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THE INFLUENCE OF SOLAR ACTIVITY FLUCTUATIONS ON LONG-TERM CLIMATIC EVENTS IN THE NORTH-CASPIAN REGION FOR THE PERIOD BEFORE 2017

P. I. Buharitsin[1] A. N. Andreev[2]

[1]Astrakhan expedition base of the Institute of hydro problems, RAS

Astrakhan State Technical University, 414025, Astrakhan, Tatischeva Street, 16\5, engineering ecology and nature management department;

[2] Hydrometerlogical centre of the Caspian fleet, 414000, Astrakhan, A. Guzhvin's Street, 8.

INTRODUCTION

During the design of long-term climatic forecast for the North-Caspian region the authors were using current data on the dependence of Earth climate from fluctuations of solar activity under the influence of total gravitating interaction between Earth, the Sun, the Moon and other planets. The authors were using present-day patterns of the dependence of Earth on circular vibrations of the solar activity and fluctuations of the rotation speed of the Earth under the influence of summary gravitational interaction between the Earth, the Moon, the Sun and other planets during the design of the long-term forecast of the extreme climatic changes in the North-Caspian region.

RHYTHMS OF THE SOLAR ACTIVITY AND THEIR INFLUENCE UPON THE LONG-TIME CLIMATE EVENTS IN THE NORTH-CASPIAN REGION

In N.S. Sidorenkov's work there are close connections between the rotation fluctuations of the Earth and changes in climate characteristics. In the periods of low-speed rotation of the Earth the repetition of the meridianal form of atmospheric circulation (C) in the first sector of the Northern hemisphere (from 50 w. l. till 80 e. l.) increases, and zonal (W and E) - decreases.

The mass of ice in the polar zones, tempo of growth of the global air temperature, total amount of cloudiness and precipitations decrease. The medium wind speed in the near-earth layer and evaporation from the surface and the sea increase.

In 1973 there began the period of faster Earth rotation, which finished in 2010, which will result in a new climatic change which will last for about 35 years (till 2040-2045).

The influence of the solar activity processes on the Earth climate was recorded more than two centuries ago and nowadays it is beyond any doubt. The basic cycles of the solar activity are the following:

- 11-year cycles (by Schwab-Wolf) are defined by the quantity of spots on the Sun surface. There the cycle is the time between two minimums of the sun spots. The duration of the cycle is from 7,3 to 17,1; the average one is 11,2 (the name 11-year stems from it). Since 1755 every cycle has the ordinal number. At present the 23d cycle is going.

- 22-year cycles (by Hoil). During the succession of one 11-year cycle by another one, the polarity of the head and tail sun spot in each hemisphere of the Sun changes, which allowed Hoil to single out the 22-year period, consisting of even and odd 11-year cycles.

- 80-year ("century") cycles were recorded by A. L. Gansky. In 1939 Gleisberg counted the duration of the century cycles – 78 years. The existence of these cycles was confirmed by M. N. Gnevyshev.

- 190-year cycles ("indiction"). In 1948 L. L. Predtechensky recorded the cycle of the solar activity -190 years. It was called indiction, which means "returning". D. A. Bonov counted the duration of the indiction – 176 years (8 cycles of 22 years each).

The differences in magnetic properties of even and odd 11-year cycles define the differences of their influence upon the Earth climate. After the middle of 2007 the new 24-year cycle started. The cycle is even. Its influence upon climate characteristics appears in the following:

- the atmospheric pressure in the arctic zone decreases during the maximum solar activity and increases in the temperate latitudes;

- the zonal type of atmospheric circulation increases during the maximum of the solar activity;

- well-developed monopolar magnetic poles strengthen the meridianal type of atmosphere circulation during the even 11-year cycle;

- peaking of meridianal circulation in the middle latitude strengthens temperature contrasts with the intrusion of arctic air up to latitude 30-50 n. l. and it brings overall fall in the temperature.

