

7th Workshop

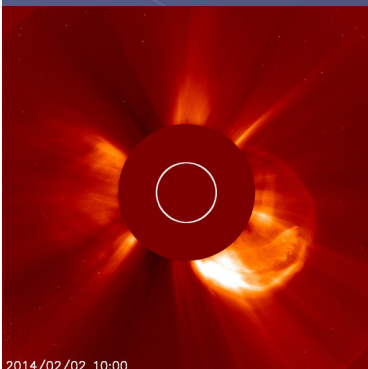
"Solar Influences on the Magnetosphere, ionosphere and Atmosphere",
Sunny Beach, Bulgaria, 1-5 June 2015

The `Sun-climate` relationship and tree-rings widths

*Komitov B.⁽¹⁾, Duchlev P.⁽¹⁾, Kirilova D.⁽¹⁾,
Byandov G. ⁽²⁾, Kiskinova N.⁽²⁾*

(1) BAS-Institute of Astronomy and NAO "Rozhen"

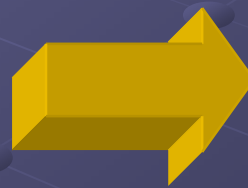
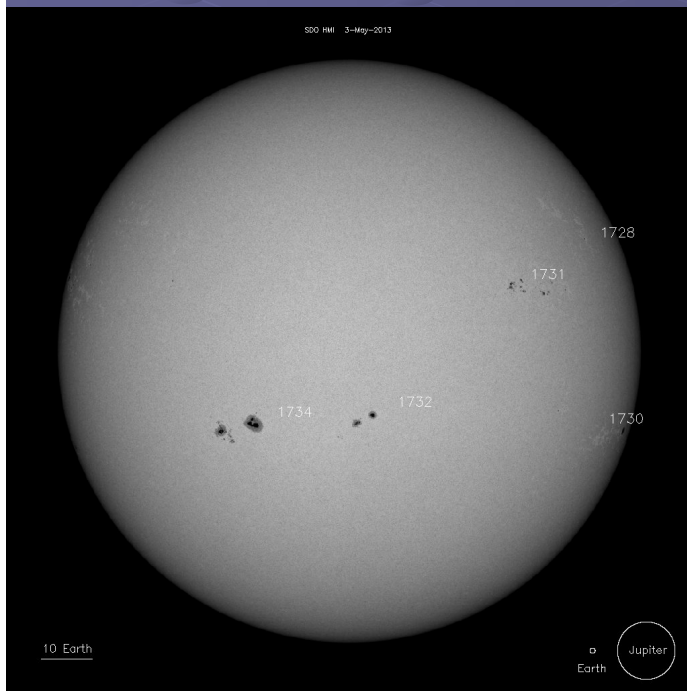
(2) Astronomical Observatory "Yury Gagarin" –St.Zagora



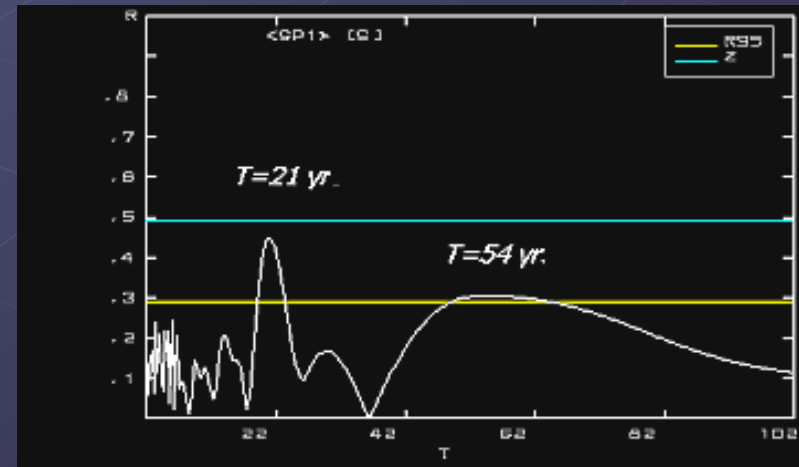
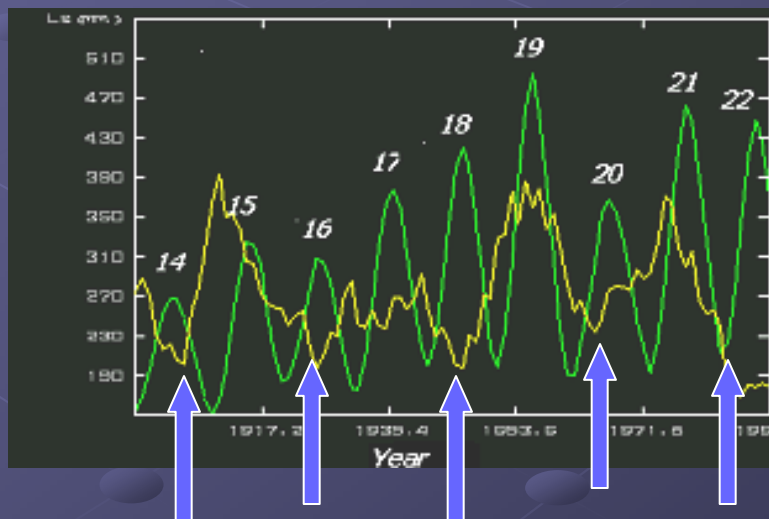
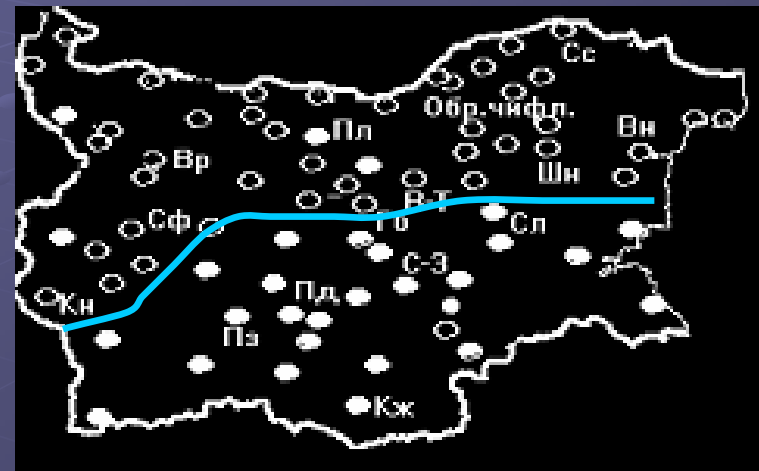
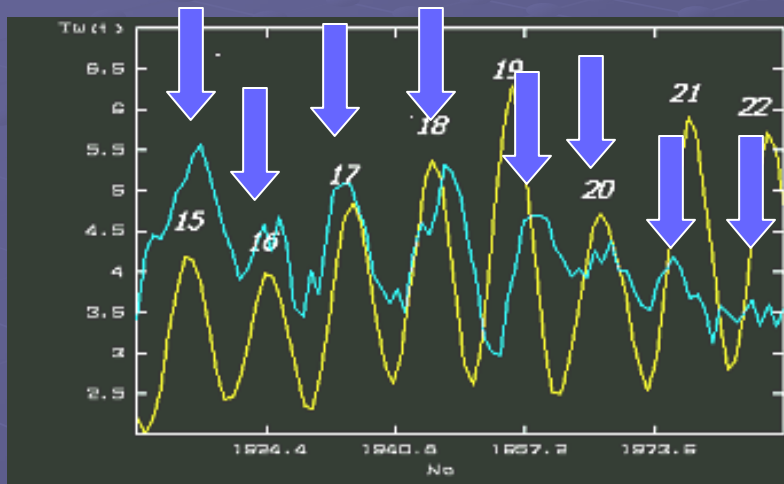
Tree rings, solar activity and climate changes in the past



Andrew Douglas (1867- 1962) - “the father of dendrochronology”

