JOURNÉES 2013 SYSTÈMES DE RÉFÉRENCE SPATIO-TEMPORELS

NATURAL AND SYSTEMATIC POLAR MOTION JUMPS

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OBJECTIVES

- Determination of epochs and values of small jumps of polar motion coordinates

USED DATA

- Coordinates **X** and **Y** of polar motion and their errors from:
  - The solution **OA10** for the period 1899.7-1992.0
  - The solution **C04** of IERS for the period 1962.0-2013.5
- Integrated time series of **X**, and **Y**

METHODS

- Partial Fourier approximation + Method of Least Squares;
- Time series numerical integration by trapezoid rule
- Graphical solution for linear and parabolic fits of selected data parts

RESULTS

- Value and velocity jumps of polar motion mostly during the minima of PM amplitude
- A few systematic PM jumps outside the PM minima: (1) - in 1963.8 and (2) - connected with error jumps in 1902, 1917.3, 1968, 1972, 1991.3
- Anomaly PM jump in 2008.5

Integrated time series from the solution OA10

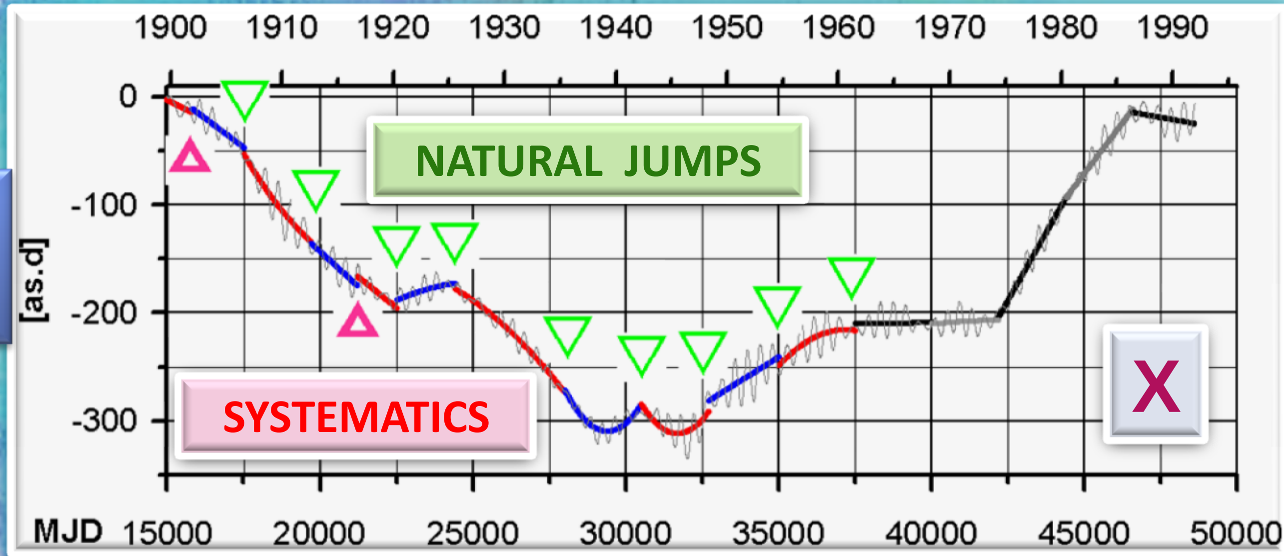
1. The integration transforms:
Constant data - to linear segment
Linear segment - to parabola