NOTE: taking into consideration the total quantity of the sun spots in the 11-year cycle, besides the basic one, they single out three more maximums of the activity:

- 1-2 years before the basic one;

- 1-2 year after the basic one;

- 5 years after the basic one.

Apart from that:

- monopolar magnetic poles on the sun surface are better developed on the recession curve and on the minimum of the solar activity of the 11-year cycles. That explains the presence of two maximums in atmospheric processes connected with the sector structure of the magnetic poles:

1)with the maximum solar activity;

2)not long before the minimum of the solar activity.

The influence of the solar activity upon the climatic characteristics is of regional character. It strengthens atmospheric processes in some regions and weakens it in others. The

change of the climate on the coast and the water area of the North Caspian region are of single direction. The temperature regime in Astrakhan, Tyuleny island, Kulaly island, Ganyushkino, Atyrau, Peshnoi, Fort-Shevchenko during 1938-2003 was changing synchronically. Periods of the sudden change in the temperature emerge simultaneously and have one trend – increase or decrease.

The use of many-year data of observations of atmospheric temperature in Astrakhan since 1836 allowed to single out the peculiarities of temperature regime from the 8th to the 23rd 11-year cycle of the solar activity and to spread them throughout North-Caspian region.

One may single out indiction (1833-2007). It consists of two century cycles (1833-1923 and 1924-2007) and eight 22-year ones. The duration of the cycle is 175 years (by Bonov).

Every century cycle consists of eight 11-year ones. The duration of the first one is 91 years, the second one - 84.

Peculiarities of temperature regime of the solar activity cycles (table 1) are:

- medium atmospheric temperature of the even 11-year cycle is colder thah that of an odd one. Together they comprise a 22-year Hoil cycle, in the average the difference is 0,5 degrees;

- medium temperature of the cold season (November-March) of the even cycle is colder than that of an odd one, the difference is about 0,9 degrees;

- medium atmospheric temperature in March of the even cycle (0,8 degrees difference), February (1,7 degrees difference), December (1,1 degrees difference) is colder than that of corresponding temperatures of the odd cycle;

- medium atmospheric temperature of the period of solar activity fall of the even 11-year cycle is colder than that of an odd one (the average difference is 1,0 degrees)

- the lowest temperature during the century cycle of the solar activity has the first and the third 11-year cycles; from the fifth to the eighth 11-year cycles the atmospheric temperature increases;

- medium temperatures of 22-year cycles increase from the first to the fourth (in the century cycle);

- medium temperature of the even and odd 11-year cycles, in the century cycle, increase from the first to the fourth;

- the biggest growth of atmospheric temperatures is in the first and the fourth of the 22-year cycles (0,6 degrees).

On the whole, during the century cycle of the solar activity (80-90 years) the temperature regime develops in the following way. The decrease in the temperature during the first and the third 11-year cycles is lower than the norm (9,6 degrees Celsius). From the fifth to the eighth 11-year cycles the increase in the temperature is above the norm.

The temperature regime differs drastically at different stages of the 11-year cycles. At the stage of the solar activity fall there are about 70 per cent of extremely cold and warm years

(winter seasons). The repetition of the cold years is 3 times more frequent in even 11-year cycles. The repetition of the warm years (winter seasons) is 2 times more frequent in the odd 11-year cycles.

The new, the 24th even 11-year cycle of the solar activity began in the middle of 2007 and will continue till the middle of 2017 (the forecast). The total duration of the cycle will be 10,8+\-0,7 years. The basic maximum of the solar activity was in the first half of 2011. The maximums of 5-6year cycles were expected at the end of 2009 – the beginning 2010 and in the period between 2014 and the beginning of 2015.

Typical for even 11-year cycles decrease in the atmospheric pressure in the polar areas during the periods of increasing solar activity will force to move the arctic anticyclone to the north-east. Atlantic cyclones, formed in the humid sea air, will be northerner than usual. This will cause the decrease in the amount of precipitations in the Volga and the Kama.

