

Combination strategies for Earth Orientation variations monitoring

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Observatoire de Paris

Overview

Current approach : time series combination C04

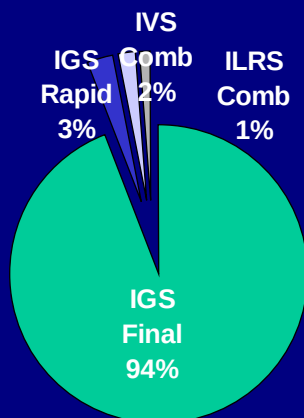
Consistency EOP with current ITRF realization based on SINEX combinations using CATREF)

Alternative approach based on robust combinations

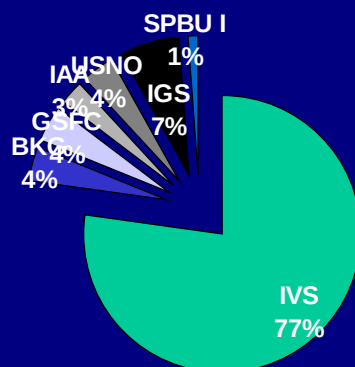
- ✓ SINEX combinations of IGS, IVS using CATREF
- ✓ Multi-technique Combination: GINS-DYNAMO program

Weighting of the various techniques in C04 combination

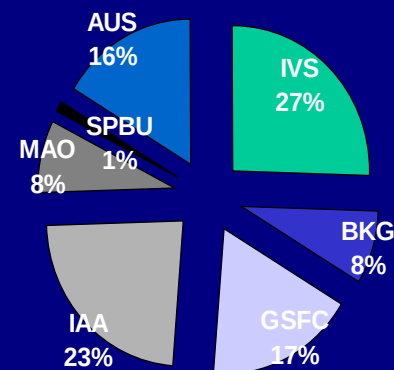
Polar coordinates (x,y)



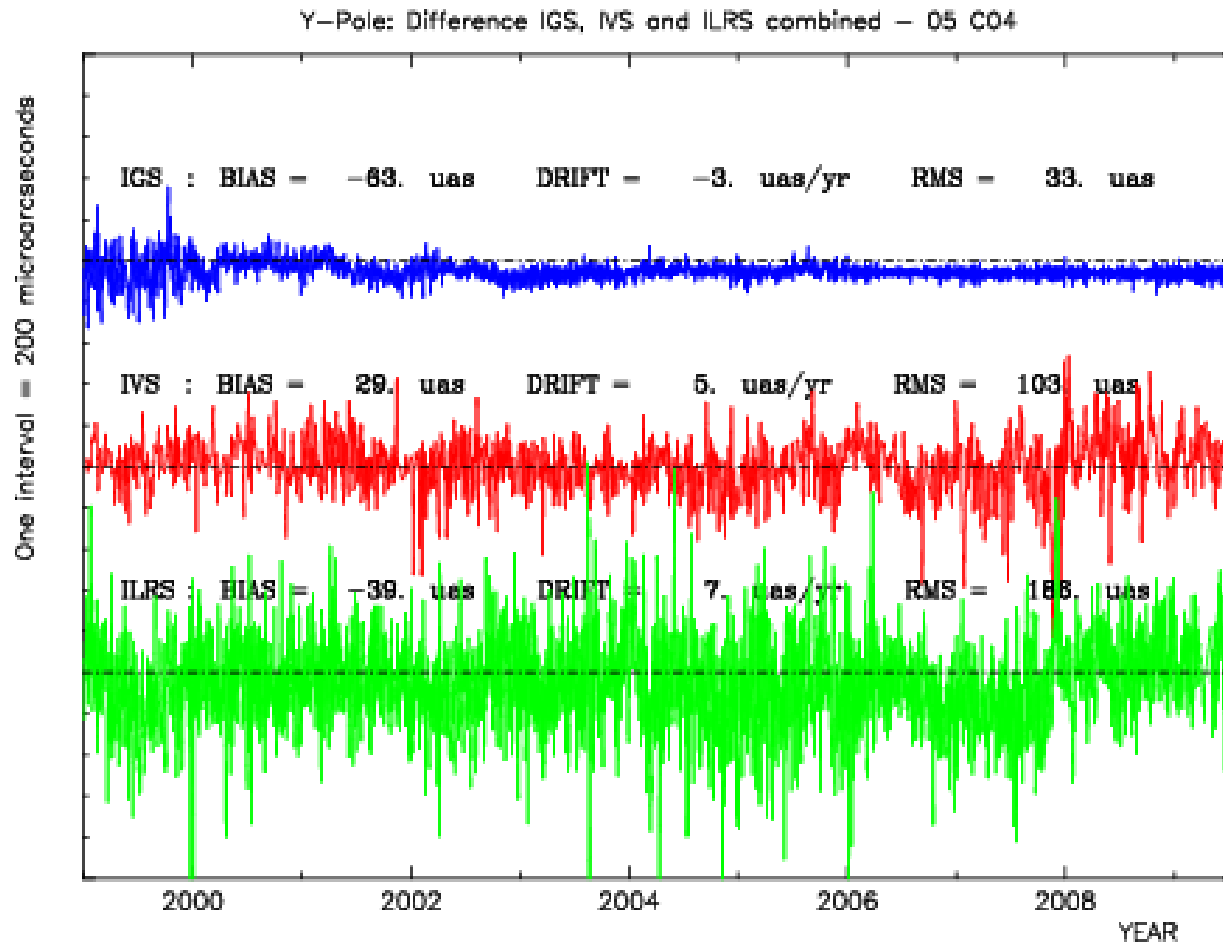
UT1



dPsi, dEps



Y-Pole: differences Combined solutions – C04



UT1 densification by LOD(GPS) Method of Combined Smoothing (Vondrak)

- UT1 is observed by VLBI with a time resolution of 3-4 days, 5-8 μs
- UT1 intensive 15-20 μs
- LOD is observed by satellite methods with a short-term accuracy (7 μs) and high resolution (1 day)
- LOD first derivative of UT1 $\text{LOD} = -d(\text{UT1-TAI})/dt$

Method of Combined smoothing

Two relatively smooth curves

- a) One fitting well to VLBI UT1 estimates
- b) Second one fitting well to GPS LOD estimates
- c) Both curves are tied by constraints: the latter is the first derivative of the former

Combined smoothing is a generalization of Vondrak smoothing (Vondrak and Gambis, 1999; Vondrak and Cepek, 2000)

