METEOROLOGICAL OBSERVATIONS ON ELEPHANT ISLAND

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ABSTRACT. Meteorological data collected by the Joint Services Expedition on Elephant Island during the summer of 1970–71 are presented and discussed. The season was characterized by relatively stable atmospheric conditions and an unexpectedly high frequency of southerly winds. It is tentatively suggested that this may be a regularly recurring feature of the climate of Elephant Island, a function of location in relation to the main outflow routes for Antarctic air.

METEOROLOGICAL observations were carried out on Elephant Island by members of the Joint Services Expedition during the period 5 December 1970–26 March 1971. These dates roughly define the summer season in this outer oceanic zone of Antarctica. The main object of the observations was to provide background climatological information for concurrent glaciological, geomorphological and biological research programmes, but, because Elephant Island bridges a major observational gap between the widely separated stations of the South Orkney Islands and South Shetland Islands proper, it was felt that such short-term records might also be a useful contribution to Antarctic climatology in general. An incidental aim of the observations was to provide an objective statement of weather conditions experienced by the expedition.

LOCATION AND SITE

The Elephant Island station was located near to the expedition base camp (lat. 61°12′S., long. 55°09′W.), which was 175 m. above sea-level and situated near the landward margin of an ice-free headland, adjacent to and west of the snout of Endurance Glacier (Fig. 1). The exposure of the site is generally poor, with high ground extending through the whole sector from east-south-east to north-north-west. To the south the ground rises to over 250 m. within a distance of 0·5 km. There is a relatively low gap to the west of the station, but westward from the gap the ground rises steeply in a narrow ridge to the summit of Mount Elder, 973 m. high and 3 km. distant from base camp. There is relatively free exposure in the north to east-south-east sectors; north-eastward across Endurance Glacier to the western summits of Paardo Ridge (10·5 km.) and eastward, parallel to the south coast of the island, to Clarence Island (48 km.). The screen was sited 30 m. south-west of the base camp hut on a broad low strip of stable lateral moraine. The surface is level and is composed of angular blocks of phyllite and schist with areas of more finely comminuted material forming the centres of large sorted circles.

INSTRUMENTS AND METHODS

The screen, which was set up with the floor 1·3 m. above the ground surface, was equipped with standard thermometers, a twin-bulb thermograph and a hair hygrograph. A Mk II rain gauge was sited about 5 m. away from the screen and a marine barograph was accommodated in the base hut.

Observations were made daily at 09.00 and 21.00 hr. zone time while the base camp was manned, but there were two protracted periods during which expedition operations were transferred to other locations, and for which autographic records only are available for the main station. However, general wind and weather observations were continued, according to the prescribed code and at the appointed times, at all outlying camps. Wind data are based on hand-anemometer readings, corrected to the standard 10 m. height; unless otherwise stated, they incorporate records from all camps.

OBSERVATIONS

Pressure

Elephant Island lies between the cold reservoir of the Weddell Sea and the relatively warmer Scotia Sea, near to the axis of the semi-permanent sub-polar trough of low pressure centred over the eastern part of the Weddell Sea. To the south-west, a weak ridge of high-pressure over

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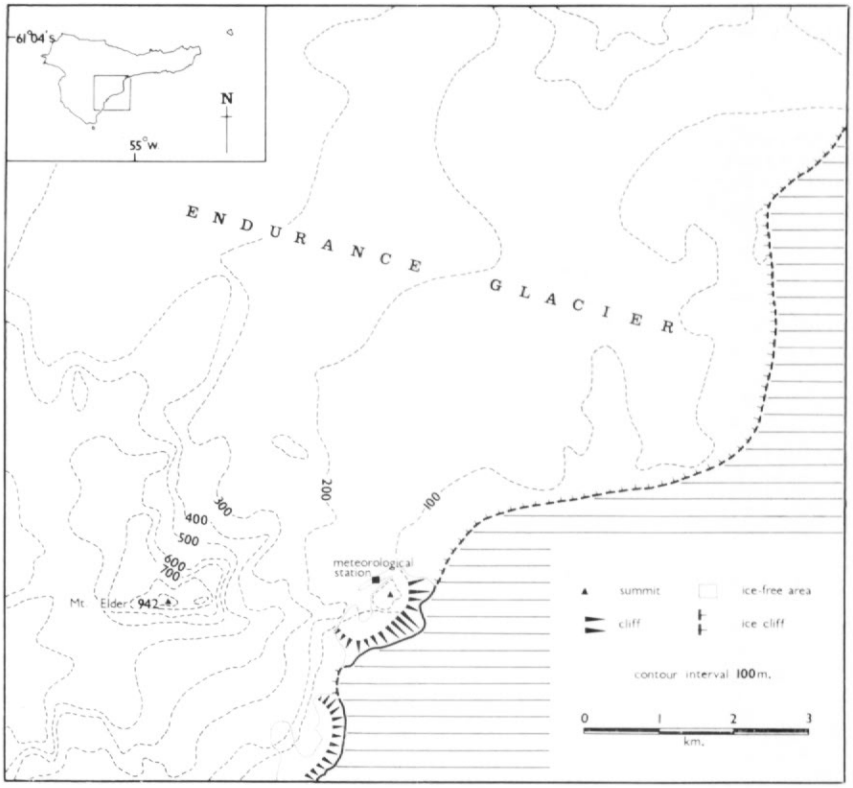