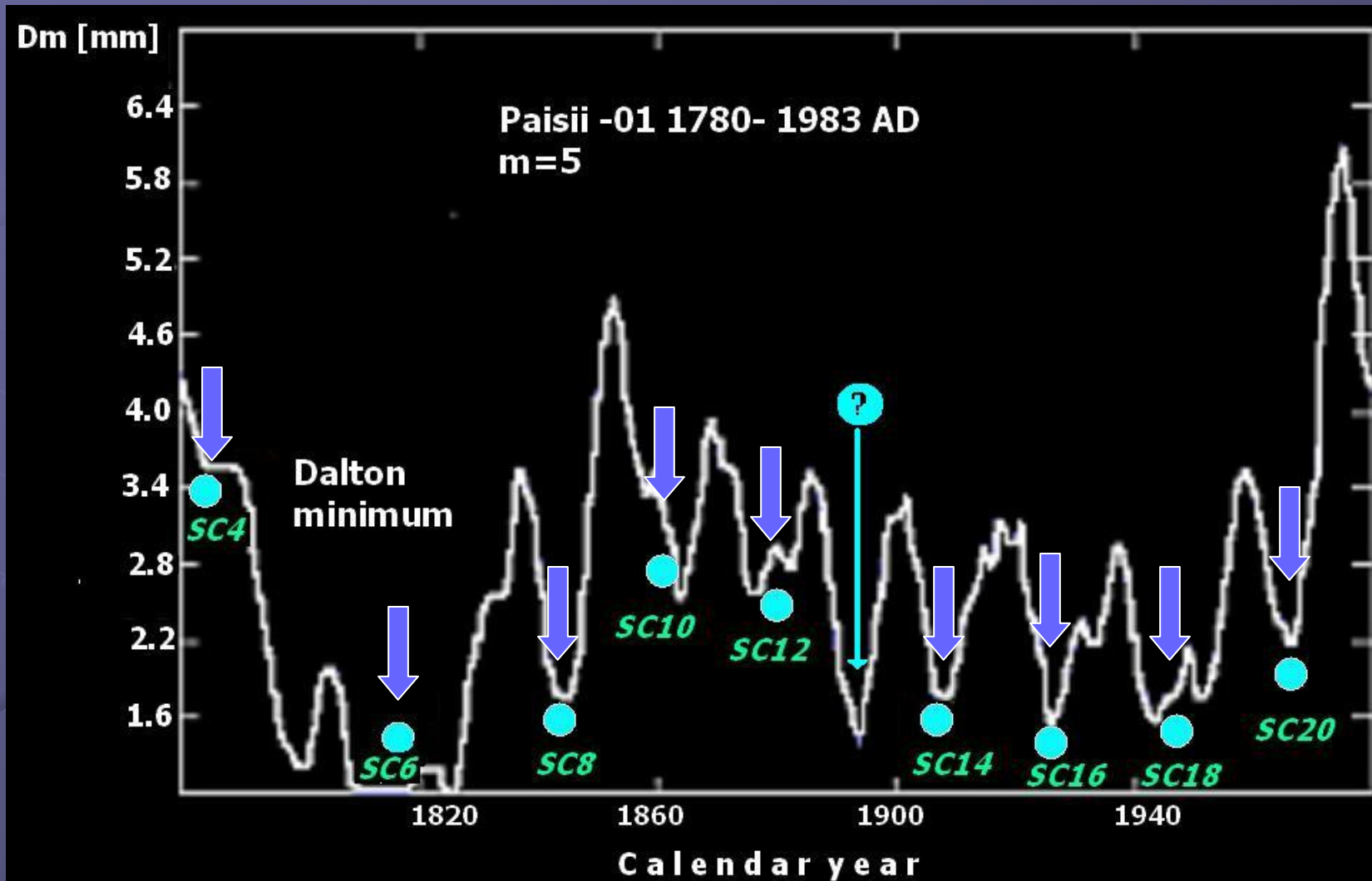


32 years ago: The “Sun-climate” relationship in Bulgaria by instrumental data

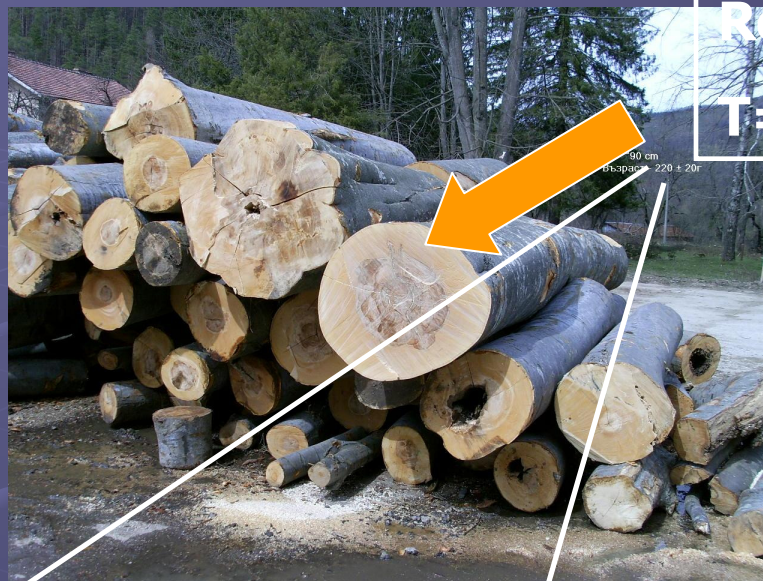


Tree sample "Gurkovo-01" (Paisii -01) (1780-1982AD)

(general smoothed profile)



2013 AD: "Rositsa"-01 and 02 tree samples



Rositsa-01
T = 245 ± 5 yr



Rositsa-02
T ≈ 160 ± 3 yr

For tree samples in Balkan Mountain Range...

(Village Buinovtsi ; Municipality - Elena; Province- Veliko Tarnovo)



Time series analysis and kinematical models

(Komitov 1986, 1997, 2001)

$$f(t) = A_0 + A \cos(2\pi t/T) + B \sin(2\pi t/T)$$

$$\sum_{i=1}^N (y_i - A_0) \cos \frac{2\pi(i-1)}{T} = A \sum_{i=1}^N \cos^2 \frac{2\pi(i-1)}{T} + B \sum_{i=1}^N \sin \frac{2\pi(i-1)}{T} \cos \frac{2\pi(i-1)}{T}$$
$$\sum_{i=1}^N (y_i - A_0) \sin \frac{2\pi(i-1)}{T} = A \sum_{i=1}^N \cos \frac{2\pi(i-1)}{T} \sin \frac{2\pi(i-1)}{T} + B \sum_{i=1}^N \sin^2 \frac{2\pi(i-1)}{T}$$

$$y_i = f(t), t = i - 1 = 0, 1, 2, \dots$$

$$SR = \frac{1 - R^2}{\sqrt{N}}$$

$$R^2 SR = 454 N^2 + 346$$

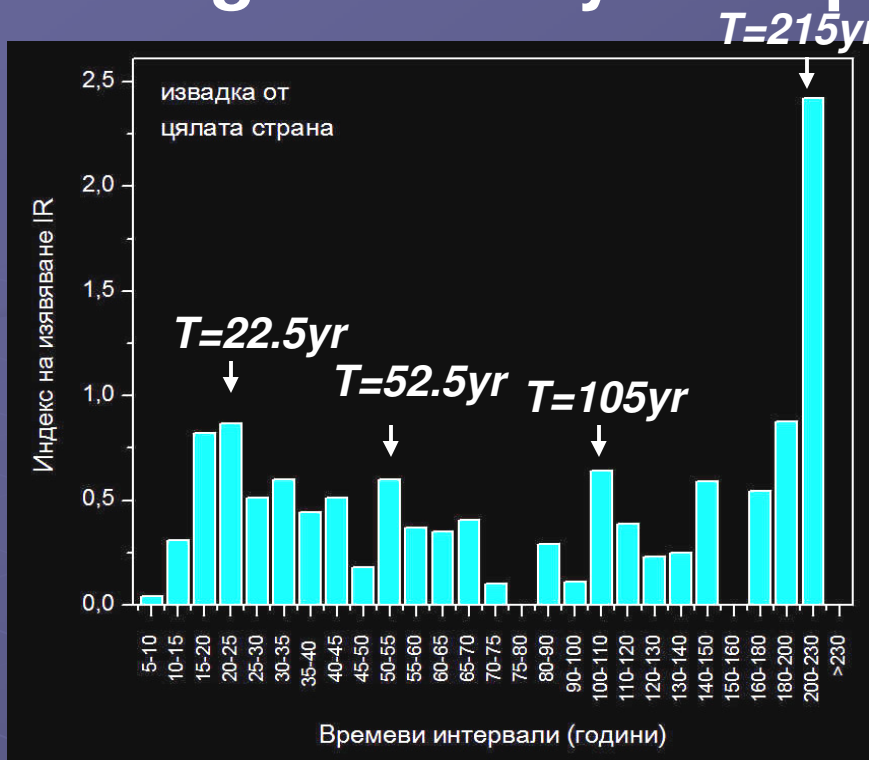
$$a(T) = \sqrt{A^2(T) + B^2(T)}$$

$$S = \int_{T_1}^{T_2} a(T) dT$$

$$\varphi(t) = A_0 + \sum_{j=1}^m \left\{ A_j \cos \frac{2\pi t}{T_j} + B_j \sin \frac{2\pi t}{T_j} \right\}$$

