Precipitation change in Canada

Canadian Environmental Sustainability Indicators

Environment and Climate Change Canada
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Canada

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Precipitation change in Canada

Changes in climate variables such as temperature, precipitation and humidity affect a wide range of natural processes and human activities. Precipitation in different forms (rainfall and snowfall) plays a vital role for ecosystems, the availability of surface water, and recharge of groundwater. Precipitation change can influence crops, forests, infrastructure, human health, the spread of disease, the availability of water and the health of ecosystems.

Using the average precipitation values from 1961 to 1990 as a baseline, this indicator compares how much the precipitation for a given year departs from the "normal". The indicator shows the national annual and seasonal precipitation departures[1] from 1949, when nationwide recording of consistent and comparable climate observations began, to 2023, the latest year for which complete data is available. It also spatially represents the precipitation departures for 2023 and the change in precipitation trends since 1949.

National annual precipitation change

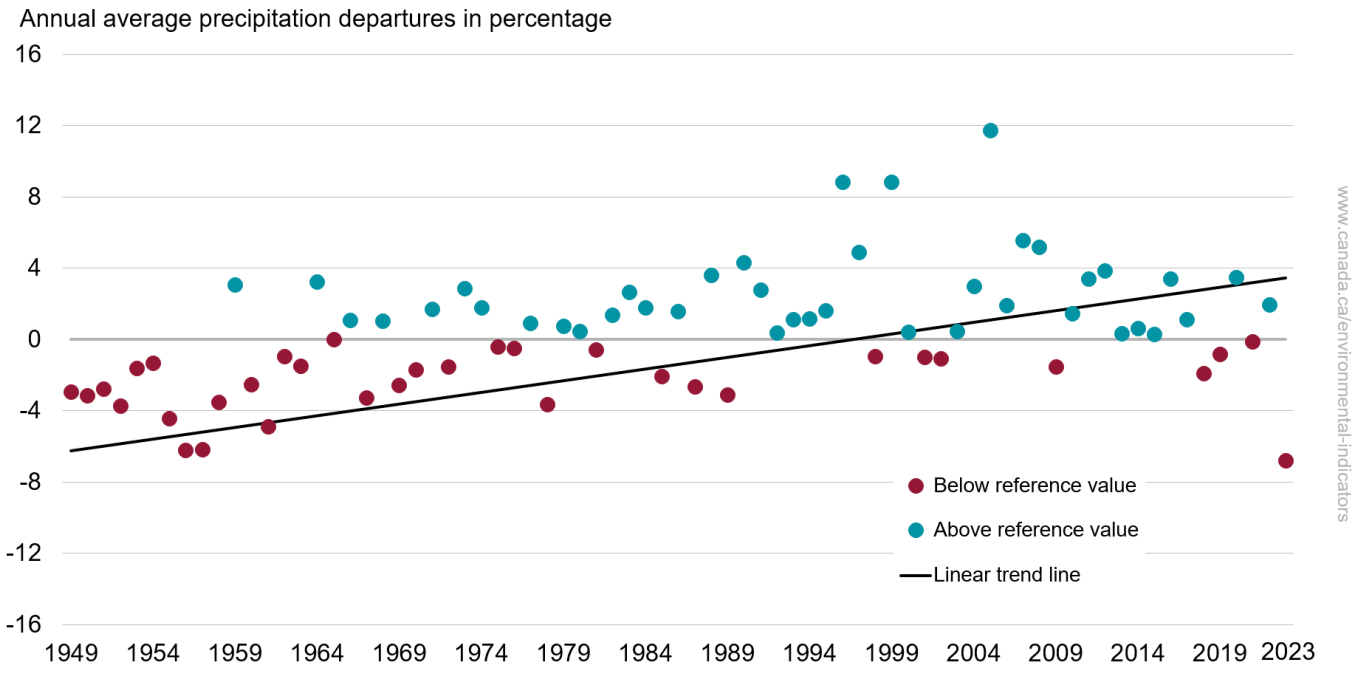
Key results

- In 2023, the national average precipitation was 6.8% below the 1961 to 1990 reference value[2]
- From 1949 to 2023, there is a trend in the national average precipitation departures, showing a 1.3% increase per decade over that period
- Annual average precipitation was above the reference value 29 times over the last 40 years

[1] The precipitation departure corresponds to the difference between the observed precipitation values and a precipitation reference value, also called the "normal". The average of precipitation annual values from 1961 to 1990 is commonly used as a baseline for comparing how precipitation for a given year departs from what could be referred to as the "normal" in long-term climate change assessments.

