Earth rotation presents surprises in 2010-2020s: LOD and Chandler wobble varies

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USED DATA

Combined solutions of Earth Orientation center of IERS in Paris

	time step
- EOP C01 since 1846 r. (eopc01.iau2000.1846-now)	0.05 yr
- EOP C01 since 1900 r. (eopc01.iau2000.1900-now.dat)	0.05 yr
- EOP C04 since 1962 r. (eopc04_IAU2000.62-now)	1 day
- EOP C01 since 1890 r. (eopc01.iau2000.1846-now)	0.05 yr

https://hpiers.obspm.fr/eop-pc/index.php

Trend $a(t - t_0) + b$ t_0=1900 r.

X-coordinate: a = 0,86 mas/year, b = 30,42 mas

У-coordinate: a = 2,99 mas/year, b = 37,65 mas

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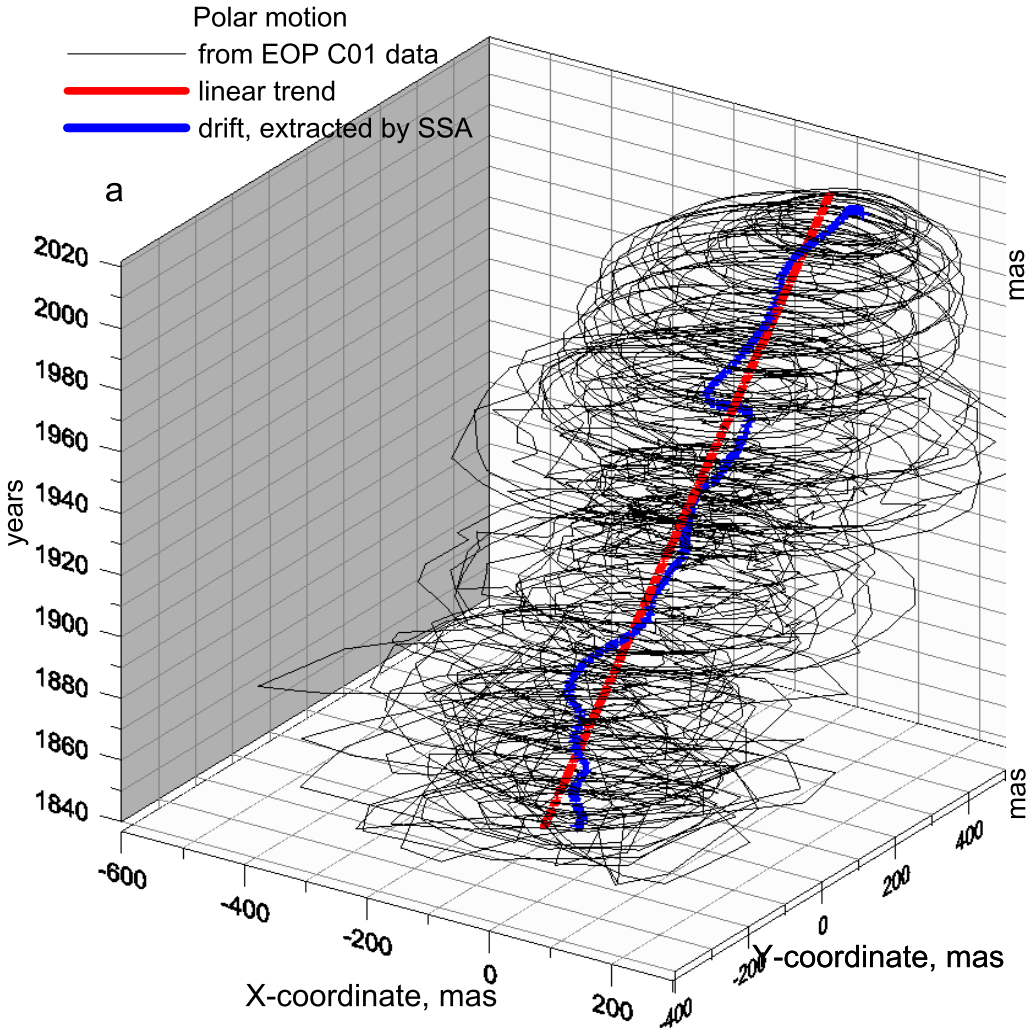
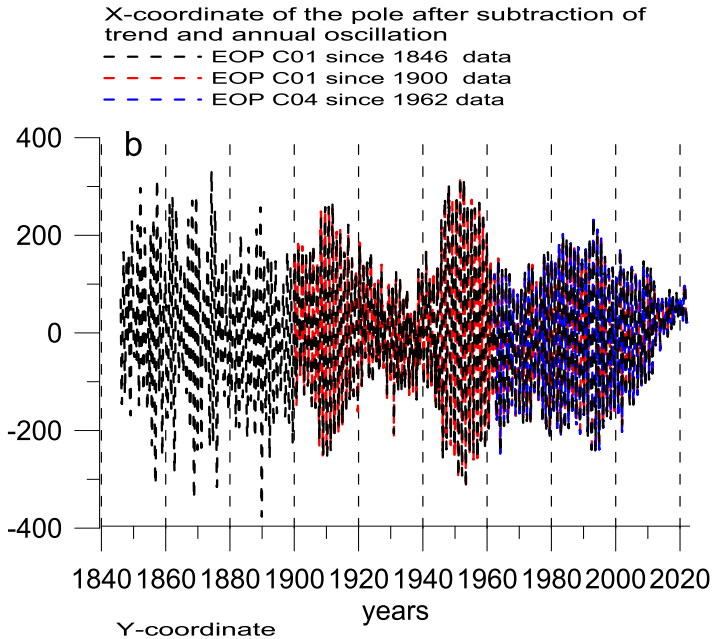
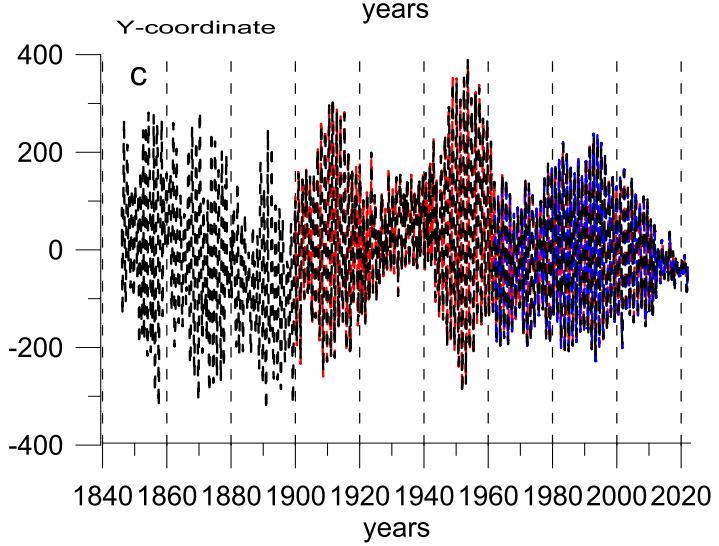
Polar motion since 1846 year