The tree ring widths cycles appearance distribution

IR



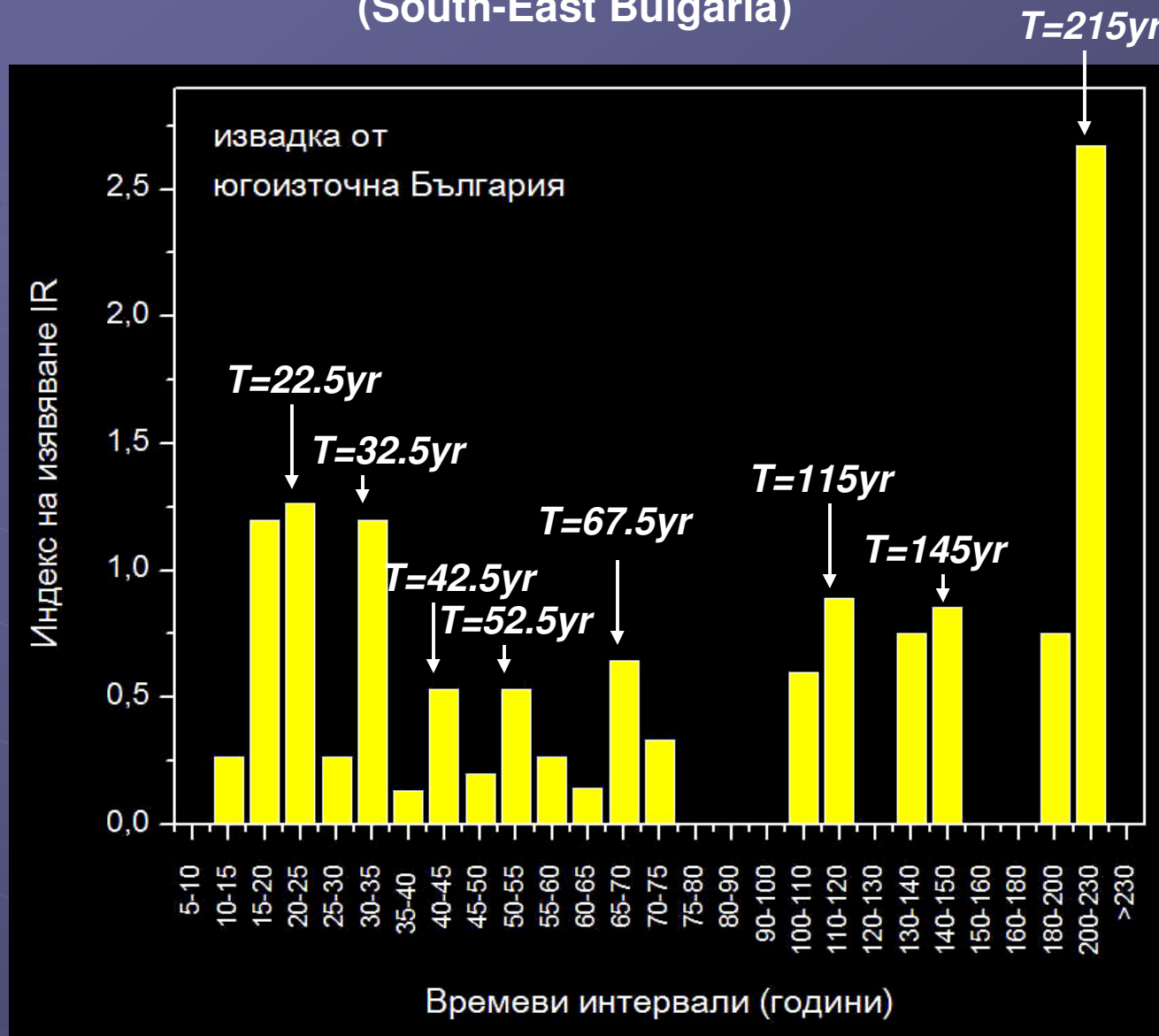
$$IR_{\Delta t} = \frac{\sum_{m=1}^{\leq 45} m_i}{z-1} \cdot N_{\Delta t}$$

Magnitude (m)	T	$R/\sigma(R)$	Description
1		2.0 – 3.5	weak
2		3.5 – 5.0	moderate
3		5.0 – 6.0	moderate-strong
4		6.0 – 8.0	strong
5		> 8.0	very strong

The tree ring widths cycles appearance distribution

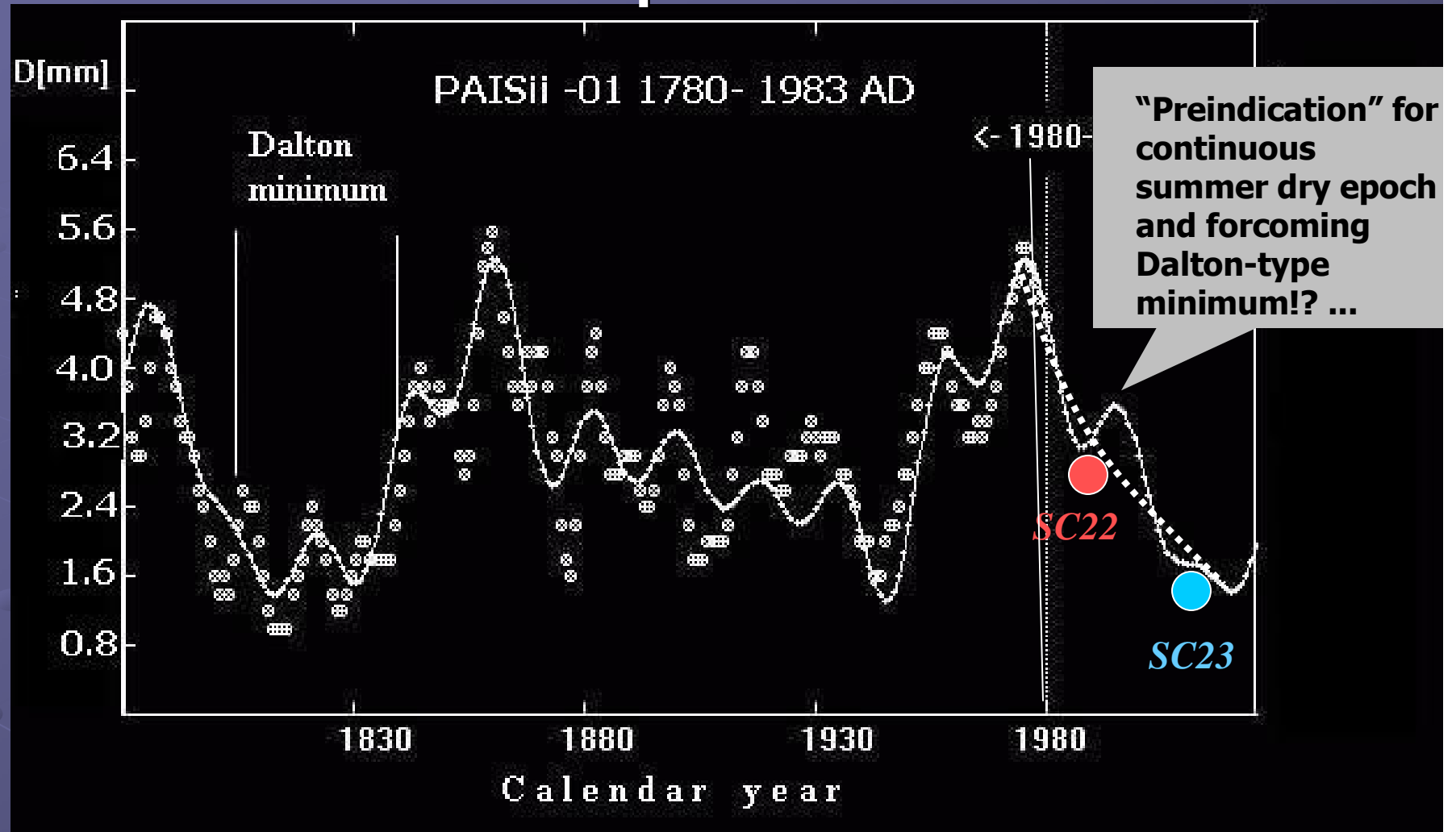
(South-East Bulgaria)

