FEDERAL SERVICE OF RUSSIA FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING

Russian Federation State Research Center

Arctic and Antarctic Research Institute

Russian Antarctic Expedition

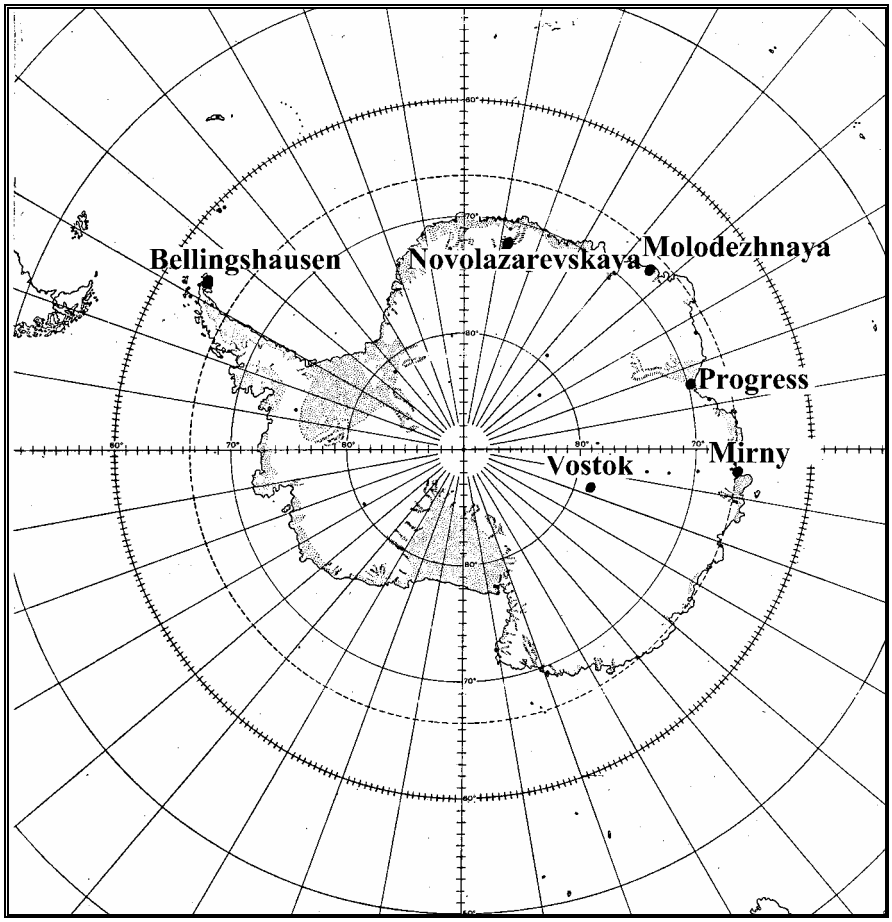
QUARTERLY BULLETIN

№3 (20)

July - September 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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CONTENTS

PREFACE……...1

1. DATA OF AEROMETEOROLOGICAL OBSERVATIONS AT THE RUSSIAN ANTARCTIC STATIONS……...3
2. METEOROLOGICAL CONDITIONS IN JULY-SEPTEMBER 2002 ……18
3. REWIEW OF THE ATMOSPHERIC PROCESSES ABOVE THE ANTARCTIC IN JULY-SEPTEMBER 2002……24
4. BRIEF REVIEW OF ICE PROCESSES IN THE SOUTHERN OCEAN IN JULY-SEPTEMBER 2002……27
5. TOTAL OZONE MEASUREMENTS AT MIRNY STATION IN THE THIRD QUARTER OF 2002……...28
6. GEOPHYSICAL OBSERVATIONS AT RUSSIAN ANTARCTIC STATIONS IN JULY –SEPTEMBER 2002……..29
7. STUDY OF THE ENERGY EXCHANGE BETWEEN THE ATMOSPHERE AND THE UNDERLYING AT BELLINGSHAUSEN STATION……37
8. MAIN RAE EVENTS IN THE THIRD QUARTER OF 2002……..44

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 has been issued on a quarterly basis from 1998.

Section I of this issue contains monthly averages of standard meteorological and solar radiation observations and upper-air sounding for the third quarter of 2002.

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

The atmospheric pressure values in the meteorological tables are referenced to sea level for 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 contain 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 recommended by the World Meteorological Organization.

The Bulletin contains brief overviews with an assessment of the natural 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 in the Southern Ocean (Section 4) is performed using satellite data received at the Bellingshausen, Novolazarevskaya and Mirny stations and observations conducted at the coastal Bellingshausen and Mirny stations. The anomalous character of ice conditions is evaluated in comparison with multiyear averages of the drifting ice edge location and multiyear averages of 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 Ice Regime and Forecasting Department over the period 1971-1995.

Section 5 presents an overview of total ozone (TO) based on measurements at the Russian stations.

Data of geophysical observations published in the Bulletin (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 observations at Vostok station.

Sections 7 presents some results of the seasonal experiments carried out by the IFA group of the Russian Academy of Science (RAS) under the program of studies of the thermal interaction of the atmosphere with the underlying surface.

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

Russian Antarctic stations in operation in July - September 2002

MIRNY OBSERVATORY

STATION SYNOPTIC INDEX	**89592**
METEOROLOGICAL SITE HEIGHT ABOVE SEA LEVEL	**39.9 m**
GEOGRAPHICAL COORDINATES	**φ = 66°33′ S; λ = 93°01′ E**
GEOMAGNETIC COORDINATES	**Φ = -76.8°; Δ = 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	**φ = 70°46′ S; λ = 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	**φ = 62°12′ S; λ = 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	**φ = 78°27′ S; λ = 106°52′ E**
GEOMAGNETIC COORDINATES	**Φ = -89.3°; Δ = 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	**φ = 69°23′ S; λ = 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

JULY 2002

MIRNY OBSERVATORY

Table 1.1

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

July 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	1011.3	961.9	0.6	0.1	
Air temperature, °C	-13.7	-5	-28.1	3	1.2	
Relative humidity, %	76			1.8	0.4	
Total cloudiness (sky coverage), tenths	7.6			0.9	0.8	
Lower cloudiness(sky coverage),tenths	5.3			2.3	1.5	
Precipitation, mm	48.4			-21.7	-0.4	0.7
Mean wind speed, m/s	13.1	24		0.4	0.3	
Prevailing wind direction, deg	158					
Total radiation, MJ/m^2	9			0.0	0.0	1.0
Total ozone content (TO), DU						

Table 1.2

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

July 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
983	53	-13.6	3.8					
925	512	-12.9	6.2	89	15	99	1	1
850	1153	-16.0	5.7	85	13	97	1	1
700	2603	-21.4	6.1	75	8	77	1	1
500	5012	-35.9	5.5	40	5	48	1	1
400	6529	-46.1	4.7	18	6	49	1	1
300	8385	-59.3	4.2	357	9	58	1	1
200	10850	-68.7	3.9	326	8	64	1	1
150	12574	-68.8	4.3	294	10	86	1	1
100	14983	-72.1	4.4	277	16	94	1	1
70	17066	-74.4	4.4	273	24	96	2	3
50	19023	-76.4	4.8	268	33	97	7	8
30	22042	-75.6	5.4	266	49	97	14	9
20	24511	-73.8	6.5	262	64	97	17	9

Table 1.3

Anomalies of standard isobaric surface heights and temperature

July 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	42	0.9	3.2	1.5
700	54	1.0	1.8	1.0
500	72	1.0	1.8	1.0
400	82	1.1	1.8	1.1
300	91	1.1	0.6	0.5
200	87	1.0	-0.4	-0.3
150	92	1.0	0.8	0.6
100	104	1.0	1.0	0.6
70	120	1.0	1.7	0.8
50	123	0.9	1.5	0.6
30	200	1.3	3.6	1.2
20	327	1.9	4.7	1.3

NOVOLAZAREVSKAYA STATION

Table 1.4

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

July 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	986.5	1005.8	965.7	-1.1	-0.2	
Air temperature, °C	-12.8	-6.6	-23.3	4.5	1.7	
Relative humidity, %	46			-4.4	-0.6	
Total cloudiness (sky coverage), tenths	7.9			2.4	1.7	
Lower cloudiness(sky coverage),tenths	2.2			1.1	1.2	
Precipitation, mm	83			44.7	1.0	2.2
Mean wind speed, m/s	15	34		4.4	1.9	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	1			-1.2	-0.5	0.4
Total ozone content (TO), DU						

Table 1.5

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

July 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	-12.9	9.7					
925	519	-13.6	7.4	110	18	98	2	2
850	1154	-18.5	6.2	101	19	98	2	2
700	2577	-25.7	4.5	91	12	87	2	2
500	4949	-39.0	5.0	77	7	56	2	2
400	6444	-48.9	4.6	57	5	41	2	2
300	8280	-60.1	4.2	30	4	26	2	2
200	10738	-69.5	3.9	326	4	41	2	2
150	12444	-70.9	3.9	294	7	66	2	2
100	14827	-74.1	3.9	279	11	81	2	2
70	16886	-76.4	3.8	278	16	85	2	2
50	18822	-77.2	3.9	274	23	87	5	5
30	21762	-74.1	4.3	268	33	86	12	9
20	24123	-71.9		268	43	87	22	9

Table 1.6

Anomalies of standard isobaric surface heights and temperature

July 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	25	0.6	2.5	1.4
700	30	0.7	1.6	0.8
500	39	0.7	1.2	0.8
400	46	0.7	1.5	1.0
300	55	0.8	2.1	1.9
200	75	1.0	2.0	1.3
150	91	1.2	2.6	1.9
100	127	1.6	3.7	2.6
70	170	2.0	5.1	3.6
50	204	2.8	6.7	3.8
30	329	2.6	11.3	6.5
20	510	4.0	13.5	6.6

BELLINGSHAUSEN STATION

Table 1.7

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

July 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	995.5	1012.9	956.2	1.6	0.3	
Air temperature, °C	-6.7	0.3	-17.8	-0.1	0.0	
Relative humidity, %	89			0.6	0.2	
Total cloudiness (sky coverage), tenths	9.4			1	1.7	
Lower cloudiness(sky coverage),tenths	7.6			0.5	0.5	
Precipitation, mm	76.6			23.6	0.9	1.4
Mean wind speed, m/s	6.3	18		-1.1	-0.8	
Prevailing wind direction, deg	180					
Total radiation, MJ/m^2	23.6			-0.4	-0.1	1.0

VOSTOK STATION

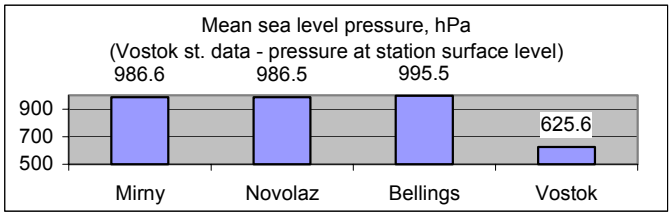
Table 1.8

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

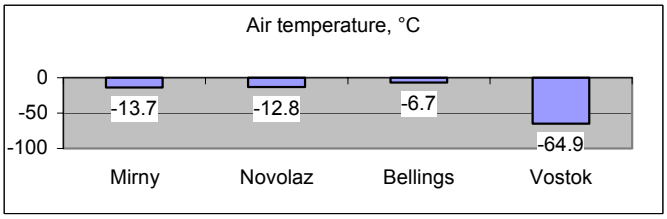
July 2002

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	625.6	642	607.5	4.5	0.7	
Air temperature, °C	-64.9	-41.4	-75	2.2	0.8	
Relative humidity, %	54			-14.6	-3.4	
Total cloudiness (sky coverage), tenths	2			-0.8	-0.8	
Lower cloudiness(sky coverage),tenths	0			0	0.0	
Precipitation, mm	4			0.8	0.3	1.3
Mean wind speed, m/s	4.7	12		-1	-1.1	
Prevailing wind direction, deg	225					
Total radiation, MJ/m^2	Polar night					
Total ozone content (TO), DU						

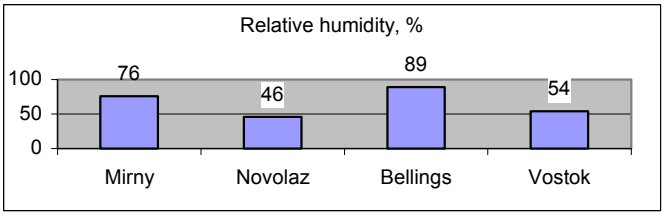
July 2002



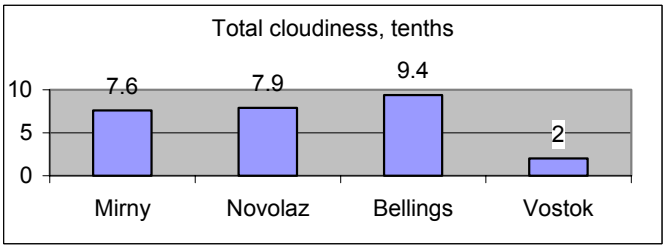
$(f-f_{avg})/\sigma_f$ 0.1 -0.2 0.3 0.7



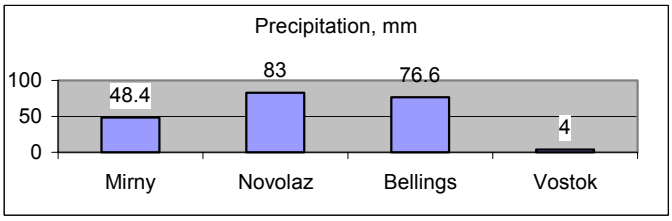
$(f-f_{avg})/\sigma_f$ 1.2 1.7 0.0 0.8



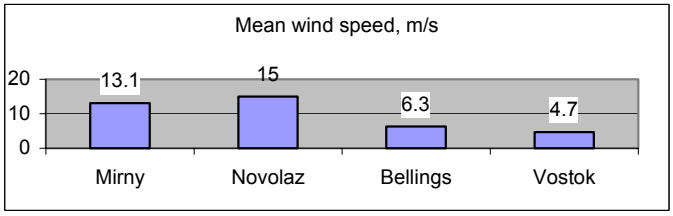
$(f-f_{avg})/\sigma_f$ 0.4 -0.6 0.2 -3.4



$(f-f_{avg})/\sigma_f$ 0.8 1.7 1.7 -0.8



f/f_{avg} 0.7 2.2 1.4 1.3



$(f-f_{avg})/\sigma_f$ 0.3 1.9 -0.8 -1.1

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

AUGUST 2002

MIRNY OBSERVATORY

Table 1.9

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

August 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	977.3	995.4	955.8	-7.1	-1.2	
Air temperature, ^{0}C	-17.5	-6.1	-28.2	-0.3	-0.1	
Relative humidity, %	71			-2	-0.5	
Total cloudiness (sky coverage), tenths	6.8			0.1	0.1	
Lower cloudiness(sky coverage),tenths	4.2			1.4	1.1	
Precipitation, mm	33.8			-33.6	-0.7	0.5
Mean wind speed, m/s	11.4	25		-1.5	-0.9	
Prevailing wind direction, deg	158					
Total radiation, MJ/m^2	74			7.6	1.2	1.1
Total ozone content (TO), DU	293	446	179			

Table 1.10

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

August 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
971	53	-17.5	4.1					
925	419	-16.5	5.5	94	12	97	0	0
850	1245	-19.6	4.6	87	10	96	0	0
700	2644	-23.2	5.7	73	4	62	0	0
500	4875	-38.3	5.8	33	3	32	0	0
400	6377	-48.1	5.3	348	1	13	0	0
300	8221	-59.7	4.7	295	2	17	0	0
200	10703	-66.3	4.7	281	9	66	0	0
150	12442	-67.5	4.8	279	15	87	0	0
100	14869	-69.2	5.2	280	24	93	0	0
70	16998	-69.3	5.6	281	34	95	0	0
50	19016	-67.9	5.8	284	44	95	1	1
30	22105	-67.1	6.5	285	61	96	7	8
20	24651	-64.2	7.8	281	67	97	13	9
10	28030	-55.7		30	0			

