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Meteorological Conditions of the Basen Nunatak in Western Dronning Maud Land, Antarctica, During the Years 1989-2001

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Abstract

Meteorological conditions and the statistics for the years 1989-2001 of the Basen nunatak in western Dronning Maud Land are presented. The data are from the Finnish research station Aboa (73°03'S, 13°24'W) and the main observed quantities used here are atmospheric pressure, air temperature, wind speed and direction. Results have been compared to some neighbouring weather stations. The air temperature and wind speed showed the annual cycle and in the air pressure data the semi-annual oscillation was seen. The effect of the nunatak could be seen in wind direction and air temperature values. The dominant wind direction was 30° but the influence of the katabatic outflow was also visible. The Neumayer station can be used as a good reference to estimate the weather patterns in the Basen area.

Key words: Dronning Maud Land, Aboa, meteorological conditions, nunatak

1. Introduction

The surface of Antarctica is mostly covered by snow and ice, including the ice cover on the surrounding seas during the winter. Together with Southern Ocean, the snow blanket has a large influence to the continent's radiation budget and climate. The coastal areas have a more variable climate than the high altitude areas because they are affected by changing sea ice extent and cyclonic activity related to the poleward moving air masses (*King and Turner*, 1997). The sea ice extent around Antarctica has a pronounced annual cycle with minimum in February-March and maximum in September-October (*König-Langlo et al.*, 1998).

Weather patterns in the western Dronning Maud land area are influenced by synoptic systems moving across Weddell Sea (*King and Turner*, 1997). Poleward moving air masses do not usually penetrate over the inland plateau because they are deflected by the topography and flow parallel to the coast (*Bromwich*, 1988). Coastal stations are subject to the cyclonic storms which play an important role in the snow

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accumulation in the area (*Noone et al.*, 1999). The semi-annual oscillation and the El Niño-Southern Oscillation (ENSO) have an effect to the climatology in Antarctica (*Van den Broeke*, 1998). The semi-annual oscillation consists of the twice-yearly contraction and expansion of the pressure trough around Antarctica, in response to differences in heat storage between Antarctica and the surrounding oceans (*Van den Broeke*, 1998). ENSO is the most pronounced inter-annual climatic variations found on Earth and can be detected in and around Antarctica (*King and Turner*, 1997).

The correlation of temperature with surface elevation appears to be strong in Antarctica, although the major ice shelves are anomalously cold for their low elevation (*King and Turner*, 1997). The temperature inversion is dominant feature especially during the winter due to the negative surface net radiation (*King and Turner*, 1997). Katabatic winds are resulting from the drainage of cold, dense air from the interior of the continent forced by gravity over a sloping surface (*King and Turner*, 1997).

Since 1989 meteorological data have been collected at the Finnish research station Aboa (73°03'S, 13°24'W) located in Basen nunatak in western Dronning Maud Land (Fig. 1, Table 1). Basen is the most northern nunatak of the Vestfjella nunatak range near the grounding line. Vestfjella is located approximately parallel to the coast. During the austral summer the surroundings of Aboa are mostly snow free (Fig. 2). *Launiainen et al.* (1995) have earlier published the meteorological data from Aboa covering 1989-1994. Previous climatology studies have described widely the meteorological conditions in western Dronning Maud Land (*König-Langlo et al.*, 1998; *Reijmer*, 2001).

Table 1. The weather stations, their locations and the time range of data used in this study. The exact coordinates of the Aboa weather station have been given since the weather station location has been changed slightly in 2003 and small changes in station location may be visible in the new weather data. Neumayer is an ice shelf station and its elevation is not quite constant.

Weather station	Location	Latitude	Longitude	Elevation (m a.s.l.)	Months of data available
Aboa	Nunatak 120 km from the ice edge	73°02'32.592"S	13°24'23.633'W	484	Feb 1989 - Oct 2001
Buoy 5895	Ice shelf 0.3 km from the ice edge	72°31'12"S	16°49'48"W	37	Jan 1990 - Jan 1994
Neumayer	Ice shelf 5 km from the ice edge	70°39'S	8°15'W	~40	Jan 1989 - Dec 2001

This paper gives the results of the meteorological statistics for the years 1989-2001 from the Aboa weather station. The Aboa station climatology is presented for air temperature, wind and air pressure. For comparison, an automatic buoy weather station at ice shelf edge and the German Neumayer station are employed (Table 1). The buoy weather station was located on the edge of the ice shelf about 120 km from Aboa (Fig. 1) and Neumayer is located approximate 330 km from Aboa.