Fig. 1. Sketch map of the Elephant Island base camp area.

the Antarctic Peninsula, an area of frequent outflow of cold Antarctic air, is another recurring feature of the circulation, but the main gradient of increasing pressure is directed northward across the region, so that the main isobaric alignment is roughly east–west. The region is traversed by a constant procession of high- and low-pressure systems throughout the year. Anticyclones are generally short-lived and relatively unimportant, but, according to Lamb (1964*a*), the area has the greatest frequency of depression tracks in the Antarctic. Depressions develop to the north and west of the Antarctic Peninsula and many track across the island chain and spiral into the Weddell Sea trough. Short-term fluctuations of atmospheric pressure with the passage of successive frontal systems are frequent, rapid and often substantial.

Average values of barometric pressure are generally low; according to Pepper (1954), mean monthly pressure at all stations south of lat. 60°S. is less than 1,000 mbar, with about 80 per cent of all observations below this value. Extreme limits are thought to be between 940 and 1,040 mbar. There is a double annual pressure wave, the main peak occurring in early winter with a secondary maximum occurring in December or January. The lowest monthly means generally occur in October or November. Variations on Elephant Island followed the normal seasonal trend, mean pressure reaching a peak in January, then declining through February to March (Table Ia).

Actual values were somewhat lower than expected, though, in the absence of acceptable long-term "normals", it is not possible to assess accurately the extent of the deviation. However, for Signy Island, 435 km. to the east-north-east, provisional figures for the 4 months of the 1970–71 summer season were on average 3·6 mbar below the 1951–60 normals. The greatest deviation, 6·2 mbar, was in March. On Elephant Island, during the period of record, over 90 per cent of all observations were below 1,000 mbar (Table Ib).

TABLE Ia. M.S.L. PRESSURE (mbar)

Month	*Daily mean*	*Highest*	*Date*	*Lowest*	*Date*
December	987·2	1005	31	970	25
January	991·4	1009	7/8	972	31
February	990·0	1003	28	972	1
March	988·6	1007	2/3	971	25
Season	989·3	1009	7/8 Jan.	970	25 Dec.

TABLE Ib. M.S.L. PRESSURE; NUMBER OF OBSERVATIONS IN 5 mbar RANGES

Month	970–974·9	975–979·9	980–984·9	985–989·9	990–994·9	995–999·9	1000–1004·9	1005–1009·9	*Total*
December	9	42	30	57	46	29	13	5	231
January	6	16	46	57	48	38	16	26	253
February	7	12	25	51	52	65	12	0	224
March	18	24	23	44	41	45	8	6	209
Season	40	94	124	209	187	177	49	37	917
Per cent season	4·3	10·4	13·4	22·9	20·0	19·8	5·3	3·9	100

Temperature

In terms of temperature, the climate of the region is less severe than that of other parts of the Antarctic. The regime is typically oceanic and is characterized by low maxima, relatively modest extremes of cold and a relatively small temperature range. Throughout the year, the temperature gradient is orientated roughly north-west to south-east across the region, with the isotherms following the set of ocean currents and lying nearly parallel to the island chain. Pepper drew the −10° C mean monthly isotherm for July, normally the coldest month, across Elephant Island and the 1·0° C isotherm for January, the warmest month, a little to the south of the island. The mean annual temperature is thought to be in the region of −3° C.

