The 19th of May, 2015
at Sao Miguel, Azores, Portugal

Nutation from VLBI: comparison and CRF issues

EVGA 2015

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l'Observatoire de Paris | SYRTE

Systèmes de Référence Temps-Espace

Introduction

FIELD : Geodetic Very Long Baseline Interferometry

Purpose :

Astrometric :

ICRF2 (soon ICRF3) Cf « The second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry », IERS technical note no.35

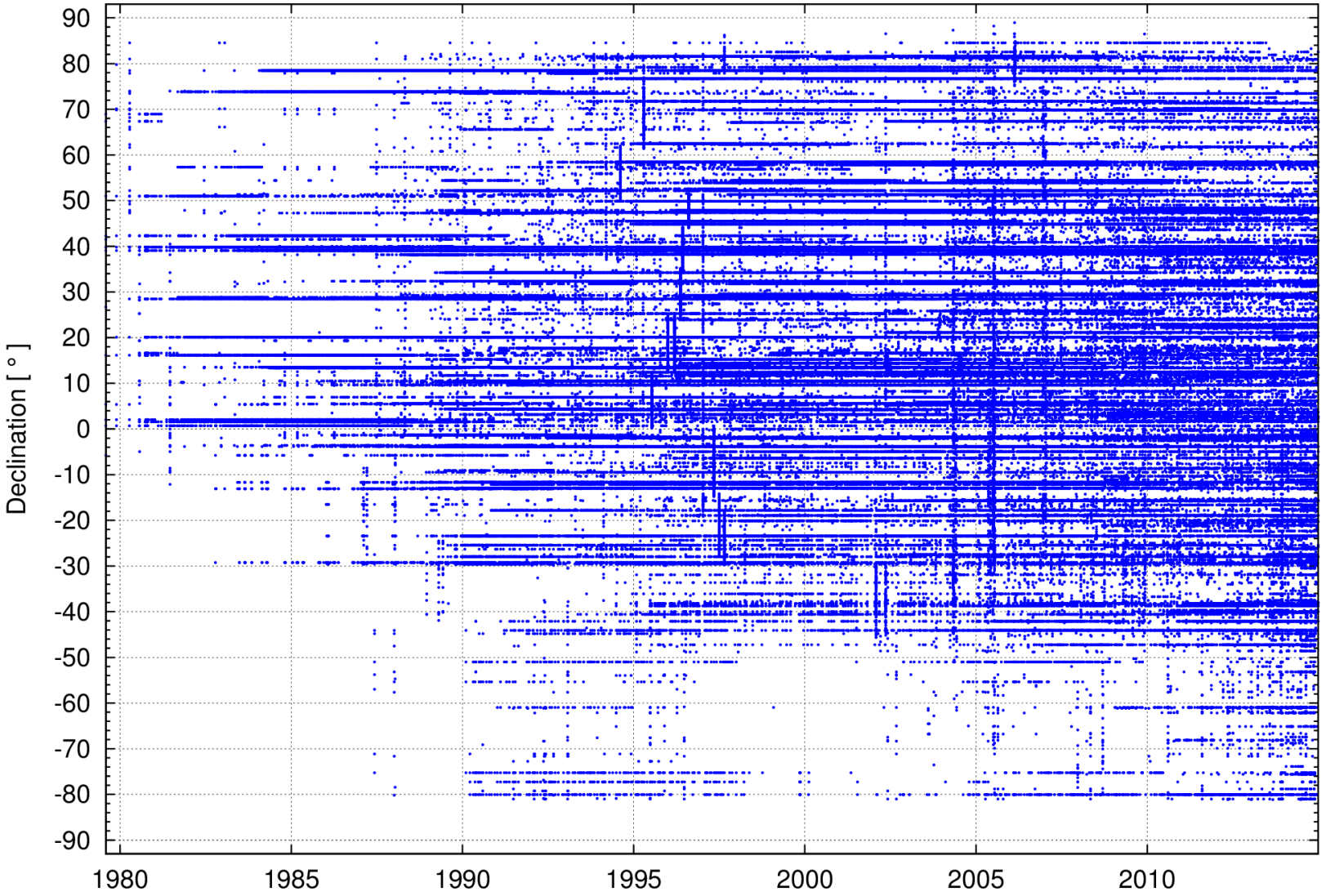
Geodesic :