[2] The average of annual values from 1961 to 1990 is commonly used as a baseline for comparing how precipitation for a given year departs from what could be referred as the "normal". The 1961-1990 reference value is used to compare anomalies in the Intergovernmental Panel on Climate Change Sixth Assessment Report and the World Meteorological Organization Annual Statements on the Status of the Global Climate.

Figure 1. Annual average precipitation departures from the 1961 to 1990 reference value, Canada, 1949 to 2023



Data for Figure 1

Note: Departures are presented in percentage relative to the average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions. A trend line indicates a statistically significant trend based on the Mann-Kendall and Sen methods at the 95% confidence level.
Source: Environment and Climate change Canada (2026) Canadian Gridded Homogenized Monthly Precipitation – Version 2 (CanGridPmlyV2).

The climate tended to be wetter from the mid-1970s onward, with the wettest year being 2005, at 12% above the reference value. In contrast, Canada's driest year on record was 2023 at 7% below the reference value.

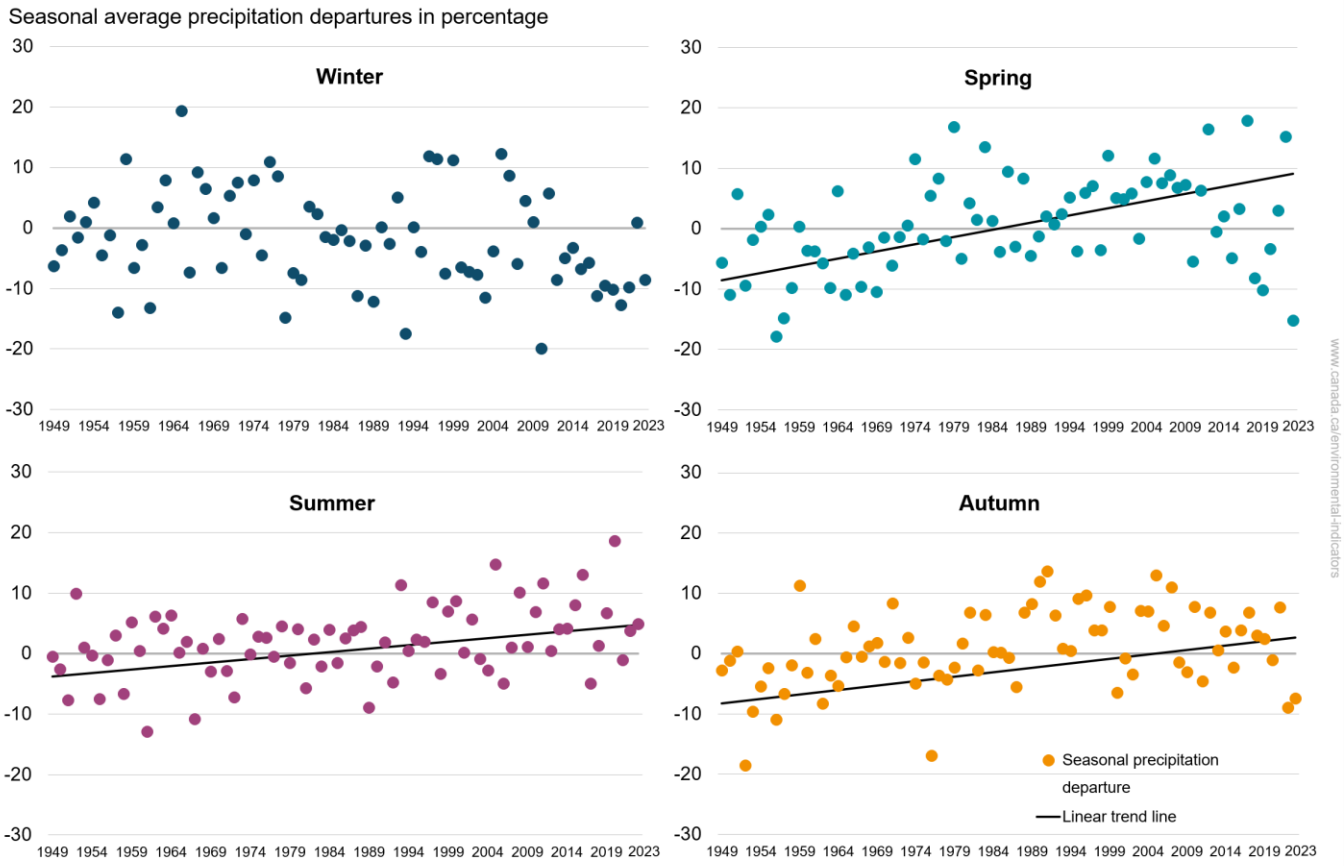
The observed increase in temperature is a contributor to the overall increasing trend in precipitation. Rising temperatures intensify evaporation and transpiration on land but also on the oceans which increases the atmospheric humidity resulting in more precipitation.

