

# New Zealand’s coldest recorded temperature – Review

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## Summary statement

I recommend that  $-25.6^{\circ}\text{C}$ , recorded at Eweburn, Ranfurly on 17 July 1903, remain conditionally accepted as New Zealand’s coldest recorded temperature, pending the outcome of an investigation by a WMO committee who plan to evaluate it as possibly the coldest recorded temperature in Oceania.

On the balance of evidence contained in this report, I think it is reasonable to believe that  $-25.6^{\circ}\text{C}$  was recorded in Eweburn, Ranfurly on 17 July 1903. However, there are some caveats to be aware of, most notably that there is a lack of meaningful information pertaining to the climate station at Eweburn, Ranfurly, at the time period under examination herein.

## Purpose of this report

The purpose of this report is to provide a comprehensive (but not necessarily exhaustive, given time constraints) review of available information pertaining to New Zealand's coldest recorded temperature, which is  $-25.6^{\circ}\text{C}$  at Eweburn, Ranfurly on 17 July 1903. The expected outcome of this report is that sufficient information will be provided and appraised in order to make an informed judgement regarding the conditional acceptance of the aforementioned record as New Zealand's coldest recorded temperature.

Following commencement of this review, NIWA received an enquiry from the Rapporteur of Weather and Climate Extremes for the World Meteorological Organization. He had been advised of a media report about the Eweburn temperature, and requested documentation of the value for consideration by an ad-hoc WMO evaluation committee as possibly the coldest temperature extreme measured in Oceania. This report will be made available to WMO for this purpose.

## Background

On 3 July 1995,  $-21.6^{\circ}\text{C}$  was recorded at Ophir, Central Otago. At the time, this was recognised as the coldest temperature ever recorded in New Zealand. The instruments used for this reading were checked by MetService (NZ) and confirmed as accurate (Appendix III). At the time of measurement, the weather station at Ophir was not recognised by the New Zealand Meteorological Service as an official weather station, however it appears the station was operating according to standard meteorological practice with regard to site exposure and the use of a Stevenson Screen (Appendix III).

On 12 July 2011, NIWA announced a member of staff (Ms Georgina Griffiths) had discovered a new record for New Zealand's coldest temperature:  $-25.6^{\circ}\text{C}$  (the actual recording was  $-14^{\circ}\text{F}$ ) recorded at Eweburn, Ranfurly on 17 July 1903. This discovery resulted from digitisation of some old paper daily records which were not previously present in NIWA's climate database. Naturally, this discovery generated media interest. However, NIWA's acceptance of this record was called into question by Mr William Cockerill. Mr Cockerill was the individual who observed the  $-21.6^{\circ}\text{C}$  temperature measurement in Ophir on 3 July 1995 (three gentlemen were witness to the reading – Mr Cockerill, an associate, and a Justice of the Peace), and in correspondence with NIWA he called for NIWA to review and/or "provide better (more substantive) verification that is backed by international standards" with respect to the  $-25.6^{\circ}\text{C}$  measurement made at Eweburn, Ranfurly on 17 July 1903. After considering Mr Cockerill's correspondence in light of the Eweburn observations and newspaper information published at the time, Ms Georgina Griffiths concluded there was good reason to retain the "coldest" status for the Eweburn observation. Dr David Wratt, Chief Climate Scientist at NIWA, notified Mr Cockerill that "based on the Eweburn measurements and the supporting evidence... NIWA decided to designate the Eweburn measurement of  $-25.6^{\circ}\text{C}$  on 17 July 1903 as New Zealand's coldest recorded temperature." Further correspondence from Mr Cockerill concluded by asking that "NIWA review their belated acceptance of the Eweburn result, and... note that the reliability of this reading was not substantiated at the time."

## Information sources used

Information utilised in this report was obtained from archived newspapers available digitally and online, including the *Otago Daily Times*, *The Mount Ida Chronicle*, and *The Southland Times*, CliFlo (digital climate records), paper-climate records, and historic weather charts (formerly held at NIWA's Park Road storage facility in Miramar, Wellington, but now held by Archive New Zealand in Auckland).

## July 1903 weather prior to severe cold

\*Note that indented information has been obtained/transcribed from newspaper articles, and bracketed information was not in the original newspaper articles\*

A significant snowstorm, beginning on the evening of Friday 10 July, occurred throughout the South Island:

On Friday afternoon (10 July) cold rain set in, changing in Dunedin to sleet and snow at 9pm. On Saturday morning the city and surrounding hills were white with a fairly heavy coating, and from advices it is evident that a heavy snowstorm has occurred all over the country. The snowstorm has been the heaviest experienced for years in Central Otago. In the city (Dunedin) a thaw set in on Saturday morning (11 July), and the snow melted from the footpaths and housetops gradually, but there was still a good coating on the hills last evening (Sunday 12 July). So far no advice has been received of any thaw in the country, but the weather was clearing in the interior, and the storm seemed to be passing off to the south.

Naseby correspondent: There was about 2ft snow in the township. The recent snowfall is described by many old residents as the heaviest in their experience. One or two cases of roofs having broken through due to the weight of snow. The trees, also, have sustained much damage.

Palmerston correspondent: the fall of snow ceased on Saturday evening (11 July) but, with the exception of a slight thaw where traffic had been, what fell is still lying on the low ground. The oldest inhabitant has never known snow to lie so long on the low ground as the present (Tuesday 14 July).

Information from a Ranfurly correspondent suggests the weather pattern in the build-up to the snow event was typical of what would be expected in the lower South Island, i.e. it is likely a pre-frontal north/northwesterly airflow was present. This is further supported by correspondence from St Bathans:

Ranfurly correspondent: On Friday night (10 July), after a summer-like day, the snow began to fall heavily, and on Saturday morning (11 July) at daylight there was a fall of about 2ft.

St Bathans correspondent (writing on Tuesday 14 July): the weather took a decided change on Friday. A north-wester blowing, accompanied with rain, brought the snow melting off the hills, and this flooded the Dunstan Creek. At 6pm the wind veered round to the south-east. By 10pm 12in of snow had fallen, and in the morning (Saturday 11 July) 32in was measured. It has proved to be a record fall for the short time it came down. Keen frost has set in today with a bright blue sky.

Under such synoptic-scale circulation, it is expected that heavy rain would be falling prior to the passage of a cold front throughout the West Coast, as well as along and immediately east of the Southern Alps. This is supported by reports made from Hokitika and Lake Wanaka:



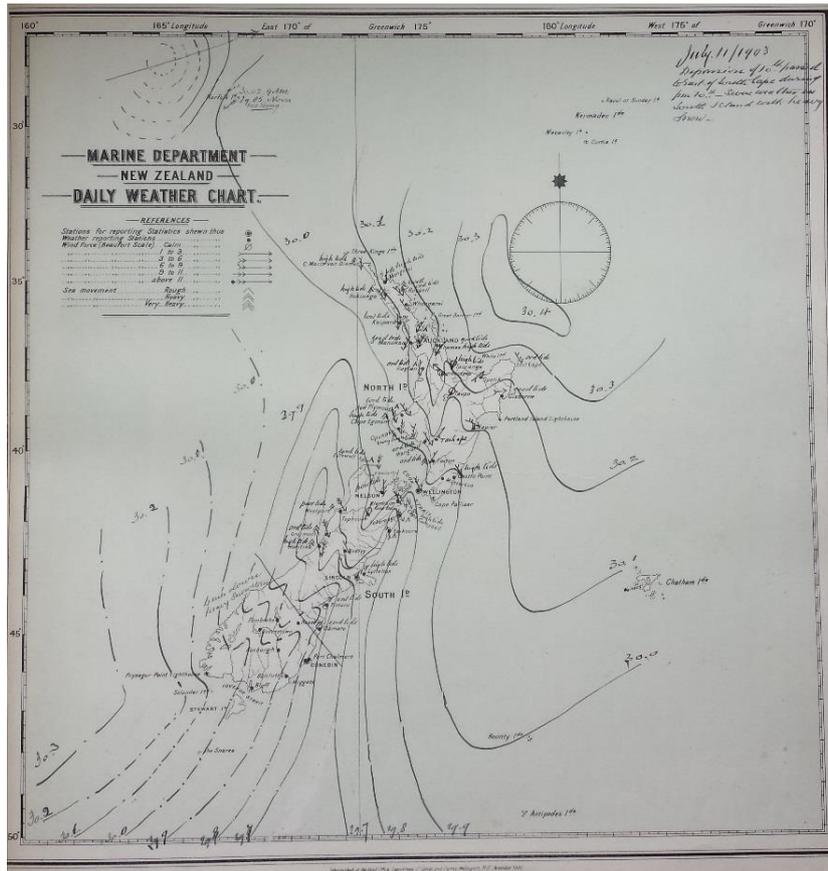


Figure 2. Weather chart for Saturday 11 July, showing what may be interpreted as a shift to a southerly airflow over the southern South Island after the passage of a cold front. The air temperatures in the wake of the cold front were likely to be particularly low, given reports of heavy snowfall at the sea-level or near sea-level locations of Dunedin and Palmerston.



