

**ACTIVITY indices represent the  
solar**

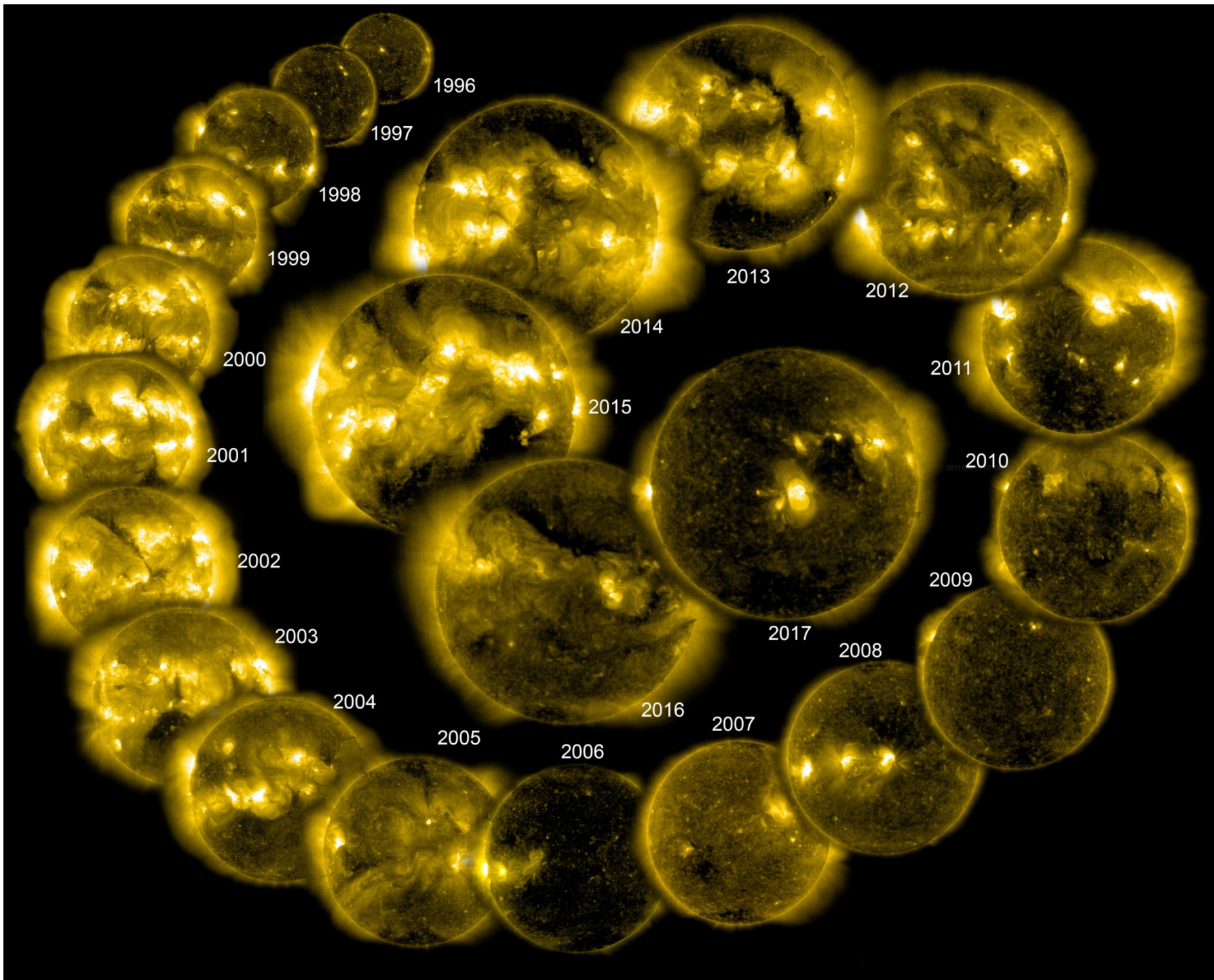
**Cycles and the effects of their  
solar-terrestrial connections.**



**Bulgaria, June 4 - 8, 2018**

**TENTH WORKSHOP : "Solar Influences on the  
Magnetosphere, Ionosphere and Atmosphere"**

**M.Ryabov, A. Sukharev, L. Sobitnyak ,  
Odessa observatory "URAN-4" Radio Astronomy Institute  
of the National Academy of Sciences of Ukraine.**



# Abstracts

- **Systematization of solar activity indices was held out that represent physical characteristics based on data from cycles of discreteness and continuity, N-S asymmetry of wave and corpuscular manifestations. As such indices daily data was examined on total area groups of sunspots-Sp, Wolf numbers-W, "Spotless" index separately for the northern and southern hemispheres of the Sun.**

# Abstracts

- **The properties of « directly function» for indexes : Sp, W, total solar irradiance (TSI), and flux radio emission at 10.7 cm wave were considered . On this basis the substantiation of efficiency of their influence on the Earth was made.**
- **Additionally we offer the records of Earth motion in orbit, when it turns out to be under the influence of activity of Northern, Southern hemispheres of the Sun or is in the plane of the Solar equator. The result of the impact of solar activity on the Earth has a limited and selective character and can be determined according to the modified "geoeffectivity" indices.**

# Abstract

- **Each of these indices shows properties of solar cycles that are not visible when you use their monthly and smoothed values for the full solar disk. Analysis of the total solar irradiance (TSI ) according to the satellite observations for the period from 1978 to 2017 was conducted using correlations and Wavelet analysis.**

# Important problem

- **The basis for the submission of development of solar cycle for many years are calculated index- mean month Wolf numbers.**
- **On the basis of these data the impression of continuous smoothed the process of development of the solar cycle.**
- **These are statistical data and does not allow you to explore the real physical processes shaping the solar cycle.**

## **Solar and Solar – Terristreal Indexes (every days, mean months and years)**

- **W- Wolf number (calculated )**
- **Sp – summery sunspots area (observation) –  
N-S data on long time interval.**
- **F 10.7 cm radio flux (observation)**
- **Solar wind parameters (velocity and  
pressure)**
- **Geomagnetic indexes**
- **And many others!**

# SILSO data

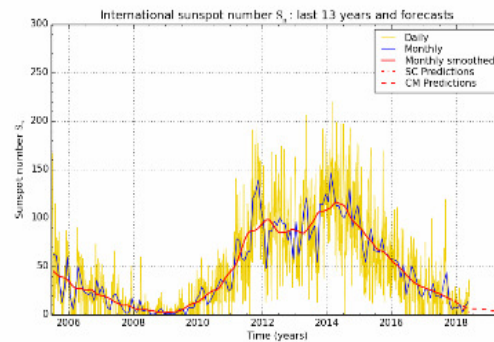


Sunspot Index and Long-term Solar Observations

## Menu

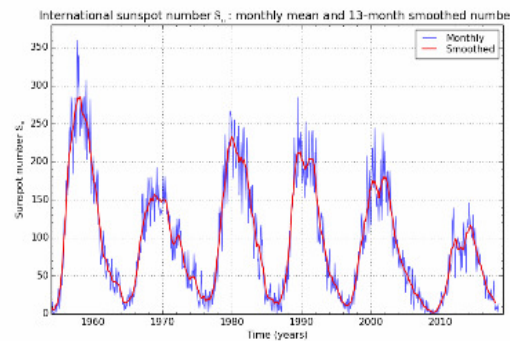
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## Sunspot Number

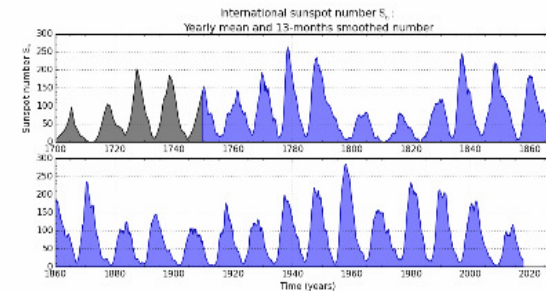


SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2018 June 1

Daily, monthly and 13-month smoothed sunspot numbers for the past 13 years, and 12-month ahead predictions.

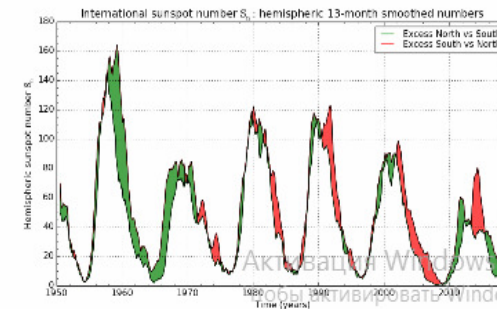


SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2018 June 1



SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2018 June 1

Yearly mean and 13-month smoothed monthly sunspot number since 1700.



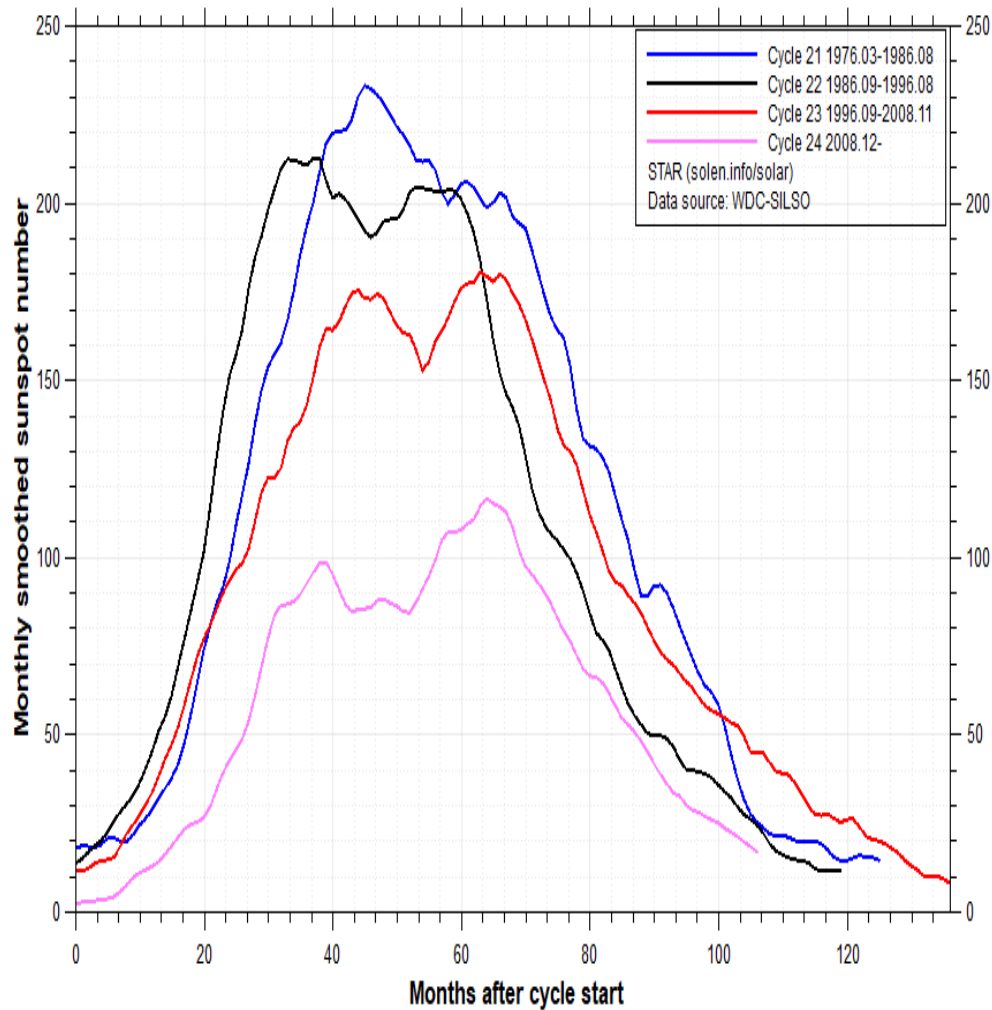
SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2018 June 1

North and South hemispheric sunspot numbers (13-

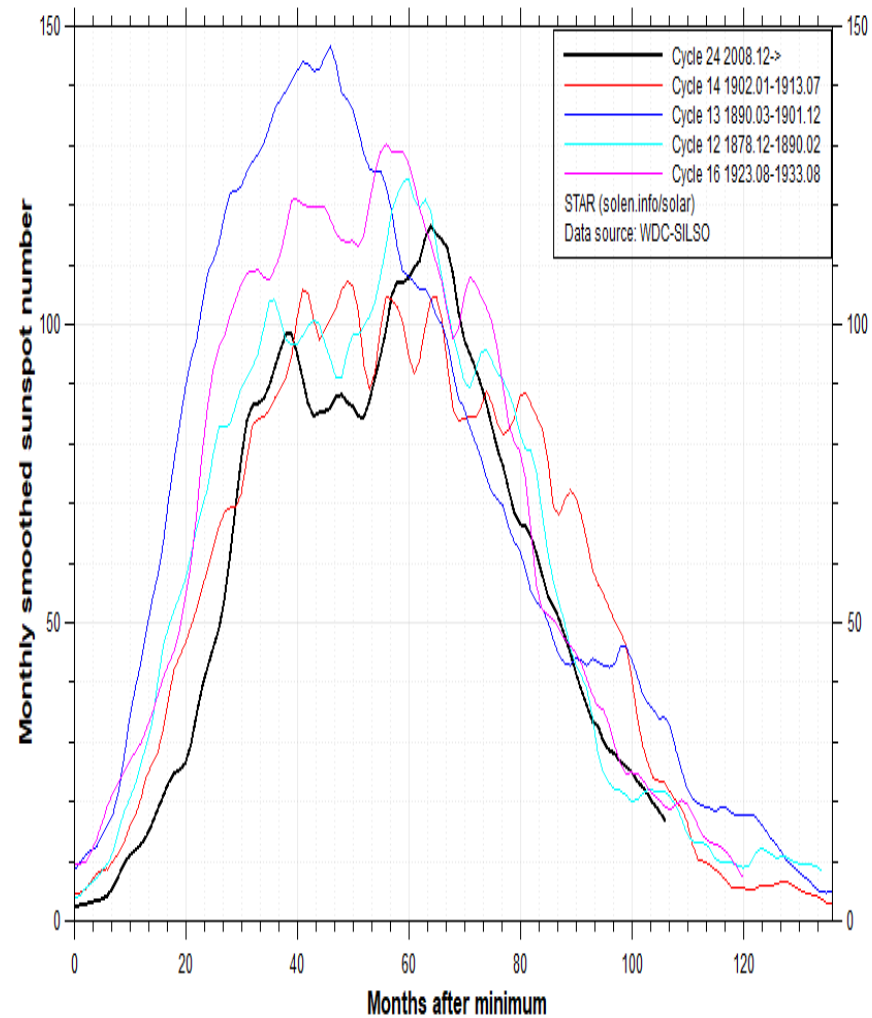




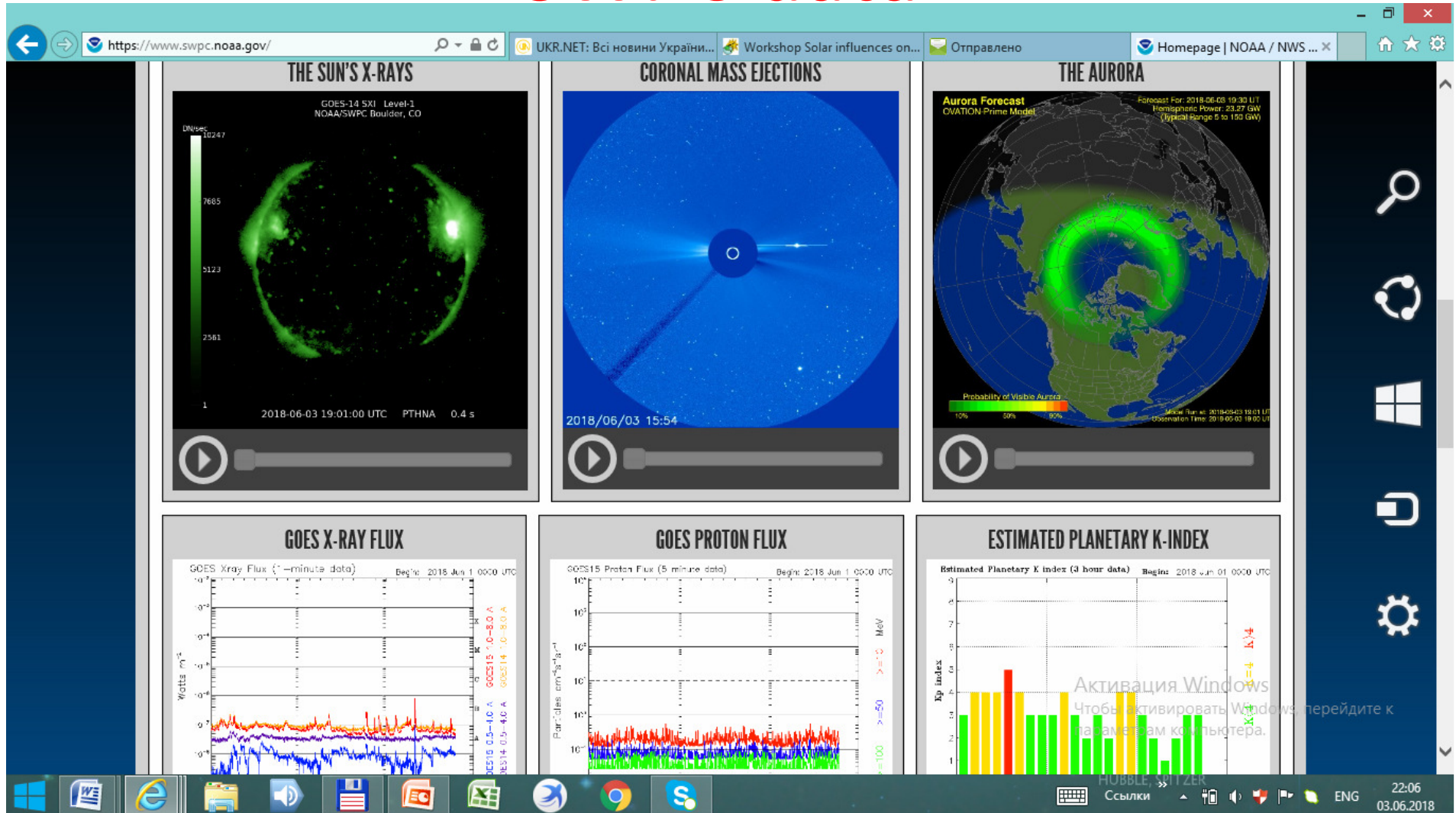
### Last solar cycles comparison



### Similar amplitude solar cycles comparison



# SWPC data



# Results statistical investigations

- **Solar cycle appears to be a continuous smoothed the process on the based only W mean monthly data.**
- **Calculated minimum, time phases of rise, maximum and increase of the solar cycle.**
- **N-S asymmetry is considered as a result of the time shift.**

ENG 中文

- What is SOS?
- Getting SOS
- Education
- SOS Explorer
- Datasets**
- Support

# Science On a Sphere<sup>®</sup>

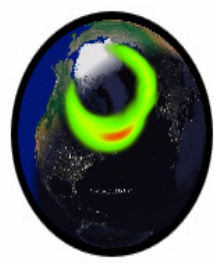
National Oceanic and Atmospheric Administration



Search datasets  Submit Categories ▾ Live Programs

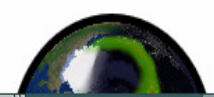
## Search Results

Datasets found for "space weather": 8



**Aurora** Apr. 17, 2013  
**Duration:** Sep. 30, 2012 to Oct. 01, 2012  
**Keywords:** Ovation, Aurora Borealis, Aurora, Space Weather, Northern Lights, Astronomy

**Dataset Contact:** NOAA / Space Weather Prediction Center (SWPC)  
**Visualization Developer:** NOAA / Space Weather Prediction Center (SWPC)