National seasonal precipitation change

Key results

- Over the 1949 to 2023 period,
  - spring, summer and autumn tended to be wetter, showing an overall upward progression of their average precipitation departures (2.4%/decade, 1.1%/decade and 1.5%/decade, respectively)
  - in winter, precipitation departures varied but did not show an increasing or decreasing trend
- Most of the wettest seasons have been observed since the late 1990s, while most of the driest seasons occurred in the 1950s and the 1960s

Figure 2. Seasonal average precipitation departures from the 1961 to 1990 reference value, Canada, 1949 to 2023



Data for Figure 2

Note: Departures are presented in percentage relative to the seasonal average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions. Seasons are defined as winter (December, January and February), spring (March, April and May), summer (June, July and August), and autumn (September, October and November). A trend line indicates a statistically significant trend based on the Mann-Kendall and Sen methods at the 95% confidence level.
Source: Environment and Climate change Canada (2026) Canadian Gridded Homogenized Monthly Precipitation – Version 2 (CanGridPmlyV2).

Over the period from 1949 to 2023, the wettest winter recorded occurred in 1965, while the wettest spring, summer and fall were in 2017, 2020 and 1991, respectively. The driest season recorded occurred in 2010 for winter, 1956 for spring, 1961 for summer and 1952 for autumn.

Regional precipitation change

Regional precipitation departures

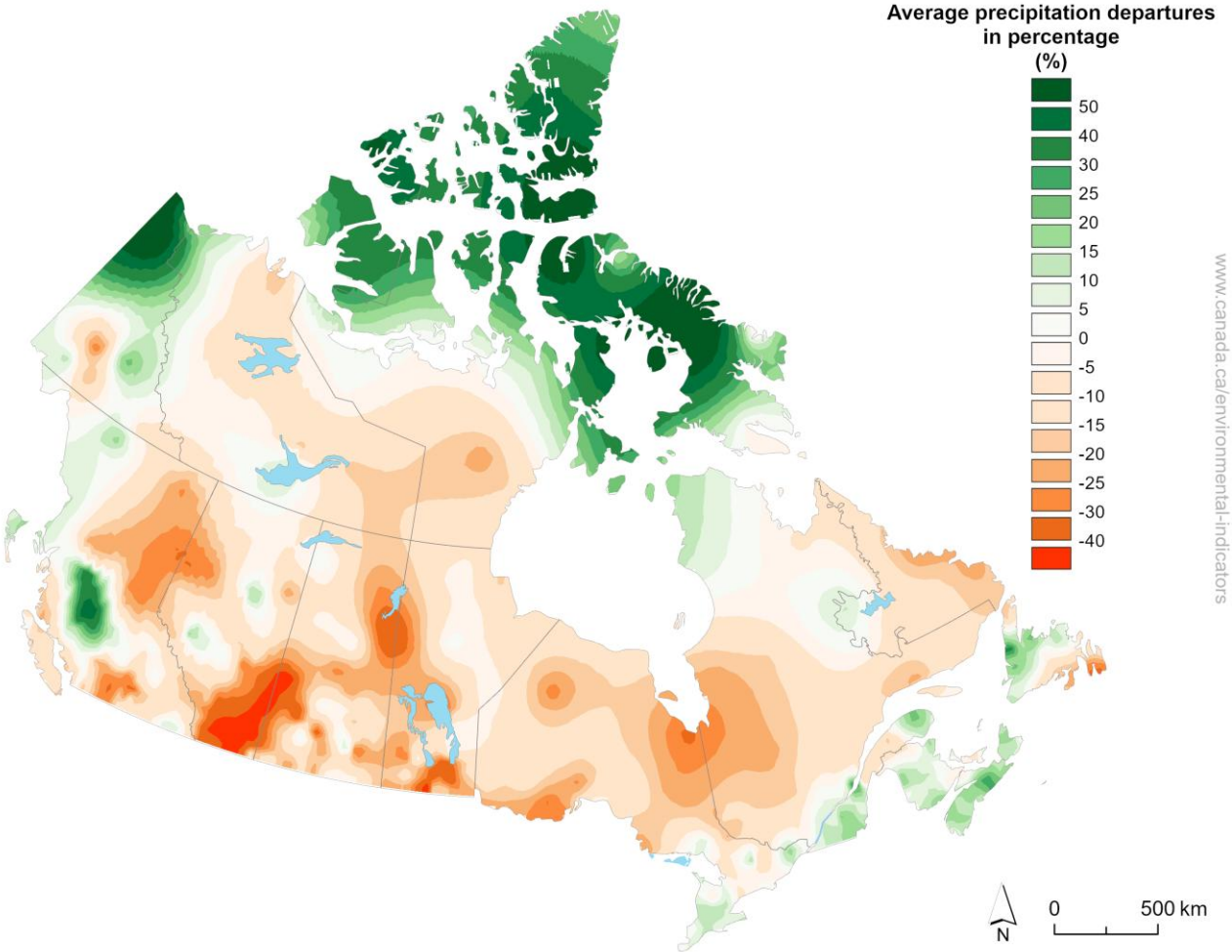
This section presents the difference between precipitation recorded in 2023 and the normal (departures from the 1961 to 1990 reference value) at the regional level.