IR

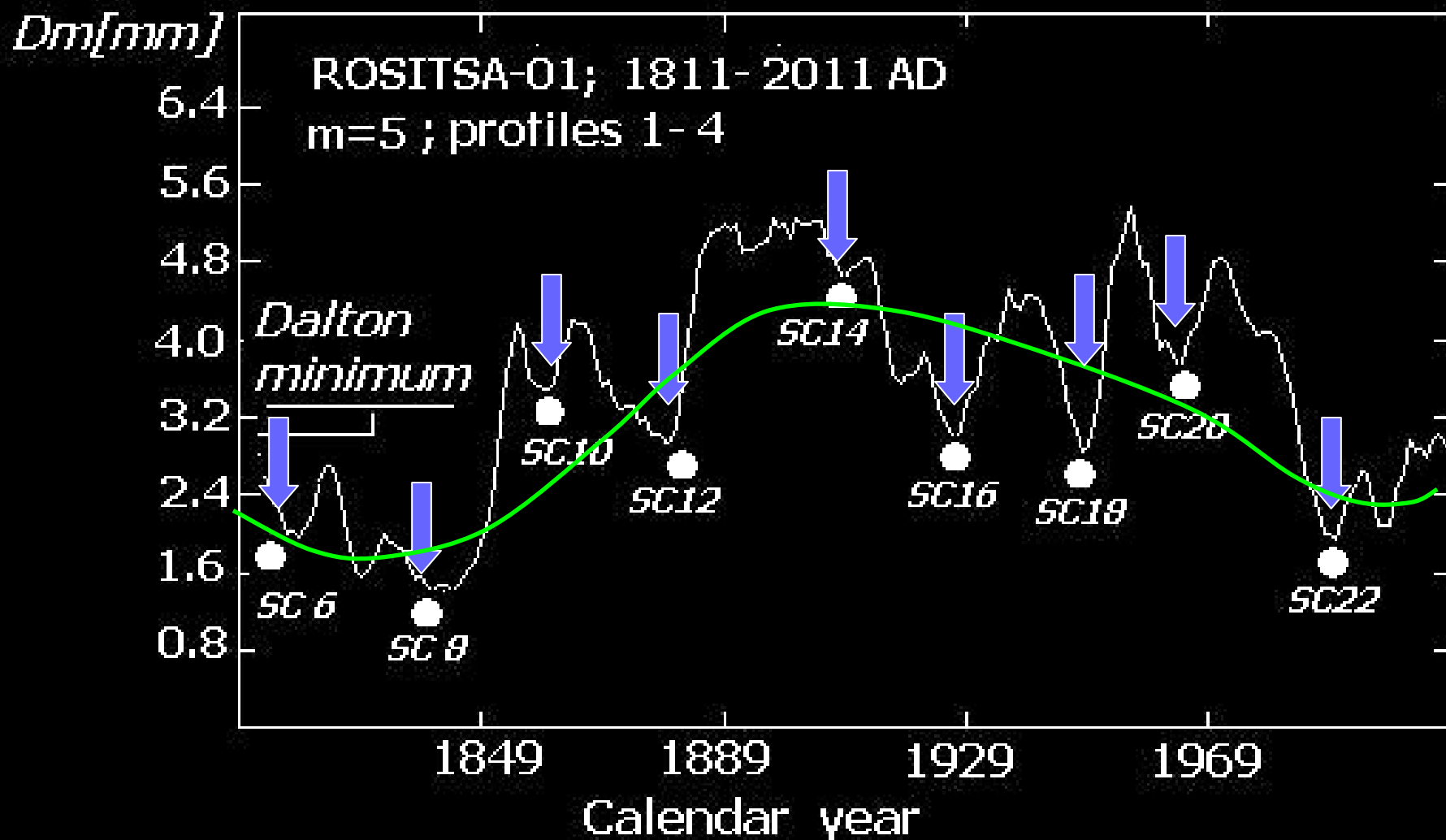


T

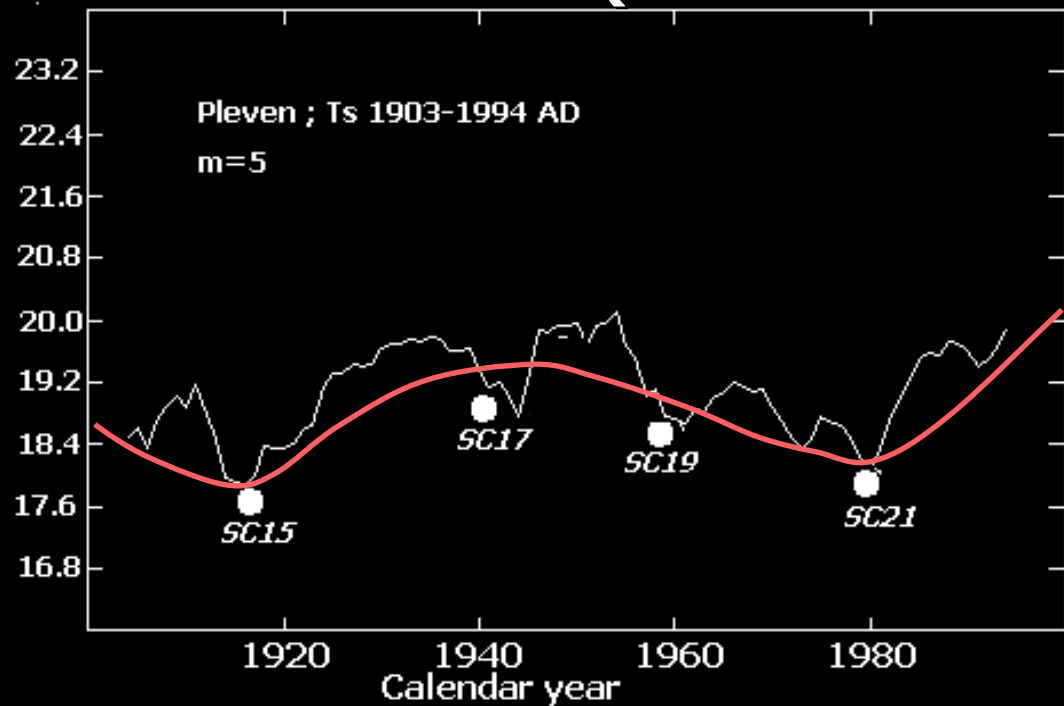
Gurkovo-01(Paisii -01): kinematic model and forecast up to 2010 AD



"Rositsa -01" (1811-2011 AD)
(200-year general smoothed radial profile)



"Rositsa -01" and Pleven temperature data (1900-1994 AD)