Figure 3. Heavy snowfall in St Bathans, July 1903 (F. M. Pyle).

## July 1903 severe cold event

Following the considerable snowfall event of 10/11 July, an extended cold event occurred, which (taking into account reports from the time) was significant because of the length of time it lasted, its severity, and also how widespread it was. A number of generally brief, yet vivid descriptions of the cold are provided in newspaper reports from the time, and these tell the story of a prolonged extreme cold spell which (to me) is difficult to imagine in New Zealand. Appendix I contains all descriptions obtained from newspapers of the time, but below are those I consider most pertinent:

Otago Daily Times (ODT) Friday 17 July, Gore correspondent: the weather is very cold. The snow still lies on the ground and is frozen hard by hoar frosts. A singular result of the thaw that has evidently taken place up-country is the numerous blocks of ice that are floating down the Mataura River.

ODT Friday 17 July, Invercargill telegram: states that an extremely hard frost prevails there, which is unusual so close to the sea, especially during the day.

ODT Saturday 18 July: The 2.10pm train from Dunedin to Ida Valley could not get beyond Middlemarch, as on arrival at the latter station it was found that no water could be got for the engine, the water in the tanks having been frozen into one solid mass. The intensity of the cold on the Otago Central line of railway may be gauged from the fact that one of the railway officials at Capburn had to keep on his overcoat, gloves and muffler the other morning while eating his breakfast, notwithstanding that a good fire was burning in the room.

ODT Monday 20 July: Mr John Roberts recorded severe frosts at Gladbrook (Gladbrook appears to be very close to Middlemarch). On the morning of 16 July, -5F (-20.6°C). On 17 July minimum temperature was -13F (-25°C) whilst it was 0F (-17.8°C) at 5pm, -4F (-20°C) at 6pm, -6F (-21.1°C) at 10pm. The temperature fell 10deg between 10am and 10pm (which infers the 10am temperature was 4F (-15.6°C)). On Saturday (18 July) -7F (-21.7°C). The frost had a peculiar and beautiful effect on the vegetation, the spikes of the pinus insignis trees being converted to icicles, and horseshoes attached to fences transformed into icicles of about the thickness of a finger.

ODT Tuesday 21 July: From figures supplied by Mr John Roberts we learn that the greatest cold experienced at Gladbrook was on Friday last (17 July), when the thermometer stood at -13F (-25°C). A very cold snap was experienced in July, 1899, but the lowest reading of the thermometer was then -11.5F (-24.2°C). In 1899 there was a considerable difference between the maximum and minimum temperature, but last week the temperature was very low almost the whole time.

ODT Tuesday 21 July: Wetherstones correspondent writes under date Monday 20 July: the frost has been the most severe experienced for many years – probably since the year 1862. It was freezing all day on Friday (17 July), even in the sun, and the ground was slippery and dangerous. Beef and mutton are frozen, and can only be cut with a saw or chopper, a knife being of no use. Turnips, potatoes and milk are also frozen, and the ink in the post office is in a similar state.

ODT Wednesday 22 July: Deep Stream correspondent writes: During the whole of last week the frosts have been phenomenal, culminating on Friday morning last (Friday 17 July), when the thermometer here stood at -8F (-22.2°C). Numbers of ducks and swans

were here last week, frozen out on the Upper Taieri, but since the river has been completely frozen over they have left for more open waters further down country.

ODT Thursday 23 July: St Bathans correspondent informs that snow fell there to a depth of 3ft 5in in the recent storm, and that the frosts were terribly severe, the cold being the most intense the residents have ever experienced, the winter of 1895 not excepted.

ODT Thursday 30 July: Naseby correspondent writes: the snow still lies on the ground to the depth of at least a foot. There has been very little thaw, and hard frost, night after night, has been the rule.

### Cold spell observations from Ranfurly and surrounding areas

The July 1903 severe cold event appears to have resulted from anticyclonic circulation patterns persisting in the wake of the significant snow event. Figure 4 shows the weather chart for Friday 17 July, the day on which  $-25.6^{\circ}\text{C}$  was recorded at Eweburn, Ranfurly:

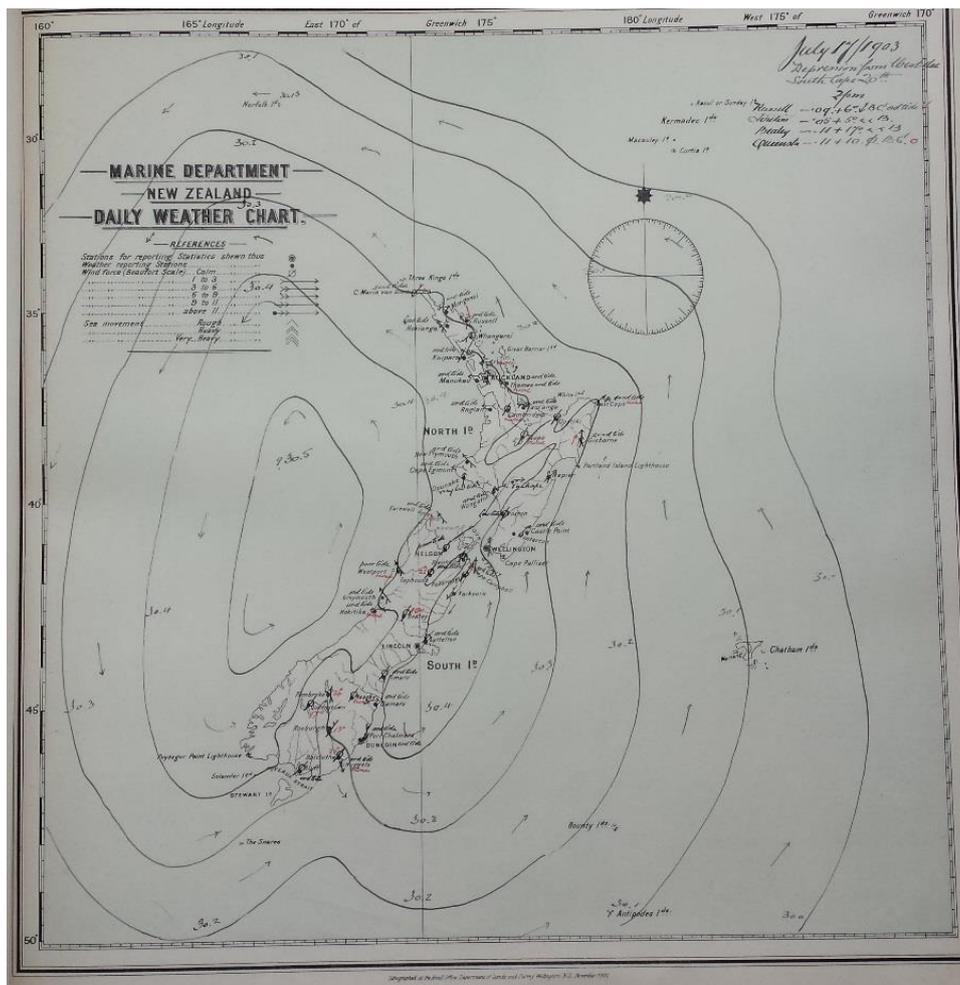


Figure 4. Weather chart for Friday 17 July, showing what may be interpreted as anticyclonic circulation prevailing over New Zealand.

*The Mount Ida Chronicle (TMIC)* was published weekly on a Friday morning, and provided useful information regarding the severe snow and cold experienced in and around Ranfurly during July 1903:

*TMIC* Friday 17 July: Naseby: Since the snow storm the frost has been very severe. On Wednesday night (15 July) the thermometer recorded four more degrees of frost still. We are told that at Ranfurly on Tuesday night (14 July) the frost was the most severe experienced for nine years.

*TMIC* Friday 17 July: The frost at Ida Valley on Tuesday night was so intense that although a fire was kept burning both in and under the engine, the water in the boiler injectors froze. One of the reasons why the train cannot travel on the Ida Valley section is, as mentioned above, the difficulty of keeping the water in the injectors of the engines from freezing. Even while the train was standing at Ranfurly on Wednesday (15 July) night for about an hour it froze.

*TMIC* Friday 31 July: On this occasion, as in the case of the last great snowstorm four years ago, the main disaster has been followed by phenomenal frosts, the intensity of which will remain proverbial in the district for many a year to come; and even those who were fortunate enough to be in a position to trouble themselves little about the snow have in many cases had to suffer physical, social or business injuries at the hands of its ally, King Frost.

