



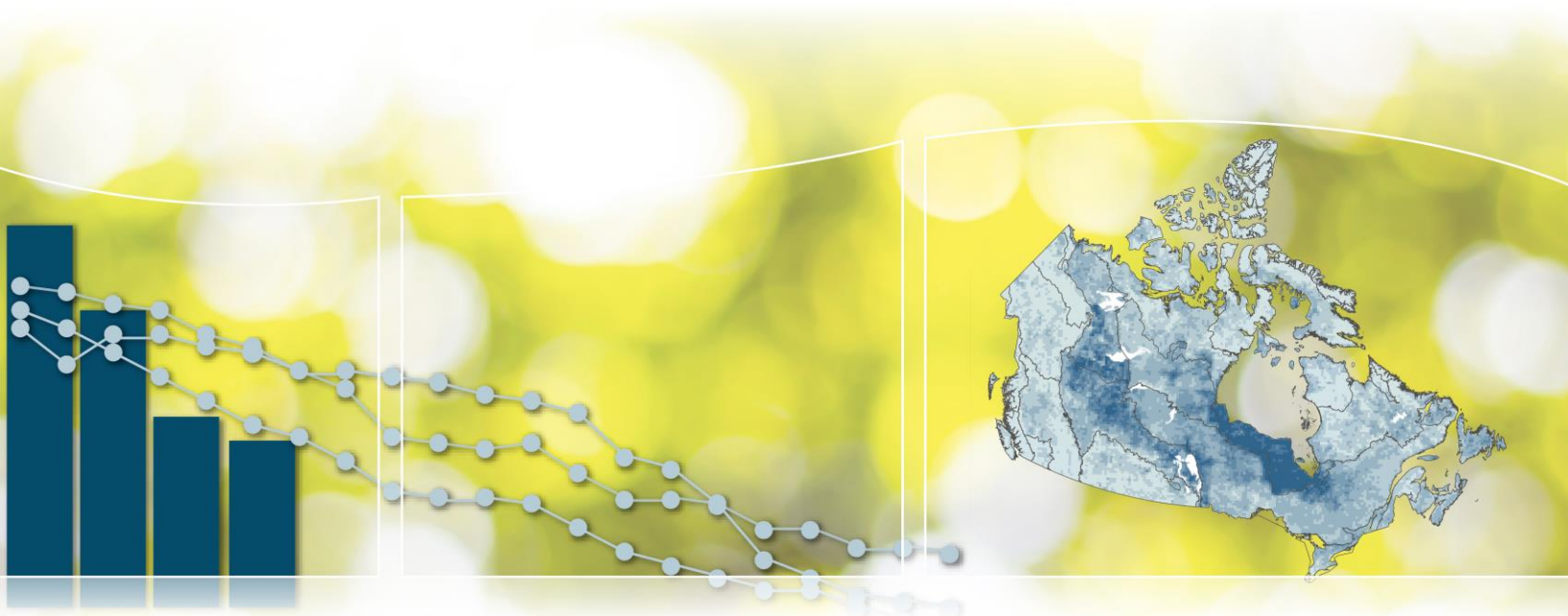
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Canadian Environmental Sustainability Indicators

Temperature Change in Canada



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Canadian Environmental Sustainability Indicators

Temperature Change in Canada

May 2016

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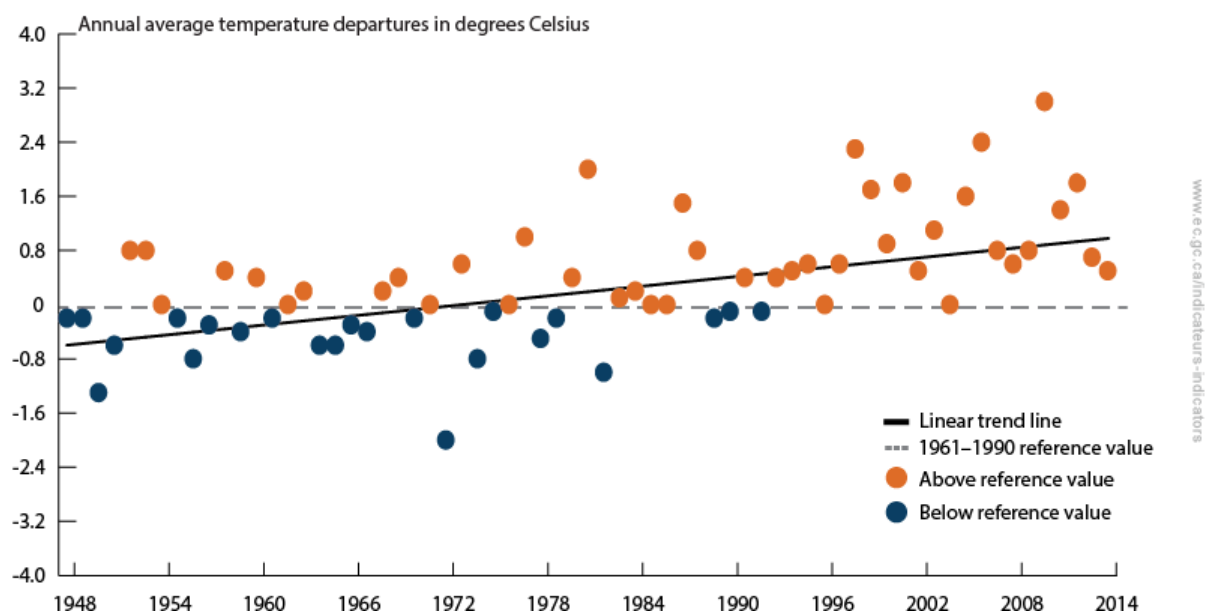
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Part 1. Temperature Change in Canada Indicator

