Spots on the Sun and Life on the Earth

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Abstract: The paper deals with a new integrated method of reconstruction and forecasting of climatic changes on the Earth. The method is based on proxy data pollen analysis method, fossil and recent spore-pollen spectra, ^{14}C analysis method, basic elements of climate, Similarity Indices (SI) of solar Activity, expressed in number of Wolf's (Wm^2), and forecasting of climate changes. The techniques of reconstruction and forecasting are presented and discussed.

Keywords: Sun activity, Sun spots, the Earth, Environment, Climate, Studies, Integrated methods, Similarity Index (SI), Biological and Physical systems, Holocene, Prognoses, Environment, Climate till 2050 year.

«The biggest challenge for mankind after smashing of the atom will become the weather and climate forecasts».

Sergey I. Vavilov, Academic of the Rassiun Academy of Sciences

The Sun is the main trigger of climatic changes on the Earth. The other planets of the Solar system, such as the Moon, Mars, Saturn, and others exerted their influence naturally on the Earth`s climate in the past too, as they are doing at the present time. The Sun`s influence on the Earth`s climate has been thoroughly studied by scientists for a long time [1-6]. A huge data of knowledge in this field of investigations obtained. And nevertheless, it is absolutely urgent that further studies in this field have to carry on as far as there are a much of problems and difficulties still. "All these difficulties force us to "put the cart (palaeodata) before the horse (the Sun)" and to go looking for ways in order to estimate the role of solar influences on the climate directly on the basis of palaeodata. The principle of "detection and attribution", which we suggest, is aimed at detecting climatic changes in the past, which could be connected, without presumptions, with changes in solar influence. This, in its turn, requires a large amount of precisely dated findings of palaeodata and their space-and-time analysis throughout millenarian time scales [7].

New advanced of the paleodata were presented on 20th – 23rd May, 2014 during the second meeting of the **«Solar Forcing"** Group in Davos, Switzerland. The Group members decided to follow the next principles in their research work:

(1) To choose the periods of solar activity extremes which have the minimum connections with volcanic eruptions when detecting solar signals and characteristic features of their manifistation;

(2) To take into consideration the fact that the solar activity has cyclic components with a precisely established frequency connection between the solar and volcanic activities;

(3) To establish regions of high resistance to the Sun`s influence, based on palaeodata and model works. New local the palaeodata should be obtained for these regions;

(4) To intensify efforts aimed at the perception of advanced progressive methods of studying palaeodata, reflecting the role of the Sun`s influence on the environment of the past;

(5) Not to use the temperatures of the Earth`s poles or global temperatures with the purpose of forecasting, because these averaged data do not represent regional data and distort regional climatic characteristics [7].

This presentation is mostly aimed at: (1) showing how the spore-pollen analysis method can contribute to the environmental reconstruction and (2) showing how to predict a climate changes in the future with the use of the spore-pollen analysis method data and with the help of the integrated approach. The fact that there is an adequate connection between vegetation and climate, does not, and should not, raise any doubts. Pollen and spores produced by plants at any place on the Earth and settling down on its surface form spore-pollen spectra (PSC) and are a reliable indicators and monitors of the environment. Therefore the content of these spectra reflect the connection between the climate and the vegetation, which can be expressed by Similarity Indices [6, 8]. This characteristic allows assessing the composition of fossil SPS in comparison

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ISSN: 1814-8085 / E-ISSN: 1927-5129/19

