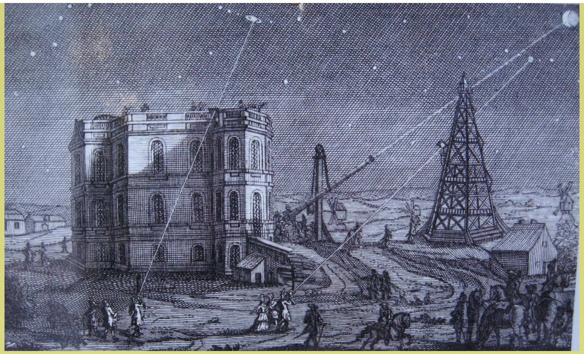

Analysis of Chandler wobble excitation, reconstructed from observations of the polar motion of the Earth

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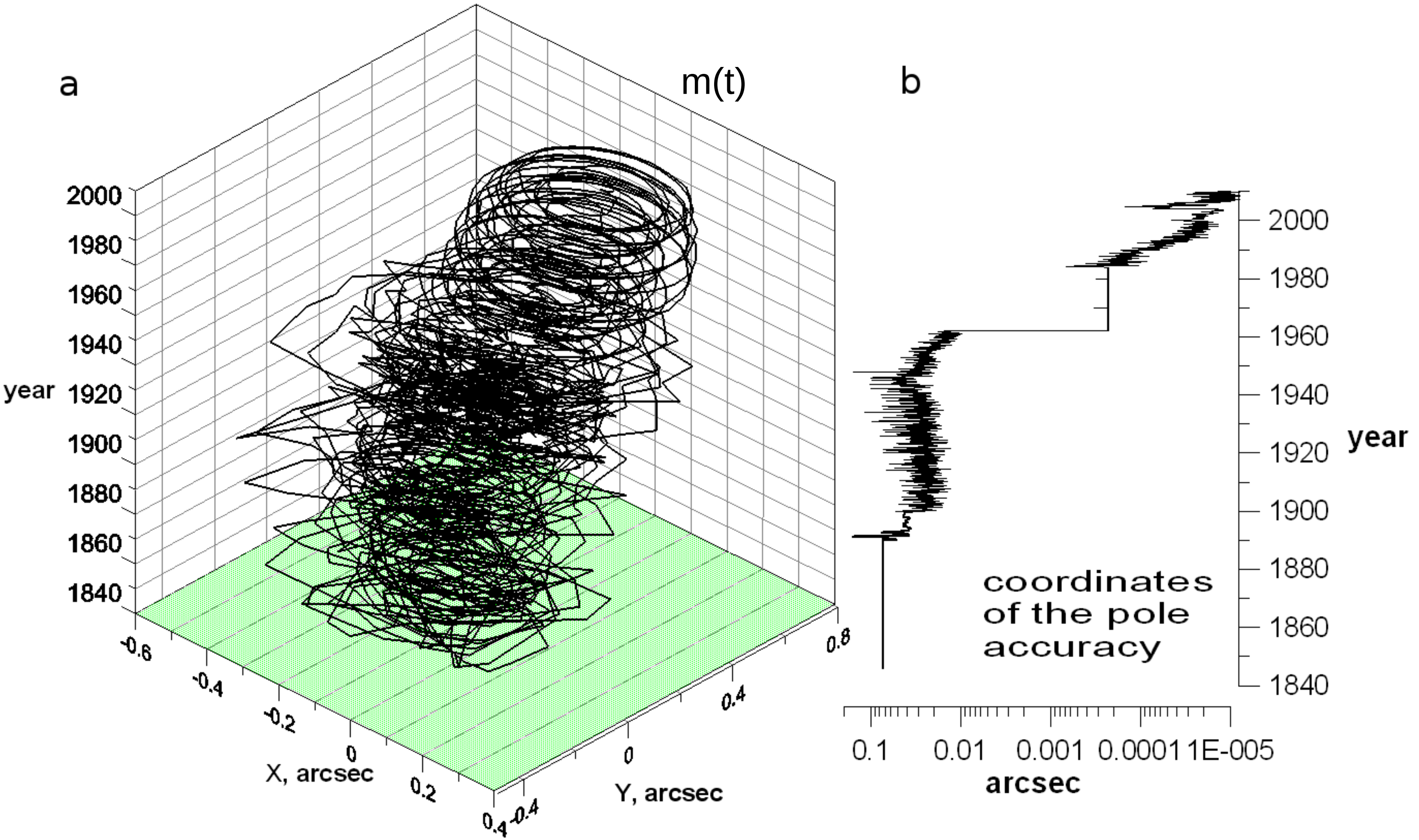
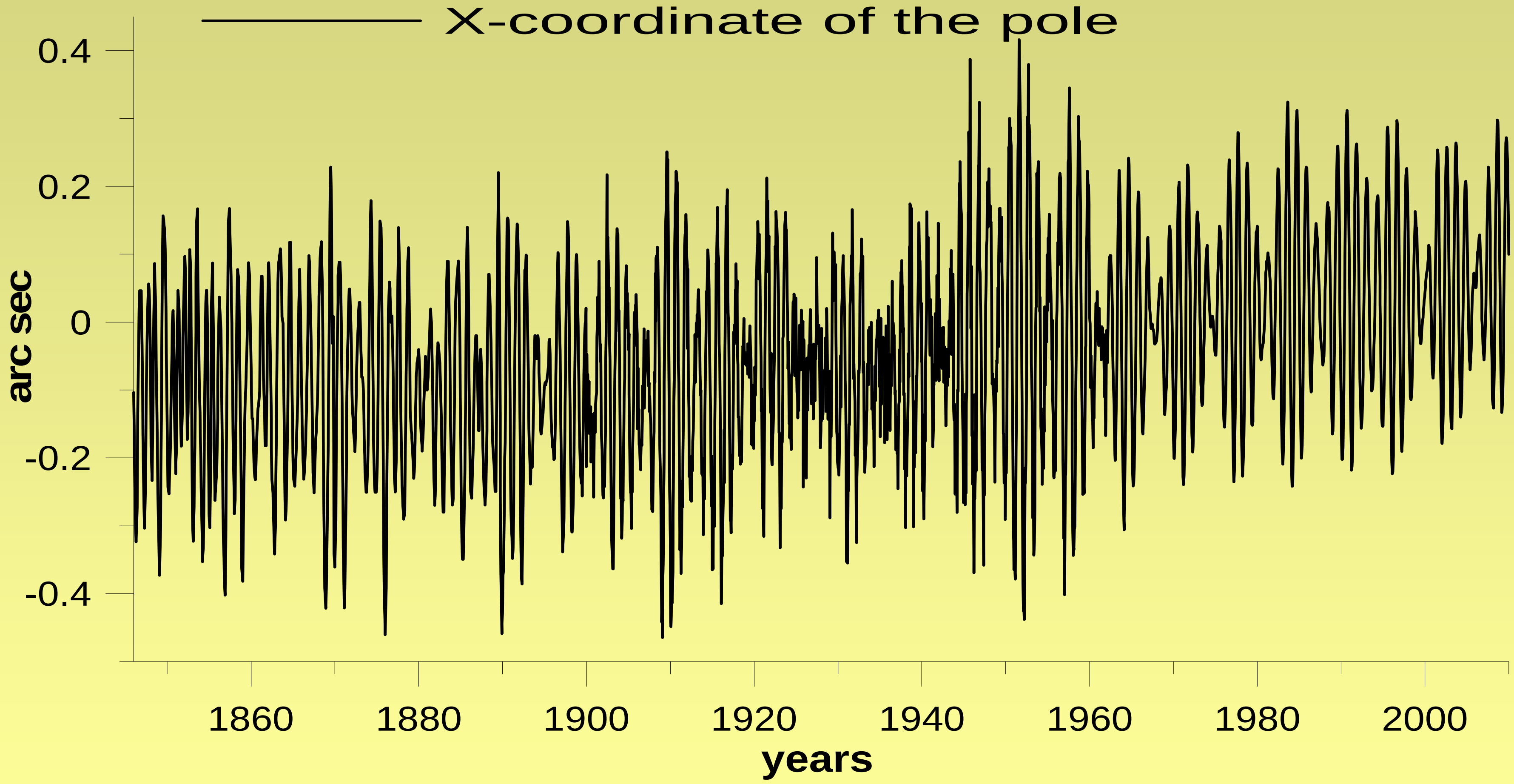
Journees 2010, September 20 – 22, 2010, Paris Observatory

