Analysis of time series of the EOP and the ICRF source coordinates

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Goals of our work

- Obtain the EOP and coordinates of the ICRF sources from VLBI observations from 1984 to 2010 by ARIADNA software on base of the IERS Conventions 2010.
- 1) Analysis of motions of the ICRF sources
- 2) Analysis of the EOP

a) ICRF2

b) ICRF2 + motions

Background for work

1. Working Group on the "Theory of the Earth Rotation" started work (2013)
One of goals is “the development of theories of Earth rotation that are fully consistent and that agree with observations”

We plan to use new series of corrections *dX* and *dY* to the X and Y coordinates of the CIP to improve the IAU2000 nutation theory

Background for work

- 2. IAU Working Group for ICRF3 formed (2012)

Goals are expand number of sources and improve accuracy

We plan to use time series of the sources coordinates and derived motions to

1) improve the ICRF2 catalog and

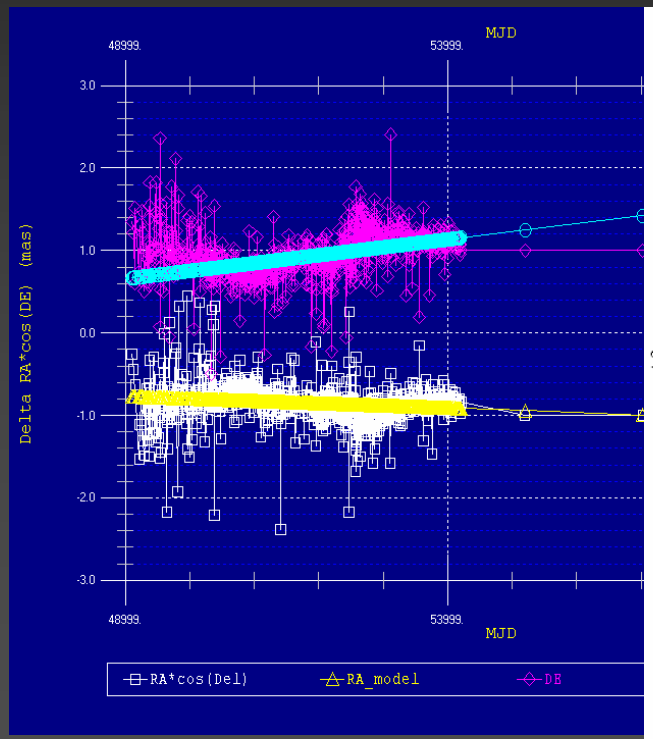
2) determine systematic parts of motions that connected with secular aberration and the Earth precession motion imperfection

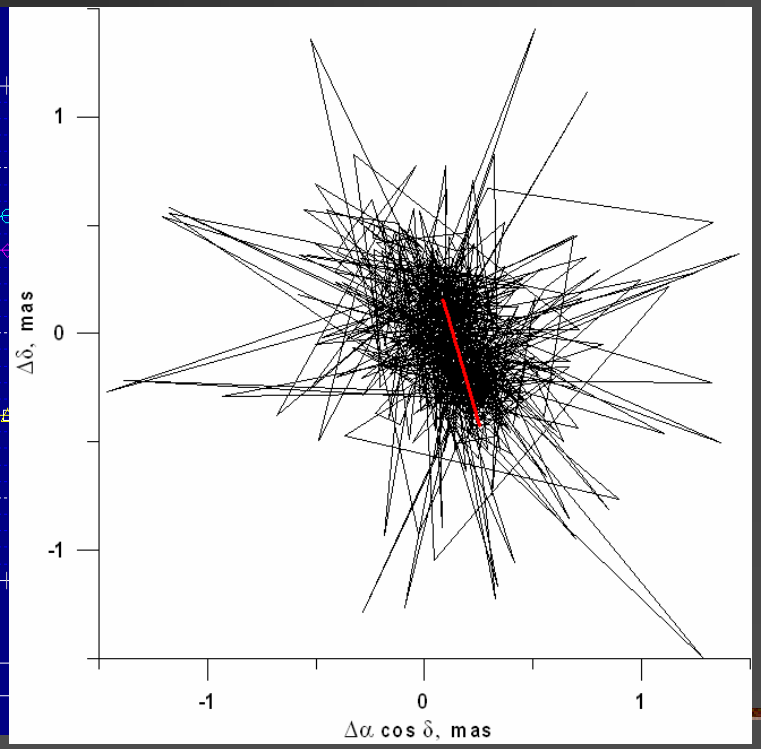
Motion of core or defining „radio source“ 1044+719

