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Distribution and Movement of Low Pressure Systems in the Weddell Sea Region during FGGE

By Annette Kirk and Peter Speth*

Summary: Based on surface observations different meteorological conditions in regions of the Weddell Sea area are presented. Charts show the seasonal frequency distribution of cyclones south of 45 ° S during the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE) 1979. Meridional profiles of the zonal frequencies of the systems are compared with corresponding profiles of sea level pressure (SLP), and examples of typical cyclone tracks are given.

Zusammenfassung: Anhand von Stationsmeldungen werden die unterschiedlichen meteorologischen Verhältnisse in verschiedenen Regionen des Weddell-See-Gebietes gezeigt. Abbildungen zeigen die jahreszeitlichen Häufigkeiten von Tiefdruckgebieten südlich von 45 ° S während FGGE 1979. Meridionalprofile von zonalen Verteilungen der Systeme werden mit den zugehörigen Profilen des Bodenluftdruckes verglichen und Beispiele typischer Zugbahnen von Zyklonen gezeigt.

1. INTRODUCTION

The Weddell Sea region is an interesting research area. In many case studies SCHWERDTFEGER and his collaborators discussed the special meteorological aspects (e. g. SCHWERDTFEGER et al., 1959; SCHWERDTFEGER, 1962; SCHWERDTFEGER & KACHELHOFFER, 1973; SCHWERDTFEGER, 1974, 1975a, 1975b, 1976, 1977; SCHWERDTFEGER & KOMRO, 1978; SCHWERDTFEGER, 1979a, 1979b). From the climatological point of view the Weddell Sea with its coldest coastal area of Antarctica is a source region of cold water, ice, and cold air. This is based on the large southern extension of the Weddell Sea basin up to 78 ° S. The western part of the Weddell Sea is bounded by the north-south oriented Antarctic Peninsula with mountains between 1000—2000 m in elevation, which block the air masses flowing from east to west. Therefore the stable cold air masses drifting over the ice covered Weddell Sea change the flow direction and drift northward parallel to the mountain ridge up to at least 63 ° S, where the Antarctic Peninsula ends. This flow from south to north advects cold air, ice, and water masses into areas dominated by the westerlies (van LOON et al., 1971). SCHWERDTFEGER & AMATURO (1979) discussed in detail the surface wind field and related weather conditions along the coast of the Antarctic Peninsula. The persistent 'barrier winds' along the east side of the Peninsula have often been misinterpreted in synoptic analyses as low pressure systems over the central Weddell Sea.The described cyclonic atmospheric flow forces the oceanic circulation of the so-called Weddell Gyre, which transports the ice and cold water masses to the north and east. By that reason sea surface temperatures in the South Atlantic sector are lower than in southern oceans at the same latitude. The Weddell Gyre extends as for as 30° E with an influence on the eastern boundary of the Weddell Sea. This can be seen from synoptic observations of the stations SANAE (70 ° S, 2 ° W) and Halley Bay (75 ° S, 27 ° W) (see section 2): the warmer air advected by synoptic systems crosses the belt of cold water advected by the Weddell Gyre from the west, and the temperatures decrease. The result is a relatively low yearly mean air temperature at the given stations.

The data available for the Southern Hemisphere (SH) prior to 1979 have a low degree of accuracy because of irregular measurements and large areas devoid of data. In the last few years the Australian operàtional analyses improved due to new interpolation-schemes and modern methods of satellite imagery. The

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most complete set of atmospheric data ever obtained has been supplied by the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE), which was conducted from December 1978 to November 1979. The observational network was enhanced during this period, especially in the SH. Drifting buoys, constant level balloons, ship observations, satellites and planes enabled a much more detailed analysis of the hemisphere than ever before. The present study is based on sea-level maps for the 11-month period January 1979 to November 1979, analysed by the European Centre for Medium Range Weather Forecasts (ECMWF)/Reading, U. K. A 4-dimensional data-assimilation system has been used to produce the FGGE level III-b data-set at the ECMWF (BENGTSSON et al., 1982a). The system consists of a three-dimensional multivariate optimum interpolation, a nonlinear normal mode initialization, and an associated automatic system for data checking. A 15-level model with a horizontal resolution of 1.875 degrees is used for the dynamical assimilation. The quality of the observations, and in particular, those from the special observing systems must be regarded as very high.

The aim of this paper is to give an overview of the distribution and movement of cyclones in the Weddell Sea region (45° S—80° S, 90° W—40° E) during FGGE 1979 with the aid of higher qualified analyses than in the past, and to discuss the synoptic situation with the aid of synoptic observations measured by Antarctic stations. Section 2 will give an insight into the meteorological conditions in the Weddell Sea area during 1979; in section 3 the seasonal distribution of low pressure systems is shown and meridional profiles of the total and relative numbers of systems which occurred per season, are given. In section 4 typical cyclone tracks during the FGGE period are presented followed by concluding remarks in section 5.

2. SURFACE OBSERVATIONS

To get an insight into the meteorological conditions of 1979, monthly mean surface observations of temperature (T) and sea level pressure (SLP) are shown for stations in the Weddell Sea area (Fig. 1). The data were made available by the National Center for Atmospheric Research (NCAR)/Boulder, USA. Data gaps could be filled by time series provided by Schwerdtfeger/Madison, USA. For comparison, the data

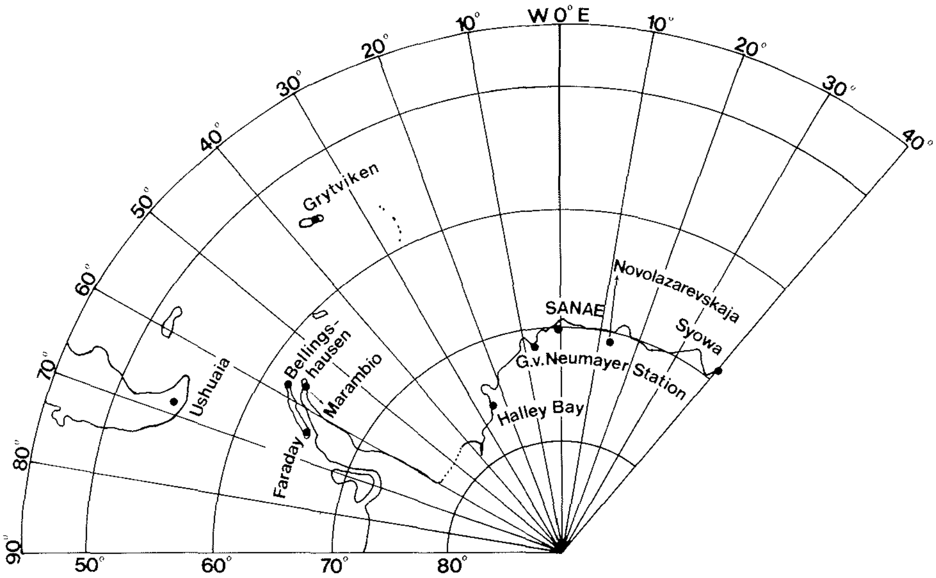


Fig. 1: Map of study area between 90° W—40° E and 45° S—90° S with stations showing monthly mean values of synoptic observations.