Compromise between the 3 conditions

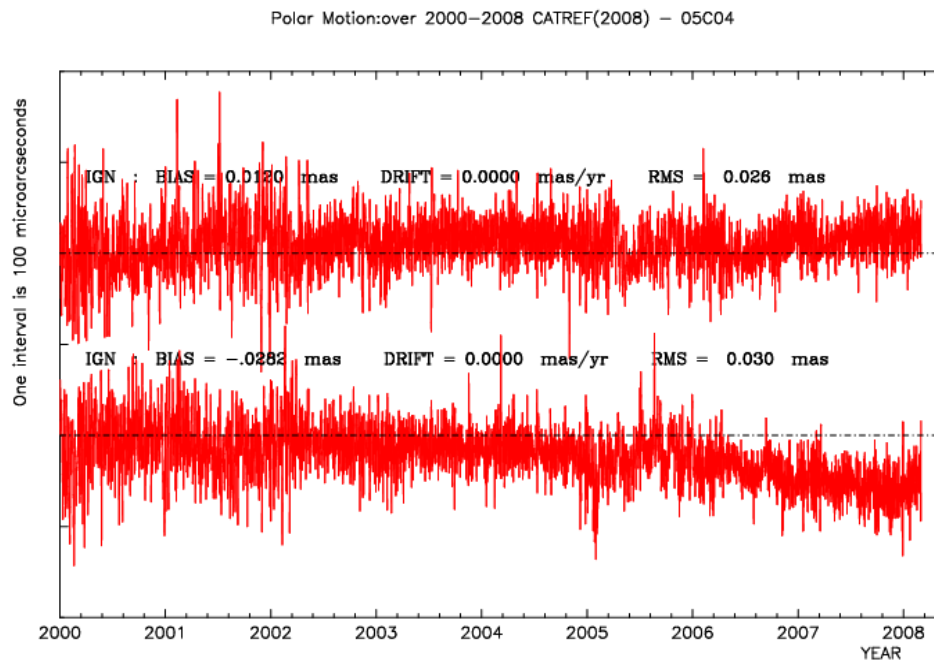
In addition

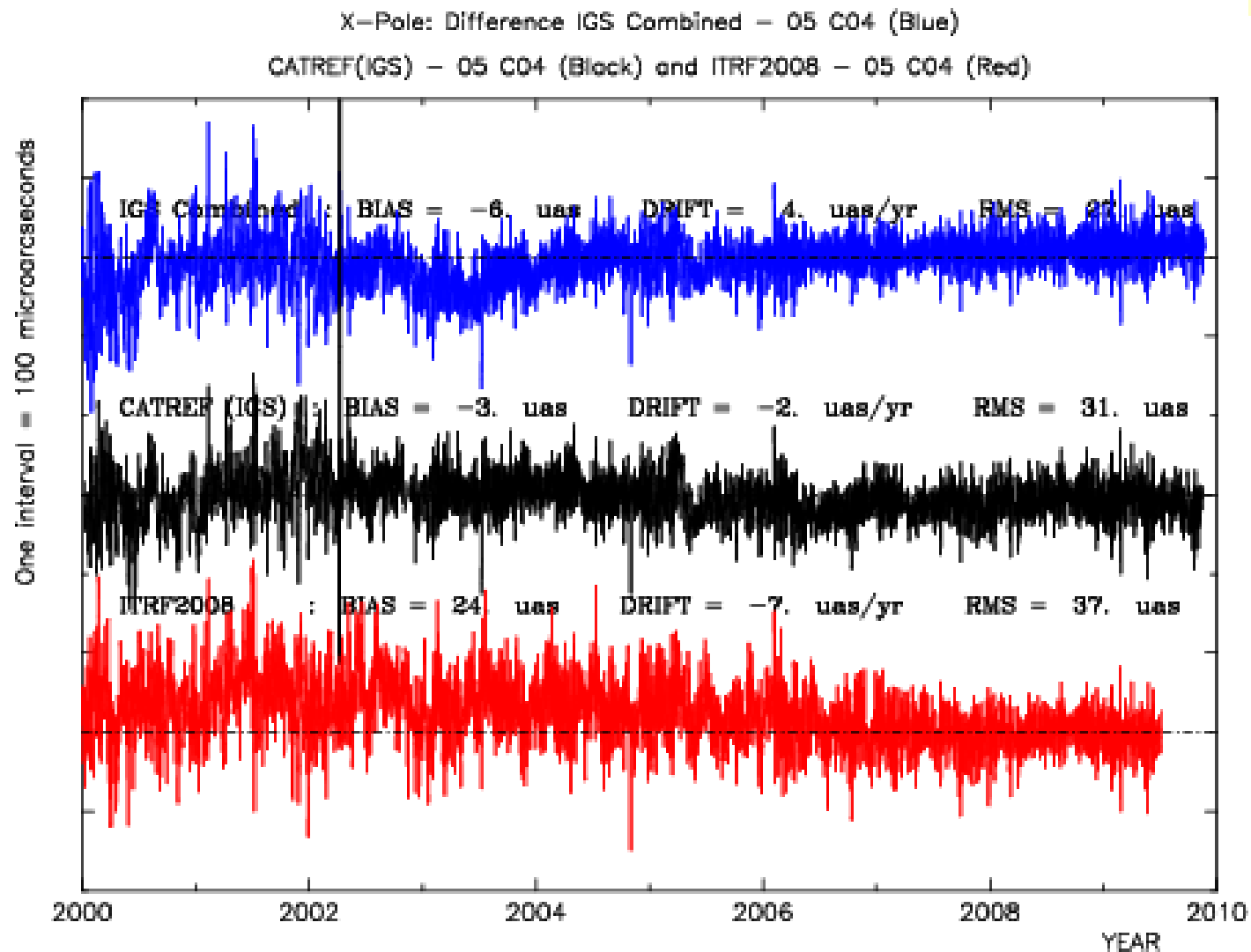
Bias in LOD is removed

