

**PREDICTIONS FOR SC25, SC26 AND SC27
MAGNITUDES IN RELATION TO THE LONG TERM
SOLAR ACTIVITY CHANGES**

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THE GRAND SOLAR ACTIVITY MINIMA AND THEIR PREDICTION: SOME IMPORTANT ASPECTS

- **The grand solar minima - quasi regular or stochastic phenomena? / A call for the solar dynamo theory**
- **The new grand minimum in 21st century - Gleissberg, Dalton or Maunder- type? What is the criteria?**
- **The long term solar activity changes and Gnevishhev-Ohl's rule violations . Are the last ones relate to the grand solar minima?**
- **The downward solar activity tendency after 1991 AD- a lucky circumstance and chance for the modern technical infrastructure**
- **The short and terrestrial environment changes (climate, tektonics, biosphere etc.)**

SC25, SC26 AND SC27 MAGNITUDE PREDICTION: USED METHODS

- **A regression model, based on “Waldmeier’s rule” and mean monthly sunspot number data for the first 18-36 months after the corresponding Schwabe-Wolf’s cycle (for the present SC25) (already successfully used for SC24)**
- **Autoregression models, describing the relationships between adjacent sunspot cycles magnitudes in Schöve series (for SC25 and SC26)(already successfully used for SC24)**
- **Time series models for the Zurich series, based on T-R periodogram procedure and their extrapolation until 2080 AD (for SC25, SC26 and SC27)**

TWO-FACTOR REGRESSION MODEL FOR MAGNITUDE OF SCHWABE-WOLF'S CYCLE, BASED ON INSTRUMENTAL DATA AND WALDMEIER' RULE. APPLICATION TO SC24

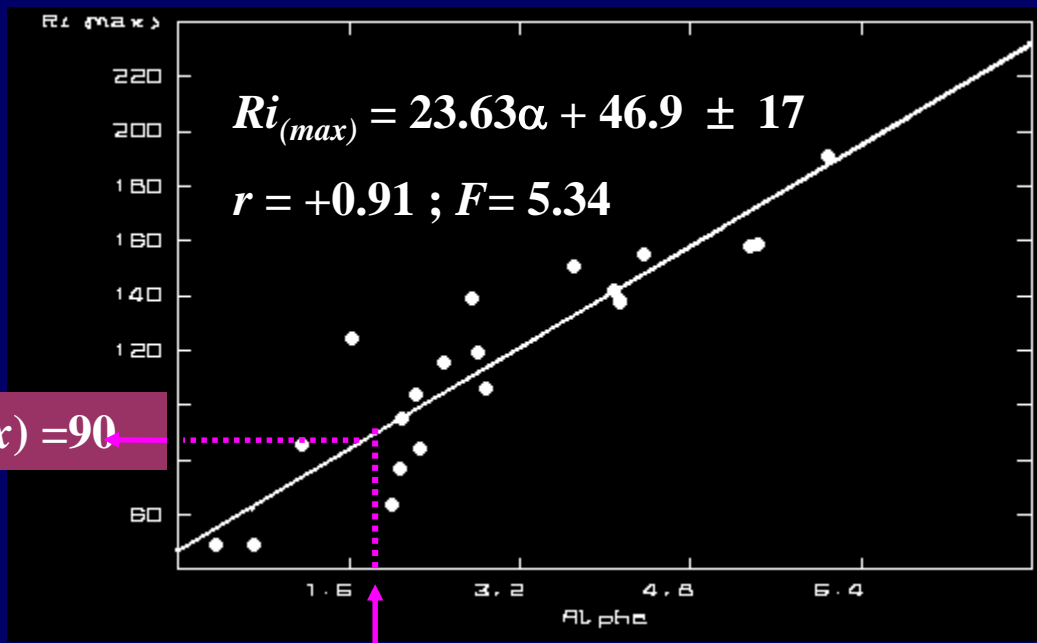
(Komitov et al.2010, Komitov and Kaftan 2011)