Abb. 1: Kartenausschnitt des Untersuchungsgebietes zwischen 90° W—40° E und 45° S—90° S mit den Stationen, für die Monatsmittel synoptischer Beobachtungen vorliegen.

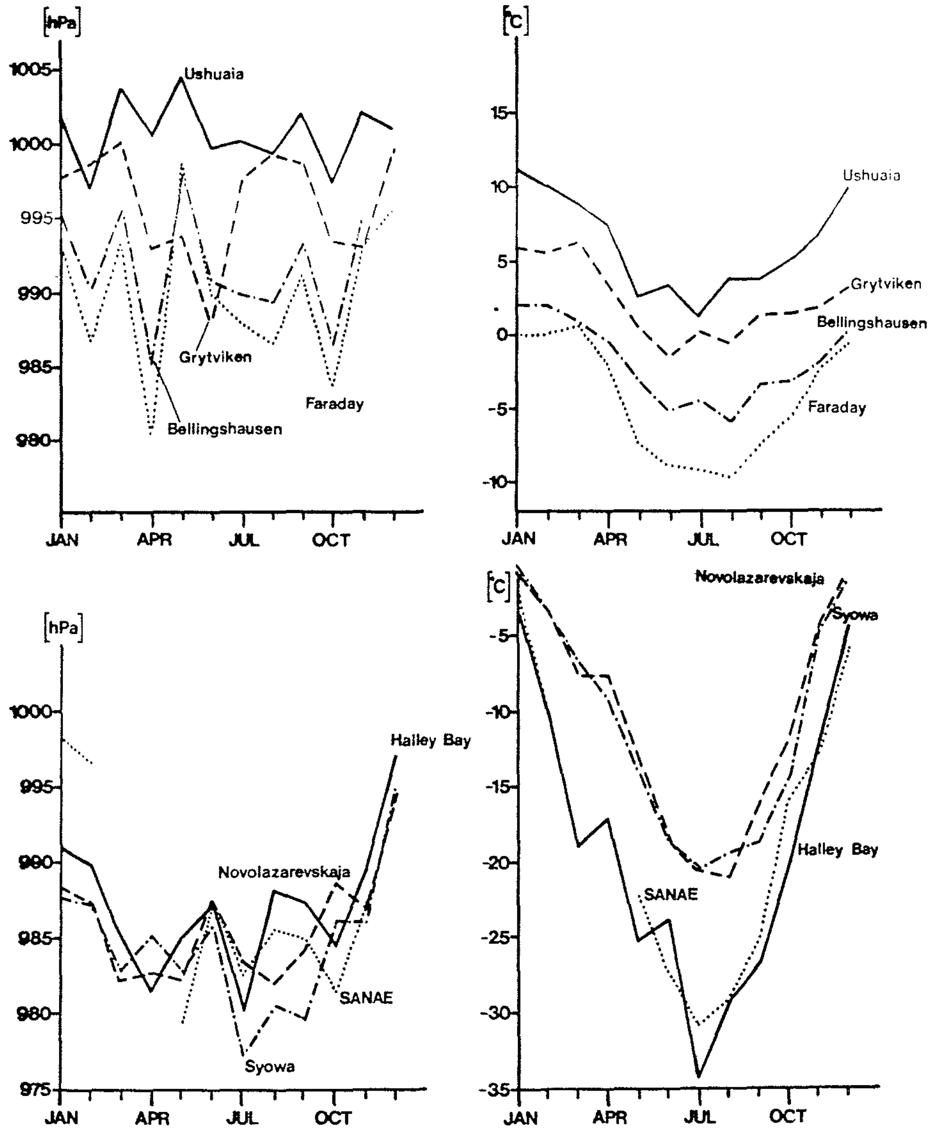
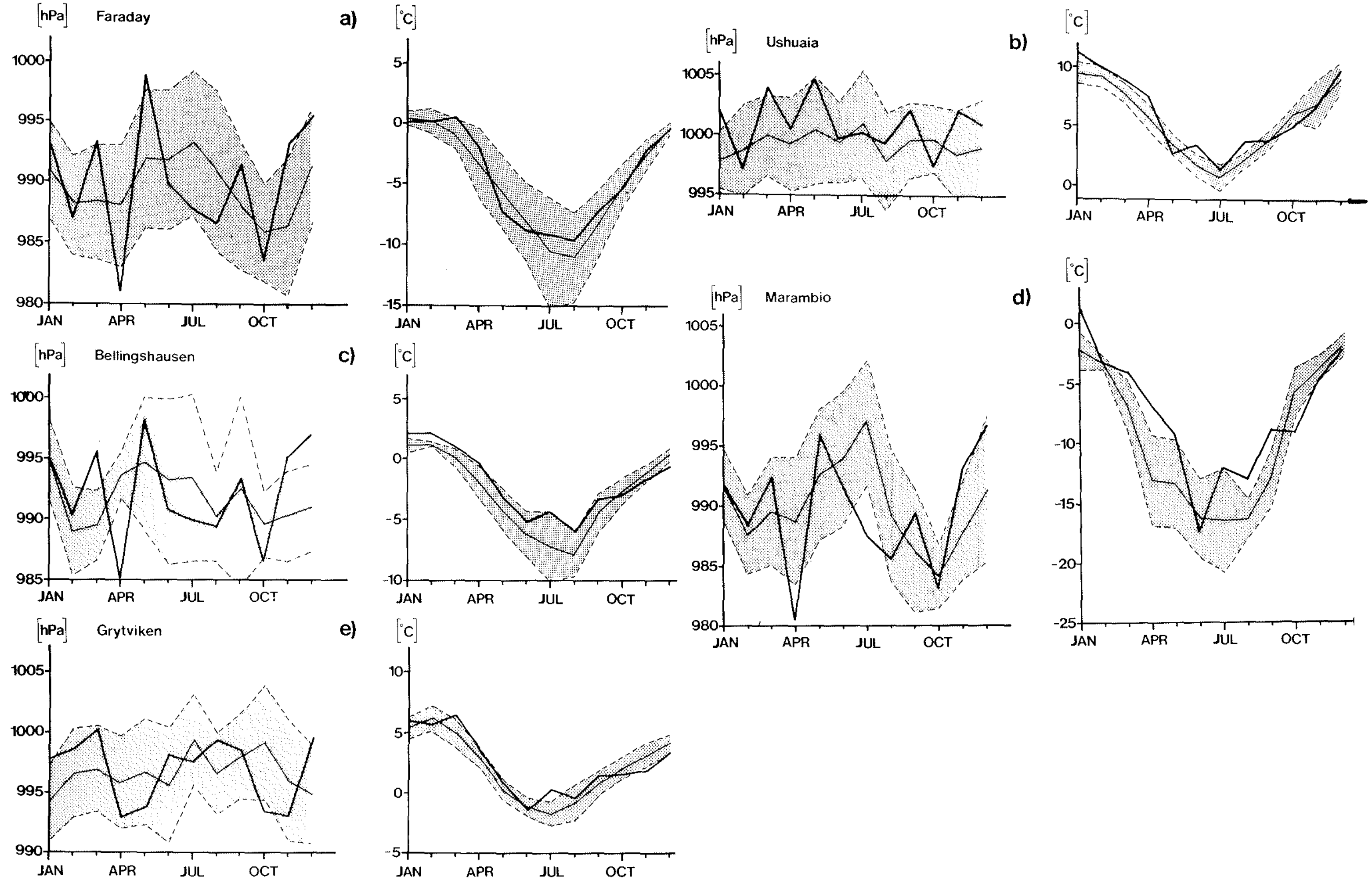


