



Ministry for the Environment Atmosphere and Climate Indicators 2023

Updated Datasets supplied by NIWA

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Executive summary

The Ministry for the Environment (MfE) previously acquired climate and atmospheric datasets from NIWA which contributed to the *Our Atmosphere and Climate 2020* report. MfE requested updated versions of many of these datasets, so that the data set could be complete to the end of 2022. Several of the datasets previously provided were no longer required. These data will contribute to the MfE's and Stats NZ's 2023 environmental reporting obligations.

This report describes the datasets that were requested by MfE, and outlines the methodologies used to generate the datasets. In many cases a client report or journal article detailing the methodologies used has already been written, so references to those reports are provided where relevant.

Data were successfully delivered to MfE along with this report. Datasets were typically provided as .csv or Microsoft Excel (.xlsx) files.

1 Project Scope

The Ministry for the Environment (MfE) previously acquired climate and atmospheric datasets from NIWA (Macara et al., 2020), which contributed to the *Our atmosphere and climate 2020* report (Ministry for the Environment & Stats NZ, 2020). These datasets typically ended in December 2019. MfE requested updated versions of many of these datasets, to complete the data to the end of 2022. These data will contribute to the 2023 environmental reporting obligations of MfE and Stats NZ. The following datasets were provided to MfE:

- For 30 regionally-representative sites:
 - Maximum, minimum and mean temperature (daily).
 - Growing degree days (monthly, base 10°C and base 5°C).
 - Rainfall (daily), and annual rainfall indices (rx1day and r95ptot).
 - Maximum, average daily maximum and days above p99 wind gust (monthly and annual).
 - Standardized Precipitation Evapotranspiration Index (3-, 6- and 12-monthly).
- National temperature time-series data (annual seven-station series).
- Southern Oscillation Index (monthly and annual).
- Ozone concentrations measured at Lauder (daily and annual).
- Greenhouse gas concentrations measured at Baring Head (monthly):
 - Mean CO₂
 - Mean CH₄
 - Mean N₂O.

1.1 Selection of regionally-representative sites

The following criteria were used to select regionally-representative climate stations:

1. The station must currently be open (as at 1 January 2023).
2. The station is likely to remain open for the foreseeable future.
3. The station has a long record of reliable good-quality data.
4. The station is located near a large city (e.g., at an airport site) so is representative of the climate where many people in the region live.
5. Normally one station per region is to be selected. However, if deemed necessary to adequately represent a large region, two or three stations may be selected.

The regionally-representative sites chosen, and the associated climate stations where climate data were extracted, are listed in Section 8.1. Several changes to the station chosen for a given location were made compared to the previous iteration of this work (Macara et al., 2020). This resulted from a review of the stations previously selected, which found some stations had recently closed. These changes have been bolded in the relevant tables presented in Section 8.1

2 Data sources

Many of the datasets provided to MfE were obtained from NIWA's national climate database (CliDB), with Virtual Climate Station Network (VCSN) data used to infill missing data. Data stored in CliDB are subject to routine quality control processes, as outlined in Section 2.1 below. An overview of VCSN data is provided in Section 2.2. Section 3.1 to Section 3.10 describes the climate and atmospheric datasets provided to MfE and the procedures we have used to generate these datasets where appropriate. In cases where journal papers and client reports have already been written describing how these data were generated, the reader is referred to the relevant publications.

Note a homogeneity assessment of daily temperature, rainfall, and wind time series at individual stations was not performed. Inhomogeneities in climatic time series can be caused by changes in station location, station exposure, instrumentation and observing practices. However, where data from two adjacent sites are used contiguously, inhomogeneity between the two series has been mitigated by comparing (via statistical regression analysis) the stations against each other and then scaling one of the stations accordingly. Results of the regression analyses are presented in Section 8.2.

2.1 CliDB data quality control

Temperature, rainfall, and wind data prepared for MfE and described in this report were derived from raw data values extracted from NIWA's National Climate Database (CliDB). These raw data can be accessed for free from <http://cliflo.niwa.co.nz/> and while no guarantee is made regarding the accuracy of the data, all reasonable skill and care has been applied so that the data in the database are as reliable as possible.

The following quality control procedures are undertaken for all data in CLIDB. As observed values are transferred into permanent data tables in the database (e.g., MAX_MIN_TEMP, RAIN etc.) from temporary input tables (e.g., RMS_AWS, RMS_DLYCLI etc.) they are automatically inspected for errors. Gross errors which occur when values fall outside prescribed extreme thresholds are flagged for further investigation and not transferred into CLIDB. Potential errors defined through statistical distributions (e.g., beyond the 1st or 99th percentiles for that place/time) are uploaded to the data archive but appear on automated daily error reports until being confirmed or corrected by a trained technician.

NIWA is also responsive to data quality issues raised by users, and user-initiated manual data checks are carried out as soon as possible after issues are reported. Finally, systematic audits of the climate database data tables are conducted from time to time to identify, report and resolve any residual data quality issues.

2.2 VCSN data

NIWA's Virtual Climate Station Network (VCSN) data are based on a spatial interpolation process to estimate climate conditions in observation-sparse areas. VCSN data have regular spatial and temporal coverage and were used in this project to infill missing climate data at observational sites.

The VCSN consists of a grid of 11491 data points, known as *virtual climate stations*, covering the New Zealand area. Each of these virtual climate stations has interpolated values of Daily Rainfall, Wind Speed, Maximum and Minimum Temperature, Relative Humidity, Mean Sea Level Pressure, Vapour Pressure, Potential Evapotranspiration, Soil Moisture, 10 cm Earth Temperature and Global Solar Radiation. The virtual stations contain rainfall data from 1960, data from 1972 for all the above

parameters except wind, and data from 1997 including wind. The grid point separation is 0.05 degrees latitude and longitude which is approximately 5km.

VCSN data are calculated using *ANUSplin*, a software tool that takes data values from irregularly-spaced observing sites and provides interpolated values at regularly spaced grid point locations. Specifically, the data are calculated by the ANUSplin trivariate (three independent variables: easting, northing and a third variable, e.g., elevation) thin-plate smoothing spline interpolation methodology, described by Wratt et al. (2006).

3 Methodologies

3.1 Infill of daily time series

The methodology used to infill daily time series data was developed during previous work carried out for MfE (Macara and Tait, 2015). This methodology was followed to generate daily time series of temperature, rainfall, and wind at each of the 30 regionally-representative sites:

1. Extract all available station data, using multiple stations if necessary, to cover required data period.
6. Perform regressions to obtain systematic scaling factor where station data overlap.
7. Scale secondary station data from regression results.
8. Select nearest VCSN grid point data.
9. Perform regressions as above.
10. Infill original station time series with scaled secondary station and VCSN grid point data.