z=1.150,

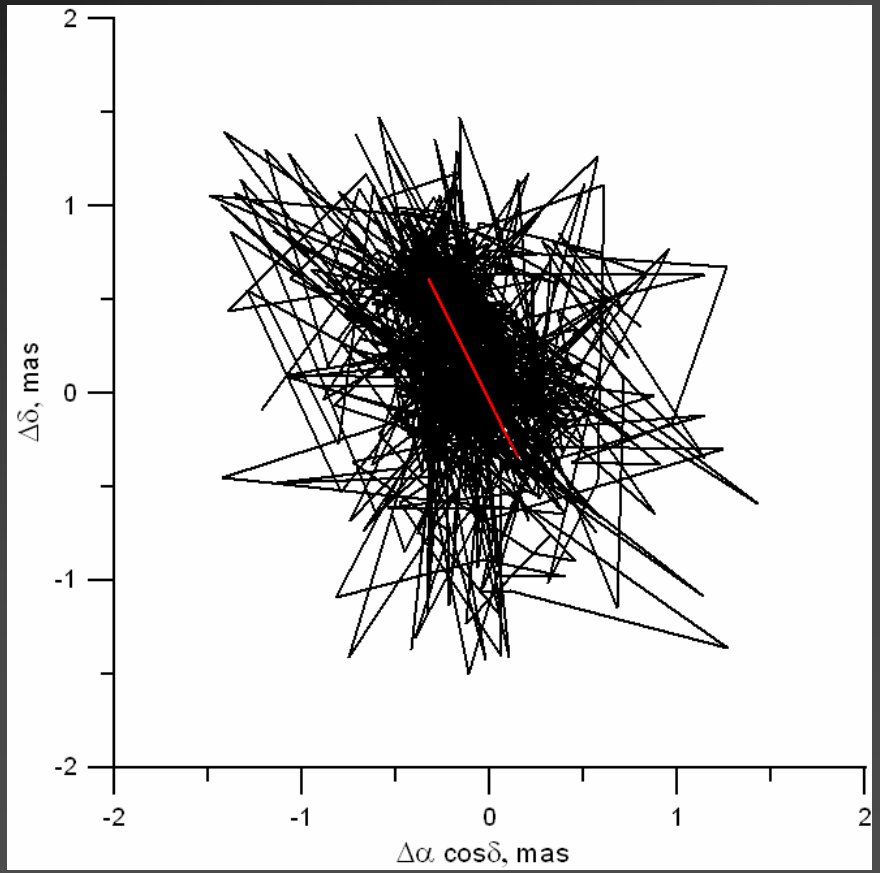
|μ|≈ (43 ± 2) μas/y,

V_T ≈1.2c (apparent)





Motion of 0202+149 (not defining)



Map of motions

- The apparent motions of 573 extragalactic radio sources were estimated from global solution for 3193 series of the VLBI observations from 1984 to 2010.

  The least square method with constraints was applied.

- We see that most radio sources (including defining sources) are characterized by significant apparent motions.

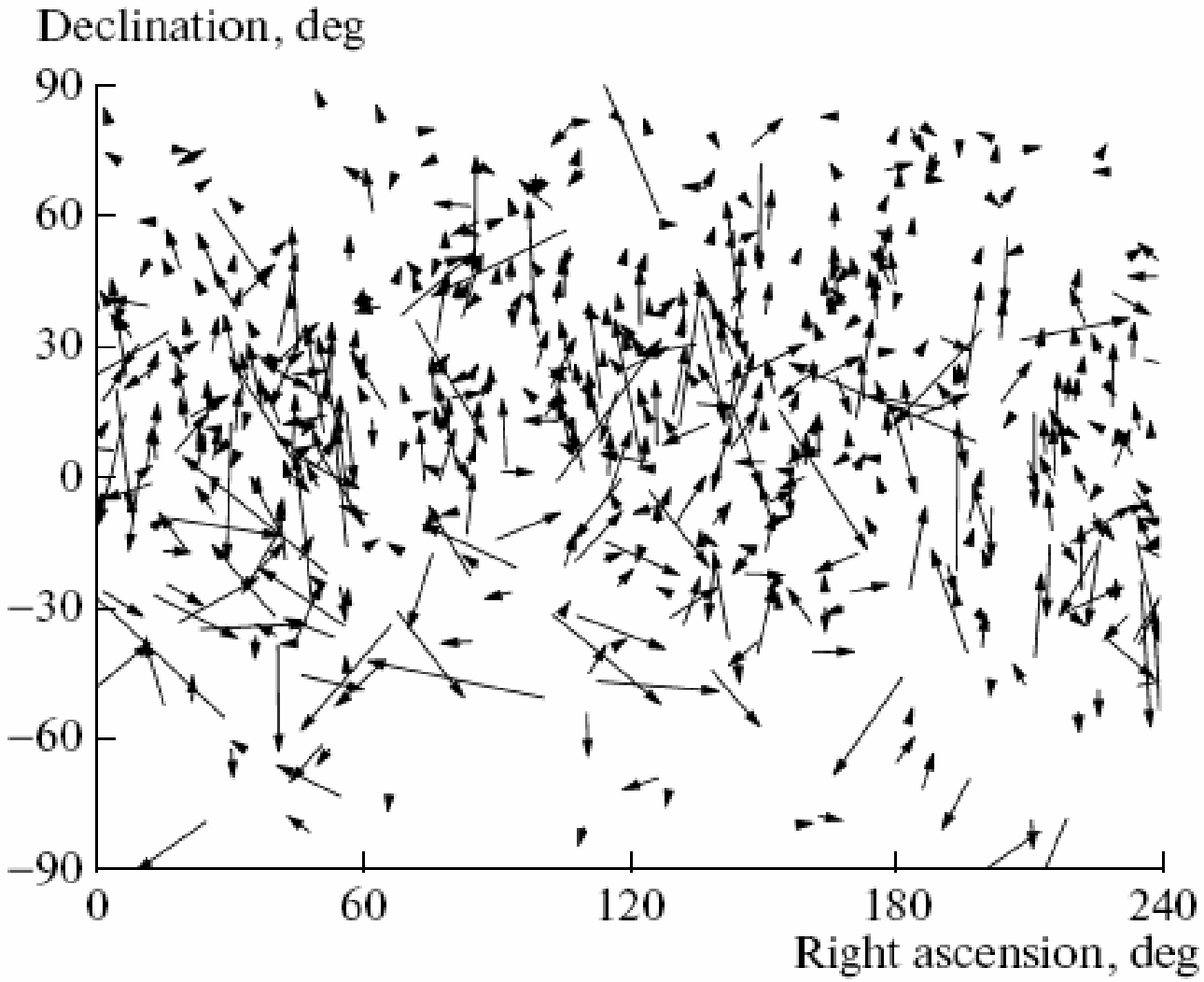


Fig. 1. The distribution of the apparent motions of radio sources depending in right ascension and declination.