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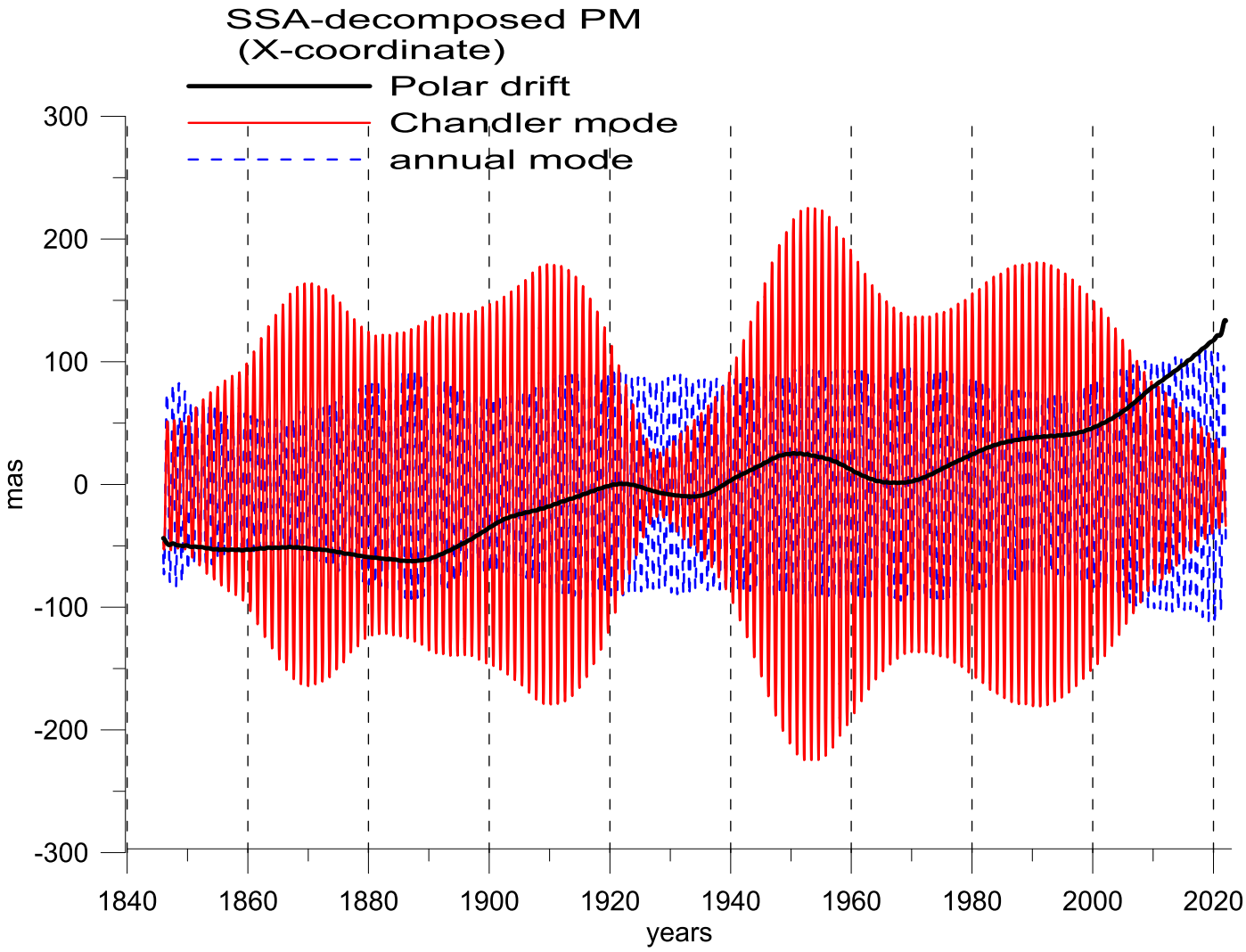
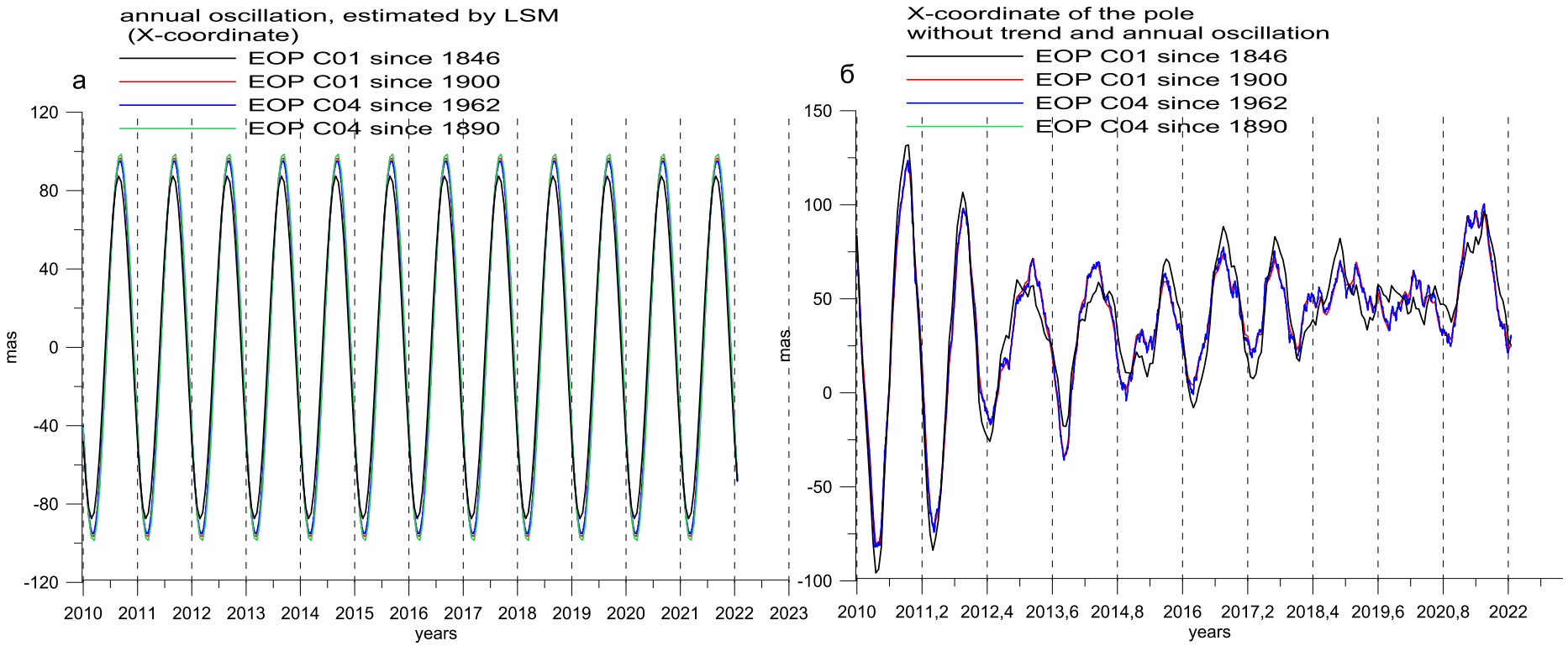
Singular Spectrum Analysis (SSA) of PM