Determined on the base of monthly Ri data for the first 36 months after the SC- minimum

$$\alpha = \frac{dRi}{dt}$$

Rm - the mean monthly value of Ri during the minimum

$Ri_{(max)}$ - the solar cycle (SC) magnitude



α (SC24) = 1.89

For SC 24 magnitude:

$$Ri_{(max)} = 86.5 \pm 16$$

Real SC24 magnitude = 82

Two- factor regression model:

$$Ri_{(max)} = 20.76\alpha + 1.94 Rm + 41.5 \pm 16$$

$R = +0.92 ; F = 5.97$

SC

A FORECAST FOR SC25

$$Ri_{\max} = A\alpha + B ; Ri_{\max}(SC25) = 99 \pm 26$$

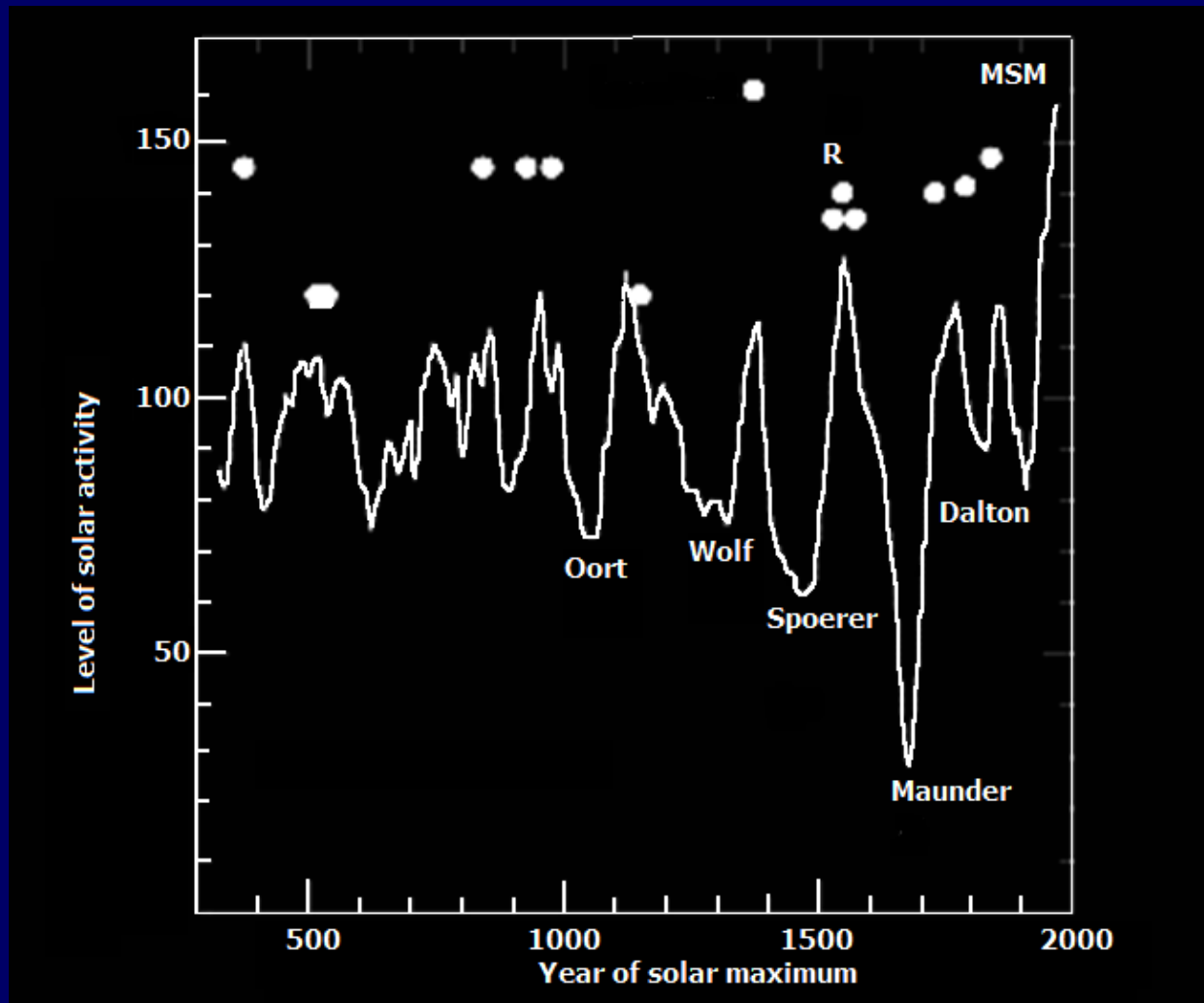
$$SN_{\max}(SC25) = 149 \pm 39$$

$$Ri_{\max} = A\alpha + B.R_m + C ; Ri_{\max}(SC25) = 99 \pm 26$$

$$SN_{\max}(SC25) = 100 \pm 39$$

THE SCHOVE'S SERIES (296-2000 AD)

