Long-term variations of the EOP and ICRF2

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Goals of our work

The stability of ICRF2 based on 295 new "defining" sources selected on the basis of positional stability and the lack of extensive intrinsic source structure.

Among the 295 selected defining sources of the ICRF2, only 97 are also defining sources of the ICRF1.

We show that

1) new set of defining sources is not ideal (many of them show significant apparent motions)

2) small rotation of the celestial reference frame is transformed to long-term variations of the EOP

and

3) suggest new method of stabilization of the celestial reference frame

Software ARIADNA (Zharov, 2009) was used.

Solutions used in work:

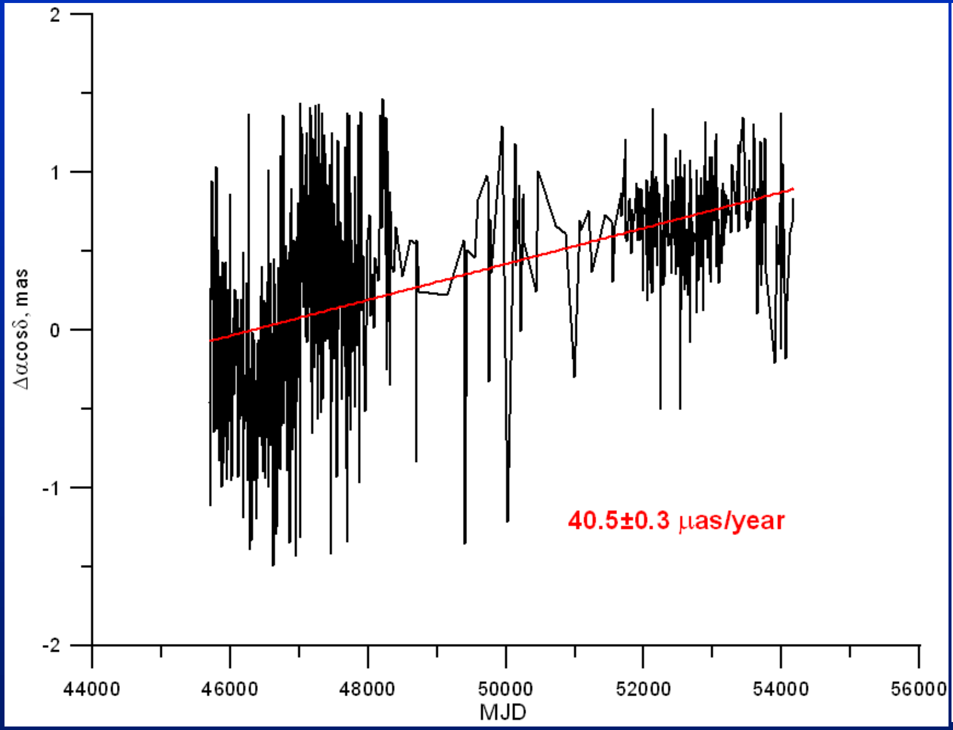
sai2009a.eops (ICRF2, IAU2000,VTRF2008)

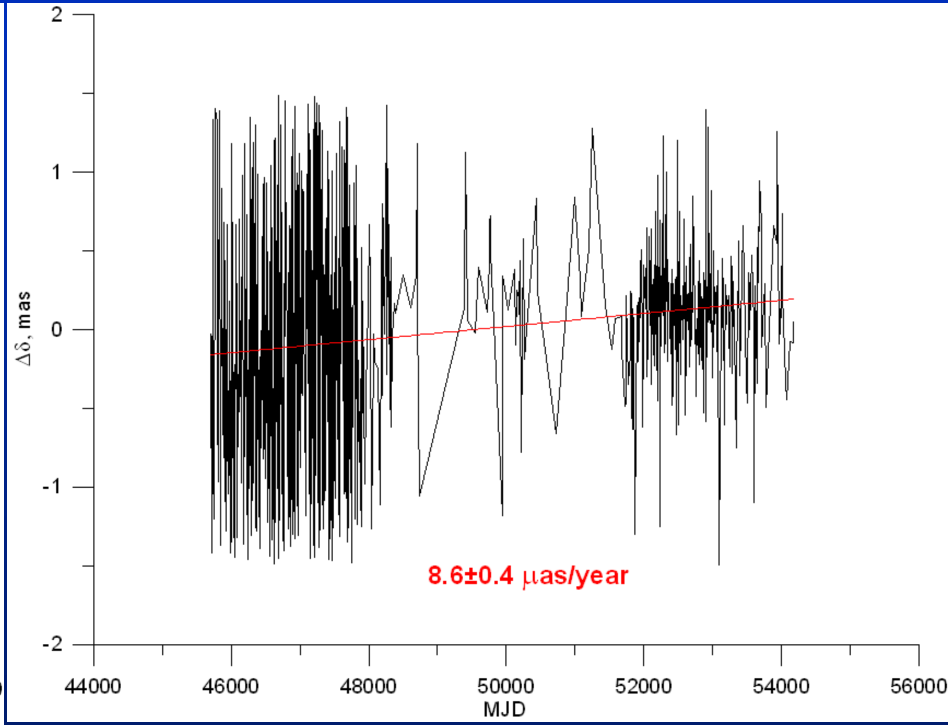
sai2009b.eops (ICRF2corr,IAU2000,VTRF2008)

Estimation of the motion parameters

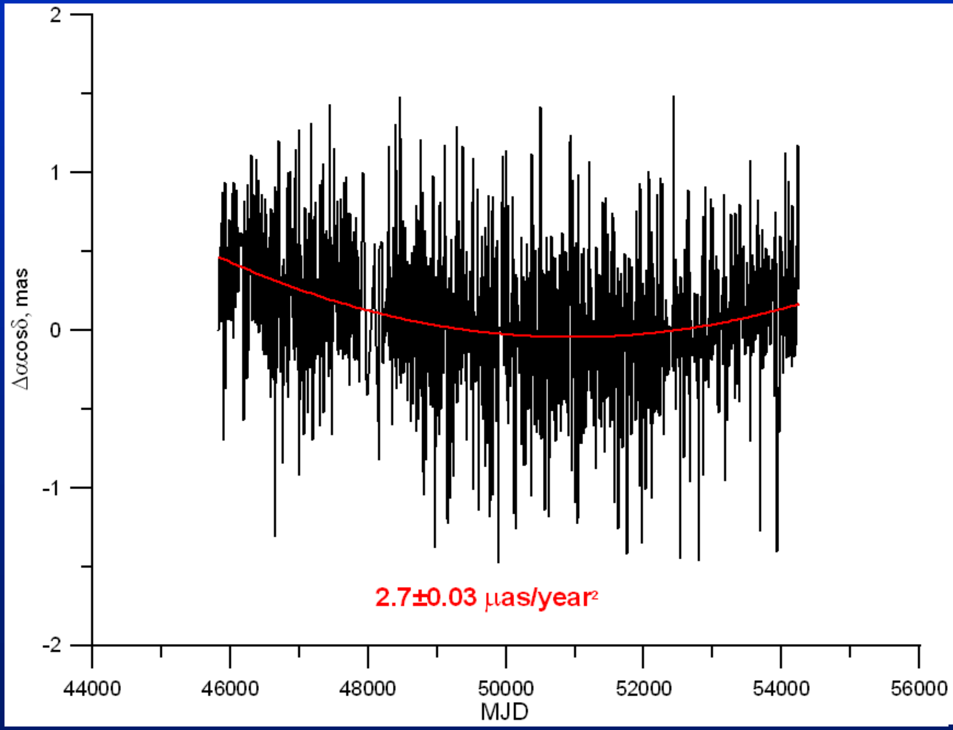
1. Time series of the sources coordinates were used for analysis
2. Variations of each coordinate were fitted by polynomial function

