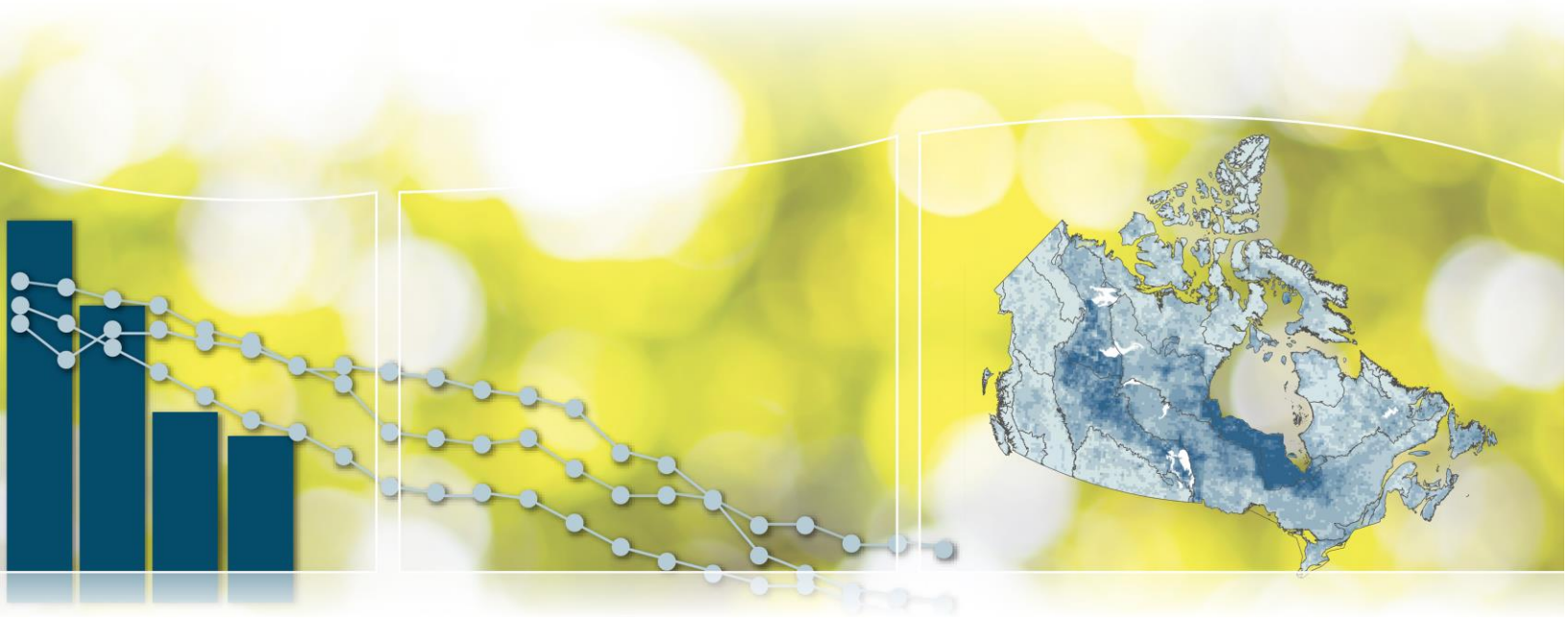
Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canadian Environmental Sustainability Indicators

Precipitation Change in Canada



Canada

Suggested citation for this document: Environment and Climate Change Canada (2016) Canadian Environmental Sustainability Indicators: Precipitation Change in Canada. Consulted on *Month day, year*.
Available at: www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=ACD78526-1

Cat. No.: En4-144/76-2016E-PDF
ISBN: 978-0-660-04757-7

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Canadian Environmental Sustainability Indicators