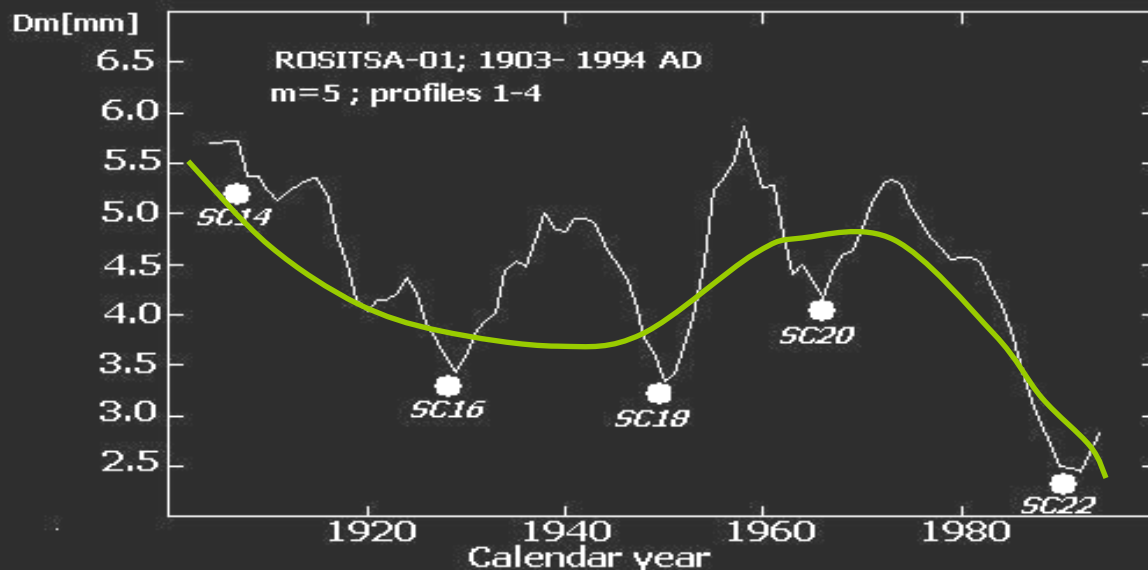


$$t = -0.804D_m + 19.3$$

$$r = -0.56$$

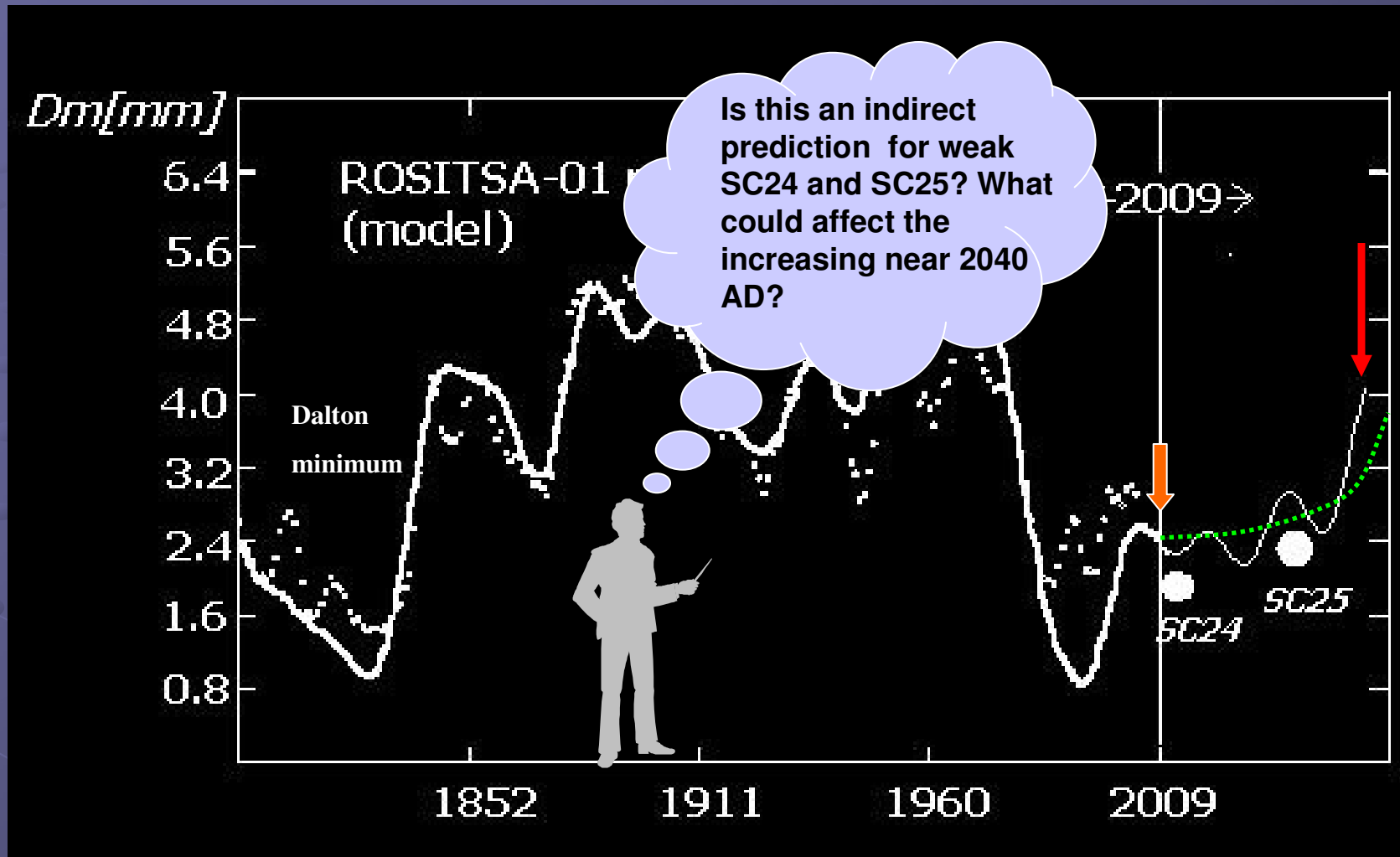
$$F = 1.44 ; F^*(95) = 1.34$$

t - the smoothed 5-year
warm semi-year
temperature in Pleven

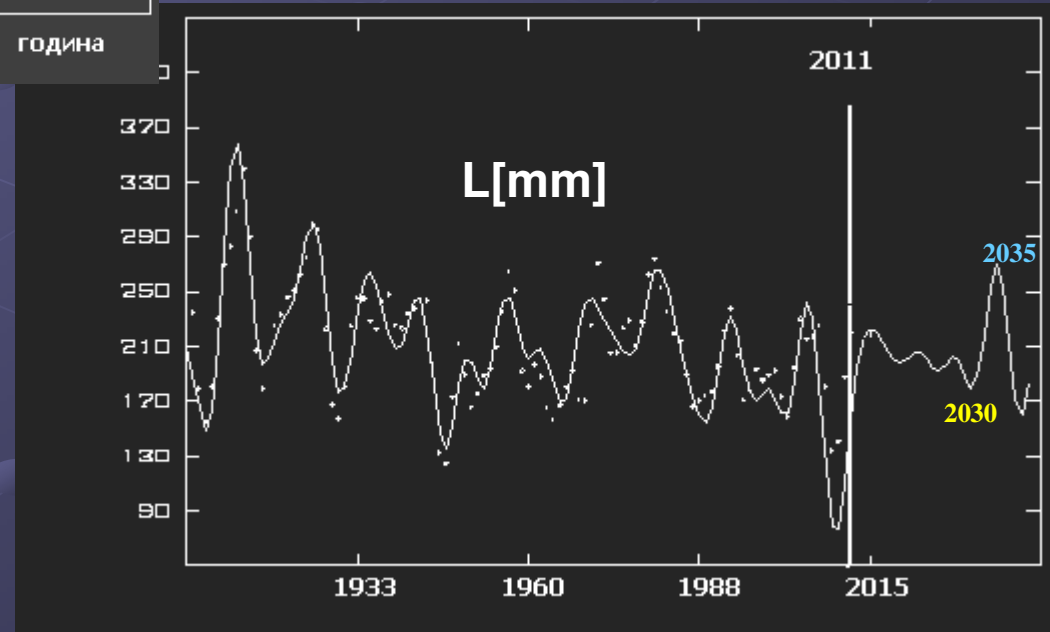
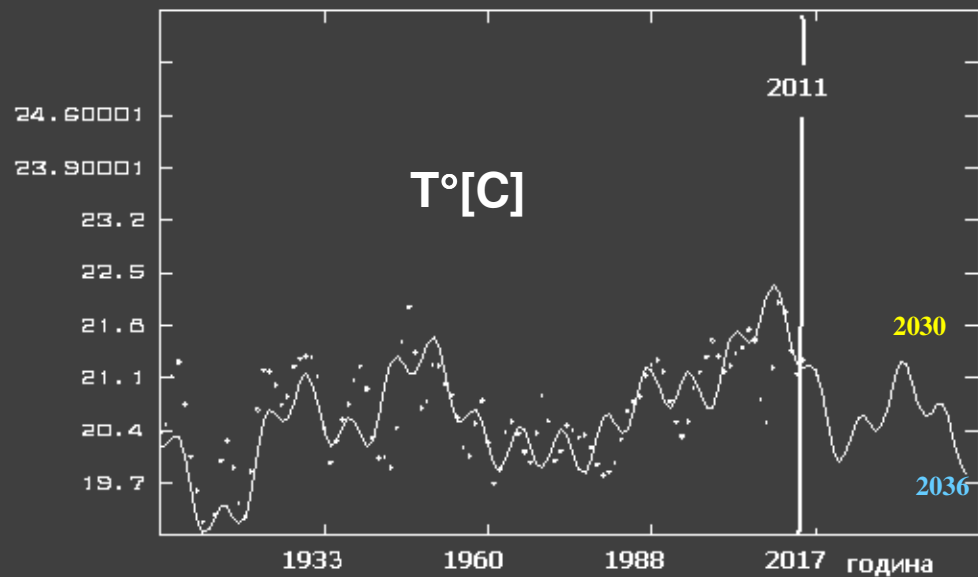


D_m - the smoothed 5-
year tree ring width of
"Rositsa-01"

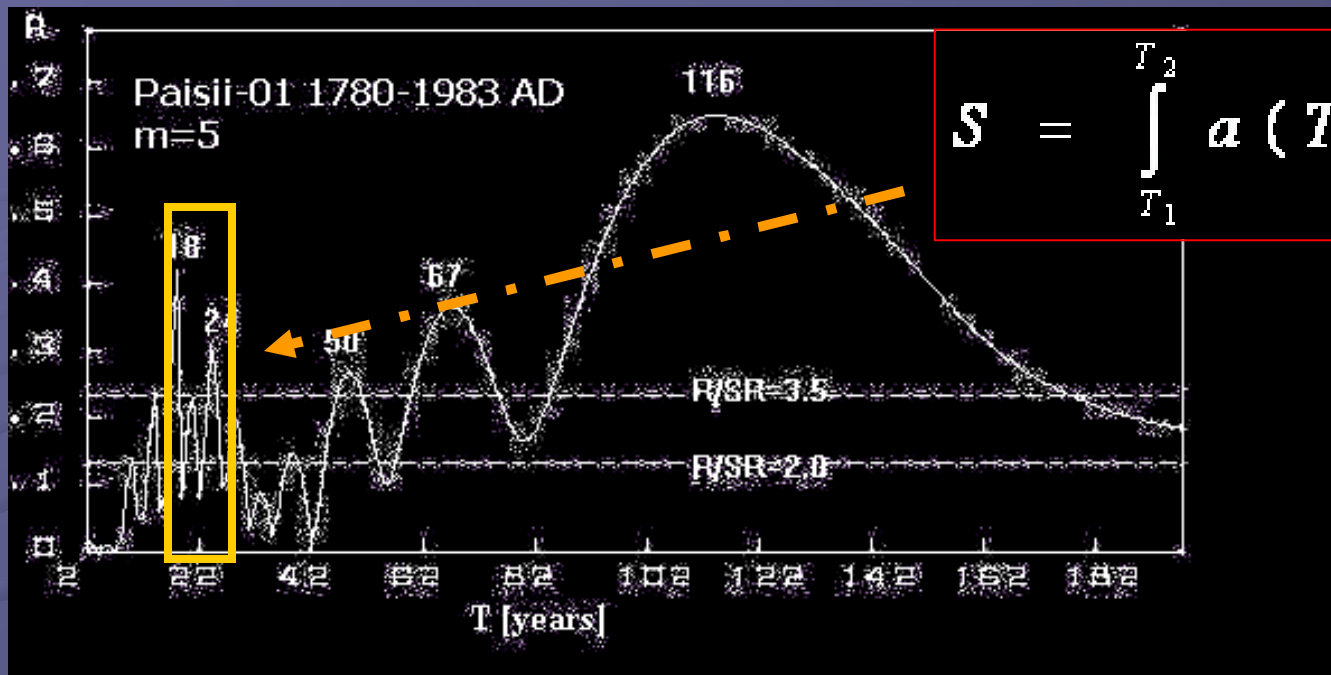
"Rositsa -01" (1811-2011 AD): kinematic model and forecast up to 2045 AD



