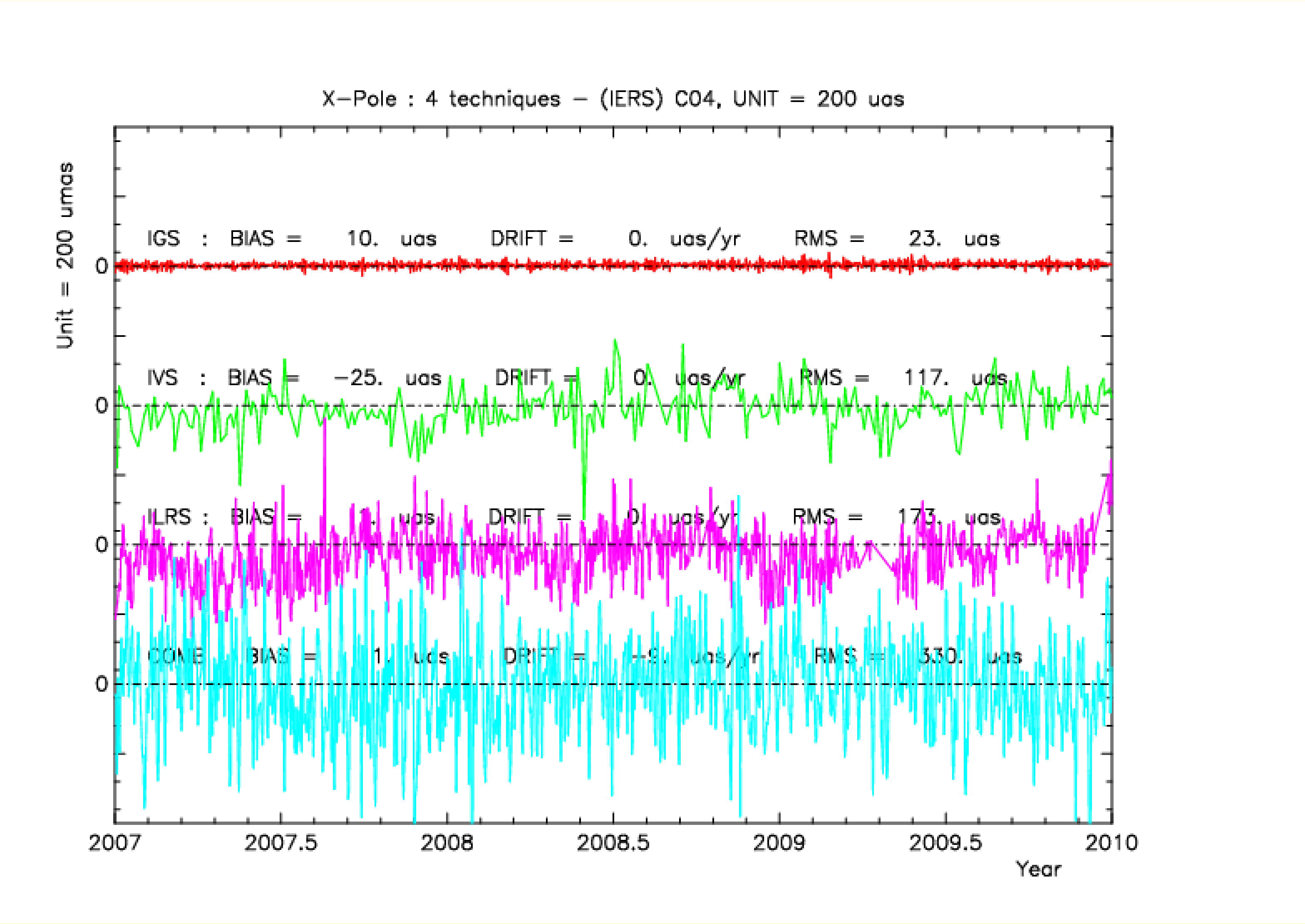




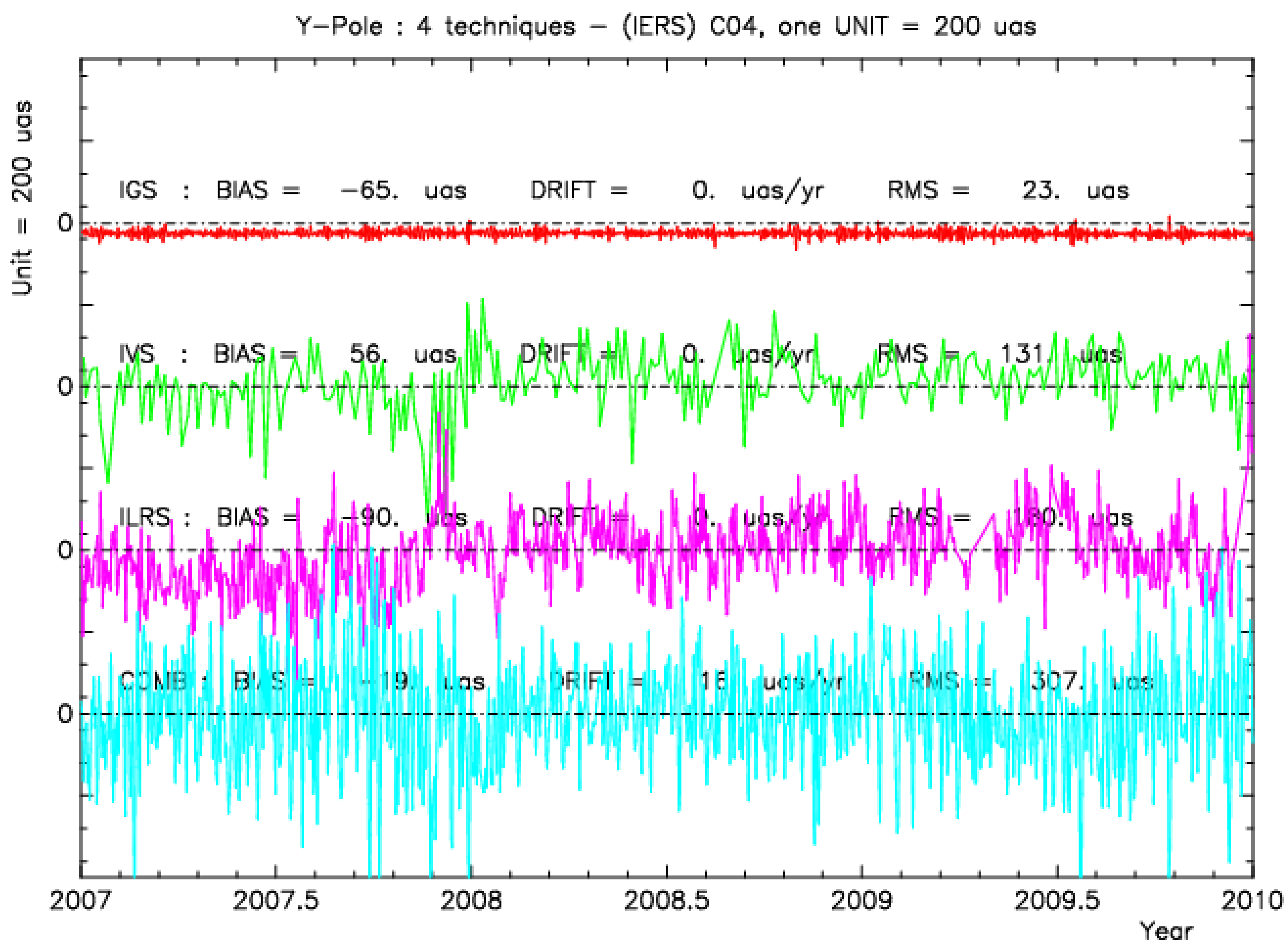
Combined solution



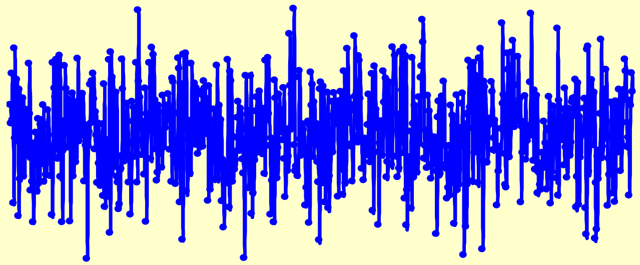
Agreement between different techniques and C04