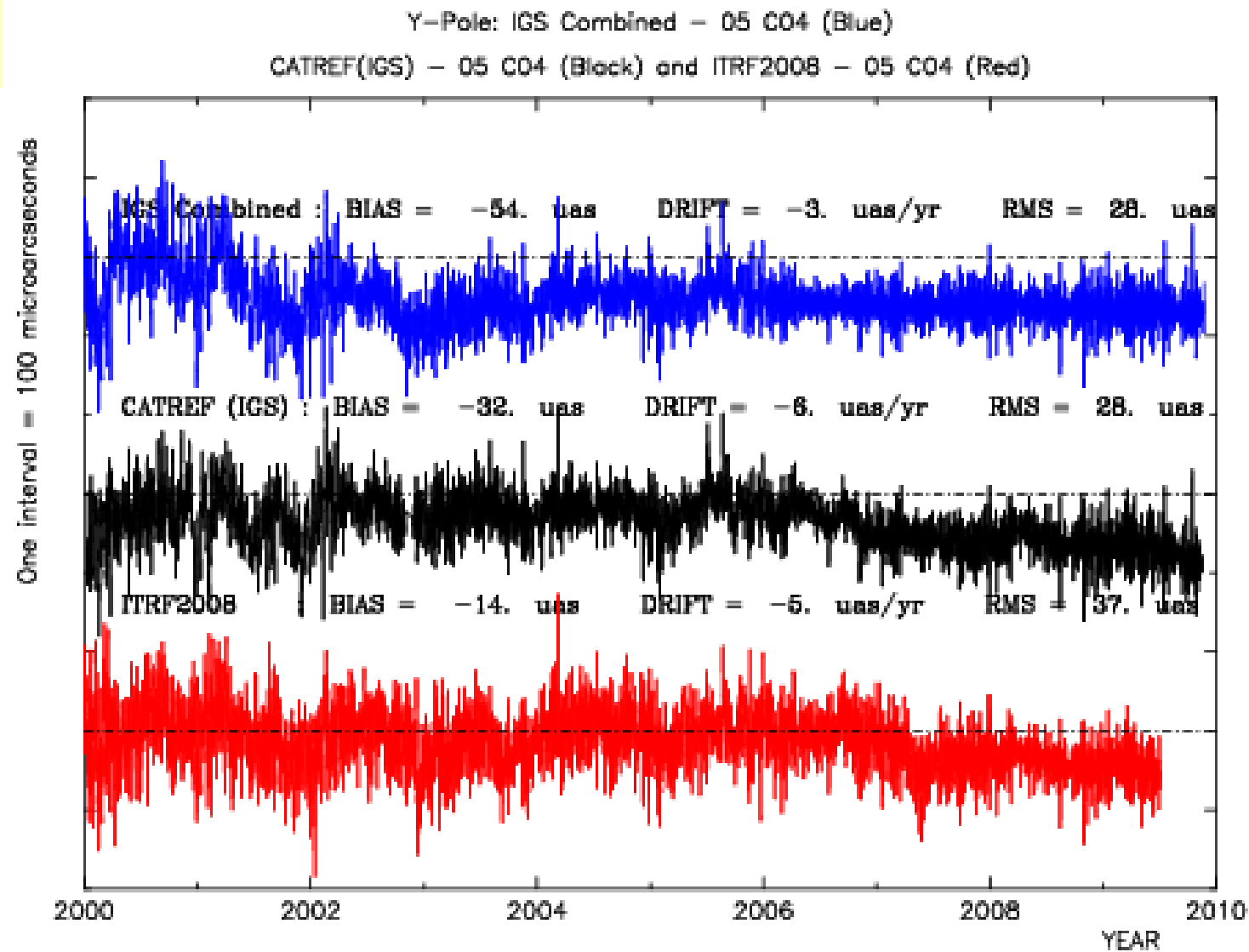
14d signal in LOD is filtered out

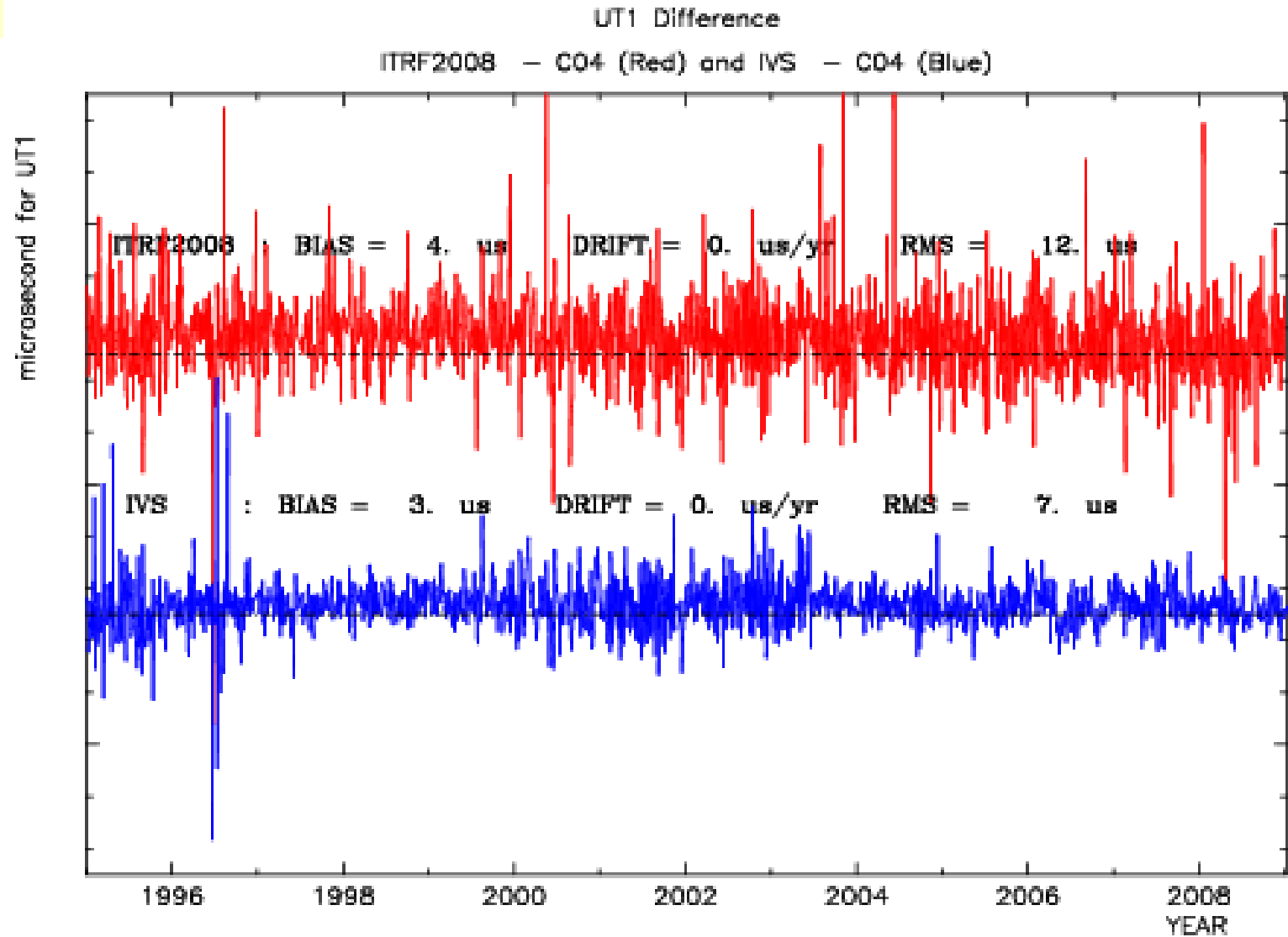
C04 : consistency maintenance with ITRF (CATREF)