Fig. 2: (above): Monthly mean values of sea level pressure (SLP) in hPa and temperature (T) in °C for Ushuaia (54° S, 64° W), Grytviken (54° S, 36° W), Bellingshausen (62° S, 60° W) and Faraday (65° S, 64° W) in 1979.
(below): As above for Halley Bay (75.5° S, 27° W), SANAE (70° S, 2° W), Novolazarevskaja (71° S, 12° E) and Syowa (69° S, 39.5° W).

Abb. 2: (oben): Monatsmittelwerte von Bodenluftdruck in hPa und Temperatur in °C für Ushuaia (54° S, 68° W), Grytviken (54° S, 36° W), Bellingshausen (62° S, 60° W) und Faraday (65° S, 64° W) für 1979.
(unten): Wie oben für Halley Bay (75.5° S, 27° W), SANAE (70° S, 2° W), Novolazarevskaja (71° S, 12° E) und Syowa (69° S, 39.5° E).

of eight stations are arranged on Figs. 2a and 2b. Faraday (65.2° S, 64.4° W) is positioned on the western side of the Antarctic Peninsula, while Ushuaia (54° S, 68° W) is located on the southern tip of South America. While the annual cycle of T is similar at these two stations, larger variations of SLP occur for Faraday. The minima of SLP for both stations in April and October show the half-yearly oscillation of the pressure (van LOON, 1967; STEPKO & WIELBINSKA, 1981). Grytviken, South Georgia (54° S, 36° W) and Bellingshausen (62.2° S, 59.8° W) will be compared with the previous stations. Faraday and Bel-


a)
Faraday
[hPa]
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Ushuaia
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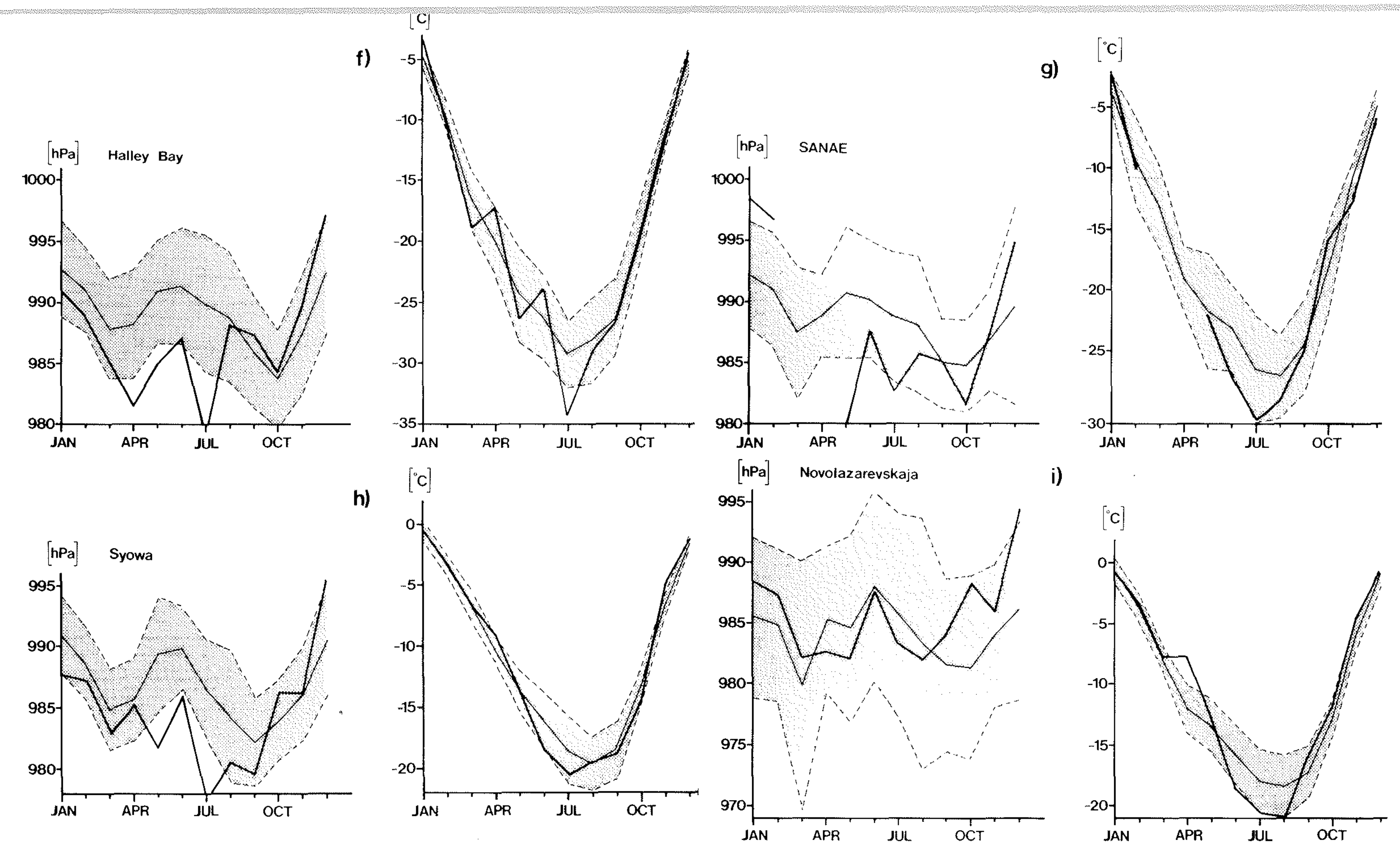


