An Introduction to the Polar Motion

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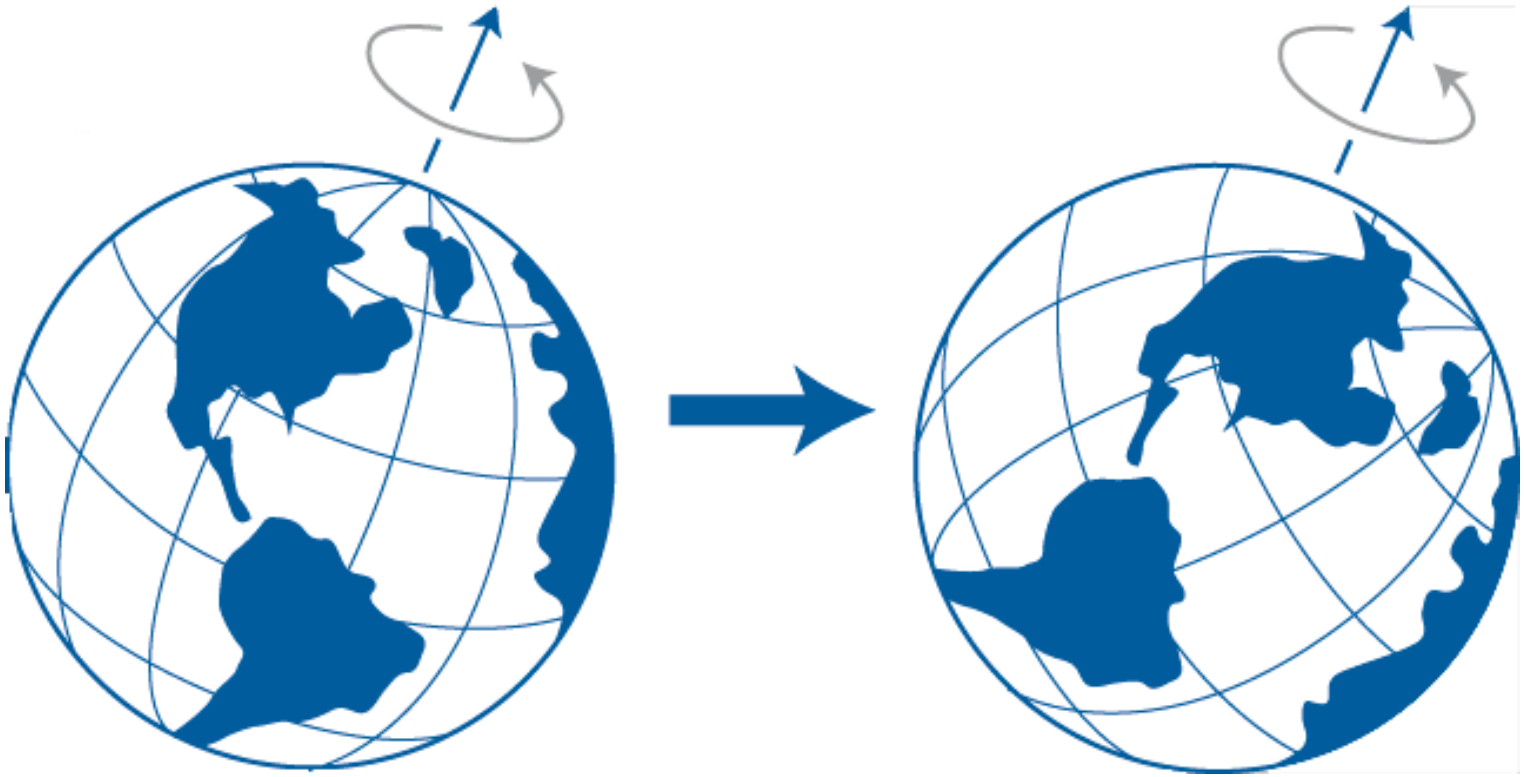
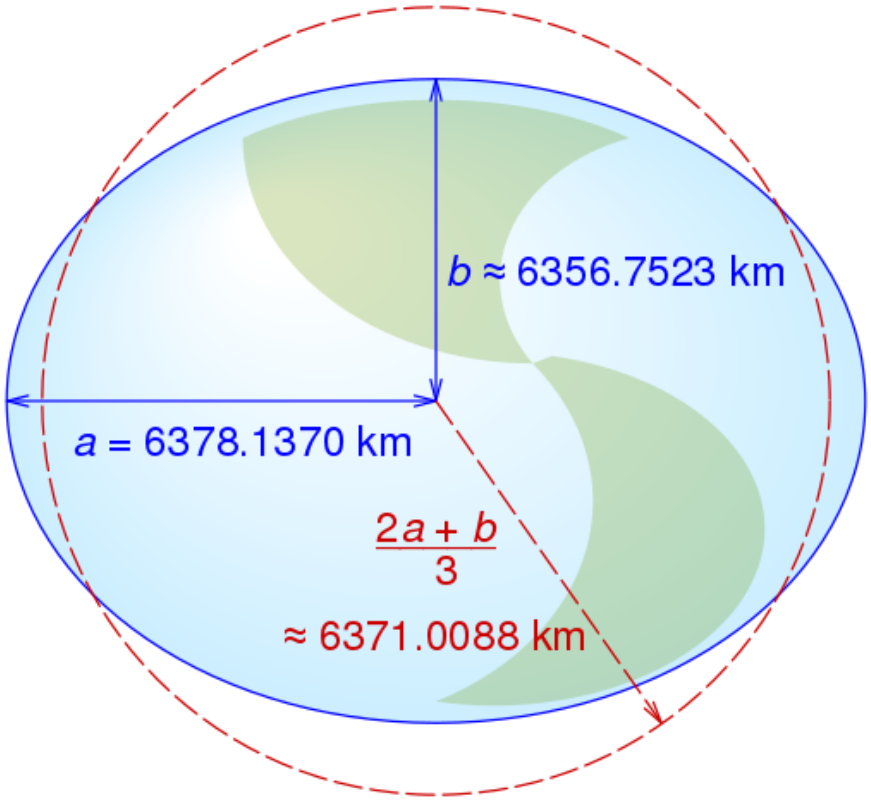
What is polar motion?



