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CERTAIN FEATURES OF WIND CONDITIONS IN THE SOUTHEAST OF WESTERN SIBERIA

by

S. A. Sapozhnikova

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CERTAIN FEATURES OF WIND CONDITIONS IN THE SOUTHEAST OF WESTERN SIBERIA

By: S. A. Sapozhnikova

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ABSTRACT (U) An analysis is made of the distribution of prevailing wind directions, average wind speeds, and the change with altitude of wind speeds in the boundary layer of the atmosphere over the southeastern part of West Siberia. The principal purpose of the study was to analyze the effect of station sites on meteorological element measurements. The basic data consisted of average wind speeds and frequencies of various wind directions measured at 107 weather stations and at 20—40 other stations at which more complex characteristics were machine-computed. The data were collected mostly in the 1936—1960 period with observations made every four hours. Much of value in this paper is contained in the numerous tables and figures. Orig. art. has: 10 tables.

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
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М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

CERTAIN FEATURES OF WIND CONDITIONS IN THE SOUTHEAST OF WESTERN SIBERIA

S. A. Sapozhnikova

The distribution of the prevailing wind direction, the average wind velocities and the recurrence of the velocities, including the maxima, and also the change with altitude of the average wind velocity in a layer up to 100 m above ground in the investigated territory are analyzed. The established interrelationships of phenomena permit a number of practical and methodical conclusions to be made.

The southeast of Western Siberia which encompasses Altayskiy Kray (excluding Gorno-Altayskaya A.O.), Novosibirskaya Oblast', Tomskaya Oblast' and Kemorovskaya Oblast' were investigated by us. This takes in a considerable part of the West Siberian lowland, covered by forest, which to the south passes into the Barabinsk and Kulunda Steppes, the hilly sections of the foothills of the Salairskiy range and the Kuznetskiy Alatau. The data from the adjacent Gorno-Altayskaya A.O. is one of the problems under study.

It is known that the velocity and direction of wind at the height of a weather vane essentially depend on local conditions. This hinders very much the practical use of data of isolated stations in their inter- and extrapolation of the surrounding territory.

Therefore it seems necessary to set down some general rules enabling the dissemination of climatic data from the separate stations into the surrounding territory to be more complete and reliable.

Certain laws, which are associated with basic parameters of wind conditions are tied directly to physicogeographic conditions, expounded in article [6]. Here we will dwell, first, on the disclosure of certain general features, which, with an adequate degree of probability, can be projected to any point of the study area or to a specific part of it, and, secondly, on the disclosure of an interrelationship among individual parameters of wind conditions, making it possible by elementary parameters (for example, the average wind velocity) to have an approximate representation of other, more complicated characteristics.

The data of 107 stations consisting of average wind velocities and recurrence of their directions were furnished as a basis of the investigations, and in addition, the data from 20-40 stations, calculated with the aid of machines were furnished for the more complicated characteristics (for a list of these stations, see Appendix). All the data pertain to the period 1936-1960 with four-times-a-day observations (at 0100, 0700, 1300 and 1900 hours). Of the 107 stations, some have observations only over a part of the prescribed period, but covering not less than 10 years.

The original tables were compiled at the Novosibirsk Hydrometeorological Observatory under the direction of V. L. Kukharskiy and I. A. Iznairskiy and, in the machine development part, at the Novosibirsk Branch of the NIIAK [Scientific Research Institute of Aeroclimatology] under the direction of S. D. Koshinskiy. A. G. Belozerov participated in the calculations of the tables, that were put in the text.

Furthermore, certain aeroclimatic data were used, basically in a layer up to 500 m above ground covering the period 1938-1952. We used them for the indirect characteristics of macrocirculatory features, having in mind that the effects of the latter on the surface wind do not arise directly, but by way of the wind in the free atmosphere. Altitudes were selected up to 500 m, but not 1-1.5 km, where the wind approaches geostrophism, because these altitudes are more comparable to ground data, and since there are a fewer gaps in pilot balloon observations, due to unfavorable weather conditions (low overcast and others). Aerological observations were made chiefly at 0300 and 1500 hours by Moscow official time, which approximately corresponds to 0600 and 1800 hours based on local solar time. The average from these periods of wind velocity, both at the earth's surface and at an altitude of 200-500 m is close to the average for twenty-four hours. These data were then used for the approximate calculations of wind velocities at altitudes of 50 and 100 m.

