FEDERAL SERVICE OF RUSSIA FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING

Russian Federation State Research Center

Arctic and Antarctic Research Institute

Russian Antarctic Expedition

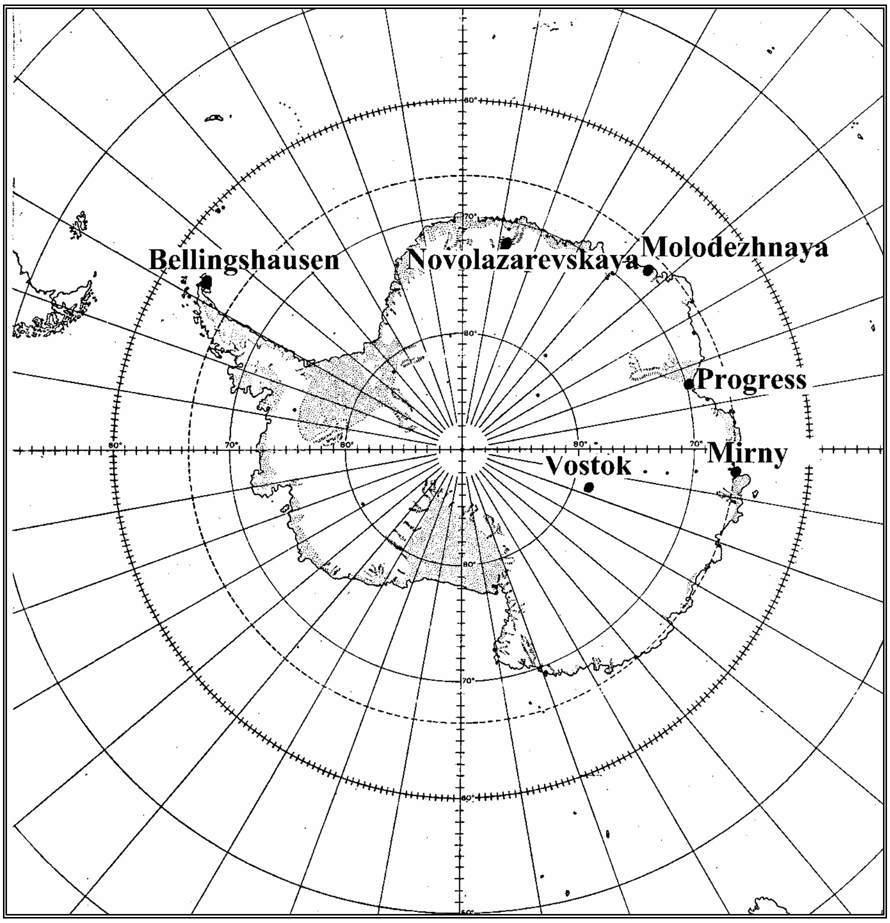
QUARTERLY BULLETIN

№1 (18)

January - March 2002

STATE OF ANTARCTIC ENVIRONMENT

Operational data of Russian Antarctic stations



St. Petersburg

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Edited by V.V. Lukin

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Authors and contributors

Editor-in-Chief - M.O. Krichak (Russian Antarctic Expedition (RAE) Department)

Section 1 - M.O. Krichak (RAE)

Section 2 - Ye.I. Aleksandrov (Department of Meteorology)

Section 3 - V.A. Belyazo (Department of Long-Range Weather Forecasting)

Section 4 - A.I. Korotkov (Department of Ice Regime and Forecasting)

Section 5 - Ye.Ye. Sibir (Department of Meteorology)

Section 6 - I.P. Yeditkina, R.Yu. Lukianova, I.V. Moskvin, A.V. Frank-Kamenetsky (Department of Geophysics)

Section 7 - V. Ye. Lagun, S.V. Yagovkina (Department of Air-Sea Interaction)

Section 8 - V.A. Kuchin, V.V. Lukin (RAE)

Translated by I.I. Solovieva

Editor-in-Chief – M.O. Krichak

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For more information about the contents of this publication, please, contact

Arctic and Antarctic Research Institute of Roshydromet

Russian Antarctic Expedition

Bering St., 38, St. Petersburg 199397 Russia

Phone: (812) 352 15 41

Fax: (812) 352 28 27

E-mail: lukin@raexp.spb.su

CONTENTS

PREFACE

The Bulletin is prepared on the basis of data reported from the Russian Antarctic stations in real time via the communication channels. The Bulletin is published from 1998 on a quarterly basis.

Section I in this issue contains monthly averages of standard meteorological and actinometric observations and upper-air sounding at the Russian Antarctic stations for the first quarter of 2002.

Standard meteorological observations are carried out at the present time at Mirny, Novolazarevskaya, Bellingshausen and Vostok stations. The upper-air sounding is carried out once a day at 00.00 UT at two stations - Mirny Observatory and Novolazarevskaya. More frequent sounding is conducted at both stations during the International Geophysical Intervals (IGI) in accordance with the International Geophysical Calendar.

The meteorological tables present the atmospheric pressure referenced to sea level for the coastal stations and to the station level for the inland Vostok station located at a height of 3488 m.

Along with the monthly averages of meteorological parameters, the tables also present their deviations from multiyear averages (absolute anomalies), normalized anomalies (deviations in σ_f fractions - $(f-f_{avg})/\sigma_f$) and relative anomalies (f/f_{avg}) of the monthly sums of precipitation and total radiation. The statistical characteristics necessary for calculation of anomalies were derived at the AARI Department of Meteorology for the period 1961-1990 as recommended by the World Meteorological Organization.

The Bulletin contains brief overviews with an assessment of the anomalous state of the Antarctic environment based on actual data.

Sections 2 and 3 are devoted to the meteorological and synoptic conditions. The analysis of ice conditions of the Southern Ocean (Section 4) is based on satellite data received at Bellingshausen, Novolazarevskaya and Mirny stations and observations conducted at the coastal Bellingshausen and Mirny stations. The anomalous character of ice conditions is evaluated against the multiyear averages of the drifting ice edge position and the onset of different ice phases in the coastal areas of the Southern Ocean adjoining the Antarctic stations. The multiyear averages were obtained at the AARI Department of Ice Regime and Forecasting over the period 1971-1995.

Section 5 contains as usual, an overview of total ozone (TO) based on measurements at the Russian Mirny, Novolazarevskaya and Vostok stations.

Data of geophysical observations published in Section 6 present the results of measurements in Mirny Observatory and at Vostok station under the geomagnetic and ionospheric programs (magnetic and riometer observations). Data of riometer observations are presented as plots of the maximum daily values of space radio-emission absorption at the 32 MHz frequency.

Geophysical information also includes the magnetic activity index (PC-index), which is calculated on the basis of geomagnetic observation data at Vostok station.

Sections 7 presents an article on the upper-air sounding database of the AARI prepared within the framework of the geo-information system “the Antarctic” and the use of these data for monitoring of the free atmosphere state of the Southern Polar Area.

The last Section of the Bulletin (8) is traditionally devoted to the main directions and events of the logistics activity of RAE during the period under consideration.

Russian Antarctic stations in operation in January - March 2002

MIRNY OBSERVATORY

STATION SYNOPTIC INDEX	**89592**
METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**39.9 m**
GEOGRAPHICAL COORDINATES	**$\varphi = 66°33' S$; $\lambda = 93°01' E$**
GEOMAGNETIC COORDINATES	**$\Phi = -76.8°$; $\Delta = 151.1°$**
BEGINNING AND END OF POLAR DAY	**7 December - 5 January**
BEGINNING AND END OF POLAR NIGHT	**No**

NOVOLAZAREVSKAYA STATION

STATION SYNOPTIC INDEX	**89512**
METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**119 m**
GEOGRAPHICAL COORDINATES	**$\varphi = 70°46' S$; $\lambda = 11°50' E$**
BEGINNING AND END OF POLAR DAY	**15 November - 28 January**
BEGINNING AND END OF POLAR NIGHT	**21 May - 23 July**

BELLINGSHAUSEN STATION

STATION SYNOPTIC INDEX	**89050**
METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**14.3 m**
GEOGRAPHICAL COORDINATES	**$\varphi = 62°12' S$; $\lambda = 58°56' W$**
BEGINNING AND END OF POLAR DAY	**No**
BEGINNING AND END OF POLAR NIGHT	**No**

VOSTOK STATION

STATION SYNOPTIC INDEX	**89606**
METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**3488 m**
GEOGRAPHICAL COORDINATES	**$\varphi = 78°27' S$; $\lambda = 106°52' E$**
GEOMAGNETIC COORDINATES	**$\Phi = -89.3°$; $\Delta = 139.5°$**
BEGINNING AND END OF POLAR DAY	**21 October - 21 February**
BEGINNING AND END OF POLAR NIGHT	**23 April - 21 August**

PROGRESS STATION

METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**64 m**
GEOGRAPHICAL COORDINATES	**$\varphi = 69°23' S$; $\lambda = 76°23' E$**
BEGINNING AND END OF POLAR DAY	**21 November - 21 January**
BEGINNING AND END OF POLAR NIGHT	**28 May - 16 July**

1. DATA OF AEROMETEOROLOGICAL OBSERVATIONS AT THE RUSSIAN ANTARCTIC STATIONS

JANUARY 2002

MIRNY OBSERVATORY

Table 1.1

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

January 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	983	996.8	988.2	-8	-2.4	
Air temperature, °C	-1.2	3.7	-10.6	0.4	0.4	
Relative humidity, %	83			12.6	2.7	
Total cloudiness (sky coverage), tenths	6.8			-0.2	-0.2	
Lower cloudiness(sky coverage),tenths	5.1			2	1.5	
Precipitation, mm	32.2			16.7	1.1	2.1
Mean wind speed, m/s	7.8	20		0	0.0	
Prevailing wind direction, deg	90					
Total radiation, MJ/m^2	814			-4.2	-0.1	1.0
Total ozone content (TO), DU	305	333	291			

Table 1.2

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

January 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T °C	Dew point deficit, D °C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
978	53	-1.4	3.6					
925	495	-2.3	5.5	86	20	96	0	0
850	1161	-6.4	4.4	86	20	92	0	0
700	2653	-15.6	4	79	14	80	0	0
500	5113	-30.8	5.2	81	11	56	0	0
400	6668	-39.8	5.4	83	5	26	0	0
300	8586	-49.6	5.3	204	0	3	0	0
200	11264	-44.4	9.4	279	2	14	0	0
150	13197	-42.7	12.2	297	1	11	0	0
100	15941	-41.3	15.2	351	0	5	0	1
70	18367	-40.9	16.8	57	1	18	3	3
50	20660	-39.8	18.6	83	5	57	4	5
30	24166	-36.9	21.1	78	10	93	5	5
20	26980	-34.4	22.1	91	14	96	7	7
10	31909	-27.5	24.8	88	22	98	14	9

Table 1.3

Anomalies of standard isobaric surface heights and temperature

January 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	-47	-1.6	1.7	2.0
700	-42	-1.3	-0.1	-0.1
500	-59	-1.4	-1.9	-1.7
400	-68	-1.4	-0.7	-0.8
300	-69	-1.4	0.9	1.0
200	-60	-1.1	0.5	0.4
150	-55	-1.0	0.7	0.9
100	-45	-0.8	0.9	0.8
70	-42	-0.7	-0.1	-0.1
50	-41	-0.7	0.0	0.0
30	-38	-0.6	0.9	0.7
20	-39	-0.6	0.2	0.2
10	-12	-0.2	0.2	0.1

NOVOLAZAREVSKAYA STATION

Table 1.4

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

January 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	986.4	1001	969.9	-5.2	-1.4	
Air temperature, °C	-0.4	6.4	-9.6	0	0.0	
Relative humidity, %	56			-1.1	-0.2	
Total cloudiness (sky coverage), tenths	6.1			0.1	0.1	
Lower cloudiness(sky coverage),tenths	1.8			0.2	0.2	
Precipitation, mm	3.7			0.9	0.1	1.3
Mean wind speed, m/s	7.2	19		0.6	0.4	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	803			-30.3	-0.5	0.96
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

Table 1.5

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

January 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T °C	Dew point deficit, D °C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
973	122	0.2	7.7					
925	533	-2.4	7.1	102	19	95	0	0
850	1197	-7.2	6.6	99	20	92	0	0
700	2682	-16.3	6.1	96	20	90	0	0
500	5150	-29.5	6	117	9	48	0	0
400	6711	-39.1	4.9	146	10	43	0	0
300	8630	-50.4	4.1	171	12	45	0	0
200	11286	-46.8	6.6	204	10	54	0	0
150	13200	-45.2	8.6	226	7	49	0	0
100	15917	-42.3	10.8	253	3	39	0	0
70	18347	-39.9	12.6	340	2	32	1	1
50	20658	-37.5	14	52	2	48	1	1
30	24196	-34.1	16.3	77	7	83	1	1
20	27059	-30.9	18	77	11	94	1	1
10	32013	-24.6	20.9	84	15	96	4	5

Table 1.6

Anomalies of standard isobaric surface heights and temperature

January 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	-23	-0.7	1.1	1.1
700	-18	-0.5	1.3	1.1
500	-7	-0.1	1.3	0.9
400	3	0.1	1.8	1.4
300	16	0.3	1.4	1.1
200	14	0.2	-1.1	-0.9
150	0	0.0	-1.2	-1.1
100	-14	-0.2	-0.1	-0.1
70	-2	0.0	0.7	0.5
50	3	0.0	1.6	1.5
30	18	0.3	3.1	2.2
20	71	0.8	4.1	2.0
10	129	1.6	4.7	2.0

BELLINGSHAUSEN STATION

Table 1.7

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

January 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$…	Relative anomaly f/f_{avg}
Sea level pressure, hPa	988.1	1005.6	967.1	-4.8	-1.8	
Air temperature, °C	2	6.6	-1	0.8	1.3	
Relative humidity, %	90			4.4	1.0	
Total cloudiness (sky coverage), tenths	9.8			0.6	1.2	
Lower cloudiness(sky coverage),tenths	8.2			0.5	0.6	
Precipitation, mm	94.6			54.7	3.9	2.4
Mean wind speed, m/s	6.7	16		0.3	0.4	
Prevailing wind direction, deg	315					
Total radiation, MJ/m^2	445			-30.7	-0.7	0.93

VOSTOK STATION

Table 1.8

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

January 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Station surface level pressure, hPa	633.6	652.4	618.7	-1	-0.2	
Air temperature, °C	-28.8	-12.2	-45.7	3.2	2.1	
Relative humidity, %	56			-16.9	-3.5	
Total cloudiness (sky coverage), tenths	5.5			1.6	2.0	
Lower cloudiness(sky coverage),tenths	1.4			1	1.7	
Precipitation, mm	3.1			2.2	2.4	3.4
Mean wind speed, m/s	1.6	10		-2.9	-3.6	
Prevailing wind direction, deg	180					
Total radiation, MJ/m^2	1056			-34.5	-0.8	0.97
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

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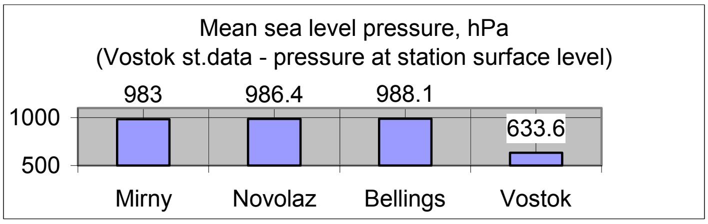
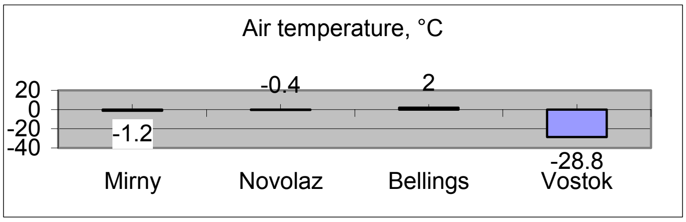
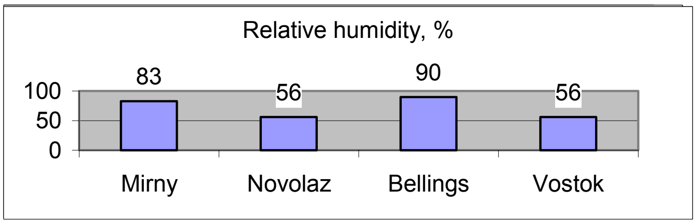


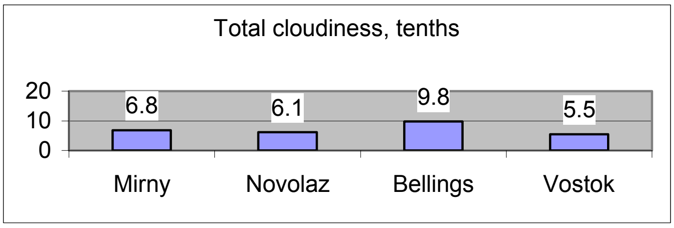
$(f\text{-}f_{avg})/\sigma_f$ -2.4   -1.4   -1.8   -0.2



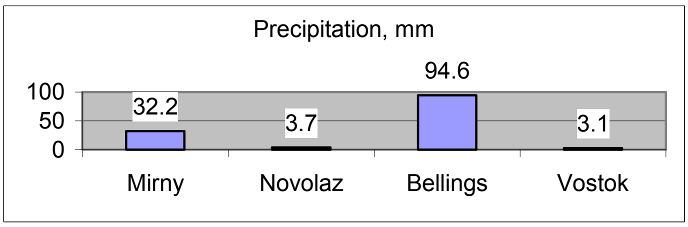
$(f\text{-}f_{avg})/\sigma_f$ 0.4   0.0   1.3   2.1



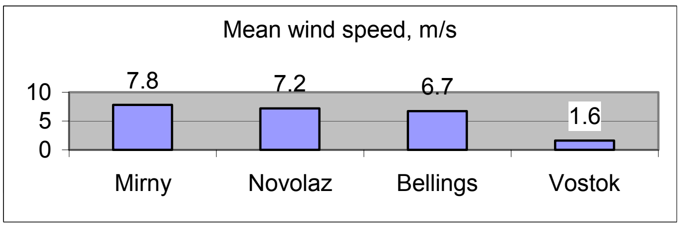
$(f\text{-}f_{avg})/\sigma_f$ 2.7   -0.2   1.0   -3.5



$(f\text{-}f_{avg})/\sigma_f$ -0.2   0.1   1.2   2.0



f/f_{avg} 2.1   1.3   2.4   3.4



$(f\text{-}f_{avg})/\sigma_f$ 0.0   0.4   0.4   -3.6

Fig. 1.1. Comparison of monthly averages of meteorological parameters at the stations, January 2002.