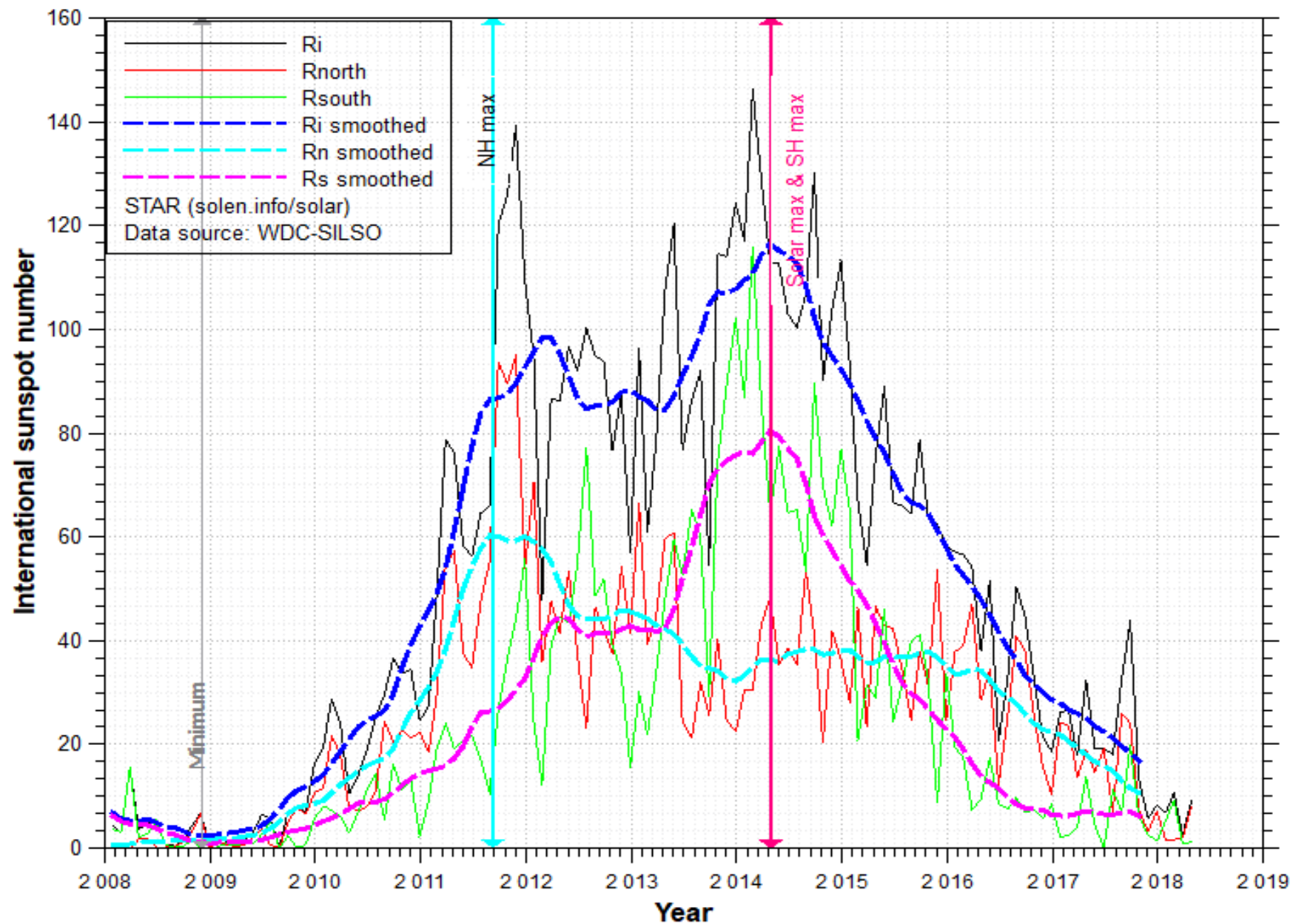


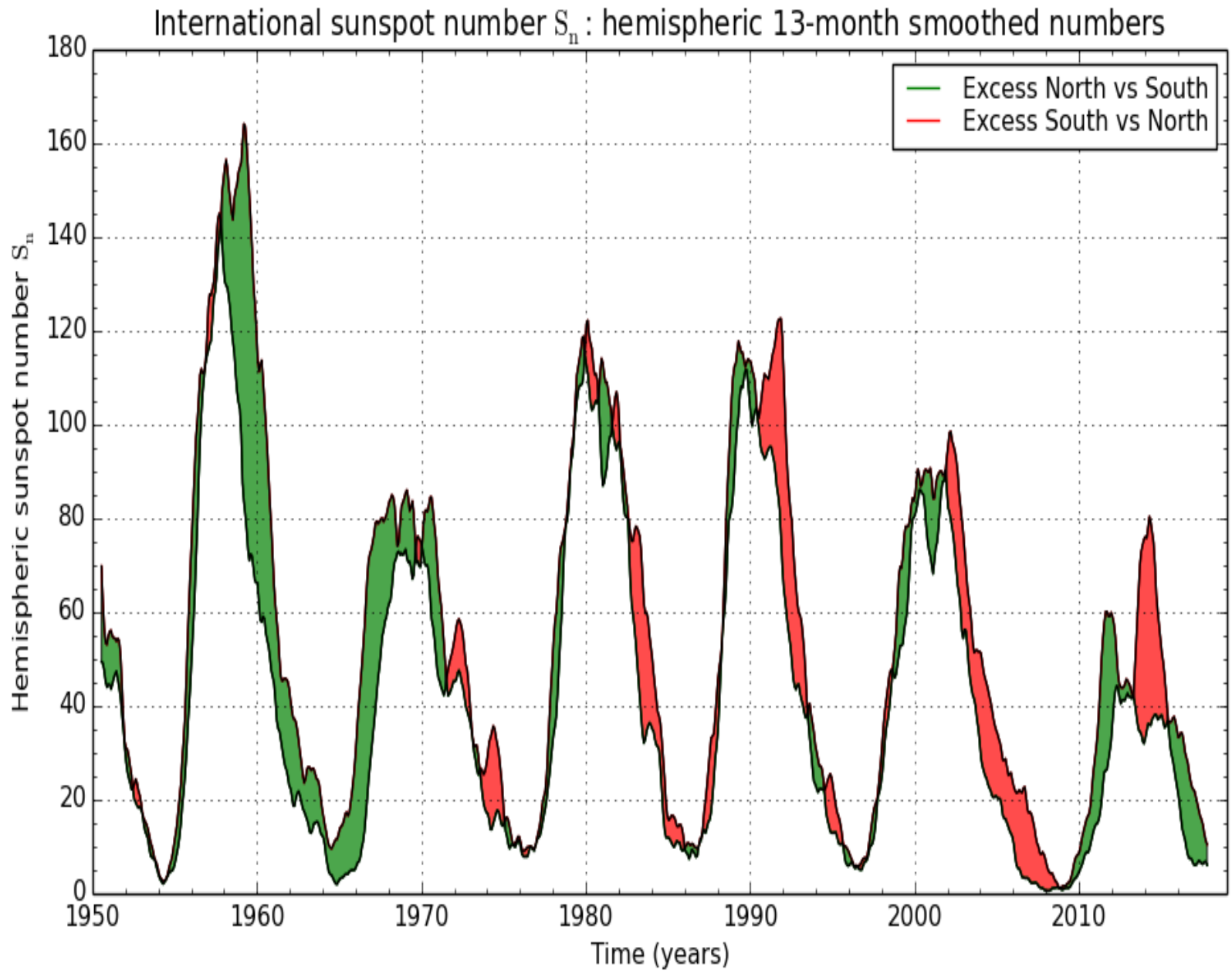
**Aurora with Air Traffic** Apr. 17, 2013  
**Duration:** Sep. 30, 2012 to Oct. 01, 2012

**Dataset Contact:** NOAA / Space Weather Prediction Center (SWPC)

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# Solar cycle 24 progress





# Physical properties of solar activity indices

- Discreteness of the data observation.
- The difference of the northern and southern hemisphere activity.
- Directly influence
- Consider the manifestation of each of these properties.

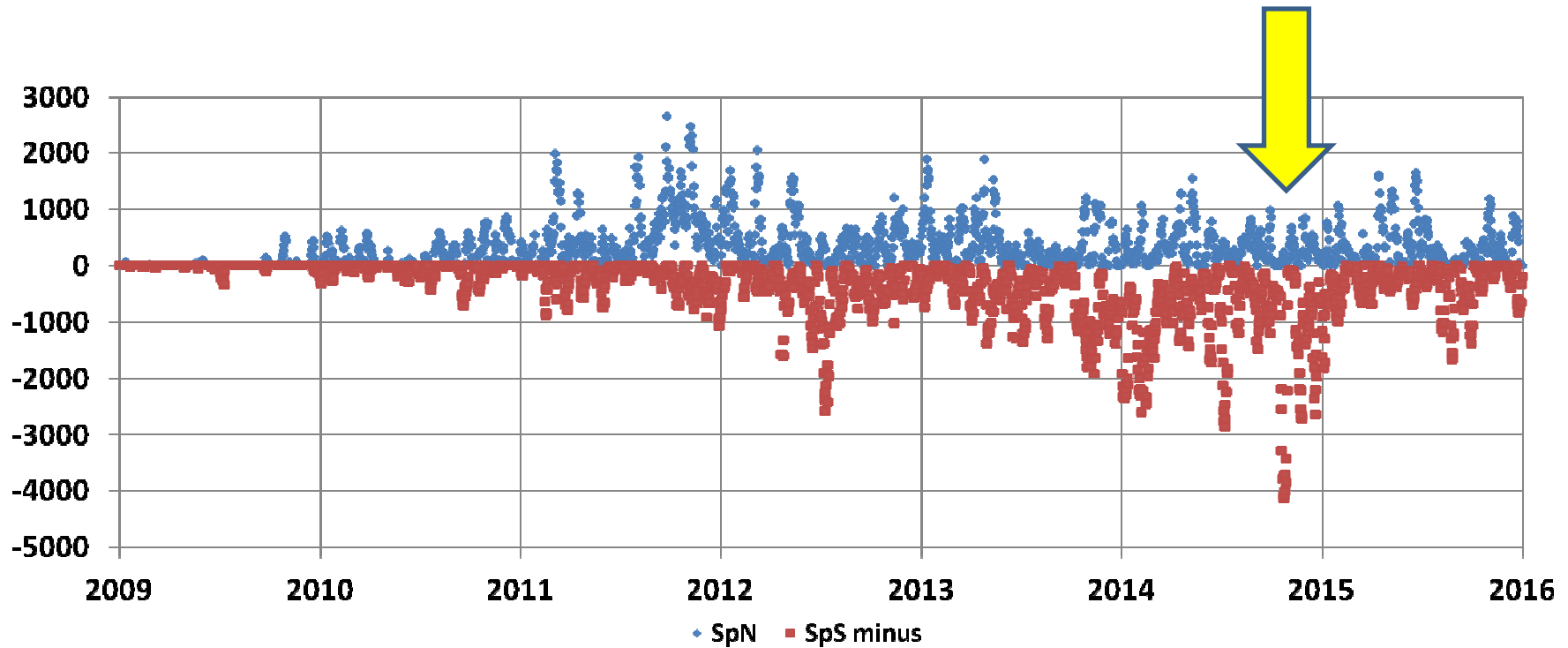
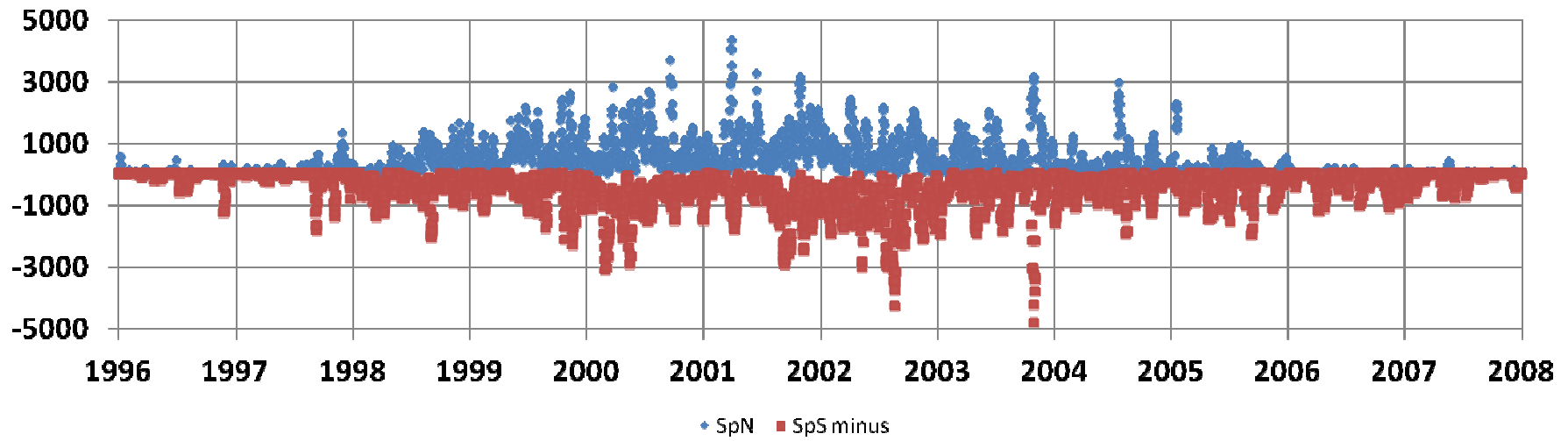
# Alternative solutions

- Alternative solutions are implemented not only by time and amplitude processes but also with the use of the research results of wave processes forming the solar cycle.
- For these purposes we use the wavelet analysis and Fourier filtering.
- Alternative to N-S asymmetry is a separate consideration of the manifestations of the northern and southern hemisphere activity.