Let's examine some of the general features of wind conditions at an altitude of 500 m.

In Table 1 are shown the predominant directions and average wind velocities at an altitude of 0.5 km above the earth's surface by months (for the location of stations, see Fig. 1). The compass bearing having the most recurrence was considered to be the predominant direction. In those instances where two adjacent compass bearings with the most recurrence differed by not more than 3%, the most frequently recurring compass bearing was recorded, as a compromise of these bearings (for example WSW or WNW).

During the winter over the entire plain of the territory, southwestern and western winds were clearly predominant; these were characteristic for the latitudes under investigation (50-60° N lat.). The regional macrocirculatory factor — an offshoot of the Siberian anticyclone, closely allied to the Gorno-Altayskaya A.O. favors the development of the southern component. During the warm season (from May through August) the spread in the variation of the prevailing wind direction increases somewhat. In the northwest (Aleksandrovskoye) northwest winds predominate, which undoubtedly are associated with the monsoon-like winds of the coastal areas of the North Arctic Ocean [8].

Table 1. Prevailing direction (compass bearings) and average wind velocity (m/s) at an altitude of 500 m.

Month	Aleksandrov-skoye		Kolpashevo		Barabinsk		Novosibirsk		Barnaul	
	compass bearings	m/s	compass bearings	m/s	compass bearings	m/s	compass bearings	m/s	compass bearings	m/s
I	WSW	8.7	WSW	8.9	W	9.1	SW	8.6	SW	8.1
II	WSW	8.4	WSW	8.9	W	9.1	WSW	8.7	SW	8.0
III	WSW	9.0	SW	9.2	WSW	9.2	WSW	9.3	WSW	8.4
IV	W	8.4	SW	8.8	WSW	8.8	WSW	9.0	SW	7.4
V	NW	8.4	SW	8.3	W	8.9	WSW	8.6	W	7.4
VI	NW	8.0	NW	7.6	W	7.8	W	7.3	WSW	6.9
VII	NW	6.8	SSW	6.4	W	7.0	WSW	6.5	WSW	6.4
VIII	NW	8.0	NW	7.2	WNW	7.2	WSW	6.7	WSW	6.5
IX	WSW	8.4	WSW	8.4	WSW	8.4	WSW	8.4	SW	7.4
X	WSW	9.9	SW	9.2	WSW	9.3	WSW	9.9	SW	8.3
XI	W	9.5	W	9.1	WSW	9.0	WSW	9.8	SW	8.8
XII	WSW	9.4	WSW	8.9	WSW	9.5	WSW	9.1	SW	9.5

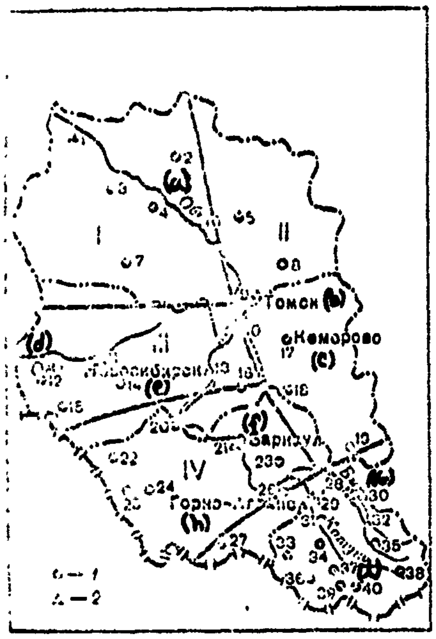

Fig. 1. The network of meteorological stations and regions for prevailing wind direction in July. 1 — meteorological stations, 2 — meteorological stations with aerological observations. Roman numerals indicate the regions; Arabic numbers — the number of the stations, the list of which can be seen in the Appendix.
KEY: (a) Ob'; (b) Tomsk; (c) Kemerovo; (d) Om'; (e) Novosibirsk; (f) Barnaul; (g) Biya; (h) Gorno-Altaisk; (i) Katun'.

According to the degree of movement in the south (Barabinsk, Novosibirsk) the prevailing direction can be shifted to western and southwestern bearings (but the predominance is more weakly expressed). Thus, in Barabinsk, the difference between the extreme recurrences of directions in July amounts to 13% (W — 19%, SE — 6%), and in January 17% (W — 24%, NE — 7%).

