

CLASSIFICATION OF SOUTHERLY WINDS AT WELLINGTON - by Flying Officer
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The basis of the classification described in the note is the classification of the transformations of the meridional front suggested by Squadron Leader C.E. Palmer in "Synoptic Analysis over the Southern Oceans".

In addition to synoptic situations which involve only the meridional front or depressions which have developed on the meridional front in the Tasman Sea, several other types of situation in which southerly winds may be experienced at Wellington are described.

Some figures relating to the duration of southerlies and to rain-falls are included.

CLASSIFICATION

Type I. Two somewhat similar situations are included in the first type. (a) Tropical cyclones which move from the north or northeast towards Lord Howe or Norfolk Island and recurve towards the North Island of New Zealand. (b) Wave cyclones which develop off the Queensland Coast or occasionally over Queensland, on a meridional front which has become stationary along a line running eastward from Queensland. When the track of these cyclones lies across the southern half of the North Island a southeasterly wind will set in at Wellington while the centre is still west of the North Island. This is really an easterly wind which is "turned" through Cook Strait. If the path of the centre crosses the North Island there will always be a southerly at Wellington but owing to the high speed at which tropical cyclones usually travel in these latitudes the southerly may last for a few hours only.

Figure I is an example of type IA. and figure II of type IB.

Type II. Meridional front situations. These may be subdivided as follows:

IIA. Simple cold front with no wave developments at least until the front has passed right over New Zealand.

IIIB. Simple cold front followed by a secondary front within twenty-four hours.

IIC. Waves develop on the meridional front south of Tasmania or in the Tasman Sea and pass to the south of the South Island. The cold front of the final wave crosses New Zealand, its orientation as it passes Wellington usually being NNW to SSE.

IID. A wave or waves develop off the New South Wales Coast after the meridional front has moved on to New Zealand. The front will in this case become stationary about or north of Cook Strait.

Examples of these four types are shown in figures III to VI.

Type III. Westerly or Southwesterly depressions. Westerly depressions usually occur when an anticyclonic belt extending from Queensland to North of New Zealand persists for several days. There is then usually a strong westerly gradient across the South Tasman Sea and to the south of New Zealand. Considerable fluctuations of pressure are recorded at Awarua and Puysegur Point and a southwesterly wind change occurs in Otago. These southwesterly winds are temporary and seldom advance far north of Christchurch. These fluctuations are assumed to be associated with the passage eastward of disturbances well to the south of New Zealand. Southwesterly depressions tend to develop when an anticyclone remains centred over Victoria for several days and during the same period a low is centred southeast of Chatham Islands. There are thus southwesterly gradient winds over New Zealand. Sometimes in this situation a front appears west of New Zealand lying in a southwest-northeast line. Wave disturbances

develop south of New Zealand and occlude as they move over the country from the southwest, the passage of the occlusions over Wellington being marked by a brief period of rain and a temporary wind change to the south. On other occasions the frontal system seems to be absent but the wind at Wellington alternates between light northwesterlies and light southerlies. Possibly heating over the land during the day is the controlling factor here.

Type IV. Polar Front. Occasionally the polar front moves northward over New Zealand bringing in its wake very cold air and to Wellington one of its well-known "three day southerlies". The weather is showery unlike the thick weather associated with depressions which cross the North Island. Usually the front is retarded east of Chatham Islands and a wave cyclone develops. This circulation helps to maintain an intense anticyclone over or southeast of the South Island.

An example of a type IV situation is shown in Figure VII.

Type V. East Coast Secondaries. Very often when a meridional front, more especially the cold front of the last of a series of waves which have formed in the Tasman Sea on the transformed meridional front, passes Wellington there is no wind change at Wellington. This is because the associated cyclonic centre has been retarded and is situated south of New Zealand at the time of the front passage. The gradient behind the front is thus westerly or southwesterly and the cold air flows northeastward along the western side of the Southern Alps, turns round the northern end of this obstruction and flows through Cook Strait as a northwesterly wind. As the centre of low pressure moves slowly eastward the gradient over the South Island becomes gradually more southerly until finally the cold air is able to stream up the east coast of the South Island without being deflected by the Alps. The wind shift line between this air and that which has come through Cook Strait develops frontal characteristics (on the east coast only) as it travels northwards. How far this "front" extends out to sea is not known, but it is probably not more than a hundred miles. The situations described under type III in which there are no fronts could also be classified as belonging to type V. It may be of interest to examine one of these situations in more detail. This is done in the final section of this note.

DURATION OF SOUTHERLIES AND WEATHER CHARACTERISTICS

Table I. shows the average duration of southerly winds at Wellington in the different situations described above. Unfortunately the number of southerlies which I have been able to classify is not large but the following points are brought out:

- (a) Prolonged southerlies (3 to 5 days) occur when the polar front moves north over New Zealand, especially when wave development takes place on the front east of Chatham Islands.
- (b) Southerlies usually last for two or three days in type I. situation and sometimes in type II situations. If the meridional front passes over New Zealand undeformed the southerly wind blows at Wellington for about one day but if the front is deformed by orographic influences and this deformation results in a wave cyclone east of New Zealand between Kermadec and Chatham Islands, the southerly will naturally be prolonged.
- (c). Southerlies associated with westerly or southwesterly depressions or with east coast secondaries almost always last for less than one day.

Table II. contains some rainfall figures for each type of southerly. The following points are to be noted.

- (a) Type I. Usually heavy and prolonged (warm front) rain.
- (b) Types II, III and V. Light or moderate rainfall. With undeformed meridional fronts there is only a narrow rain band or often no rain at all. When however the front is deformed or when it becomes stationary just north of Wellington (type IIId) the rain is more prolonged

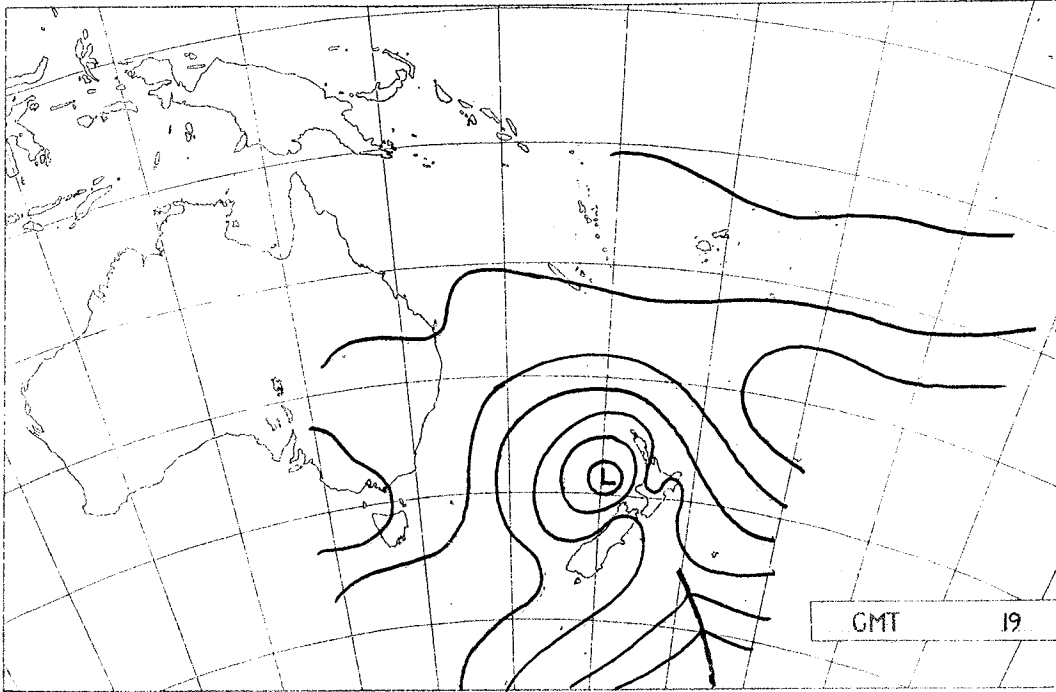


Fig. 1
Type I a.

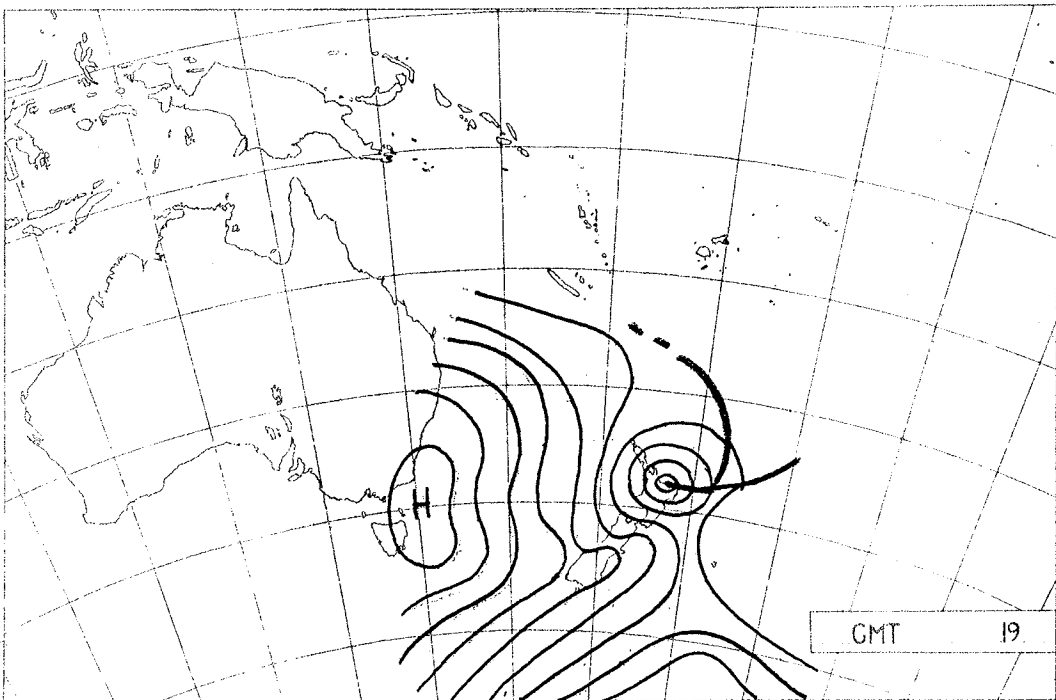


Fig. 2.
Type I b.

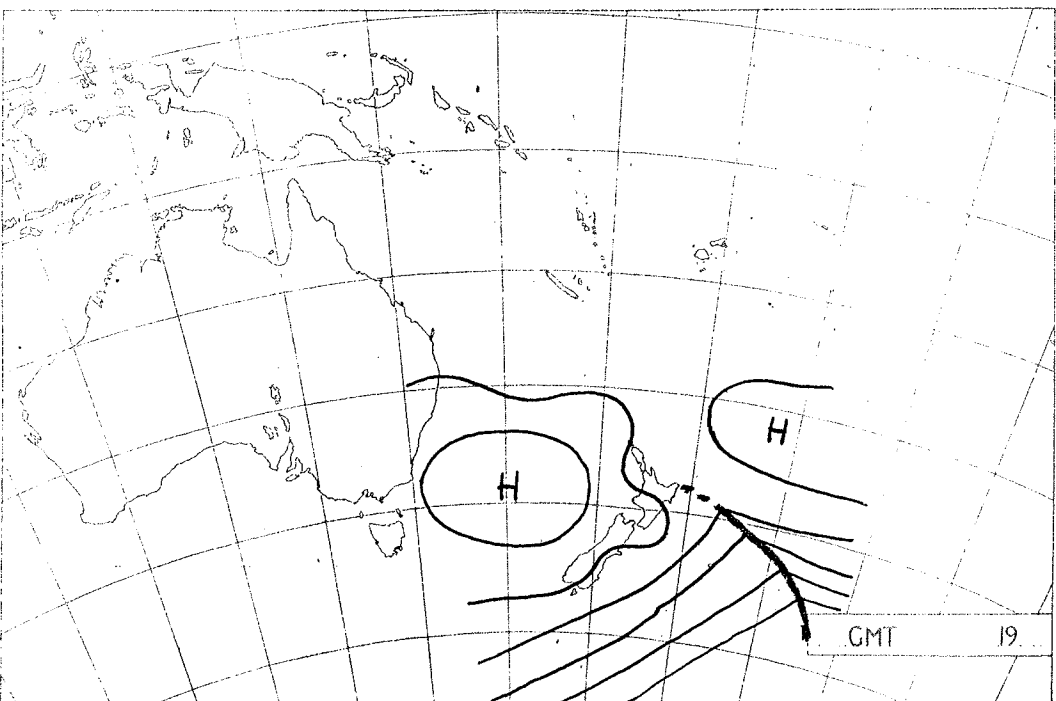


Fig. 3
Type II a.

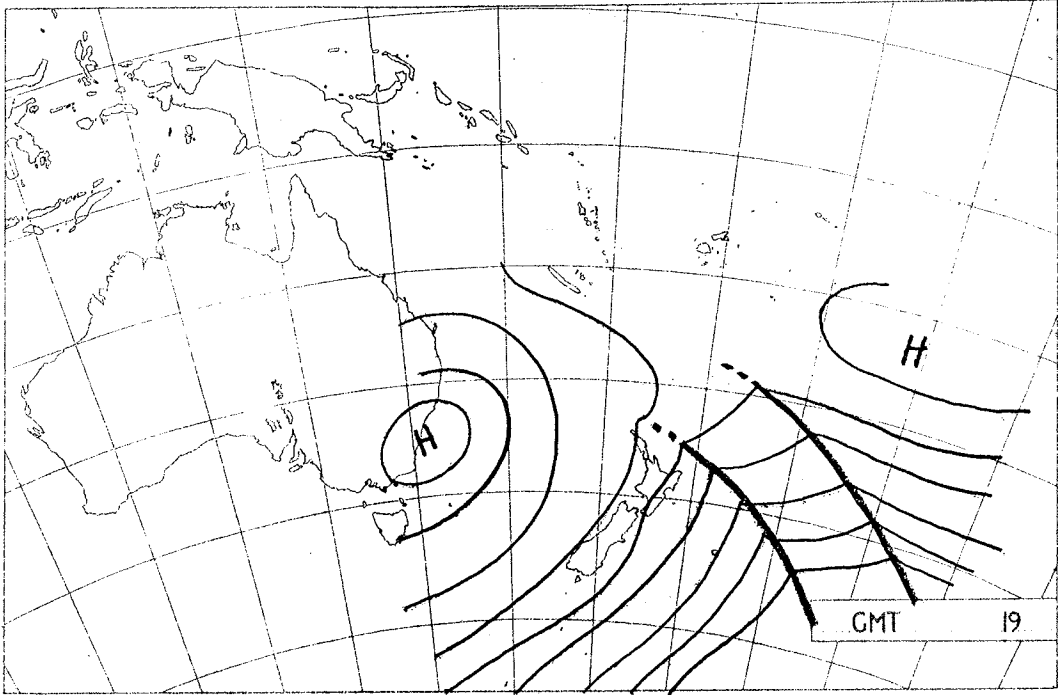


Fig. 4
Type II b.

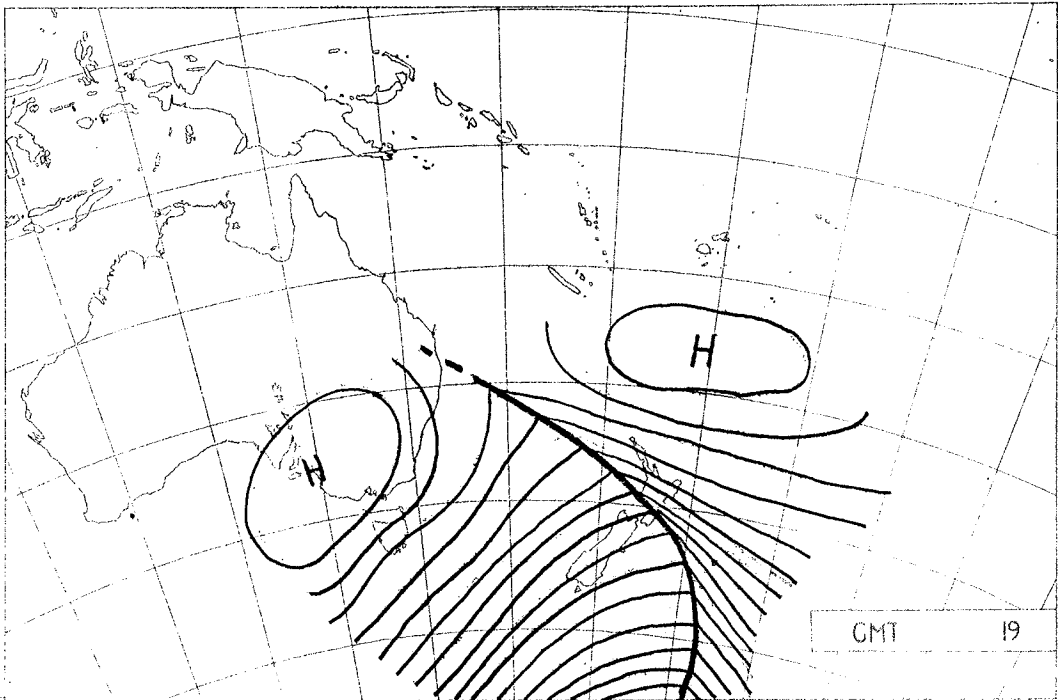


Fig 5.
Type II c.

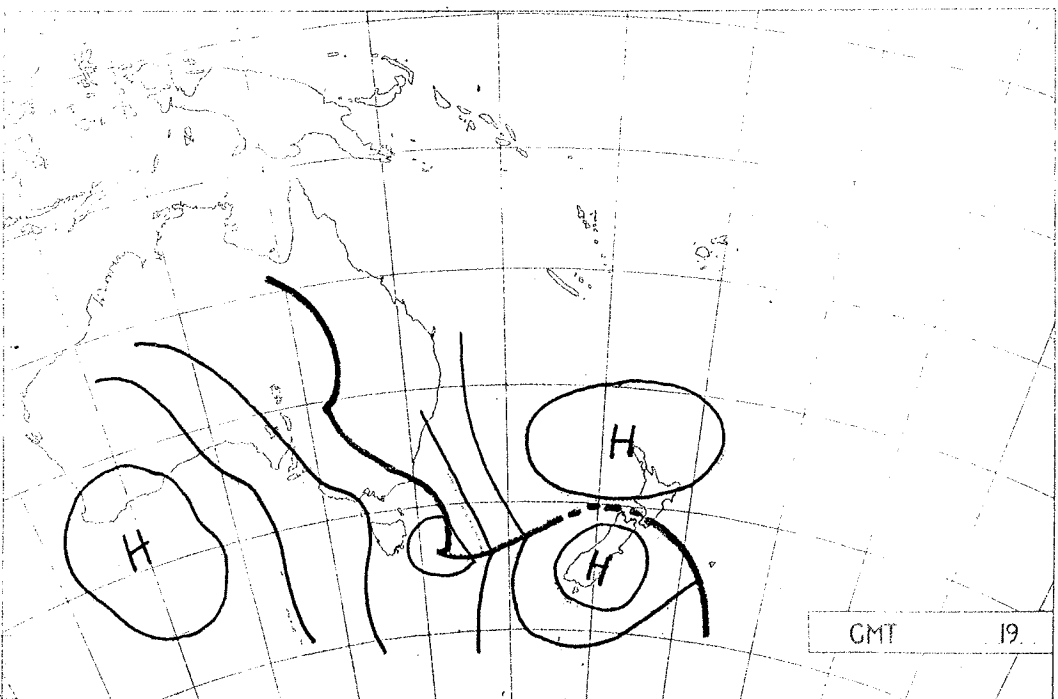


Fig. 6
Type II d.

Fig. 7
Type IV

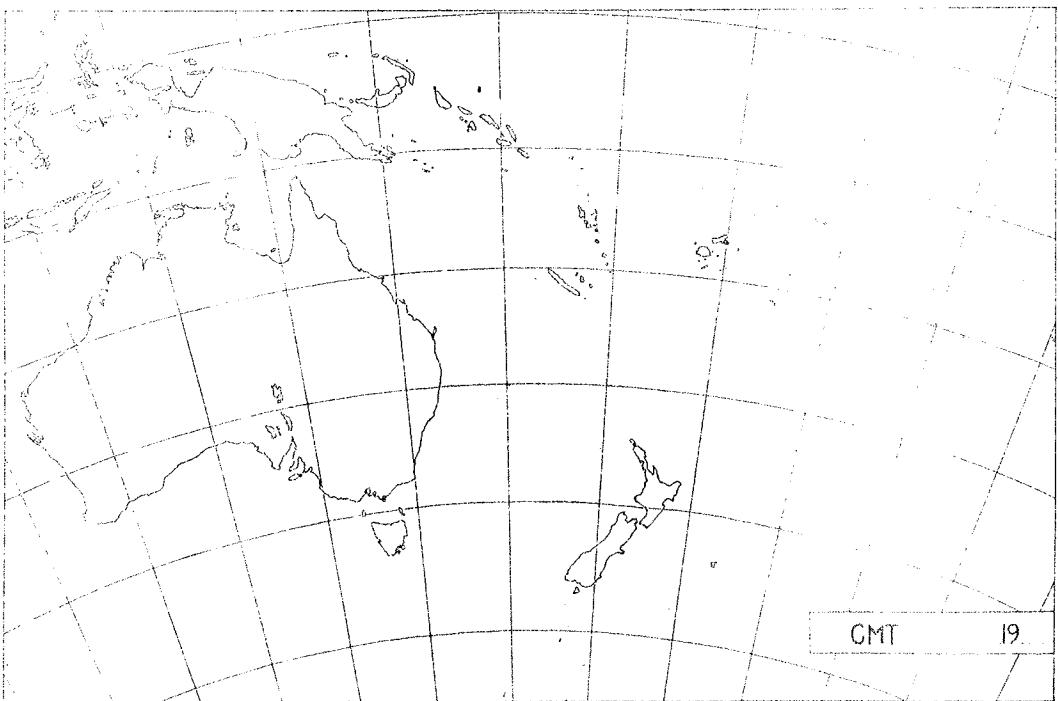
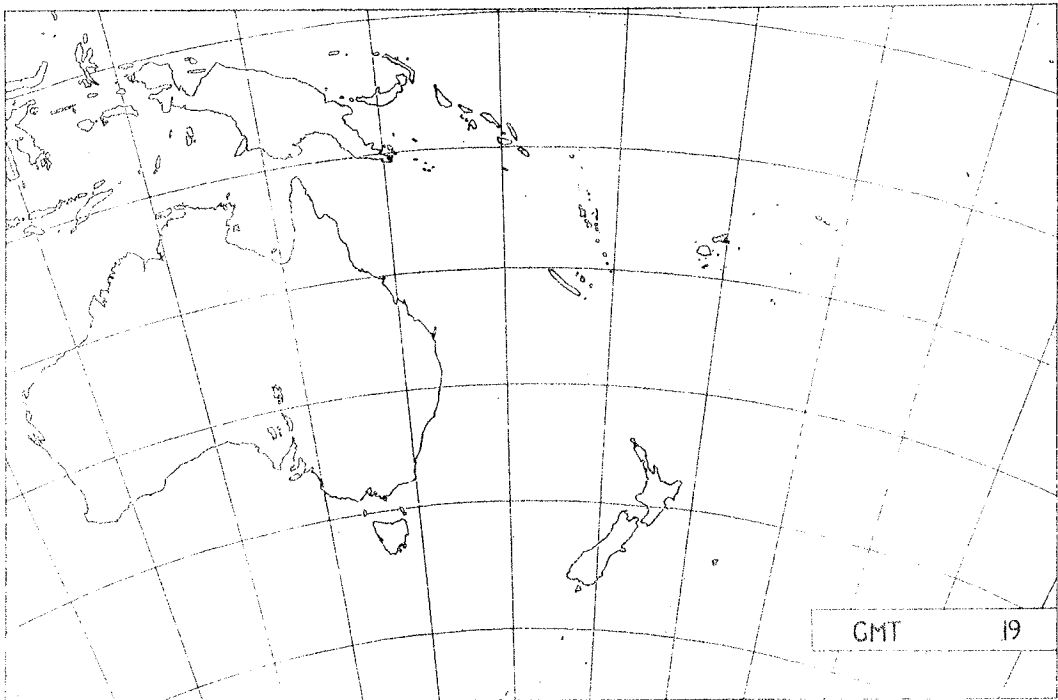
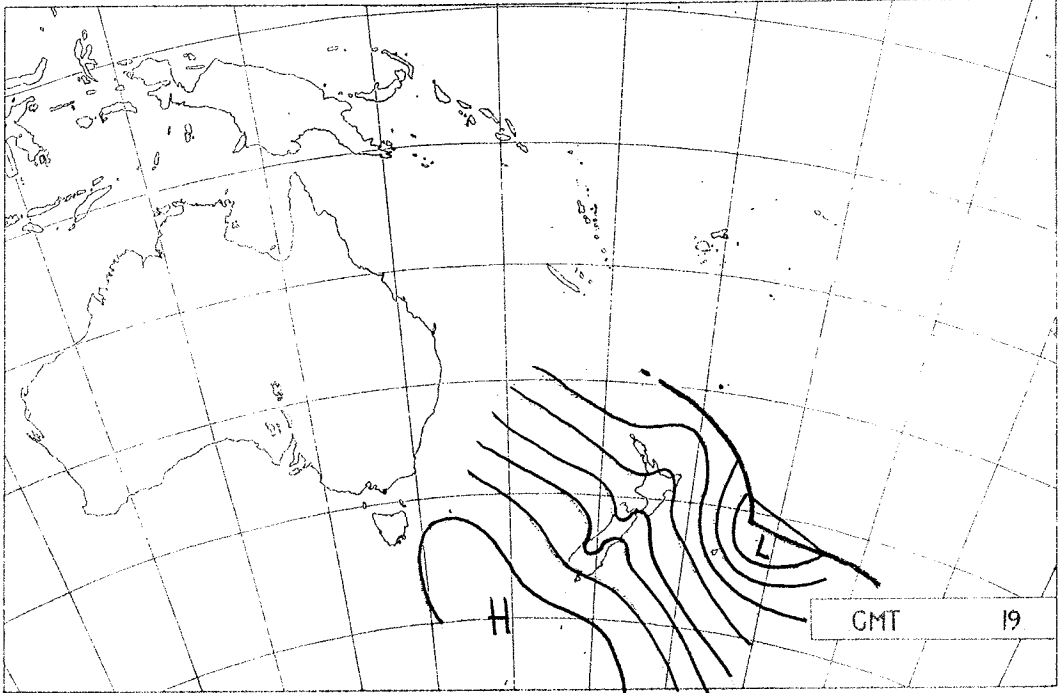


TABLE 1.

Summary of types Jan. - June 1941 and Average duration of Southerly at Wellington for each type.

No. of cases	$\frac{1}{5}$	$\frac{11a}{5}$	$\frac{11b}{4}$	$\frac{11c}{3}$	$\frac{11d}{9}$	$\frac{111}{7}$	$\frac{IV}{4}$	$\frac{V}{4}$
No. resulting in Southerly at Wn.	5	5	4	2	7	4	3	3
Average Duration	2½d.	1½d.	1d	2d.	2d.	9hrs.	4d.	1d.

TABLE 11.
Rainfall at Wellington

Type of Situation	Date	Rainfall in 24hrs before s. change	Rainfall after s. change	Duration of rainfall	Type	Date	R. 24hrs before change	R. after Change	Duration of R.
1.	14/3/41	032	102	{ 100 pts. after 48 hrs.	11d.	3/1/41	-	-	-
1.	24/3/41	047	217	36 hrs.	11d.	11/1/41	082	013	12hrs.
1.	5/6/41	035	074	mainly in 24 hrs.	11d.	5/2/41	008	-	-
					*11d.	13/2/41	111	452	2½days
11a.	20/2/41	-	011	12 hrs.	*11d.	2/5/41	055	199	2½days
11a.	27/2/41	-	-	-	11d.	25/11/41	002	004	6hrs.
11a.	20/4/41	-	tr.	1 hr.	11d.	29/11/41	047	004	after 12 hrs.
11a	23/4/41	-	019	12 hrs.	11d.	30/12/41	-	006	12hrs.
11a	27/4/41	-	tr.	24 hrs.					
11a	2/12/41	tr.	036	12 hrs.	111.	20/5/41	022	-	-
11a	10/12/41	-	-	-	111.	1/11/41	066	038	12hrs.
					111.	3/11/41	-	-	-
11b	7/4/41	023	018	005 at 1st front 013 at 2nd front	111.	18/12/41	-	040	12hrs.
11b	7/5/41	-	034	12 hrs.					
11b	8/6/41	-	002	at front	IV.	1/4/41	-	003	12hrs.
11b	8/11/41	-	088	12 hrs.	IV.	13/4/41	-	193	2days
					IV.	16/6/41	-	094	2 days
11c	29/1/41	004	002	12 hrs.					
11c	6/3/41	003	005	12 hrs.					

* these two situations are combinations of types 11d. & 1.

but there is rarely more than a total of 100 points.

(c) Type IV. Fairly heavy rainfall but showery character is typical of cold polar outbreak. The three well-known types of Wellington southerlies are therefore accounted for: the "dirty" southerly, Type I; the "three day southerly buster", Type IV, or a combination of types I and II; the fine southerly, Types II, III and V (but not always) and sometimes the later stages of type IV southerlies.

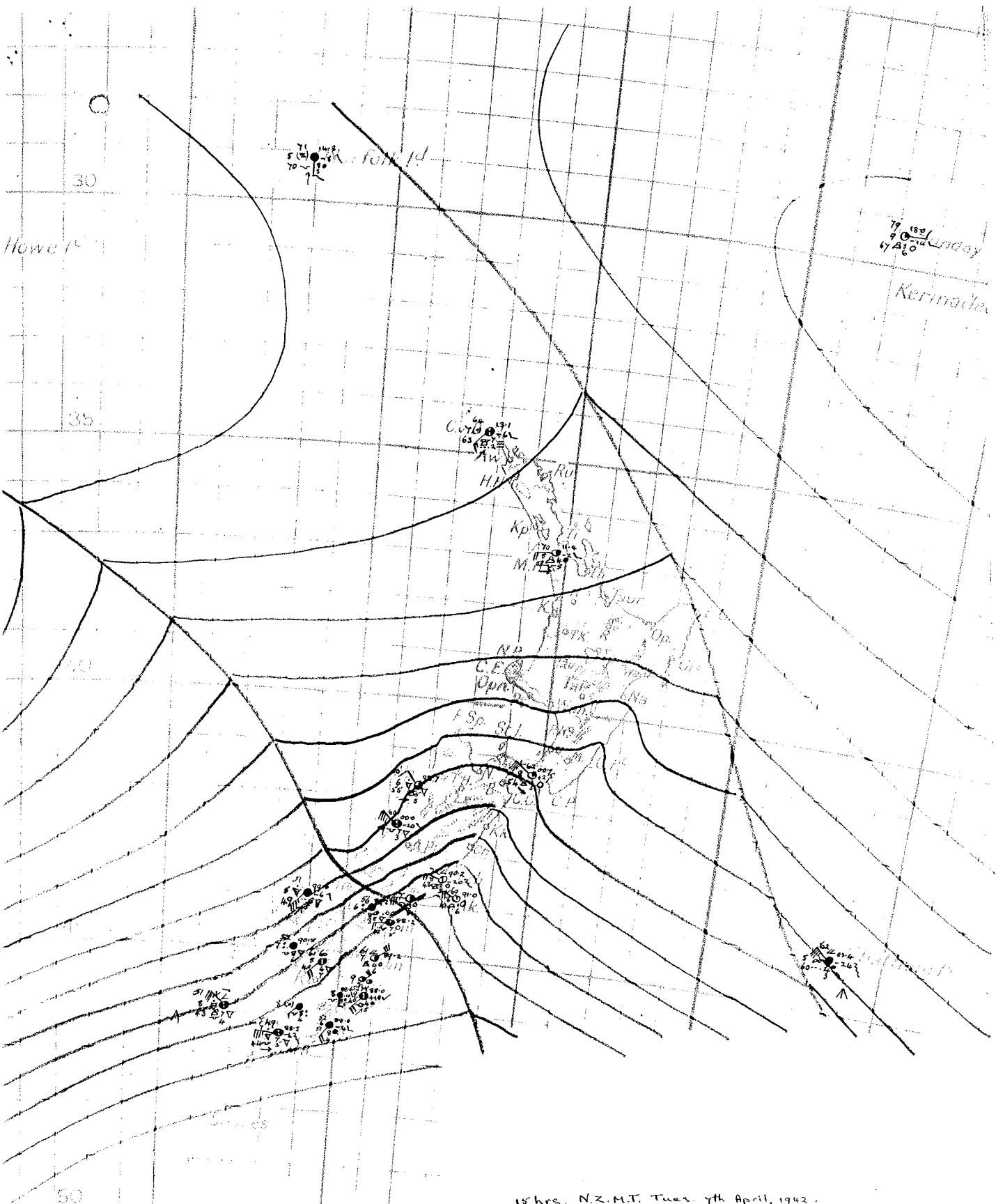
ANALYSIS OF A TYPE V SITUATION.

1. Previous history of the situation. About midday on Monday, 6th April, 1942, a front was lying stationary just north of Blenheim. Its orientation was almost east and west the eastern extension of it passing just south of Chatham Islands. During the afternoon light rain began to fall from altostratus at Christchurch and winds south of the front had an easterly tendency. The front began to move slowly southward and it was evident that a wave, was developing on the front west of the South Island. This disturbance, still a shallow open wave, crossed the South Island just north of Christchurch during the night and moved rapidly east-southeastward and is of no further interest in this investigation. The cold front of the wave crossed the North Island on the morning of the 7th April. Early on the same morning a secondary cold front moved on to southwest Otago and it is with the history of this front and the wind flow in the rear of it that the remainder of this discussion is concerned.

2. History of Secondary Cold Front. Synoptic charts for the following times have been analysed: 15 hrs. Tues. 7th April, 09 hrs., 15 hrs., 18 hrs. and 24 hrs. Wed., 8th April and 06 hrs. Thurs., 9th April. (All times are N.Z.M.T.) The evidence for the times of the passage of the front at various places is set out in the accompanying Table. The evidence also shows that the front is a "real" one. Meteograms for Wigram, Woodbourne and Wellington supply further evidence, if it is required. The drop in temperature at Wigram is masked by the diurnal fall but a drop of 17 degrees between 14 and 17 hours is greater than usual and in addition although cloud conditions were not markedly different on the 8th the maximum temperature on that day was approximately 10 degrees lower than on the 7th. The front passes Woodbourne at 04 hrs. and does not pass Wellington until ten hours later. It seems probable therefore that the section of the front which passes Woodbourne becomes stationary soon afterwards and the northwestern extension of the front swings round and approaches Wellington from the west. There is some evidence that this distortion is already a young wave and that it begins to deepen after 09 hrs. on the 8th in the meteogram for Woodbourne. Pressure begins to fall again after 09 hrs. and cloud increases with further rain in the afternoon.

3. History of the southerly current which reached Wellington early on the morning of 9th April. Some rainfalls, thunderstorms and wind changes which occurred in the South Island on 8th April are listed. The onset of the southwesterly current over the land east of the Southern Alps is not very clearly marked but there are some signs of it. Between 12 and 15 hours there are the following wind changes: Oamaru, West 2 to Southwest 3; Orari, North 2 to Southwest 2; Ashburton, West-northwest 5 to Southeast 4. Also between 09 and 15 hours the wind at Queenstown changed from Northwest to Southwest. At 18 hrs. the wind at Christchurch changed from Northwest to Southwest with a thunderstorm. There is unfortunately no further news of its progress until 06 hrs. reports on the 9th show it blowing right along the east coast of the South Island and to have reached Cape Palliser and Wellington. Already it is dying out in Canterbury although it is blowing strongly offshore.

4. Conclusions. The aim of this short study is to show that the wind changes at Christchurch and Wellington on the 8th and 9th are not frontal, i.e. there is no change in air mass and therefore it is incorrect to mark the wind shift line on the charts by drawing a secondary cold front. I am led to this conclusion by consideration



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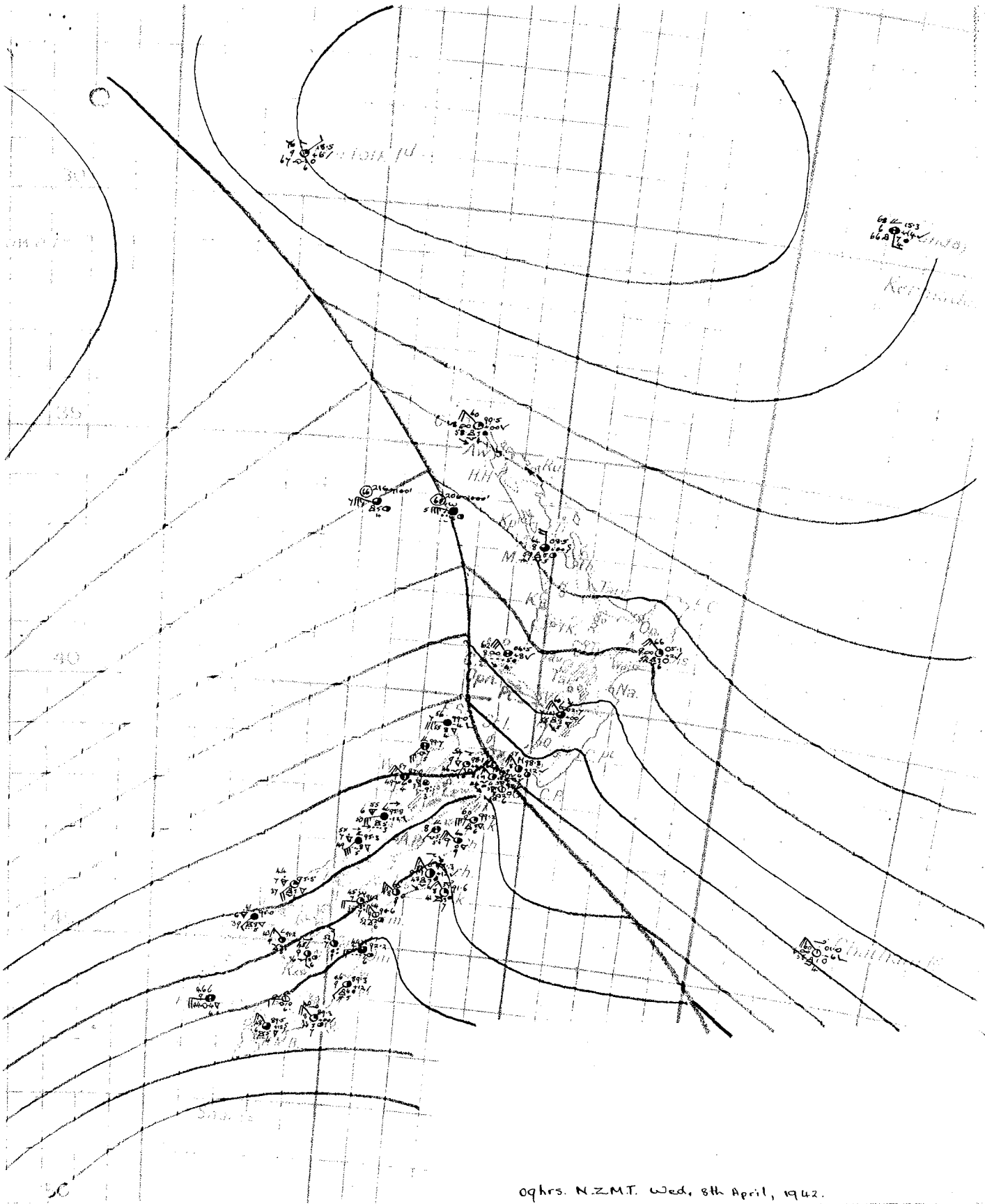
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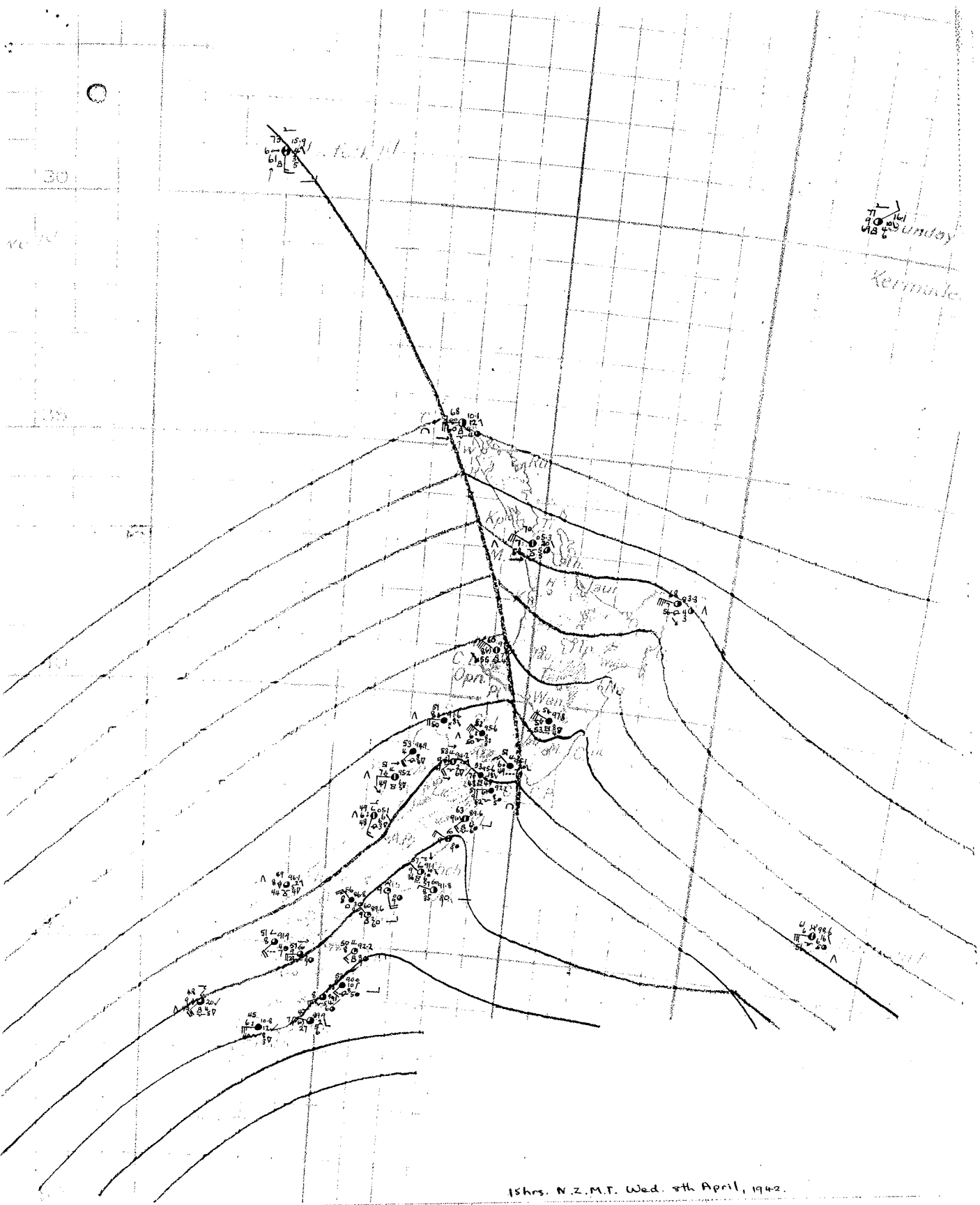
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15 hrs. N.Z.M.T. Tues. 7th April, 1942.



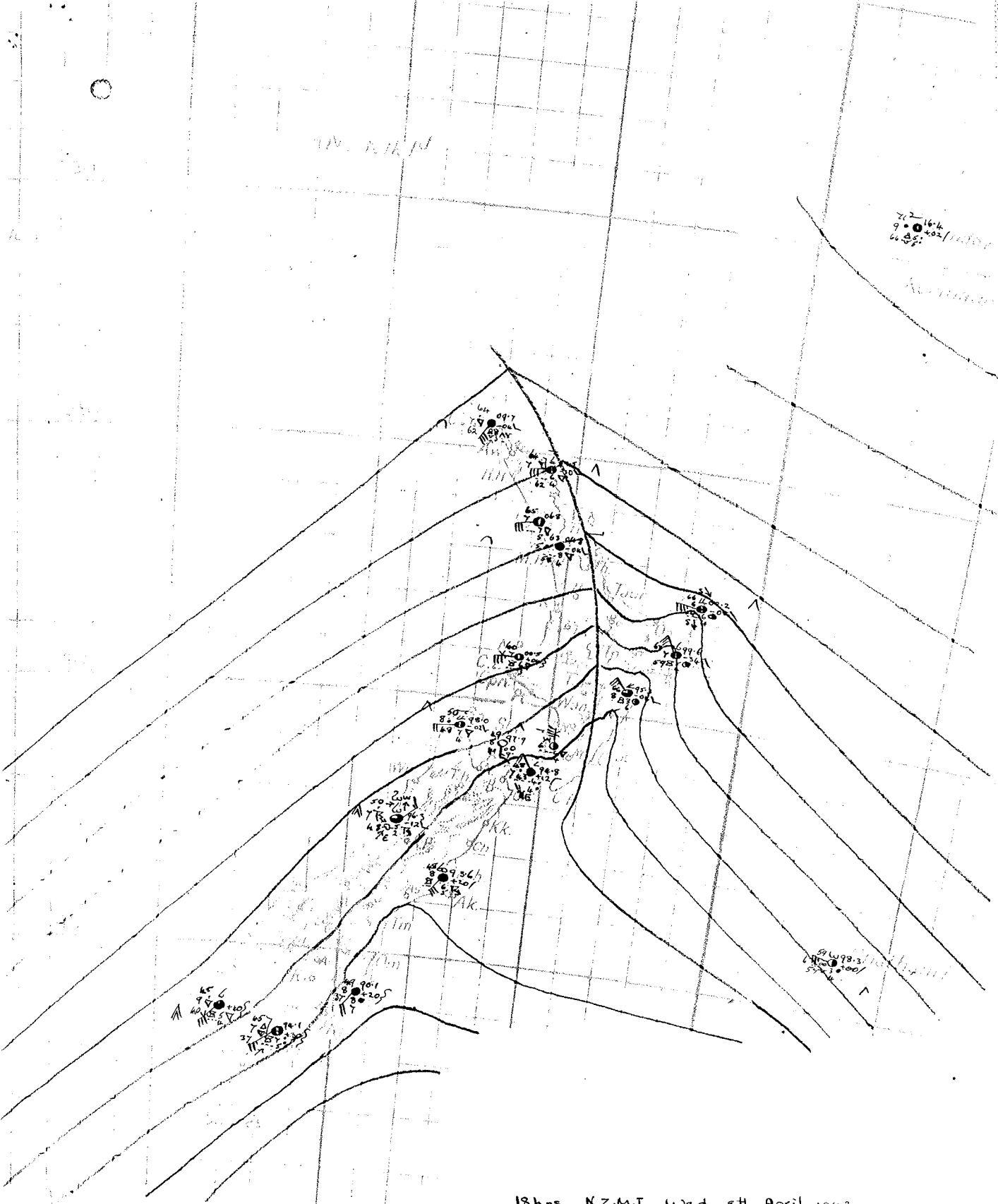
09hrs. N.Z.M.T. Wed, 8th April, 1942.



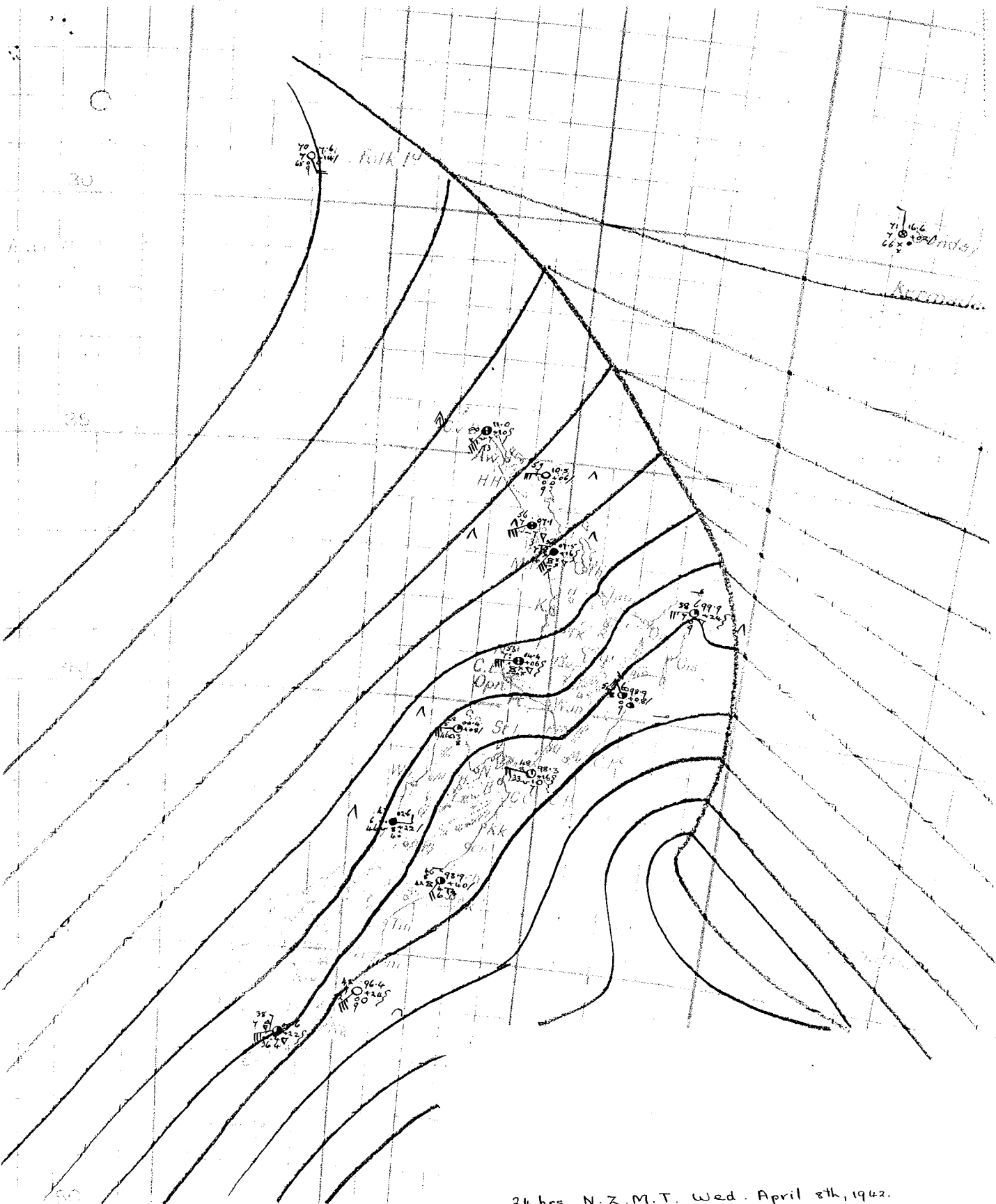
15hrs. N.Z.M.T. Wed. 8th April, 1942.

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9-0-402/111111
66-0-0



18 hrs. N.Z.M.T. Wed. 8th April, 1942.



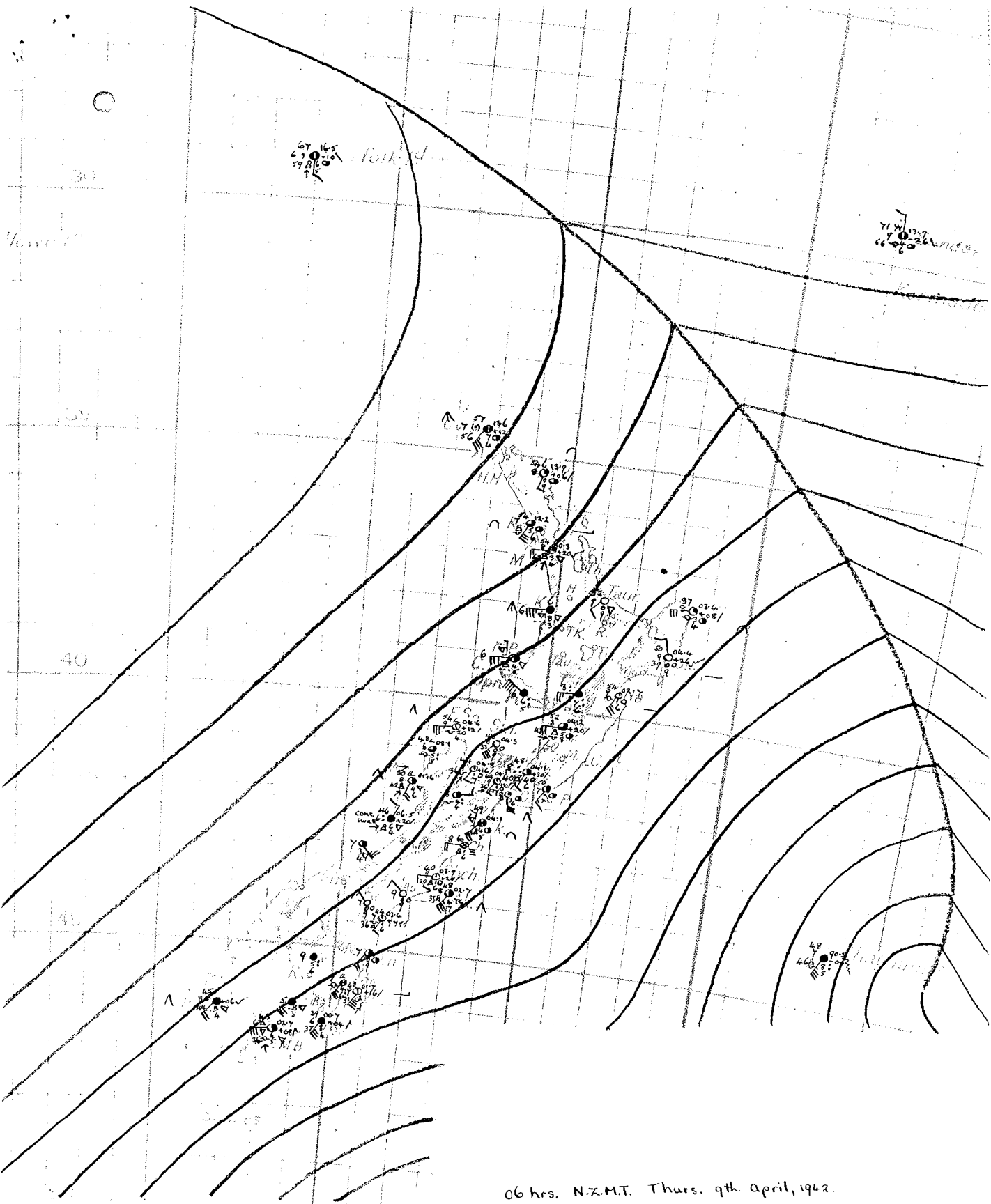
70 70.6
70.3
69.9

Park 14

71 6.6
70.8
69.7

Kermadec

24 hrs. N.Z. M.T. Wed. April 8th, 1942.



06 hrs. N.Z.M.T. Thurs. 9th April, 1942.

TABLE SHOWING EVIDENCE FOR PASSAGE OF COLD FRONT ON 7th & 8th APRIL, 1942.

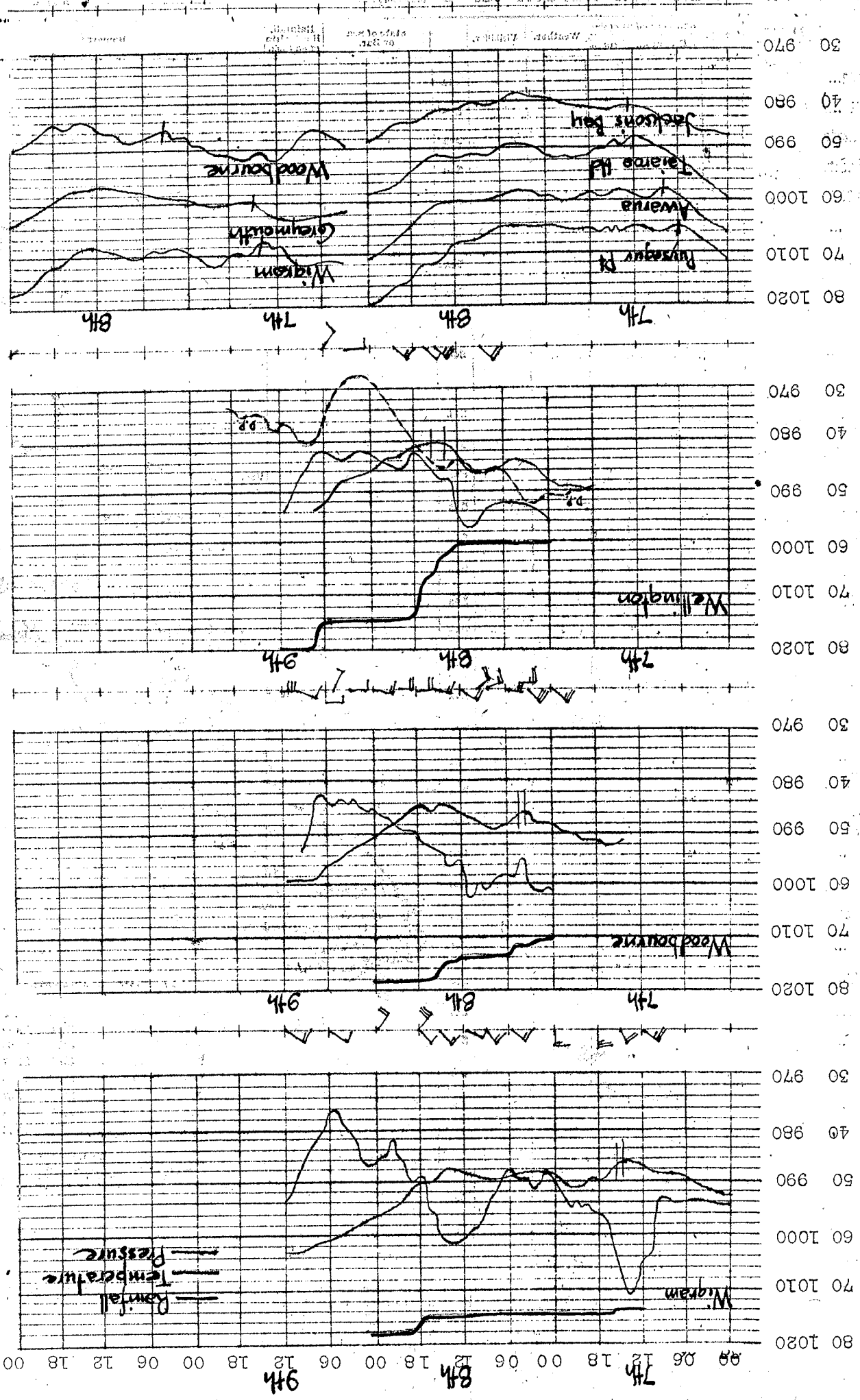
<u>PLACE</u>	<u>TIME</u>	<u>Baro- meter.</u>	<u>Wind</u>	<u>Temper- ature.</u>	<u>Weather.</u>
Puysegur Pt.	06.30/7th	Fall & rise.	N7-W7	53° -49° in 1½ hr.	Rain heavier.
Awarua	08.30/7th	Fall & rise.	NNW4 - W4	-	Heavy rain at 0900
Gore Alexandra	10.00/7th 11.30/7th	- -	- -	61° -54° in 1 hr.	Heavy rain at 10.00 Heavy rain at 11.30
Taiaroa Hd.	12.00/7th	Fall & rise.	NW3 - SW4	57° - 52° in 3 hr.	-
Jackson Bay	12.00- 15.00/7th	Fall & steady	NW7 - SW7	58° -51° in 3 hr.	-
Fairlie Ashburton Wigram	14.00/7th 15.00/7th 16.15/7th	- - Fall & rise	- - No, ch- ange.	- - -	Showery from 14.00 Shower at 15.00 Shower at 17.15
Greymouth	16.00 - 19.00/7th	Fall & steady	NW4-W5	-	Heavy rain 1700-2245
Ashley S.F. Balmoral Spray Pt.	17.00/7th? 16.30/7th? Before 09. 00/8th	- - -	- - S3	- - Cool, snow on top.	Rain at 17.00 Rain at 16.30 Showers cleared by evening.
Woodbourne	0400/8th	Fall & rise.	NW6-W5	62° -56°	Shower (5 pts.)
Ocean Bay	After 09.00/8th	-	NW3-W	-	Fine at 09.00 showers later.
Asbestos Cot- tage(2000')	0900-1200 /8th	-	W3-SW5	-	Showery
Wellington	14.00/8th	Fall & rise	NW5-NW1	53°-43° in 6 hours.	Rain in 6 hrs. 32 pts.
New Plymouth	15.00/8th	Fall & rise	NNW5- NW7	65°-60° in 3 hrs.	Showers 1500-1800
C. Reinga	18.00/8th	Fall & rise	W4- SW6	-	Showers 1800

In addition many reports of fresh snow on mountains on 8th April.

REPORTS OF THUNDERSTORMS, RAIN ETC., ON APRIL 8th & 9th.

Gore Alexandra	16.00/8th 21.30- 23.00/8th				Rain Moderate rain 11 pts.
Orari	(12.00/8th (15.00/8th		N2 bc SW2 bc		Thunderstorm
Ross	00.00- 01.00/8th				Thunderstorm
Murchison	00.00- 09.00/8th				Thunderstorm
Kahurangi Pt. Arnold Power Stn.	16.00/8th 12.00- 18.00/8th				Thunderstorm Thunderstorm with hail(Greymouth 1800)

WATER RESOURCES DIVISION
UNITED STATES GEOLOGICAL SURVEY



30 970
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— Rainfall
— Temperature
— Pressure

00 06 12 18 00 06 12 18 00 06 12 18 00

of the following facts:

(a) There are many reports of fresh snow on the ranges of the South Island on the 8th, suggesting the arrival during the previous afternoon and night of a colder air mass. There is no further drop in temperature reported on the 8th and such rainfalls and thunderstorms as occur are quite unrelated in time and could not be frontal. They are simply instability phenomena.

(b) Meteorograms for Wigram, Woodbourne and Wellington show that there is no further substantial drop in temperature with the onset of the southerly wind. The low minimum temperature at 06 hrs. at Wigram is due to the clear sky and light wind.

(c) All the South Island barograms show a marked discontinuity in barometric tendency on the afternoon of the 8th but this cannot be a front passage as the beginning of the abrupt rise occurs almost simultaneously at all Stations.

(d) There is no wind-shift on the west coast of the South Island on the 8th. The winds there changed to southwest when the cold front passed on the 7th and continued to blow from that quarter (except for a light local easterly at Greymouth), thereafter. The change of wind direction on the east coast and at Wellington and the pressure rises are therefore not caused by the passing of a front but simply by the movement of a centre of low pressure in the south. This centre is associated with the original meridional front and the secondary front. When the low is south of New Zealand the isobars over the country are westerly (if orographical distortion is smoothed) and part of the air reaching the west coast flows over the Alps and on to the plains as a northwest wind and part is deflected to the north and flows round the northern end of the mountain chains and through Cook Strait as a northerly wind. When the trough of the low passes the isobars run from south of west and pressure begins to rise, but the air flow over and round the ranges is still controlled by the mountains and valleys. Only when the isobars run parallel to the line of the Alps or from a more southerly direction is the air able to flow directly up the east coast. Between this air and the air which has come over the Alps or through Cook Strait a line squall may form and thunderstorms develop.