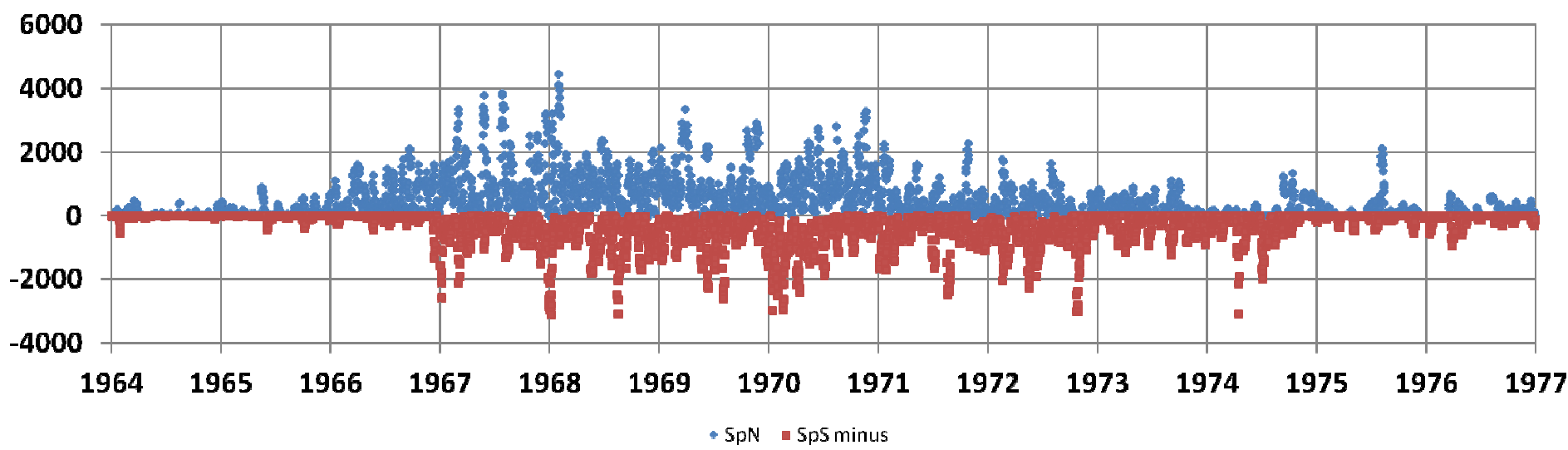


- **N-S asymmetry cycles**
- **N and S cycles ?**

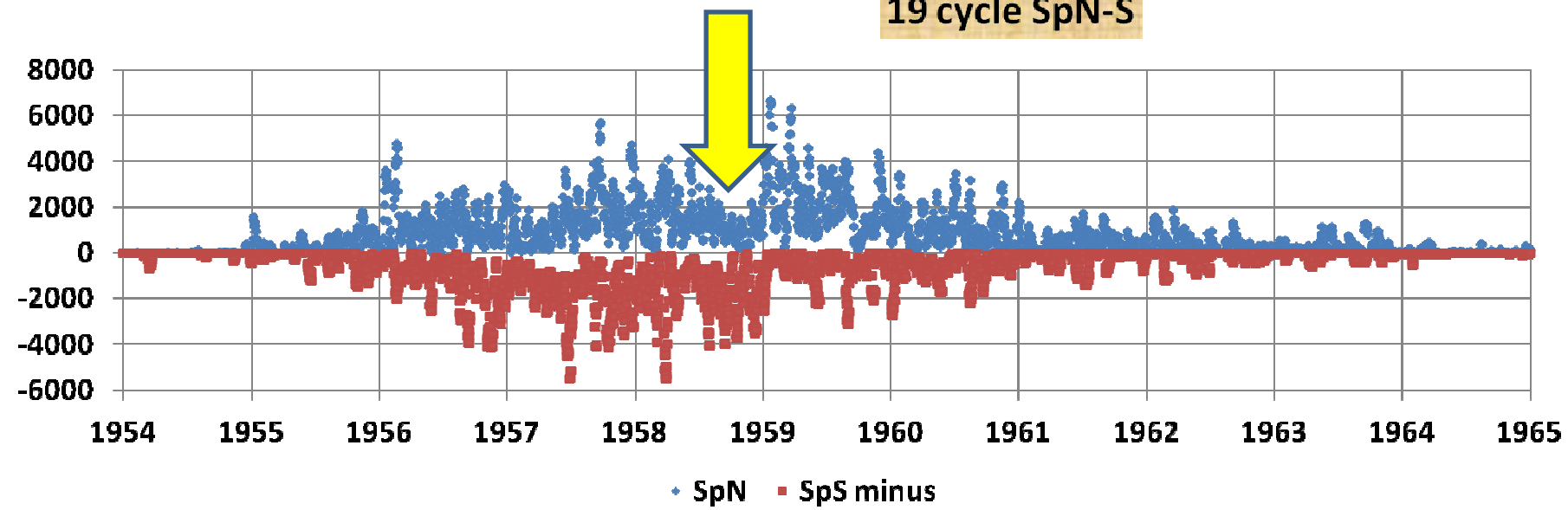
### 23 cycle SpN-S days



### 20 cycle SpN-S

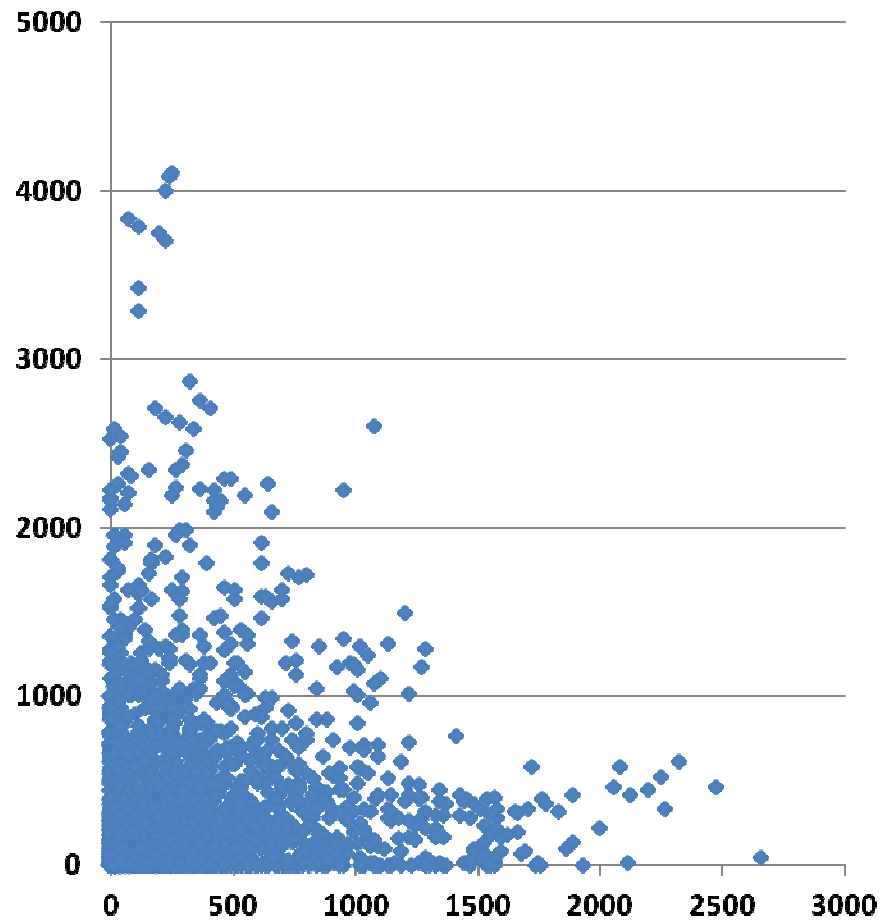


### 19 cycle SpN-S

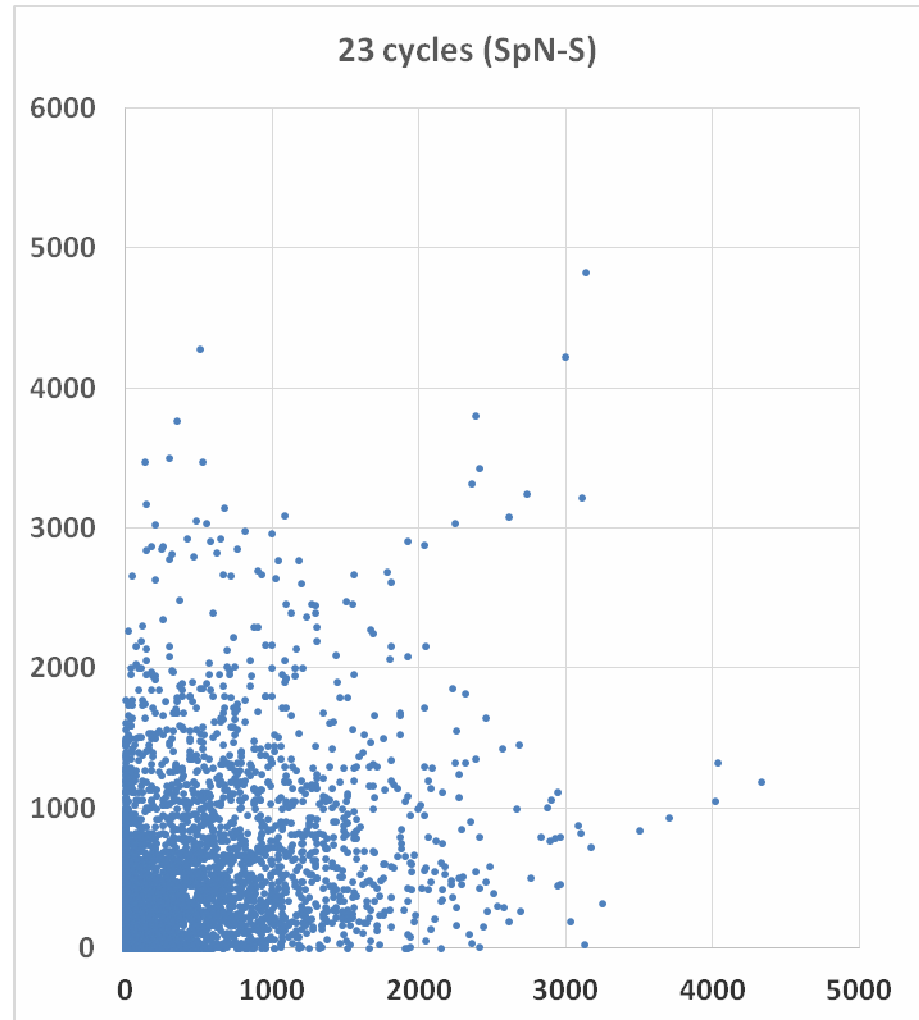


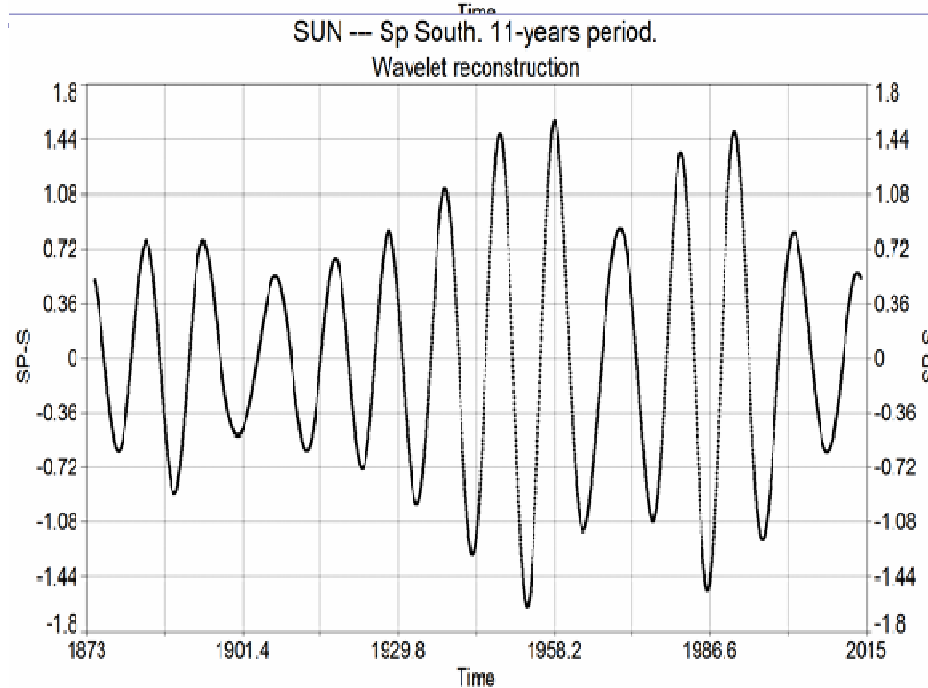
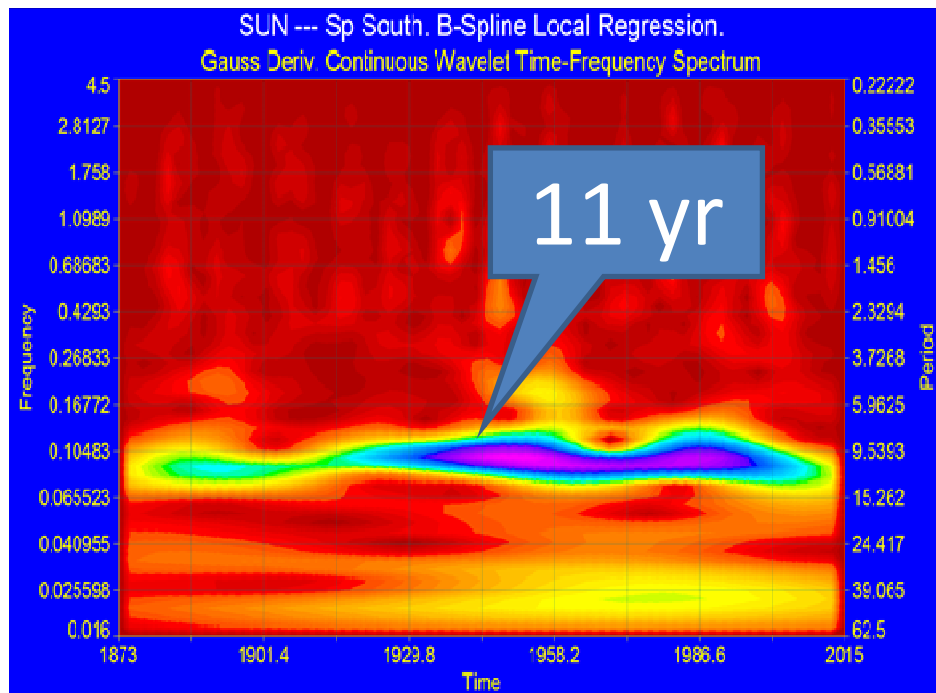
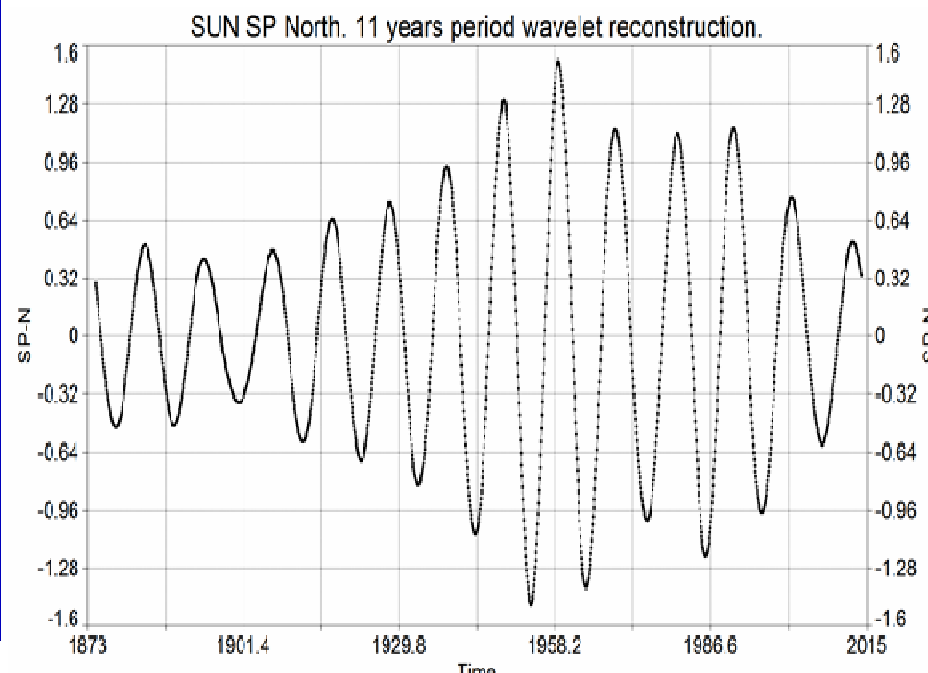
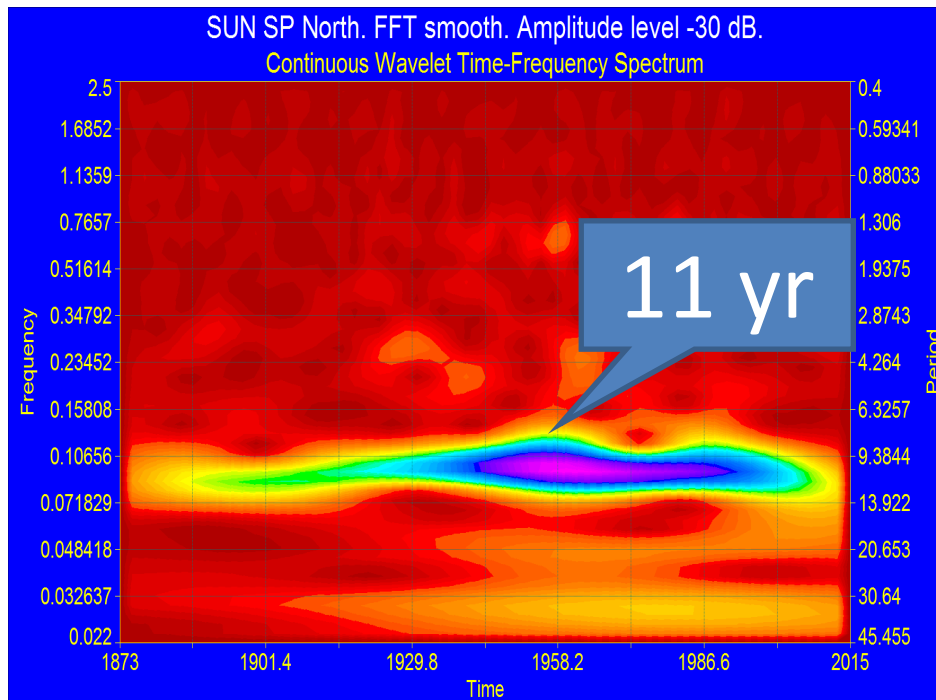
# 23 – 24 cycle ( SpN-S)

24 cycle (SpN-S)

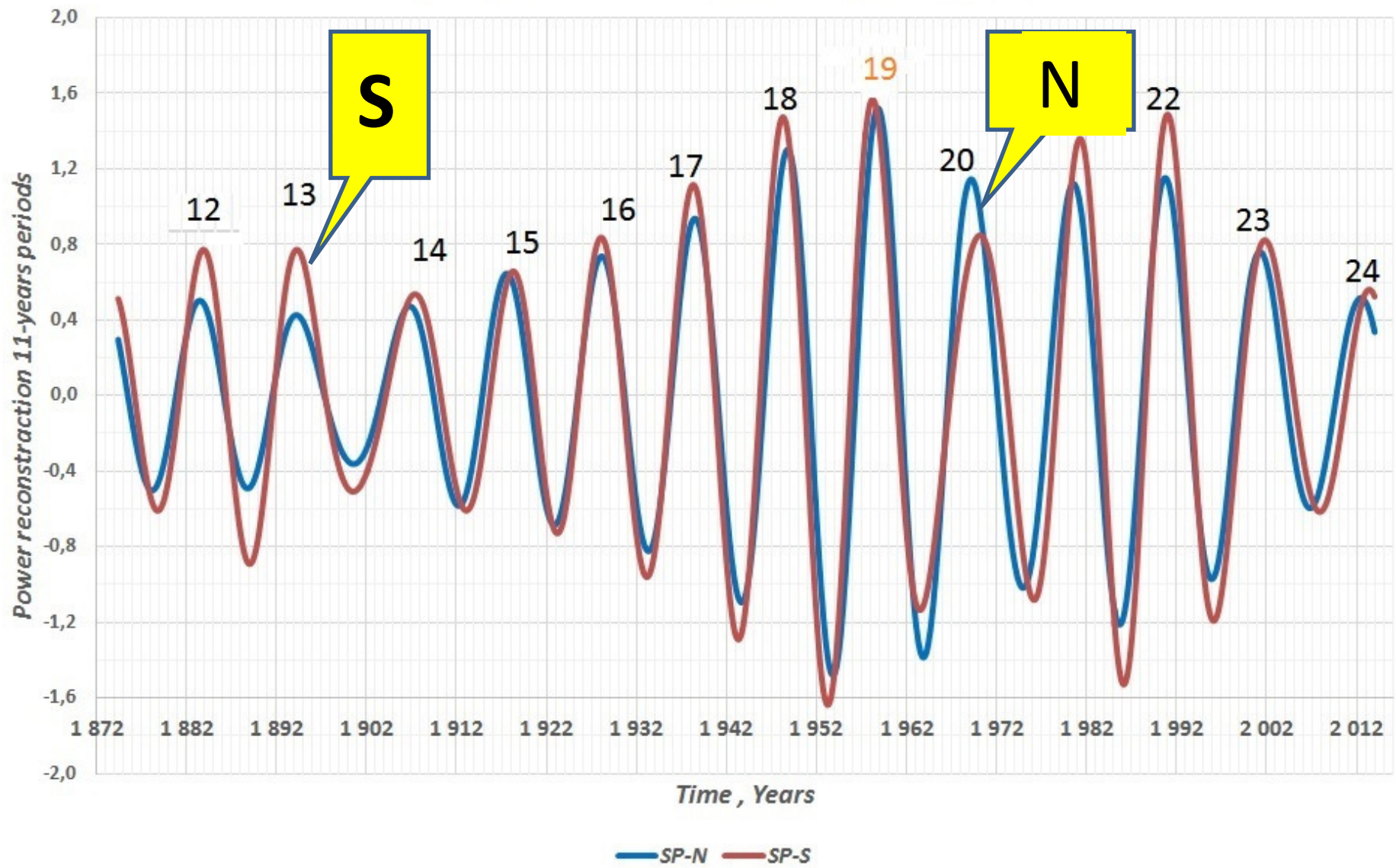


23 cycles (SpN-S)



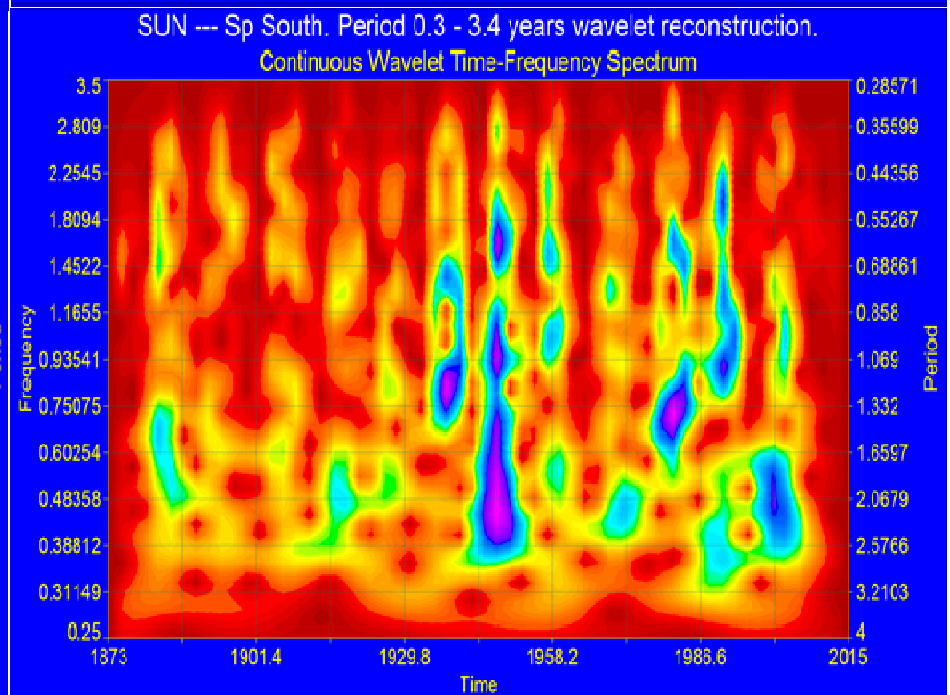
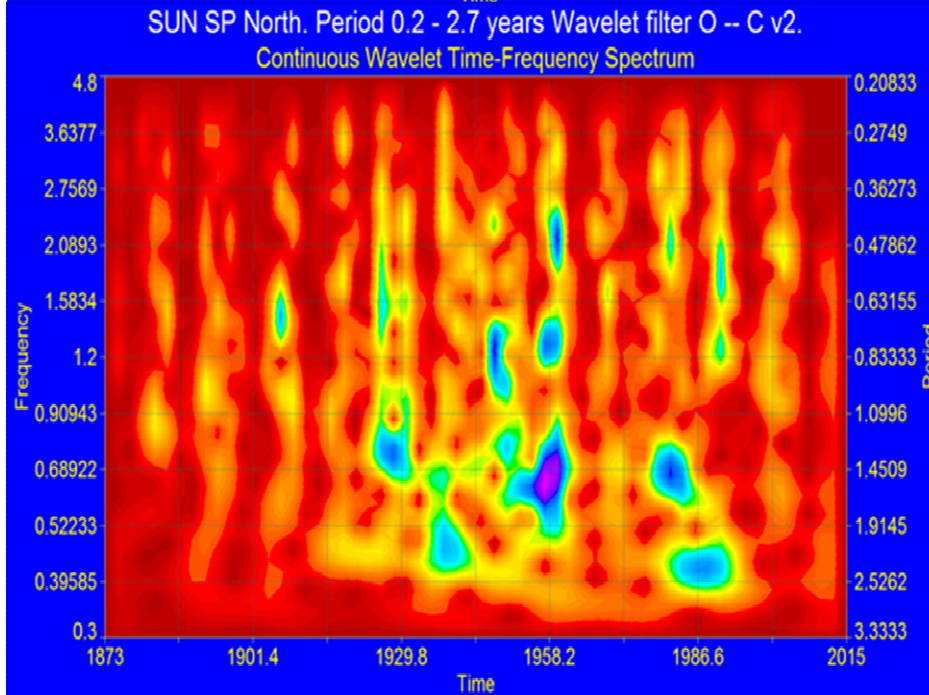
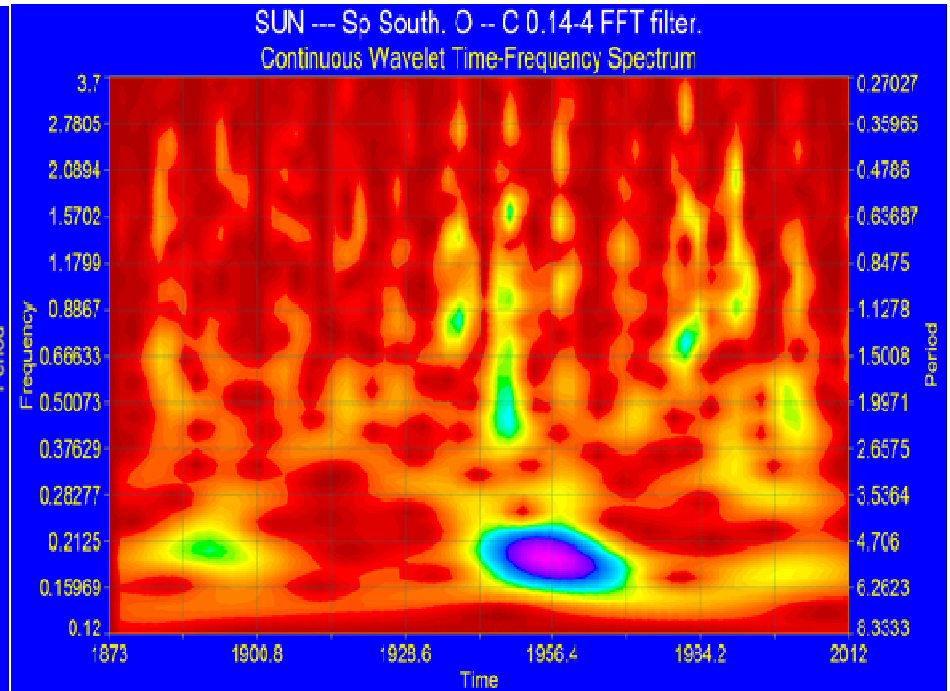
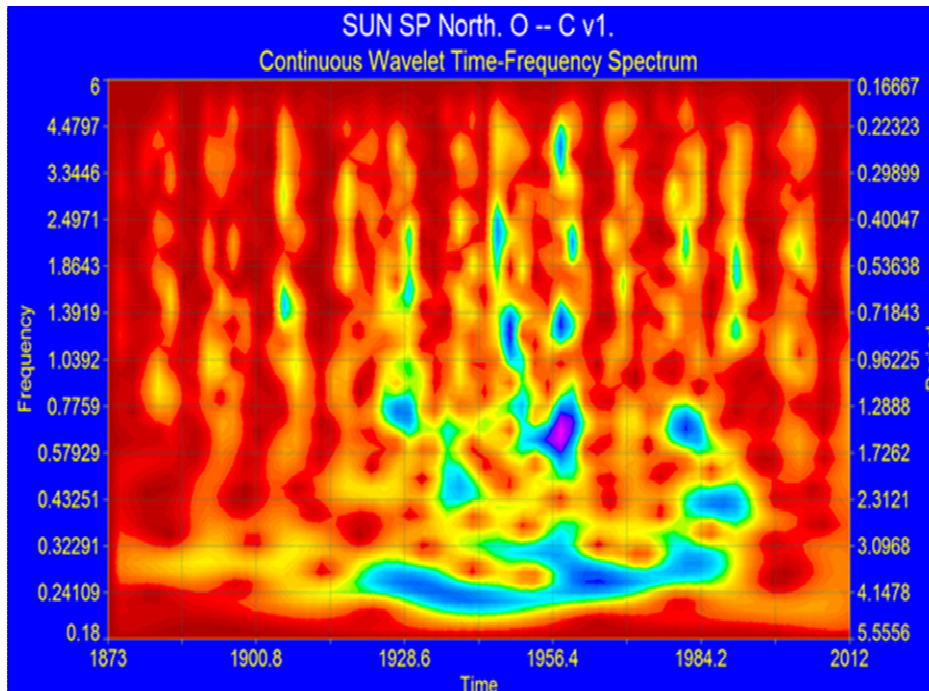