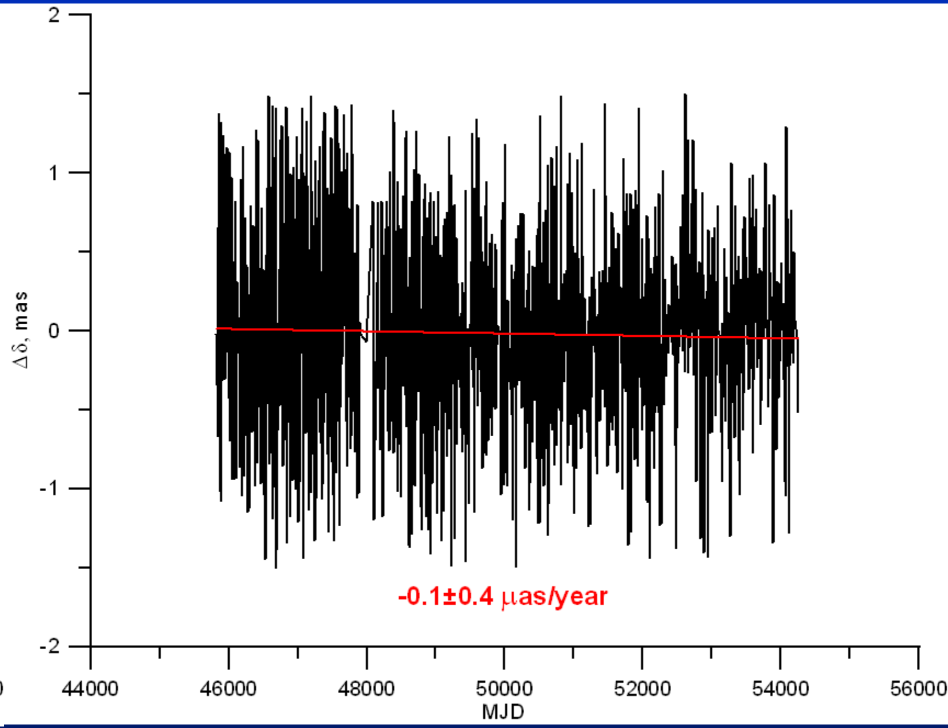
Motion of 0106+013 (other – defining) N > 1500



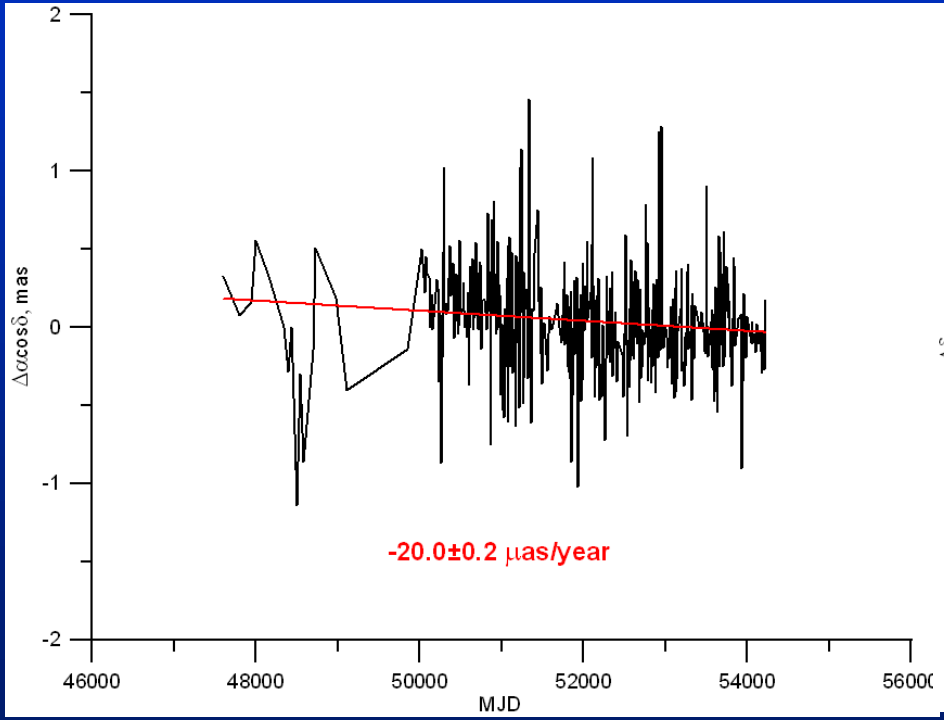


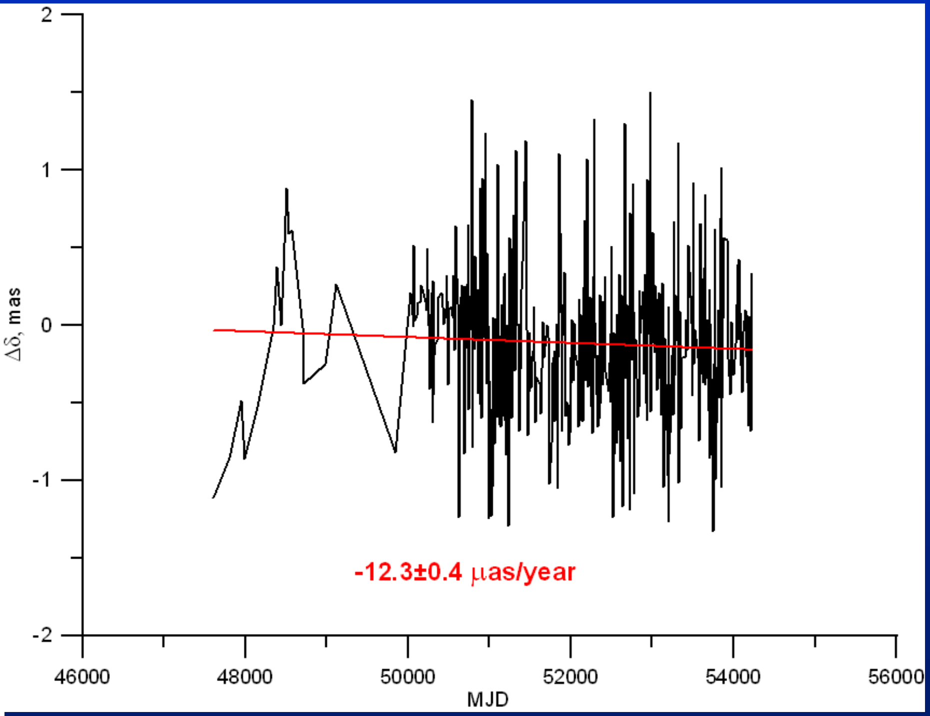
Motion of 0229+131 (candidate – defining) N > 2500