During the transition seasons, when the annual maxima of velocities occurs, the west-southwest directions predominate. The basic minimum of average wind velocities is phased to July, whereas in the south, velocities maintain the same level in August as well. The second minimum occurs in the winter — in January or February. As already has been pointed out, the maximum is phased to the transition seasons: in the spring — in March, in the autumn — in October-November. It should be noted that if, in the south the winter reduction in velocities can be explained by the direct influence of anticyclonic offshoots, then it is not possible to project this explanation to the northern part of the territory, where the winter is in a sphere of cyclonic activity; in addition, the marked reduction of velocities can be attributed to the effect of the thermal stratification of a confined layer of air.

Table 2. The thickness of the surface inversion layer or isothermy (km) and the corresponding difference in temperatures (Δt).

Month	Aleksandrovskoye		Novosibirsk (Bugry)		Omsk		Semipalatinsk	
	km	Δt	km	Δt	km	Δt	km	Δt
I	1,5	5,4	1,0	3,6	1,0	5,4	1,0	5,4
II	1,0	5,7	1,0	2,9	1,0	5,0	1.5	5,9
III	0,4	2,8	0,4	0,7	0,4	1,8	1,0	4,5
IV	0,4	0,9	0,1	0,0	0,1	0,0	0,3	0,0
V	—	—	0,1	0,0	—	—	—	—
VI	—	—	0,1	0,0	—	—	—	—
VII	—	—	0,1	0,0	—	—	—	—
VIII	—	—	0,1	0,0	—	—	—	—
IX	0,1	0,1	0,1	0,1	0,1	0,0	0,3	0,2
X	—	—	0,1	0,1	0,1	0,0	0,3	0,7
XI	1,0	2,[illegible]	1,0	0,8	1,0	1,6	1,0	1,6
XII	1,0	5,0	1,0	2,7	1,0	4,1	1,0	3,0

Note: Omsk and Semipalatinsk characterize areas to the west and south of the territory under investigation.

As can be seen from the data in Table 2, the thickness of the inversion layer measures 1-1.5 km during the winter in the territory under investigation. Only from May through August in the north, and from April through September in the south is inversion not observed.

It will be recalled that the indicated features of temperature stratification pertain to averaged data over 6 and 18-hour periods of observations. They are close to the stratification of the average twenty-four hour temperature.

The investigated features of wind conditions at an altitude of 0.5 km directly affect wind conditions at the earth's surface (according to weather vane data).

Table 3 lists a summary of the prevailing directions of wind based on the combined data of all stations for January and July. During the calculation of this table the A. A. Tsvid method was used. The prevailing wind direction was determined for each station and then the number of stations was calculated (in %) with the prevailing wind direction within each of the compass bearings.

Table 3. Probability of the prevalence of a particular wind direction (% of the stations).

Regions[1]	N	NE	E	SE	S	SW	W	NW	No. of stations
January									
All of the territory..	0	1	1	1	20	76	1	0	107
July									
Northwest (I).........	65	6	0	0	0	0	0	29	17
Northeast and east (II)...........	0	0	0	9	39	47	3	2	32
Central (III).........	0	24	0	0	3	39	16	18	31
Southwest (IV)........	10	33	0	0	0	49	4	4	27

[1]The boundaries of the regions are given in Fig. 1.

Winds of a southerly and southwesterly direction prevail during January at the 96 stations of the plains in the territory. From the given probability it is possible to predict that at any point in the investigated territory southerly and southwesterly winds prevail in January.

In July the distribution of the prevailing wind direction is considerably more complicated: first, it differs essentially by regions, secondly, it varies inside the regions (the distribution of regions is represented in Fig. 1). Just as in the northwest, northerly and northwesterly winds prevail at an altitude of 0.5 km, so also in the central and in the southwest — the southwesterly winds prevail. In the northeast and east, scanty aerological data, in conjunction with southwesterly winds play a significant role in the south, where such winds can be favored also by the local orography — valleys oriented from south to north, in which a large part of the stations of this region are located.

A considerable variation of the prevailing direction within the confines of the regions is explained by local winds, whose formation during the warm season also promotes moderation of the macrocirculatory processes as well as a more pronounced effect on the local features, governed by a well-defined daily variation of the

Table 4. Probability of the prevalence of a specific direction for weak (≤1 m/s) and strong (≥10 m/s) winds (% of the stations).