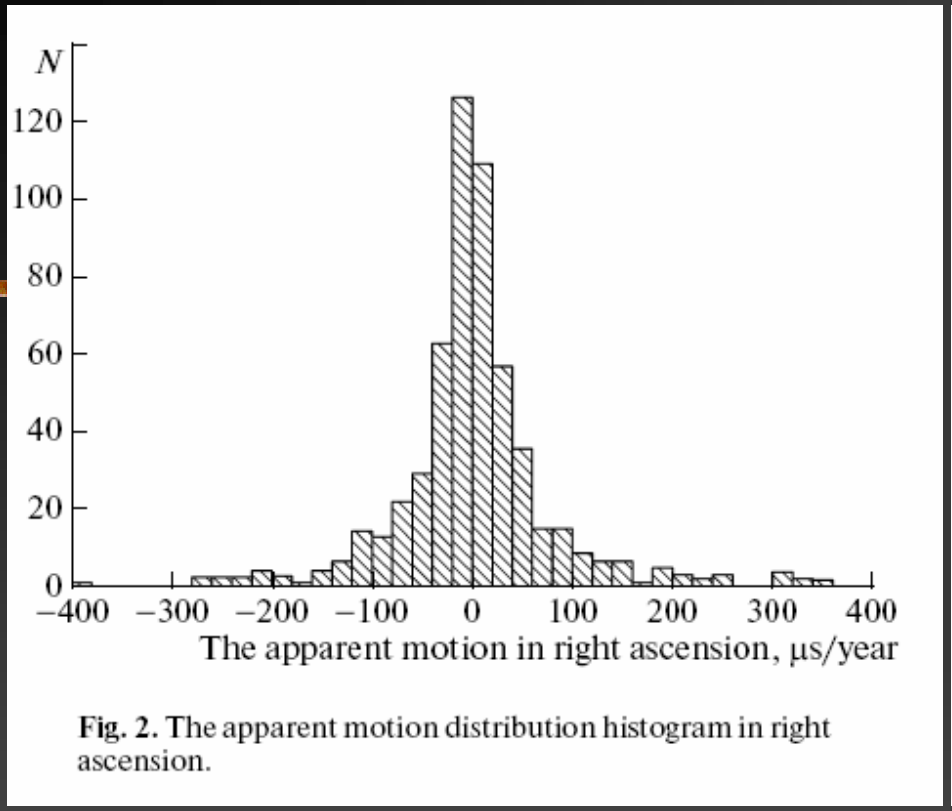


Fig. 2. The apparent motion distribution histogram in right ascension.

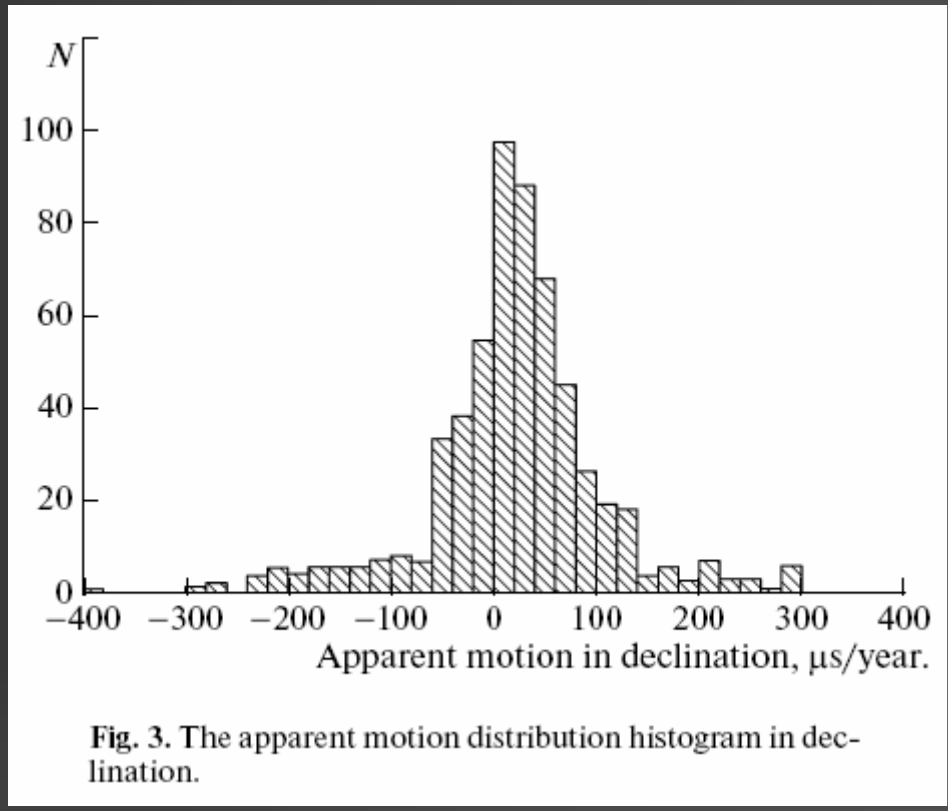
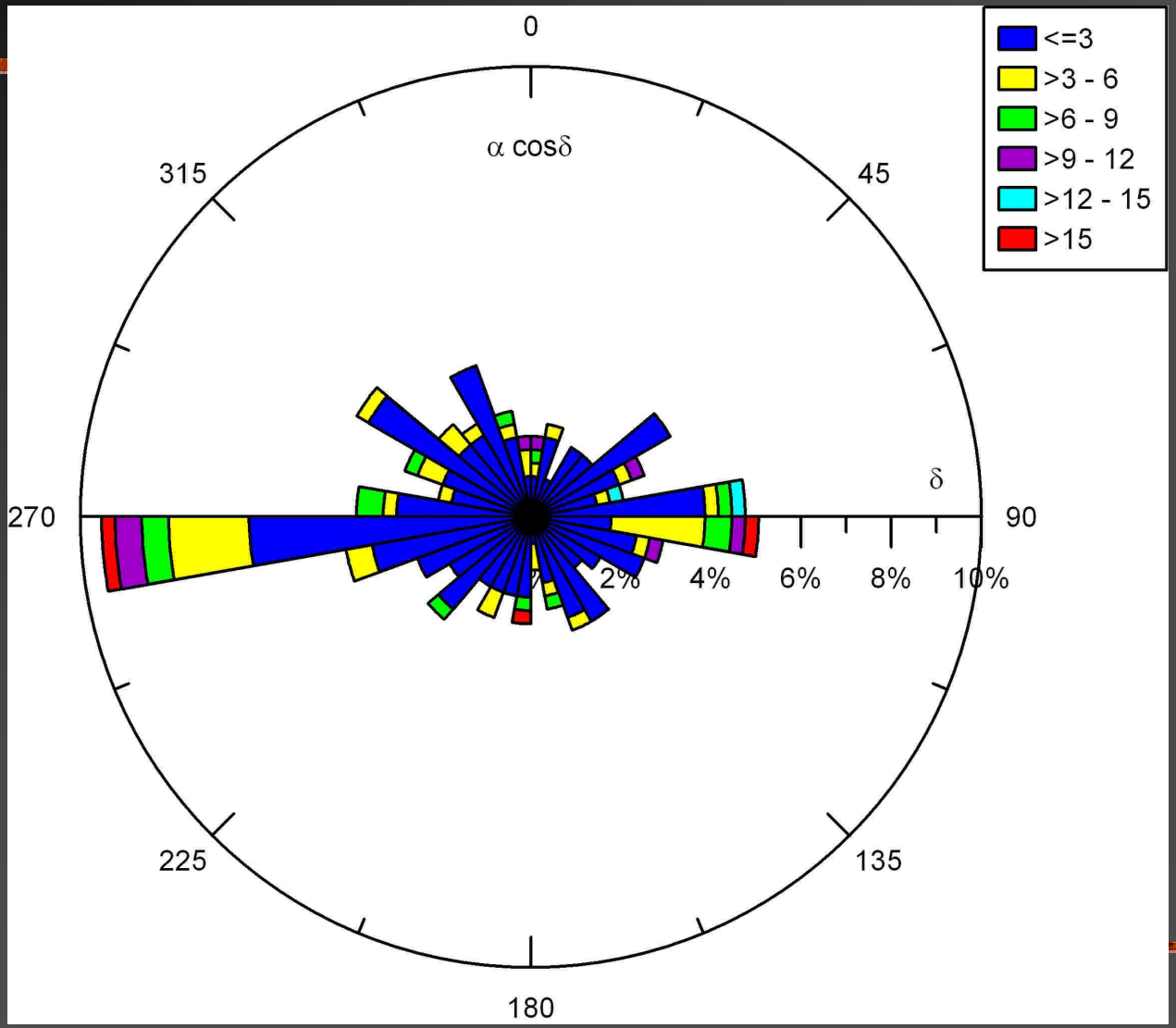