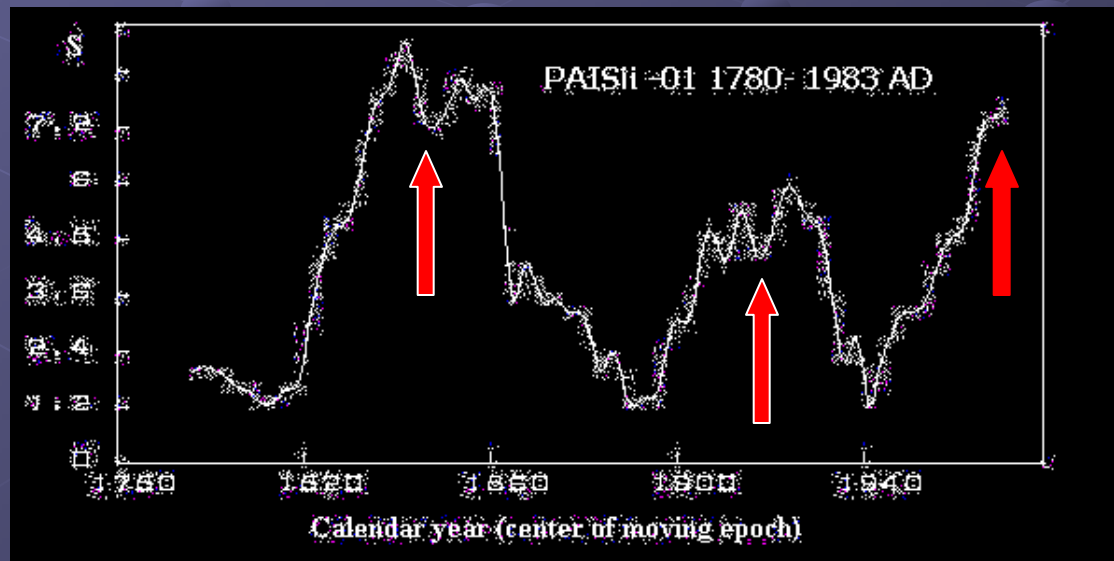
Pleven : May – July (1903-2013 AD)



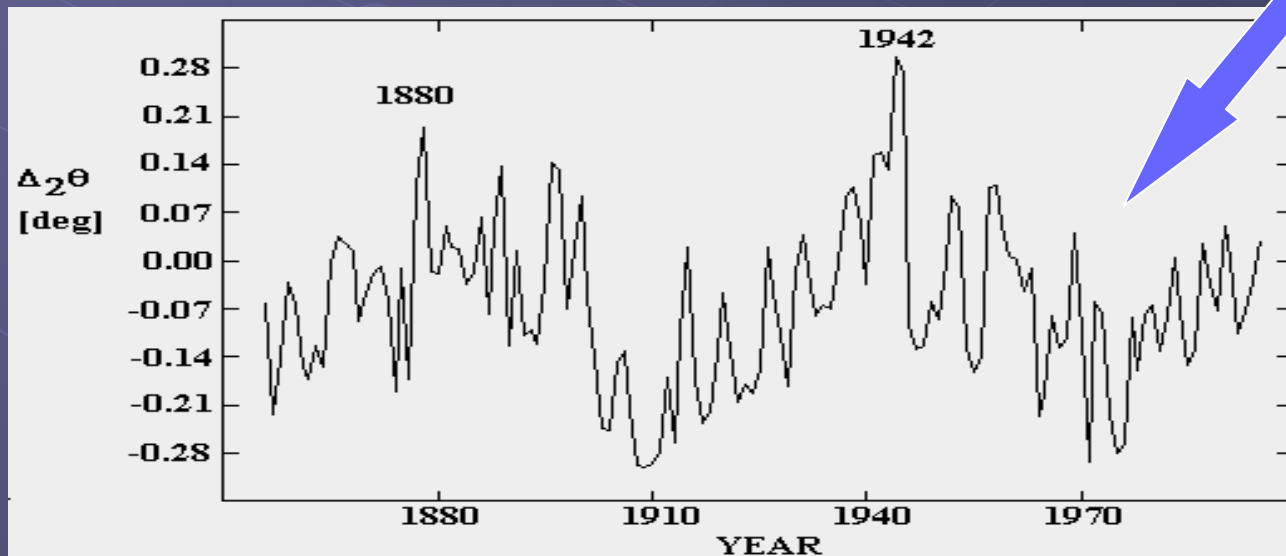
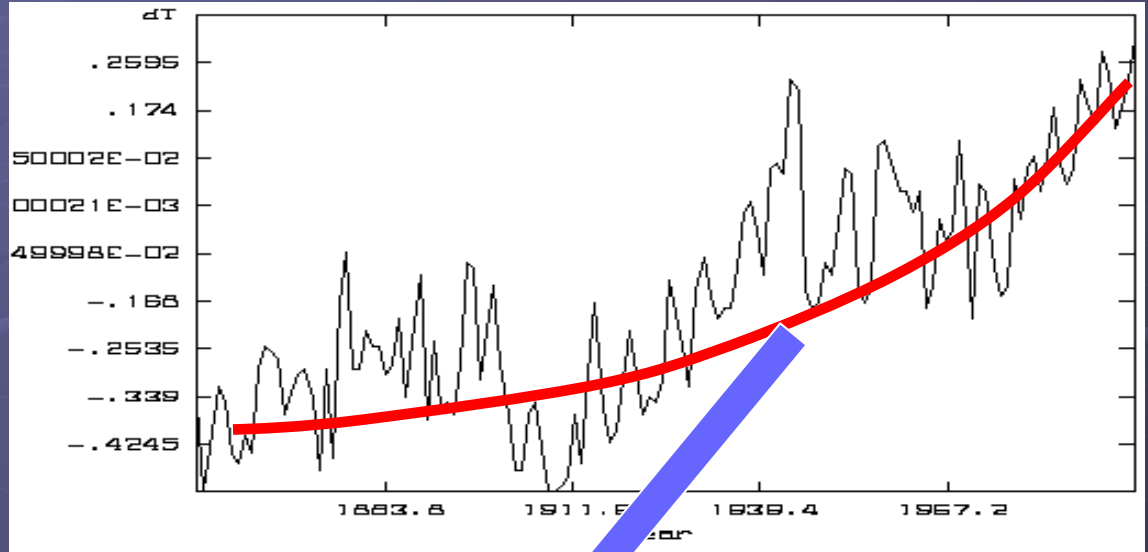
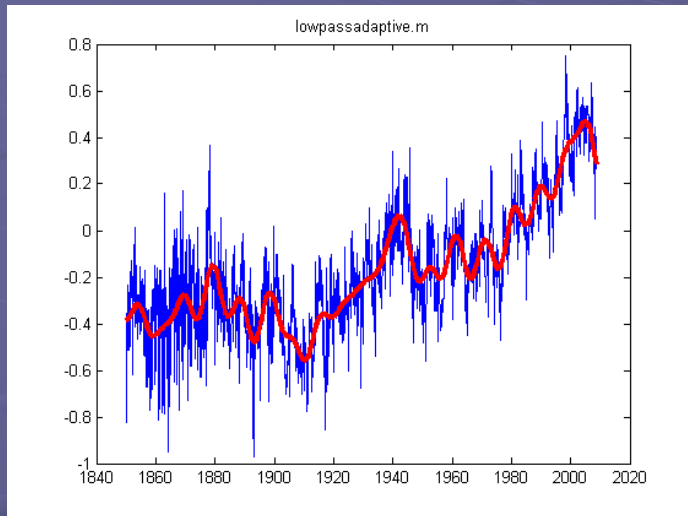
“Gurkovo -01” (1780-1982 AD) (TR-spectra and integral power index S in range 17-25yr)