Key results

In 2023,

- most of Northern Canada experienced annual precipitation above the 1961 to 1990 reference value
- precipitation significantly higher than the reference value was observed in the northern Yukon and Nunavut, in central British Columbia and Nova Scotia
- precipitation below the reference value was recorded in eastern British Columbia, central Saskatchewan, the southern parts of the Prairies and Ontario, and around James Bay

Figure 3. Regional average precipitation departures from the 1961 to 1990 reference value, Canada, 2023



Note: Departures are presented in percentage relative to the average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions.
Source: Environment and Climate Change Canada (2026) Climate Modelling Research Division

Regional precipitation change trends

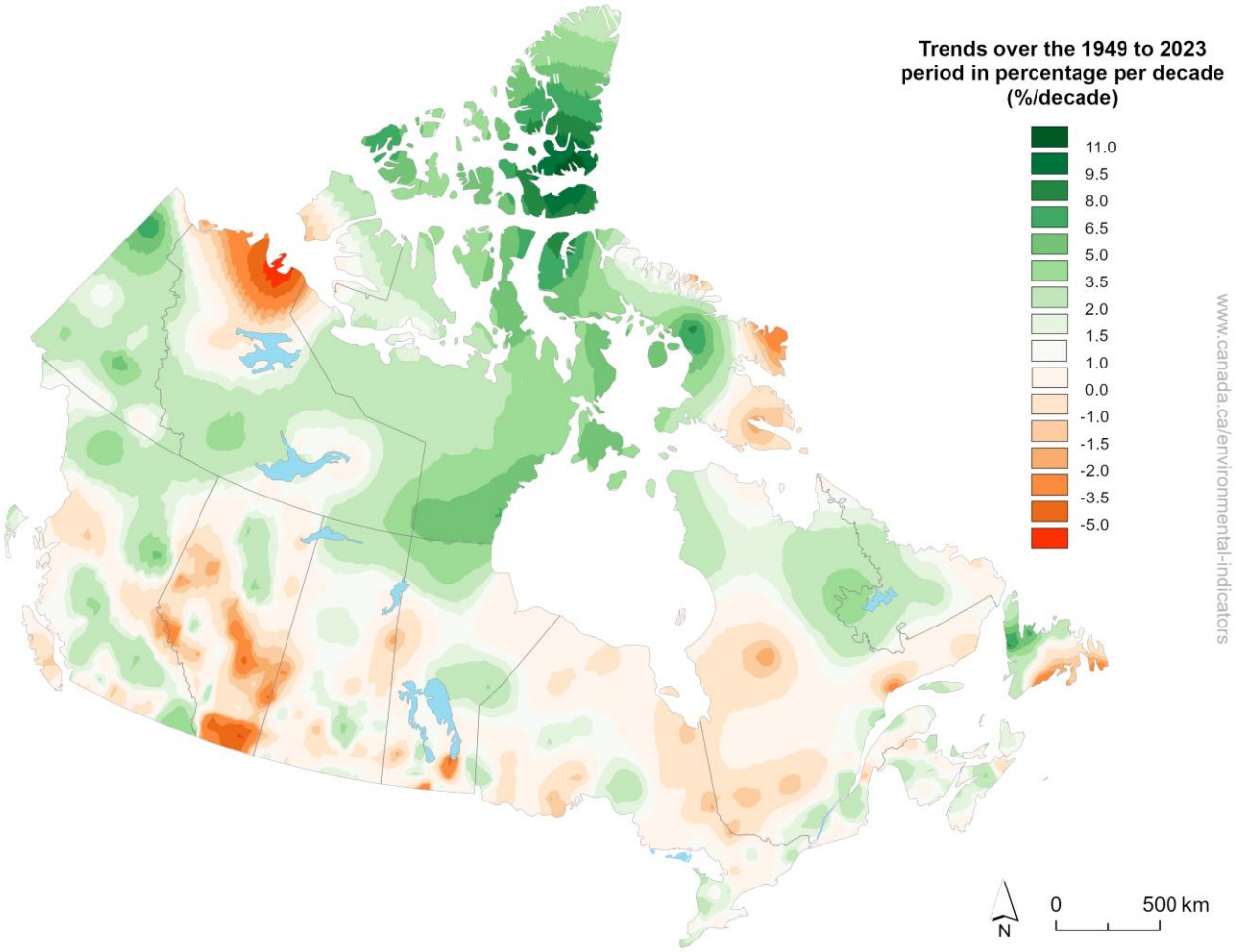
This section presents the long-term trends in precipitation change over the period from 1949 to 2023 at the regional level.