*The Mount Ida Chronicle* was the only publication I came across which made mention of the temperatures recorded at the Eweburn, Ranfurly station (I have included a copy of this article in Appendix II):

*TMIC* Friday 24 July: After the sharp frosts for a few nights at the beginning of the season the weather turned fine and mild, which continued till eve of the snow-storm the week before last. For a week or so after that the frost was exceptionally severe, especially towards the end of last week. On Friday morning (17 July) the thermometer registered -4F (-20°C), at Naseby and Gimmerburn, **while it went as low as -14F (-25.6°C), at Ranfurly. This is the most intense cold experienced in that district since it was settled.** At Gimmerburn on Friday (17<sup>th</sup>) night the thermometer was -8F (-22.2°C).

Owing to the intense cold the *Chronicle* staff found it extremely difficult to get their issue printed last week, as the papers would often freeze together, and it was only by thawing them over the stove that the work could be gone on with at all. This proved a very tedious process. We have often experienced a certain amount of difficulty with the frost in winter, but that was a record.

At Ranfurly, with the exception of spirits, nearly all the liquids in the bottles froze. Sometimes the bottles broke, and the glass falling down would leave the contents standing on the shelf in a solid block.

The oldest inhabitant has never before seen so heavy a fall of snow in this district.

From Kyeburn: The frost during the last week was said to be the most severe ever experienced for the time it lasted, and it was actually dangerous to be out about sundown, as several have found to their cost by having fingers and toes frostbitten.

## Temperature observations

Obtained from *TMIC* Friday 14 August (see also Figure 5). Note the values published here appear to be incorrectly printed/copied when compared to the actual paper record for the Eweburn, Ranfurly:

The rainfall as recorded at Eweburn Nursery, Ranfurly, for the month of July was .51in. Rain fell on two days. The lowest readings of the thermometer were as follows: - 15<sup>th</sup>, 4F (-15.6°C); 16<sup>th</sup>, 10F (-12.2°C); 17<sup>th</sup>, 14F (-10.0°C), 18<sup>th</sup>, 5F (-15°C), 31<sup>st</sup>, 2F (-16.7°C); the lowest being on the 17<sup>th</sup> when it was 14F below zero (-25.6°C) or 46F of frost. The highest reading was 51F (10.6°C) on the 1<sup>st</sup>, and the lowest temperature during the day was 1F (-17.2°C) on the 16<sup>th</sup>.

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 **METEOROLOGICAL**  
Mount Ida Chronicle, Volume 35, Issue 9380, 14 August 1903

[▶ About this newspaper](#)

## METEOROLOGICAL

The rainfall as recorded at Eweburn Nursery, Ranfurly, for the month of July was .51in. Rain fell on two days. The lowest readings of the thermometer were as follows:—15th, 4deg; 16th, 10deg; 17th, 14deg; 18th, 5deg; 31st, 2deg; the lowest being on the 17th, when it was 14deg below zero, or 46deg of frost. The highest reading was 51deg on the 1st, and the lowest temperature during the day was 1deg on the 16th.

The rainfall and snow when melted which fell at Kokonga during the month of July measured 2.93in—viz., on the 11th 2.50in and on the 12th .43in. These were the only two days on which rain or snow fell. The rain measured 14in and the snow measured 14in unmelted.

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Figure 5. Meteorological observations for July 1903 at Eweburn Nursery, Ranfurly. Printed in *The Mount Ida Chronicle*, Friday 14 August 1903.

Figure 6 shows a copy of the paper record for July 1903 at Eweburn, Ranfurly:

**METEOROLOGICAL RETURN (3RD CLASS STATION).**

OBSERVATIONS taken at Eweburn Nursery, Ranfurly for the Month of July, 1903. (Recorded at 9:30 a.m.)

Date.	Temperature in Shade at Time of Observation.	RAIN FOR PREVIOUS 24 HOURS.	WIND.		Cloud: 0 to 10.	Remarks on the Weather during previous 24 Hours.
		Total Fall in Inches.	Direction.	Force: 0 to 10		
1						
2	30. 40		N W	2	4	Fine but cloudy
3	29. 46		N W	8	6	Fine to stormy showers
4	38. 42		N W	8	2	Stormy threatening
5	18. 23		-	0	0	Stormy to fine
6	23. 40		N W	8	0	Stormy threatening
7	24. 28		-	0	6	Dull threatening
8	24. 40		N W	2	4	Stormy threatening
9	28. 34		-	0	0	Stormy to fine
10	29. 32		-	0	6	Dull rainy appearance
11	33. 45		N W	4	8	Stormy threatening
12	28. 40	. 35	N W	2	10	Stormy heavy fall of rain
13	22. 30		-	0	0	Stormy to fine
14	16. 26		-	0	8	Dull threatening
15	16. 20		-	0	0	Fine clear sky.
16	-4. 14		-	0	0	Fine clear sky
17	-10. -4		-	0	0	Fine clear sky
18	-14. -6		-	0	0	Fine clear sky
19	-5. 10		-	0	2	Fine to dull threatening
20	16. 26		-	0	0	Fine clear sky
21	14. 36		-	0	6	Dull threatening
22	8. 18		-	0	6	Dull threatening
23	16. 22		-	0	8	Dull to fine
24	20. 30		-	0	8	Dull stormy app.
25	20. 22	. 16	-	0	4	Dull to fine
26	21. 31		-	0	6	Dull to fine
27	8. 16		-	0	0	Fine clear sky
28	14. 16		-	0	0	Fine clear sky
29	29. 32		N W	4	0	Fine clear sky
30	13. 30		-	0	6	Dull threatening
31	-0. 16		-	0	6	Dull threatening
31	-2. 26		-	0	2	Fine to threatening

Figure 6. Copy of paper (physical) record from July 1903 at Eweburn, Ranfurly.

Daily minimum air temperatures for a selection of available stations in July 1903:

Table 1. Daily minimum air temperatures recorded during the snow storm and subsequent cold spell of July 1903 (°C).

	Ranfurly,Eweburn	Dunedin, Leith Valley	Hokitika Town	Lincoln	Tapanui
9/07/1903	-1.7	3.3	7.8	0.4	1.1
10/07/1903	0.5	9.4	8.9	7.2	-1.7
11/07/1903	-2.2	0.6	11.9	2.6	-2.8
12/07/1903	-5.6	0.6	6.1	0.6	-5.6
13/07/1903	-8.9	0	1.1	1.4	-4.4
14/07/1903	-8.9	0	-1.7	2	-6.1
15/07/1903	-20	2.2	-1.7	-0.2	-8.3
16/07/1903	-23.3	0	-1.7	-3.7	-8.9
17/07/1903	-25.6	-0.6	0.6	-5.6	-7.8
18/07/1903	-20.5	0	3.9	0.4	-7.2
19/07/1903	-8.9	1.1	1.7	5.1	-2.2
20/07/1903	-10	3.9	-1.1	5.1	-1.7
21/07/1903	-13.3	0	3.9	4.8	-1.1
22/07/1903	-8.9	0	5	3.6	-2.2

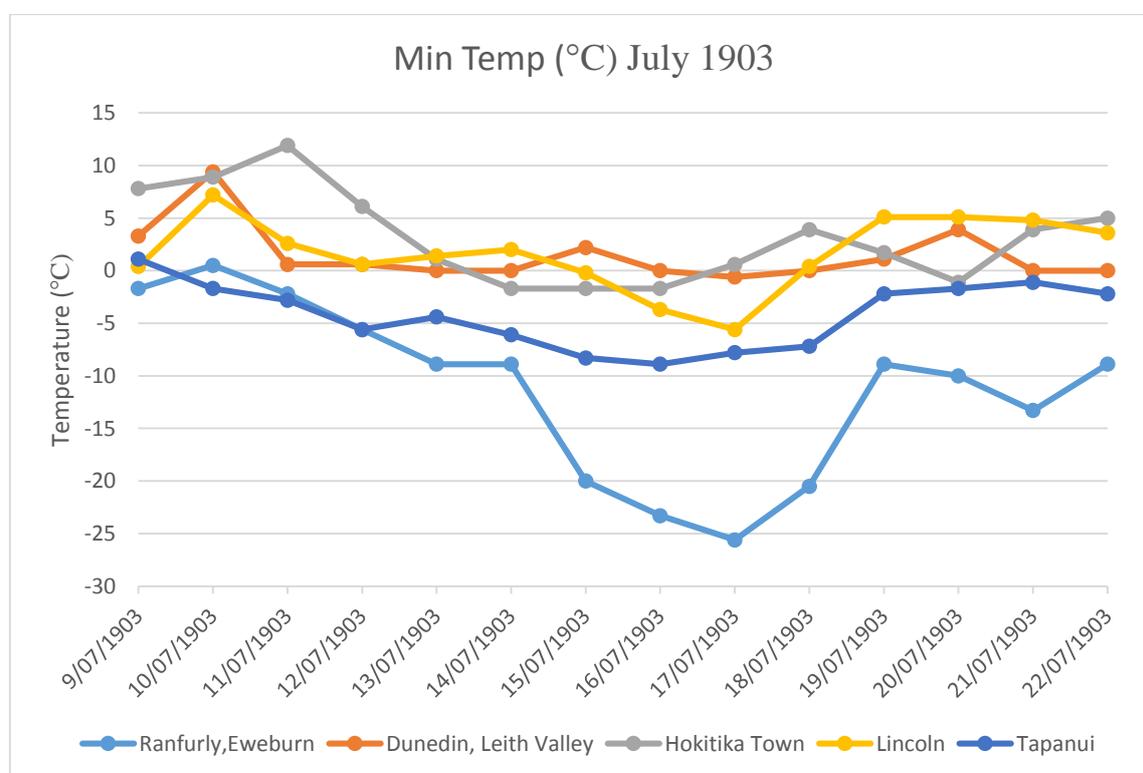


Figure 7. Daily minimum air temperatures recorded for the period 9 – 22 July 1903 at selected stations.