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May 2016

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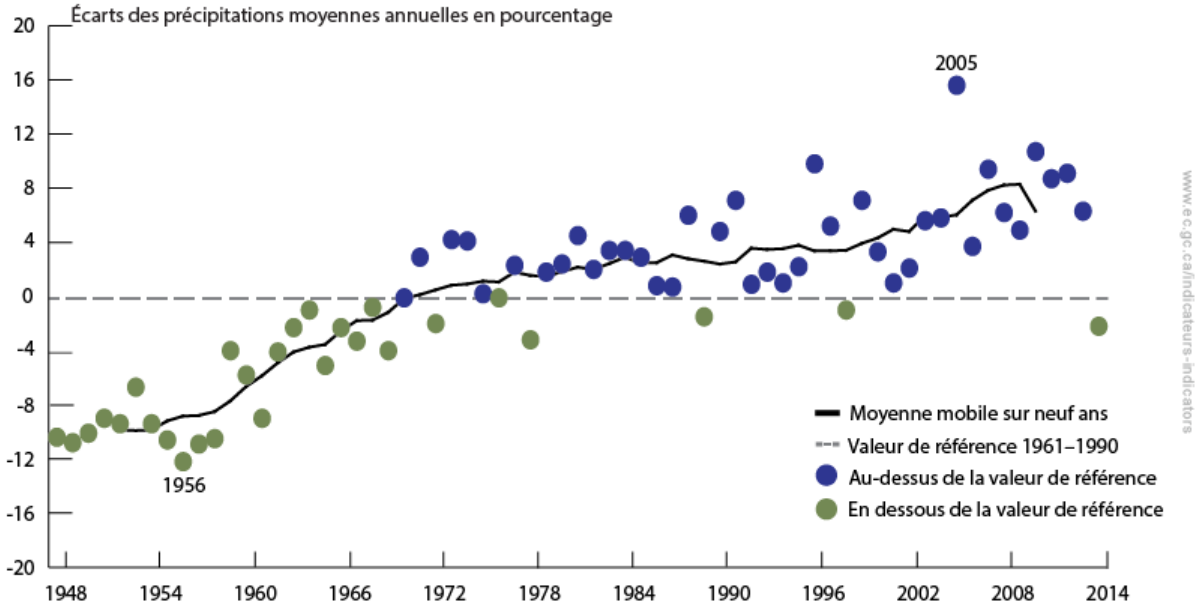
Part 1. Precipitation Change in Canada Indicator

Changes in climate variables such as temperature, precipitation and humidity affect a wide range of natural processes and human activities. Globally, while annual average precipitation varies greatly from region to region, precipitation at land-based stations has been near the reference value[1,2] for the third consecutive year. In 2014, global precipitation was 0.52 millimetres or 0.05% below the 1961–1990 reference value.

Annual average precipitation in Canada for the year 2014 was 2% below the 1961–1990 reference value.[3] However, the climate tended to be wetter from the mid-1970s onward, as shown by an ever increasing nine-year moving average, with the wettest year being 2005, at 16% above the reference value. In contrast, Canada's driest year on record was 1956 at 12% below the reference value. Regional patterns vary greatly however (see Regional precipitation change).

Figure 1. Annual average precipitation departures from 1961–1990 reference value, Canada, 1948 to 2014



Data for Figure 1

Note: Annual average precipitation departures were computed for weather stations across Canada with sufficiently long data records to allow for trend calculation and were then interpolated to a 50-kilometre spaced grid. Annual grid points values were averaged together to produce an annual time series of precipitation departures representing the entire country.

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[1] National Oceanic and Atmosphere Administration (NOAA) State of the Climate Global Analysis – Annual 2015.

[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 Fifth Assessment Report and the World Meteorological Organization Annual Statements on the Status of the Global Climate.