- ❑ Extensions of the EOP series issued with the ITRF2005 frame over the interval 2006 until now
- ❑ We are able to maintain the consistency of 05 C04 solution with ITRF2005 at the level of about **30-50 μas** : at the level of the uncertainty estimated for the pole components.
- ❑ Proposed Strategy : monitoring the consistency of 05C04 with ITRF2005 occurring every 6-12 months









Alternative approach: robust combination SINEX combinations IGS + IVS using CATREF In conjunction with ITRS Center

- CATREF has been implemented at the EOP Center.

Weekly combinations

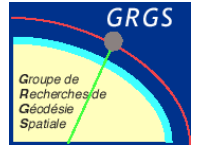
IGS SINEX files are regularly processed

Soon, IVS and then Combination IGS + IVS

- We plan to combine daily SINEX files generated by VLBI (intensive sessions) and by GPS (rapid solutions).

Rigorous method: GRGS Program

Global combination of a terrestrial frame and Earth Orientation Parameters at the normal equation level



Techniques processing

SLR F. Deleflie

GPS S. Loyer

DORIS L. Soudarin

VLBI G. Bourda

OCA

CNES/CLS

CNES/CLS

Obs Bordeaux

Combination

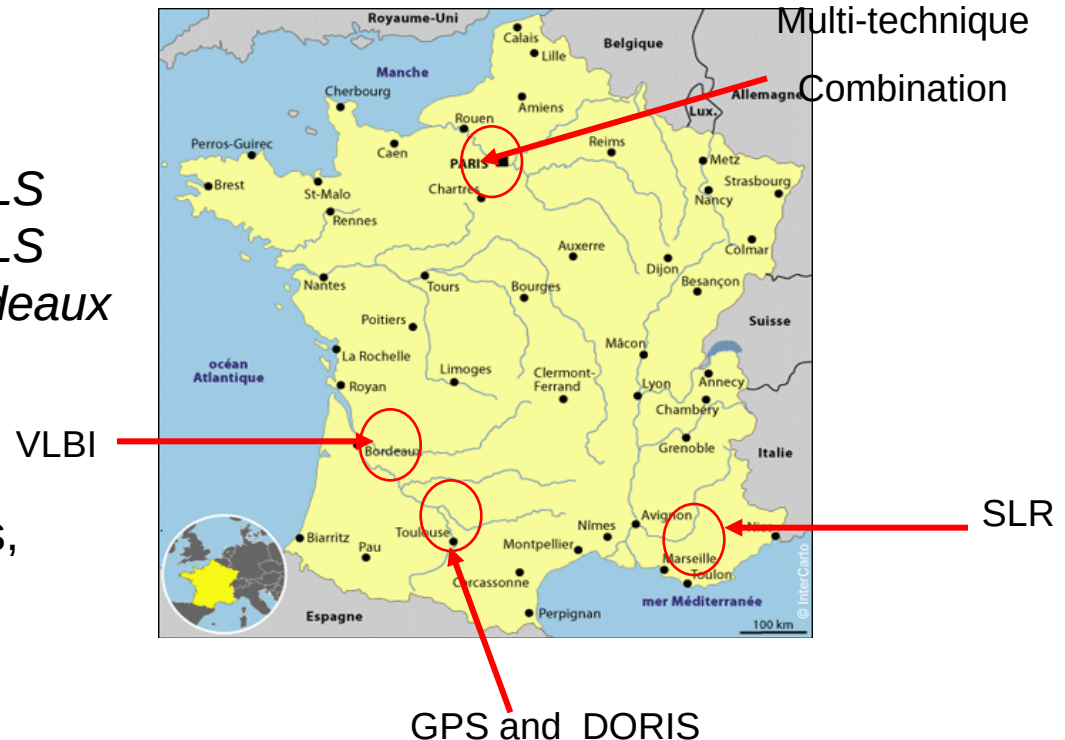
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Multi-technique
Combination



Global combination, GINS-DYNAMO program

- Towards an consistent combination of:
EOP+ station coordinates, tropospheric parameters, CRF (in the future)
- Techniques have their own strengths and weaknesses
- Use of same software (GINS), identical conventional models and constants
- Should benefit from mutual constraints brought by the various techniques
- Densification and complementarity
UT1 (VLBI) + LOD (GPS)
Nutation (VLBI) + nutation drift (GPS)
- Decrease temporal resolution of EOP: now 6h, future 3h ?