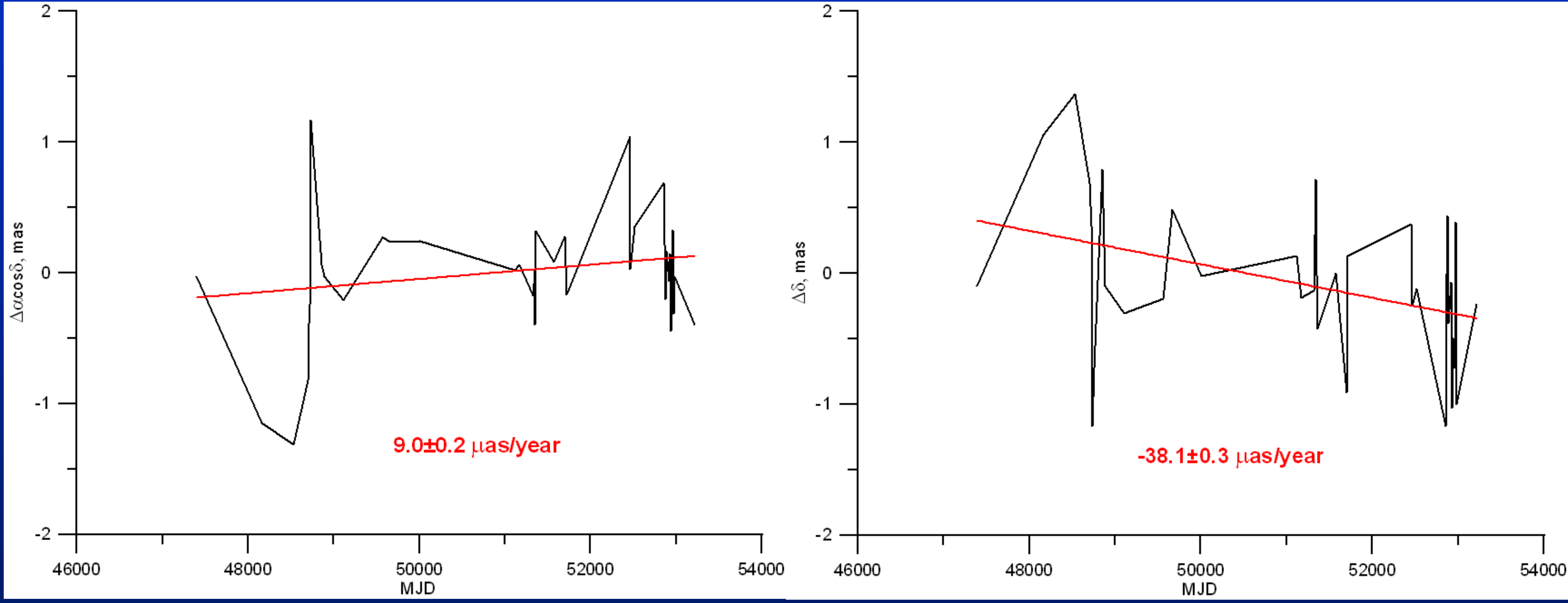


Motion of 0556+238 (defining – defining)
N > 600



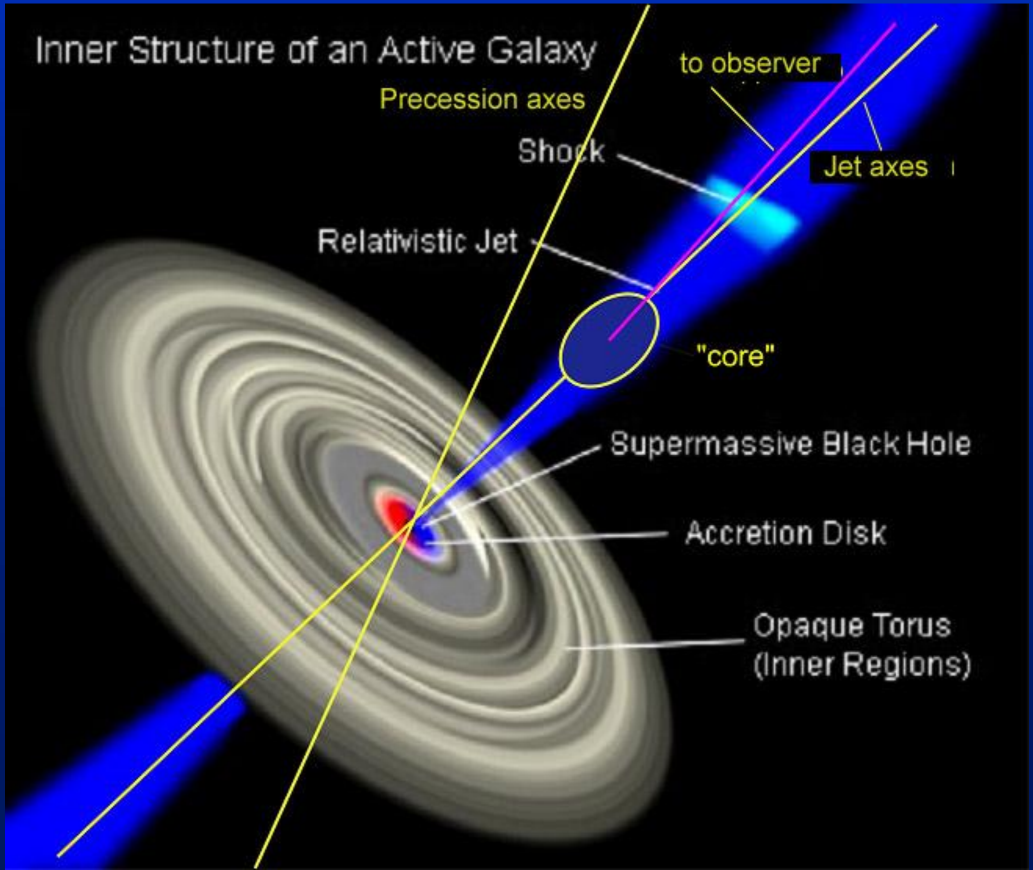


Motion of 0536+145 (other – defining)
N ~ 50



Blandford-Rees model of radio source

Radio emission originates both from the quasi-steady jet itself (emission region or "core" extends from r_{min} to r_{max} and r_{max}~f^{-1}) and from behind strong shock waves which are formed behind dense condensations that are accelerated to relativistic speeds by the flow



1) Radio source of ICRF is the emission region
2) Position of radio source is position of the brightness center of the emission region
3) Linear motion of radio source can be explained by the precessional motion of jet
4) Quadratic motion can be explained by the acceleration of the dense condensations at first, and then deceleration
5) Motion of radio source is sum of systematic motion of object in space (Titov) and apparent (random) motion of emission region