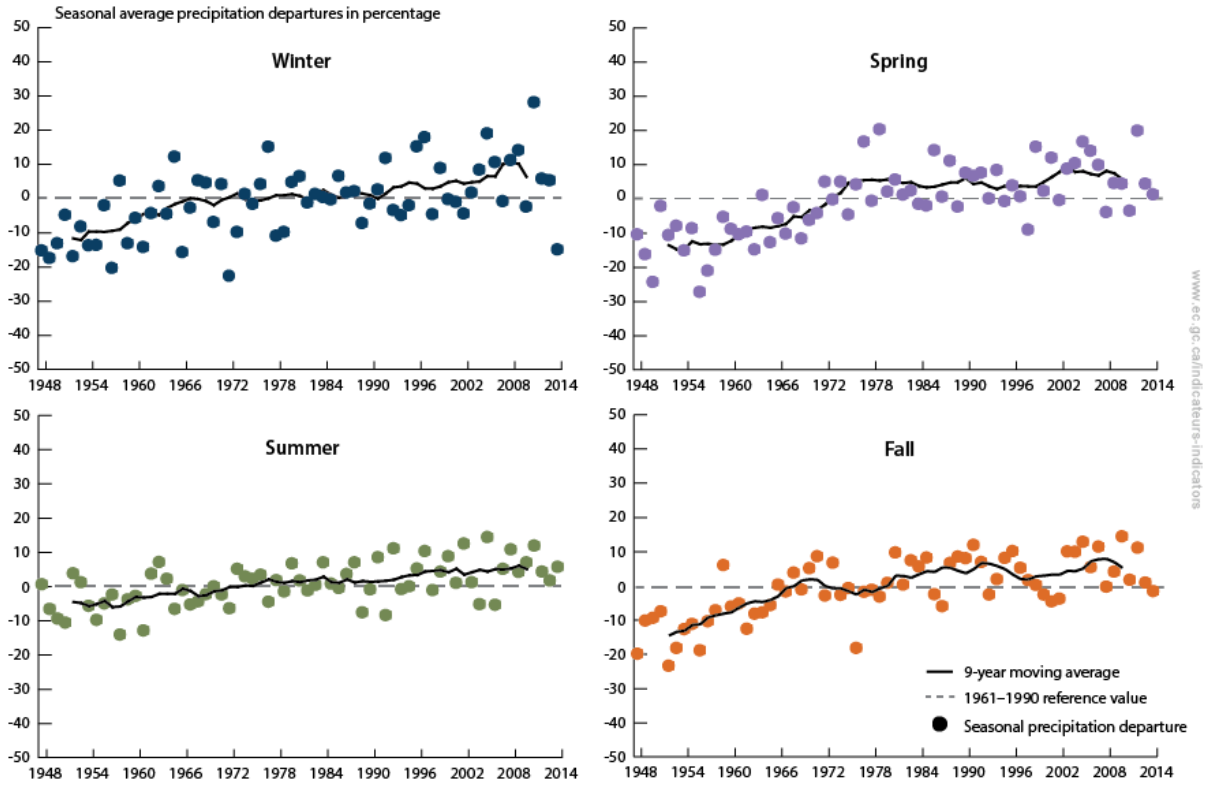
[3] It should be noted that average precipitation in northern Canada is generally much less than it is in southern Canada, and hence a percent departure in the north represents much less precipitation than the same percentage in the south.

Source: Environment and Climate Change Canada (2015) Adjusted and Homogenized Canadian Climate Data (AHCCD).

Seasonal precipitation change

During the past 67 years (1948–2014), the seasonal average precipitation departures for Canada have shown an overall upward progression for each of the four seasons (as illustrated by the nine-year moving average lines in the charts below). All seasons tended to be wetter than the corresponding 1961–1990 reference value from the mid-1970s onward. The wettest winter recorded occurred in 2011,[4] while the wettest spring, summer and fall were in 2012, 2005 and 2010, respectively. The driest seasons recorded were all in the 1950s (winter 1957, spring 1956, summer 1958 and fall 1952).

Figure 2. Seasonal average precipitation departures from the 1961–1990 reference value, with nine-year moving average, Canada, 1948 to 2014