A list of secondary climate stations and VCSN grid point agent numbers used for infilling missing data at each location are provided in Section 8.1. Results of the regression analyses are presented in Section 8.2.

The following procedure was followed if there was no overlap between data of the primary and secondary stations at a given location:

1. Extract all available station data, and select nearest VCSN grid point data.
2. Perform regressions between the primary station and VCSN data, then scale VCSN data.
3. Perform regressions between the scaled VCSN data and the secondary station data, then scale the secondary station data.
4. Merge the open station data and scaled secondary station data, using primary station data where available. Infill missing daily values with the adjusted VCSN data.

Subsequent steps needed respectively for each parameter are described in the Sections below.

3.2 Daily temperature

Daily time series of maximum (T_{max}) and minimum (T_{min}) temperature were generated following the methodology described in Section 3.1. Daily mean temperature (T_{mean}) was calculated as shown below in Equation (1):

$$T_{mean} = \frac{(Daily\ T_{max} + Daily\ T_{min})}{2} \quad (1)$$

All available data were provided, specifically:

- Complete daily time series (i.e. no missing data) were available for the period 1 January 1972 – 31 December 2022 at all 30 regionally-representative sites.
- Daily time series were extended prior to 1972 at some sites where primary and/or secondary station data were available. Complete daily time series were not necessarily available prior to 1972, because VCSN temperature data (used to infill missing data) were only available from 1 January 1972.

3.3 Daily rainfall

Daily time series of rainfall were generated following the methodology described in Section 3.1. Data were provided back to 1 January 1960.

3.3.1 Rainfall indices

Annual rainfall indices were calculated from the daily rainfall datasets. The indices calculated were *rx1day* and *r95ptot*, using ClimPACTv3.1.3 software (Climpact, 2023):

- ***rx1day*** = the annual maximum 1-day precipitation total.
- ***r95ptot*** = the percentage of annual precipitation contributed from very wet days, where very wet days are defined as those where the daily rainfall exceeds the 95th percentile of daily precipitation totals during the period 1991-2020. The 95th percentile was calculated from the base period 1991-2020, where daily rainfall total > 1 mm.

3.4 Daily wind

Daily wind datasets for 30 New Zealand locations were extracted from CliDB, and missing data were infilled. VCSN data are not appropriate for infilling purposes as a) there is no wind gust variable in the VCSN dataset, and b) daily wind speed data in the VCSN dataset only start in 1997. Therefore, data from nearby climate stations only was used. Nearby station data were only substituted for the period of time that the primary station was operating. Substitute data from nearby stations were used if the r^2 from the associated regression equation was > 0.50. Where more than one nearby station was used to substitute data, the nearby station with the highest r^2 was predominantly used to infill missing primary station data.

3.4.1 Wind indices

Monthly and annual (calendar year) data were provided for maximum wind gust, average daily maximum wind gust and days above $p99$. Days above $p99$ is a count of the number of days where the maximum wind gust was greater than the 99th-percentile wind gust speed (from all available data). The 99th-percentile wind gust speed was calculated from all available daily wind gust data at each of the 30 nationally-representative locations, respectively. On average, the $p99$ daily maximum wind gust will be exceeded on approximately 3.6 days per year. Therefore, annual counts higher than this indicate more days than usual with very strong wind gusts recorded, whereas annual counts lower than 3.6 indicate fewer strong wind gust days than usual.

3.4.2 Wind data caveats

Infilling of wind gust data for a given location could not be done using VCSN data, and was hampered by missing daily maximum gust data respectively at available nearby stations. Observed wind speeds

demonstrate high spatial variability due to modification by local topography, and therefore can differ considerably between different sites at a given town or city. In some cases, no suitable station data were available to infill missing wind gust data. This was not an issue for the daily temperature and rainfall datasets (Sections 3.2 and 3.3), due to the relatively homogeneous spatial coverage available to the VCSN gridpoint calculations.

Note that the p99 wind gust speed may be below what might be considered ‘damaging’ at a given location; however applying this threshold enables the capture of a reasonable number of relatively strong ‘potentially damaging’ wind gust occurrences. The use of a percentile threshold means that the index is relative to each location, meaning the same proportion of higher wind speed gusts are captured at each location compared to the use of an absolute value (e.g., 100 km/hr). This method is employed because some locations are typically subject to stronger winds than others. For example, Wellington will record maximum wind gusts in excess of 100 km/hr far more frequently than Nelson.

3.5 Growing degree days

Growing degree days (GDD) is a heat accumulation index related to crop development through phenological stages, typically calculated as the daily accumulated temperature above a base temperature. Base temperatures may be selected based on a threshold for plant growth. This threshold varies widely between plant species (Luo, 2011). NIWA routinely calculates GDD totals for base temperatures of 5°C and 10°C, and these data are stored in CliDB.

Calculation of GDD is based on daily mean temperature. For example, if the mean temperature on a particular day is 15°C, and the base temperature is 10°C, the GDD is 5 degree-days (Tait, 2008). If a base temperature of 5°C is applied to the previous example, the GDD is 10 degree-days. When the mean temperature of a given day is lower than the base temperature, the GDD is 0 degree-days. Daily GDD may be accumulated to generate a GDD total. The GDD total can be linked to the maturity of a crop, and may be used to estimate crop harvest times (Gordon & Bootsma, 1993; Macara, 2018).

Monthly GDD base 5°C and base 10°C totals were calculated for the period 1972-2022 at 30 regionally-representative New Zealand sites. Calculations were based on daily mean temperature data generated at these 30 locations, as described in Section 3.2.

3.6 SPEI

The Standardized Precipitation Evapotranspiration Index (SPEI) is commonly used as a drought index. This index was calculated for 30 nationally-representative locations, using ClimPACTv3.1.3 (Climpact, 2023), with the 1991-2020 baseline specified when prompted by the software. SPEI is calculated using daily temperature and rainfall data described in Section 3.2 and Section 3.3, following the methodology described in Vicente-Serrano et al. (2010).

3.7 National temperature time series

NIWA’s ‘seven station’ temperature series is a time series of New Zealand’s national temperature, derived from temperature measurements at seven locations: Auckland, Masterton, Wellington, Hokitika, Nelson, Lincoln and Dunedin. These locations were chosen because they provide broad geographical coverage, with reliable records dating back to at least the early 1900s. A full peer-reviewed report on the temperature data homogenisation methodology and adjustments for each of the seven climate stations and the combined seven station series has been produced and is available from <https://niwa.co.nz/seven-stations>.

For the period 1909-2022, annual mean temperature and associated anomalies (difference from the 1991-2020 climate normal) were provided to MfE.