(Komitov, 1997; Komitov and Bonev, 2000, 2001)



AUTOREGRESSION RELATIONSHIPS BETWEEN SUNSPOT CYCLES MAGNITUDES IN SCHOVE SERIES (296-2000 AD) (*Komitov, 2007*)

$$\Delta W_{max}(2n, 2n+2) = 98.5 - 1.06W_{max}(2n) ;$$

$$R = -0.71 ; F = 2.04 ; F^*(99\%) = 1.59$$

$$W_{max}(SC24) = 89 \pm 29 \quad 2n \rightarrow (W_{max}(SC22) = 157)$$

$$W_{max}(SC26) = 96 \pm 29 ; \quad 2n \rightarrow (W_{max}(SC24) = 82)$$

$$\Delta W_{max}(2n, 2n+2) = 69 - 1.16W_{max}(2n) + 0.4W_{max}(2n+1) ;$$

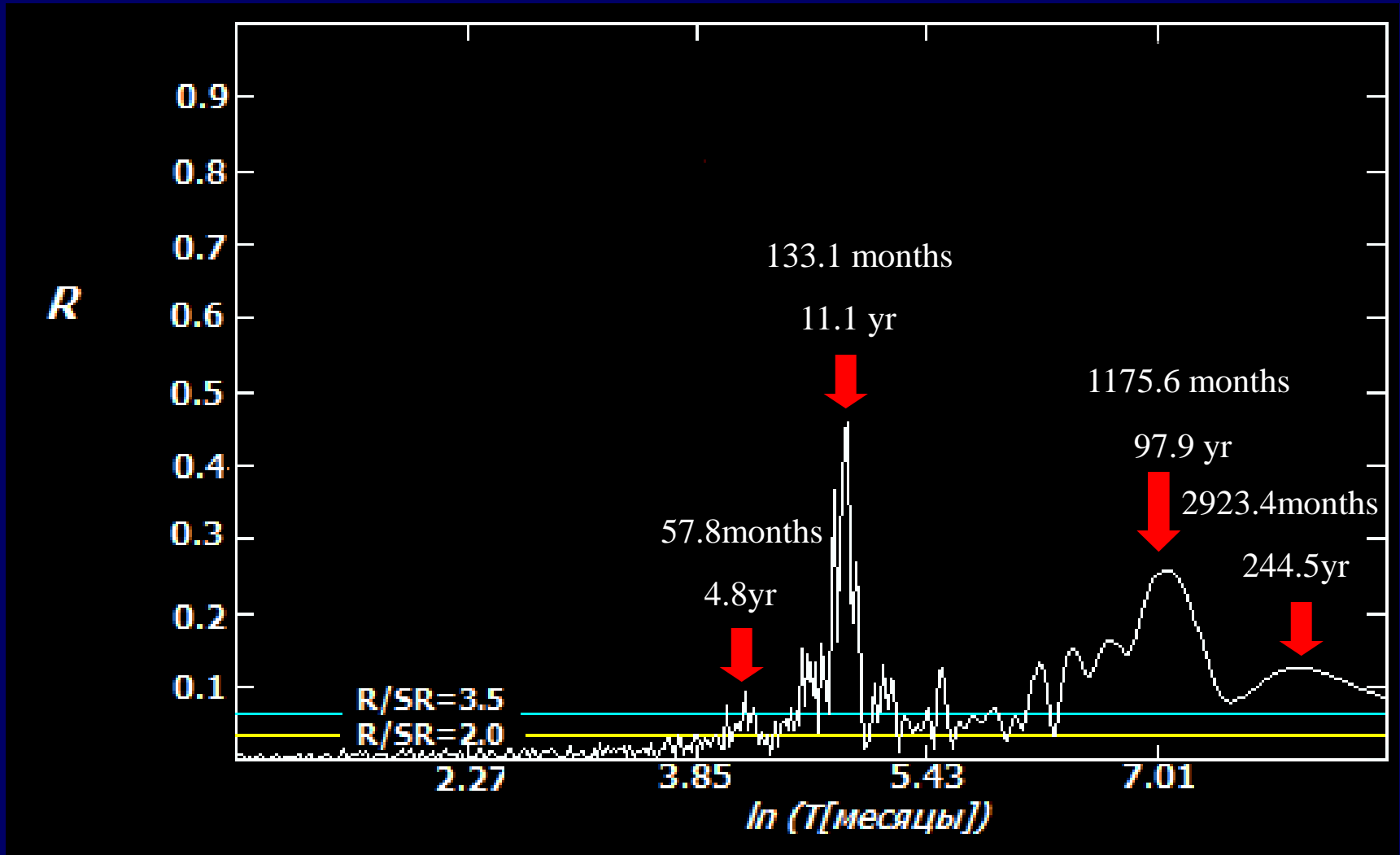
$$R = 0.78 ; F = 2.45 ; F^*(99\%) = 1.59$$