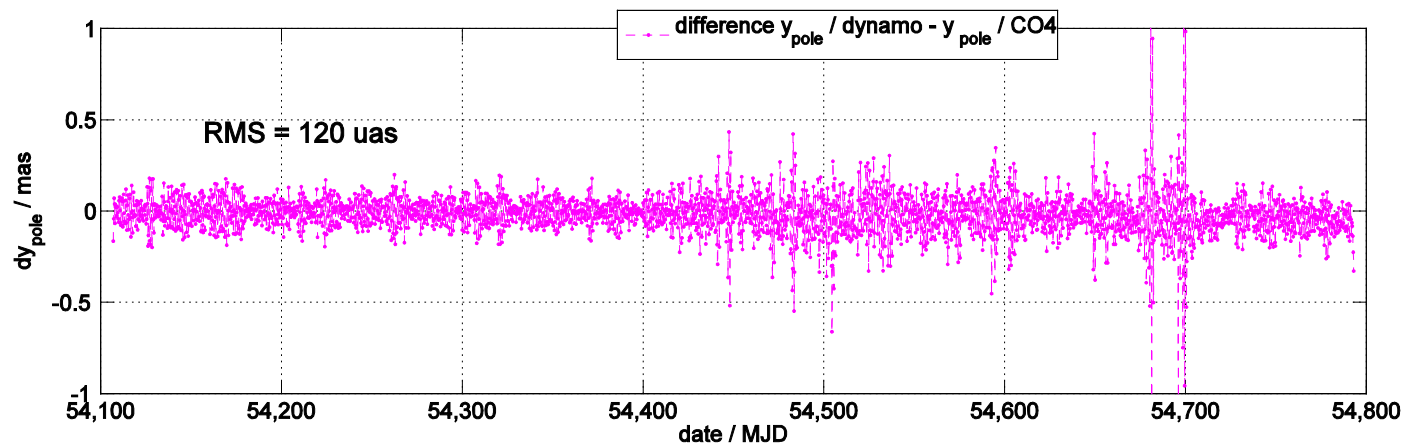
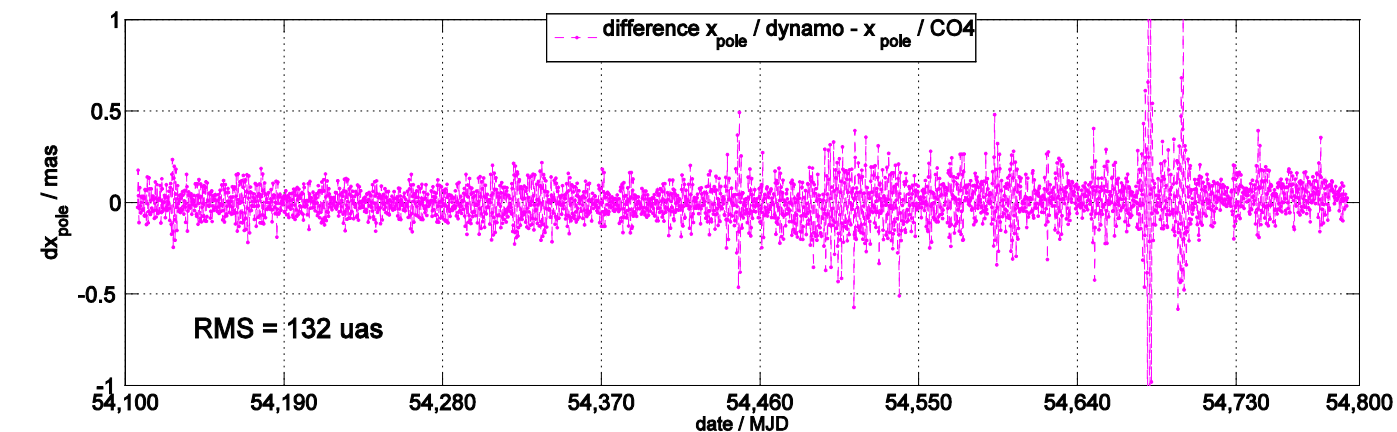
However difficulties !!