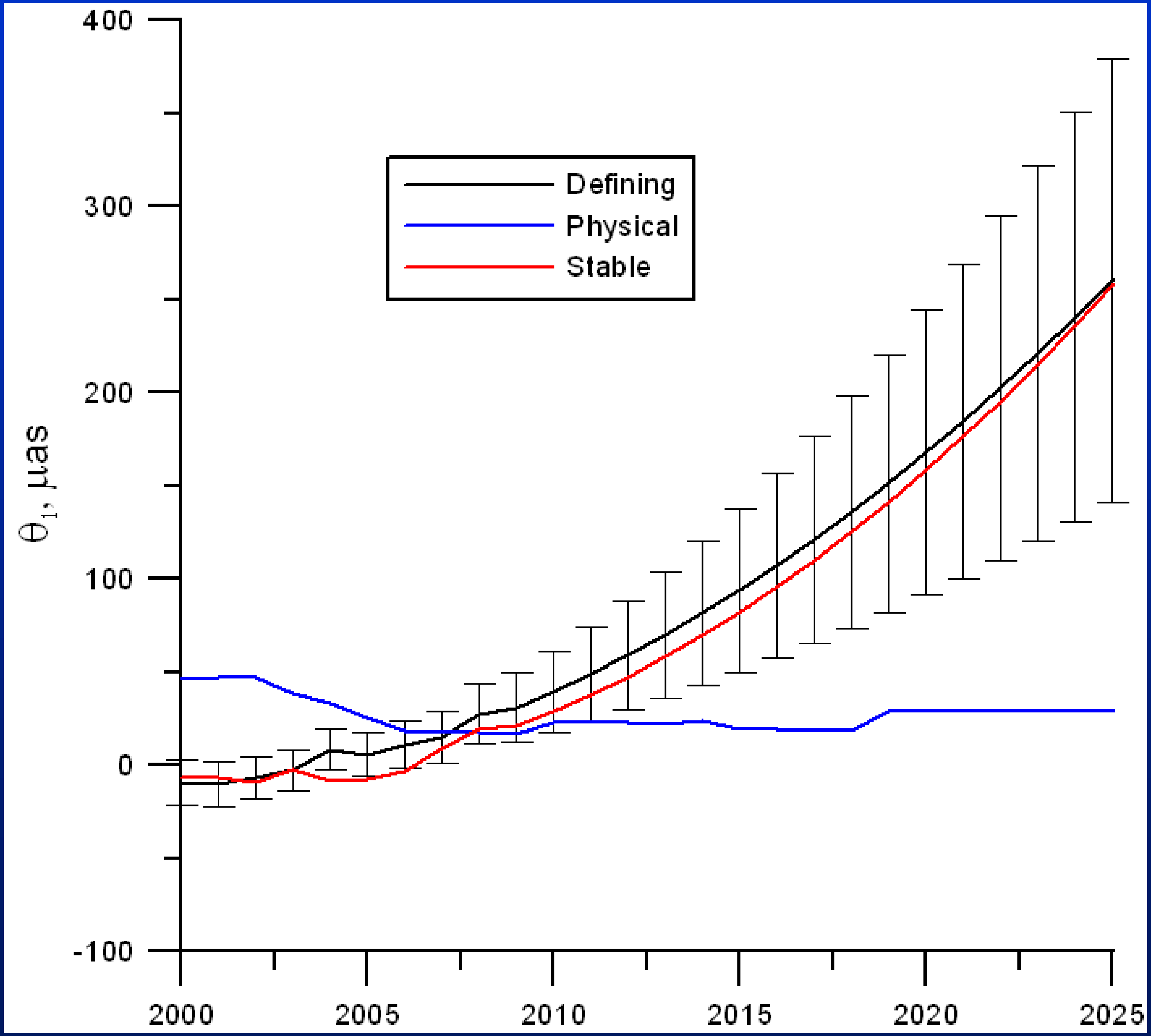
Rotation of the ICRF

$$\vec{s}(t) = \begin{pmatrix} 1 & -\theta_3 & \theta_2 \\ \theta_3 & 1 & -\theta_1 \\ -\theta_2 & \theta_1 & 1 \end{pmatrix} \vec{s}(t_0),$$

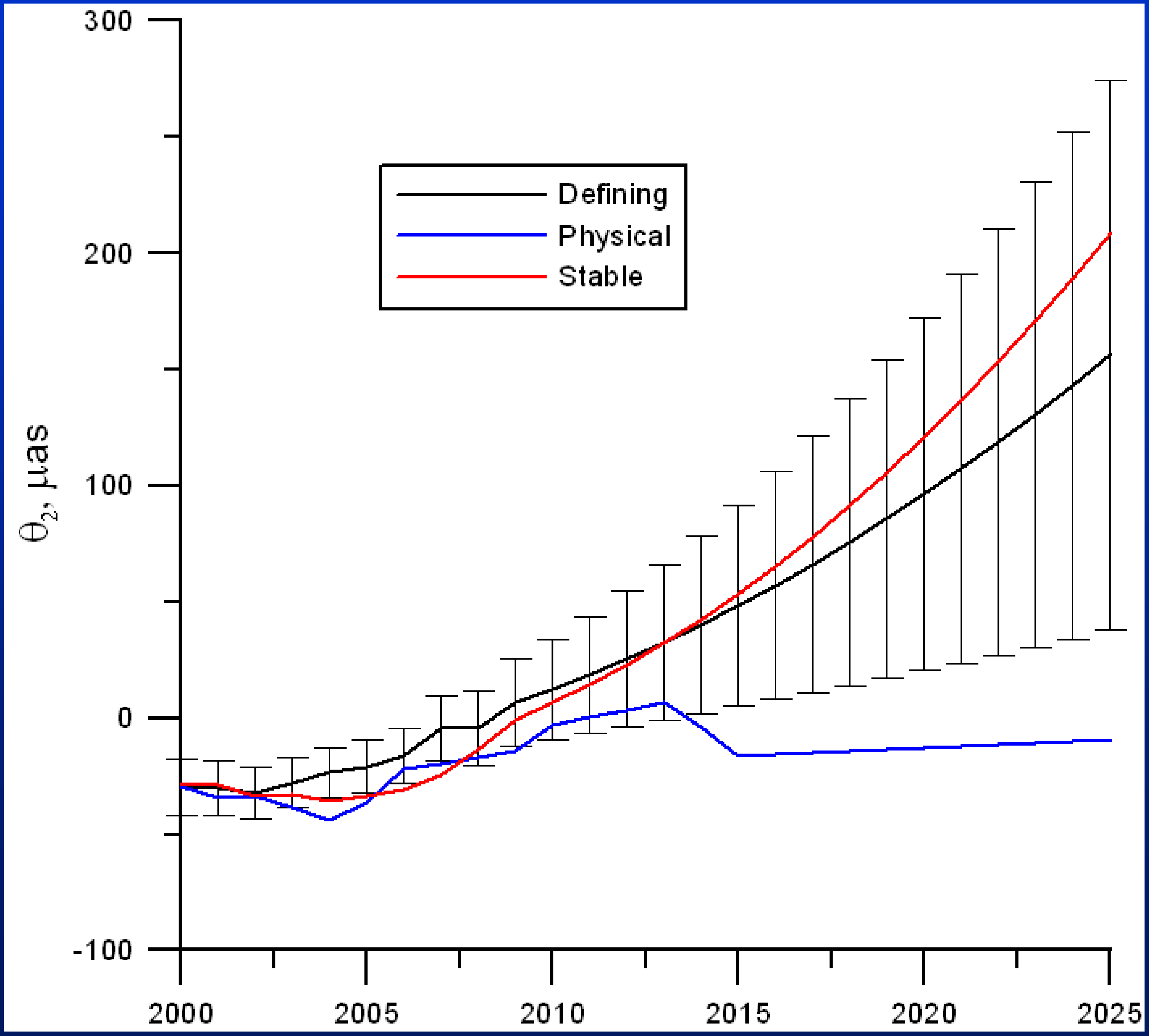
$\vec{s}(t), \vec{s}(t_0)$ are the unit vectors of a source