Regions	Velocity, m/s	N	NE	E	SE	S	SW	W	NW	No. of stations
					January					
All of the territory	≤1	0	5	18	10	38	27	2	0	20
	≥10	0	0	0	0	15	78	2	5	20
					May					
Northwest (I)	≤1	12	0	0	0	25	25	13	25	4
	≥10	0	0	0	0	0	25	25	50	4
Remaining territory (II-IV)	≤1	6	0	0	6	31	19	31	7	16
	>10	0	0	0	0	6	81	10	3	16
					July					
Northwest (I)	≤1	0	0	0	0	25	50	13	12	4
	≥10	25	25	0	0	0	0	0	50	4
Remaining territory (II-IV)	≤1	3	12	6	6	19	19	13	22	16
	≥10	3	3	0	0	12	70	12	0	16
					October					
All of the territory	≤1	0	0	0	5	20	75	0	0	20
	>10	0	0	0	0	10	80	10	0	20

radiation balance, and together with it – the daily variation of turbulent exchange and the differences in the temperature of the surface below. This, in its totality, promotes the formation of local winds.

The appreciable increase in the prevalence of northeast winds at a number of stations in III and IV regions is associated with night winds at stations located in valleys extending from the northeast to the southwest.

Table 4 represents the probability of prevalence of a specified direction for weak (≤1 m/s) and strong (≥10 m/s) winds. It is based on data from 20 stations, for which computers calculated the direction of the wind at various velocities. In computing the recurrence of the direction of weak winds it was assumed that complete calm practically does not occur and that a wind velocity of less than 1 m/s in all probability has the same direction as a wind velocity of 1 m/s. In connection with this all calms were divided according to directions proportional to the recurrence of the latter at a velocity of 1 m/s.

During January the recurrence of direction of strong winds corresponds completely with the general recurrence. The predominant direction of weak winds, as one would expect, might be almost any one, depending upon the local features of relief. During July it was found to be possible to combine II-IV regions. All three regions combined express a prevalence of a southwesterly direction more clearly with strong winds than without differentiation according to velocities. Only one station — Tatarsk — recorded a weak prevalence of northerly and northeasterly directions (by 20%), with the northwesterly direction having a recurrence of 19%. This, apparently, is connected with the location of Tatarsk at the border with region I.

So as far as weak winds are concerned, they can practically be from any direction. In the northwest (I region) strong winds in July are the most likely from the northwest direction, but possibly the northerly and northeasterly directions as well. The prevailing direction of weak winds has a preferential southern and western component that coincides with the orientation of the relief of a station, for which calculations were made.

In May and October, when an increase of wind velocities are observed, the prevalence of southwesterly winds is especially marked.

Table 5 gives the characteristics of directions of strong winds with low probability (≤5%). In January there is not one station where the probability of strong winds in the southwest and western directions would be less than 5%, whereas at 80-90% of the stations the probability of strong winds in the northerly, northeasterly and easterly direction is less than 5%.

The tabular breakdown in this fashion is "inconsequential" with respect to strong wind directions, stable for all the territory, and it can have practical value.

Table 5. Percent of stations, for which a prevalence of a specific direction of strong winds (≥10 m/s) is of low probability (<5%).

Regions	N	NE	E	SE	S	SW	W	NW	Number of stations
				January					
All of the territory	90	80	80	35	10	0	0	75	20
				July					
Northwest (I)	43	14	11	57	71	43	43	29	4
Remaining territory (II-IV)	16	24	46	62	16	14	14	46	16

Unfortunately, during July there is no such stability of "inconsequential" directions. Nevertheless, in the northwest region it is possible to delineate the less "consequential" southerly and southeasterly directions, and in the remaining territory – the southeasterly direction.

The general indication of the prevalence of the direction of strong and weak winds leads to the following conclusions. With respect to strong winds it is possible to affirm with a great deal of reliability that throughout the investigated territory, with the exception of the northwest region, strong winds over an entire year have a primarily southwest direction. In the northwest region during the winter the prevailing southwesterly direction of strong winds shifts during the summer to the northwest, north, and even northeast. Weak winds just as in the winter, also can be from any direction in the summer.