Combination strategy to be applied

To ensure stability of reference frames over successive week determination

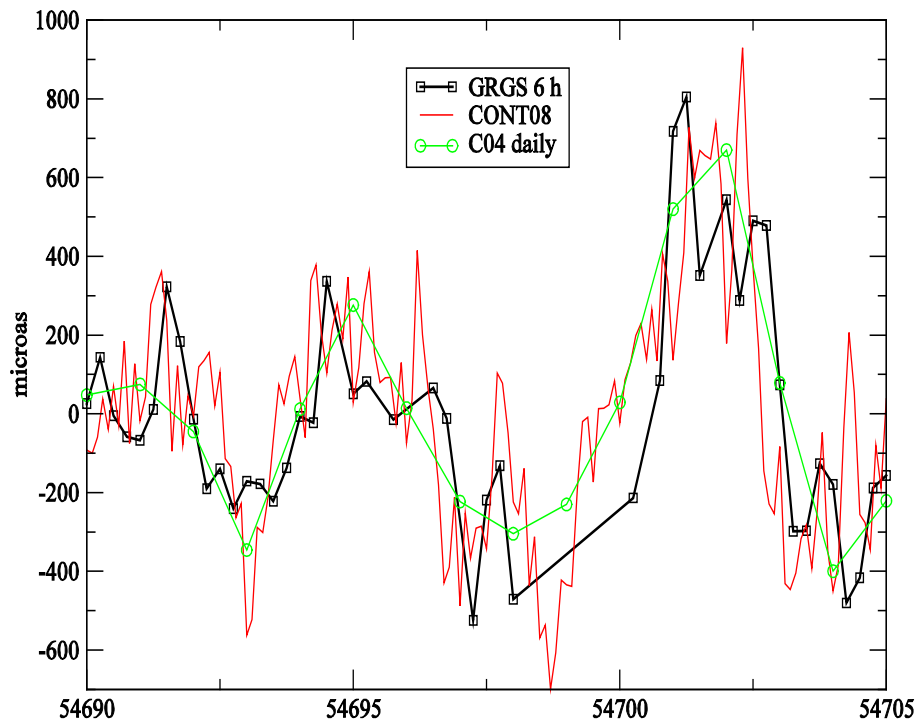
Weighting of the various techniques

Pole components Comparison multi-technique – C04

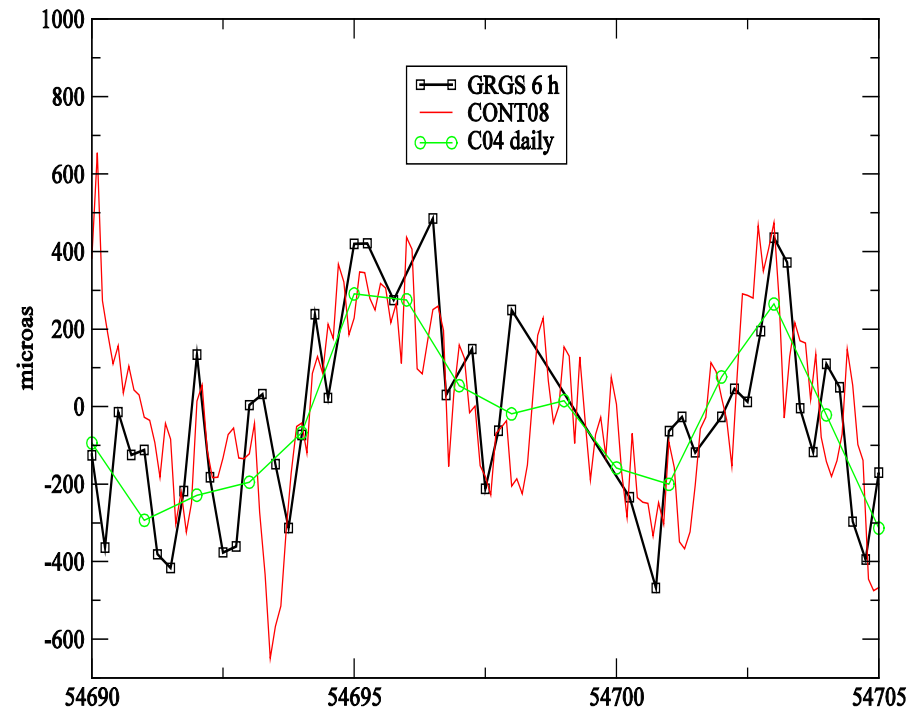


High frequency Polar motion over CONT08 campaign

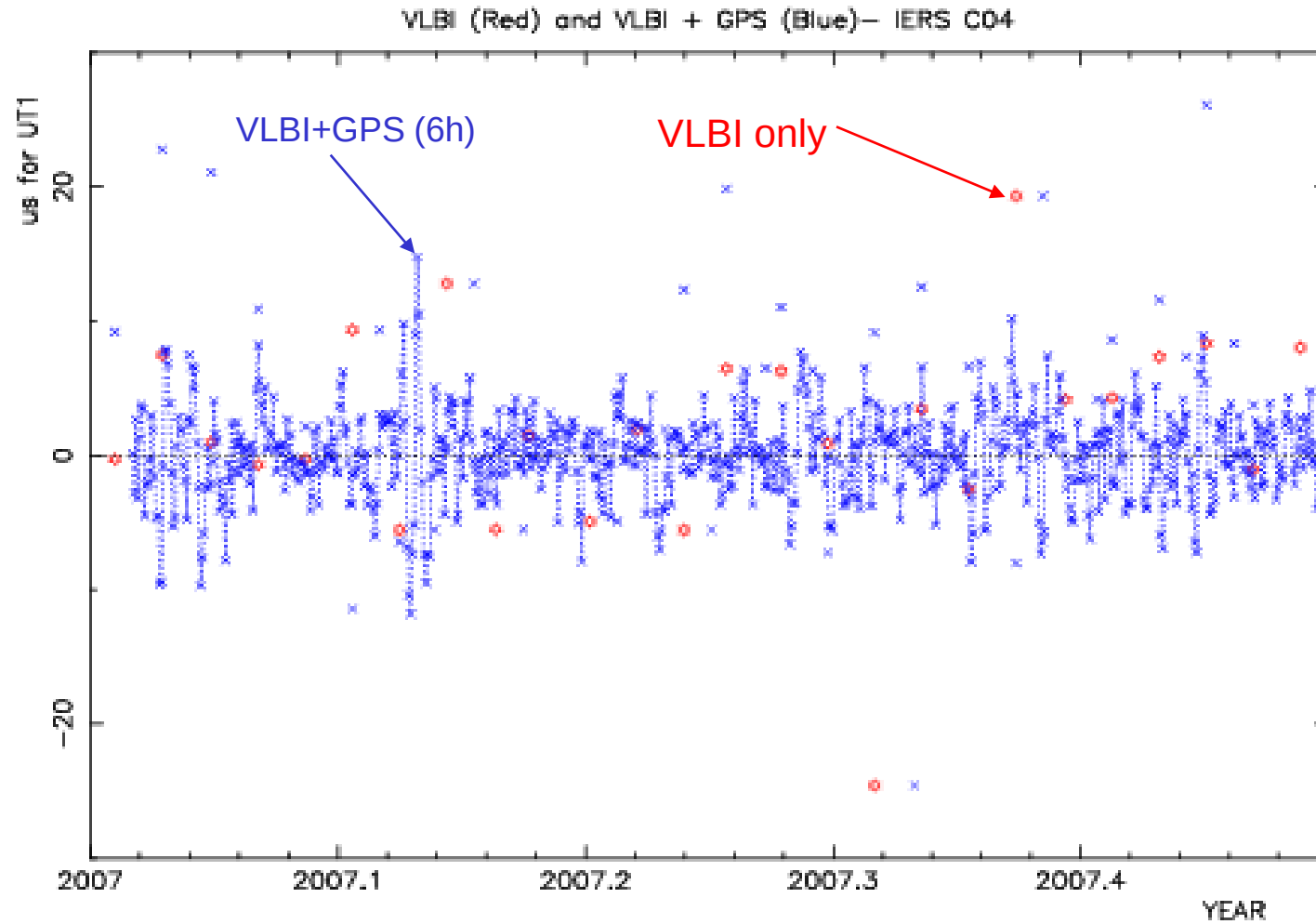
Pole coordinate XP - Periods < 5 days



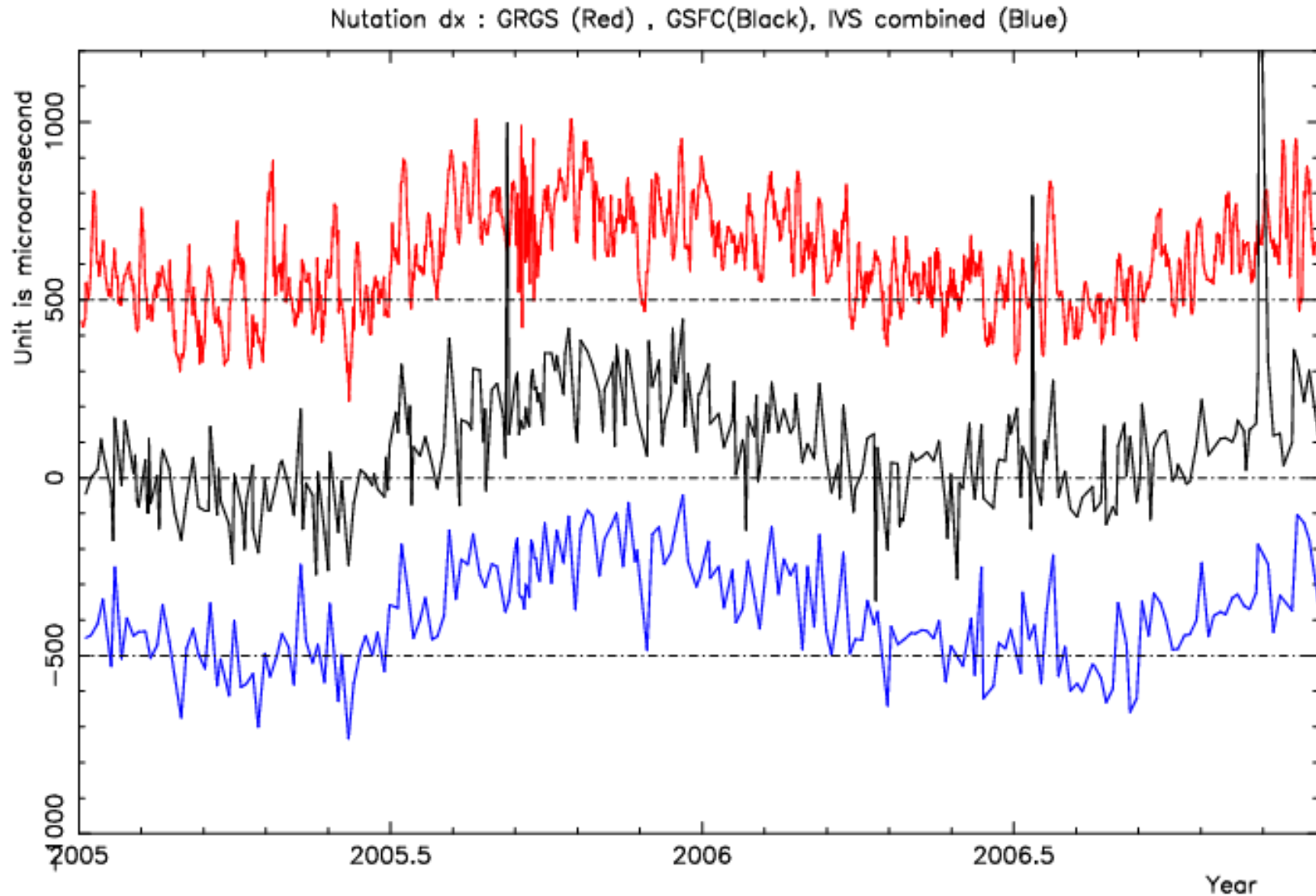
Pole coordinate YP - Periods < 5 days



Densification of UT1 using VLBI+GPS

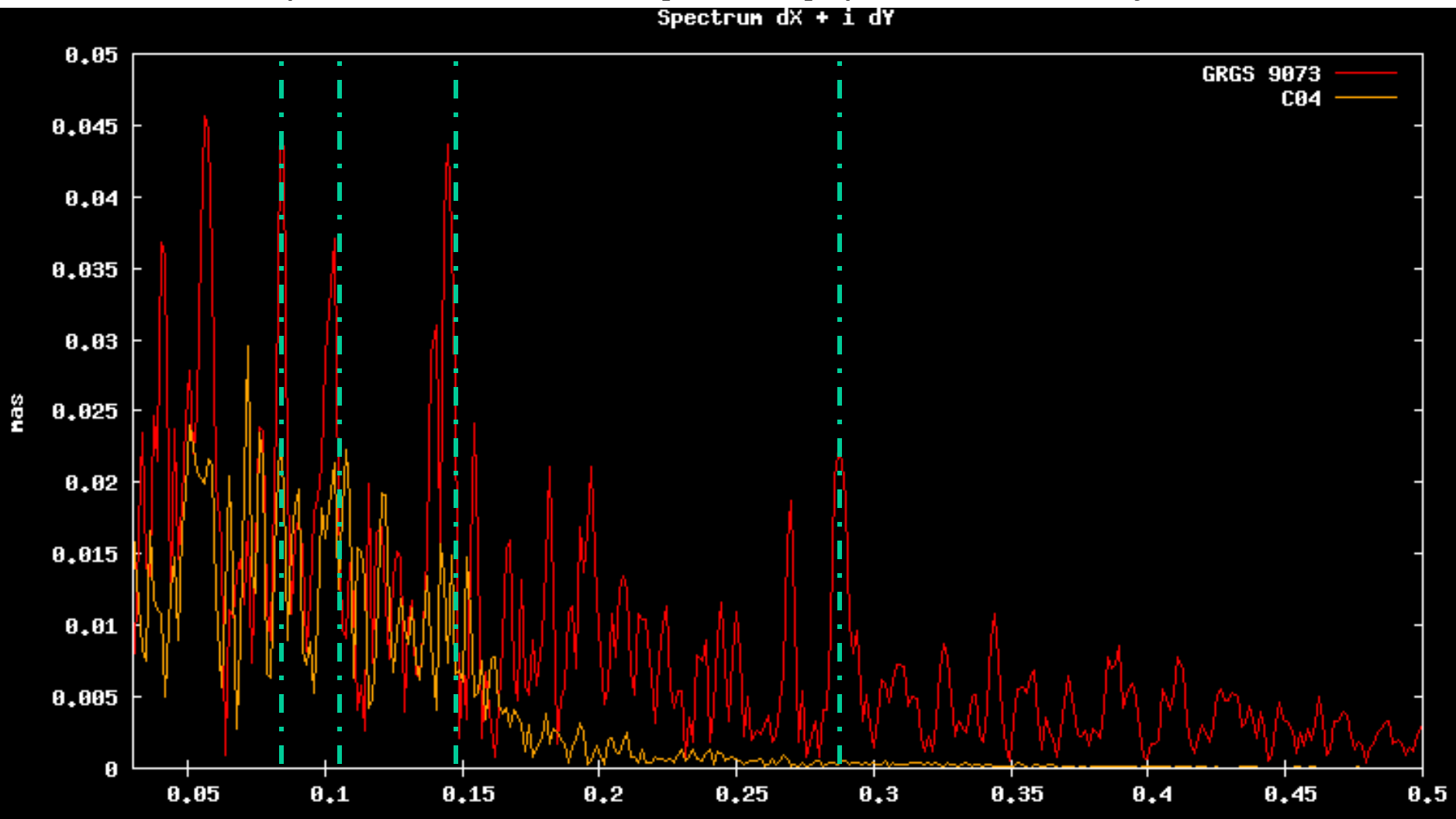


Densification of the nutation series



Nutation offsets $dX + i dY$: prograde spectrum