for moments t and $t_0 = \mathrm{J2000.0}$

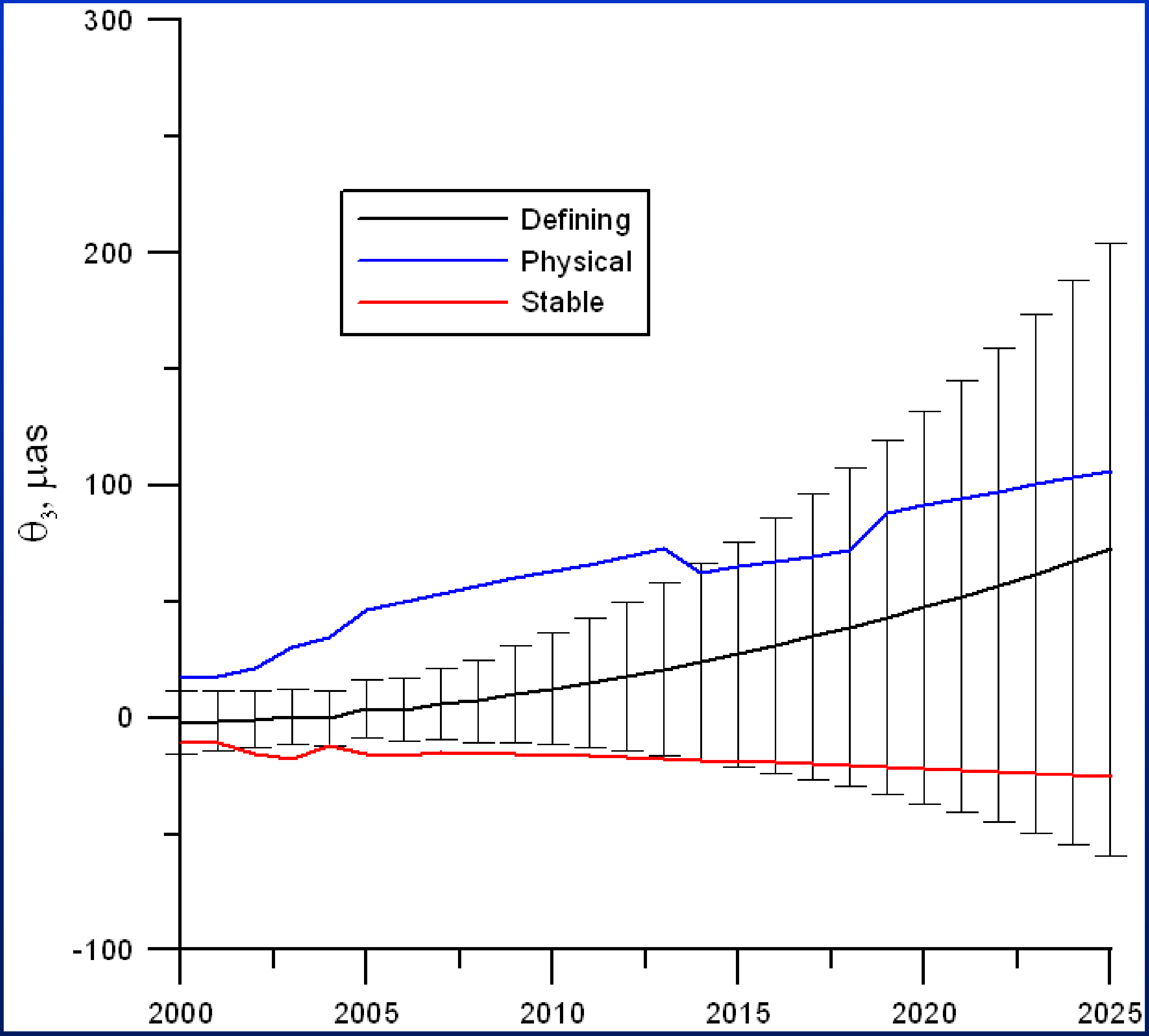
Rotation of the ICRF (θ_1)



Rotation of the ICRF (θ_2)



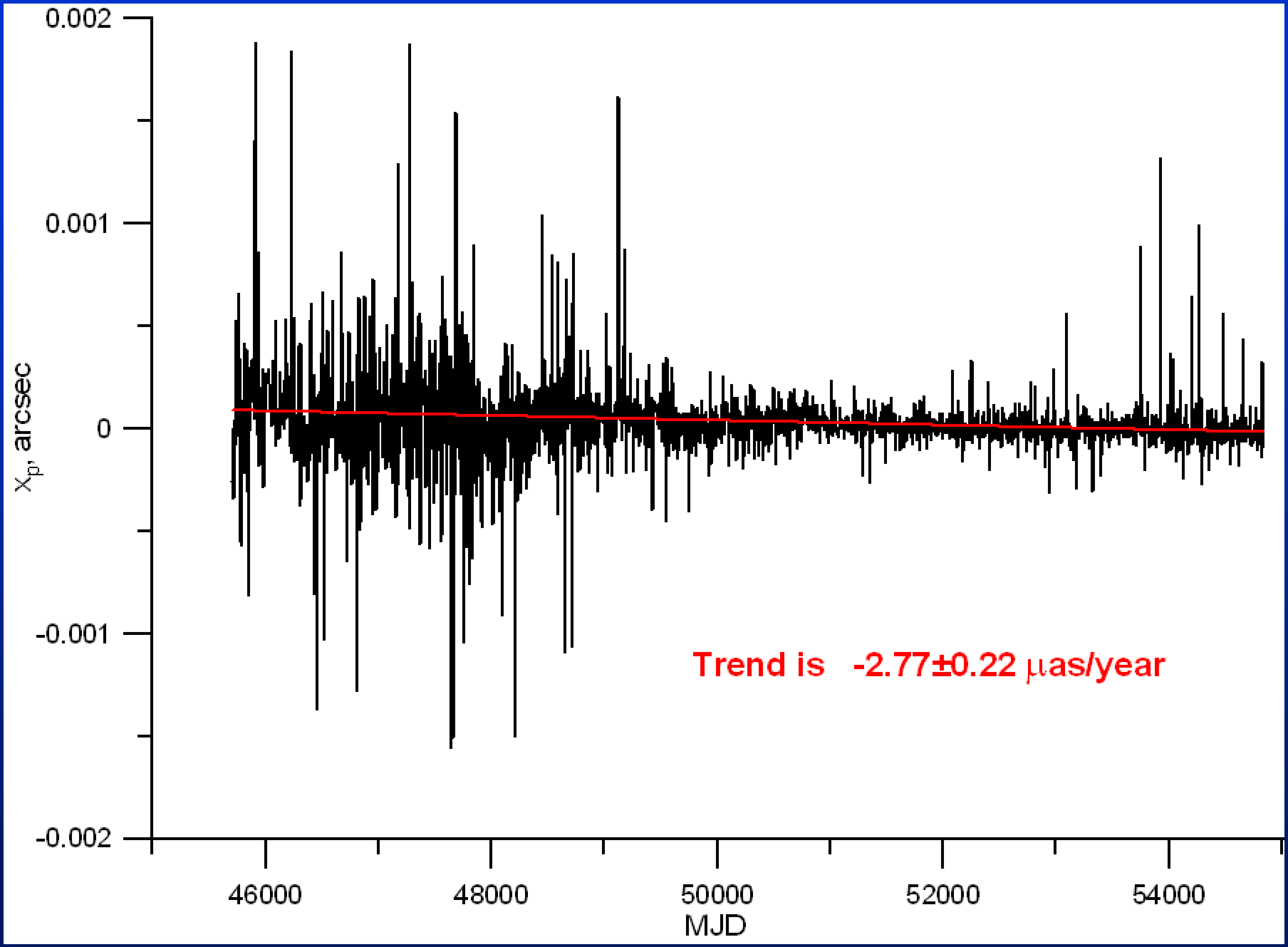
Rotation of the ICRF (θ_3)