FEBRUARY 2002

MIRNY OBSERVATORY

Table 1.9

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

February 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	979.7	992.3	958.5	-8.9	-2.7	
Air temperature, ^{0}C	-6.5	0.2	-16.7	-1.3	-1.2	
Relative humidity, %	80			11.6	2.6	
Total cloudiness (sky coverage), tenths	7.4			0.7	1.2	
Lower cloudiness(sky coverage),tenths	5			2	2.0	
Precipitation, mm	61.3			44.1	2.6	3.6
Mean wind speed, m/s	9.5	25		0.4	0.3	
Prevailing wind direction, deg	90					
Total radiation, MJ/m^2	497			-7.1	-0.1	1.0
Total ozone content (TO), DU	298	324	267			

Table 1.10

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

February 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T ^{0}C	Dew point deficit, D ^{0}C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
976	53	-8.4	3.1					
925	471	-9.7	5.7	130	5	39	2	2
850	1125	-10.3	5.5	78	4	61	2	2
700	2602	-17.1	5.4	331	2	21	2	2
500	5060	-30.1	5.4	279	9	74	2	2
400	6619	-39	4.8	273	14	82	2	2
300	8545	-48.4	4.7	275	17	84	2	2
200	11232	-44.1	8.5	271	15	91	2	2
150	13159	-44.1	11	271	14	90	3	3
100	15869	-44.5	13.3	271	11	88	4	4
70	18263	-43.8	14.9	270	9	90	5	6
50	20527	-43.1	16.8	269	6	86	8	8
30	23978	-41.6	18.2	277	3	71	10	9
20	26737	-38.8	20	297	2	58	12	9

Table 1.11

Anomalies of standard isobaric surface heights and temperature

February 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	-54	-1.9	0.1	0.1
700	-55	-1.7	-0.3	-0.2
500	-58	-1.4	0.3	0.2
400	-55	-1.1	1.2	0.9
300	-38	-0.8	2.3	1.8
200	-27	-0.5	0.7	0.6
150	-27	-0.5	-0.1	-0.1
100	-41	-0.7	-0.9	-0.9
70	-44	-0.7	-0.9	-1.0
50	-54	-0.9	-0.6	-0.7
30	-64	-1.0	-0.4	-0.4
20	-72	-1.0	0.3	0.2

NOVOLAZAREVSKAYA STATION

Table 1.12

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

February 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	979	993	963	-10.1	-2.2	
Air temperature, ^{0}C	-4	1.5	-11.1	-0.6	-0.7	
Relative humidity, %	45			-4.4	-1.0	
Total cloudiness (sky coverage), tenths	6.1			-0.2	-0.2	
Lower cloudiness(sky coverage),tenths	0.7			-0.6	-0.9	
Precipitation, mm	0			-1.8	-0.5	0.0
Mean wind speed, m/s	9.8	24		0.7	0.5	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	513			31.8	0.8	1.1
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

Table 1.13

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

February 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T ^{0}C	Dew point deficit, D ^{0}C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
965	122	-4.8	9.8					
925	459	-6	8.8	113	12	97	0	0
850	1114	-10.8	7.2	102	12	98	0	0
700	2576	-20.4	4.3	102	9	89	0	0
500	5009	-32.3	5.3	169	3	41	0	0
400	6554	-42	4.5	219	5	50	0	0
300	8455	-50.9	4.2	227	8	67	0	0
200	11128	-44.9	7.7	240	9	90	0	0
150	13053	-44.4	9.6	240	9	89	0	0
100	15769	-44.1	11.3	242	8	91	1	1
70	18164	-43.3	12.3	244	7	89	1	1
50	20440	-42.4	13.3	239	5	87	2	3
30	23897	-41.4	14.6	236	3	75	4	4
20	26663	-39.6	15.4	224	2	48	5	5
10	31491	-33.4	17.8	236	1	20	11	9

Table 1.14

Anomalies of standard isobaric surface heights and temperature

February 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	-72	-2.2	-0.1	-0.1
700	-79	-2.4	-1.3	-1.4
500	-90	-2.4	-0.3	-0.3
400	-90	-2.1	-0.1	-0.1
300	-90	-1.9	1.2	1.0
200	-79	-1.8	0.4	0.3
150	-78	-1.8	0.1	0.1
100	-80	-1.7	-0.2	-0.2
70	-79	-1.6	-0.1	-0.1
50	-80	-1.4	0.3	0.3
30	-78	-1.2	0.7	0.5
20	-64	-0.8	0.7	0.4
10	-25	-0.3	2.3	1.0

BELLINGSHAUSEN STATION

Table 1.15

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

February 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	986.6	1003.5	964.2	-3.1	-1.2	
Air temperature, ^0C	2.4	7.5	-0.7	1	1.4	
Relative humidity, %	90			2.1	0.6	
Total cloudiness (sky coverage), tenths	9.7			0.6	1.0	
Lower cloudiness(sky coverage),tenths	8			0.2	0.3	
Precipitation, mm	81.2			14.1	0.7	1.2
Mean wind speed, m/s	7.6	16		0.7	1.4	
Prevailing wind direction, deg	315					
Total radiation, MJ/m^2	289			-14.0	-0.4	0.95

VOSTOK STATION

Table 1.16

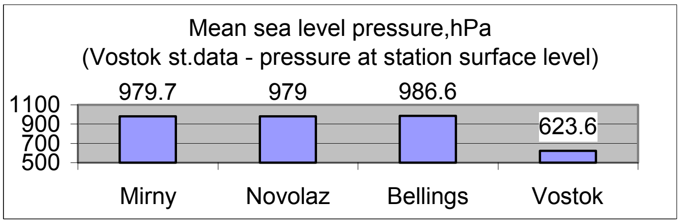
Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

February 2002

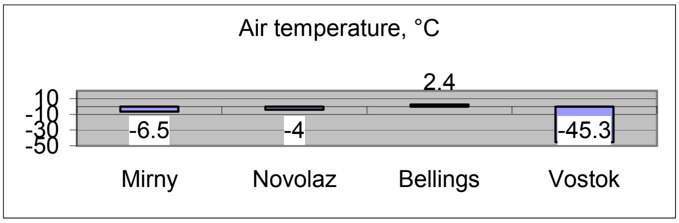
Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Station surface level pressure, hPa	623.6	636.1	617.4	-6.1	-1.5	
Air temperature, ^0C	-45.3	-30.5	-60	-0.9	-0.6	
Relative humidity, %	53			-18.7	-3.6	
Total cloudiness (sky coverage), tenths	4.1			0.5	0.6	
Lower cloudiness(sky coverage),tenths	0			0	0.0	
Precipitation, mm	0			-0.8	-1.1	0.0
Mean wind speed, m/s	1.7	11		-3.3	-3.7	
Prevailing wind direction, deg	158					
Total radiation, MJ/m^2	633.3			30.3	1.1	1.05
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

F e b r u a r y 2 0 0 2



$(f-f_{avg})/\sigma_f$ -2.7 -2.2 -1.2 -1.5



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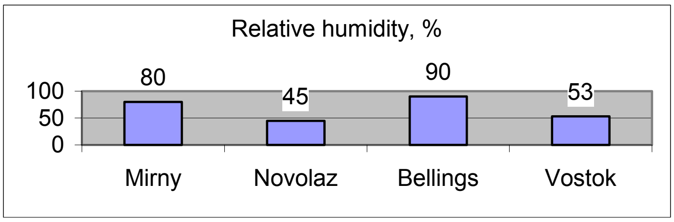
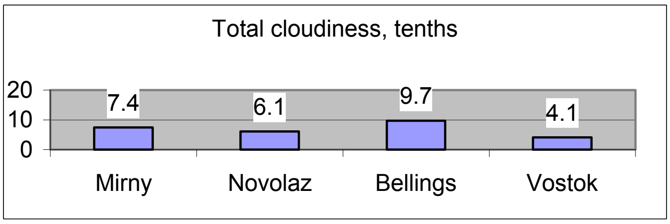
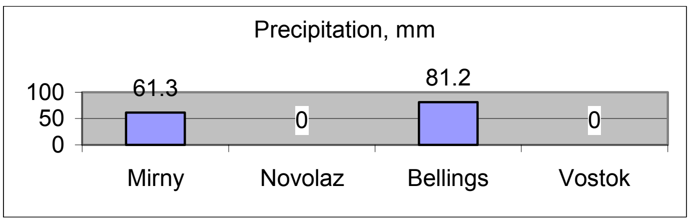


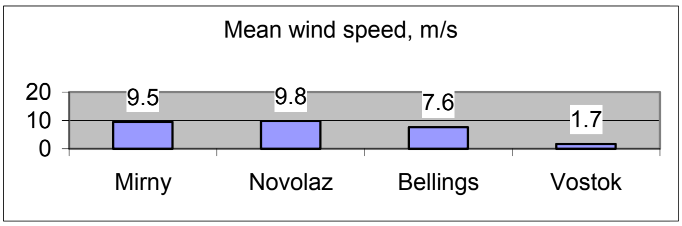
$(f-f_{avg})/\sigma_f$ 2.6 -1.0 0.6 -3.6



$(f-f_{avg})/\sigma_f$ 1.2 -0.2 1.0 0.6



f/f_{avg} 3.6 0.0 1.2 0.0



$(f-f_{avg})/\sigma_f$ 0.3 0.5 1.4 -3.7

Fig. 1.2. Comparison of monthly averages of meteorological parameters at the stations, February 2002.

MARCH 2002

MIRNY OBSERVATORY

Table 1.17

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

March 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	992.2	1010.5	961.8	5.3	1.6	
Air temperature, ^{0}C	-7.8	-0.7	-21.6	2.3	1.5	
Relative humidity, %	81			11.4	2.3	
Total cloudiness (sky coverage), tenths	7.5			0.8	0.9	
Lower cloudiness(sky coverage),tenths	4.8			2	2.2	
Precipitation, mm	46			16.4	0.5	1.6
Mean wind speed, m/s	9.8	21		-1.2	-1.0	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	303			12.8	0.4	1.04
Total ozone content (TO), DU	299	344	245			

Table 1.18

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

March 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T ^{0}C	Dew point deficit, D ^{0}C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
987	53	-8.5	2.8					
925	553	-9.1	4.9	91	12	97	1	1
850	1203	-11.9	4.7	82	8	82	1	1
700	2677	-16.8	5	26	1	18	1	1
500	5139	-30.4	5.5	287	5	59	1	1
400	6692	-40.5	4.8	285	8	69	1	1
300	8601	-51.4	4.7	289	13	78	1	1
200	11242	-48.1	6.7	287	13	89	1	1
150	13142	-47.2	8.9	286	13	93	2	2
100	15824	-47.4	10.9	284	12	94	2	2
70	18184	-47.9	11.8	281	11	96	3	3
50	20379	-48.4	12.6	279	11	95	5	5
30	23748	-48.4	13.7	276	11	95	9	9
20	26421	-47.4	14.6	271	13	92	11	9

Table 1.19

Anomalies of standard isobaric surface heights and temperature

March 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	58	1.9	1.8	1.8
700	68	2.1	2.3	2.5
500	90	2.1	2.2	1.4
400	106	1.6	1.7	1.1
300	116	1.9	0.5	0.4
200	96	1.7	-1.4	-1.2
150	87	1.5	-0.7	-0.9
100	84	1.4	-0.4	-0.5
70	83	1.2	-0.6	-0.6
50	55	0.8	-0.6	-0.6
30	60	0.8	-0.8	-0.5
20	56	0.5	-0.9	-0.6

NOVOLAZAREVSKAYA STATION

Table 1.20

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

March 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	990.7	1006.4	973.8	4.5	1.3	
Air temperature, ^{0}C	-7.5	-1	-17.4	0.3	0.3	
Relative humidity, %	47			-2.2	-0.5	
Total cloudiness (sky coverage), tenths	5.7			-0.6	-0.6	
Lower cloudiness(sky coverage),tenths	1.4			-0.3	-0.3	
Precipitation, mm	21.9			13	0.8	2.5
Mean wind speed, m/s	11.5	24		0.9	0.6	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	248			-2.3	-0.1	0.99
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

Table 1.21

Results of aerological atmospheric sounding (from CLIMAT-TEMP messages)

March 2002

Isobaric surface, P, hPa	Isobaric surface height, H m	Temperature, T ^{0}C	Dew point deficit, D ^{0}C	Resulting wind direction, deg	Resulting wind speed, m/s	Wind stability parameter	Number of days without temperature data	Number of days without wind data
976	122	-8.1	9.8					
925	545	-8.8	10.4	111	16	94	0	0
850	1193	-13.6	8.7	99	15	95	0	0
700	2648	-20.4	6.8	92	9	83	0	0
500	5083	-33.1	7.2	97	2	21	0	0
400	6621	-43.3	5.8	224	1	12	0	0
300	8504	-54.4	4.9	255	4	31	0	0
200	11121	-48.9	6.7	272	5	65	0	0
150	13014	-48.5	8.3	269	5	71	0	0
100	15675	-48.8	9.9	281	6	79	2	2
70	18016	-48.9	10.7	288	6	84	2	2
50	20225	-49.1	11.5	287	7	87	2	3
30	23580	-48.2	12.3	293	9	89	8	8
20	26249	-46.8	13	292	12	97	11	9

Table 1.22

Anomalies of standard isobaric surface heights and temperature

March 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	39	1.3	-0.3	-0.3
700	34	1.0	0.1	0.1
500	44	1.0	0.8	0.4
400	50	0.9	0.3	0.2
300	46	0.7	-0.9	-0.8
200	28	0.5	-0.8	-0.7
150	23	0.4	-0.8	-0.9
100	12	0.2	-0.4	-0.4
70	7	0.1	0.3	0.3
50	11	0.2	0.8	0.6
30	49	0.4	2.8	1.2
20	41	0.4	2.7	1.1

BELLINGSHAUSEN STATION

Table 1.23

Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

March 2002

Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Sea level pressure, hPa	991.6	1018.9	969.7	-1.2	-0.3	
Air temperature, ^0C	-0.1	3.9	-6.4	-0.4	-0.4	
Relative humidity, %	84			-3.3	-1.0	
Total cloudiness (sky coverage), tenths	9.1			0.1	0.3	
Lower cloudiness(sky coverage),tenths	8.2			0.4	0.5	
Precipitation, mm	56.8			-15.4	-0.6	0.8
Mean wind speed, m/s	5.7	17		-1.4	-2.0	
Prevailing wind direction, deg	158					
Total radiation, MJ/m^2	172			-22.8	-1.3	0.88

VOSTOK STATION

Table 1.24

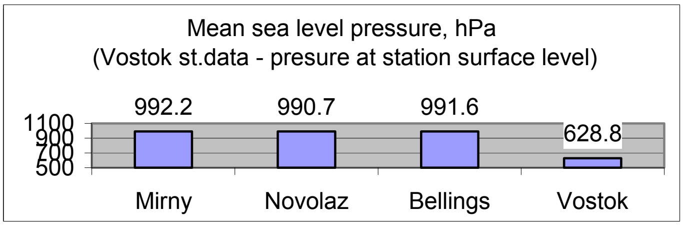
Monthly averages of meteorological parameters (f) and their deviations from multiyear averages (f_{avg})

March 2002

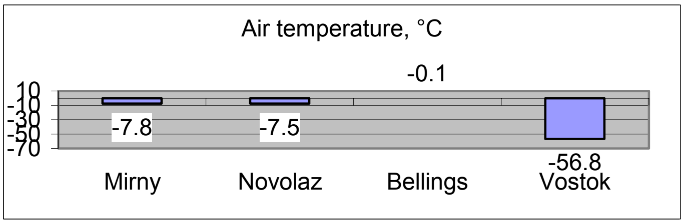
Parameter	$f_{mon.avg}$	f_{max}	f_{min}	Anomaly $f-f_{avg}$	Normalized anomaly $(f-f_{avg})/\sigma_f$	Relative anomaly f/f_{avg}
Station surface level pressure, hPa	628.8	638.8	620.4	3.8	1.0	
Air temperature, ^0C	-56.8	-44.5	-69.4	1.3	0.6	
Relative humidity, %	55			-14.2	-2.8	
Total cloudiness (sky coverage), tenths	1.6			-2	-2.0	
Lower cloudiness(sky coverage),tenths	0			-0.1	-0.5	
Precipitation, mm	3.5			1.3	0.5	1.6
Mean wind speed, m/s	1.8	10		-3.7	-4.1	
Prevailing wind direction, deg	202					
Total radiation, MJ/m^2	260			36.2	2.5	1.16
Total ozone content (TO), DU	*					

* Data of TO measurements require quality control and will not be published until it is done.