Earth's pole motion from the bulletin IERS EOP C01

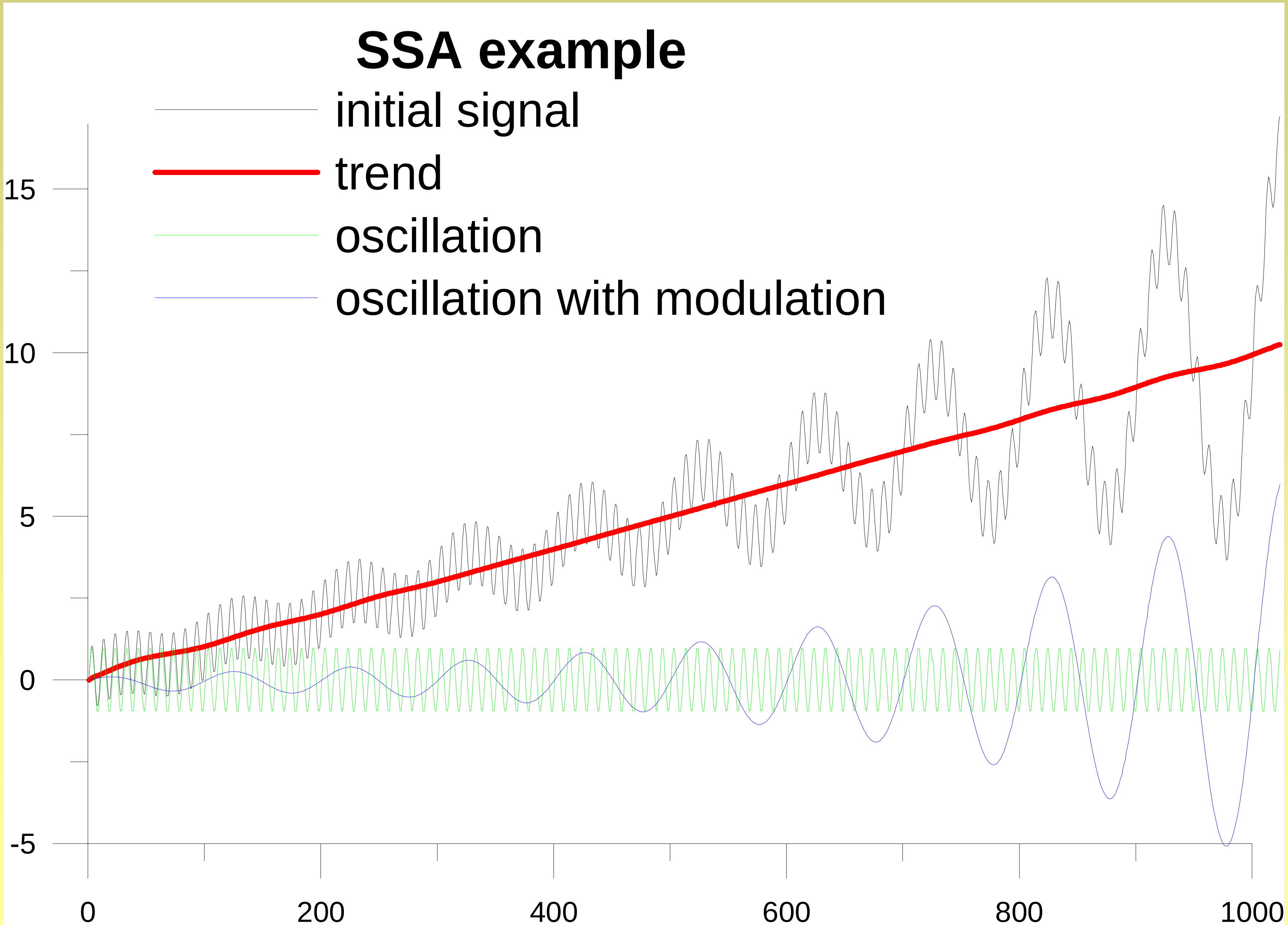
Since 1846 yr, step 0.05 yr



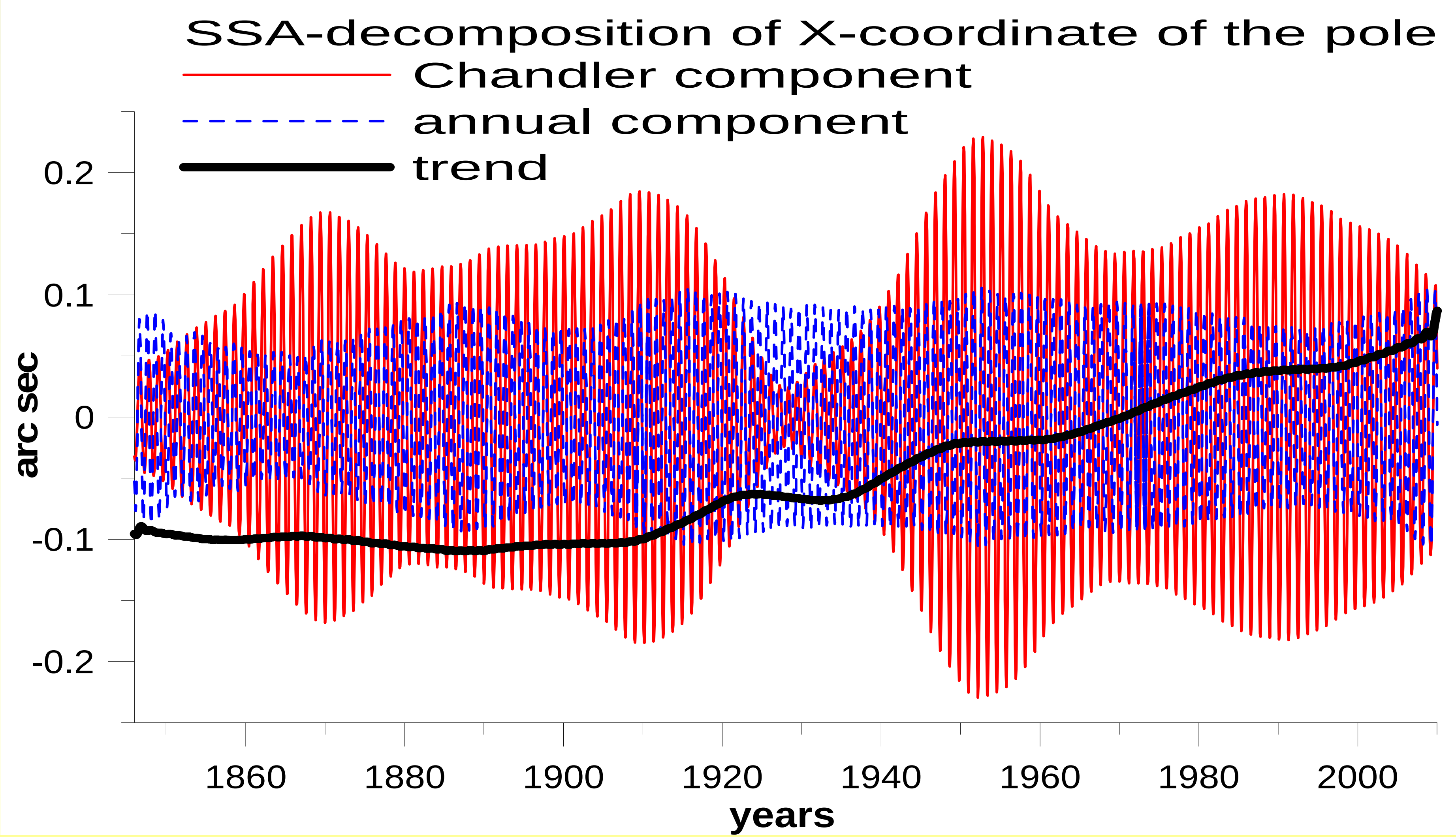
X-coordinate



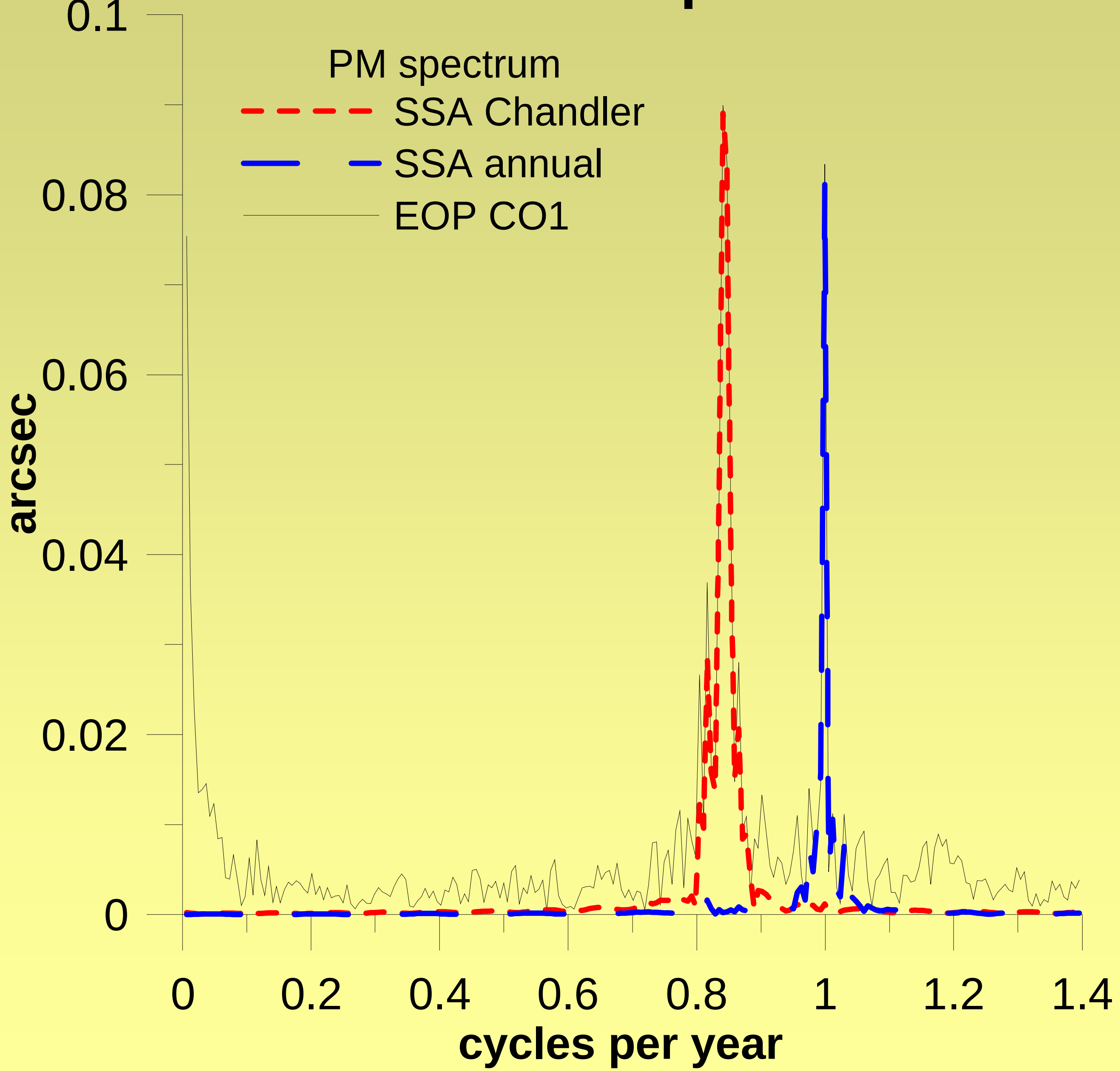
SSA method – "caterpillar"



Result of SSA of the 2-D pole coordinate time series on the example of X-coordinate



Amplitude spectrum of initial signal and SSA-components



Journées 2010 "Systèmes de référence spatio-temporels", September 20-22, 2010, Paris, France