Consequently, in those cases, when for all practical purposes the direction, namely of weak winds is important, it is necessary above all to use the data of stations, even if located in that same inhabited locality, so as to assure the complete uniformity of site conditions and principally of relief (the orientation of a valley, direction of the outlet of a lateral valley or ravine, and the like).

In solving a number of problems it is insufficient to know the wind velocity at the height of the weather vane (i.e., at a height of about 10 m). With reference to tall structures wind velocities at a height of 50, 100 m and more are of practical interest. Pilot balloon observations can be used at altitudes of 100, 200, and 500 m for the approximate characteristics of recorded velocities. Results of these observations are given, in part, in Table 1 and Fig. 2.

Wind velocities read from a weather vane are portrayed in a series of cartograms for velocities at a height of 500 m (Fig. 2). In sketching of the latter, data were used of stations located on an open level site. A comparison of these maps bears out that in January as well as in July the distribution of wind velocities at a height of 10 and 500 m has little in common. This is not only the case with higher wind velocities at a height of 500 m, but also within the appreciably different configuration of contour lines. Based on the height of the weather vane, both in January and in July, the maximum velocities are designated to the southwest steppe part of the territory, but minima – to the northern forested part, while at a height of 500 m, corresponding to the macroprocesses, the highest velocities are observed in the north and northwest. Such an anomaly is well explained by differences in mesorelief [6].

By taking into consideration mesorelief, and also the rather well expressed proportioning of the change of wind velocity to the logarithm of the height, the wind velocities were calculated for a height of 50 and 100 m (Table 6). A more rapid increase in wind velocities in winter is found to be in full agreement with the effect of the corresponding thermal stratification and this is confirmed by other investigations [3, 7 and others]. The same can be said about the effect of surface configuration. It is well-known [2, 4, and others] that wind velocity is greater with altitude in valleys and over forests than on the plains, and is even greater over uplands.

Proceeding from the general patterns of wind velocity change with altitude, it should be stressed that the data in Table 6 pertain only to average daily velocities of the wind. Daytime