Data for Figure 2

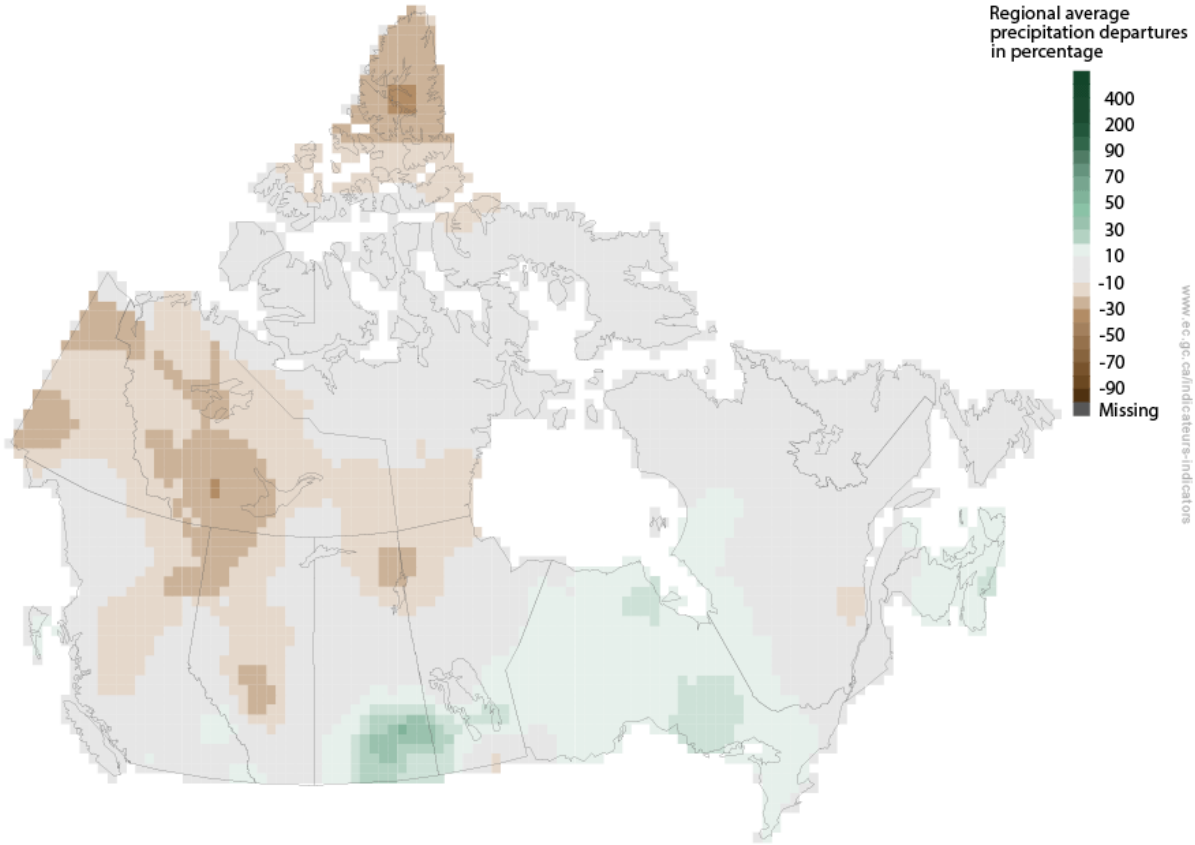
Note: Seasonal average precipitation departures were computed for weather stations across Canada with sufficiently long data records to allow for trend calculation and were then interpolated to a 50-kilometre spaced grid. Annual grid point values were averaged together to produce an annual time series of precipitation departures representing the entire country. Seasons are defined as winter (December of previous year, January and February), spring (March, April and May), summer (June, July and August) and fall (September, October, and November). The seasonal average precipitation departures for 2014 are based on preliminary data.
Source: Environment and Climate Change Canada (2015) Adjusted and Homogenized Canadian Climate Data (AHCCD).

[4] Winter corresponds to the months of December of the previous year, and January and February of the reported year.

Regional precipitation change

In 2014, while annual average precipitation in the country as a whole was 2% below the Canadian 1961–1990 reference value, southern Saskatchewan and some areas in Ontario had wetter conditions than the reference value while most of Yukon, Northwest Territories and part of Nunavut (Ellesmere Island) had drier conditions. The rest of the country had average precipitation departures near the reference value.

Figure 3. Regional average precipitation departures from 1961–1990 reference value, Canada, 2014



Note: Annual average precipitation departures were computed for 464 weather stations across Canada and were then interpolated to a 50-kilometre spaced grid.
Source: Environment and Climate Change Canada (2016) Canadian Gridded Temperature and Precipitation Anomalies (CANGRD).

Part 2. Data Sources and Methods for the Precipitation Change in Canada Indicator

Introduction

The Precipitation Change in Canada indicator is part of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues.

Description and rationale of the Precipitation Change in Canada indicator

Description

The Precipitation Change in Canada indicator measures the annual and seasonal precipitation departures (or anomalies) for the years 1948 to 2014. For this indicator, the annual departure is the percentage difference 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 period of 1961 to 1990 (often referred to as the 1961–1990 normal). This reference period is consistent with the approach used to compare anomalies in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report and the World Meteorological Organization (WMO) Annual Statements on the Status of the Global Climate. The indicator is calculated using data from weather stations across Canada with sufficiently long data records to allow for a meaningful trend calculation. Total precipitation includes the combination of rainfall and snowfall.

Rationale

Much of Canadian economic and social activity is climate dependent. Understanding how Canada's climate is changing is important for developing adaptive responses. 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 1948.

The IPCC and the United Nations Framework Convention on Climate Change (UNFCCC) use precipitation, among other variables, to assess long-term changes in climate. Precipitation is considered by the WMO Global Climate Observing System (GCOS) as an Essential Climate Variable.

Data

Data source

Environment and Climate Change Canada's Adjusted and Homogenized Canadian Climate Data (AHCCD) were used for the calculation of the Precipitation Change in Canada indicator.

Spatial coverage

The indicator provides national coverage.