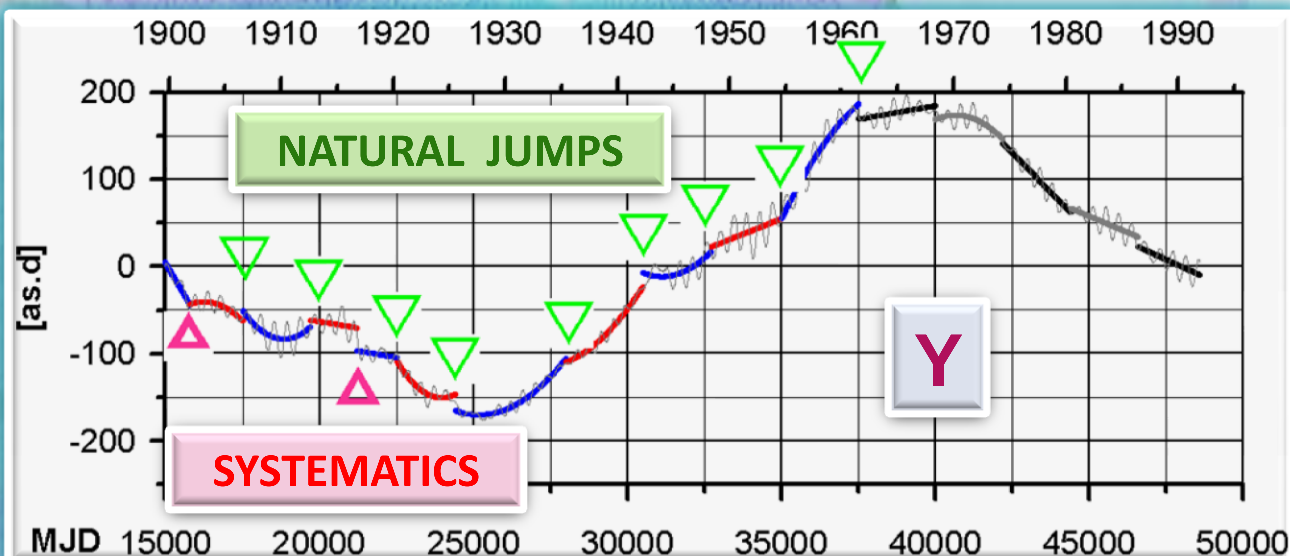
2. Selective frequency filter:
Suppress of all high-freq. oscillations
Amplification of low-freq. oscillations

3. In integrated time series:
The end epochs of linear / parabolic piecewise data parts correspond to the epochs of data jumps

I. Natural impulses:
Value and velocity jumps of polar motion during the minima of PM amplitude in 1906, 1913, 1920, 1926, 1936, 1942, 1948, 1954 and 1961