Precession-nutation

Earth Rotation

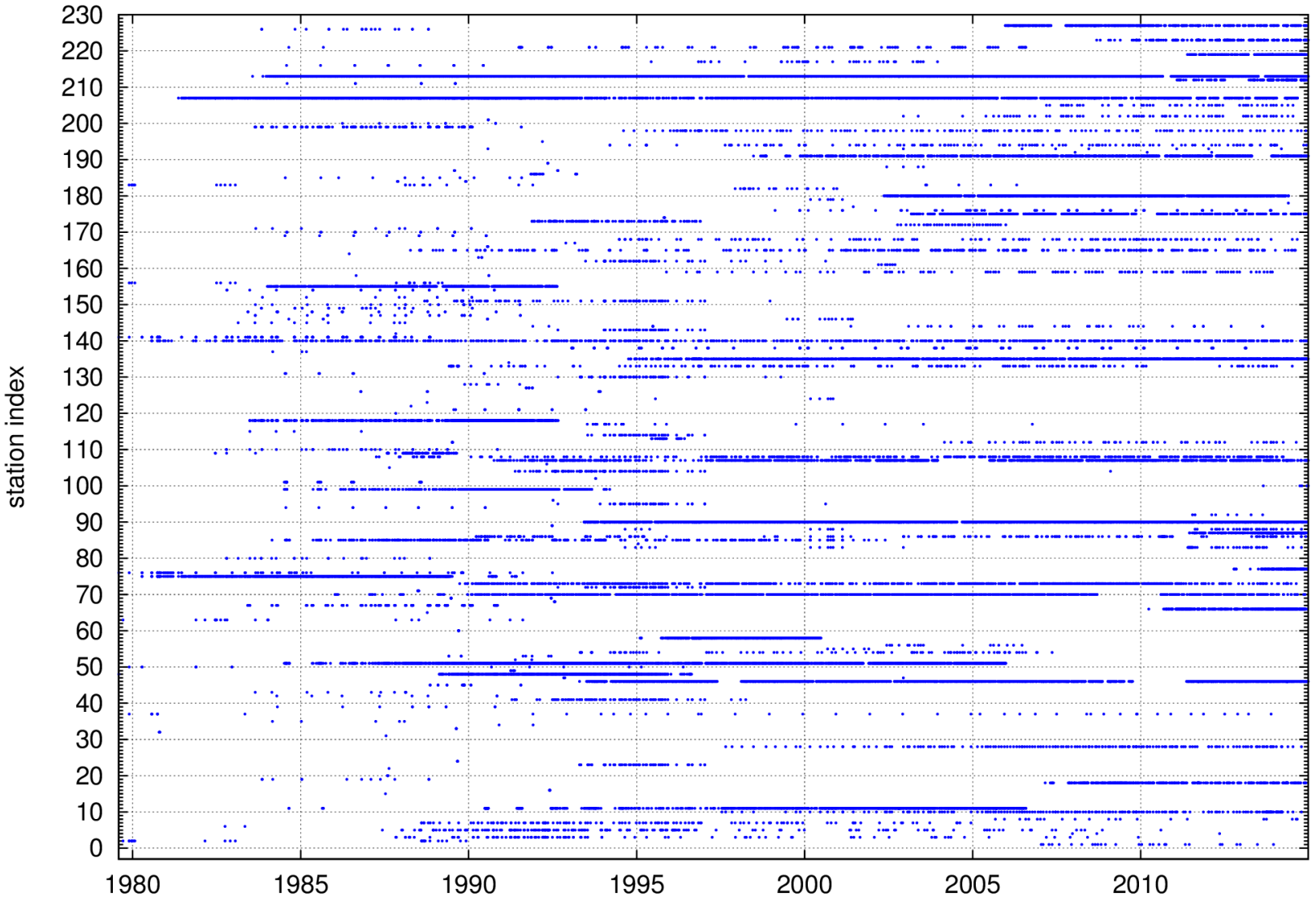
ITRF

AVAILABLE SET OF DATA



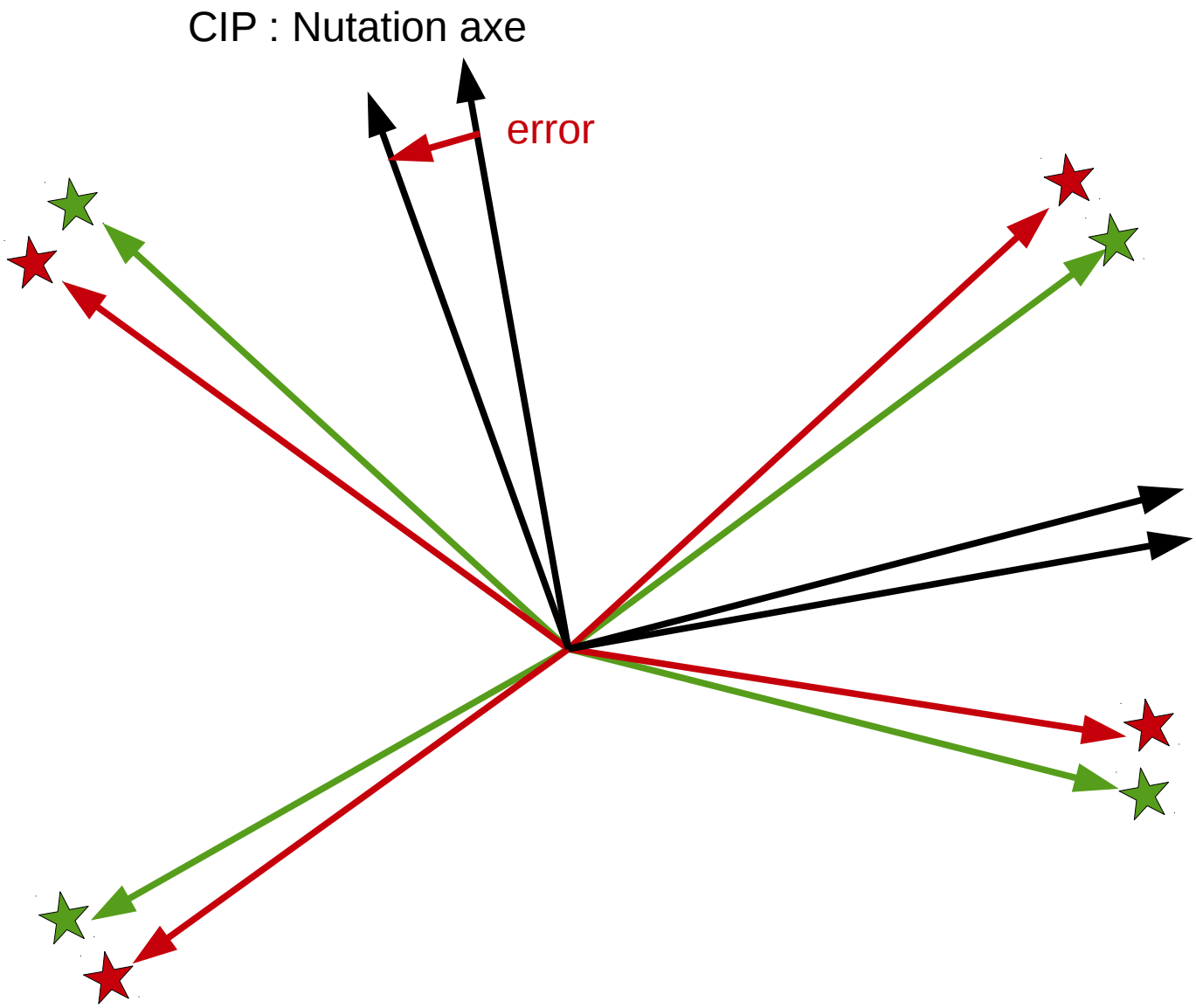
- **35** years of observation (up to 24h duration)
- ~ **8000** VLBI sessions
- **5771** radiosources

AVAILABLE SET OF DATA



- **35** years of observation (up to 24h duration)
- ~ **8000** VLBI sessions
- **227** stations (fixed and mobile)

Why Study CRF issue ?