Table 1.11

Anomalies of standard isobaric surface heights and temperature

August 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	150	3.5	0.2	0.1
700	110	1.9	0.4	0.2
500	-49	-0.6	-0.3	-0.1
400	-56	-0.6	0.1	0.1
300	-49	-0.5	0.8	0.5
200	-30	-0.3	4.1	2.0
150	14	0.1	5.0	2.1
100	81	0.7	5.9	2.0
70	155	1.0	7.5	2.0
50	210	1.2	9.2	1.9
30	348	1.4	9.0	1.4
20	510	1.5	9.1	1.2
10	-405	-0.6	5.2	0.4

NOVOLAZAREVSKAYA STATION

Table 1.12

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

August 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	983.8	1008.3	966.5	-2.7	-0.5	
Air temperature, ^{0}C	-16.1	-6	-27.8	2.2	0.9	
Relative humidity, %	41			-9.7	-1.3	
Total cloudiness (sky coverage), tenths	7.4			2	1.5	
Lower cloudiness(sky coverage),tenths	1.2			0.3	0.4	
Precipitation, mm	4.2			-38.2	-0.8	0.1
Mean wind speed, m/s	10.5	22		-0.1	0.0	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	3.2			-1.9	-0.4	0.9
Total ozone content (TO), DU						

Table 1.13

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

August 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
969	122	-15.7	11.1					
925	477	-14.7	11.4	116	12	96	2	2
850	1111	-18.8	11.2	106	12	92	2	2
700	2532	-25.6	8.5	121	7	80	2	3
500	4912	-38.1	6.0	172	3	36	2	2
400	6412	-48.3	5.4	206	4	40	3	2
300	8250	-60.6	4.9	224	6	48	3	2
200	10690	-72.0	4.4	240	9	63	2	2
150	12370	-74.5	4.4	253	10	73	3	4
100	14706	-78.2	4.4	256	12	78	4	4
70	16710	-80.5	4.0	269	16	84	5	6
50	18609	-80.5	3.8	272	20	86	6	6
30	21473	-78.2	5.2	285	23	86	22	9
20	24000	-63.7	7.0	330	40	99	30	9

Table 1.14

Anomalies of standard isobaric surface heights and temperature

August 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	-2	0.0	3.1	1.6
700	7	0.1	2.2	1.1
500	30	0.4	2.8	1.9
400	45	0.6	2.7	2.0
300	62	0.7	2.0	2.1
200	69	0.7	0.5	0.4
150	70	0.7	1.0	0.7
100	78	0.8	1.0	0.7
70	49	0.4	1.2	0.7
50	40	0.3	2.5	1.2
30	38	0.2	4.6	1.7
20	293	1.4	16.9	4.9

BELLINGSHAUSEN STATION

Table 1.15

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

August 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	999.4	1024.2	974.6	7.4	1.2	
Air temperature, ^{0}C	-4.7	1	-14.4	2	0.8	
Relative humidity, %	87			-0.9	-0.3	
Total cloudiness (sky coverage), tenths	8.9			0.4	0.8	
Lower cloudiness(sky coverage),tenths	8.4			1.2	1.2	
Precipitation, mm	25.8			-42.4	-1.2	0.4
Mean wind speed, m/s	6.6	21		-1.2	-1.3	
Prevailing wind direction, deg	315					
Total radiation, MJ/m^2	80.9			-5.1	-0.6	0.9

VOSTOK STATION

Table 1.16

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

August 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	614.3	627.5	603.9	-5.3	-0.7	
Air temperature, ^{0}C	-71.5	-57.5	-80.3	-3.5	-0.9	
Relative humidity, %	54			-14.6	-3.5	
Total cloudiness (sky coverage), tenths	1.8			-1.6	-1.5	
Lower cloudiness(sky coverage),tenths	0			0	0.0	
Precipitation, mm	0			-3.1	-0.8	0.0
Mean wind speed, m/s	3.7	7		-1.9	-2.4	
Prevailing wind direction, deg	225					
Total radiation, MJ/m^2	5			3.4	2.0	2.7
Total ozone content (TO), DU						

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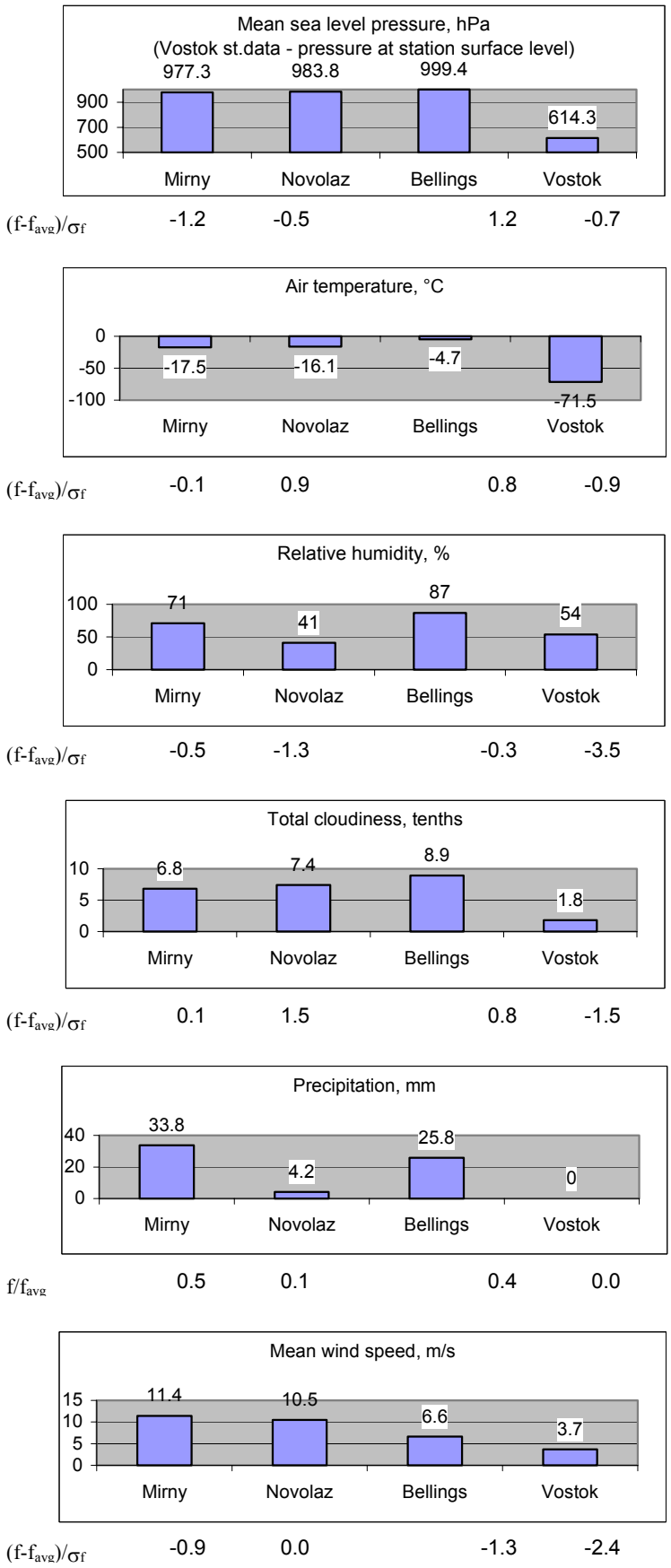


Fig. 1.2. Comparison of monthly averages of meteorological parameters at the stations, August 2002.

SEPTEMBER 2002

MIRNY OBSERVATORY

Table 1.17

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

September 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	984.4	1000.6	964.8	2.3	0.5	
Air temperature, ^{0}C	-15.5	-7.1	-27.6	1.2	0.5	
Relative humidity, %	73			1.6	0.3	
Total cloudiness (sky coverage), tenths	6.8			0.3	0.3	
Lower cloudiness(sky coverage),tenths	3.8			1	0.8	
Precipitation, mm	48.8			-12.1	-0.2	0.8
Mean wind speed, m/s	13.3	28		1.2	0.8	
Prevailing wind direction, deg	112					
Total radiation, MJ/m^2	219			-3.6	-0.2	1.0
Total ozone content (TO), DU	382	445	225			

Table 1.18

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

September 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
978	53	-16.0	4.0					
925	469	-15.9	5.7	94	16	99	0	0
850	1102	-19.2	4.8	86	16	98	0	0
700	2538	-23.1	5.7	81	8	72	0	0
500	4939	-36.9	6.6	107	2	17	0	0
400	6452	-46.3	5.3	177	1	7	0	0
300	8315	-56.7	4.7	260	4	21	0	0
200	10853	-59.3	5.0	284	12	61	0	0
150	12661	-57.9	5.7	287	20	78	0	0
100	15237	-54.0	6.7	291	30	82	2	2
70	17542	-49.6	8.7	294	39	82	3	3
50	19765	-45.7	10.7	294	45	83	3	4
30	23234	-40.9	13.7	298	48	82	4	5
20	26020	-38.2	15.8	299	50	80	7	9

Table 1.19

Anomalies of standard isobaric surface heights and temperature

September 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	13	0.3	-0.1	0.0
700	11	0.3	0.1	0.1
500	17	0.3	0.8	0.5
400	26	0.4	1.8	1.1
300	41	0.6	3.3	2.6
200	118	1.4	9.9	5.5
150	214	2.4	12.6	5.3
100	392	4.5	16.4	4.5
70	583	5.7	19.1	3.7
50	761	5.4	20.7	3.4
30	1091	4.7	19.9	2.9
20	1301	3.7	16.8	2.2

NOVOLAZAREVSKAYA STATION

Table 1.20

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

September 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	984.6	1006.5	944.1	0.4	0.1	
Air temperature, ^{0}C	-15.7	-7.1	-27.6	1.5	0.8	
Relative humidity, %	47			-4.1	-0.6	
Total cloudiness (sky coverage), tenths	7.3			1.9	1.9	
Lower cloudiness(sky coverage),tenths	2			1.2	1.3	
Precipitation, mm	90.5			45.4	0.8	2.0
Mean wind speed, m/s	11.3	36		1.4	0.7	
Prevailing wind direction, deg	135					
Total radiation, MJ/m^2	169			-4.8	-0.3	1.0
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)

September 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
970	122	-16.5	10.2					
925	488	-16.6	9.8	111	14	96	4	5
850	1116	-21.4	8.8	100	14	92	4	4
700	2526	-28.2	6.3	92	8	68	4	4
500	4874	-40.9	5.6	95	1	9	4	4
400	6359	-49.8	5.3	226	2	17	4	4
300	8191	-60.2	5.0	231	6	41	4	4
200	10661	-66.7	4.9	237	9	64	5	5
150	12384	-69.3	4.8	242	11	73	6	6
100	14776	-72.7	4.6	247	14	75	7	7
70	16863	-72.0	4.8	251	17	77	7	7
50	18853	-70.0	5.0	253	20	77	8	8
30	21969	-63.1	5.2	256	19	64	14	9
20	24633	-50.7	8.6	20				

Table 1.22

Anomalies of standard isobaric surface heights and temperature

September 2002

P, hPa	$H-H_{avg}$, m	$(H-H_{avg})/\sigma_H$	$T-T_{avg}$, °C	$(T-T_{avg})/\sigma_T$
850	15	0.4	-0.3	-0.2
700	10	0.2	-0.8	-0.6
500	-7	-0.1	-0.8	-0.7
400	-11	-0.2	0.5	0.5
300	-7	-0.1	1.8	1.6
200	26	0.4	5.6	3.5
150	69	1.0	5.6	3.3
100	120	1.6	4.6	2.4
70	168	1.8	6.2	2.7
50	220	1.9	8.2	2.7
30	363	2.0	11.9	2.9
20	571	2.0	18.1	3.2

BELLINGSHAUSEN STATION

Table 1.23

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

September 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	1003.1	1022.3	970.7	12	3.5	
Air temperature, ^{0}C	-3.3	5.4	-15.3	1.1	0.6	
Relative humidity, %	92			3.3	1.3	
Total cloudiness (sky coverage), tenths	9.7			0.9	1.8	
Lower cloudiness(sky coverage),tenths	8.1			0.2	0.3	
Precipitation, mm	50.6			-12.2	-0.6	0.8
Mean wind speed, m/s	6.6	19		-1.4	-1.4	
Prevailing wind direction, deg	158					
Total radiation, MJ/m^2	176.3			-37.7	-2.1	0.8

VOSTOK STATION

Table 1.24

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

September 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	623.4	632.4	616.7	5.4	1.2	
Air temperature, ^{0}C	-67.9	-55.2	-79.2	-2.2	-0.6	
Relative humidity, %	54			-15	-3.5	
Total cloudiness (sky coverage), tenths	2.5			-1.4	-1.4	
Lower cloudiness(sky coverage),tenths	0			-0.1	-0.5	
Precipitation, mm	0			-3	-1.1	0.0
Mean wind speed, m/s	1.1	8		-4.4	-4.9	
Prevailing wind direction, deg	225					
Total radiation, MJ/m^2	111			11.5	1.0	1.1
Total ozone content (TO), DU	*					

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

September 2002

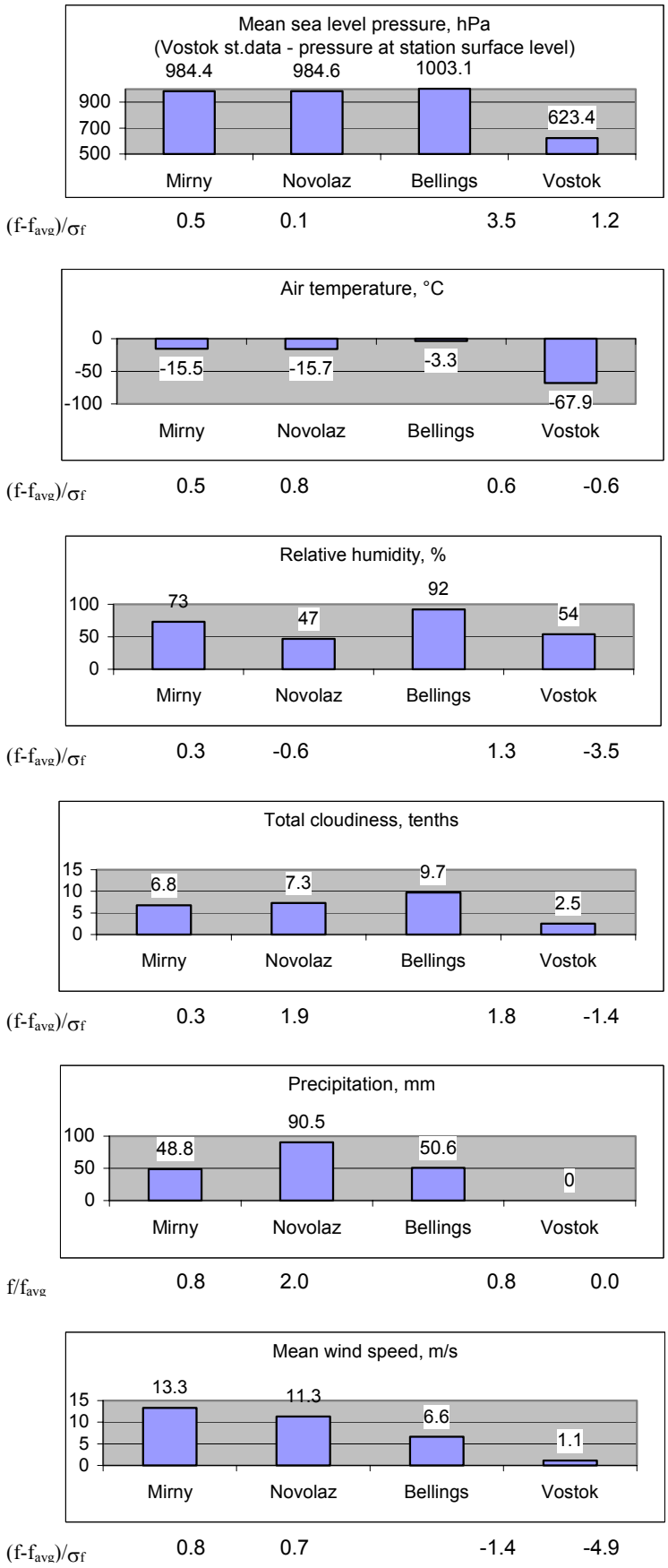


Fig. 1.3. Comparison of monthly averages of meteorological parameters at the stations, September 2002.