Key results

Over the period from 1949 to 2023,

- most of Canada experienced an increase in annual average precipitation
- increasing trends were observed for most of northern Canada, northern parts of British Columbia, central Manitoba, northeastern Quebec and western Newfoundland
- decreasing trends were observed in northern Northwest Territories, central and southern Alberta, in southern Manitoba and eastern Newfoundland

Figure 4. Regional precipitation change trends, Canada, 1949 to 2023



Note: Trends are presented in percentage relative to the average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions.
Source: Environment and Climate Change Canada (2026) Climate Modelling Research Division

About the indicator

What the indicator measures

The Precipitation Change in Canada indicator presents the annual and seasonal precipitation departures (or anomalies) for the years 1949 to 2023. As well, it shows a spatial distribution of precipitation departures for the year 2023 and trends in precipitation change over the period from 1949 to 2023. Due to the time needed to update the gridded and homogenized precipitation dataset from the raw precipitation measurements, there is a lag between data collection and reporting.

For this indicator, departures are expressed as the difference in percentage of the value of a given year against a reference value as denominator. The reference values used in this indicator are the annual and seasonal precipitation averages for the reference period of 1961 to 1990 (often referred to as the "1961 to 1990 normal"). This reference period is consistent with the approach used to compare anomalies in the Intergovernmental Panel on Climate Change Sixth Assessment Report and the World Meteorological Organization Annual Statements on the Status of the Global Climate.

The indicator is calculated using data from climate stations across Canada with sufficiently long data records to allow for a meaningful trend calculation. Total precipitation includes the combination of rainfall and snowfall.

Why this indicator is important

Precipitation in different forms (rainfall and snowfall) is a key element of the water cycle through its contribution to replenishing freshwater sources (rivers, lakes, reservoirs, underground aquifers). Changes in precipitation directly impact human and natural systems. Increases in temperature typically create more evaporation and result in more precipitation overall. However, climate change also affects the atmospheric and ocean circulation patterns. Changes in precipitation will therefore not be the same everywhere and some areas could experience drier conditions, while others experience wetter conditions.

Too much precipitation can lead to adverse effects such as crop damage, soil erosion, flooding, damage to buildings and infrastructure, and waterborne disease outbreaks resulting from contaminated run-off or untreated wastewater being released into the environment. On the other hand, a decrease in precipitation can adversely impact agricultural activities (crop losses, reduced plant growth), water supply (drinking water accessibility, reduced sanitary conditions), water levels and flows (warming waters, less oxygen available for aquatic ecosystems), and the risk of wildfires.

Understanding how Canada's climate is changing is important for developing adaptive responses to these effects. The Precipitation change in Canada indicator helps show how Canada's precipitation has changed since nationwide recording of consistent and comparable climate observations began in 1949.

The Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change use precipitation, among other variables, to assess long-term changes in climate. Precipitation is considered by the World Meteorological Organization - Global Climate Observing System as an Essential Climate Variable.