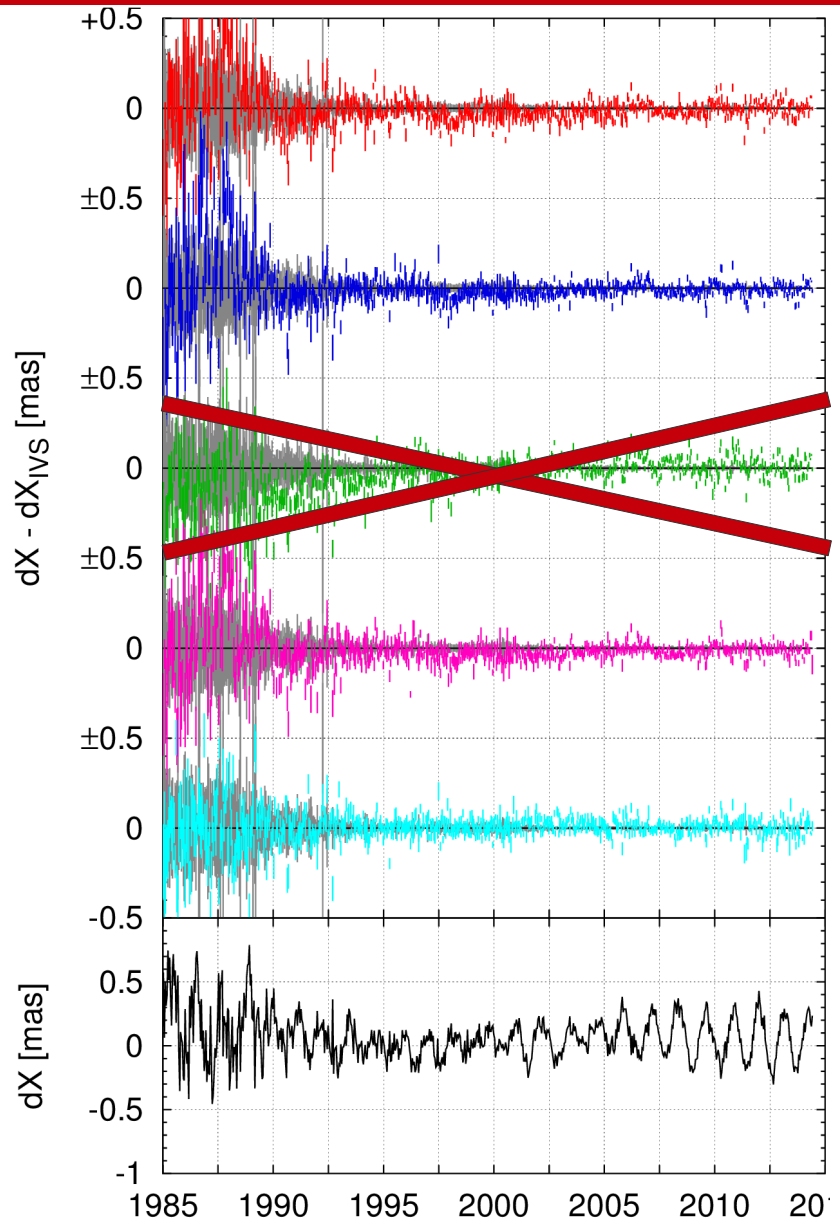


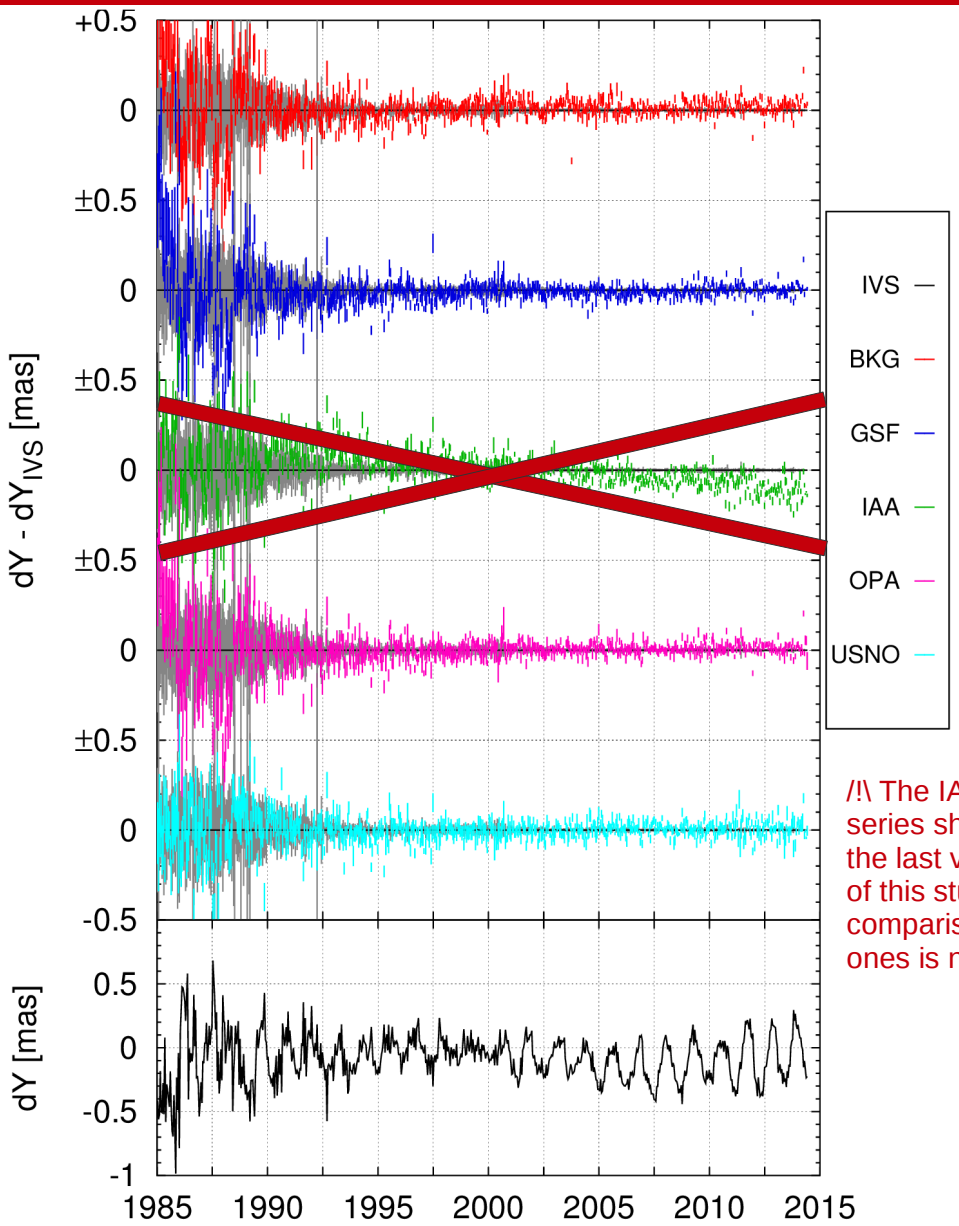
Error on Celestial Reference Frame

during the data Analysis can led to

an error on nutation parameter

IERS Nutation Time Series - Comparison



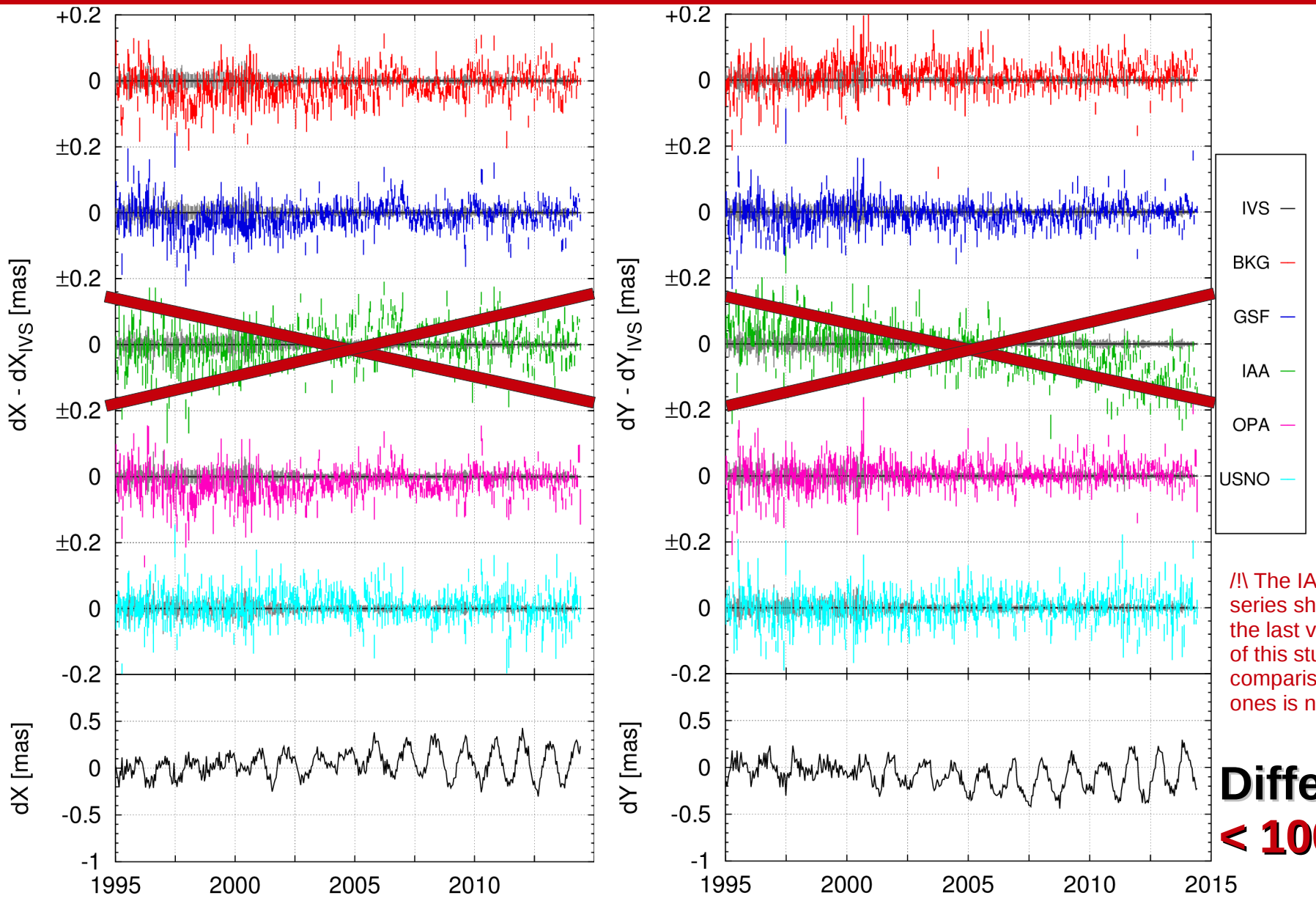


- Smoothed over 15 days
- errorbars for smoothed data are non inflated !

(some use 1.5 inflation)

/!\ The IAA nutation time series showed here is not the last version at the time of this study, so the comparison with the other ones is not appropriate.

