Environment and Climate Change Canada   Environnement et Changement climatique Canada

Canadian Climate Normals 1961-1990

1.0 Introduction

"Normals" is the term commonly used for values of climatic elements averaged over a fixed, standard period of years. In the 1930's, the 30-year period from 1901 to 1930 was selected as the first international standard period. The selection of this number of years was somewhat arbitrary, however it was considered sufficiently long to eliminate year-to-year variations. In 1960 it was agreed that countries should continue to use 30-year periods, but that normals should be updated every decade rather than every 30 years, beginning with the period 1931 to 1960.

In Canada in the first part of this century there were a limited number of stations with observations over the 1901-1930 period. As a result, averages were computed based on all available data, rather than the normals period. The first set of 30-year normals was computed for the 1921-1950 period, using adding machines. Sets were produced after the end of each subsequent decade. The first computer for climate applications was installed in 1965, in part to facilitate normals production.

2.0 Climate elements

Except where labelled "extreme", values of the climate elements are averages for the 1961-1990 period, or for a portion of that period no shorter than 20 years. Extreme values are the highest or lowest occurrence for all years for which data were available. Extremes whose corresponding means are missing should be used with caution. They are often derived from less than twenty years of observations, and may not be indicative of occurrences which could be expected over longer periods.

The starting and ending dates for station observing programs are for the total period of observation, and hence refer to the period used to calculate the extreme values.

Symbols used with the data include "+" to indicate a value occurred more than once in a given period and "M" to indicate there are no data for the period. "N" or "X" indicates that some data do exist, but not enough to derive a value. See "Missing Data" below for more information. In cases where a "+" appears, dates given are for the most recent event. Where a "*" replaces a number in the "days with" section, the quantity is less than one.

In the following text, stations are categorized as either "ordinary" or "principal". The former are typically stations that record daily temperature and/or precipitation amounts. In contrast principal stations take hourly observations for all or parts of the day. In the following paragraphs, stations for which elements such as pressure, relative humidity and wind are included are usually principal.

2.1 Temperature

Temperatures are measured in a louvered box called a Stevenson screen, mounted 1.5 m above the ground, which is usually a level, grassy surface. At most ordinary stations the maximum temperature is the highest recorded in a 24-hour period ending in the morning of the next day. The minimum values are for a period of the same length, beginning in the evening of the previous day. Mean temperature is the average of the two. At most principal stations the maximum and minimum temperatures are for a day beginning at 0600 Greenwich (or Universal) Mean Time, which is within a few hours of midnight local standard time in Canada.

Dry-bulb temperature, like daily maximum and minimum temperatures, is measured in the Stevenson screen, which protects the thermometers from direct sunlight. Dry-bulb temperatures are recorded hourly at principal climate stations. Values given are hourly averages for each month and year, for all hours combined, and for each individual hour.

2.2 Degree-days

Degree-days for a given day represent the number of degrees Celsius that the mean temperature is above or below a given base. For example, heating degree-days are the number of degrees below 18°C. If the temperature is equal to or greater than 18°C, then the number will be zero. Values above or below the base of 18°C are used primarily to estimate the heating and cooling requirements of buildings. Values above 5°C are frequently called growing degree-days, and are used in agriculture as an index of crop growth. Values in the tables represent the average accumulation of degree-days, above or below a selection of base temperatures, for a given month or year.

2.3 Season of minimum temperature above 0°C

Averages and extremes are given for the beginning and ending dates of the annual cycle in which the minimum temperature, measured in the Stevenson screen 1.5 m above ground, rises above 0°C and remains there for an extended period. The values shown are based on dates for each year for which data are available. These data are often used in agricultural applications. Caution is advised since minimum temperatures at ground level are usually colder.

2.4 Precipitation

Rain, drizzle, freezing rain, freezing drizzle and hail are usually measured using the standard Canadian rain gauge, a cylindrical container 40 cm high and 11.3 cm in diameter. The precipitation is funneled into a plastic graduate which serves as the measuring device.

Snowfall is the measured depth of newly fallen snow, measured using a snow ruler. Measurements are made at several points which appear representative of the immediate area, and then averaged. "Precipitation" in the tables is the water equivalent of all types of precipitation.

At most ordinary stations the water equivalent of snowfall is computed by dividing the measured amount by ten. At principal stations it is usually determined by melting the snow that falls into Nipher gauges. These are precipitation gauges designed to minimize turbulence around the orifice, and to be high enough above the ground to prevent most blowing snow from entering. The amount of snow as determined by this method normally provides a more accurate estimate of precipitation than using the "ten-to-one" rule. Even at ordinary stations the normals precipitation values will not always be equal to rainfall plus one tenth snowfall. Missing observations is one cause of such discrepancies.

Precipitation measurements are usually made four times daily at principal stations. At ordinary sites they are usually made once or twice per day. Rainfall, snowfall and precipitation amounts given represent the average accumulation for a given month or year.

2.5 Snow cover

Snow cover is the depth of accumulated snow on the ground, measured at several points, which appear representative of the immediate area, and then averaged. End-of-month values are given.

2.6 Number of days with specified parameters

These give the average number of days per month or year on which a specific meteorological event occurs.