December, with a mean temperature of −1·3° C, was the coldest month of the observation period. Thereafter, mean temperatures increased in January and declined again in February. The seasonal fall of temperature was halted in March, which, for the period of the slightly curtailed record, was marginally warmer than January (Table IIa). This was not the case at Signy Island, where January was the warmest month and mean temperatures declined steadily through both February and March. Mean values for Elephant Island were somewhat lower than those for Signy Island, the discrepancy averaging 1·6° C for the period, with a maximum difference of 2·2° C in December. However, when altitude effects are taken into account, differences between the two stations appear slight and are perhaps insignificant. Using "corrected" figures for Elephant Island, based on an estimated mean temperature lapse-rate of 0·7° C/100 m., the mean difference for the season reduces to 0·4° C, Elephant Island being the colder station. Signy Island, however, was the colder station in March, which appears to reflect a normal tendency for mean temperatures to fall in an easterly direction along the island chain; long-term records demonstrate that the South Orkney Islands are consistently cooler than the South Shetland Islands, probably because the former are more exposed to the cold air source of the Weddell Sea. These differences are most pronounced in the winter period.

TABLE IIa. TEMPERATURE (°C); MEANS

Month	00.00	03.00	06.00	09.00	12.00	15.00	18.00	21.00	*Daily mean*	*Mean daily* *Max.*	*Min.*	*Extremes* *Max.*	*Date*	*Min.*	*Date*
December	−2·3	−2·2	−1·8	−0·8	−0·4	−0·4	−1·2	−1·9	−1·3	0·7	−3·0	6·2	10	−4·6	31
January	−0·8	−0·8	−0·5	0·1	0·4	0·4	0·1	−0·7	−0·2	1·3	−1·6	4·8	15	−5·2	30
February	−1·0	−1·3	−1·2	−0·2	0·2	0·4	−0·7	−1·1	−0·6	1·4	−2·2	6·6	27	−6·7	4
March	−0·2	−0·3	−0·2	0·1	0·3	0·5	0·2	−0·5	0·0	2·6	−2·7	15·6	4	−9·5	16
Season	−1·1	−1·2	−0·9	−0·2	0·1	0·2	−0·4	−1·1	−0·5	1·5	−2·4	15·6	4 Mar.	−9·5	16 Mar.

Diurnal variations of temperature on Elephant Island were not very marked. The average amplitude was smallest in January (2·9° C), increasing slightly through February (3·6° C) to March (5·3° C) as the period of daylight shortened and nocturnal cooling became more pronounced. In December, minima tended to occur around or soon after midnight, but in subsequent months the daily minimum usually occurred around 03.00 hr. Daily maxima generally occurred between 12.00 and 16.00 hr. The largest daily range of the observation period was 13·3° C. This was associated with warm clear conditions in early March when föhn effects were apparent. The smallest daily range, 0·7° C, was recorded in mid-February and was associated with moist northerly winds and overcast conditions.

The pattern of diurnal temperature change is superimposed on one of short-term non-periodic variation caused by changing pressure systems and associated with winds bringing air from different sources of temperature. Under prevailing cyclonic conditions, therefore, air temperature on Elephant Island fluctuates rapidly from day to day within the relatively narrow limits imposed by the oceanicity of the climatic regime. Such rapid fluctuations of temperature often take place across the freezing point, which is of particular significance in a morpho-genetic and pedogenic context (O'Brien and others, in press). During the period 10 December–26 March, 68 freeze-thaw cycles were recorded in the screen. Of these, 47 were of less than 24 hr. duration; three were greater than 72 hr. duration. Table IIb provides some indication

TABLE IIb. FREQUENCY TEMPERATURE (°C); NUMBER OF OBSERVATIONS AT ALL HOURS IN 2° C RANGES

Month	*Negative* −10	−8	−6	−4	0° −2	2	4	6	*Positive* 8	10	12	14	16	*Total*
December	0	0	0	69	74	33	4	0	0	0	0	0	0	180
January	0	0	3	32	104	78	30	1	0	0	0	0	0	248
February	0	2	6	50	63	79	23	1	1	0	0	0	0	225
March	6	9	14	28	45	60	19	16	2	3	2	1	1	206
Season	6	11	23	179	286	250	76	18	3	3	2	1	1	859

of the intensity of freezing episodes and also shows that about 58 per cent of all observations were negative values. The lowest temperature recorded was −9·5° C. This occurred with the passage of a cold front and the establishment of a south-westerly air stream in mid-March. The range of positive temperatures was somewhat greater. The extreme maximum, 15·6° C, was recorded in föhn conditions in early March and appears to be a record high for the region.