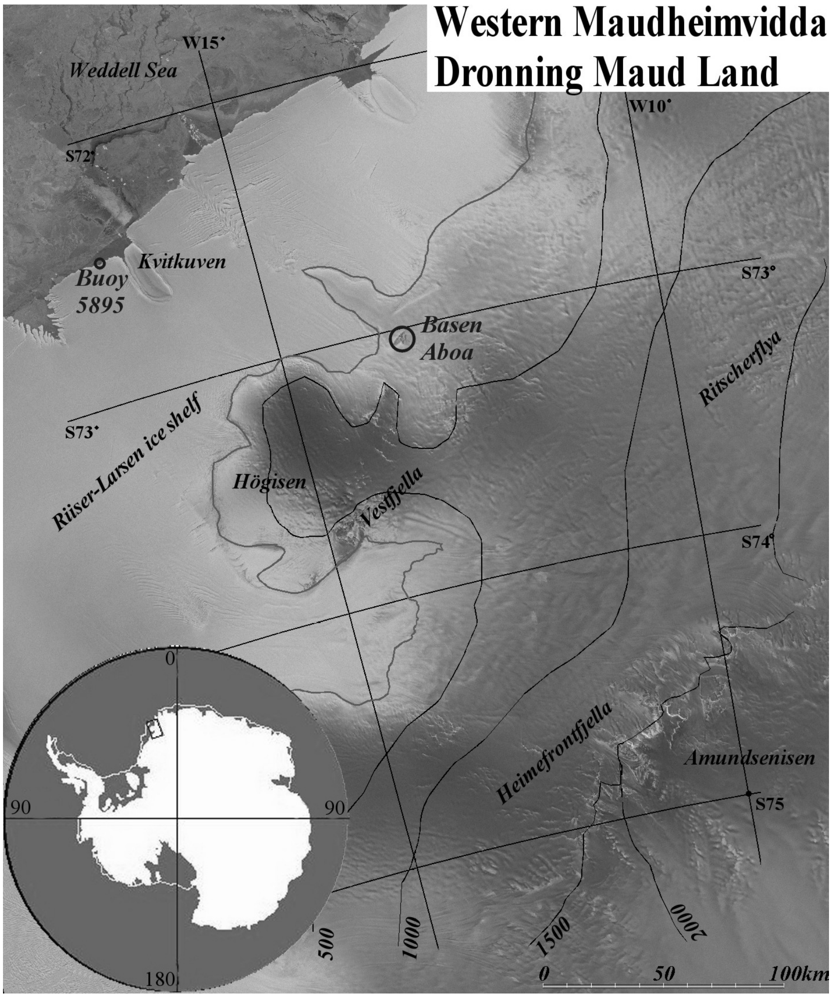

Fig. 1. Map of the Maudheimvidda area in western Dronning Maud Land showing the locations of the Finnish research station Aboa on the Basen nunatak and Buoy 5895. Part of a RADARSAT mosaic has been used as a background (RADARSAT data © Canadian Space Agency 1997).

2. *Climate in western Dronning Maud Land*

Reijmer (2001) studied the meteorological conditions in Dronning Maud Land and used automatic weather station data covering years 1998-2000. Two of the weather stations were situated in the area discussed in this paper; AWS 4 (72°45'S, 15°30'W) was located on the ice shelf and AWS 5 (73°06'S, 13°10'W) about 10 km from the Finnish research station Aboa on the ice sheet (*Reijmer*, 2001). The near surface climate in Dronning Maud Land is determined by a combination of predominant katabatic winds and synoptic winds forced by transient cyclones travelling eastwards parallel to the coastline (*Reijmer*, 2001). In western Dronning Maud Land the prevailing wind direction is from east to northeast (*Gjessing and Wold*, 1986; *Reijmer*, 2001). The air temperature in Dronning Maud Land is very variable, especially in winter when the meridional and vertical temperature gradients are largest (*Reijmer*, 2001). Large changes in temperature often coincide with changes in wind speed and direction, and are due to passing low pressure systems advecting relative warm and moist maritime air to the south (*Reijmer*, 2001).