Dynamical system of the rotating Earth

$$\frac{i}{\sigma_c}\frac{dm(t)}{dt} + m(t) = \chi(t)$$

$$\sigma_c = 2\pi f_c(1 + i/2Q)$$

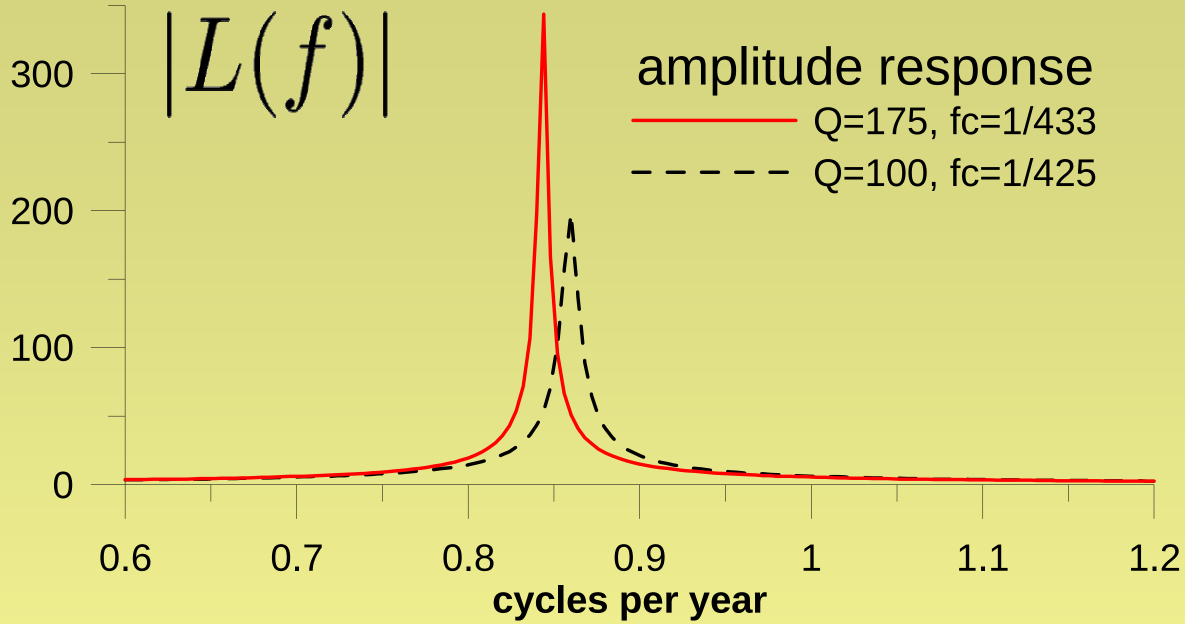
To find $\chi(t)$ - inverse problem

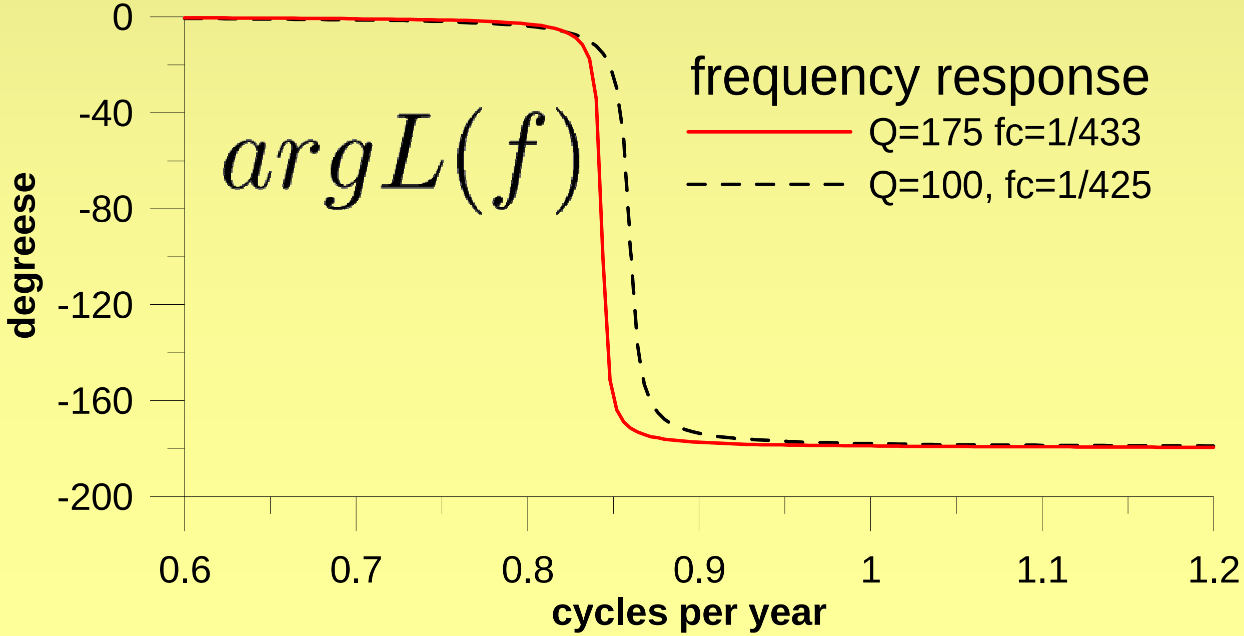
$$\hat{m}(f) = L(f)\cdot\hat{\chi}(f)$$

$$L(f) = \frac{\sigma_c}{\sigma_c - 2\pi f}$$

Parameters used $f_c = \frac{1}{433}$ days^{-1} $Q = 175$

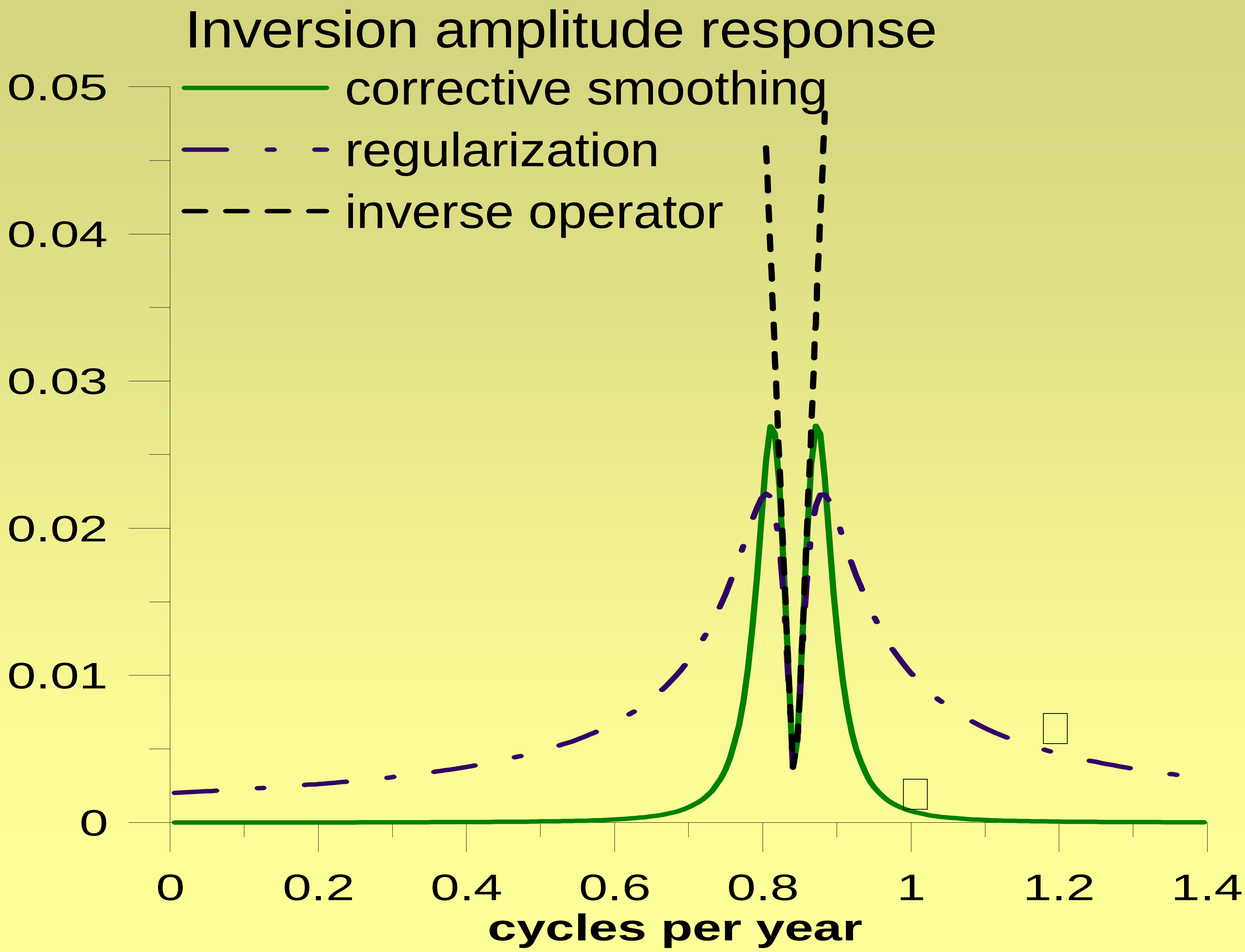
Frequency response





Journées 2010 "Systèmes de référence spatio-temporels", September 20-22, 2010, Paris, France

Amplitude frequency response of inverse operators



Journées 2010 "Systèmes de référence spatio-temporels", September 20-22, 2010, Paris, France

Wilson-Jeffreys filter

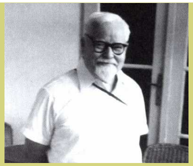