Sp "Nother" and "South" 11-years cycles



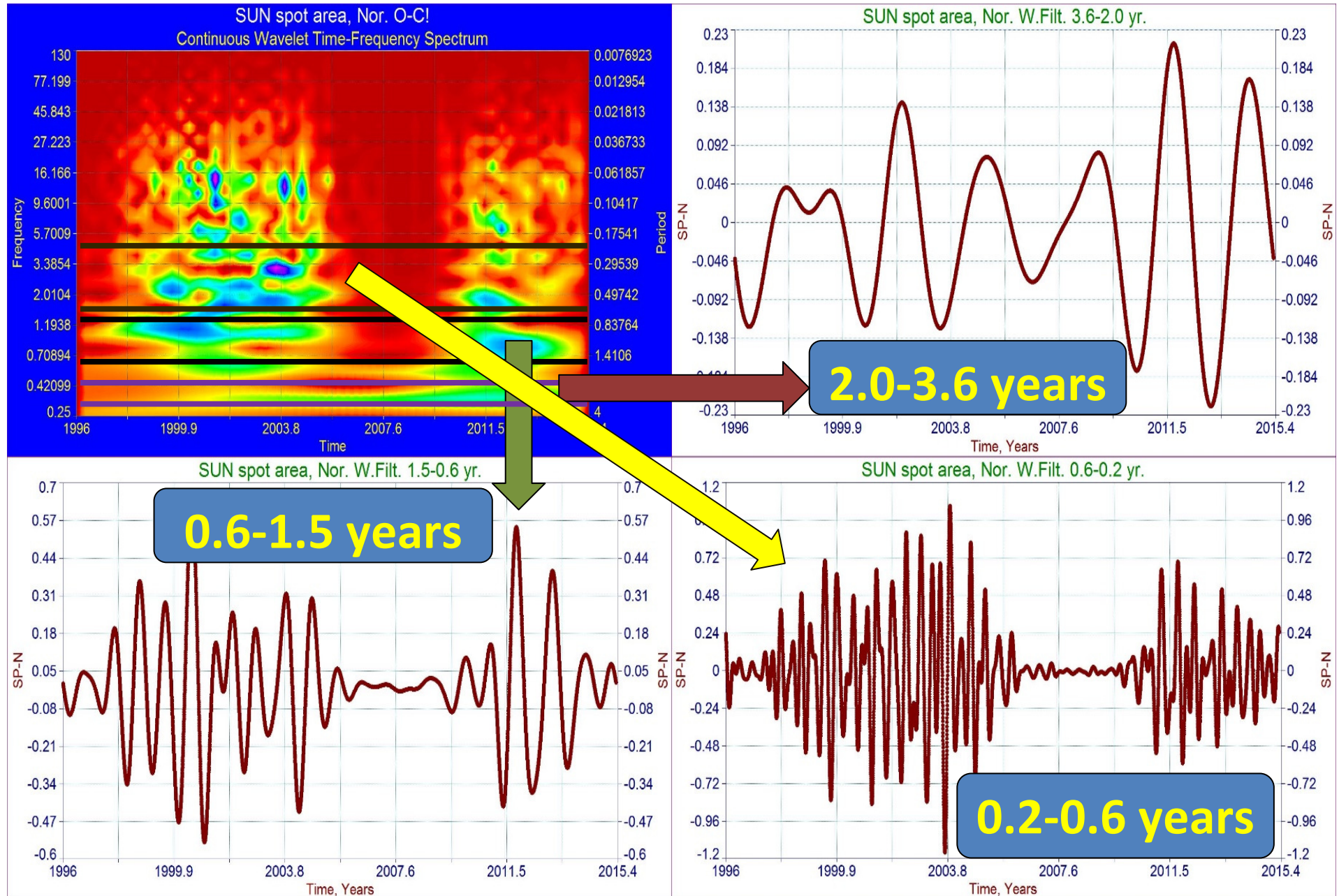
# N and S cycles activity

<b>N cycle</b>	<b>Sp-T min</b>	<b>Long T min</b>	<b>Sp-N min</b>	<b>Long N-min</b>	<b>Sp-S min</b>	<b>Long S-min</b>
<b>12</b>	<b>1878,54</b>	<b>10,46</b>	<b>1878,17</b>	<b>10,66</b>	<b>1878,84</b>	<b>10,21</b>
<b>13</b>	<b>1889,00</b>	<b>11,50</b>	<b>1888,83</b>	<b>11,75</b>	<b>1889,04</b>	<b>11,50</b>
<b>14</b>	<b>1900,50</b>	<b>12,54</b>	<b>1900,58</b>	<b>11,67</b>	<b>1900,54</b>	<b>12,54</b>
<b>15</b>	<b>1913,04</b>	<b>10,00</b>	<b>1912,25</b>	<b>10,67</b>	<b>1913,09</b>	<b>10,12</b>
<b>16</b>	<b>1923,04</b>	<b>10,17</b>	<b>1922,92</b>	<b>10,41</b>	<b>1923,21</b>	<b>9,96</b>
<b>17</b>	<b>1933,21</b>	<b>10,29</b>	<b>1933,33</b>	<b>10,34</b>	<b>1933,17</b>	<b>10,12</b>
<b>18</b>	<b>1943,50</b>	<b>9,96</b>	<b>1943,67</b>	<b>10,16</b>	<b>1943,29</b>	<b>9,96</b>
<b>19</b>	<b>1953,46</b>	<b>10,29</b>	<b>1953,83</b>	<b>10,00</b>	<b>1953,25</b>	<b>10,25</b>
<b>20</b>	<b>1963,75</b>	<b>11,92</b>	<b>1963,83</b>	<b>11,09</b>	<b>1963,50</b>	<b>12,67</b>
<b>21</b>	<b>1975,67</b>	<b>10,29</b>	<b>1974,92</b>	<b>10,75</b>	<b>1976,17</b>	<b>9,92</b>
<b>22</b>	<b>1985,96</b>	<b>10,00</b>	<b>1985,67</b>	<b>10,25</b>	<b>1986,08</b>	<b>10,04</b>
<b>23</b>	<b>1995,96</b>	<b>11,75</b>	<b>1995,92</b>	<b>10,91</b>	<b>1996,13</b>	<b>11,79</b>
<b>24</b>	<b>2007,71</b>		<b>2006,83</b>		<b>2007,92</b>	

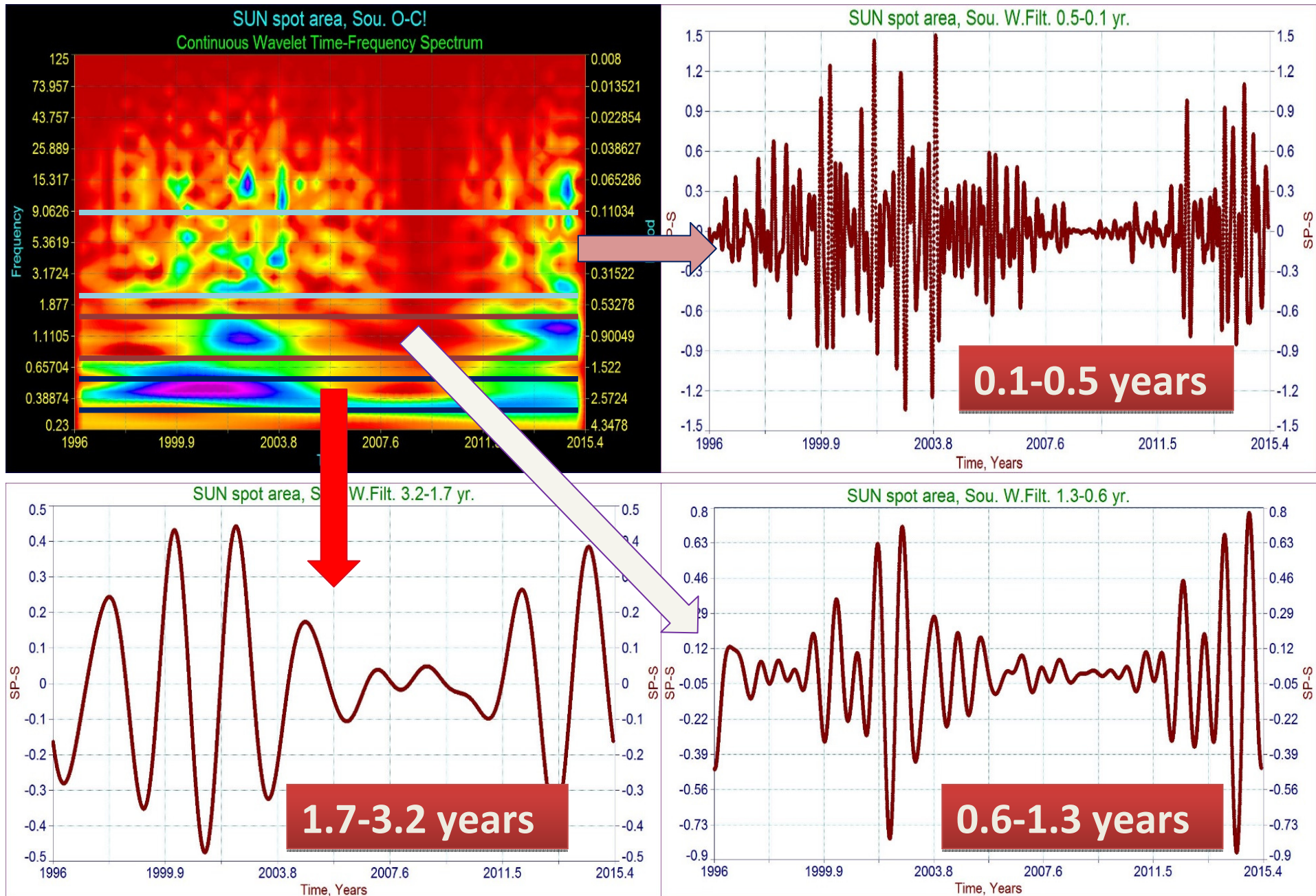




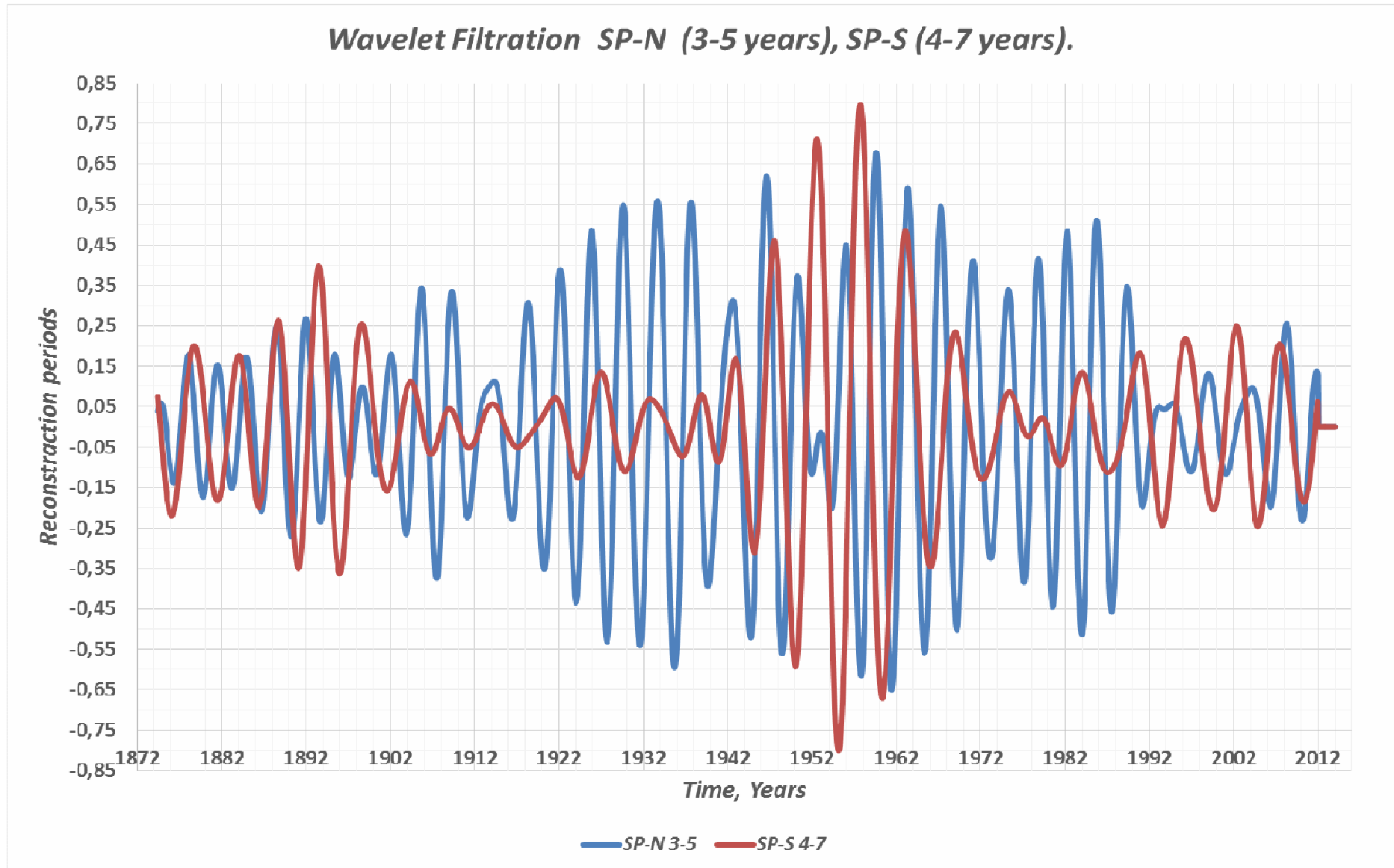
# Periodical process Sp-N in CWT filter bands



# Periodical process Sp-S in CWT filter bands



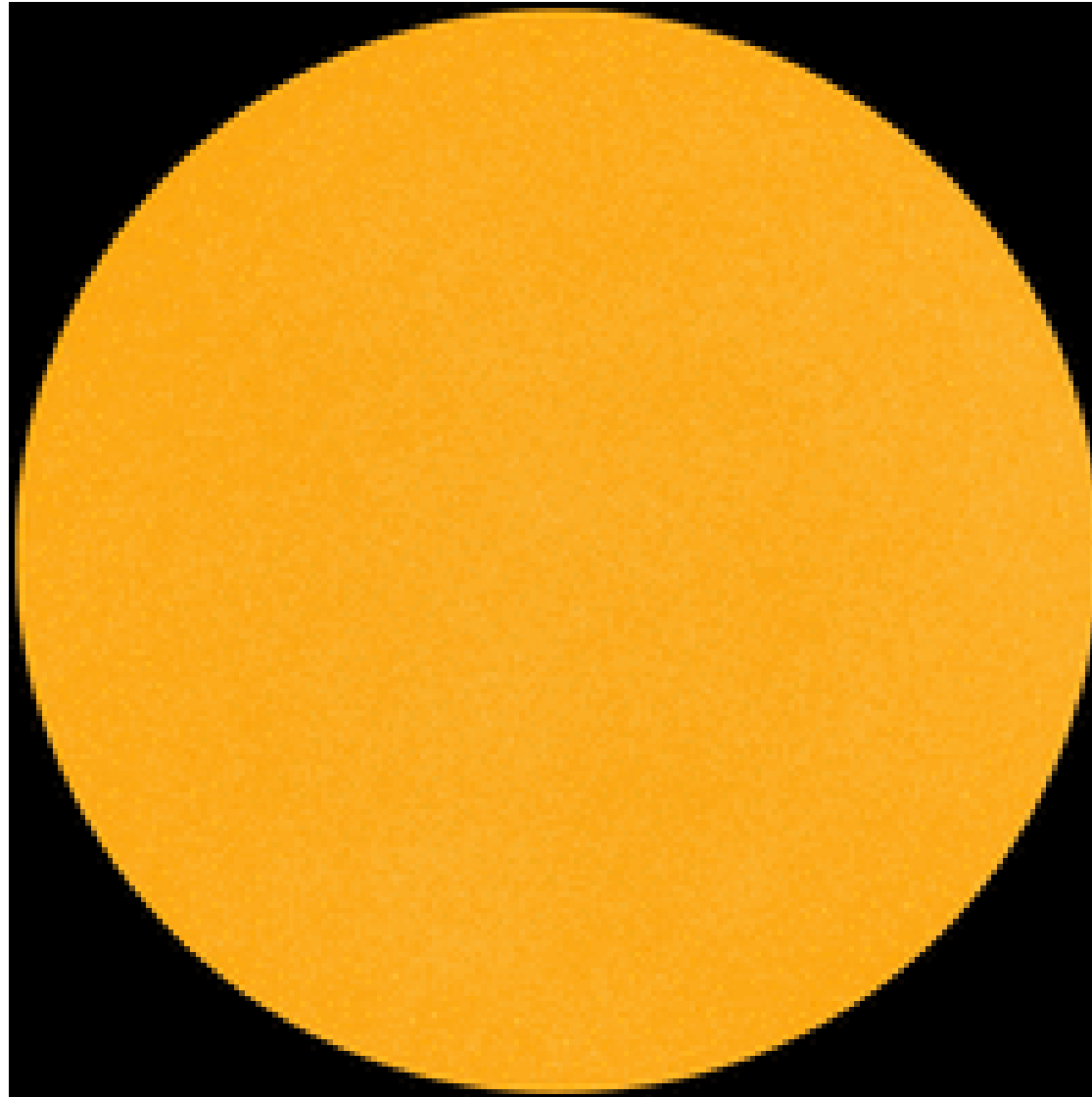
# N and S cycles (period 3-7 years)



# **Results investigation N and S solar activity**

- **Is determined by the physical nature of double cycle highs as changing activity of the northern and southern hemispheres of the Sun.**
- **Define real data cycles of N and S hemispheres activity.**
- **Explores the wave processes determining the development of the northern and southern hemispheres.**

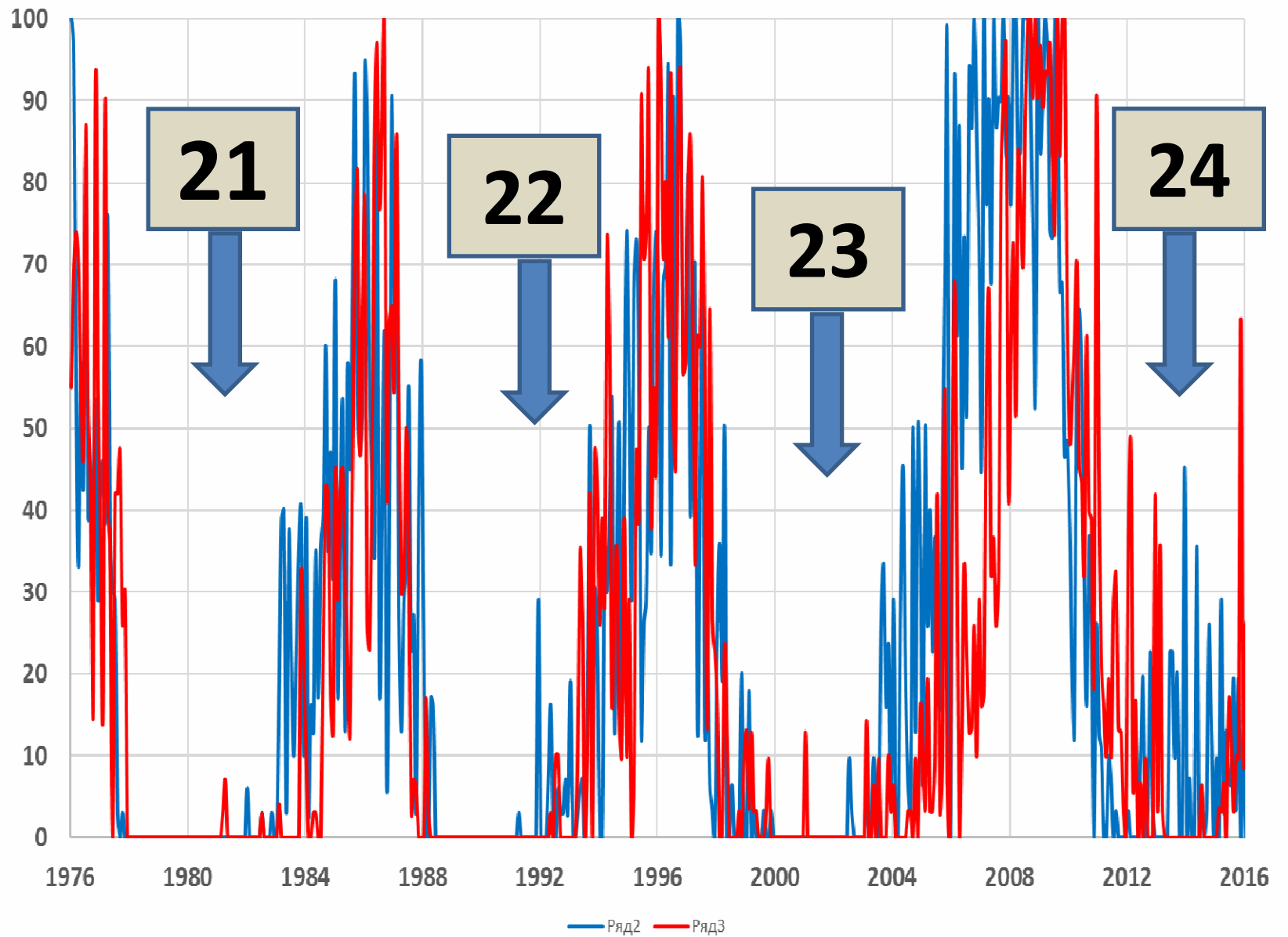
# N and S «Spotless» cycles



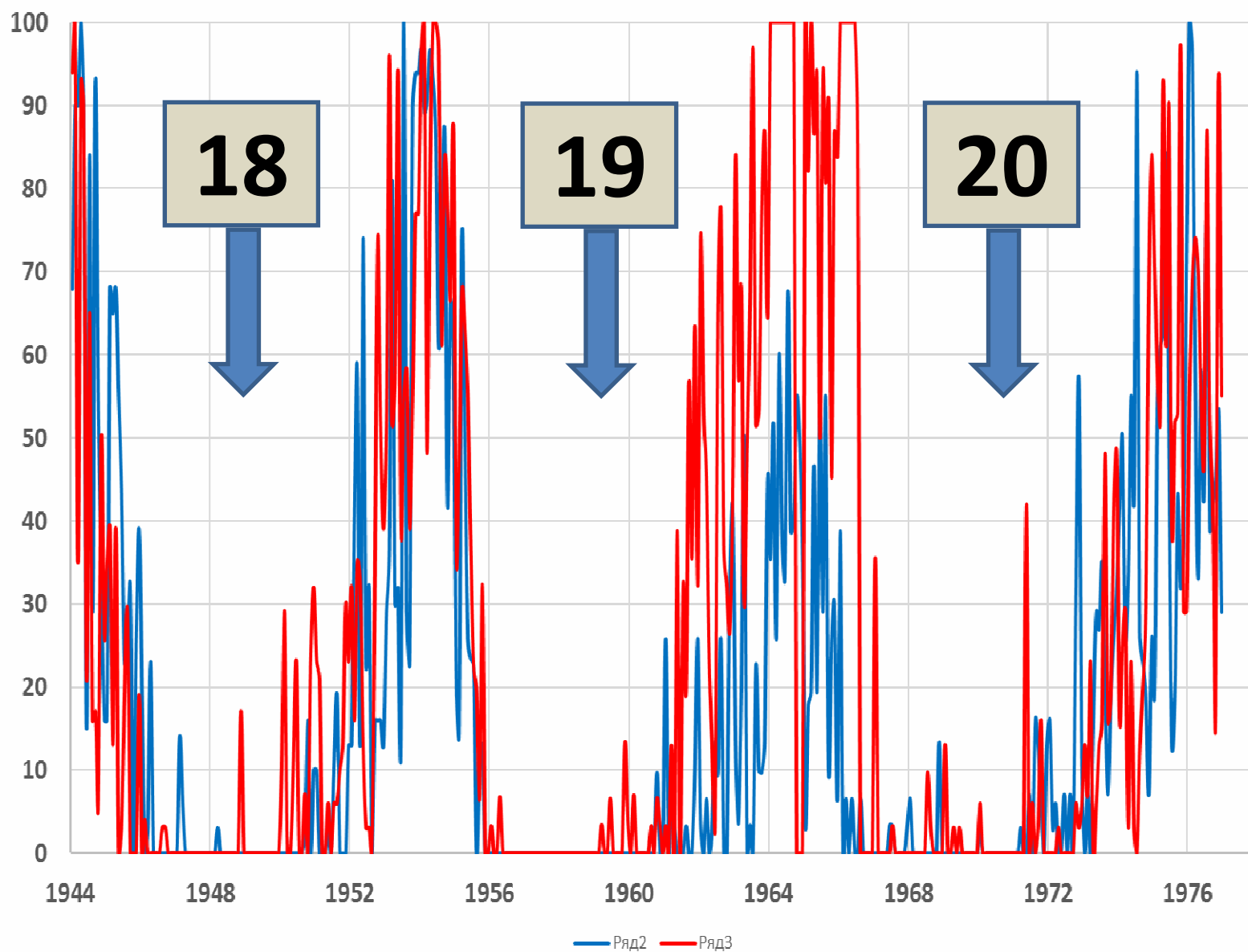
# Solar cycles anti - activity

- The spotless days "contains important information about the periods ending generate magnetic fields, groups of spots.