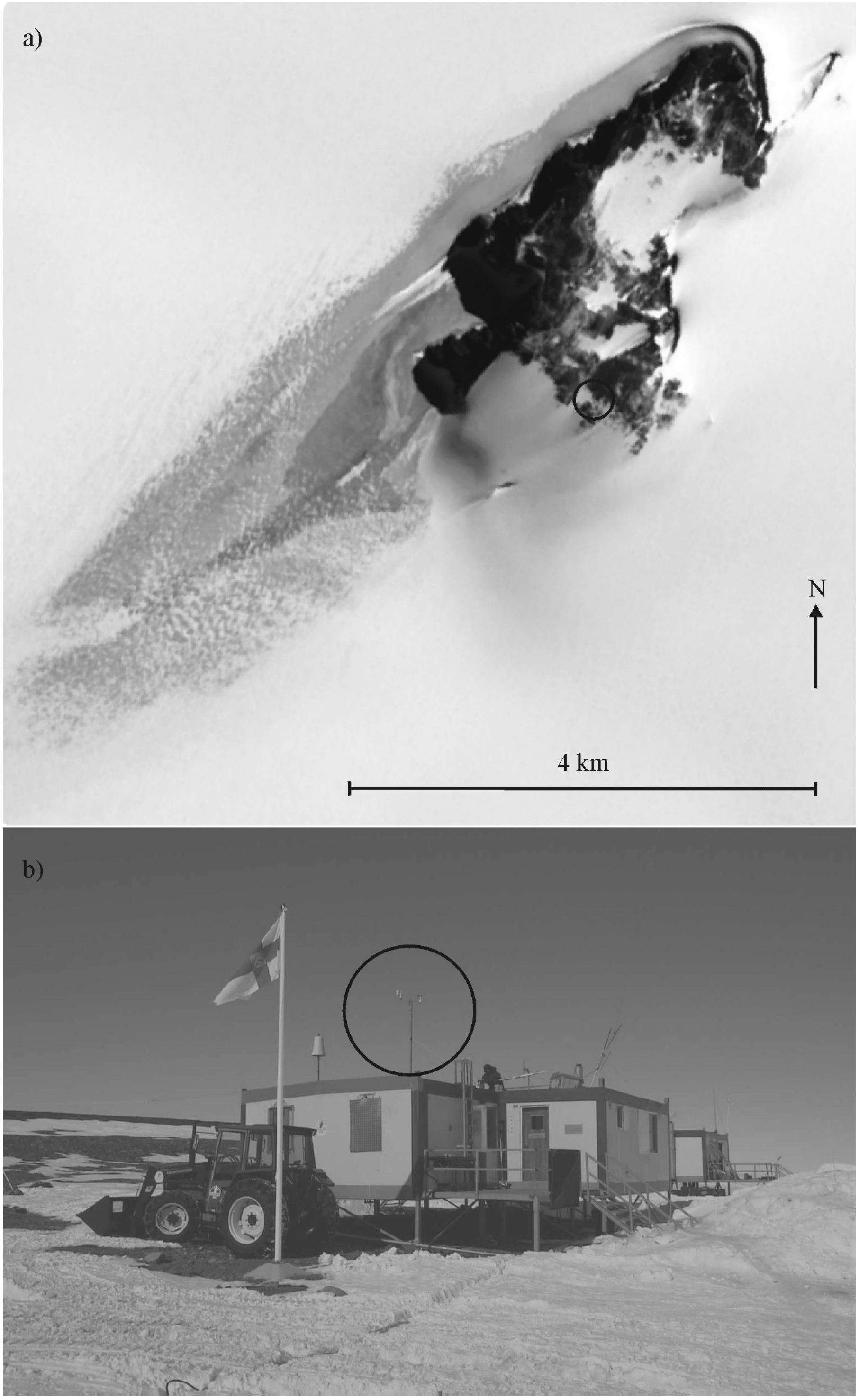

Fig. 2. Part of the TERRA/ASTER© image from November 8, 2001, showing the Basen nunatak and the snow free surfaces (a). The location of the station has been marked by a circle. The low altitude blue ice area is seen on the side of the nunatak. The weather station was located on the roof of the research station (b).

König-Langlo et al. (1998) published Neumayer (70°39'S, 8°15'W) data from 1991-1995. Neumayer is located on the ice shelf about 330 km from Aboa to north-east. At Neumayer the distribution of wind direction had a peak between 80° and 90°, which results mainly from synoptic disturbance, although the local topography appears to exert some control over the surface wind regime (*König-Langlo et al.*, 1998). The rather low mean annual air pressure was 986.2 hPa and wind speed 8.9 m s^{-1} (*König-Langlo et al.*, 1998). During 1991-1995 the mean annual air temperature at Neumayer was -16.1°C. The slightly positive temperatures may occur at times from December to February (*König-Langlo et al.*, 1998).

Precipitation characteristics at the coast and in the high interior are very different; coastal snowfall is episodic in association with synoptic scale features such as cyclones and fronts, while in the interior direct orographic lifting with adiabatic cooling is the dominant precipitation formation mechanism (*Bromwich*, 1988). The moisture coming to Dronning Maud Land plateau originates from Weddell Sea in north-east (*Noone et al.*, 1999; *Reijmer and Van den Broeke*, 2001). Mean annual accumulation in western Dronning Maud Land has been on the ice shelf 380 mm w.e. (time range 1975-1989) and near Aboa 343 mm w.e. (time range 1974-1989) (*Isaksson and Karlén*, 1994).

The layered structure of snow cover is a result of the sequence of weather events (*Colbeck*, 1991). The upper layers of snow are influenced by solar radiation penetration, diurnal reversals of the temperature gradient and the action of wind (*Colbeck*, 1991). The properties and stratigraphy of surface snow have been analysed in the vicinity of Aboa during the austral summers 1999/2000, 2000/2001 and 2003/2004 (*Kärkäs et al.*, 2002). More detailed studies on snow stratigraphy and meteorological conditions would be worthwhile in the future.

3. Collected data

An automatic weather station was set up at Aboa at an elevation of 484 m a.s.l. in January 1989, and it broke down finally at the end of October 2001 (Fig. 2). This MILOS 200 weather station (Vaisala) recorded synoptic observations at 3-h intervals (*Launiainen et al.*, 1995). The sensors were installed in a height of 4 m (pressure, temperature, moisture) and 6 m (wind). Air pressure, air temperature, wind speed and wind direction values have been used in this study. The orientation of the weather mast was found to be incorrect about 10° and this may cause too northern wind directions (personal communication with Dr. Virkkula during 1999/2000). The research station has been used only in summer time and the maintenance of the weather station has not been taken care every year. There have been some gaps in the received data. A new weather station was installed during the austral summer 2003/2004 about 200 m away from the main building and the location of the old weather station. On the nunatak the seasonal snow melts during summer. Therefore the highest summer temperatures are above 0°C and represent local conditions above the bare ground heated by solar radiation (*Launiainen et al.*, 1995). The station is situated on a slope, facing to the south, and the winds are distorted by the local topography.

For the years 1989-2001 some meteorological observation periods were incomplete or totally missing. There was also another weather station operating at Aboa only for a summer use in January 2000 and January 2001 by the aerosol laboratory about 200 m from the research station (*Koponen et al.*, 2003). In this paper January

2001 data from that station have been used. The data from the following months are totally missing; Jan 1989, Sep 1990, May-Jun 1991, Jun-Nov 1997, Oct-Nov 1999, Nov-Dec 2000 and Nov-Dec 2001.

Aboa weather station data have been compared to the automatic buoy weather station number 5895 (*Launiainen et al.*, 1991) operated on the edge of the ice shelf for 4 years (Fig. 1, Table 1) and also to the mean monthly weather data of the German Neumayer station received straight from Alfred Wegener Institute (Table 1). Regular meteorological measurements at Neumayer started in 1981. Neumayer is situated on the Ekstrøm Ice Shelf and no ice free land surface exists there.

4. *Results*

Monthly and annual temperature, air pressure, wind speed and wind direction values have been used for determining the climate variability in the area. In Table 2 are shown the monthly mean values of wind, gust, air temperature and pressure at Aboa with standard deviations and minimum and maximum values. Monthly mean values are compared with Buoy 5895 and Neumayer in Figure 3. The mean annual values are shown in Table 3. The measured extreme values at Aboa during 1989-2001 are seen in Table 4.

Table 2. The monthly mean values of wind speed (*WS*), gust, air temperature (*T*) and pressure (*p*) from Aboa. The recorded minimum and maximum values are shown. The directional constancy of wind (*dc*) and gust coefficient are determined from 3-h averages.