2. METEOROLOGICAL CONDITIONS IN JULY-SEPTEMBER 2002

In July-September 2002, both the above and below zero small temperature anomalies close to 1 σ were observed at Bellingshausen, Mirny and Vostok stations were preserved. The Novolazarevskaya station differed from the other stations by a large heat anomaly in July with the normalized temperature anomaly comprising 1.7 σ. In the interannual temperature variations, July 2002 at Novolazarevskaya station was the fourth in the rank of warm years.

Figure 2.1 characterizes the temperature conditions in July-September over the entire continent. It presents the monthly averages and the absolute and normalized surface temperature anomalies at the Russian and non-Russian meteorological stations. The actual data contained in /1/ and multiyear averages over the period 1961-1990 contained in /2/ were used. One can see that in July-September the observed tendency for the dominance in the territory of Antarctica of extensive heat sources from early 2002 was preserved. In July and September, the above zero temperature anomalies covered the central part of the mainland and almost the entire coast of East Antarctica. The heat source center in July was located in the Polar Plateau area. At Amundsen-Scott station, July 2002 was the warmest July for the entire observation period from 1957 at the mean monthly air temperature of -53.4^o C and the anomaly of 2.5σ. Large temperature anomalies were also observed at the Atlantic coast in the area of the Queen Maud Land (Novolazarevskaya and Syowa stations). The temperature anomaly at these stations was 4.5^o C (1.7σ).

In August, the territory occupied with positive anomalies was observed to decrease. Small (not more than 1σ) negative anomalies were observed in the zone of the Indian Ocean coast of East Antarctica, in the Ross Sea area and in the southwestern part of the Antarctic Peninsula.

In September, the heat anomalies were almost twice as small, but they were observed in the same vast territory. In the coastal Pacific zone in these months, there were small negative temperature anomalies.

An assessment of long-period changes in mean monthly air temperature at the Russian stations in these months detects a statistically significant trend at Novolazarevskaya (July, September) and Bellingshausen (August) stations (Fig. 2.2-2.4). The temperature increase was 3.4^o C and 1.9^o C for July and September from 1961 at Novolazarevskaya station and 2.8^{o}C at Bellingshausen station for August (from 1968).

Table 2.1

Linear trend parameters of mean monthly surface air temperature

Stations	Parameter	VII	VIII	IX	VII	VIII	IX
		Entire observation period			1992-2002 period		
Novolazarevskaya, 1961-2002	^{o}C/1 year	0.80	0.05	0.45	1.47	-1.01	-1.41
	%	36.7	2.5	26.8	17.6	20.3	19.7
	P	95	-	90	-	-	-
Mirny, 1957-2002	^{o}C/1 year	0.23	0.16	0.45	3.42	1.28	0.15
	%	11.8	7.2	23.1	41.7	17.1	2.1
	P	-	-	-	-	-	-
Vostok, 1957-2002	^{o}C/1 year	-0.09	0.05	-0.23	3.71	-0.13	-0.63
	%	3.9	2.0	9.7	47.6	2.1	9.6
	P	-	-	-	-	-	-
Bellingshausen, 1968-2002	^{o}C/1 year	0.38	0.80	-0.07	0.92	1.34	-0.46
	%	13.3	34.4	4.0	11.8	17.6	7.3
	P	-	95	-	-	-	-

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).

During the last decade, no statistically significant linear temperature trend was observed at the Russian stations.

The atmospheric pressure during the months under consideration almost at all Russian stations was close to a multiyear average. Small positive anomalies in July and September and negative in August were recorded except for Bellingshausen station. In September, the mean monthly pressure at this station was equal to 1003.1 hPa with the anomaly comprising 12.0 hPa (3.6 σ). Such a high atmospheric pressure in September was recorded at this station for the first time over the entire observation period from 1968.

In multiyear variations of atmospheric pressure at the Russian stations, the tendency for the pressure decrease in July and August was preserved. At the 95% confidence level, the negative trend was observed at Novolazarevskaya (July) and Mirny (August) stations and a positive – at Vostok station (September). In 1993-2002, statistically significant trends are observed in the interannual variations of atmospheric pressure for August at Vostok (negative) and for September at Bellingshausen (positive) stations.

During the months under consideration, abundant precipitation was recorded at the Russian stations in July (Bellingshausen, Novolazarevskaya and Vostok) and in September (Novolazarevskaya). In July and September, precipitation in the area of Novolazarevskaya was twice as high as a multiyear average (in July 1973 and in September 1971, the amount of precipitation was approximately 4 times as high as a multiyear average). In August, the amount of precipitation at all Russian stations was less than a multiyear average. Following the tendencies in multiyear changes of the sums of precipitation at the Russian stations in the months under consideration, it is noted that the tendency for a decrease in the amount of precipitation fallout predominates.

References:

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

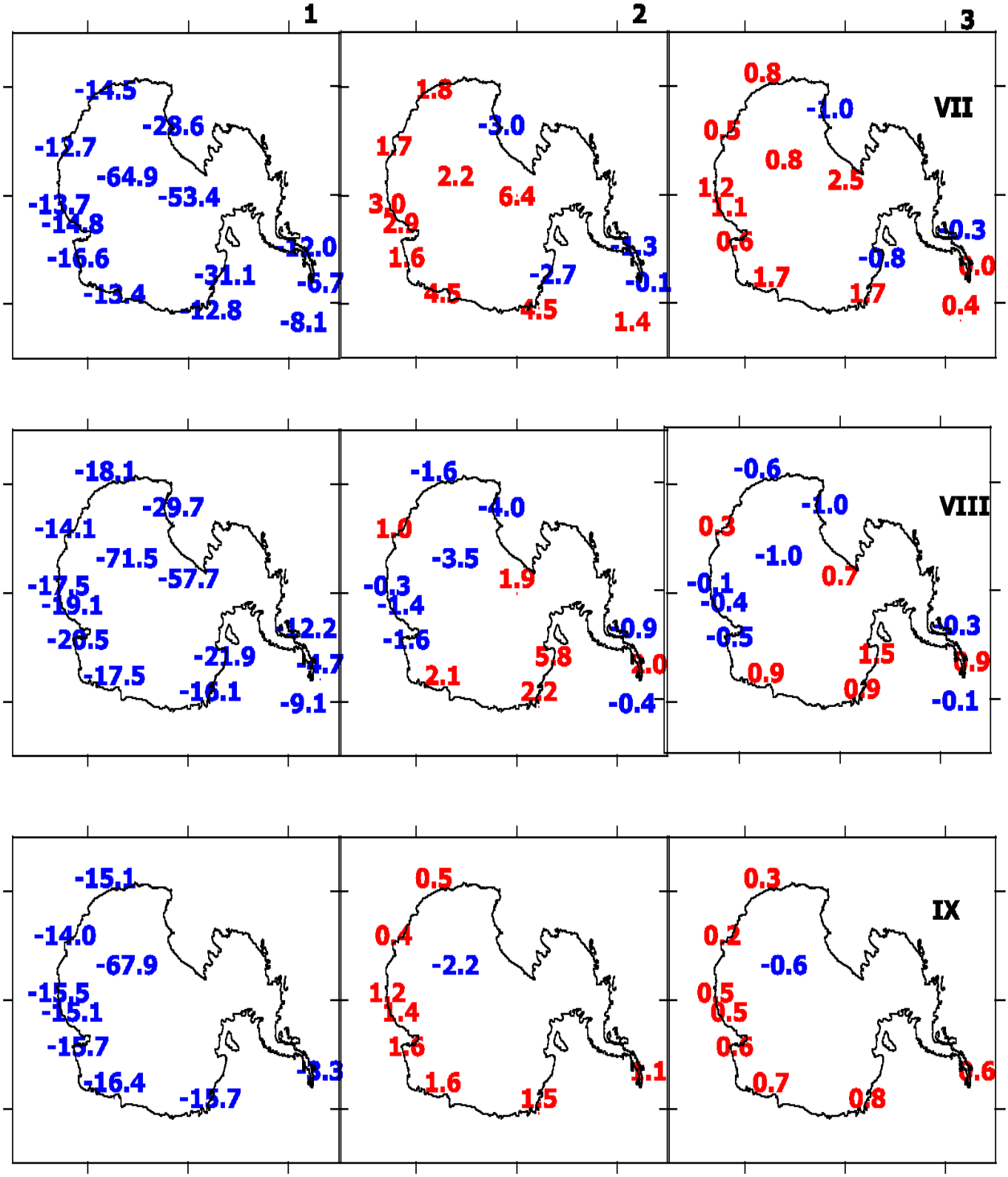


Fig. 2.1. Surface air temperatures (1) and their absolute (2) and normalized (3) anomalies in July (VII), August (VIII) and September (IX) 2002 based on data of stationary meteorological stations in the Southern Polar Area.

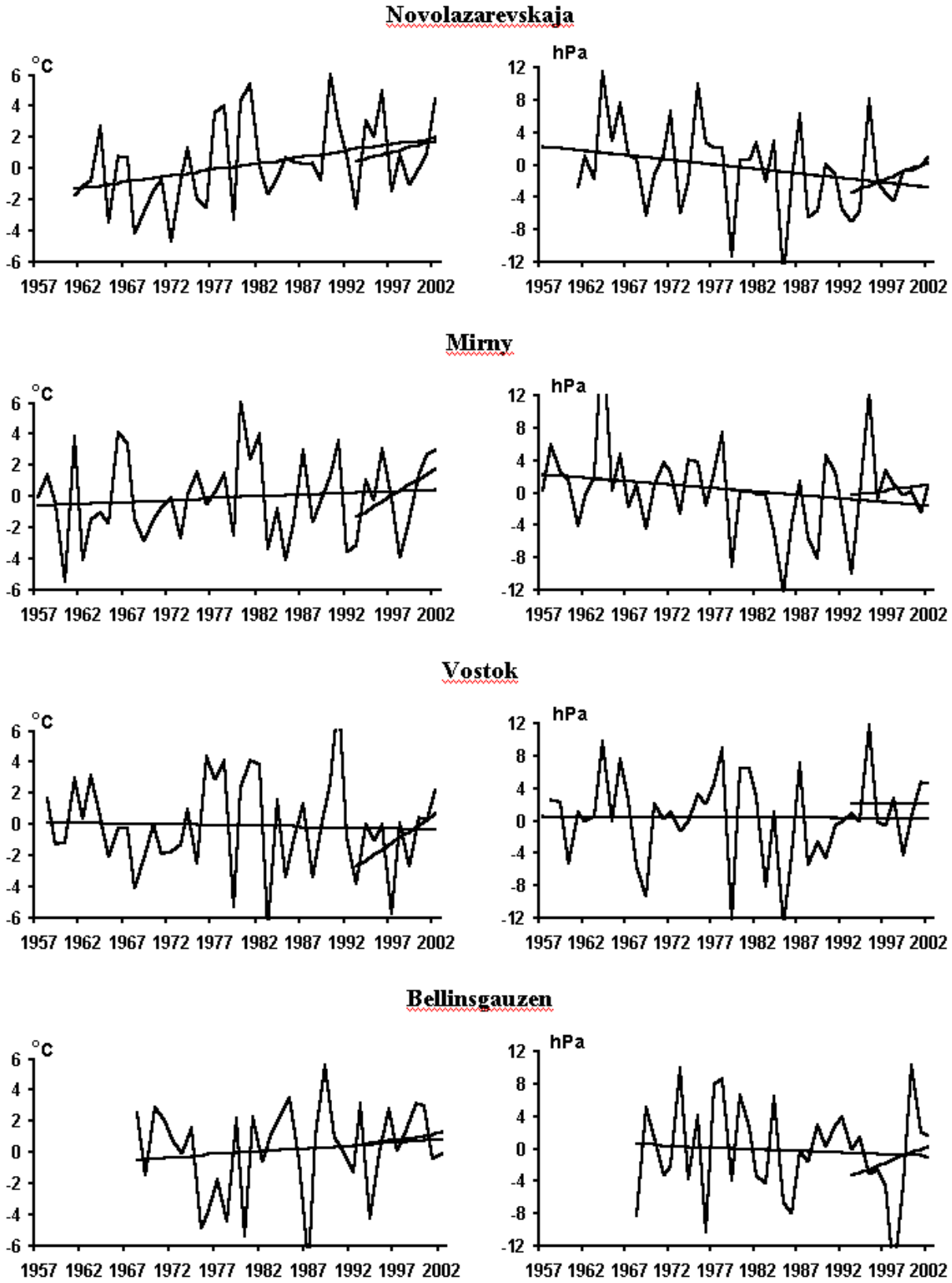


Fig. 2.2. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. July.

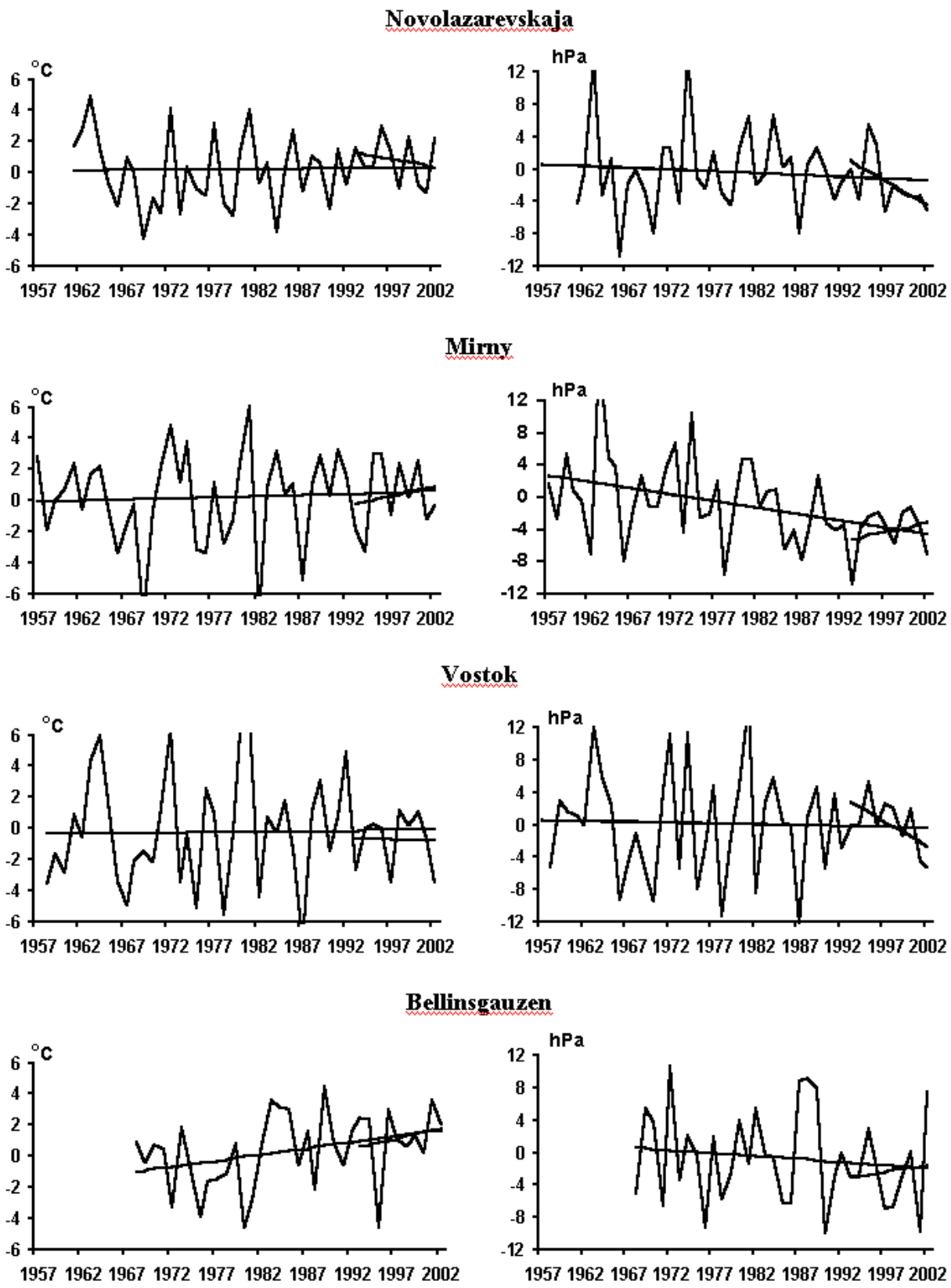


Fig. 2.3. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. August.