Daily maximum air temperatures for a selection of available stations in July 1903:

Table 2. Daily maximum air temperatures recorded during the snow storm and subsequent cold spell of July 1903 (°C).

	Ranfurly,Eweburn	Dunedin, Leith Valley	Hokitika Town	Lincoln	Tapanui
9/07/1903	0.0	11.7	11.1	17.7	18.9
10/07/1903	7.2	11.7	14.4	16.2	15.6
11/07/1903	4.4	9.4	13.6	18.1	13.3
12/07/1903	-1.1	4.4	13.9	2.9	10.0
13/07/1903	-3.3	4.4	14.7	5.7	8.9
14/07/1903	-6.7	3.3	11.4	4.6	7.8
15/07/1903	-15.6	5.0	10.6	7.4	-0.6
16/07/1903	-20.0	7.2	12.8	7.8	4.4
17/07/1903	-21.1	6.1	13.1	7.3	7.2
18/07/1903	-12.2	4.4	11.7	8.2	11.1
19/07/1903	-3.3	5.6	9.4	8.4	11.1
20/07/1903	2.2	10.6	12.8	9.3	6.1
21/07/1903	-7.8	8.9	12.2	10.0	10.0
22/07/1903	-5.6	6.7	12.8	7.9	7.8

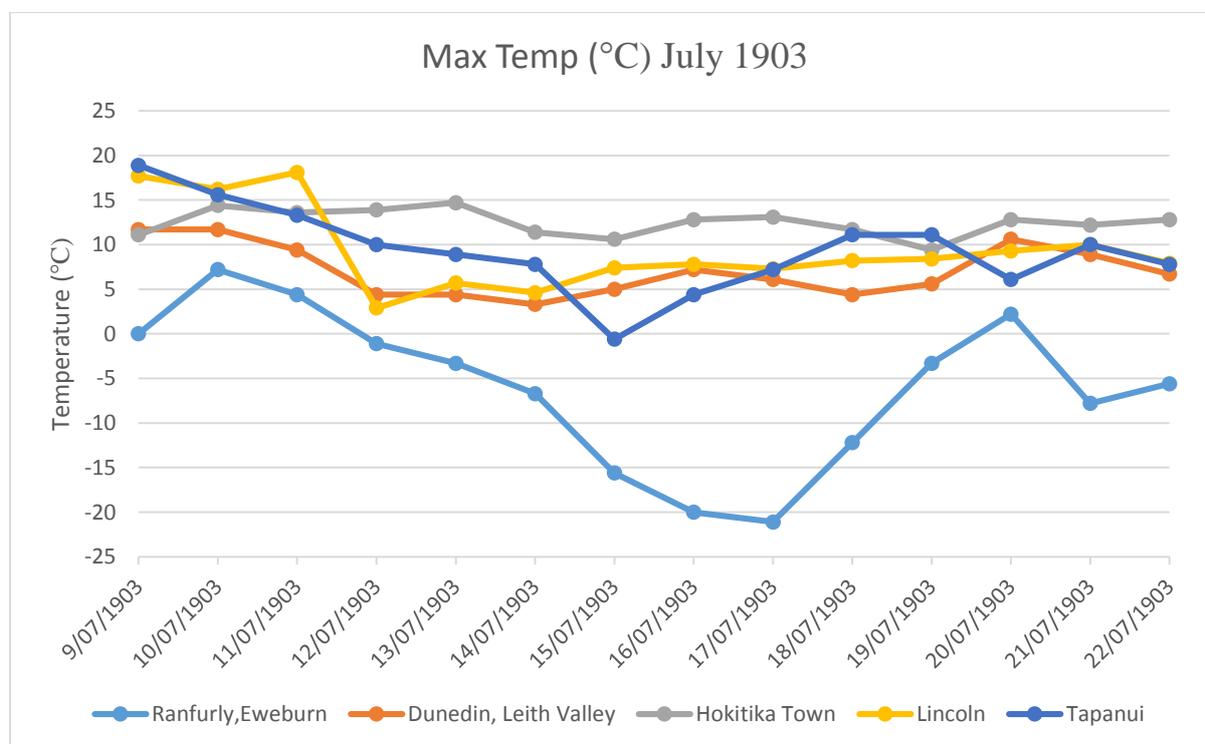


Figure 8. Daily maximum air temperatures recorded for the period 9 – 22 July 1903 at selected stations.

Tables 3 and 4 show temperatures recorded at Gladbrook and Invercargill during the July 1903 cold spell, as reported in the *Otago Daily Times* and *The Southland Times* respectively.

Table 3. Temperatures recorded at Gladbrook (near Middlemarch) during the cold spell of July 1903.

<b>Gladbrook temperature measurements</b>				
<b>July 1903</b>				
	<b>Max (°F)</b>	<b>Max (°C)</b>	<b>Min (°F)</b>	<b>Min (°C)</b>
<b>11th</b>	43	6.1	30	-1.1
<b>12th</b>	38	3.3	22	-5.6
<b>13th</b>	37	2.8	25	-3.9
<b>14th</b>	38	3.3	23	-5.0
<b>15th</b>	29	-1.7	6	-14.4
<b>16th</b>	22	-5.6	-6	-21.1
<b>17th</b>	17	-8.3	-13	-25.0
<b>18th</b>	24	-4.4	-7	-21.7

Table 4. Temperatures recorded at Invercargill during the cold spell of July 1903.

<b>Invercargill temperatures July 1903 (obtained from Southland Times)</b>			
	<b>Max (°C)</b>	<b>Min (°C)</b>	<b>8pm temp (°C)</b>
<b>For 24hr period ending 8pm</b>			
<b>11th</b>	4.4	-1.1	2.2
<b>12th</b>	6.7	-1.7	2.2
<b>13th</b>	3.3	-3.9	-0.6
<b>14th</b>	5.6	-1.1	0.0
<b>15th</b>	6.7	0.0	0.0
<b>16th</b>	7.2	-6.1	1.1
<b>17th</b>	5.6	-8.3	-2.8
<b>18th</b>	2.8	-6.7	1.1
<b>19th</b>	12.8	0.6	0.0
<b>20th</b>	9.4	-2.2	3.3

## Evidence supporting the observations

It appears that the expected conditions required for such low minimum air temperatures at Eweburn, Ranfurly, were met over the course of the July 1903 severe cold spell, namely:

1. Fresh snowfall/snowcover on the ground. The area received an especially heavy snowfall approximately 1 week prior to the coldest temperature recording. Snow lying on the ground is important because it acts as an insulator, which has two notable properties: Snow reflects a considerable proportion of solar radiation (which would otherwise be absorbed at the Earth's surface and released as heat during the night), and similarly the presence of snow cover prevents a ground heat flux from contributing heat to the near-surface atmosphere.
2. Anticyclonic synoptic-scale circulation. Stagnant air associated with high pressure systems allows cold-air pools to form through a lack of turbulent mixing. I can't be certain that cold-air pooling occurred, however a notable feature of Ranfurly is that it is situated on the Maniototo Plain at an elevation of ~ 400 m a.s.l., and the plain is typically surrounded by higher elevation hills and mountains. Thus, the local topography is more of a basin rather than a valley, which suggests cold-air pooling could be supported in the area, as opposed to cold air drainage which occurs 'down-valley' at night.
3. Clear skies. In order for such low temperatures to occur in New Zealand you would expect clear skies throughout the night, so that no outgoing long-wave radiation is re-radiated back to the surface. Due to the anticyclone present at the time, it may be inferred that skies were indeed clear, and this is supported by daily 9am observations made at Ranfurly which described the weather as "Fine clear sky" for the duration of the severe cold event, as well as noting zero-tenths of cloud at the time of respective observations.
4. Some form of drying mechanism. At such low temperatures, the air would either have to be of incredibly low humidity/vapour pressure, and/or have its moisture removed in some way, in order to prevent the formation of fog. At Glenbrook (near Middlemarch, where -25°C was recorded on Friday 17 July 1903), it was reported that "*the frost had a peculiar and beautiful effect on the vegetation, the spikes of the pinus insignis trees being converted to icicles, and horseshoes attached to fences transformed into icicles of about the thickness of a finger.*" As such, it seems a hoar frost of sorts occurred, which would have provided a mechanism through which moisture was removed from the atmosphere. Whilst Ranfurly is in a different location to Middlemarch, it is feasible that such a drying mechanism occurred in the Ranfurly area as well.