Fig. 3. The apparent motion distribution histogram in declination.

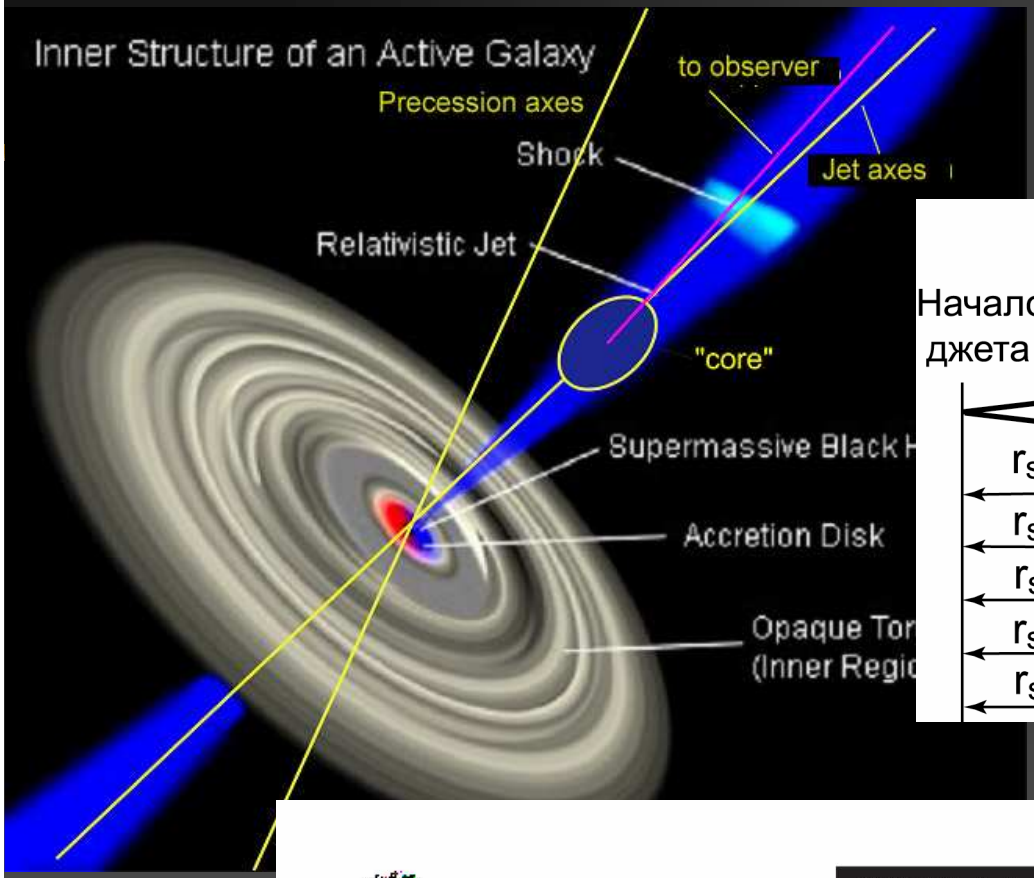
1) Great number of the sources (339 sources out of 573) have velocities that exceed 50 μs per year

2) The apparent motion distribution is not normal !

