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THE ANALYSIS OF AIR TEMPERATURE CHANGES AND THE PRECIPITATION RATE IN RUSSIAN ISHYM RIVER AREA FROM 1955 TILL 2012

SUMMARY. Weather determines many if not all aspects of human life. Meteosensitivity of human health has been studied by certain branches of science. Observation of meteorological elements changes, including temperature and precipitation, makes it possible not only to observe the weather, but also to anticipate it. With the help of monitoring data on air temperature and precipitation for the period from 1955 to 2012 (series of 58 years) in the Town of Ishym, the average annual temperature, and long-time average annual precipitation have been analyzed. Deviations of annual highs and lows from January to December and February have been identified. The detected average annual temperature changes confirm the existence of global warming. Ranking by average monthly temperature and precipitation revealed most of the warm, cold, wet and dry years. Months and years of the absolute maximums and minimums are determined. Out of 58 years in the town of Ishym only 18 years are marked by an average annual temperature below the annual standard. During the past 2012 year the town of Ishym failed to be the leader in any of the indicators. Average annual precipitation analysis showed that out of 58 years 31 years (more than half) was indicated by greater annual precipitation than the climatic norm (380 mm). The comparison of average air temperatures in the northern hemisphere and the town of Ishym shows that it has been cooler in Ishim in the past three years than in the hemisphere as a whole. The results of this research can provide the basis for forecasting climate changes in the town of Ishym. In addition, the data can be used in the teaching of local history, geography, etc.

KEY WORDS. The average air temperature, precipitation, climate change, weather in the town of Ishym, the annual course of air temperatures.

Currently there is no lack in the forecasts of the future thermal state of the planet. The subject of thermal well-being is one of the discussed topics in the world. Climatologists consider global warming as a scientific fact, astrophysics who watch solar activity, in contrast, are more inclined to believe that we are living on the eve of the Little Ice Age. The study of climate change has moved to the forefront of science. This is evidenced by the rising number of monographs [1–4].

Economists, farmers and physicians joined to discuss the problem of thermal future of the world and Russia [5–9]. First reports from the regional forecasting the effects of global warming in some regions of Russia appeared [10–11].

Climate observations are needed to determine the current state of weather and climate, their variability, for monitoring of climate change and identifying their causes, for forecasting of hazardous weather and early warning of it, and also to determine the effects of weather on human health, especially of school children [5]. In these circumstances it is important to analyze the primary meteorological data obtained by instrumental methods in Ishym River Russian Area with climate-agrarian economy.

According to our research the average long-term rate of monthly air temperature in Ishym (Table 1) is close to the means of the climatic norm. However, there is a slight deviation in months: in all months except July and September, the means are in the range of 1°C above the norm. But in July and September it is colder than the climate norm by only 0.1°C. But the average annual air temperature for the period of 58 years is almost twice the norm.

Table 1

The average long-term air temperature rate (1955–2012)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Norm	-18	-17.1	-10.1	2.1	11	16.6	19	15.3	10	1.3	-8.3	-14.4	0.6
Annual mean	-17.6	-16.5	-8.8	2.7	11.6	17.1	18.9	15.5	9.9	2.3	-7.4	-14.6	1.1

The analysis of the annual change of the average monthly temperature of winter months showed that of 58 years observation the annual minimum is in January only in 27 cases that is less than a half. In 31 cases it is either December (15 cases: 1955, 1959, 1962, 1966, 1968, 1978, 1984, 1986, 1991, 1992, 1997, 2002, 2004, 2009, 2012) or February (16 cases: 1956, 1961, 1964, 1965, 1967, 1971, 1975, 1976, 1988, 1993, 1994, 2001, 2003, 2005, 2007).

In general, in December in 33 of 58 cases the recorded temperature is at or above normal. For January, the number is 35 cases out of 58, for February—34. The coldest winter was in 1968–1969. Then the average temperature for the three winter months was -26°C though the normal average winter temperature was -16.5°C. The coldest December in 58 years of observation series was 1966, the average monthly temperature reached -25.3°C. The coldest January and February during the study period were the corresponding months of 1969: the average January temperature reached -30.8°C and in February—24.4°C.

The mildest winter can be considered the winter of 1982–1983. The average winter temperature was -9.9°C. However, the warmest winter was recorded in other years. The highest average temperature in December was registered in 2006 (-6.9°C), in January—in 2007 (-8.3°C) in February—in 2002 (-8.0°C).

The analysis of the annual variation of mean monthly temperatures of summer months also found shift of the peak from July to June or August, though compared with the annual minimum, it is recorded in fewer cases: 12 out of 58. For example, a summer extreme average temperature in June was recorded in 1958, 1960, 1973, 1982, 1991, 1994, 1997, 2005, 2006, 2011, and in August—in 2003 and 2010. It is also associated with deviations from normal.

The warmest June was recorded in 1991 (21.3°C), July—in 1989 (22.9°C), August—in 2003 (20.4°C). The coldest summer months were observed in: June—1979 (13°C), July—1997 (15.5°C), August—1981 (12.2°C).