Wind

Wind is undoubtedly the most obtrusive climatic element on Elephant Island; gales are common and the frequency of calms is low. Long-term records from nearby stations suggest that the mean annual wind speed for the area is in the region of 14 kt. Maximum mean velocities are experienced at the equinoxes, while minima tend to occur in December and January. Although changing pressure systems generate winds from all sectors, generally there is a pressure gradient for westerly winds in the area and these tend to predominate. However, to the south of the island arc the zonal westerlies give way to easterlies and winds with an easterly component are important at some stations at certain times of the year (Pepper, 1954).

Mean wind speed on Elephant Island during the period of observation was 13·7 kt (Table IIIa). December, with a mean speed of 10·7 kt, was the calmest month, mean velocities increasing through January (13·3 kt) and February (15·3 kt) to March (15·4 kt). Mean values were higher by an average of 2 kt than those for Signy Island for the same period. This, together with lower frequency of calms and light winds on Elephant Island (14 per cent), may be due in part to the effects of altitude at the base camp station and the fairly exposed situations of the three outlying camps. The velocity-distribution curve is typically cyclonic.

TABLE IIIa. WIND SPEED (kt); NUMBER OF OBSERVATIONS

Month	0–3	4–10	11–21	22–33	34+	*Total*
December	9	26	10	0	1	46
January	7	33	14	5	1	60
February	7	21	19	3	3	53
March	6	21	16	8	1	52
TOTAL	29	101	59	16	6	211
Per cent season	14·0	47·9	27·9	7·3	2·9	

The frequency of gale-force winds for the season was 2·9 per cent, February being the stormiest month (Tables IIIa and VII). The highest gusts occurred in a westerly gale on 25 February and were estimated to be in excess of 70 kt.

During the season as a whole, winds from all sectors were well represented, but those from the south-west quarter were most frequent, the dominant direction being south (Table IIIb). South to south-west, followed by east and north-east winds, tended to predominate in December, while the most frequent directions in January were north-east and south to south-east. Southerly winds again tended to prevail in February and it was only in March that the expected predominance of westerlies and north-westerlies developed. At Signy Island, in contrast, winds with a mainly westerly component predominated throughout the period, except in January when, as at Elephant Island, south-east winds were frequent.

TABLE IIIb. WIND DIRECTION FREQUENCY (deg.) IN 12 30° SECTORS (per cent)

Month	350–010	020–040	050–070	080–100	110–130	140–160	170–190	200–220	230–250	260–280	290–310	320–340
December	2·6	9·3	10·0	16·6	2·4	3·4	22·7	10·7	2·4	7·1	2·4	10·4
January	10·6	15·8	7·9	4·7	13·3	12·0	11·2	10·0	3·5	3·9	5·2	3·7
February	14·3	5·4	5·3	3·6	5·4	8·9	26·8	7·1	10·7	7·1	3·6	1·8
March	5·6	1·9	1·9	7·4	1·9	2·0	11·2	9·4	11·2	18·5	14·5	14·5
TOTAL	33·1	32·4	25·1	32·3	23·0	26·3	72·6	37·2	27·8	36·9	25·7	30·4
Per cent season	8·2	8·0	6·2	7·9	5·7	6·6	18·0	9·3	7·0	9·1	6·4	7·5

Generally the strongest winds were from the south-west to north sector and the lightest winds from the south and south-east (Fig. 2). Fig. 2 also illustrates shelter effects at the base station, the prominence of westerlies and northerlies and the relative infrequency of north-westerlies, suggesting a turning of winds from the whole north-west quadrant around the flanks of Mount Elder. A similar topographic turning was also apparent in the south-west.

It was found that the lowest air temperatures generally accompanied south to south-easterly winds. Relatively higher temperatures were associated with north to west winds, while föhn conditions with abnormally high air temperatures and low relative humidities occasionally developed with the wind in the west. However, the greatest chill effects were associated with the generally more vigorous, humid and "normally" more prevalent winds from the south-west to north-east sector, particularly those from the south-west and north-east directions (Fig. 2). On the other hand, the "colder" winds off the Weddell Sea were relatively light and dry and had appropriately smaller chill indices. The generality of this situation is reflected in