Motion of „radio sources“

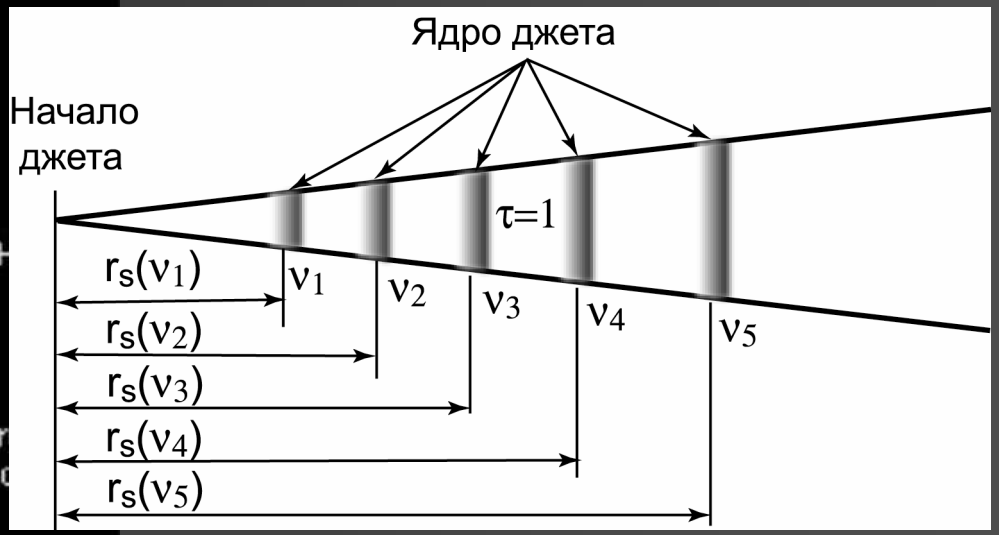


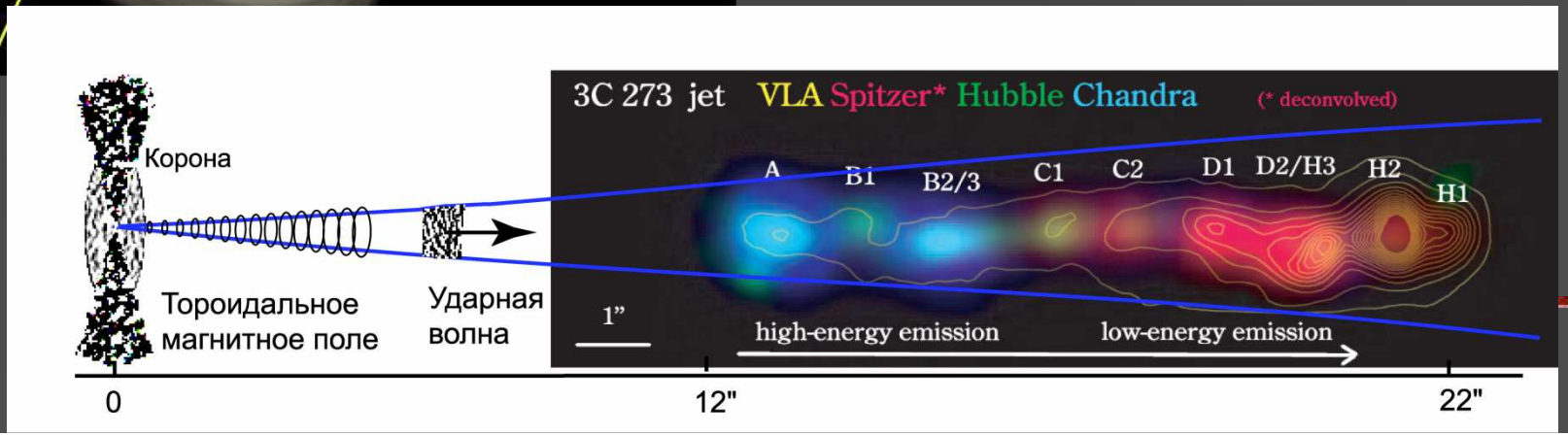
The jets physics



$r_s \sim \nu^{-1}$ ⇨

8GHz➞40GHz $\Delta\tau_g \approx$ 10÷20 ns !

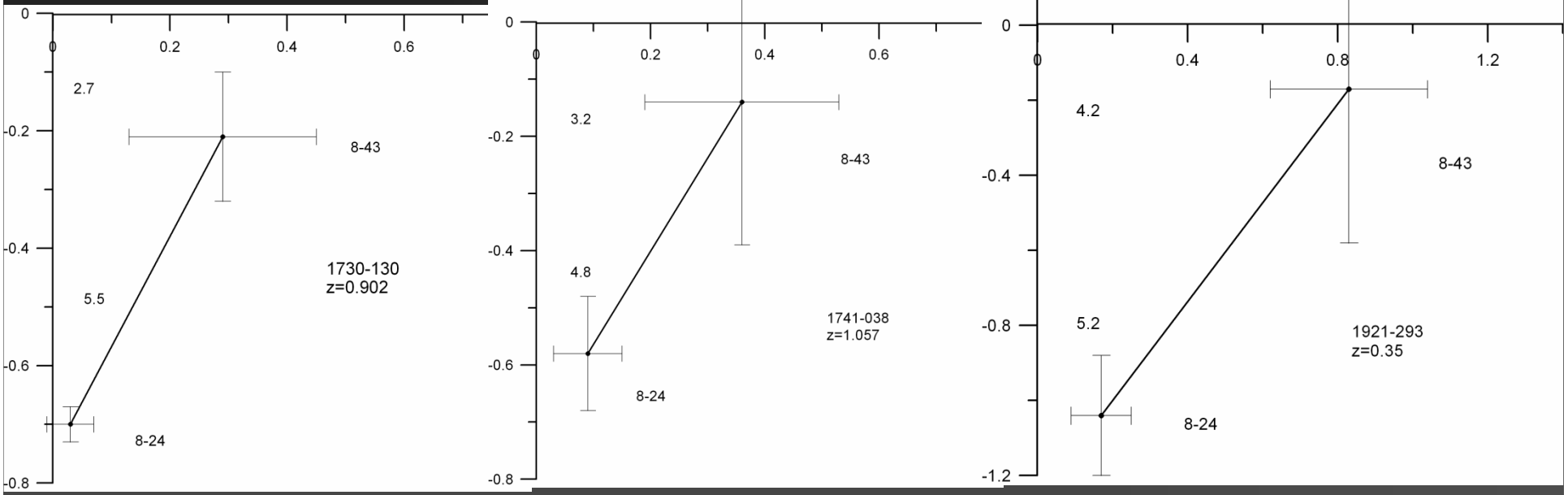




$$\tau_1 - \tau_2 = \frac{1}{c}(\vec{B}\cdot\vec{s}_1 - \vec{B}\cdot\vec{s}_2) = \frac{B\sin\theta}{c}(\Delta\theta_2 - \Delta\theta_1)$$