	WS (m s^{-1})	*WS max* (m s^{-1})	*Gust* (m s^{-1})	*Gust max* (m s^{-1})	*Gust /WS*	*dc*	*T* (°C)	*T max* (°C)	*T min* (°C)	*p* (hPa)	*p max* (hPa)	*p min* (hPa)
Jan	5.4±1.1	30.3	9.1±5.9	41.2	1.60	0.73	-5.2±1.3	9.7	-25.4	931.6±3.6	952.1	912.5
Feb	6.0±1.5	35.0	10.1±6.3	45.8	1.59	0.85	-8.7±1.5	5.9	-23.9	929.9±3.2	948.9	909.1
Mar	6.9±1.6	34.5	11.1±6.5	44.7	1.55	0.84	-13.5±1.4	-0.3	-31.2	926.3±2.9	945.2	891.1
Apr	7.1±1.6	35.0	11.0±6.7	42.2	1.55	0.88	-17.5±1.0	-5.9	-37.0	926.5±3.5	947.0	898.8
May	7.7±1.7	35.0	12.4±8.1	45.3	1.56	0.86	-19.0±1.2	-6.4	-42.0	925.5±4.5	950.0	892.2
Jun	9.1±3.1	41.2	13.6±8.3	48.3	1.55	0.90	-19.4±1.5	-5.9	-38.6	929.9±5.7	964.1	883.1
Jul	7.7±2.1	42.7	12.5±8.3	54.5	1.55	0.85	-21.5±2.1	-7.3	-41.2	926.3±4.7	952.1	887.3
Aug	9.0±2.2	47.3	14.2±9.1	57.6	1.53	0.88	-21.9±2.7	-5.0	-37.4	923.8±3.9	963.8	876.8
Sep	8.3±1.7	47.3	13.5±8.9	57.1	1.50	0.89	-20.8±2.0	-5.5	-40.2	926.8±4.2	986.8	890.6
Oct	7.7±1.4	42.7	12.2±8.4	50.0	1.50	0.86	-16.6±1.6	0.5	-35.4	922.8±2.8	950.1	890.7
Nov	8.6±2.0	44.8	13.4±9.2	56.6	1.49	0.89	-10.5±0.9	3.2	-27.2	927.0±3.7	947.9	895.1
Dec	6.4±2.6	30.3	10.2±6.4	41.2	1.57	0.75	-5.5±1.8	9.1	-15.4	929.7±5.1	947.7	904.1

4.1 *Wind speed and direction*

Wind speed had a seasonal cycle being the highest during the winter months. Extreme wind speeds were observed at Aboa in 9-10 August 1992 (Table 4). Aboa had higher wind speeds than Buoy 5895 located on the ice shelf but lower than values from Neumayer (Fig. 3). The mean wind speed at Aboa has been 7.7 m s^{-1} based on 3-h average values (Fig. 4a). Totally 77% of observed wind speeds were ≤ 10 m s^{-1} and 3% ≤ 1 m s^{-1}. The ratio of gust to mean wind speed (1.5-1.6; Table 2) shows that no extremely high gusts or low wind periods were observed in the monthly averages covering the years 1989-2001. The directional constancy of wind *dc* is defined as the ratio of vector-averaged wind speed to mean wind speed (Table 2). When *dc*=1 wind blows from a well-defined direction all the time. At Aboa the *dc* values are quite constant and high for all year around.

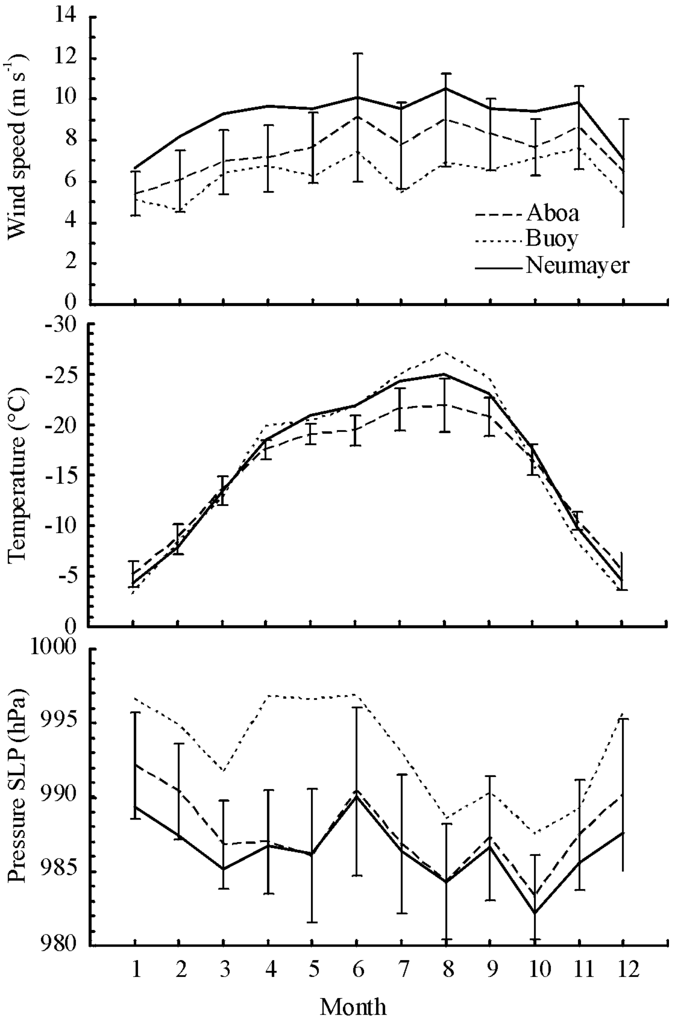

Fig. 3. The monthly mean wind speed, air temperature and pressure reduced to sea level from Aboa, Buoy 5805 and Neumayer. The error bars show the standard deviations of Aboa data.