Spectra of GRGS / C04 [0.05,0.5] cpd $\leftrightarrow$ 2 – 20 days



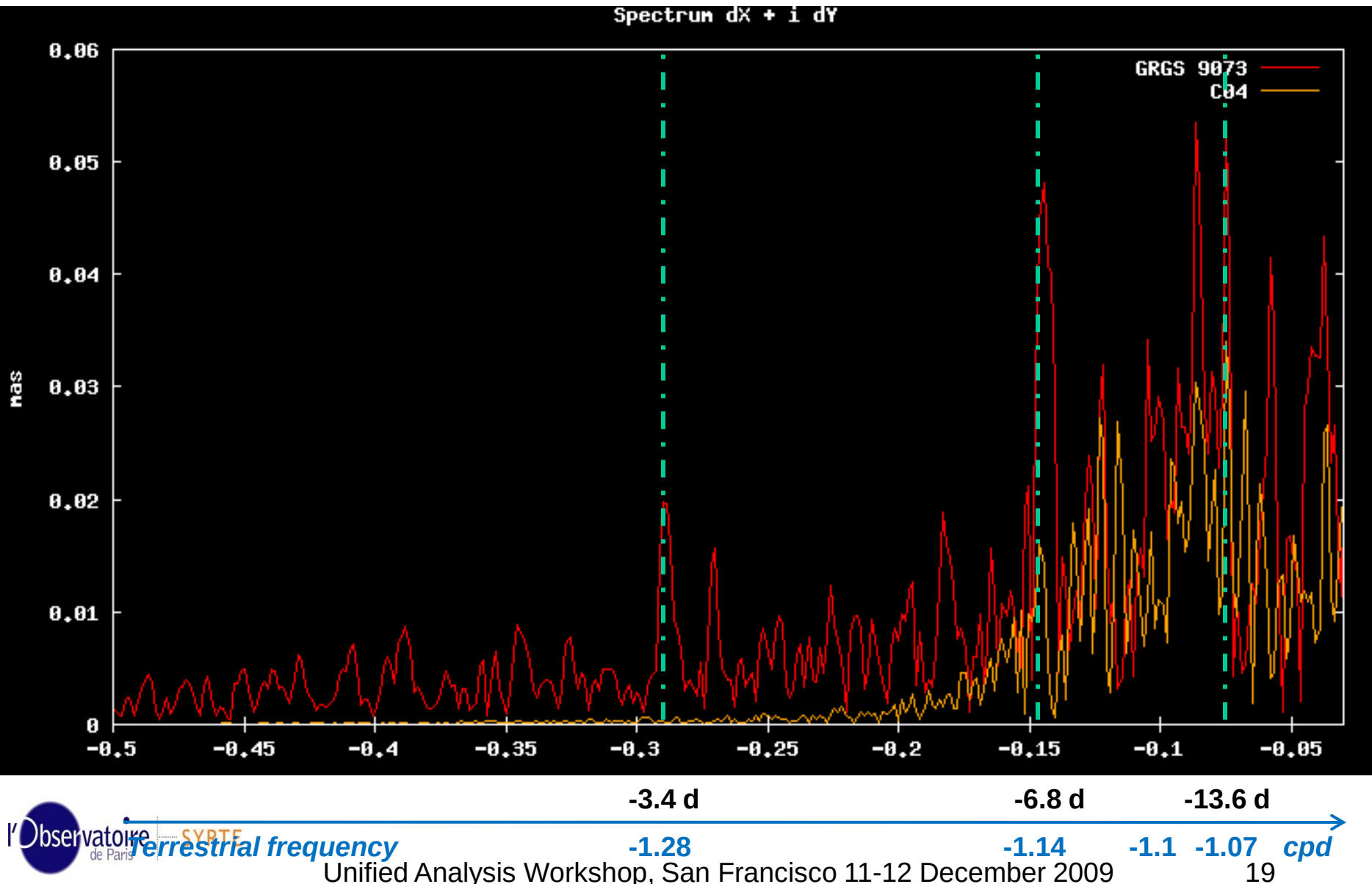
+13.6d Ψ_{11}

+6.8d

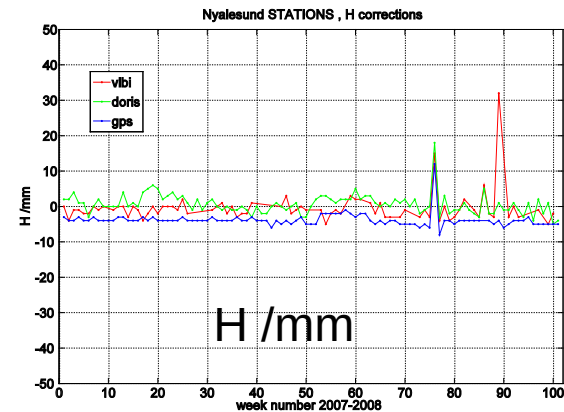
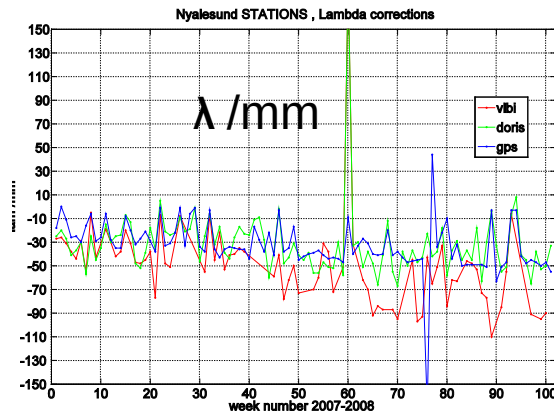
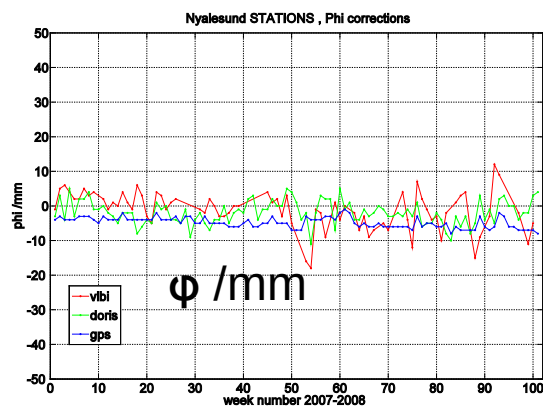
+3.4d

Nutation offsets $dX + i dY$: retrograde spectrum

Spectra of GRGS / C04 [0.05,0.5] cpd $\leftrightarrow$ 2 – 20 days



Ny-Alesund : 3 geodetic Co-located techniques : VLBI, GPS, DORIS



	VLBI	GPS	DORIS
ϕ (mm)	5.6	5.0	3.9
λ (mm)	61.3	39.0	42.3
H (mm)	4.6	4.3	2.9
ϕ rate (mm/y)	-3.4	-1.4	-0.2
λ rate (mm/y)	-23.6	-13.7	-7.3
H rate (mm/y)	1.0	-0.3	-1.1

RMS / ITRF2005

Rate / ITRF2005

Conclusions

❑ EOP monitoring currently based on time series combination: C04
Consistency wrt to ITRF monitored regularly, now about 40 μ as for pole

❑ In connection with ITRS center

CATREF implemented at Paris Observatory

Regularly running for weekly IGS SINEX files, soon for IVS and Combinations

We plan to process the daily IGS and IVS SINEX when available

❑ In the frame of GRGS

➤ approach based on GINS-DYNAMO

- Densification
- Geophysical studies (rapid and sub diurnal EOP)

Difficulty in the combination strategy

- Stabilization of reference frames over successive weeks, local ties
- Weighting of techniques