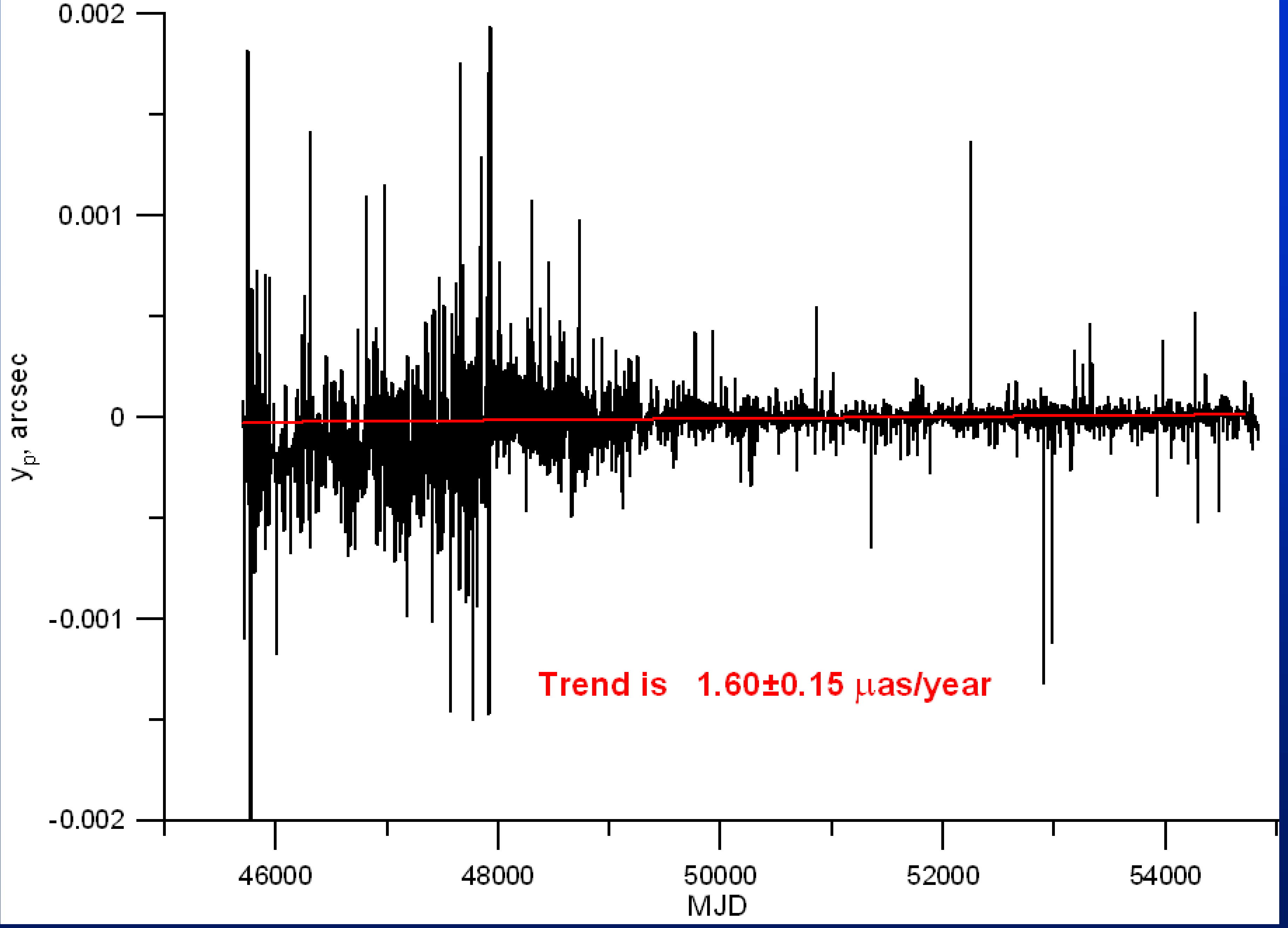
Variations of the EOP due to rotation of the ICRF

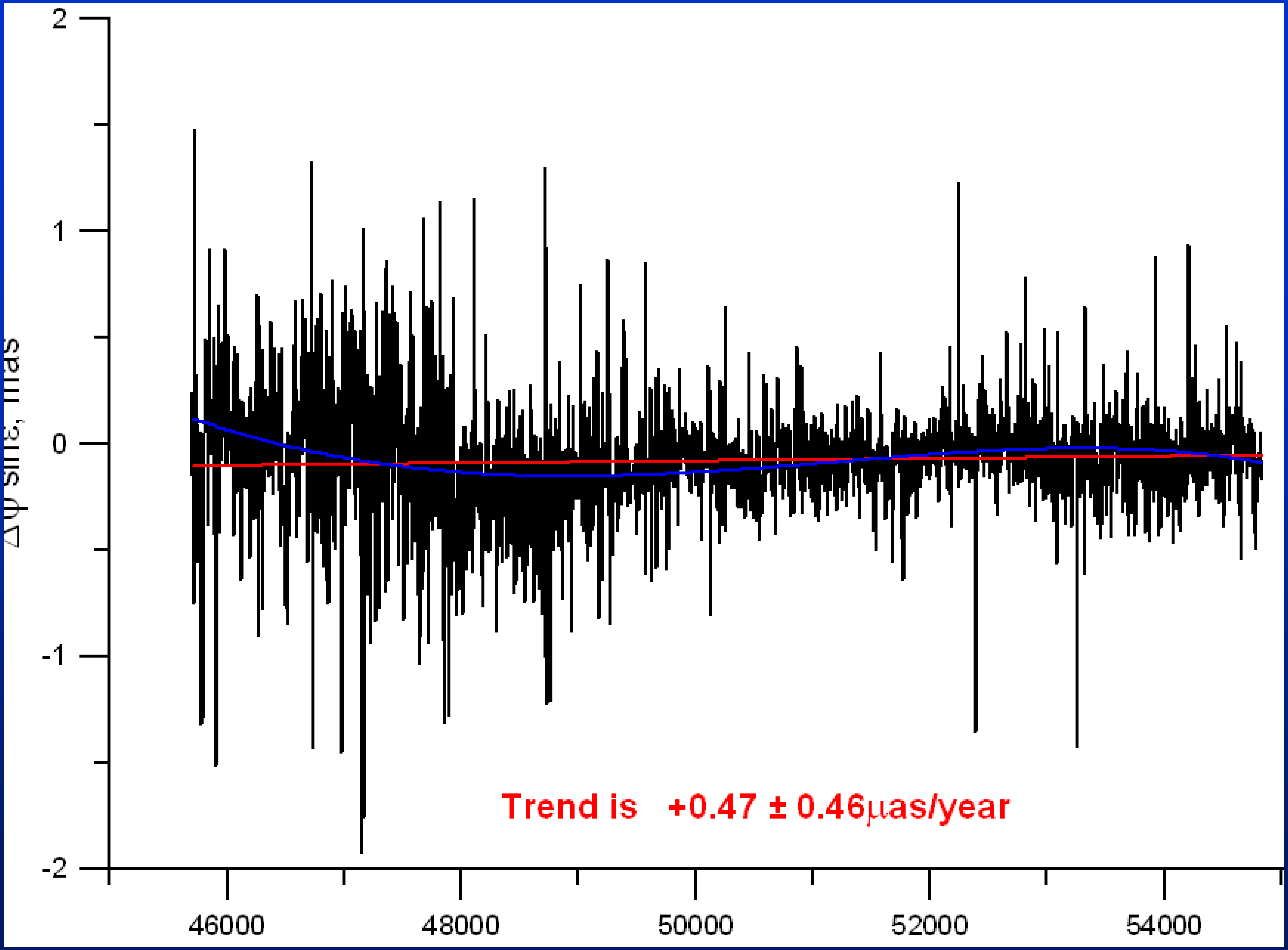
Difference between solutions :