In the north-Caspian region anticyclone feature of the climate will increase under the influence of Azorsky and Siberian anticyclones. The weather will be dryer. The amount of precipitations will decrease, especially during autumn-winter season and in spring. Continental arctic air mass, where Siberian anticyclone is formed, will lead a sharp fall in the temperature as a result of intensive radiation cooling.

Intensification of the meridianal form of circulation of the atmosphere during the periods of maximum solar activity will lead to a bigger fall in the atmospheric temperature during autumn-winter period because of artic air intrusion.

The average year atmospheric temperature in the 24-year cycle will be about 9 degrees Celsius which is 0,6 degrees lower than a many-year norm. It is also1,8 degrees Celsius lower than in the 23 cycle (1996-2007). The fall in the average year temperature will be because of a sharp temperature decrease of the cold season (November-March) till minus 3,0 – 3,5 degrees Celsius. It is 0,7 – 1,2 degrees Celsius lower the norm and 3,0 -3,5 degrees Celsius lower, 1996-2007.

Thus, for 11 years (2007-2017) in Astrakhan region and in the water area of the North Caspian region we should expect dry, with cold winters and strong eastern winds, weather. The total decrease in the quality of the precipitations in the Volga and the Kama rivers will result in the lowering of the Caspian sea level. The winter duration instead of usual 80-100 days (during the last 20 years) will increase to 100-120, and even 120-140 days. Taking into consideration the forecast of the solar activity of the 24th cycle and the peculiarities of the temperature regime of the even 11-year cycle we can suppose that winter seasons of 2008\2009, 2009\2010, 2010\2011, 2012\2013, 2013\2014, 2015\2016 will be colder than the norm. The winter seasons of 2008\2009, 2012\2013, 2013\2014 will be very severe (for about 4,5-5 months).

WINTER TYPIFICATION ACCORDING TO THE DEGREE OF SEVERITY

Table 1. The total of daily negative temperatures in winter in Astrakhan (from 1984 to 2010)

Years	November	December	January	February	March	Total
1984-1985	from 01.11 -50,6	-224,4	-172,0	-178,7	up to 21.03 -99,5	-725,2
1985-1986	from 18.11 -31,5	-89,8	-71,1	-153,3	up to 25.03 -32,6	-378,3

1986-1987	from 15.11 -37,2	-81,2	-253,3	-187,3	up to 29.03 -102,0	-661,0
1987-1988	from 11.11 -28,3	-86,4	-206,4	-223,8	up to 11.03 -5,8	-550,7
1988- 1989	from 03.11 -15,7	-60,3	-76,6	up to 20.02 -41,8	-	-194,4
1989-1990	from 19.11 -9,5	-49,5	-120,5	-98,3	up to 16.03 -1,3	-279,1
1990-1991	-	from 10.12 -93,6	-108,6	-162,9	up to 11.03 -24,4	-389,5
1991-1992	from 02.11 -7,6	-111,7	-92,6	-86,6	up to 17.03 -13,1	-311,6
1992-1993	from 26.11 -3,0	-122,1	-113,9	-139,7	up to 16.03 -52,8	-431,5
1993-1994	from 08.11 -209,2	-116,6	-113,6	-149,7	up to 15.03 -53,8	642,5
1994-1995	from 06.11 -30,9	-147,8	-29,2	-14,4	up to 17.03 -26,6	-248,9
1995-1996	from 14.11 -1,4	-121,4	-228,3	-134,0	up to 29,03 -31,6	-516,7
1996-1997	-	-100,8	-205,2	-133,0	up to 8.03 -0,8	-439,8
1997-1998	from 06.11 -17,7	-140,8	-198,5	-201,6	up to 26,03 -9,7	-568,3
1998-1999	from 10.11 -59,5	-88,4	-70,2	-31,1	-3,9	-253,1
1999-2000	from 08.11 -95,8	-17,1	-27,8	-12,0	-	-152,7
2000-2001	from 11.11 -21,8	-41,6	-88,8	-68,6	-2,8	-223,6
2001-2002	from 06.11 -3,7	-117,6	-61,7	-13,0	-	-196,0
2002-2003	-11,6	-289,3	-74,5	-155,5	-29,1	-560
2003-2004	-	from 02.12 -21,0	-58,7	up to 22.02 -18,7	-	-98,4
2004-2005	from 23.11 - 18,5	-7,7	-35,9	-116,5	-	178,6
2005-2006	-	from 22.12 -10,9	-346,7	-129,1	-	-486,7
2006-2007	from 19.11 -34,9	-37,1	-7,9	-84,7	-1,4 till 17.03	-166,0
2007-2008	from 7 .11 -28,7	-100,3	-274,9	-141,0 till 22.02	-	-544,9
2008-2009	-	from 14.12 -142,3	-1,3	-60,0	-13,5	-217,1
2009-2010		from 15.12		till 19.02		-407,7 moderate.