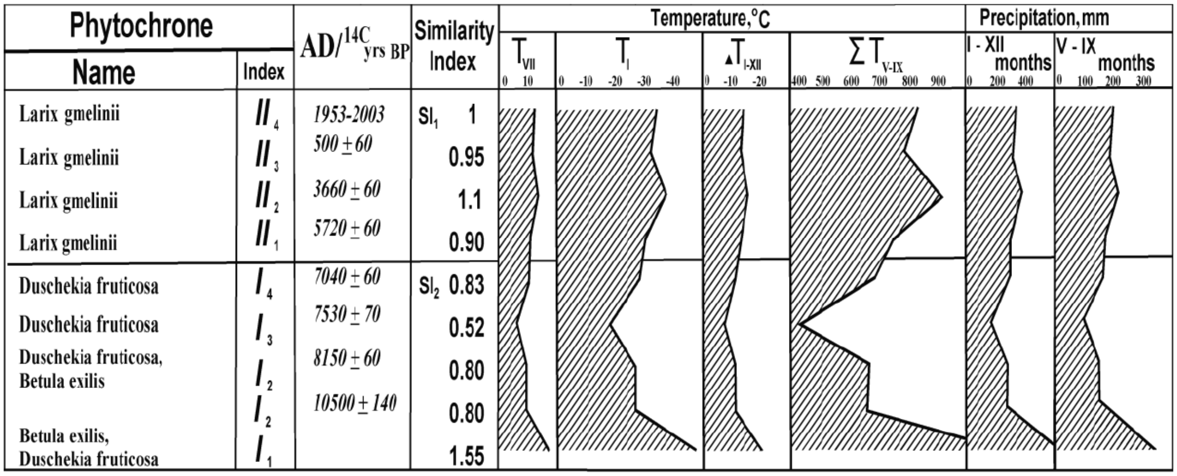

Figure 1: Graphs, illustrating the character of environment changes, the warmth and precipitation availability in the basin of the Fomich River Basin, Taymyr Peninsula, Russia during the last 10500 years or so.

with the SPS composition of modern surface samples – a model, reflecting the character of modern vegetation of this or that research area on the Earth.

As regards the assessment of climates of the past and modeling forecasts of climatic changes in future, the use of Similarity Indices method can make a real contribution in the solution of this one of most important modern problem. The possibility to express the connection which exists between the components of the contemporary vegetative cover (flora and vegetation) and the components of the vegetative cover of the past, and in consequence also the climate of the past in any of the studied regions can be realized through Similarity Indices (SI). The introduced index helps us to make a reliable correlation of fossil SPS on the zonal and the phytoceonotic levels.

By the quantitative characteristics of the climate and their dynamic in time, reconstructed for the Fomich River basin and for the Taymyr Peninsula, two types of climates have been established: tundra and forest (Figure **1**).

The suggested new method does not only allow to reconstruct of elements of climates of the past and their deviations in comparison with today's elements, but also allows making a forecast of climate changes in the future on the regional level, as well as using the obtained data for a forecast of climate changes in the future on the global level.

Taking into account the data of reconstruction of climate only as a basis, we can talk about of a trend of climatic changes in the future only. However, compare the Sun activity forecast expressed in Wolf units (MaxWm^2, MinWm^2), made by V.N. Kupetsky (1998) [9], with the climatic characteristics which have been reconstructed by us, we could make then a more precise forecast of climatic changes for the Taymyr Peninsula and for the Russian part of Arctic (Table **1**).

The above forecast lets us to make the following basically important conclusions.

(1) The climate's warming, which is currently being observed on the Earth (the 23rd cycle of the Sun's activity) may be go to compilation;

(2) during the following two cycles (24th and 25th) the Sun's activity will decrease to 100 –110 Wolf units, which will cause a cooling of the climate on the Earth;

(3) in the following, the 26th cycle, the Sun's activity will increase up to 130 Wolf units, which will cause a warming of the climate again;

(4) in the 27th cycle (2037-2048 years) the Sun's activity will decrease to 100 Wolf units, causing a cooling on the Earth again.

Thus, the forecast of climatic changes in the Arctic, which we have worked based on the Sun's-Earth's connections, is an objective natural reality. It is safe to say, the climate fluctuations in the Arctic, which we have identified for the last 12-10 thousand years, will continue in the forthcoming 50 - 100 years.