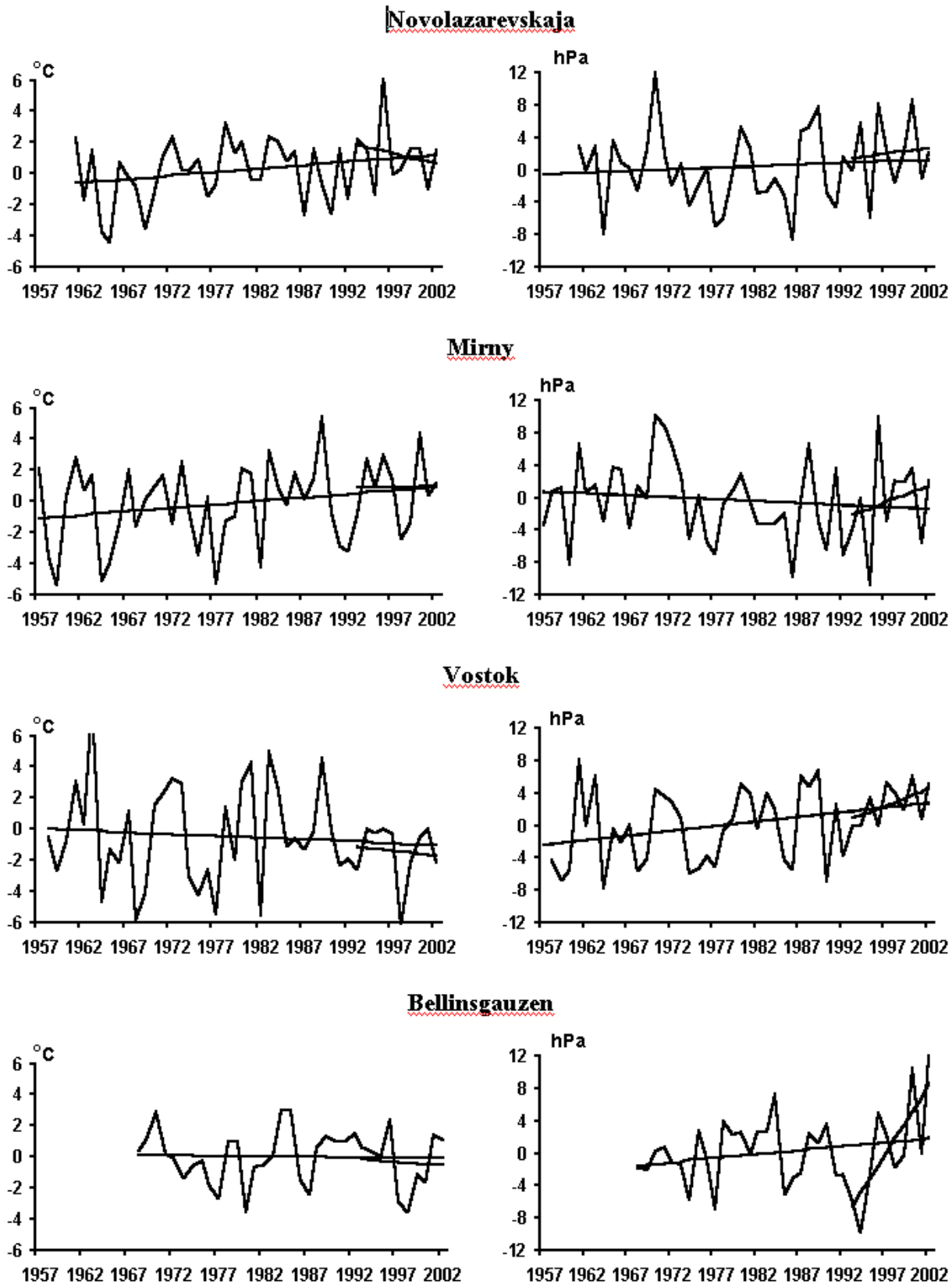


Fig. 2.4. Interannual variations of air temperature and atmospheric pressure anomalies at the Russian Antarctic stations. September.

3. REVIEW OF THE ATMOSPHERIC PROCESSES ABOVE THE ANTARCTIC IN JULY-SEPTEMBER 2002

The 2002 winter period in the Antarctic was characterized by the decreased intensity of the zonal processes. A pronounced west-east transport of the air masses at temperate and high latitudes of the Southern Hemisphere was rarely observed compared to multiyear data. The obstruction processes connected with meridional air flows were a typical feature of the pre-winter period continuing in June-September.

In July, the zonal processes (Z form) were observed only for 4 days (by 6 days less than a multiyear average). As a multiyear average, the values of the frequency of occurrence of Z, M_a and M_b forms of the atmospheric circulation reduced to a 30-year period (1964-1993) [4] were adopted. In July, the meridional circulation of M_a form was actively developed (17 days, which is 5 days greater compared to a multiyear average). The meridional form M_b has achieved a multiyear average in its development and even exceeded it (10 days, by 1 day greater). In the development of meridionality, cyclones moved along the western periphery of high pressure ridges to the Antarctic persisting frequently above the Weddell, Riiser-Larsen and Mawson Seas and less frequently above the Cosmonauts and Commonwealth Seas.

Table 3.1

Frequency of occurrence of the forms of atmospheric circulation in the Southern Hemisphere and its anomalies in July-September 2002

Month	Frequency of occurrence (days)			Anomalies (days)		
	VII	VIII	IX	VII	VIII	IX
Z	4	11	4	-6	-1	-8
M_a	17	13	14	5	2	3
M_b	10	7	12	1	-1	5

The West Atlantic and Kerguelen trajectories of cyclones were the most active. According to the field of pressure anomalies, the depression above the Weddell Sea was developed most of all with mean monthly pressure near the southeast coast being almost by 6 hPa less than a multiyear average. Due to the outflow of relatively warm air masses, an area of significant above zero temperature anomalies was formed in the frontal part of this depression above the extensive territories of the Queen Maud Land. The air temperature increase in the area of the Mawson Sea and Wilkes Land was less significant. An intense interlatitudinal air exchange and active cyclonic activity have resulted in the anomalous temperature increase at the inland stations (by 1-3°). The exits of the cyclones to the Antarctic coast were accompanied with wind increases and overcast weather with snowfalls and snow storms. Thus, at Novolazarevskaya station, the mean wind speed in July was higher than a multiyear average by more than 5 m/s with the number of days with snow and snow storms also much higher than a multiyear average (The authors of this review use multiyear averages obtained by a team of meteorologists and forecasters in /1/ using data of Russian and non-Russian stations from the time of opening of each of them prior to 1979).

In August, there was some increase of activity of zonal circulation, with its frequency of occurrence comprising 11 days. On the contrary, the frequency of occurrence of the processes of meridional forms has decreased becoming also close to a multiyear average (Table 3.1). In total, the number of days with the meridional processes was much greater than that of the zonal processes. The main feature of zonality was its high-latitudinal character and the comparatively restricted size of the cyclones slowly moving along the coastal zone. The Antarctic High was still distinguished by the decreased intensity. Similar to July, the increased background air temperature was mainly preserved at the coastal and inland stations, but the values of the above zero temperature anomalies were much lower than in July. In general, the atmospheric circulation and weather conditions in Antarctica were common for the middle of winter. This also refers to the conditions in the upper atmosphere where the development of the stratospheric vortex in August as well as in July was as usual. One notes only the increased impulsiveness and the change of the general westerly transport in some periods to SW and NW with significant temperature fluctuations at this. Thus, according to data of upper air sounding at Novolazarevskaya station, a temperature of -76° C, -83° C prevailed in the 15-20 km layer whereas during the periods August 2-3 and 12-14, the temperature has decreased to -86° C, -89° C with the increased southwesterly upper-air flows to 25-35 m/s.

In September, the dominance of the meridional forms for many months was reconstructed again (see Table 3.1). Zonality was noted only for 4 days whereas at the meridional processes, the ridges of subtropical Highs directed towards Antarctica developed as a rule above the western regions of the Atlantic and the Indian Oceans. An especially active anticyclogensis was observed above the South Atlantic where the high-pressure ridges spread far southward towards the western Weddell Sea and the Antarctic Peninsula. In these regions, large positive anomalies of mean monthly pressure comprising more than 10 hPa were recorded. Positive pressure anomalies were also observed at the dome, i.e. the Antarctic High in September was anomalously developed, which was reflected in the location of the prevailing trajectories of cyclones and in the areas of their persistence that were slightly more northward than usually. The cyclones

persisted most frequently above the northern margins of the Riiser-Larsen and Cosmonauts Seas and the Mawson and D'Urville Seas. A meridional outflow of relatively warm air masses to high latitudes has determined the formation of the above zero temperature anomalies in the coastal areas of the given seas. This refers to the Princess Ragnhild Coast and the Wilkes Land. Due to the anomalous development of the Antarctic High, an area of below zero temperature anomalies (about -2°C at Vostok station) was formed above the inland areas.

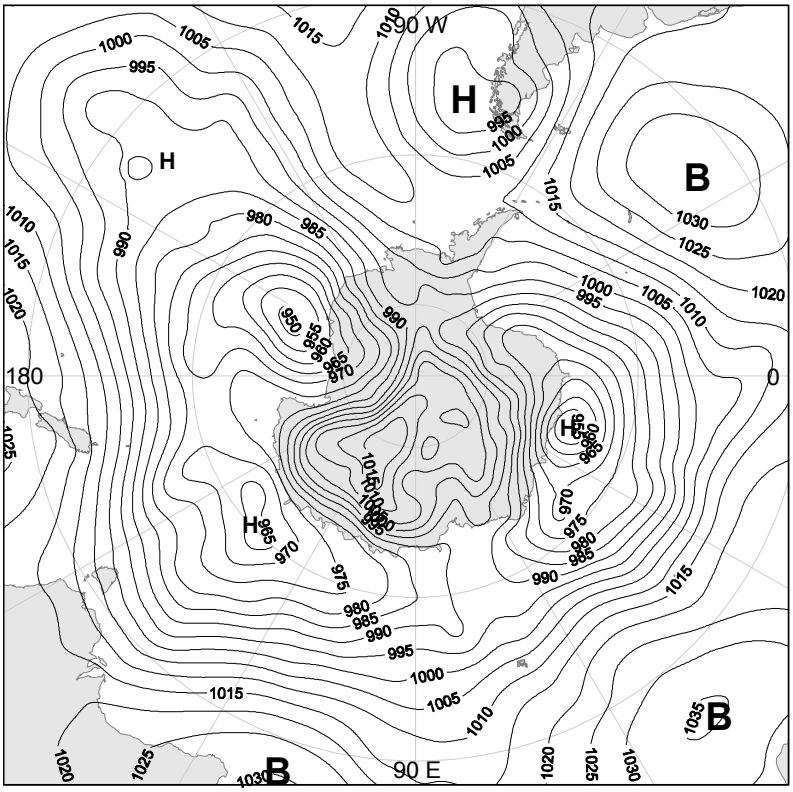
It is noted that the structure of the field of anomalies of mean monthly pressure looks closer to the M_b circulation form in spite of its smaller absolute frequency of occurrence compared to M_a form [2, 3]. The meridional processes of the M_b circulation form developed more intensely. The synoptic situation during the period September 15-17 can serve as an example when the centers of the West Atlantic and Indian Ocean Highs with the pressure at the centers of about 1030 hPa occupied an anomalously southern position (approximately 50° S and 35° S, respectively) while above the African sector of the Southern Ocean, an extensive deep multicentered depression was formed where the pressure dropped to 920 hPa (Fig. 3.1a). At the atmospheric fronts of this depression, generation of young active cyclones occurred. The coast of the Queen Maud Land was under the influence of the front. On September 16, an absolute minimum of the atmospheric pressure of 929.9 hPa was recorded at Novolazarevskaya station with the air temperature increasing to -7.1^o C. A prolonged snow storm was observed at the ESE wind of 30-35 m/s.

In the troposphere in the western-eastern circumpolar flow of the Southern Hemisphere, three long planetary waves were formed whose troughs were located in the zone of sub-Antarctic and temperate latitudes above the African sector of the Southern Ocean as well as above the Australian sector and the center of the Pacific sector (Fig. 3.1 b). In the central areas of these troughs, independent centers of the cyclonic circulation were formed. Thus, it can be considered that one circumpolar vortex of the Southern Hemisphere typical of the Z form processes has divided into 3 cells. The deepest and most significant in area was a cell above the African sector of the Antarctic. Such a character of the circumpolar vortex state is typical exactly of M_b form of the atmospheric circulation [3].

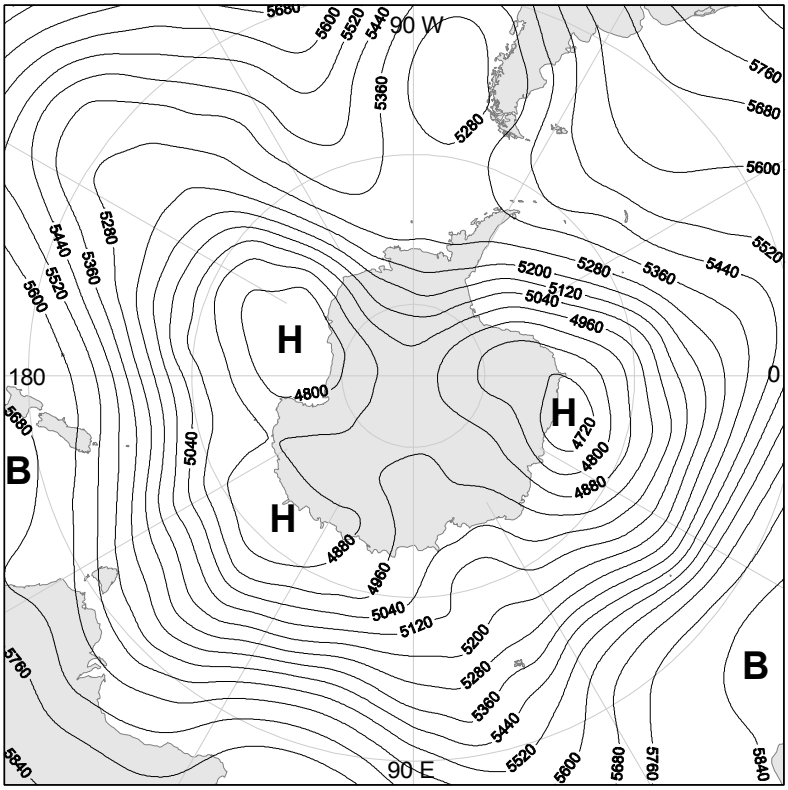
In the lower stratosphere at the background of typically winter circulation, one can note more frequent than usually perturbations of the westerly upper-air flow. On September 5-11 at heights of 15-30 km, the increased SW-NW winds up to 80-105 m/s were observed. The case of a dramatic (explosive) warming in the layer higher than 20 km from September 25 should be noted when the temperature has increased by 20-30° C. Thus, on September 28 at a height of about 30 km, a temperature of -19°C was recorded. A more complete picture of the processes in the upper layers of the atmosphere can be obtained by analyzing the materials of the entire network of the upper-air stations in the Southern Hemisphere after their processing.

References:

1. Hydrometeorological support for shipping in the Southern Ocean. Ed. By Korotkevich Ye.S. and Ryzhakov L.Yu. – L.: Gidrometeoizdat, 1985. – 184.
2. Dydina L.A., Rabtsevich S.V., Ryzhakov L.Yu., Savitsky G.B. Atmospheric circulation forms in the Southern Hemisphere. – AARI Proceedings, 1976, V. 330, p. 5-16.
3. Ryzhakov L.Yu. Some characteristics of the anomalous development of the atmospheric circulation forms in the Southern Hemisphere at the cold time of the year. – AARI Proceedings, 1976, V. 330, p. 17-29.
4. Ryzhakov L.Yu., Rabtsevich S.V. Results of developing a method of long-range meteorological forecasting for winter for the Antarctic // AARI Proceedings. – 1999. – V. 441 – p. 59-72.



a)



b)

Fig. 3.1. a) Mean surface pressure, September 15-17, 2002;
b) Mean H-500 hPa field, September 15-17, 2002.