# 21- 24 cycles

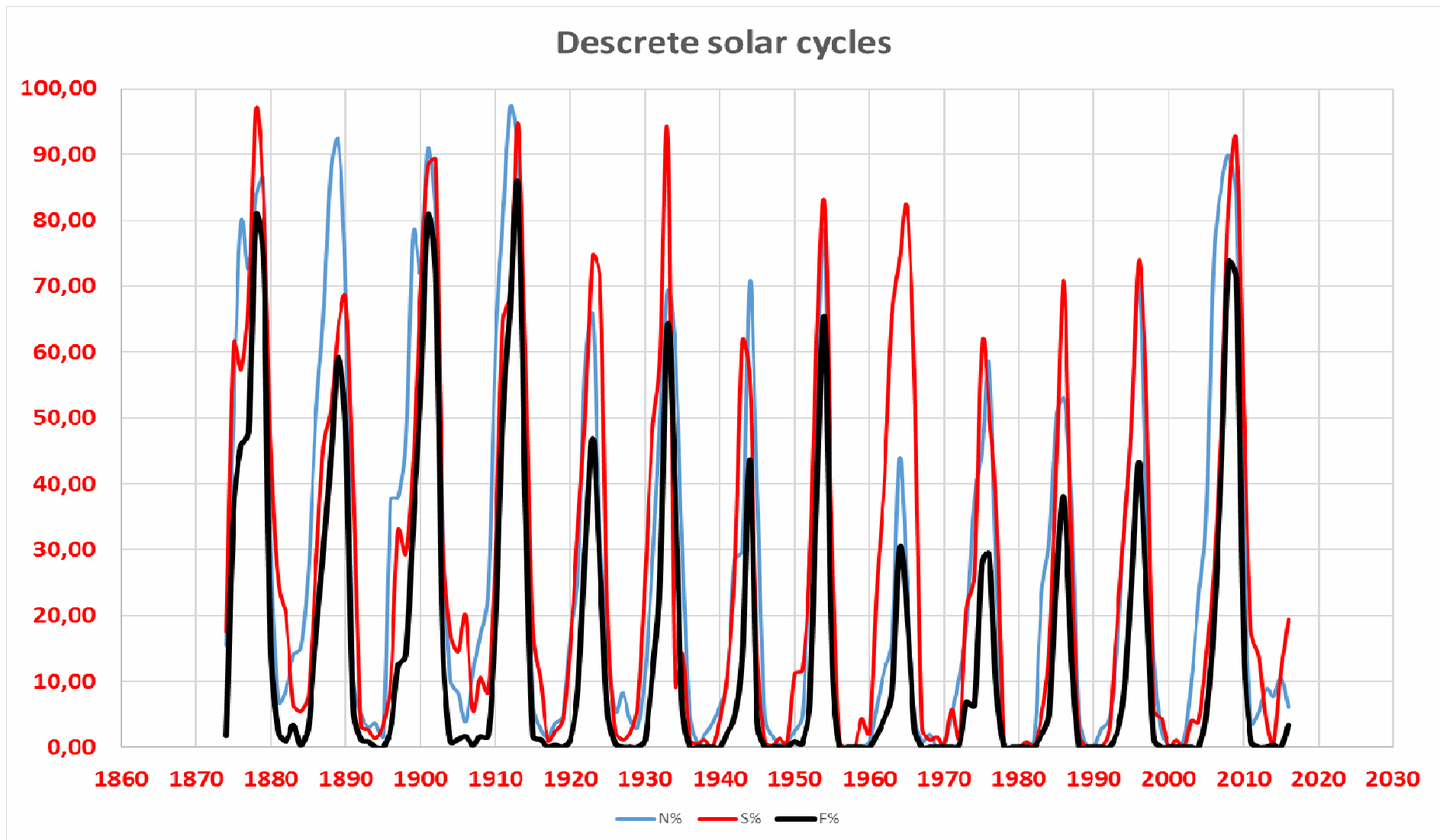


# 18 - 20 cycles

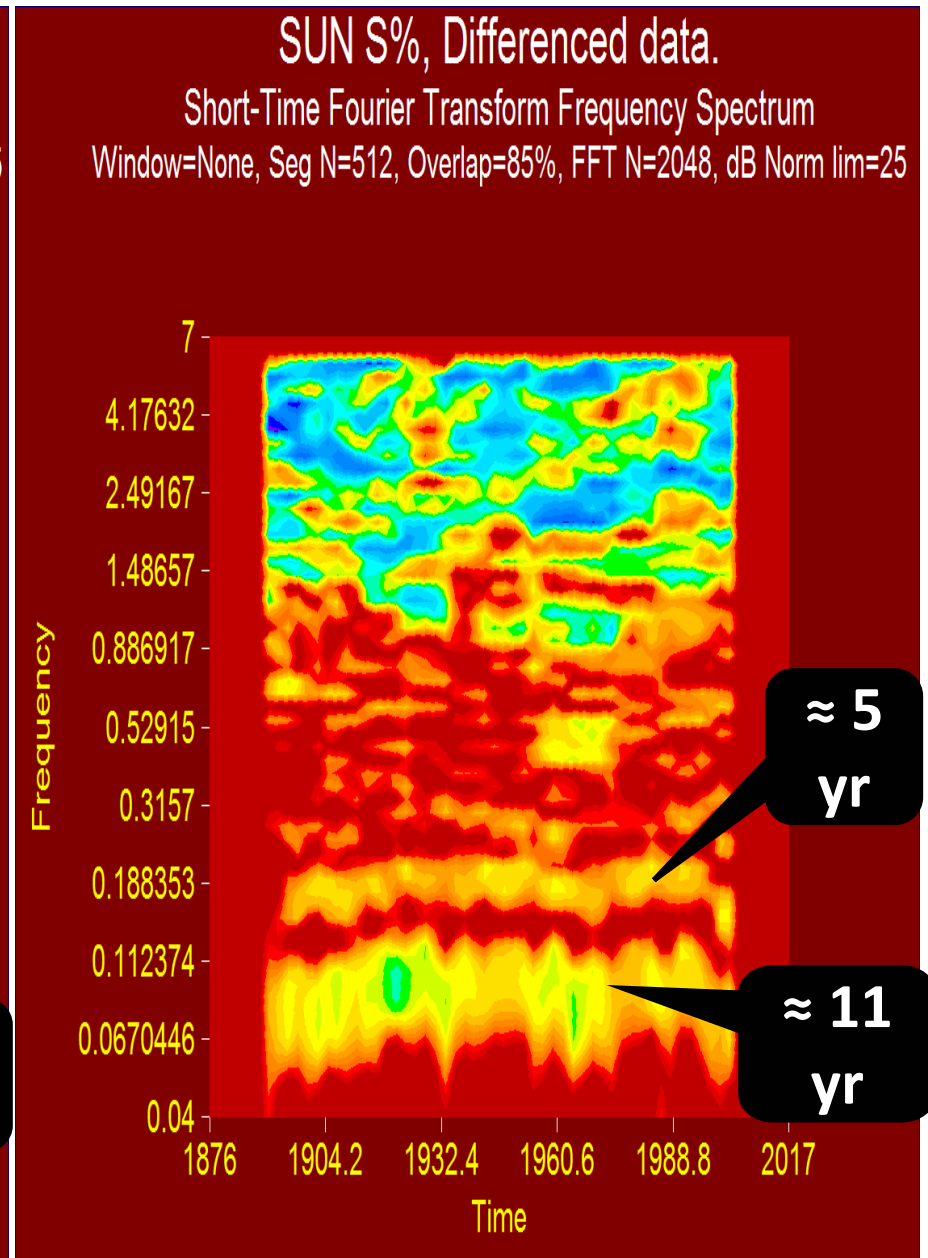
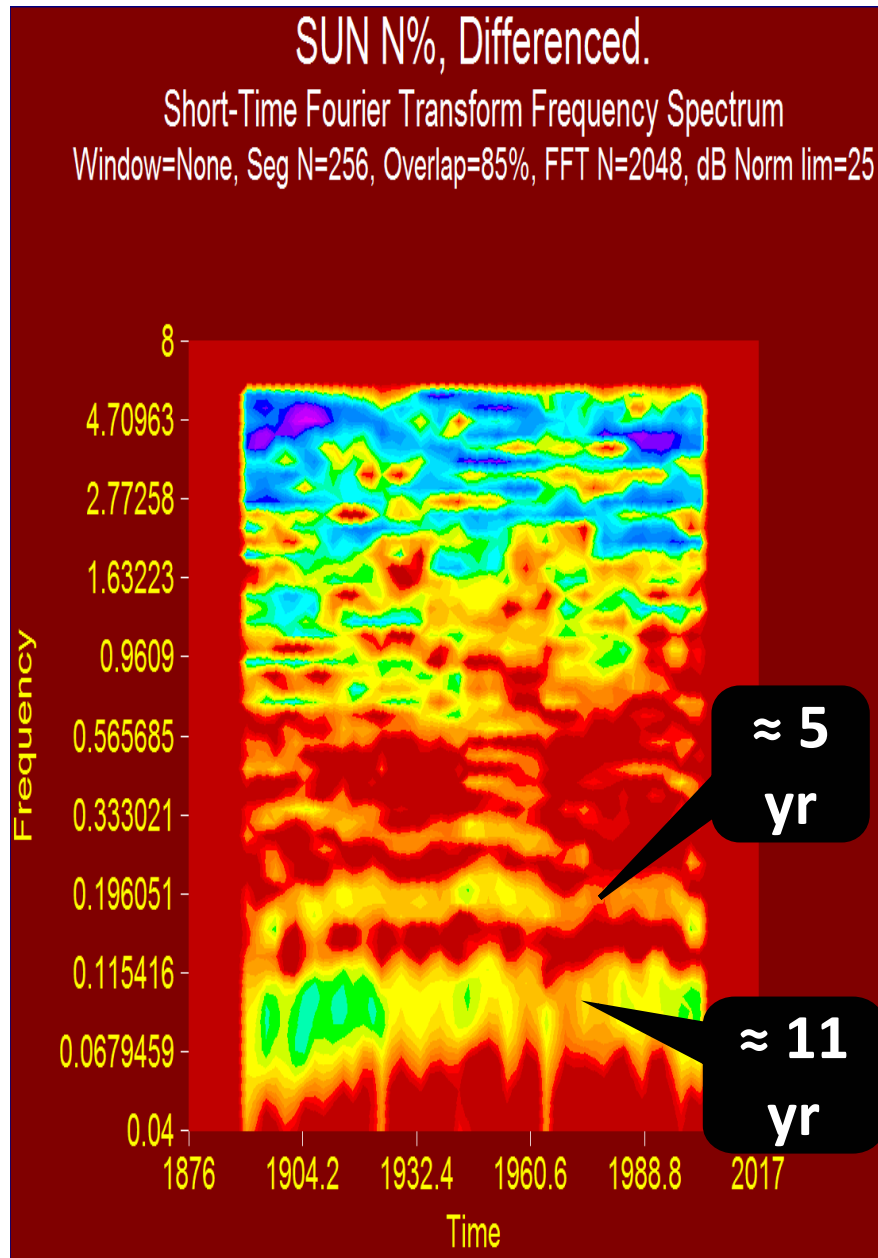




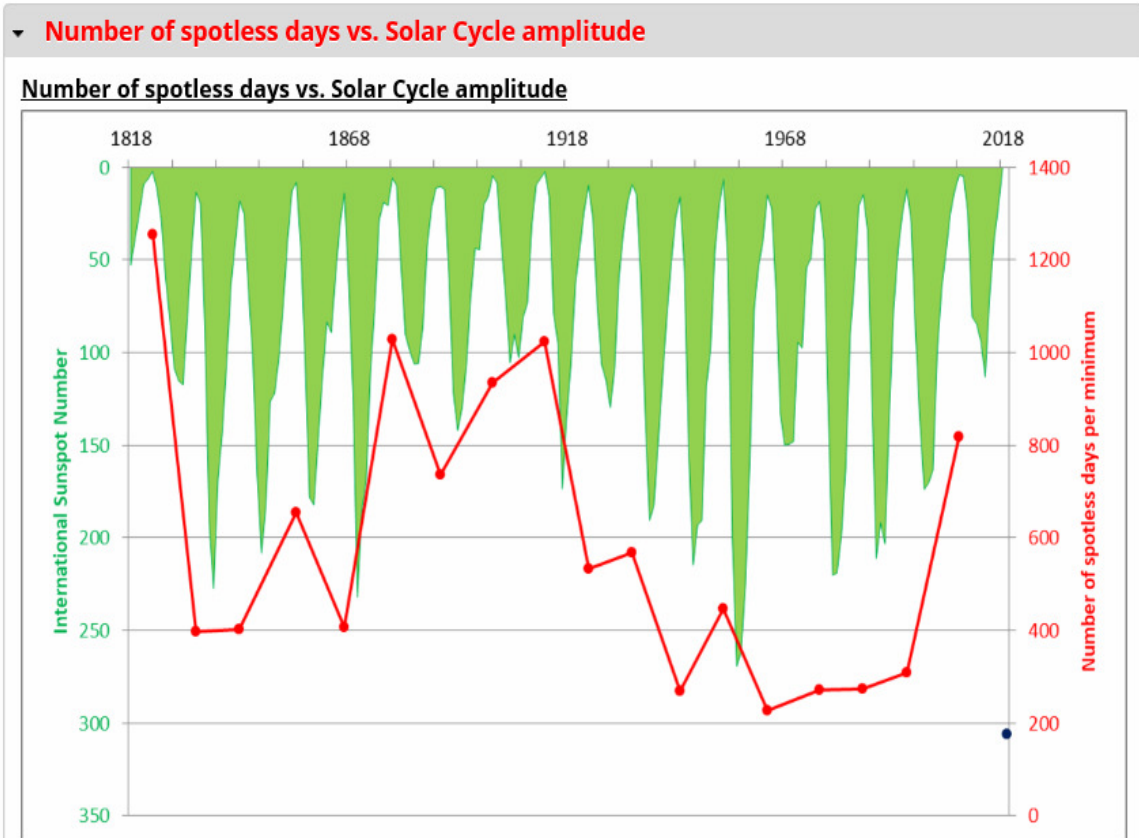
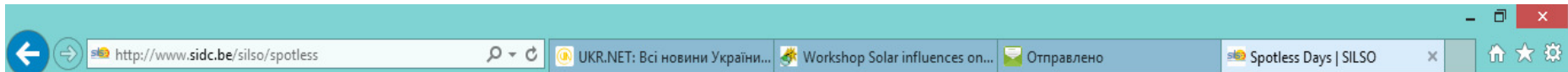
# Solar Cycles of anti activity



# Short-Time FFT spec. N and S cycles solar anti-activity



# Spotless days vs. Solar Cycle Amplitude



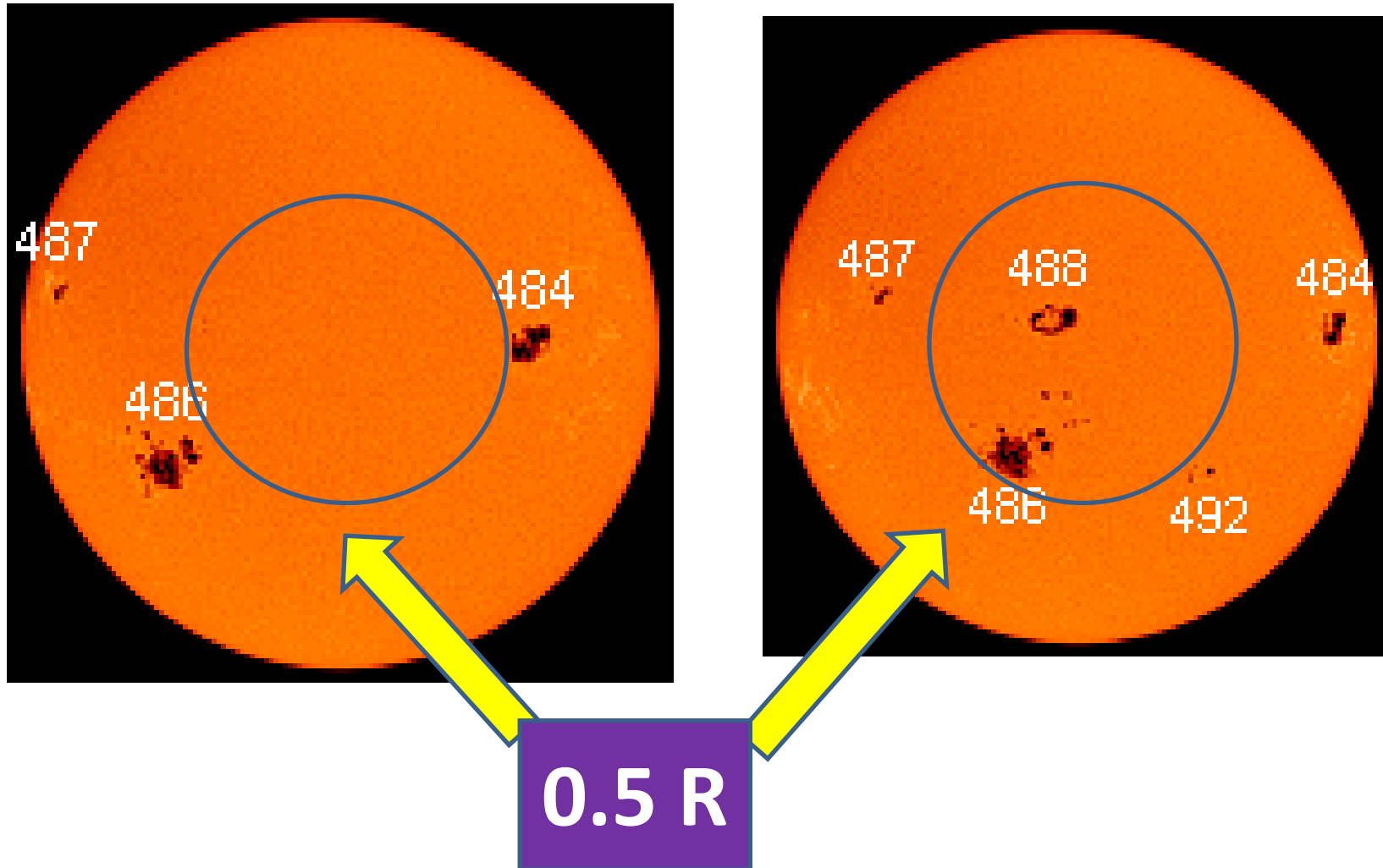
The graph above shows the evolution of the total number of spotless days per cycle minimum transition and the yearly international sunspot number ( $S_n$ ) since 1818. Note the values for  $S_n$  are in reverse order. The number of spotless days has been set in the year of the cycle minimum. For example, there were 817



# Modifying indexes for solar-terrestrial relations

- **As you know the most effective active regions located in the center zone of the solar disk.**
- **In a different directory presents data on numbers of Wolf (SIDS) and Sp – sunspots area (Pulkovo) located in the zone of RADIUS equal to half of the solar disk.**
- **Such indexes can be described as effective on the Earth environment.**
- **They have the property directionality.**

