Characteristics of circulation seasons and their mean temperatures in Tomsk

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The paper presents analysis of the starting dates of circulation seasons such as fall, prewinter, winter, prespring, spring, and summer in the 20th century and some peculiarities of their temperature regime in Tomsk.

Climatic prediction of the Earth is the problem of vital importance for the humanity. Several modern determinations of the climate are at hand, but in all determinations the main result of the interaction of all the components of the climatic system is the weather. To define the genetic relation between the weather and one of the basic climate forming factors – atmospheric circulation, it is expedient to use the large-scale systematizations of circulation processes. The most acceptable one, in our opinion, for these goals is the B.L. Dzerdzeevskii classification based on the selection of elementary circulation mechanisms (ECM).[1]

The above-mentioned classification makes it possible to study in a more detail the intraannual structures of different meteorological fields depending on the circulation seasons close to the natural rhythms. Such a study is all the more important because in the scientific literature many facts are given of ambiguous annual manifestation of the general warming of climate.[2,3]

This paper presents the results of a joint analysis of time characteristics of circulation seasons and dynamics of seasonal mean temperature of air in Tomsk. We used the information about the dates (D_s) of the beginning of circulation seasons (fall, prewinter, winter, prespring, spring, summer) over a period from 1899 to 1985 published in literature over a period from 1986 to 1997, the data by T.V. Romashova (Tomsk State University) were used by seasons defined using the methods by N.V. Rutkovskaya.[5] The seasonal mean temperatures in Tomsk were calculated with the use of data of daily resolution positioned on a server of VNIIGMIMTsD of Obninsk. A detailed description of the procedure of separating out the circulation seasons is available in the literature.[1] Seasons are defined according to an indication of reconstruction of the Earth's thermobaric field and represent the periods of the development and conservation of inherent definite ECM (Fig. 1).

Having analyzed the dates of coming of seasons, we obtained the following results (Table, Fig. 2).

Figure 2 shows the dynamics of D_s during the investigated period and the results of its approximation by a polynomial of the 6th power.

Table. Statistics of date of coming of circulation seasons

Season	Statistics			
	Mean date	Standard deviation, days	The earliest date	The latest date
Prespring	March 10	13	Feb. 5	Apr. 8
Spring	April 11	10	Mar. 17	May 1
Summer	May 24	13	Apr. 29	June 25
Fall	September 1	15	Aug. 1	Oct. 14
Prewinter	October 10	12	Sep. 14	Nov. 13
Winter	November 26	15	Oct. 19	Dec. 28

1. Prespring and spring

Periods with processes of 1a, 2, 7b types[1] are related to these seasons when three outbreaks of the southern cyclones are observed. On the surface maps we can see the polar region of high pressure, surrounded by the "ring" of cyclone trajectories developed at the Arctic front, or regenerating the polar-front ones.

Over the entire area of continents the pressure is low, over the oceans the pressure is high. The mean date of coming of prespring is March 10 and of spring is April 11. A tendency of later coming of the season was observed for prespring over a period from 1899 to the late 1940s. Early in the 1960s the second peak of D_s was observed. The direction of the second peak of D_s was the same, but this peak was less intense than the first one. The third peak of D_s falls on the late 1990s. However, the linear trend-analysis has revealed during the above period, as a whole, a general tendency of earlier coming of the season, in the last 20 years by 4 days, on the average.

The dynamics of D_s of the spring season before 1970s is identical to prespring but it is less pronounced. From the late 1970s we observed a sharp change, i.e., earlier coming of the season. The linear trend indicates this tendency.

2. Summer

This season involves the period with processes of the 4 and 5 types when we can observe, as a rule, one process of blocking and violating zonality due to