ICE THICKNESS

The maximum thickness of the ice of the natural growth in the North Caspian region is observed in January – February, and even during very severe winters it is no more than 60 cm in the north-western part and 90 cm in the north-east (table 3).

Table 2. The absolute maximums of the ice thickness in the delta of the Volga and the North Caspian Sea, centimeters.

Point	December			January			February			March	
	1 ten days	2 ten days	3 ten days	1 ten days	2 ten days	3 ten days	1 ten days	2 ten days	3 ten days	1 ten days	2 ten days
Astrakhan	32	42	46	49	47	52	60	64	64	62	60
Ikryanoe	19	37	40	41	44	55	66	71	71	67	63
Olya	19	27	29	32	35	45	52	55	55	46	35
Iskustvennyi ostrov	15	20	21	28	38	49	52	55	55	47	36
Tulenyi ostrov	20	20	20	20	40	45	50	52	50	50	43
Chistaya	17	22	26	28	42	56	69	70	68	67	59

Banka											
Ukatnyi ostrov	28	36	43	46	47	53	53	54	56	60	60
Shalyga	35	47	58	61	64	64	64	64	70	74	72
Peshnoi	35	41	60	75	64	72	75	78	75	70	69
Zhilaya kosa	25	45	60	66	70	73	83	86	88	90	89
Kylaly ostrov	16	23	26	29	34	46	46	55	56	57	54

CONCLUSION

Such essential forecast changes in hydrological and climatic conditions will certainly tell badly on all, without any exceptions, economic branches, and not only in Astrakhan and Astrakhan region, but in the whole north-Caspian region. It will result in additional expenditures both in warm, and in cold seasons of the investigated period. The increase in the continental character of the regional climate will affect agriculture, water transport, and fishing industry. It will be necessary to conduct additional dredging, reclamation operations, and, possibly, reconstruction of many existing coastal sea and river hydrotechnic constructions and objects. There will be rapid increase in housing and public utilities costs on water delivery, especially in summer-autumn drought periods, as well as, on heating of accommodations, service and industrial buildings in cold seasons. Consumption of electrical and heating energy and of various types of fuel will grow considerably.

Lowering of the Caspian Sea level primarily will affect its shallow Northern part. In warm summer seasons it leads to intensive heat penetration and water evaporation from vast shallow waters of North Caspian, increase in sea water salinity up to hazardous levels and rise of hypoxia vast zones.

In cold seasons, as the result of shallow waters low thermal capacity under the influence of low temperature and intensive wave overturn in the initial period of ice formation, strong ice cover will appear at North Caspian. Its thickness reaches its maximum long-standing values in the middle of winter.

In view of the fall of the Caspian Sea level and decrease in the depth of shallow north part of the sea, the intensity of hummocking ice processes will sharply increase. Particular risk will be in the form of floating packed ice brought by wind and streams into the deep-water middle part of the sea and drifting along the shores to the south. The sea bottom, practically all over the territory of the North Caspian, will be subjected to exaration by heavy drifting ice. The frequency and intensity of dangerous set-downs will increase. This will lead to massive fish mortality, especially in winter months under ice and in spring during its concentration during spawning season.

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