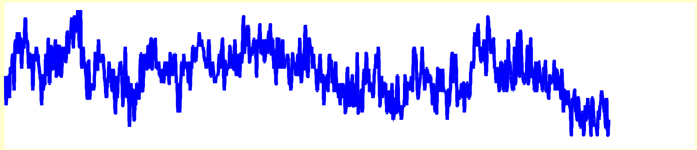
Agreement different techniques and C04



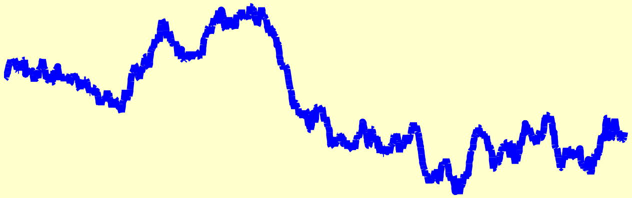
Allan variance analysis:
different noise types in the time domain



White noise

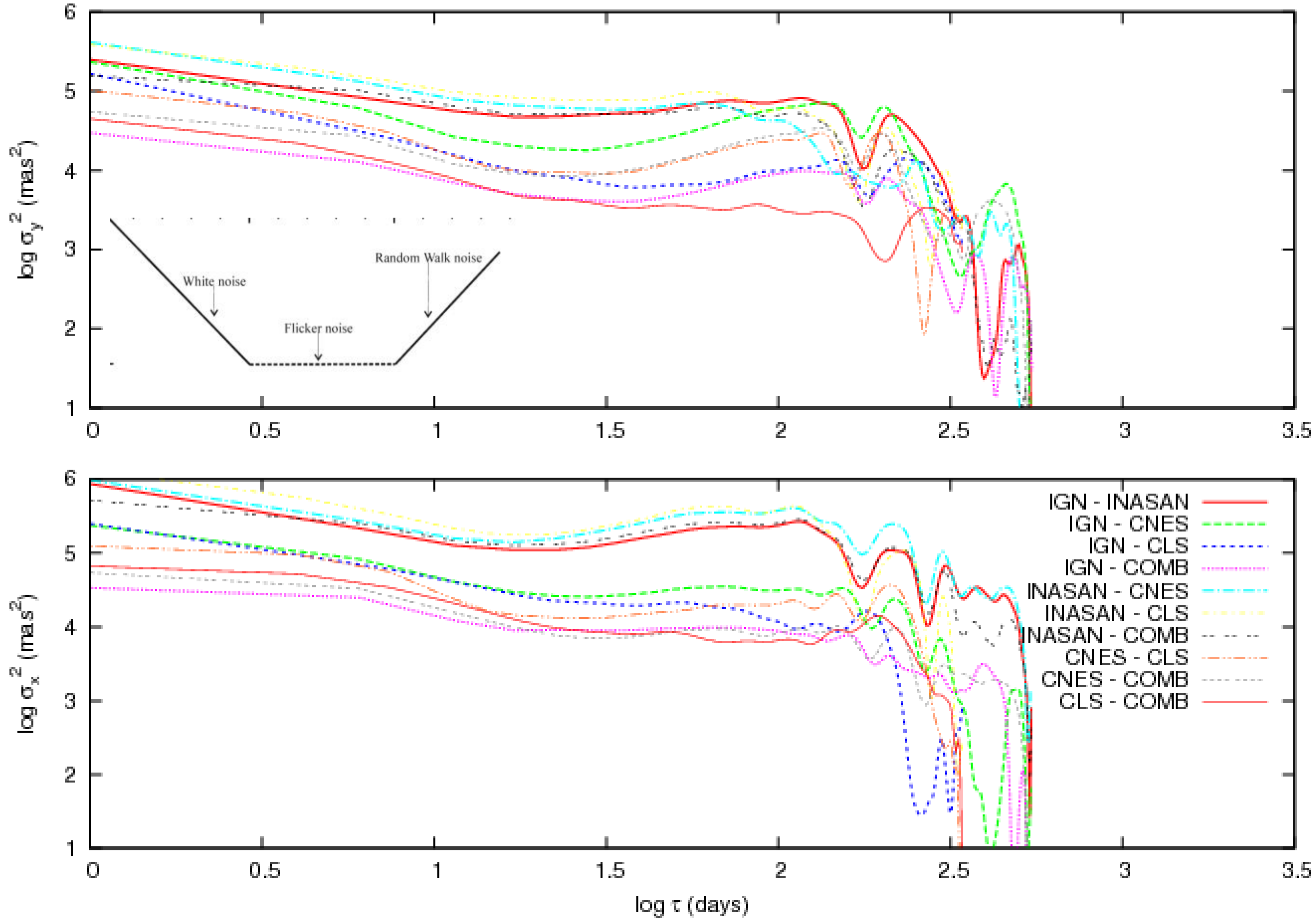


Flicker noise

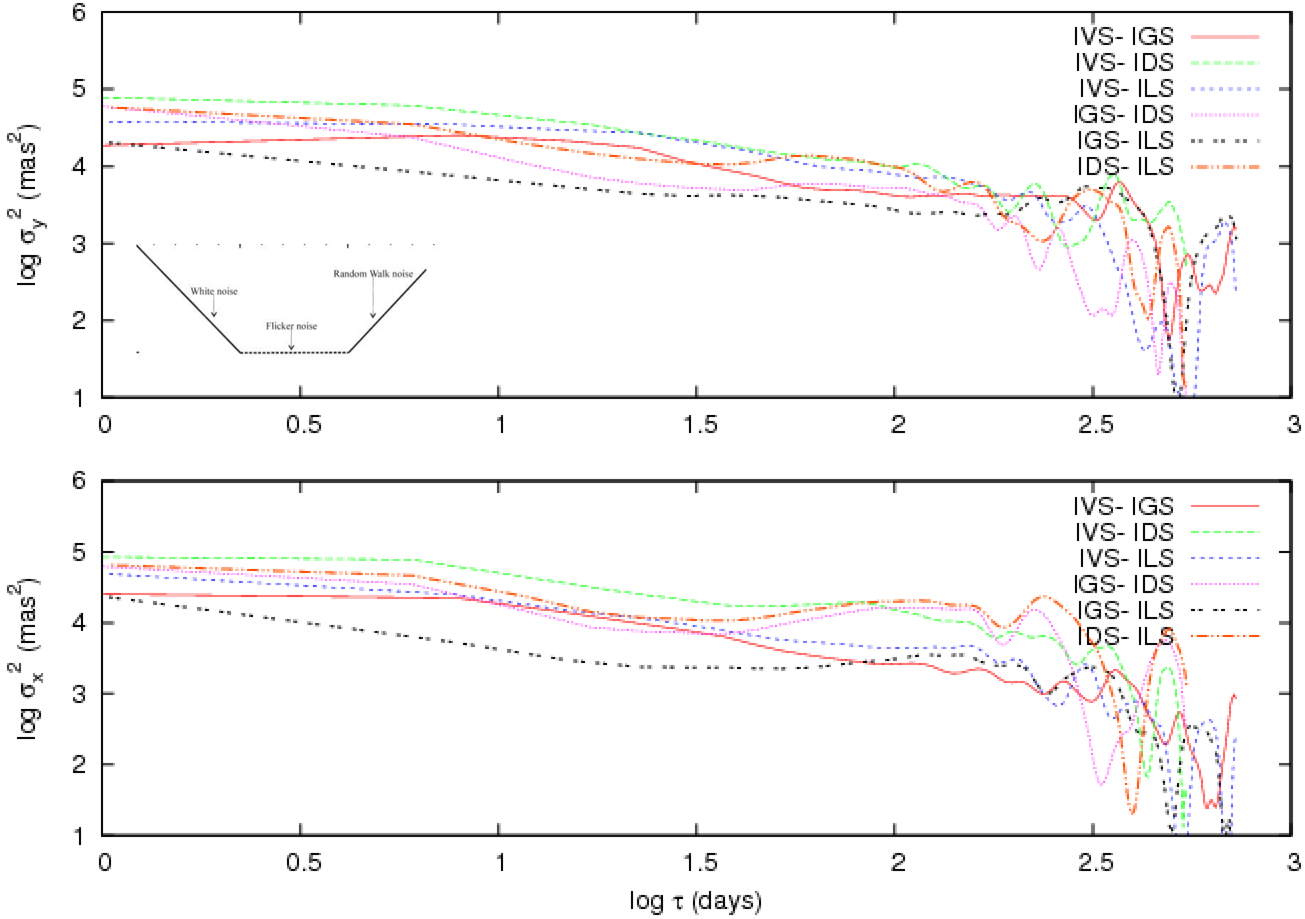


Random walk noise

Allan variance of differenced DORIS series



Allan variance, different techniques



Global combination: interest of the method

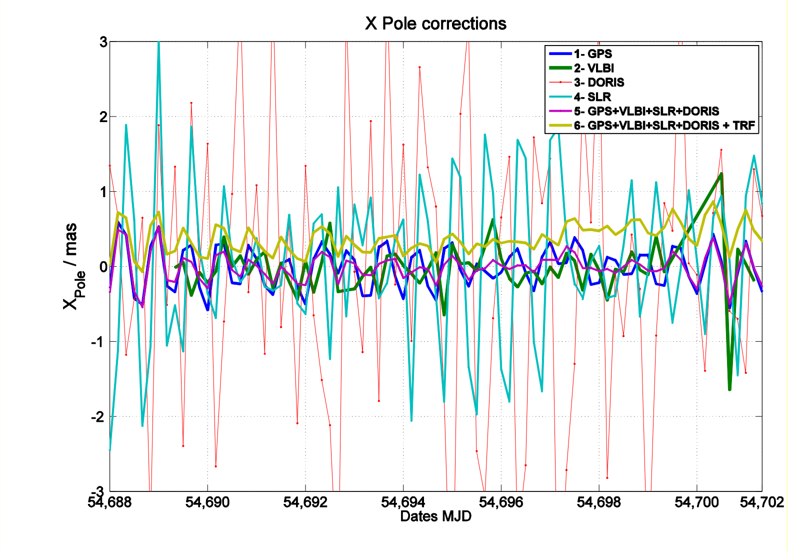
•Towards an optimal combination of:
EOP+ station coordinates, tropospheric parameters, CRF (in the future)

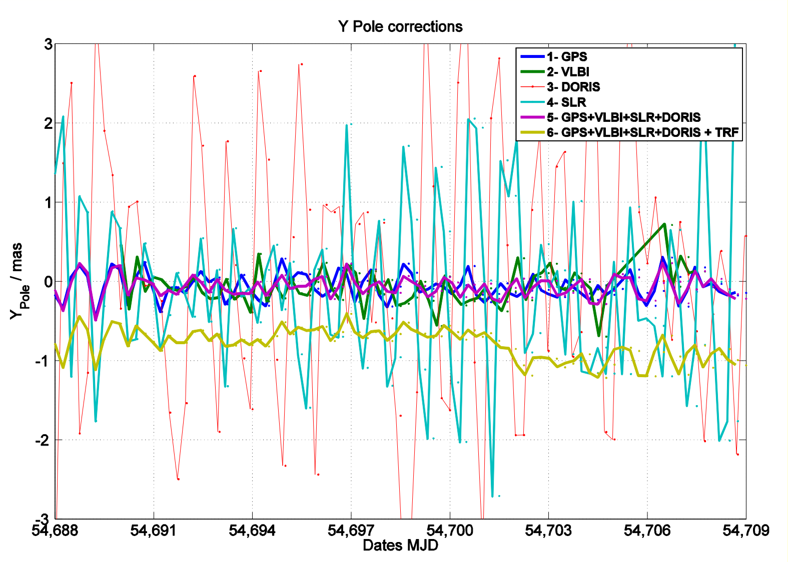
•Techniques have their own strengths and weaknesses
• Use of same software (GINS), same conventional models
•Should benefit from mutual constraints of the various techniques
•Densification and complementarity
UT1 (VLBI) + LOD (GPS)
Nutation (VLBI) + nutation drift (GPS)

•Decrease temporal resolution of EOP: 6h, 3h ?

However difficulties !!
Combination strategy to be applied
To ensure stability of reference frames over successive week determination
Weighting of the various techniques

Polar Motion 6H estimation





Conclusions

- Combination of four DORIS independant series
- Precision of the DORIS combined polar motion is around 300 μas ‘compared to .9 mas in 2005)
- Accuracy takes into account the inconsistancy 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
- Multi-technique analysis approach including DORIS may improve the overall consistency

Different observation techniques and multi-disciplinary scientists needed to progress..