II. Systematics:
PM jumps connected with error jumps in 1902, 1917.3; outside PM amplitude minima



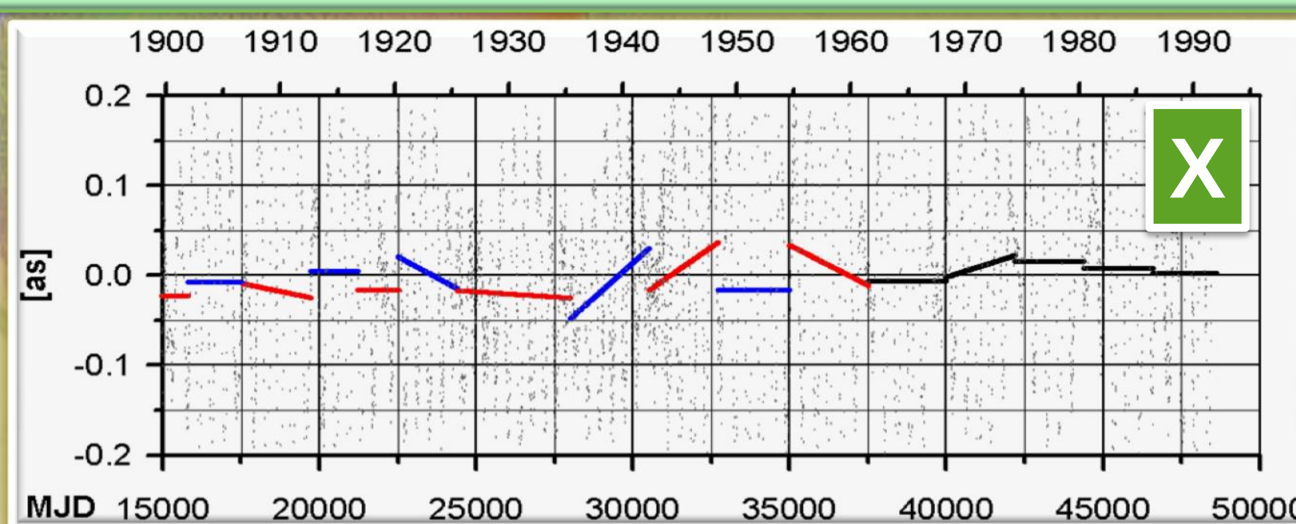


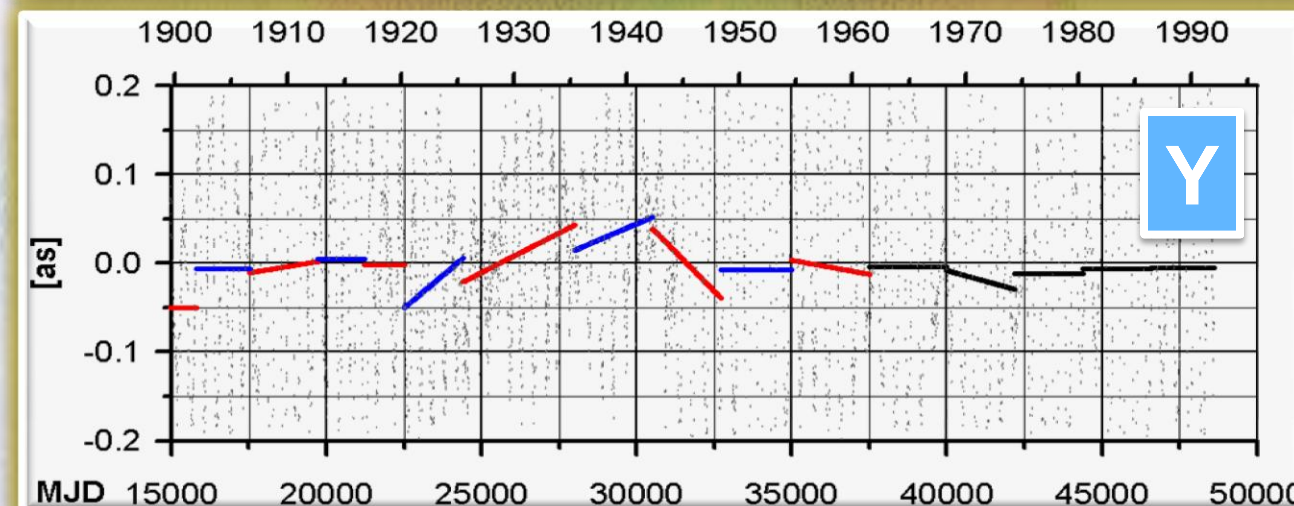
PM jumps for the period 1900 - 1962

Epoch	Dev. [mas]	Vel. [mas/a]
1899.7	-22	0
1902.0	-7	0
1906.8	-7	-2.6
1912.8	+5	0
1917.0	-16	0
1920.5	+30	-6.8
1925.8	-20	-0.8
1935.8	-50	+11.4
1942.8	-20	+8.8
1948.9	-16	0
1955.2	+35	-6.5

1899.7	-50	0
1902.0	-7	0
1906.8	-10	+2.1
1912.8	+5	0
1917.0	-2	0
1920.5	-50	10.8
1925.8	-20	+6.5
1935.8	+15	+5.4
1942.8	+40	-12.9
1948.9	-8	0
1955.2	0	-2.3

- 10 deviations from the mean zero line with values between -50, +40 mas
- 6 velocity jumps with values between -13, +12 mas/a
- At least 2 sistematics in 1902, 1917.3 outside the PM minima