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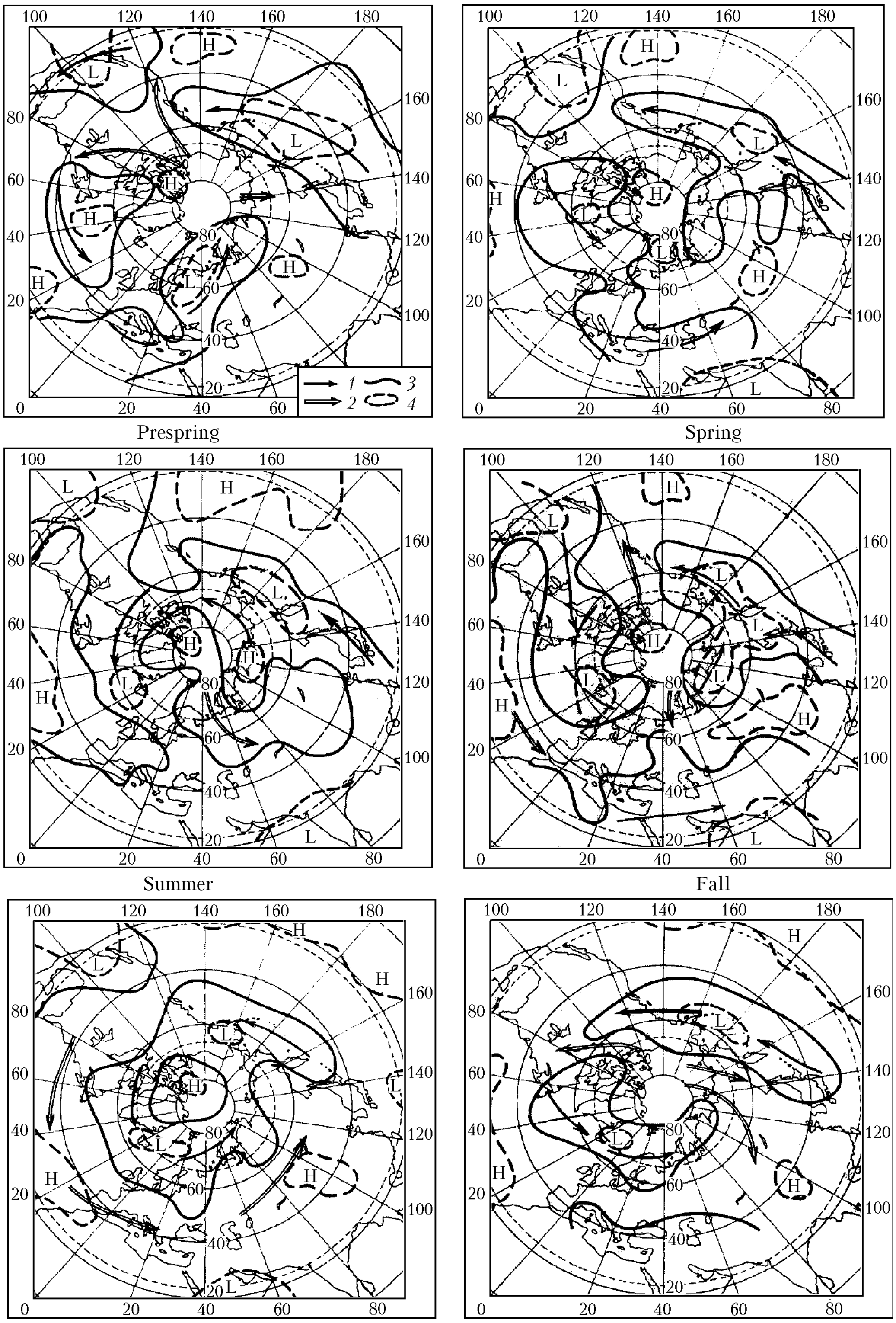

Fig. 1. Season typical circulation schemes: generalized trajectories of cyclones (*1*); the same for anticyclones (*2*); lines of demarcation (*3*); baric centers (*4*).

the polar invasion in Europe. On the major part of high latitudes zonal trajectories of cyclones remain. The summer is coming, on the average, on May 24. The latest and earliest dates are June 25 (1926) and April 29 (1940). Two peaks are traced (Fig. 2) of later coming of the season in the middle of 1920s and early in the 1960s. From 1982 to 1997 the trend for earlier coming of the season was observed.

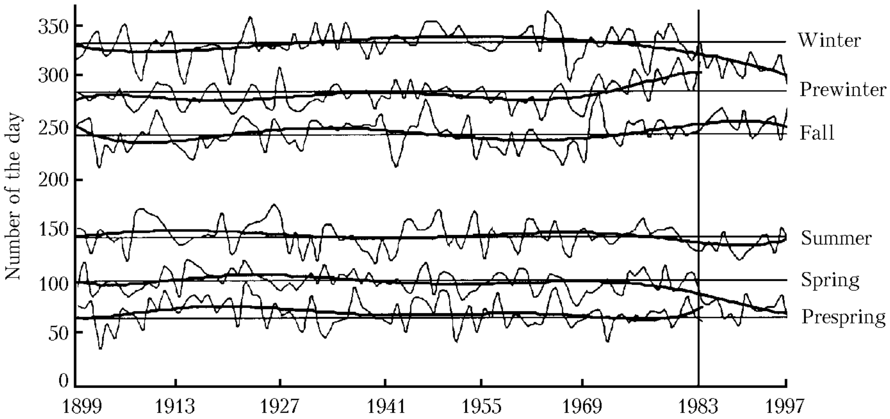

Fig. 2. Dynamics of dates of the beginning of seasons.