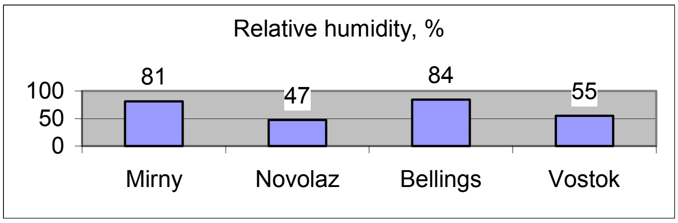
March 2002



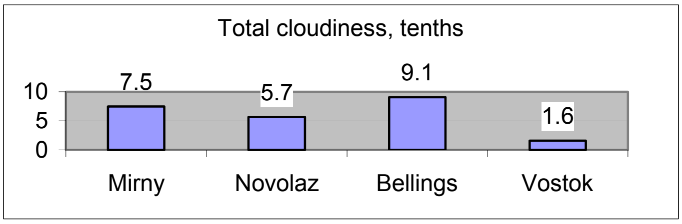
$(f-f_{avg})/\sigma_f$ 1.6 1.3 -0.3 1.0



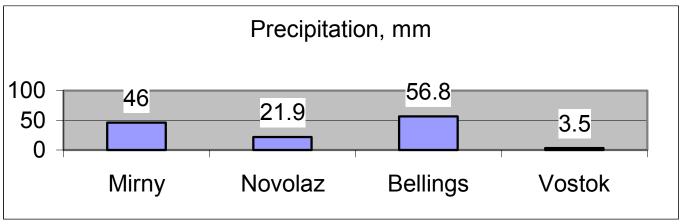
$(f-f_{avg})/\sigma_f$ 1.5 0.3 -0.4 0.6



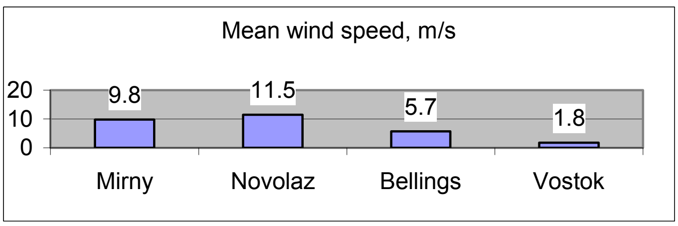
$(f-f_{avg})/\sigma_f$ 2.3 -0.5 -1.0 -2.8



$(f-f_{avg})/\sigma_f$ 0.9 -0.6 0.3 -2.0



f/f_{avg} 1.6 2.5 0.8 1.6



$(f-f_{avg})/\sigma_f$ -1.0 0.6 -2.0 -4.1

Fig. 1.3. Comparison of monthly averages of meteorological parameters at the stations, March 2002.

2. METEOROLOGICAL CONDITIONS IN ANTARCTICA IN JANUARY-MARCH 2002

The meteorological conditions of January-March 2002 were characterized by the presence of large above zero temperature anomalies. At Vostok station in January, the mean monthly temperature comprised -28.8° C (Fig. 2.1). In the interannual temperature variations, January 2002 was the warmest for the entire observation period. At Bellingshausen (in February) and Mirny (in March), the mean monthly temperatures were the third in the rank of warm years.

The temperature conditions in January-March over the entire continent are characterized in Fig. 2.1 where monthly averages and the absolute and normalized surface temperature anomalies at the Russian and foreign stations are presented. Actual data contained in /1/ and multiyear averages for the 1961-1990 period contained in /2/ were used.

In January-March, the heat center in East Antarctica still persisted. In January, its core was located near Vostok station. In February, the area of the center has decreased, while in March it expanded anew. The core of the center was displaced to the Polar Plateau area. The temperature anomaly at Amundsen-Scott station was +4.0° C (+2.3σ). In the interannual temperature variations, March 2002 has become the second in the rank of warm years at this station (the warmest being observed in 1988).

In the western part of the Indian Ocean coast of Antarctica, a small cold center was observed in January-March (see Fig. 2.1). In January, its core was located near Syowa station (with anomalies comprising -1.2 ° C, -1.4σ). In February, the area of the cold center has increased and its core moved to the Mirny station area. The temperature anomaly here comprised -1.3°C (-1.2σ). In March, the center has decreased again. In its center in the vicinity of Syowa station, the temperature anomaly was -1.0°C (-0.5σ). In March, in the area of the Weddell Sea and the Antarctic Peninsula, a new cold center was formed. The values of anomalies in the center were not greater than -1.0σ.

An assessment of long-period changes of mean monthly temperature of the months under consideration reveals a positive trend at Bellingshausen and Novolazarevskaya stations and a negative trend at Mirny station (Fig. 2.2-2.4). At Vostok station for January, the trend sign is positive, whereas for February-March, it is negative. However, a statistically significant linear trend is recorded only at Bellingshausen station for January and February (Table 2.1). During the last decade, no statistically significant linear trends of mean monthly air temperature are observed at the Russian stations. One can only note the appearance of a negative trend sign for January-March at Novolazarevskaya and Bellingshausen stations.

Table 2.1

Linear trend parameters of the monthly surface air temperature averages

Stations	Parameter	I	II	III	I	II	III
		Entire observation period			1992-2002 period		
Novolazarevskaya, 1961-2002	°C/1 year	0.13	0.16	0.18	-0.30	-0.36	-1.21
	%	18.6	21.0	19.8	17.1	13.5	28.4
	P	-	-	-	-	-	-
Mirny, 1957-2002	°C/1 year	-0.08	-0.04	-0.02	0.19	-1.30	2.07
	%	10.7	5.3	2.0	6.7	43.8	46.0
	P	-	-	-	-	-	-
Vostok, 1957-2002	°C/1 year	0.22	-0.02	-0.09	0.88	0.40	-0.84
	%	20.1	1.6	6.1	17.5	13.2	20.4
	P	-	-	-	-	-	-
Bellingshausen, 1968-2002	°C/1 year	0.39	0.32	0.26	-0.07	-0.33	-0.05
	%	60.8	48.3	31.6	4.9	16.4	2.3
	P	99	99	90	-	-	-

Note: First line is the linear trend coefficient;
Second line - dispersion explained by the linear trend;
Third line - level of significance (given if it exceeds 90%, 95% or 99 % confidence intervals).

The atmospheric pressure at the Russian stations was lower than a multiyear average in January-February and higher in March (except for Bellingshausen station). The largest pressure anomalies were observed in February.
At Novolazarevskaya station, mean monthly pressure has dropped to 979 hPa for the first time over the entire observation period with the anomaly comprising -10.1 hPa (-2.2σ). Significant negative pressure anomalies occurred in February for the second time over the entire observation period at Mirny station (-9.1 hPa, -2.7σ) and at Vostok station (-6.3 hPa, 1.5σ).

The atmospheric pressure trend at the Russian stations for the months under consideration is negative over the entire observation period (Fig. 2.2-2.4). The only exception is a positive trend at Bellingshausen station in February and at Vostok station in March. During the last decade, a statistically significant negative trend is recorded in January at Mirny and Novolazarevskaya stations.

The amount of precipitation in January-March at the Russian stations was predominantly higher than a multiyear average. Precipitation at Vostok station in January and at Mirny station in February was 3.6-fold greater than a multiyear average. Such a significant sum of precipitation at these stations was recorded for the second time over the entire observation period. More than two-fold precipitation fallout than a multiyear average was recorded at Bellingshausen station and Mirny in January and at Novolazarevskaya station in March.

In March, the amount of precipitation was close to a multiyear average only at Bellingshausen station whereas at Novolazarevskaya and Vostok stations, precipitation was absent in February.

References:

1. http://www.ncdc.noaa.gov/ol/climatedata.html
2. Atlas of the Oceans. The Southern Ocean. RF MD (in press)

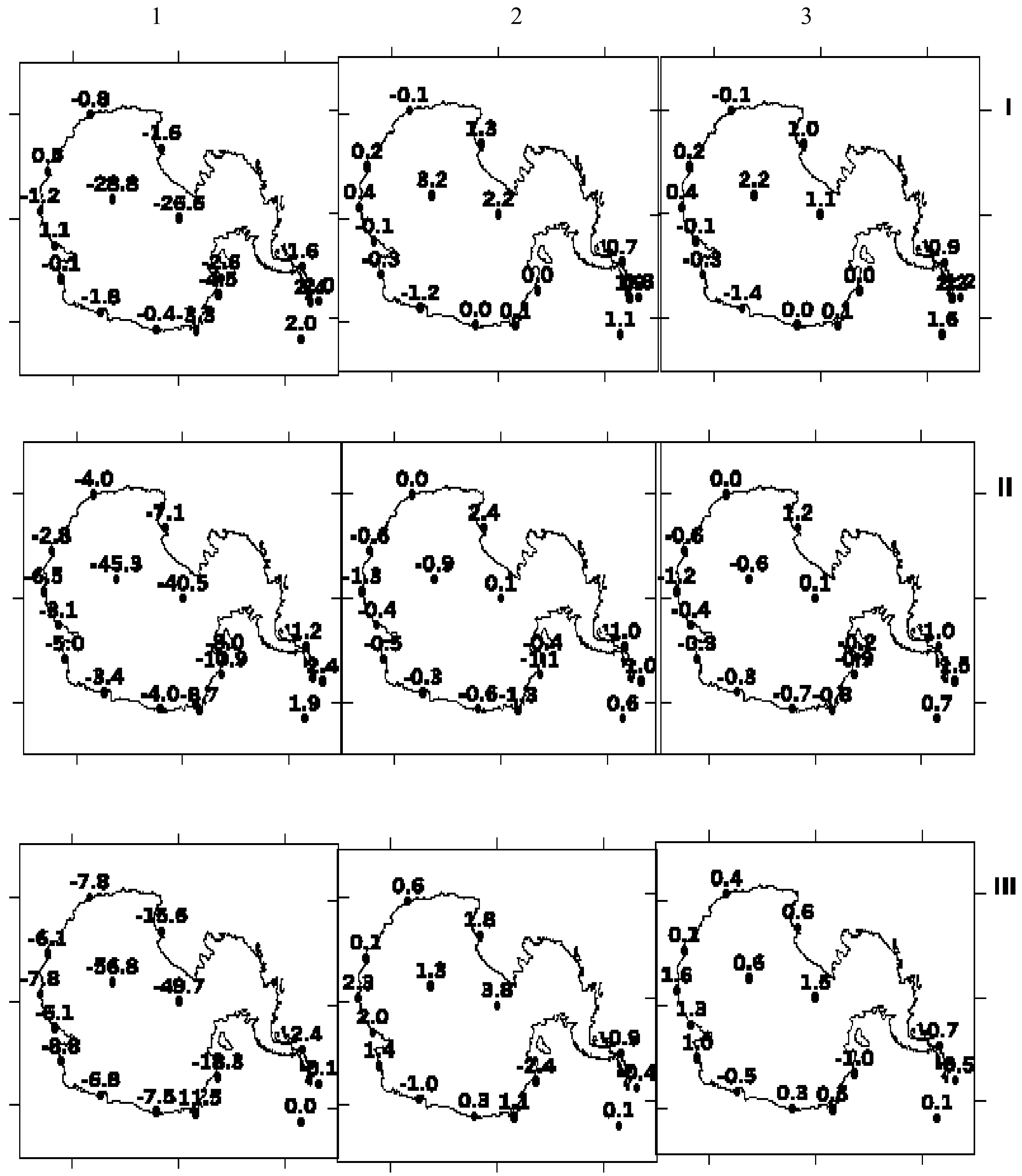


Fig. 2.1. Surface air temperatures (1) and their absolute (2) and normalized (3) anomalies in January (I), February (II) and March (III) 2002 based on data of stationary meteorological stations in the Southern Polar Area

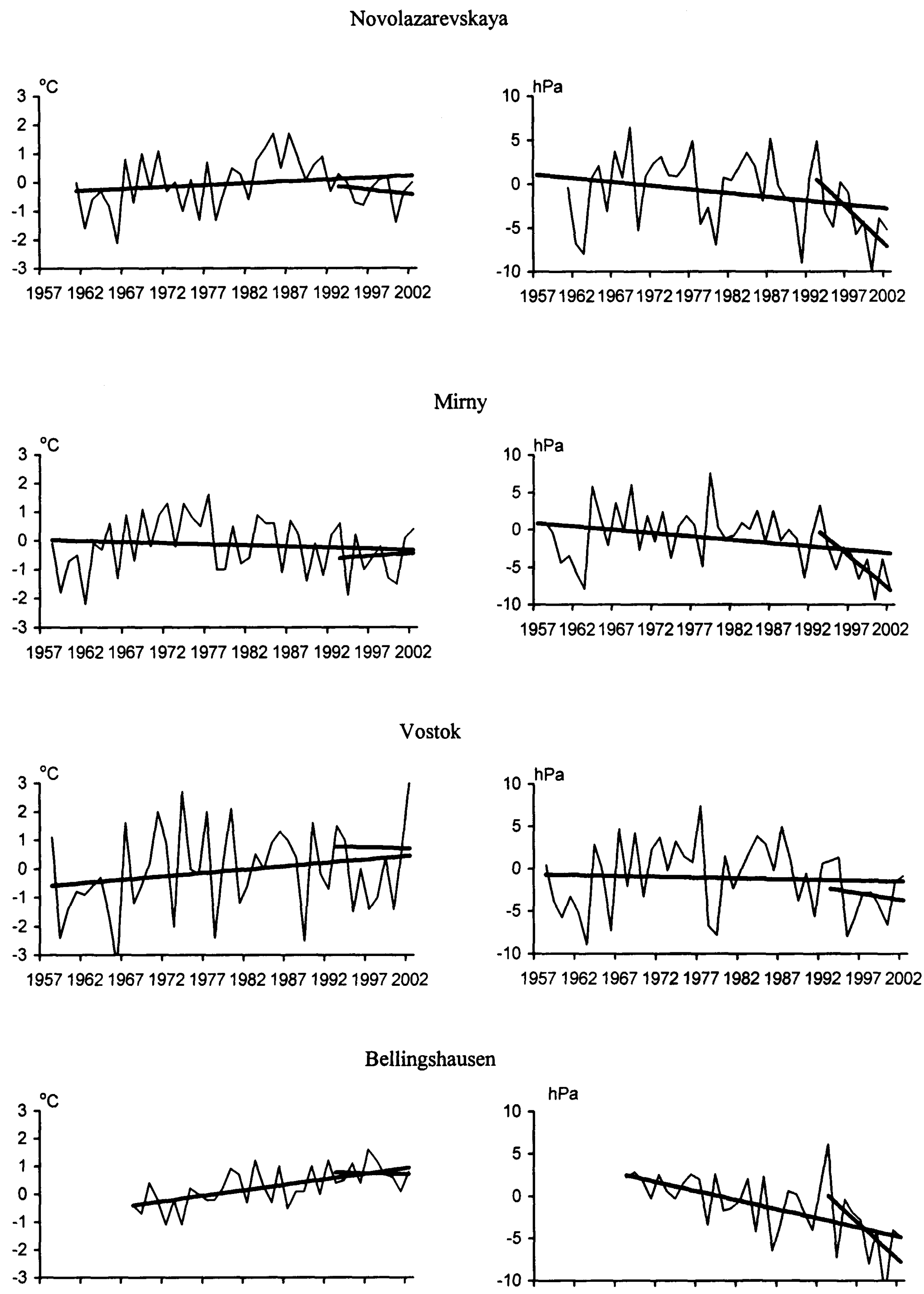


Fig. 2.2. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. January.