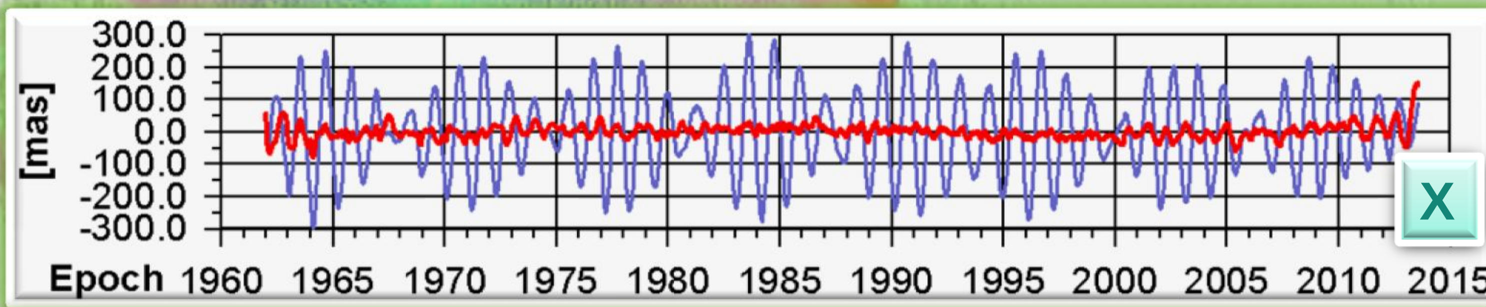


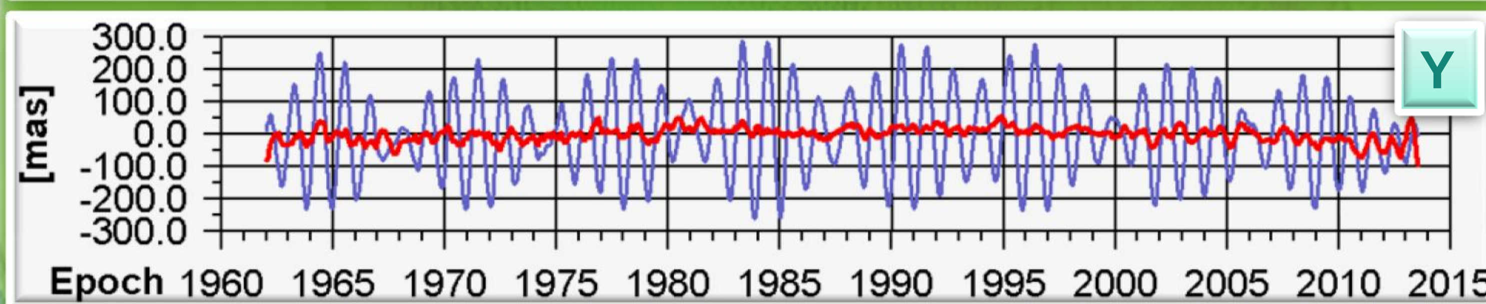


PM time series from the solution C04

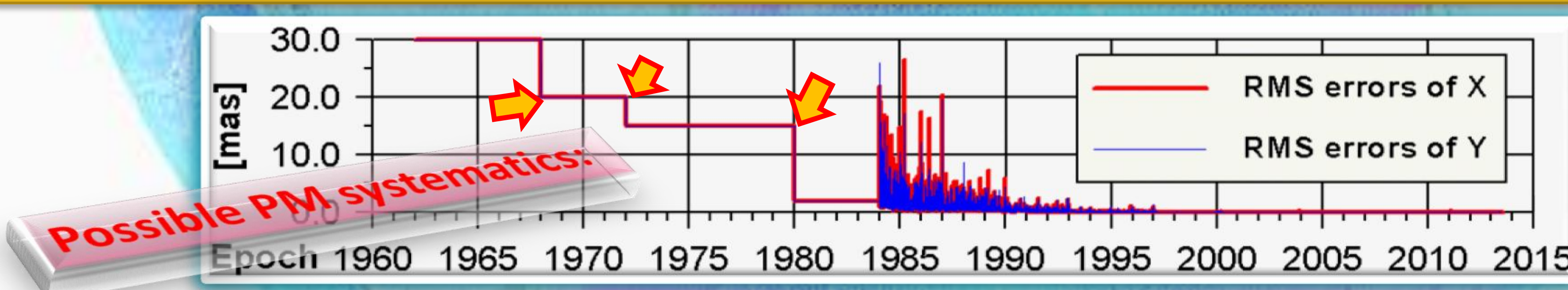
Blue lines – X and Y pole coordinates after remove the global linear fits