# Effect directionally



# SILSO – Sunspots bulletin

monthlybull200310.pdf - Adobe Reader

Файл Редактирование Просмотр Окно Справка

Инструменты Подписание Комментарии

Просмотреть или добавить комментарии

SOLAR PHYSICS DEPARTMENT

UCCLE DAILY PROVISIONAL RELATIVE SUNSPOT NUMBERS FOR OCTOBER 2003

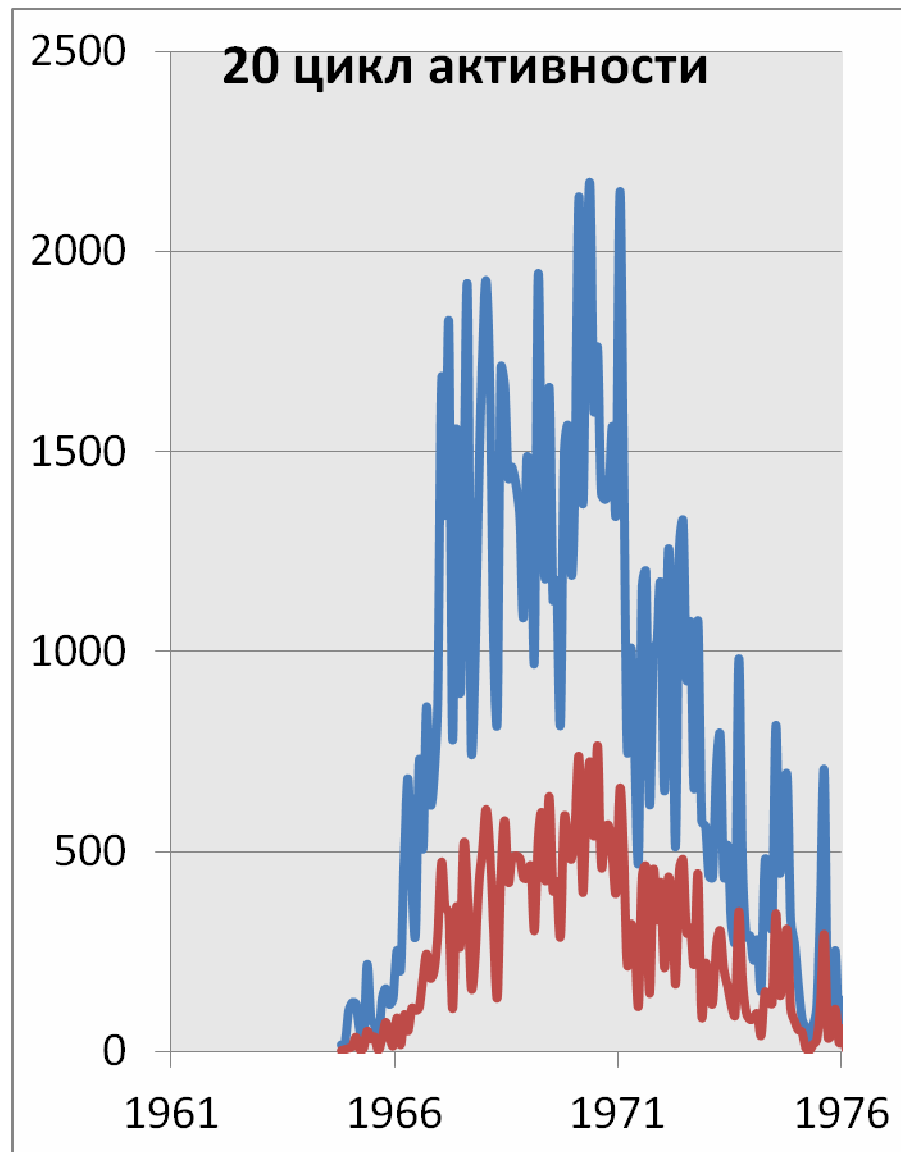
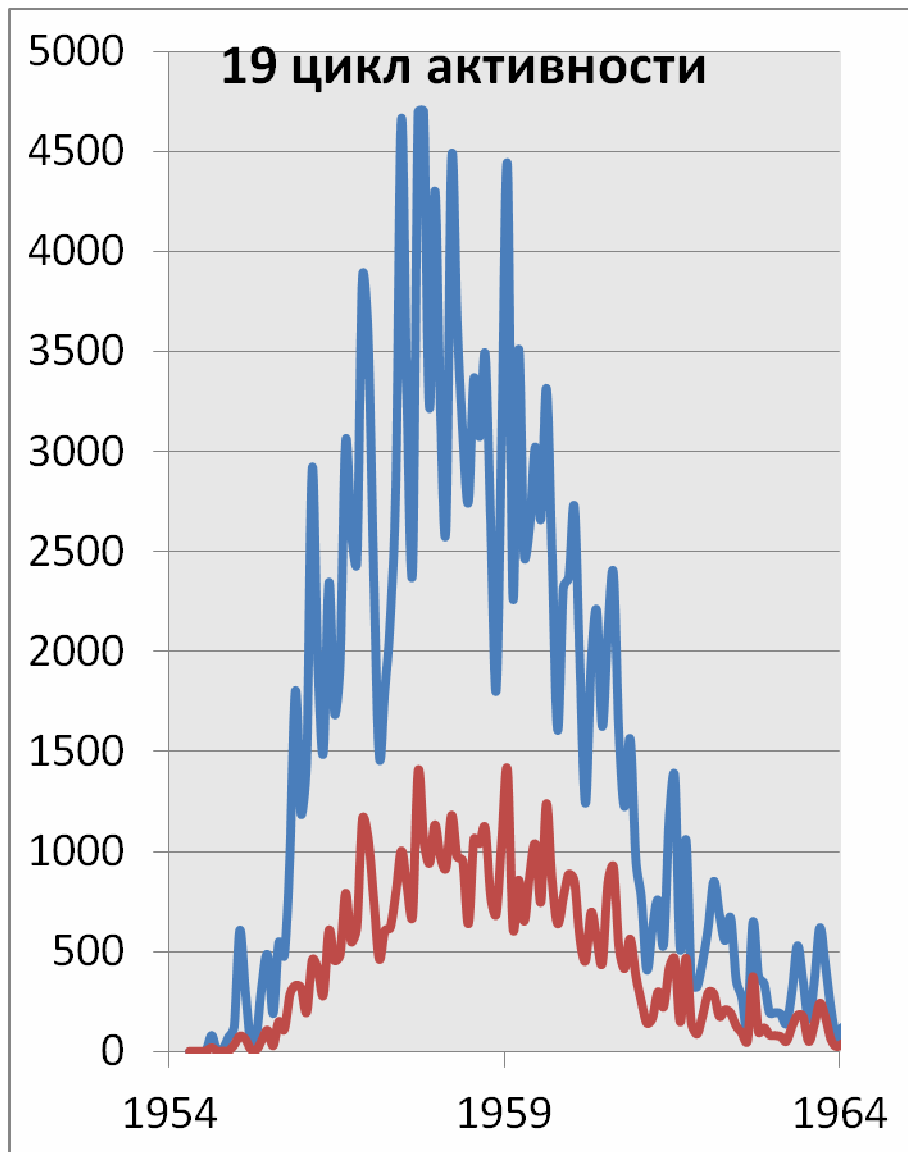
DATE	UT	NUMBER OF GROUPS	NUMBER OF SPOTS	RELATIVE TOTAL	SUNSPOT NORTH	NUMBERS SOUTH	CENTRAL	PPSI	QUAL	OBS
2	1410	6	44	104	11	93	84	64.5	3	OB
4	930	5	52	102	0	102	72	89.4	3	OB
5	800	5	60	110	0	110	88	94.9	3	OB
7	1235	4	48	88	0	88	62	98.7	3	OB
8	830	4	32	72	11	61	35	93.7	2	OB
10	1400	4	26	66	11	55	14	50.0	2	OB
11	915	5	27	77	23	54	15	29.0	2	DB
12	830	3	6	36	11	25	12	2.6	2	DB
13	915	2	3	23	11	12	12	2.2	3	OB
14	930	1	2	12	0	12	0	1.8	3	OB
15	930	1	5	15	15	0	15	0.4	3	OB
16	816	2	4	24	12	12	0	0.5	3	ST
17	817	3	6	36	13	23	12	0.5	3	VI
18	1010	3	22	52	36	16	16	21.0	1	ST
19	935	3	35	65	54	11	0	13.0	2	ST
20	930	3	27	57	44	13	12	48.9	3	OB
22	915	3	76	166	79	27	33	66.7	3	OB
23	930	3	89	119	85	34	100	82.6	2	OB
24	1340	2	63	83	50	33	50	90.2	3	OB
25	1000	3	89	119	71	48	57	96.2	2	OB
27	1020	6	167	227	102	125	74	175.1	3	OB
28	940	7	225	295	112	183	215	201.3	3	OB
29	844	8	175	255	96	159	201	251.3	3	VI

The relative mean sunspot number is 93.2.

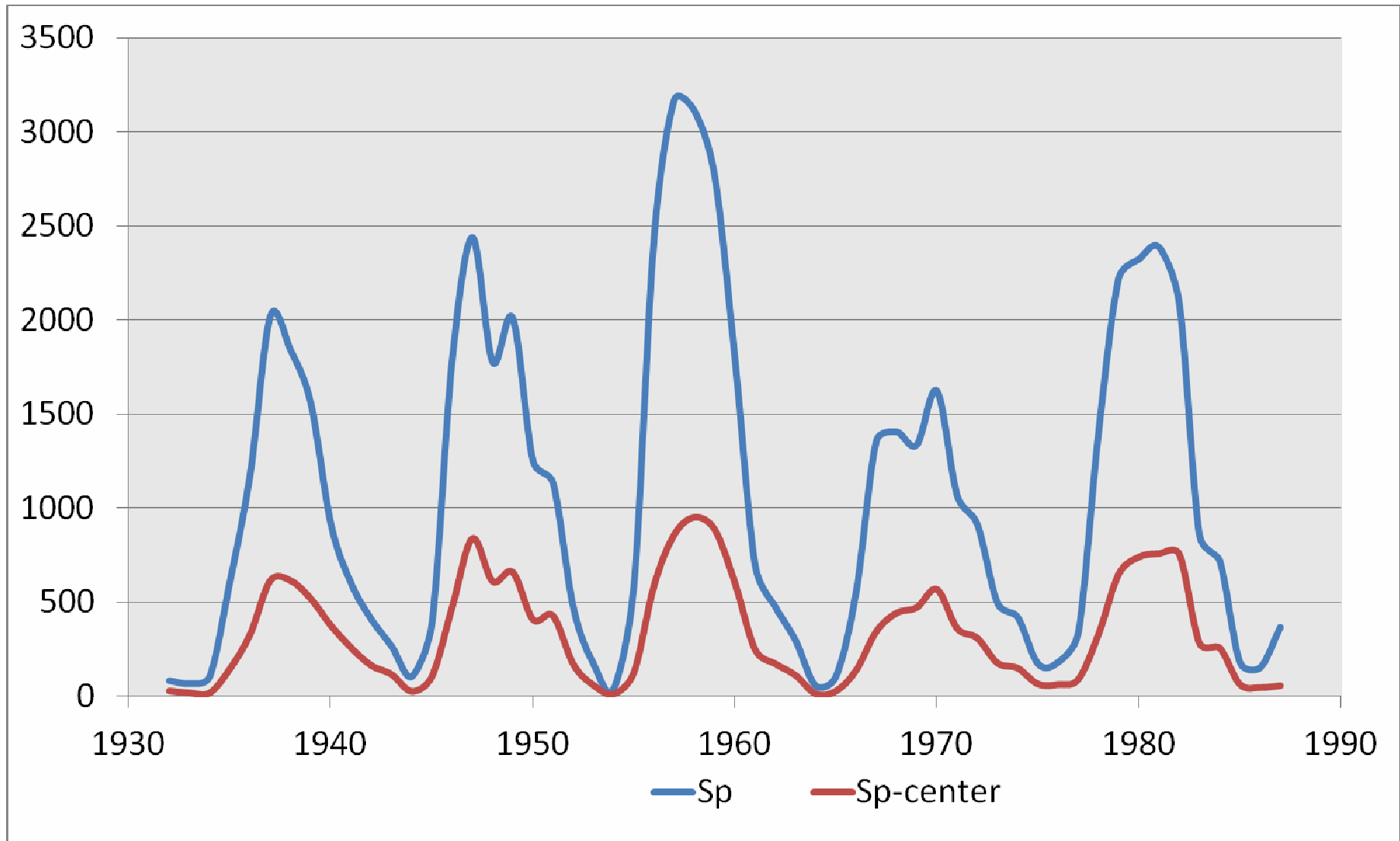
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Чтобы активировать Windows, перейдите к параметрам компьютера.

22:34  
03.06.2018

# 19 – 20 cycles



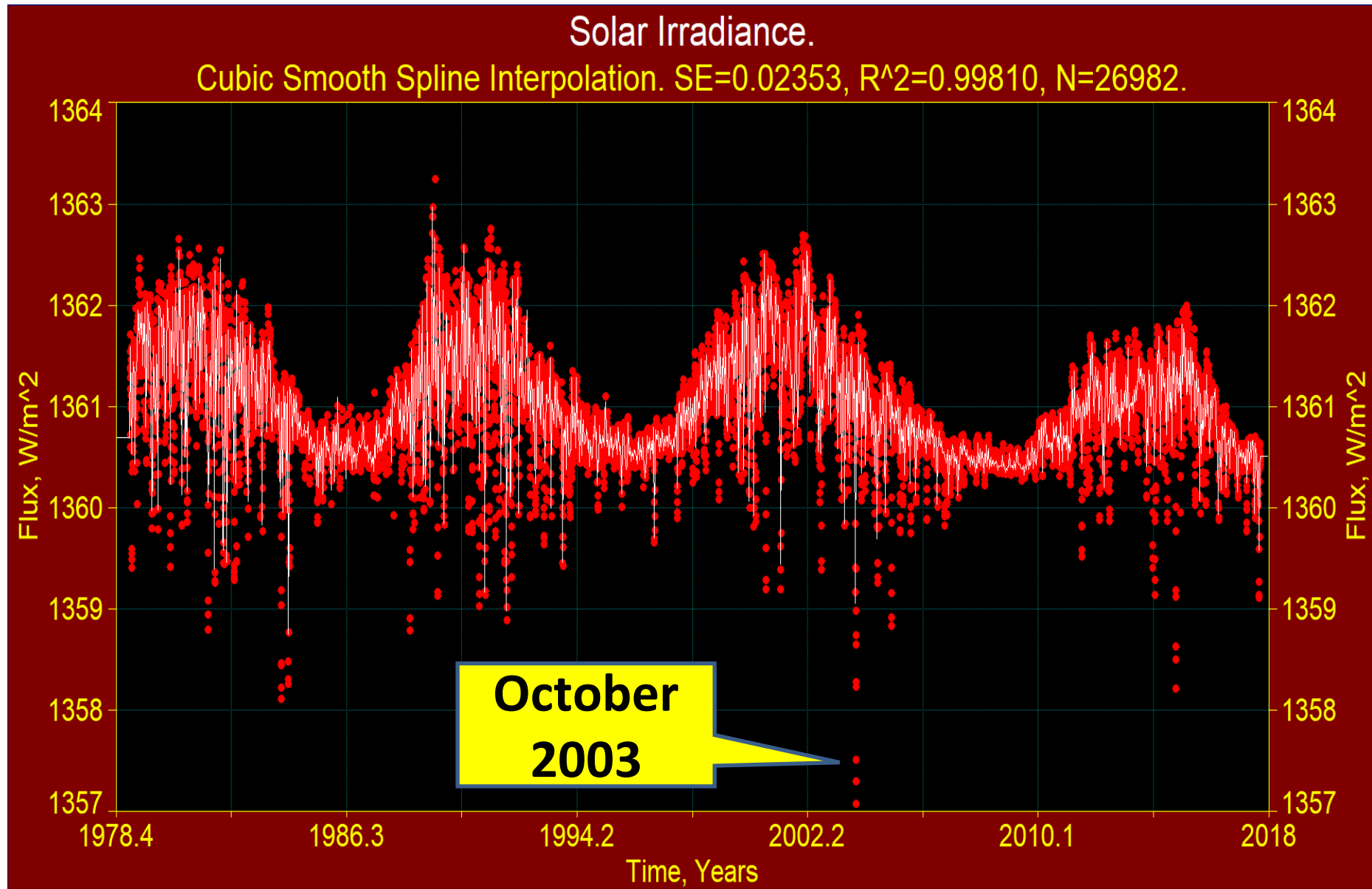
# Solar index Sp



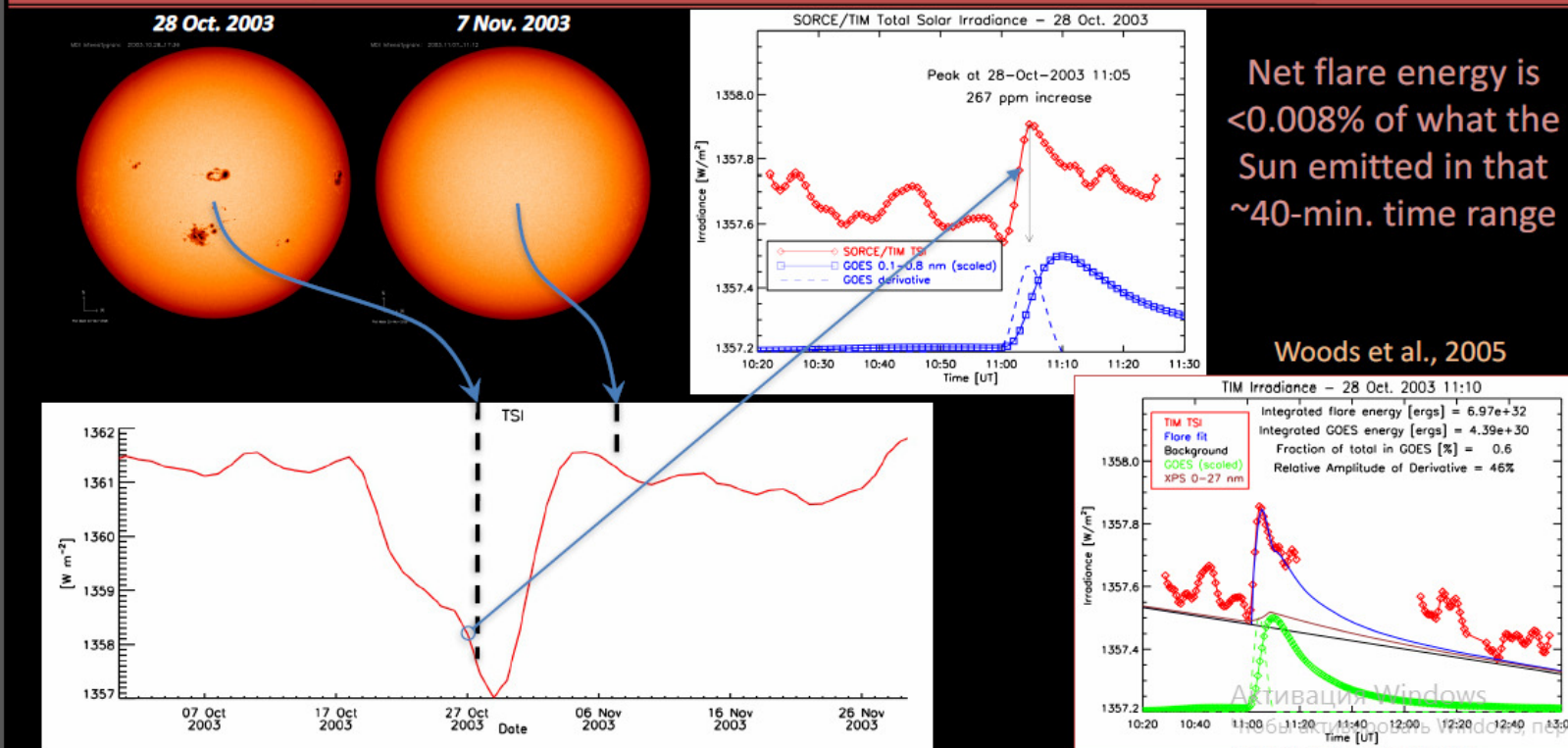


- Solar Irradiance

# Solar Irradiance data



# Perspective on Flares Compared to the TSI



Net flare energy is <0.008% of what the Sun emitted in that ~40-min. time range

Woods et al., 2005

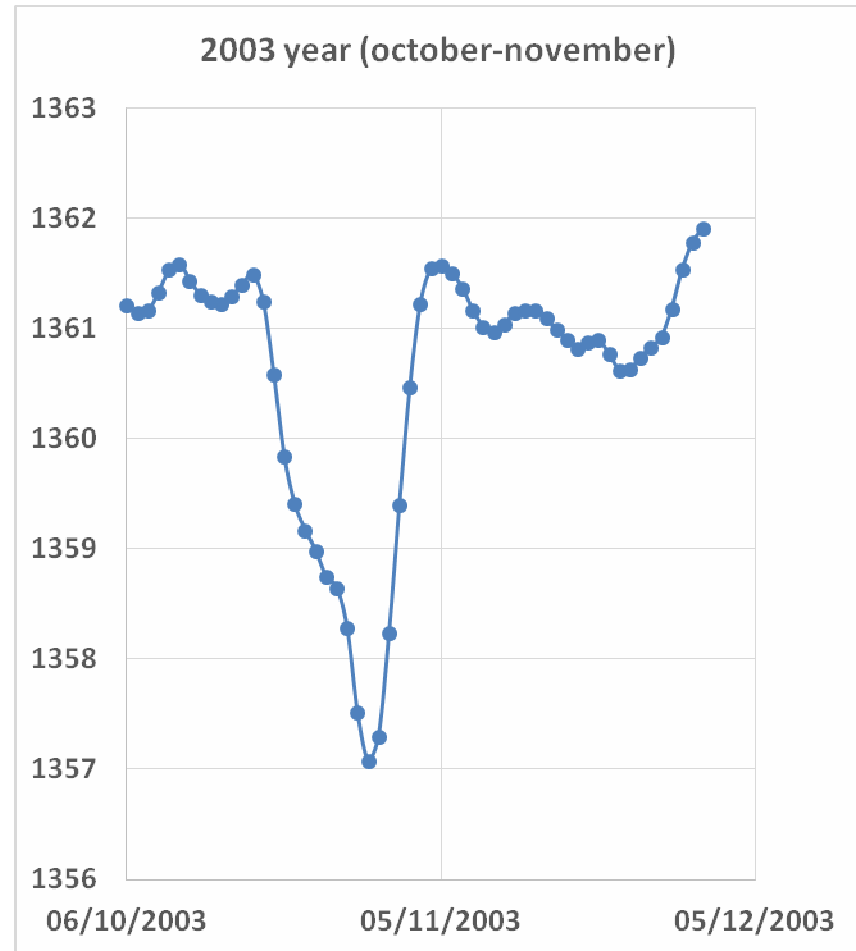
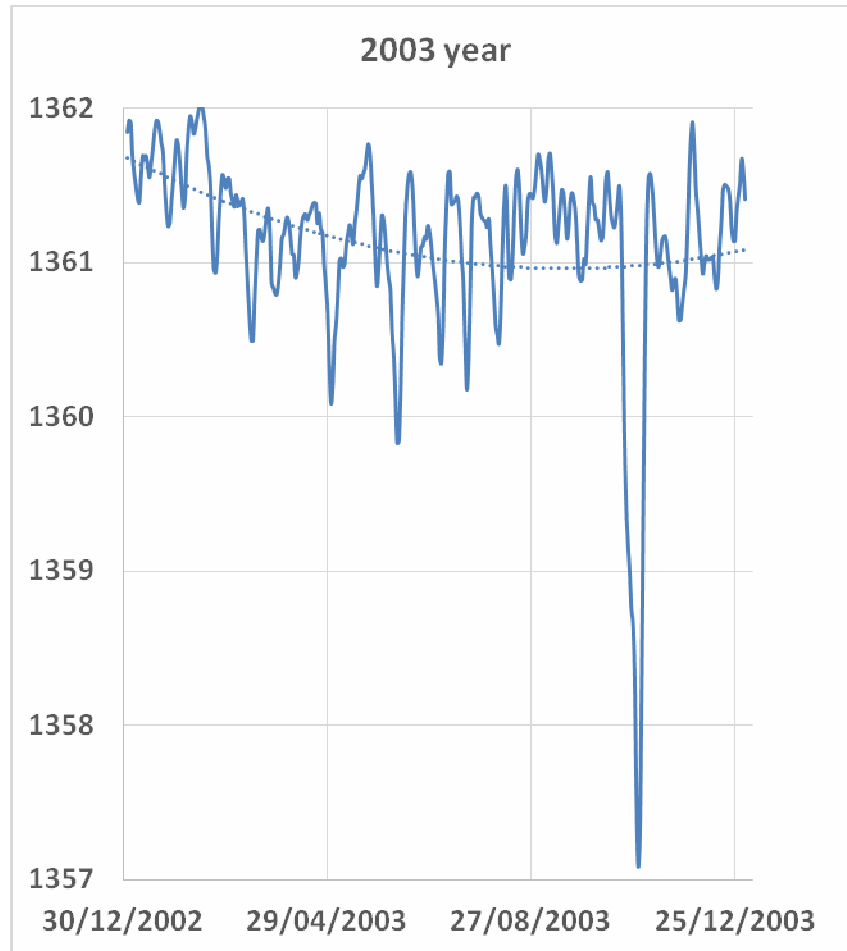
Heliophysics Summer School  
HAO, 7 Aug. 2017