Cycles – Years - Sunspots (Wm^2) – Similarity Indices (SI) – Forecasts of Climatic Changes

As it was shown above, the Similarity Indices Method works reliably on the level of biological

Table 1: Forecast of changes in the main climatic elements in the forthcoming 50 years for the high-latitude regions of Arctic. Note: In the brackets there are deviations of climatic elements from values of the 1950 – 2003 years

Kupetsky, 1998 [9]			Ukraintseva, 2005, Ukraintseva, Pospelov, 2010 [8, 10]					
Cycle Year Max W			Years (AD/BP)	Element of Climate				
				T_{VII}	T_{I}	▲ T for year	Precipitation мм	SI
27	2048	100	2048	(–0,6)	(–1,7)	(–0,7)	(–36)	0,95
26	2036	130	2036	12,3	–33,8	– 13,4	348	1,0
25	2024	110	2024	(– 0,6)	(– 1,7)	(– 0,7)	(– 36)	0,95
24	2012	100	2014	(– 0,6)	(–1,7)	(– 0,7)	(–36)	0,95
23 *	**2000**	**140**	**2000**	**12,3**	**–33,8**	**–13,4**	**348**	**1,0**
			500±60	11,7(–0,6)	–32, 1(–1,7)	–12,7(–0,7)	312 (– 36)	0,95
			3660±60	**13,5(+1,2)**	**–37,2 (+3,4)**	**–14,7 (+1,3)**	**383(+ 35)**	**1,1**
			5720±60	11,1(–1,2)	–30,4(–3,4)	–12,0(–1,4)	313(–35)	0,9
			7040±60	10,2(–1,2)	–28,0(–5,8)	–11,2(–2,2)	289(–69)	0,83
			7530±70	6,4(–5,9)	–17,6(–6,2)	–7,1(–6,4)	181(–167)	0,52
			8150±60	9,8(–2,5)	–27,0(–6,8)	–10,7(–2,7)	278(–70)	0,80
			10500±60	9,8(–2,5)	–27,0(–6,8)	–10,7(–2,7)	278(–70)	0,80

systems. That is why it was a natural idea to try to implement this method to estimate solar activity, manifesting itself in the number of sunspots and their groups on its surface and expressed in Wolf's numbers. In order to calculate the Similarity Indices we used the same formula as we did for the SI calculation in biological systems, namely: X/Y=SI, where:

X is the number of sunspots and their groups (Wm^2) in any cycle and in any year of observation in the past;

Y is the number of sunspots and their groups ($W m^2$) in the cycle and in the year of contemporary (present) observations, which is equal to one - '1';

SI is the Similarity Index.

Example of a SI calculation:

Cycle 23, year 2000, the number of sunspots observed on the Sun during this 11-year cycle is equal to 140; made equal to one – '1'.

Cycle 22, year 1989, the number of sunspots observed on the Sun during this 11-year cycle is equal to 158. We divide 158 by 140 and obtain the SI, which is equal to 1.1285, etc.

In conclusion, a wealth of paleoecological data have been obtained from peat archives across the Globe and one of the remaining challenges is now to interpret these data in term of quantitative past climate and environment changes and use the obtained We have calculated the Similarity Indices for 29 cycles of solar activity, beginning from year 2000 down to year 1705 for MAXs and MINs of the 11-year cycles; for average MAXs and average MINs of the 22-year cycles; for average MAXs and average MINs of the 44-year cycles (Table **2**).

The analysis of the data shown in Table **2** enables us to make the following important conclusions:

(1) It is right and advisable to use the Similarity Indices Method also on the physical level.

(2) 11 – year cycles of the Sun activity are individual in the number of sunspots. SI reflects this individuality.

(3) Average minimums of sunspots in 11-year and in 22-year cycles are also individual. SI reflects this individuality too.

(4) Average maximums of sunspots in 44-year cycles and average minimums of sunspots in 44-year cycles standing side by side in the time scale (solar time matrices) differ, but every second one is similar. The Similarity Indices are illustrated this distinctive characteristic of the 44 – year cycles of solar activity quite obviously.