Temporal coverage

The indicator is calculated using data from climate stations across Canada for the period 1948 to 2014. Seasons are defined as winter (December of the previous year, January and

February), spring (March, April and May), summer (June, July and August) and fall (September, October and November).

Data completeness

Adjustments for data variations caused by changes in site exposure, location, instrumentation, observer and observing procedures over the 67-year reporting period were performed on the dataset. Corrections account for wind undercatch, evaporation and gauge-specific wetting losses. For a detailed discussion of data completeness, please refer to Environment and Climate Change Canada's Adjusted Precipitation Data.

Data timeliness

The data are current up to 2014.

Methods

The Precipitation Change in Canada indicator is based on Environment and Climate Change Canada's gridded precipitation anomalies data (Canadian Gridded Temperature and Precipitation Anomalies [CANGRD]), which in turn is based on the Adjusted and Homogenized Canadian Climate Data (AHCCD) for historical climate observations and on near real-time data in the national climate archives for the current year.

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.

The annual mean precipitation departures are computed at each observing station and for each year by subtracting the reference value (defined as the average over 1961–1990 reference period) from the relevant annual values. They are then normalized by dividing by the reference value and expressed in percentage to produce normalized precipitation departures.

The 1948–2014 period is used because nationwide recording of consistent and comparable climate observations began in 1948 in Canada. A nine-year moving average for precipitation is used because precipitation is non-linear (i.e., there is no inherent link in precipitation amounts from one year to the next). The nine-year moving average smooths the variation in the year-to-year fluctuations to help show the trends in the data over the longer nine-year period.

More information about the calculation method can be found in the Climate Trends and Variations Bulletin documentation.

Caveats and limitations

Breaks in the data can be a concern. To mitigate this, the Precipitation Change in Canada indicator uses homogenized and adjusted station data for precipitation. These data have been adjusted to account for discontinuities in the data from non-climatic factors, such as changes in observation methods, equipment or station location. 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.

Part 3. Annexes

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

Table A.1. Data for Figure 1. Annual average precipitation departures from 1961–1990 reference value, Canada, 1948 to 2014

Year	Precipitation departures (percentage)	Wettest year ranking
1948	-10.4	62
1949	-10.8	65
1950	-10.1	61
1951	-9.0	57
1952	-9.4	59
1953	-6.7	56
1954	-9.4	60
1955	-10.6	64
1956	-12.2	67
1957	-10.9	66
1958	-10.5	63
1959	-4.0	52
1960	-5.8	55
1961	-9.0	58
1962	-4.1	53
1963	-2.3	47
1964	-1.0	42
1965	-5.1	54
1966	-2.3	48
1967	-3.3	50
1968	-0.8	41
1969	-4.0	51
1970	-0.1	40
1971	2.9	25
1972	-2.0	45
1973	4.2	18
1974	4.1	19
1975	0.2	38
1976	-0.1	39
1977	2.3	27
1978	-3.2	49
1979	1.8	31
1980	2.4	26
1981	4.5	17
1982	2.0	30

Year	Precipitation departures (percentage)	Wettest year ranking
1983	3.4	22
1984	3.4	21
1985	2.9	24
1986	0.8	36
1987	0.7	37
1988	6.0	11
1989	-1.5	44
1990	4.8	16
1991	7.1	8
1992	0.9	35
1993	1.8	32
1994	1.0	34
1995	2.2	28
1996	9.8	3
1997	5.2	14
1998	-1.0	43
1999	7.1	7
2000	3.3	23
2001	1.0	33
2002	2.1	29
2003	5.6	13
2004	5.8	12
2005	15.6	1
2006	3.7	20
2007	9.4	4
2008	6.2	10
2009	4.9	15
2010	10.7	2
2011	8.7	6
2012	9.1	5
2013	6.3	9
2014	-2.2	46

Note: Annual average precipitation departures were computed for weather stations across Canada with sufficiently long data records to allow for trend calculation and were then interpolated to a 50-kilometre spaced grid. Annual grid points values were averaged together to produce an annual time series of precipitation departures representing the entire country.
Source: Environment and Climate Change Canada (2015) Adjusted and Homogenized Canadian Climate Data (AHCCD).