Red lines – PM residuals after remove all oscillations from annual/Chandler frequency band, determined by 16 harmonics of partial Fourier approximation with periods between 0.97-1.36a





RMS errors of PM data. Significant changes in 1968.0, 1972.0, 1980.0, 1984.0 and 1993.

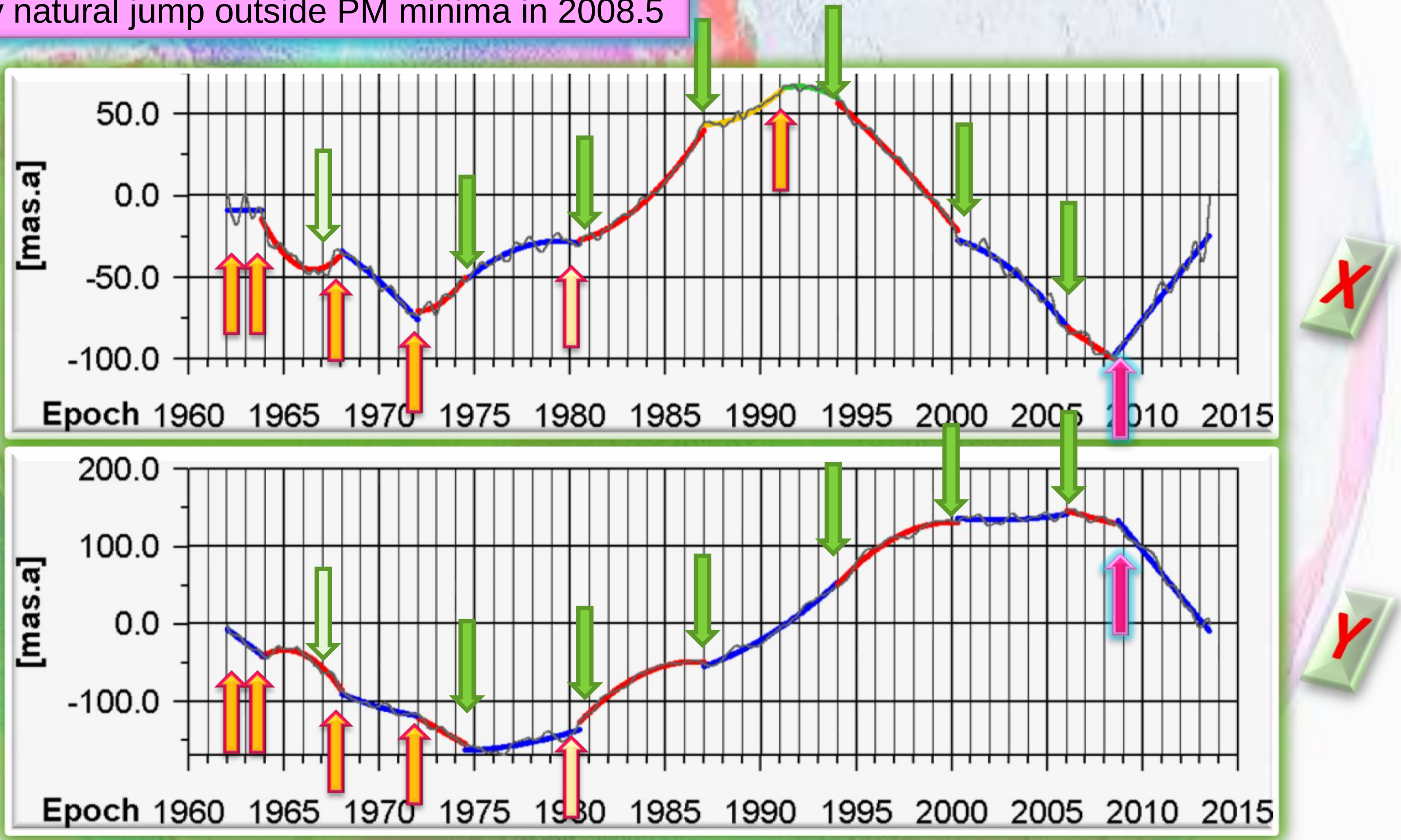