It is hard to escape the conclusion that this characteristic of the 44-year cycles are the rule or

Table 2: The Similarity Indices (SI) Illustrated the Distinctive Characteristic of the 44 – Year Cycles of Solar Activity Quite Obviously

	MAX 11-years sycles			Mean value		Mean value		MIN 11-years cycles			Mean		Mean	
Sun's cycles, №№	Year	Sun spot numbers (W)	Similarity Indeses	22 years MAX	Similarity Indeces	44 years MAX	Similarity Indeces	Year	Sun spot numbers (W)	Similarity Indeces	22 years MIN	Similarity Indeces	44 years MIN	Similarity Indeces
Цикл		W	SI	W	SI	W	SI		W	SI	W	SI	W	SI
23	2000	140	1	149	1.0	140	1	1986	13	1	<0		- 2	
22	1989	158	1,128571					1976	13	1				
21	1979	156	1,114286	131	0.8701			1964	10	0,769231	11,5	1		
20	1968	106	0,757143					1954	4	0,307692			6.5	1
19	1957	190	1,357143	171	1.1476	132	0,942857	1944	10	0,769231	7	0,608696		
18	1947	152	1,085714					1933	6	0,461538				
17	1937	114	0,814286	96	0.6442			1923	6	0,461538	6	0,521739		
16	1928	78	0,557143					1913	1	0,076923			3.2	0,492308
15	1917	85	0,607143	84	0.5637	80	0,571429	1901	3	0,230769	2	0,173913		
14	1905	64	0,457143					1889	6	0,461538				
13	1893	85	0,607143	75	0.5033			1878	3	0,230769	4,5	0,391304		
12	1883	64	0,457143					1867	7	0,538462			7.5	1,153846
11	1870	139	0,992857	118	0.7919	124	0,885714	1856	4	0,307692	5,5	0,478261		
10	1860	96	0,685714					1843	11	0,846154				
9	1848	124	0,885714	131	0.8791			1833	8	0,615385	9,5	0,826087		
8	1837	138	0,985714					1823	2	0,153846			4	0,615385
7	1830	71	0,507143	58	0.3893	74	0,528571	1810	0	0	1	0,086957		
6	1816	46	0,328571					1798	4	0,307692				
5	1804	48	0,342857	90	0.6040			1784	10	0,769231	7	0,608696		
4	1787	132	0,942857					1775	7	0,538462			8.2	1,261538
3	1778	154	1,1	130	0.8724	107	0,764286	1766	11	0,846154	9	0,782609		
2	1769	106	0,757143					1755	10	0,769231				
1	1761	86	0,614286	84	0.5637			1744	5	0,384615	7,5	0,652174		
0	1750	83	0,592857					1733	5	0,384615			5	0,769231
-1	1738	85	0,607143	88	0.5906	**70**	0,5	1723	10	0,769231	7,5	0,652174		
-2	1727	90	0,642857					1711	0	0				
-3	1717	52	0,371429	51	0.3423			1700	5	0,384615	2,5	0,217391		
-4	1705	49	0,35							0				

which is not to exclude, even a law. This should be proved by further solar activity observations. We suppose that it would be advisable to use this fundamental rule for the climatic changes` forecasting on local, regional and global levels.

Consequently, only the synthesis of solar-telescopic data, paleobiogeographical data, paleoclimate data, and modern meteorological data allow making a valid long-term global forecast of climatic changes in the future. Regional and local forecasts will be then of the primary value. The level of contemporary scientific knowledge does not show us any other way yet. This forecast is needed to be taken into consideration in management plans. Thus, our results give ground scientific basis for climatic management and policy support.

And in conclusion, a wealth of palaeoecological data have been obtained from peat archives across the Globe (PAGES), and one of the remaining challenges of nowadays is to interpret these data in term of quantitative past climate and environment changes and use the obtained data for the forecasts of climatic changes on the Earth.

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Received on 26-11-2019 Accepted on 05-12-2019 Published on 14-12-2019

https://doi.org/10.29169/1927-5129.2019.15.09