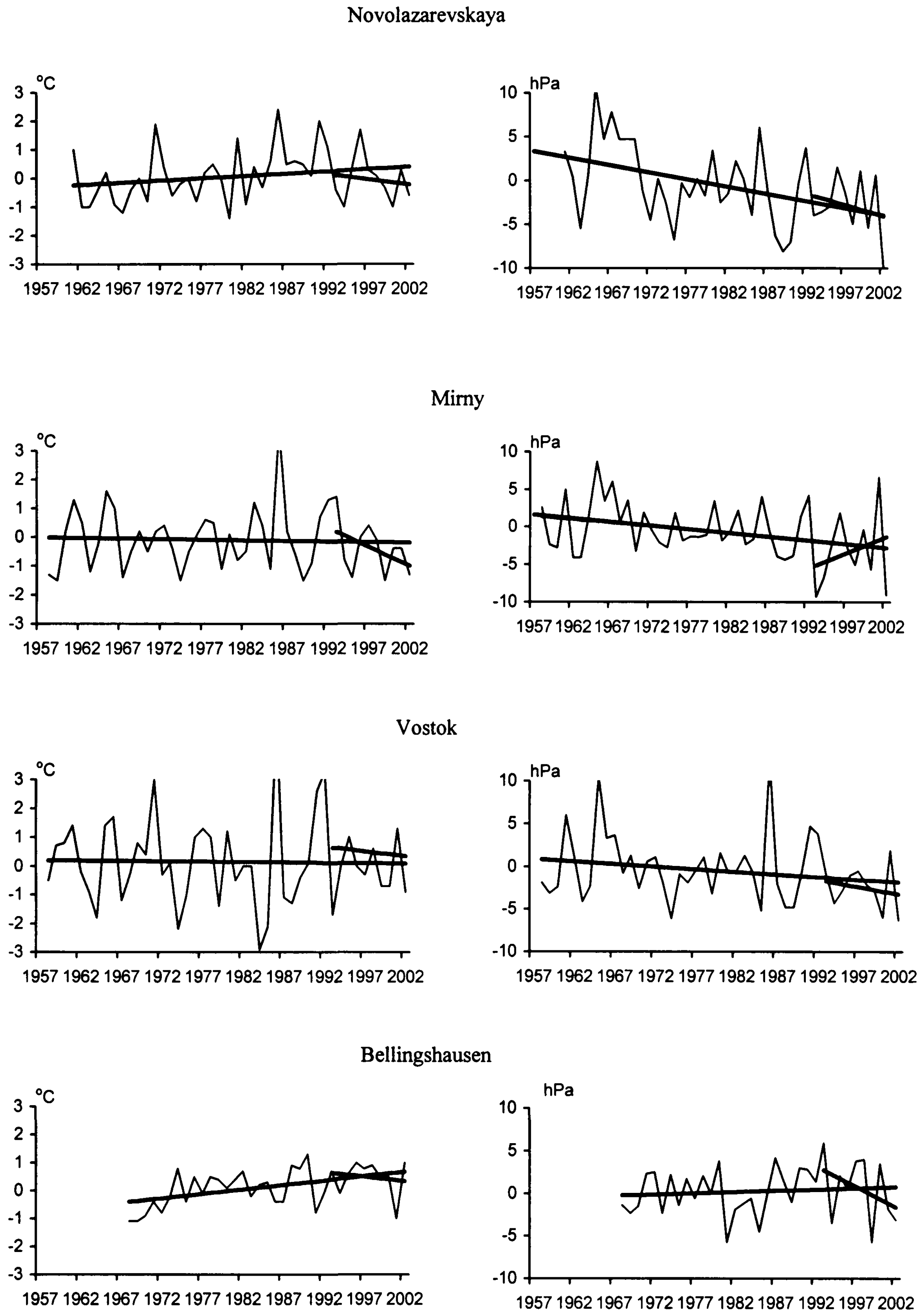
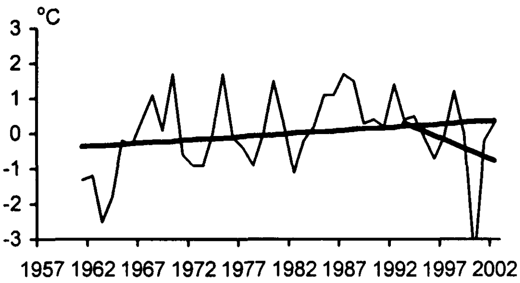
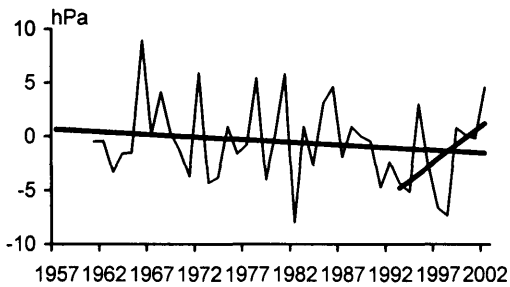


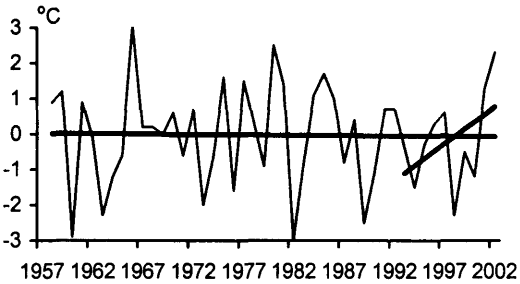
Fig. 2.3. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. February.

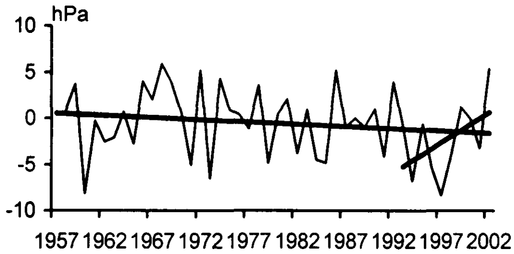
Novolazarevskaya



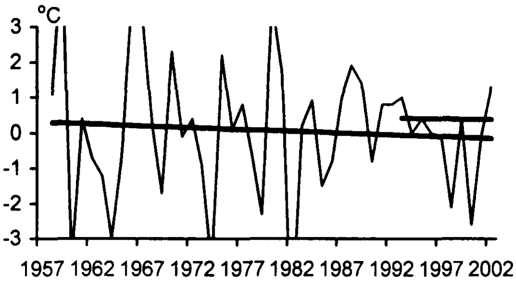


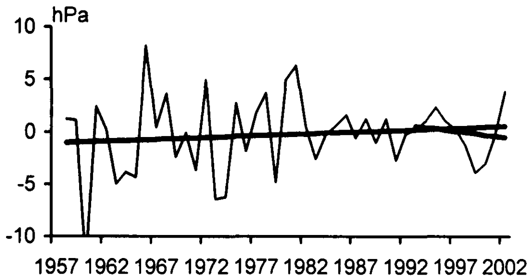
Mirny



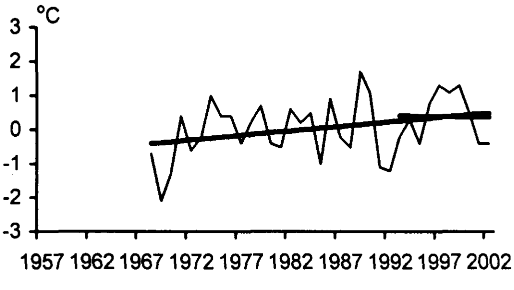


Vostok





Bellingshausen



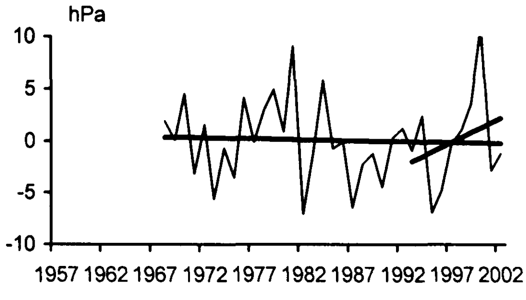


Fig. 2.4. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. March.

3. ATMOSPHERIC PROCESSES ABOVE THE ANTARCTIC IN JANUARY-MARCH 2002

In January, the greatest activity of cyclones was observed in the East-Pacific, Falkland and Kerguelen trajectories, which contributed to the formation of three deep negative surface pressure anomalies in the area of the Antarctic Peninsula and the Lazarev Sea. Thus, one can speak about a belt of negative pressure anomalies covering the eastern areas of the western Antarctic and almost all seas of the eastern Antarctic. This is typical of the high-latitudinal zonal circulation, which dominates in the multiyear regime in this month.

The processes of the meridional M_a and M_b forms were more rare (see Table 3.1). The intensity of the interlatitudinal exchange was weak similar to the summertime.

Table 3.1

Frequency of occurrence of the atmospheric circulation forms in the Southern Hemisphere and their anomalies in January-March 2002

Month	Frequency of occurrence (days)			Anomalies (days)		
	Z	M_a	M_b	Z	M_a	M_b
January	14	9	8	1	-3	2
February	10	5	13	-3	-3	6
March	9	11	11	-6	1	5

In February, the intensity of meridional processes remained low. The increased activity of mesoscale processes at the Antarctic front was preserved, whereas in the Lazarev Sea area, the impact of cyclonic features in the Falkland branch of the trajectories was added. This has led to preserving a vast sub-Antarctic belt of significant negative surface pressure anomalies extending from the Antarctic Peninsula to the D'Urville Sea. However, the "gravity center" of the anomalies was displaced along the Antarctic coast eastward.

During the weak interlatitudinal exchange processes, the air temperature was characterized by small below zero anomalies in the coastal regions of East Antarctica and above zero anomalies in the north of the Antarctic Peninsula.

In March, weak intensity of atmospheric circulation, especially of its meridional forms was preserved. In West Antarctica, predominantly in the central part of the Pacific Ocean sector, situations of high pressure ridges hindering zonal transport were observed throughout the entire month, which is typical of the meridional type circulation form M_b. The frequency of occurrence of meridional processes was significantly greater in this month compared to a multiyear average (see Table 3.1).

The cyclonic activity in East Antarctica in March was manifested in the trajectories that have a significant latitudinal component located predominantly north of the 60^{th} parallel. The velocities of cyclones were insignificant. The most active were the New Zealand and the East Pacific branches of the trajectories.

An anomalous development of the continental high pressure area was noted in March.

Based on data of upper-air sounding of Mirny Observatory, the minimum temperature of the tropopause gradually decreased from -58^{o} C in January to -65^{o} C in March. The maximum height of the tropopause over the study period was recorded in March comprising 11.6 km. The greatest frequency of occurrence of jet currents of the prevailing western direction was recorded in February (6 cases). The greatest wind speed in the jet current axis (51 m/s) was noted on March 20.

The stratospheric vortex parameters were within the summer range.

4. BRIEF REVIEW OF ICE PROCESSESS IN THE SOUTHERN OCEAN FROM DATA OF SATELLITE AND COASTAL OBSERVATIONS AT THE RUSSIAN ANTARCTIC STATIONS IN JANUARY-MARCH 2002

A distinguishing feature of the summer 2002 in the Antarctic is an enormous calm in the coastal zone south of the 65th parallel observed from December to March. An anomalously decreased cyclonic activity has also governed here similar peculiar ice consequences.

Thus, in February, the absolute majority of the coastal area from Weddell Sea through Prydz Bay was practically completely ice-cleared (see Table 4.1). The Atlantic ice massif was simultaneously developed over its entire extent from the Antarctic Peninsula to 15^{o} W occupying a rarely observed southernmost position at which its northern boundary has retreated on average to 70^{o}S. Significant masses of last year ice, primarily unbroken landfast ice were also preserved in the Davis and Mawson Seas. In this respect, quite indicative appears to be an example of Treshnikov Bay where according to Mirny Observatory observations (Tables 4.2 and 4.3) the landfast ice after melting by 70-80 cm during the summer has not broken up at all (see section 4a).

New autumn ice formation began everywhere on the first days of March and was very intense. This has determined a rapid reconstruction of the solid circumpolar ice belt and its rapid growth everywhere except for the Cosmonauts Sea area.

Table 4.1

Latitudinal location of the external northern drifting ice edge in the Southern Ocean based on satellite data of Novolazarevskaya station in February 2002

Meridians	Actual	Multiyear average
60º W	64.2[1]	64.2[1]
50º W	69.1	65.3
40º W	70.2	69.3
30º W	70.6	73.1
20º W	69.4	72.5
10º W	70.2	70.4
0º	69.6[1]	69.3
10º E	69.6	69.3
20º E	69.4	69.1
30º E	68.4	68.5
40º E	68.0	67.8
50º E	66.7	66.3
60º E	67.4[1]	66.8
70º E	68.4[1]	67.3

Note: [1] – clear, no ice – instead of the ice edge position, latitude of the Antarctic coast point is given at its crossover with the corresponding meridian.

Table 4.2

Dates of the main ice phases in the areas of Russian Antarctic stations in January-March 2002

Station (water body)		Landfast ice breakup		Ice clearance		Ice formation	
		Start	End	First	Final	First	Stable
Mirny	Actual	10.03	NO	NO	NO	01.03	01.03
	Multiyear average	23.12	05.02	12.02	NO	11.03	12.03
Bellingshausen (Ardley Bay)	Actual	From September 10, 2001 – ice-clear					
	Multiyear average						

Note: NO – phenomenon not observed

Table 4.3

Average landfast ice thickness (cm) and snow depth on landfast ice (cm)

in the Mirny Observatory area from data of profile measurements in January-March 2002

Months	I	II	III
Ice thickness	103	-	64
Snow depth	3	-	14

4a. UNIQUE ICE REGIME PHENOMENON IN THE MIRNY OBSERVATORY AREA

For the first time over an almost half a century history of Mirny station, there was no landfast ice decay in 2002.

Breaking of the edge of local 30-km landfast ice began only on March 10, which is 2.5 months later compared to the usual dates (December 23) and an almost one month later than the landfast ice breakup recorded on February 15, 1964. At this time, the landfast ice here was already completely broken up and exported even in the anomalous “late” years (an extremely late date of the final old landfast ice decay where the station roadstead was completely ice cleared was on March 9, 1960).

In 2002 by March 18, only 20% of the landfast ice area was broken up. The breakup developed as usual in the northwest in the form of a band whose top approached the station to a distance of about 20 km. However, the broken landfast ice was not exported and by March 30, it was frozen together again.

This event is not a simple anomaly, but a peculiar ice cataclysm. One encounters the anomalous development of ice processes in the Antarctic almost every year. However, this year, there is probably a simultaneous manifestation of the substance and the mechanism maintaining a specific equilibrium of the Southern polar climatic system functioning in the self-oscillation regime.

Given a general dynamic nature of the landfast ice breakup and calving of icebergs, one can consider this year event as a special example of the compensation response to the formation of giant icebergs in some marginal Antarctic seas that were abundant in the summer of 2002.