$$\chi(t) = \frac{ie^{-i\pi f_C \Delta t}}{\sigma_c \Delta t}\left[m_{t+\frac{\Delta t}{2}} - e^{i\sigma_c \Delta t} m_{t-\frac{\Delta t}{2}}\right]$$

$$m = m_X + i m_Y$$

$$m_X = \sin X \qquad m_Y = -\sin Y$$

Jeffreys H. (1940) The variation of latitude, Mon Not Roy Astr. Soc., Vol. 100, 139-155
Wilson C. (1985), Discrete polar motion equations, Geophys J. Roy. Astr. Soc., Vol. 80, 551-554

Tikhonov regularization



$$L_{reg}^{-1}(f) = \frac{L^*(f)}{L^*(f)L(f)+\alpha}$$

parameter chosen

$$\alpha = 500$$

LSA-model of the annual oscillation

	amplitude	phase for 1846.0
X-coordinate	0.088"± 0.005"	231° ± 3°
Y-coordinate	0.078"± 0.006"	148° ± 4°

Panteleev corrective smoothing

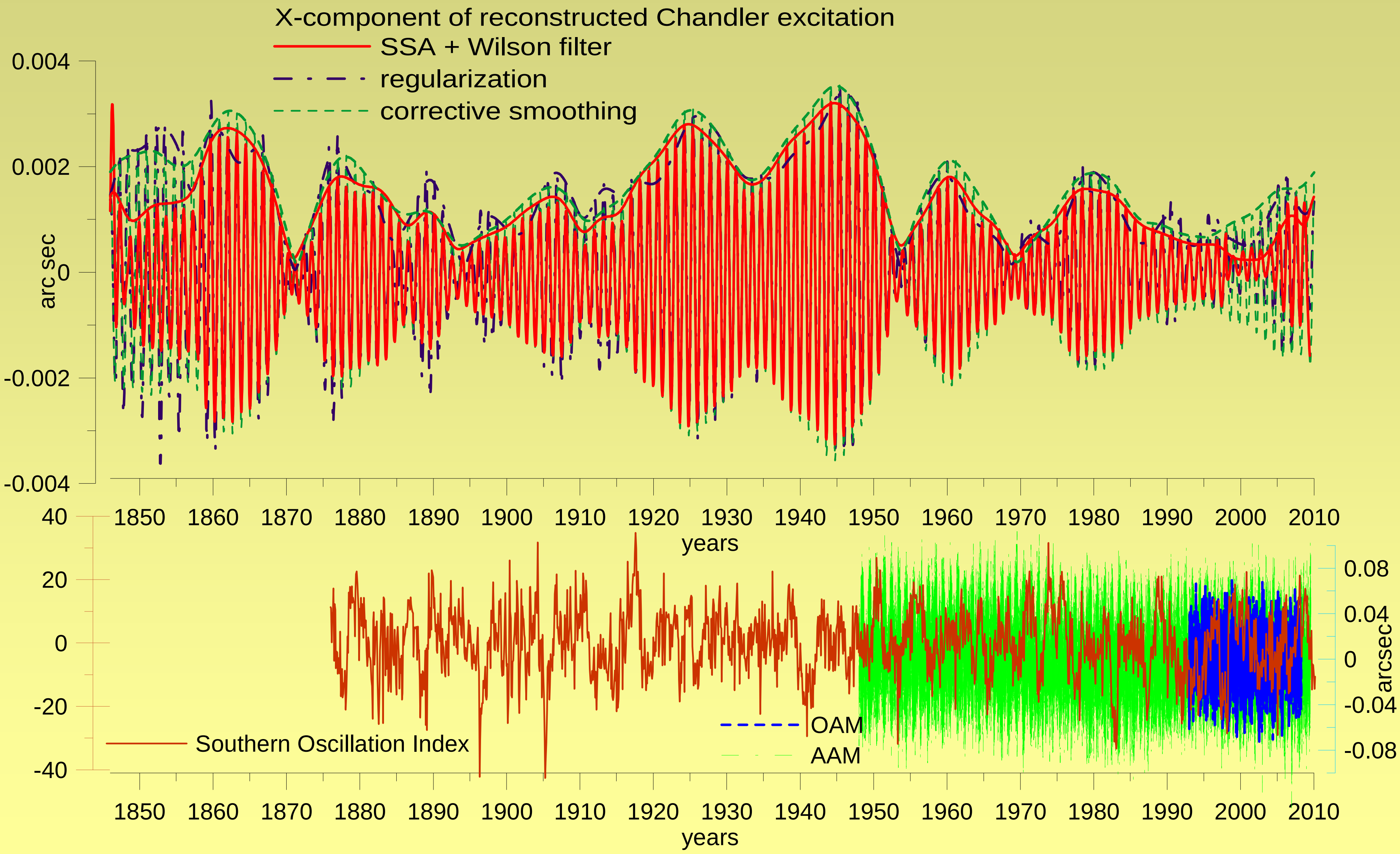
$$L_{corr}^{-1}(f) = \frac{L_{filter}(f)}{L(f)}$$