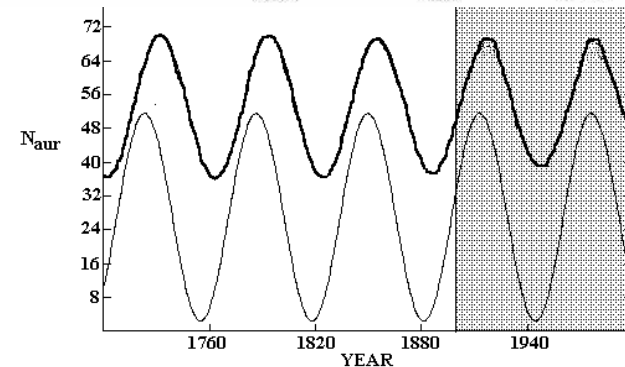
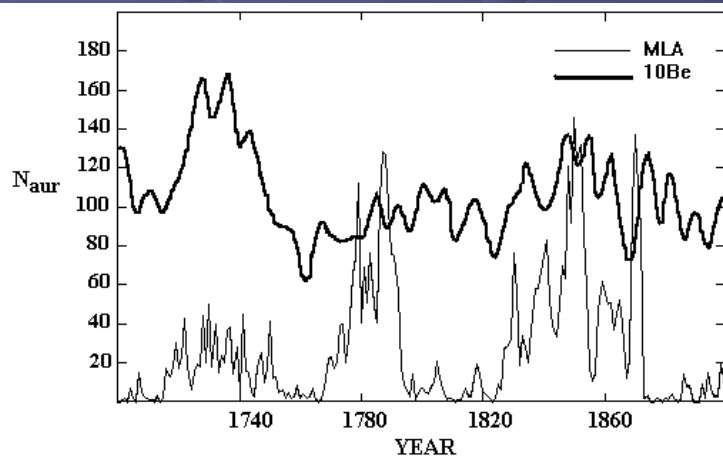
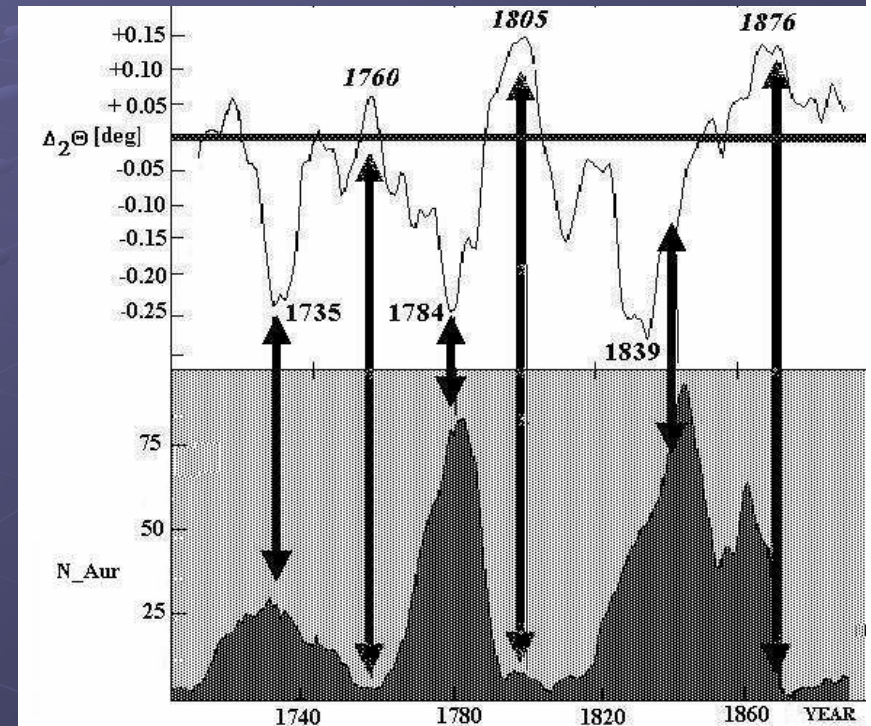
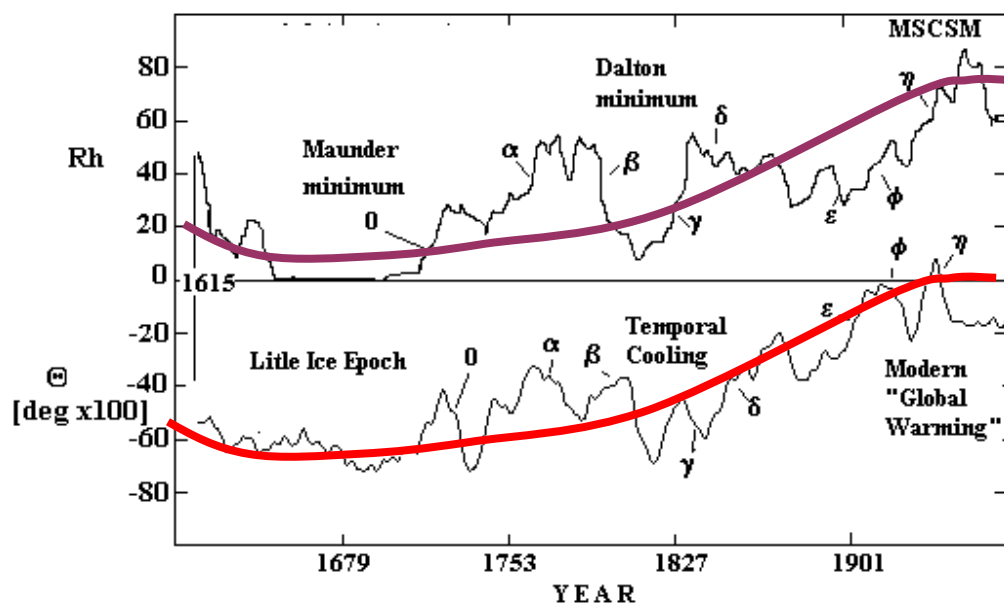
$$S = \int_{T_1}^{T_2} a(T) dT$$



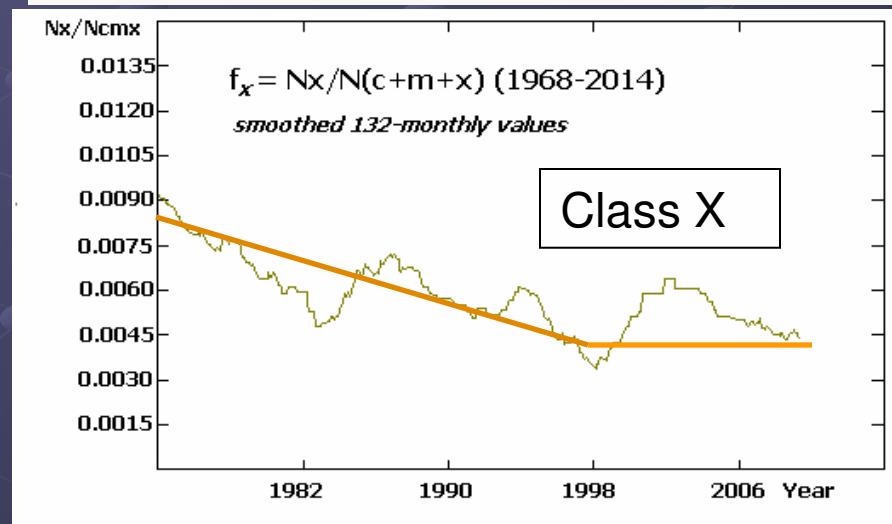
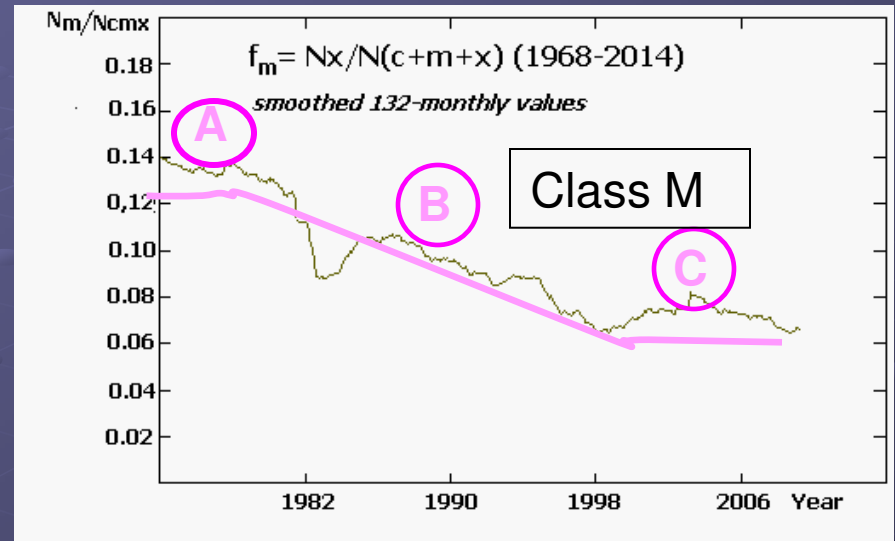
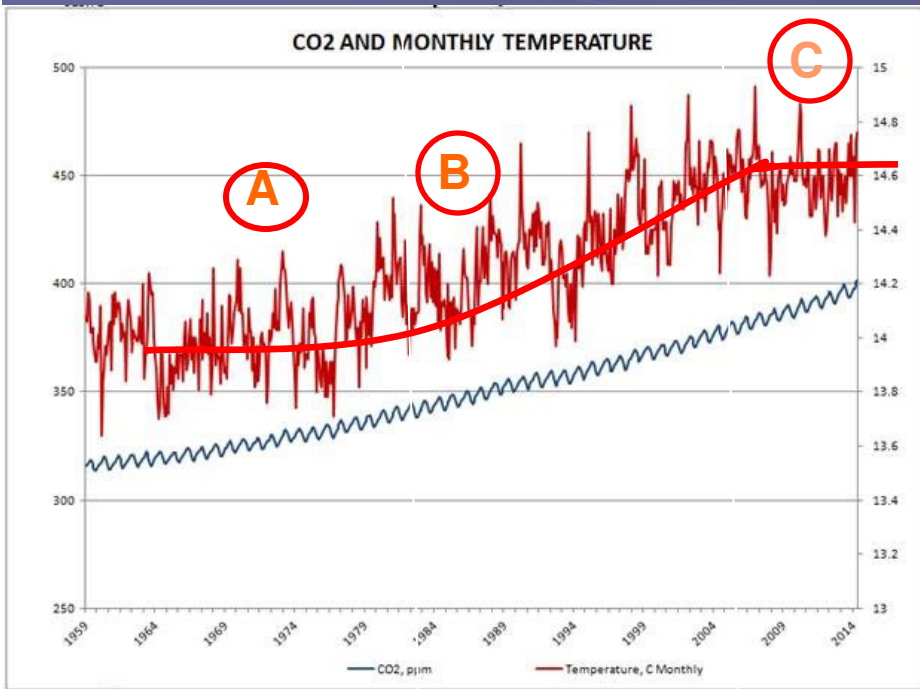
The ~60yr cycle in climate changes during the modern epoch (last ~150-160 years)