Based on the analysis of the changes of average monthly temperature, we ranged years by temperature conditions. The results of the analysis are compiled in Table 2, in which we can see the years with the highest and the lowest average monthly temperatures.

Table 2

The highest and the lowest average monthly temperatures (1955–2012)

	The highest		The lowest		Norm
January	2007	-8.3	1969	-30.8	-18
February	2002	-8	1969	-24.4	-17.1
March	2002	-2.3	1960	-17.4	-10.1
April	1995	8.9	1988	-5	2.1
May	2004	15.8	1969	6.8	11
June	1991	21.3	1979	13	16.6
July	1989	22.9	1997	15.5	19
August	2003	20.4	1981	12.2	15.3
September	1957	14.4	1958	6.2	10
October	1997	7.3	1976	-5.2	1.3
November	2008	0.4	1993	-18.1	-8.3
December	2006	-6.9	1966	-25.3	-14.4

The temperature leaders are mostly years after 1990. However, ten warmest years are the years from the entire period of observation. The last 2012 is among the top ten in April, June, July, August, September and October. The coldest are mainly the years of the last century, however the coldest December of 2012 occupies 56 of the 58. It was colder in Ishym in December only in 1968 and in 1966.

The average annual temperature in the period from 1955 to 2012 is shown in Figure 1.

The warmest year (in terms of average annual temperature) was in 1995, the temperature was 3.4°C for the climatic norm in 0.6°C. The coldest year is 1969; the average annual temperature was -2.3°C.

40 out of 58 years have an average annual temperature equal to or above normal; the average annual temperature above normal in two or more times was recorded in 29 of 58 cases (that is half). The excess of norm in 3 times was fixed in 18 years, in

4 times—in 7 cases. 4 years (2007, 2008, 1983, and 1995) with the average annual temperature that exceeded 5 climatic norms were registered. 1995 has an average annual temperature in 5.6 times higher than normal. As can be seen from Figure 1, the trend line shows the tendency of increase of average annual temperature.

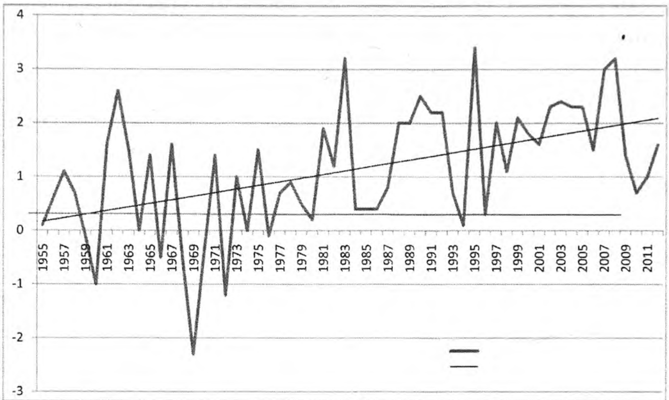

Figure 1: Changes of average annual temperatures for the period from 1955 to 2012 (horizontal line indicates the annual rate of temperature).

In addition to average annual temperatures there are always monthly minimum and maximum means of temperature. The absolute maximum and minimum temperature for the period of the study are presented in Table 3.

Table 3

The maximum and minimum temperatures (1955–2012)

	The absolute minimum		The absolute maximum	
Month	year	t, °C	year	t, °C
January	1979	-46.5	2007	3.9
Fabruary	1967	-46.3	1992	8.5
March	1971	-41.1	2008	14.2
April	1958	-29.8	1982	30.6
May	1969	-9.1	2004	36.5
June	1984	-2.6	1963	37.5
July	1989	2.2	1989	37.1
August	1968	-3.3	1967	37.2
September	1968	-6.9	2003	32.4
October	1969	-29.6	1999	25
November	1974	-40.2	2006	13.8
December	1968	-51.1	1982	4.1

The lowest temperature was recorded in December 1968. It was -51.1°C. The highest temperature was recorded in June 1963—+37.5°C.

Hydrometeorological Centre of Russia on its website [12] published the data that the decade of the nineties of the last century was the warmest one. The 2000s proved to be a little cooler. According to the analysis of our data in Ishym, the situation is a little bit different.

The decade of the 1990s includes the warmest year. There were only two years with an average temperature that is lower than normal. The average temperatures below normal were recorded in 39 cases that is one third of the total number of months in a decade.

For the same period of the 2000s 31 out of 120 cases of average monthly temperatures below normal were identified. There is not a year with an average annual temperature that is below normal, 4 years of high ranks (in 1990—only two).

In addition, there are 7 out of 12 leaders of the highest monthly average temperature (1 rank). Accordingly, it can be assumed that the 2000s proved to be warmer than the 1990s and all other decades. The analysis of ranging shows an increase in the average monthly temperatures of spring and autumn for the current 12 years.

The analysis of the average annual precipitation showed that 31out of the 58 years (more than a half) were observed with the annual precipitation more than the norm (380 mm). Six out of those (1990, 1980, 1972, 1966, 1992, and 1983) are with the precipitation in the normal range—from 373.3 to 388.6 mm. 1977 is the year with the highest rate of precipitation (545.5 mm), with the smallest rate (203.2 mm)—1962.