$$L_{filter}(f) = \frac{f_0^4}{(f - f_c)^4 - f_0^4}$$

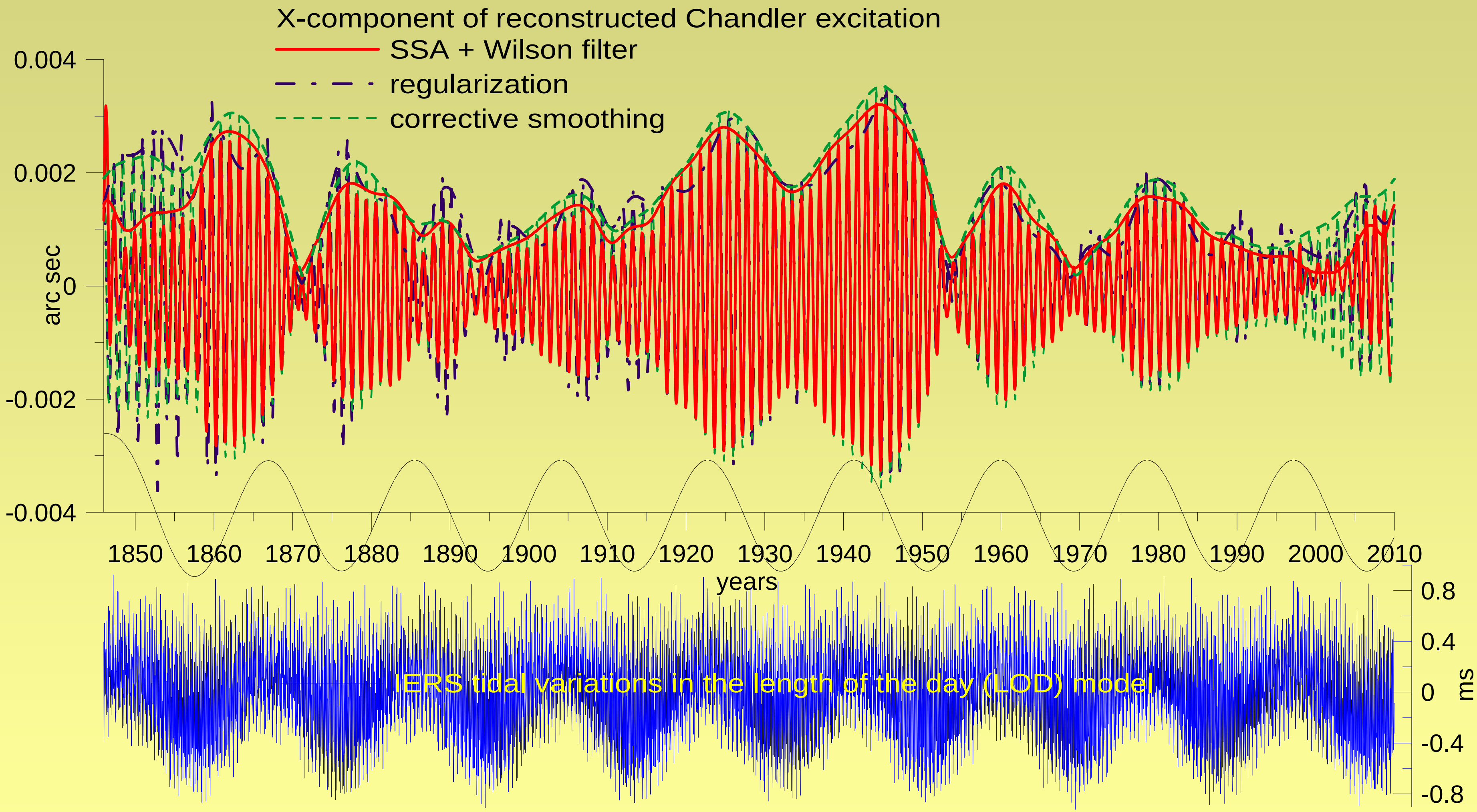
Parameter used

$$f_0 = 0.04$$

Comparison with different processes



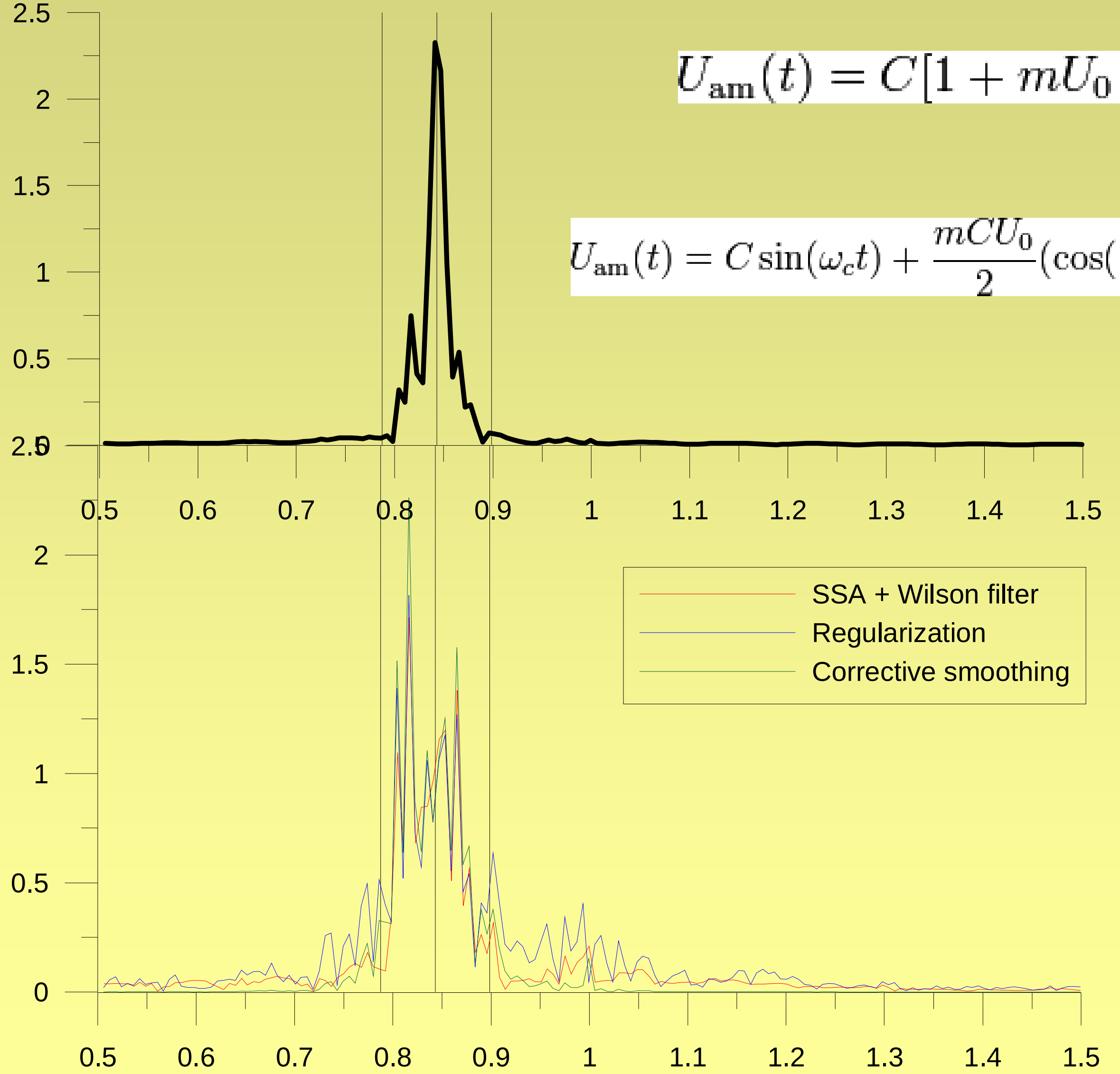
Chandler excitation and
Tidal model for the Length of day LOD