Fig. 3: Longer-term annual cycle of SLP in hPa and T in °C with corresponding standard deviation (broken lines). The area of deviation is shaded. The curve for 1979 is extra bold.
a: Faraday; mean for 1947—1982 (SLP, T); b: Ushuaia; mean for 1971—1981 (SLP, T); c: Bellingshausen; mean for 1968—1980 (SLP), 1968—1982 (T); d: Marambio; mean for 1973—1981 (SLP), 1970—1980 (T); e: Grytviken; mean for 1971—1982 (SLP, T); f: Halley Bay; mean for 1956—1982 (SLP, T); g: SANAE; mean for 1957—1981 (SLP, T); h: Novolazarevskaja; mean for 1962—1981 (SLP), 1961—1982 (T); i: Syowa; mean for 1957—1979 (SLP, T).

Abb. 3: Langzeitlicher Jahresgang von Bodenluftdruck in hPa und Temperatur in °C mit zugehöriger Standardabweichung (gestrichelte Linien). Der Schwankungsbereich ist schattiert. Der Kurvenverlauf für 1979 wird durch eine dicke durchgezogene Linie dargestellt.
a: Faraday: Mittelungszeitraum 1947—1982 (SLP, T); b: Ushuaia; Mittelungszeitraum 1971—1981 (SLP, T); c: Bellingshausen; Mittelungszeitraum 1968—1980 (SLP), 1968—1982 (T); d: Marambio; Mittelungszeitraum 1973—1981 (SLP), 1970—1980 (T); e: Grytviken; Mittelungszeitraum 1971—1982 (SLP, T); f: Halley Bay; Mittelungszeitraum 1956—1982 (SLP, T); g: SANAE; Mittelungszeitraum 1957—1981 (SLP, T); h: Novolazarevskaja; Mittelungszeitraum 1962—1981 (SLP), 1961—1982 (T); i: Syowa; Mittelungszeitraum 1957—1979 (SLP, T).

lingshausen show similar curves for SLP and T. Grytviken has the same latitude as Ushuaia, but influenced by the Weddell Sea its annual mean temperature is 5K lower. Halley Bay (75.5° S, 26.8° W) and SANAE (70° S, 2° W) on the southeast/east border of the Weddell Sea show a similar T-curve in spite of their different locations in latitude. However, the T amplitudes are increased compared with the stations on the Antarctic Peninsula. At Novolazarevskaja (71° S, 12° E) it is warmer than at SANAE. This shows that SANAE and Halley Bay are influenced by the dominating circulation over the Weddell Sea area. The low temperatures of the stations on Fig. 2b compared to those on Fig. 2a are also surely caused by katabatic winds in this region flowing down from the ice plateau. Syowa (69° S, 39.5° E) in the east of the reflected area behaves similar to Novolazarevskaja, but shows an extreme SLP-minimum in July. Apart from that there is a remarkably similar behaviour in the SLP-curves for the stations located in the eastern part of the research area with minima in autumn and/or winter.

From Figs. 2a and 2b it follows that the meteorological conditions are quite different in the western and in the eastern part of the Weddell Sea area. But the curves discussed represent only the year 1979 and not longer-term conditions. A comparison of FGGE-values for temperature and sea level pressure with longer-term means and the corresponding standard deviation (Fig. 3) shows that a strong low pressure period dominated in autumn and winter. In April SLP at different stations show values below the deviation range of the longer-term mean. This is pronounced in the western Antarctic Peninsula region (see Bellingshausen and Faraday) and in the eastern part of the Weddell Sea basin (see Halley Bay and SANAE), where the low pressure period extends to July. This is also the case for Syowa lying at the coast of East Antarctica. Generally T does not exhibit major departures from the longer-term mean.

The deviations of the SLP found at these stations in the Weddell Sea region agree with the results found by PHYSICK & TUCKER (1981), who noted for the stations in East Antarctica that the circumpolar low pressure belt during FGGE was more intense than previously registered. According to BENGTSSON et al. (1982b) the studies during FGGE strongly suggest that the winter circulation in the SH generally is more intense than previously assumed. They found from the ECMWF analyses of FGGE that the winds at the surface are generally stronger than in the known climatology. We will refer further in the text to "known climatology" as the longer-term behaviour of principal parameters of the mean monthly circulation, described earlier by 1) the synoptic analyses by the Australians, 2) synoptic analyses made for the International Geophysical Year (IGY) 1957/58 in South Africa (TALJAARD & van LOON, 1964; TALJAARD, 1972) and 3) mean charts published in atlas form by TALJAARD et al. (1969). Both the interannual variability and the longer-term fluctuations in the SH are very large. As TRENBERTH & van LOON (1981) pointed out, in 1976 the circulation was just as anomalous and persistent as it was during FGGE, but for the most part with the opposite sign. Van LOON & ROGERS (1981) compared the strength of the westerlies at the surface during FGGE with strengths during reasonable number of other years. They found that in winter the westerlies were clearly exceptionally strong between 50° S and 65° S in comparison with the ten winters 1957/58, 1972—79 from Australian operational analyses, because the mean for June/July/August 1979 was 2.5 σ above the ten-year-average.

The next section will show the distributions of cyclones during FGGE for the Weddell Sea region and surroundings, and compare the results with earlier studies.

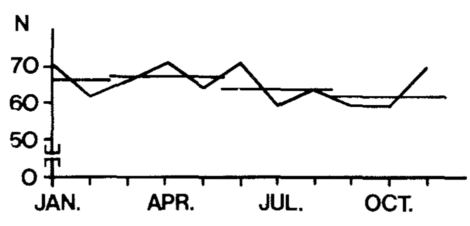


Fig. 4: Total number of cyclones per month observed in the study area from January to November 1979; bars denote averages per season: summer (Jan, Feb), autumn (Mar, Apr, May), winter (Jun, Jul, Aug) and spring (Sep, Oct, Nov).