L=256

Annual harmonic and residual series since 2010



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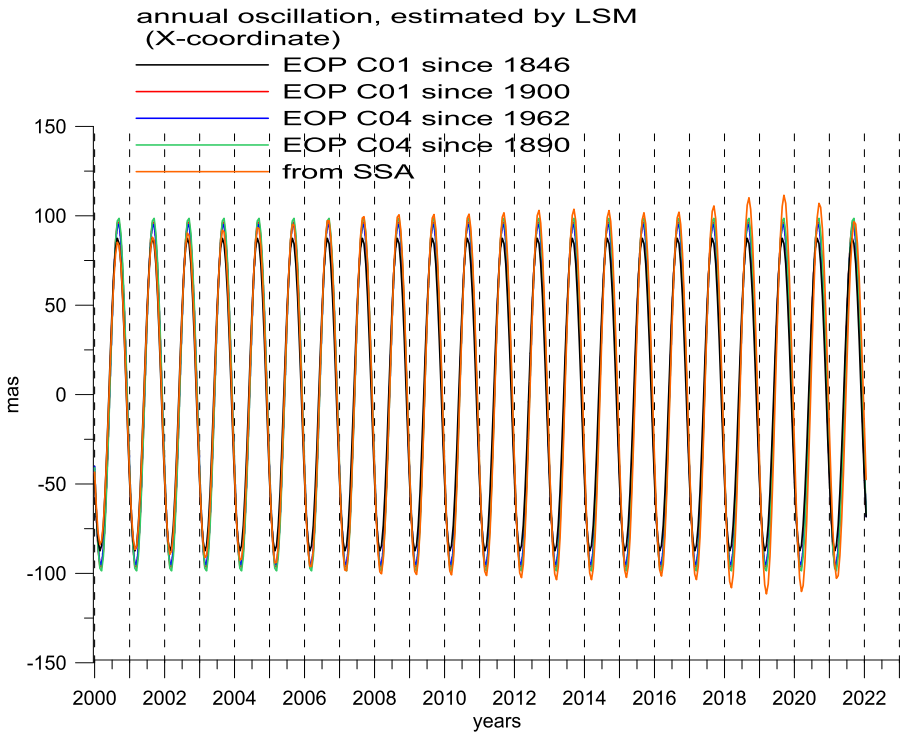
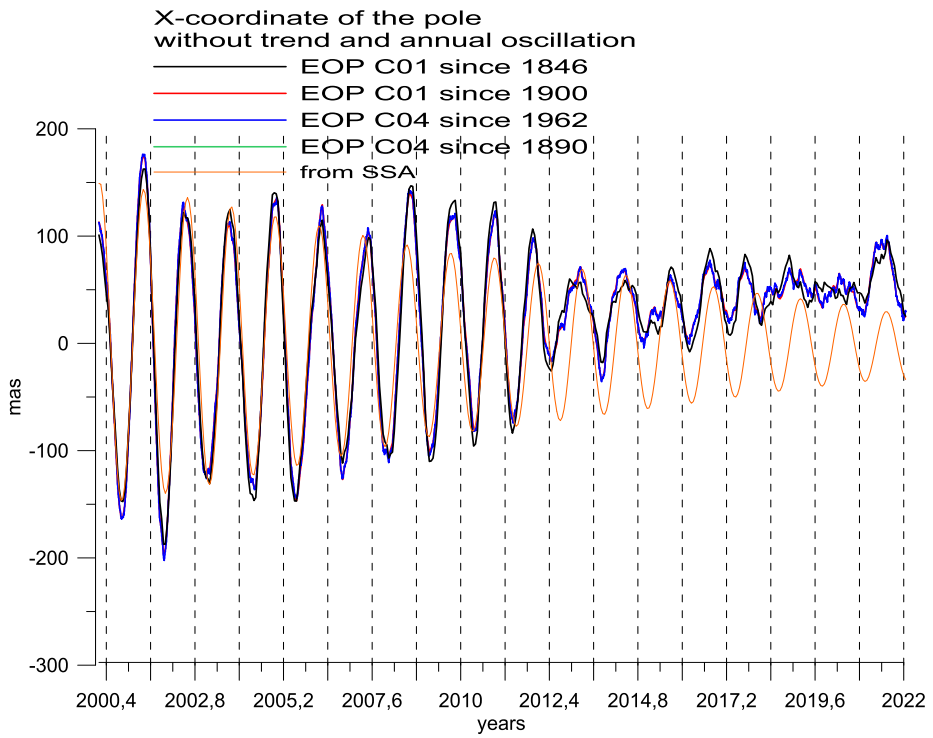
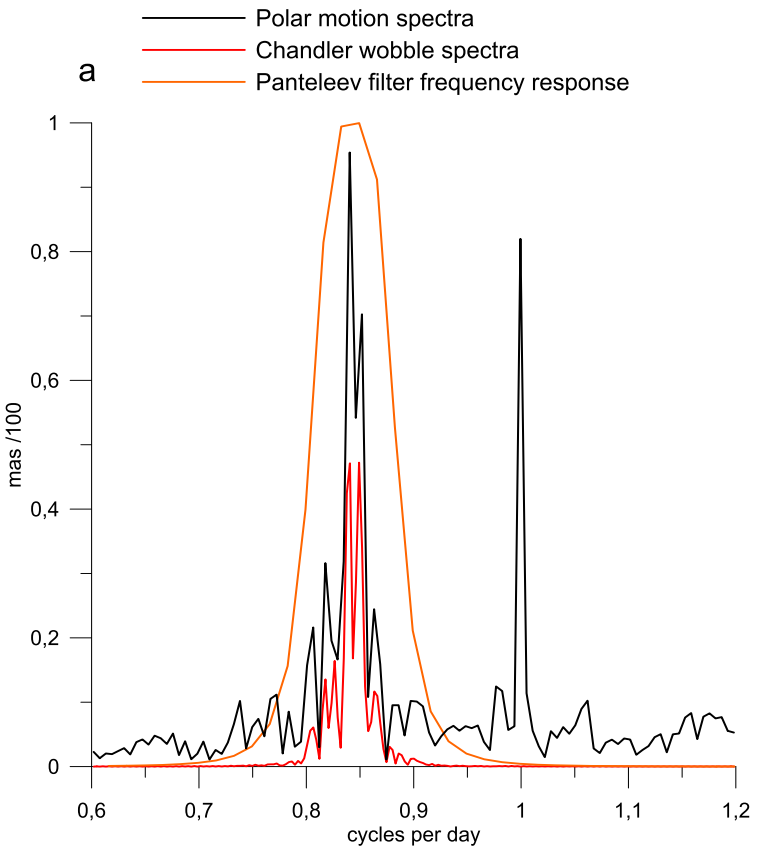
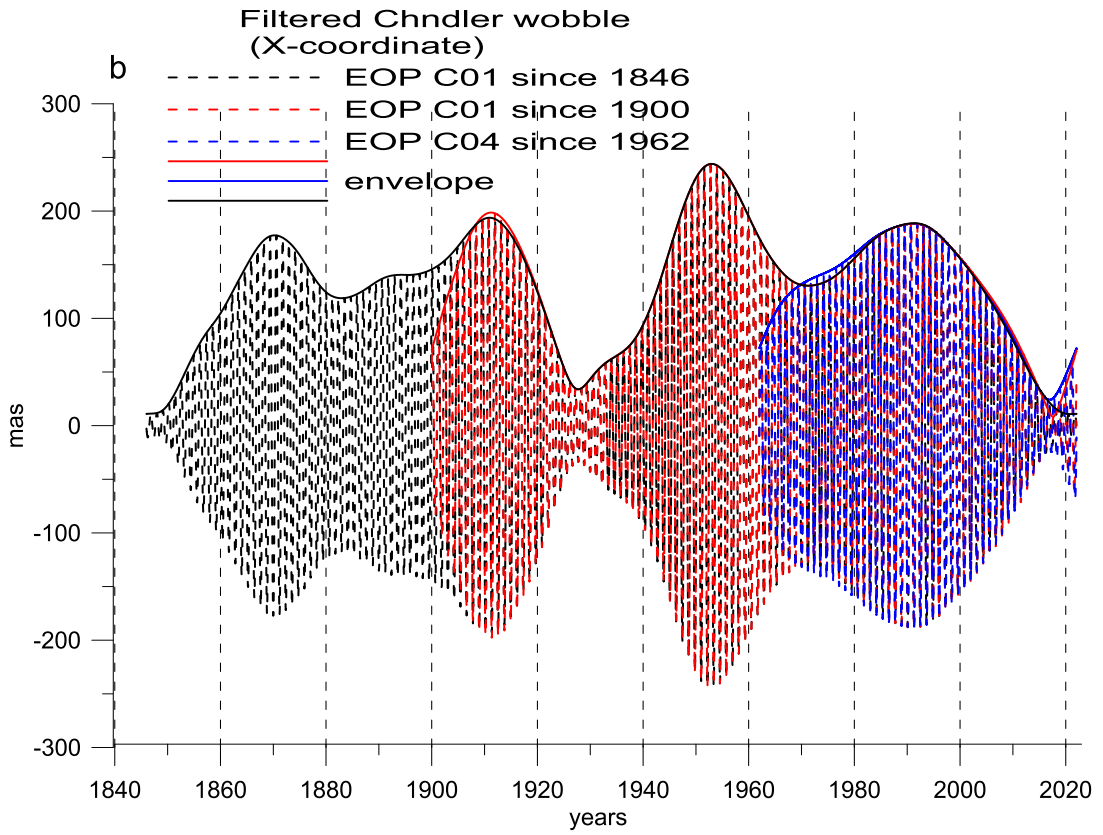
Annual harmonic and residual series since 2000 with SSA