IERS Nutation Time Series - Comparison



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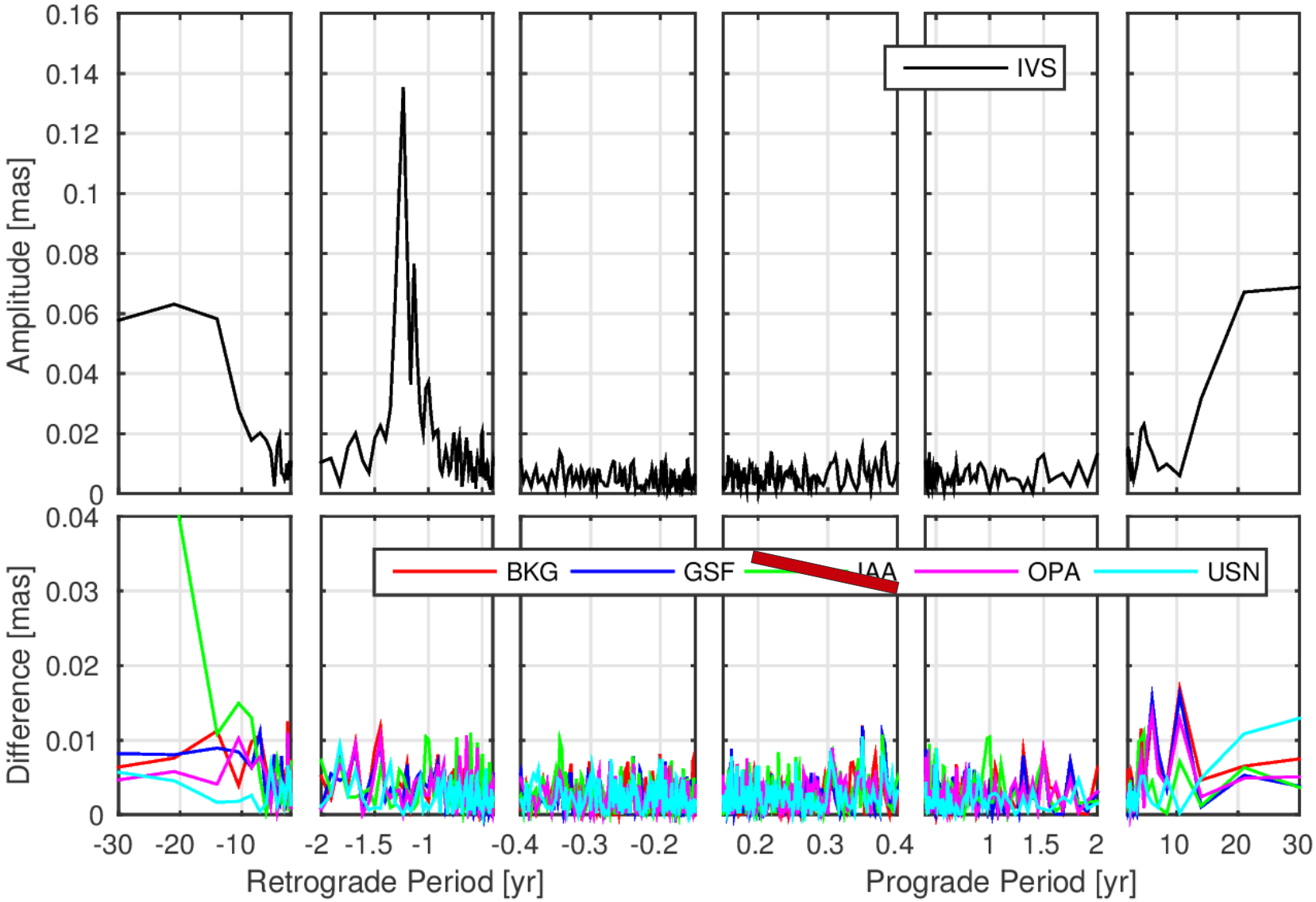
Differences : < 100 µas