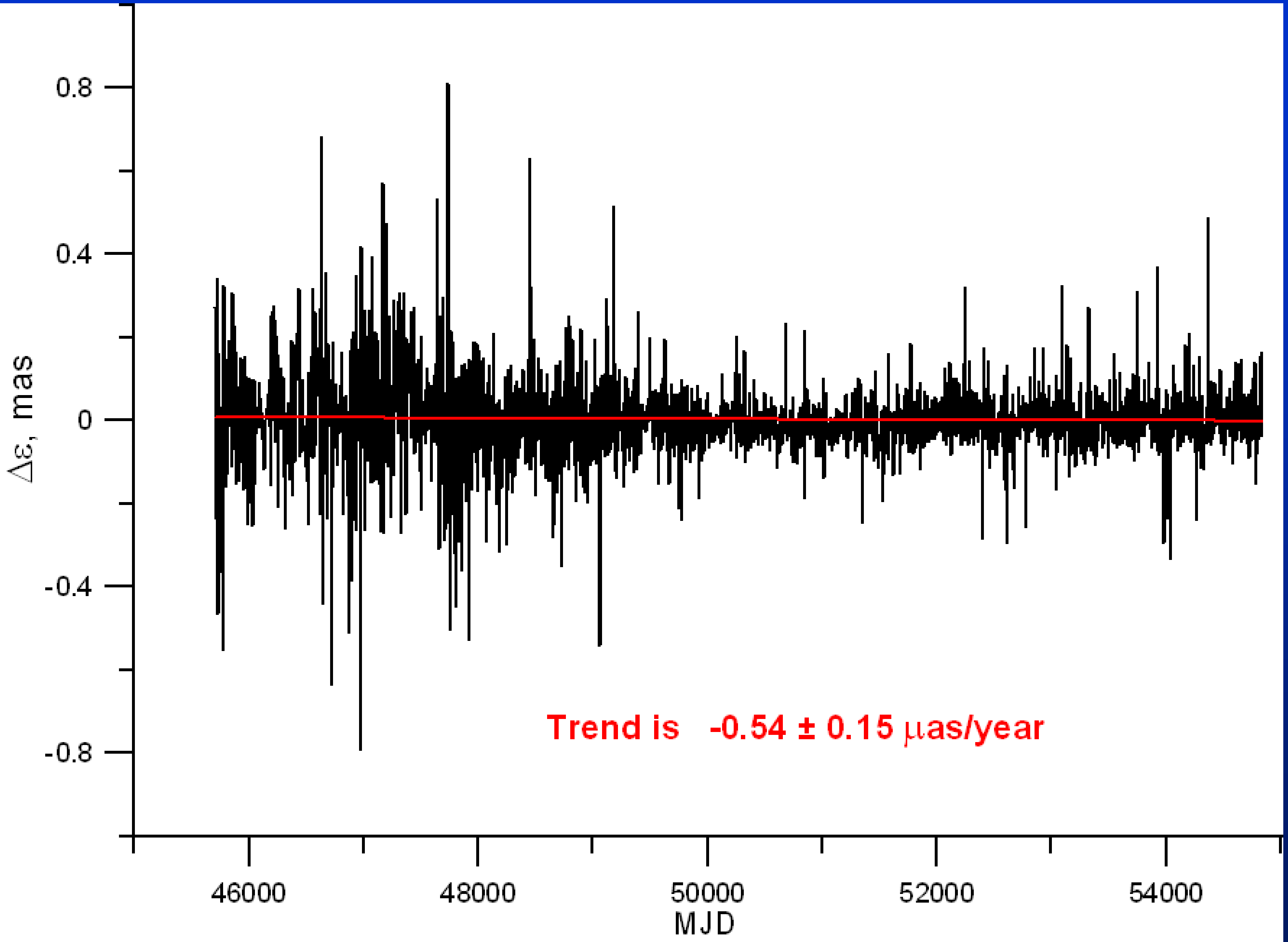
sai2009a.eops (ICRF2) and sai2009b.eops (ICRF2corr)

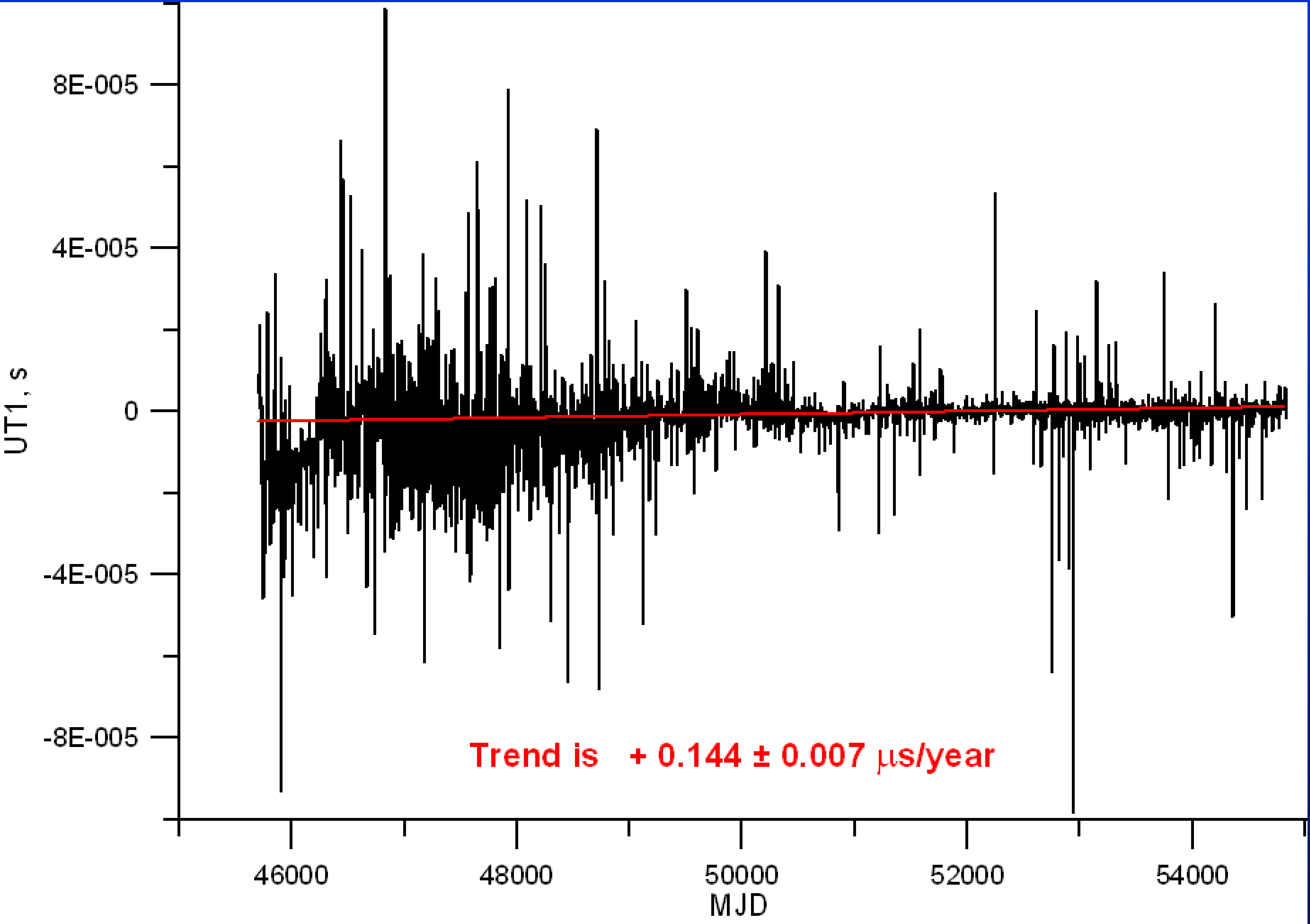


0.002
0.001
0
-0.001
-0.002
X_p, arcsec
46000
48000
50000
52000
54000
MJD
Trend is -2.77±0.22 μas/year


0.002
0.001
0
-0.001
-0.002
y_p, arcsec
46000
48000
50000
52000
54000
MJD
Trend is 1.60±0.15 µas/year