4. BRIEF REVIEW OF ICE PROCESSES IN THE SOUTHERN OCEAN IN JULY-SEPTEMBER 2002

During this period, the intense expansion of the circumpolar sea ice belt that began in June after prolonged stabilizing in April-May, was continued (see review 4 for quarter 2 of 2001). This was promoted by the increased resulting export character of advection of the Antarctic ice cover due to a tendency of the active development of meridional forms of the atmospheric macro-processes that was observed in the southern polar area for many months.

As a result by September, the ice extent of the Southern Ocean in general has obviously achieved its usual mean multiyear values. The area of ice spreading in the Cosmonauts Sea and in the area between the Mawson Sea and the Dumont D'Urville Sea was slightly less than a multiyear average (Table 4.1) while the Balleny ice massif and the ice belt in the adjoining Ross Sea differed probably by the increased dimensions.

In the context of the above said, of interest is an almost complete reconstruction of the usual regime of development of ice processes in the vicinity of the Antarctic Peninsula, which was observed prior to the onset of the "warm" winter period from 1996. The fact of the increased duration of the ice period in the area of the South Shetland Islands to the previously common 5 months (Table 4.2) against 2-2.5 months for the last 6 years serves as an effective indirect confirmation of this, although the landfast ice remained poorly developed due to frequent breakups.

In conclusion, one should note a decreased intensity of the growth of second-year landfast ice in the Mirny Observatory area whose thickness practically corresponds to ordinary ice that was preserved throughout the entire autumn-winter period (Table 4.3).

Table 4.1

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

Meridians	Actual	Multiyear average
50º E	60.1	59.1
60º E	59.3	59.3
70º E	59.3	59.1
80º E	58.2	58.3
90º E	60.0	59.5
100º E	-	59.9
110º E	61.4	60.6
120º E	62.2	61.3
130º E	62.8	61.9
140º E	61.9	62.3

Table 4.2

Dates of the onset of main ice phases in the areas of Bellingshausen field base (Ardley Bay) in winter of 2002

	Ice formation		Landfast ice formation		Freeze up		Landfast ice breakup		Ice clearance	
	First	Stable	First	Stable	First	Final	Start	End	First	Final
Actual	07.06	07.06	08.06	08.09	NO	NO	15.10	30.10	31.10	03.11
Multiyear average	09.05	08.06	11.06	13.06	03.07	07.07	10.09	09.10	12.10	05.11

Note: NO – Phenomenon not observed (has not yet occurred)

Table 4.3

Average landfast ice thickness (cm) and snow depth (cm) on landfast ice in the area of Mirny Observatory from profile measurement data in July-September 2002

	Ice			Snow		
Months	VII	VIII	IX	VII	VIII	IX
Actual	105	123	142	21	22	18
Multiyear average	101	119	137			

5. TOTAL OZONE MEASUREMENTS AT MIRNY STATION IN THE THIRD QUARTER OF 2002

Observations of total ozone (TO) after the end of polar night began on July 31 at Mirny station, on September 10 at Vostok station and on September 28, 2002 at Novolazarevskaya station. Since data of Vostok station appear to be unreliable requiring additional analysis and observations at Novolazarevskaya station began only in late September, this overview is restricted to the analysis of the results of measurements only at Mirny station.

During the polar night, the total ozone in Mirny not only did not decrease but also even slightly increased compared to April and May (monthly averages of 273 Dobson units and 254 Dobson units, respectively) comprising 293 Dobson units in August. It is noted that such a high monthly average of the ozone concentration in August was last observed a decade ago in 1992. A monthly average of TO in September was even higher – 382 Dobson units, i.e., the ozone level was almost equal to Mirny values in spring in the 1970s. At the same time (see Fig. 5.1), in the third quarter there were very dramatic oscillations in August ranging from 179 Dobson units on August 7 to 446 Dobson units on August 31, and in September – from 225 Dobson units on September 8 to 452 Dobson units on September 23. Such oscillations could be probably attributed to the Changed character of the atmospheric circulation in August after a significant displacement of the stratospheric vortex and its deformation in late July (see a review of the atmospheric processes in section 3 of this issue). The activity and the frequency of occurrence of the zonal circulation have also increased while the Antarctic High has attenuated. In the middle of the month with decreasing temperature, the lowest TO values were observed in the stratosphere. In September, the tendency of the dominance of the meridional circulation forms for many months was reconstructed that was manifested in sharp ozone concentration fluctuations at Mirny station.

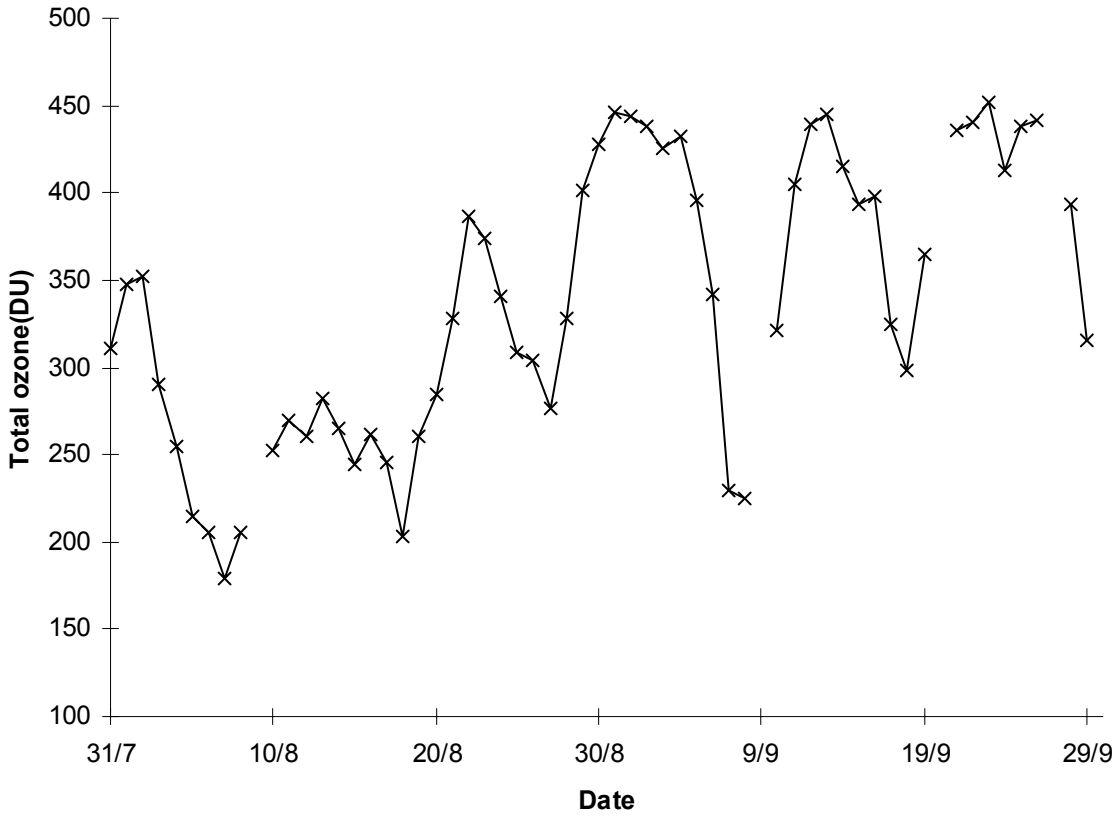


Fig. 5.1 Total ozone daily averages at Mirny station in the third quarter of 2002

6. GEOPHYSICAL OBSERVATIONS AT RUSSIAN ANTARCTIC STATIONS IN JULY-SEPTEMBER 2002

MIRNY OBSERVATORY

Mean monthly absolute geomagnetic field values

	July	*August*	*September*
Declination	*86.53.5.W*	*87.01.6.W*	*86.52.6.W*
Horizontal component	*13875 nT*	*13877 nT*	*13829 nT*
Vertical component	*-57504 nT*	*-57526 nT*	*-57557 nT*

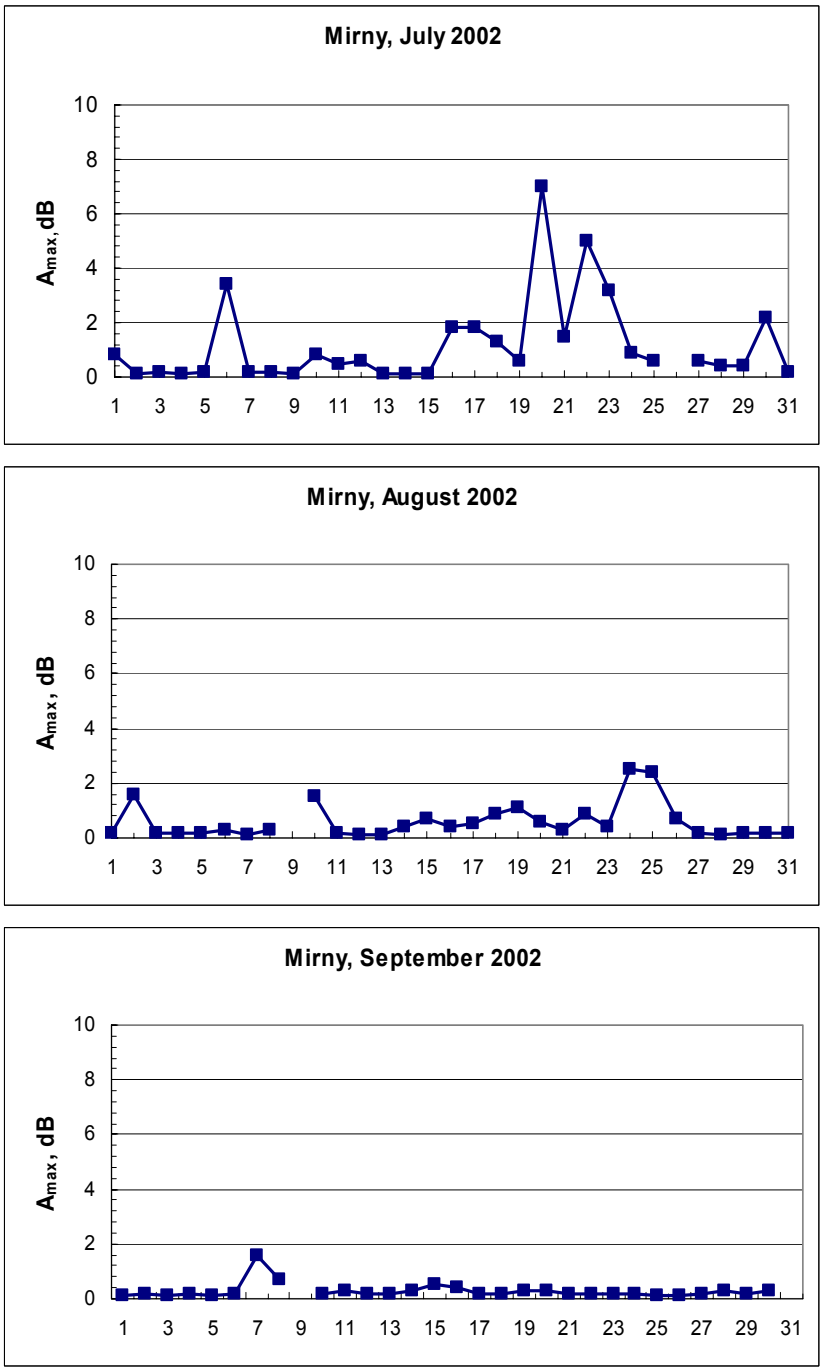


Fig. 6.1. Maximum daily space radio-emission absorption at the 32 MHz frequency from riometer observations in Mirny Observatory.

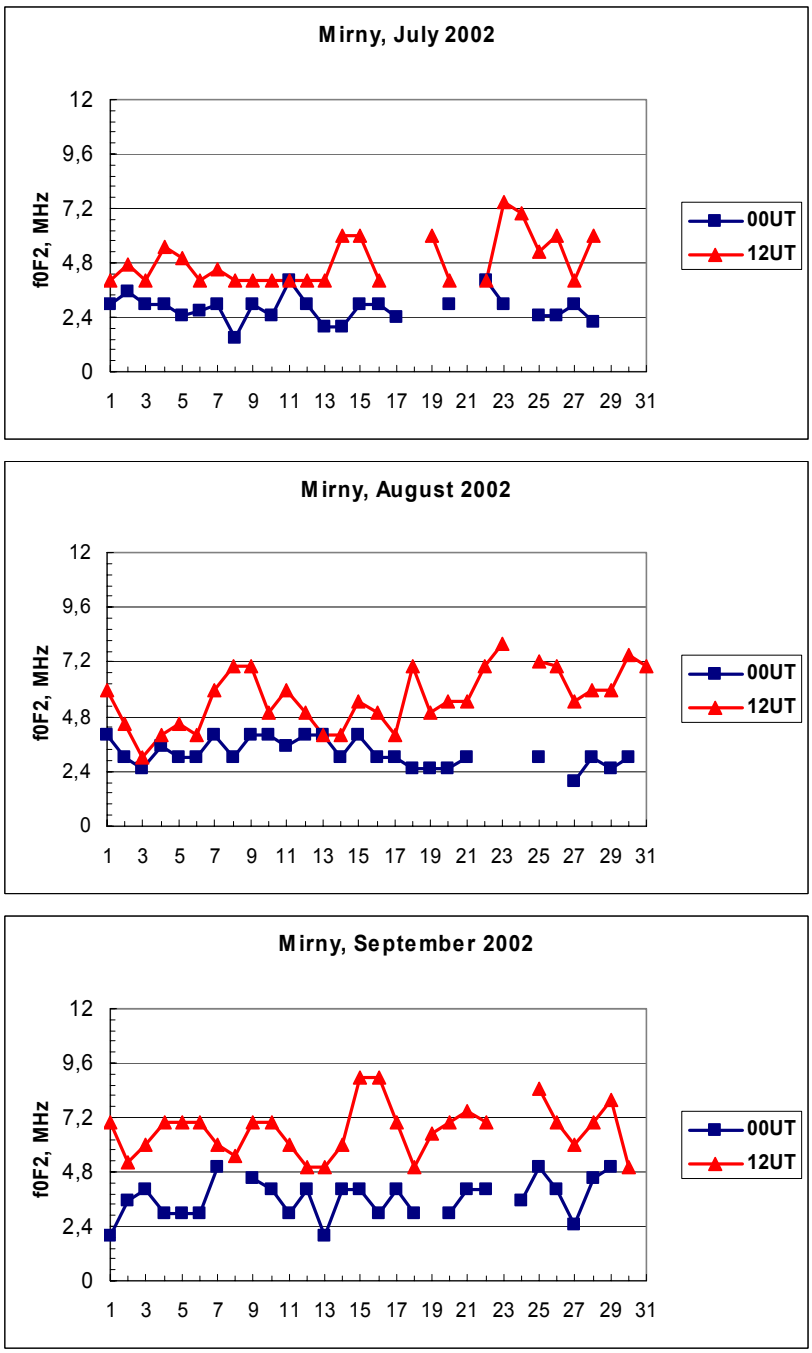


Fig. 6.2. Daily variations of critical frequencies of the F2 (f0F2) layer in Mirny Observatory.