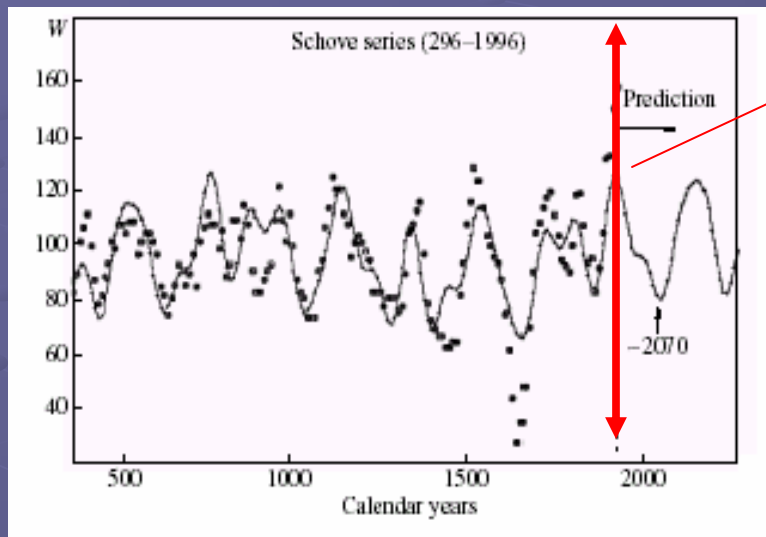
Quasi 60-yr oscillations in auroral (MLA) activity, “cosmogenic” ^{10}Be production rates and climate



Temperature changes during the last decades: The “solar freezer” is TURN OFF ?!...



The new grand solar minimum (1)

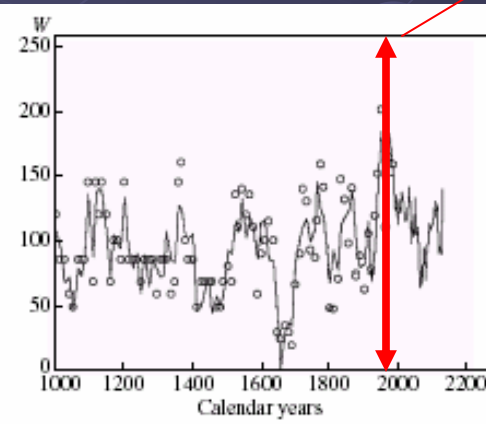
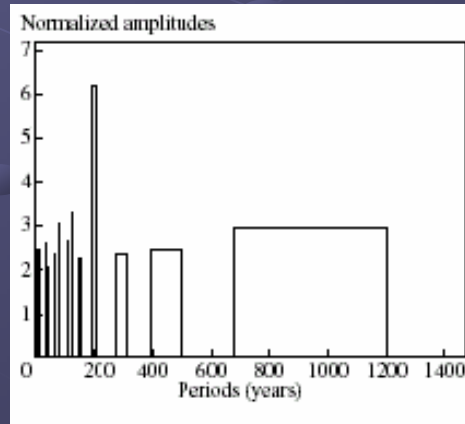


-> forecast

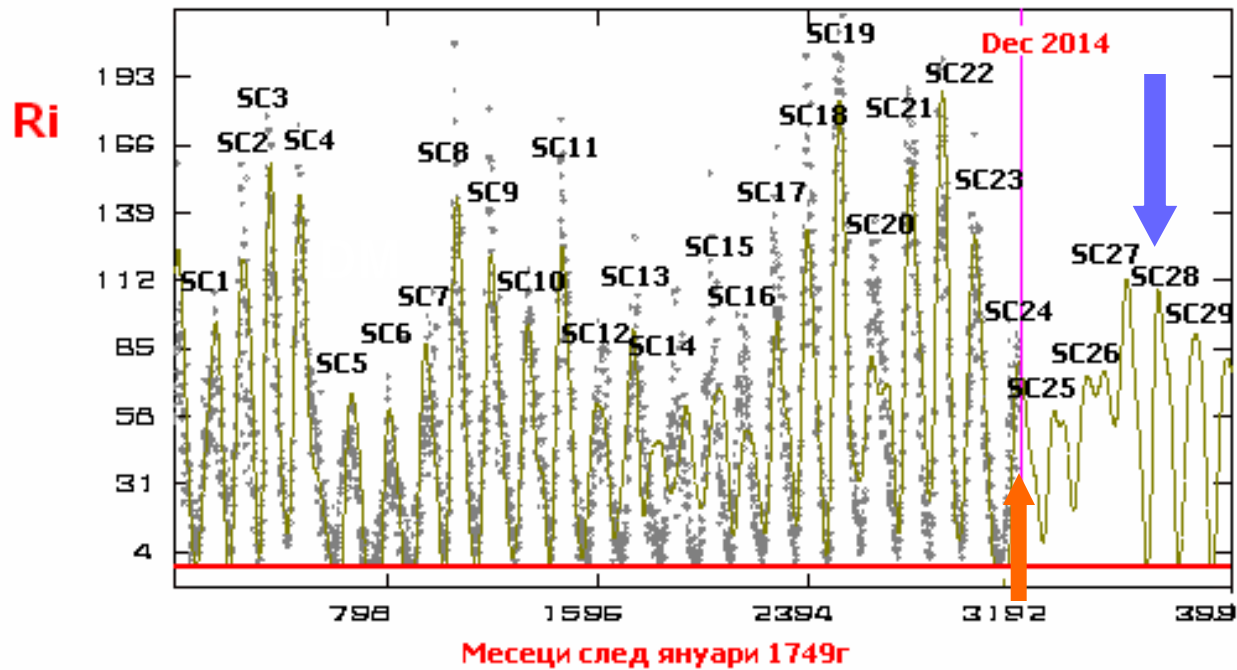
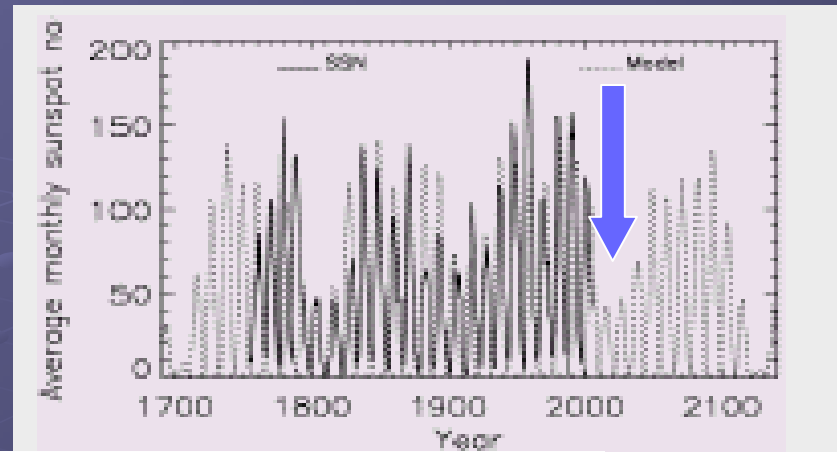
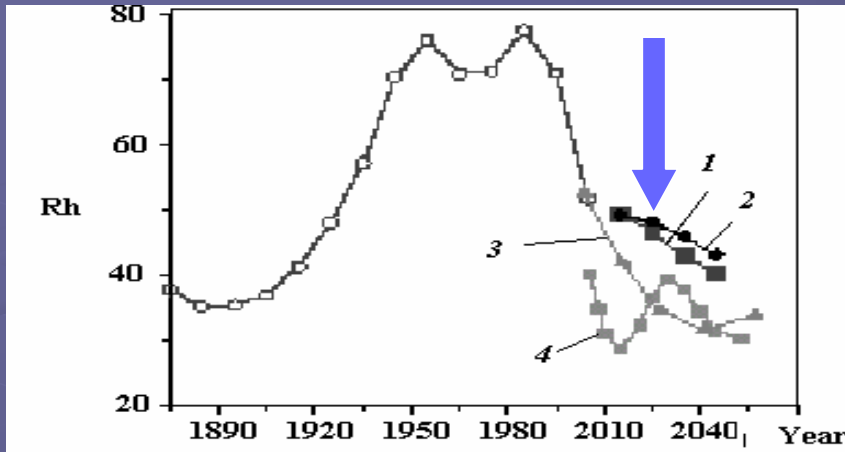
Model based on T-R analysis (Komitov 1986,1997,2001)

->forecast

Model based on Kaftan's method (1994)



The new grand solar minimum (2)



SC26 and SC27: Possible scenario