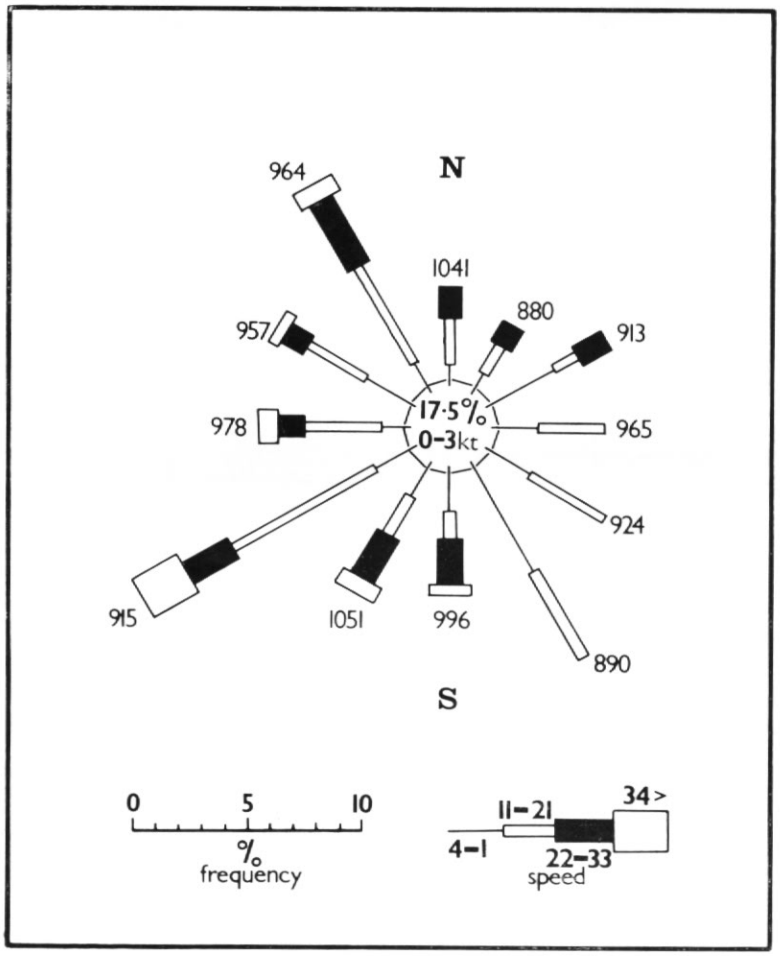

Fig. 2. Wind rose for the Elephant Island base station. The boxed figures are mean wind-chill indices for each direction.

the relative inhospitability and floristic and avifaunal poverty of north- and west-facing coasts of the island.

Precipitation and humidity

Both precipitation and relative humidity in the region are generally high. Precipitation occurs mainly in the form of snow but rain also occurs in the summer months and significant contributions to annual totals are made by rime deposition. Most of the precipitation is associated with fronts of the numerous depressions which track across the area. Due to the difficulties of measurement in cold environments, there is little information available on amounts involved, but it has been estimated (Robin and Adie, 1964) that some of the ice caps of the South Shetland Islands receive up to 150 cm. water equivalent per year. Snow-pit studies at the head of Endurance Glacier suggest that the maximum accumulation on Elephant Island for 1970–71 was about 175 cm. water equivalent. According to Pepper (1954), there appears to be little seasonal variation in the distribution of precipitation.

Although there are no contemporary comparative data, precipitation totals for Elephant Island (Table IV) appear rather high when compared with "representative" figures for other

TABLE IV. PRECIPITATION (mm.)

Month	*Total*	*Maximum fall*	*Date*
December	97	14	29
January	99	14	30
February	75	—	—
March	171	30	14
TOTAL	442		
MEAN	110·5		

stations. This may be partly due to normal orographic effects but it probably also reflects the more acute drift problems encountered at the relatively high-level Elephant Island site. The total for March was abnormally large and was almost certainly inflated by drifting caused by the strong westerlies which prevailed in the latter part of the month. February, in which lighter southerly winds predominated, was the driest month. Precipitation generally was mainly associated with winds from the northerly quadrants, the driest conditions being associated with southerly winds. The relative frequency of snow was much higher than that of rain (Table VII) and only about 12 per cent of the measured total fell as rain or drizzle. Rain was most often associated with winds from the northern sector. For the most part, precipitation intensities were light, but occasional heavy falls of rain or snow did occur, mainly in showers from cumulus or cumulo-nimbus clouds, usually while the wind was in the south-west to north-west sector. Continuous precipitation was mainly associated with north to north-east winds.