VOSTOK STATION

Mean monthly absolute geomagnetic field values

	July	*August*	*September*
Declination	*121.05.55.W*	*121.06.31.W*	*121.08.61.W*
Horizontal component	*13441 nT*	*13488 nT*	*13485 nT*
Vertical component	*-58129 nT*	*-58132 nT*	*-58134 nT*

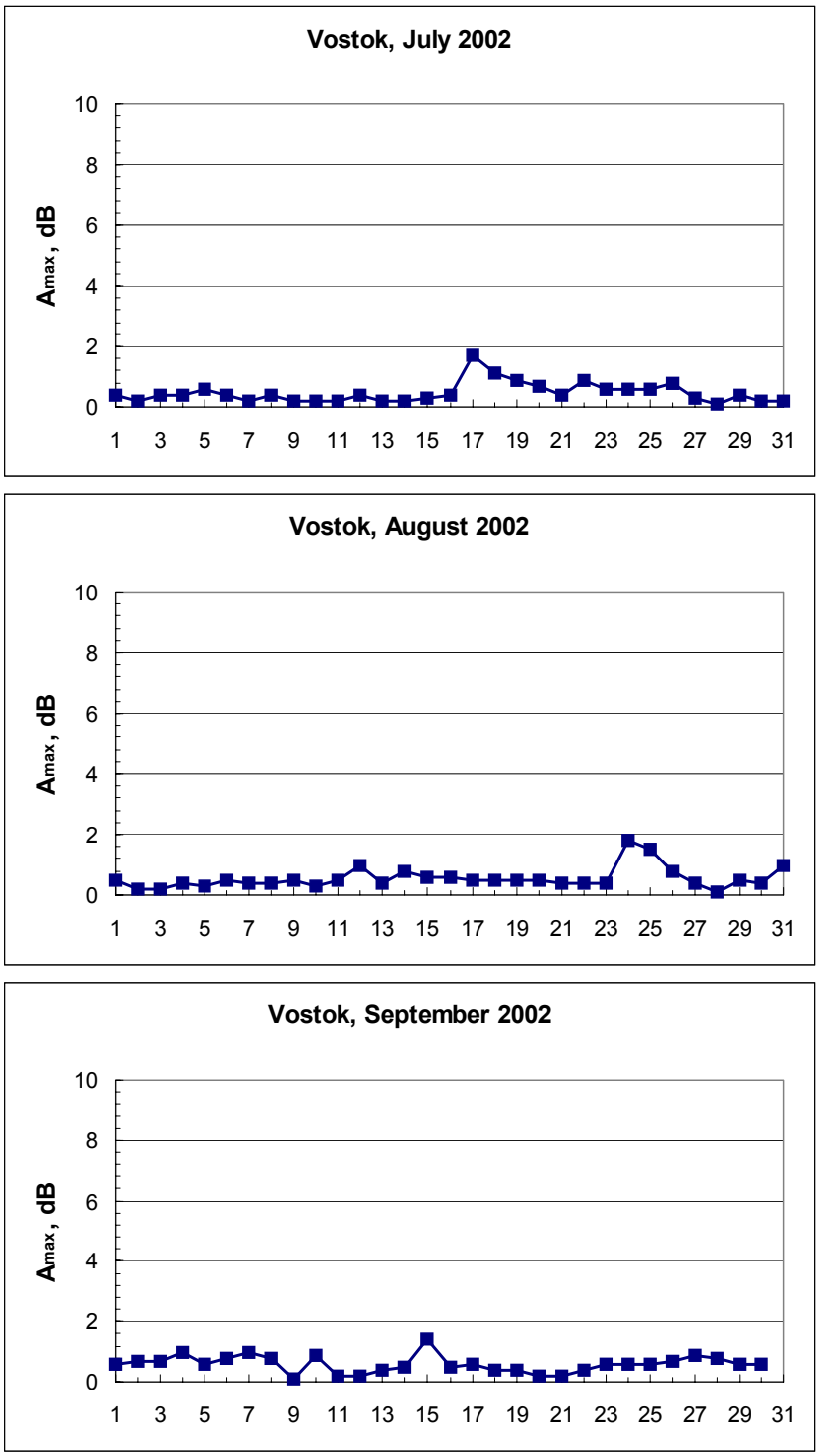


Fig. 6.3. Maximum daily space radio-emission absorption at the 32 MHz frequency from riometer observations at Vostok station.

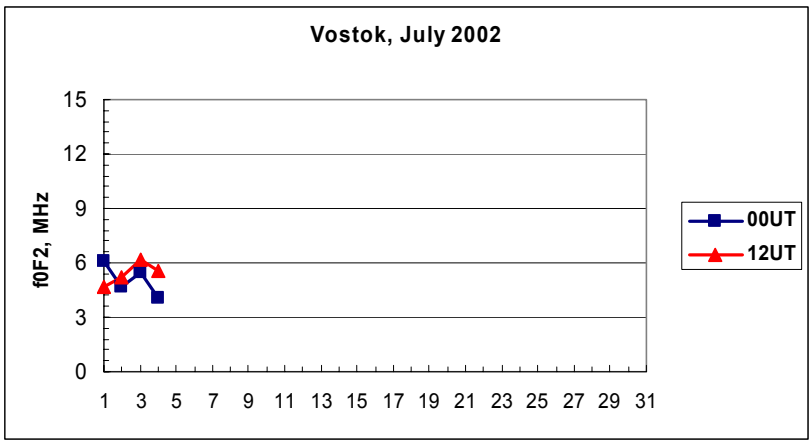


Fig. 6.4. Daily variations of critical frequencies of the F2(f0F2) layer at Vostok station*

* - from July 4, 2002, the ionospheric observations were temporarily stopped due to malfunction of the "BIZON" ionosonde.

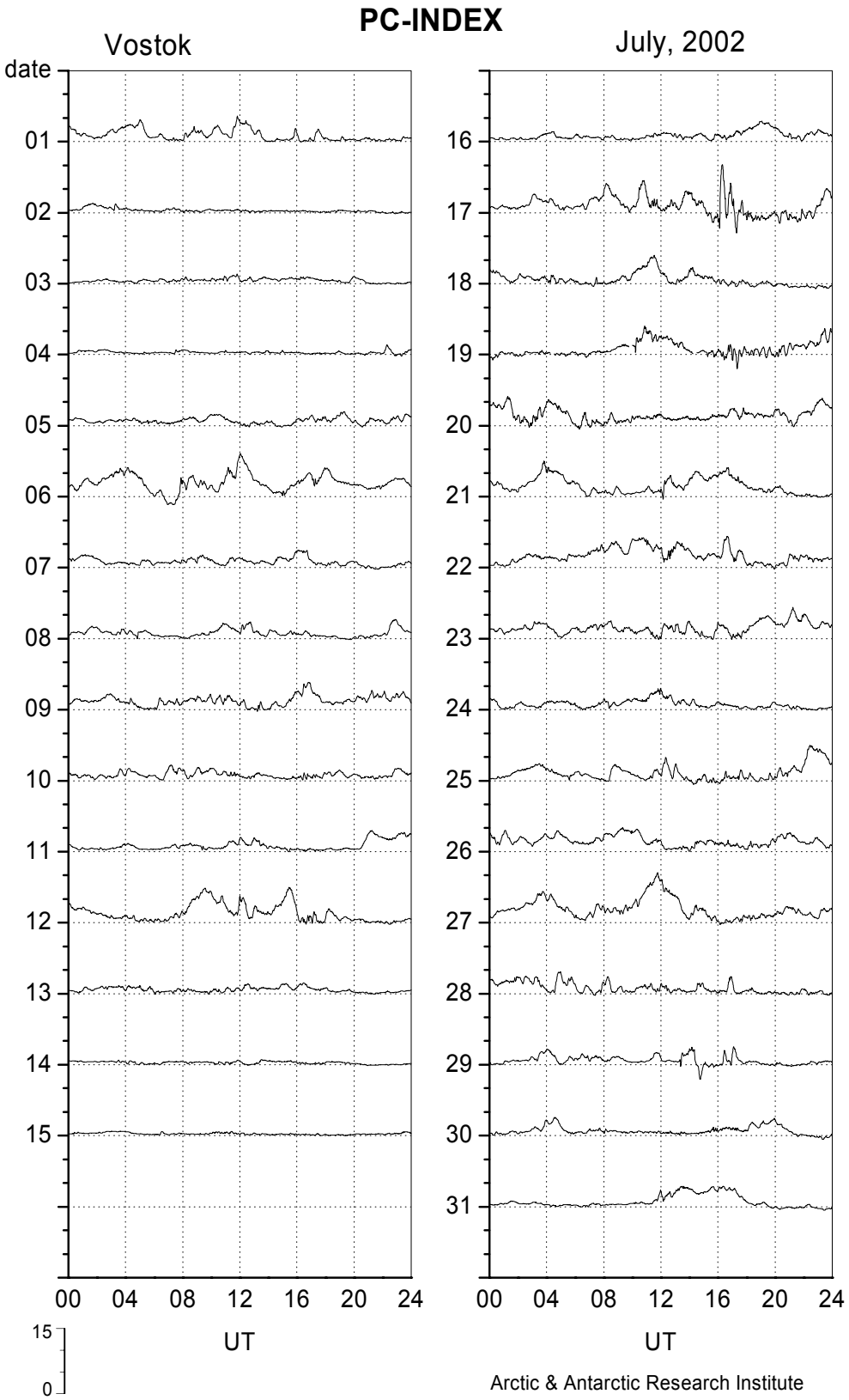

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Fig. 6.5.

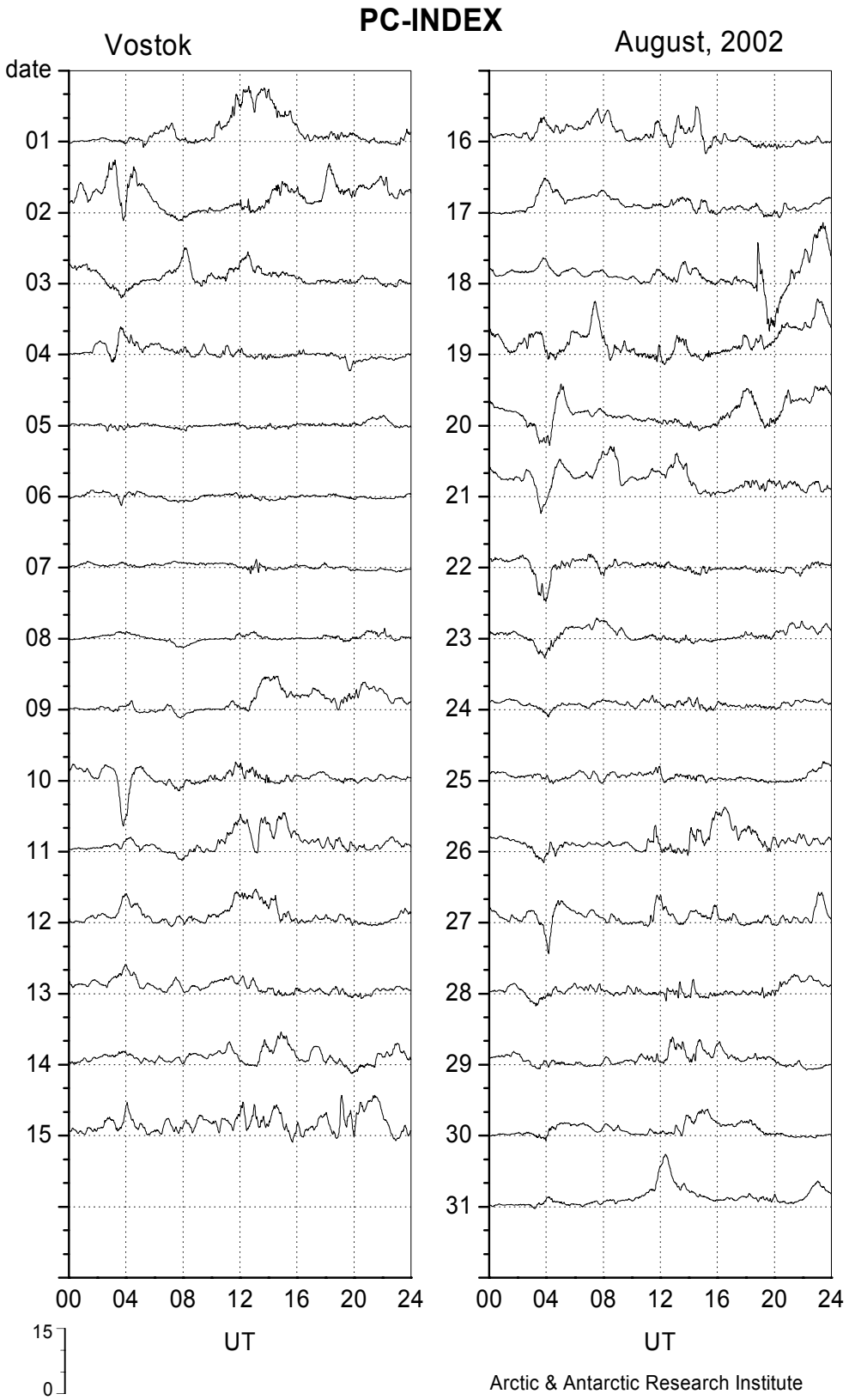
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Fig. 6.6.

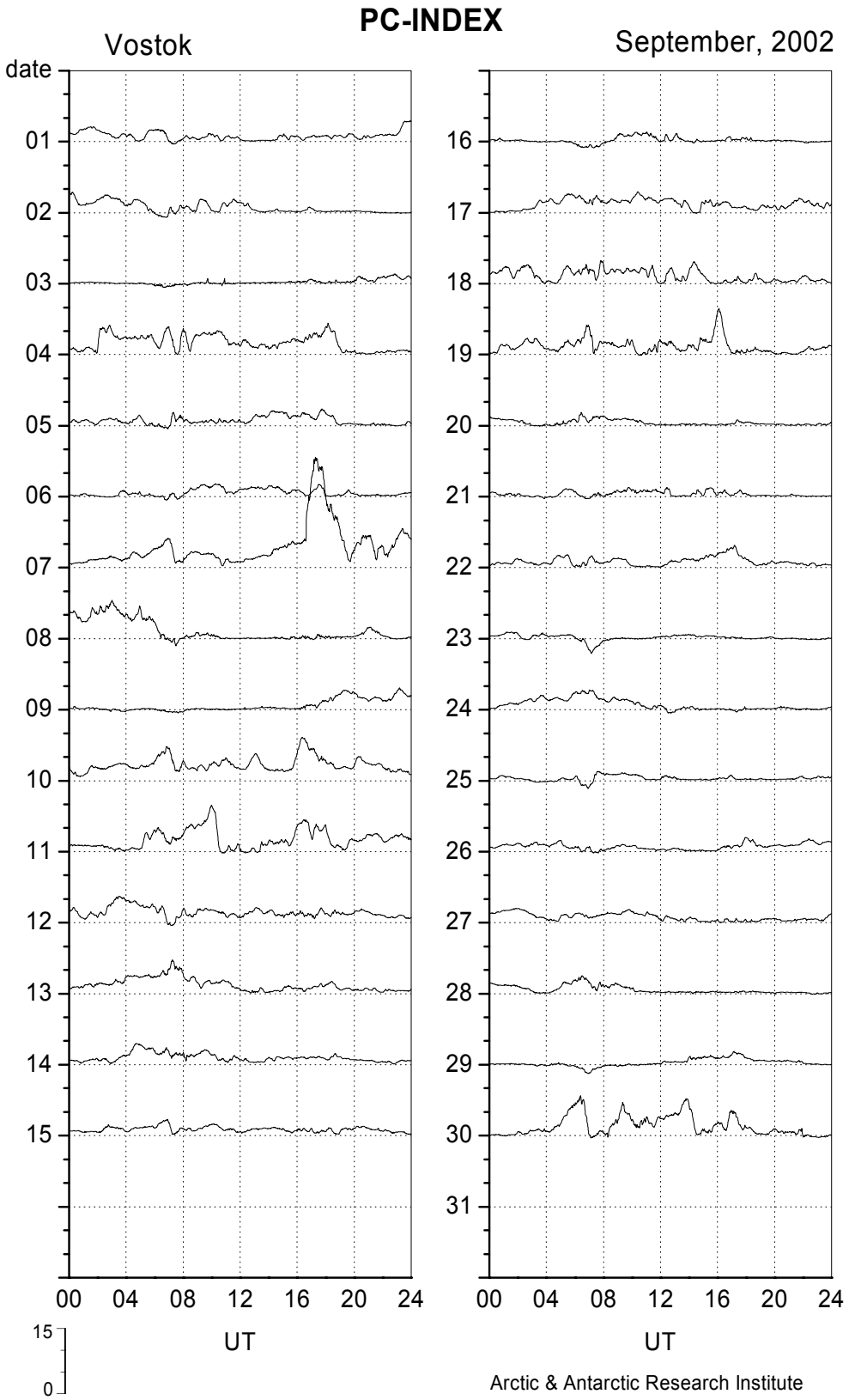
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Fig. 6.7.