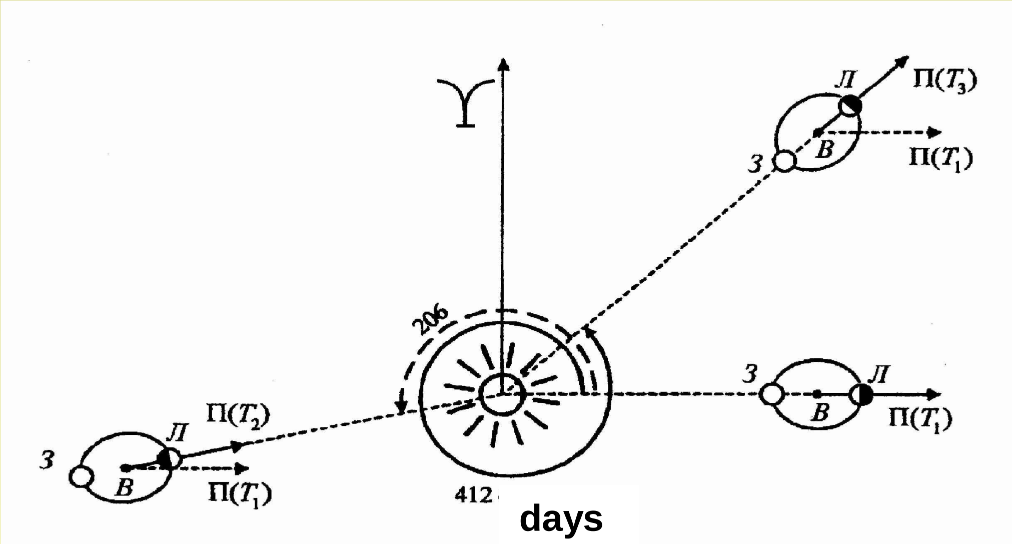
Spectrum of reconstructed excitation, amplitude modulation

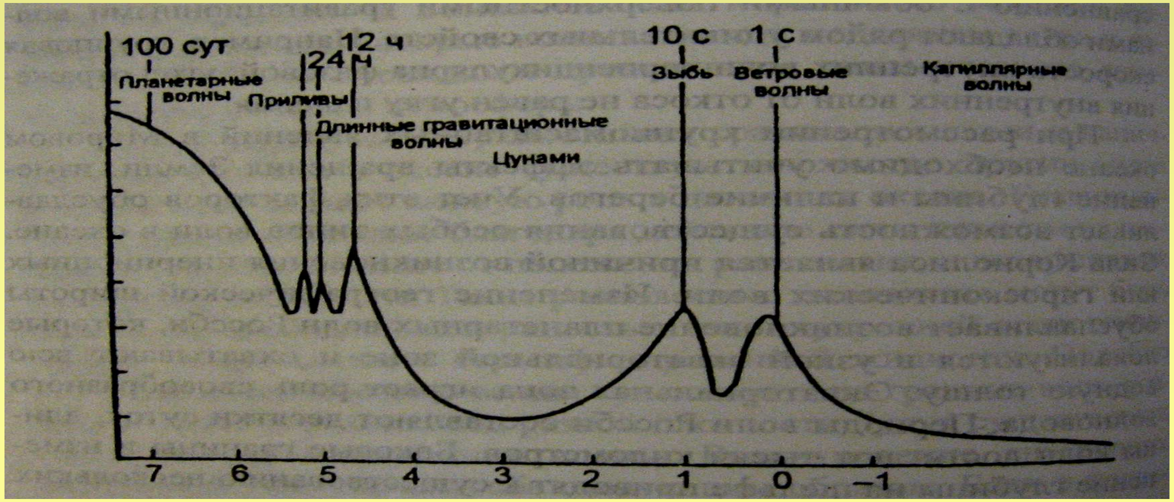
$$U_{\mathrm{am}}(t) = C[1 + mU_0 \sin(\omega_s t + \varphi)] \sin(\omega_c t).$$

$$U_{\mathrm{am}}(t) = C \sin(\omega_c t) + \frac{mCU_0}{2}(\cos((\omega_c - \omega_s)t - \varphi) - \cos((\omega_c + \omega_s)t + \varphi)).$$



Full moon in perigee repetition cycle and ocean





Avsyuk Yu. N. Tidal forces and natural processes, 1996, Moscow, Schmidt Institute of Physics of the Earth, Russian Academy of Sciences.

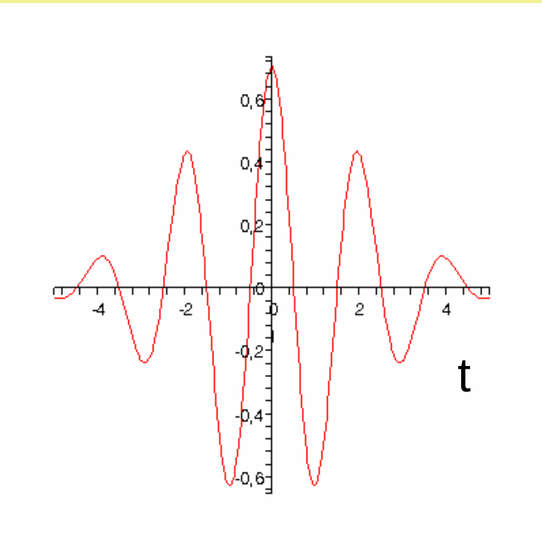
Anisimova E P., Pokazeev K.V. Introduction to physics of hydrosphere. Moscow, MSU, 2002.