In wind direction data 0° indicated calm conditions and 90° was east, 180° south, 270° west and 360° north. All 0° values were invalidated because they were related to other error codes or too long calm conditions possible due to the accumulation of rime and ice. It was impossible to distinguish the true calm values. Totally 10% of the used wind data was insufficient. Wind direction distribution is shown in Figure 4b. According to the wind direction distribution the most dominant wind direction was 30°, although the strongest winds blew from 20°. There was seen some constancy from directions of 190-210° and 330-340°. The peak in 190-210° indicated the katabatic winds from the interior. In total 76% of all winds blew from 20-40°. For the directions of 190-210° the value was 8% and for 330-340° only 2%. Figure 5 shows that wind direction has been 20-40° during the strongest wind speeds. The well-defined distribution in wind direction was probably due to local topography. Aboa is located on the slope of the nunatak. The topography is the single most important factor in shaping the Antarctic surface wind regime (*Parish*, 1988).

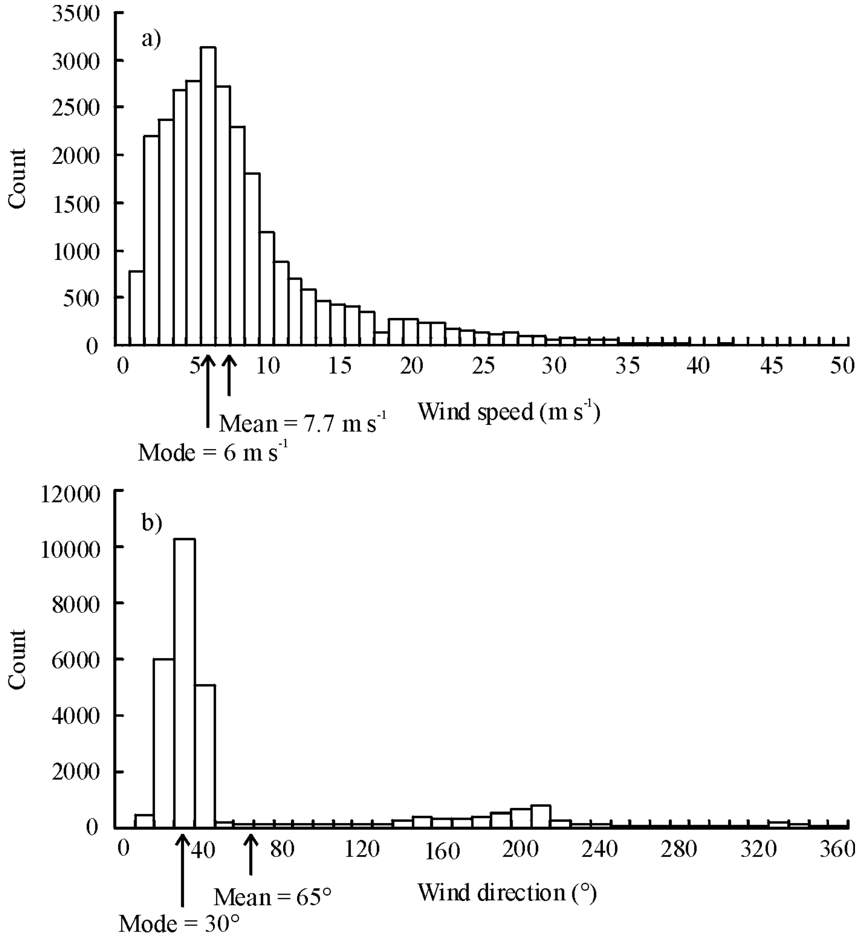

Fig. 4. The wind speed (a) and wind direction (b) distributions at Aboa based on 3-h average data. The mean and mode values have been marked.

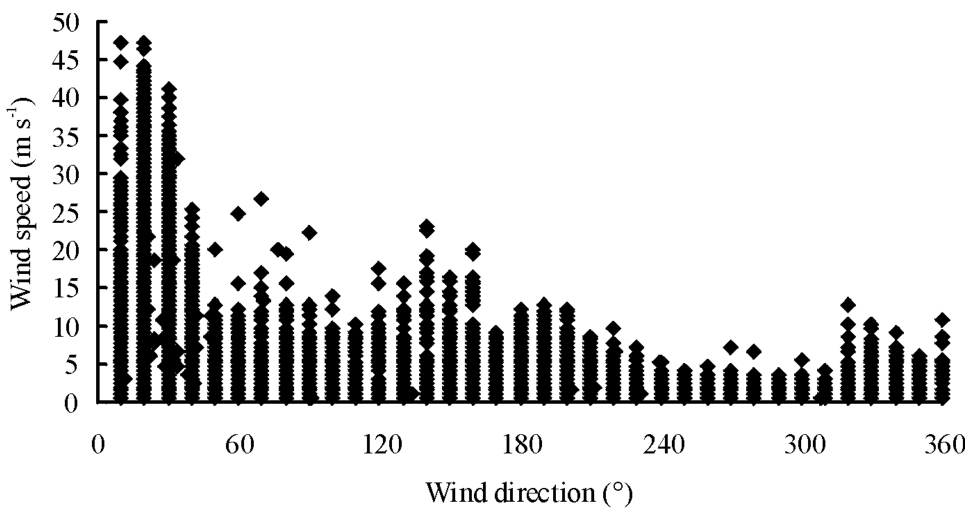

Fig. 5. Wind directions and speeds during 1989-2001.

Table 3. The annual mean values of wind speed (*WS*), air temperature (*T*), pressure (*p*) and pressure reduced to sea level (p_{SLP}) from Aboa, Buoy 5895 and Neumayer. The number of days with T≥0°C are listed. In the parenthesis the missing months have been replaced with the monthly average values of Aboa of the whole period.

