

Title of dataset	Daily temperature time series, 1909 - 2019
Variables	<p>Dataset: daily_temperature_station</p> <p>location_name: NIWA station location</p> <p>date: Measurement date</p> <p>statistic: Measured parameter - maximum daily temperature (maximum), mean daily temperature (average), and minimum daily temperature (minimum).</p> <p>temperature: Temperature measurement for a given statistic in degree Celsius (°C)</p> <p>station_name_niwa: NIWA station name</p> <p>agent_number: NIWA station identifier</p> <p>Dataset: annual_and_seasonal_temperature_national_timeseries</p> <p>year: Measurement year</p> <p>temperature: Temperature measurement in degree Celcius</p> <p>data_released: Year data released</p> <p>source: Data source</p> <p>anomaly: Deviation from reference-period measurements</p> <p>reference_period: Reference period</p>
Environmental reporting topic	<p>Temperature is a direct measure of the 'Climate' topic.</p> <p>Frost and warm days is a direct measure of the 'Climate' topic.</p> <p>Growing degree days is a direct measure of the 'Climate' topic.</p>
Environmental reporting category	The accuracy of the data source is of high quality.
Environmental report	Our atmosphere and climate 2020
Relevant measure on the Stats NZ Tauranga Aotearoa, Environment website	<p>Temperature</p> <p>Frost and warm days</p> <p>Growing degree days</p>

<p>Other data and reports which relate to this measure</p>	<p>Related indicators</p> <p>Temperature</p> <p>Growing degree days</p> <p>Frost and warm days</p> <p>Global greenhouse gas emissions</p> <p>El Niño Southern Oscillation</p> <p>Interdecadal Pacific Oscillation</p> <p>Southern Annular Mode</p> <p>Sea-surface temperature</p> <p>Greenhouse gas concentrations</p> <p>Drought</p> <p>Related content</p> <p>Our atmosphere and climate 2020</p> <p>Environment Aotearoa 2019</p> <p>Our atmosphere and climate 2017</p> <p>Environment Aotearoa 2015</p> <p>‘Seven-station’ series temperature data</p> <p>Climate change 2013: The physical science basis</p> <p>Technical report</p> <p>Ministry for the Environment Atmosphere and Climate Report 2020: Updated Datasets supplied by NIWA</p>
<p>Methodology (collection & analyses)</p>	<p><i>New Zealand temperature</i></p> <p>NIWA’s ‘seven-station’ temperature series uses temperature measurements from seven ‘climate stations’: Auckland, Masterton, Wellington, Hokitika, Nelson, Lincoln, and Dunedin (Macara et al., 2020; NIWA, n.d.-b). These sites offer a representative latitudinal (north to south) spread with reliable records dating back to the early 1900s.</p> <p>For each site, NIWA merged temperature records from local sites to form a long time series. The data were adjusted for climatic differences between sites and changes in exposure or instrumentation at the same site. This prevents the introduction of significant biases with time.</p> <p>Reasons for climatic differences between sites include:</p> <ul style="list-style-type: none"> • altitude – higher elevations at a given location are generally colder than lower elevations (eg, in Wellington, the measuring site at