5. RESULTS OF TOTAL OZONE MEASUREMENTS

Regular observations of the total ozone were continued during the entire first quarter of this year at Mirny and Vostok stations and until March 8, 2002 at Novolazarevskaya station. However, data of TO observations at Vostok and Novolazarevskaya stations require checking and additional analysis and will not be published until this is done.

The ozone content at Mirny station was stable in the first quarter of 2002 (see Fig. 5.1). More significant TO oscillations were noted only in the second half of March. Monthly TO averages in January-March were close (304 Dobson units in January, 297 Dobson units in February and 298 Dobson units in March) being slightly higher than the corresponding values last year.

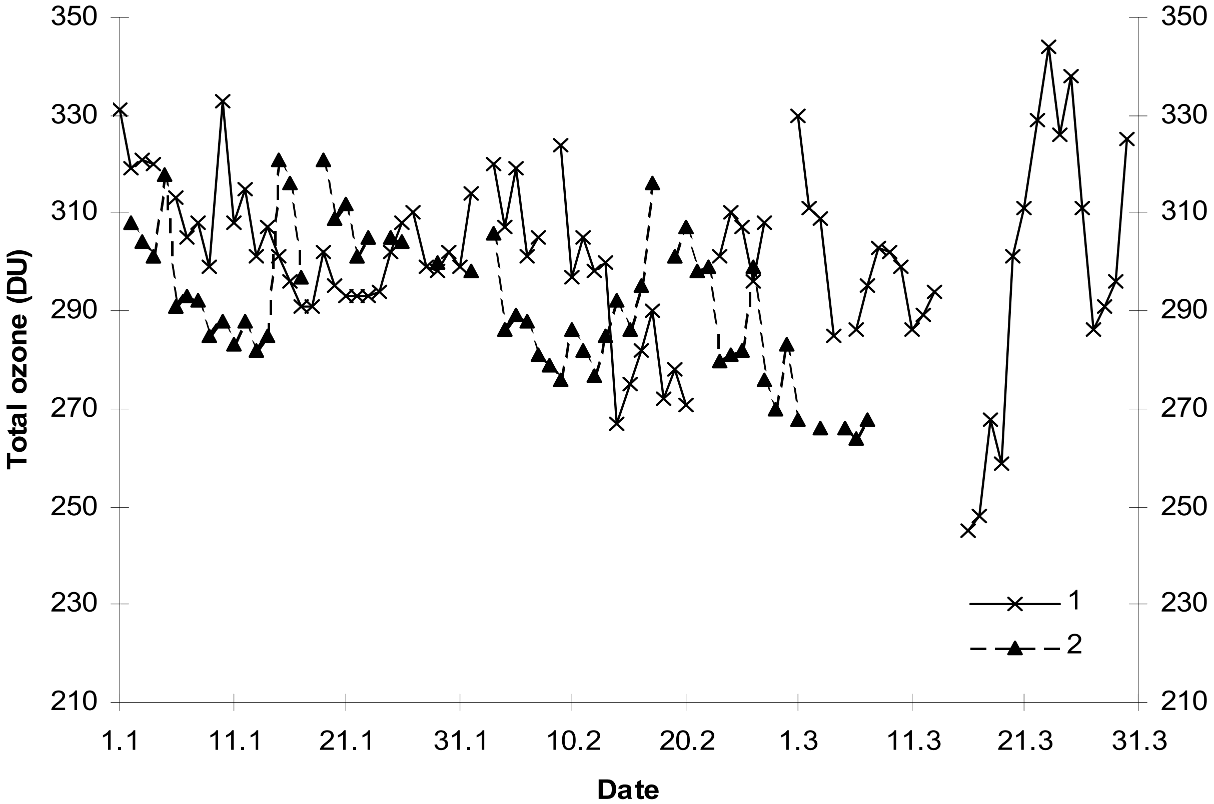


Fig. 5.1. Daily total ozone averages at Mirny station in the first quarter of 2002.

6. GEOPHYSICAL OBSERVATIONS AT RUSSIAN ANTARCTIC STATIONS IN JANUARY-MARCH 2002

MIRNY OBSERVATORY

Mean monthly absolute geomagnetic field values

	January	*February*	*March*
Declination	*86°48.6'W*	*86°45.3'W*	*86°49.7'W*
Horizontal component	*13947 nT*	*13983 NT*	*13942 nT*
Vertical component	*-57471 nT*	*-57470 nT*	*-57483 nT*

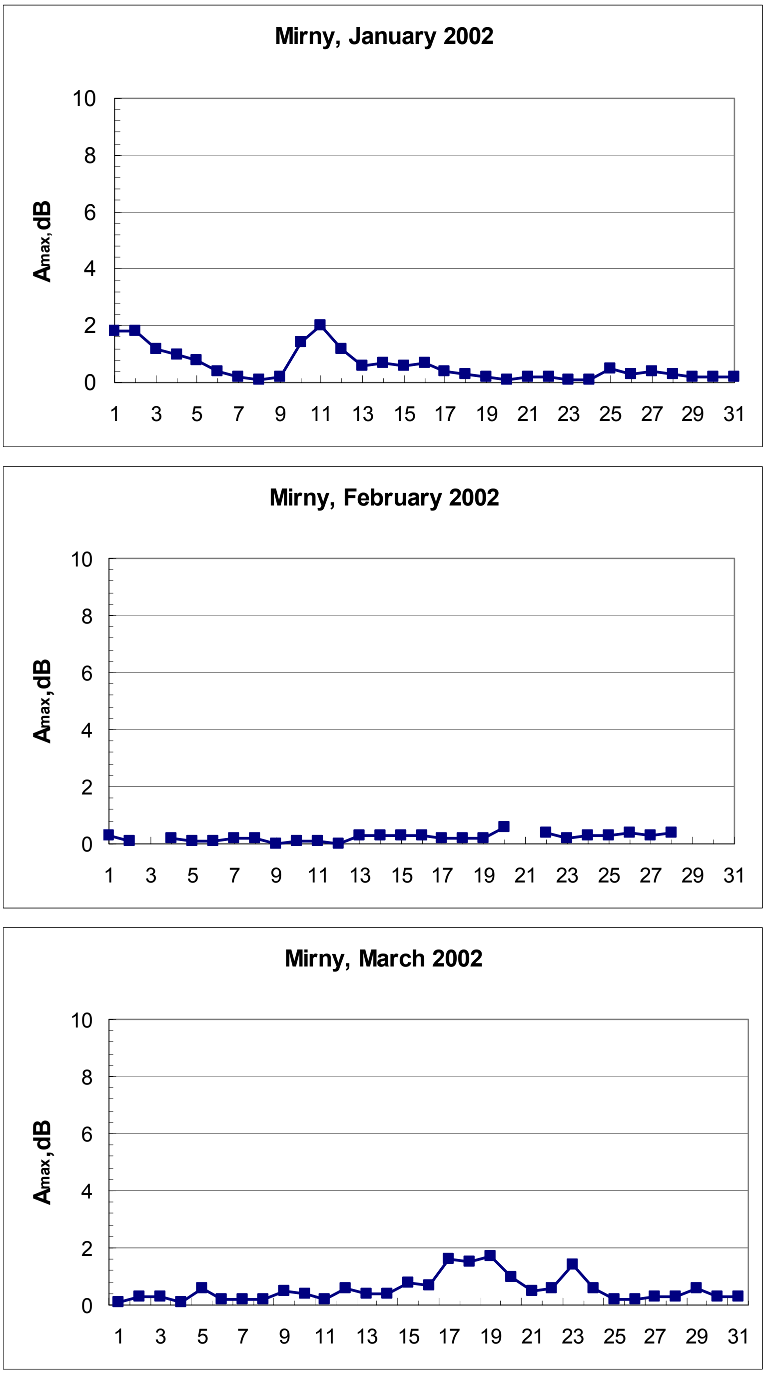


Fig. 6.1. Maximum daily space radio-emission absorption at the 32 MHz frequency from riometer observations in Mirny Observatory.

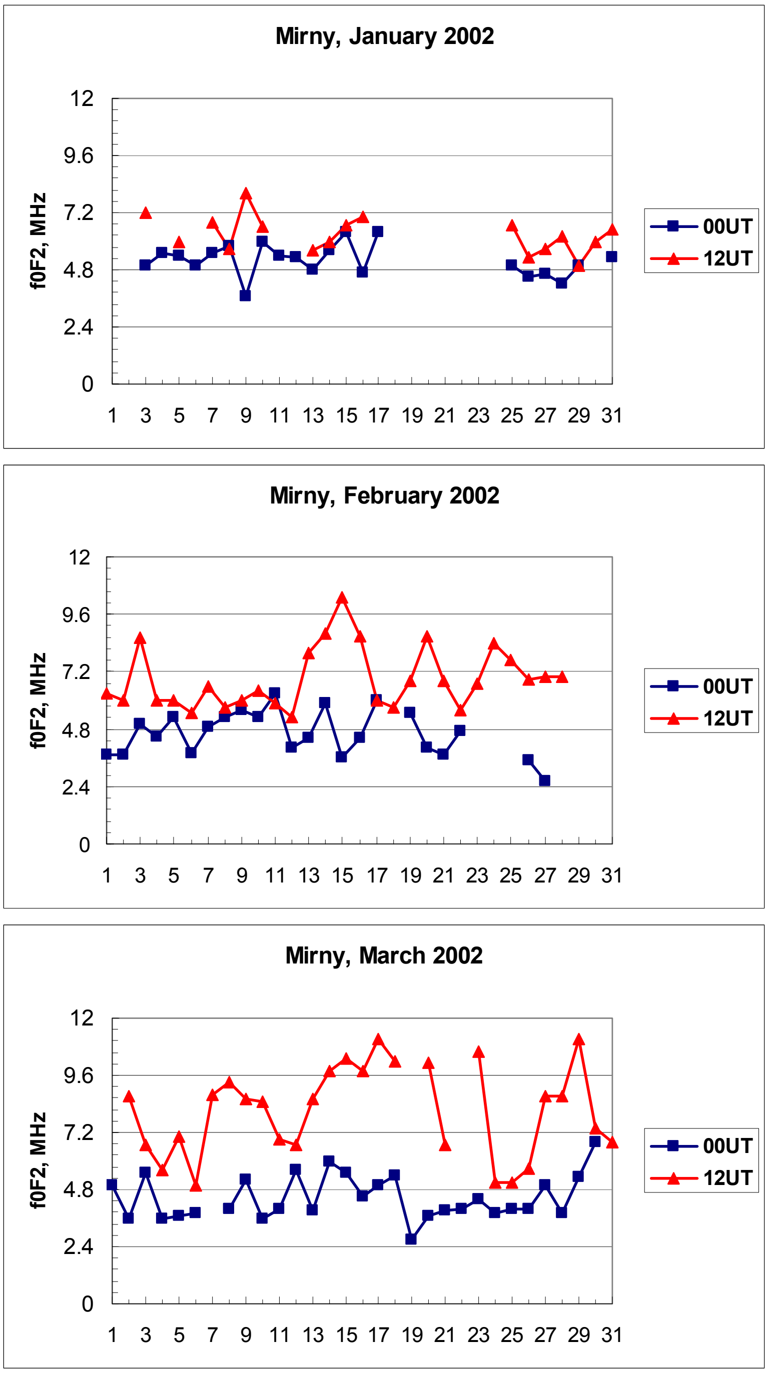
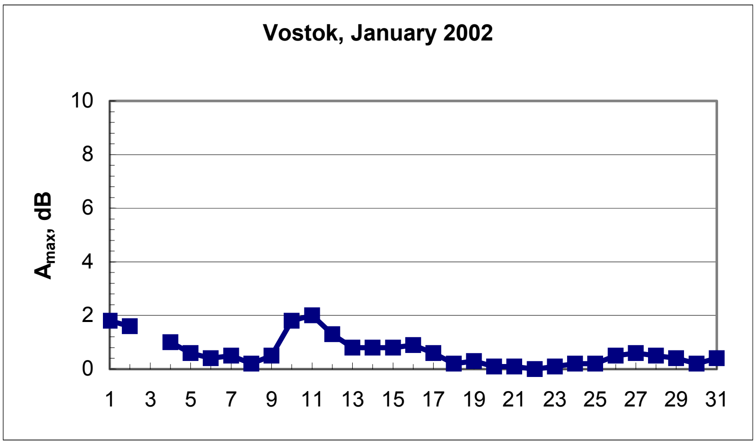


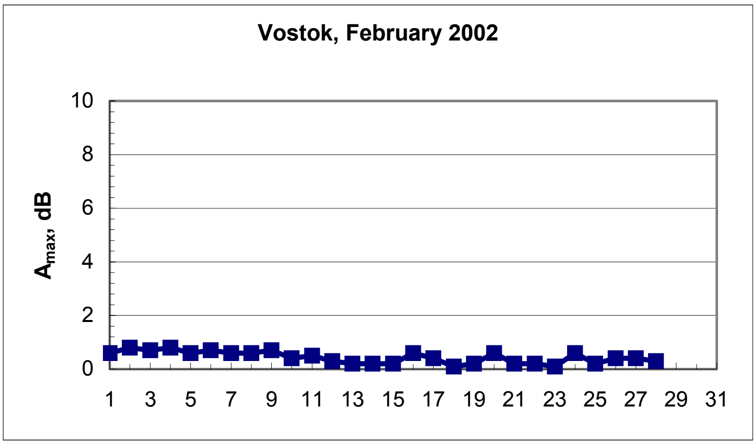
Fig. 6.2. Daily variations of critical frequencies of the F2 (f0F2) layer in Mirny Observatory.

VOSTOK STATION

Mean monthly absolute geomagnetic field values

	January	*February*	*March*
Declination	*120°48.75'W*	*120°07.56'W*	*120°02.79'W*
Horizontal component	*13457 nT*	*13454 nT*	*13423 nT*
Vertical component	*-58102 nT*	*-58097 nT*	*-58158 nT*





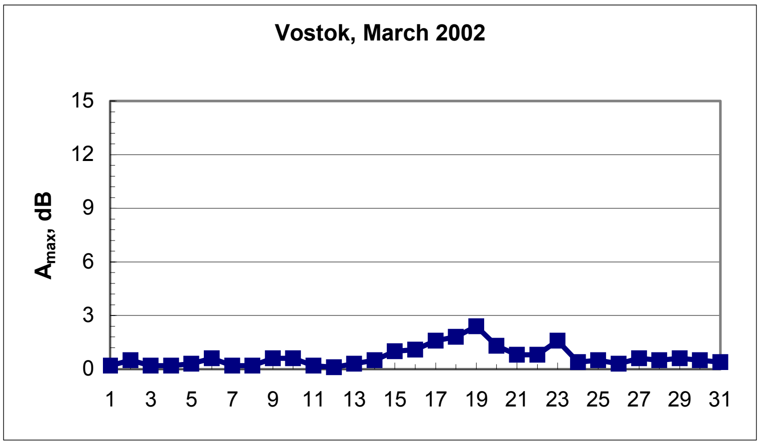


Fig. 6.3. Maximum daily space radio-emission absorption at the 32 MHz frequency from riometer observations at Vostok Station.