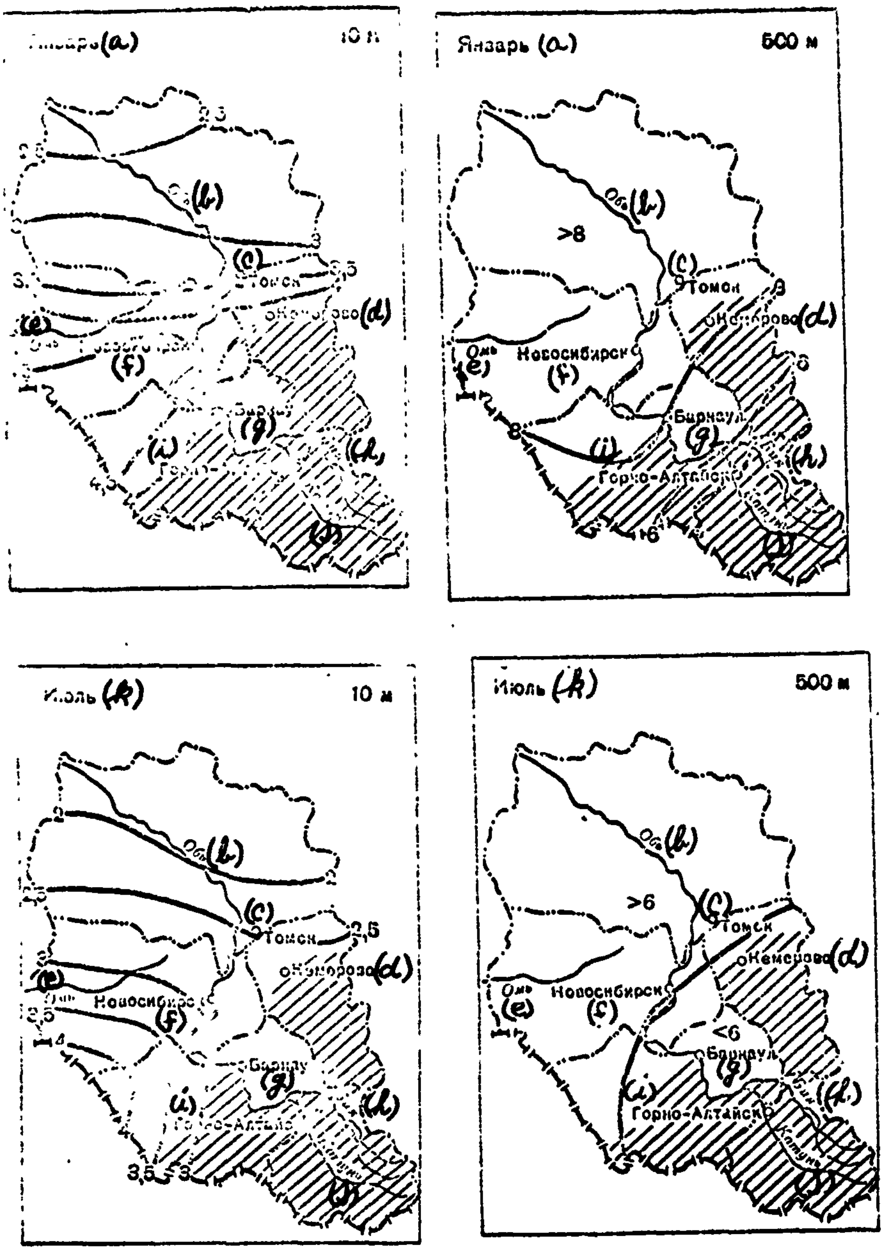

Fig. 2. Wind velocity (m/s) at an elevation of 10 m (weather vane in an open level site) and at 500 m (pilot balloon observations).
KEY: (a) January; (b) Ob'; (c) Tomsk; (d) Kemerovo; (e) Om'; (f) Novosibirsk; (g) Barnaul; (h) Biya; (i) Gorno-Altaisk; (j) Katun'; (k) July.

velocities with altitude will be slower, whereas the nighttime velocities, conversely, are considerably faster. The absence of direct observations does not lend to a quantitative evaluation of a recorded daily run. But in certain cases a deviation can have practical value.

Information on the recurrence of wind velocities is an essential addition to average velocities, since it is namely the recurrence of velocities higher or lower than the specified limit that is taken into consideration in a number of cases. Wind velocities of ≤2 m/s can be useful or, conversely, damaging. In some instances higher wind velocities, exceeding for example, 10 or 12 m/s are dangerous.

Table 6. Calculated average wind velocities at an altitude of 50 and 100 m ($\bar{v}_{50}$, $\bar{v}_{100}$) depending on the velocity at an altitude of 10 m ($\bar{v}_{10}$).

v_{10}	In open level sites in the forest-steppe and steppe regions				In forest regions, and also in valleys independent of the regions			
	$\bar{v}_{50}$		$\bar{v}_{100}$		$\bar{v}_{50}$		$\bar{v}_{100}$	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
1	—	—	—	—	2,5	2	3,0	2,5
2	—	—	—	—	3,5	3	4,5	4,0
3	—	—	—	—	5,0	4	6,0	5,0
4	5,5	5	6,0	5,5	6,0	—	7,0	—
5	7,0	6	7,5	7,0	—	—	—	—
6	8,0	—	8,5	—	—	—	—	—
7	9,5	—	10,0	—	—	—	—	—

Note. Wind velocities at an altitude of 10 m correspond to velocities at an altitude of the weather vane.

In the available literature recurrence of velocities usually covers a gradation broad enough that it can be determined not only by a relatively small amount of data and by a wide variation of wind velocities themselves which limit the gradation range in avoiding significant random errors, but certain specific deficiencies of observations by weather vane can also be determined. One of the most common deficiencies consists of systematic over estimates of recurrence at some velocities (for example, 12 m/s) owing to a reduction of recurrence at other velocities (for example, 10 and 14 m/s). During an expansion of gradation these discrepancies are usually cancelled out.

Deficiencies in wide gradations, which are especially sensitive in meeting particular practical requirements, usually outside of standard frames of reference, can also be compensated for. The simplest procedure for obtaining recurrence of velocities within any limits consists of a graphic interpolation of integral recurrence of wind velocities on an idealized grid, proposed by L. Ye. Anapol'skaya and L. S. Gandin [1 and others].