TRS in rigid body approximation



Inertia tensor of earth in TRS:

$$\mathbb{J} = \mathrm{diag}\{A, B, C\}$$

Where $A = B < C$
The ideal frame of ITRS is based on Tisserand mean axis.

3 poles of Earth

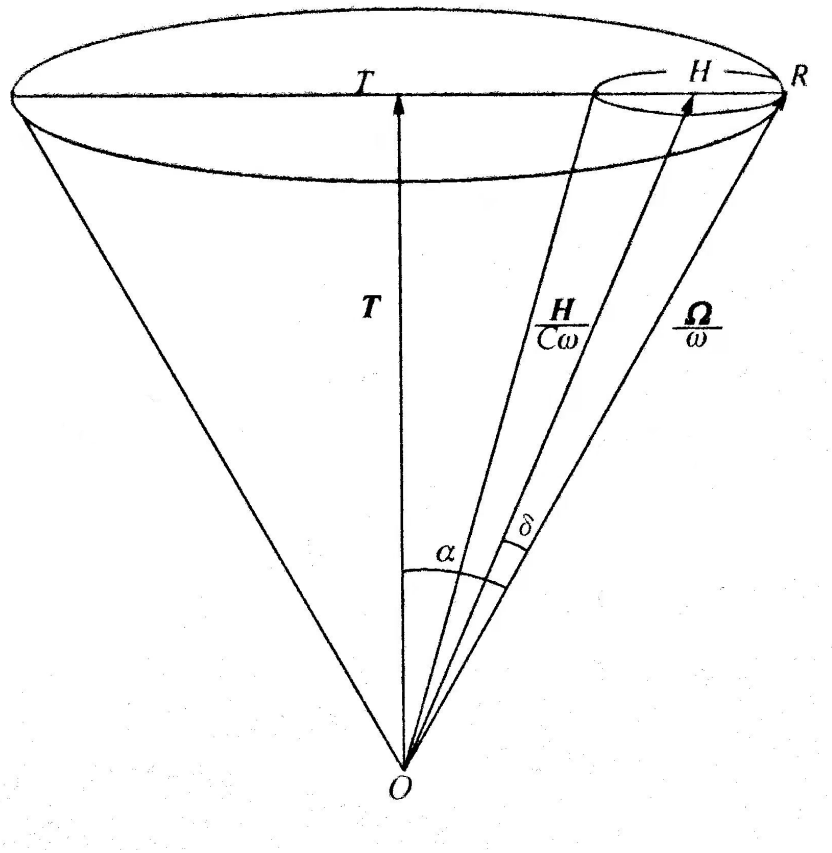


Figure: Vector cones of Earth rotation.