Integrated time series of PM residuals from the solution C04

6 natural jumps during PM minima – in 1974.5, 1980.5, 1987, 1994.1, 2000.3 and 2006; plus 1968?

5 sistematics in 1962.0, 1963.8, 1968, 1972, 1991.2 (X only); plus eventually in 1980

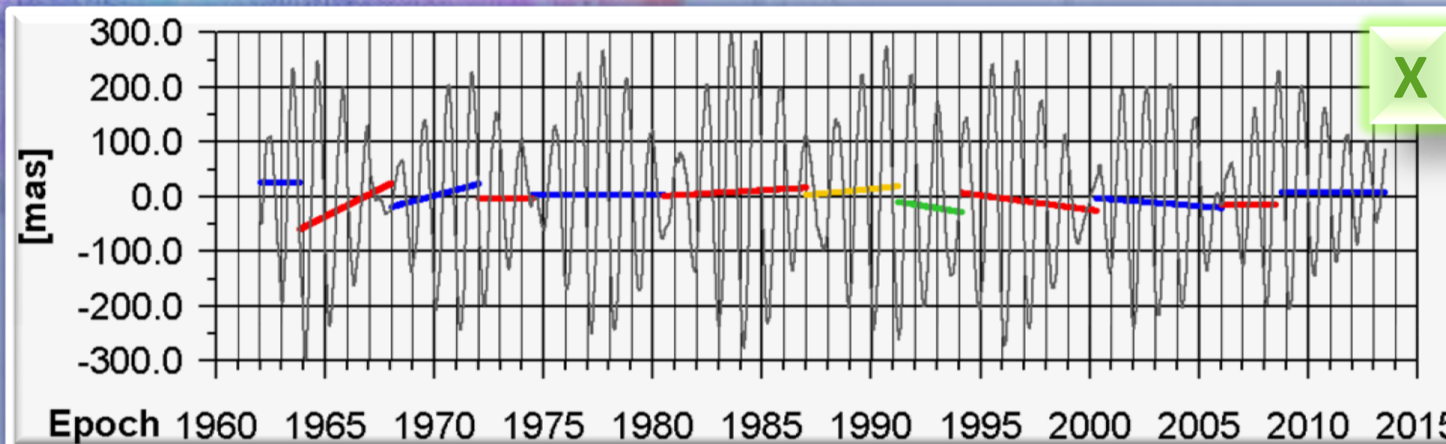
Anomaly natural jump outside PM minima in 2008.5