IERS Nutation Time Series - Spectra

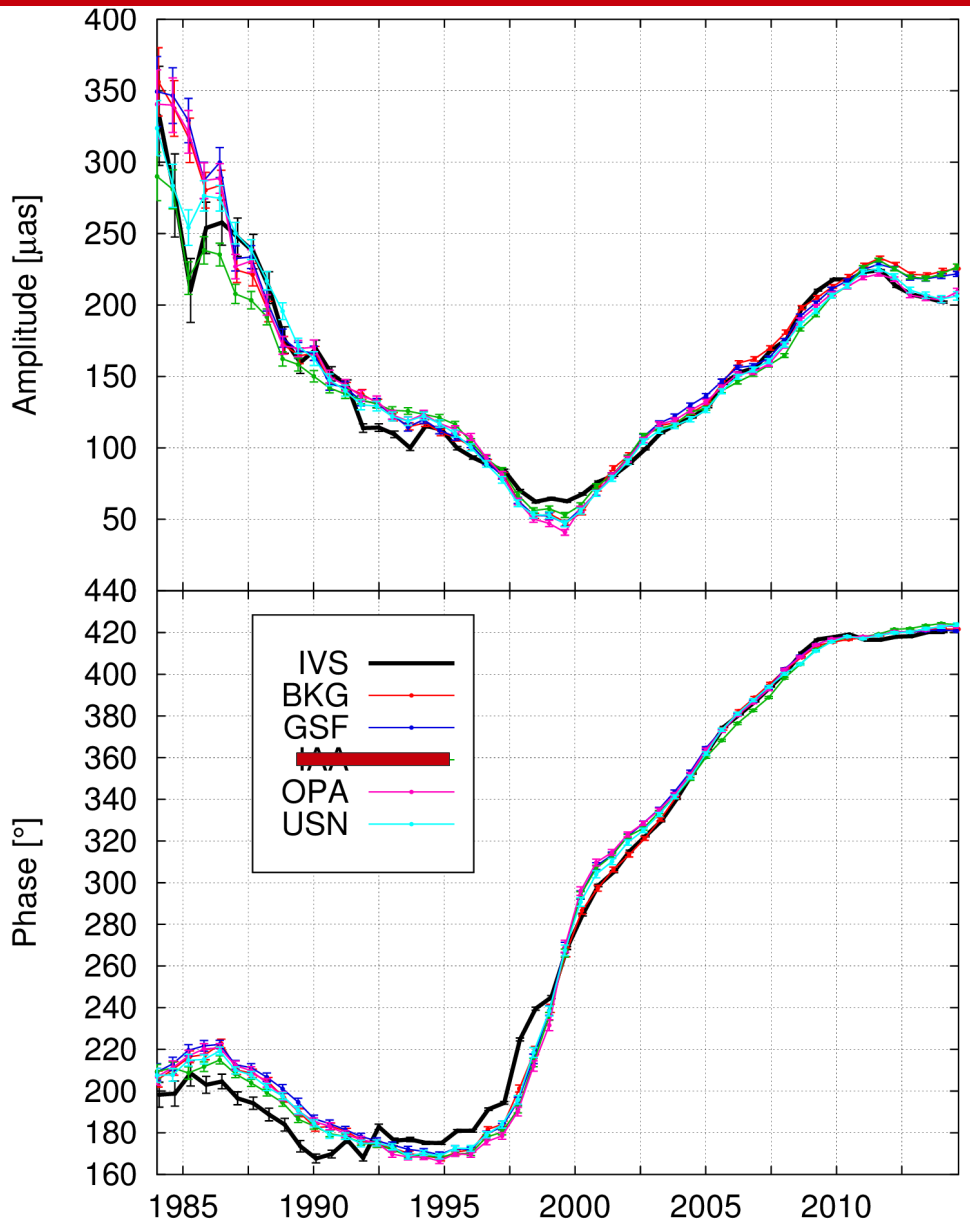


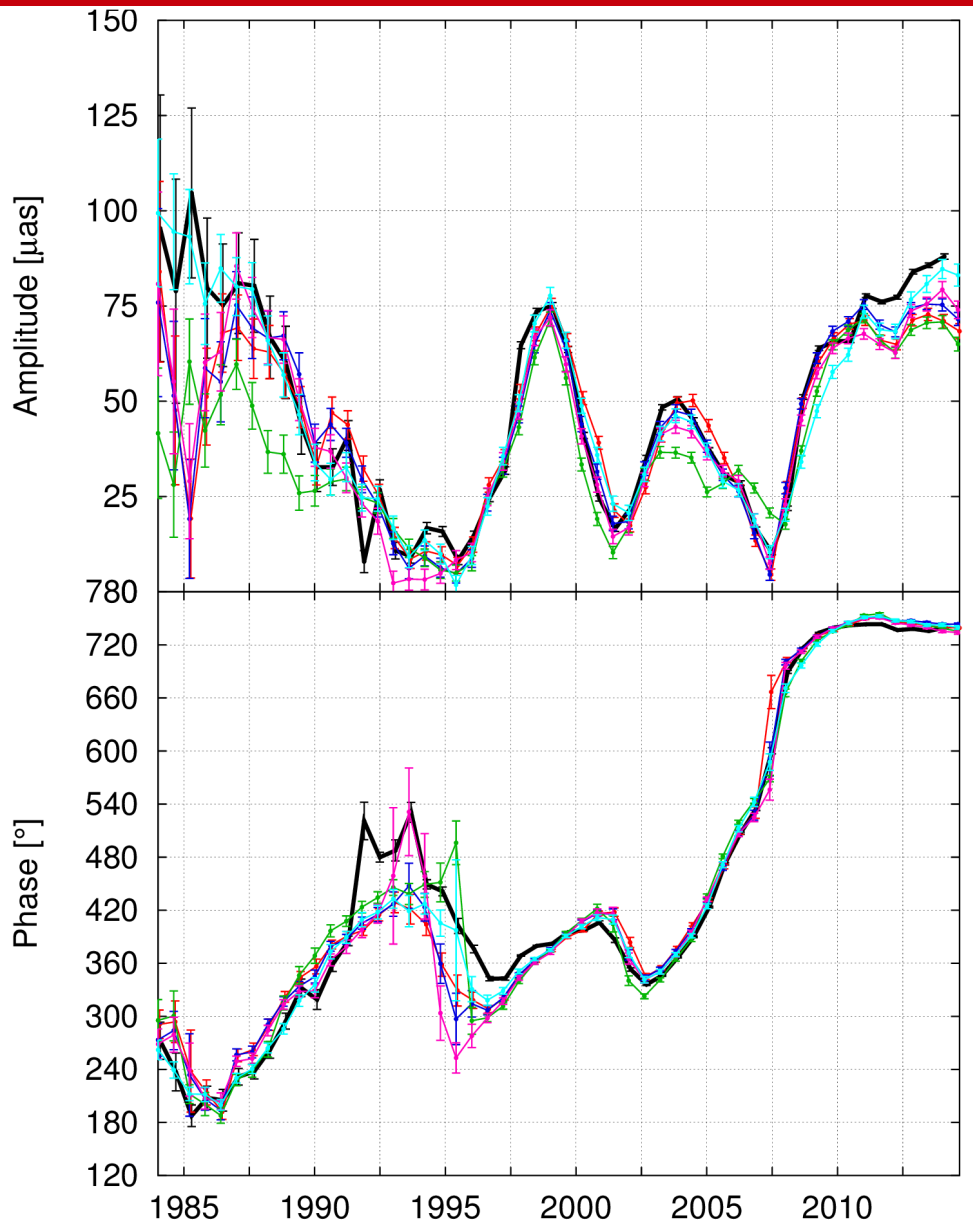
Amplitude differences :

< 10 µas for periods **< 2 years**

< 20 µas for periods **> 2 years**

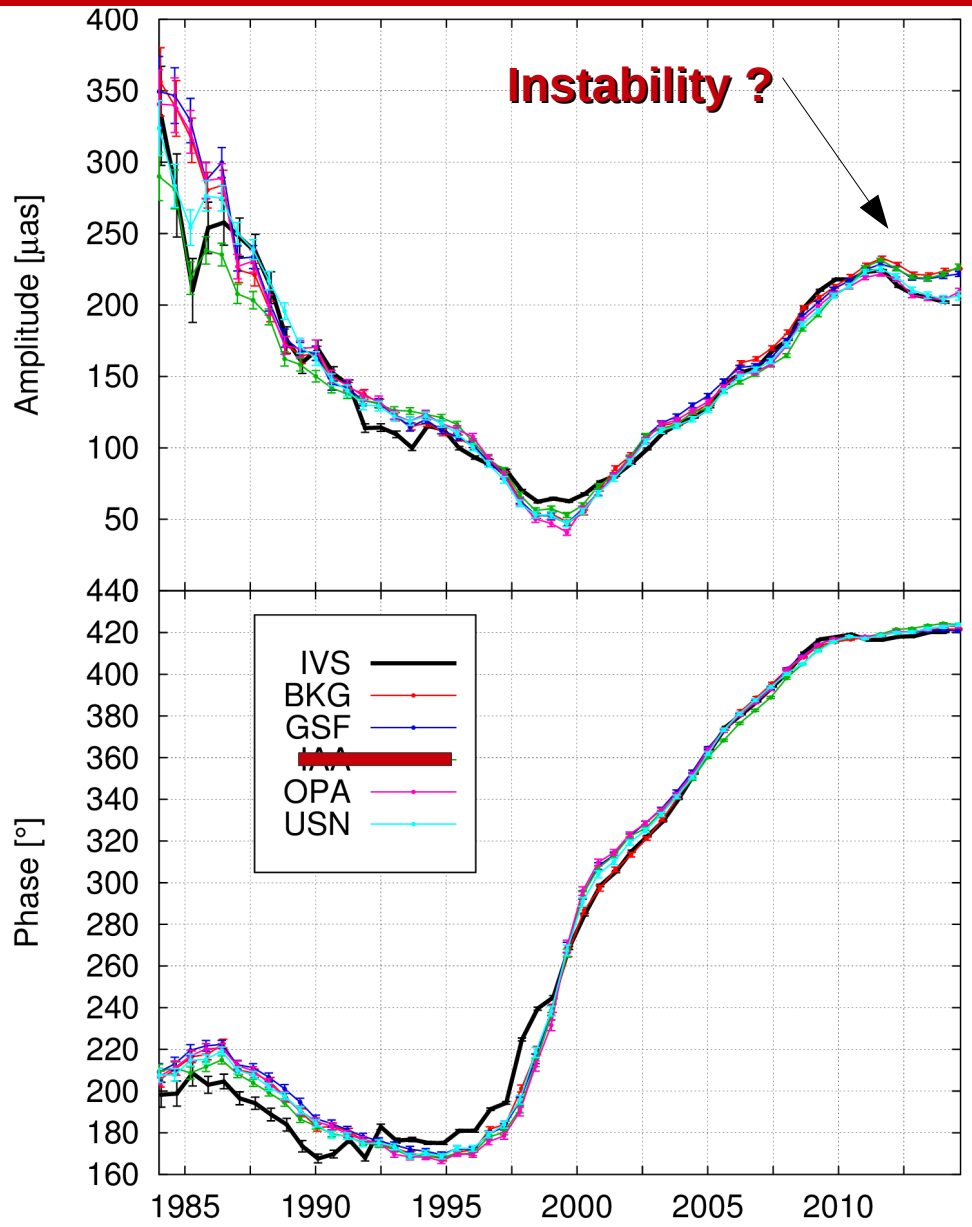
Free Core Nutation and Annual nutation Adjustements