Abb. 4: Anzahl der Tiefdrucksysteme pro Monat im Untersuchungsgebiet in der Zeit von Januar bis November 1979; die Querbalken stehen für Jahreszeitenmittel: Sommer (Jan, Feb), Herbst (Mär, Apr, Mai), Winter (Jun, Jul, Aug) und Frühling (Sep, Okt, Nov.).

3. SEASONAL DISTRIBUTION OF LOW PRESSURE SYSTEMS

TALJAARD & van LOON (1963) presented charts indicating the positions and dates of cyclogenesis, the centres of sea level cyclones and anticyclones and the centres of 500 hPa geopotential minima during the summer of the IGY in the SH. They showed the tracks of the cyclones, anticyclones and 500 hPa minima for January 1958 and listed the main features of the distributions and tracks. They found a WNW-ESE orientation of tracks, two maxima in meridional frequency (20°—25° S; 60°—70° S) and a greater amount of low pressure systems in the region of East Antarctica than in West Antarctica. They also found cluster areas of cyclone centres near 25° E, 75° E, 105°—115° E, 145° E in the east of the Ross Sea and in the Bellingshausen Sea, occurring in the same areas for the months. STRETEN (1969) discussed the frequency and distribution of low pressure systems for the summers 1966/67 to 1968/69.

For determining frequency distributions of cyclones during FGGE we used daily charts (00 GMT) of sea level pressure analyses prepared by the ECMWF/Reading, U K. (BJOERHEIM et al., 1980) for the FGGE period January until November 1979. Cyclones are defined as low pressure systems with at least one closed isobar (using 5 hPa intervals). The procedure to find the distribution was conducted by counting all low pressure centres every day, so that the systems existing for any length of time were counted on every day of presence.

The monthly frequency of low pressure systems analysed (Fig. 4) varies only a little over the whole period; averaged over seasons we find a slight maximum in autumn. The histogram of cyclone intensity (Fig. 5) shows a clear shift to lower pressure in autumn, while in other seasons less intense systems dominate. The mean minimum pressure of all cyclones per month in the Weddell Sea area has a remarkable minimum in April 1979 (Fig. 3). This feature could also be seen in the SLP-curves of the synoptic observations at the stations located on the Antarctic Peninsula (Figs. 2a and 2b) for 1979.

According to TALJAARD (1967) "a difficulty exists in the SH in defining the seasons for studying phenomena on a hemispheric scale." He assumed that "the temperature is the most important element which determines the atmospheric circulation and, therefore, the temperature of the sea, which occupies 81% of the hemisphere, is taken as the most appropriate criterion for defining the seasons." So he defines two main seasons, the warm (summer) and the cold season (winter) of four months December to March and June to September, respectively, and two short intermediate seasons of two months April, May and October, November, respectively. We use this approach in the following pages, but because of lack of data we had to omit December for the summer season.

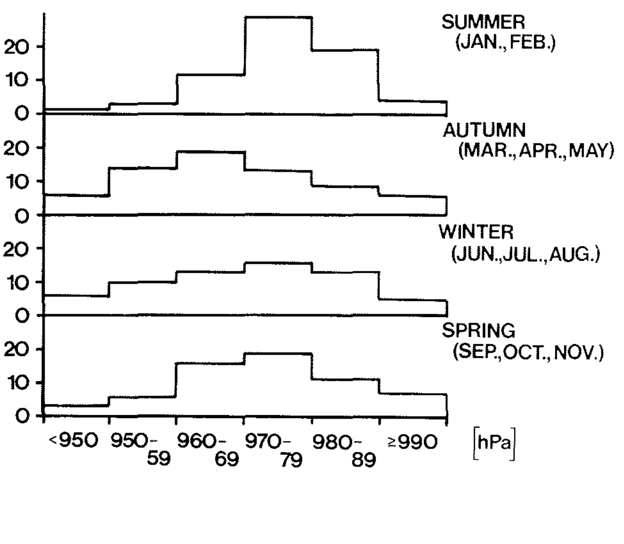


Fig. 5: Histograms of intensity in hPa of disturbances per season.

Abb. 5: Histogrammdarstellung der Intensität in hPa der pro Jahreszeit auftretenden Störungen.

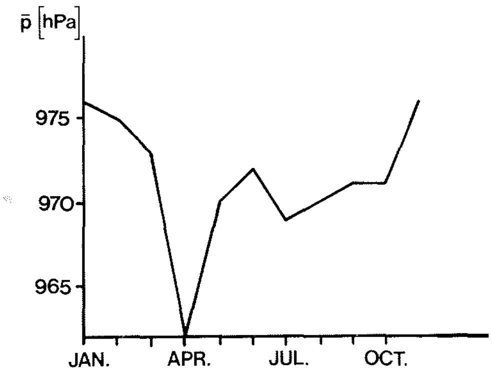


Fig. 6: Monthly mean SLP in hPa of all daily disturbances with at least one closed isobar in the study area in 1979.

Abb. 6: Monatlich gemittelter Kerndruck in hPa aller im Untersuchungsgebiet auftretenden täglichen Störungen mit wenigstens einer geschlossenen Isobare für 1979.

The seasonal fields of sea level pressure (SLP) which were computed from twice-daily analyses of the ECMWF are shown in Fig. 7. The mean latitudinal distribution of pressure, averaged between 90° W and 40° E, shows a stationary depression extending between 60—70° S (Fig. 8). The minimum values of the depression are 980 hPa in autumn as seasonal minimum and 986 hPa in summer as seasonal maximum. This latitudinal surface pressure minimum has two separate centres (Fig. 7): one west of the Antarctic Peninsula and another at the eastern boundary of the considered area. Besides these low pressure centres the main features of the pressure field in 1979 are its zonality and as a consequence, the large meridional