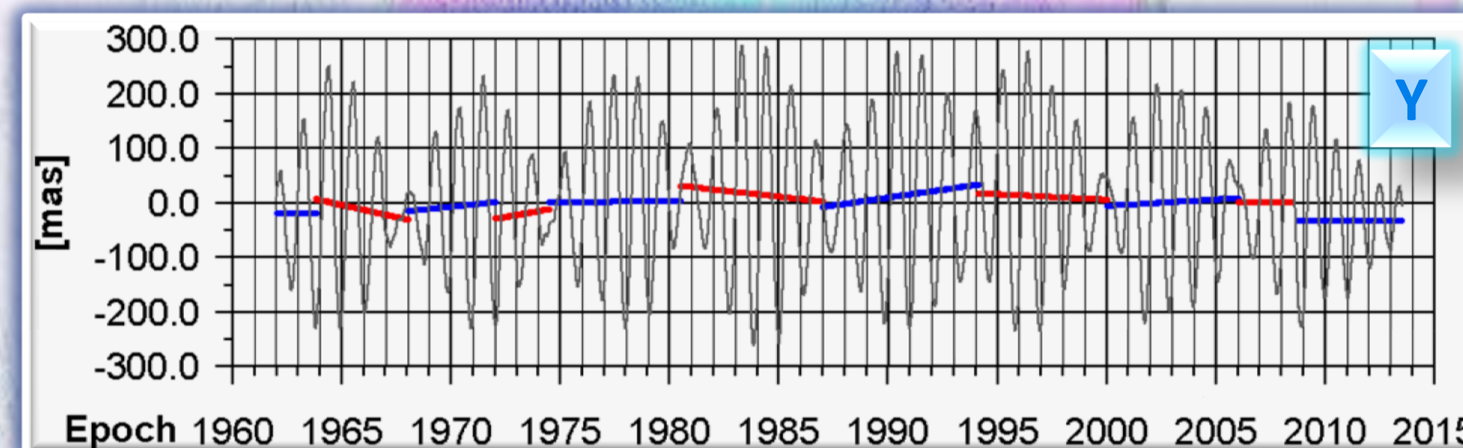


PM jumps for the period 1962 - 2013

Epoch	Dev. [mas]	Vel. [mas/a]
1962.0	+27 .3	0
1963.8	-59.0	+20.0
1968.0	-18.0	+10.5
1972.0	-3.7	0
1974.5	+3.2	0
1980.5	+1.8	+2.3
1987.0	+3.2	+3.8
1991.2	-8.5	-6.6
1994.1	+7.5	-5.2
2000.3	-2.1	-3.1
2006.0	-14.6	0
2008.5	+8.4	0
1962.0	-17.4	0
1963.8	+7.4	-9.0
1968.0	-14.6	+4.1
1972.0	-28.8	+7.2
1974.5	+2.6	0
1980.5	+31.7	-4.4
1987.0	-6.8	+5.7
1994.1	+18.2	-2.0
2000.3	-4.9	+2.3
2006.0	+1.9	0
2008.5	-32.8	0