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

Geophysical observations were conducted at Novolazarevskaya (magnetic), Vostok and Mirny (magnetic, vertical sounding of the ionosphere and riometer observations) stations. Unfortunately, due to malfunction of the instruments, the vertical sounding at Vostok station was stopped on July 4, 2002.

The state of the ionosphere is characterized by the behavior of the critical frequencies of the F2 (f0F2) layer. The daily variations of f0F2 were weakly pronounced, which is related to the polar night and the absence of the ionosphere illumination.

During the third quarter of 2002 the magnetic storms were observed on July 5-6, 11 and 17-18 and August 1-4. Prolonged periods of perturbations were observed on August 9-21 and 26-31. The beginning of September was also characterized by the increased magnetic activity: the magnetic storms were recorded on September 4, 7-8, 10-11 and 19 and 30. The strongest magnetic storm began on September 7 (with the PC-index of more than 20 from Vostok data). The polar lights at the time of this magnetic storm were observed even at the latitude of St. Petersburg.

The most intense perturbations were accompanied with intrusion of high-energy solar protons 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 July 16-26, August 24-26 and September 7. During the same periods, disappearance of signal at the ionosondes of Mirny and Vostok was recorded (B phenomenon).

7. STUDY OF THE ENRGY EXCHANGE BETWEEN THE ATMOSPHERE AND THE UNDERLYING SURFACE AT BELLINGSHAUSEN STATION

Repina I.A., Buchnev I.A.

For the development of the theoretical models of interaction between the atmosphere and the underlying surface, a purposeful collection of experimental data is necessary. Such experiments allow preparing information required for the consideration of the vortex dynamics and energy in the sub-polar area to which, in particular, the area of the Russian Antarctic Bellingshausen station belongs. It is interesting because it is located near the Antarctic convergence zone and is characterized by the intensified energy exchange processes, especially in the summertime at a significant solar energy influx / 1 /. Data / 2 / show that the vortex exchange here is so intense that it is one of the decisive factors in the formation of the averaged energy regime of the atmosphere both in polar areas and at temperate latitudes.

The direct measurements of the energy exchange parameters were carried out by the team of the Obukhov Institute of the Atmosphere Physics of RAS at Bellingshausen station during the period December 20, 2001 to March 10, 2002 in accordance with the program of studies of the thermal atmosphere/underlying surface interaction. The group of specialists of IFA RAS faced the following objectives:

1. Study of the energy exchange of the atmosphere and the underlying surface using instrumental measurements of heat and momentum fluxes in the sub-surface atmospheric layer under the different background conditions.
2. Improvement of the scheme of parameterization of the processes in the boundary layers of the atmosphere above the different types of the surface for use in practical calculations and in the development of regional and large-scale models.

The heat and momentum fluxes were determined from the direct measurements of the temperature fluctuations and the vertical and horizontal wind speed by means of the inertial-dissipative method / 3 /. This method has an important advantage compared to the conventional method of turbulent fluctuations / 4 / primarily because it allows avoiding the errors related to the choice of the averaging interval. The measurements were made in the absence of strong precipitation and at the wind speed of less than 20 m/s. The measurement height ranged from 2 to 5 m.

The results of measurements of the sensible heat fluxes and dynamic speed U_*, which is a momentum flux characteristic are presented in Table 7.1. The stability parameter *z/L* gives information on the stratification of the atmosphere. If $z/L \geq 0.05$, stratification is considered stable, if $-0.05 \leq z/L \leq 0.05$ — stratification is neutral. At $z/L \leq -0.05$, stratification is unstable.

Fig. 7.1 presents the daily variability of the sensible heat flux. In all cases of daytime measurements, the heat flux is positive, i.e., directed from the surface. Its value changes from tens to hundreds W/m^2 depending on meteorological conditions. The most intense energy exchange occurs during the period 12:00 to 16:00 local time (16:00 to 20:00 GMT), then, its intensity decreases becoming practically extinct by 22 hours local time. Exactly at this time, thick inversion layers were observed indicating stable stratification of the atmosphere.

In the numerical modeling of the boundary layer for calculations of the averaged latent and sensible heat fluxes and momentum from the measurements of meteorological parameters, the so-called aerodynamic bulk-formulas are applied / 4 /. They use dimensionless exchange coefficients: resistance coefficient (C_D) for calculating the momentum flux and Stanton number (C_H) for calculating the sensible heat flux. The coefficient of aerodynamic resistance of the underlying surface C_D and the related roughness parameter z_0 are the most important aerodynamic surface characteristics. The experimental determination of the roughness parameter is extremely difficult as it depends to a greater extent on stratification of the atmosphere. The resistance coefficient for neutral condition C_{DN} and roughness parameter were calculated according to the scheme proposed in / 5-7 /. For calculating the roughness parameter, the processed data were subdivided into four groups by the sectors of wind direction 315-45^0, 45-135^0, 135-225^0 and 225-315^0.

The roughness parameter is approximated by the so-called Charnok ratio $z_0 = \alpha \frac{u_*^2}{g}$, where α — Charnok parameter and g — free fall acceleration / 6 /. Fig.7.2 shows the derived experimental dependence $z_0\left(\frac{u_*^2}{g}\right)$ for different wind direction sectors. The highest roughness parameter value corresponds to the sector with sea surface.

As a result of the experiment, it was determined that strong southerly wind dominates at Bellingshausen station causing perturbations at sea surface.

The distribution of the obtained roughness parameter values for different wind directions is shown in Fig. 7.3. One can see that the southerly wind is characterized by the greatest scattering of the observed values.

The dependence of the resistance coefficient on the wind speed calculated taking into account stratification of the atmosphere for neutral conditions (Fig.7.4), is well approximated by a linear ratio. The Stanton coefficient C_H, determined from the direct heat flux measurements depends on stability of the atmosphere (Fig. 5). This dependence is

approximated by a polynomial. The averages of the obtained exchange coefficients: $C_H * 10^3 = 3.35 \pm 0.23$; $C_D * 10^3 = 2.48 \pm 0.34$.

The obtained exchange coefficients allow us to calculate the statistical characteristics of the turbulent fields and can be used for construction of the parametric models of the atmosphere/underlying surface energy exchange.

The authors express their gratitude to the Head of the Bellingshausen station Sakharov O.S. for comprehensive assistance and support in the conduct of the experiment.

References

1. Dolganov L.V. Atmospheric conditions of the Southern polar area. L.; Gidrometeoizdat. 1986. 176 p.
2. Romanov V.F., Ariskina N.V., Vasilyev V.F., Lagun V.Ye. Energy of the atmosphere in polar areas. L.; Gidrometeoizdat. 1987. 296 p.
3. Large W.G., Pond S. Sensible and latent heat flux measurements over the ocean// J.Phys.Oceanogr. 1982. V. 12. P. 464-482.
4. Bush K. Fluxes in the surface layer above the sea// In: Modeling and forecasting the upper ocean layers (ed. By Kraus). L.; Gidrometeoizdat. 1979. C. 79-85.
5. Grachev A.A., Fairall C.W., Larsen S.E. On the determination of the neutral drag coefficient in the convective boundary layer// Boundary Layer Meteorology. 1998. V 86: P. 257-278.
6. Gert Konig. Roughness length of an Antarctic ice shelf// Polarforschung. 1985. V. 55(1). P 27-32.
7. Parlange M.B., Porte-Agel F. On Monin-Obukhov similarity in the stable atmospheric boundary layer// Boundary Layer Meteorology. 2001. V 99. P. 225-248.

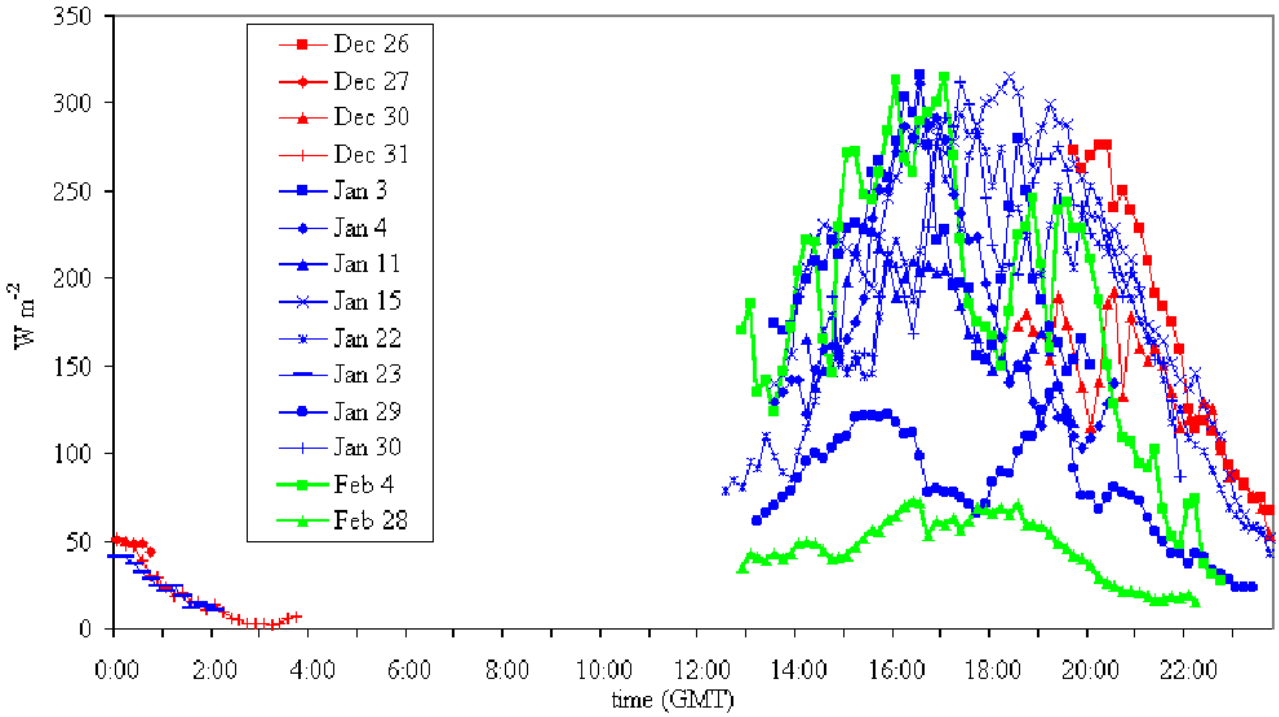


Fig.7.1. Heat fluxes obtained from direct measurements of fluctuations of meteorological parameters at Bellingshausen station (December 2001 — February 2002).

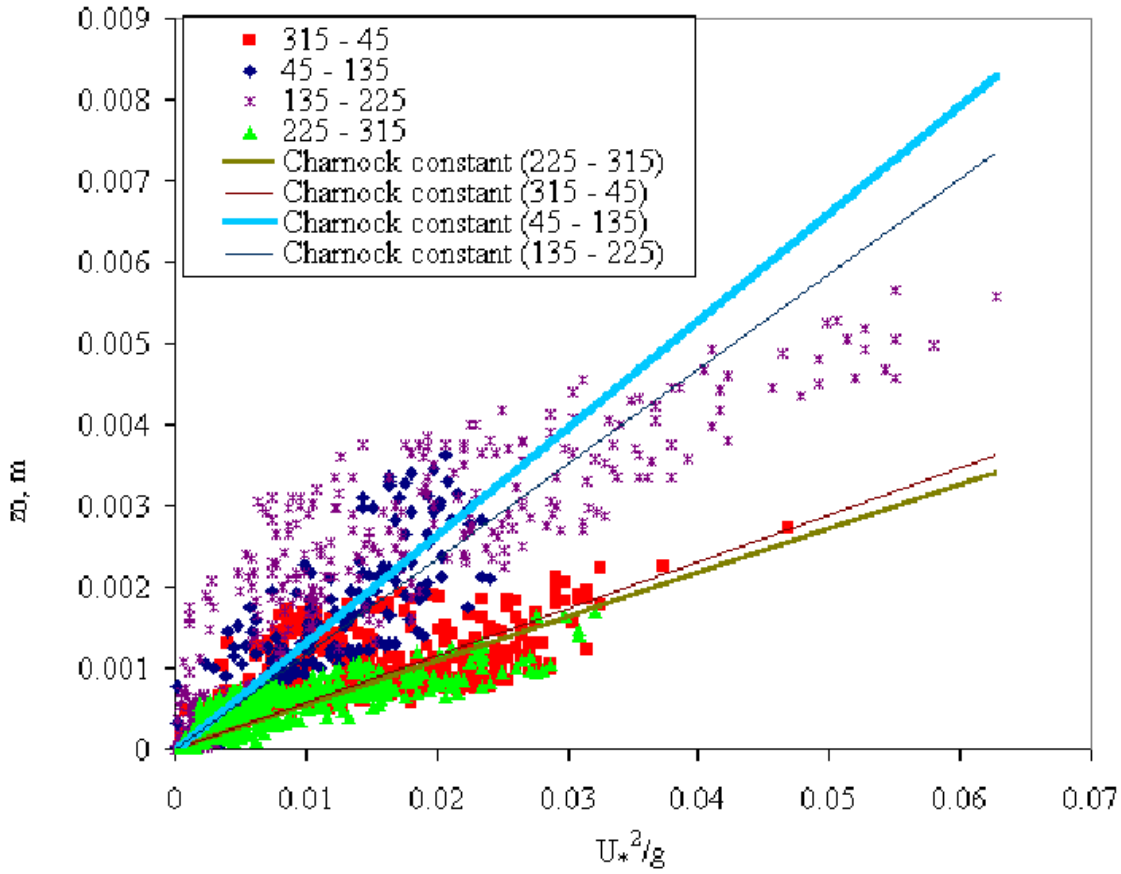
Table 7.1

Summary table of the data obtained from the direct measurements of fluctuations of meteorological parameters
(H — heat flux; U_* — dynamic wind speed; z/L — stability parameter, where z — measurement height, L — Monin-Obukhov scale)