Related initiatives

The indicator contributes to the Sustainable Development Goals of the 2030 Agenda for Sustainable Development. It is linked to Goal 13, Take urgent action to combat climate change and its impacts.

Related indicators

The Extreme heat events indicator reports trends in the cumulative number of days per year and in the average number of degrees Celsius per year of extreme heat conditions across Canada.

The Greenhouse gas concentration indicator presents atmospheric concentrations as measured from sites in Canada and at a global scale for 2 greenhouse gases: carbon dioxide and methane.

The Temperature change in Canada indicators present annual, seasonal and regional temperature departures (or anomalies).

The Sea ice in Canada indicators provide information on variability and trends in sea ice in Canada during the summer season.

The Snow cover indicators provide information on spring snow cover extent and annual snow cover duration in Canada.

Data sources and methods

Data sources

The Precipitation change in Canada indicator is based on Environment and Climate Change Canada's gridded precipitation departures, or anomalies, data (CanGridP mlyV2), which in turn is based on the Canadian Homogenized Monthly Precipitation data (CanHomP mlyV2) for historical climate observations.

More information

The indicator is calculated using precipitation data collected from climate stations across Canada for the period from 1949 to 2023. The dataset contains homogenized time series of monthly total precipitation for 425 long-term stations in Canada. The 1949 to 2023 period was used because nationwide recording of consistent and comparable climate observations began in 1949 in Canada.

Data for the year 2023 was the most recent available at the time of drafting this indicator. There is a delay between data collection and reporting because of the time required to update the gridded and homogenized precipitation dataset from the raw precipitation measurements.

The dataset replaced the first and second generation adjusted precipitation datasets that were used in the previous versions of the Precipitation change in Canada indicator.

Methods

The CanGridP mlyV2 dataset provides spatially continuous estimates of monthly precipitation across Canada for climate analysis and trend assessment. It is the gridded version of a homogenized station dataset (CanHomP mlyV2).

The CanHomP mlyV2 dataset relies on homogenized precipitation time series from 425 climate stations across Canada. To reduce bias caused by incomplete records, missing monthly values are infilled using spatial interpolation. Measurement inconsistencies were also corrected.

The CanGridP mlyV2 dataset is produced by interpolating (Kriging method) the CanHomP mlyV2 dataset onto a national grid with cells of 10 square kilometres. Precipitation data were assumed to be uniform and equal for a given cell. Monthly precipitation data for each grid cell were averaged together to produce the annual and seasonal time series representing the entire country.

Departure values are expressed in percentages relative to the corresponding reference value (defined as the average over the 1961 to 1990 reference period).

Total precipitation considered in this indicator includes rainfall and snowfall amounts. Rainfall amounts were adjusted to take into consideration wind undercatch, evaporation and wetting losses of the rain gauge, while snowfalls were converted to snow water using density corrections based on coincident ruler and Nipher measurements.

More information

The annual departure is the average of all monthly departures, and the seasonal departure is the average of the monthly departures in the corresponding season. Seasons are defined as winter (December of the previous year, January and February of the current year), spring (March, April and May), summer (June, July and August) and autumn (September, October and November).

Non-parametric statistical tests were carried out on annual and seasonal average precipitation departures data to detect the presence of a linear trend and, if present, to determine the orientation (positive or negative) and magnitude of the rate of change (slope). The standard Mann-Kendall trend test was used to detect trend presence and orientation, while the Sen's pairwise slope method was used to estimate the

slope. A trend was reported when the Mann-Kendall test indicated the presence of a trend at the 95% confidence level.

For the regional indicators, statistical tests were carried out on the precipitation departure time series for each individual grid cell. From the obtained slope, the change in precipitation was expressed as the percent change per decade and was calculated over the period from 1949 to 2023: slope value (%/year) x 10 years. For 52% of the cells, the Mann-Kendall test indicated the presence of a trend at the 95% confidence level. However, the trend results from all cells were displayed on the map.

For detailed information on the steps to develop the Canadian Homogenized Monthly Precipitation data and the trend calculations, please consult the articles Observed Precipitation Trends Inferred from Canada's Homogenized Monthly Precipitation Dataset (Wang *et al.*, 2023) and Precipitation Trends in Version 2 of the Canadian Homogenized Monthly Precipitation Dataset (Wang *et al.*, 2026).

Recent changes

Regional precipitation change trends have been added to present the long-term trends across Canada for the period from 1949 to 2023.