Gabor window-transform

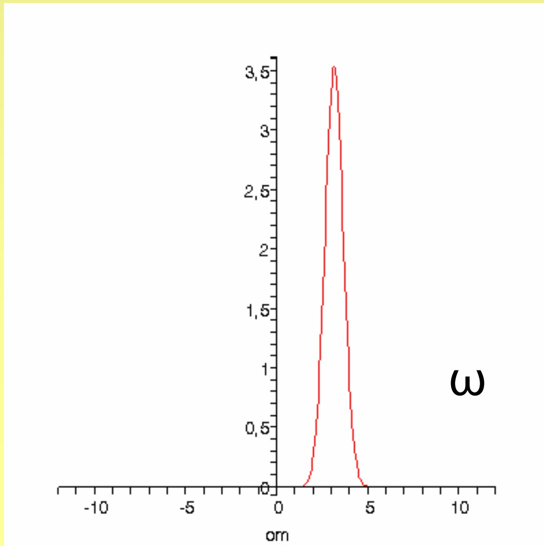
$$S_g f(\omega, t) = \int_{-\infty}^{\infty} f(\tau) g^*_{\omega,t} d\tau = \int_{-\infty}^{\infty} f(\tau) g(\tau - t) e^{-i\omega\tau} d\tau$$

$$g_{\omega,t} = g(\tau - t) e^{i\omega\tau}$$

$$S_g f(\omega_0, t) = \frac{1}{e^{i\omega_0 t}} \int_{-\infty}^{\infty} f(\tau) g(t - \tau) e^{i\omega_0 (t-\tau)} d\tau$$



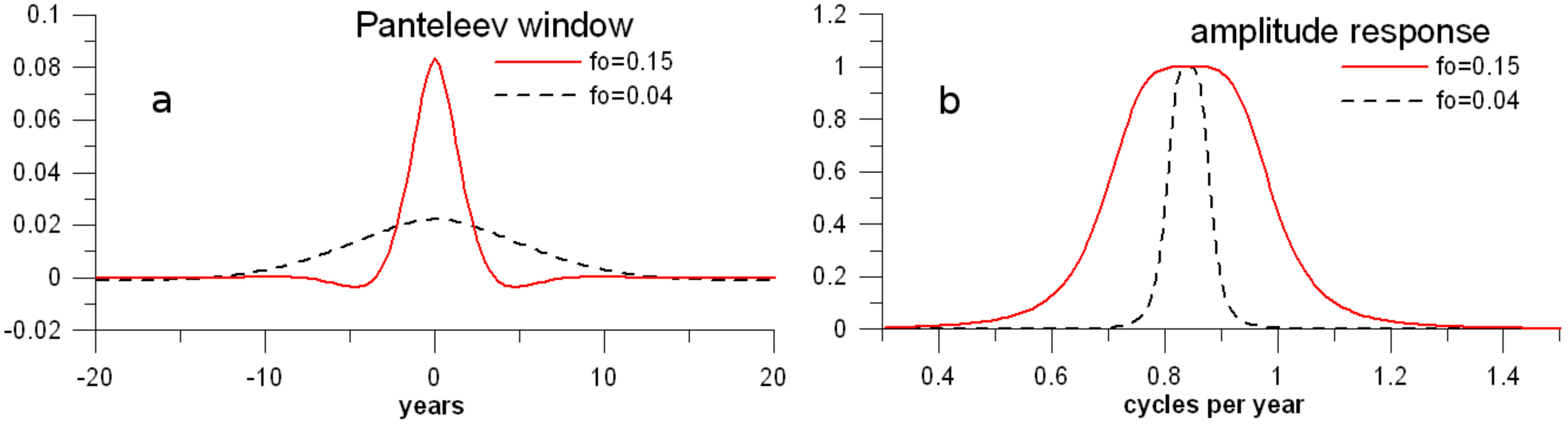
$$h_{\omega_0,t} = g(t) e^{i\omega_0 t}$$



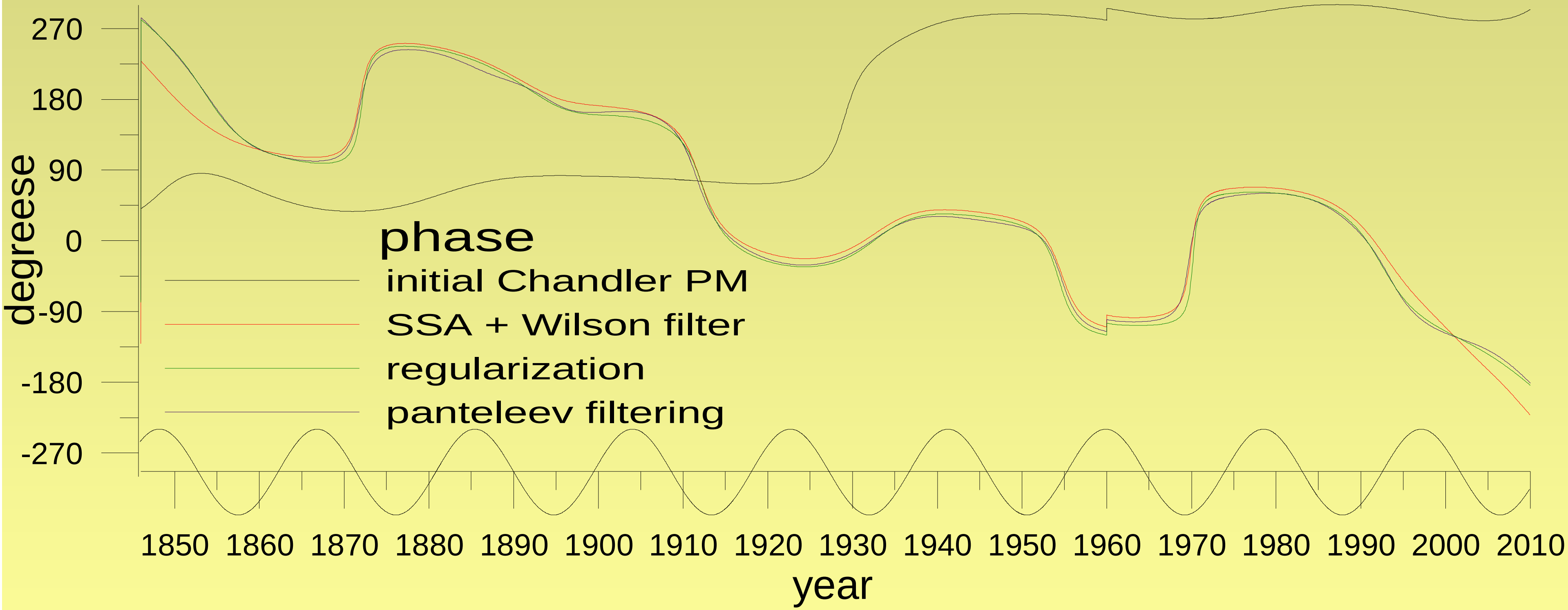
Panteleev filters impulse response

$$h(t) = \frac{\omega_0}{2\sqrt{2}} e^{-\frac{\omega_0 |t|}{\sqrt{2}}} \left(\cos \frac{\omega_0 t}{\sqrt{2}} + \sin \frac{\omega_0 |t|}{\sqrt{2}} \right)$$

$$\omega_0 = 2\pi f_0$$



Phase changes



Conclusions

1) Chandler excitation was reconstructed by three methods for inverse problems solving:

Panteleev corrective smoothing,

Wilson-Jeffreys filter after SSA,

Tikhonov regularization with annual component subtraction

The results are similar. It gives hope they are reliable.

2) 18,6-year modulation of Chandler excitation, synchronous with the saros tidal cycle and related LOD changes has been found. It could prove that tidal energy is transferred to chandler excitation, probably, through the ocean and atmosphere. The mechanism is still to be found.

This work is performed with support of the President of Russia grant МК-4234.2009.5 and RFBI grant 10-05-00215-a.


REMERCIE DE VOTRE ATTENTION!