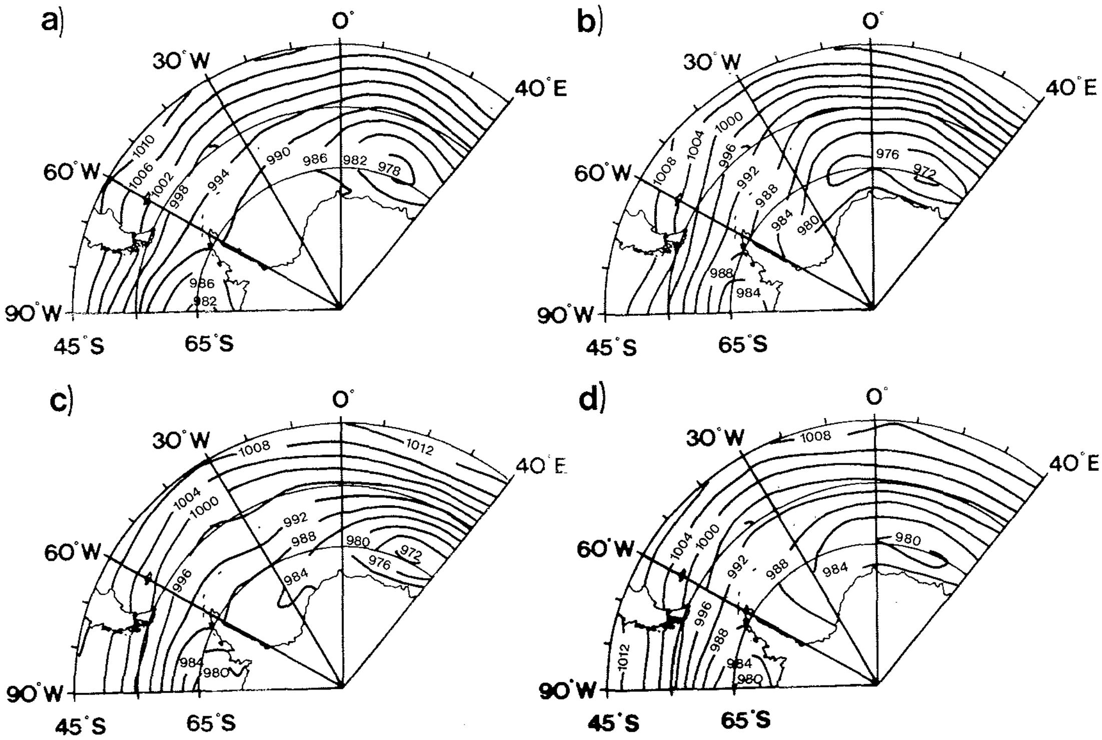


Fig. 7: Mean SLP-field in hPa over the study area from the ECMWF level III-b FGGE-dataset for the seasons: (a) summer (Jan, Feb, Mar), (b) autumn (Apr, May), (c) winter (Jun, Jul, Aug, Sep) and (d) spring (Oct, Nov).

Abb. 7: Horizontalverteilung des Bodenluftdruckes in hPa für das Untersuchungsgebiet aus dem ECMWF level III-b FGGE-Datensatz für die Jahreszeiten: (a) Sommer (Jan, Feb, Mär), (b) Herbst (Apr, Mai), (c) Winter (Jun, Jul, Aug, Sep) und (d) Frühling (Okt, Nov).

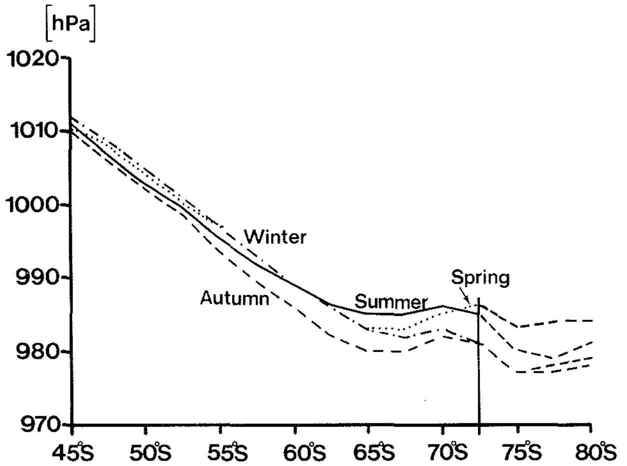


Fig. 8: Merdional profiles of zonal mean SLP in hPa averaged between 90° W and 40° E for the four seasons as in Fig. 7.

Abb. 8: Meridionalprofile des zonal gemittelten Bodenluftdruckes in hPa, gemittelt zwischen 90° W und 40° E für die vier Jahreszeiten wie in Abb. 7.

pressure gradients. STEPKO & WIELBINSKA (1981) show that especially in April the meridional pressure gradient reaches its maximum with more than 2 hPa per 100 km (see also van LOON & ROGERS, 1981).

In Fig. 9 horizontal distributions of low pressure systems are shown. The distributions were obtained by averaging the number of low pressure systems over an area with sidelengths of 5 degrees in latitude and 10 degrees in longitude. The data have been corrected to 45 ° S by multiplying the frequency in each block by

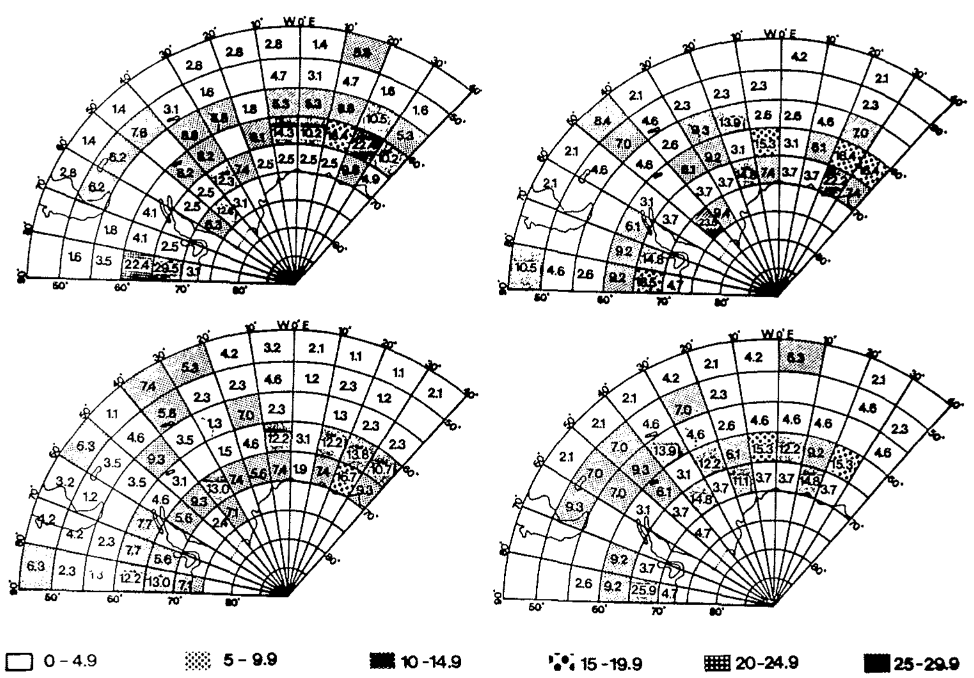


Fig. 9: Distribution of surface cyclone centres per 'unit block' (see text) per season (mean of (a) summer, (b) autumn, (c) winter and (d) spring).