Further evidence supports the occurrence of -25.6°C being recorded at Eweburn, Ranfurly on 17 July 1903. Newspaper and temperature reports from throughout the region almost exclusively describe and show that the coldest time of the severe cold event was indeed on Friday 17 July, as it was in Eweburn, Ranfurly. Minimum temperatures recorded from around the region on the morning of 17 July 1903 (which were reported in newspapers) included -25.0°C at Gladbrook (which is located very close to Middlemarch), -22.2°C at Deep Stream (appears to be approximately 20km south of Middlemarch), and -20.0°C recorded at Naseby and Gimmerburn. Gimmerburn (~ 9-10km southwest of Ranfurly) also recorded -22.2°C on the evening/night of Friday 17 July.

On the balance of evidence summarised in this section, I think it is reasonable to believe that -25.6°C was recorded in Eweburn, Ranfurly on 17 July 1903. However, there are some caveats (outlined in the next section) to be aware of.

## Caveats and unresolved issues

Whilst I see no glaring reason to doubt the temperature recorded at Eweburn, Ranfurly, there are some caveats and unresolved issues to be considered, which may hinder the ability of such a temperature to be accepted as official under the rigours of a WMO investigation:

### Station information

Very little station information exists. What instruments were used, were the instruments housed according to standard meteorological procedure (e.g. Stevenson Screen), what was the exposure of the site where the instruments were located, what affect (if any) did the considerable snowfall have (e.g. were the instruments clear of snow, how high above the snow surface were they located)?

Eweburn, Ranfurly observations were recorded on a "Meteorological Return 3<sup>rd</sup> Class Station" form. I am yet to discover a formal definition of a '3<sup>rd</sup> Class Station'. However, it would appear that the definition is likely tied to the type of form the observations are written on, which in turn is linked to the observations being made at that station, as opposed to it being an indication of the reliability/accuracy of the measurements being made at a given station. Of the paper records I was able to obtain from other South Island stations during the late-1800's to early-1900's, Hokitika, Bealey and Dunedin observations were recorded on a "Meteorological Observations" form (Figure 9), which was larger in size, and a greater number of climatological variables were recorded, when compared to the '3<sup>rd</sup> Class Station' form. These would appear to be '1<sup>st</sup> class stations' as each of these three are one of the eleven stations established for "systematic observations... by means of carefully prepared instruments, supplied by Government to the Observatories at Mongonui, Auckland, Napier, New Plymouth, Wellington, Nelson, Christchurch, Dunedin and Southland, and since then to two other stations, namely Hokitika and Bealey" (Hector, 1869).

As at January 1897, observations from Eweburn, Ranfurly were recorded on a '2<sup>nd</sup> Class Station' form, but were recorded on '3<sup>rd</sup> Class Station' forms from November 1897. No specific indication was provided as to why there was a change, however there is minimal difference between the two forms (Figures 10 and 11): e.g. a '2<sup>nd</sup> Class Station' included a column for barometer observations, humidity observations and the state of the sea, bar or river, whereas a '3<sup>rd</sup> Class Station' didn't have these observations on the form, and instead included a column for weather remarks. A memorandum by Henry J Matthews (the Eweburn, Ranfurly observer at that time) dated 31 January 1897 said "Dear Sir, I enclose return for Jan. I don't quite understand 'Humidity' but if the form is not in order I shall be glad of any instructions necessary". Given that January 1897 was when the station was opened, the observer may have simply been sent an inappropriate form (the '2<sup>nd</sup> Class Station; form) given the observations being made at Eweburn, Ranfurly, and was later provided with the more appropriate form (the '3<sup>rd</sup> Class Station' form).

Interestingly, observations at Christchurch were recorded on a '3<sup>rd</sup> Class Station' form for a period of time in the early-1900's, despite it being a '1<sup>st</sup> Class Station'. As such, fewer climatological observations were recorded compared to normal at that station, and only 9 a.m. temperatures were recorded, as opposed to daily maximum and daily minimum temperatures. Again, I don't think the inference should be made that a '3<sup>rd</sup> Class Station' is any less reliable: rather, that observations recorded aren't as comprehensive as for those at '1<sup>st</sup> Class Stations'.

**METEOROLOGICAL OBSERVATIONS.**  
 Taken at Lincoln, New Zealand, for the Month of December 1891.  
 Altitude above the sea 65 feet.

RECORDED AT 9.30 A.M.

DATE.	Barometer uncorrected.	Attached Thermometer.	Thermometer uncorrected reduced to 32° Fahr. and Sea level.	SELF-REGISTERING INSTRUMENTS, FOR 24 HOURS PREVIOUS.										Rain-fall in inches on the ground.	Wind, Directional Movement in miles in previous 24 hours.	Amount of Cloud—0 to 10.	Direction of Wind at Middle of Cloud.	GENERAL REMARKS.
				Dry Bulb (corrected).				Wet Bulb (corrected).			Radiation (corrected).							
				Maximum.	Minimum.	Mean.	Range.	Maximum.	Minimum.	Mean.	Solar.	Terrestrial.						
1	29.765	62	29.745	62.8	48.2	53.5	44.6	60.6	47.6	52.1	135.8	14.6	10.3	224	5	S.E.	91	Slight very fine light clouds
2	30.214	61	30.196	67.4	42.6	58.0	26.8	57.4	41.8	50.6	137.0	37.2		166	1	N.E.	68	Light & strong breeze very fine
3	30.210	63	30.191	66.2	55.0	60.6	11.2	58.0	52.2	54.1	130.2	52.2		401	10	N.E.	64	Slight breeze - wind died down at
4	30.318	62	30.297	70.0	44.6	57.3	25.4	61.0	44.6	52.8	137.2	41.0		141	4	S.E.	43	" air very hot - cumulus clouds
5	30.314	61	30.345	77.0	45.6	61.3	31.4	62.8	45.2	54.0	151.0	42.8		192	1	N.E.	61	Light breeze - cool but hot steam

Figure 9. Meteorological Observations form, which appears to be that which observations from probable '1st Class Stations' were made.

**METEOROLOGICAL RETURN (2ND CLASS STATION).**

Observations taken at Central Nursery Teceburn for Month of February 1897.  
 Altitude above sea 1400 feet Received at 9.30 a.m.

Date.	WIND.		Barometer. (2)	Ther. in Shade.	Humidity.	Rain in inches.	Weather. (3)	State of Sea, Bar, or River	
	Direction.	Force. (1)							
1		6.	29.5	46			B	h = 15 x 17	= 25.5
2	S.E.	2	29.5	56			0	c = 75 x 3	= 22.5
3	S.W.	7. B.	29.4	38		0.38	W.	c = 25 x 4	= 7.6
4		6.	29.2	48			0	w(0) = 95 x 1	95.0

Figure 10. 2nd Class Station form.

**METEOROLOGICAL RETURN (3RD CLASS STATION).**

OBSERVATIONS taken at Central Nursery Teceburn for the Month of January, 1898.  
 (Recorded at 9.30 a.m.) 9. a.m.

Date.	Temperature in Shade at Time of Observation.	Rain for previous 24 Hours. Total fall in Inches.	Wind.		Cloud: 0 to 10.	Remarks on the Weather during previous 24 Hours.
			Direction.	Force: 0 to 10.		
1	50 - 79		N.E.	6	1	Fine warm
2	65 - 70		S.E.	4	0	Fine
3	46 - 70		S.E.	6	2	Fine
4	45 - 65		—	0	6	Dull heavy appearance
5	50 - 69		—	0	4	Fine, calm

Figure 11. 3rd Class Station form.

### Temperature observations

The daily maximum temperatures recorded at Eweburn, Ranfurly around the time are particularly low. Given clear sunny skies under anticyclonic conditions, it's difficult to reconcile daily maximum air temperatures of  $-20.0^{\circ}\text{C}$  and  $-21.1^{\circ}\text{C}$  on 16 July and 17 July 1903 respectively. Does this suggest instrument error, or poor instrument exposure (e.g. the station was located at a nursery which was established in 1897, were the instruments shaded/surrounded by trees)? From the paper record at the time, it is not explicit that the temperatures are indeed the maximum temperatures recorded on each day. I came across a newspaper article reporting on the establishment of the Eweburn nursery, which stated that "*a complete set of meteorological instruments is in use, and observations are taken daily at 9am and 5pm*". Could it be that the 'daily maximum air temperatures' are actually the temperatures recorded at 5pm? If this were the case, it doesn't explain why daily minimum but not maximum temperatures were recorded, unless the 'daily minimum temperatures' were actually the air temperatures at 9am.