Year	*WS* (m s^{-1}) Aboa	*WS* (m s^{-1}) Buoy 5895	*WS* (m s^{-1}) Neumayer	*T* (°C) Aboa	*T≥0°C* (days) Aboa	*T* (°C) Buoy 5895	*T* (°C) Neumayer	*p* (hPa) Aboa	p_{SLP} (hPa) Aboa	*p* (hPa) Buoy 5895	p_{SLP} (hPa) Buoy 5895	p_{SLP} (hPa) Neumayer
1989*	7.9 (7.7)		8.7	-16.7 (-15.6)	0		-17.1	927.2 (927.7)	987.7 (988.2)			987.3
1990*	8.1	6.7	9.2	-14.7 (-14.2)	0	-15.7	-15.7	927.8 (928.9)	988.3 (989.4)	989.6	994.2	989.3
1991**	6.5 (6.8)	6.2	9.0	-13.3 (-14.2)	11	-16.3	-15.5	928.4	988.9	987.8	992.4	987.8
1992	7.3	6.3	8.4	-15.5	6	-15.4	-16.0	927.9	988.4	990.6	995.2	985.8
1993	6.6	5.9	8.5	-15.8	0	-16.1	-16.5	925.6	986.1	986.3	990.9	984.3
1994	7.2		9.1	-15.5	0		-16.1	927.8	988.3			986.5
1995	8.2		9.6	-15.0	0		-16.2	927.5	988.0			986.5
1996	8.0		9.3	-13.9	0		-14.3	928.3	988.8			987.4
1997***	(7.2)		9.3	(-14.9)	0		-15.7	(927.5)	(988.0)			986.4
1998	7.8		9.5	-15.1	0		-15.7	923.4	983.9			982.7
1999**	9.0 (8.8)		9.5	-14.7 (-14.5)	1		-16.1	927.0 (926.7)	987.5 (987.2)			985.3
2000**	6.6 (6.8)		8.4	-17.6 (-16.0)	0		-17.8	927.4 (927.6)	987.9 (988.1)			988.6
2001**	7.0 (7.2)		9.9	-16.2 (-14.8)	1		-15.3	926.4	986.9			985.8
Mean	7.5 (7.5)	6.3	9.1	-15.3 (-15.0)		-15.9	-16.0	927.1 (927.2)	987.6 (987.7)	988.6	993.2	986.4
S.D.	0.8 (0.6)	0.3	0.5	0.9 (0.7)		0.4	0.8	1.4 (1.4)	1.4 (1.4)	1.9	1.9	1.8

* One month data missing from Aboa.
** Two months data missing from Aboa.
*** Six months data missing from Aboa.

On the glacier 10 km from Aboa wind direction distribution had a highest peak around 60° (*Reijmer*, 2001). On the ice shelf the wind direction distribution from Buoy 5895 gave two peaks; one around 70° and another around 180°. Buoy 5895 has been located on the western side of the Kvitkuven ice rise, which might have caused these peaks. Neumayer is frequently influenced by easterly winds associated mostly with eastward moving cyclones (*König-Langlo et al.*, 1998). The wind data from Neumayer showed maxima between 80° and 90°, which was mainly due to synoptic disturbance (*König-Langlo et al.*, 1998).

Typical wind speeds that cause the drifting snow vary between 6 and 13 m s^{-1} (*Bromwich*, 1988; *König-Langlo et al.*, 1998). At Aboa 47% of the observed wind speeds were between 6-13 m s^{-1}. *Gallée* (1997) suggested that blowing snow attributes for removal of around 32 mm a^{-1} averaged over whole Antarctic. Snowdrift sublimation is one of the major terms in the surface mass balance of Antarctica and can be up to 17 cm w.e. a^{-1} near the windy and relatively warm coast (*Bintanja*, 1998). At Neumayer drifting and blowing snow events are restricted to cyclonic conditions, which are connected mainly with the advection of air masses from the east (*König-Langlo et al.*, 1998).

Table 4. The recorded extreme values of wind speed (10-minute mean, *WS max*), wind gust (*Gust max*), air temperature (*T max/min*) and air pressure (*p max/min*) at Aboa.

WS max (m s^{-1})	*Gust max* (m s^{-1})	*T max* (°C)	*T min* (°C)	*p max* (hPa)	*p min* (hPa)
47.3	57.6	9.7	-42.0	964.1	876.8
9 Aug 1992	10 Aug 1992	4 Jan 1991	12 May 1995	15 Jun 1999	11 Aug 1994

Table 5. The monthly differences between the Neumayer and Aboa data for wind speed, air temperature and pressure (SLP). It is suggested to subtract the following corrections if Neumayer data is used for the Aboa area.

	WS (m s^{-1})	*T* (°C)	p_{SLP} (hPa)
Jan	1.3	0.8	-2.8
Feb	2.2	0.8	-3.0
Mar	2.4	0.1	-1.7
Apr	2.5	-1.1	-0.3
May	1.9	-1.9	0.1
Jun	1.0	-2.5	-0.3
Jul	1.8	-2.7	-0.5
Aug	1.5	-3.0	-0.04
Sep	1.2	-2.4	-0.7
Oct	1.7	-1.2	-1.2
Nov	1.2	0.7	-1.8
Dec	0.6	0.8	-2.6

4.2 Temperature

The monthly mean air temperatures at Aboa were well below freezing and had a strong annual cycle (Table 2, Fig. 3). Some recorded daily summer temperatures have been extremely high due to strong radiation and snow free surface (Table 2). Coldest months were July and August and warmest ones December and January. The highest recorded temperature 9.7°C was observed 4 January 1991 and the lowest -42°C was observed 12 May 1995. Neumayer and Buoy 5895 had warmer summer months and colder winter months than Aboa (Figs. 3 and 6). They are both located on the ice shelf and the cold winter temperatures could be caused by temperature inversion. The monthly average values differed least during spring and autumn months when the low pressure systems were predominant in the whole area. If we use the Neumayer temperature data for the Aboa area it is suggested to use monthly corrections shown in Table 5.