Solar Irradiances

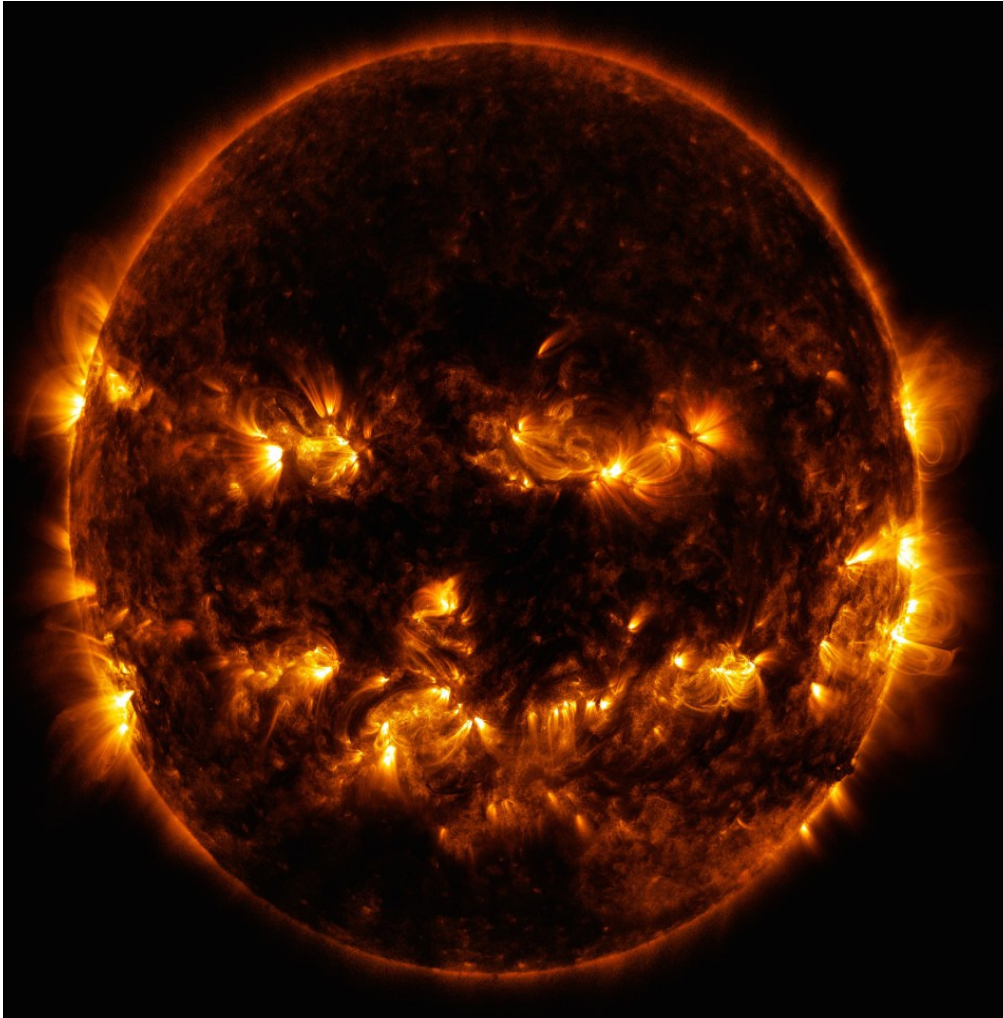
LASP Greg Kopp - p. 12

CHANDRA, HUBBLE, SPITZER

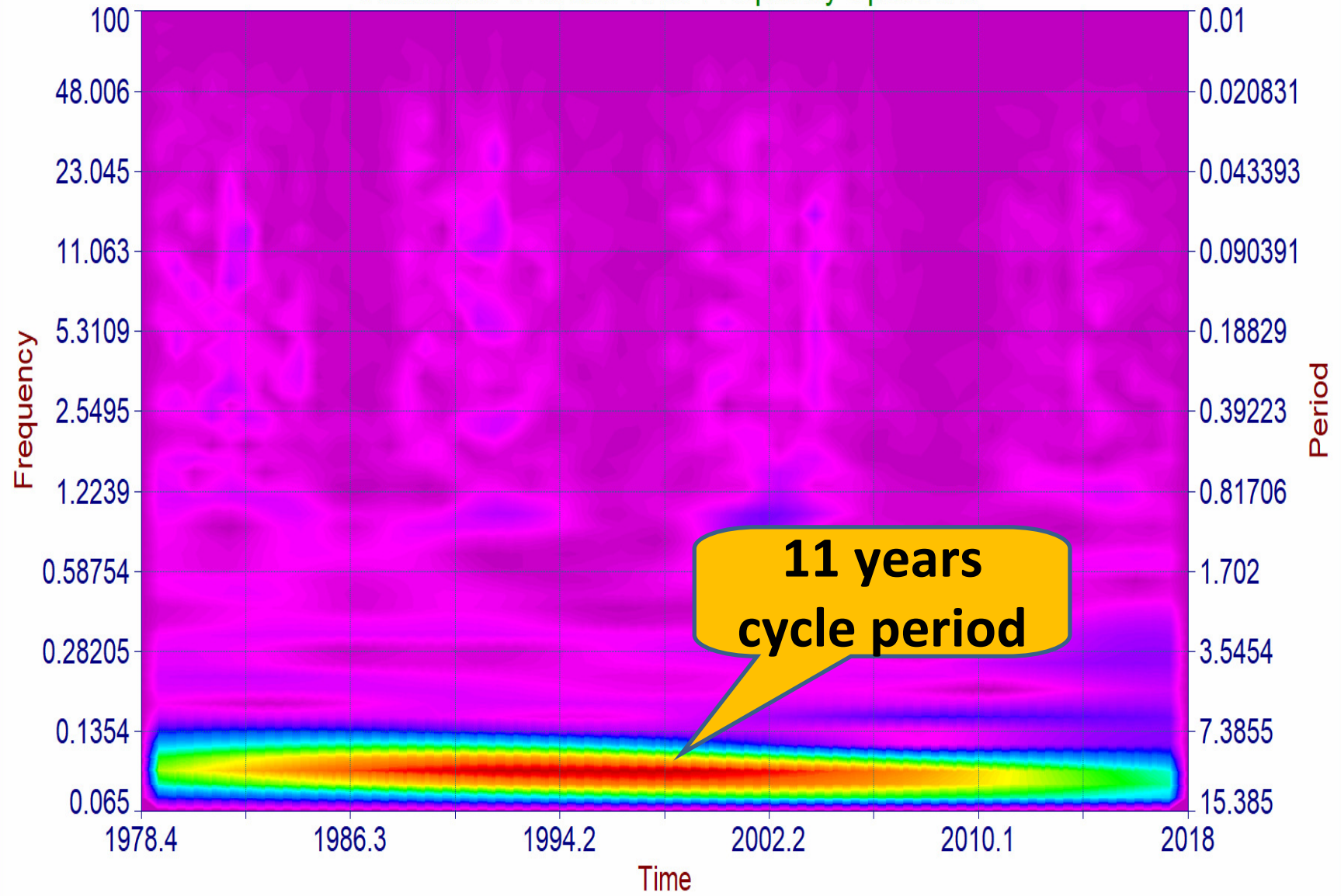
# Fluctuation SI



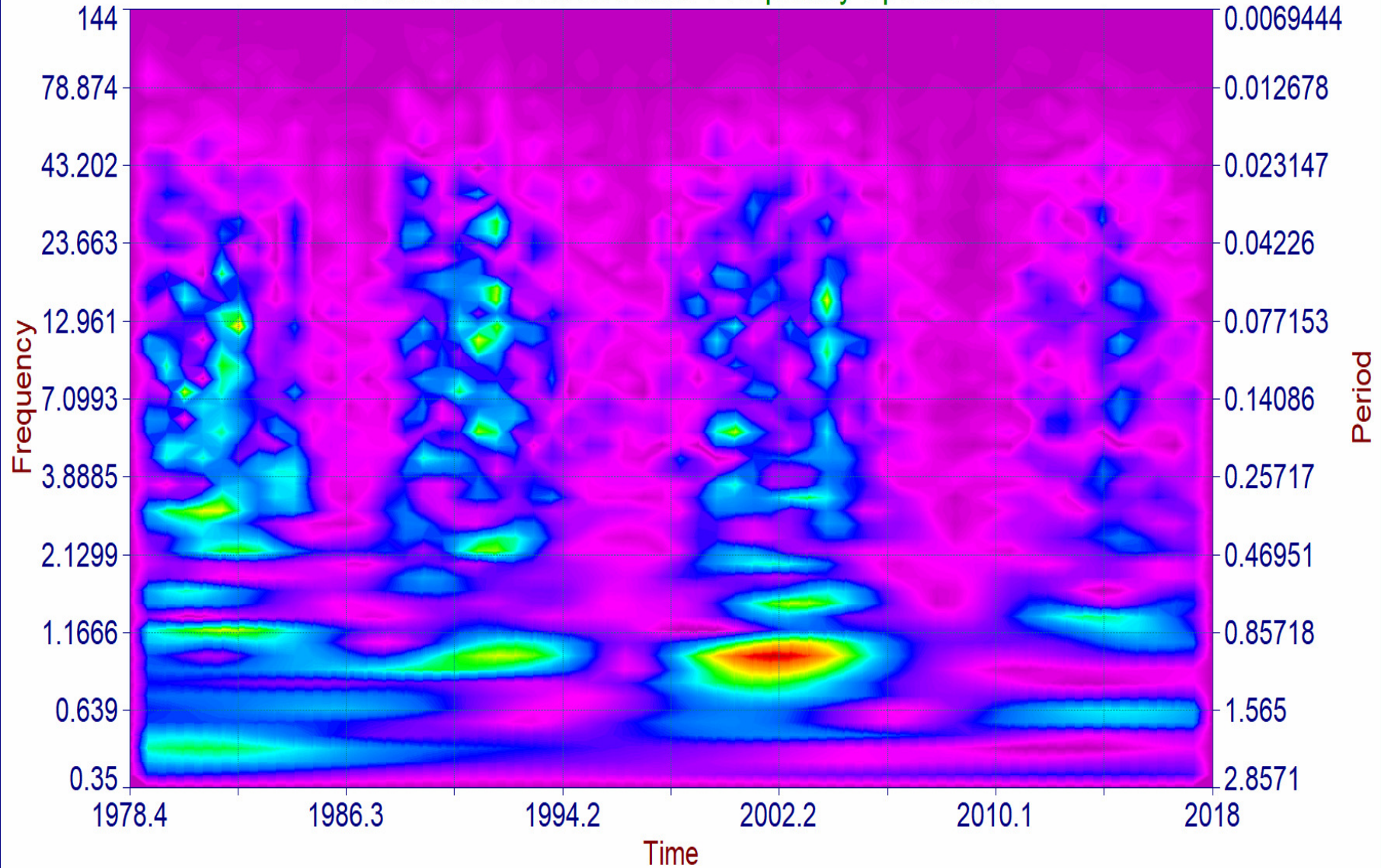
# Solar complex activity.



Solar Irradiance. Cubic smooth spline interpolation. Del.mean 1360.9879 W/m<sup>2</sup>.  
Continuous Wavelet Time-Frequency Spectrum



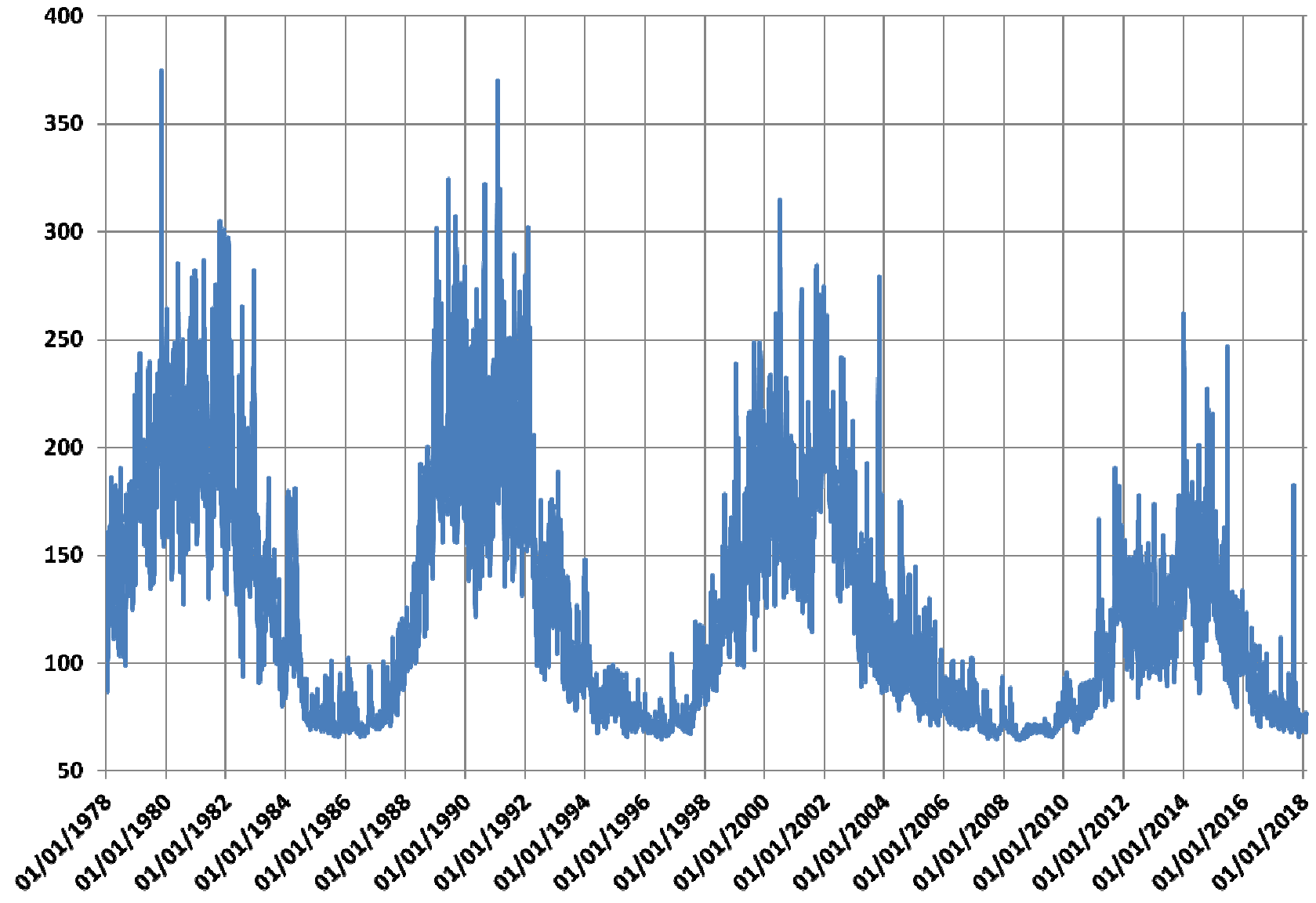
Solar Irradiance. O-C. Del. 11-yr solar cycle.  
Continuous Wavelet Time-Frequency Spectrum



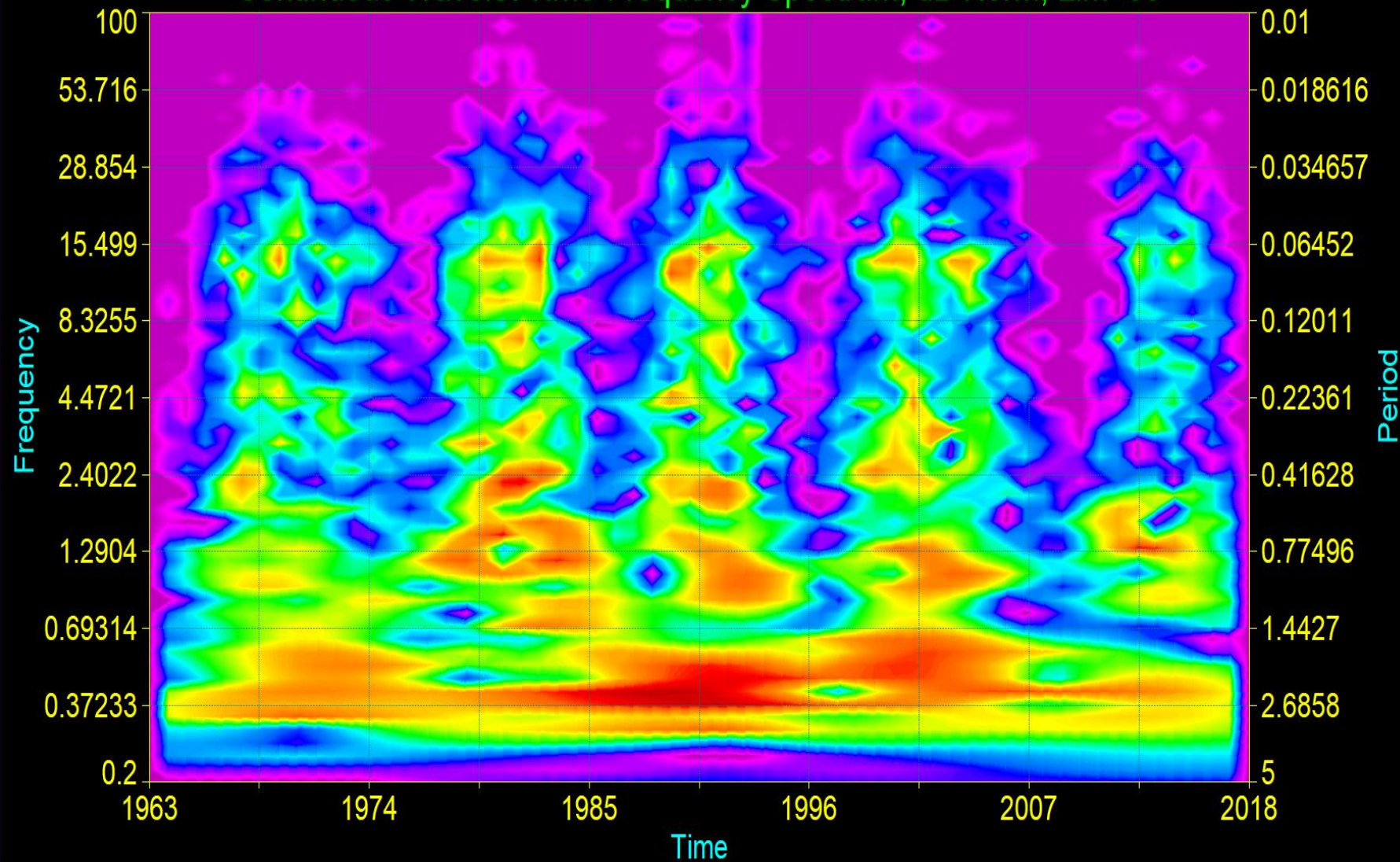
- **Solar index F 10.7 cm**



F 10.7 cm (1978 - 2017 yy )