The leaders of the highest and lowest rates of precipitation in a month are presented in Table 4. The highest rate of precipitation was observed in June 1970 (185.5 mm), the lowest (0 mm)—in March 1998.

Table 4

Months with the highest and lowest precipitation totals

Month	Year	Total	Year	Total	Norm
	The highest		The lowest		
January	2001	54.6	2004	2.2	14
February	1998	33.5	1962	1.3	10
March	1994	35.8	**1998**	**0**	12
April	1995	77	1958	0.1	20
May	1966	116.6	1959	1.3	30
June	**1970**	**185.5**	1955	6.1	58
July	1992	117.2	1974	8.4	69
August	1979	116.8	1981	0.3	58
September	1973	93	2008	7.4	38
October	1969	94.9	1991	2.2	30
November	1989	87.7	2005	4.6	24
December	2004	45.2	1974	0.4	17

Much snow (87.7 mm, that is 3.7 monthly norm) fell in November 1989. Snowy November of 2012 is in the 5th place: it was 51.5 mm in a month that is more than two norms.

The ranking of the average monthly precipitation showed that years with precipitation that is above normal are of minor amount: from 4 years in June till 18 in February. With the amount of precipitation less than normal most years (36) are in July. The smallest number of years (22) with the precipitation that is below normal is in December.

It is noted that a smaller amount of precipitation (relative to normal) falls from May till September. In general, the observed period distribution of precipitation is quite uneven, it is impossible to identify some regularity.

If to compare the temperature data for the Northern Hemisphere, Russia [12–13] and Ishym, it is possible to find out some differences. Thus, in the Northern Hemisphere the warmest year out of 122 years of observations (1891–2012) was 2010 with an anomalous temperature 0.73°C. In Ishym the warmest year (in terms of average annual temperature) was 1995 with an anomalous temperature 2.8°C.

Table 5

Comparison of average temperature ranks in the Northern Hemisphere and in Ishym

Rank of the average temperature of the Northern Hemisphere for months and for a yearover 122 years of observations (1891–2012) [12–13]													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
2010	6	9	3	3	2	2	2	1	9	5	1	20	1
2011	22	20	11	7	10	5	6	8	7	5	16	7	9–10
2012	21	32	16	1	1	1	1	4	2	7	6	30	5–7
Rank of the average temperature of Ishym for months and for a yearover 58 years of observations (1955–2012)													
2010	55	52	32	14	20	26	36	3	27	18	5	47	39
2011	49	39	36	13	36	22	49	44	2	4	48	37	33
2012	47	46	19	2	18	6	5	9	7	8	23	56	22

Table 5 compares the ranks of the average temperature of the last three years in the Northern Hemisphere and in the town of Ishym. The indicators show that in the past three years it is colder in Ishym than in the whole hemisphere.

Table 6 shows the ranks of the average temperature in 2012 in Russia and Ishym. Although the study period is not the same (for Russia, 122 years were studied, for Ishym—58), however the ranking allows to track the warmest and the coldest years. As can be seen from table 6, 2012 was the leader of the temperature in the whole of Russia in May and June. For Ishym, the last year was not the leader in any month. The average annual temperature in 2012 is only ranked 22 out of 58. April, June, July, August, September and October 2012 in Ishym are among the ten warmest months in 58 years of observations. For comparison, the corresponding figures in Moscow are not among the top ten warmest.

Table 6

The average temperature rank for months and for 2012 year over 122 years of observations (1891–2012) on the territory of Russia [12] and over 58 years of observations (1955–2012) in Ishym

Region	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Russia	38	56	47	5	1	1	3	17	4	16	17	93	7
The Northwest Federal District	21	57	28	12	4	14	21	46	10	16	14	105	9
The Central Federal District	43	107	45	8	15	37	14	28	19	14	13	85	17
The Southern Federal District	69	120	103	1	1	5	22	7	28	12	30	84	17
The North-Caucasian Federal District	105	122	108	1	1	3	17	9	21	23	62	114	54
The Volga Federal District	34	91	40	1	8	14	25	6	40	6	7	69	5
The Urals Federal District	40	32	27	4	9	1	4	24	8	22	48	94	5
The Siberian Federal District	40	34	52	11	3	1	2	65	2	60	51	100	9
The Far East Federal District (North)	80	93	90	18	26	25	19	21	116	2	4	42	23
The Far East Federal District (South)	25	101	57	16	3	3	17	9	5	18	16	57	14
Moscow	40	98	62	15	18	45	13	29	18	26	14	90	24
Ishym	47	46	19	2	18	6	5	9	7	8	23	56	22

Thus, the analysis of the average long-tern air temperature and precipitation for 58 years in Ishym has revealed the peculiarities of the process of the meteorological elements. A shift of the minimum and maximum in the annual cycle has been observed. The warmest and coldest months and years have been identified. The current 20 years have been the warmest in the period of observation.

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