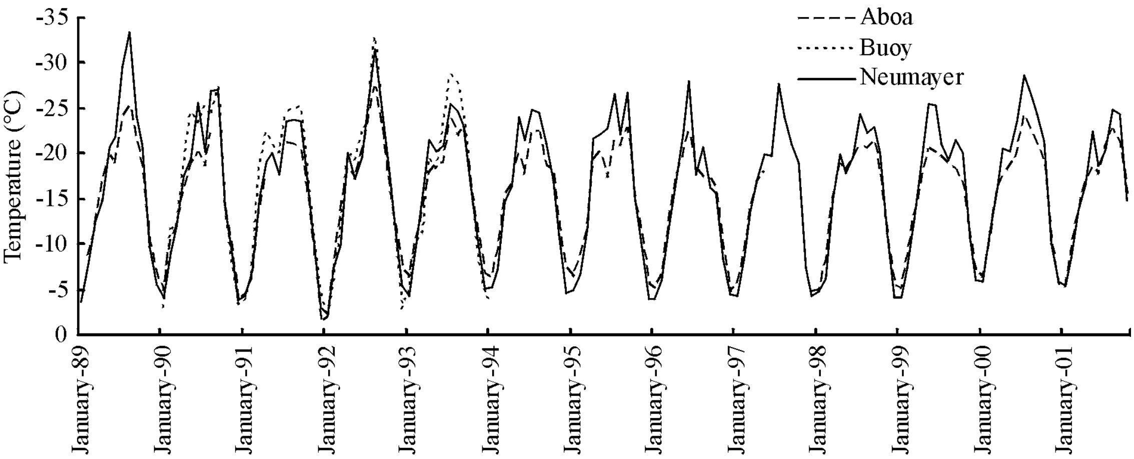

Fig. 6. The monthly temperature values from Aboa, Buoy 5895 and Neumayer covering years 1989-2001 (Buoy 1990-1993).

The mean annual temperature at Aboa was -15 °C (Table 3; Fig. 7). It was one degree warmer than at Neumayer. The Dutch weather station AWS 5 located 10 km from Aboa recorded the mean of -17.1 °C for the years 1998-2000 (*Reijmer*, 2001). Those three years were 0.5 degrees colder than average at Neumayer. AWS 5 is located at an elevation 121 m lower than Aboa. *Fortuin and Oerlemans* (1990) found a linear regression with elevation and latitude for surface temperatures in Antarctica. Their regression coefficients for Aboa gives too low mean annual surface temperature value; -16.8 °C. The difference might be explained by the local effect of the nunatak. *Reijmer* (2001) gave also lower annual temperature to the ice shelf (AWS 4 -20.0 °C, years 1998-2000) than Buoy 5895 (-15.9 °C, years 1990-1993; Table 3).

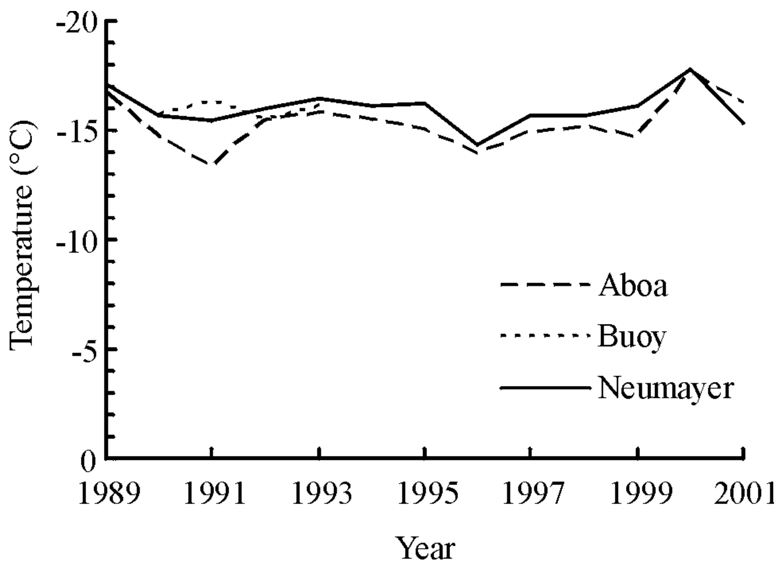

Fig. 7. The annual mean air temperatures from Aboa, Buoy 5895 and Neumayer. In calculations the missing monthly values of Aboa have been replaced with the monthly mean value of 1989-2001.

4.3 Air pressure

The Neumayer air pressure was reduced to sea-level using the simple rule of thumb: 8 m increase in elevation corresponds to 1 hPa decrease in pressure (personal communication with Dr. König-Langlo). The same has been used here for the Aboa and Buoy data. The mean annual air pressure at Aboa has been 927.2 hPa and while reduced to sea level it is 987.7 hPa (Table 3). The monthly values correlate well with the values from Neumayer (r = 0.91). The winter air pressure values from Aboa and Neumayer were similar but the lower air pressure values were observed at Neumayer during the summer and this might be due to its closer location to the circumpolar trough. The air pressure at Aboa can be estimated from the values from Neumayer (Table 5).

The semi-annual oscillation was causing the minimum in the air pressure in spring and autumn (Fig. 3), which indicates that there was maximum depression activity during these months; the circumpolar trough was deepest and also closest to the continent at that time (*King and Turner*, 1997). The half-yearly wave has maximum in summer and autumn, which represents the months in which the circumpolar trough is situated furthest away from the continent (*Van den Broeke*, 1998). This is also seen in decrease in snow accumulation during the summer months (*Enomoto*, 1991). The lowest annual mean pressure in Aboa was observed in 1998 (Table 3). According to *Reijmer and Van den Broke* (2001) in 1997-98 a strong El Niño influence was observed and the mean pressure at Neumayer was lower than average in 1998.