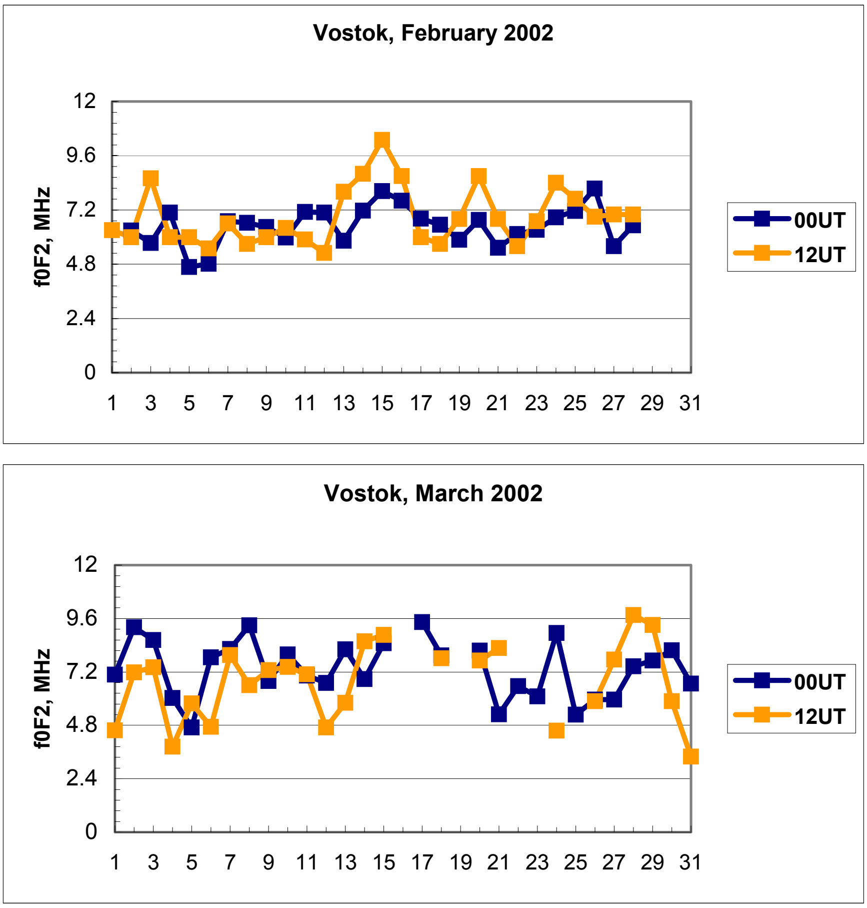
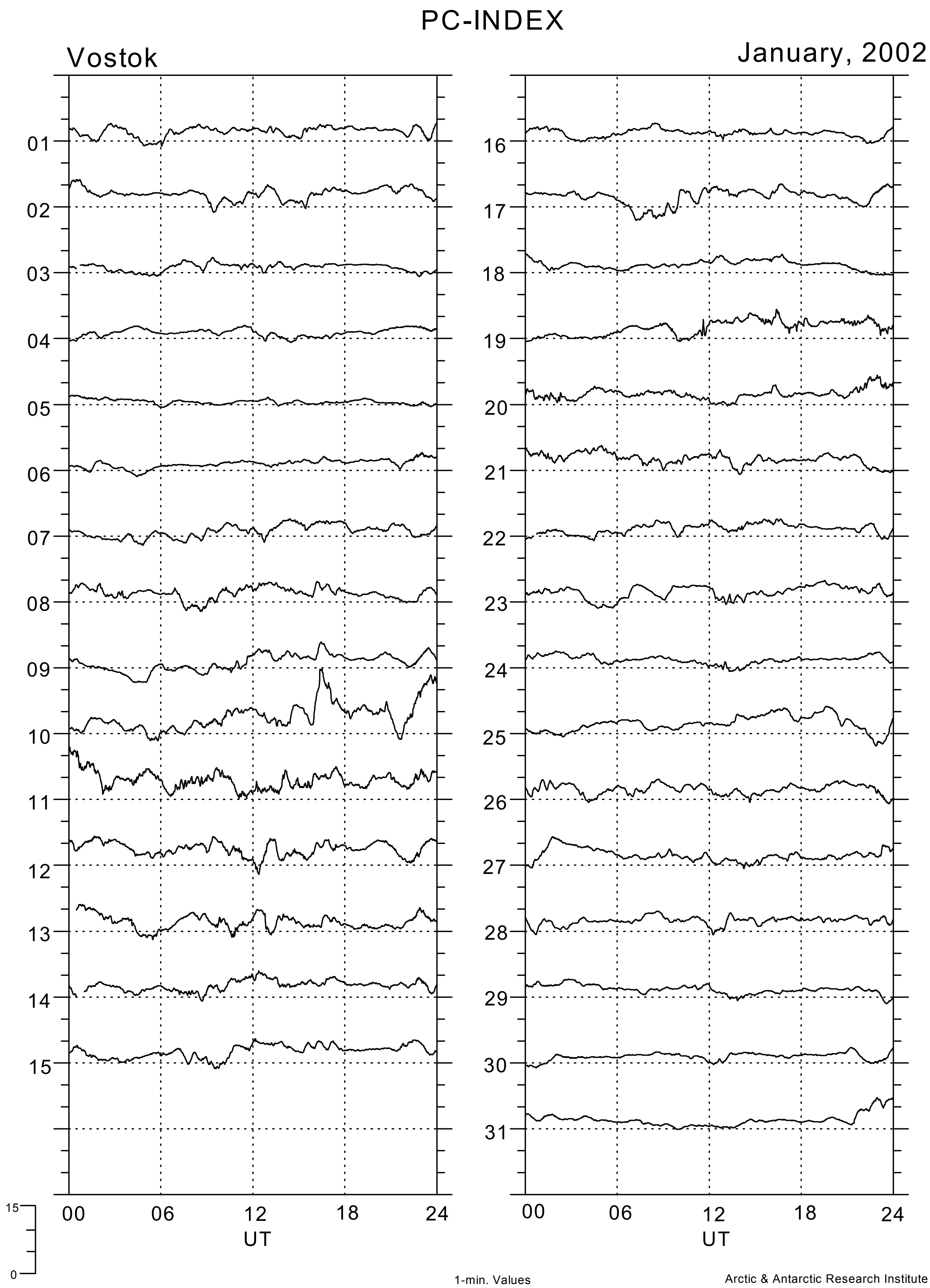


Fig. 6.4. Daily variations of critical frequencies of the F2 (f0F2) layer at Vostok station.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Arctic & Antarctic Research Institute

Fig. 6.5.

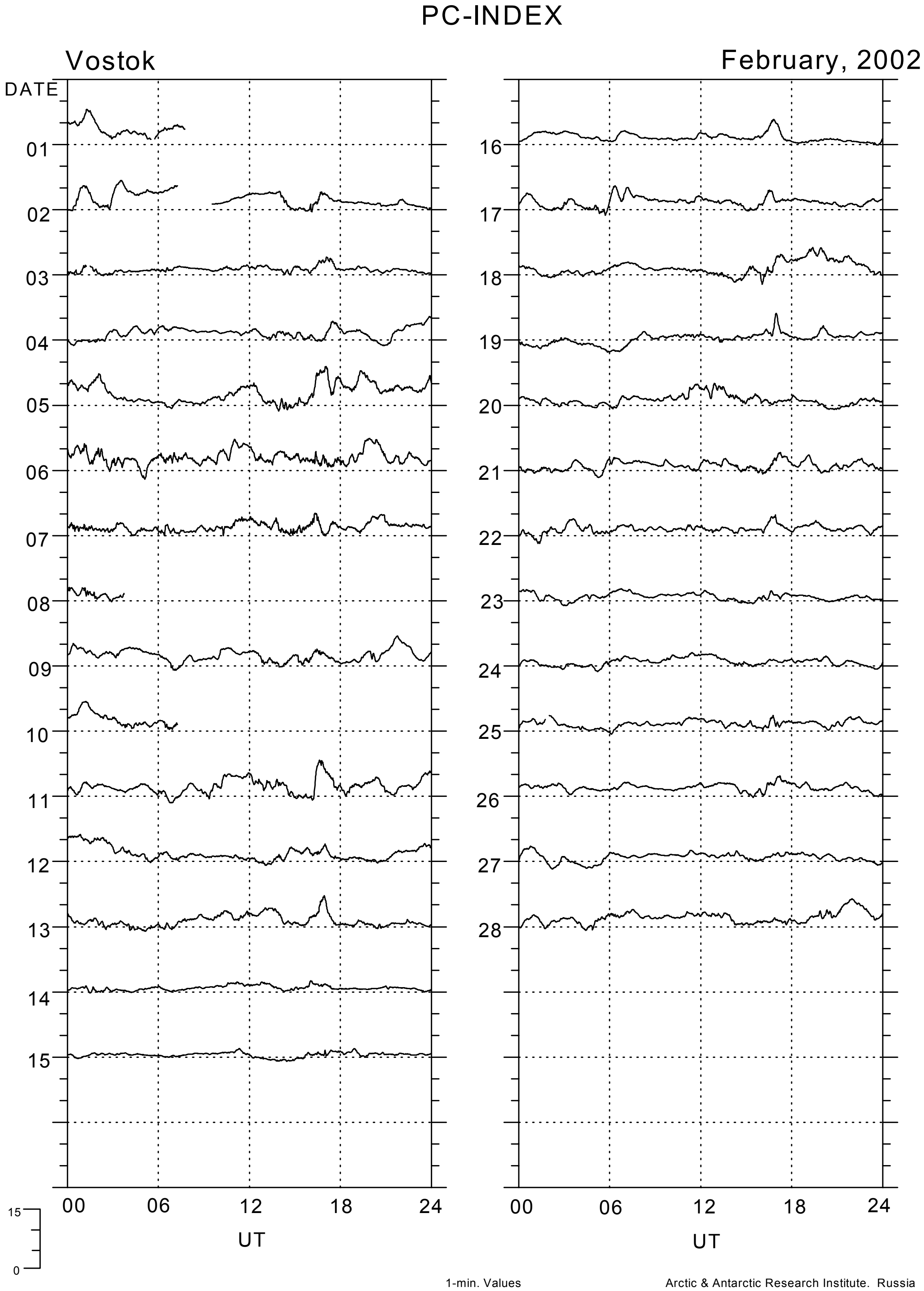
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Fig. 6.6.

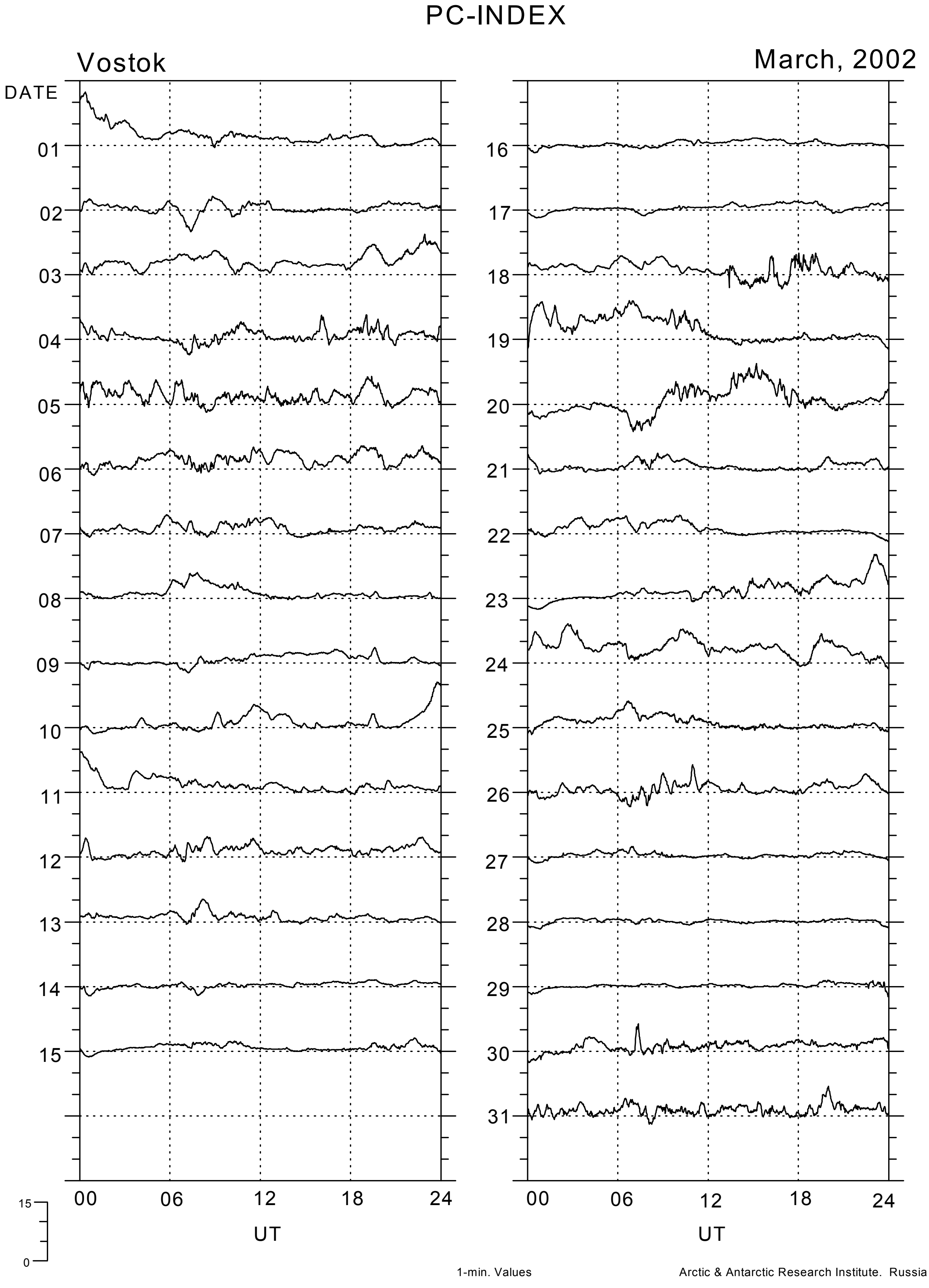
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Fig. 6.7.

Review of the state of the geomagnetic field and ionosphere above the Antarctic in the first quarter of 2002

At the beginning of 2002, the observations of the ionosphere using a vertical sounding method were resumed. Regular observations began from February. A digital ionosonde “BIZON” was installed and launched into operation. In addition to standard observations, the ionosonde “BIZON” allows recording the amplitude signal characteristics, motion of inhomogeneities in the ionosphere during the periods of high sub-storm activity.

Geomagnetic observations were continued at Novolazarevskaya, Mirny and Vostok stations. The first quarter of 2002 was relatively quiet in respect of magnetic activity. Moderate magnetic storms were observed on January 1-2 and 10-13, February 5-6, February 28 – March 1 and March 18-24.

Part of magnetic storms was accompanied with intrusion of high-energy solar proton fluxes to the southern polar ionosphere. The effects of these intrusions, the so-called absorption events in the polar cap (PCA) were recorded by riometers at Mirny and Vostok stations. Significant PCA events were observed on January 1-7, January 10-17 and March 17-25. It is noted that the observed phenomena in the PCA were quite weak by intensity. The absorption value obtained from riometer data was not greater than 2 dB.

During the period of increased magnetic activity on January 1-2 and 10-13, a decrease of f_0F2 at Mirny station is observed at midnight hours. A similar decrease of critical frequencies at midnight hours is observed on February 5-6 and on February 27 in Mirny Observatory and at Vostok station. In Mirny Observatory, a large gradient between the midday and midnight f_0F2 values compared to Vostok station data was observed in February-March, which can be related to a different level of illumination at these stations in the autumn period.

7. SOME FEATURES OF THE FREE ATMOSPHERE REGIME IN ANTARCTICA

Lagun V.Ye., Jagovkina S.V.

The climatic regime of the free atmosphere of the Southern Polar Area is characterized by some specific features as compared with the state of the troposphere and the stratosphere of other climatic zones /1,22/. These features include powerful spring stratospheric warming events, a unique dynamic regime of a strong circumpolar vortex, maximum resources of available potential energy on our planet, special conditions of the radiation energy exchange and physical-chemical transformations in the atmosphere. Significant experience of upper-air sounding at the Russian (Soviet) Antarctic stations has been presently summarized in the meteorological block (see /8, 9/) of the geo-information system (GIS) “The Antarctic”, which is intended for a numerical analysis of the environmental state of the Southern Polar Area based on available observation data over the period of instrumental measurements.

The main data sources on the state of the free atmosphere above Antarctica in the GIS “The Antarctic” are as follows (by decreasing priority):

- AARI archives (after data conversion to the electronic format and data quality control);
- AEROSTAB archive prepared at VNIIGMI-WDC;
- British Antarctic Survey archive;
- National archives of countries-operators in the Antarctic;
- Data disseminated via the Global Telecommunication System (GTS) as messages;
- CARDS archive (Comprehensive Aerological Data Set, USA /12/;
- MONADS archive (MONthly Aerological Data Set) prepared at VNIIGMI-WDC based on the CARDS archive /21/.

The List of Antarctic stations of atmosphere sounding that has multiyear observation series included into the AARI database is presented in Table 7.1 (as of the state on 01.04.2002).

As an example, Table 7.2 prepared by N.N. Kazakova, presents the actual number of vertical soundings of the atmosphere made at Bellingshausen station. Similar data were prepared for all Russian Antarctic stations.

Table 7.2 characterizes the time distribution of a full number of radiosonde launches at Bellingshausen station, whose results are available for the analysis of climatic changes of the free atmosphere parameters above the Antarctic Peninsula over the period 1969-1999. A comparison of data in Table 7.2 and corresponding information from the most known CARDS data set has revealed that the AARI archive contains a more complete description of the free atmosphere regime. For example, the number of sounds for 1970 at Bellingshausen station in the CARDS archive comprises only 39% of the entire number of upper air-soundings presented in Table 7.2.