Abb. 9: Horizontalverteilung der Zyklonenzentren am Boden in Einheitszonen (siehe Text) für die Jahreszeiten (Mittel für (a) Sommer, (b) Herbst, (c) Winter und (d) Frühling).

the factor F = 4 / n * cos45 ° / cos ϕ, where n is the number of months used as a season and ϕ is the mid-latitude of the block. This method makes the present results directly comparable with TALJAARD (1967) and STRETEN (1969).

The high frequencies occur in all seasons in the same areas. These areas are: west of the Antarctic Peninsula (60—70 ° S, 80—90 ° W), the eastern part of the considered area (60—70 ° S, 10—40 ° E), and the central Weddell Sea (65—75 ° S, 30—50 ° W). The frequency maxima of cyclones identify the pressure minima shown in Fig. 7. Because of the procedure used in determining the frequencies, the large cyclone frequencies in the west and the east of the Weddell Sea region resemble the strongly stationarity nature of the low pressure systems (STRETEN, 1969).

Meridional profiles of the total numbers of systems which occurred per season in 5 degrees latitude zones are given in Fig. 10. The curves are not continued polewards of 70 ° S because of doubtful SLP-analyses over the Antarctic continent. Therefore a part of the Weddell Sea which is important for the maintenance of the prevailing surface winds and currents had to be omitted. The relative densities of the systems, referring to the zone between 42.5 ° S and 47.5 ° S as unit zone, are included as broken lines. The summer meridional profile of cyclone frequency shows a maximum at 62.5 ° S which decreases to a minimum south of the circumpolar trough (Fig. 8) over Antarctica. In the density profile, the peak at 62.5 ° S is more pronounced. The winter profile of cyclone frequency also shows a peak at 62.5 ° S (67.5 ° S on the density profile), but this peak is less marked than in summer. It is interesting to see that the subantarctic

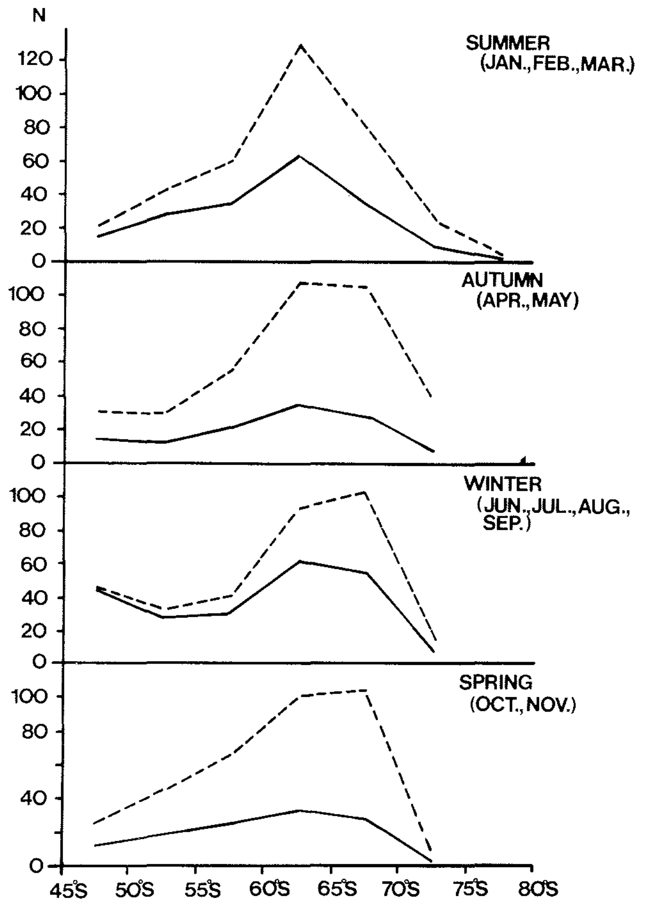
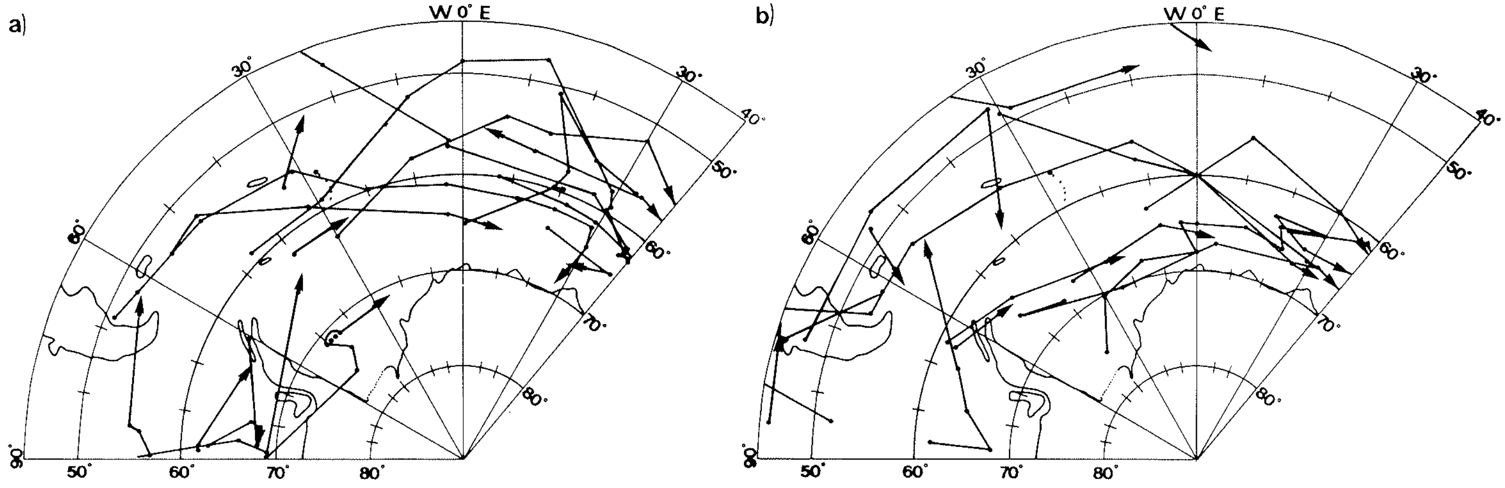


Fig. 10: Meridional profiles of total numbers of cyclone centres per 5 degree latitude zone (full line) and the same numbers corrected for the latitudinal variation of the area of the zones (broken lines, 'density profiles') for the seasons.