- In the case of rainfall and precipitation, 0.2 mm or more must occur before a "day with" is counted. The corresponding figure for snowfall is 0.2 cm.
- A day with freezing precipitation is counted if there is an occurrence of 0.2 mm or more of rain or drizzle, which turns to ice on contact with the underlying surface.
- Fog for this purpose is defined as a suspension of very small water droplets reducing the horizontal visibility to less than 1 km.
- A day with thunderstorms occurs if thunder is heard.
- Days with smoke/haze, blowing dust or blowing snow are counted if the horizontal visibility is reduced to 10 km or less by these elements.
- A day with hail is counted when hail, ice pieces 5 mm or more in diameter, occur at the observing site.

2.7 Pressure

Station pressure is the force exerted on the earth's surface by a column of air of unit cross-sectional area extending from the surface of the earth to the outer limit of the atmosphere. It is given in kilopascals: one kilopascal is equal to 10 millibars, 0.2953 inches of mercury, or 0.145 pounds per square inch. The standard instrument for the measurement of atmospheric pressure is the mercury barometer, in which the air pressure is balanced against the weight of a column of mercury in a glass tube that contains a vacuum.

Sea level pressure is computed by adding to the observed station pressure the equivalent weight of an air column extending from sea level to the station elevation.

Values are monthly averages computed from individual hourly observations.

2.8 Moisture

Vapour pressure is the pressure exerted by the moisture in the air. It increases with both atmospheric temperature and moisture content. It is related to relative humidity in that the latter is the ratio of the actual value of vapour pressure to its value if the air were saturated at the same temperature. For a note on the unit of measurement, see the section on station pressure.

Relative humidity and vapour pressure are derived from standard air temperature measurements, and directly measured moisture parameters, such as wet-bulb temperature. Dew-point temperature, similarly derived, is also an indicator of moisture in the air.

2.9 Wind

The majority of wind measurements are made by anemometers installed at ten meters above the ground. A substantial minority of sites have instruments installed at other heights, usually greater than ten meters. Wind in the first ten's of meters above the ground tends to increase in speed and veer with height.

Winds are normally measured at level, open sites removed as much as possible from obstacles to wind flow such as trees, buildings, or hills. At the majority of principal stations, wind is measured by taking a one- or (since 1985) two-minute mean at each observation, from a U2A anemometer. At other wind-measuring sites, values are usually obtained from autographic records of U2A or 45B anemometers. Averaging periods may vary from one minute to an hour. Winds measured by U2A's are recorded to the nearest ten degrees, while those from the 45B provide them to eight points of the compass. The extreme gust speed is the instantaneous peak wind observed from the anemometer dials, or abstracted from a continuous chart recording.

Where directions were measured more precisely than eight points, they have been converted to this format. The direction is defined as that from which the wind blows.

2.10 Sunshine and solar radiation

In Canada, bright sunshine observations are made using the Campbell-Stokes sunshine recorder, first developed in 1863. It consists of a 10 cm glass sphere which focuses sunlight on a card calibrated in hours. Sunlight burns a trace on the card, allowing the observer to determine to the nearest tenth of an hour the amount of sunshine that occurs on a given day. It should be noted that the recorder measures only "bright" sunshine, which is less than "visible" sunshine. For example, sunshine immediately after sunrise and just before sunset would not be bright enough to register. Values given are the totals for each month and year.

Solar radiation, which is a measure of the sun's electro-magnetic energy, is available for a small number of stations across Canada. These data are presented for each measured radiation field, namely, global (RF1), diffuse (RF2), reflected (RF3), and net (RF4) radiation.

2.11 Visibility and cloud cover

The number of hours (or observations) in three classes, of visibility in kilometers (< 1 km, 1-9 km, > 9 km), and cloud cover in tenths of sky covered (0-2/10, 3-7/10, 8-10/10), are computed for principal stations.

2.12 Soil temperature

Monthly averages of soil temperatures measured at a selection of standard depths (5, 10, 20, 50, 100, 150 and 300 cm) are given. Morning and afternoon averages are also given for depths of 5, 10 and 20 cm.

2.13 Evaporation

Monthly averages of calculated lake evaporation (mm) derived from evaporation pan measurements are given. Lake evaporation represents water loss from ponds and small reservoirs but not large lakes. Lake evaporation tends in general to be about a third less than measured pan evaporation.

3.0 Accuracy and representativeness of data

The normals values are derived from data in the National Archive System of Environment and Climate Change Canada. While considerable effort is made to ensure the accuracy of these data, no guarantee can be given that they are error free.

The question of the extent to which climate elements measured at one site are representative of surrounding locations is often raised. There is no simple answer to this question, with factors such as the magnitude of the distance from the observing site, homogeneity of the terrain, and nature of the element having to be considered. For example, over rough ground or in a built-up area, wind speeds can vary dramatically over distances of a few meters. In contrast, air temperature tends to be a less variable weather element. Over flat, uniform terrain temperature measurements at a single site may be representative of conditions tens of kilometers, or even further, away. Expert advice should be sought when using these data at locations where representativeness is in question.

4.0 Missing data

Except for extremes, the following rules were used to determine whether monthly values would be calculated. In the case of daily temperatures (maximum, minimum and mean values) the "three-five rule" was used, i.e., a month was counted as missing if more than five daily observations were missing (more than three, if consecutive).

In the case of average monthly amounts of rain, snow and precipitation, months were excluded if one or more days were missing. The same method was used for elements which are accumulative, such as degree-days and "days with". In the case of extreme values, no data were excluded from the selection process. The "three-five" rule was used for most of the remaining elements.