In the process of initial data control, the gaps in operational information were filled and random and systematic errors leading to non-uniformity of the initial data set were removed on the basis of information about the statistical structure of the upper-air component fields and available meta-data (technical station certificates). The methods for control of upper-air data are described in details in /13, 17, 19 etc./. Detection and removal of systematic errors was performed by comparing data of the nearest stations, international intercalibration of sound sensors and thermodynamic modeling of the sound equipment. Data obtained from TEMP messages via GTS channels are often distorted by random errors appearing during data transmission as a result of incorrect coding procedures at the transmitting station or technical inaccuracy of data transfer. Such errors can be significant. That is why it is necessary for all observations of sounds to be subjected to quality control prior to data analysis.

The quality control also requires taking into account the data statistics within a month. Monthly averages of meteorological parameters are calculated in the cases where not less than ten soundings a month were made at the station and when the interval between the measurements was not greater than 5 days /5, 19/.

The examples of the analysis of information contained in the database are presented below /6,7 /.

West Antarctica

The specific features of the free atmosphere regime above the western Antarctic should be considered taking into account that pronounced warming in the surface layer is observed in this region. According to data of the British Faraday station located on the western shore of the Antarctic Peninsula, the trend of annual temperature averages for the period 1951-2000 was $+0.06 \pm 0.04$ °C year^{-1} being significant at the 1% significance level /16, 18, 19/. This warming occurred simultaneously with the decrease of sea ice spreading area in the Bellingshausen Sea /15/, and was also accompanied by the corresponding changes in the regional marine and terrestrial ecosystems. The surface warming coincides with the temperature changes in the troposphere above the Peninsula. The analysis of the warming process is based on a 44-year temperature data archive at the standard levels for the period 1956-1999. /19/. Since the program of upper-air measurements at Faraday station was completed in 1982, to supplement the data set on air temperature in the region, the results of upper air sounding at Bellingshausen (until 1999) and Marambio (up to present) stations were used.

Table 7.1

List of Antarctic upper-air stations from the AARI database

Index	Name	Latitude, S	Longitude	Standard synoptic times	Period
89009	Amundsen Scott	90	0 E	00, 12	1963 – 2001
89050	Bellingshausen	62.2	58.9 W	00	1969 – 1999
89611	Casey	66.3	110.5 E	00, 12	1959 – 2001
89571	Davis	68.6	78.0 E	00, 12	1959 – 1964, 1969-2000
89642	Dumont D'Urville	66.7	140.0 E	00, 12	1985 – 2000
89063	Faraday	65.4	64.4 W	00, 12	1957 – 1982
89022	Halley	75.5	26.4 W	00, 12	1957 – 2002
89657	Leningradskaya	69.5	159.4 E	00, 12	1983 – 1991
94998	Macquarie Island	54.5	158.9 E	00, 12	1950-1951, 1957-2000
89055	Marambio	64.2	56.7 E	00, 12	1982 – 2000
89564	Mawson	67.6	62.9 E	00, 12	1957-79, 1989-90, 1994-2000
89664	McMurdo	77.9	166.7 E	00, 12	1956 – 2000
89592	Mirny	66.5	93.0 E	00, 12	1957 – 2002
89542	Molodezhnaya	67.7	45.9 E	00, 12	1978 – 1998
89002	Neumayer	70.7	8.4 W	00, 12	1983 – 2001
89512	Novolazarevskaya	70.8	11.8 E	00, 12	1978 – 2002
89001	Sanae	70.3	2.4 W	00, 12	1985 – 1992
89532	Syowa	69.0	39.6 E	00, 12	1980 – 2000
89662	Terra Nova Bay	74.7	164.1 E	00, 12	1994 – 2000
89606	Vostok	78.5	106.9 E	00, 12	1980 – 1992

The annual temperature averages at the 500 hPa level and the corresponding linear trends above the Antarctic Peninsula are presented in Fig.7.1 and compared with such in the surface layer /18, 19/. At the 500 hPa level, a statistically significant (<1% significance level) warming of about 1.5 °C is observed for the period 1956-1999, comprising about 60% of the surface warming. The tendency for the tropospheric warming above the Antarctic Peninsula is in agreement with the change of the Antarctic Oscillation index (annular mode - AAO) /17/. The AAO index (see Fig.7.1) is based on the first main component of the geopotential field of the 850 hPa isobaric surface in the area between 20° to 90° S calculated from reanalysis data of NCEP/NCAR for each month over the period 1958-1997. The index values after 1997 were obtained by projection of the empirical orthogonal function structure to a monthly anomaly of the 850 hPa surface height.

Table 7.2

Number of upper-air soundings at Bellingshausen station (N – number of non-launches)

adopted from N.N. Kazakova

RAE	Year	Sounde type	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	N
14	1969	RKZ-2				3	28	12 14	17 8	17 10	131 2	29	25	28	27
15	1970	RKZ-2	31	28	28	24	2 27	15 9	16 9	14 17	3 22	30	29	30	30
16	1971	RKZ-2	30	27	31	30	2 27	21 9	25 5	12 16	27	30	30	30	14
17	1972	RKZ-2	29	29	31	30	31	30	30	31	30	31	30	24	1
18	1973	RKZ-2	29	28	29	29	26	29	28	30	28	28	26	31	27
19	1974	RKZ-2	31	25	30	28	29	27	26	29	29	30	29	31	24
20	1975	RKZ-2	31	27	31	28	31	30	31	31	29	30	30	31	5
21	1976	RKZ-5	31	29	31	30	31	30	30	31	30	31	30	31	1
22	1977	RKZ-5	31	28	31	30	31	30	31	31	30	31	30	31	-
23	1978	RKZ-5	31	29	31	30	31	28	31	31	30	31	30	31	2
24	1979	RKZ-5	31	28	29	29	30	30	31	31	30	31	30	31	4
25	1980	RKZ-5	8	29	31	30	16	-	10	31	30	31	30	31	89
26	1981	RKZ-5	31	28	31	30	30	30	29	30	30	30	29	31	7
27	1982	RKZ-5	31	28	31	30	31	30	31	31	30	30	30	31	1

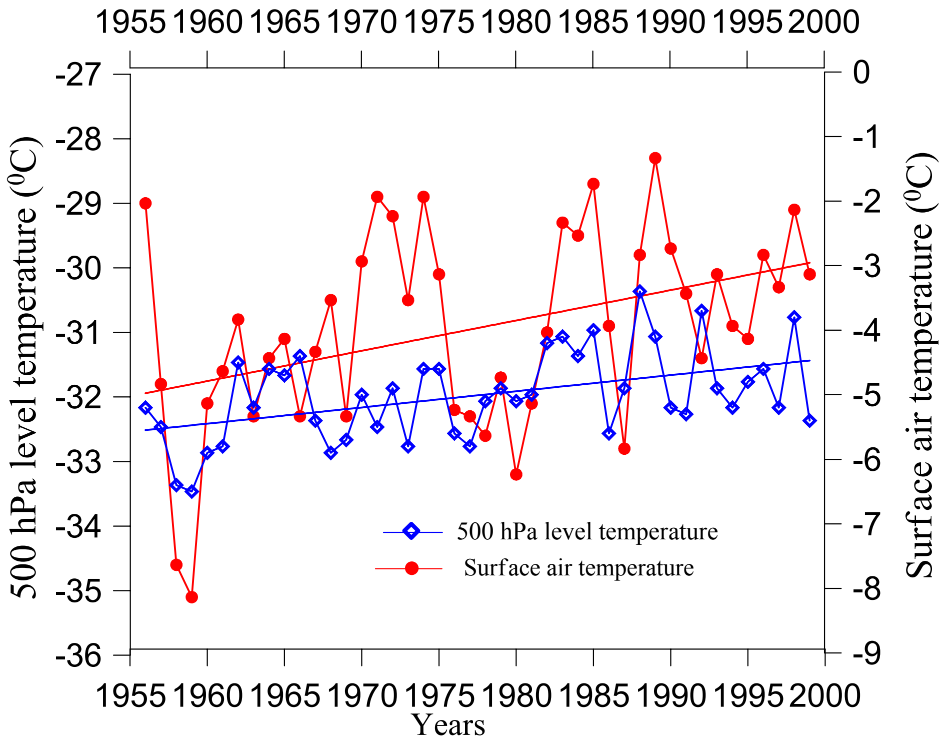
Table 7.2 (Continued)

28	1983	RKZ-5	31	27	31	30	31	30	30	30	30	31	30	31	3
29	1984	RKZ-5	30	29	31	30	29	30	30	31	30	31	30	31	3
30	1985	RKZ-5	29	28	31	29	30	30	30	31	29	31	30	30	7
31	1986	RKZ-5	31	28	31	30	30	30	31	31	30	31	30	31	1

32	1987	RKZ-5, MARZ-2-2	31	28	31	30	31	30	31	31	30	31	30	31	-
33	1988	MARZ-2-2	31	29	28	30	31	28	30	30	30	31	30	31	7
34	1989	MARZ-2-2	31	28	29	29	31	28	30	31	29	30	30	22	17
35	1990	MARZ-2-2	29	28	30	28	30	25	30	30	29	31	29	22	25
36	1991	MRZ-3A	7	-	30	29	30	28	28	31	29	27	29	28	69
37	1992	MRZ-3A	31	31	32	34	34	33	27	30	28	33	32	29	15
38	1993	MRZ-3A	30	28	31	30	31	29	31	30	30	30	30	31	3
39	1994	MRZ-3A	31	23	31	30	29	26	30	31	30	31	30	31	12
40	1995	MRZ-3A	31	28	22	30	29	30	29	31	30	31	30	31	13
41	1996	MRZ-3A	30	29	31	30	25	30	29	30	30	31	28	-	43
42	1997	MRZ-3A	-	-	-	-	-	-	-	-	-	-	13	31	-
43	1998	MRZ-3A	31	28	31	30	31	30	31	31	30	31	30	31	-
44	1999	MRZ-3A	31												-

Note: in 1969-1971, along with the RKZ-3 soundes, launches of actinometric soundes (ARZ) were made, their number being presented in the upper line for the corresponding month

The coincidence of the tendencies of the interannual variability of the dynamic AAO index and the thermal regime parameters of the atmosphere above the Antarctic Peninsula indicates that the pronounced regional warming can be related to the prevailing changes in the circulation conditions in the Southern Hemisphere. A possible role of the oceanic processes in the formation of surface warming above the Antarctic Peninsula is discussed in /3/.



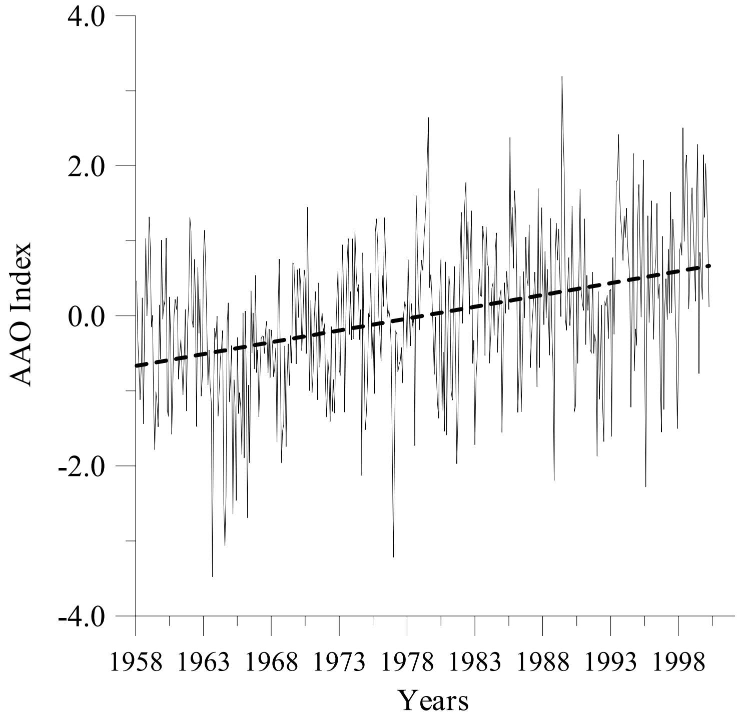


Fig.7.1. Interannual air temperature changes above the Antarctic Peninsula near the underlying surface (circles) and at the 500 hPa level (diamonds) over the period 1956-2000 (upper figure) / 18, 19 / and temporal change of monthly averages of the Antarctic Oscillation index (AAO) over the period 1958-2000 from data / 23 / (bottom figure)

Figure 7.2 presents inter- and intra-annual air temperature changes averaged for Faraday, Bellingshausen and Marambio stations at the 100 hPa level. As follows from the analysis of Fig. 7.2, during the last decade of the 20th century, the average temperature in the lower stratosphere above the Antarctic Peninsula has decreased by 4 - 5 °C in the autumn-summer months in comparison with the conditions of the 1970s- 1980s, which is accompanied by the total ozone decrease in the region recorded at Faraday/Akademik Vernadsky stations. For mean annual conditions, the temperature trend for the period 1956-1999 comprises -0.06 ± 0.08 °C $year^{-1}$ being statistically insignificant. In the summer season, a negative temperature trend (-0.07 ± 0.07 °C $year^{-1}$) is statistically significant at the 10 % significance level being twice as much as the corresponding value for the winter season (-0.03 ± 0.04 °C $year^{-1}$). The aforementioned cooling in the lower stratosphere (at the level of 150–100 hPa) is probably related to the changed radiation forcing due to the decreased ozone content and increased carbon dioxide concentration.

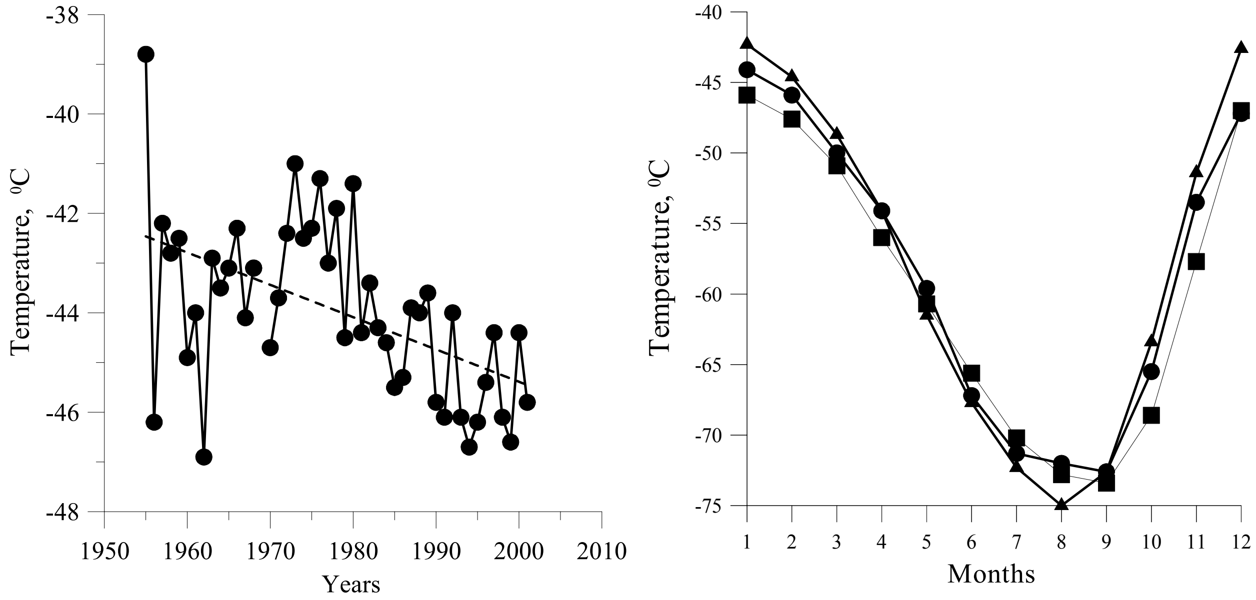


Fig. 7.2. Interannual air temperature changes averaged for Faraday, Bellingshausen and Marambio stations at the 100 hPa level for January (left-hand figure) and multiyear annual temperature variations (right-hand figure) for three decades: 1971-1980 (triangles), 1981-1990 (circles) and 1991-2000 (squares)

Fig. 7.3(a) presents averaged vertical air temperature profiles above Bellingshausen station for the central months of each season over the entire period of instrumental measurements (1969-1999). As can be seen in Fig. 7.3(a), the amplitude of the annual temperature variations in the stratosphere is around 45 degrees while the temperature distribution in the troposphere in logarithmic coordinates is linear (see the right-hand side of Fig. 7.3(a)). The latter peculiarity of the temperature profile gives grounds for choosing the vertical coordinate in the regional climate model of Antarctica.