Abb. 10: Meridionalprofile der Gesamtzahl von Störungen für Gebiete mit 5 Grad Breitenabstand (durchgezogene Linien) und die gleiche Anzahl korrigiert für die breitenabhängige Änderung der Flächengröße (gestrichelte Linien, ‚Dichteprofile') für die Jahreszeiten.



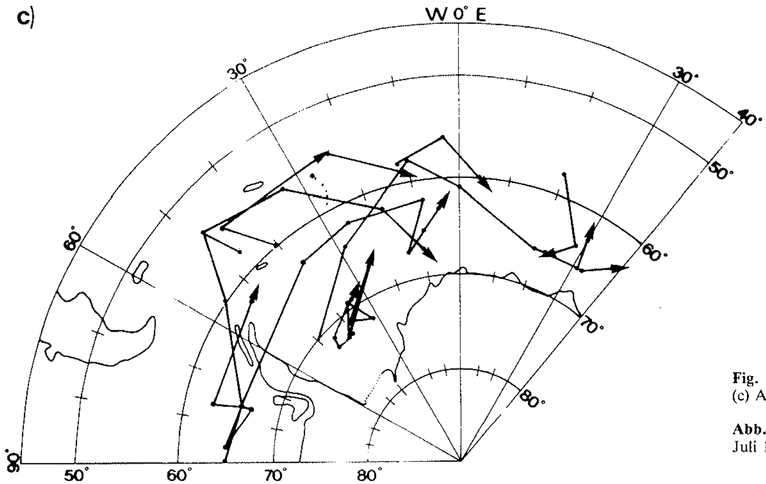


Fig. 11: Daily positions and tracks of cyclones in the study area during (a) January 1979, (b) July 1979 and (c) April 1979.

Abb. 11: Tägliche Positionen und Zugbahnen von Zyklonen im Untersuchungsgebiet im (a) Januar 1979, (b) Juli 1979 und (c) April 1979.

peak is about 2 degrees north of the mean axis of the circumpolar trough (Fig. 8). This is in good agreement with TALJAARD (1967) for the IGY. The Weddell Sea region shows no remarkable difference for the FGGE period 1979.

The field distributions in Fig. 9 reveal that in the western part of the research area the belt of largest frequencies seems to be farther in the north, but reaches the continental coastline in the eastern part. The belt seems to follow the position of the ice edge, which is important for the cyclone tracks (ACKLEY, 1979, 1981a, 1981b; CARLETON, 1981, 1983; STRETEN, 1983).

4. CYCLONE TRACKS

Van LOON (1962), TALJAARD & van LOON (1963) and TALJAARD (1967) published cyclone tracks for the SH for different summers prior to the IGY, and for the months of the IGY. STRETEN (1983) referred to cyclone tracks in the Ross Sea in May 1979 (FGGE). In this paper a number of tracks of selected systems are shown. Fig. 11 gives track charts for the individual FGGE-months January (summer), July (winter) and April. Generally the cyclones cross the Antarctic Peninsula or come from the western side of South America and move eastward. After passing the Weddell Sea area they turn southeast to the Antarctic continent, slow down and partially disappear ('graveyard'). The relatively high total number of cyclones in the investigated area in April (Fig. 4) and the minimum peak of the central surface pressure in the disturbances (Fig. 6) can be interpreted from the very southerly tracks of extremely deep depressions in April (Fig. 11c).

5. CONCLUSION

The results presented in this paper are based on monthly synoptic observations at Antarctic stations in the Weddell Sea area and on the level III-b data set of analyses produced by the ECMWF for the FGGE period January to November 1979. FGGE has, for the first time, provided a reliable global data set, and the experiment has supplied the most complete set of atmospheric data ever obtained (BENGTSSON et al. 1982b). This is especially true for the Southern Hemisphere. The quality of the analyses must be regarded as very high, because of the improved data coverage, primarily due to drifting buoys. We are interested especially in the Weddell Sea region and surroundings because of the German Antarctic activities at the Georg von Neumayer-station (70° S, 8° W) and the special meteorological aspects in that area described particularly by SCHWERDTFEGER and his collaborators.

The main result of our study is that during FGGE, the seasonal sea level pressure (SLP) field is characterized by a high zonality, i. e. strong meridional pressure gradients. The circumpolar low pressure belt in the area between 90° W and 40° E is located between 60—70° S with two separate centres, one in the west of the Antarctic Peninsula, the other located at 30—40° E at the eastern boundary of our area under investigation. Extreme low pressure values can be found in autumn with very deep cyclones. The behaviour of the SLP-field seems to be abnormal in comparison with the known climatology. According to GUYMER & LeMARSHALL (1981) and BENGTSSON et al. (1982b) the studies during FGGE suggest, that the winter circulation in the SH is generally more intense than previously assumed, and that the extreme pressure values in autumn and early winter 1979 are mainly explained by the improved data coverage. In contrast to this van LOON & ROGERS (1981) and TRENBERTH & van LOON (1981) show that FGGE, in comparison to the longer-term mean, behaves as an anomalous year in autumn/winter. The conventional station data and other sources such as the investigations of the intensity of the westerlies in the SH assess the statements of especially low pressure systems and a more intense low pressure belt during FGGE. While the summer circulation was quite normal, the winter shows clearly abnormal behaviour (see also PHYSICK & TUCKER, 1981 and STRETEN & PIKE, 1980). This can be exemplified by the station data in comparison with their climatology and is in good agreement with our results. For the temperatures there are no outstanding deviations from the longer-term mean in any way.

The investigation of the frequency distribution of daily disturbances during FGGE in the research area shows (in good agreement with the charts of the mean seasonal SLP fields) that most of the systems are located in the west of the Antarctic Peninsula and at the eastern boundary of the research area. The axis of the belt with highest frequencies extends slightly inclined from northwest (South America) to southeast towards the Antarctic coastline, and so seems to follow the ice edge of the pack ice. This can be duplicated with the aid of cyclone tracks. Based on these tracks it became evident, that the frequency maxima point to the strongly stationary nature of the low pressure systems in these areas (''graveyards'').

In summary, the results show that based on the FGGE level IIIb-analyses of the ECMWF and the monthly mean synoptic data of selected Antarctic stations in the Weddell Sea area, the SH circulation in autumn/winter 1979, with reference to the SLP field, was abnormal. We concur with van LOON, that this is not only a result of the improved data coverage during FGGE, primarily the drifting buoys, but can also clearly be seen by comparing observations with corresponding climatological data.

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