PM spectra since 1846 and filtered Chandler wobble





Frequency response of Panteleev's filter

$$L_h(f) = \frac{f_0^4}{(f - f_c)^4 + f_0^4}$$

f_c=1/433 days^{-1} f_0=0,04 years^{-1}

$\omega_0 = 2\pi f_0$:

Pantellev's window

$$h(t) = \frac{\omega_0}{2\sqrt{2}} e^{-\left(\frac{\omega_0 |t|}{\sqrt{2}} - i2\pi f_c t\right)} \left(\cos\frac{\omega_0 t}{\sqrt{2}} + \sin\frac{\omega_0 |t|}{\sqrt{2}}\right)$$

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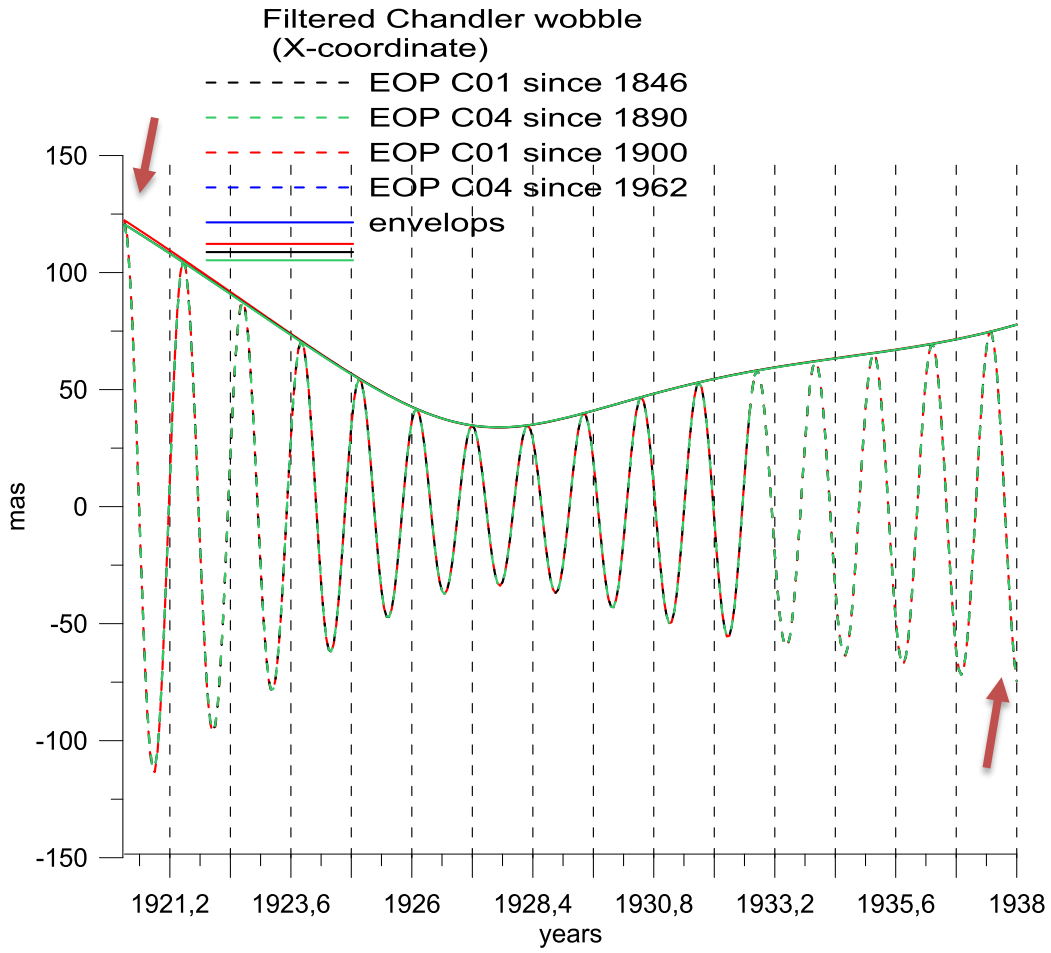
Phase drift of the Chandler wobble in 1920-1940