Two temperatures were recorded consistently on each day from 1 August 1897. On the October 1897 observation form, the observer wrote "minimum register during night be self registering thermometer". As such, it seems the station had an operational minimum registering thermometer, allowing overnight minimum temperatures to be observed. In my opinion, the second temperature recorded each day would appear to be the temperature recorded at 9 a.m. This would explain the very cold "maximum temperatures" registered during the July 1903 cold spell which were seemingly too cold given weather conditions at the time (clear skies and sunny conditions). Each '3<sup>rd</sup> Class Station' form noted the time observations were to be carried out, and the observer was always very studious in scribbling out the '30' in '9.30 a.m.' on each form, suggesting a conscious and deliberate effort was made to carry out and show that observations were indeed made at 9 a.m. each day. When examining the forms from Eweburn, Ranfurly, it became apparent that the second temperature recorded each day was highly unlikely to be the maximum temperature. For example, on 25 December 1897, the observer noted it was a "fine very warm" day, yet the 'max' temp was only  $15.5^{\circ}\text{C}$  ( $60^{\circ}\text{F}$ ). I suggest that this would not be the maximum temperature recorded on a very warm day in December at such a location. A similar situation occurred on 23 December 1897, and I noted numerous other examples of such a situation throughout the paper records for Eweburn, Ranfurly.

November 1916 was the last month that A W Roberts was the observer at Eweburn, Ranfurly. In March 1917, Morrison took over, and it appears from this month forward that the second temperature recorded on the '3<sup>rd</sup> Class Station' forms were indeed daily maximum air temperatures. It would be interesting to perform an analysis of monthly average maximum temperatures at the station up to November 1916, and then for the remaining months on record, to see if there is a discernable or significant difference.

Table 5 shows the mean maximum temperatures recorded, and indeed highlights a difference in the monthly mean maximum air temperatures recorded. It seems clear to me that from 1897 (with the possible exception of January 1897) to February 1917, the second temperature recorded on the forms were not the daily maximum air temperature that would have occurred, but it is likely that they were the daily maximum temperatures from March 1917 onwards. As such, the data on CliFlo (New Zealand's National Climate Database, maintained by NIWA) will need to be removed.

Table 5. Eweburn, Ranfurly mean maximum temperatures for each month, separated at March 1917 when a new observer took over.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1897	20.1	6	13	8.6	4.3	2.8	2.5	4.9	11	11.8	15.9	15.3	9.7
1898	17.8	12.7	14	-	3.6	1.6	1.1	1.8	6.8	10	14.1	15.5	-
1899	16.4	14.2	6.7	3.1	-0.2	-0.9	-2	-0.2	7.1	11.5	13.1	13.4	6.9
1900	14.8	12.4	12.6	7	5.3	-0.7	2.6	5.1	9.2	11.1	12.1	14.6	8.8
1901	15.5	13.9	10.9	8.5	3.1	0.2	0.4	-2.5	6.2	10.5	12.6	13.2	7.7
1902	15.8	15	11.7	7.2	1.9	0.1	0.7	-0.2	2.3	7.3	10.7	10.8	6.9
1903	10.7	12.3	10.6	6.2	2	-1.1	-3.5	-0.4	5	9.8	13.2	14.3	6.6
1904	16.3	13	9.5	6	3.7	0.5	-0.4	1	4.2	8.3	10.9	12.9	7.2
1905	13.3	14.5	12.5	6.8	2.4	-0.8	-0.4	0.5	5.4	7.7	11.4	13.8	7.3
1906	11.9	11.3	9.9	6.1	3.8	1.1	0.3	1.2	4.4	9.5	11.7	15.2	7.2
1907	16.1	14.6	13.6	9.5	3.3	0.7	0.2	0.8	5.3	9.9	13.4	16.4	8.6
1908	15.6	14.7	10.6	6.4	4	2.4	-2.5	-1.8	7.4	8.9	13.2	12.5	7.6
1909	12.3	14.1	13.1	7.8	5.7	3.1	0.5	3.9	6.4	9.9	13.6	17.1	8.9
1910	14.6	15.8	11.5	7.1	6.4	2.4	-0.4	4.3	7.1	11.6	15	14.1	9.1
1911	13.7	14.5	13.2	10.2	4.9	1.8	-0.7	3.3	6.2	10.5	11.4	11.8	8.4
1912	13.8	11.6	8.9	7.1	2.8	1.8	0.7	2.2	6.4	10	10.1	15.5	7.6
1913	15.3	12.7	11.5	6	2.5	1.2	2.3	2.7	8	10.3	11.1	12.9	8
1914	15	13.7	11.8	7.7	1.3	1.2	1.8	3.5	7.2	10.6	10.9	12.7	8.1
1915	13.9	13	10	6.7	3.7	0.7	1	2.5	8.4	11.6	12.5	15.3	8.3
1916	14.5	14.4	13.2	9.6	4.1	3.4	1.2	3.1	8	9.5	13.3	16.7	9.2
1917	17.5	14.1											
<b>Mean</b>	<b>15.0</b>	<b>13.3</b>	<b>11.4</b>	<b>7.2</b>	<b>3.4</b>	<b>1.1</b>	<b>0.3</b>	<b>1.8</b>	<b>6.6</b>	<b>10.0</b>	<b>12.5</b>	<b>14.2</b>	
1917			21	16	11.3	7.5	8.6	9.8	13.2	16.2	19.8	19.8	
1918	21.6	22.2	19.8	15.3	11.4	6.8	4.1	8.5	12.1	16	16.3	18.2	14.4
1919	17.5	22.2	20.3	15	11.2	7.5	6.5	9.1	11	16.4	15.4	20.1	14.3
1920	20.8	23.1	20.8	17	10.4	7.9	9.5	6.2	13.1	17.4	16.8	21.4	15.4
1921	22.2	21.4	19	15.3	12.4	8.2	8.2	9.7	14.1	15.7	18.8	19.4	15.4
1922	21.4	23.3	16.8	17.2	11.4	5.6	6	9.7	13.3	18.3	17.8	19.8	15.1
<b>Mean</b>	<b>20.7</b>	<b>22.4</b>	<b>19.6</b>	<b>16.0</b>	<b>11.4</b>	<b>7.3</b>	<b>7.2</b>	<b>8.8</b>	<b>12.8</b>	<b>16.7</b>	<b>17.5</b>	<b>19.8</b>	

### **Recommendation**

That -25.6°C, recorded at Eweburn, Ranfurly on 17 July 1903, remain conditionally accepted as New Zealand's coldest recorded temperature, pending the outcome of an investigation by a WMO committee who plan to evaluate it as possibly the coldest recorded temperature in Oceania.

### **References**

Hector, Sir James (1869). 'Meteorological Report, 1868: Together with Abstract of All Meteorological Returns for New Zealand Prior to that Date'. Available at Alexander Turnbull Library, Wellington.

## Appendix I – Information obtained from newspaper articles

### **Otago Daily Times:**

#### **Monday 13 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030713.2.42&e=-----10--1----0-->

On Friday afternoon (10 July) cold rain set in, changing in Dunedin to sleet and snow at 9pm. On Saturday morning the city and surrounding hills were white with a fairly heavy coating, and from advices it is evident that a heavy snowstorm has occurred all over the country.

The most serious block to train traffic was on the Otago Central line, the train from Ida Valley failing to reach Ranfurly on Saturday. Access was re-established on Sunday 12 July due to a powerful engine being sent to clear the way.

At Rough Ridge grade the snow was 3ft deep on the rails, and all Ida Valley Plain was under 2ft of snow. An unsuccessful attempt was made to get the mails through from Naseby to Ranfurly, the snow being too deep.

The snowstorm has been the heaviest experienced for years in Central Otago, and last evening (Sunday 12 July) it was still snowing in the south.

In the city a thaw set in on Saturday morning (11 July), and the snow melted from the footpaths and housetops gradually, but there was still a good coating on the hills last evening (Sunday 12 July). So far no advice has been received of any thaw in the country, but the weather was clearing in the interior, and the storm seemed to be passing off to the south.

Lawrence correspondent reports awakening to at least 6in of snow on the ground on Saturday (11 July).

Palmerston correspondent: snow began to fall at midnight Friday 10 July, continued more or less all Saturday until time of report, when snow was still falling (Saturday afternoon, 11 July). Snow depth 8 or 9in. Word received that early Saturday morning snow was 4ft deep at Morrison's, Waihemo, and still falling.

Macraes correspondent: 2ft snow depth on Saturday with 15 hours continuous fall, and still falling.

Oamaru 3in of snow Saturday morning, Kurow 9in. Saturday morning 4in Timaru, 1ft Fairlie. In Timaru, fine weather on Sunday 12 July but in the evening the weather was threatening. In Ashburton, snowfall began about 8am, between 8am and noon on Saturday 8 to 10in snow had fallen and still continued.