Where $\omega = \boldsymbol{\Omega} \cdot \boldsymbol{T}$

- T Tisserand mean pole
- H Angular momentum pole
- R Angular velocity pole of Earth

$$\alpha \approx 0.2'', \delta \approx 0.7\text{mas}$$

$$\frac{\bar{TH}}{\bar{HR}} = \frac{A}{C-A} = 304.4$$

Polar motion

The polar motion is defined as position of pole H in TRS, and we adapt a polar motion vector $\vec{\rho}$ (before H.Jeffreys,1963 & Atkinson,1975):

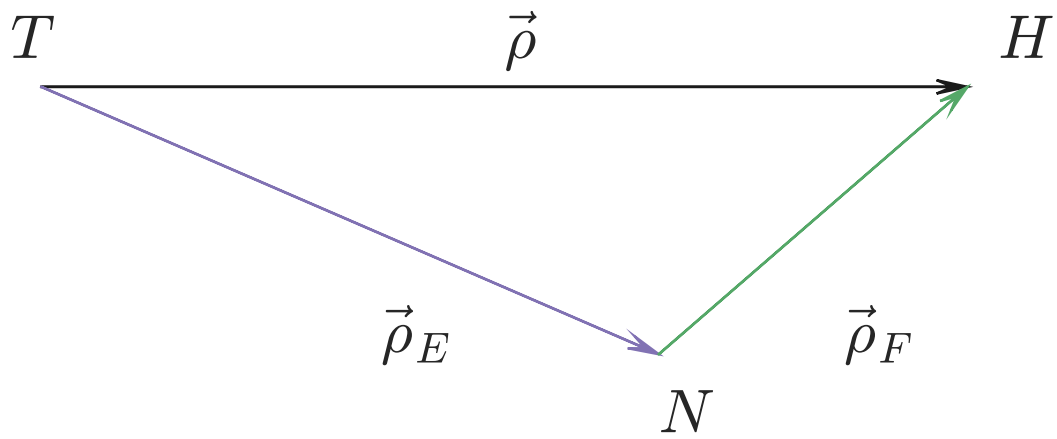


Figure: Where $\vec{\rho}$ is polar motion, $\vec{\rho}_E$ is free component while $\vec{\rho}_F$ forced component, N is the CIP

polar motion of CIP in ITRS

- **Euler period** (Assume that Earth is a rigid body):

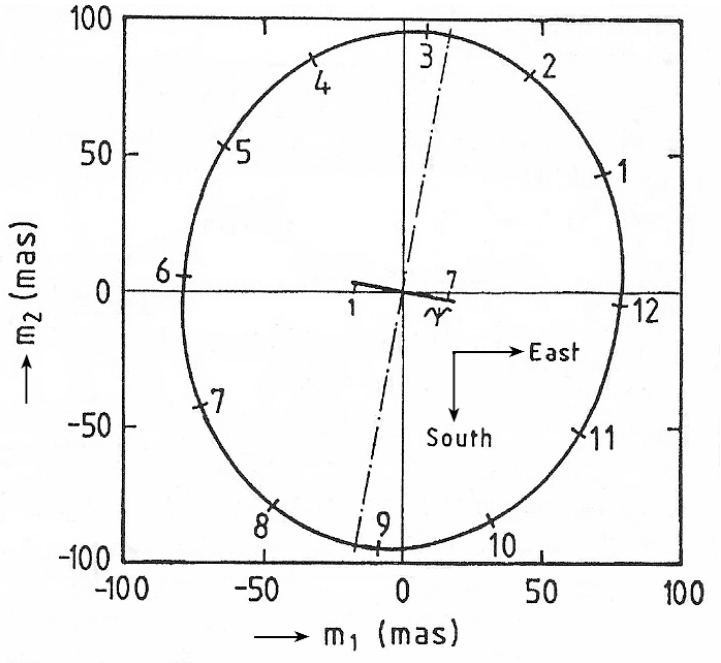
$$\frac{2\pi}{\omega}\frac{A}{C-A} = 303.6d$$

  Where $\omega = \boldsymbol{\Omega} \cdot \boldsymbol{T}$

- **Chandler wobbling**:
  Period:$\tau_C = 435\mathrm{d}$ and Amplitude :$0.1" - 0.2"$
  Newcomb think it is Euler free polar motion with solid earth