December 2001 — March 2002

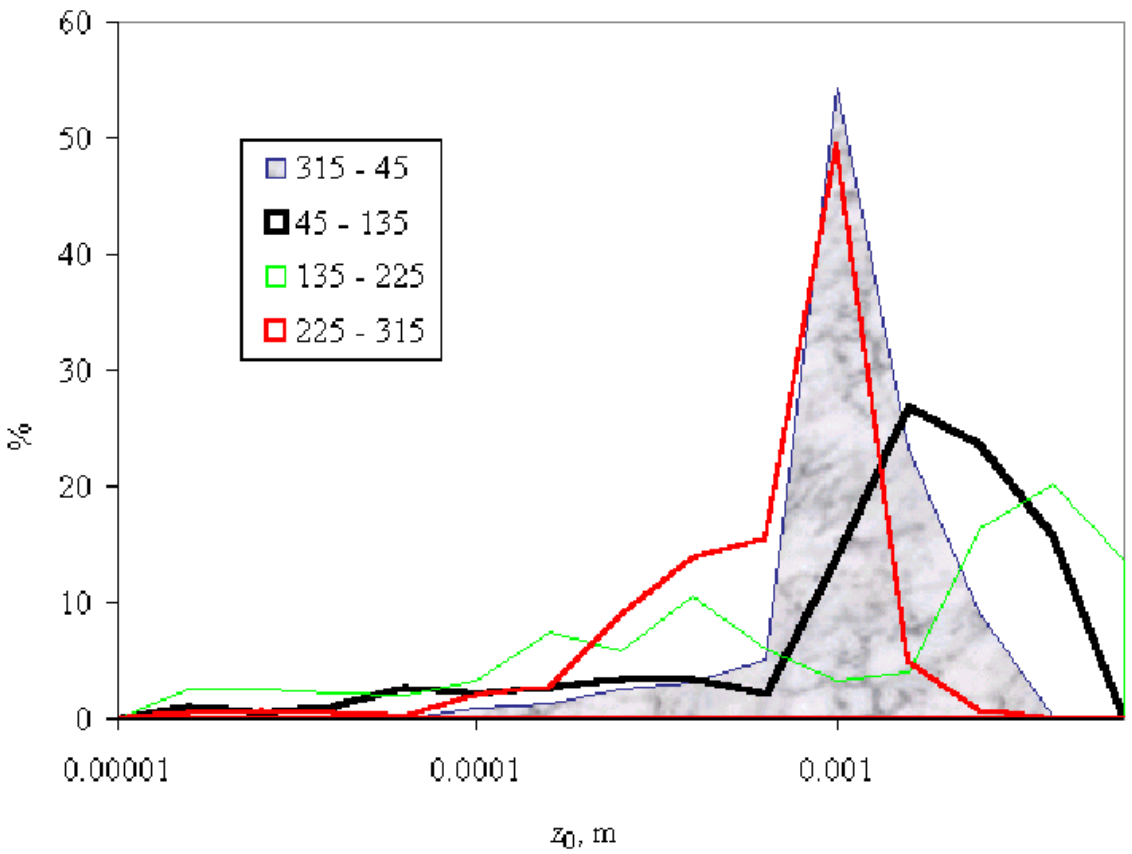
Date	Time (GMT)	H W/m^2	U_* M/s	z/L	Date	Time (GMT)	H W/m^2	U_* M/s	z/L
23.12.01	18:00	317	0.485	-0.279	07.01.02	13:00	27	0.083	-4.695
	19:00	258	0.384	-0.498		14:00	25	0.063	-9.814
	20:00	233	0.392	-0.388		15:00	35	0.093	-4.177
	21:00	197	0.381	-0.359		16:00	88	0.182	-1.451
	22:00	155	0.405	-0.236		17:00	68	0.117	-4.232
26.12.01	19:00	274	0.495	-0.228		18:00	92	0.147	-2.918
	20:00	270	0.505	-0.212		19:00	57	0.124	-2.952
	21:00	228	0.525	-0.160	11.01.02	14:00	165	0.47	-0.158
	22:00	125	0.46	-0.129		15:00	198	0.465	-0.196
	23:00	88	0.365	-0.180		16:00	190	0.46	-0.194
27.12.01	0:00	50	0.305	-0.173		17:00	205	0.42	-0.274
	1:00	44	0.345	-0.102		18:00	148	0.4	-0.229
28.12.01	17:00	188	0.298	-0.714		19:00	169	0.39	-0.282
	18:00	240	0.351	-0.557		20:00	118	0.375	-0.220
	19:00	186	0.362	-0.394	15.01.02	13:00	140	0.227	-1.195
	20:00	220	0.465	-0.222		14:00	192	0.298	-0.725
30.12.01	18:00	173	0.32	-0.530		15:00	217	0.295	-0.841
	19:00	169	0.306	-0.590		16:00	258	0.302	-0.927
	20:00	114	0.27	-0.582		17:00	271	0.316	-0.849
	21:00	160	0.305	-0.562		18:00	302	0.336	-0.791
	22:00	120	0.331	-0.330		19:00	286	0.321	-0.852
	23:00	89	0.31	-0.293		20:00	236	0.274	-1.136
31.12.01	0:00	51	0.335	-0.130		21:00	191	0.276	-0.912
	1:00	23	0.36	-0.042		22:00	137	0.276	-0.654
	2:00	14	0.355	-0.023		23:00	73	0.243	-0.506
	3:00	3	0.415	-0.001		23:59	54	0.227	-0.452
	4:00	7	0.37	-0.008	21.01.02	13:00	91	0.35	-0.212
03.01.02	13:00	174	0.386	-0.300		14:00	122	0.395	-0.199
	14:00	188	0.362	-0.389		15:00	155	0.375	-0.297
	15:00	229	0.359	-0.484		16:00	136	0.415	-0.193
	17:00	227	0.373	-0.430		17:00	143	0.4	-0.227
	19:00	187	0.415	-0.257	22.01.02	12:00	79	0.168	-1.689
	20:00	151	0.48	-0.136		13:00	81	0.15	-2.407
04.01.02	13:00	142	0.365	-0.289		14:00	85	0.133	-3.643
	15:00	165	0.366	-0.336		15:00	150	0.184	-2.418
	16:00	272	0.417	-0.373		16:00	212	0.192	-2.932
	17:00	279	0.48	-0.252		17:00	281	0.281	-1.250
	18:00	183	0.391	-0.308		18:00	273	0.254	-1.645
	19:00	116	0.36	-0.245		19:00	202	0.165	-4.419
	20:00	109	0.36	-0.233		20:00	236	0.238	-1.723
05.01.02	20:00	248	0.515	-0.185		21:00	188	0.249	-1.221
	21:00	184	0.495	-0.154		22:00	125	0.221	-1.154
	22:00	126	0.45	-0.139		23:00	69	0.193	-0.959
	23:00	69	0.425	-0.087	23.01.02	0:00	41	0.207	-0.444
						1:00	22	0.205	-0.234
						2:00	10	0.09	-1.287

Date	Time (GMT)	H W/m^2	U_* M/s	z/L	Date	Time (GMT)	H W/m^2	U_* M/s	z/L
26.01.02	17:00	169	0.167	-3.593	12.02.02	12:00	170	0.48	-0.155
	18:00	147	0.156	-3.817		13:00	185	0.445	-0.212
	19:00	127	0.15	-3.729		14:00	205	0.47	-0.199
	20:00	86	0.133	-3.685		15:00	271	0.52	-0.195
	21:00	63	0.106	-5.236		16:00	313	0.525	-0.219
	22:00	39	0.103	-3.463		17:00	315	0.55	-0.191
	23:00	27	0.073	-6.954		18:00	167	0.515	-0.123
29.01.02	13:00	61	0.174	-1.162		19:00	208	0.54	-0.133
	14:00	85	0.177	-1.535		20:00	211	0.555	-0.124
	15:00	110	0.184	-1.749		21:00	94	0.52	-0.066
	16:00	118	0.19	-1.731		22:00	71	0.54	-0.043
	17:00	78	0.159	-1.947		23:00	32	0.42	-0.038
	18:00	84	0.146	-2.689	13.02.02	18:00	174	0.376	-0.333
	19:00	125	0.195	-1.691		19:00	190	0.41	-0.278
	20:00	76	0.207	-0.853		20:00	121	0.415	-0.171
	21:00	73	0.262	-0.406		21:00	104	0.39	-0.176
	22:00	37	0.183	-0.578		22:00	67	0.36	-0.142
	23:00	24	0.176	-0.406		23:00	64	0.385	-0.111
	23:59	23	0.19	-0.310	14.02.02	17:00	242	0.337	-0.633
30.01.02	14:00	189	0.249	-1.220		18:00	153	0.269	-0.799
	15:00	148	0.25	-0.942		19:00	211	0.322	-0.636
	16:00	206	0.241	-1.454		20:00	141	0.341	-0.357
	17:00	292	0.344	-0.704		21:00	95	0.325	-0.277
	18:00	219	0.354	-0.487		22:00	74	0.37	-0.143
	19:00	268	0.393	-0.435	22.02.02	14:00	148	0.45	-0.164
	20:00	226	0.373	-0.430		15:00	230	0.515	-0.170
	21:00	195	0.401	-0.301		16:00	144	0.43	-0.182
	22:00	152	0.38	-0.273	28.02.02	12:00	35	0.129	-1.606
31.01.02	15:00	100	0.161	-2.366		13:00	43	0.153	-1.070
	16:00	74	0.167	-1.580		14:00	49	0.136	-1.916
	17:00	128	0.186	-1.971		15:00	42	0.144	-1.384
	18:00	140	0.165	-3.086		16:00	64	0.157	-1.658
	19:00	104	0.143	-3.458		17:00	59	0.156	-1.559
	20:00	79	0.118	-4.726		18:00	66	0.144	-2.223
04.02.02	16:00	135	0.299	-0.500		19:00	58	0.16	-1.408
	17:00	159	0.296	-0.610		20:00	36	0.134	-1.485
	18:00	123	0.275	-0.587		21:00	20	0.116	-1.234
	19:00	98	0.214	-0.988		22:00	19	0.147	-0.557
	20:00	109	0.256	-0.644		23:00	16	0.137	-0.572
	21:00	68	0.238	-0.498	05.03.02	12:00	27	0.105	-2.303
	22:00	63	0.179	-1.088		13:00	64	0.17	-1.300
07.02.02	15:00	120	0.37	-0.235		14:00	95	0.138	-3.618
	16:00	88	0.425	-0.111		15:00	129	0.15	-3.794
09.02.02	16:00	289	0.5	-0.231		16:00	150	0.166	-3.292
	17:00	266	0.45	-0.289		17:00	143	0.156	-3.748
	18:00	219	0.47	-0.211		18:00	116	0.194	-1.595
	19:00	213	0.49	-0.181		19:00	113	0.163	-2.656
	20:00	122	0.445	-0.137		20:00	78	0.136	-3.090
	21:00	88	0.455	-0.090		21:00	39	0.112	-2.731
	22:00	78	0.445	-0.085		22:00	15	0.075	-3.524
						23:00	4	0.068	-0.928
						23:59	2	0.09	-0.137



- Fig. 7.2. Charnok ratio obtained for different wind speeds as a result of experiment at Bellingshausen station $z_0 = \alpha \frac{u_*^2}{g}$. The wind direction in the corresponding sectors is given in degrees.

  α — Charnok constant, u_* — dynamic wind speed, g = 9.8 m/s^2 — free fall acceleration.



- Fig. 7.3. Distribution of roughness coefficient z_0 for different wind speeds. The wind direction in the corresponding sectors is given in degrees.

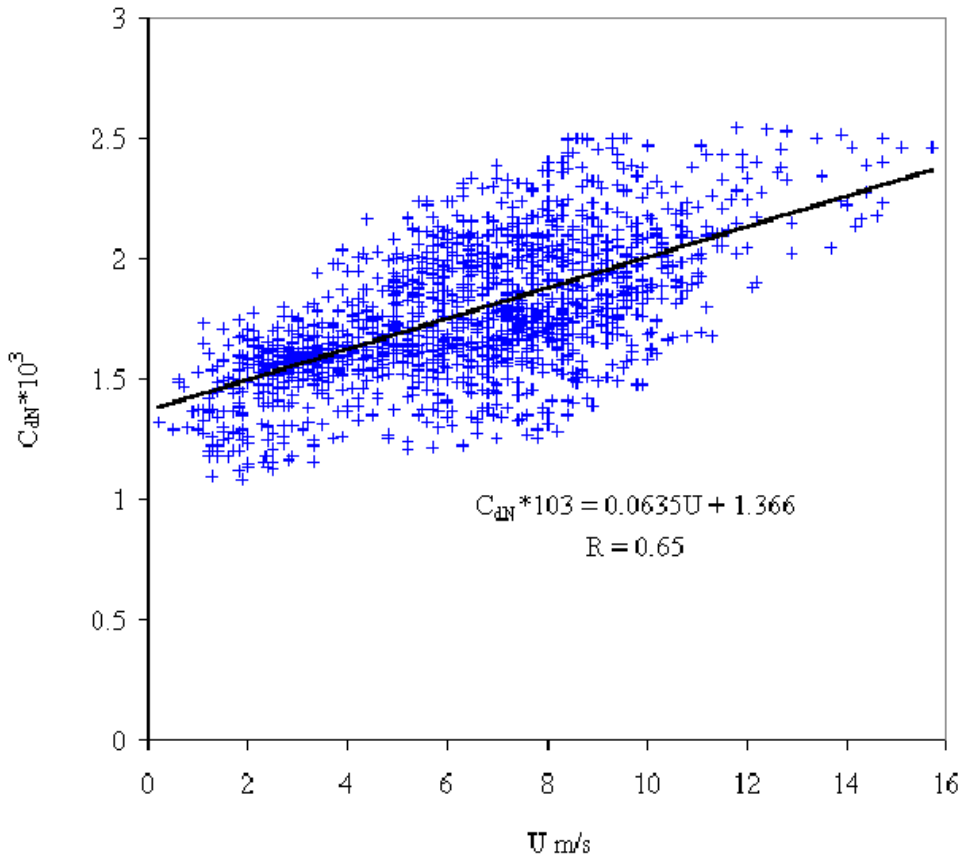


Fig. 7.4. Dependence of resistance coefficient on the wind speed for neutral stratification of the atmosphere R — correlation coefficient.

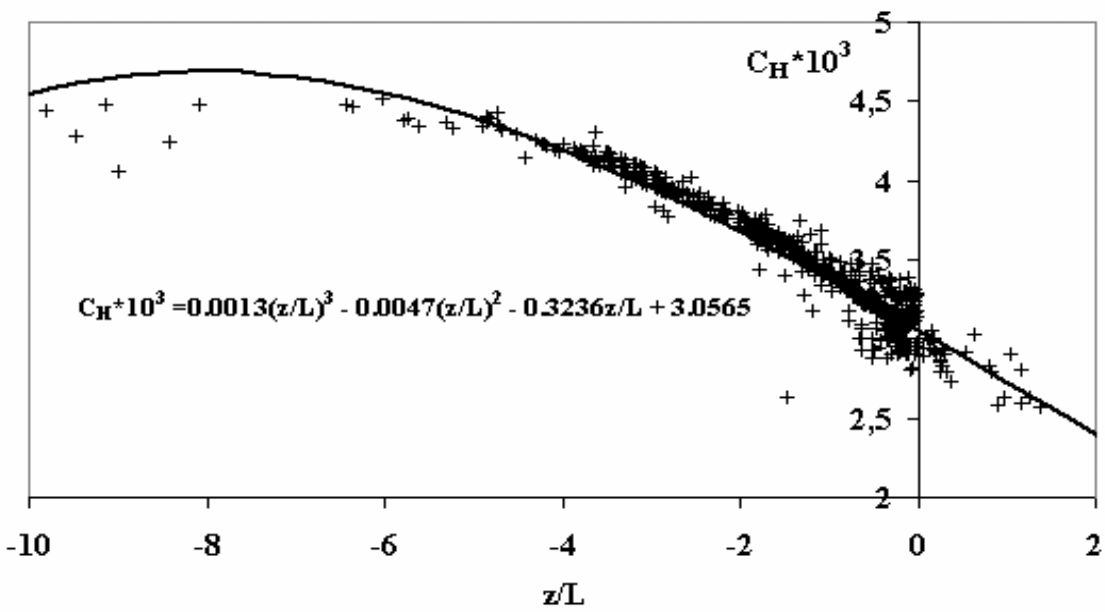


Fig. 7.5. Dependence of the Stanton number on the atmosphere stability parameter

8. MAIN RAE EVENTS IN THE THIRD QUARTER OF 2002

July 1, 2002	Evacuation of all personnel of the 46th winter and 47th seasonal Russian Antarctic Expedition from the "Magdalena Oldendorff" by South African helicopters to the "Agulhas" completed.
July 10, 2002	The "Agulhas" arriving to Cape Town. Ceremonial welcome of polar explorers, seamen and aviators by the public representatives and officials of South Africa. End of work of the Operational Headquarters.
July 11-12, 2002	Expedition participants (71 persons) returning from Cape Town to Russia by regular flights.
July 12-15, 2002	Meeting three groups of the expedition participants in Pulkovo airport (St. Petersburg).
July 18, 2002	The icebreaker "Almirante Irizar" reaches the place of the stay of the "Magdalena Oldendorf".
August 6, 2002	Attempt of routing the "Magdalena Oldendorf" to open ice failing and the "Magdalena Oldendorf" returning to the previous area. The icebreaker departing to her homeport.
August 7, 2002	Transfer of Ipatov V.A., engineer-mechanic of Bellingshausen station to Chile for medical examination and treatment.
August 7-14, 2002	Traverse from Novolazarevskaya station to the barrier and back with the aim of diesel fuel supply of the station.
August 6, 2002	The R/V "Akademik Fedorov" arriving to St. Petersburg after the repair in Germany.
August 8, 2002	Re-equipment of the ozone measurement station at Novolazarevskaya completed.
September 9-15, 2002	Next traverse from Novolazarevskaya station to the barrier to the diesel fuel depot.
September 10-20, 2002	ATCM XXV in Warsaw. The Russian Delegation included Lukin V.V., RAE Head and Pomelov V.N., RAE lead ecologist. The Meeting paid special attention to the Russian Project of deep ice drilling and penetration to the subglacial Lake Vostok. The Russian side presented the Draft Comprehensive Environmental Evaluation for this activity. Due to a complexity of the problem, the Meeting decided to consider the Project in the full volume at ATCM XXVI in Madrid in June 2003.
September 23-305, 2002	Next traverse from Novolazarevskaya station to the barrier for diesel fuel re-supply.