Table A.2. Data for Figure 2. Seasonal average precipitation departures from the 1961–1990 reference value, with nine-year moving average, Canada, 1948 to 2014

Year	Winter precipitation departure (percentage)	Spring precipitation departure (percentage)	Summer precipitation departure (percentage)	Fall precipitation departure (percentage)
1948	-15.1	-10.3	0.7	-19.8
1949	-17.3	-16.1	-6.5	-10.1
1950	-13.0	-24.2	-9.3	-9.3
1951	-4.7	-2.0	-10.5	-7.4
1952	-16.8	-10.5	3.9	-23.3
1953	-8.1	-7.8	1.3	-18.1
1954	-13.6	-15.0	-5.6	-12.6
1955	-13.5	-8.5	-9.7	-11.1
1956	-1.9	-27.1	-4.9	-18.8
1957	-20.2	-20.9	-2.3	-10.3
1958	5.3	-14.8	-14.0	-7.1
1959	-13.0	-5.2	-3.7	6.1
1960	-5.6	-8.7	-2.7	-6.0
1961	-14.1	-10.3	-12.8	-5.1
1962	-4.2	-9.5	3.8	-12.5
1963	3.7	-14.7	7.2	-8.1
1964	-4.4	1.2	2.3	-7.7
1965	12.3	-12.6	-6.5	-5.6
1966	-15.6	-5.6	-1.0	0.4
1967	-2.6	-10.1	-5.2	-1.6
1968	5.4	-2.4	-4.3	3.9
1969	4.7	-11.5	-2.2	-1.0
1970	-6.8	-6.1	0.1	5.2
1971	4.3	-4.1	-2.3	8.7
1972	1.5	5.1	-6.3	-2.8
1973	-9.7	-0.1	5.2	6.8
1974	1.4	5.1	3.0	-2.6
1975	-1.5	-4.5	2.3	-0.6
1976	4.3	4.3	3.5	-18.1
1977	15.2	16.8	-4.4	-1.7
1978	-10.8	-0.5	1.9	-1.1
1979	-9.7	20.4	-1.4	-3.1
1980	4.9	2.2	6.8	0.9
1981	6.6	5.7	1.8	9.8
1982	-1.1	1.3	-1.1	0.4
1983	1.4	2.5	0.5	7.5
1984	0.5	-1.4	7.1	5.7
1985	-0.2	-1.9	0.9	8.3
1986	6.7	14.3	-0.4	-2.4
1987	1.8	0.7	3.7	-5.9
1988	2.2	11.2	7.1	6.7

Year	Winter precipitation departure (percentage)	Spring precipitation departure (percentage)	Summer precipitation departure (percentage)	Fall precipitation departure (percentage)
1989	-7.1	-2.2	-7.5	8.6
1990	-1.4	7.7	-0.8	8.1
1991	2.7	6.8	8.6	12.0
1992	11.9	7.7	-8.3	7.0
1993	-3.3	0.2	11.2	-2.5
1994	-4.8	8.5	-0.7	2.0
1995	-1.9	-0.6	0.1	8.2
1996	15.3	4.0	5.3	10.2
1997	18.0	0.8	10.4	5.3
1998	-4.5	-8.9	-1.0	1.7
1999	9.0	15.3	4.4	0.3
2000	-0.1	2.4	8.9	-2.5
2001	-0.9	12.1	1.1	-4.5
2002	-4.3	-0.3	12.6	-3.7
2003	1.8	8.9	1.3	10.1
2004	8.5	10.5	-5.1	10.0
2005	19.1	16.8	14.5	12.9
2006	10.7	14.1	-5.3	5.5
2007	-0.7	10.0	5.2	11.5
2008	11.3	-3.8	10.9	-0.2
2009	14.2	4.7	4.3	4.2
2010	-2.3	4.5	7.1	14.5
2011	28.2	-3.4	12.0	1.8
2012	5.9	20.0	4.4	11.2
2013	5.4	4.5	1.8	1.0
2014	-14.8	1.4	5.8	-1.5

Note: Seasonal average precipitation departures were computed for weather stations across Canada with sufficiently long data records to allow for trend calculation and were then interpolated to a 50-kilometre spaced grid. Annual grid point values were averaged together to produce an annual time series of precipitation departures representing the entire country. Seasons are defined as winter (December of previous year, January and February), spring (March, April and May), summer (June, July and August) and fall (September, October, and November). The seasonal average precipitation departures for 2014 are based on preliminary data.
Source: Environment and Climate Change Canada (2015) Adjusted and Homogenized Canadian Climate Data (AHCCD).

Annex B. References and additional information

References and further reading

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Related information

Temperature Change in Canada

www.ec.gc.ca

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