3.8 Southern Oscillation Index

Southern Oscillation Index (SOI) values were calculated for the period January 1876 – December 2022 using monthly Tahiti and Darwin mean sea level pressure (MSLP). The Troup method was applied to calculate SOI (Troup, 1965), detailed in Equation (2) below:

$$SOI = \frac{[(T - T_c) - (D - D_c)]}{[\sigma(T - D)]} \quad (2)$$

where: T = Tahiti monthly MSLP

T_c = Tahiti climatological monthly pressure (1991-2020)

D = Darwin monthly MSLP

D_c = Darwin climatological monthly pressure (1991-2020)

As noted in Equation (2) above, SOI was calculated using the latest 30-year MSLP baseline (1991-2020), which is best practice.

3.9 Ozone Concentration

Ozone data are measured at NIWA's research facility at Lauder, Central Otago (45.04°S, 169.68°E, altitude 370 metres above sea level). The methodologies associated with the measurement of these data are described in Liley et al. (2014).

Various versions of the combined total column ozone dataset have been made available over time (Bodeker et al., 2001a; 2001b). For Environmental Reporting prior to 2020, v2.8 was used. However, v2.8 is less valid now and has been found to be low by about 10 DU in recent data. Recent work by Bodeker Scientific (BS) updated the combined total column ozone dataset version 3.4 (Bodeker et al., 2020). The v3.4 update improved error detection and the mathematical methods for comparison with ground-based data and interpolation. It also included error analysis to provide an individual uncertainty for each grid point and date. It also introduced a new technique for imputation of missing values, based on an AI system. However, the gap-filled v3.4 dataset is only available to the end of 2016.

Most recently BS and NIWA have produced a v3.5 dataset that extends to the end of 2019 - but found that the agreement with Lauder Dobson data is poorer before about 2010. Therefore, v3.4 was provided up to 2010, with v3.5 data provided thereafter. Differences between v3.4 and v3.5 since 2010 do not exceed 4.1 DU (Liley, pers. comm., 2020).

3.10 Greenhouse Gases

Greenhouse gas concentrations are measured at NIWA's field site at Baring Head, near Wellington. The methodologies associated with the measurement of these data are described in Mikaloff-Fletcher and Nichol (2014). Methane (CH₄) data are on the WMOx2004A scale. Carbon Dioxide data (CO₂) are on the WMOx2019 scale (about 0.1-0.2 ppm higher than the WMOx2007 scale), and Nitrous Oxide (N₂O) is on NOAA2006A.

4 Data delivery

The following table lists the file formats of the datasets that were delivered to MfE.

Table 4-1: Datasets delivered to MfE and associated file formats.

Dataset	Date range of data	File format
Maximum, minimum and mean temperature (daily)	At least 1972 – 2022	.csv
Growing degree days (monthly)	1972-2022	.csv
National temperature time-series (annual)	1909-2022	.csv, .xlsx
Rainfall (daily)	1960-2022	.csv
Rainfall indices: rx1day and r95ptot (annual)	1960-2022	.csv
Maximum, average daily maximum and days above p99 wind gust (monthly and annual)	1972-2022	.csv
Standardised Precipitation Evapotranspiration Index (3-, 6- and 12-month)	At least 1972-2022	.csv
Southern Oscillation Index (monthly and annual)	1876-2022	.csv
Ozone concentrations (daily)	1978-2022	.txt
Greenhouse gas concentrations (monthly)	1972-2022 (CO ₂) 1989-2022 (CH ₄) 1996-2022 (N ₂ O)	.csv

5 Acknowledgements

The World Meteorological Organization and its Commission for Climatology (CCI) Expert Team on Sector-Specific Climate Indices (ET-SCI) are acknowledged for developing ClimPACTv3.1.3, which was utilised to calculate rainfall indices and SPEI.

6 Glossary of abbreviations and terms

CH ₄	Methane
CliDB	NIWA's national climate database
CO ₂	Carbon Dioxide
GDD	Growing degree days
MfE	Ministry for the Environment
MSLP	Mean sea level pressure
N ₂ O	Nitrous Oxide
NIWA	National Institute of Water and Atmospheric Research Ltd
p99	99th-percentile
r95ptot	Percentage of annual precipitation contributed from very wet days.
rx1day	Annual maximum 1-day precipitation total
SOI	Southern oscillation index
SPEI	Standardized precipitation evapotranspiration index
Tmax	Maximum temperature
Tmean	Mean temperature
Tmin	Minimum temperature
VCSN	Virtual climate station network

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8 Appendix

8.1 Regionally-representative sites

8.1.1 Stations selected – temperature and rainfall

Note: If more than one station is listed for a given location, then a contiguous record was developed from these data according to the methods outlined in Section 3.1. Bolded entries to the table below indicate changes from the previous iteration of this dataset update (Macara et al., 2020).

Location	Station (agent #)	VCSN agent #
Auckland	Auckland Aero (1962)	25397
Blenheim	Blenheim Aero Aws (4326) Blenheim Aero (4322)	27539
Christchurch	Christchurch Aero (4843)	21209
Dannevirke	Dannevirke Ews (26958) Dannevirke (2534)	27324
Dunedin	Dunedin, Musselburgh Ews (15752) Dunedin, Musselburgh (5402)	19446
Gisborne	Gisborne Aws (2810) Gisborne Aero (2807)	30645
Gore	Gore Aws (5778) Gore, Grasslands D.S.I.R. (5780)	12819
Hamilton	Hamilton Aws (2112) Hamilton Aero (2110)	27690
Hokitika	Hokitika Aero (3909)	19484
Invercargill	Invercargill Aero (5814)	10735
Kerikeri	Kerikeri Ews (1056)	27019
Lake Tekapo	Lake Tekapo, Air Safaris (4970)	14142
Masterton	Masterton Aero Aws (36735) Masterton, Te Ore Ore (7578)	29832
Milford Sound	Milford Sound Aws (18309) Milford Sound (4107)	7697
Napier	Napier Ews (41330) Napier Nelson Pk (2997)	30044
Nelson	Nelson Aws (4271) Nelson Aero (4241)	20596
New Plymouth	New Plymouth Aws (2283) New Plymouth Aero (2282)	27582
Queenstown	Queenstown Aero Aws (5451) Queenstown Aero (5450)	14551
Reefton	Reefton Ews (3925)	18967
Rotorua	Rotorua Aero Aws (1770) Rotorua Aero 2 (1768)	30493

Location	Station (agent #)	VCSN agent #
Tara Hills	Tara Hills Aws (5212) Omarama, Tara Hills (5211)	13473
Taumarunui	Taumarunui Aws (35135) Taumarunui (2250)	29238
Taupo	Taupo Aws (1858) Taupo Aero (1856)	28898
Tauranga	Tauranga Aero Aws (1615) Tauranga Aero (1612)	28397
Timaru	Timaru Aero Aws (5086) Timaru Aero (5084)	19839
Waiouru	Waiouru Ews (41329) Waiouru Treatment Plant (3629)	29323
Wellington	Wellington, Kelburn Aws (25354) Wellington, Kelburn (3385)	28602
Whanganui	Whanganui, Spriggens Park Ews (3715)	28141
Whangaparaoa	Whangaparaoa Aws (1400)	21808
Whangarei	Whangarei Aero Aws (1287) Whangarei Aero (1283)	21619

The following table shows the period for which daily Tmax and daily Tmin (“Daily temperature”) and daily rainfall data were available at each station. If the station is still operating (at the time this report was written), then the end date is “present”.

