The following five papers were included in a symposium on **"The ecology of the Subantarctic Islands of New Zealand"** *at the 1964 Conference.*

THE CLIMATE OF THE AUCKLAND ISLANDS, CAMPBELL ISLAND AND MACQUARIE ISLAND

J. F. DE LISLE

New Zealand Meteorological Service

Introduction

The Subantarctic islands to the south of New Zealand lie in a narrow belt of latitudes (48°S.–55°S.) within a region of strong and persistent westerly winds. They are north of the latitudes usually traversed by the great cyclonic storms of the southern oceans and south of the paths usually taken by the travelling anticyclones of the subtropical latitudes. The southernmost island, Macquarie I., lies very near the Antarctic Convergence, the relatively sharp boundary between the cold antarctic waters and the warmer subantarctic waters. The northernmost group, the Bounty Is., lies in about the same latitude as the south of New Zealand.

Systematic meteorological observations have been made on the Auckland Is., Campbell I., and Macquarie I., which are all on the whole cloudy, bleak and wind-swept but with a slight amelioration of climate on the Auckland Is. The rainfall is moderate but spread over more than 300 days a year. A description of the physical features of Auckland Is. and Campbell I. was given by Falla (1947) and of Macquarie I. by Mawson (1915).

A station established on the northern end of Macquarie I. in December 1911 by Mawson's Antarctic Expedition operated during 1912-13 and was continued by the Australian Weather Bureau in 1914-15. It was re-established in April 1948 by the Australian National Antarctic Research Expedition (A.N.A.R.E.) and since then both surface and upper air meteorological observations have been made. Records for the period 1911-14 were published by Newman (1929) and summaries are now published in the A.N.A.R.E. Reports, Series D.

Meteorological observations were first made regularly on Campbell I. in 1904 at the sheep station in Tucker Cove and continued until October 1907 (see Marshall 1909). No further observations appear to have been made until 1941 when the New Zealand Government established coast watching stations on both Auckland and Campbell Is. Regular surface meteorological observations were made at Port Ross and Carnley Harbour on the Auckland Is. and at Tucker Cove, Campbell I. The Carnley Harbour station closed in April 1944 and the Port Ross station in March 1945. After the war the Campbell I. station was established permanently under the control of the N.Z. Meteorological Service and carries out both surface and upper air observations. In April 1957 the station was shifted from its relatively sheltered position in Tucker Cove to a less protected position on a spur in Perseverance Harbour about 700 yards south of Beeman Hill.

The N.Z. Meteorological Service publishes each year summaries of surface data from Campbell I. and has published (1963) a summary of radiosonde data.

The climate of Campbell I. was described by Hitchings (1949) and de Lisle (1964). Fabricius (1957) has dealt with the climate of most subantarctic islands.

Weather Systems Affecting the Subantarctic Islands

The increased meteorological programme in high latitudes initiated during the International Geophysical Year in 1957-58 has given a much clearer understanding of the large scale circulation in the Southern Hemisphere than was possible previously.

Radiosonde and radarwind soundings show that the high-level circulation over the Antarctic and Subantarctic region is fairly simple. The combined effect of the large temperature differences between low and high latitudes and the rotation of the earth produce in the stratosphere a gigantic cyclonic (clockwise) vortex. It has a central low pressure cold core over the south pole and strong westerly winds reaching to middle latitudes. This broad belt of zonal westerlies attains a speed of about 200

knots in the core of the polar jet-stream which extends upwards to the limit of the soundings at 25-30 km.

In the mid-troposphere (about 5 km.) the flow pattern is more complicated. There are several low pressure centres in the polar regions surrounded by a sinusoidal belt of zonal winds in middle latitudes with lesser speeds than in the stratosphere.

With the arrival of the sun over Antarctica in the spring, a sudden warming takes place in the atmosphere at high levels. The central low pressure core weakens and moves away from its symmetrical position to be replaced by a weak anticyclone with smaller cyclonic centres off the coast of the continent. The high level zonal westerly winds in middle latitudes weaken.

On the surface the weather systems are more complicated than at high levels. Over the oceans surrounding the continent there is a belt of cyclonic activity throughout the whole year. Further north a succession of anticyclones moves across Australia, the Tasman Sea and New Zealand at intervals predominantly of 6-7 days. Their centres may pass to the north of New Zealand, across or sometimes even to the south of the country. The first type of path is more likely in winter and spring and the other two in summer and autumn.

Each anticyclone is separated from the next by a trough of relatively low pressure. On the eastward side of the trough the wind is from a northerly quarter and on the westward side from a southerly or westerly quarter. Marked differences in temperature between the air masses on the eastern and western sides of the trough usually result in a cold front separating them, generally oriented NW-SE or N-S. The series of surface anticyclones and troughs correspond respectively to the ridge and trough wave motion observed in the high level westerly flow.

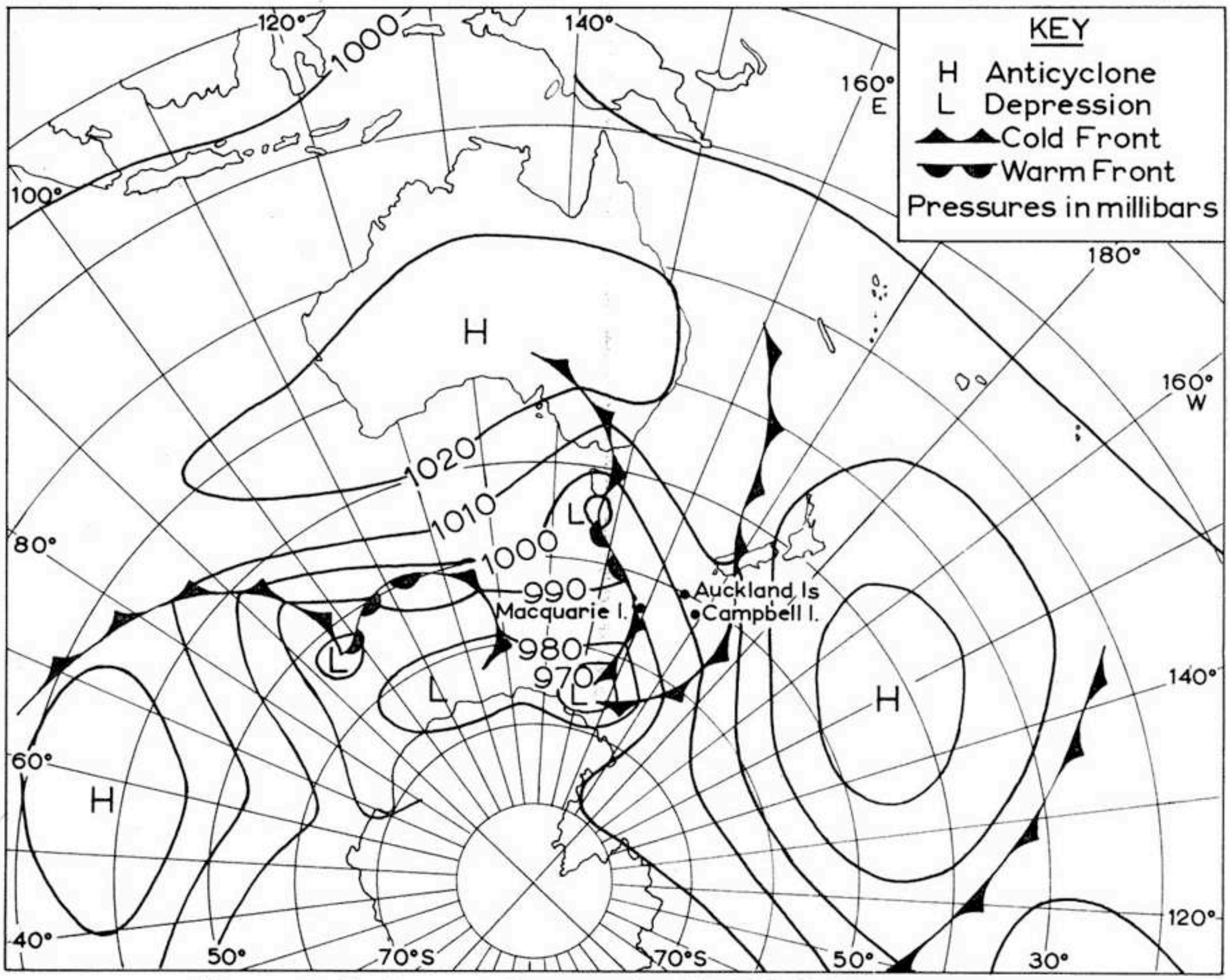

FIGURE 1. *Surface weather map for 1200 NZST 18 May 1962.*

The front in the trough may extend southwards to a deep depression centred somewhere between latitude 55°S. and the Antarctic Continent (Figure 1). Sometimes this whole system of anticyclones, intervening front and depression in the far south moves over the Macquarie I., Campbell I., New Zealand area unchanged. As the cold front moves over the subantarctic islands it is preceded by gale force winds often accompanied by violent gusting. The frontal passage is marked by a period of rain followed by a change to a westerly or southerly winds and showers of rain or hail.

Although frontal passages across the islands are frequent, this straightforward sequence of events is subject to considerable variation. Anticyclones moving from Australia, across New Zealand and out to the east normally change their intensity, speed and direction of movement. Connected with these changes cyclonic depressions may form in the low pressure trough.

Depressions affecting the subantarctic islands may originate south of Australia or in the Tasman Sea and tend to move south-eastwards growing in intensity. Although for much of the time the weather on the subantarctic islands is controlled by the passage of frontal systems, there are often anticyclones and depressions in their neighbourhood.

Passage of Anticyclones and Depressions

Mean annual surface pressure, averaged around circles of latitude in the southern hemisphere, has a maximum in the subtropics, a minimum in latitudes 65-70°S. and a secondary maximum over the Antarctic. The positions of the primary maximum and minimum show small seasonal changes.

The mean monthly M.S.L. pressure at Campbell I. (lat. 52½S.) is greater than that at Macquarie I. (lat. 54½S.). The difference is greatest in January (about 6 mb.) and least in June (about 3 mb.).

However, the monthly frequency distributions of M.S.L. pressure are approximately the same at both islands and both are negatively skewed (see Figure 2). Intense anticyclones (central pressure more than 1020 mb.) and deep depressions (central pressure less than 990 mb.) may pass near either island in any month of the year. Twelve years of Campbell I. data show most anticyclones and fewest depressions in July and August (de Lisle 1964) and extreme pressures of 1038.6 mb. and 947.4 mb.

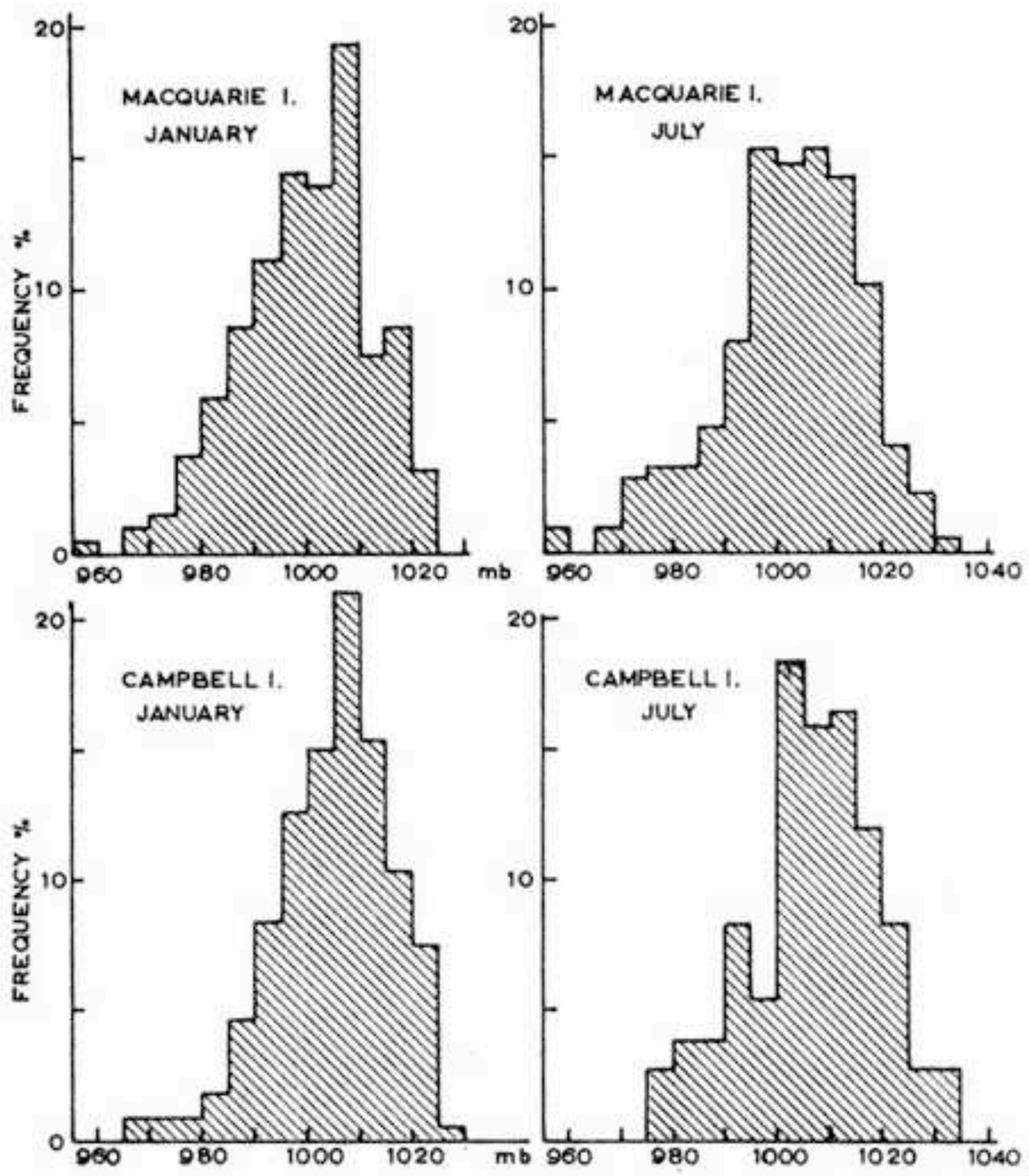

Figure 2. *Frequency distribution of M.S.L. pressures (once daily) for the months of January and July at Macquarie Island and Campbell Island (6-7 years' data).*

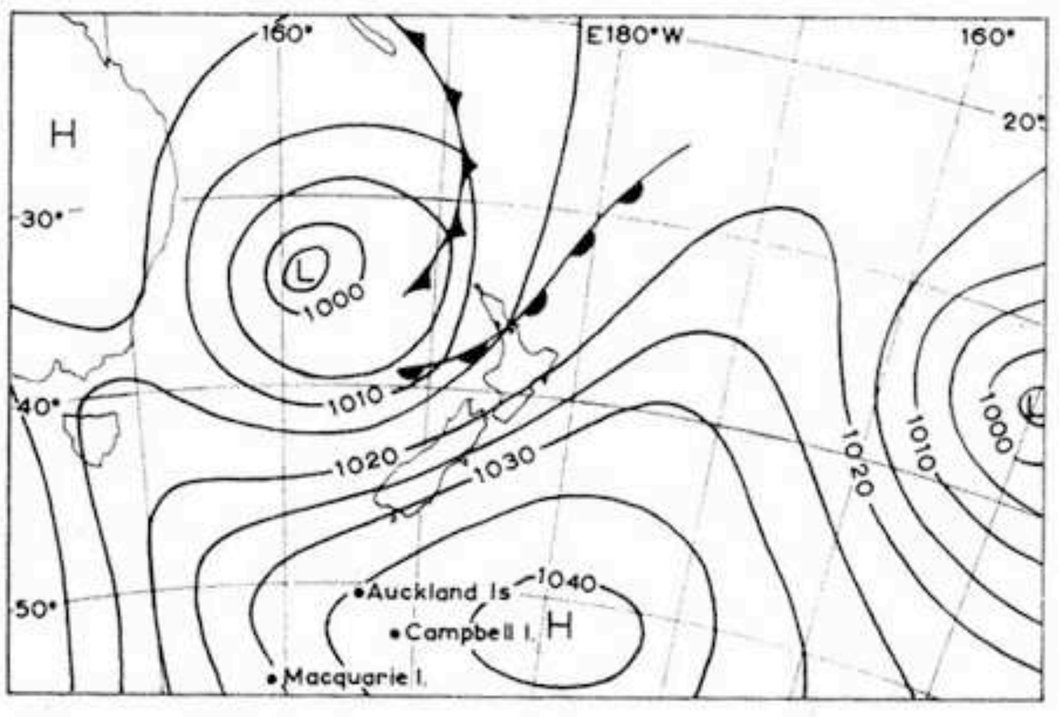

Figure 3. *Surface weather map for 1200 NZST 26 July 1959 showing intense anticyclone in high latitudes.*

During the passage of an anticyclone the weather usually remains overcast with periods of drizzle. In an intense anticyclone which passed over Campbell I. in July 1959 (Fig. 3), the M.S.L. pressure from 22-27 July exceeded 1020 mb., with a maximum of 1035 mb. There were only 2.8 hours of sunshine and light rain or drizzle fell on every day except one. These conditions were caused by a subsidence inversion in the upper air and moist air in the lower layers. The temperature at the 850 mb. level (about 5000 ft.) was up to 5°C. warmer than at the 900 mb. level (about 3000 ft.). Below the inversion the air was saturated; but above, the relative humidity had dropped to 20-35%.

The passage of a deep depression is accompanied by a period of moderate or heavy rain and falls of more than one inch in a day have been recorded at Auckland, Campbell and Macquarie I.

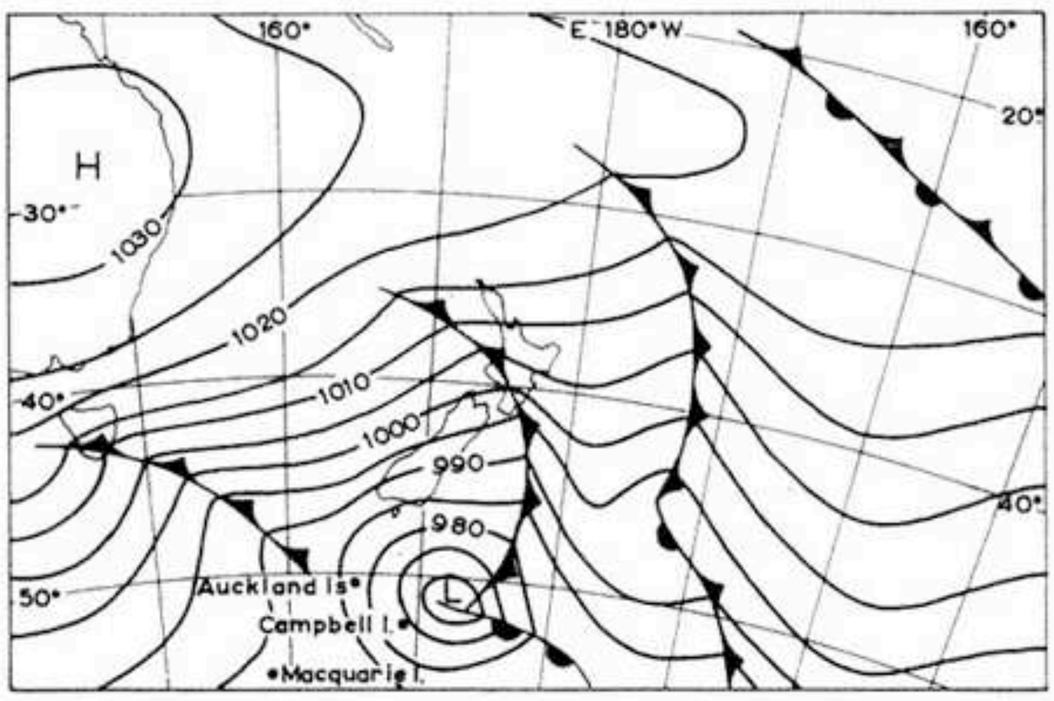

FIGURE 4. *Surface weather map for 0600 NZST 27 June 1961 showing movement of a deep depression over Auckland Islands and Campbell Island.*

An example of a depression crossing Campbell I. is shown in Figure 4. On a cold front approaching the SW of the South Island of New Zealand a wave depression formed on 26 June 1961, deepened rapidly and moved southeastwards over Campbell I. On the 26th the wind at Campbell I. was fresh WNW and the weather cloudy to overcast with intermittent rain. 1.16 inches of rain fell during the day. After the depression moved over on the 27th the wind became fresh to strong SE and all day there was continuous rain amounting to 1.94 inches accompanied by some snow.

CLIMATIC ELEMENTS

The long term effect of the passage over the subantarctic islands of the anticyclones, depressions and frontal systems constitutes their climate. The separate weather elements, which when taken together in the long term make up the climate, are considered below.

WIND (Tables 1-5).

Because of the rugged and broken terrain, it is impossible to find a site on Auckland, Campbell or Macquarie I. where the measured surface wind would be representative of the wind flow over the whole island.

In all seasons the mean wind in the lowest few thousand feet of the atmosphere in latitudes 48-55°S. is from WNW to W (Table 1). At the surface, also, winds from a westerly quarter predominate (see Table 2) and speeds are higher than those found over southern New Zealand. At Invercargill there are on the average about 10 days a year when the maximum gust is 50 knots or more, while at Macquarie I. there are about 78 such days a year (see Table 3). Winds over the subantarctic islands tend to be strongest in spring.

TABLE 1. *Mean wind at 850 mb. (about 5000 ft.) in degrees and knots.*

	Jan.	April	July	Oct.
Invercargill (1956-60)	285/20	285/17	278/12	296/13
Campbell I. (1961-62)	273/27	272/33	265/23	282/32
Macquarie I. (1957-61)	281/28	285/28	284/22	283/27

TABLE 2. *Percentage frequencies of surface wind directions.*

Direction	Auckland Is.	Campbell I.		Macquarie
	Port Ross	Carnley Harbour	Tucker Cove	I.
N	10.0	7.2	13.8	9.4
NE	5.3	3.2	2.8	0.5
E	1.9	3.5	2.5	1.8
SE	4.3	2.2	2.2	3.5
S	8.4	4.4	6.1	6.8
SW	20.0	12.6	11.3	4.7
W	23.3	24.2	32.6	40.5
NW	24.6	32.7	25.5	29.8
Calm	2.1	10.0	3.2	3.0

TABLE 3. *Number of days per year with maximum gusts of varying speeds; Macquarie I., 1949-60.*

Speed knots	No. days per year	Speed knots	No. days per year
01–09	0.3	50–59	49.3
10–19	15.3	60–69	20.3
20–29	59.9	70–79	6.2
30–39	111.0	80–89	1.5
40–49	100.9	90–99	0.3

The reported surface winds are affected by topography at all stations except Port Ross. The main plateau on Macquarie I. (c. 1000 ft. a.s.l.) shelters the station from winds between SSW and WSW. Except for further slight sheltering from winds between NNE and ENE, the flow is uninterrupted. Both the Tucker Cove and Beeman Hill sites on Campbell I. are sheltered to some extent from the west and at Tucker Cove winds between N and W tend to become very gusty. The Port Ross station in Auckland Is. is unobstructed. Most weather observations were made on a small hill NW of the station. Carnley Harbour is very exposed to the W and NW. The harbour produces funnel effects and violent squalls often occur.

The frequencies of specified wind speeds over the year at Macquarie I. and Campbell I. given in Table 4 show slightly more of the higher speeds at Campbell I., possibly because the sites are not representative.

Table 4. *Frequency distribution (per mille) of specified surface wind speeds in knots (after Fabricius 1957).*

Speed knots	Macquarie I.	Campbell I.
Calm	30	33
01–09	161	164
10–19	354	291
20–29	330	339
30–39	112	141
40–49	12	29
50–59	1	3
60–90	< 1	< 1

Some experiments to find a satisfactory permanent site for an anemometer on Campbell I. illustrate the great variations in wind speed due to topography. An anemometer was temporarily erected on the summit of St. Col Peak (984 ft.) and comparisons made between the wind force there and at a number of sites on the leeward side (see Table 5).

Table 5. *Average ratio of St. Col Peak wind to Sheep Camp wind according to direction, May-August 1950.*

Wind direction	Average ratio St. Col: Sheep Camp	Wind direction	Average ratio St. Col: Sheep Camp
N	2.1	S	1.6
NE	1.0	SW	1.3
E	1.9	W	1.7
SE	2.2	NW	2.2

Number of observations 721

Gusts greater than 122 knots were recorded once at the exposed site on St. Col Peak and for a 6 hour period on the same day the wind at Sheep Camp averaged 55 knots. On the peaks higher than St. Col even stronger winds will occasionally be experienced.

Cup counter anemometers operated for two years at both the Sheep Camp and St. Col Peak sites. During this period the average daily wind run at St. Col Peak was 737 miles and at Sheep Camp 413 miles. The highest daily run at St. Col Peak was 1063 miles and at Sheep Camp 649 miles.

In exposed positions on the Macquarie I. plateau and on the peaks on Auckland Is. winds as high as on St. Col Peak would be expected.

SUNSHINE, HUMIDITY AND CLOUD

(Tables 6 and 7)

South of New Zealand cloudiness increases considerably. Campbell I. receives on the average only 653 hours of bright sunshine each year compared with 1670 hours at Invercargill. Sunshine was measured at Port Ross, Auckland Is. for only 5 months from November 1944-March 1945. The total for this period at Port Ross was 610 hours compared with 421 hours at Campbell I. Macquarie I. receives on the average 850 hours a year.

Table 6. *Average frequency each year of daily sunshine duration for period 1949-53.*

Hours sunshine/day	Days/year Macquarie I.	Campbell I.
Nil	105.2	138.1
0.1– 0.9	65.9	77.0
1.0– 1.9	43.4	40.6
2.0– 2.9	37.8	30.2
3.0– 3.9	24.8	21.2
4.0– 4.9	25.8	15.0
5.0– 5.9	17.6	11.6
6.0– 6.9	13.8	9.8
7.0– 7.9	11.8	8.8
8.0– 8.9	6.6	4.2
9.0– 9.9	5.6	4.2
10.0–10.9	3.9	2.3
11.0–11.9	2.0	1.2
12.0–12.9	0.6	0.6
13.0–13.9	0.2	0.2

Fabricius (1957) suggested that Campbell I. sunshine is reduced by the cover of stratiform cloud formed by the advection of warm air in NW winds. The island also increases its own cloudiness by causing the normally moist airstream to be lifted in crossing its hilly surface.

Overcast conditions are frequent over the island with only broken cloud over the sea. Campbell I. has on the average 215 days each year with less than 1 hour of sunshine per day. Macquarie I. has 171 such days (see Table 6).

At Campbell I. skies are usually overcast in the early morning (there is an average of 291 days a year of overcast at 0900 NZST), but frequently the cloud breaks somewhat during the day. Although skies are predominantly cloudy or overcast there are by contrast occasional days of brilliant sunshine. During 1942-62, Campbell I. had on the average 14 days each year with at least 8 hours sunshine. During 1949-53 Macquarie I. had 17 such days each year. The lowest few thousand feet of the atmosphere which are concerned in low cloud formation by the lifting process are usually moist.

TABLE 7. *Percentage of occasions on which the relative humidity at 900 mb. (about 3000 ft.) was 80% or more at Campbell I. and Invercargill 1956-61.*

Month	Campbell I.	Invercargill
Jan.	76	24
Feb.	66	33
Mar.	72	41
Apr.	68	35
May	75	38
June	70	40
July	71	37
Aug.	72	38
Sept.	69	25
Oct.	67	30
Nov.	64	28
Dec.	73	32

Humidity data from the daily radiosonde flight at Campbell I. (Table 7) illustrate the moist conditions in the lower layers which the sunshine and rainfall figures show are typical of all three islands. Humidity data from Invercargill are included in Table 7 for comparison.

RAINFALL (Tables 8-10)

Rainfall is spread fairly evenly throughout the year with a slight autumn maximum at all islands (Table 8). Except at Carnley Harbour where orographic effects increase rainfall, the annual totals are only moderate (40-60 inches) but the number of raindays is large. Much of the precipitation is in the form of light rain or drizzle (see Table 10). The variability from year to year in both amount and number of raindays is small.

TABLE 8. *Mean monthly rainfall and number of raindays at Port Ross (1941-45) and Carnley Harbour (1941-44), Auckland Is., Tucker Cove (1941-56), Campbell I., and Macquarie I. (1914-55, 9 years only).*

	Number of inches/days per month			
	Port Ross	Carnley Harbour	Campbell I.	Macquarie I.
Jan.	4.2/22	7.2/25	4.9/26	4.0/26
Feb.	4.8/22	5.7/24	4.2/24	3.3/26
Mar.	5.5/27	5.7/26	5.6/28	4.4/28
Apr.	7.0/27	9.8/28	4.9/27	3.9/27
May	5.9/26	9.3/29	5.4/28	3.1/29
June	5.8/26	7.4/29	4.8/28	3.1/27
July	3.3/28	5.3/29	4.0/28	3.0/28
Aug.	4.3/28	7.3/30	4.5/29	3.1/28
Sept.	4.9/27	5.9/29	4.8/27	3.6/27
Oct.	4.1/27	5.1/29	4.8/28	3.4/26
Nov.	4.4/25	5.4/25	4.7/26	2.7/24
Dec.	4.9/26	8.6/28	4.6/26	3.5/26
Totals	59.1/311	82.7/331	57.2/325	41.1/322

TABLE 9. *Computed intensity in inches of rainfall at Tucker Cove, Campbell I.*

Return period, years	2	5	10	20	50
Duration of fall, hours	Rainfall, inches				
1	0.4	0.5	0.5	0.6	0.7
6	1.0	1.3	1.5	1.7	1.9
12	1.4	1.8	2.1	2.4	2.7
24	1.9	2.6	3.0	3.4	4.0
48	2.4	3.2	3.8	4.3	5.0
72	2.7	3.8	4.5	5.2	6.1

NOTE. Return period is the average interval between those years which contain a rainfall at least equal to the amounts shown. Figures were calculated from 21 years' data by Robertson (1964).

TABLE 10. *Frequency of daily rainfall amounts on Macquarie I., 1949-60.*

Rainfall inches	No. days per year	Rainfall inches	No. days per year
Nil	42.8	0.80–0.99	1.5
0.01–0.19	258.6	1.00–1.19	0.3
0.20–0.39	47.6	1.20–1.39	0.3
0.40–0.59	10.1	1.40–1.59	0.2
0.60–0.79	3.6		

Heavy rainfalls are sometimes experienced during the passage of a cyclonic depression and its associated frontal system. The intensity of heavy falls is greater at Campbell I. than at Macquarie I. where the greatest 24-hour fall in 12 years was in the range 1.40 to 1.59 inches (Table 10). At Campbell I. a 24-hour fall of 1.9 inches would be expected on the average every two years and a fall of 3.0 inches once in 10 years (Table 9). It is expected that the intensities at Auckland Is. would be similar to those at Campbell I.

The spatial distribution of rainfall is irregular on the subantarctic islands because they are hilly and experience high winds.

Snow may fall in any month on Campbell I. and on the average there are 41 days of snow a year. The falls are usually light and on only 11 of these days does the snow lie on the ground.

At Macquarie I. during the period 1948-51, snow fell in all months except December and January. On the Auckland Is. the numbers of snow days per year at Port Ross during 1942-44 were 13, 16 and 27 respectively and at Carnley Harbour in 1942-43 were 110 and 70. Hail may occur in any month. On Campbell I. there are falls of hail in about 60 days of the year. From the short records Port Ross appears to have fewer days of hail each year than Campbell I. and Carnley Harbour more. Thunder and lightning are uncommon.

TEMPERATURE (Tables 11-13)

Mean monthly temperatures decrease with increasing latitude, Auckland Is. being 2-3°F. warmer than Campbell I., which is 3-5°F. warmer than Macquarie I. On the Auckland Is. there are temperature differences due to topography especially in summer when the mean monthly temperature is up to 3°F. warmer at Port Ross than at Carnley Harbour (see Table 11).

Because the subantarctic islands are all in a zone of strong westerly winds both the annual and daily variations of temperature are small. They are largest in the Auckland Is. and least at Macquarie I. The daily range at Campbell I. and Auckland Is. is greatest in December-January and least in June, while on Macquarie I. there is little variation during the year. Although in January there is 6-7°F. difference in mean daily range between Port Ross and Macquarie I., in June the difference is only 2°F.

Table 12. *Extreme maximum and minimum temperatures in °F.*

	Extreme maximum	Extreme minimum
Port Ross	67.0	26.4
Carnley Habour	64.7	28.2
Tucker Cove	66.1	20.6
Beeman Hill	64.0	23.0
Macquarie Island	53.0	16.0

Table 11. *Monthly mean and extreme temperatures in °F. for Auckland Is. (Port Ross, May 1941-March 1945; Carnley Harbour, May 1941-April 1944), Campbell I. (Tucker Cove, 1941-57) and Macquarie I.*

	J	F	M	A	M	J	J	A	S	O	N	D
Approximate mean temperature												
Port Ross	52.1	51.8	49.7	47.8	43.7	41.7	42.9	42.5	44.4	46.1	47.2	49.7
Carnley Harbour	50.2	50.7	50.2	46.6	42.6	42.2	42.9	42.0	43.6	44.3	44.7	46.7
Campbell I.	49.0	48.6	47.3	44.8	43.0	40.1	40.1	40.5	41.7	43.0	44.9	47.2
Macquarie I.	44.2	43.8	42.7	41.2	39.4	37.5	37.4	37.8	38.2	39.1	40.1	43.0
Mean daily maximum temperature												
Port Ross	58.6	58.0	55.2	51.3	48.4	46.1	47.8	47.8	49.9	52.3	53.7	56.1
Carnley Harbour	55.3	56.2	55.2	51.2	47.1	46.3	47.5	47.1	48.5	50.4	51.0	52.8
Campbell I.	53.3	53.0	51.3	48.6	46.6	43.6	43.9	44.4	45.7	47.3	49.7	52.1
Macquarie I.	47.2	46.6	45.4	43.9	42.0	40.4	40.2	40.6	41.4	42.0	43.3	45.9
Mean daily minimum temperature												
Port Ross	45.7	45.5	44.2	43.5	39.3	37.8	37.9	37.2	38.9	39.9	41.0	43.3
Carnley Harbour	45.0	45.2	45.2	42.0	38.0	38.1	38.2	37.0	38.9	39.3	39.5	41.1
Campbell I.	44.6	44.3	43.2	41.1	39.4	36.5	36.4	36.7	37.5	38.7	40.0	42.2
Macquarie I.	41.1	40.6	39.6	38.0	36.4	34.1	34.2	34.3	34.2	35.8	36.8	39.5
Mean monthly maximum temperature												
Port Ross	65.0	66.8	65.3	57.7	54.2	51.4	54.4	53.7	57.4	60.5	60.0	63.2
Carnley Harbour	62.0	65.8	64.5	58.3	52.1	53.6	55.6	54.0	57.2	58.2	58.4	60.2
Campbell I.	60.4	59.1	58.3	54.3	52.0	48.5	49.7	49.0	50.1	52.8	56.4	57.8
Macquarie I.	50.3	49.9	48.6	47.3	46.4	44.7	43.9	44.0	44.8	45.6	47.7	50.0
Mean monthly minimum temperature												
Port Ross	35.8	36.3	34.5	33.4	29.1	28.7	27.4	28.9	28.7	29.1	31.5	32.4
Carnley Harbour	37.9	37.9	37.3	34.1	29.0	31.9	29.5	29.1	30.5	32.5	31.2	31.6
Campbell I.	36.7	35.4	34.4	32.4	29.5	28.0	26.8	27.8	27.5	28.7	30.4	32.6
Macquarie I.	36.6	35.2	33.0	31.7	28.2	25.2	24.0	24.6	24.3	29.2	30.0	34.8

Notes. 1. Approximate mean temperature = ½ (maximum + minimum) temperature.

2. Temperature records at Carnley Harbour were incomplete during 1943.

The highest temperatures recorded at Auckland Is. and at Campbell I. are much the same, approximately 65°F., and are 12°F. higher than that at Macquarie I. (Table 12). The extreme minimum at Macquarie I. is 10°F. lower than that at Port Ross.

Sea temperatures at Campbell I. are about 3°F. warmer than the earth temperatures at 12 inches in mid winter and about 1½°F. colder in midsummer (Table 13).

TABLE 13. *Mean monthly earth and sea temperatures.*

	Earth temp. at 1 foot Campbell I.	Sea temp. Campbell I.	Auckland Is.
Jan.	51.0	49.5	50.8
Feb.	50.3	49.1	51.0
Mar.	48.5	48.5	50.5
Apr.	45.6	46.7	49.3
May	43.2	45.3	47.4
June	40.3	43.2	46.1
July	39.5	42.6	45.7
Aug.	40.0	42.9	45.1
Sept.	41.3	43.7	46.0
Oct.	43.4	44.6	46.8
Nov.	46.5	46.1	47.9
Dec.	49.6	48.5	49.2

NOTE. Sea temperatures for Campbell I. taken monthly in the enclosed waters of Tucker Cove, 1943-55, and for Auckland Is. at Port Ross, 1941-45.

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OCEANOGRAPHY AND MARINE ZOOLOGY OF THE NEW ZEALAND SUBANTARCTIC

ELLIOT W. DAWSON

*N.Z. Oceanographic Institute, D.S.I.R., Wellington.**

The Subantarctic Islands of New Zealand, comprising Bounty and Antipodes, Auckland and Campbell, Macquarie and the Snares, lie within the Subantarctic zone of surface waters, bounded on the north by the Subtropical Convergence Region and on the south by the Antarctic Convergence about the latitude of Macquarie I. (Fig. 1).

Whether the Chatham Is., the Snares, and even the southern New Zealand mainland should be considered 'subantarctic' may be resolved by defining as 'subantarctic' any regions washed by 'subantarctic water', in the hydrologist's use of the term. Undoubtedly these more northern regions show the effects of subantarctic waters and so should be discussed with the New Zealand Subantarctic. Similarly, Macquarie I., lying close to the Antarctic Convergence, should be included because it shows the mixed influence of Antarctic and Subantarctic waters.

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