$$W_{max}(SC24) = 92 \pm 27 ; \quad 2n \rightarrow (W_{max}(SC22) = 157) ; \quad 2n+1 \rightarrow (W_{max}(23) = 121)$$

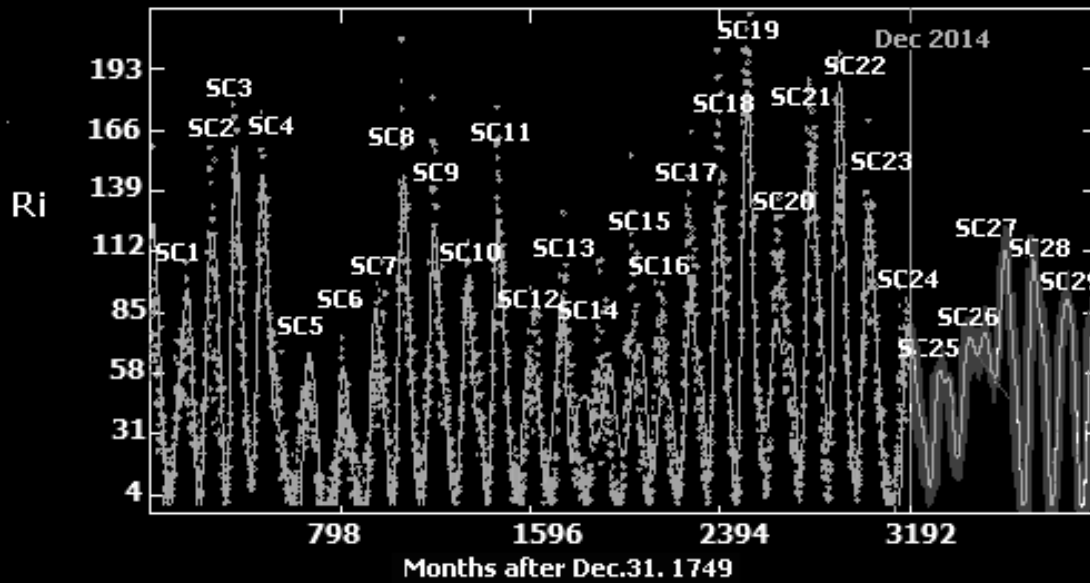
$$W_{max}(SC26) * = 94 \pm 27 ; \quad 2n \rightarrow (W_{max}(SC24) = 82) ; \quad 2n+1 * \rightarrow (W_{max}(25) = 99*)$$

ZURICH SERIES R_i (1749-2015): T-R SPECTRA

$T_0 = 2$ months; $q = 1.02$; $m = 400$; $T_{max} = 2 * 1.02^m = 5508$ months
(459 years)