Station (agent #)	Daily temperature	Daily Rainfall
Auckland Aero (1962)	31/12/1965 – present	1/5/1962 – present
Blenheim Aero Aws (4326)	7/9/1990 – present	1/10/1990 – present
Blenheim Aero (4322)	31/12/1971 – 30/4/1986	1/6/1941 – 31/3/1987
Christchurch Aero (4843)	31/12/1953 – present	1/8/1943 – present
Dannevirke Ews (26958)	14/6/2007 – present	14/6/2007 – present
Dannevirke (2534)	31/12/1950 – 30/6/2015	1/1/1951 – 31/7/2015
Dunedin, Musselburgh Ews (15752)	8/8/1997 – present	8/8/1997 – present
Dunedin, Musselburgh (5402)	18/1/1947 – 31/8/1997	1/1/1918 – 31/8/1997
Gisborne Aws (2810)	12/12/1989 – present	12/12/1989 – present
Gisborne Aero (2807)	31/1/1940 – 28/2/1993	1/5/1937 – 27/4/2021
Gore Aws (5778)	11/7/1986 – present	13/7/1986 – present
Gore, Grasslands D.S.I.R. (5780)	31/12/1971 – 31/12/1986	1/10/1971 – 31/12/1986
Hamilton Aws (2112)	31/5/1990 – present	1/6/1990 – present
Hamilton Aero (2110)	31/12/1971 – 29/9/1988	1/3/1935 – 30/9/1988
Hokitika Aero (3909)	31/12/1963 – present	1/12/1963 – present
Invercargill Aero (5814)	31/5/1948 – present	1/9/1939 – present
Kerikeri Ews (1056)	30/9/1981 – present	1/10/1981 – present
Lake Tekapo, Air Safaris (4970)	31/12/1927 – present	1/5/1925 – present

Station (agent #)	Daily temperature	Daily Rainfall
Masterton Aero Aws (36735)	27/2/2009 – present	27/2/2009 – present
Masterton, Te Ore Ore (7578)	31/12/1992 – 30/9/2009	1/9/1992 – 30/9/2009
Milford Sound Aws (18309)	18/7/2000 – present	18/7/2000 – present
Milford Sound (4107)	31/12/1933 – 9/10/2019	1/12/1929 – 9/10/2019
Napier Ews (41330)	13/5/2016 – present	13/5/2016 – present
Napier Nelson Pk (2997)	31/12/1939 – 28/2/2016	1/1/1870 – 29/2/2016
Nelson Aws (4271)	7/2/1992 – present	31/12/1981 – present
Nelson Aero (4241)	31/3/1943 – present	1/6/1941 – present
New Plymouth Aws (2283)	2/12/1991 – present	19/1/1982 – present
New Plymouth Aero (2282)	31/12/1943 – 31/12/1991	1/1/1944 – 26/10/2021
Queenstown Aero Aws (5451)	19/6/1991 – present	1/1/1982 – present
Queenstown Aero (5450)	31/12/1971 – 20/9/1992	1/9/1968 – 24/8/1993
Reefton Ews (3925)	31/12/1971 – present	1/8/1960 – present
Rotorua Aero Aws (1770)	19/12/1991 – present	31/12/1981 – present
Rotorua Aero 2 (1768)	31/12/1971 – 31/12/1991	11/12/1963 – 31/12/1991
Tara Hills Aws (5212)	30/4/1985 – present	21/4/1985 – present
Omarama, Tara Hills (5211)	23/10/1949 – 31/12/1985	1/11/1949 – 31/12/1985
Taumarunui Aws (35135)	21/12/2007 – present	20/12/2007 – present
Taumarunui (2250)	30/4/1947 – 21/11/2016	1/9/1913 – 30/11/2016
Taupo Aws (1858)	31/5/1990 – present	1/6/1990 – present
Taupo Aero (1856)	31/12/1975 – 7/12/1989	1/2/1976 – 11/8/1997
Tauranga Aero Aws (1615)	31/12/1990 – present	1/6/1990 – present
Tauranga Aero (1612)	31/1/1941 – 28/2/1989	1/1/1910 – 31/1/1996
Timaru Aero Aws (5086)	3/6/1990 – present	4/6/1990 – present
Timaru Aero (5084)	31/12/1971 – 30/11/1989	1/9/1956 – 30/11/1989
Waiouru Ews (41329)	14/1/2016 – present	14/1/2016 – present
Waiouru Treatment Plant (3629)	31/12/1971 – 28/2/2022	1/6/1950 – 28/2/2022
Wellington, Kelburn Aws (25354)	28/4/2004 – present	29/4/2004 – present
Wellington, Kelburn (3385)	31/12/1930 – 31/8/2005	3/12/1927 – 31/10/2005
Whanganui, Spriggens Park Ews (3715)	31/12/1971 – present	1/5/1937 – present
Whangaparaoa Aws (1400)	30/9/1999 – present	6/12/1986 – present
Whangarei Aero Aws (1287)	9/8/1990 – present	9/8/1990 – present
Whangarei Aero (1283)	31/8/1967 – 12/3/1988	1/8/1943 – 12/3/1988

8.1.2 Stations selected – wind

Note: If more than one primary station is listed for a given location, then these data were merged (i.e., the data record was extended back in time) according to the methods outlined in Section 3.4. Bolded entries to the table below indicate changes from the previous iteration of this dataset update (Macara et al., 2020).