Modulations can be produced according to the low

Если воспользоваться формулой сложения косинусов

$$\cos\omega_1 t + \cos\omega_2 t = 2\cos\frac{(\omega_1-\omega_2)t}{2}\cdot\cos\frac{(\omega_1+\omega_2)t}{2},$$

видно, что близкие частоты ω_1, ω_2 дают колебание на промежуточной частоте с амплитудной модуляцией низкой частоты, равной полуразности между ними. Из спектра ЧДП на рис. 2а заметно что наличие двух пиков с частотами $\omega_1 = 2\pi\cdot 0.84, \omega_2 = 2\pi\cdot 0.85$, которое даёт модуляцию частотой $(\omega_1-\omega_2)/2 \approx 2\cdot\pi\cdot 0.005$, т.е. периодом около 200 лет. При этом половину периода знак модулирущего косинуса будет положительным, половину – отрицательным. Переход амплитуды модуляции через ноль как раз и будет эпохой минимума ЧДП с одновременной сменой фазы на π.

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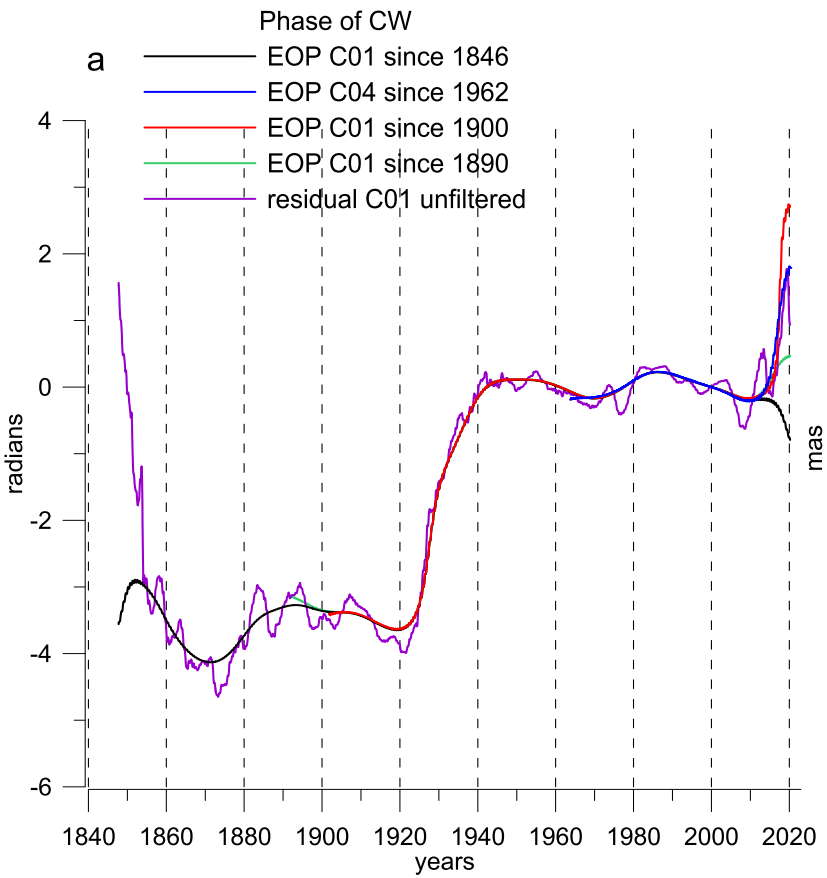
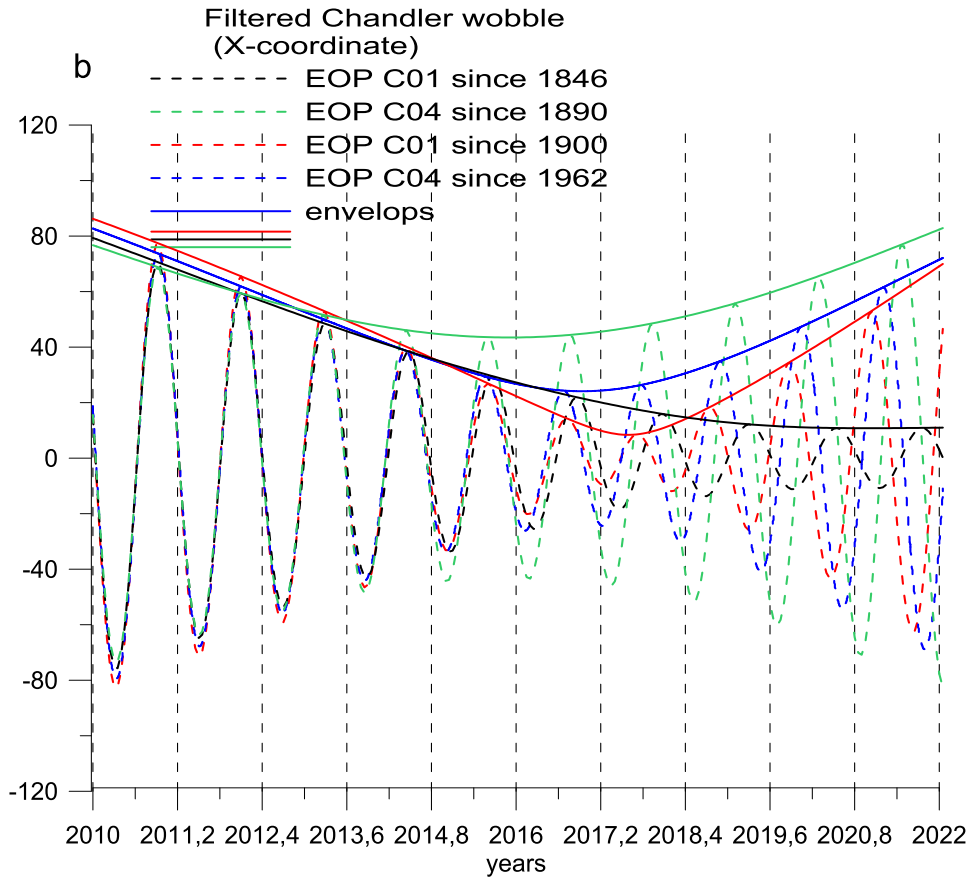
Chandler wobble - phase drift and amplitude changes