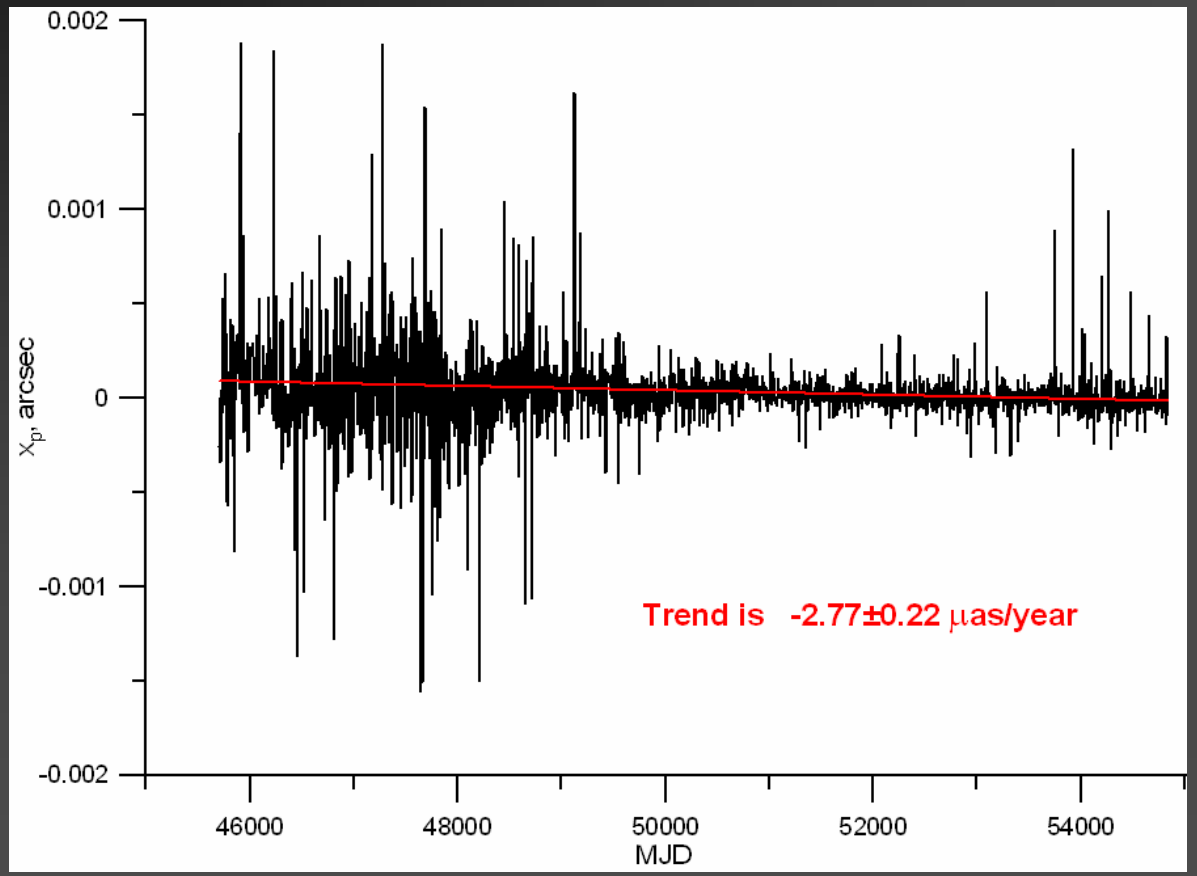
$$\Delta\theta_1 = \frac{r_1}{D} = \frac{kf_1^{-1}}{D}; \Delta\theta_2 = \frac{r_2}{D} = \frac{kf_2^{-1}}{D}$$

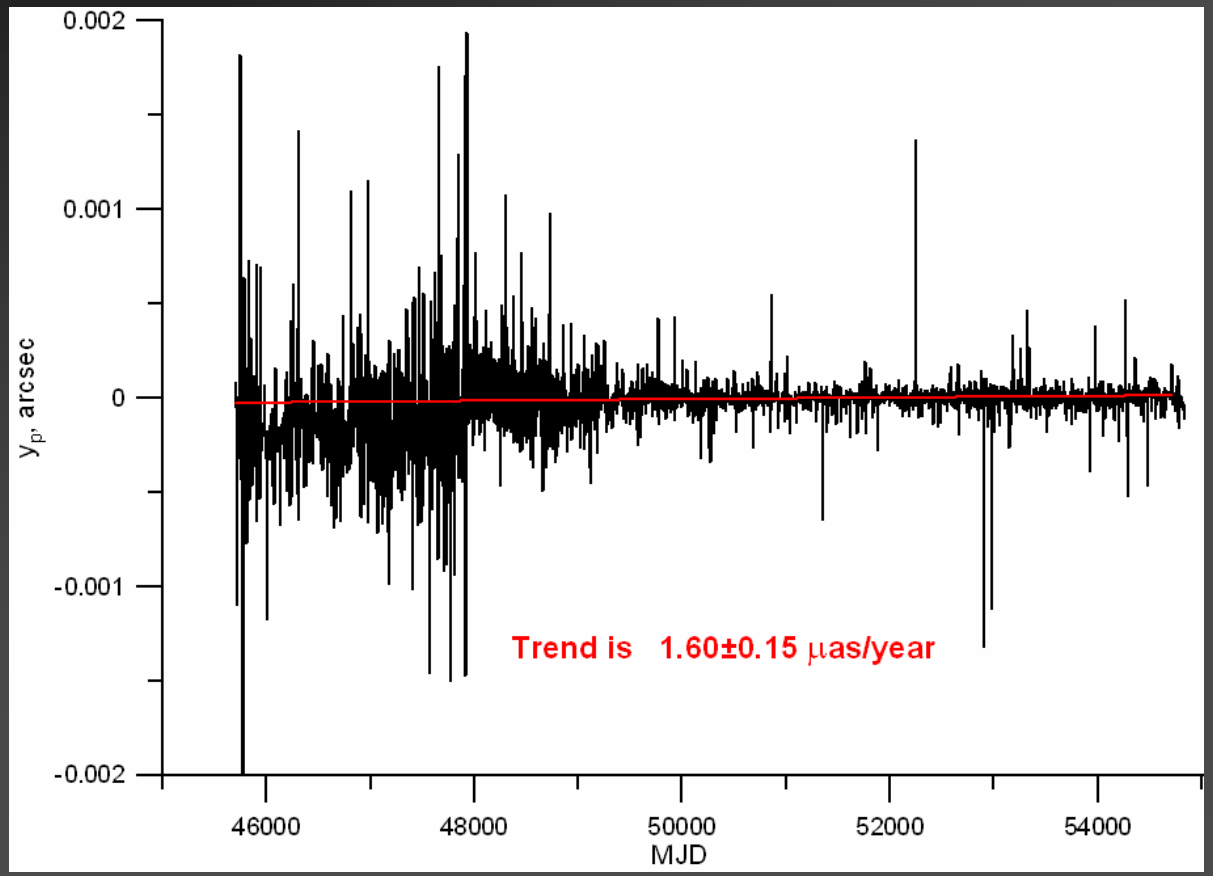
$$\tau_1 - \tau_2 = \frac{B\sin\theta}{c}\frac{k}{D}\left(\frac{1}{f_2} - \frac{1}{f_1}\right)$$