5. Conclusions

The coastal areas of the Antarctic continent have variable climate compared to the polar plateau and they are affected by the intense cyclonic storms from Southern Ocean. The Finnish research station Aboa (73°03'S, 13°24'W) is located in western Dronning Maud Land on the Basen nunatak. The area is influenced by the weather systems moving across Weddell Sea. This study describes the meteorological statistics from Aboa covering the years 1989-2001, and compares the data to Buoy 5895 operated on the ice shelf in 1990-1994 and the Neumayer station.

The seasonal variations were evident for wind, temperature and pressure; stronger winds and lower temperature dominate during winter. In the air pressure the semi-annual oscillation of the circumpolar trough could be seen. Diurnal fluctuations were stronger during summer for the temperature and wind due to solar radiation.

The local climate of Aboa is characterised by the effect of the nunatak. The mean annual air temperature was -15 °C, wind speed 7.5 m s^{-1}, air pressure reduced to sea level 987.6 hPa and the dominant wind direction 30° during 1989-2001. The mean annual air temperature was few degrees warmer than the measured values on the nearby glacier at lower elevation (*Reijmer*, 2001).

Annual temperature was also a degree warmer than value from Neumayer and it was not showing the decrease of temperature with increasing latitude. Neumayer had a wider difference between summer and winter temperatures having warmer summers and colder winters than Aboa. Colder winters at Neumayer were partly due to temperature inversion and warmer summers caused by more coastal location near the sea, even though Aboa having snow free rock surfaces heated by solar radiation during the summer. The monthly air pressure and wind speed values at Aboa correlate well with the values from Neumayer showing the influence of same cyclonic activity. Wind directions at Aboa were significantly constant due to local topography and katabatic winds were seen in the wind direction data showing a peak around 190-210°.

The MILOS 200 weather station broke down at the end of November 2001 at Aboa and the new weather station was set up during the season 2002/2003. The area has come in for wide range of scientific research and the climatic data is important to get to support the other studies.

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References

Bintanja, R., 1998. The contribution of snowdrift sublimation to the surface mass balance of Antarctica. *Annals of Glaciology,* **27**, 251-259.

Bromwich, D.H., 1988. Snowfall in high southern latitudes. *Reviews of Geophysics,* **26**(1), 149-168.

Colbeck, S.C., 1991. The layered character of snow covers. *Reviews of Geophysics,* **29**(1), 81-96.

Enomoto, H., 1991. Fluctuations of snow accumulation in the Antarctic and sea level pressure in the southern hemisphere in the last 100 years. *Climatic Change,* **18**, 67-87.

Fortuin, J.P.F. and J. Oerlemans, 1990. Parameterization of the annual surface temperature and mass balance of Antarctica. *Annals of Glaciology,* **14**, 78-84.

Gallée, H. 1998. Simulation of blowing snow over the Antarctic ice sheet. *Ann. Glaciol.*, **26**, 203-206.

Gjessing, Y. and B. Wold, 1986. Absolute movements, mass balance and snow temperatures of the Riiser-Larsenisen Ice Shelf, Antarctica. *Nor. Polarinst. Skr.*, **187**, 23-31.

Isaksson, E. and W. Karlén, 1994. Spatial and temporal patterns in snow accumulation, western Dronning Maud Land, Antarctica. 1994. *Journal of Glaciology*, **40**(135), 399-409.

King, J.C. and W.M. Turner, 1997. *Antarctic meteorology and climatology*. Cambridge Univ. Press, New York. 409 pp.

Koponen, I.K., A. Virkkula, R. Hillamo, V.-M. Kerminen, M. Kulmala, 2003. Number size distribution and concentrations of the continental summer aerosols in Queen Maud Land, Antarctica. *Journal of Geophysical Research,* **108**(D18), 4587 doi:10.1029/2003JD003614.

Kärkäs, E., H.B. Granberg, C. Lavoie, K. Kanto, K. Rasmus and M. Leppäranta, 2002. Physical properties of the seasonal snow cover in Dronning Maud Land, East-Antarctica. *Annals of Glaciology,* **34**, 89-94.

König-Langlo, G., J.C. King and P. Pettré, 1998. Climatology of the three coastal Antarctic stations Dumont d'Urville, Neumayer, and Halley. *Journal of Geophysical Research*, **103**(D9), 10 935-10 946.

Launiainen, J., J. Uotila, T. Vihma, P. Taalas, K. Karlsson and J. Siivola, 1995. Meteorological observations at the Aboa station. *Antarctic Reports of Finland*, No **5**, 30 pp.

Launiainen, J., T. Vihma, J. Aho and K. Rantanen, 1991. Air-sea interaction experiment in the Weddell Sea. *Antarctic Reports in Finland*, No **2**, 46 pp.

Noone, D., J. Turner and R. Mulvaney, 1999. Atmospheric signals and characteristics of accumulation in Dronning Maud Land, Antarctica. *Journal of Geophysical Research*, **104**(D16), 19 191-19 211.

Reijmer, C.H., 2001. Antarctic meteorology -A study with automatic weather stations. PhD thesis, Utrecht University. 158 pp.

Reijmer, C.H. and M. R. Van den Broeke, 2001. Moisture source of precipitation in western Dronning Maud Land, Antarctica. *Antarctic Science* **13**(2): 210-220.

Van den Broeke, M.R., 1998. The semi-annual oscillation and Antarctic climate. Part 1: influence on near surface temperatures (1957-79). *Antarctic Science* **10**(2) 175-183.