Annual component

Annual component $\boldsymbol{m}$ of polar motion is a forced motion excited predominantly by atmospheric dynamics.(H.Volland,1994)



$$\boldsymbol{m} = -\frac{\nu_C B \tilde{p}}{2}\left[\frac{e^{i\ell\Omega_a(t-t_0)}}{\ell-\nu_C} - \frac{e^{-i\ell\Omega_a(t-t_0)}}{\ell+\nu_C}\right] e^{i\lambda_0}$$

Where $\nu_C = 1/\tau_C = 0.83\mathrm{yr}^{-1}$ is Chandler frequency, $B \approx 29.0\mathrm{mas/hPa}$, $t_0 = -0.07\mathrm{yr}$, $\lambda_0 = 170^\circ$

How is polar moving?

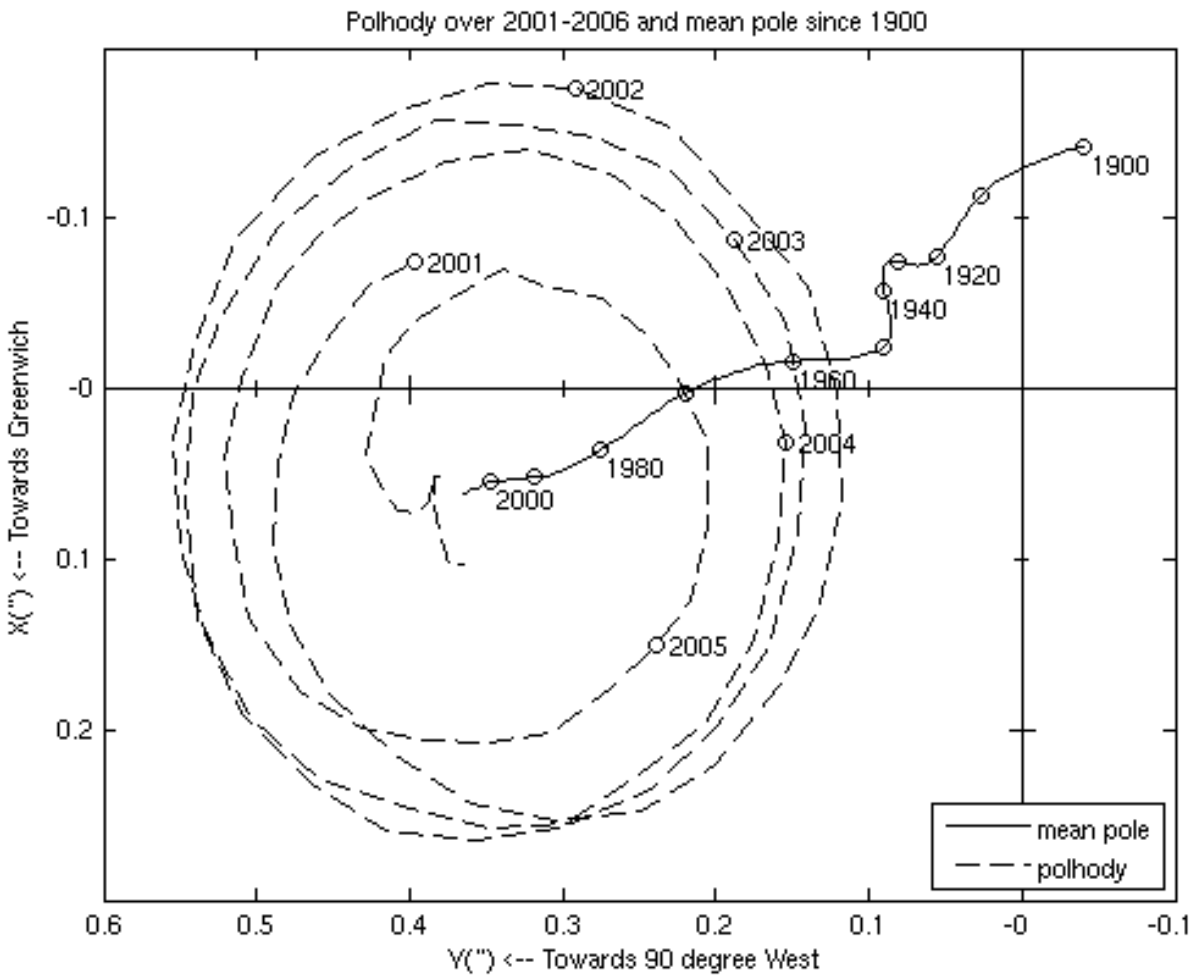
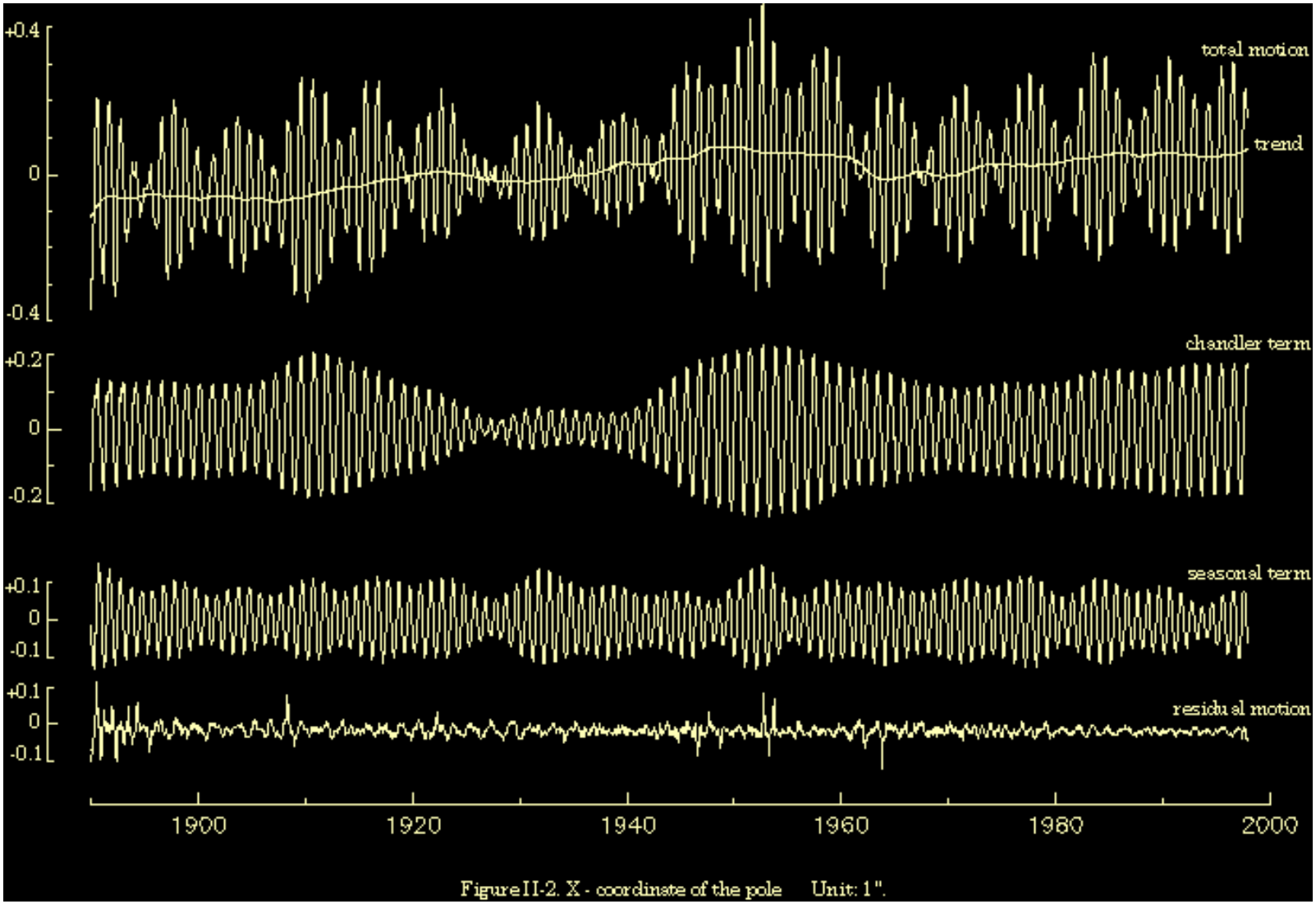
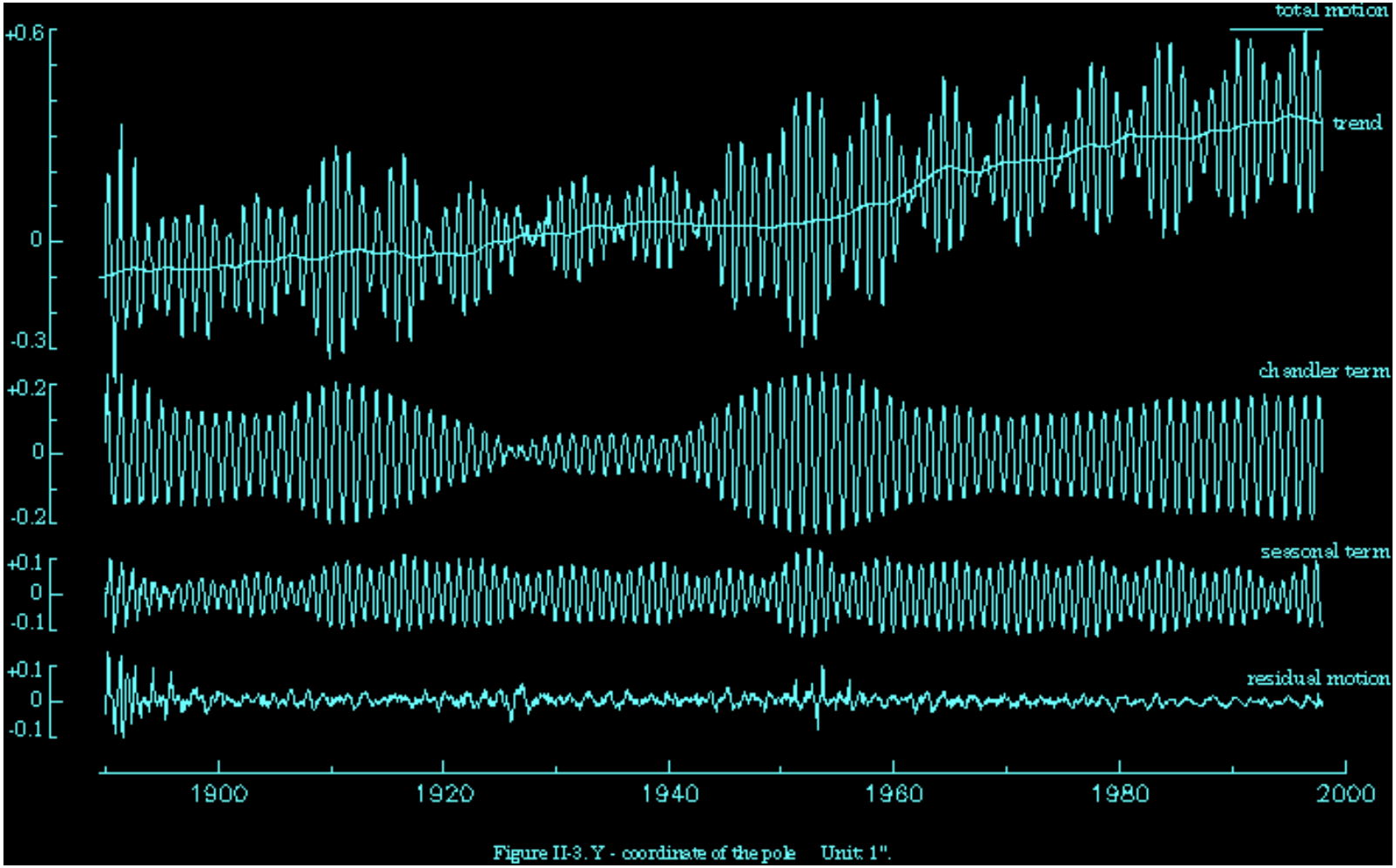


Figure: Polar motion 2001-2006 provided by the former Central Bureau 1st Jan. 2001.

X component


+0.4
0
-0.4
total motion
trend
+0.2
0
-0.2
chandler term
+0.1
0
-0.1
seasonal term
+0.1
0
-0.1
residual motion
1900
1920
1940
1960
1980
2000
Figure II-2. X - coordinate of the pole Unit: 1".

Y component


total motion
trend
chandler term
seasonal term
residual motion
+0.6
0
-0.3
+0.2
0
-0.2
+0.1
0
-0.1
+0.1
0
-0.1
1900
1920
1940
1960
1980
2000
Figure II-3.Y - coordinate of the pole Unit: 1".

THANKS FOR LISTENING!