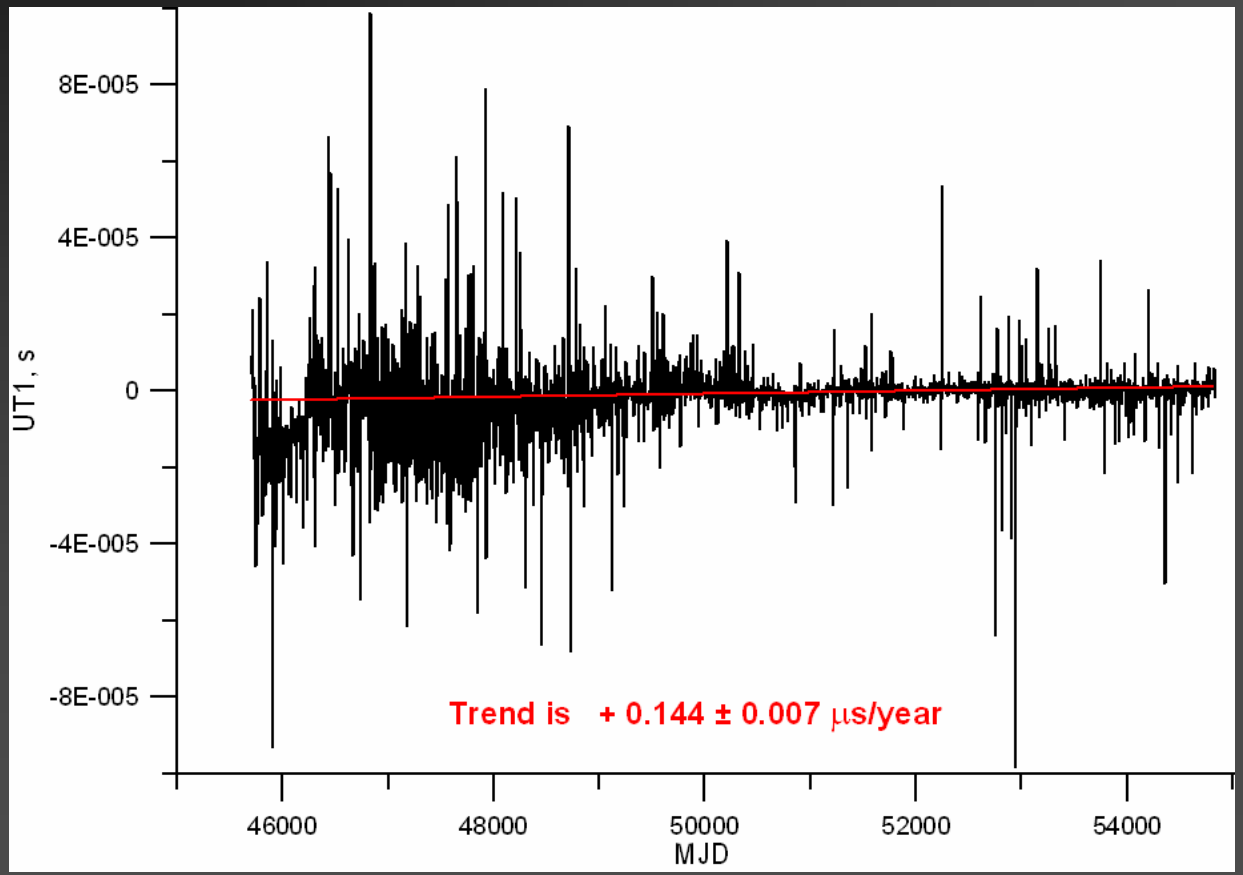


G. E. Lanyi et al. THE CELESTIAL REFERENCE FRAME AT 24 AND 43 GHz. I. ASTROMETRY The Astronomical Journal, 139:1695–1712, 2010