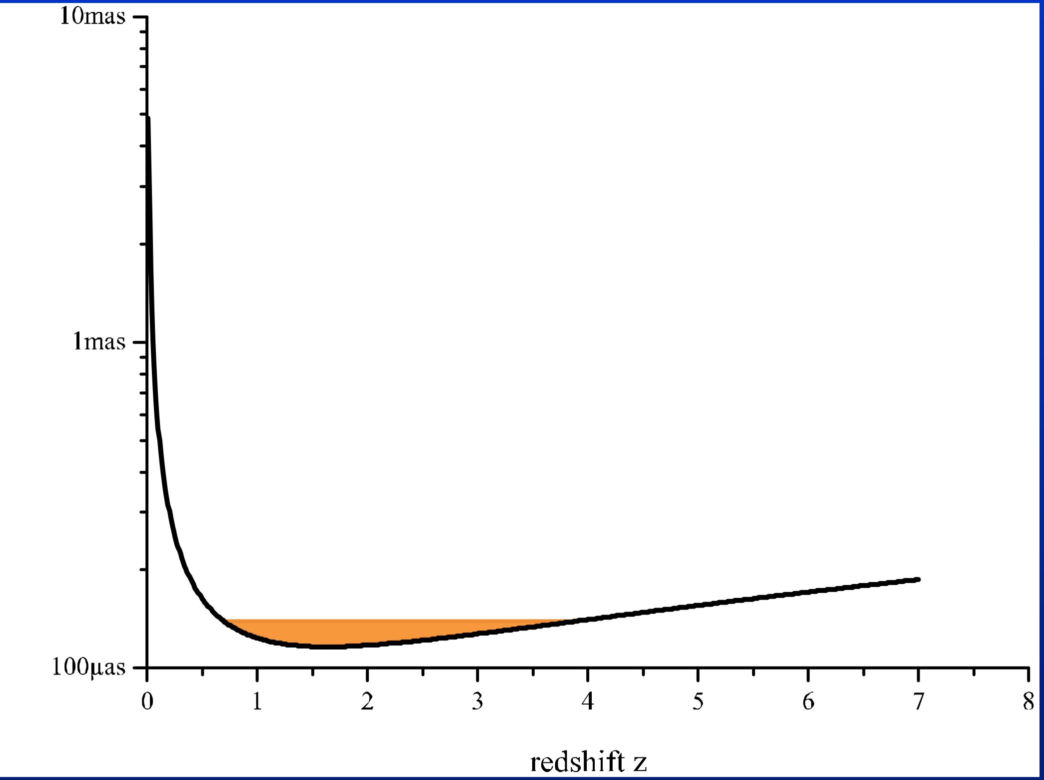

2
1
0
-1
-2
Δψ sinε, mas
Trend is +0.47 ± 0.46μas/year
46000
48000
50000
52000
54000


0.8
0.4
0
-0.4
-0.8
Δε, mas
46000
48000
50000
52000
54000
MJD
Trend is -0.54 ± 0.15 μas/year



8E-005
4E-005
0
-4E-005
-8E-005
UT1, s
Trend is + 0.144 ± 0.007 μs/year
46000
48000
50000
52000
54000
MJD

Cosmological model and angular size

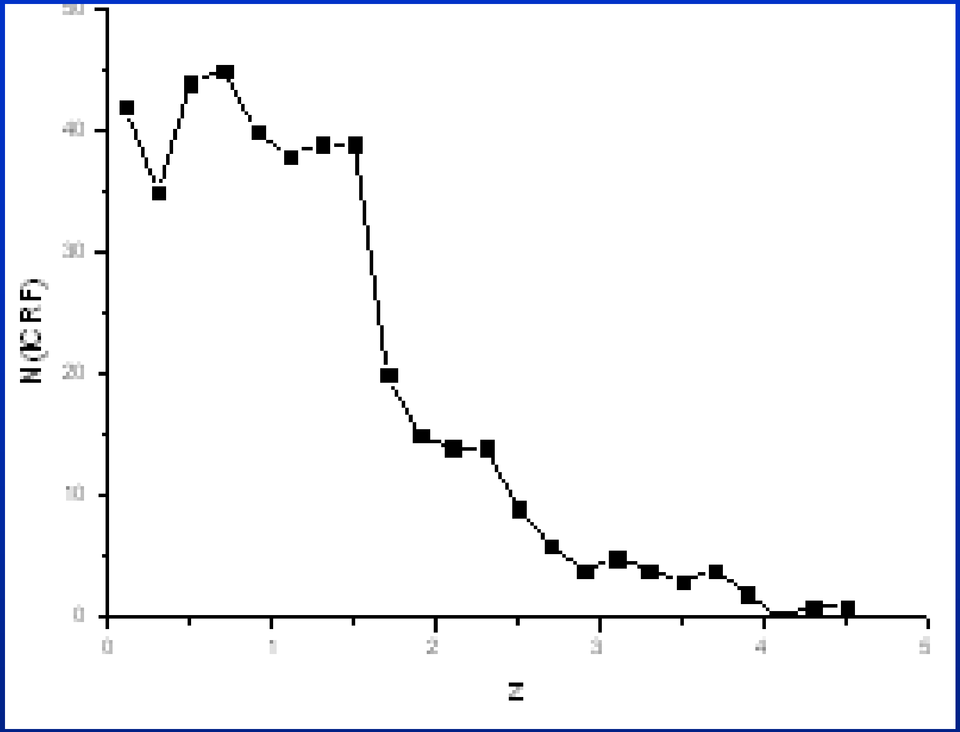


Angular size of standard length has minimal value for z=1.63

Angular size of 1 parsec is 118 microarcseconds

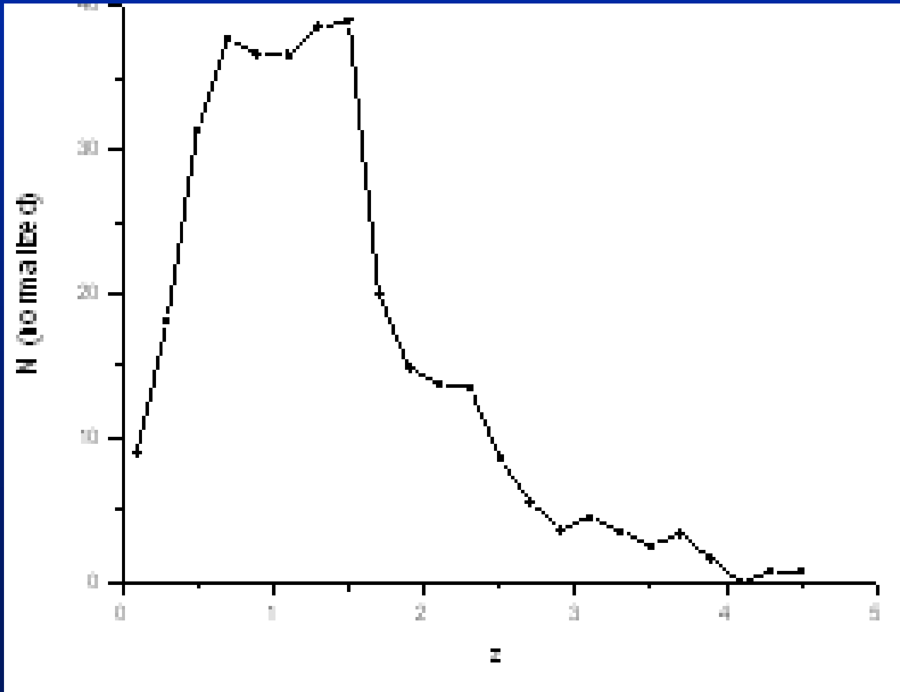
Cosmological criteria is used for selection of sources at redshifts which corresponds to minimal angular shift of radio emission center

Selection with z-criteria



Distribution of 261 ICRF sources

137 sources with z in Range 0.8 – 3.0



Conclusions

Motion of radio source can be explained by simple physical models of motion of the emission region.

Rotation of the ICRF is transformed to secular variations of EOP.

Two criteria were used to improve stability of the celestial reference frame : “cosmological” and “kinematical”.

The first one allows to select the sources at redshifts which corresponds to minimal angular shift of the emission center.

The second one allows to choose the sources with well known and predictable motions for long time interval.

Thank you!