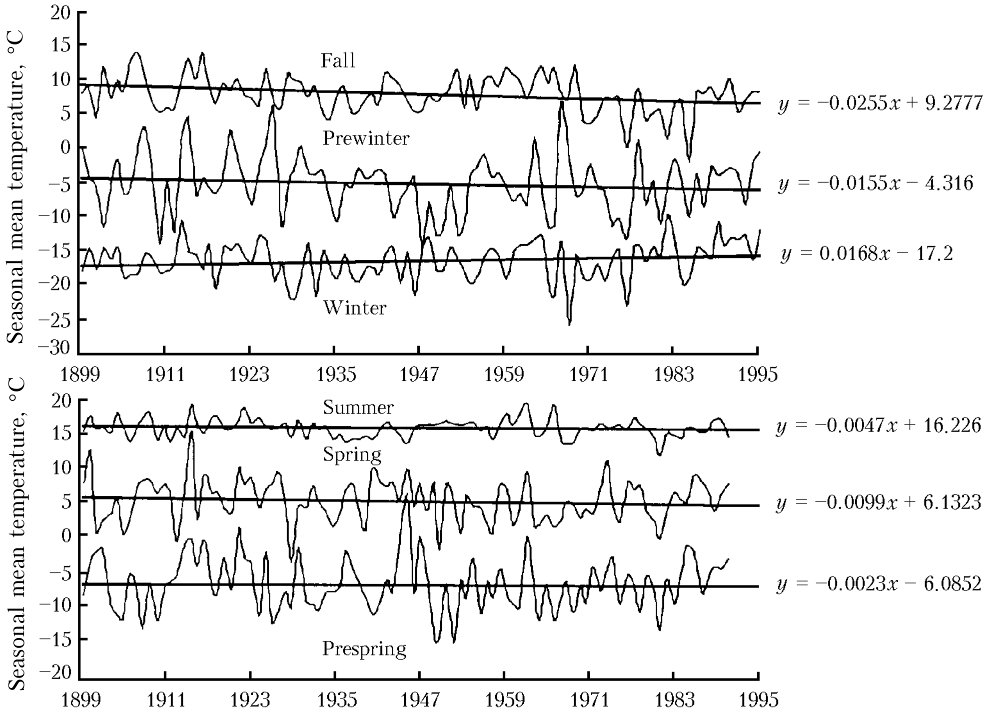

Fig. 3. Seasonal mean temperature in Tomsk.

3. Fall and prewinter

The periods with the processes of the 6 and 7 types correspond to these seasons. The polar region of high pressure is shifted to the Pacific Ocean sector. The invasions of polar air masses are observed through Alaska and Chukotka areas. Simultaneously the Hawaiian maximum is enhanced and its crest is transported to the north.

The mean date of coming of the fall is the 1st September. The earliest beginning was observed in 1943 (1st August) and the latest beginning was observed in 1985 (October 14). The dynamics of D_s in the fall is the reverse of that in the summer. The earlier coming of the season was observed in the 1910–1915 period and early in the 1960s with a further trend for later periods. It should be noted that in the fall the wave character of D_s is best manifested. Two waves are observed with a period of half a century. At present a descending branch of a phase of later coming of the season is observed, which, evidently, will end by the end of the first decade of 21st century.

Prewinter begins on October 10. In the long-living variation of D_s the periods exist both of later coming of the season (1934–1955, 1970–1985) and earlier coming of the season (1899–1933, 1956–1969). Latest dates were recorded in 1963 (September 14) and in 1982 (November 13). As a whole, the dynamics of characteristics of prewinter and fall is identical. In the last eleven years prewinter came later than many-year mean dates.

4. Winter

During this season the processes prevail of the 8 type with two simultaneously occurring polar invasions spaced at 80–100° of longitude. Cyclonic activity at the Arctic front and regeneration at this front of polar-front cyclones produce the quasi-permanent low between two invasions.

On the average, the winter begins on November 26. In the course of D_s one wave with a period about 75 years is traced. After 1970 a tendency of earlier coming of the season is observed.

The relationship between the date of coming of the season and its duration was estimated using the coefficients of pair correlation. The relationship for all the seasons is that, the later comes the season, the shorter is its duration, but the significant ($r = 0.5–0.6$) is the relationship only for prespring, spring, summer, and prewinter.

Figure 3 shows the variation of seasonal mean temperatures in Tomsk and the results of its linear approximation. Prespring, spring, and summer are characterized by very weak (from 0.2 to 0.9°/100 years) secular linear trend for cooling. This tendency (up to 2.5°/100 years) is more pronounced for the fall, and for prewinter it is 1.5°/100 years. A tendency of the increase of seasonal mean temperature is typical only for the winter (1.7°/100 years). Besides, in the middle 1980's a tendency of the increase of seasonal mean temperatures in all the seasons was observed.

References

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