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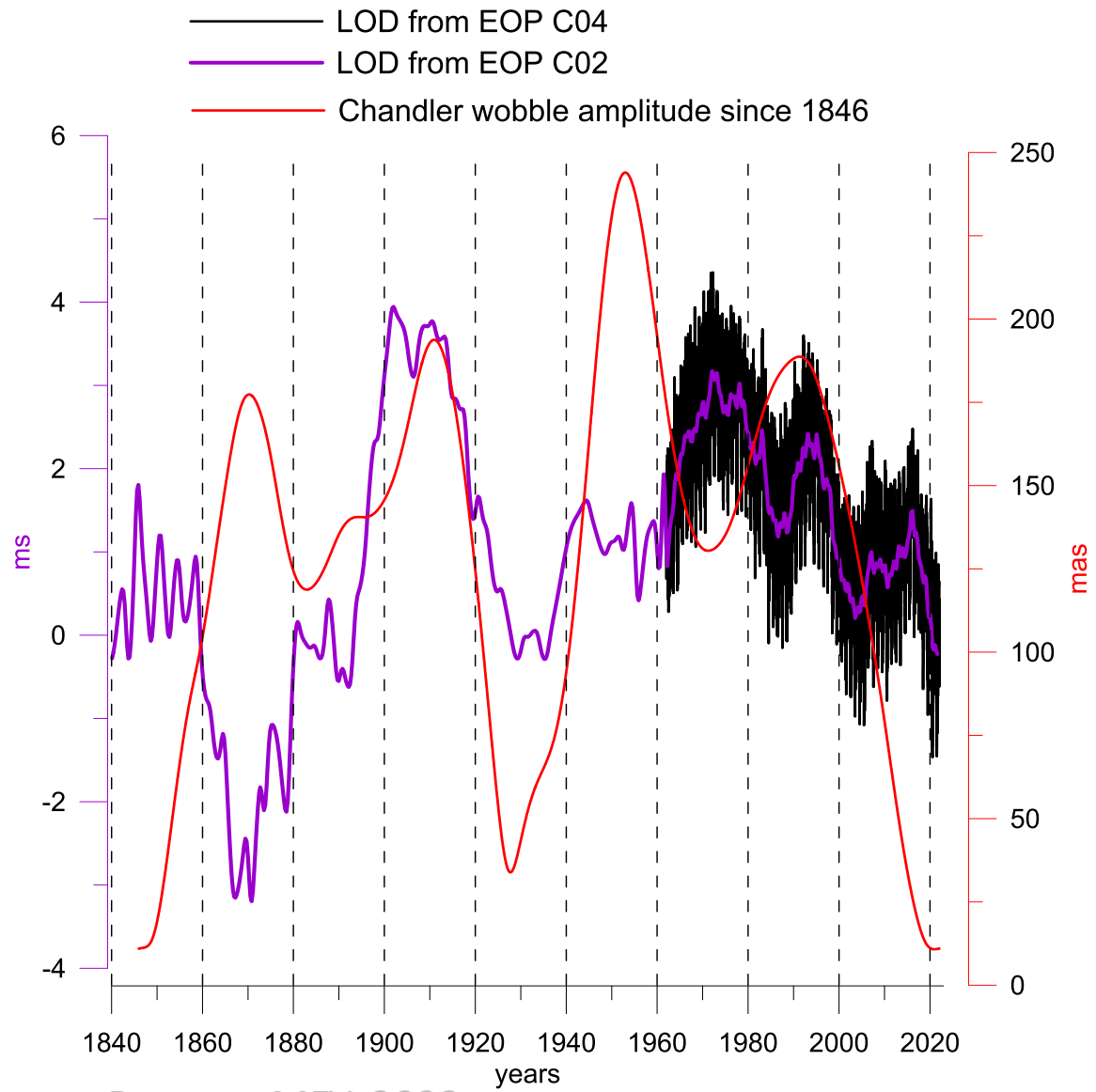
Chandler wobble and LOD since 1840



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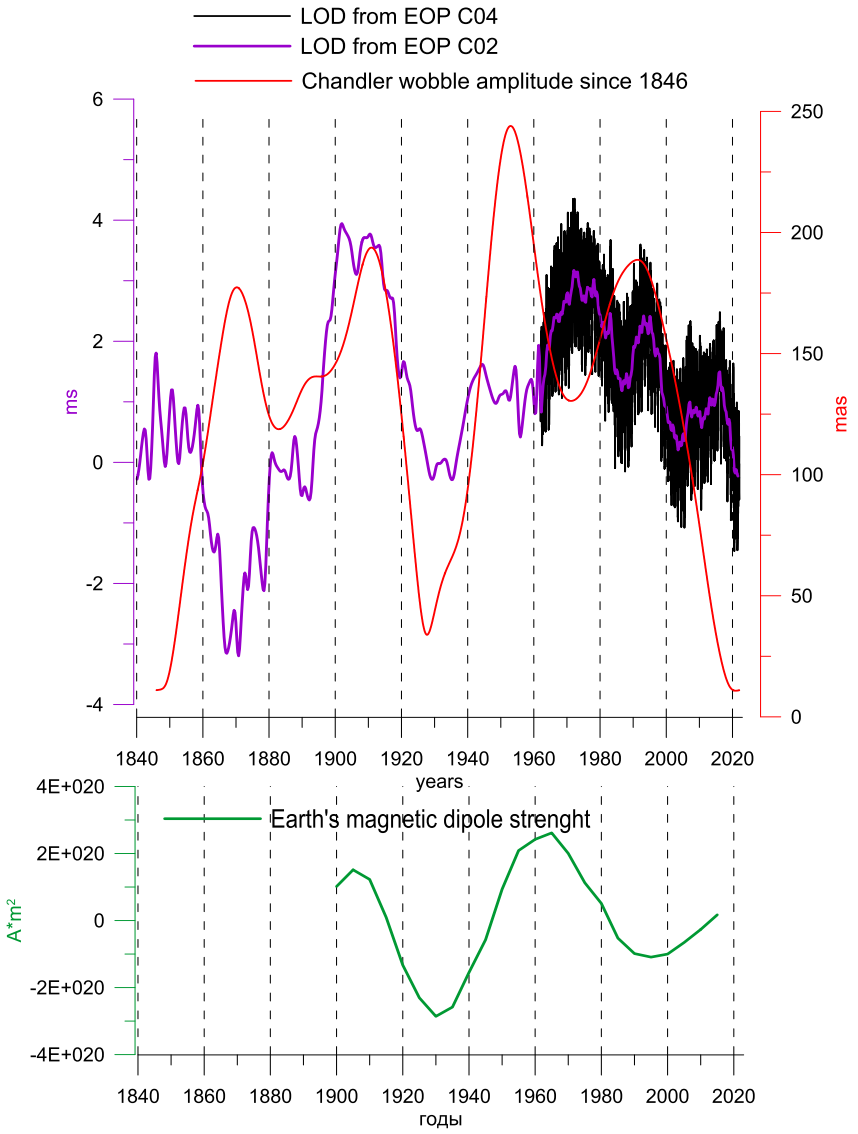
Chandler wobble and LOD since 1840