11 July (Saturday) report from Hokitika, an exceptionally heavy downpour all night and continuing this morning.

#### **Tuesday 14 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030714.2.39&e=-----10--1----0-->

A peculiar feature of the snowstorm was that at Waimate comparatively little fell, while between Maheno and the Horse Range only a slight sleety fall was experienced.

The frost that set in on Sunday night (12 July) appears to have had the effect of binding the snow.

Naseby correspondent: the fall of snow in that district considered to be the heaviest for some 15 years. There was about 2ft snow in the township.

Palmerston correspondent: the fall of snow ceased on Saturday evening but, with the exception of a slight thaw where traffic had been, what fell is still lying on the low ground. The oldest inhabitant has never known snow to lie so long on the low ground as the present. Light showers of sleet and rain fell at intervals on Sunday (12 July). The weather at present is very threatening, and shows every appearance of a further fall of snow.

Improving weather reported in Westport.

### **Wednesday 15 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030715.2.54&e=-----10--1----0-->

There is still great depth of snow in Central Otago.

The longest stretch of unbroken wire in Otago was that between Naseby and Ophir, a distance of more than 40 miles. This line was erected about 30 years ago, and its freedom from interruption was due to the fact that it was situated in high country, in which the snowfall was not preceded by rain. Other sections partially unaffected were the Peninsula lines and that from Green Island to Taieri Beach, the warmth from the ocean in these localities preventing the snow from freezing on the wires.

Cromwell: The snowfall here was the heaviest for years. There was not much in town, but two or three miles away there was from 6in to 12in on the ground. Hard frost has set in.

Clyde: Severe frosts are delaying an early thaw. The snow on the high tops is very deep.

Alexandra: About 6in fell on Friday night in the town. The frost last night was very severe, and the indications point to its being harder tonight.

Naseby correspondent: The recent snowfall is described by many old residents as the heaviest in their experience. One or two cases of roofs having broken through due to the weight of snow. The trees, also, have sustained much damage.

Ranfurly correspondent under date July 13 (Monday): On Friday night, after a summer-like day, the snow began to fall heavily, and on Saturday morning at daylight there was a fall of about 2ft.

### **Thursday 16 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030716.2.50&e=-----10--1----0-->

St Bathans correspondent (writing on Tuesday 14 July): the weather took a decided change on Friday. A north-wester blowing, accompanied with rain, brought the snow melting off the hills, and this flooded the Dunstan Creek. At 6pm the wind veered round to the south-east. By 10pm 12in of snow had fallen, and in the morning (Saturday 11 July) 32 in was measured. It has proved to be a record fall for the short time it came down. Keen frost has set in today with a bright blue sky.

Lake Wanaka correspondent (writing on Tuesday 14 July): On Wednesday (8 July) rain began to fall, and on Thursday (9 July) the Cardrona River was in flood. The rain continued during Friday, but on Friday evening snow began to fall, and has continued ever since. We now have a foot of snow in the Cardrona township, and above the township snow is 2 to 3ft deep.

Oamaru: the snowstorm has been followed here by cold winds during the daytime and severe frosts at night.

Arrowtown correspondent (writing under date Friday 10 July): the snowfall here was very heavy, and over 2ft depth on low levels was measured. Great damage has been done to fruit and ornamental trees through the weight of snow snapping off branches.

Timaru: a report from the Mackenzie Country says that there is 3ft of snow on the plain – one of the heaviest falls on record.

### **Friday 17 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030717.2.52&e=-----10--1----0-->

Mr John Roberts telegraphed yesterday (Thursday 18 July) that -5F (-20.6°C) was registered at Gladbrook on Wednesday night.

Gore correspondent: the weather is very cold. The snow still lies on the ground and is frozen hard by hoar frosts. A singular result of the thaw that has evidently taken place up-country is the numerous blocks of ice that are floating down the Mataura River.

Invercargill telegram: states that an extremely hard frost prevails there, which is unusual so close to the sea, especially during the day.

On Saturday (11 July) 42in of snow on the Otamatata Saddle. At Omarama, 35in of snow.

It is estimated that compared with the snowstorm of 1895, the fall on the present occasion is much greater.

### **Saturday 18 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030718.2.64&e=-----10--1----0-->

The 2.10pm train from Dunedin to Ida Valley could not get beyond Middlemarch, as on arrival at the latter station it was found that no water could be got for the engine, the water in the tanks having been frozen into one solid mass. The intensity of the cold on the Otago Central line of railway may be gauged from the fact that one of the railway officials at Capburn had to keep on his overcoat, gloves and muffler the other morning while eating his breakfast, notwithstanding that a good fire was burning in the room.

“A commercial Traveller Snowed Up and Almost Frozen Up” writes from Blackstone Hill on Wednesday: snow fell to a depth of 2ft 9in to 3ft. The mail coach reported snow between Becks and St Bathans to be lying 3ft deep nearly all the way. Everything liquid freezes into a solid block even with a large fire nearby. Many sheep and hundreds of birds have perished.

-3F (-19.4°C) registered at the Hakataramea fish hatchery on Friday morning (17 July).

A passenger on the Timaru to Fairlie train last Tuesday (14 July): The cold was so severe that three to four feet from the fire (within the "engine" carriage of the train) there were icicles on the engine, and when the fireman opened the door to coal his fire you could see the frost falling in the air, while for the male passengers the breath from their nostrils was freezing on their beards.

**Monday 20 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030720.2.37&cl=CL2.1903.07.20&e=-----10--1----0-->

Snowstorm occurred over a week ago, however snow still lay in Palmerston on roofs and along roadsides and hedges shaded from the sun.

Mr John Roberts recorded severe frosts at Gladbrook (Gladbrook appears to be very close to Middlemarch). On the morning of 16 July, -5F (-20.6°C), on 17 July minimum temperature was -13F (-25°C), on Saturday (18 July) -7F (-21.7°C). On Friday (17 July) it was 0F (-17.8°C) at 5pm, -4F (-20°C) at 6pm, -6F (-21.1°C) at 10pm. The temperature fell 10deg between 10am and 10pm, so it may be inferred the 10am temperature was 4F (-15.6°C). The frost had a peculiar and beautiful effect on the vegetation, the spikes of the pinus insignis trees being converted to icicles, and horseshoes attached to fences transformed into icicles of about the thickness of a finger. Strath Taieri plains, 12in deep snow at the start of the week was 5in deep on Saturday 18 July.

On Friday night (17 July), there was 4ft of snow at Benmore.

**Tuesday 21 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030721.2.59&e=-----10--1----0-->

The recent snowstorm was undoubtedly the most severe experienced in the back country since the year 1895. Fortunately, the atmospheric conditions since the storm took place have been as favourable as could have been expected. The depth of snow was very considerable, but generally there was an absence of wind, and consequently sheep seeking shelter were not in such danger of being buried in drifting snow as is usually the case. One important difference between 1895 and this year is that on the former occasion the first snowfall was followed by other heavy falls in rapid succession, while this year there has so far been only one fall, though its effect has been considerably accentuated by the severity of the frost.

Advices received from Roxburgh yesterday (Monday 20 July) stated that a thaw had set in on Sunday (19 July). The only conditions likely to produce a rapid thaw, however, are either warm winds or warm rain, otherwise the snow will lie for a considerable time, so completely is it frozen.

From figures supplied by Mr John Roberts we learn that the greatest cold experienced at Gladbrook was on Friday last (17 July), when the thermometer stood at -13F (-25°C). A very cold snap was experienced in July, 1899, but the lowest reading of the thermometer was then -11.5F (-24.2°C). In 1899 there was a considerable difference between the maximum and minimum temperature, but last week the temperature was very low almost the whole time. The comparative figures for the two periods are as follow:

<b>Gladbrook temperature measurements</b>				
<b>July 1899</b>				
	<b>Max (°F)</b>	<b>Max (°C)</b>	<b>Min (°F)</b>	<b>Min (°C)</b>
<b>21st</b>	39	3.9	30	-1.1
<b>22nd</b>	39	3.9	17	-8.3
<b>23rd</b>	40	4.4	20	-6.7
<b>24th</b>	32	0.0	12	-11.1
<b>25th</b>	14	-10.0	5	-15.0
<b>26th</b>	31	-0.6	-11.5	-24.2
<b>27th</b>	53	11.7	13	-10.6
<b>28th</b>	47	8.3	44	6.7
<b>July 1903</b>				
	<b>Max (°F)</b>	<b>Max (°C)</b>	<b>Min (°F)</b>	<b>Min (°C)</b>
<b>11th</b>	43	6.1	30	-1.1
<b>12th</b>	38	3.3	22	-5.6
<b>13th</b>	37	2.8	25	-3.9
<b>14th</b>	38	3.3	23	-5.0
<b>15th</b>	29	-1.7	6	-14.4
<b>16th</b>	22	-5.6	-6	-21.1
<b>17th</b>	17	-8.3	-13	-25.0
<b>18th</b>	24	-4.4	-7	-21.7

Arrowtown correspondent, writing on the 18<sup>th</sup> (Saturday 18 July): states that the cold was exceptionally severe last week, and almost everything of a liquid nature was frozen. The storekeepers and hotelkeepers have sustained considerable loss owing to all the cordials, vinegar, and patent medicines freezing and bursting the bottles. There was a slight thaw on Saturday morning (18 July), when indications pointed to milder weather.

Matakanui correspondent reports that the fall of snow there on Saturday 11 July was 24in deep on the high and low country. Intense frost followed until yesterday morning (Monday 20 July), and no snow has gone. Yesterday it looked as if a thaw would set in.

Wetherstones correspondent writes under date Monday 20 July: the frost has been the most severe experienced for many years – probably since the year 1862. It was freezing all day on Friday (17 July), even in the sun, and the ground was slippery and dangerous. There was a slight thaw on Sunday (19 July), the day being clear and warm, but this morning (Monday 20 July) the frost was as keen as ever. Beef and mutton are frozen, and can only be cut with a saw or chopper, a knife being of no use. Turnips, potatoes and milk are also frozen, and the ink in the post office is in a similar state.

An Invercargill telegram states that rain fell last night (Monday 20 July night), and the hard frost has gone meantime.

A Fairlie telegram says that a thaw occurred on Sunday (19 July) and yesterday (Monday 20 July).

Letter to the editor: Sir, - In Saturday's report (18 July) in the Times re the snowstorm here reference was made to the case of a poor railway official at Capburn, who while eating his breakfast beside a good fire, had to be enveloped in a greatcoat, with muffler and gloves, so intense was the cold. But what about the case, or the condition, during the same storm, of the poor unfortunate platelayers, who had to stand out in it all from 7am till 9pm, with a bit of cold lunch, and hair, whiskers and eyebrows hanging in solid ice – one of whom was so badly frostbitten that his hands are now useless, and will be for some weeks to come? How would the official referred to have liked that?

### **Wednesday 22 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030722.2.40&e=-----10--1----0-->

Advices received from Hakataramea Valley yesterday stated that a thaw had taken place on Monday (21 July), as a result of which there was 1ft less snow on the ground than previously. Information to hand from other districts states that the snow is disappearing slowly.

Deep Stream correspondent writes: During the whole of last week the frosts have been phenomenal, culminating on Friday morning last (Friday 17 July), when the thermometer here stood at -8F (-22.2°C). On Saturday (18 July), however, the day was overcast, and a slight thaw began, and has continued up to the time of writing. Numbers of ducks and swans were here last week, frozen out on the Upper Taieri, but since the river has been completely frozen over they have left for more open waters further down country.

Bald Hill Flat correspondent writes under date 19 July (Sunday): all work in this locality is at a standstill, owing to the extreme cold. The snow still lies on the low country to a depth of 14in, and on the hills it is much deeper. This, combined with the heavy hoar frost (which was like a pall over the place, and excluded the sun for the greater part of last week), made things, to put it mildly, decidedly uncomfortable. All liquids were frozen solid, with the exception of the more ardent ones.

### **Thursday 23 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030723.2.54&e=-----10--1----0-->

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Advice was received yesterday from the Mackenzie Country to the effect that the depth of snow varied from 16in to 2ft. The fall has been heaviest in the direction of Burke's Pass, that towards the Waitaki district being less severe.

In many cases the intense cold following the snow has had the effect of causing the bottles containing liquids to burst, but at Kurow the results are not so bad, though the temperature was no doubt as low. In the stores at Kurow all the corks of bottles containing fluid magnesia, Vitadatio, and other patent medicines have been forced out, and now stand on top of the frozen liquid. Everything is freezing in the rooms of dwellings at Omarama in spite of the fires.

A Duntroon correspondent writes: I have often heard of frozen iron sticking to the fingers, but never experienced the same till Friday, when I picked up an adze, and happened to touch the head. My fingers froze to it. I pulled them away quickly, but not without leaving a little skin on the adze.

St Bathans correspondent informs that snow fell there to a depth of 3ft 5in in the recent storm, and that the frosts were terribly severe, the cold being the most intense the residents have ever experienced, the winter of 1895 not excepted.

#### **Thursday 30 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=ODT19030730.2.64&e=-----10--1----0-->

Naseby correspondent writes: the snow still lies on the ground to the depth of at least a foot. There has been very little thaw, and hard frost, night after night, has been the rule. It is anticipated that this winter will prove more disastrous than that of 1895. Snow fell again this (Wednesday, 29 July) morning.

### **The Mount Ida Chronicle:**

#### **Friday 17 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=MIC19030717.2.5&cl=CL2.1903.07.17&e=-----10--1----0-->

Naseby: Since the snow storm the frost has been very severe. On Wednesday night (15 July) the thermometer recorded four more degrees of frost still. We are told that at Ranfurly on Tuesday night (14 July) the frost was the most severe experienced for nine years.

The frost at Ida Valley on Tuesday night was so intense that although a fire was kept burning both in and under the engine, the water in the boiler injectors froze. One of the reasons why the train cannot travel on the Ida Valley section is, as mentioned above, the difficulty of keeping the water in the injectors of the engines from freezing. Even while the train was standing at Ranfurly on Wednesday (15<sup>th</sup>) night for about an hour it froze.

#### **Friday 24 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=MIC19030724.2.12&cl=CL2.1903.07.24&e=-----10--1----0-->

After the sharp frosts for a few nights at the beginning of the season the weather turned fine and mild, which continued till eve of the snow-storm the week before last. For a week or so after that the frost was exceptionally severe, especially towards the end of last week. On Friday morning the thermometer registered -4F (-20°C), at Naseby and Gimmerburn, while it went as low as -14F (-25.6°C), at Ranfurly. This is the most intense cold experienced in that district since it was settled. At Gimmerburn on Friday (17<sup>th</sup>) night the thermometer was -8F (-22.2°C).

Owing to the intense cold the *Chronicle* staff found it extremely difficult to get their issue printed last week, as the papers would often freeze together, and it was only by thawing them over the stove that the work could be gone on with at all. This proved a very tedious process. We have often experienced a certain amount of difficulty with the frost in winter, but that was a record.

At Ranfurly, with the exception of spirits, nearly all the liquids in the bottles froze. Sometimes the bottles broke, and the glass falling down would leave the contents standing on the shelf in a solid block.

The weather is very severe. On Thursday, the 16<sup>th</sup>, the thermometer at 9.30am was -4F (-20°C), Friday same time -8F (-22.2°C). The oldest inhabitant has never before seen so heavy a fall of snow in this district. On the morning of the fall the depth was from 14in at the mouth of the Gimmerburn to 30in up the creek towards Highfield on the flat.

Kyeburn: The frost during the last week was said to be the most severe ever experienced for the time it lasted, and it was actually dangerous to be out about sundown, as several have found to their cost by having fingers and toes frostbitten.

#### **Friday 31 July 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=MIC19030731.2.7&cl=CL2.1903.07.31&e=-----10--1---0-->

On this occasion, as in the case of the last great snowstorm four years ago, the main disaster has been followed by phenomenal frosts, the intensity of which will remain proverbial in the district for many a year to come; and even those who were fortunate enough to be in a position to trouble themselves little about the snow have in many cases had to suffer physical, social or business injuries at the hands of its ally, King Frost.

#### **Friday 14 August 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=MIC19030814.2.16&cl=CL2.1903.08.14&e=-----10--1---0-->

The rainfall as recorded at Eweburn Nursey, Ranfurly, for the month of July was 51in. Rain fell on two days. The lowest readings of the thermometer were as follows: - 15<sup>th</sup>, 4F (-15.6°C); 16<sup>th</sup>, 10F (-12.2°C); 17<sup>th</sup>, 14F (-10.0°C), 18<sup>th</sup>, 5F (-15°C), 31<sup>st</sup>, 2F (-16.7°C); the lowest being on the 17<sup>th</sup> when it was 14F below zero (-25.6°C) or 46F of frost. The highest reading was 51F (10.6°C) on the 1<sup>st</sup>, and the lowest temperature during the day was 1F (-17.2°C) on the 16<sup>th</sup>.

#### **Friday 21 August 1903:**

<http://paperspast.natlib.govt.nz/cgi-bin/paperspast?a=d&d=MIC19030821.2.15&cl=CL2.1903.08.21&e=-----10--1---0-->

At St Bathans during July the rainfall was 3.59in. Rain or snow fell on 5 days. The mean temperature at 9.30am was 30.61F (-0.8°C), the highest reading at that hour being 50F (10.0°C) on the 2<sup>nd</sup> and the lowest 9F (-12.8°C) on the 16<sup>th</sup>.



## Appendix III – Information regarding the 1995 Ophir measurement

The first figure below shows a copy of a MetService news release, which states that the instruments used at Ophir were checked and confirmed as accurate. The second figure is a photo taken on 9 July 1995 at the Ophir weather station.

