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Abstract

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Meteorological Characteristics of the Interior Region of East Antarctica Based on Observations at Pionerskaya Station

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Before the work of the First Soviet Antarctic Expedition, the climate and weather of the interior regions of the sixth continent were, in essence, unknown, since prior to this expedition year-round meteorological observations in Antarctica had been conducted only on the coast.

The first continuously operating inland station in the history of Antarctic research was Pionerskaya Station, built 375 km from the Mirny Observatory in the direction of the South Geomagnetic Pole, at an elevation of about 3000 m above sea level, at the coordinates: 69°44′ S and 95°30′ E.

The observation program at Pionerskaya Station included standard meteorological observations, actinometric, aerological, and glaciological observations. In the near-surface air layer from the surface up to 11 m, gradient observations of temperature were carried out, and in summer, in the layer from 0 to 2 m, observations of wind speed were also made.

Observations of snow accumulation, the dynamics of the snow surface, and the structure of snow at various depths in pits constituted the glaciological part of the work program at Pionerskaya Station.

Important both for investigating structural transformations of snow and for studying features of the climate of the interior regions were observations of temperature and of the movement of temperature waves within the thickness of the snow cover, carried out down to a depth of 16 m.

The observations at Pionerskaya Station, as well as the observations conducted en route from Mirny to the site where the station was built, made it possible to collect interesting and unique material characterizing the nature of the interior regions of Antarctica. They made it possible to reveal a number of features of certain geophysical processes occurring in these regions.

In the present article we give, for the time being, only the meteorological characteristics of this region of East Antarctica.

Atmospheric pressure. The mean value of atmospheric pressure at Pionerskaya Station, calculated from the results of observations conducted over nine months from May 1956 through February 1957, proved to be 689.2 mm. The amplitude of fluctuations in pressure over this period proved considerable, amounting to 53.9 mm.

According to monthly mean data, especially low pressure is observed in August, September, and October, with a minimum in October; however, the absolute minimum, equal to 661.9 mm, was observed in August. The maximum pressure at Pionerskaya was observed in July, whereas its maximum monthly mean value was in December. The absolute maximum pressure proved to be 715.8 mm. Such a distribution of the various characteristics of atmospher-

pressure at Pionerskaya over time is explained by its considerable fluctuations in amplitude, with periods from one to nine days.

The altitude of the station, determined from aneroid readings, proved to be 2700 m above sea level. But this value is clearly underestimated owing to the influence on the pressure value of the cushion of cold air that constantly lies over the ice dome of Antarctica, and requires refinement.

Table 1

Pressure distribution

	V	VI	VII	VIII	IX	X	XI	XII	I	For 9 mo.
Monthly mean	693.7	688.4	686.3	681.0	683.0	680.5	692.0	700.2	697.5	689.2
Maximum	711.3	700.1	715.8	697.4	693.8	695.0	704.2	711.7	705.1	715.8
Minimum	678.3	677.7	662.2	661.9	670.6	663.9	678.3	687.0	686.6	661.9

Temperature regime. The temperature regime at Pionerskaya Station is distinguished by great severity.

Table 2

Temperature distribution

	V	VI	VII	VIII	IX	X	XI	XII	I	For 9 mo.
Monthly mean	−43.4	−43.6	−47.7	−51.3	−43.6	−39.7	−31.6	−21.5	−22.7	−38.3

	V	VI	VII	VIII	IX	X	XI	XII	I	For 9 mo.
Absolute maximum	−31.2*	−26.7*	−28.6*	−37.8*	−26.9*	−25.8*	−21.4	−13.4	−14.7	−13.4
Absolute minimum	−53.6*	−56.0	−64.0	−66.8	−58.8	−55.5	−44.0	−35.2	−35.1	−66.8

* The extreme temperature was selected from fixed-time observations.

As can be seen from Table 2, the coldest month is August, with a mean temperature of −51.3°, i.e., lower than the long-term mean January temperature in the region of the pole of cold—Verkhoyansk. The warmest month is December, whose mean temperature is −21.5°. The absolute maximum temperature was noted in December (−13.4°), and the absolute minimum (−66.8°) was recorded in August.

The temperature in the area of Pionerskaya Station is determined by the flow of air from the central, higher regions of the continent, by radiation conditions, and by the temperature regime within the thickness of the snow cover.

In the summer period the influence of radiation conditions is very noticeable. The highest temperatures are observed from the second ten-day period of December through the first ten-day period of January, and the maximum temperatures —in the third ten-day period of December.

The mean annual air temperature at Pionerskaya is very low. If the course of the mean temperature from February through April is taken to be the same as it was from September through November—which agrees well with the general course of the curve of monthly mean temperature changes—then the mean annual temperature proves to be −38.3°. This temperature is evidently very close to the climatic norm, since it differs by only one degree from the temperature in the snow layer at a depth of 16 m. The temperature measured at this depth changed during almost the entire observation period only within the limits from −39.2 to −39.4°. This shows that at a depth of 16 m at Pionerskaya Station the seasonal temperature fluctuations practically die out.

Air humidity. The air humidity in the area of Pionerskaya Station is characterized by low water-vapor pressures, caused by low air temperatures, and by a relatively small change

variability of relative humidity. The mean relative humidity is 72%, and its lowest value is 60%. Such high air humidity is explained by the fact that the

station is located in a zone of ice clouds.