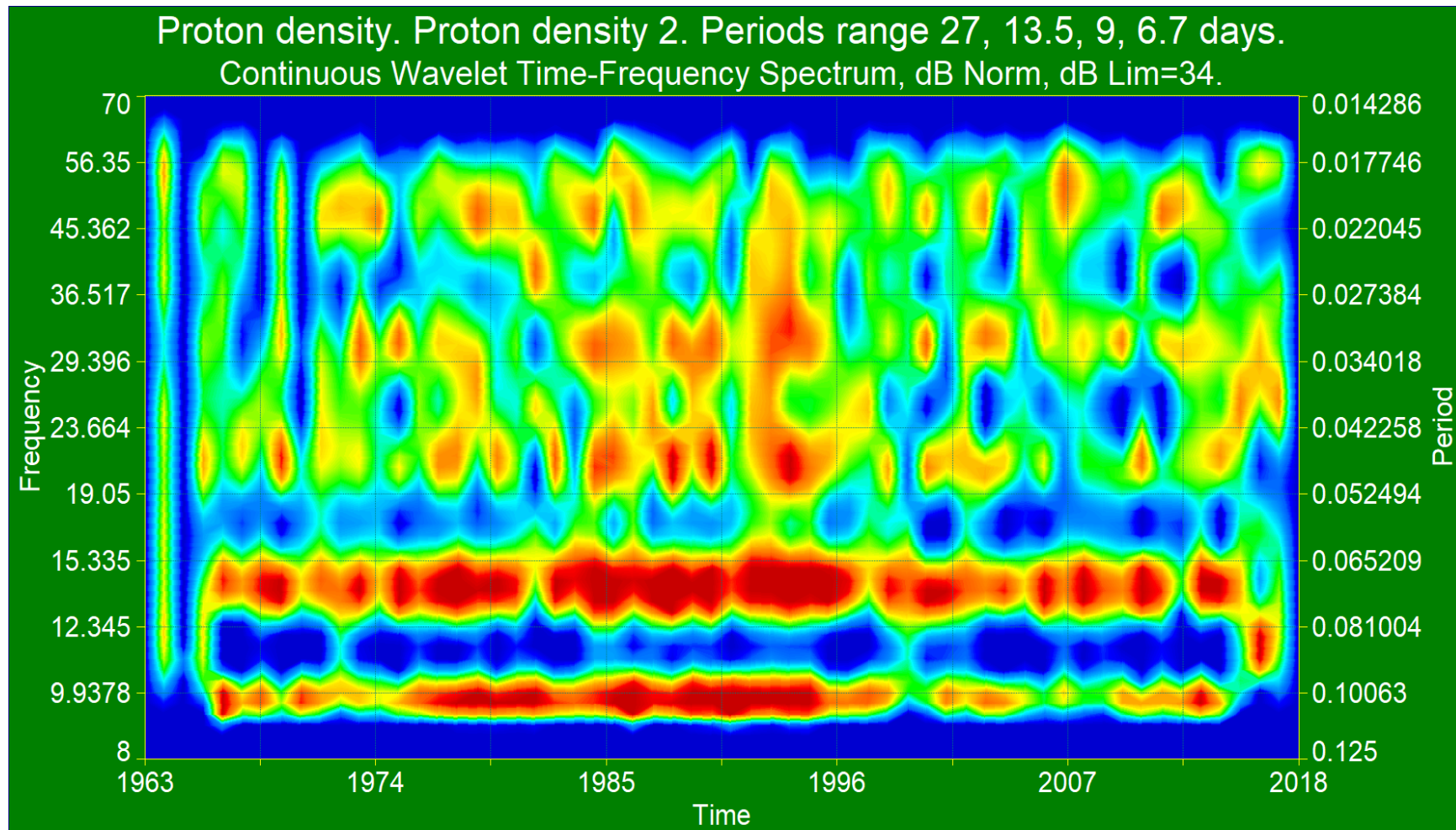


Solar radio index F10.7 deleted 11yr cycle.  
Continuous Wavelet Time-Frequency Spectrum, dB Norm, Lim=35

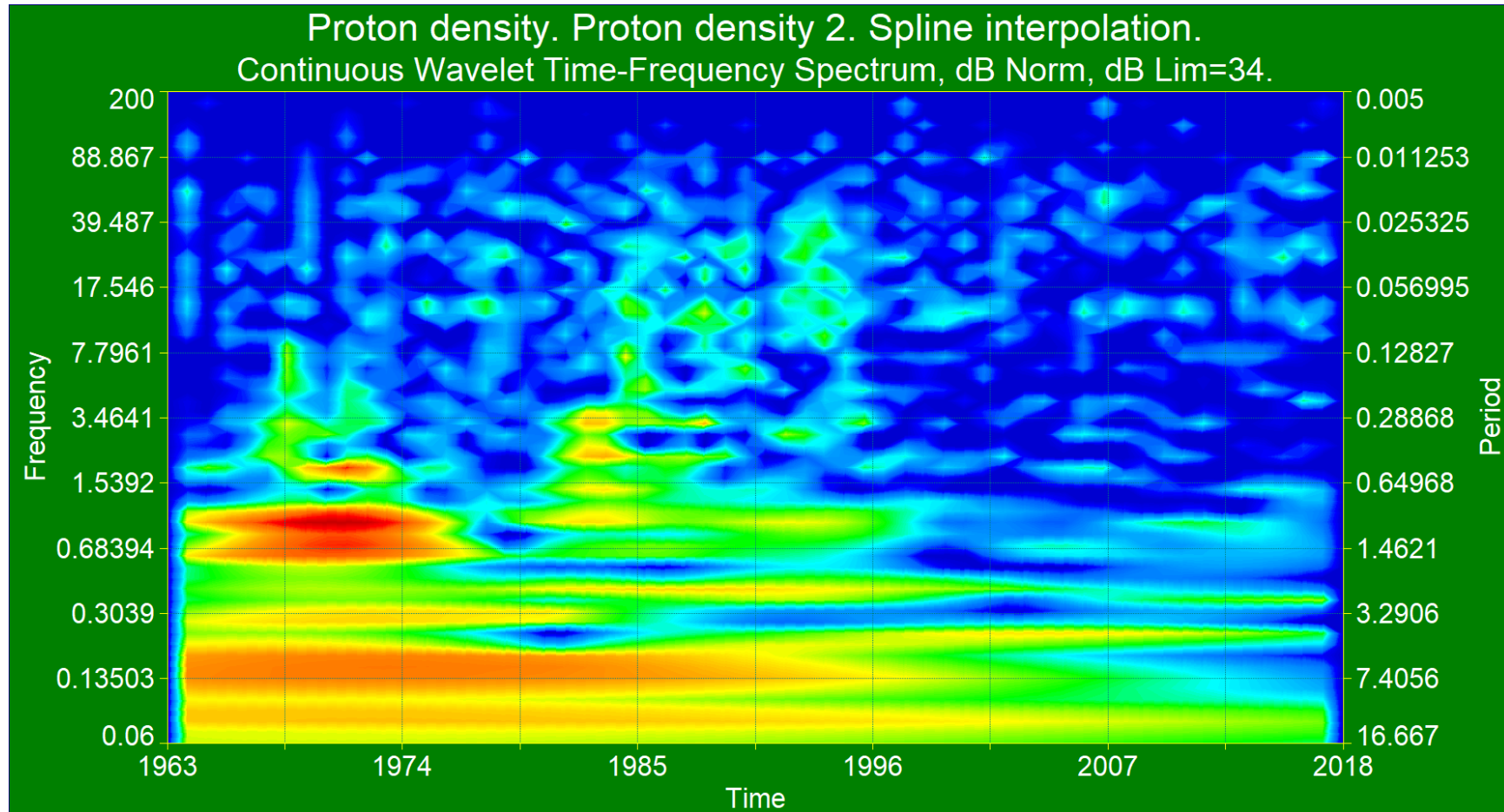


- **Solar-terrestrial Indexes  
and its properties**

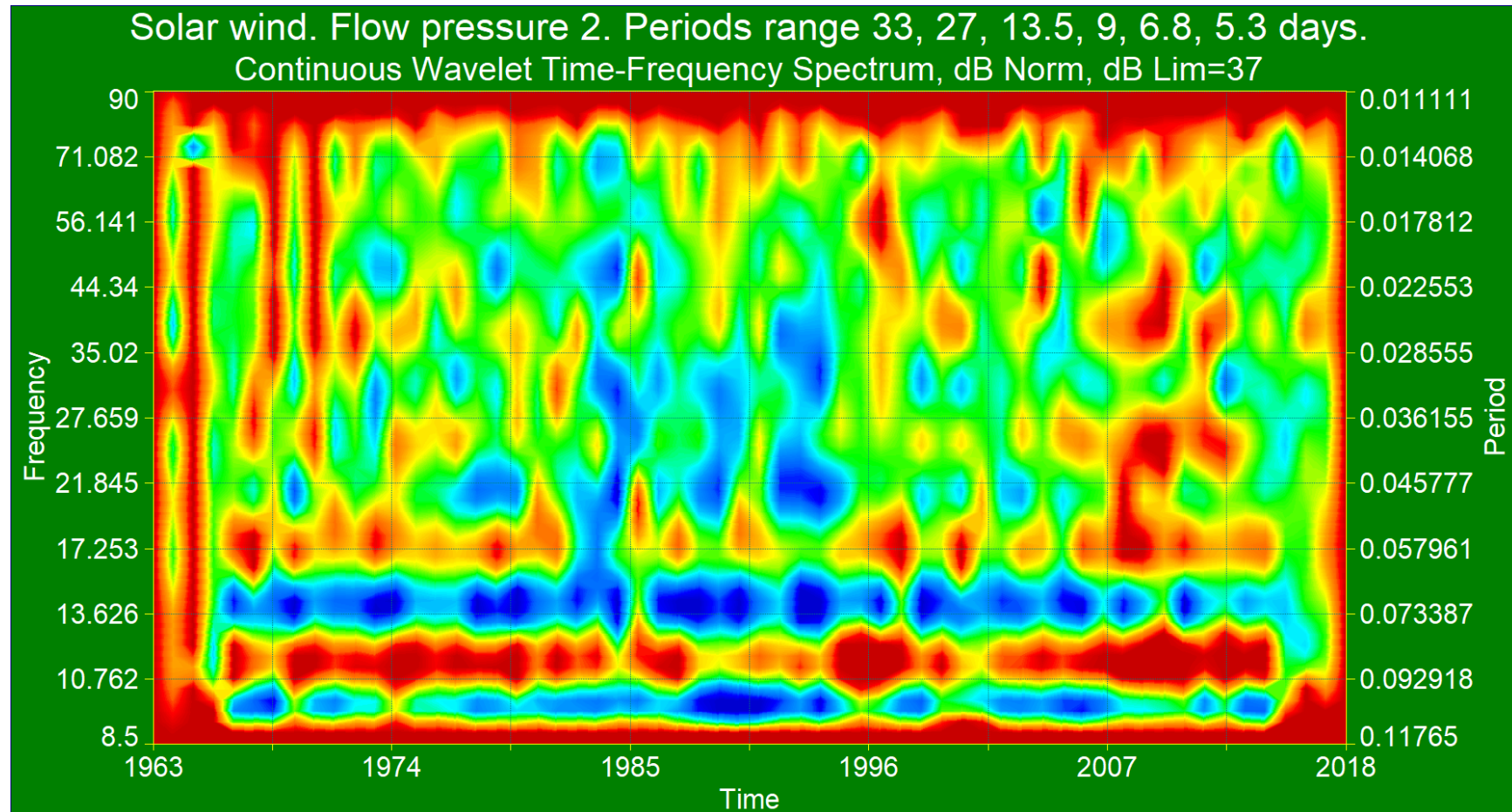
# Proton density (27, 13.5, 9, 6.7 days)



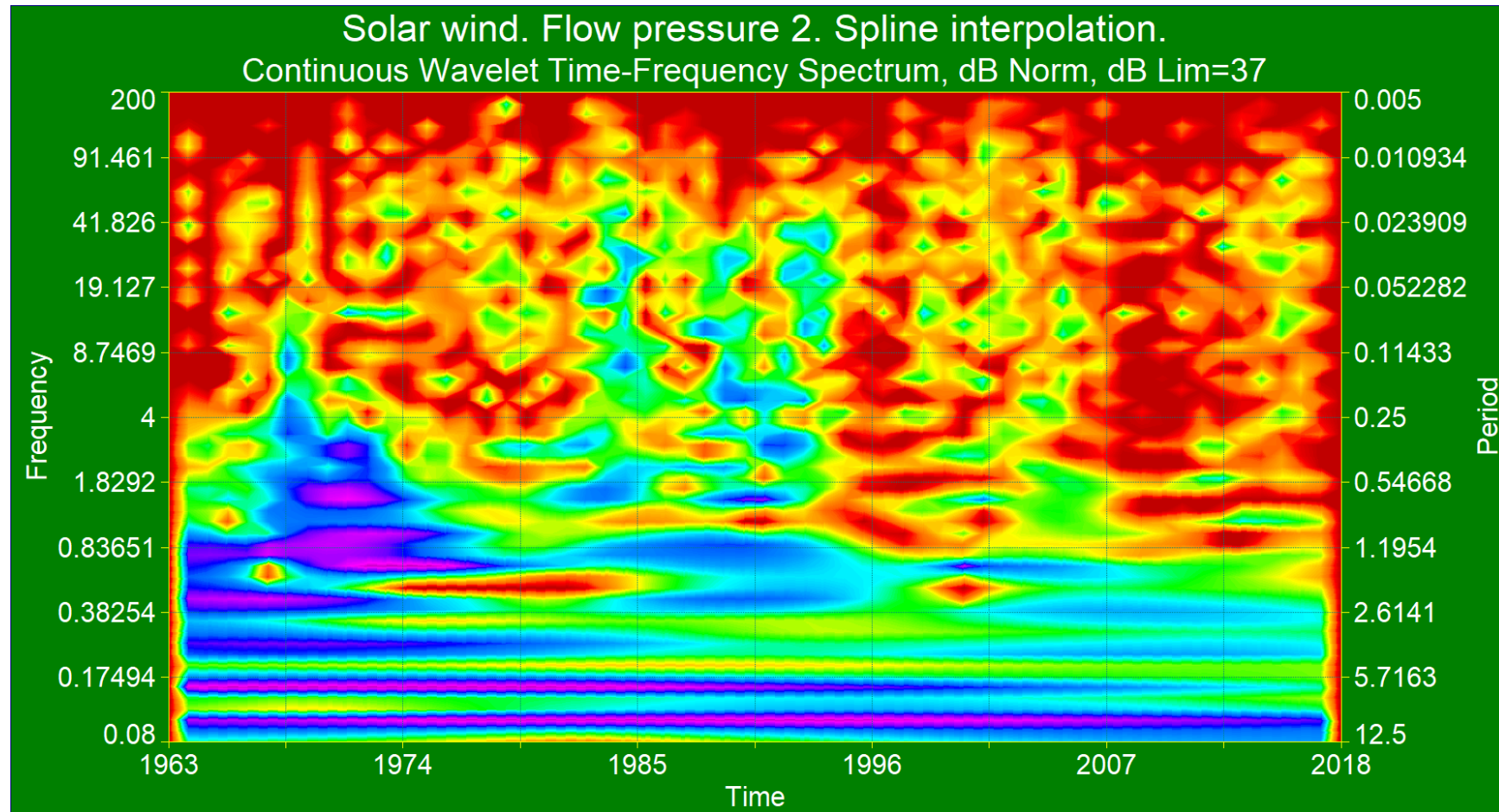
# Proton density – long periods



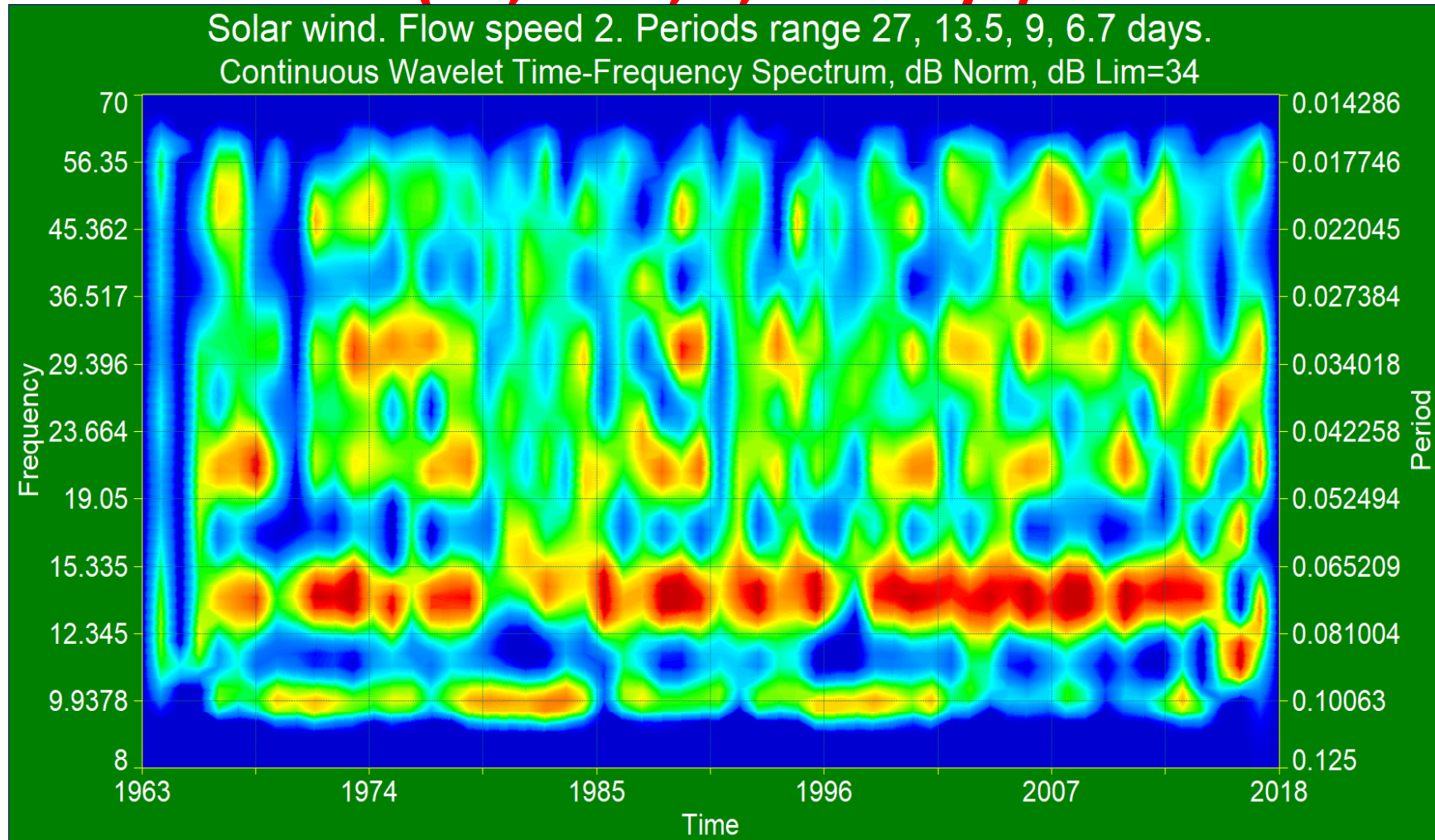
# Solar wind pressure (33,27, 13.5, 9,6.8,5.3 days)



# Solar wind pressure – long period

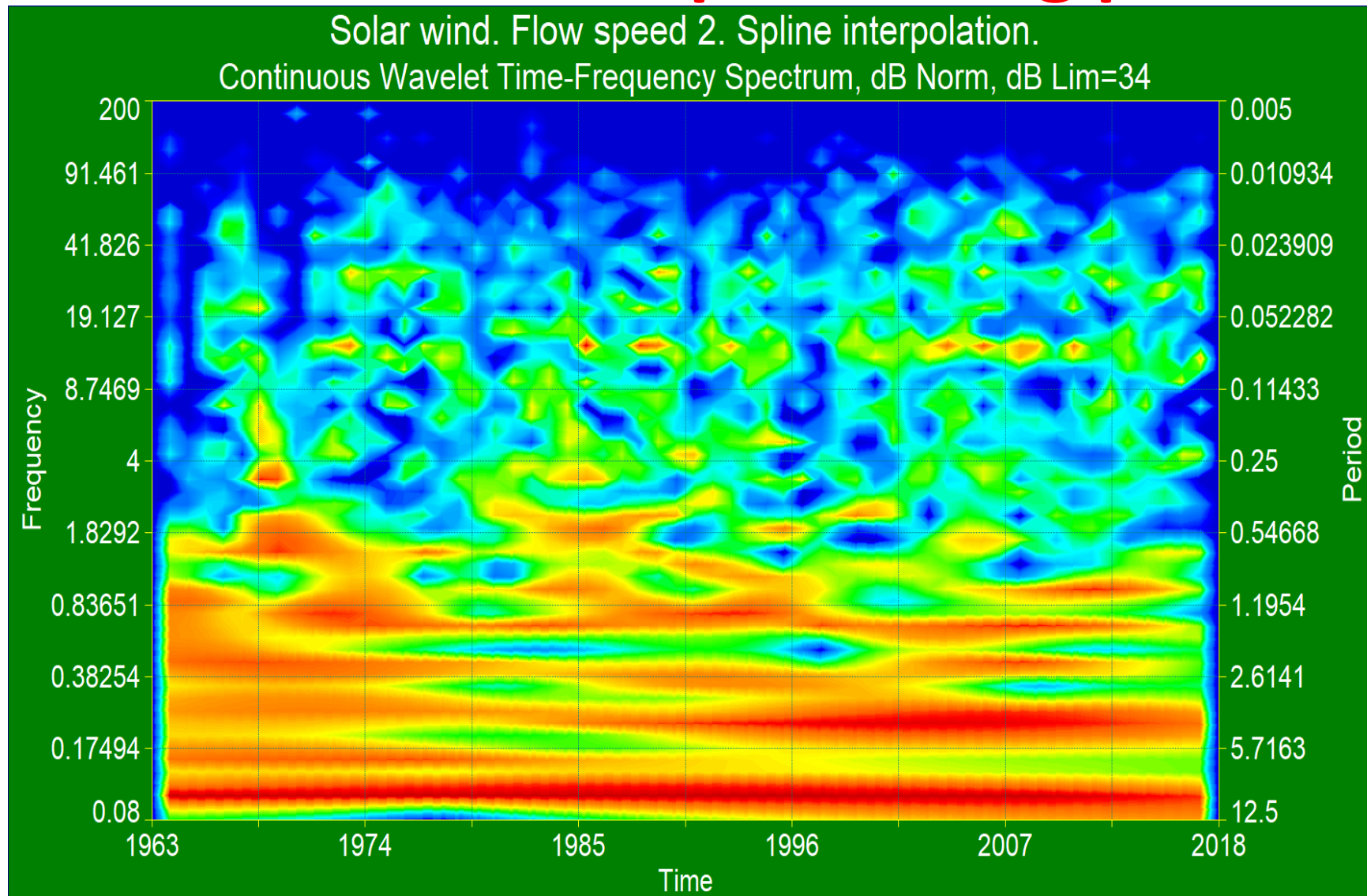


# Solar wind . Flow speed (27, 13.5, 9, 6.7 days)





# Solar wind .Flow speed –long period



# Conclusion

- To day requires modernisation about solar activity indices.
- They should reflect the difference in activity of Northern and Southern hemispheres of the Sun, the directional effects of their actions on the Earth, discrete and continuous nature of the manifestations.
- Also of great importance is an understanding of the basic periodic processes forming the solar cycle and the time of their existence.

**Thank You for attention !**