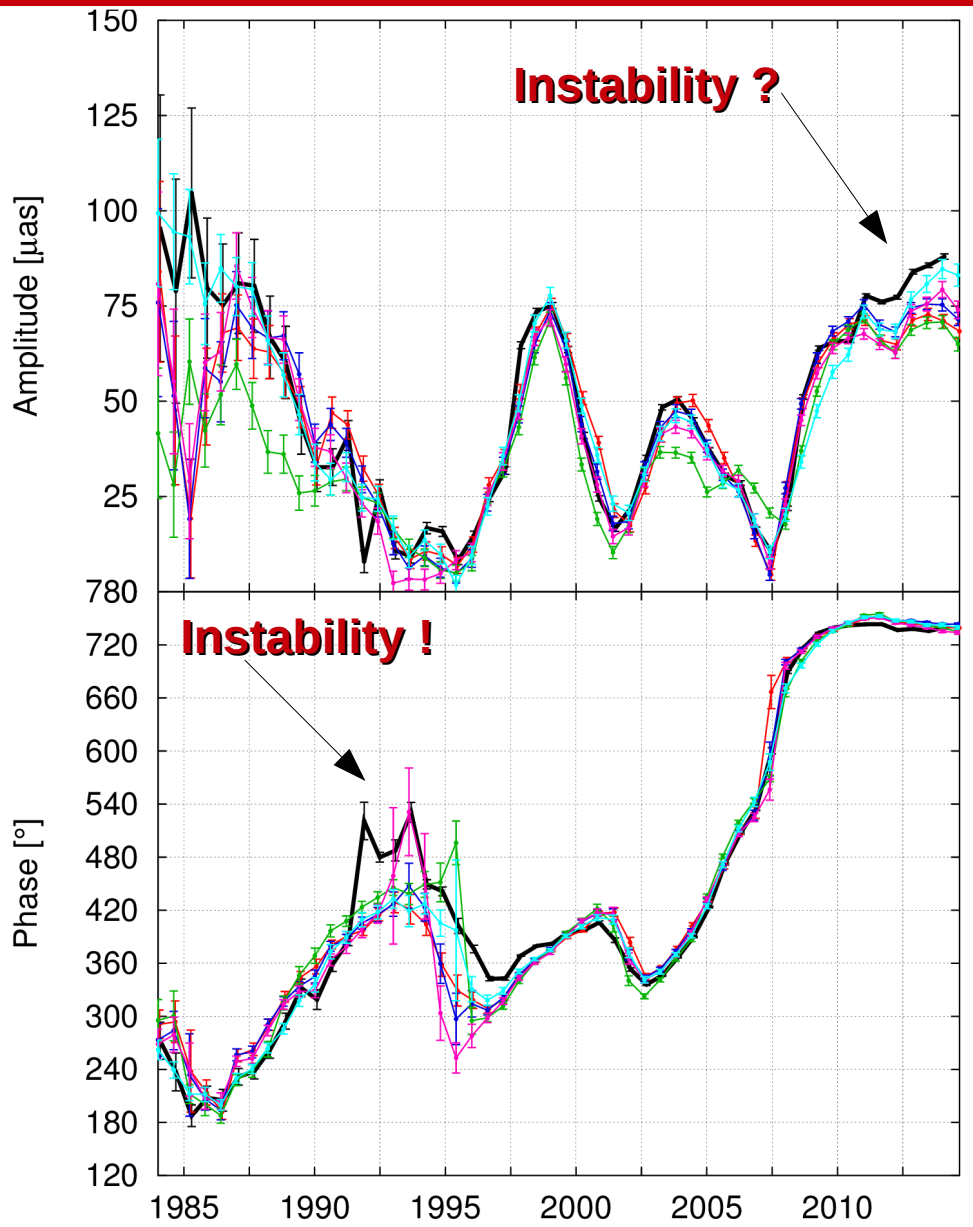




Stable over **10 µas** (amplitude), **10°** (FCN phase), **30°** (Annual Phase)

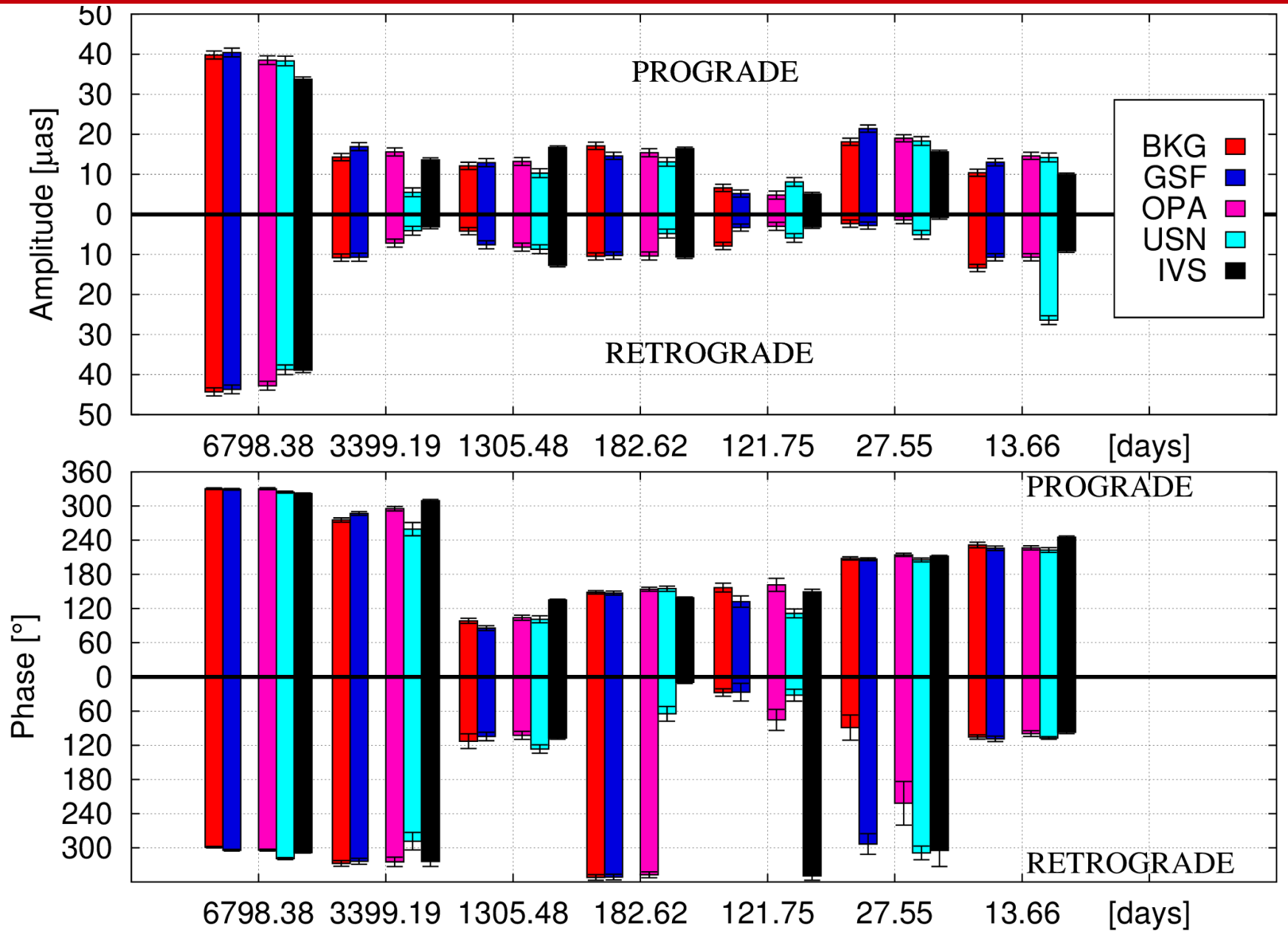
Free Core Nutation and Annual nutation Adjustements





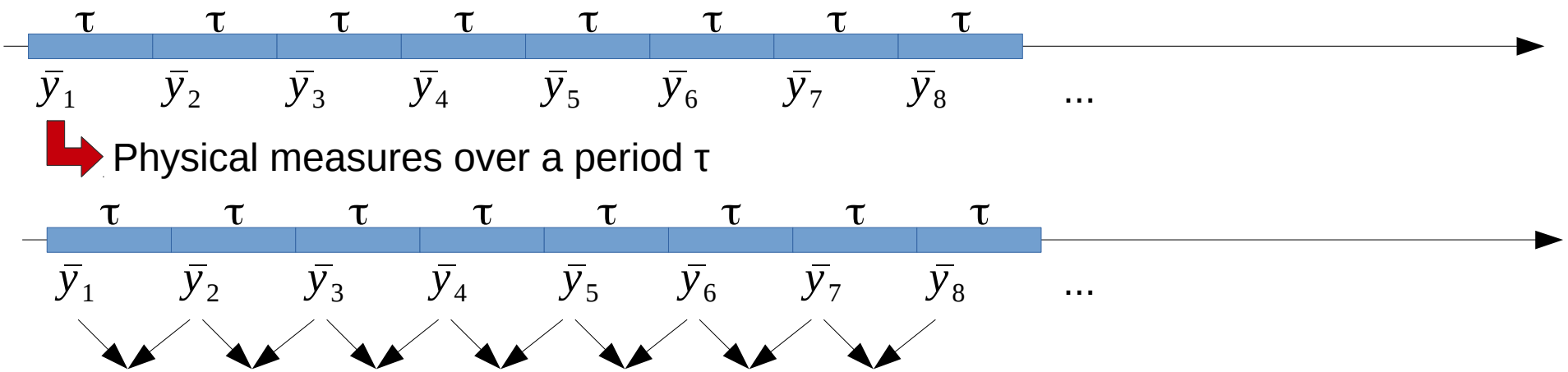
Stable over **10 µas** (amplitude), **10°** (FCN phase), **30°** (Annual Phase)