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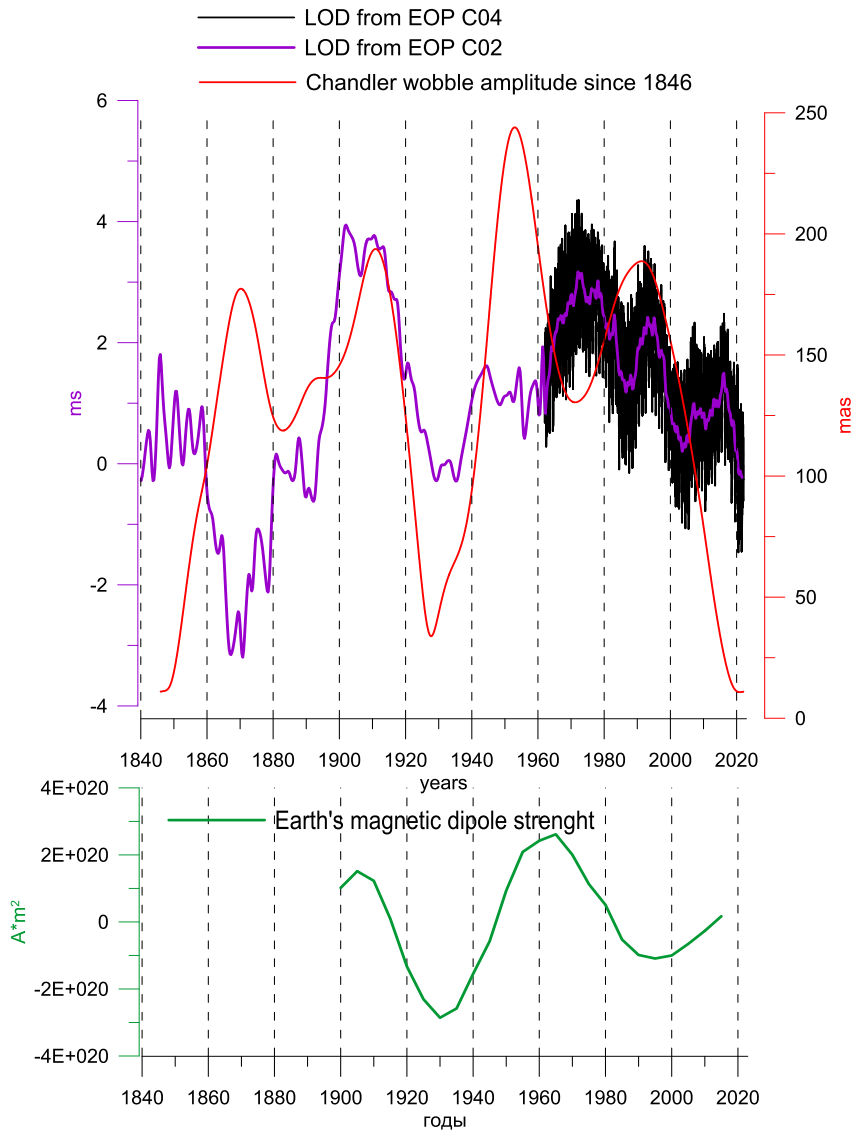
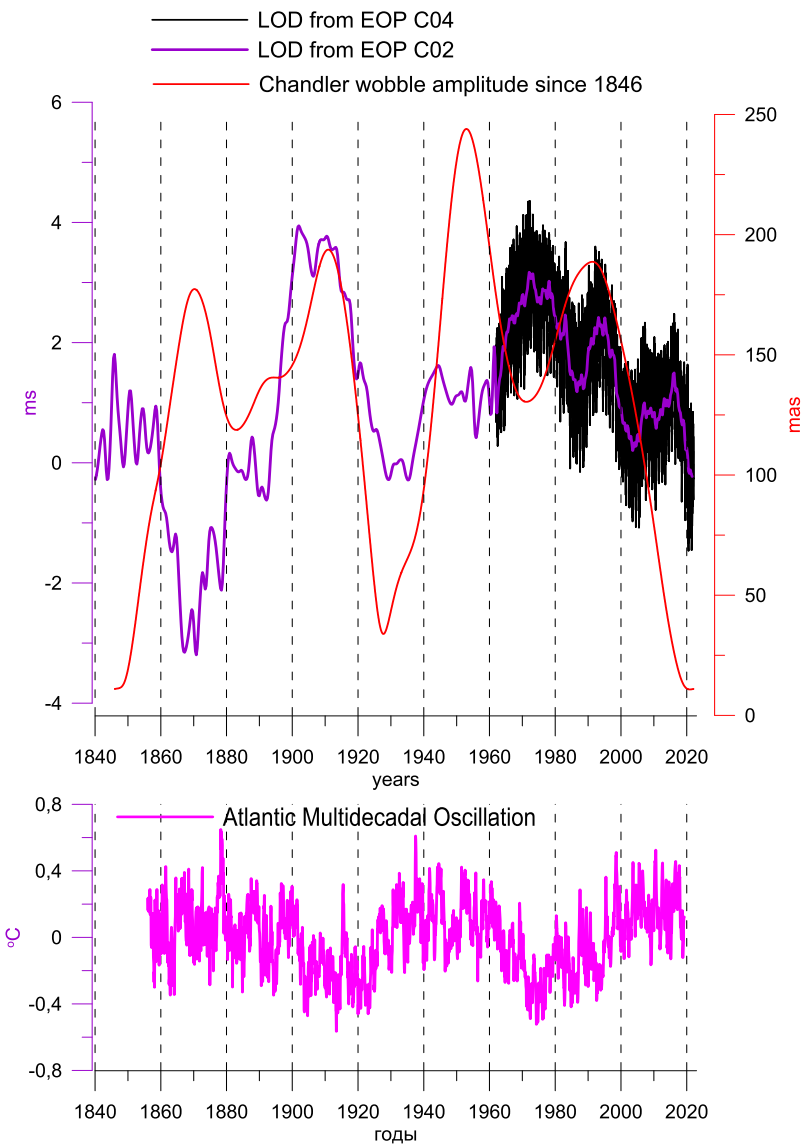
Chandler wobble and LOD since 1840 with other factors