The previous iteration of the indicator was based on the Adjusted and Homogenized Canadian Climate Data. Due to station automation and closure of volunteer stations, the precipitation dataset could no longer be updated. This indicator relies on an improved dataset using the Canadian Homogenized Monthly Precipitation data. Since the 2 datasets were developed with different methods, results from the indicator could differ from its previous versions.

Caveats and limitations

Breaks in the data can be a concern. To mitigate this, the Precipitation change in Canada indicator uses homogenized station data for precipitation. Adjustments for data variations caused by changes in site exposure, location, instrumentation, observer, and observing procedures over the 75-year reporting period were performed on the dataset. Observations from nearby co-located stations are sometimes merged to produce longer time series.

A given variation in the amount of precipitation for a station with low normal precipitation will result in a much larger departure then for a station with high normal precipitation. This is due to precipitation amounts at monitoring stations being normalized against their respective reference value in the calculation of the national departure.

Resources

References

Environment and Climate Change Canada (2024) Canadian Homogenized Monthly Precipitation. Retrieved on May 13, 2026.

Wang, X. L., Y. Feng, V. Y. S. Cheng, and H. Xu (2023) Observed Precipitation Trends Inferred from Canada's Homogenized Monthly Precipitation Dataset. Journal of Climate 36(22): 7957 to 7971. Retrieved on May 13, 2026.

Wang, X. L., Y. Feng, F.W. Zwiers, and V. Y. S. Cheng (2026) Precipitation Trends in Version 2 of the Canadian Homogenized Monthly Precipitation Dataset. Atmosphere-Ocean 64(3): 215 to 230. Retrieved on May 13, 2026.

Annex

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Annual average precipitation departures from the 1961 to 1990 reference value, Canada, 1949 to 2023

Year	Precipitation departure (percentage)	Wettest year ranking
1949	-2.9	64
1950	-3.1	66
1951	-2.8	63
1952	-3.7	70
1953	-1.6	56
1954	-1.3	52
1955	-4.4	71
1956	-6.2	74
1957	-6.2	73
1958	-3.5	68
1959	3.1	14
1960	-2.5	60
1961	-4.9	72
1962	-0.9	48
1963	-1.5	53
1964	3.2	13
1965	0.0	42
1966	1.1	31
1967	-3.3	67
1968	1.0	32
1969	-2.6	61
1970	-1.7	57
1971	1.7	23
1972	-1.5	54
1973	2.9	16
1974	1.8	21
1975	-0.4	44
1976	-0.5	45
1977	0.9	33
1978	-3.6	69
1979	0.8	34
1980	0.5	36
1981	-0.6	46
1982	1.4	27
1983	2.6	18
1984	1.8	22
1985	-2.1	59
1986	1.6	25
1987	-2.6	62
1988	3.6	9
1989	-3.1	65
1990	4.3	7
1991	2.8	17
1992	0.4	39
1993	1.1	30
1994	1.2	28
1995	1.6	24
1996	8.8	3
1997	4.9	6
1998	-0.9	49
1999	8.9	2
2000	0.4	38
2001	-1.0	50
2002	-1.1	51
2003	0.5	37
2004	3.0	15
2005	11.7	1
2006	1.9	20
2007	5.6	4
2008	5.2	5
2009	-1.5	55
2010	1.5	26
2011	3.4	12
2012	3.9	8
2013	0.4	40
2014	0.6	35
2015	0.3	41
2016	3.4	11
2017	1.1	29
2018	-1.9	58
2019	-0.8	47
2020	3.5	10
2021	-0.1	43
2022	1.9	19
2023	-6.8	76

Note: Departures are presented in percentage relative to the average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions.
Source: Environment and Climate change Canada (2026) Canadian Gridded Homogenized Monthly Precipitation – Version 2 (CanGridPmlyV2).