Others Principal Nutation Adjustements



IERS Nutation Time Series – Allan variance

Theoretical knowledge :



Physical measures over a period τ

$$\frac{1}{2}\left(\bar{y}_k - \bar{y}_{k+1}\right)^2 = \sigma^2_{(2)}(\tau) \Rightarrow \left\langle \sigma^2_{(2)}(\tau) \right\rangle$$

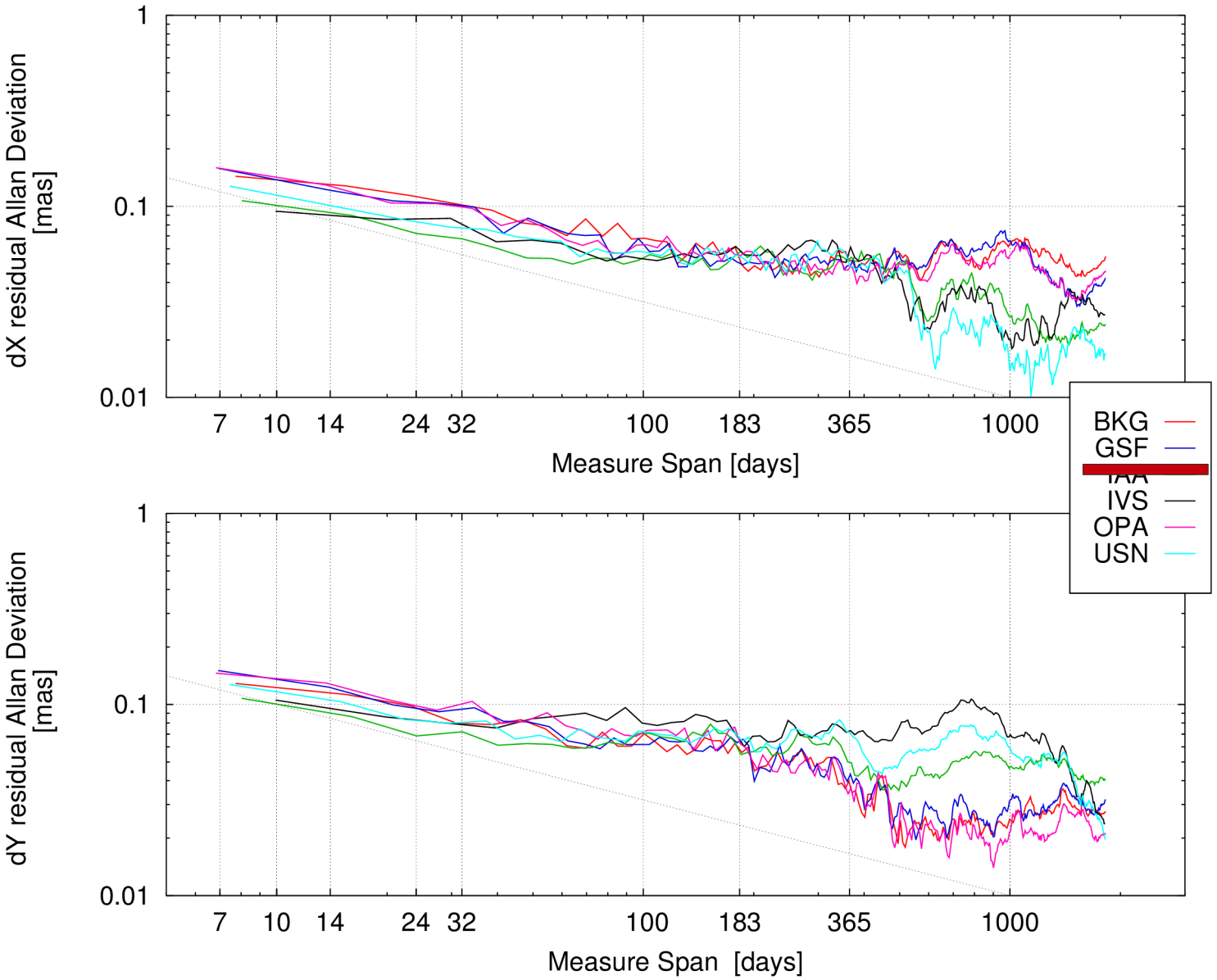
Allan Variance measurement

Estimation of the true variance of the data set given τ

The Allan variance serie with respect to τ allow to :

- **determine the type of noise associated with datas**
- **estimate the true variance of datas**

IERS Nutation Time Series – Allan Deviation



Result :

Flicker Noise
+
periodic signal at long period
(> 5 years)

Or

White Noise
+
Outliers

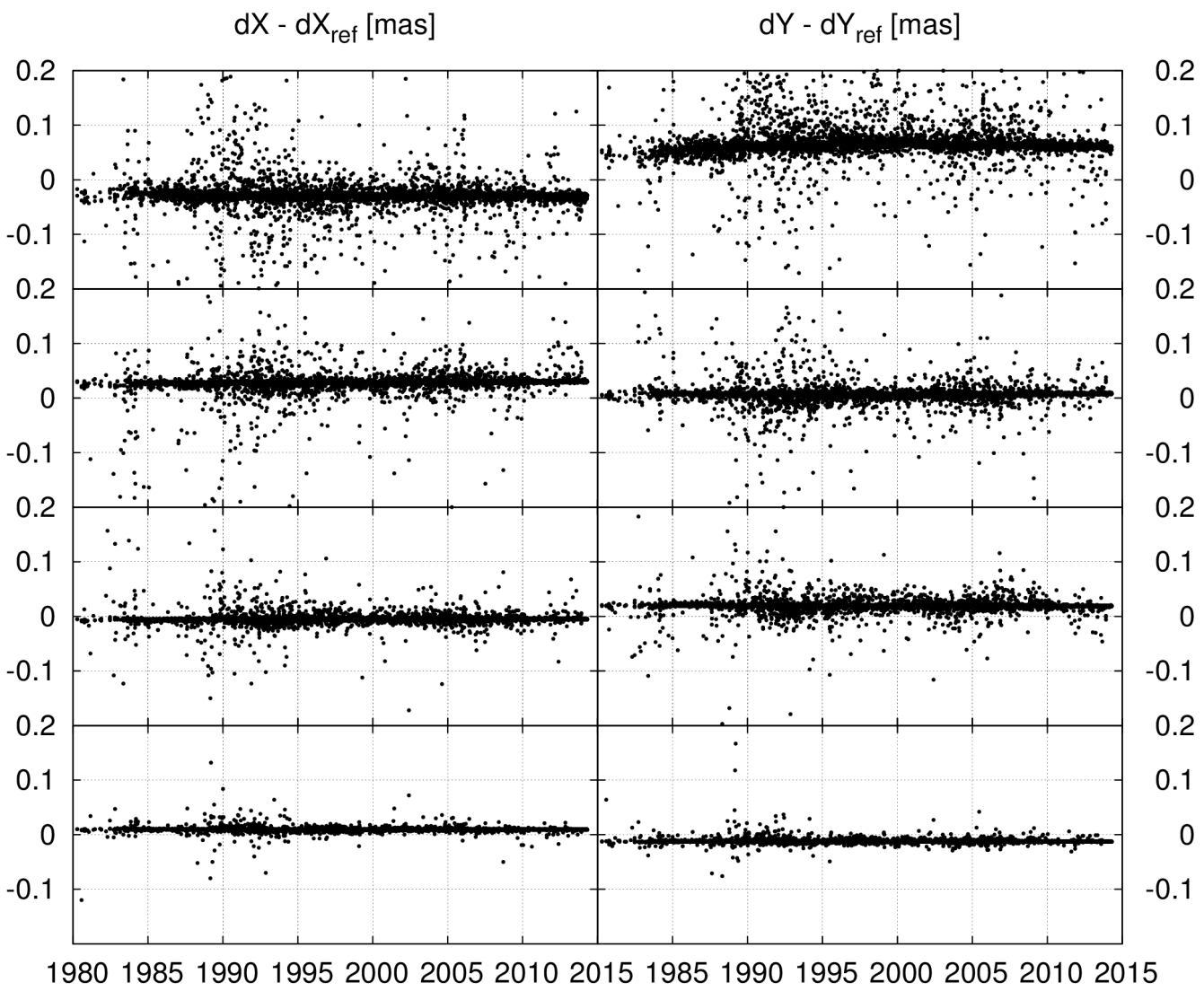
Remark : A rejection of outliers has been done beforehand