KINEMATIC MODELS OF Ri and SN TIME SERIES AND THEIR EXTRAPOLATION



$$Ri_{max}(SC24)=78 \pm 26$$

$$Ri_{max}(SC25)=58 \pm 26$$

$$Ri_{max}(SC26)=79 \pm 26$$

$$Ri_{max}(SC27)=113 \pm 26$$

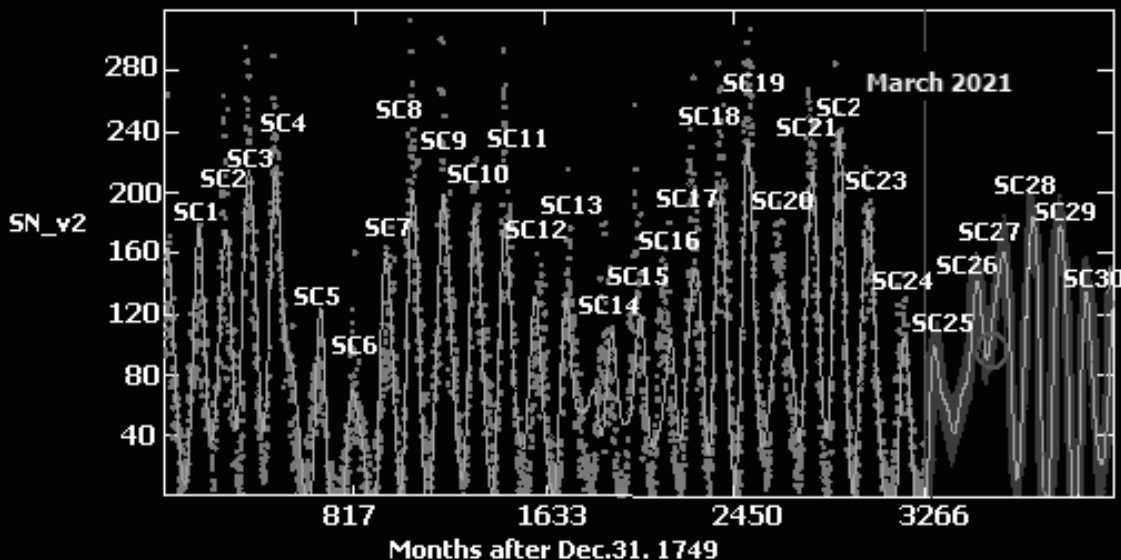
G-O rule
violation?!