For a quantitative explanation of the seasonal air temperature variations in the stratosphere, especially the formation of strong summer inversion, it is necessary to assess a relative contribution of radiation heating, dynamic factors and the ozone genesis processes /2, 10/. This has become possible in recent years due to construction of three-dimensional models of the general atmospheric circulation with interactive description of photochemical processes /4, 20/.

East Antarctica

In the troposphere of East Antarctica, no statistically significant climatic changes in the temperature field were recorded. The peculiarities of the surface warming of the atmosphere in the area of the Schirmacher Oasis where the Russian Novolazarevskaya and the Indian Maitri stations are located are set forth in /11, 14/. For the last forty years including the year 2000, insignificant warming in the surface layer is observed here in all seasons and months of the year except for May. This warming becomes significant only at the annual temperature averaging.

The thermal regime parameters of the free atmosphere are demonstrated in Fig. 7.3 (b). When plotting Fig.7.3(b), all sounding times were taken into account.

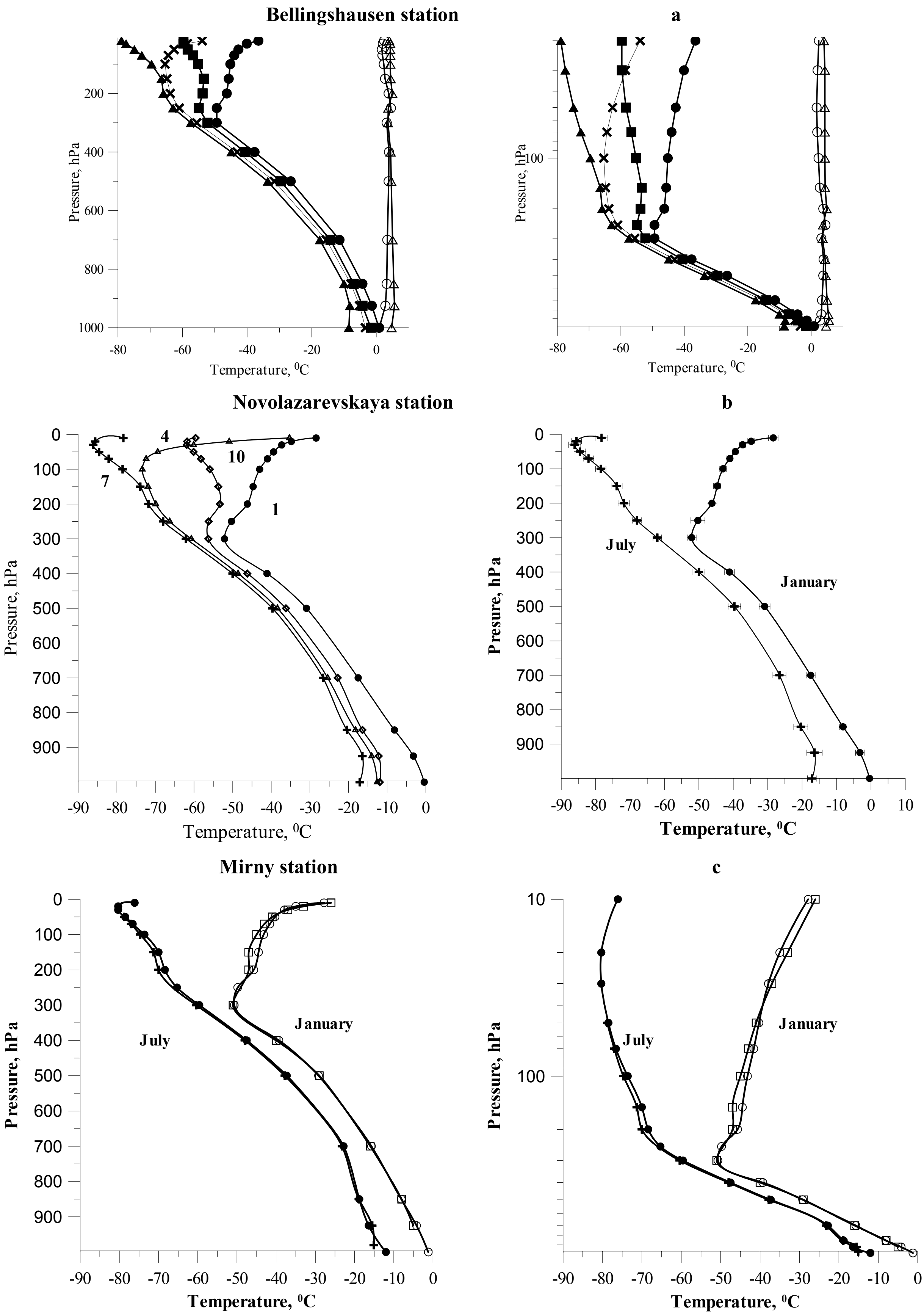


Fig. 7.3. Vertical air temperature distribution above the Russian Antarctic stations

a) Bellingshausen station: averaged temperature profiles for January (circles), April (squares), July (triangles) and October (crosses) for the entire period of instrumental measurements (1969-1999). White circles and triangles denote the values of RMS deviations of air temperature for January and July, respectively.

b) Novolazarevskaya station: averaged vertical temperature profiles for the central months of the seasons (left-hand side, Arabic figures – numbers of the months) and the temperature variability range in January and July (right-hand side, straight line segments – RMS deviations) for mean multiyear conditions over the period 1964-2000.
c) Mirny station: averaged temperature profiles for January (white circles) and July (black circles) over the period 1957-2000 in comparison with 2000 data (squares and crosses, respectively). The axis of right-hand figures (a, c) is given at the logarithmic scale.

The typical features of the intra-annual air temperature change (from winter to summer) at the coastal Antarctic Novolazarevskaya station include:

- formation of a strong temperature inversion in the lower stratosphere;
- more significant amplitude of annual oscillations greater than 60 degrees in the 30-100 hPa layer compared to the sub-Antarctic island Bellingshausen station;
- pronounced mean multiyear temperature maximum above the tropopause (below - 80^0 C).

At the oldest Russian Antarctic Mirny station, the upper-air sounding is conducted from 1956. As follows from Fig. 7.3(c), in 2000, the air temperature distribution above Mirny station in the troposphere did not practically differ from a mean multiyear profile with warming observed in the lower stratosphere and cooling in the middle stratosphere, as compared with averages for the measurement period although the indicated deviations are not statistically significant.

Temporal temperature variations at the 850 hPa level in the data of Mirny station over the last 20-year period are shown in Figure 7.4, which demonstrates a complicated quasi-cyclic structure of interannual temperature fluctuations. The indicated interannual variability structure can be related to semi-annual fluctuations and the El-Nino – South Oscillation phenomenon since the extreme winter and summer temperatures typically fall on the years of anomalous development of El-Nino.

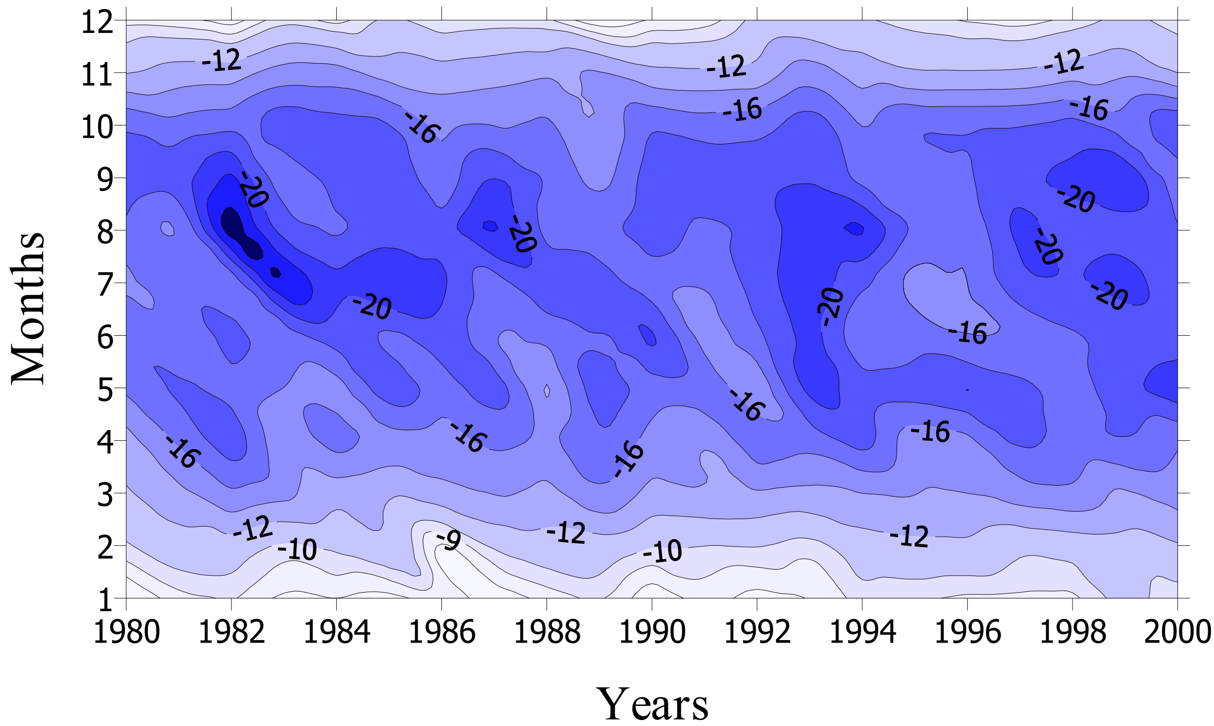


Fig. 7.4. Interannual air temperature changes at the 850 hPa level at Mirny station over the period 1980-2000

The aforementioned examples of the analysis of upper air sounding data at the Russian and foreign Antarctic stations indicate the need for resuming upper-air observations at Bellingshausen station (for instance with the help of the Antarctic community), which should be supplemented by total ozone measurements and diagnosis of polar stratospheric clouds on whose ice crystals the chloride bearing compounds destroying the ozone molecules are deposited. This will allow us to continue monitoring of the largest warming tendency in the troposphere in the Southern Hemisphere and trace the ozone layer evolution.

Organization of access to the database on climate of the Southern Polar Area

Data presented in this section have been already prepared for putting and have been partly put to Internet (http://www.aari.nw.ru/projects/Antarctica/stations). Such information serves as a quantitative basis for preparation of the section of the Handbook On Antarctic Climate devoted to the regime of the troposphere and stratosphere of the Southern Polar Area.

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8. MAIN EVENTS OF RAE ACTIVITY IN THE FIRST QUARTER OF 2002

January 1, 2002	Bellingshausen station transferred to the 47th RAE wintering team. Fandeyev N.P. turning over his duties to Sakharov O.S.
January 2, 2002	Traverse dispatched from Vostok station on one DT-30P transporter for studies under the Program of Radio Echo Sounding of Lake Vostok. Four people participate in the traverse. A reserve diesel power station delivered to the airfield of Novolazarevskaya station for support of aircraft flight and prepared for operation.
January 6, 2002	DT-30 No. 6 transporter departing Vostok station for supporting the research traverse.
January 6, 2002	Work for preparation of the runway and equipment to receive aircraft at Novolazarevskaya station. A reserve diesel power station delivered to the airfield. Departure of the traverse to the barrier (two vehicles and four people) to deliver the aviation fuel to the station.
January 7, 2002	Work on preparation and testing of the fuel pipeline for the seasonal supply operations at Mirny station.
January 9, 2002	According to the Plan of implementing the Protocol on Environmental Protection to the Antarctic Treaty, more than 500 t of waste of station life activity loaded onboard the British ship “Anne Bye” charted by the ecological organization “Mission of Antarctic” for utilization outside the Antarctic in Montevideo. The waste was collected in the course of a 4-year cycle of work.
January 10, 2002	Repair of two heavy transport vehicles completed at Mirny station.
January 10, 2002	Delivery by the traverse from the oil base at the Lazarev Sea barrier to Novolazarevskaya station of 45 m^3 of aviation kerosene for support of aviation flights.
January 12, 2002	Departure from Vostok station of a sledge-caterpillar traverse comprised of 7 vehicles and 12 people to Mirny station.
January 16, 2002	Geophysical traverse to Vostok station completed; a radio-echo sounding of lake Vostok over 774 km conducted.
January 20, 2002	Visit of the Director of the Indian National Center of Antarctic Research Dr. Pandi with accompanying persons to Novolazarevskaya station.
January 23, 2002	Flight from St. Petersburg to Vostok station of the 47th RAE wintering team of 12 persons headed by the RAE Head Lukin V.V.
January 24, 2002	Flight from St. Petersburg to Novolazarevskaya station of the 47th RAE seasonal team. Preparation of the runway and repair of two administration-living houses at Novolazarevskaya station completed.
January 26, 2002	A cross was established at Bellingshausen station at the hill in the place allocated for the construction of an orthodox church with a liturgy for all Russians perished in the Antarctic. Flight of a group of 11 persons including a priest, an architect and representatives of mass media to Punta Arenas by Chilean Air Force aircraft. Visit to Maitri station of Russian polar explorers from Novolazarevskaya station invited to the celebration of the Day of the Republic of India.
January 27, 2002	DS-3 aircraft operating under the Program of a Joint Scandinavian Expedition landing at the airfield of Novolazarevskaya station.
January 30, 2002	IL-76-TD aircraft from Cape Town operating under the Program of a Joint Scandinavian Expedition landing at the airfield of Novolazarevskaya station. The airplane delivered 7 people of the 47th seasonal RAE. Taking onboard the polar explorers from Aboa, Wasa and Troll Bases, the airplane flew back on February 3. The 47th RAE wintering team arrived to Vostok station.

February 1, 2002	Vostok station transferred to the new wintering team headed by Bolshakov V.S. with Sazikov V.S. turning over his duties. Start of preparation of containers with supplies for the 47^{th} RAE in St. Petersburg for shipment to Cape Town by ships on the line .
February 4, 2002	Flight from Vostok station of 16 persons of the wintering and seasonal teams by aircraft C-130
February 6, 2002	Start of work of the geological team of 5 people in the temporary field camp in the western area of the Schirmacher Oasis.
February 10, 2002	Implementation of a system of measures on energy saving, temporary closing down of the mess-room house at Vostok station.
February 11, 2002	Completing the program of seasonal geological activities in the western area of the Schirmacher Oasis.
February 11, 2002, February 12, 2002	Arrival of the 47^{th} seasonal and 46^{th} wintering expedition participants (in two groups) from Vostok station to St. Petersburg airport.
February 15-19, 2002	Stay at Bellingshausen station of the Russian yacht “Apostle Andrey” making circumnavigation.
February 23, 2002	Arrival to Mirny station of the sledge-caterpillar traverse from Vostok station, start of repair and technical maintenance of vehicles. Departure of planned traverse to the Lazarev Sea barrier from Novolazarevskaya station for fuel resupply.
March 1, 2002	Return of planned traverse to Novolazarevskaya station from the Lazarev Sea barrier; tanks prepared for receiving fuel from the supply vessel.
March 7, 2002	Work on reconstruction of the diesel electric station fuel tanks at Bellingshausen station completed.
March 8, 2002	Departure of the preparatory traverse from Mirny station to the 97^{th} km of the Mirny-Vostok route.
March 11, 2002	At Mirny station the technician-mechanic Stepanov S.F. was urgently operated for hernia.
March 14, 2002	The work of the R/V “Akademik Karpinsky” in the study area in the eastern Cosmonauts Sea completed, ship transit to the study area in the Riiser-Larsen Sea .
March 15, 2002	Arrival of the MV “Grigory Mikheyev” to Bellingshausen station, conduct of loading operations. Departure of 4 people of the wintering team, 10 people of seasonal team and 9 volunteers from the station. Eight winterers headed by Sakharov O.S. left at the station.
March 25, 2002	Revision conducted by polar explorers at Mirny station and preparation fromof the base of fuel-lubricating materials at Stroiteley island for receiving fuel. Installation and starting new diesel-generator at Vostok station.