Center Analysis Strategy

	BKG	GSF	IAA	OPA	USN
CRF	a priori **ICRF2** NNR 295 Def. sources ?? global / ?? local	A priori **gsf2012a.src** NNR 295 Def. sources 1670 global / 39 local	**NOT THE GOOD VERSION**	A priori **ICRF2** NNR 295 Def. sources ?? global / 39 local	A priori **ICRF2** NNR 295 Def. sources 846 global / 852 local
Nutation	A priori **IAU2006/2000A** Apply recommandation **IERS Convention 2010**	A priori **IAU2006/2000A** Apply recommandation **IERS Convention 2010**	**NOT THE GOOD VERSION**	A priori **IAU2006/2000A** Apply recommandation **IERS Convention 2010**	A priori **IAU2006/2000A** Apply recommandation **IERS Convention 2010**
Tropo	Zenith : **1h linear spline** VMF1 wet partial derivative (segmented) A priori made by make_vmf_trp_file from GSFC **based on VMF1** Gradient : East and north **offset** A priori **from DAO model**	Zenith : **20-min linear spline** VMF wet partial derivative (segmented) A priori **VMF total mapping function** Saastamoinen model Gradient : **6-hour linear spline** east and north A priori **from DAO model**	**NOT THE GOOD VERSION**	Zenith : **20-min linear spline** A priori **VMF1 mapping function** Gradient : **6-hour** east and north **offset** A priori **from DAO model**	Zenith : **20-min linear spline** NMF wet partial derivative (segmented) A priori **NMF dry mapping function** Saastamoinen model Gradient : **6-hour linear spline** at all station except 110 A priori **from DAO model**
Clock	1h linear spline	Quadratic (local) + 1h linear spline (segmented)	**NOT THE GOOD VERSION**	Quadratic (local) + 1h linear spline	Quadratic (local) + 1h linear spline
Elevation cutoff	5° elevation cutoff	5° elevation cutoff	**NOT THE GOOD VERSION**	5° elevation cutoff	5° elevation cutoff
Software	CALC 11.01 Solve 2014.02.21	CALC 11 SOLVE 2014.02.21	**NOT THE GOOD VERSION**	CALC 11.0 SOLVE 2014.02.21	CALC 11 SOLVE 2014.02.21

Specific study on strategy choice about CRF

Radiosources estimated globally



Referent solution :
A priori ICRF2

Solution 1 :
A priori ICRF2 1mas perturbed

Solution 2 :
A priori ICRF2 0,5mas perturbed

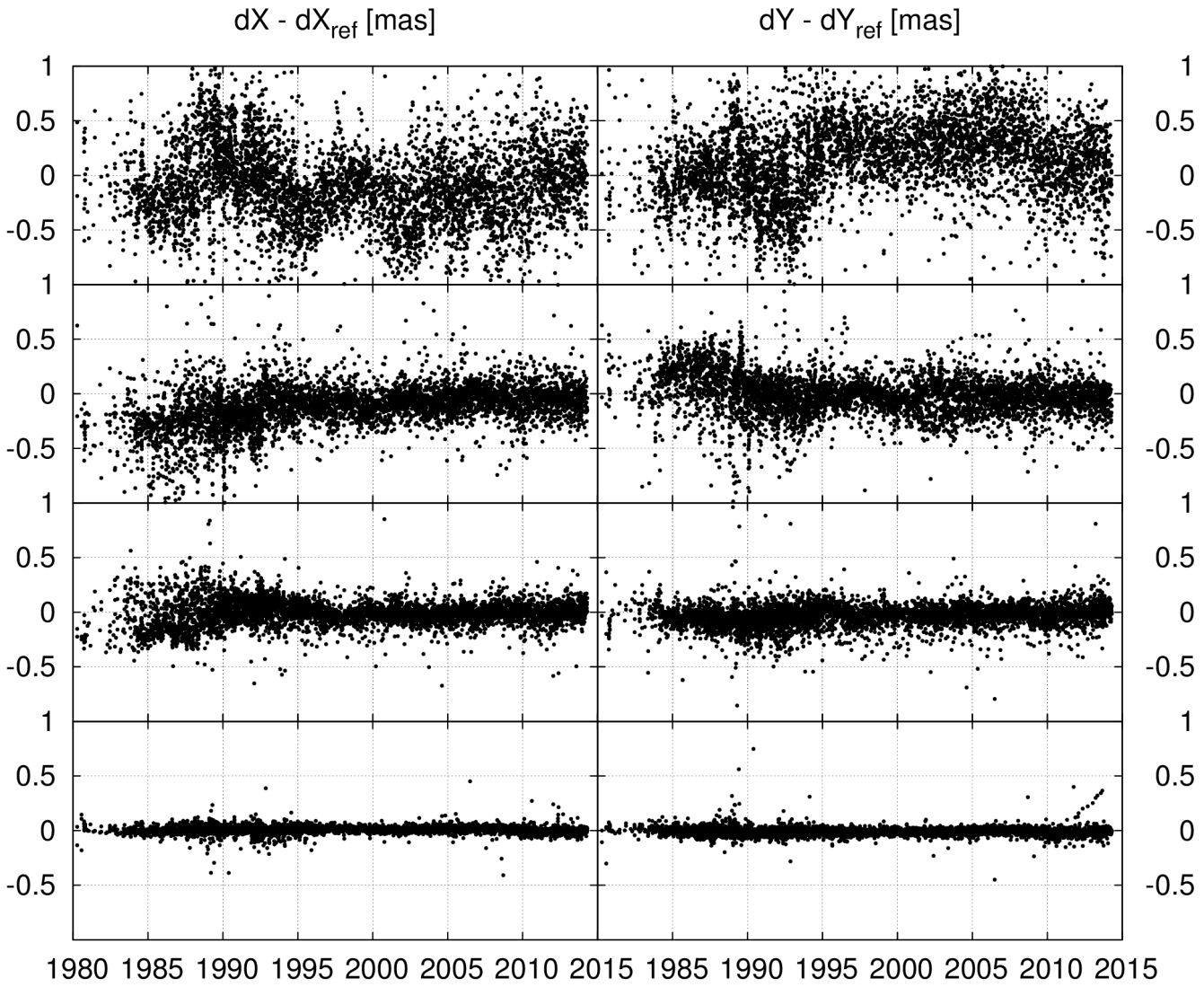
Solution 3 :
A priori ICRF2 0,25mas perturbed

Solution 4 :
A priori ICRF2 0,1mas perturbed

Perturbation by white noise

Specific study on strategy choice about CRF

Radiosources not estimated



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Solution 4 :
A priori ICRF2 0,1mas perturbed

Perturbation by white noise

Conclusion

- There exist differences between nutation time series of IERS **at the order of 100 µas**
- Those are consequences of differences in nutation adjustements **at the order of 10 µas** in amplitude and **at the order of 10-30°** in phase
- Residuals after adjustements seem to be animated by a **flicker noise** with a periodic signal at long period (> 5 years)
- Signal are stable **at 100 µas over 7 days** and at **few tenth of µas over period of several years**

Thanks

I thank you for your attention

If you want to contact me :

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