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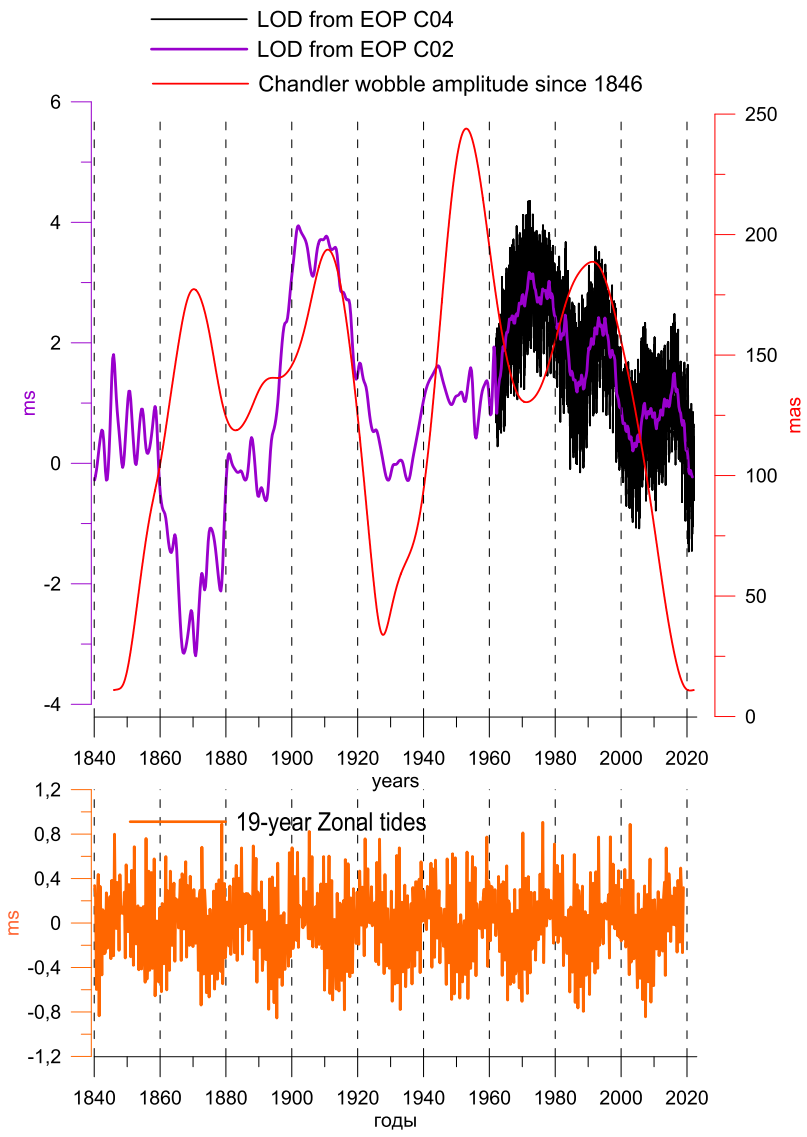
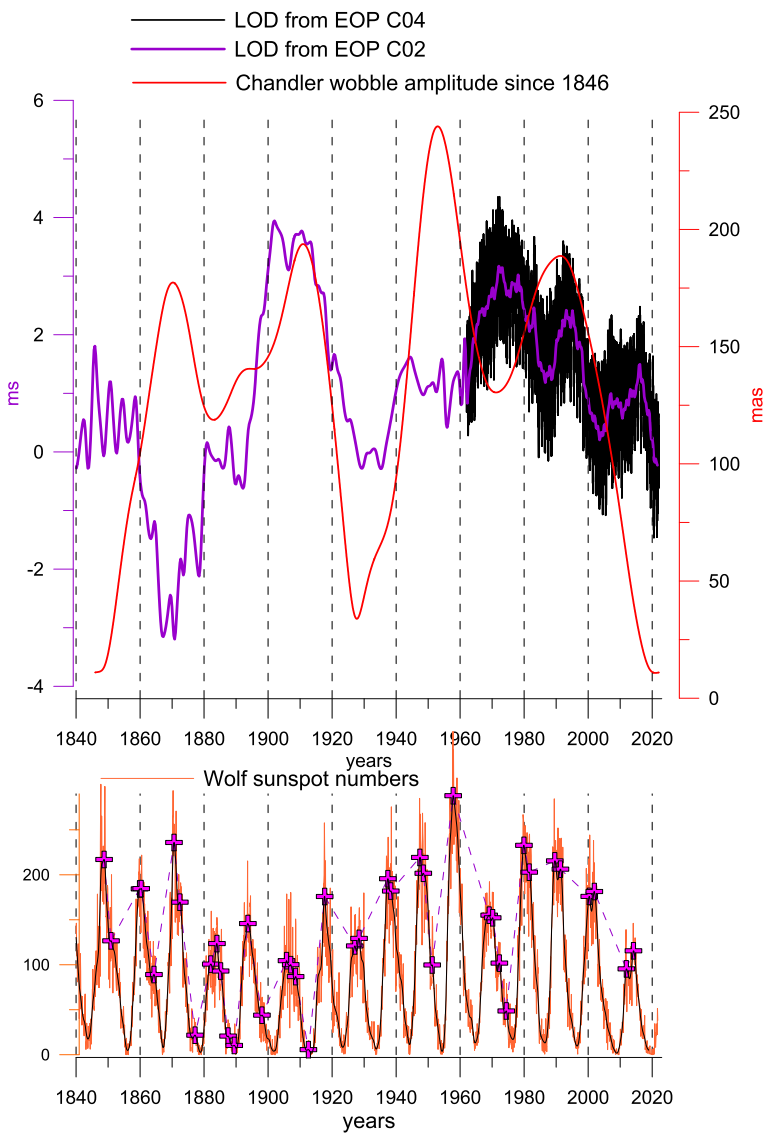
Chandler wobble and LOD since 1840 with other factors





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Conclusions

- Chandler wobble decayed in 2016-2020 and appeared again in 2021 г
- Phase of the CW increased by 2 radians since 2000 and continues to grow
- We are witnesses of the repition of the phenomena, happened around 1926
- Earth rotation velocity is increasing since 2016
- Is there connection between CW and LOD and/or other processes is to be studied

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Literature

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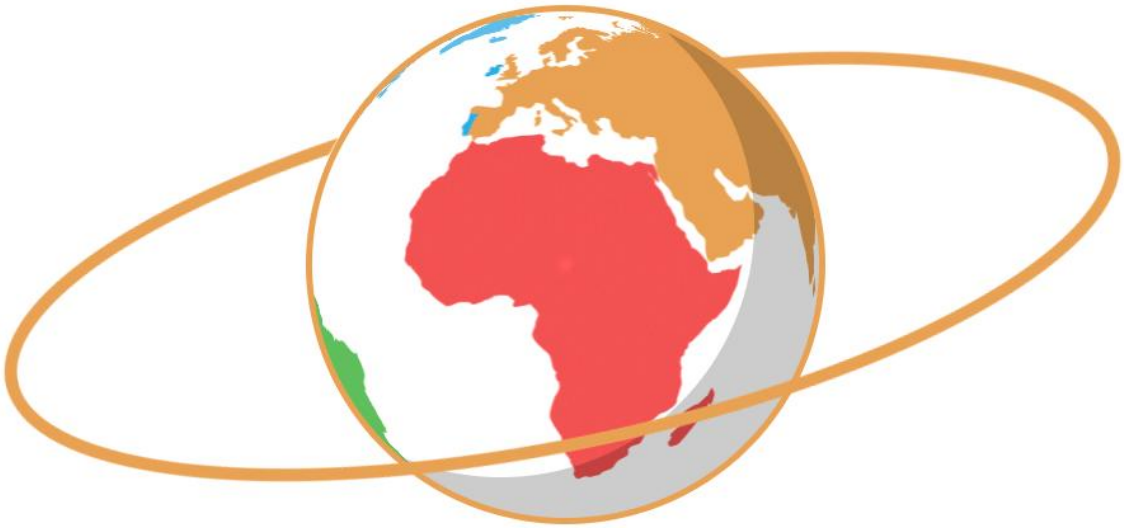
Thank you for attention!



Muchas gracias!