Variations of the EOP due to rotation of the ICRF



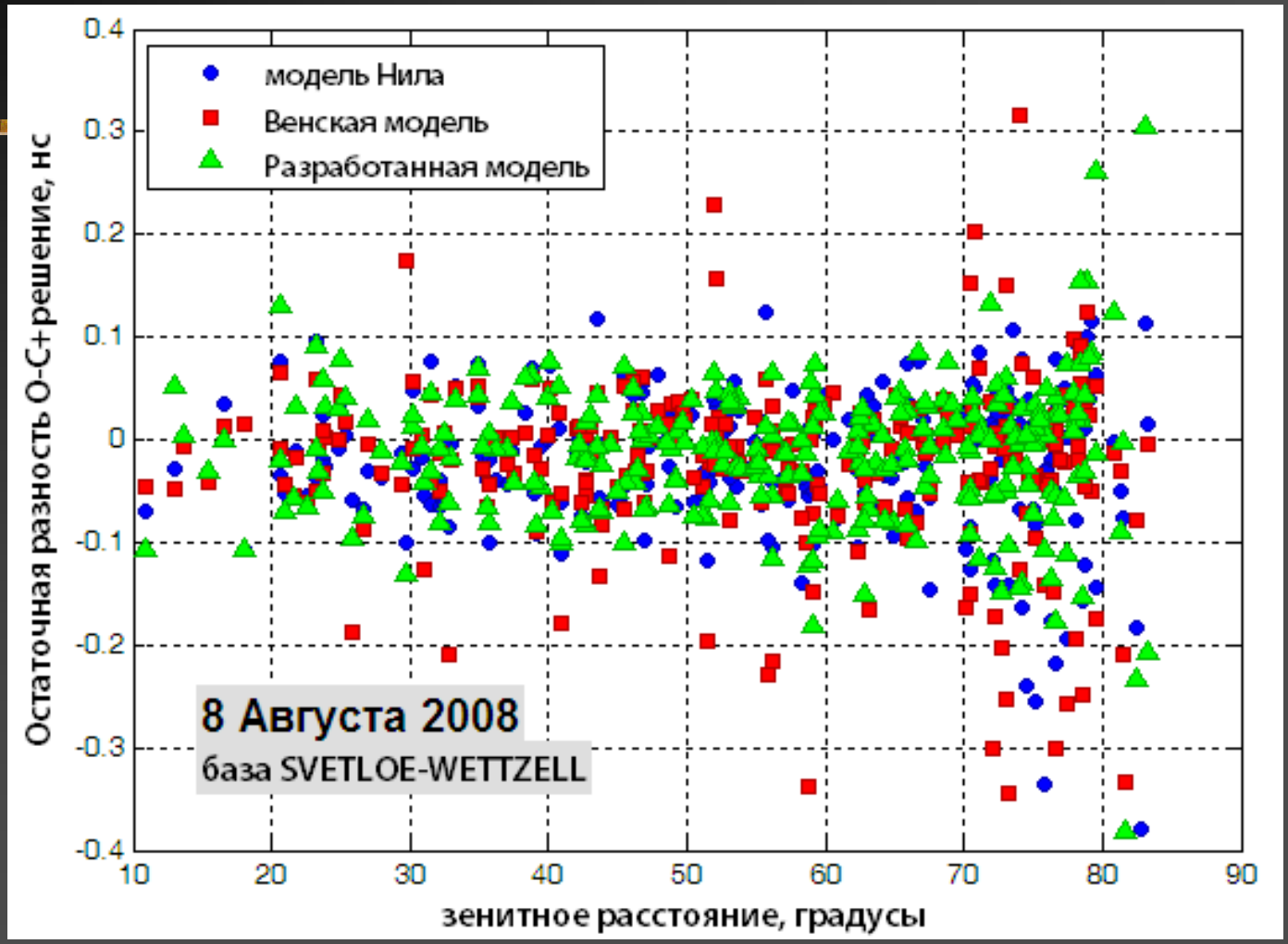

0.002
0.001
0
-0.001
-0.002
y_p, arcsec
46000
48000
50000
52000
54000
MJD
Trend is 1.60±0.15 μas/year


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

Improvement of delay model

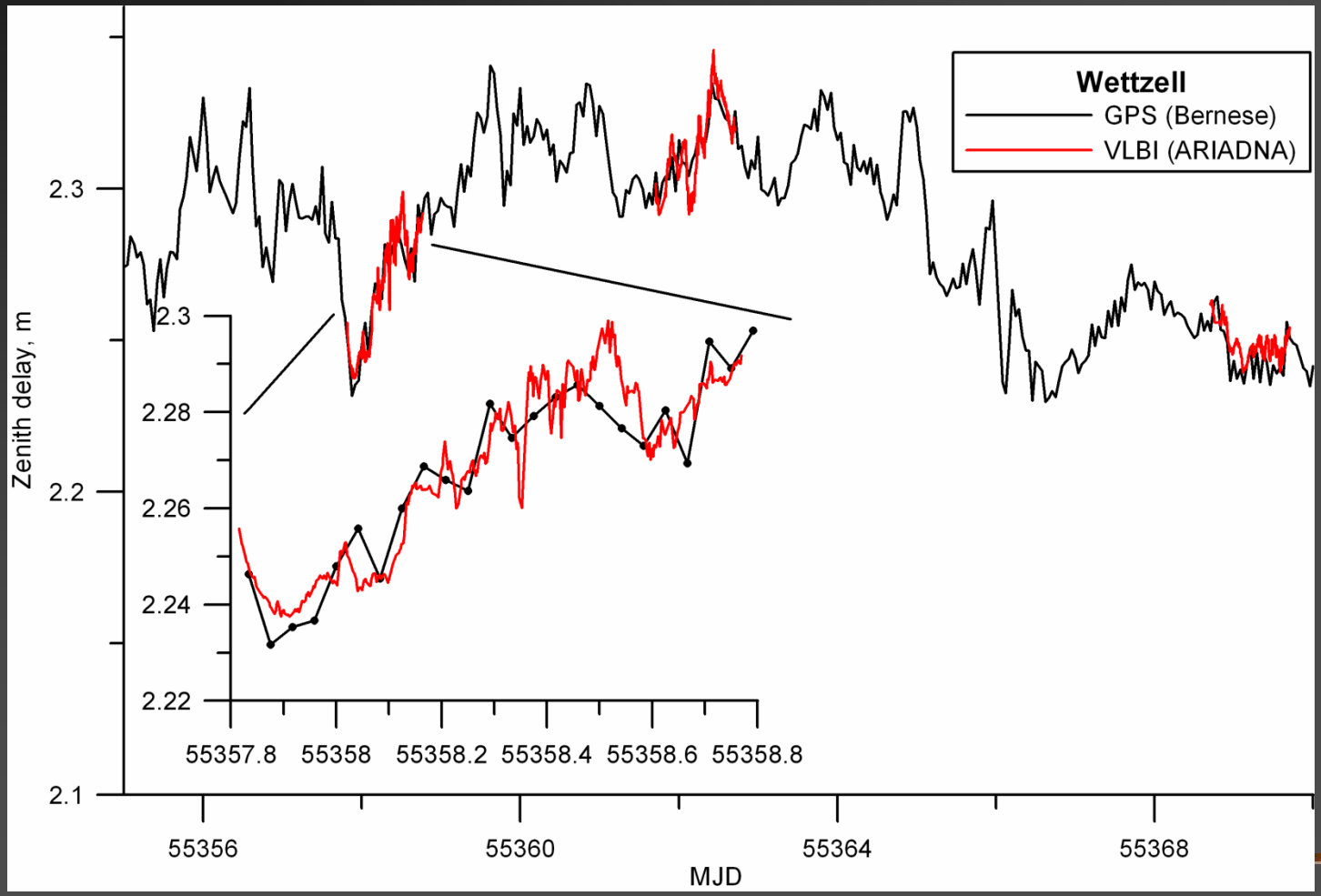
- 3-D troposphere modeling
- Tropospheric delay from GPS

3-D troposphere modeling



from D.Duev thesis (2012)

Tropospheric correction from GPS measurements ($\sigma \approx 2$ mm)



Conclusion

- New time series of the EOP were obtained; they can be used for improvement of the Earth nutation theory
- New time series of the ICRF2 sources were obtained and their motions were calculated; they can be used for improvement of the ICRF2 catalog and precession constants

Thank you for attention !