$$SN_{max}(SC24)=122 \pm 38$$

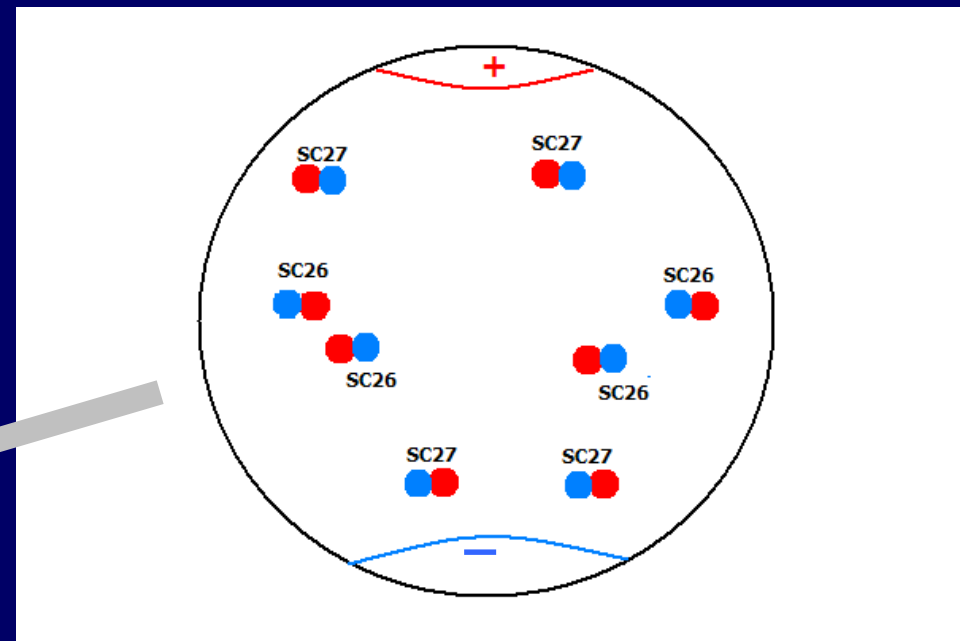
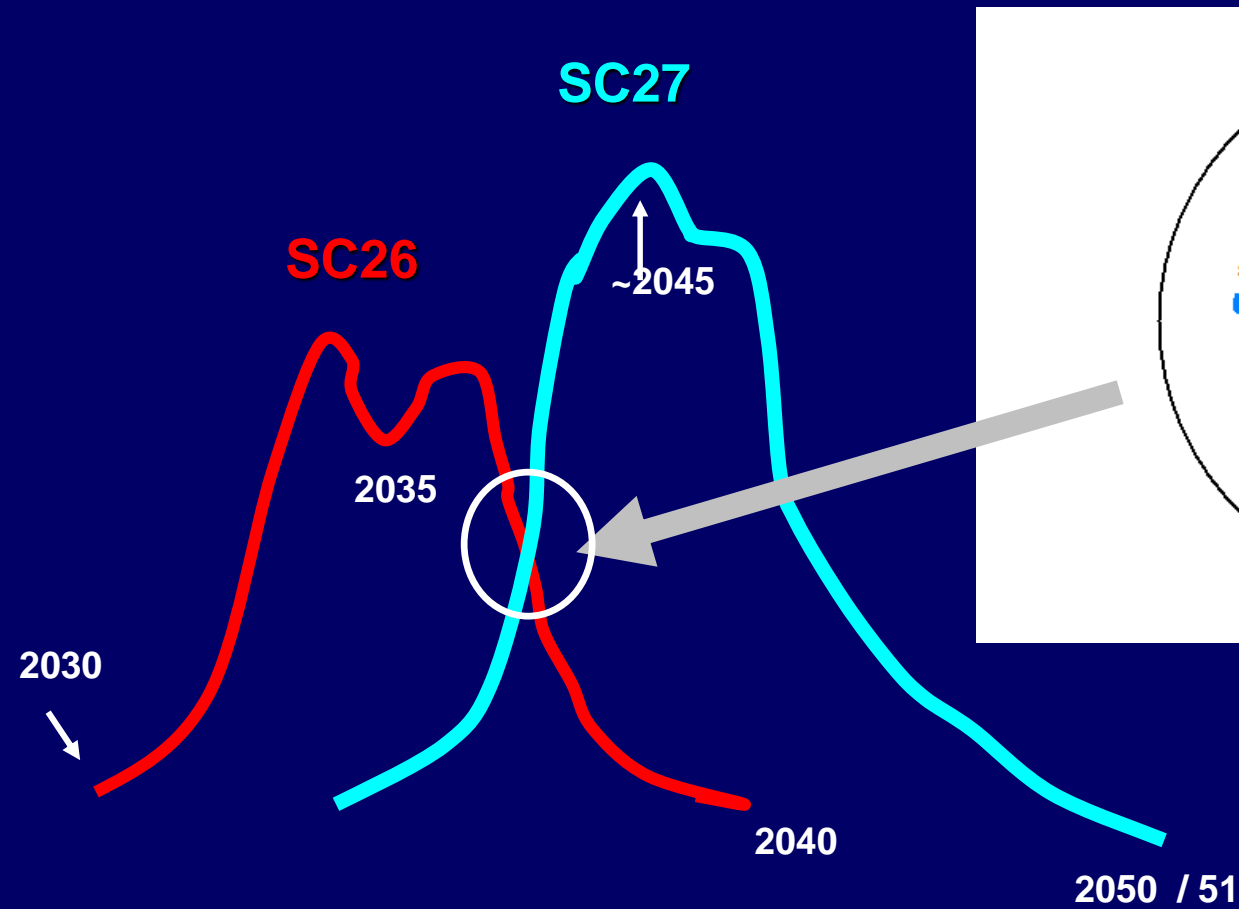
$$SN_{max}(SC25)=97 \pm 38$$

$$SN_{max}(SC26)=142 \pm 38$$

$$SN_{max}(SC27)=164 \pm 38$$



THE MINIMUM BETWEEN SC26 AND SC27: A POSSIBLE SCENARIO



CONCLUSIONS

- The used there three types of forecasting models has been successfully tested for SC24. The predicted values of SC24 magnitude are enough close to the real one
- SC24 as well as the predicted SC25, SC26 and SC27 magnitudes indicate for relative low or middle levels of solar activity for the first half of 21st century, essentially lower than during the middle and second half of 20th century. The most powerful from all these ones (SC27) seems to be slightly lower than SC23
- The kinematic models extrapolation in combine with the G-O rule violation for SC22-SC23 and (possible) for SC24-SC25 indicates for a continuous and "flat" Dalton-type grand minimum, which has been started after SC22 and ended \sim 2080 AD. Its morphological features should be rather similar to the grand minima before 1000 AD as to these during the second calendar millenium.
- A "phase catastrophe" for the pair SC26-SC27 between 2030- 2040 AD is possible

Thank you !