	<p>Kelburn is about 120 metres higher than the historic one at Thorndon)</p> <ul style="list-style-type: none"> proximity to the sea – the sea surrounding New Zealand has a moderating influence on air temperatures, such that coastal areas are typically warmer in winter and cooler in summer compared to inland locations. <p>This methodology has been reviewed nationally and internationally (NIWA, n.d.-a). See NIWA (n.d.-b) for further information on the temperature data homogenisation methodology, and adjustments for each of the seven climate stations and the combined seven station series.</p> <p>We also present the temperature anomaly. This is the difference from a baseline temperature which is typically calculated as the average of 30 years or more of temperature data. Observed temperatures greater than the baseline temperature are positive anomalies, while those less than the baseline are negative anomalies (National Oceanic and Atmospheric Administration, n.d.). Typically, the World Meteorological Organization (WMO) recommends a 1981 to 2010 baseline period to allow comparison among different datasets. However, in this case, we use the period 1961 to 1990 as it is “a standard reference period for long-term climate change assessments” (WMO, 2017). Such 30-year averages are known as climate normals – the conditions most likely to be experienced at a given location. The 1961 to 1990 climate normal period provides a benchmark against which historic and contemporary observations can be compared.</p> <p><i>Global land temperature</i></p> <p>Global mean annual ‘land surface only’ temperature anomaly data sources are:</p> <ul style="list-style-type: none"> Met Office Hadley Centre global anomaly: This data is derived from CRUTEM 4.6.0.0 dataset produced by the Met Office Hadley Centre, UK and the Climate Research Unit at the University of East Anglia (Jones et al., 2012). NOAA global anomaly: This data is derived from the Global Historical Climatology Network-Monthly (GHCN-M) (Global Historical Climatology Network - Monthly) (Menne, Williams, Gleason, Rennie, & Lawrimore, 2018; National Oceanic and Atmospheric Administration National Centers for Environmental information, 2020) NASA global land anomaly: This data is from the National Aeronautics and Space Administration (NASA), Goddard Institute for Space Studies GISS Surface Temperature Analysis (GISTEMP v4) (GISTEMP Team, 2020; Lenssen et al., 2019). <p>Global mean annual temperature anomalies (difference from baseline) are based on the same period (1961 to 1990) we have used for the New Zealand data. For further information on the global datasets and why they differ, see Hartmann et al. (2013).</p>
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	<p>Thirty Sites</p> <p>NIWA provided temperature data extracted from NIWA's National Climate Database (CLIDB) for 30 climate stations from at least 1972 to 2019 (Macara et al., 2020). In some cases it was possible to extend the series where older (mostly closed) climate stations were located very near to the location of a currently open station. This allowed the time series for some stations to go as far back as 1928 (eg, Lake Tekapo). Missing data, where records were not available for all days, were replaced using daily Virtual Climate Station Network (VCSN) data from 1972 onwards (Macara & Tait, 2015). As temperature data were only available for Kerikeri from 1981, Masterton from 1992, Taupō from 1975, and Whangaparāoa from 1999, data for these sites were extended back to 1972 using adjusted VCSN data.</p> <p>Criteria used to select the 30 climate stations are described in Macara et al. (2020). The climate data from these 30 stations are representative of the climate of the area from where they were measured. They more closely represent the climate where many people in each region live, rather than the climate of each region as a whole. Other indicators using the same 30 locations (but not necessarily the same climate stations) in this series are: frost and warm days, growing degree days, drought, wildfire risk, rainfall, extreme rainfall, and extreme wind.</p>
Limitations to data & analysis	
Changes to time series	
References	<p>GISTEMP Team. (2020). GISS Surface Temperature Analysis (GISTEMP) (Version 4) [Dataset]. NASA Goddard Institute for Space Studies. Retrieved from https://data.giss.nasa.gov/gistemp/</p> <p>Hartmann, D. L., Klein Tank, A. M. G., Rusticucci, M., Alexander, L. V., Brönnimann, S., Charabi, Y., ... Zhai, P. M. (2013). Observations: Atmosphere and Surface. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, ... P. M. Midgley (Eds.), <i>Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change</i> (pp. 159–254). Retrieved from https://www.ipcc.ch/report/ar5/wg1/</p> <p>Jones, P. D., Lister, D. H., Osborn, T. J., Harpham, C., Salmon, M., & Morice, C. P. (2012). Hemispheric and large-scale land-surface air temperature variations: An extensive revision and an update to 2010. <i>Journal of Geophysical Research: Atmospheres</i>, 117(5), 1–29. https://doi.org/10.1029/2011JD017139</p> <p>Lenssen, N.J., Schmidt, G.A., Hansen, J.E., Menne, M.J., Persin, A., Ruedy, R., & Zyss, D. (2019). Improvements in the GISTEMP uncertainty model.</p>

	<p><i>Journal of Geophysical Research: Atmospheres</i>, 124(12), 6307-6326. https://doi.org/10.1029/2018JD029522</p> <p>Macara, G., Nichol, S., Sutherland, D., Liley, B., Paul, V., & Srinivasan, R. (2020). <i>Ministry for the Environment Atmosphere and Climate Report 2020: Updated Datasets supplied by NIWA</i> (NIWA Client Report No. 2020100WN). Retrieved from https://www.mfe.govt.nz/publications/environmental-reporting/ministry-environment-atmosphere-and-climate-report-2020-updated</p> <p>Macara, G., & Tait, A. (2015). <i>Infilling of missing climate data: temperature, rainfall and wind</i> (NIWA Client Report No. WLG2015-33). Retrieved from https://data.mfe.govt.nz/document/21253-macara-g-tait-a-2015-infilling-of-missing-climate-data-for-the-2015-environmental-synthesis-report-temperature-rainfall-and-wind/</p> <p>Menne, M. J., Williams, C. N., Gleason, B. E., Rennie, J. J., & Lawrimore, J. H. (2018). The global historical climatology network monthly temperature dataset, version 4. <i>Journal of Climate</i>, 31(24), 9835-9854. https://doi.org/10.1175/JCLI-D-18-0094.1</p> <p>NIWA. (n.d.-a). <i>Review</i>. Retrieved from https://niwa.co.nz/our-science/climate/information-and-resources/nz-temp-record/review</p> <p>NIWA. (n.d.-b). <i>'Seven-station' series temperature data</i>. Retrieved from https://niwa.co.nz/our-science/climate/information-and-resources/nz-temp-record/seven-station-series-temperature-data</p> <p>National Oceanic and Atmospheric Administration National Centers for Environmental Information. (2020). <i>Climate at a Glance: Global Time Series</i> [Dataset]. Retrieved from https://www.ncdc.noaa.gov/cag/global/time-series</p> <p>World Meteorological Organization (2017). <i>WMO guidelines on the calculation of climate normals</i> (WMO-No. 1203). Retrieved from https://library.wmo.int/doc_num.php?explnum_id=4166</p>
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