Relative humidities on Elephant Island were most often in the range 70 to 99 per cent (Table Vb). The fairly even distribution of values within these limits is not really typical for the region and the number of occasions when relative humidity reached 100 per cent is somewhat greater than is normally expected. Mean relative humidities were lowest in January and highest in December and March (Table Va). The highest daily values tended to occur around midnight in December but later in the early morning period as the season advanced. Lowest daily values generally occurred between 14.00 and 18.00 hr. zone time. The lowest relative humidities of the season accompanied high air temperatures and were associated with föhn winds. The minimum recorded was 45 per cent though this value is not particularly low in such circumstances. Under föhn conditions, relative humidities tended to fluctuate rapidly within wide limits.

Cloud and visibility

Large amounts of cloud are usual in this region and the cover probably averages about 7 oktas. There is a tendency for maximum cloud in autumn and spring and minimum cloud

TABLE Va. RELATIVE HUMIDITY (per cent) MEANS

Month	00.00	03.00	06.00	09.00	12.00	15.00	18.00	21.00	*Mean*
December	89·7	89·4	88·6	87·3	86·9	86·4	86·4	87·8	87·8
January	78·0	78·7	77·3	77·7	75·2	76·4	76·7	79·1	77·4
February	82·9	82·1	81·1	78·6	77·7	76·8	79·7	79·2	79·8
March	87·3	86·2	89·0	88·8	88·5	86·1	85·9	87·6	87·4
Season	84·5	84·1	84·0	83·1	82·1	81·4	82·2	83·4	83·1

TABLE Vb. FREQUENCY RELATIVE HUMIDITY (per cent); NUMBER OF OBSERVATIONS IN 5 PER CENT RANGES

Month	40	45	50	55	60	65	70	75	80	85	90	95	100
December	0	0	0	0	0	5	22	12	26	24	16	38	32
January	0	0	0	0	13	41	43	29	56	48	7	6	0
February	0	2	2	4	23	26	30	18	23	24	42	28	1
March	0	0	0	6	4	9	16	9	22	22	40	59	10
TOTAL	0	2	2	10	40	81	111	68	127	118	105	131	43

in winter and summer (Pepper, 1954). Average cover at Elephant Island, at 09.00 and 21.00 hr. zone time, during the period of record was about 6·5 oktas (Table VI). January, with a high frequency of north to north-east winds, was the cloudiest month, while February, in which southerly winds predominated, was the least cloudy. There was a slight detectable diurnal variation in cloud amount, cover generally being less at night than during the day. Greatest cloud amounts were yielded by the northern sector, particularly the north-east quadrant, while lowest amounts were from the south-east quadrant. No systematic observations of cloud height were undertaken, but it was noted that the cloud base was below the summit of Mount Elder (973 m.) on about 70 per cent of occasions.

TABLE VI. CLOUD AMOUNT (oktas)

Month	*Mean at 09.00 hr.*	*Mean at 21.00 hr.*	*Mean*
December	6·8	6·5	6·65
January	7·2	6·6	6·9
February	6·0	6·6	6·3
March	6·6	6·5	6·55
Season	6·65	6·55	6·6

Throughout the season stratified cloud formations tended to predominate. The most frequent low cloud type was stratus, followed by stratocumulus, fractostratus and nimbostratus; convection clouds, cumulus and cumulonimbus types occurred relatively infrequently. The high frequency of fairly structureless stratus is probably an orographic effect and the general prevalence of stratified cloud reflects the relative stability of air masses affecting Elephant Island for much of the period. The most frequently occurring medium cloud type was altocumulus and the commonest cirriform species were cirrus and cirrostratus. Lee-wave, roll and lenticular cloud formations were observed on a number of occasions. Wave formations were usually particularly well developed to leeward of Paardo Ridge whenever föhn effects were apparent at base camp. Lee-roll clouds were observed with fresh to strong offshore winds on both north and south coasts of the island. They were usually associated with well-developed lenticular formations at higher levels. Lenticular form was also a common feature of the summit cloud cap of Clarence Island in a wide range of conditions.

Visibility on Elephant Island was generally good by "normal" standards and was in excess of 40 km. on an average of 40 per cent of occasions. February had the best visibility record and March the poorest. Visibility of less than 1 km., the normal arbitrary limit for fog (Table VII), was recorded on about 6 per cent of occasions, which is high in relation to past summer values for nearby stations and it is obviously another distinguishing characteristic of altitude

TABLE VII. WEATHER; NUMBER OF DAYS

Month	*Wind*		*Rain*	*Snow*	*Sleet*	*Drizzle*	*Cloudy*	*Clear*	*Drift*	*Showers*	*Fog*	*Hail*
	>22 kt	*>34 kt*										
December	3	1	5	16	2	2	20	2	2	5	3	0
January	13	1	11	20	5	3	21	1	6	15	2	0
February	9	4	8	18	8	1	14	2	2	4	0	0
March	9	3	8	15	6	3	18	1	9	7	3	4
TOTAL	34	9	32	69	21	9	73	6	19	31	8	4

difference. On about 50 per cent of occasions obscurity was due to low cloud. Heavy snowfall and/or heavy drifting reduced visibility to less than 1 km. on a further 25 per cent of occasions and the remaining cases were caused by low-level advection fog reaching the station. Hill fog occurred with wind from all sectors but it was mainly associated with north to north-east winds. "Haar" was generally associated with light mild and humid northerly winds but it also occurred with the wind in the south-east. Shallow inversion fog was observed occasionally but it failed to rise to the level of the station.

Discussion

Conditions on Elephant Island during the summer of 1970–71 departed somewhat from projected norms. Weather was generally more stable than expected, with apparently slightly smaller total cloud amounts and better visibility than "normal". Also, except in March, mean air temperatures were marginally below "normal". These characteristics were combined with an unusually high frequency of southerly winds. A synoptic statement for each day of the observation period is made in Fig. 3.

Undoubtedly the most important factor influencing the weather of the season was the pressure deficit in the area. Over the region as a whole, pressure appears to have been marginally higher than normal to the south and south-west of Elephant Island and lower than normal to the north and east. The largest negative anomalies occurred at Stanley (Falkland Islands), where mean pressure for December was 6·9 mbar below the 1951–60 average; this is more than twice the average deviation from the long-term smoothed mean. It would appear that the axis of the sub-polar trough, normally located to the south of the island arc, was displaced northward during this period. As a result, the majority of depressions followed a course to the north of Elephant Island, causing relatively cold, stable Antarctic air to be drawn across the area rather more frequently than usual. This effect was not apparent over the whole area. Signy Island, for example, did not experience an abnormal frequency of southerly winds; apart from January, when winds from the south-east are normally important, westerlies predominated throughout the period.

It is tentatively suggested that the distinctive wind regime experienced on Elephant Island during 1970–71 may not be solely a product of the abnormal regional pressure distribution and not entirely unique to the season but a fairly normal feature of the climate, resulting from the position of Elephant Island *vis-à-vis* the Antarctic Peninsula and the Weddell Sea, and the directing and controlling influence of these features in relation to the main air-mass trajectories of the region. Particularly important in this connection is the main outflow route along the western margin of the Weddell Sea for continental air from the west Antarctic plateau. It seems entirely reasonable to suppose that Elephant Island would be exposed to this meridional flow of cold Antarctic air much more frequently than would nearby island groups further removed from the Antarctic Peninsula outflow zone.

There is a measure of support for this interpretation implicit in the regional climatological analyses of Pepper (1954), Lamb (1964*b*) and Wilson (1968), but clearly any interpretation of this type, based on such a limited period of observation, is highly speculative and it will obviously require many years of continuous observation before anything firm can be stated about possible distinctive features of the climate of Elephant Island.

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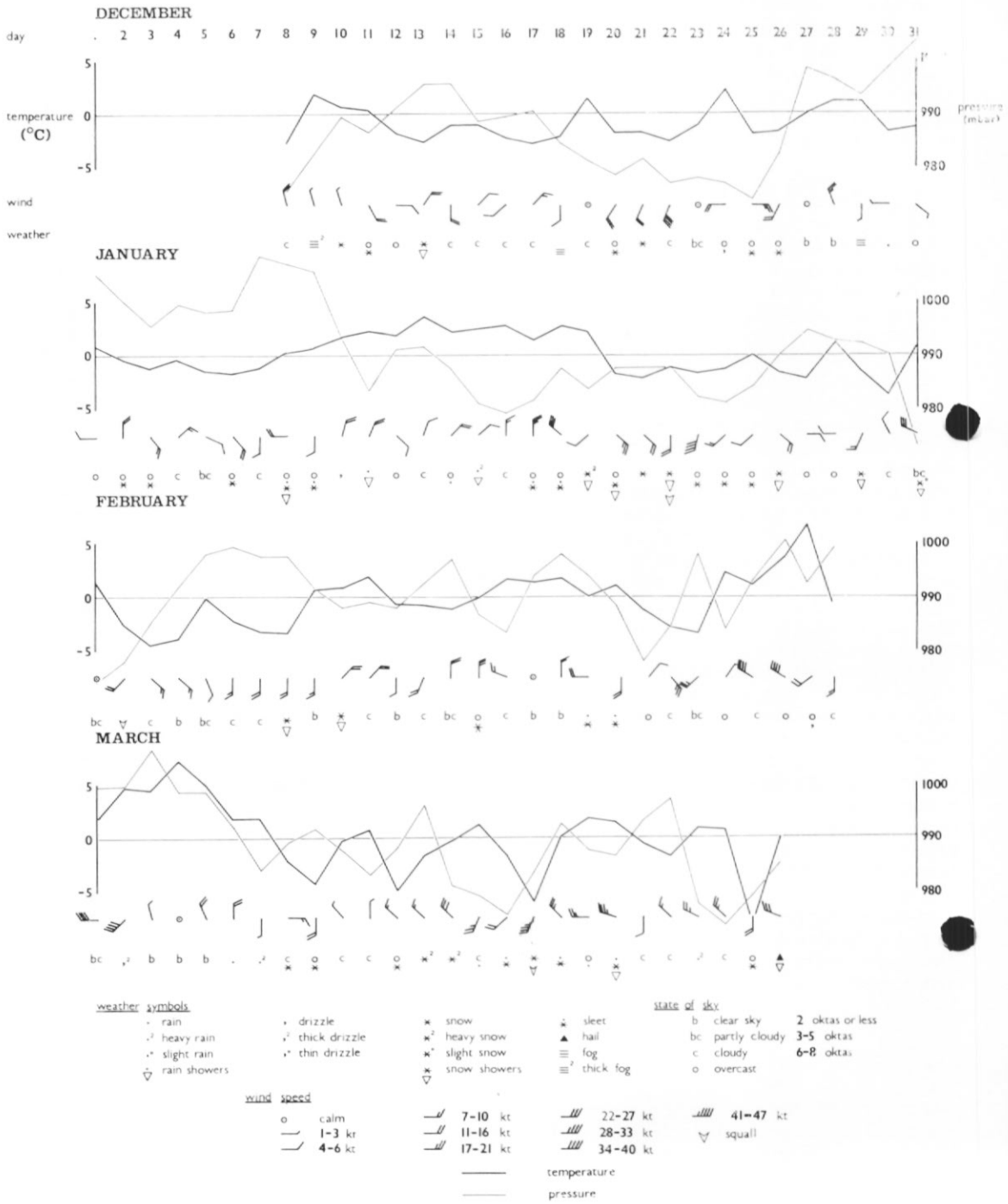

Fig. 3. Pressure, temperature, wind and weather on Elephant Island, 8 December 1970–26 March 1971, at 09.00 hr. zone time.

REFERENCES

LAMB, H. H. 1964*a*. Circulation of the atmosphere. (*In* PRIESTLEY, R. E., ADIE, R. J. *and* G. DE Q. ROBIN, *ed. Antarctic research*. London, Butterworth and Co. (Publishers) Ltd., 265–77.)

————. 1964*b*. The climate. (*In* PRIESTLEY, R. E., ADIE, R. J. *and* G. DE Q. ROBIN, *ed. Antarctic research*. London, Butterworth and Co. (Publishers) Ltd., 278–91.)

————., ROMANS, J. C. C. *and* L. ROBERTSON. In press. Three soil profiles on Elephant Island. *British Antarctic Survey Bulletin*.

PEPPER, J. 1954. *The meteorology of the Falkland Islands and Dependencies, 1944–1950*. London, Falkland Islands and Dependencies Meteorological Service.

ROBIN, G. DE Q. *and* R. J. ADIE. 1964. The ice cover. (*In* PRIESTLEY, R. E., ADIE, R. J. *and* G. DE Q. ROBIN, *ed. Antarctic research*. London, Butterworth and Co. (Publishers) Ltd., 100–17.)

WILSON, C. 1968. Climatology of the cold regions—Southern Hemisphere. *CRREL Monogr.*, No. 1–A3C, 77 pp.