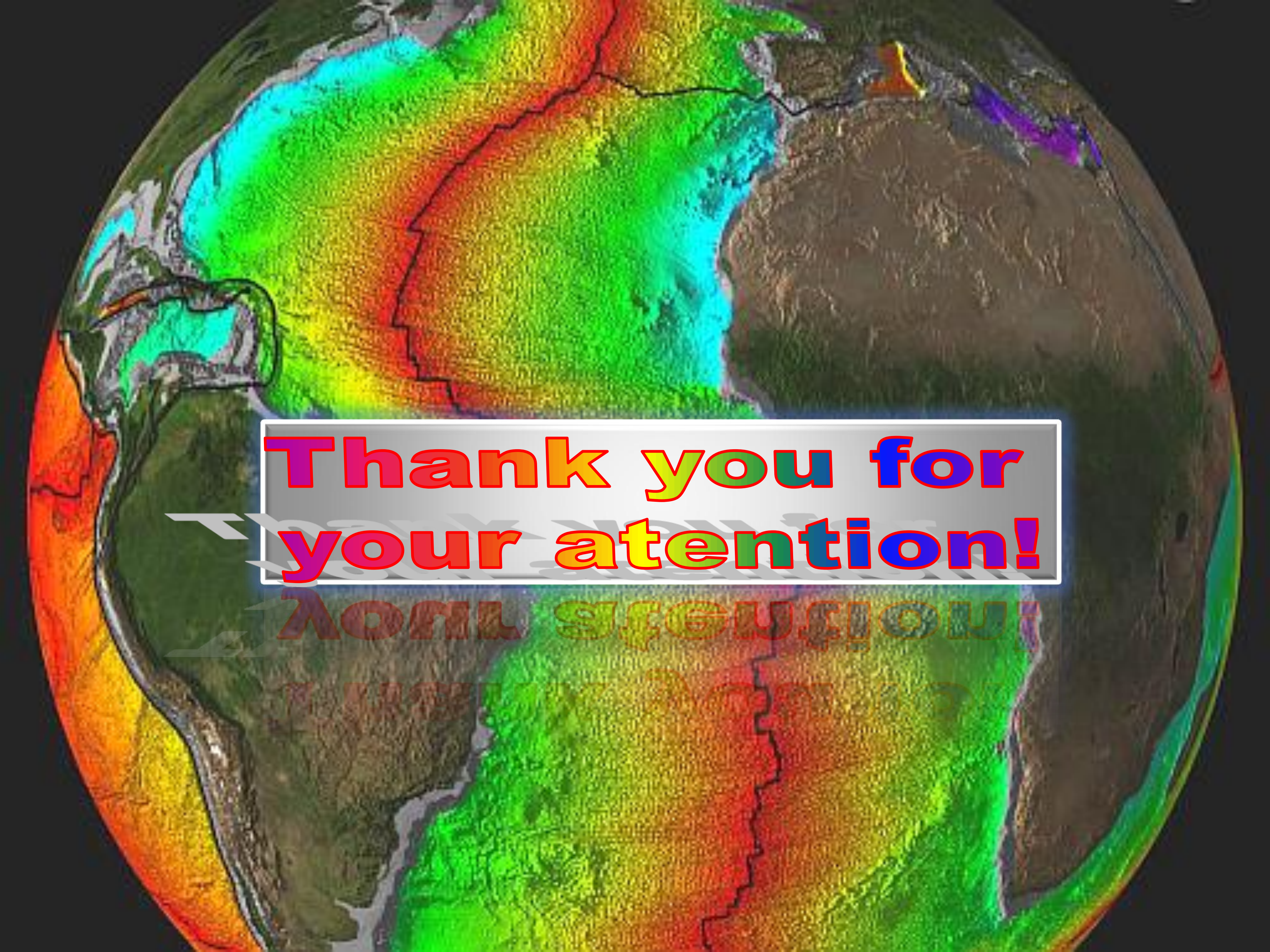
- 12 for X and 11 for Y jumps from the zero with values between:
  - -59, +27 (+32?) mas for systematic jumps;
  - -15, +18 (+32?) mas for natural impulses during the PM minima;
  - -33, +8 mas for the anomaly jump in 2008.5
- 4 velocity jumps between -5.2, +5.7 mas/a due to natural impulses





CONCLUSIONS

- The method of data and velocity jumps determination based on the linear and parabolic trends in the integrated time series is highly sensitive to any impulse behavior of the observed variations due to various geophysical processes like earthquakes, tornadoes, hurricanes, geomagnetic jerks or to some systematic data deviations.
- The method is extremely sensitive to small data jumps hidden inside the level of random noise and high frequency oscillations of the data, because the integrated time series obtain almost zeroed amplitude of high frequency elements, while the original data with mean linear or constant behavior obtain magnitude in the integrated time series as large as the time intervals of these parts.
- The most of the detected data and velocity jumps occur almost regularly in 6-year intervals during the PM amplitude minima due to seasonal and Chandler beat, so the natural origin of these jumps is supposed. Some systematics are connected with the error jumps in 1902, 1917.3, 1968, 1972, 1991.3. Anomaly PM jump occurs in 2008.5, when X increases by 8mas and Y decreases by 33mas, while during PM minima the jump magnitudes are less then 18mas and less then 6mas/a for the velocity. The 2008.5 anomaly probably prolongs the PM beat period up to 7-8 years.


Thank you for
your atention!