This grid was applied and checked against a large empirical set of values in order to obtain a method of extrapolating the probability of high velocities. It was possible to use the above mentioned interpolation to a great advantage having in mind that climatological problems consist not just in recording all random phenomena of past meteorological conditions, but in the prognosis of future conditions on the basis of the past. If in some cases there is a graphic smoothing out and it ameliorates certain individual features of a sequence, then, for such an element as wind, this would have doubtful practical value, considering the spottiness of its distribution. A graphic illustration of this is given in [6] in the examples of the variation of strictly average wind velocities at 1-2 m/s or even higher, depending upon local conditions.

The stations, which report in the literature only the mean values of wind velocities make matters more complex. The latter is connected not only with the fact that the calculation of recurrence requires, as a rule, a long period of observation, but also with a great deal of difficulty in similar calculations, and with a large volume of such tabulations, as well.

In connection with this the question arises as how to obtain the recurrence of velocities by an indirect method for these stations. Conventional statistical procedures of similar calculations, i.e., calculations of statistical parameters of the distribution and their regionalization [5 and others], in this case, are not applicable, since these parameters, except for the average values, will not be at the disposal of persons, using the information. Therefore, the problem arises about using other indices for features covering a broad distribution, which could be applied in differentating the latter.

For wind velocities, as elements of essentially positive and approximate values approaching the zero limit, the actual average velocity to a known degree determines the values of parameters of a higher order (standards, coefficients, asymmetries, and even excesses). The second index of the structural feature of a sequence is the twenty-four hour period, and in certain cases, the annual amplitude of the wind velocity. The more significant the recorded amplitude, the greater should be the differentiation of the particular aggregate (daytime, nighttime, winter, summer), which is included, generally for example, in the annual aggregate. As a result the variation of the entire aggregate, on the whole should increase, and the distribution should be more even.

In checking the feasibility of periodicity of wind velocities as an additional index for features of recurrence of wind velocities as an average for the year, the data according to recurrence of all existing stations at our disposal were broken down, depending not only on average annual velocities, but also on the average daily amplitude of velocities in July. The amplitude was characterized by the ratio of the wind velocity at 1300 hours to the velocity at 0100 hours. The July amplitude was taken as the maximum in the annual course.

The results of these calculations are presented in Table 7; they are graphically smoothed and rounded and their approximation is considered to be 5%. They provide a sort of a safeguard, i.e., for an integral probability of velocities higher than the defined limit. From them a probability below the defined limit (as a supplement up to 100%) as well as a probability within the defined limits can be obtained if necessary.

This table demonstrates quite graphically the effect of the daily amplitude of wind velocity on the mean annual recurrence of velocities. If corrected, it has a common link with the average velocity. Other things being equal, an increase in amplitude leads to an increase of recurrence not only at low velocities (0-1 m/s), but also at high velocities, while there is a simultaneous decrease of recurrence at intermediate (for example, 2-6 m/s) wind velocities.

Table 7. Average annual tolerance of wind velocities (%) at certain average annual velocities ([illegible] m/s) and the daily amplitude of velocity in July $\left(\frac{v_{1}}{v_1}\right)$.

$\bar{v}$	$\frac{v_{1}}{v_1}$	Velocities (m/s)									
		0 1	2	4	6	8	10	>12	>14	18	20
2,0	<2	50	50	20	5	2	1	.	.	.	
	2-4	55	45	20	5	2	1	.	.	.	
	>4	60	40	20	10	4	2	1	.	.	.
2,5	<2	45	55	20	10	4	2	.	.	.	
	2-4	50	50	25	10	4	2	.	.	.	
	>4	55	45	25	15	5	3	2	1	.	.
3,0	<2	40	60	30	15	5	3	1	.	.	
	2-4	40	60	30	15	5	3	1	.	.	
	>4	45	55	35	20	10	5	3	2	.	.
3,5	<2	30	70	40	20	10	5	2	1	.	
	2-4	35	65	40	20	10	5	2	1	.	
4,0	<2	25	75	45	25	10	5	3	1	.	.
	2-4	30	70	45	25	15	5	4	2	.	.
4,5	<2	20	80	50	30	15	10	5	2	.	.
	2-4	25	75	50	30	15	10	5	3	1	.
5,0	<2	20	80	60	35	20	10	5	3	.	.
5,5	<2	15	85	60	40	25	15	10	5	1.	.

Note. Here, and further on, the symbol "." signifies that the tolerance is less than 1%.

The aforementioned makes it possible to recommend a similar approximate method for calculating standard distributions of wind velocities in those cases, when for some reason more precise methods cannot be applied. Data on the recurrence of velocities, as is well-known [1 and others], makes possible the calculation by means of a graphic interpolation on an appropriate idealized grid of maximum velocities, possible once in 1, 5, 10, or 20 years.

An analysis of results of a similar calculation showed, as one should expect, the absence of well defined connection between maximum of wind velocities and average velocities (annual and maximum average monthly). Additional checking of the daily amplitude of velocity did not give satisfying results. An especially large dispersion of values was obtained by comparing the data of the investigated territory with that of the adjoining Gorno-Altayskaya A. O. In the valleys of the Altay Mountains, in spite of the considerable lowering of average velocities, the maximum velocities seem to be disproportionately high.

In processing further analysis the maximum velocities calculated by all the stations, were divided into three groups depending upon the relief (plain, hilly relief, foothills and mountains), and within the groups — into subgroups, depending on maximum average monthly velocity. The averaged maximum velocities with the possible occurrence of once in 20 years, are represented in Table 8. They bear out the complexity of relief, by which these same average velocities accelerate to maximum velocities. The physical aspect of this phenomenon, in our opinion, can be explained in the following way. Complex relief, by increasing the frictional force, lowers the general level wind velocities, but simultaneously, it governs the formation of the large vortices, owing to whatever wind velocity significantly increases in separate gusts.

Table 8. Maximum wind velocity (m/s), with the possible occurrence of once in 20 years, under different conditions of relief, averaged according to intervals of maximum average monthly velocity.

Relief	Maximum average monthly velocity (m/s)							
	1,0–1,9	2,0–2,9	3,0–3,9	4,0–4,9	5,0–5,9	6,0–6,9	7,0–7,9	8,0–8,9
Plain	—	—	24 (4)	26 (4)	27 (5)	30 (2)	—	—
Hilly relief	—	—	25 (1)	30 (6)	34 (2)	32 (1)	—	—
Foothills, mountains	25 (2)	26 (7)	27 (2)	32 (2)	—	36 (1)	—	57 (1)

Note. In parentheses the number of stations is given.

From the construction of an interrelated system of contour lines Table 9 was derived, in which maximum velocities with the possible occurrence of once in 1, 5, 10, and 20 years are shown, depending on the form of relief and the maximum average monthly velocities. Using this table it is possible to estimate the maximum velocities, knowing the average monthly velocities and the relief of the territory.

Table 9. Maximum wind velocity (m/s), with the possible occurrence of once in 1, 5, 10, and 20 years depending upon the maximum average monthly velocity ($\bar{v}_{max}$ m/s), depending on the form of relief.

$\bar{v}_{max}$ (m/s)	Year	5 years	10 years	20 years
On the plain				
3	15	18	20	21
[illegible]	18	21	23	21
5	21	21	26	27
6	23	26	28	30
7	25	29	31	33
In hilly relief				
3	17	20	22	23
4	20	23	25	27
5	23	27	29	31
6	27	31	33	35
In foothills and mountainous regions				
[illegible]	15	20	22	24
[illegible]	18	23	25	28
[illegible]	22	27	29	32
5	25	31	33	37
6	29	35	38	41
7	33	40	43	46
8	33	45	49	53

It should be mentioned that the specified feature also appears in the graphic extrapolation of the recurrence of velocities on the idealized grid by Anapol'skaya and Gandin. In mountainous regions the integral recurrence of velocities is not completely idealized once it is in the range of high velocities.

This example once again bears out how important it is to consider in its proper framework, the third climate-forming factor - the surface of the ground, the effect of which imparts a great deal of complexity to wind conditions.

In conclusion let us note that the analysis conducted of certain features of wind conditions in southeast Western Siberia, besides having direct use taking into account the latter, also has practical value. It bears out as to how far the feasibility of evaluating wind conditions in the territory can be expanded in those cases, where the climatologist has the occasion not to be limited by constants recorded at a meteorological site and by their linear inter- and extrapolation into the surrounding territory.

In the future, climatologists, equipped with more complete basic data and improved methods, will also be able to achieve more exacting calculations. But even approximate calculations, analogous with those above, and accessible for a wide circle of climatologists, would significantly upgrade the practical accuracy of climatic data, which is determined not only by the accuracy of calculations at the point of observations, but also by the accuracy of inter- and extrapolations into the surrounding territory.

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