Location	Primary station (agent #)	Stations used for infill (agent #)
Auckland	Auckland Aero (1962)	Pukekohe Ews (2006)
Blenheim	Blenheim Aero Aws (4326) Blenheim Aero (4322)	Awatere Valley, Dashwood Raws (18468). Vernon Lagoon (4411).
Christchurch	Christchurch Aero (4843)	Christchurch, Kyle St Ews (24120). Winchmore Ews (4764). Timaru Aero Aws (5086).
Dannevirke	Dannevirke Ews (26958)	Waione Raws (12636).
Dunedin	Dunedin, Musselburgh Ews (15752) Dunedin, Musselburgh (5402)	N/A.
Gisborne	Gisborne Aws (2810) Gisborne Aero (2807)	Gisborne Ews (24976). Napier Aero Aws (2980). Napier Aero (2977).
Gore	Gore Aws (5778)	Invercargill Aero Aws (11104). Invercargill Aero (5814).
Hamilton	Hamilton Aws (2112) Hamilton Aero (2110)	Hamilton, Ruakura Ews (12616). Hamilton, Ruakura 2 Ews (26117). Pukekohe Ews (2006). Tauranga Aero (1612).
Hokitika	Hokitika Aws (3910) Hokitika Aero (3909)	Westport Aero Aws (7342). Greymouth Aero Ews (23934).
Invercargill	Invercargill Aero Aws (11104) Invercargill Aero (5814)	Tiwai Point Ews (5823).
Kerikeri	Kerikeri Aerodrome Aws (37258)	Purerua Aws (1196). Kaikohe Aws (1134).
Lake Tekapo	Lake Tekapo Ews (24945)	Tara Hills Aws (5212).
Masterton	Masterton Aero Aws (36735)	Masterton Ews (40984)
Milford Sound	Milford Sound Aws (18309) Milford Sound (4107)	N/A.
Napier	Napier Aero Aws (2980) Napier Aero (2977)	Whakatane Ews (15876). Gisborne Aws (2810). Gisborne Aero (2807).
Nelson	Nelson Aws (4271) Nelson Aero (4241)	N/A.
New Plymouth	New Plymouth Aws (2283) New Plymouth Aero (2282)	Cape Egmont (3497). Hawera Aws (25222). Stratford Ews (23872).
Queenstown	Queenstown Aero Aws (5451) Queenstown Aero (5450)	Cromwell Ews (26381).
Reefton	Reefton Ews (3925)	N/A.
Rotorua	Rotorua Aero Aws (1770) Rotorua Aero 2 (1768)	Whakatane Aero Aws (1673). Whakatane Aero (1672).
Tara Hills	Tara Hills Aws (5212)	Pukaki Aerodrome Aws (36596). Lake Tekapo Ews (24945). Mt Cook Ews (18125).

Location	Primary station (agent #)	Stations used for infill (agent #)
Taumarunui	Taumarunui Aws (35135)	N/A.
Taupo	Taupo Aws (1858) Taupo Aero (1856)	Rotorua Aero Aws (1770). Rotorua Aero 2 (1768). Turangi 2 Ews (25643).
Tauranga	Tauranga Aero Aws (1615) Tauranga Aero (1612)	Rotorua Aero Aws (1770). Rotorua Aero 2 (1768). Pukekohe Ews (2006).
Timaru	Timaru Aero Aws (5086) Timaru Aero (5084)	Oamaru Aws (25937). Ashburton Aero Aws (26170). Orari Estate Ews (35704). Christchurch Aero (4843).
Waiouru	Waiouru Airstrip Aws (39148)	N/A.
Wellington	Wellington, Kelburn Aws (25354) Wellington, Kelburn (3385)	Wellington Aero (3445)
Whanganui	Whanganui, Spriggens Park Ews (3715)	Whanganui Aws (3719). Palmerston North Aws (3243).
Whangaparaoa	Whangaparaoa Aws (1400)	Auckland, North Shore Albany Ews (37852).
Whangarei	Whangarei Aero Aws (1287) Whangarei Aero (1283)	Warkworth (1374). Leigh 2 Ews (1340).

The following table shows the period of time for which daily maximum wind gust data were available at each station. If the station is still operating (at the time this report was written), then the end date is “present”.

Station (agent #)	Stations used for infill (agent #)
Ashburton Aero Aws (26170)	11/2/2006 – present
Auckland Aero (1962)	1/7/1971 – present
Auckland, North Shore Albany Ews (37852)	23/12/2009 – present
Awatere Valley, Dashwood Raws (18468)	10/8/2000 – 11/9/2013
Blenheim Aero (4322)	1/1/1972 – 31/3/1987
Blenheim Aero Aws (4326)	15/9/1990 – present
Cape Egmont (3497)	1/1/1972 – 1/8/1985
Christchurch Aero (4843)	1/1/1972 – present
Christchurch, Kyle St Ews (24120)	1/11/2002 – present
Cromwell Ews (26381)	6/4/2006 – present
Dannevirke Ews (26958)	14/6/2007 – present
Dunedin, Musselburgh (5402)	1/7/1981 – 10/8/1997
Dunedin, Musselburgh Ews (15752)	8/8/1997 – present
Gisborne Aero (2807)	1/1/1972 – 31/12/1991
Gisborne Aws (2810)	1/6/1990 – present
Gisborne Ews (24976)	30/12/2012 – present
Gore Aws (5778)	13/7/1986 – present
Greymouth Aero Ews (23934)	29/1/2008 – present
Hamilton Aero (2110)	1/7/1978 – 29/9/1988

Station (agent #)	Stations used for infill (agent #)
Hamilton Aws (2112)	1/6/1990 – present
Hamilton, Ruakura Ews (12616)	25/10/1996 – 27/2/2007
Hamilton, Ruakura 2 Ews (26117)	10/11/2005 – present
Hawera Aws (25222)	29/1/2004 – present
Hokitika Aero (3909)	1/1/1972 – 27/3/2006
Hokitika Aws (3910)	17/10/1991 – present
Invercargill Aero (5814)	1/1/1972 – 26/11/2009
Invercargill Aero Aws (11104)	2/2/1995 – present
Kaikohe Aws (1134)	15/11/1985 – present
Kerikeri Aerodrome Aws (37258)	1/7/2009 – present
Lake Tekapo Ews (24945)	19/6/2003 – present
Leigh 2 Ews (1340)	1/1/1973 – present
Masterton Aero Aws (36735)	1/3/2009 – present
Masterton Ews (40984)	17/10/2015 - present
Milford Sound (4107)	1/10/1973 – 12/3/1996
Milford Sound Aws (18309)	1/5/2007 – present
Mt Cook Ews (18125)	30/3/2000 – present
Napier Aero (2977)	1/11/1973 – 31/12/1989
Napier Aero Aws (2980)	3/10/1990 – present
Nelson Aero (4241)	1/1/1972 – 31/12/1991
Nelson Aws (4271)	30/11/1991 – present
New Plymouth Aero (2282)	1/1/1972 – 31/12/1991
New Plymouth Aws (2283)	2/11/1991 – present
Oamaru Aws (25937)	22/9/2005 – present
Orari Estate Ews (35704)	10/7/2008 – 23/3/2021
Palmerston North Aws (3243)	1/9/1991 – present
Pukaki Aerodrome Aws (36596)	23/12/2008 - present
Pukekohe Ews (2006)	21/2/1986 - present
Purerua Aws (1196)	9/11/2013 – present
Queenstown Aero (5450)	1/1/1972 – 20/9/1992
Queenstown Aero Aws (5451)	29/10/1991 – present
Reefton Ews (3925)	21/4/1999 – present
Rotorua Aero Aws (1770)	16/11/1991 – present
Rotorua Aero 2 (1768)	1/1/1972 – 31/12/1991
Stratford Ews (23872)	13/6/2002 – present
Tara Hills Aws (5212)	21/4/1985 – present
Taumarunui Aws (35135)	31/1/2008 – present
Taupo Aero (1856)	21/12/1981 – 30/11/1989
Taupo Aws (1858)	1/6/1990 – present