Wind regime. The wind regime is characterized by stability both in wind direction and in wind speed (Tables 3-5). The wind

Table 3

Distribution of wind speeds

	V	VI	VII	VIII	IX	X	XI	XII	I	For 9 months
Mean speed	8.4*	8.4*	11.6	9.6	10.6	9.7	10.6	9.9	12.4	10.1
Maximum from means	19	17	20	16	20	15	18	20	20	20
Number of days with storm	8	2	11	3	6	3	5	9	19	66

* Observations were made at a height of 2 m.

at Pionerskaya Station always blows in the quadrant from east to south (see Table 5), and the mean wind speed throughout the year is approximately 10 m/sec. In summer a regular diurnal variation of wind speed is observed, with a maximum around noon and a minimum around midnight. Calms were not observed at the station,

Table 4

Frequency of wind observations with different speeds

Wind speed limit, m/sec	V	VI	VII	VIII	IX	X	IX	XII	I	Total cases: number	Total cases: %
0–1	0	0	0	0	0	0	0	0	0	0	0
2–5	7	6	0	3	0	1	0	2	0	19	7
6–10	17	17	12	17	17	18	14	15	9	136	49
11–15	5	7	15	10	11	12	15	13	18	106	38
15	2	0	4	1	2	0	1	1	4	15	6

just as not a single hurricane was recorded. The strongest winds were observed in January, when 19 days with storm were recorded. In winter the winds have predominantly a southeast direction, turning to southerly. In summer east-southeast winds prevail.

Cloudiness. Here stratocumulus clouds predominate; their lower boundary is at the level of the station, and their upper boundary is 200–500 m above the station. The mean cloudiness for the observation period was about 5 tenths. The number of clear days was 78, and the number of overcast days by total cloudiness was 97.

The clouds here consist of the finest ice crystals, often poorly developed, or of their fragments, and therefore resemble clouds of snow dust. Multicolored halos, false suns, pillars, single and double parhelia, and rainbows are often observed. Ice clouds and the almost constant transport of snow by wind in these places reduce the transparency of the atmosphere. In 34% of all observation cases the meteorological visibility is below 500 m, and in 73% of cases below 4 km (Table 6).

At Pionerskaya, precipitation clearly distinguishable by the observer was often observed. During the period from May to January, 124 days were recorded

with snow, 49 days with snow fog, and 105 days with snow haze. During the same period, 128 days with a general blizzard and a blizzard with precipitation were recorded. Drifting snowstorms or ground drifting snow were observed almost daily (Table 7).

According to snow-measurement observations carried out on a site measuring (100 ×100) m, an increase in snow cover, converted to an annual value, of about 40 cm was recorded. This corresponds to approximately 160 mm of precipitation in terms of water.

Conclusions. 1. As the first investigations have shown, the regions of the high mountain plateau of East Antarctica are distinguished by an unusually severe meteorological regime. The mean annual and mean seasonal air temperatures in these regions are lower than any mean temperatures hitherto observed on the globe.

Table 5

Distribution of mean speeds by direction
(data averaged from V 1956 to I 1957)

	SSW	S	SSE	SE	ESE	E
Number of observation cases	2	62	366	484	178	7
Frequency, %	1	6	33	44	16	1
Mean speed, m/sec	7.5	9.8	10.9	10.2	8.4	6.3

Table 6

Characteristics of atmospheric transparency

Visibility limits	V	VI	VII	VIII	IX	X	XI	XII	I	Total for 9 months, number of cases	Total for 9 months, % frequency
0–3 points (0–500 m)	14	13	17	5	13	7	5	9	13	96	34
4–6 points (1–4 km)	10	11	8	15	15	20	15	9	7	110	39
7–9 points (10 km)	7	6	5	11	8	4	10	13	11	75	27

2. The severity of the climate of the high mountain plateau of Antarctica is aggravated by constant strong winds. In winter their speed is considerably less than the wind speed on the coast, at Mirny. But in summer the reverse pattern is observed, as a result of which the mean annual wind speed at Pionerskaya is only slightly lower in magnitude than the mean annual wind speed at Mirny. The severity of the climate of the interior regions of Antarctica is also due to low pressure, which at Pionerskaya is approximately 1.5 times lower than on the coast, and to the relatively high humidity of the air.

Table 7

Number of days with various atmospheric phenomena

	V	VI	VII	VIII	IX	X	XI	XII	I	For 9 months
Snow	19	18	15	9	10	6	9	21	17	124
Fog	10	6	3	0	2	5	4	5	14	49
Haze	7	12	8	16	17	22	4	8	11	105
Blizzard with snow	18	17	15	9	10	6	7	15	12	109
Drifting snow	9	9	9	12	13	16	15	12	18	113
Ground drifting snow	21	18	12	25	17	27	24	14	18	176
Dangerous blizzards	23	21	23	17	18	17	24	20	25	188
Snowstorm	0	0	0	0	0	0	2	2	11	15
Aurora	2	8	10	2	0	0	0	0	0	22

All these features of the climate and weather extremely limit the possibilities for the operation of aviation and ground transport and create very difficult conditions for human life and work on the high mountain plateau of Antarctica.

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Note: Figure translations are in progress. See original paper for figures.