Table A.2. Data for Figure 2. Seasonal average precipitation departures from the 1961 to 1990 reference value, Canada, 1949 to 2023

Year	Precipitation departure in winter (percentage)	Precipitation departure in spring (percentage)	Precipitation departure in summer (percentage)	Precipitation departure in autumn (percentage)
1949	-6.3	-5.6	-0.5	-2.7
1950	-3.7	-11.0	-2.6	-1.1
1951	2.0	5.7	-7.7	0.3
1952	-1.5	-9.4	9.9	-18.6
1953	1.0	-1.9	1.1	-9.6
1954	4.2	0.4	-0.3	-5.4
1955	-4.5	2.4	-7.5	-2.4
1956	-1.2	-17.8	-1.0	-10.9
1957	-14.0	-14.8	3.0	-6.7
1958	11.4	-9.8	-6.7	-1.9
1959	-6.6	0.4	5.2	11.3
1960	-2.8	-3.6	0.4	-3.1
1961	-13.2	-3.7	-12.9	2.5
1962	3.5	-5.7	6.1	-8.2
1963	7.9	-9.8	4.2	-3.6
1964	0.8	6.2	6.3	-5.3
1965	19.4	-10.9	0.2	-0.6
1966	-7.3	-4.1	2.0	4.6
1967	9.2	-9.6	-10.8	-0.5
1968	6.5	-3.1	0.9	1.2
1969	1.7	-10.4	-2.9	1.8
1970	-6.6	-1.4	2.4	-1.3
1971	5.4	-6.1	-2.9	8.4
1972	7.6	-1.3	-7.2	-1.6
1973	-1.0	0.6	5.7	2.7
1974	7.9	11.5	-0.1	-4.9
1975	-4.5	-1.7	2.8	-1.5
1976	10.9	5.5	2.6	-16.9
1977	8.6	8.3	-0.4	-3.6
1978	-14.8	-2.0	4.6	-4.3
1979	-7.4	16.8	-1.5	-2.3
1980	-8.5	-4.9	4.1	1.7
1981	3.6	4.3	-5.7	6.8
1982	2.3	1.5	2.4	-2.7
1983	-1.5	13.5	-2.1	6.5

Year	Precipitation departure in winter (percentage)	Precipitation departure in spring (percentage)	Precipitation departure in summer (percentage)	Precipitation departure in autumn (percentage)
1984	-2.0	1.3	4.0	0.3
1985	-0.3	-3.8	-1.5	0.2
1986	-2.1	9.4	2.6	-0.7
1987	-11.2	-2.9	3.9	-5.5
1988	-2.9	8.3	4.5	6.9
1989	-12.2	-4.4	-8.9	8.2
1990	0.1	-1.2	-2.1	11.9
1991	-2.6	2.0	1.8	13.7
1992	5.1	0.7	-4.8	6.4
1993	-17.4	2.4	11.3	0.9
1994	0.2	5.2	0.4	0.4
1995	-3.9	-3.7	2.3	9.1
1996	11.9	5.9	1.9	9.7
1997	11.5	7.0	8.5	3.9
1998	-7.5	-3.6	-3.3	3.9
1999	11.2	12.1	7.0	7.8
2000	-6.5	5.1	8.7	-6.4
2001	-7.2	5.0	0.2	-0.8
2002	-7.8	5.8	5.7	-3.5
2003	-11.5	-1.7	-0.9	7.1
2004	-3.8	7.8	-2.8	7.0
2005	12.3	11.7	14.7	13.0
2006	8.7	7.5	-4.9	4.7
2007	-5.9	8.9	1.0	11.1
2008	4.5	6.9	10.1	-1.4
2009	1.0	7.3	1.1	-3.0
2010	-20.0	-5.4	6.9	7.8
2011	5.7	6.3	11.6	-4.6
2012	-8.5	16.4	0.4	6.8
2013	-4.9	-0.5	4.0	0.6
2014	-3.3	2.1	4.1	3.7
2015	-6.8	-4.9	8.0	-2.3
2016	-5.7	3.3	13.0	3.9
2017	-11.2	17.8	-4.9	6.9
2018	-9.5	-8.2	1.3	3.0
2019	-10.2	-10.1	6.7	2.5
2020	-12.7	-3.3	18.6	-1.1

Year	Precipitation departure in winter (percentage)	Precipitation departure in spring (percentage)	Precipitation departure in summer (percentage)	Precipitation departure in autumn (percentage)
2021	-9.8	3.0	-1.1	7.7
2022	0.9	15.3	3.8	-9.0
2023	-8.6	-15.2	5.0	-7.4

Note: Departures are presented in percentage relative to the seasonal average for the reference period from 1961 to 1990. A positive departure indicates that the observed precipitation was greater than the reference value, while a negative departure indicates drier conditions. Seasons are defined as winter (December, January and February), spring (March, April and May), summer (June, July and August), and autumn (September, October and November).
Source: Environment and Climate change Canada (2026) Canadian Gridded Homogenized Monthly Precipitation – Version 2 (CanGridPmlyV2).