Changes in climate variables such as temperature, precipitation and humidity affect a wide range of natural processes and human activities. In 2014, the global average temperature was one of the warmest ever recorded, with a temperature of almost 0.6 degrees Celsius (°C)¹ above the 1961–1990 reference value (or the average temperatures recorded between 1961 to 1990).²

In Canada, the national average land temperature for the year 2014 was 0.5°C above the reference value. Annual average temperatures were consistently above or equal to the reference value from 1993 onward. The warmest year was 2010, at 3.0°C above the reference value. Canada's coldest year since 1948 was 1972 at 2.0°C below the reference value. Five of the ten warmest years occurred within the last decade. From 1948 to 2014,³ a trend was detected in annual average temperature departures, indicating an overall warming of 1.6°C over that period. Patterns are different across regions of the country however (see [Regional temperature change](#)).

Figure 1. Annual average temperature departures⁴ from the 1961–1990 reference value, Canada, 1948 to 2014



[Data for Figure 1](#)

¹ World Meteorological Organization (WMO) [Statement on the status of the global climate in 2014](#).

² The average of annual values from 1961 to 1990 is commonly used as a baseline for comparing how temperature for a given year departs from what could be referred to 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 The reported time series begin in 1948, as this is the first year that consistent and comparable climate observations were collected nationwide in Canada.

⁴ Departures are obtained by subtracting the 1961–1990 reference value from the relevant observed annual value.

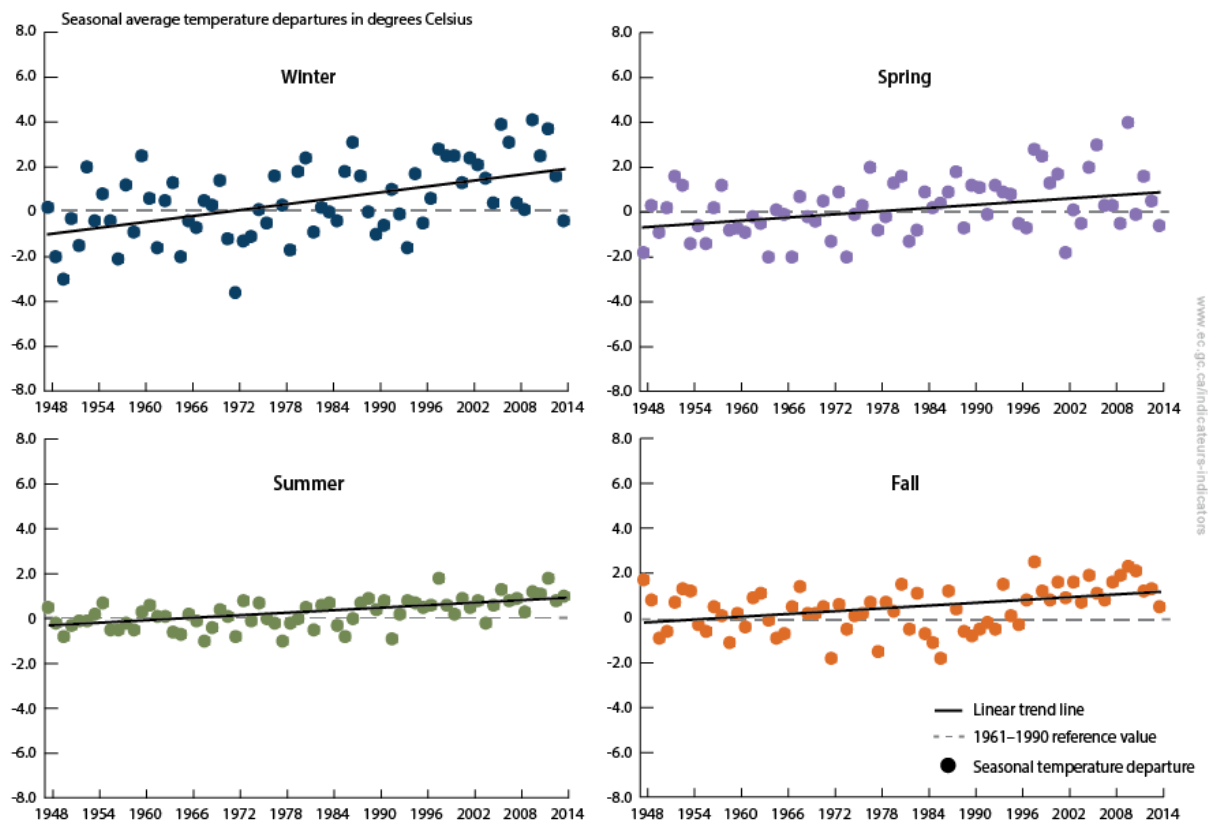
Note: Annual average temperature departures were computed for weather stations across Canada with sufficiently long data records to allow for trend calculation and were then interpolated to a 50-kilometre spaced grid. Annual grid points values were averaged together to produce an annual time series of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

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

Seasonal temperature change

Like the national annual average temperature, seasonal average temperature increased over the 67-year period (1948–2014). Among seasons, warming has been most pronounced for winter, with a 3°C warming trend detected over the 1948 to 2014 period. Warming trends of 1.6°C, 1.4°C and 1.5°C were detected for spring, summer and fall, respectively. The warmest winter and spring recorded were both in 2010.⁵ The warmest summer was in 2012, while the warmest fall was in 1998.

Figure 2. Seasonal average temperature departures compared with the 1961–1990 reference value, Canada, 1948 to 2014



[Data for Figure 2](#)

Note: Seasonal average temperature 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. Seasonal grid points values were averaged together to produce a seasonal time series of temperature departures representing the entire country. