551.524.37(931)

N.Z. Met.S. Misc. Pub. 173
ISSN 0110-6937

MINISTRY OF TRANSPORT

NEW ZEALAND METEOROLOGICAL SERVICE

AN AIR FROST CHRONOLOGY FOR NEW ZEALAND

Statistics of First and Last
Air Frost Dates, and of Air Frost
Free Duration in New Zealand

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WELLINGTON, NEW ZEALAND—1981

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AN AIR FROST CHRONOLOGY FOR NEW ZEALAND

Abstract

Statistics are presented for 166 New Zealand locations of the distributions of:

I date of first frost

II date of last frost

and

III duration of frost free season.

These statistics have been calculated on all available data, and include extremes, selected percentiles, means and standard deviations, and ranges for I, II and III. Also included are the sample size and number of frost free years.

Confidence limits based on normal and distribution-free assumptions are given for means, selected percentiles, and the standard deviations.

Generalised maps of extreme early and extreme late frost are presented. These maps demonstrate the steep spatial gradients which can exist in the data, and the extreme values inland. A map of frost free years is presented, which illustrates the relatively frost free coastal margins. Evidence exists in these maps for significant local effects, in the larger river valleys and about the lakes of the South Island, about Cook Strait and in the Manawatu Gorge, and east of even quite minor ranges.

The variability of spatial differences of first and last frost dates is shown to be of the order of weeks on climate sub-grid scales. An upper bound for this variability is estimated.

The distribution of extreme levels, variability, skewness and shape of the three distribution types over New Zealand is discussed. The general applicability of the normal distribution is shown, but it is demonstrated that various distinctly non-gaussian aspects are present, especially inland in the frost dates and about the coast in the frost free duration.

Statistically significant relationships are found between frost date statistics and mean annual temperature and mean annual range, and the regional variation of these relationships discussed. The implications for rational mapping of frost date statistics are considered.

1. Introduction

This publication presents statistics relating to:

- I date of first air frost
- II date of last air frost
- III duration of air frost-free season

for New Zealand.

The frosts discussed here are air frosts, defined as occasions when the temperature in a standard meteorological screen 1.3 metres above a level grass surface, falls below 0° Celsius. Records of ground frost (as measured by grass minimum thermometers) are also kept by the New Zealand Meteorological Service, but these are not considered in this publication.

In calculating these statistics, the number of days from the beginning of the year was used in I and II. The duration of the frost-free season III is defined as the number of days between the last frost of one year and the first frost of the following year.

As this is a first publication concerning frost dates the opportunity has been taken to analyse useful historical records from closed climatological stations as well as current records.

In general, the variability both in space and with time of frost is considerable. Frost occurs as a result of a sequence of processes. While it is difficult to predict frost or to determine the magnitude of the various changes the general factors involved are well known. These are firstly the advection of cold air over the land, in New Zealand generally from the southerly quarter, and the further cooling of the air close to the surface as a result of radiational heat loss from the surface at night. This cooling will be most intense in clear, calm conditions.

Topographic variations are well known influences of frost occurrence. These variations have effects through:-

a) radiation balance
b) effects on cloud distribution
c) effects on wind distribution
d) flow and ponding effects on cold air drainage. *

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* A full discussion of this problem may be found in Geiger (1965).

On a larger scale, general influences of some importance include:

the moderating effect on temperatures of the sea in coastal areas;

the general decrease of temperature with altitude;

the orientation and slope of the ground;

the nature and texture of the soil and surface cover;

the amount of moisture in the lower layers of the atmosphere and the level of soil moisture;

and finally the great variability induced both spatially and temporarily in the day to day weather produced by synoptic disturbances.

About the coast the sea/land breeze regime is likely to be important, while inland the effects of mountain/valley wind systems, with their complicated dependence on thermal effects and synoptic variation may be expected to be important influences affecting frostiness.

2. The Statistics

The main statistics tabulated are the extremes (maximum, minimum), selected percentiles and the mean, standard deviation and extreme range; pages 41 - 52.

The station tables are listed in numerical order according to station number within the sections A through I. (See the Station location key, map 1). An alphabetical list of stations names with associated page numbers is given on pages 5 - 6. The latitude and longitude of each station are included in the table headings, and its location is approximately given by the station number. The first two digits of the five specify the last digit of the numbers of degrees South and East. The next two digits give the approximate position, in tenths of one degree South and East respectively, within the "square". The last digit relates to a particular site and is for recording purposes. Thus FOXTON F05421 is approximately 40.4 South, 175.2 East, as indicated in map 1. Also given in the station table headings is the site elevation, in metres.

At the right hand of the tables are two columns headed N and n. The first variate, N gives the length of data period. The second, n, gives the number of frost free years in the years of full record.

In the body of the table are presented the percentiles (10, 25, 50, 75, 90 percent) the extremes, means and standard deviations, and also the extreme range.

The listed values have been calculated as follows: -

i) mean : $M = (\Sigma D)/N$

ii) standard deviation : $SD = \sqrt{\{(\Sigma D^2 - NM^2)/(N-1)\}}$

where D is either the date expressed as a number of days from the beginning of the current year, or the duration of the frost free season in days, and N is the number of observations of the quantities concerned.

iii) percentiles : the k'th percentile = k(N + 1)/100'th observation

after the observations have been ranked from smallest to greatest.

Where k(N + 1)/100 was fractional the percentile was taken as the average of the value of the sum of the observations whose ordinal numbers lie about k(N+1)/100. Because of the sampling fluctuations no more refined method was thought justified.

In these calculations due allowance was made for leap years, and the length of the frost free season was taken as:

$$D = D_{FN+1} - D_{LN} + 364, \text{ where}$$

D_{FN+1} is the number of days into year N + 1 of the first frost, and D_{LN} is the number of days into year N of the last frost.

In some years in some areas no air frost occurred, notably in Westland and Northland. The frost-free period then includes the whole year. In these cases no mean, standard deviation or range was calculated for the dates of first and last frost. The frost-free period taken then is the natural one of complete length in time from last frost to the next frost. Some of these frost-free period statistics are consequently extremely large.

In the calculation of the percentile values for records with frost-free years, N was still taken as the number of years of record. Attaching some probability to the non frosty year in this manner avoids bias in the long term expected number of air frosts.

3. Errors

The statistics relate to threshold type events. Because of the large variations which may occur in meteorological data over quite short time and space scales these threshold statistics may be expected to reflect this rather sensitively. An estimate of an upper bound to the variation in the date statistics is given in 4.

Other mechanical errors may arise in recording the observations and in converting a temperature threshold occurrence date into a number of days from the beginning of the year, etc.

A pilot study showed that an error rate of about 2% existed in finding the actual temperature threshold occurrence, as recorded, and the magnitude of this error was generally small ($\sim$ 10 days). The overall effect on the calculated sample statistics was negligible.

All conversions of dates into numbers of days from the beginning of the year have been checked.

4. A Comparison of Temporal and Short Scale Spatial Variability

In analysing this data set, a special study was made of those few climate records which existed contemporaneously within an area small by comparison with the general separation of stations in the climatological network.

At a given station A, the date of first/last frost in a given year was compared with the date of first/last frost at a neighbouring station B. The difference is a measure of the spatial variability in first/last frost dates. These differences are referred to as the Space Differences (Sp D). Also the date of first/last frost at each station can be compared with the corresponding date for the same station in the following year. These differences are referred to as the Time Differences (Ti D).

Statistics of Sp D and Ti D are given in Table 1; the mean differences correspond to systematic effects in time or space, and the dispersion about the mean differences correspond to the time variation about these mean differences. In particular, the standard deviation of the space differences can be taken as a measure of the time variation of the local space differences of the first or last frost dates.

From these tables it is seen that

a) the mean space differences are considerably larger than the mean time differences, which are generally small.

b) however, the mean space difference variability is rarely less than two weeks and may be as much as five weeks or more.

Table 1a: Summary of Distribution Characteristics : First Frost Dates.

		|Mean Sp D|	Standard Deviation of Sp D	n	|Mean Ti D|	Standard Deviation of Ti D	n
1.	Levin -Waitarere	31	24	11	1 3	31 14	10 10
2.	Masterton Airport -Waingawa	14	32	7	1 1	24 51	6 6
3.	Nelson -Nelson Airport	43	36	8	2 5	29 29	7 7
4.	Christchurch Airport -Wigram	4	11	15	2 0	25 24	21 30
	Wigram -Christchurch	3	15	31	0 0	24 22	30 37
	Christchurch Airport -Christchurch	4	17	22	2 0	25 22	21 37
5.	Timaru -Timaru Airport	14	18	8	2 1	27 24	7 7
6.	Gore -East Gore	13	28	23	0 0	21 39	22 22
7.	Invercargill 1 -Invercargill 2	9	12	11	0 1	14 18	10 17
	Invercargill 2 -Invercargill Airport	41	50	9	1 0	18 53	17 26
	Invercargill 1 -Invercargill Airport	54	56	3	0 0	14 53	10 26

|Mean Sp D| - Magnitude of mean of space differences of first frost, where Sp D is date of first frost at station A - date of first frost at neighbouring station B, in same year.

|Mean Ti D| - Magnitude of mean of time differences of first frosts, where Ti D is date of first frost at station A in year - date of first frost at same station A in preceding year.

n - Sample size.

Table 1b: Summary of Distribution Characteristics : Last Frost Dates.

		Mean Sp D	Standard Deviation of Sp D	n	Mean Ti D	Standard Deviation of Ti D	n
1.	Levin -Waitarere	46	31	11	1 3	34 39	10 10
2.	Masterton Airport -Waingawa	10	17	6	19 2	24 31	4 6
3.	Nelson -Nelson Airport	44	34	8	4 0	52 17	7 7
4.	Christchurch Airport -Wigram	4	27	15	1 4	23 31	21 30
	Wigram -Christchurch	7	32	30	4 2	31 37	30 37
	Christchurch Airport -Christchurch	3	25	22	1 2	23 37	21 37
5.	Timaru -Timaru Airport	13	23	8	4 5	23 44	7 7
6.	Gore -East Gore	1	25	22	1 1	39 35	21 21
7.	Invercargill 1 -Invercargill 2	14	21	11	1 0	32 25	10 17
	Invercargill 2 - Invercargill Airport	25	25	9	0 1	25 46	17 8
	Invercargill 1 -Invercargill Airport	9	38	3	1 1	32 46	10 8

|Mean Sp D| - Magnitude of mean of space differences of last frost, where Sp D is date of last frost at station A - date of last frost at neighbouring station B, in same year.

|Mean Ti D| - Magnitude of mean of time differences of last frost, where Ti D is date of last frost, at station A in year - date of last frost at same station A in preceding year.

n - Sample size.

Even in the case of Christchurch, where there is a relatively flat and uniform topography compared with much of New Zealand, the dispersion of the differences of dates of first/last frost is quite considerable being about two to four weeks.

A pooled estimate of the space and time difference variabilities was formed weighting each variance by the appropriate number of observations. The pooled estimates of variability in the space and time differences were compared, as in Table 2 and Figure 1.

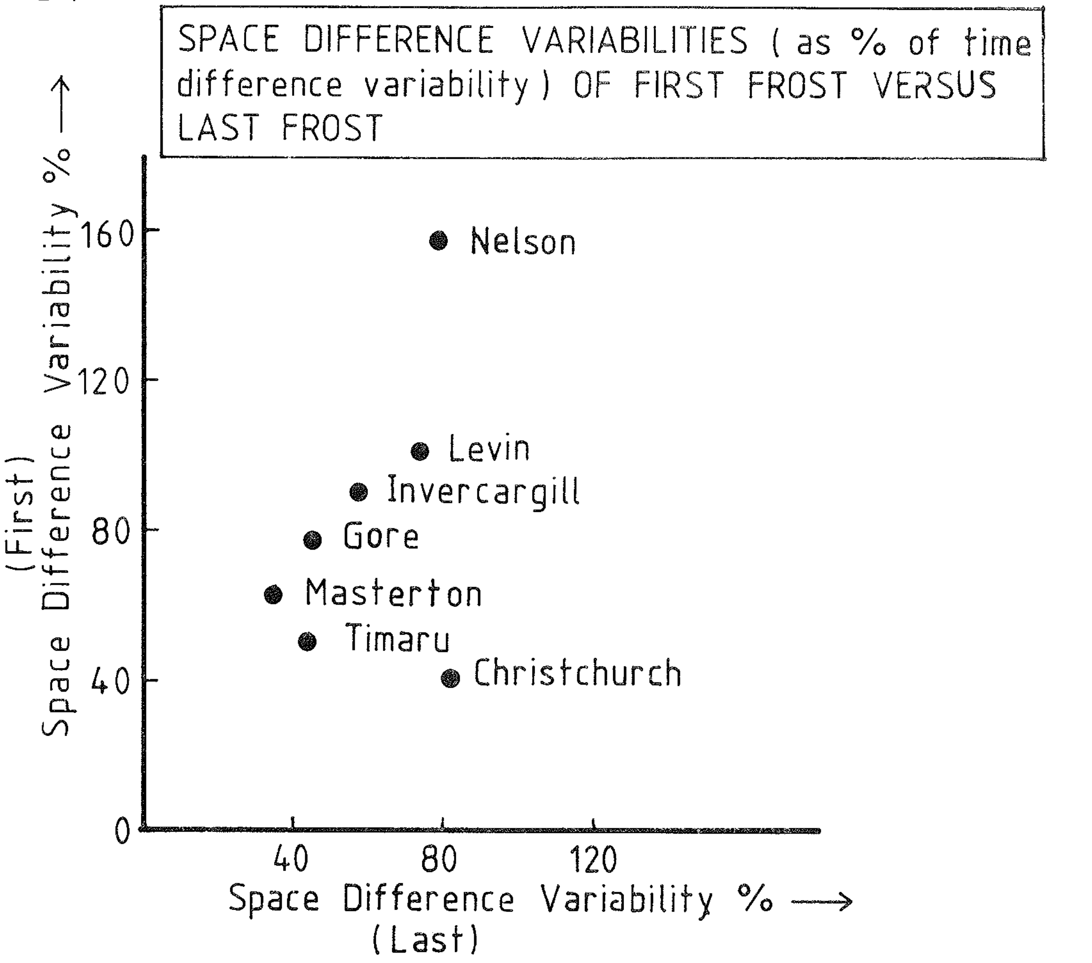
a) There is a moderate correlation between the two sets of percentages (first, last) when Christchurch is excluded.

b) The pooled time variability of the space differences is generally smaller than that of the pooled time differences but can be greater, especially in sheltered coastal locations, where the spatial variation of frost occurrence may be very great.

Table 2: Space Difference Variability as Percentage of Time Difference Variability

	First Frost	Last Frost
Levin	101	73
Masterton	63	35
Nelson	157	79
Christchurch	41	82
Timaru	50	44
Gore	77	45
Invercargill	90	57

FIG 1



The preceding analysis assumes no random or systematic error in the instrumental records of temperature. A systematic error will influence the mean differences, and a small random error will influence the standard errors of the space differences.

Clearly we can partition the time variability of the space differences of first or last frost σ^2 say into a portion σ_i^2 due to random instrumental error and σ_r^2 a portion due to real variability so that:

$$\sigma^2 = \sigma_i^2 + \sigma_r^2$$

if uncorrelated.

The quantity σ^2 which we can measure and is discussed in Table 1, appears then as an upper bound for both quantities σ_i^2 or σ_r^2

5. Extreme Values

Maps 2 and 3 present information about the extreme dates for first and last frost occurrence in New Zealand. The extremes are from all available records.

These maps are highly generalised and only a broad indication of frost date occurrence may be taken from them. They cannot provide highly reliable point estimates. The equal date contours are, however, strongly correlated with the equal date contours for the various percentiles of extreme frost occurrence.

Stations with at least one frost free year are shown in Map 4. For each such station the number of frost free years is shown as a fraction of the total number of years of record. At several places the locations of sites changed and in this case both the records before and after the site change are shown.

A number of interesting features are apparent from these maps. In summary, they are: -

i) A large area of extreme early first frost and extreme late last frost in the Central North Island, with lobes running northeast towards East Cape and north-northwest to Coromandel; and an even larger region in the interior South Island. A smaller extreme exists in inland Wairarapa, in both first and last frost dates. A further local extreme exists inland from Waipoua in Northland.

ii) Frost free years occur along the coastal margins from Haast north on the western coast and from Banks Peninsula north on the east coasts. In general Northland and Westland are the main frost free areas. Local maxima of frost free years occur about Cook Strait and in the Manawatu Gorge, where strong winds are common.

iii) In the major river valleys east of the South Island main divide and about the Southern Lakes there is evidence of important local effects, both acting to produce later first frosts and earlier last frosts. The influences of strong katabatic flows, which may be expected to give some mixing, and heat store effects from the presence of neighboring large bodies of water are likely to be important.

6. Variability

The standard deviations of dates of first and last frost, and of frost free duration, were mapped over New Zealand. There was quite wide variation spatially so the following discussion is given in terms of a range of weeks; contouring of the unsmoothed variabilities is not suggested.

Much of the variability in first and last frost dates about the coasts lies within the range 2-4 weeks where a well defined frost year occurs. In the central North Island the first frost dates become more variable, lying within the range 5-7 weeks about the Volcanic Plateau. Similar increases in variability are found inland in the South Island, where it is typically in the range 4-5 weeks in inland Canterbury and Southland. A local minimum appears about Central Otago, where the first frost variability is of the order of 2-4 weeks.

The last frost date variabilities are typically of 3-4½ weeks in inland areas, in both islands.

A much greater spatial variation is evident in the frost free durations. Inland, where there is generally a well defined frosty period every year everywhere in New Zealand, it is typically from 20-50 days. Near or on the coasts, however, where there may be frost free years, there is wide spatial variation possible in these frost free variabilities. 15 to 40 days is quite typical in coastal Canterbury, Otago and Southland, and also about Cook Strait. About Northland, Auckland and Westland however, the range is more typically 10-400 days. About Fiordland, the east coast of the North Island and Bay of Plenty, and the Manawatu it is intermediate being more of the order of 20-150 days.

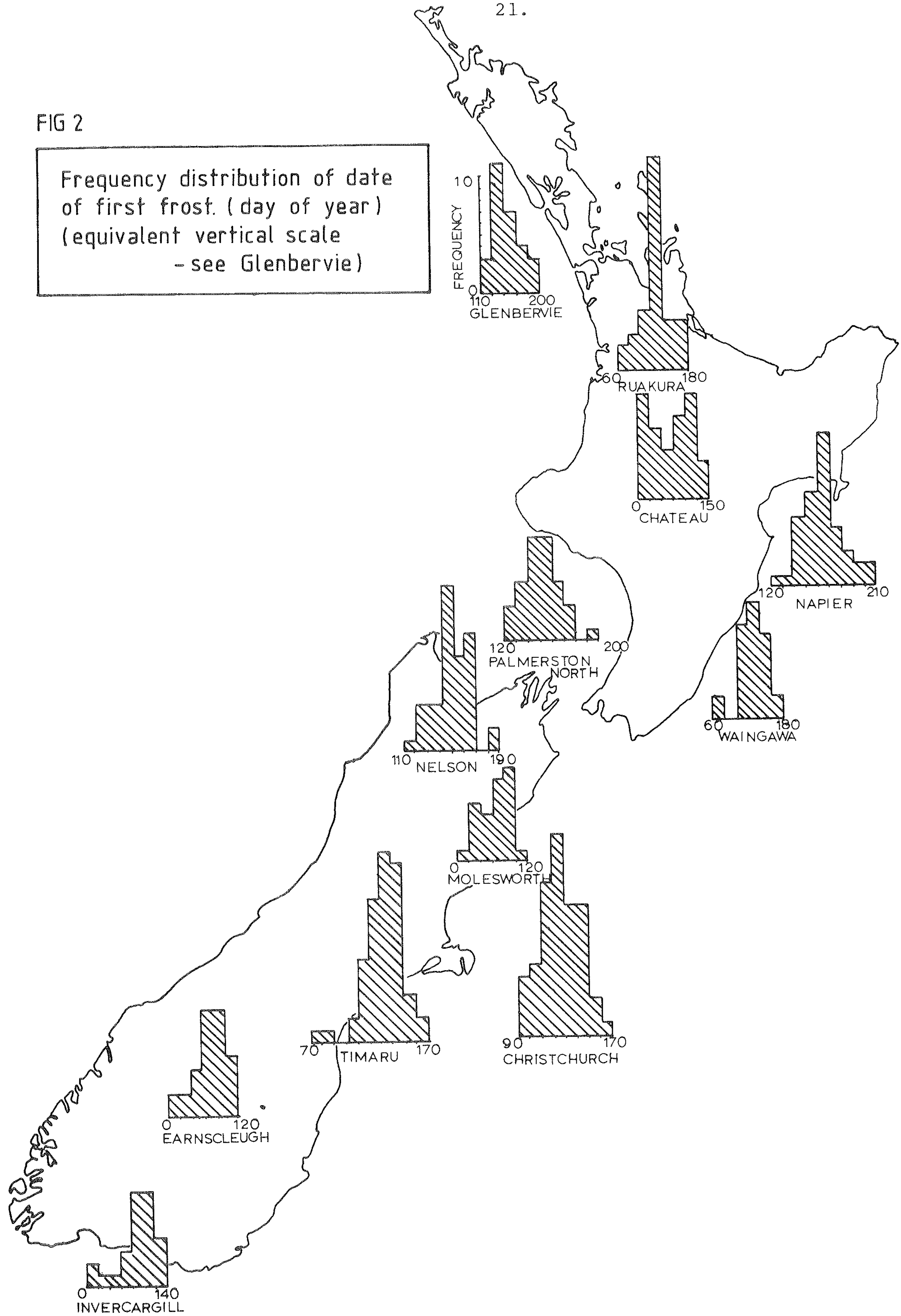
7. Distributional Form

An examination was made of the histograms of first and last frost date for all the longer records (25 years or more). Most of these distributions can be fitted quite closely by a normal distribution but the following characteristics of the data were noted.

i) Some of the distributions appear quite skew. A few appear almost uniform, bimodal or even polymodal. The first and last frost date distributions tend to be merely skewed about the coasts, but as one goes inland and to high levels not only does skewness usually increase but also the other non-gaussian features, such as bimodality appear.

FIG 2

Frequency distribution of date of first frost. (day of year) (equivalent vertical scale - see Glenbervie)



ii) The duration of frost-free season tended to be most skew in the less frost prone areas (Northland, Auckland and Westland) and in general, about the coastal margins, although some quite skew distributions appear in the central North Island and east of the Southern Alps.

Figures 2-4 present a typical selection of histograms of each of the three parameters, and illustrate some of the above points.

In frost risk studies one is particularly interested in the more extreme "outside" percentiles, for example the 10% date of first frost and the 90% date of last frost. Overseas, the assumption is often made that the dates are normally distributed. (Waggoner, 1968). While this is also generally true in New Zealand (in the overall mean squared discrepancy sense for example) this criterion may be insensitive to departures concentrated near the tails of the distribution. Differences of up to 3 weeks can separate the 10 percentile dates of first frost calculated from the empirical distribution function and the normal distribution function, even when the overall χ^2 is not significant. (Goulter and Hurnard, 1979).

To provide a guide to the normality of the data, sensitive to departures from normality in the more extreme values, Table 3 should be consulted. This gives the discrepancies DIS between empirical and gaussian estimates of the 10 and 90 percentile values for each of the distribution types (for locations where frosts occur every year).

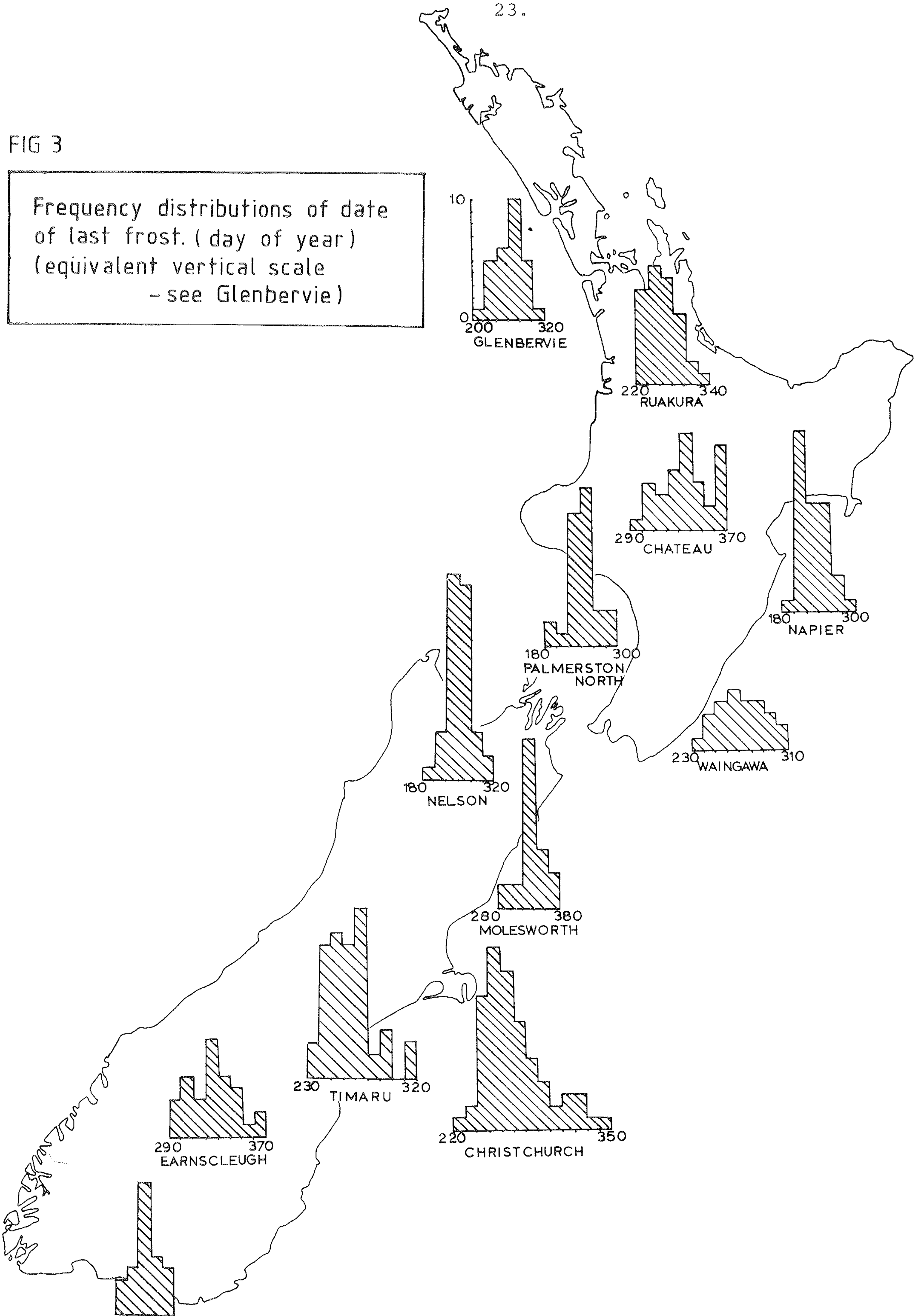
Gaussian estimates of the 10 and 90 percentile values were derived using the sample mean and standard deviation to estimate the population moments.

In the frost dates, about 19% of all these values equal or exceed 1 week; about 9% equal or exceed 10 days; and about 3% equal or exceed 15 days. Most of the more extreme deviations are to be found inland; of the 95 locations 27 have at least one deviation in excess of 10 days.

In the frost free durations many large deviations from normality occur inland but in general the greatest deviations occur about the coasts where some years may be frost free.

FIG 3

Frequency distributions of date of last frost. (day of year) (equivalent vertical scale - see Glenbervie)



Inset 3°

FIG 4

Frequency distributions of length of frost-free period (days) (equivalent vertical scale - see Glenbervie)

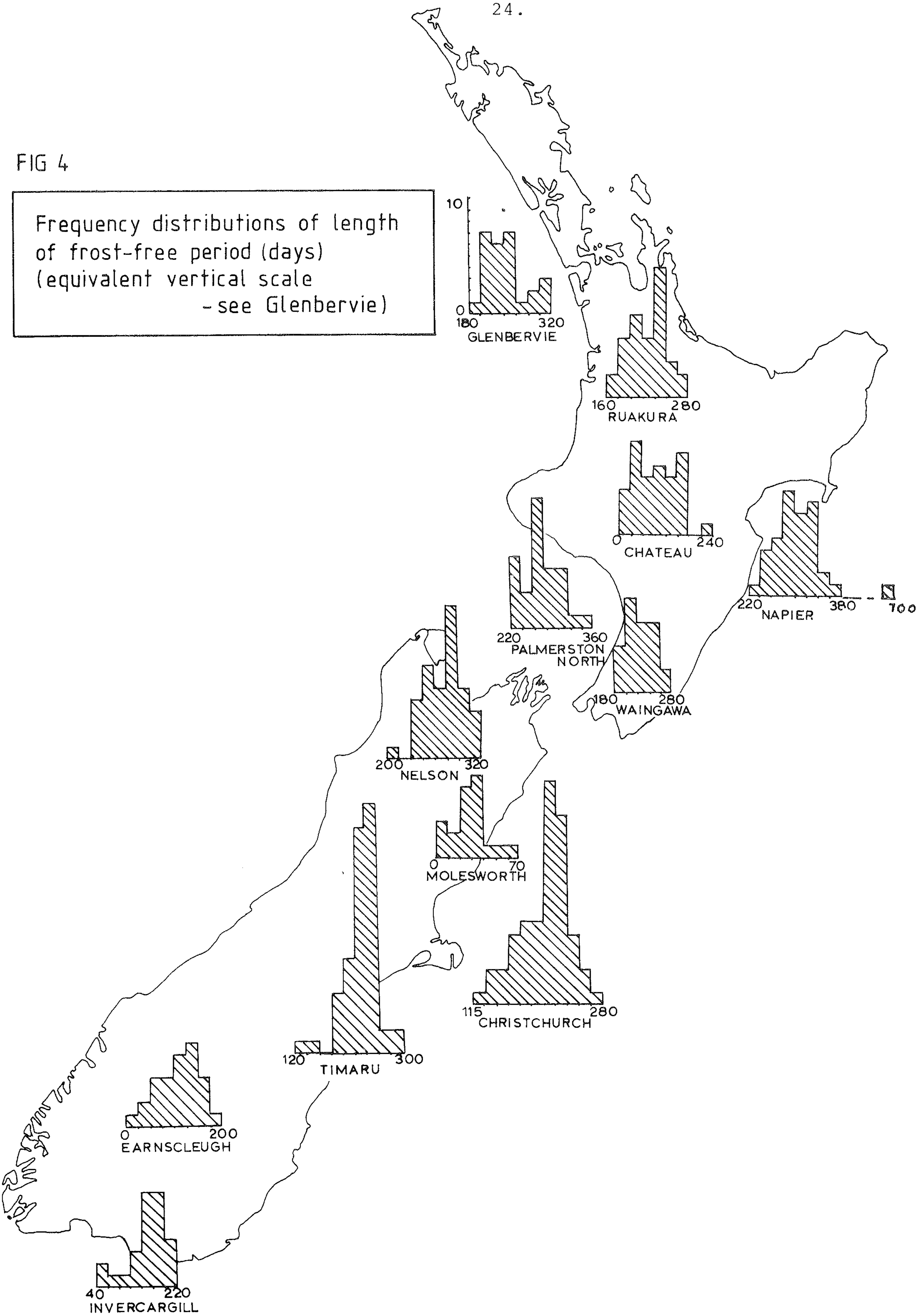


Table 3: Discrepancies from Normal of Empirical 10 and 90 Percentiles (Discrepancy DIS = Observed - Expected, in days)

LOCATION	FIRST		LAST		FROST FREE DURATION	
Percentiles	10	90	10	90	10	90
Dargaville	-2.6	2.6	-10.2	-3.8	-4.0	4.0
Glenbervie	-1.0	9.1	-10.4	2.4	5.3	19.7
Riverhead	0.6	-0.6	7.3	5.7	-0.2	1.2
Whenuapai	-0.6	4.6	6.4	-3.4	7.1	5.9
Oratia	-4.6	8.6	-9.6	4.6	5.8	10.2
Waihi	-1.0	-1.0	-1.2	6.2	-3.3	15.3
Te Aroha	1.7	-3.7	0.8	3.2	-7.2	1.2
Rotoheu	1.6	-0.6	1.0	0.0	-6.6	-1.4
Kawerau	-1.0	2.1	-3.9	4.9	0.4	6.6
Rotorua	-1.3	-4.7	3.4	7.6	-8.5	4.5
Whakarewarewa	-0.4	2.4	5.0	8.1	-11.2	-1.8
Waiotapu	-4.6	2.6	-0.9	9.9	-6.6	3.6
Kaingaroa	-9.6	-0.4	5.1	-0.1	-12.6	-4.4
Wairapukao	-4.9	-0.1	-4.7	1.7	7.0	12.0
Taupo	-8.3	4.3	0.4	0.6	-5.9	6.9
Minginui	-6.6	2.6	-6.4	4.4	-16.3	6.3
Otara	-4.6	-5.4	-4.2	5.2	-4.5	1.5
Maramarua	2.4	0.6	6.4	1.6	2.4	-0.4
Ruakura	-9.7	4.7	1.1	2.9	0.1	6.9
Whatawhata	-2.4	1.4	6.0	8.0	-10.3	-8.7
Rukuhia	5.4	-7.4	-2.0	-2.0	2.4	17.6
Arapuni	2.0	3.0	-1.0	5.0	-9.9	-3.1
Pureora	-16.0	-1.0	-11.5	0.4	-3.2	-4.8
Taumarunui	-1.2	0.2	0.3	1.7	-4.7	-1.3
Te Wera	-2.2	-2.8	-8.2	-4.8	6.8	7.2
Chateau	-2.5	-4.5	-4.3	1.3	-6.0	9.0
Pahiatua	-1.3	-1.6	1.6	5.4	-20.3	-10.7
Bagshot	1.8	3.2	-7.9	1.9	-8.0	4.0
Masterton	-2.9	2.9	-6.9	0.9	4.7	11.3
Waingawa	-8.4	3.4	-1.3	5.3	1.1	6.9
Waipukurau	-4.0	-1.9	5.8	-0.8	-3.9	1.9
Dannevirke	0.6	2.4	-7.9	0.9	0.1	4.9
Ngaumu	-7.0	3.0	-0.4	4.4	-1.6	7.6
Gisborne	8.0	-1.0	2.8	3.2	1.3	-11.3
Hastings	-5.9	4.9	1.7	2.3	-1.6	-1.4
Havelock North	-5.9	-2.1	6.6	7.4	-8.6	1.4
Gwavas	-13.7	0.7	-2.2	10.2	-7.6	-0.4
Paraparaumu	1.7	3.3	2.4	-5.4	7.4	-4.4
Flockhouse, Bulls	6.7	-15.7	11.8	-11.8	-66.0	-20.0
Tangimoana	-1.0	-8.0	-7.0	-1.0	-8.2	9.2
Palmerston North	0.6	-1.6	2.6	6.4	-0.5	2.4
Mangahao Hydro	0.1	-1.1	-2.7	3.7	0.1	6.9
Palmerston North Boys' High School	-4.7	-4.3	2.0	0.0	1.5	9.5
Otaki	-3.4	2.4	5.7	0.3	5.7	13.3
Karioi	-10.4	0.4	-0.2	8.2	-2.5	-6.5
Hiwi, Taihape	12.3	-13.3	0.4	3.6	13.0	-4.0

continued over

Table 3: Discrepancies fron Normal of Empirical 10 and 90 Percentiles (Discrepancy DIS = Observed - Expected, in days)

LOCATION	FIRST		LAST		FROST FREE DURATION	
Percentiles	10	90	10	90	10	90
Hokitika	0.7	0.3	1.7	3.3	-4.5	3.4
Milford Sound	-0.6	7.6	0.0	3.0	-2.4	7.4
Appleby	-1.7	-1.3	1.0	3.0	-1.9	-2.1
Nelson Airfield	2.7	0.3	1.0	1.0	-3.6	4.6
Nelson	4.1	-6.1	5.4	1.6	-2.2	-4.8
Woodbourne	-16.0	-3.0	-3.0	2.0	-10.9	-2.1
Waihopai	2.3	-1.3	0.8	1.2	9.0	0.0
Hanmer	-16.7	-8.3	5.6	-2.6	-11.3	8.3
Hanmer	-11.7	-6.3	-3.0	-2.0	-21.3	-0.7
Molesworth	-5.2	-6.8	1.1	4.9	-6.3	-5.7
Balmoral Plantation	-11.6	-4.4	2.6	12.4	-10.3	0.3
Hermitage	-14.2	-2.8	-1.3	2.3	-9.9	6.9
Lake Coleridge	-3.2	-2.8	1.6	0.4	-0.9	0.9
Rudstone, Methven	5.1	-13.1	-0.9	3.9	-1.6	-0.4
Highbank	-1.9	4.9	-1.4	-5.6	7.7	2.3
Winchmore	0.8	-0.8	-2.0	2.0	-4.7	10.7
Ashburton	-6.7	4.7	-5.4	-0.6	-11.2	3.2
Ashley State Forest	-1.3	1.3	6.1	9.9	-11.5	5.4
Darfield	-3.2	0.2	-5.3	1.3	-2.0	0.0
Eyrewell	-4.6	-2.4	2.1	9.9	-5.4	-3.6
Christchurch Airport	-8.9	-1.1	0.8	2.2	-7.9	3.9
Wigram	-3.2	-1.8	3.6	6.4	-1.5	-1.6
Christchurch	-1.4	-0.6	3.4	7.6	-7.2	-5.8
Lincoln	0.3	-4.3	-1.2	0.2	-7.0	-5.0
Lake Tekapo	-19.9	-8.1	-2.3	7.3	-37.6	-13.4
Adair	0.0	1.0	0.1	5.9	-11.2	-2.8
Timaru	1.6	-2.6	2.4	0.6	0.7	-8.7
Waimate	3.8	1.2	7.6	-1.6	3.1	1.9
Tara Hills	-21.2	-1.8	-8.2	2.2	-10.3	-7.7
Naseby	5.7	11.3	2.3	-2.3	0.4	5.6
Waipiata	-4.2	5.2	-3.4	5.4	-7.0	3.0
Taieri	-5.6	-2.4	-0.3	6.3	-9.6	-5.4
Dunedin	5.8	10.2	-1.9	-1.1	-2.3	11.3
Dunedin	-5.7	3.7	-19.7	4.7	-10.3	13.3
Queenstown	-6.9	-3.1	1.7	-0.7	-5.2	-1.8
Mid-Dome	-19.5	-4.5	-1.4	6.4	-24.5	-5.5
Cromwell	-5.0	3.0	1.6	10.4	2.4	1.6
Ophir	-9.5	0.4	0.4	4.6	-1.9	5.9
Earnscleugh	-18.0	-1.0	-5.6	5.6	-19.3	-0.7
Alexandra	-5.7	-1.3	0.8	7.2	1.3	6.7
Manorburn	2.5	6.4	-2.7	-0.3	-1.9	9.9
Roxburgh	9.0	-10.0	-4.2	7.2	15.0	-7.0
Moa Flat	-5.3	-1.7	-5.2	12.2	-10.3	-3.7
Tapanui	12.1	-11.1	-3.4	0.4	-6.4	4.4
Otautau	-11.6	-2.4	-10.3	-0.7	-28.7	-10.3
Gore	-5.0	-3.0	-2.9	3.9	-8.5	-0.6
East Gore	-16.5	-5.6	-1.0	2.0	-4.5	-11.5
Invercargill	0.8	3.2	-2.3	1.3	-8.2	-8.8
Invercargill Airport	-20.3	-4.7	-7.2	4.2	-18.5	-14.5

8. Confidence Limits

8.1 The Normal Case

As has been demonstrated in 7, the majority of the distributions can be taken as nearly gaussian. For these distributions, confidence limits at the 60 and 90% levels are presented in Table 4 for the mean, standard deviation and percentiles. (See for example: Brooks and Carruthers, 1953.)

For the non-normal distributions, the percentiles give a more adequate representation of the distribution and non-parametric confidence levels which utilise some of the calculated sample percentiles as confidence limits, are presented in Table 5 for guidance.

As a practical guide to whether a distribution can be considered normal or not, it is suggested that the 10 and 90 percentiles as given in the tables be compared with the expressions:

$$x'_{10} = \bar{x} - 1.285 \times \sigma$$

and

$$x'_{90} = \bar{x} + 1.285 \times \sigma$$

respectively. These are the exact expressions for normally distributed data. ($\bar{x}$ and σ are the sample mean and standard deviation respectively; x'_{10} and x'_{90} are the 10 and 90 percentiles values in a 'normal' sample).

If the discrepancy DIS = x - x' for either the 10 or 90 percentiles exceeds 1 week it is suggested that for a quick guide, Table 5 be used. If both DIS values are numerically smaller than 1 week Table 4 should be used.

These discrepancies from normal are given in Table 3 for the longer period samples ($n > 20$ years).

8.2 Example of Use and Interpretation of Tables

Tabulated in Table 4, as a function of sample size n, (in columns) and confidence level (%) (in rows) are multiplicative factors appropriate to finding confidence limits for the relevant population parameters, either for the mean in A or the standard deviation in B. Multiplication of the sample standard deviation by the factors in A and addition to the sample mean gives the indicated confidence interval for the population mean.

Multiplication of the sample standard deviation by the factors in B simply gives the indicated upper and lower confidence limits.

Multiplication of the sample standard deviation by the factors in C gives the one standard deviation upper and lower limits from the indicated percentiles.

EXAMPLE

To derive 90% confidence limits for the population mean, standard deviation and percentiles for Otara date of first frost.

Since both DIS values -4.6, -5.4 are less in magnitude than 1 week, we use Table 4A. For the population mean μ of the Otara date of first frost, we enter the tables at $n = 25$ (nearest the sample size $n = 24$ for Otara) and read .35. Thus with sample mean date of first frost = 6 June and standard deviation of date of first frost = 19. Using (6 June = 157th day of the year from the date key), then

Prob (157 - 0.35 x 19 < true mean date of first frost < 157 + .35 x 19) = 0.90

i.e. Prob (30 May < μ < 12 June) = 0.90

For the population standard deviation, Table 4B gives:

Prob (19 x .81 < σ_{pop} < 19 x 1.31) = 0.90

i.e. Prob (15.4 < σ_{pop} < 24.8) = 0.90

For the 1 standard deviation limits for the sampling distribution of the population 10 (or 90) percentile value, we read 0.34 from 4C, and then (approximately)

Prob (128 - 0.34 x 19 < μ_{10} < 128 + 0.34 x 19) = .68

These probability statements are to be interpreted as (for example in the case of the mean)

"We are 90% confident that the interval 30 May to 12 June contains the true population mean date of first frost".

Table 4: Normal or Near Normal Distributions : Confidence Interval Factors

A — Sample Size n

Confidence (%)		n = 5	10	15	20	25	30	35	40	45
Mean										
60	U	.47	.29	.23	.20	.17	.16	.15	.14	.13
	L	-.47	-.29	-.23	-.20	-.17	-.16	-.15	-.14	-.13
90	U	1.07	.61	.47	.40	.35	.31	.29	.27	.25
	L	-1.07	-.61	-.47	-.40	-.35	-.31	-.29	-.27	-.25

B — Sample Size n

Confidence (%)		n = 5	10	15	20	25	30	35	40	45
Standard Deviation										
60	U	1.55	1.29	1.21	1.17	1.15	1.13	1.12	1.11	1.10
	L	.81	.85	.87	.89	.90	.90	.91	.91	.92
90	U	2.37	1.64	1.45	1.37	1.31	1.27	1.25	1.23	1.21
	L	.64	.72	.76	.79	.81	.82	.83	.84	.85

C* — Sample Size n

± 1 Standard Deviation from the indicated percentile		n = 5	10	15	20	25	30	35	40	45
10 or 90	U	.77	.54	.44	.38	.34	.31	.29	.27	.25
	L	-.77	-.54	-.44	-.38	-.34	-.31	-.29	-.27	-.25
Percentiles										
25 or 75	U	.61	.43	.35	.30	.27	.24	.23	.21	.20
	L	-.61	-.43	-.35	-.30	-.27	-.24	-.23	-.21	-.20
50	U	.56	.39	.32	.28	.25	.22	.21	.19	.18
	L	-.56	-.39	-.32	-.28	-.25	-.22	-.21	-.19	-.18

* In the case of the percentiles, the ± 1 standard deviation limits provide only an approximate 68% confidence interval for the given population percentile.

In infinite repeated sampling the true mean could be expected to fall within the interval 90 percent of the time provided there is no climate change. That is, the Otara distribution of dates of first frost remains normal with the same mean and standard deviation.

8.3 Non-Parametric Confidence Limits

Because of the variation in the form of the distribution it was thought desirable to provide a distribution free approach to the problem of confidence levels. The standard asymptotic result for the standard error of percentiles is (see Lindgren, 1968):

$$SE_p = \frac{SD}{\sqrt{N}} \times \frac{\sqrt{p(1-p)}}{Y_p}$$

p is the percentile expressed as a fraction

Y_p is the frequency ordinate at X_p

X_p is the 100p percentile

SD is the sample standard deviation

N is the sample size

To use this result in practice involves an estimate of Y_p, either graphically from a histogram, or analytically on the fitting of a suitable frequency curve. Particularly when p is small (or large) Y_p is small and small fluctuations in Y_p can cause large variations in SE_p.

By a simple application of the binomial distribution to a series of n observations ranked in numerical order, say:

$$x_{(1)} \;,\; x_{(2)} \;,\; \ldots \;,\; x_{(n)}$$

where

$x_{(i)}$ is the ith smallest value it can be shown that

$$P(x_{(r)} < \mu_p < x_{(s)}) = \sum_{k=r}^{S-1} {}^{n}C_k \, p^k \, (1-p)^{n-k}$$

Here,

P( ) is the probability of the event described within the parentheses and μ_p is the 100p percentile value in the population.

No assumption about the form of the population distribution is made in this result, although there is an assumption about the existence of an underlying distribution.

Although the approach is exact and general, sharper probability statements can be obtained if more is assumed about the underlying population.

Table 5: Non-Normal Distribution : Some Confidence Levels

Confidence Interval	Sample Size n: 11	15	19	23	27	31	35	39	43
Min $<\mu_{10}<x_{25}$ or $x_{75}<\mu_{90}<$ Max	.596	.738	.829	.888	.927	.952	.968	.978	.986
Min $<\mu_{25}<x_{50}$ or $x_{50}<\mu_{75}<$ Max	.923	.969	.987	.994	.997	.998	.999	.999	.999
$x_{25}<\mu_{50}<x_{75}$	.934	.964	.980	.989	.994	.996	.998	.999	.999

Tabulated are confidence levels provided by the intervals represented in the left hand margin (read from main tables)

Min - earliest first or last frost date

Max - latest first or last frost date

X_p - 100p-percentile value of sample (in main tables)

μ_p - theoretical population 100p-percentile value, estimated by X_p

See 8.3

(from Binomial Tables, Computation Laboratory, Harvard University).

By reference to the Otara example considered above, we can see that from Table 5:

(with n = 24 so linearly interpolating between n = 23 and n = 27)

the minimum first frost date at Otara (5 May = Min from main tables) and

the 25 percentile value of first frost date there (17 May = x_{25}) constitute a 90 percent confidence interval for the true population 10 percentile value μ_{10} of Otara first frost dates.

i.e. Prob (5 May $< \mu_{10} <$ 17 May) = .90

Similarly

Prob (17 May $< \mu_{50} <$ 19 June) = .99

a 99 percent confidence interval for the median first frost date is provided by the quartile dates in the main tables.

9. Influences

A preliminary investigation of factors which might help to determine frost date statistics was made. The aim is to develop predictive relationships for frost date, to supplement the known frost date statistics and enable the more confident mapping of these statistics.

9.1 Geographical

In general terms the 10 and 50 percent first frost dates occur earlier with increasing elevation, latitude and distance inland. The 50 and 90 percent last frost dates occur later with these variables. The dominant effect here is temperature, which decreases with elevation and latitude. There is an effect of distance inland which is probably partly sheltering.

9.2 Meteorological

Mean annual temperature and mean annual range of temperature both quite strongly influence earliness or lateness of frost date statistic. It is to be expected that the lower the mean annual temperature the longer the frost season and the more extreme the earliness or lateness of the first and last frost respectively.

Figure 5 shows why mean annual range might be expected to have some predictive value; on a crude linear approximation the geometry of the situation gives:

$$\delta t = \frac{\delta r}{\tan \theta}$$

where θ is as defined in Figure 5,

t is the time of first frost

r is the semi-range, ½ x Range,

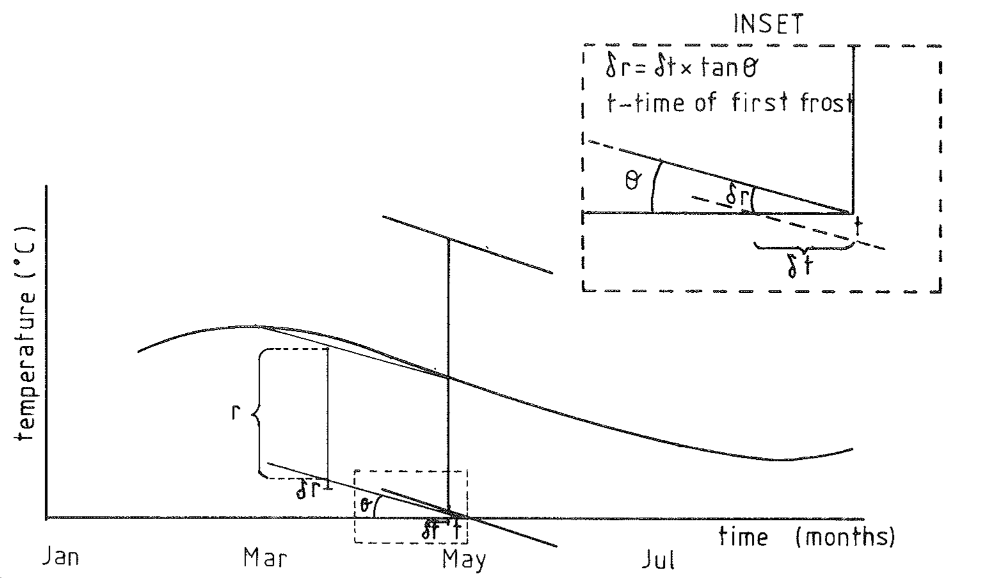
where Range is defined as the width of the envelope of temperature, which is visualised as the smallest region about the mean annual temperature curve which can be expected to contain all temperatures.

The refinement of this approach to a time dependent range envelope can obviously be done. Holding θ fixed, a further assumption, then should have:

$\delta t \propto \delta r$, so it is meaningful to look for this type of dependence in the statistics.

FIG 5

SEGMENT OF MEAN ANNUAL TEMPERATURE CURVE WITH RANGE ENVELOPE VERSUS TIME



In a preliminary study a multiple linear regression of frost date statistic (10% and 50% first frost dates, 50% and 90% last frost dates) on mean annual temperature and temperature range was run, for locations with frost every year, over all New Zealand. Table 6 presents the coefficients, their standard deviations, the standard error of the residuals, and the squared multiple correlation (R^2) values.

Table 6:

	Constant (S.D.)	Mean Annual Temperature (S.D.)	Mean Annual Range (S.D.)	R^2(%)	S.E. (days)
Date of First Frost					
10 Percentile Date Estimator	11.6 (27.5)	1.59 (0.14)	-1.02 (0.18)	67	22.9
50 Percentile Date Estimator	80.1 (18.9)	1.18 (0.10)	-0.90 (0.12)	73	15.7
Date of Last Frost					
50 Percentile Date Estimator	348.0 (17.8)	-1.38 (0.09)	0.85 (0.12)	79	14.9
90 Percentile Date Estimator	377.2 (20.2)	-1.31 (0.10)	0.82 (0.13)	72	16.8

The 10% first frost relationship is least satisfactory, with a standard error of about 3 weeks, but even here R^2 is quite high. In general, the temperature influences are quite strong, with standard errors of little more than a fortnight and R^2 values in excess of 70%. Slightly better results overall can be obtained by a regional analysis in many parts of New Zealand. A mapping of the residuals of these overall regressions indicate the relationships to be least satisfactory in the central and southern North Island, in Southland and along the southeast coast of the South Island. It is believed that this is related to greater exposure to windiness from the travelling synoptic disturbances.

This work is now being refined and generalised to coastal areas where frost free periods become important. It demonstrates the possibility of mapping a great deal of the variation in frost statistics by using temperature information. Because of the known variation in mean temperature data with elevation and location this approach holds some promise.

10. Acknowledgements

I thank Mr J.D. Coulter, Dr R.W. Heine, Mr S.M. Hurnard and Dr J.T. Steiner for valuable criticism and advice, and Mrs B. Collen and Mr M. Sloan for carefully drafting the figures.

11. References

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KEY TO STATION INDICATOR

The example shows how to locate a station on the map to the nearest tenth of a degree.

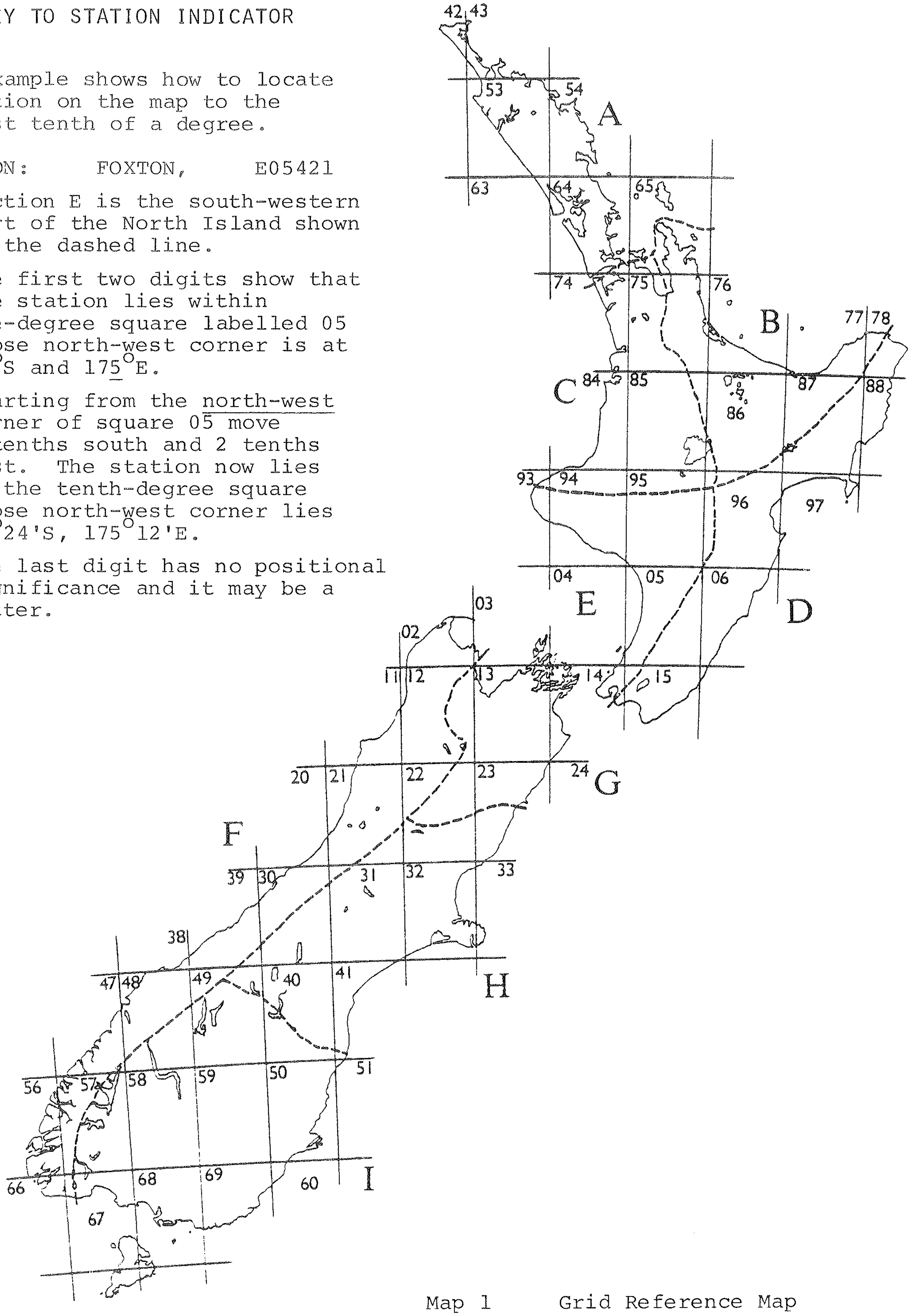
STATION: FOXTON, E05421

E Section E is the south-western part of the North Island shown by the dashed line.

0) The first two digits show that the station lies within
5) one-degree square labelled 05 whose north-west corner is at 40°S and 175°E.

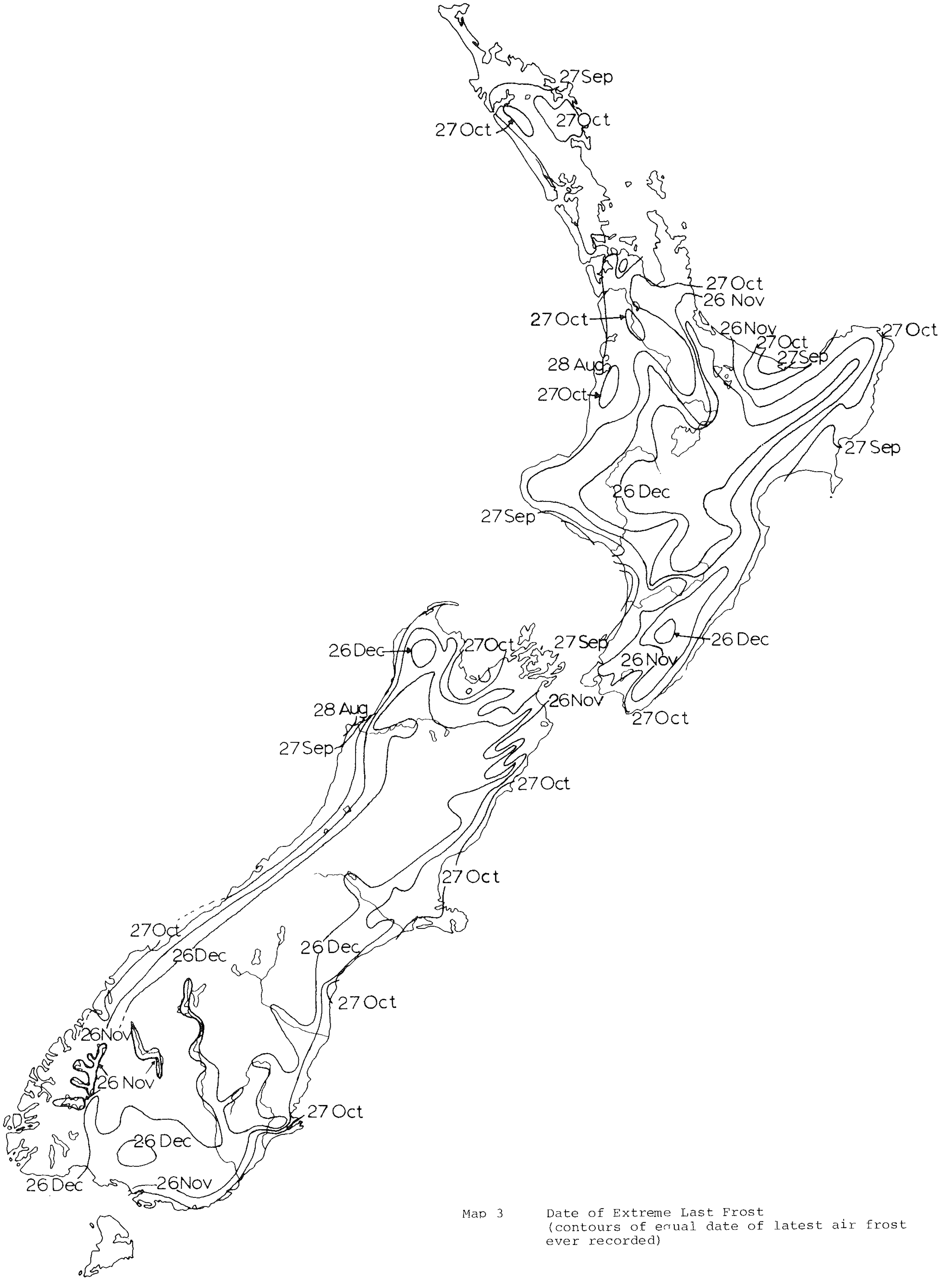
4) Starting from the north-west corner of square 05 move
2) 4 tenths south and 2 tenths east. The station now lies in the tenth-degree square whose north-west corner lies $40^{\circ}24'$S, $175^{\circ}12'$E.

1 The last digit has no positional significance and it may be a letter.

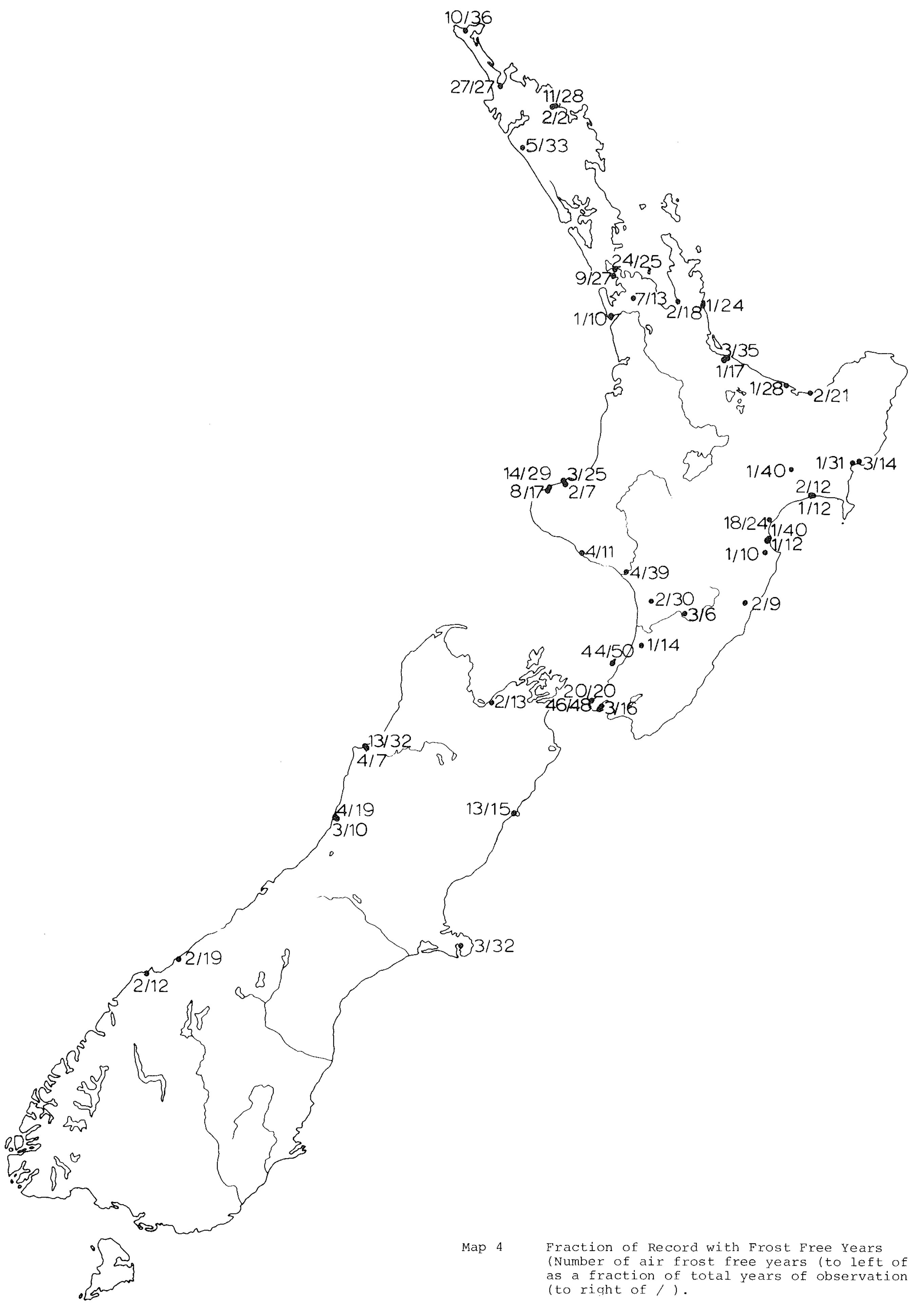


Map 1 Grid Reference Map

Map 2 Date of Extreme First Frost
(contours of equal date of earliest air frost ever recorded)



Map 3 Date of Extreme Last Frost (contours of equal date of latest air frost ever recorded)



Map 4 Fraction of Record with Frost Free Years (Number of air frost free years (to left of /) as a fraction of total years of observation (to right of /).

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
TE PAKI	Lat.	34°30'S	Long.	172°48'E	Height 57 m								
A42581	I	23 May	1 Jun	19 Jun	12 Jul	-	-	-	-	-	-	36	10
1932-1970	II	23 May	27 Jun	21 Jul	9 Aug	-	-	-	-	-	-	36	
	III	270	308	323	361	549	880	1753	489	325	1463	24	
KAITAIA AIRPORT	Lat.	35°04'S	Long.	173°17'E	Height 80 m								
A53021	I	-	-	-	-	-	-	-	-	-	-	27	27
1949-1975	II	-	-	-	-	-	-	-	-	-	-	27	
	III	-	-	-	-	-	-	-	-	-	-	-	
WAIPAPAKAURI	Lat.	35°02'S	Long.	173°15'E	Height 6 m								
A53022	I	2 Jun	.	3 Jun	8 Jun	18 Jun	.	27 Jun	10 Jun	9	25	6	0
1943-1948	II	7 Jul	.	19 Jul	11 Aug	7 Sep	.	10 Sep	12 Aug	24	65	6	
	III	277	.	283	297	319	.	329	300	20	52	5	
KERIKERI	Lat.	35°14'S	Long.	173°57'E	Height 80 m								
A53291	I	22 May	12 Jun	5 Jul	2 Aug	-	-	-	-	-	-	28	11
1945-1973	II	22 May	16 Jun	21 Jul	4 Sep	-	-	-	-	-	-	28	
	III	312	315	353	383	768	1211	1393	603	329	1081	13	
WAIPOUA	Lat.	35°39'S	Long.	173°33'E	Height 100 m								
A53651	I	6 Jun	8 Jun	14 Jun	10 Jul	27 Jul	-	-	-	-	-	33	5
1930-1962	II	9 Jun	12 Jun	19 Jul	1 Aug	27 Aug	-	-	-	-	-	33	
	III	221	294	310	350	390	743	1026	406	174	755	28	
DARGAVILLE	Lat.	35°57'S	Long.	173°50'E	Height 20 m								
A53982	I	2 May	17 May	5 Jun	18 Jun	12 Jul	28 Jul	31 Jul	22 Jun	26	90	24	0
1952-1975	II	23 May	13 Jun	12 Jul	8 Aug	25 Aug	7 Sep	18 Sep	2 Aug	31	118	24	
	III	225	262	281	330	347	378	385	320	42	160	23	
GLENBERVIE	Lat.	35°39'S	Long.	174°21'E	Height 107 m								
A54631	I	20 Apr	27 Apr	10 May	21 May	9 Jun	30 Jun	2 Jul	25 May	21	73	28	0
1948-1975	II	5 Aug	11 Aug	7 Sep	25 Sep	8 Oct	22 Oct	4 Nov	20 Sep	23	91	28	
	III	191	203	216	237	260	310	323	244	36	132	27	
RIVERHEAD	Lat.	36°42'S	Long.	174°33'E	Height 35 m								
A64751	I	28 Mar	20 Apr	6 May	18 May	6 Jun	17 Jun	10 Jul	19 May	23	104	35	0
1933-1967	II	6 Sep	10 Sep	15 Sep	23 Sep	19 Oct	4 Nov	9 Dec	1 Oct	22	94	34	
	III	178	190	196	235	258	271	287	230	31	109	34	
RIVERHEAD	Lat.	36°36'S	Long.	174°35'	Height 30 m								
A64751	I	12 May	.	30 May	8 Jun	16 Jun	.	6 Jul	8 Jun	16	55	8	0
1968-1975	II	12 Aug	.	24 Aug	26 Aug	3 Sep	.	18 Nov	4 Sep	29	98	9	
	III	201	.	264	283	291	.	301	273	32	100	8	
WHENUAPAI	Lat.	36°48'S	Long.	174°38'E	Height 31 m								
A64761	I	20 May	23 May	2 Jun	11 Jun	4 Jul	16 Jul	24 Jul	17 Jun	19	65	23	0
1946-1969	II	23 May	16 Jul	31 Jul	19 Aug	27 Aug	11 Sep	20 Sep	12 Aug	26	120	23	
	III	245	266	278	303	331	365	407	309	39	162	22	
WHENUAPAI	Lat.	36°47'	Long.	174°38'E	Height 26 m								
A64761	I	28 May	.	5 Jun	19 Jun	3 Jul	.	17 Jul	19 Jun	16	50	6	0
1970-1975	II	6 Jul	.	7 Jul	16 Jul	18 Aug	.	26 Aug	24 Jul	21	51	6	
	III	315	.	319	324	346	.	346	331	14	31	5	
ALBERT PARK, AUCKLAND	Lat.	36°51'S	Long.	174°46'E	Height 49 m								
A64871	I	30 Jun	-	-	-	-	-	-	-	-	-	25	24
1951-1975	II	30 Jun	-	-	-	-	-	-	-	-	-	25	
	III	8766+	-	-	-	-	-	-	-	-	-	-	
ORATIA	Lat.	36°54'S	Long.	174°37'E	Height 41 m								
A64961	I	5 May	10 May	25 May	11 Jun	19 Jun	11 Jul	16 Jul	8 Jun	19	72	28	0
1948-1975	II	17 Jul	28 Jul	22 Aug	31 Aug	11 Sep	29 Sep	9 Oct	31 Aug	19	84	28	
	III	217	245	253	276	297	329	336	279	31	119	27	
OWAIRAKA	Lat.	36°54'S	Long.	174°44'E	Height 45 m								
A64971	I	1 Jun	3 Jun	26 Jun	22 Jul	-	-	-	-	-	-	27	9
1949-1975	II	23 Jun	1 Jul	21 Jul	9 Aug	-	-	-	-	-	-	27	
	III	285	288	302	381	715	1274	1793	535	372	1508	17	
THAMES	Lat.	37°08'S	Long.	175°32'E	Height 3 m								
B75152	I	21 May	27 May	15 Jun	4 Jul	24 Jul	-	-	-	-	-	18	2
1958-1975	II	30 Jun	3 Jul	12 Jul	27 Jul	16 Aug	-	-	-	-	-	18	
	III	275	280	318	351	377	705	706	387	133	431	15	
WHAREKAWA	Lat.	37°09'S	Long.	175°50'E	Height 16 m								
B75181	I	19 May	24 May	30 May	8 Jun	25 Jun	11 Jul	12 Jul	11 Jun	17	54	10	0
1935-1944	II	12 Jul	22 Jul	3 Aug	11 Aug	22 Aug	2 Sep	10 Sep	12 Aug	16	60	10	
	III	272	-	290	296	314	-	335	300	20	63	9	
TAIRUA	Lat.	37°10'S	Long.	175°51'E	Height 4 m								
B75182	I	13 May	1 Jun	7 Jun	19 Jun	3 Jul	23 Jul	-	-	-	-	24	1
1952-1975	II	30 Jun	24 Jul	1 Aug	13 Aug	24 Aug	21 Sep	-	-	-	-	24	
	III	237	266	294	308	339	364	698	327	89	461	22	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
PAEROA	Lat. 37°23'S		Long. 175°40'E		Height 4 m								
B75361	I	7 Apr	18 Apr	6 May	14 May	7 Jun	14 Jun	18 Jun	17 May	19	72	14	0
1962-1975	II	16 Aug	19 Aug	25 Aug	3 Sep	10 Sep	25 Oct	31 Oct	8 Sep	22	76	14	
	III	192	205	247	253	275	296	307	255	29	115	13	
WAIHI	Lat. 37°23'S		Long. 175°51'E		Height 100 m								
B75381	I	28 Mar	20 Apr	2 May	16 May	5 Jun	13 Jun	19 Jun	18 May	21	83	30	0
1946-1975	II	1 Aug	11 Aug	23 Aug	13 Sep	26 Sep	19 Oct	12 Nov	12 Sep	24	103	28	
	III	178	198	228	241	264	304	314	245	34	136	27	
TE AROHA	Lat. 37°33'S		Long. 175°43'E		Height 13 m								
B75571	I	5 May	8 May	13 May	2 Jun	13 Jun	23 Jun	24 Jul	1 Jun	20	80	21	0
1955-1975	II	22 Jun	13 Jul	27 Jul	9 Aug	31 Aug	15 Sep	22 Sep	12 Aug	24	92	21	
	III	242	244	269	293	315	332	351	291	31	109	20	
TAURANGA	Lat. 37°40'S		Long. 176°12'E		Height 4 m								
B76621	I	9 May	20 May	2 Jun	16 Jun	6 Jul	-	-	-	-	-	35	3
1941-1975	II	2 Jun	27 Jun	19 Jul	17 Aug	2 Sep	-	-	-	-	-	35	
	III	261	275	287	320	360	519	745	350	116	484	31	
ROTOHEU	Lat. 37°54'S		Long. 176°31'E		Height 78 m								
B76951	I	1 May	6 May	11 May	22 May	9 Jun	14 Jun	7 Jul	25 May	16	67	23	0
1953-1975	II	22 Aug	24 Aug	3 Sep	17 Sep	27 Sep	16 Oct	22 Nov	19 Sep	21	92	23	
	III	196	210	234	248	274	282	292	250	26	96	22	
WHAKATANE	Lat. 37°58'S		Long. 176°58'E		Height 2 m								
B76993	I	5 May	18 May	2 Jun	15 Jun	29 Jun	20 Jul	-	-	-	-	28	1
1948-1975	II	28 May	5 Jun	16 Jul	31 Jul	17 Aug	10 Sep	-	-	-	-	28	
	III	263	266	292	328	340	381	732	334	87	469	26	
KINLEITH	Lat. 38°17'S		Long. 175°53'E		Height 383 m								
B85285	I	17 Mar	.	1 Apr	25 Apr	6 May	.	11 May	20 Apr	21	55	5	0
1953-1957	II	22 Aug	.	23 Aug	7 Oct	13 Oct	.	17 Oct	21 Sep	27	56	5	
	III	194	.	200	210	229	.	24	214	21	49	4	
KAWERAU	Lat. 38°04'S		Long. 176°43'E		Height 30 m								
B86071	I	1 May	8 May	16 May	4 Jun	23 Jun	4 Jul	14 Jul	5 Jun	21	74	22	0
1954-1975	II	13 Jul	14 Jul	21 Jul	22 Aug	6 Sep	25 Sep	29 Sep	19 Aug	25	78	22	
	III	238	245	261	288	311	336	357	287	33	119	21	
ROTORUA	Lat. 38°10'S		Long. 176°16'E		Height 297 m								
B86123	I	3 Feb	2 Apr	27 Apr	11 May	29 May	7 Jun	18 Jun	8 May	27	135	47	0
1886-1934	II	19 Jul	29 Aug	11 Sep	29 Sep	17 Oct	8 Nov	18 Nov	28 Sep	26	122	47	
	III	96	155	194	219	252	281	299	220	44	203	45	
WHAKAREWAREWA	Lat. 38 10'S		Long. 176 16'E		Height 335 m								
B86124	I	16 Apr	27 Apr	8 May	17 May	1 Jun	10 Jun	12 Jun	18 May	16	57	24	0
1952-1975	II	16 Aug	22 Aug	26 Aug	6 Sep	29 Sep	18 Oct	19 Oct	13 Sep	21	64	24	
	III	192	196	214	256	275	285	288	247	31	96	23	
ROTORUA AIR	Lat. 38°07'S		Long. 176°19'E		Height 287 m								
B86131	I	28 Apr	.	9 May	15 May	3 Jun	.	6 Jul	22 May	21	69	9	0
1966-1975	II	24 Aug	25 Aug	26 Aug	8 Sep	24 Sep	8 Oct	14 Oct	11 Sep	17	51	10	
	III	209	.	224	258	278	.	313	254	34	104	9	
WAIOTAPU	Lat. 38°20'S		Long. 176°25'E		Height 381 m								
B86341	I	22 Feb	8 Mar	24 Mar	6 Apr	23 Apr	3 May	10 May	6 Apr	19	77	26	0
1950-1975	II	28 Sep	30 Sep	11 Oct	30 Oct	21 Nov	14 Dec	27 Dec	2 Nov	25	90	26	
	III	93	108	123	153	178	203	218	157	33	125	25	
KAINGAROA	Lat. 38°24'S		Long. 176°34'E		Height 544 m								
B86451	I	2 Mar	13 Mar	4 Apr	18 Apr	1 May	10 May	11 May	16 Apr	19	70	23	0
1953-1975	II	12 Sep	26 Sep	2 Oct	21 Oct	7 Nov	24 Nov	31 Dec	23 Oct	25	110	23	
	III	93	121	155	186	203	214	222	176	33	129	22	
WAIRAPUKAO	Lat. 38°32'S		Long. 176°34'E		Height 437 m								
B86551	I	9 Jan	5 Feb	24 Feb	17 Mar	5 Apr	15 Apr	18 Apr	14 Mar	25	99	25	0
1951-1975	II	21 Oct	26 Oct	8 Nov	27 Nov	14 Dec	28 Dec	31 Dec	28 Nov	22	72	24	
	III	9	67	93	104	121	162	170	105	35	161	23	
TAUPO	Lat. 38°41'S		Long. 176°04'E		Height 410 m								
B86602	I	17 Mar	25 Mar	16 Apr	30 Apr	12 May	28 May	3 Jun	28 Apr	20	78	26	0
1950-1975	II	15 Sep	21 Sep	2 Oct	19 Oct	16 Nov	27 Nov	26 Dec	24 Oct	26	102	26	
	III	121	140	159	193	205	235	240	187	32	119	25	
WAIRAKEI	Lat. 38°38'S		Long. 176°06'E		Height 324 m								
B86611	I	21 Mar	.	27 Apr	17 May	23 May	.	9 Jun	9 May	25	80	8	0
1967-1975	II	24 Aug	.	22 Sep	18 Oct	4 Nov	.	22 Nov	15 Oct	28	90	9	
	III	154	.	185	209	241	.	255	210	35	101	8	
MINGINUI	Lat. 38°39'S		Long 176°44'E		Height 400 m								
B86671	I	1 Jan	11 Jan	26 Jan	14 Mar	28 Mar	15 Apr	18 Apr	1 Mar	33	107	23	0
1953-1975	II	5 Oct	17 Oct	4 Nov	22 Nov	5 Dec	26 Dec	29 Dec	22 Nov	23	85	23	
	III	14	21	56	105	128	167	176	99	48	162	22	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
PUKAHUNUI	Lat. 38°44'S		Long. 176°31'E		Height 668 m								
B86751	I	1 Jan	9 Jan	3 Feb	20 Mar	19 Apr	1 May	6 May	12 Mar	41	125	10	0
1948-1957	II	30 Sep	4 Oct	19 Oct	25 Nov	4 Dec	16 Dec	27 Dec	17 Nov	28	88	10	
	III	44	-	70	114	149	-	209	115	52	165	9	
WAIMIHIA	Lat. 38°50'S		Long. 176°16'E		Height 810 m								
B86821	I	9 Jan	10 Jan	11 Jan	20 Feb	15 Apr	21 Apr	26 Apr	2 Mar	43	107	11	0
1964-1975	II	31 Oct	1 Nov	7 Nov	29 Nov	27 Dec	30 Dec	31 Dec	1 Dec	25	61	12	
	III	10	12	69	79	154	162	162	93	55	152	11	
OPOTIKI	Lat. 38°00'S		Long. 177°17'E		Height 7 m								
B87021	I	7 May	17 May	1 Jun	11 Jun	29 Jun	-	-	-	-	-	21	2
1955-1975	II	16 Jun	21 Jun	17 Jul	14 Aug	6 Sep	-	-	-	-	-	21	
	III	258	268	282	303	352	713	714	351	135	456	18	
OTARA	Lat. 36°57'S		Long. 174°52'E		Height 13 m								
C64981	I	5 May	8 May	17 May	11 Jun	19 Jun	25 Jun	16 Jul	6 Jun	19	72	24	0
1952-1975	II	1 Jun	30 Jun	21 Jul	18 Aug	30 Aug	27 Sep	11 Oct	13 Aug	31	132	24	
	III	212	242	263	300	323	343	361	294	37	149	23	
PAERATA	Lat. 37°09'S		Long. 174°54'E		Height 46 m								
C74191	I	20 Jun	22 Jun	15 Jul	-	-	-	-	-	-	-	13	7
1945-1957	II	20 Jun	1 Jul	23 Jul	-	-	-	-	-	-	-	13	
	III	389	-	536	732	1106	-	1421	803	378	1032	5	
MAIORO	Lat. 37°21'S		Long. 174°43'E		Height 54 m								
C74371	I	2 Jun	7 Jun	19 Jun	2 Jul	18 Jul	-	-	-	-	-	10	1
1966-1975	II	4 Jul	5 Jul	12 Jul	21 Jul	15 Aug	-	-	-	-	-	10	
	III	283	.	327	347	365	-	724	385	139	441	8	
MARAMARUA	Lat. 37°18'S		Long. 175°15'E		Height 39 m								
C75321	I	26 Apr	1 May	6 May	19 May	9 Jun	17 Jun	7 Jul	23 May	19	72	22	0
1954-1975	II	11 Aug	22 Aug	28 Aug	11 Sep	15 Oct	23 Oct	21 Nov	18 Sep	26	102	22	
	III	194	206	215	242	278	288	318	246	33	124	21	
RUAKURA	Lat. 37°47'S		Long. 175°19'E		Height 44 m								
C75731	I	13 Mar	30 Mar	28 Apr	8 May	18 May	9 Jun	18 Jun	7 May	22	97	36	0
1940-1975	II	10 Aug	20 Aug	30 Aug	19 Sep	7 Oct	25 Oct	21 Nov	20 Sep	25	103	36	
	III	161	187	203	232	250	276	285	228	32	124	35	
WHATAWHATA	Lat. 37°49'S		Long 175°05'E		Height 104 m								
C75801	I	7 Apr	26 Apr	9 May	2 Jun	16 Jun	28 Jun	6 Jul	28 May	23	90	23	0
1953-1975	II	1 Jul	3 Aug	10 Aug	24 Aug	31 Aug	28 Sep	7 Oct	24 Aug	21	98	23	
	III	209	222	250	282	302	311	350	276	34	141	22	
RUKUHIA	Lat. 37°50'S		Long. 175°18'E		Height 66 m								
C75831	I	26 Apr	5 May	13 May	1 Jun	17 Jun	28 Jun	2 Sep	2 Jun	26	129	29	0
1947-1975	II	21 Jun	20 Jul	5 Aug	19 Aug	30 Aug	12 Sep	9 Oct	18 Aug	21	110	29	
	III	217	248	264	283	303	348	361	288	33	144	28	
CAMBRIDGE	Lat. 37°53'S		Long. 175°28'E		Height 0 m								
C75842	I	13 Apr	-	22 Apr	2 May	11 May	-	27 May	3 May	14	44	7	0
1928-1935	II	7 Sep	-	13 Sep	22 Sep	9 Oct	-	25 Oct	26 Sep	17	48	8	
	III	189	-	196	210	231	-	261	216	26	72	7	
ARAPUNI	Lat. 38°04'S		Long. 175°39'E		Height 123 m								
C85061	I	25 Apr	3 May	11 May	29 May	11 Jun	27 Jun	14 Jul	28 May	21	80	25	0
1951-1975	II	5 Aug	15 Aug	25 Aug	9 Sep	27 Sep	14 Oct	19 Oct	12 Sep	21	75	25	
	III	195	207	238	260	287	296	306	258	32	111	24	
WAIKERIA	Lat. 38°07'S		Long. 175°24'E		Height 50 m								
C85141	I	21 Mar	28 Mar	15 Apr	9 May	15 May	29 May	9 Jun	2 May	23	80	1	0
1965-1975	II	24 Aug	25 Aug	15 Sep	27 Sep	14 Oct	17 Oct	19 Oct	26 Sep	19	56	11	
	III	165	167	180	212	246	271	286	217	38	121	10	
PUREORA	Lat. 38°31'S		Long. 175°33'E		Height 600 m								
C85551	I	17 Jan	26 Jan	10 Mar	4 Apr	19 Apr	11 May	1 Jun	28 Mar	35	135	28	0
1948-1975	II	24 Aug	13 Sep	13 Oct	4 Nov	22 Nov	11 Dec	27 Dec	2 Nov	30	125	28	
	III	86	95	113	148	175	191	235	147	38	149	27	
TAUMARUNUI	Lat. 38°52'S		Long. 175°16'E		Height 171 m								
C85821	I	14 Mar	22 Mar	3 Apr	28 Apr	5 May	24 May	10 Jun	23 Apr	24	88	20	0
1947-1966	II	26 Aug	9 Sep	19 Sep	9 Oct	22 Oct	6 Nov	21 Nov	7 Oct	22	87	20	
	III	123	157	187	203	217	235	237	199	29	114	19	
TAUMARUNUI	Lat. 38°52'S		Long. 175°16'E		Height 171 m								
C85821	I	21 Mar	-	10 Apr	11 May	18 May	-	23 May	30 Apr	22	63	9	0
1967-1975	II	23 Aug	-	1 Sep	1 Oct	9 Oct	-	22 Nov	27 Sep	28	91	9	
	III	166	-	202	210	248	-	272	220	36	106	8	
NEW PLYMOUTH AIR	Lat. 39°02'S		Long 174°10'E		Height 43 m								
C94011	I	3 Jun	6 Jun	10 Jun	30 Jun	9 Aug	-	-	-	-	-	25	3
1944-1968	II	7 Jun	10 Jun	15 Jul	28 Jul	25 Aug	-	-	-	-	-	24	
	III	261	277	311	351	405	703	707	395	137	446	21	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
NEW PLYMOUTH AIR	Lat.	39°01'S	Long.	174°11'E	Height 27 m								
C94011	I	4 Jun	-	20 Jun	17 Jul	-	-	-	-	-	-	7	2
1968-1975	II	20 Jun	-	11 Jul	26 Jul	-	-	-	-	-	-	8	
	III	333	-	342	370	698	-	744	490	193	411	5	
TE WERA	Lat.	39°14'S	Long.	174°36'E	Height 180 m								
C94262	I	7 Mar	19 Mar	4 Apr	12 Apr	24 Apr	1 May	13 May	12 Apr	17	67	20	0
1956-1975	II	22 Aug	30 Aug	29 Sep	12 Oct	17 Nov	21 Nov	22 Nov	17 Oct	31	92	20	
	III	104	137	151	170	208	235	247	179	38	143	19	
CHATEAU	Lat.	39°12'S	Long.	175°32'E	Height 1119 m								
C95251	I	1 Jan	9 Jan	24 Jan	15 Mar	14 Apr	30 Apr	29 May	9 Mar	44	148	40	0
1933-1975	II	25 Oct	1 Nov	19 Nov	3 Dec	19 Dec	28 Dec	31 Dec	1 Dec	20	68	40	
	III	3	17	44	91	139	176	214	95	56	211	38	
BALLANTRAE	Lat.	40°18'S	Long.	175°50'E	Height 348 m								
D05383	I	7 May	-	3 Jun	-	-	-	-	-	-	-	6	3
1970-1975	II	7 May	-	2 Jul	-	-	-	-	-	-	-	6	
	III	297	-	-	303	-	-	309	303	-	12	2	
PAHIATUA	Lat.	40°27'S	Long.	175°50'E	Height 128 m								
D05481	I	2 Mar	15 Mar	27 Mar	27 Apr	12 May	23 May	6 Jun	20 Apr	27	96	30	0
1928-1957	II	23 Aug	14 Sep	20 Sep	12 Oct	26 Oct	16 Nov	29 Nov	12 Oct	23	98	30	
	III	109	114	150	199	218	229	256	187	41	147	29	
BAGSHOT	Lat.	40°52'S	Long.	175°46'E	Height 171 m								
D05872	I	4 Jan	19 Feb	14 Mar	29 Mar	15 Apr	11 May	5 Jun	29 Mar	31	152	27	0
1924-1950	II	15 Aug	6 Sep	28 Sep	1 Nov	15 Nov	7 Dec	28 Dec	25 Oct	32	135	27	
	III	68	80	115	149	184	218	269	151	49	201	26	
MASTERTON	Lat.	40°58'S	Long.	175°38'E	Height 112 m								
D05963	I	30 Mar	3 Apr	16 Apr	30 Apr	11 May	25 May	6 Jun	29 Apr	18	68	23	0
1920-1942	II	6 Sep	9 Sep	20 Sep	21 Oct	3 Nov	20 Nov	29 Nov	18 Oct	25	84	23	
	III	141	155	166	186	221	249	265	194	34	124	22	
MASTERTON AIR	Lat.	40°58'S	Long.	175°38'E	Height 112 m								
D05963	I	26 Apr	-	4 May	11 May	7 Jun	-	8 Jun	16 May	17	43	7	0
1951-1957	II	10 Sep	-	11 Sep	22 Sep	25 Oct	-	3 Nov	1 Oct	24	54	7	
	III	193	-	204	225	255	-	269	228	29	76	6	
WAINGAWA, MASTERTON	Lat.	40°59'S	Long.	175°37'E	Height 113 m								
D05964	I	9 Mar	30 Mar	27 Apr	10 May	23 May	9 Jun	11 Jun	7 May	23	94	26	0
1950-1975	II	22 Aug	1 Sep	11 Sep	27 Sep	14 Oct	29 Oct	5 Nov	28 Sep	20	75	26	
	III	179	191	205	221	244	261	271	222	25	92	25	
WAIPUKURAU	Lat.	40°00'S	Long.	176°32'E	Height 137 m								
D06051	I	24 Mar	5 Apr	25 Apr	5 May	19 May	31 May	25 Jun	6 May	21	93	31	0
1945-1975	II	31 Jul	12 Sep	22 Sep	7 Oct	24 Oct	6 Nov	21 Nov	7 Oct	24	113	31	
	III	154	165	186	212	230	253	278	210	32	125	30	
DANNEVIRKE	Lat.	40°13'S	Long.	176°07'E	Height 207 m								
D06212	I	17 Mar	4 Apr	16 Apr	5 May	19 May	4 Jun	18 Jun	3 May	23	93	25	0
1951-1975	II	26 Aug	31 Aug	23 Sep	11 Oct	1 Nov	12 Nov	19 Nov	10 Oct	25	85	25	
	III	124	164	186	208	220	251	261	205	32	137	24	
RATA	Lat.	40 16'S	Long.	176 23'E	Height 488 m								
D06233	I	29 May	-	1 Jun	2 Jul	-	-	-	-	-	-	9	2
1956-1964	II	29 Jul	-	9 Aug	14 Sep	-	-	-	-	-	-	8	
	III	210	-	232	289	690	-	1072	404	329	862	6	
GREYTOWN	Lat.	41°05'S	Long.	175°28'E	Height 57 m								
D15041	I	30 Mar	31 Mar	12 Apr	2 May	16 May	9 Jun	18 Jun	3 May	24	80	17	0
1913-1930	II	5 Sep	6 Sep	20 Sep	9 Oct	25 Oct	3 Nov	4 Nov	6 Oct	20	60	16	
	III	158	161	176	199	233	272	286	208	37	128	15	
NGAUMU	Lat.	41°02'S	Long.	175°53'E	Height 270 m								
D15081	I	14 Jan	10 Feb	13 Mar	26 Mar	5 Apr	3 May	26 May	25 Mar	28	132	22	0
1954-1975	II	9 Oct	18 Oct	29 Oct	17 Nov	10 Dec	21 Dec	29 Dec	17 Nov	23	81	22	
	III	60	69	91	113	149	181	199	122	40	139	21	
CANNOCK	Lat.	41°16'S	Long.	175°35 'E	Height 213 m								
D15232	I	17 May	-	24 May	7 Jun	19 Jun	-	20 Jun	6 Jun	12	34	6	0
1952-1957	II	10 Sep	-	11 Sep	21 Sep	13 Oct	-	25 Oct	25 Sep	18	45	6	
	III	235	-	242	261	265	-	268	255	13	33	5	
WAERENGA-o-KURI	Lat.	38°41'S	Long.	177°48'E	Height 340 m								
D87681	I	26 May	26 May	7 Jun	26 Jun	1 Jul	23 Jul	29 Jul	23 Jun	18	64	16	0
1949-1964	II	25 Jun	26 Jun	26 Jul	17 Aug	25 Aug	11 Sep	19 Sep	10 Aug	25	86	15	
	III	248	264	286	321	344	358	367	315	33	119	14	
MANUTUKE	Lat.	38°41'S	Long	177°53'E	Height 10 m								
D87683	I	28 Apr	30 Apr	14 May	26 May	17 Jun	23 Jun	-	-	-	-	31	1
1945-1975	II	16 Jul	30 Jul	12 Aug	29 Aug	19 Sep	5 Oct	-	-	-	-	31	
	III	205	215	255	269	294	312	664	283	79	459	29	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
GISBORNE	Lat. 38°40'S Long. 177°59'E Height 5 m												
D87692 1937-1961	I	6 Apr	22 May	1 Jun	9 Jun	21 Jun	6 Jul	3 Aug	10 Jun	21	119	25	0
	II	10 Jul	12 Jul	27 Jul	15 Aug	31 Aug	30 Sep	5 Nov	18 Aug	31	118	25	
	III	151	240	275	299	327	338	345	294	43	194	24	
GISBORNE	Lat. 38°40'S Long. 177°59'E Height 5 m												
D87692 1962-1975	I	22 May	24 May	30 May	6 Jun	5 Jul	-	-	-	-	-	14	2
	II	30 Jul	31 Jul	12 Aug	2 Sep	5 Oct	-	-	-	-	-	14	
	III	232	233	263	283	294	488	664	309	120	432	11	
ONEPOTO	Lat. 38°48'S Long. 177°07'E Height 643 m												
D87811 1936-1975	I	12 May	25 May	7 Jun	25 Jun	12 Jul	21 Aug	-	-	-	-	40	1
	II	25 Jun	9 Jul	27 Jul	20 Aug	17 Sep	4 Oct	-	-	-	-	40	
	III	213	251	282	314	335	418	672	320	74	38	38	
ESK FOREST	Lat. 39°15'S Long. 176°42'E Height 430 m												
D96272 1957-1975	I	7 May	11 May	25 May	1 Jun	9 Jun	10 Jun	6 Jul	31 May	13	60	19	0
	II	9 Aug	22 Aug	29 Aug	26 Sep	12 Oct	8 Nov	21 Nov	26 Sep	29	104	19	
	III	200	200	210	242	277	283	284	244	32	84	18	
TANGOIO	Lat. 39°18'S Long. 176°53'E Height 330 m												
D96382 1952-1975	I	16 Jun	23 Jun	-	-	-	-	-	-	-	-	24	18
	II	16 Jun	23 Jun	-	-	-	-	-	-	-	-	24	
	III	243	-	-	899	-	-	4139	1979	1949	3788	4	
KURIPAPANGO	Lat. 39°24'S Long. 176°20'E Height 488 m												
D96431 1954-1964	I	8 Jan	18 Jan	22 Feb	14 Mar	20 Mar	2 Apr	2 Apr	5 Mar	26	84	11	0
	II	9 Oct	14 Oct	24 Oct	9 Nov	2 Dec	7 Dec	8 Dec	9 Nov	22	60	10	
	III	91	92	95	115	146	161	175	121	29	84	10	
NAPIER	Lat. 39°30'S Long. 176°55'E Height 2 m												
D96591 1924-1963	I	7 May	23 May	4 Jun	14 Jun	27 Jun	14 Jul	-	-	-	-	40	1
	II	16 Jul	21 Jul	29 Jul	18 Aug	6 Sep	23 Sep	-	-	-	-	40	
	III	226	257	274	296	323	351	685	307	70	459	38	
NAPIER	Lat. 39°30'S Long. 176°55'E Height 2 m												
D96591 1964-1975	I	10 May	13 May	24 May	2 Jun	10 Jun	-	-	-	-	-	12	1
	II	29 Jul	5 Aug	19 Aug	5 Sep	14 Sep	-	-	-	-	-	12	
	III	235	240	246	272	313	485	633	306	118	390	10	
HASTINGS	Lat. 39°39'S Long. 176°51'E Height 15 m												
D96681 1928-1949	I	6 Apr	11 Apr	29 Apr	10 May	22 May	7 Jun	9 Jun	10 May	18	64	22	0
	II	29 Aug	3 Sep	16 Sep	23 Sep	7 Oct	25 Oct	23 Nov	27 Sep	20	86	22	
	III	176	189	197	226	250	256	259	224	26	83	21	
HASTINGS	Lat. 39°39'S Long. 176°51'E Height 15 m												
D96681 1950-1965	I	7 Apr	12 Apr	30 Apr	20 May	29 May	19 Jun	25 Jun	17 May	21	79	16	0
	II	21 Aug	24 Aug	2 Sep	16 Sep	27 Sep	12 Oct	17 Oct	15 Sep	16	57	16	
	III	200	203	223	238	262	274	278	241	23	78	16	
HASTINGS	Lat. 39°39'S Long. 176°51'E Height 14 m												
D96688 1966-1975	I	13 May	13 May	15 May	22 May	4 Jun	-	-	-	-	-	10	1
	II	13 Aug	20 Aug	27 Aug	3 Sep	17 Sep	-	-	-	-	-	10	
	III	219	-	245	254	271	-	623	298	133	404	8	
HAVELOCK NORTH	Lat. 39°40'S Long. 176°53'E Height 9 m												
D96689 1951-1975	I	17 Mar	28 Mar	13 Apr	27 Apr	12 May	17 May	28 May	26 Apr	18	72	24	0
	II	9 Sep	18 Sep	27 Sep	10 Oct	28 Oct	17 Nov	22 Nov	11 Oct	23	84	24	
	III	127	142	168	195	211	229	242	189	30	115	22	
GWAVAS	Lat. 39°44'S Long. 176°27'E Height 370 m												
D96743 1948-1975	I	3 Mar	15 Mar	16 Apr	28 Apr	10 May	25 May	9 Jun	26 Apr	22	98	28	0
	II	2 Oct	6 Oct	24 Oct	4 Nov	26 Nov	19 Dec	27 Dec	8 Nov	24	86	28	
	III	110	120	144	173	191	212	242	170	33	132	27	
WAIROA	Lat. 38°03'S Long. 177°25'E Height 7 m												
D97042 1951-1962	I	1 Jun	3 Jun	8 Jun	15 Jul	2 Aug	11 Aug	-	-	-	-	12	2
	II	4 Jun	7 Jun	27 Jun	18 Jul	11 Aug	4 Sep	-	-	-	-	11	
	III	251	-	309	350	390	-	721	381	135	470	9	
WAIROA	Lat. 39°00'S Long. 177°24'E Height 8 m												
D97042 1964-1975	I	2 May	16 May	2 Jun	9 Jun	19 Jun	-	-	-	-	-	12	1
	II	21 Jun	30 Jun	21 Jul	10 Aug	2 Sep	-	-	-	-	-	12	
	III	232	256	286	311	348	511	655	340	116	423	10	
KAPITI ISLAND	Lat. 40°51'S Long. 174°56'E Height 17 m												
E04891 1925-1975	I	8 Jun	7 Oct	-	-	-	-	-	-	-	-	50	44
	II	8 Jun	21 Oct	-	-	-	-	-	-	-	-	50	
	III	284	-	303	728	7934	-	14083+	3440	5981	13800	4	
PARAPARAUMU	Lat. 40°54'S Long. 174°59'E Height 7 m												
E04991 1956-1975	I	30 Apr	12 May	22 May	1 Jun	18 Jun	4 Jul	14 Jul	5 Jun	20	75	20	0
	II	21 Jun	23 Jul	6 Aug	28 Aug	10 Sep	20 Sep	8 Oct	23 Aug	26	109	20	
	III	215	248	263	280	305	321	367	283	33	152	19	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
MARTON	Lat. 40°05'S		Long. 175°25'E		Height 141 m								
E05041	I	17 Mar	28 Mar	28 Apr	16 May	3 Jun	14 Jun	15 Jun	13 May	25	90	17	0
1948-1964	II	13 Aug	18 Aug	9 Sep	19 Sep	6 Oct	2 Nov	20 Nov	21 Sep	22	99	17	
	III	187	190	208	236	251	279	288	232	30	101	16	
FLOCKHOUSE, BULLS	Lat. 40°16'S		Long. 175°17'E		Height 10 m								
E05221	I	9 Jan	4 Apr	7 May	18 May	1 Jun	8 Jun	10 Jun	11 May	34	152	20	0
1949-1968	II	7 Aug	22 Aug	1 Sep	6 Sep	8 Oct	17 Oct	22 Dec	19 Sep	31	137	20	
	III	82	93	221	245	271	283	287	231	56	205	18	
OHAKEA	Lat. 40°12'S		Long. 175°23'E		Height 46 m								
E05231	I	19 May	27 May	6 Jun	20 Jun	9 Jul	1 Aug	-	-	-	-	30	2
1940-1969	II	8 Jun	29 Jun	15 Jul	31 Jul	1 Sep	23 Sep	-	-	-	-	30	
	III	273	277	293	312	345	563	740	350	116	467	27	
TANGIMOANA	Lat. 40°18'S		Long. 175°15'E		Height 3 m								
E05321	I	28 Mar	18 Apr	9 May	26 May	6 Jun	22 Jun	22 Aug	25 May	28	147	25	0
1925-1949	II	1 Jul	9 Jul	11 Aug	2 Sep	8 Oct	31 Oct	2 Dec	8 Sep	42	154	25	
	III	148	182	219	264	285	333	364	257	52	216	24	
KAIRANGA	Lat. 40°20'S		Long. 175°28'E		Height 15 m								
E05343	I	22 Mar	-	9 Apr	12 May	22 May	-	23 May	4 May	24	62	6	0
1970-1975	II	22 Aug	-	27 Aug	25 Sep	2 Oct	-	5 Oct	18 Sep	18	44	6	
	III	167	-	201	238	255	-	268	230	37	101	5	
PALMERSTON NORTH	Lat. 40°23'S		Long. 175°37'E		Height 33 m								
E05363	I	2 May	11 May	20 May	31 May	10 Jun	19 Jun	14 Jul	31 May	16	73	33	0
1943-1975	II	30 Jun	4 Aug	21 Aug	30 Aug	9 Sep	6 Oct	20 Oct	31 Aug	23	112	33	
	III	227	234	252	273	287	314	346	273	30	119	32	
WAITARERE, LEVIN	Lat. 40°33'S		Long. 175°12'E		Height 3 m								
E05521	I	26 Apr	29 Apr	3 May	13 May	23 May	28 May	30 May	13 May	11	34	11	0
1965-1975	II	3 Sep	4 Sep	17 Sep	30 Sep	19 Oct	13 Nov	21 Nov	5 Oct	24	79	11	
	III	184	185	194	210	246	255	258	218	26	74	10	
MANGAHAO HYDRO	Lat. 40°35'S		Long 175°27'E		Height 110 m								
E05542	I	16 Apr	1 May	12 May	24 May	3 Jun	15 Jun	5 Jul	24 May	18	80	22	0
1935-1957	II	12 Aug	21 Aug	6 Sep	23 Sep	10 Oct	23 Oct	29 Oct	21 Sep	22	78	22	
	III	196	200	222	235	255	289	316	241	32	120	20	
LEVIN	Lat. 40°39'S		Long. 175°16'E		Height 46 m								
E05622	I	9 May	16 May	29 May	12 Jun	13 Jul	-	-	-	-	-	14	1
1962-1975	II	4 Jul	8 Jul	30 Jul	21 Aug	2 Sep	-	-	-	-	-	14	
	III	230	252	278	295	326	531	713	329	119	483	13	
LEVIN	Lat. 40°39'S		Long. 175°16'E		Height 46 m								
E05622	I	16 Apr	3 May	30 May	13 Jun	25 Jun	10 Jul	14 Jul	10 Jun	23	89	13	0
1949-1961	II	7 Jul	11 Jul	30 Jul	22 Aug	14 Sep	8 Oct	16 Oct	20 Aug	31	101	13	
	III	236	243	260	291	309	352	371	290	38	135	12	
PALMERSTON NORTH BOYS' HIGH SCHOOL	Lat. 40°21'S		Long. 175°37'E		Height 30 m								
E05632	I	11 Apr	13 Apr	6 May	23 May	16 Jun	27 Jun	11 Aug	25 May	29	122	21	0
1911-1932	II	27 Jul	7 Aug	15 Aug	29 Aug	18 Sep	28 Sep	15 Oct	1 Sep	21	80	21	
	III	210	220	244	254	302	323	326	266	37	116	20	
OTAKI	Lat. 40°46'S		Long. 175°09'E		Height 15 m								
E05711	I	24 Apr	30 Apr	18 May	2 Jun	20 Jun	4 Jul	27 Jul	2 Jun	23	94	22	0
1907-1928	II	16 Jun	31 Jul	10 Aug	28 Aug	15 Sep	3 Oct	19 Oct	29 Aug	27	125	22	
	III	186	228	251	264	300	341	350	275	41	264	21	
TAITA	Lat. 41°11'S		Long. 174°58'E		Height 65 m								
E14192	I	19 May	22 May	30 May	5 Jun	28 Jun	9 Jul	14 Jul	11 Jun	17	56	19	0
1957-1975	II	22 Jul	25 Jul	20 Aug	30 Aug	26 Sep	12 Oct	14 Dec	6 Sep	34	145	19	
	III	178	204	256	284	303	337	340	278	39	162	18	
KELBURN, WELLINGTON	Lat. 41°17'S		Long. 174°46'E		Height 127 m								
E14272	I	14 Jun	-	-	-	-	-	-	-	-	-	48	46
1928-1975	II	14 Jun	-	-	-	-	-	-	-	-	-	48	
	III	305	-	-	-	-	-	-	-	-	-	1	
MAKARA	Lat. 41°15'S		Long. 174°42'E		Height 305 m								
E14273	I	-	-	-	-	-	-	-	-	-	-	20	20
1956-1975	II	-	-	-	-	-	-	-	-	-	-	20	
	III	-	-	-	-	-	-	-	-	-	-	-	
THORNDON	Lat. 41°17'S		Long. 174°47'E		Height 3 m								
E14278	I	22 May	27 May	21 Jun	21 Jul	16 Aug	-	-	-	-	-	16	3
1912-1927	II	16 Jun	14 Jul	15 Aug	27 Aug	7 Sep	-	-	-	-	-	16	
	III	254	262	294	315	356	923	1136	411	258	882	12	
WALLACEVILLE	Lat. 41°08'S		Long. 175°02'E		Height 59 m								
E15102	I	20 Mar	28 Mar	12 Apr	19 Apr	7 May	13 May	15 May	22 Apr	16	56	15	0
1940-1954	II	8 Sep	13 Sep	25 Sep	23 Oct	1 Nov	25 Nov	10 Dec	18 Oct	25	93	15	
	III	99	128	167	187	215	239	248	187	37	149	14	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
KARIOI	Lat. 39°29'S		Long. 175°31'E		Height 708 m								
E95451 1945-1975	I	16 Feb	28 Feb	29 Mar	8 Apr	27 Apr	9 May	11 May	9 Apr	23	84	31	0
	II	6 Oct	18 Oct	26 Oct	20 Nov	30 Nov	27 Dec	31 Dec	18 Nov	24	87	31	
	III	84	93	109	147	180	184	204	143	37	121	30	
WAIOURU	Lat. 39°28'S		Long. 175°40'E		Height 823 m								
E95464 1961-1975	I	14 Jan	20 Jan	8 Feb	19 Mar	7 Apr	1 May	11 May	13 Mar	34	117	15	0
	II	1 Nov	2 Nov	24 Nov	12 Dec	27 Dec	29 Dec	31 Dec	8 Dec	21	61	15	
	III	38	42	58	95	124	164	169	97	42	131	14	
HIWI, TAIHAPE	Lat. 39°40'S		Long. 175°50'E		Height 657 m								
E95681 1911-1950	I	22 Jan	25 Apr	6 May	25 May	6 Jun	13 Jun	16 Jul	20 May	29	175	40	0
	II	11 Aug	28 Aug	12 Sep	29 Sep	21 Oct	6 Nov	20 Nov	30 Sep	26	101	40	
	III	76	189	204	233	261	280	305	230	42	229	39	
WANGANUI	Lat. 39°56'S		Long. 175°03'E		Height 21 m								
E95902 1937-1975	I	18 May	2 Jun	20 Jun	7 Jul	28 Jul	-	-	-	-	-	39	4
	II	8 Jun	3 Jul	24 Jul	10 Aug	27 Aug	-	-	-	-	-	39	
	III	275	290	308	328	363	555	1063	373	157	788	34	
KAIHOKA	Lat. 40°34'S		Long. 172°36'E		Height 46 m								
F02561 1932-1943	I	17 Mar	2 Apr	22 Apr	8 May	22 May	4 Jun	14 Jun	7 May	24	89	10	0
	II	2 Aug	3 Aug	5 Aug	25 Aug	8 Oct	26 Oct	27 Oct	6 Sep	32	86	10	
	III	172	.	206	226	275	.	275	230	37	103	7	
WESTPORT	Lat. 41°44'S		Long. 171°35'E		Height 2 m								
F11752 1944-1975	I	16 May	12 Jun	5 Jul	29 Jul	-	-	-	-	-	-	32	13
	II	16 May	12 Jun	11 Jul	29 Jul	-	-	-	-	-	-	32	
	III	312	320	343	404	730	1288	1468	566	337	1156	18	
HOKITIKA	Lat. 42°43'S		Long. 170°57'E		Height 3 m								
F20791 1868-1945	I	9 Apr	9 May	25 May	4 Jun	14 Jun	29 Jun	8 Aug	3 Jun	20	121	63	0
	II	30 Jul	7 Aug	15 Aug	28 Aug	13 Sep	29 Sep	20 Oct	31 Aug	20	82	63	
	III	224	234	249	275	296	319	335	277	30	111	59	
HOKITIKA	Lat. 42°44'S		Long. 170°58'E		Height 4 m								
F20791 1950-1964	I	13 Mar	7 Apr	16 May	31 May	13 Jun	22 Jun	26 Jun	25 May	25	105	15	0
	II	10 Aug	17 Aug	3 Sep	13 Sep	26 Sep	19 Oct	21 Oct	16 Sep	20	72	15	
	III	206	207	233	257	277	290	294	255	28	88	14	
HOKITIKA AIRPORT	Lat. 42°43'S		Long. 170°59'E		Height 40 m								
F20793 1968-1975	I	29 Apr	.	16 May	8 Jun	20 Jun	.	7 Jul	4 Jun	23	69	8	0
	II	25 Jul	.	19 Aug	3 Sep	26 Sep	.	11 Oct	5 Sep	26	78	8	
	III	211	.	212	280	287	.	291	263	36	80	7	
GREYMOUTH	Lat. 42°28'S		Long. 171°11'E		Height 4 m								
F21422 1947-1965	I	21 May	9 Jun	15 Jun	24 Jun	11 Aug	-	-	-	-	-	19	4
	II	21 May	16 Jun	14 Jul	30 Jul	7 Oct	-	-	-	-	-	19	
	III	274	293	318	342	708	735	742	445	184	468	14	
GREYMOUTH	Lat. 42°28'S		Long. 171°11'E		Height 4 m								
F21422 1966-1975	I	16 May	20 May	7 Jun	29 Jul	-	-	-	-	-	-	10	3
	II	11 Jun	24 Jun	11 Jul	29 Jul	-	-	-	-	-	-	10	
	III	295	-	307	347	740	-	1106	524	390	811	4	
FRANZ JOSEPH	Lat. 43°23'S		Long. 170°11'E		Height 137 m								
F30311 1954-1963	I	26 Apr	1 May	12 May	12 Jun	24 Jun	26 Jun	26 Jun	4 Jun	22	61	10	0
	II	2 Aug	.	14 Aug	23 Aug	26 Sep	.	15 Oct	2 Sep	26	74	9	
	III	166	.	201	262	301	.	318	261	46	152	9	
FRANZ JOSEPH	Lat. 43°23'S		Long. 170°11'E		Height 110 m								
F30311 1967-1975	I	8 May	.	23 May	26 May	10 Jun	.	21 Jun	30 May	14	44	8	0
	II	18 Aug	.	28 Aug	13 Sep	12 Oct	.	17 Oct	17 Sep	23	60	9	
	III	207	.	234	265	268	.	281	254	24	74	9	
JACKSON BAY	Lat. 43°59'S		Long. 168°37'E		Height 8 m								
F38961 1938-1949	I	18 May	19 May	28 May	23 Jun	31 Aug	-	-	-	-	-	12	2
	II	2 Jul	14 Jul	10 Aug	30 Aug	7 Oct	-	-	-	-	-	12	
	III	263		275	337	484	-	715	384	166	452	9	
HAAST	Lat. 43°52'S		Long. 169°00'E		Height 4 m								
F39801 1957-1975	I	17 Apr	16 May	29 May	16 Jun	12 Jul	-	-	-	-	-	19	2
	II	11 Jul	12 Aug	21 Aug	9 Sep	26 Sep	-	-	-	-	-	19	
	III	163	198	247	294	315	707	1070	329	203	907	16	
MILFORD SOUND	Lat. 44°41'S		Long. 167°55'E		Height 7 m								
F47691 1935-1954	I	29 Apr	7 May	16 May	23 May	28 May	15 Jun	19 Jun	23 May	12	51	19	0
	II	16 Aug	18 Aug	26 Aug	3 Sep	14 Sep	26 Sep	30 Sep	5 Sep	14	45	19	
	III	231	239	251	264	270	290	302	262	16	71	17	
MILFORD SOUND	Lat. 44°40'S		Long. 167°55'E		Height 3 m								
F47691 1968-1975	I	16 Apr	-	22 May	27 May	4 Jun	.	29 Jun	26 May	22	74	7	0
	II	10 Aug	.	26 Aug	5 Sep	4 Oct	.	13 Oct	11 Sep	23	64	8	
	III	186	.	228	268	276	.	276	253	34	90	7	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

Station		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
RIWAKA	Lat. 41°06'S		Long. 172°58'E		Height 8 m								
G12191	I	7 Apr	20 Apr	5 May	19 May	30 May	13 Jun	15 Jun	17 May	19	69	11	0
1959-1969	II	3 Sep	4 Sep	8 Sep	19 Sep	3 Oct	13 Oct	18 Oct	21 Sep	15	45	10	
	III	192	195	210	244	259	267	271	238	26	79	10	
GOLDEN DOWNS	Lat. 41°33'S		Long. 172°53'E		Height 274 m								
G12581	I	8 Feb	24 Feb	1 Apr	13 Apr	27 Apr	3 May	4 May	11 Apr	21	85	18	0
1931-1949	II	26 Sep	27 Sep	11 Oct	31 Oct	23 Nov	8 Dec	9 Dec	2 Nov	24	74	18	
	III	101	114	128	156	191	212	213	159	33	112	18	
GOLDEN DOWNS	Lat. 41°33'S		Long. 172°53'E		Height 274 m								
G12581	I	6 Feb	22 Mar	1 Apr	19 Apr	29 Apr	4 May	29 May	14 Apr	23	112	20	0
1950-1969	II	19 Sep	26 Sep	11 Oct	22 Oct	15 Nov	5 Dec	8 Dec	26 Oct	23	80	19	
	III	119	144	155	168	194	224	233	173	29	114	19	
APPLEBY	Lat. 41°17'S		Long. 173°06'E		Height 17 m								
G13211	I	25 Apr	9 May	21 May	30 May	10 Jun	17 Jun	8 Jul	30 May	15	74	44	0
1932-1975	II	16 Jul	6 Aug	19 Aug	28 Aug	13 Sep	1 Oct	21 Oct	1 Sep	21	97	44	
	III	206	237	253	279	288	301	315	271	25	109	43	
NELSON AIRFIELD	Lat. 41°18'S		Long. 173°14'E		Height 2 m								
G13222	I	27 Mar	23 Apr	2 May	18 May	30 May	11 Jun	22 Jun	16 May	20	87	32	0
1944-1975	II	22 Aug	27 Aug	3 Sep	26 Sep	9 Oct	20 Oct	9 Nov	22 Sep	21	79	32	
	III	176	191	216	235	256	284	297	237	33	121	31	
NELSON	Lat. 41°17'S		Long. 173°22'E		Height 10 m								
G13231	I	28 Apr	20 May	28 May	7 Jun	16 Jun	25 Jun	3 Aug	8 Jun	18	97	31	0
1921-1951	II	22 Jun	28 Jul	8 Aug	19 Aug	12 Sep	29 Sep	20 Oct	25 Aug	26	120	31	
	III	196	243	269	287	306	320	333	285	31	137	30	
BRIGHTWATER	Lat. 41°23'S		Long. 173°09'E		Height 27 m								
G13310	I	15 Apr	.	11 May	21 May	31 May	.	4 Jun	18 May	15	50	0	0
1918-1927	II	28 Aug	.	2 Sep	8 Sep	9 Sep	.	27 Sep	8 Sep	9	30	7	
	III	223	.	226	248	256	.	257	243	15	34	6	
WAKEFIELD	Lat. 41°24'S		Long. 173°03'E		Height 61 m								
G13403	I	31 Mar	.	19 Apr	13 May	24 May	.	30 May	7 May	26	60	4	0
1956-1960	II	16 Sep	.	22 Sep	11 Oct	20 Oct	.	21 Oct	7 Oct	15	35	5	
	III	163	.	.	198	.	.	256	206	47	93	3	
WOODBOURNE	Lat. 41°31'S		Long. 173°52'E		Height 27 m								
G13581	I	23 Feb	19 Mar	30 Apr	14 May	26 May	12 Jun	15 Jun	10 May	28	112	25	0
1941-1965	II	16 Aug	29 Aug	14 Sep	27 Sep	15 Oct	27 Oct	11 Nov	28 Sep	21	87	24	
	III	138	162	192	231	250	271	285	223	39	147	24	
WOODBOURNE	Lat. 31°31'S		Long. 173°52'E		Height 27 m								
G13581	I	21 Mar	31 Mar	18 Apr	8 May	26 May	7 Jun	15 Jun	8 May	25	86	10	0
1965-1975	II	30 Aug	5 Sep	12 Sep	4 Oct	18 Oct	27 Oct	3 Nov	2 Oct	20	65	11	
	III	167	170	178	233	255	265	271	218	38	105	10	
BLENHEIM	Lat. 41°31'S		Long. 173°57'E		Height 4 m								
G13592	I	28 Mar	24 Apr	4 May	12 May	24 May	15 Jun	15 Jun	14 May	19	79	29	0
1947-1975	II	20 Aug	26 Aug	4 Sep	25 Sep	8 Oct	18 Oct	1 Nov	22 Sep	19	73	29	
	III	158	180	219	234	256	281	292	233	32	134	28	
WAIHOPAI	Lat. 41°40'S		Long. 173°35'E		Height 270 m								
G13651	I	3 Apr	22 Apr	29 Apr	8 May	18 May	27 May	9 Jun	9 May	15	67	31	0
1931-1961	II	26 Aug	7 Sep	17 Sep	5 Oct	22 Oct	8 Nov	3 Dec	7 Oct	24	99	31	
	III	121	188	197	217	232	251	255	215	28	134	30	
WAIHOPAI	Lat. 41°40'S		Long. 173°34'E		Height 290 m								
G13651	I	25 Apr	26 Apr	4 May	8 May	25 May	4 Jun	10 Jun	13 May	14	46	12	0
1962-1975	II	22 Aug	25 Aug	5 Sep	27 Sep	18 Oct	2 Nov	7 Nov	28 Sep	25	77	13	
	III	181	184	189	237	251	268	277	226	32	96	11	
LAKE GRASSMERE	Lat. 41°44'S		Long. 174°09'E		Height 2 m								
G14711	I	7 May	.	25 May	7 Jun	18 Jun	.	2 Jul	6 Jun	17	56	9	0
1954-1963	II	10 Aug	.	14 Aug	23 Aug	3 Sep	.	14 Oct	27 Aug	20	65	9	
	III	239	.	263	276	293	.	312	276	24	73	7	
LAKE GRASSMERE	Lat. 41°44'S		Long. 174°09'E		Height 2 m								
G14711	I	23 May	.	28 May	4 Jun	14 Jun	.	30 Jun	7 Jun	13	38	7	0
1964-1969	II	27 Jul	.	2 Aug	17 Aug	1 Sep	.	7 Sep	17 Aug	15	42	6	
	III	274	.	276	285	319	.	326	295	23	52	5	
HANMER	Lat. 42°31'S		Long. 172°51'E		Height 387 m								
G22581	I	13 Jan	23 Jan	8 Mar	28 Mar	1 Apr	16 Apr	2 May	18 Mar	29	109	29	0
1921-1950	II	10 Sep	19 Oct	4 Nov	13 Nov	27 Nov	9 Dec	24 Dec	12 Nov	23	108	29	
	III	48	60	95	126	143	185	222	124	41	174	27	
HANMER	Lat. 42°31'S		Long. 172°51'E		Height 387 m								
G22581	I	16 Jan	10 Feb	15 Mar	4 Apr	26 Apr	1 May	4 May	31 Mar	29	108	25	0
1951-1975	II	2 Oct	8 Oct	20 Oct	8 Nov	22 Nov	2 Dec	26 Dec	7 Nov	21	85	25	
	III	67	77	120	154	177	196	205	144	41	138	24	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
MOLESWORTH	Lat. 42°05'S		Long. 173°16'E		Height 893 m								
G23021	I	1 Jan	10 Jan	18 Jan	11 Mar	22 Mar	29 Mar	10 Apr	24 Feb	31	99	31	0
1945–1975	II	18 Oct	8 Nov	20 Nov	28 Nov	14 Dec	28 Dec	30 Dec	30 Nov	18	73	32	
	III	3	27	53	95	121	133	161	86	41	158	31	
BALMORAL PLANTATION	Lat. 42°52'S		Long. 172°45'E		Height 198 m								
H22871	I	3 Feb	23 Feb	27 Mar	2 Apr	11 Apr	20 Apr	1 May	31 Mar	19	87	26	0
1950–1975	II	6 Oct	10 Oct	20 Oct	28 Oct	21 Nov	18 Dec	30 Dec	6 Nov	23	85	25	
	III	94	100	125	147	165	180	190	145	27	96	24	
HERMITAGE, MT COOK	Lat. 43°44'S		Long. 170°06'E		Height 765 m								
H30711	I	6 Jan	16 Jan	19 Feb	28 Mar	22 Apr	5 May	23 May	20 Mar	38	137	42	0
1928–1975	II	18 Sep	14 Oct	27 Oct	22 Nov	14 Dec	26 Dec	31 Dec	19 Nov	27	104	43	
	III	22	45	75	129	168	198	209	123	53	187	38	
LAKE COLERIDGE	Lat. 43°22'S		Long. 171°32'E		Height 364 m								
H31352	I	8 Mar	24 Mar	8 Apr	19 Apr	29 Apr	7 May	25 May	18 Apr	17	78	58	0
1918–1975	II	9 Sep	28 Sep	11 Oct	24 Oct	13 Nov	25 Nov	25 Dec	26 Oct	23	107	58	
	III	76	129	149	176	193	213	236	171	32	160	57	
RUDSTONE, METHVEN	Lat. 43°33'S		Long. 171°41'E		Height 371 m								
H31562	I	13 Jan	10 Apr	5 May	25 May	6 Jun	13 Jun	20 Jun	16 May	32	158	20	0
1928–1953	II	20 Aug	31 Aug	13 Sep	28 Sep	24 Oct	8 Nov	16 Nov	3 Oct	25	88	25	
	III	142	172	191	228	259	276	284	225	40	142	25	
HIGHBANK	Lat. 43°35'S		Long. 171°44'E		Height 335 m								
H31572	I	6 May	8 May	16 May	29 May	15 Jun	30 Jun	9 Jul	2 Jun	18	64	22	0
1954–1975	II	7 Aug	23 Aug	1 Sep	25 Sep	15 Oct	17 Oct	19 Oct	23 Sep	23	73	22	
	III	213	225	230	246	271	289	317	252	27	104	21	
WINCHMORE	Lat. 43°48'S		Long. 171°48'E		Height 161 m								
H31883	I	9 Mar	4 Apr	14 Apr	29 Apr	7 May	16 May	26 May	25 Apr	17	78	26	0
1950–1975	II	1 Sep	17 Sep	26 Sep	22 Oct	2 Nov	14 Nov	21 Nov	16 Oct	21	81	26	
	III	137	149	173	188	216	239	248	191	29	111	25	
ASHBURTON	Lat. 43°54'S		Long. 171°45'E		Height 101 m								
H31971	I	3 Apr	4 Apr	22 Apr	1 May	7 May	24 May	26 May	30 Apr	15	53	25	0
1951–1975	II	10 Sep	11 Sep	26 Sep	18 Oct	31 Oct	14 Nov	21 Nov	16 Oct	23	80	25	
	III	119	140	181	192	216	234	239	191	31	120	24	
ASHLEY STATE FOREST	Lat. 43°15'S		Long 172°35'E		Height 107 m								
H32252	I	7 May	18 May	26 May	7 Jun	13 Jun	23 Jun	8 Jul	5 Jun	13	62	34	0
1942–1975	II	1 Aug	24 Aug	3 Sep	14 Sep	29 Sep	31 Oct	22 Nov	19 Sep	25	113	34	
	III	196	208	244	256	281	302	313	258	30	117	33	
DARFIELD	Lat. 43°29'S		Long. 172°08'E		Height 195 m								
H32412	I	13 Mar	6 Apr	25 Apr	4 May	11 May	23 May	7 Jun	1 May	17	86	27	0
1949–1975	II	6 Sep	14 Sep	30 Sep	15 Oct	28 Oct	11 Nov	20 Nov	15 Oct	20	75	27	
	III	122	159	182	201	219	233	237	197	28	115	26	
EYREWELL	Lat. 43°24'S		Long. 172°17'E		Height 159 m								
H32424	I	26 Mar	28 Mar	6 Apr	19 Apr	27 Apr	30 Apr	8 May	17 Apr	12	43	25	0
1951–1975	II	1 Oct	2 Oct	10 Oct	18 Oct	31 Oct	25 Nov	4 Dec	23 Oct	18	64	25	
	III	117	142	168	182	194	203	218	177	23	101	24	
CHRISTCHURCH AIRPORT	Lat. 43°29'S		Long. 172°32'E		Height 30 m								
H32451	I	28 Mar	5 Apr	3 May	9 May	19 May	29 May	10 Jun	7 May	18	74	22	0
1954–1975	II	30 Aug	8 Sep	13 Sep	26 Sep	13 Oct	23 Oct	7 Nov	29 Sep	17	69	22	
	III	169	181	206	224	240	257	261	221	25	92	21	
WIGRAM	Lat. 43°33'S		Long. 172°33'E		Height 22 m								
H32552	I	28 Mar	7 Apr	19 Apr	4 May	12 May	22 May	11 Jun	2 May	17	75	31	0
1937–1969	II	20 Aug	5 Sep	14 Sep	27 Sep	18 Oct	6 Nov	20 Nov	1 Oct	23	92	31	
	III	153	173	182	217	237	250	257	213	30	104	30	
CHRISTCHURCH	Lat. 43°32'S		Long 172°37'E		Height 7 m								
H32561	I	3 Apr	13 Apr	25 Apr	5 May	15 May	25 May	10 Jun	5 May	16	68	71	0
1905–1975	II	16 Aug	29 Aug	10 Sep	22 Sep	13 Oct	8 Nov	7 Dec	28 Sep	26	113	71	
	III	132	171	200	226	239	252	283	218	31	151	70	
LINCOLN	Lat. 43°38'S		Long. 172°30'E		Height 11 m								
H32641	I	3 Mar	31 Mar	12 Apr	2 May	13 May	22 May	16 Jun	28 Apr	22	105	61	0
1881–1943	II	20 Aug	1 Sep	13 Sep	4 Oct	21 Oct	3 Nov	7 Dec	3 Oct	24	109	61	
	III	112	154	181	215	226	246	283	206	35	171	59	
LINCOLN	Lat. 43°39'S		Long. 172°28'E		Height 11 m								
H32641	I	7 Apr	9 Apr	25 Apr	6 May	18 May	25 May	26 May	5 May	16	49	12	0
1963–1975	II	13 Sep	18 Sep	27 Sep	11 Oct	29 Oct	5 Nov	7 Nov	11 Oct	17	55	13	
	III	150	158	187	207	226	242	252	205	29	102	12	
RAKAIA	Lat. 43°45'S		Long. 172°02'E		Height 106 m								
H32701	I	15 Jan	21 Jan	9 Apr	1 May	10 May	16 May	18 May	13 Apr	43	123	11	0
1915–1926	II	2 Sep	3 Sep	19 Sep	9 Nov	27 Nov	3 Dec	4 Dec	25 Oct	35	93	11	
	III	92		144	166	212		240	170	46	148	9	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
ONAWE, DUVAUCHELLES BAY	Lat. 43°46'S		Long. 172°56'E		Height 46 m								
H32791	I	23 Apr	30 May	17 Jun	1 Jul	26 Jul	-	-	-	-	-	32	3
1937-1969	II	10 Jun	6 Jul	20 Jul	9 Aug	27 Aug	-	-	-	-	-	32	
	III	245	277	314	338	368	674	741	371	123	496	27	
LAKE TEKAPO	Lat. 44°00'S		Long. 170°28'E		Height 683 m								
H40041	I	19 Jan	5 Feb	20 Mar	19 Apr	27 Apr	10 May	23 May	7 Apr	32	124	23	0
1952-1975	II	11 Sep	25 Sep	12 Oct	30 Oct	21 Nov	13 Dec	19 Dec	1 Nov	27	99	24	
	III	39	59	125	175	184	204	218	157	47	179	23	
FAIRLIE	Lat. 44°06'S		Long. 170°50'E		Height 305 m								
H40182	I	13 Jan	18 Jan	9 Mar	16 Mar	24 Mar	2 Apr	7 Apr	9 Mar	24	84	17	0
1947-1964	II	17 Oct	19 Oct	2 Nov	12 Nov	29 Nov	13 Dec	18 Dec	15 Nov	18	62	17	
	III	40	42	100	123	141	149	149	114	35	109	17	
FAIRLIE	Lat. 44°06'S		Long. 170°50'E		Height 306 m								
H40182	I	7 Mar	7 Mar	12 Mar	10 Apr	16 Apr	19 Apr	20 Apr	2 Apr	17	44	11	0
1965-1975	II	30 Sep	12 Oct	28 Oct	1 Nov	24 Nov	16 Dec	30 Dec	11 Nov	24	91	11	
	III	110	115	125	136	160	165	167	139	19	57	10	
TIMARU AIRPORT	Lat. 44°19'S		Long 171°14'E		Height 23 m								
H41323	I	3 Apr	4 Apr	7 Apr	28 Apr	8 May	28 May	15 Jun	28 Apr	21	73	11	0
1957-1967	II	26 Sep	28 Sep	5 Oct	17 Oct	3 Nov	24 Nov	8 Dec	21 Oct	21	73	10	
	III	140	143	158	189	206	232	256	186	33	116	10	
TIMARU AIRPORT	Lat. 44°18'S		Long. 171°14'E		Height 26 m								
H41323	I	15 Apr	.	23 Apr	3 May	16 May	.	26 May	4 May	14	41	8	0
1967-1975	II	31 Aug	.	27 Sep	16 Oct	6 Nov	.	22 Nov	15 Oct	26	83	9	
	III	150	.	187	210	232	.	239	206	30	89	8	
ADAIR	Lat. 44°26'S		Long 171°10'E		Height 85 m								
H41411	I	17 May	18 May	24 May	7 Jun	15 Jun	24 Jun	9 Jul	5 Jun	14	53	26	0
1950-1975	II	2 Aug	6 Aug	19 Aug	25 Aug	11 Sep	27 Sep	7 Oct	29 Aug	18	66	25	
	III	225	237	270	283	294	307	317	279	24	92	25	
TIMARU	Lat. 44°24'S		Long 171°14'E		Height 17 m								
H41421	I	13 Mar	23 Apr	5 May	16 May	24 May	30 May	15 Jun	12 May	16	94	60	0
1916-1975	II	20 Aug	31 Aug	9 Sep	19 Sep	4 Oct	17 Oct	13 Nov	22 Sep	19	85	60	
	III	123	197	218	235	247	257	283	231	27	160	59	
WAIMATE	Lat. 44°44'S		Long. 171°03'E		Height 61 m								
H41701	I	23 Mar	29 Apr	7 May	18 May	25 May	9 Jun	14 Jun	17 May	17	83	39	0
1936-1975	II	21 Jul	28 Aug	1 Sep	16 Sep	4 Oct	17 Oct	13 Nov	19 Sep	23	115	40	
	III	131	201	221	244	259	282	299	239	32	168	39	
TARA HILLS	Lat. 44°32'S		Long. 169°54'E		Height 488 m								
I49591	I	10 Jan	14 Jan	22 Feb	18 Mar	12 Apr	23 Apr	27 Apr	16 Mar	31	107	26	0
1950-1975	II	1 Oct	14 Oct	5 Nov	23 Nov	12 Dec	25 Dec	29 Dec	22 Nov	24	89	26	
	III	22	51	87	120	140	159	201	114	41	179	25	
HAWEA FLATS	Lat. 44°37'S		Long. 169°15'E		Height 366 m								
I49621	I	20 Mar	28 Mar	19 Apr	5 May	12 May	7 Jun	20 Jun	1 May	22	92	16	0
1960-1975	II	30 Aug	1 Sep	12 Sep	1 Oct	20 Oct	2 Nov	6 Nov	2 Oct	21	68	16	
	III	150	152	187	213	238	254	263	210	34	113	15	
NASEBY FOREST	Lat. 45°01'S		Long. 170°06'E		Height 655 m								
I50012	I	1 Jan	3 Jan	9 Jan	24 Jan	25 Feb	19 Mar	11 Apr	1 Feb	27	100	53	0
1923-1975	II	18 Oct	25 Nov	4 Dec	12 Dec	24 Dec	29 Dec	31 Dec	12 Dec	15	74	53	
	III	3	9	25	44	76	99	136	51	33	133	52	
WAIPIATA	Lat. 45°14'S		Long. 170°08'E		Height 472 m								
I50212	I	1 Mar	13 Mar	30 Mar	6 Apr	12 Apr	5 May	6 May	8 Apr	17	66	15	0
1942-1963	II	26 Oct	31 Oct	13 Nov	26 Nov	5 Dec	20 Dec	25 Dec	24 Nov	16	60	14	
	III	82	99	126	131	148	163	167	133	21	85	13	
TAIERI	Lat. 45°57'S		Long. 170°22'E		Height 24 m								
I50831	I	29 Jan	22 Feb	18 Mar	7 Apr	23 Apr	3 May	7 May	2 Apr	26	98	23	0
1943-1965	II	24 Sep	25 Sep	9 Oct	28 Oct	16 Nov	10 Dec	28 Dec	30 Oct	27	95	22	
	III	61	91	131	151	187	198	201	152	40	140	22	
TAIERI	Lat. 45°57'S		Long. 170°22'E		Height 24 m								
I50831	I	27 Mar	.	18 Apr	29 Apr	6 May	.	8 May	26 Apr	13	42	9	0
1966-1975	II	31 Aug	5 Sep	17 Sep	1 Oct	11 Nov	1 Dec	10 Dec	10 Oct	32	101	10	
	III	138	.	167	199	227	.	238	195	34	100	9	
DUNEDIN, BOTANICAL GARDENS	Lat. 45°52'S		Long 170°31'E		Height 73 m								
I50921	I	2 May	26 May	3 Jun	17 Jun	4 Jul	31 Jul	9 Aug	20 Jun	24	99	30	0
1913-1942	II	13 Jun	7 Jul	25 Jul	10 Aug	2 Sep	10 Sep	21 Sep	10 Aug	25	100	30	
	III	255	267	292	310	341	368	380	313	34	125	29	
MUSSELBURGH, DUNEDIN	Lat. 45°54'S		Long. 170°31'E		Height 2 m								
I50951	I	17 Apr	2 May	20 May	9 Jun	19 Jun	7 Jul	12 Jul	5 Jun	22	86	28	0
1948-1975	II	7 Jul	15 Jul	19 Aug	31 Aug	13 Sep	4 Oct	10 Oct	1 Sep	22	95	28	
	III	197	224	262	273	303	335	353	278	34	157	27	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II),
AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
QUEENSTOWN	Lat. 45°02'S		Long. 168°40'E		Height 360 m								
I58061 1930–1966	I	12 Apr	22 Apr	9 May	17 May	21 May	24 May	28 May	13 May	11	46	37	0
	II	19 Aug	4 Sep	11 Sep	28 Sep	14 Oct	23 Oct	13 Nov	28 Sep	20	86	36	
	III	173	191	208	231	247	256	266	227	24	93	36	
QUEENSTOWN	Lat. 45°02'S		Long. 168°40'E		Height 360 m								
I58061 1966–1975	I	5 May	.	9 May	21 May	27 May	.	27 May	18 May	9	22	9	0
	II	27 Aug	28 Aug	6 Sep	6 Oct	25 Oct	13 Nov	22 Nov	4 Oct	28	87	10	
	III	192	.	205	235	256	.	272	231	28	80	9	
GARSTON	Lat. 45°28'S		Long. 168°41'E		Height 308 m								
I58461 1956–1961	I	10 Jan	.	26 Jan	23 Feb	17 Mar	.	21 Mar	20 Feb	27	70	5	0
	II	26 Nov	.	27 Nov	3 Dec	18 Dec	.	31 Dec	6 Dec	14	35	5	
	III	37	.	39	86	107	.	115	75	35	78	5	
MID DOME	Lat. 45°34'S		Long. 168°30'E		Height 386m								
I58552 1950–1975	I	7 Jan	10 Jan	1 Mar	29 Mar	12 Apr	30 Apr	21 May	18 Mar	37	134	24	0
	II	2 Oct	18 Oct	27 Oct	21 Nov	2 Dec	24 Dec	30 Dec	18 Nov	23	89	25	
	III	7	30	86	131	162	180	184	120	51	177	23	
CROMWELL	Lat. 45°02'S		Long. 169°11'E		Height 233 m								
I59012 1950–1974	I	10 Mar	15 Mar	30 Mar	8 Apr	17 Apr	28 Apr	30 Apr	7 Apr	14	51	25	0
	II	12 Sep	1 Oct	8 Oct	19 Oct	1 Nov	20 Nov	21 Nov	20 Oct	16	70	25	
	III	138	147	155	165	182	195	217	169	19	79	24	
OPHIR	Lat. 45°07'S		Long. 169°37'E		Height 333 m								
I59161 1936–1971	I	3 Jan	12 Jan	8 Feb	4 Mar	22 Mar	9 Apr	24 Apr	1 Mar	30	111	36	0
	II	6 Oct	3 Nov	13 Nov	27 Nov	8 Dec	26 Dec	30 Dec	27 Nov	19	85	35	
	III	18	41	66	94	114	149	176	93	39	158	35	
MOA CREEK	Lat. 45°11'S		Long. 169°39'E		Height 427 m								
I59162 1957–1975	I	3 Jan	4 Jan	10 Jan	23 Jan	14 Feb	12 Mar	2 Apr	27 Jan	23	89	18	0
	II	3 Nov	13 Nov	9 Dec	19 Dec	28 Dec	30 Dec	31 Dec	15 Dec	15	58	18	
	III	4	7	23	30	56	83	92	39	24	88	17	
EARNSCLEUGH	Lat. 45°14'S		Long. 169°20'E		Height 152 m								
I59232 1947–1975	I	13 Jan	19 Jan	28 Feb	20 Mar	1 Apr	18 Apr	26 Apr	14 Mar	28	103	28	0
	II	20 Oct	23 Oct	7 Nov	22 Nov	6 Dec	22 Dec	30 Dec	22 Nov	19	71	29	
	III	21	40	81	118	140	164	184	112	41	163	28	
ALEXANDRA	Lat. 45°15'S		Long. 169°24'E		Height 173 m								
I59234 1929–1963	I	13 Mar	21 Mar	4 Apr	19 Apr	28 Apr	3 May	6 May	15 Apr	15	54	35	0
	II	28 Sep	30 Sep	7 Oct	17 Oct	30 Oct	19 Nov	26 Nov	21 Oct	17	59	34	
	III	123	149	160	177	189	211	217	176	22	94	34	
ALEXANDRA	Lat. 45°16'S		Long. 169°23'E		Height 154 m								
I59234 1963–1975	I	20 Mar	23 Mar	11 Apr	23 Apr	27 Apr	12 May	21 May	20 Apr	17	62	12	0
	II	18 Sep	19 Sep	26 Sep	10 Oct	1 Nov	14 Nov	21 Nov	13 Oct	20	64	13	
	III	150	152	168	186	203	220	222	186	23	72	12	
MANORBURN DAM	Lat. 45°22'S		Long. 169°36'E		Height 746 m								
I59361 1929–1973	I	1 Jan	3 Jan	7 Jan	4 Feb	2 Mar	25 Mar	5 Apr	8 Feb	30	94	43	0
	II	4 Nov	19 Nov	2 Dec	10 Dec	27 Dec	30 Dec	31 Dec	11 Dec	15	57	45	
	III	0	6	26	57	88	118	144	58	39	144	42	
ROXBURGH	Lat. 45°29'S		Long. 169°19'E		Height 120 m								
I59431 1951–1975	I	4 Jan	22 Mar	4 Apr	25 Apr	4 May	14 May	30 May	18 Apr	28	146	25	0
	II	31 Aug	9 Sep	24 Sep	13 Oct	4 Nov	21 Nov	22 Nov	14 Oct	24	123	24	
	III	55	149	170	193	213	235	272	188	42	217	23	
MOA FLAT	Lat. 45°46'S		Long. 169°17'E		Height 409 m								
I59722 1951–1975	I	2 Mar	28 Mar	19 Apr	28 Apr	13 May	22 May	24 May	28 Apr	20	83	25	0
	II	3 Sep	19 Sep	11 Oct	9 Nov	21 Nov	25 Dec	28 Dec	3 Nov	31	116	25	
	III	104	123	147	184	204	217	230	177	34	126	24	
TAPANUI	Lat. 45°57'S		Long. 169°17'E		Height 280 m								
I59921 1946–1975	I	16 Jan	16 Apr	23 Apr	15 May	22 May	27 May	30 May	6 May	25	134	30	0
	II	2 Sep	7 Sep	25 Sep	8 Oct	30 Oct	9 Nov	23 Nov	10 Oct	23	82	30	
	III	159	177	194	217	229	247	254	213	23	95	29	
OTAUTAU	Lat. 46°10'S		Long. 168°00'E		Height 60 m								
I68102 1950–1975	I	5 Jan	1 Feb	11 Mar	5 Apr	20 Apr	6 May	17 May	27 Mar	33	132	26	0
	II	6 Sep	21 Sep	13 Oct	12 Nov	23 Nov	9 Dec	22 Dec	5 Nov	27	107	26	
	III	47	59	123	145	181	188	198	143	43	151	25	
GORE	Lat. 46°06'S		Long 168°56'E		Height 75 m								
I68191 1943–1965	I	24 Mar	4 Apr	16 Apr	4 May	7 May	12 May	12 May	27 Apr	14	49	23	0
	II	8 Sep	11 Sep	30 Sep	12 Oct	5 Nov	21 Nov	8 Dec	16 Oct	25	91	22	
	III	126	146	171	200	217	231	238	193	30	112	22	
EAST GORE	Lat. 46°05'S		Long. 168°57'E		Height 75 m								
I68192 1908–1965	I	29 Jan	12 Feb	21 Mar	21 Apr	2 May	11 May	21 May	8 Apr	30	112	57	0
	II	28 Jul	7 Sep	24 Sep	13 Oct	7 Nov	21 Nov	19 Dec	14 Oct	28	144	56	
	III	49	116	149	186	213	222	271	177	44	222	54	

STATISTICS OF DATE OF FIRST FROST (I), DATE OF LAST FROST (II), AND DURATION OF FROST FREE SEASON (III)

		Min.	0.10	0.25	0.50	0.75	0.90	Max.	Mean	S.D.	Extreme Range	N	n
HOKONUI FOREST	Lat. 46°13'S		Long. 168°35'E		Height 46 m								
I68252	I	24 Feb	27 Feb	12 Mar	23 Apr	12 May	28 May	10 Jun	18 Apr	33	106	10	0
1965-1975	II	31 Aug	11 Sep	30 Sep	18 Oct	22 Nov	30 Nov	7 Dec	23 Oct	31	98	11	
	III	94	106	134	180	239	259	260	181	56	166	10	
PEBBLY HILLS	Lat. 46°13'S		Long. 168°36'E		Height 61 m								
I68261	I	1 Jan	4 Jan	8 Mar	6 Apr	24 Apr	7 May	9 May	27 Mar	39	128	15	0
1951-1965	II	11 Sep	26 Sep	11 Oct	31 Oct	16 Nov	21 Dec	25 Dec	1 Nov	28	105	14	
	III	11	42	136	156	178	190	199	146	49	188	14	
INVERCARGILL	Lat. 46°24'S		Long. 168°22'E		Height 10 m								
I68431	I	14 Apr	16 Apr	22 Apr	4 May	26 May	1 Jun	6 Jun	7 May	17	53	26	0
1926-1951	II	5 Aug	24 Aug	8 Sep	29 Sep	15 Oct	5 Nov	3 Dec	30 Sep	27	120	26	
	III	156	169	191	223	239	248	279	217	31	123	25	
INVERCARGILL	Lat. 46°25'S		Long. 168°22'E		Height 2 m								
I68432	I	16 Apr	21 Apr	29 Apr	10 May	18 May	31 May	1 Jun	10 May	12	46	18	0
1940-1957	II	28 Aug	31 Aug	8 Sep	24 Sep	11 Oct	25 Oct	26 Oct	25 Sep	18	59	18	
	III	180	182	205	225	245	264	275	224	26	95	17	
INVERCARGILL AIRPORT	Lat. 46°25'S		Long. 168°20'E		Height 0 m								
I68433	I	3 Jan	27 Jan	20 Mar	6 Apr	25 Apr	10 May	16 May	1 Apr	34	133	27	0
1949-1975	II	31 Aug	10 Sep	2 Oct	13 Oct	9 Nov	22 Nov	30 Nov	18 Oct	24	91	27	
	III	43	90	147	179	196	207	231	165	44	188	26	

APPENDIX

Table Key

See Paeroa

The table shows that in the 14 years of record, the earliest first frost there was 7 April, the median date of first frost was 14 May (half of all first frosts at Paeroa may be expected by this date), and the latest first frost recorded there was 18 June.

Similar interpretation for the dates of last air frost in row II; only 10 percent of all last air frosts occur later than 25 October on average.

For the duration of frost free period the shortest such period recorded is 192 days, the longest 307 days, and a duration of 253 days can be regarded as typical.

Frosts occurred in every year.

See Tauranga

Similar interpretations for the listed percentile dates; the 10 percentile date of first frost there is 20 May; 10 percent of all years the first frost can be expected to have occurred by then.

There were 3 years in the 35 years with no air frost recorded.

Date Key

1 1Jan	10 10Jan	20 20Jan	30 30Jan	40 9Feb	50 19Feb	60 1Mar	70 11Mar	80 21Mar
90 31Mar	100 10Apr	110 20Apr	120 30Apr	130 10May	140 20May	150 30May	160 9Jun	170 19Jun
180 29Jun	190 9Jul	200 19Jul	210 29Jul	220 8Aug	230 18Aug	240 28Aug	250 7Sep	260 17Sep
270 27Sep	280 7Oct	290 17Oct	300 27Oct	310 6Nov	320 16Nov	330 26Nov	340 6Dec	350 16Dec
360 26Dec								