Station (agent #)	Stations used for infill (agent #)
Tauranga Aero (1612)	1/3/1973 – 28/2/1989
Tauranga Aero Aws (1615)	1/6/1990 – present
Timaru Aero (5084)	1/1/1972 – 30/11/1989
Timaru Aero Aws (5086)	4/6/1990 – present
Tiwai Point Ews (5823)	2/2/1971 – present
Turangi 2 Ews (25643)	6/3/2003 – present
Vernon Lagoon (4411)	1/2/1973 – 30/6/1984
Waione Raws (12636)	5/9/1996 – 20/6/2017
Waiouru Airstrip Aws (39148)	2/7/2011 – present
Warkworth (1374)	1/4/1972 – 30/9/1999
Wellington Aero (3445)	1/1/1972 – present
Wellington, Kelburn (3385)	1/1/1972 – 31/12/2008
Wellington, Kelburn Aws (25354)	13/7/2004 – present
Westport Aero Aws (7342)	13/10/1991 – present
Whakatane Aero (1672)	1/12/1974 – 29/11/1988
Whakatane Aero Aws (1673)	6/8/1990 – present
Whakatu Ews (15876)	12/9/1997 - present
Whanganui Aws (3719)	14/12/2012 – present
Whanganui, Spriggens Park Ews (3715)	29/2/1996 – present
Whangaparaoa Aws (1400)	29/2/2012 – present
Whangarei Aero (1283)	1/3/1973 – 12/3/1988
Whangarei Aero Aws (1287)	10/8/1990 – present
Winchmore Ews (4764)	1/8/1970 – 26/8/2017

8.2 Regression analyses

8.2.1 Temperature

The following table shows the regression equation and associated R² value for analyses pertaining to daily maximum temperature (Tmax) and daily minimum temperature (Tmin).

Original	Comparison	Variable	Regression	R ²
Auckland Aero	VCSN	Tmax	1.0274x - 0.6797	0.9812
		Tmin	0.9844x + 0.6127	0.9690
Blenheim Aero Aws	VCSN	Tmax	1.0511x - 0.6967	0.9874
		Tmin	1.0264x - 0.9808	0.9698
Blenheim VCSN adjusted	Blenheim Aero	Tmax	1.0249x - 0.2081	0.9863
		Tmin	0.9605x - 0.1853	0.9781
Christchurch Aero	VCSN	Tmax	1.0165x - 0.3958	0.9919
		Tmin	1.0652x - 0.7250	0.9670
Dannevirke Ews	Dannevirke	Tmax	0.9999x - 0.6163	0.9353
		Tmin	0.9581x + 0.0477	0.8715
Dannevirke merged	VCSN	Tmax	1.0114x - 0.6818	0.9821
		Tmin	1.0015x - 0.1693	0.9714
Dunedin, Musselburgh Ews	Dunedin, Musselburgh	Tmax	1.0028x + 0.3559	0.9958
		Tmin	1.0197x + 0.0199	0.9474
Dunedin merged	VCSN	Tmax	0.9519x + 1.3848	0.9746
		Tmin	0.9868x + 1.6624	0.9511
Gisborne Aws	Gisborne Aero	Tmax	1.0049x - 0.2434	0.9793
		Tmin	0.982x - 0.0311	0.9626
Gisborne merged	VCSN	Tmax	1.0235x - 0.2847	0.9870
		Tmin	1.0313x - 0.5921	0.9775
Gore Aws	Gore, Grasslands D.S.I.R.	Tmax	1.0421x - 0.7803	0.9808
		Tmin	1.0371x - 0.4421	0.9719
Gore merged	VCSN	Tmax	1.0144x - 0.9948	0.9604
		Tmin	1.0001x + 0.1465	0.9165
Hamilton Aws	VCSN	Tmax	1.0083x - 0.2361	0.9932
		Tmin	1.0117x - 0.3376	0.9839
Hamilton VCSN adjusted	Hamilton Aero	Tmax	0.9981x - 0.1863	0.9919
		Tmin	0.945x + 1.046	0.9702
Hokitika Aero	VCSN	Tmax	1.005x - 0.2597	0.9893
		Tmin	1.0071x - 0.1422	0.9805
Invercargill Aero	VCSN	Tmax	1.0019x - 0.1178	0.9926
		Tmin	1.0445x - 0.5292	0.9730
Kerikeri Ews	VCSN	Tmax	0.9943x + 0.4399	0.9809
		Tmin	1.0446x - 0.9049	0.9697

Original	Comparison	Variable	Regression	R ²
Lake Tekapo, Air Safaris	VCSN	Tmax	1.0198x - 0.343	0.9834
		Tmin	1.0248x - 0.0909	0.9640
Masterton Aero Aws	Masterton, Te Ore Ore	Tmax	0.8765x + 1.3175	0.9144
		Tmin	0.8772x + 1.3401	0.8385
Masterton merged	VCSN	Tmax	1.0108x - 0.2253	0.9650
		Tmin	0.9759x - 0.3456	0.9389
Milford Sound Aws	Milford Sound	Tmax	1.1060x - 1.4236	0.9702
		Tmin	1.0191x - 0.1462	0.9775
Milford Sound merged	VCSN	Tmax	1.0564x - 0.0422	0.9758
		Tmin	1.0442x + 0.2170	0.9842
Napier Ews	VCSN	Tmax	1.0220x - 0.0379	0.9853
		Tmin	1.0841x - 0.0850	0.9668
Napier VCSN adjusted	Napier Nelson Pk	Tmax	1.0094x - 0.2107	0.9764
		Tmin	1.0154x - 0.1590	0.9657
Nelson Aws	Nelson Aero	Tmax	0.9956x + 0.0077	0.9747
		Tmin	0.9525x + 0.7865	0.9779
Nelson merged	VCSN	Tmax	0.9560x + 0.3738	0.9730
		Tmin	1.0036x + 0.8206	0.9731
New Plymouth Aws	New Plymouth Aero	Tmax	0.9925x - 0.0711	0.9876
		Tmin	0.9516x + 0.6217	0.9490
New Plymouth merged	VCSN	Tmax	0.9854x + 0.079	0.9864
		Tmin	1.0198x - 0.0749	0.9797
Queenstown Aero Aws	Queenstown Aero	Tmax	0.9883x - 0.1091	0.9852
		Tmin	0.9652x + 0.4059	0.9314
Queenstown merged	VCSN	Tmax	0.9924x - 1.0493	0.9877
		Tmin	1.0000x - 0.8082	0.9742
Reefton Ews	VCSN	Tmax	1.0358x - 0.3053	0.9834
		Tmin	1.0382x - 0.1874	0.9805
Rotorua merged	VCSN	Tmax	0.9954x + 0.0268	0.9930
		Tmin	1.0218x + 0.0353	0.9829
Tara Hills Aws	Omarama, Tara Hills	Tmax	0.9868x + 0.1704	0.9946
		Tmin	1.0846x - 0.8239	0.9836
Tara Hills merged	VCSN	Tmax	1.0056x - 0.3937	0.9766
		Tmin	1.0353x - 1.1009	0.9167
Taumarunui Aws	Taumarunui	Tmax	1.0551x - 0.7097	0.9695
		Tmin	1.0341x - 1.1919	0.9345
Taumarunui merged	VCSN	Tmax	1.0879x - 0.8785	0.9801
		Tmin	1.0711x - 1.1896	0.9649

Original	Comparison	Variable	Regression	R ²
Taupo Aws	VCSN	Tmax	$1.0073x - 0.2317$	0.9936
		Tmin	$1.0352x - 0.2347$	0.9790
Taupo VCSN adjusted	Taupo Aero	Tmax	$1.0072x + 0.0708$	0.9891
		Tmin	$0.9422x + 0.401$	0.9639
Tauranga Aero Aws	VCSN	Tmax	$1.0091x - 0.1269$	0.9881
		Tmin	$1.0152x + 0.1908$	0.9817
Tauranga VCSN adjusted	Tauranga Aero	Tmax	$0.9851x + 0.3878$	0.9910
		Tmin	$0.9738x + 0.8474$	0.9768
Timaru Aero Aws	VCSN	Tmax	$1.0257x - 0.3765$	0.9877
		Tmin	$1.0351x - 0.913$	0.9726
Timaru VCSN adjusted	Timaru Aero	Tmax	$1.0021x + 0.1895$	0.9878
		Tmin	$0.9701x + 0.1962$	0.9751
Waiouru Ews	Waiouru Treatment Plant	Tmax	$0.9873x - 0.1391$	0.9909
		Tmin	$0.9868x + 0.2285$	0.9627
Waiouru merged	VCSN	Tmax	$0.9933x - 0.2611$	0.9759
		Tmin	$1.0098x + 0.0978$	0.9575
Wellington, Kelburn Aws	Wellington, Kelburn	Tmax	$1.0001x + 0.0345$	0.9952
		Tmin	$0.9862x + 0.2154$	0.9822
Wellington merged	VCSN	Tmax	$1.0369x - 0.8931$	0.9801
		Tmin	$0.9365x + 0.628$	0.9709
Whanganui, Spriggens Park Ews	VCSN	Tmax	$0.9563x + 0.8499$	0.9415
		Tmin	$0.9622x + 1.3004$	0.9498
Whangaparaoa Aws	VCSN	Tmax	$1.0341x - 0.8954$	0.9605
		Tmin	$0.7832x + 3.6216$	0.8377
Whangarei Aero Aws	VCSN	Tmax	$1.023x - 0.3638$	0.9917
		Tmin	$1.0244x - 0.2621$	0.9878
Whangarei VCSN adjusted	Whangarei Aero	Tmax	$1.0069x + 0.2549$	0.9906
		Tmin	$1.0274x - 0.7773$	0.9752

8.2.2 Rainfall

The following table shows the regression equation and associated R² value for analyses pertaining to daily rainfall.

Original	Comparison	Regression	R ²
Auckland Aero	VCSN	0.886x + 0.119	0.9316
Blenheim Aero Aws	VCSN	0.9696x + 0.0825	0.9779
Blenheim VCSN adjusted	Blenheim Aero	0.9726x - 0.0355	0.968
Christchurch Aero	VCSN	0.9545x + 0.0451	0.9619
Dannevirke Ews	Dannevirke	0.9900x - 0.0552	0.9752
Dannevirke merged	VCSN	0.9307x + 0.1914	0.8929
Dunedin, Musselburgh Ews	Dunedin, Musselburgh	0.8905x - 0.0799	0.9903
Dunedin merged	VCSN	0.757x + 0.1235	0.9274
Gisborne Aws	Gisborne Aero	0.9568x + 0.1709	0.9389
Gisborne merged	VCSN	0.9449x + 0.085	0.9677
Gore Aws	Gore, Grasslands D.S.I.R.	0.9635x - 0.0555	0.9544
Gore merged	VCSN	0.9164x + 0.0237	0.9444
Hamilton Aws	VCSN	0.9832x + 0.1165	0.9488
Hamilton VCSN adjusted	Hamilton Aero	0.9859x + 0.1377	0.9637
Hokitika Aero	VCSN	1.0041x + 0.062	0.966
Invercargill Aero	VCSN	0.9777x + 0.0683	0.9762
Kerikeri Ews	VCSN	0.9575x + 0.0938	0.9757
Lake Tekapo, Air Safaris	VCSN	0.8907x + 0.0502	0.9054
Masterton Aero Aws	Masterton, Te Ore Ore	0.8010x + 0.251	0.7351
Masterton merged	VCSN	0.8860x + 0.1823	0.9164
Milford Sound Aws	Milford Sound	0.9012x + 0.4875	0.9582
Milford Sound merged	VCSN	0.9620x - 0.0576	0.9916
Napier Ews	VCSN	0.9574x + 0.1013	0.9747
Napier VCSN adjusted	Napier Nelson Pk	0.9245x + 0.0505	0.9345
Nelson Aws	Nelson Aero	0.9145x + 0.0785	0.9682
Nelson merged	VCSN	0.8586x + 0.0474	0.9626
New Plymouth Aws	New Plymouth Aero	1.0044x + 0.1073	0.8841
New Plymouth merged	VCSN	0.9715x - 0.0248	0.9587
Queenstown Aero Aws	Queenstown Aero	0.9199x + 0.2377	0.6781
Queenstown merged	VCSN	0.863x + 0.1151	0.9059
Reefton Ews	VCSN	0.98x + 0.0797	0.9587
Rotorua Aero Aws	Rotorua Aero 2	0.9701x + 0.0681	0.8725
Rotorua merged	VCSN	0.974x - 0.0137	0.9404
Tara Hills Aws	Omarama, Tara Hills	1.0182x - 0.0622	0.9849

Original	Comparison	Regression	R ²
Tara Hills merged	VCSN	$0.9502x + 0.0578$	0.9543
Taumarunui Aws	Taumarunui	$0.8800x + 0.4996$	0.8396
Taumarunui merged	VCSN	$0.9426x + 0.3160$	0.9366
Taupo Aws	Taupo Aero	$0.9825x + 0.1083$	0.9726
Taupo merged	VCSN	$0.9099x + 0.1328$	0.9452
Tauranga Aero Aws	Tauranga Aero	$0.9973x + 0.1677$	0.8518
Tauranga merged	VCSN	$0.9384x + 0.025$	0.9623
Timaru Aero Aws	VCSN	$0.9374x + 0.1018$	0.9288
Timaru VCSN adjusted	Timaru Aero	$0.9499x + 0.0171$	0.9633
Waiouru Ews	Waiouru Treatment Plant	$1.0104x + 0.1748$	0.9431
Waiouru merged	VCSN	$0.9800x + 0.1628$	0.9100
Wellington, Kelburn Aws	Wellington, Kelburn	$1.0612x - 0.0073$	0.9947
Wellington merged	VCSN	$1.0544x + 0.1245$	0.9664
Whanganui, Spriggens Park Ews	VCSN	$0.9509x - 0.0131$	0.9631
Whangaparaoa Aws	VCSN	$0.7936x + 0.1598$	0.7339
Whangarei Aero Aws	VCSN	$0.9031x - 0.0281$	0.9156
Whangarei VCSN adjusted	Whangarei Aero	$0.9318x + 0.5123$	0.9033

8.2.3 Wind

The following table shows the regression equation and associated R² value for analyses pertaining to daily maximum wind gusts.

Original	Comparison	Regression	R ²
Auckland Aero	Pukekohe Ews	1.1632x + 0.8444	0.7194
Blenheim Aero Aws	Awatere Valley, Dashwood Raws	0.7211x + 8.8914	0.5822
Blenheim Aero Aws	Vernon Lagoon	0.7185x + 9.4021	0.5811
Christchurch Aero	Christchurch, Kyle St Ews	1.1133x + 1.4372	0.7896
Christchurch Aero	Winchmore Ews	0.748x + 15.01	0.5567
Christchurch Aero	Timaru Aero Aws	0.7116x + 17.773	0.5339
Dannevirke Ews	Waione Raws	0.9509x + 5.5802	0.7036
Dunedin, Musselburgh Ews	N/A		
Gisborne Aws	Gisborne Aero	0.727x + 2.6443	0.8752
Gisborne merged	Gisborne Ews	0.9874x + 5.7799	0.7841
Gisborne merged	Napier merged	0.5208x + 14.251	0.5054
Gore Aws	Invercargill Aero Aws	0.7068x + 9.6594	0.5628
Gore Aws	Invercargill Aero	0.6725x + 10.449	0.5462
Hamilton merged	Hamilton, Ruakura merged	0.9857x + 1.2541	0.7757
Hamilton merged	Pukekohe Ews	0.9527x + 3.0601	0.6463
Hamilton merged	Tauranga Aero	0.761x + 8.7333	0.5906
Hokitika Aws	Hokitika Aero	0.9196x - 0.123	0.9751
Hokitika merged	Westport Aero Aws	0.703x + 7.3943	0.5857
Hokitika merged	Greymouth Aero Ews	0.6659x + 8.6618	0.5159
Invercargill Aero Aws	Invercargill Aero	0.9671x + 0.8112	0.9808
Invercargill merged	Tiwai Point Ews	0.7909x + 5.5335	0.806
Kerikeri Aerodrome Aws	Purerua Aws	0.7722x + 9.9044	0.7433
Kerikeri Aerodrome Aws	Kaikohe Aws	0.6706x + 12.648	0.6573
Lake Tekapo Ews	Tara Hills Aws	0.9352x + 5.7594	0.6688
Masterton Aero Aws	Masterton Ews	1.0935x + 1.537	0.8220
Milford Sound merged	N/A		
Napier merged	Whakatu Ews	0.9674x + 4.931	0.7066
Napier merged	Gisborne merged	0.9704x + 6.7718	0.5054
Nelson Aws	Nelson Aero	0.9508x + 1.8322	0.9496
New Plymouth Aws	New Plymouth Aero	0.8325x + 6.3847	0.9193
New Plymouth merged	Cape Egmont	0.616x + 14.135	0.6518
New Plymouth merged	Hawera Aws	0.8499x + 6.0639	0.6403
New Plymouth merged	Stratford Ews	0.9192x + 8.4163	0.6277

Original	Comparison	Regression	R ²
Queenstown Aero Aws	Queenstown Aero	0.8168x + 3.8202	0.8863
Queenstown merged	Cromwell Ews	0.7049x + 13.159	0.5027
Reefton Ews	N/A		
Rotorua merged	Whakatane merged	0.7859x + 9.1352	0.6328
Tara Hills Aws	Pukaki Aerodrome Aws	0.7871x + 8.0831	0.6881
Tara Hills Aws	Lake Tekapo Ews	0.7151x + 8.624	0.6688
Tara Hills Aws	Mt Cook Ews	0.5221x + 13.332	0.5841
Taumarunui Aws	N/A		
Taupo merged	Rotorua merged	0.8461x + 6.208	0.6268
Taupo merged	Turangi 2 Ews	0.5821x + 16.499	0.5248
Tauranga merged	Rotorua merged	0.818x + 8.0926	0.6184
Tauranga merged	Pukekohe Ews	0.9185x + 7.5079	0.5586
Timaru merged	Oamaru Aws	0.9113x + 1.0142	0.6597
Timaru merged	Ashburton Aero Aws	0.7835x + 3.2229	0.6395
Timaru merged	Orari Estate Cws	1.0017x + 6.5397	0.5687
Timaru merged	Christchurch Aero	0.7591x + 3.4957	0.5216
Waiouru Airstrip Aws	N/A		
Wellington, Kelburn Aws	Wellington, Kelburn	0.9889x + 2.2237	0.9062
Wellington merged	Wellington Aero	1.0201x + 5.9986	0.7855
Whanganui, Spriggens Park Ews	Whanganui Aws	0.7416x + 4.8577	0.8831
Whanganui, Spriggens Park Ews	Palmerston North Aws	0.6685x + 11.167	0.5094
Whangaparaoa Aws	Auckland, North Shore Albany Ews	1.4297x - 0.8525	0.735
Whangarei merged	Warkworth	0.6489x + 9.2573	0.6214
Whangarei merged	Leigh 2 Ews	0.6526x + 10.668	0.6061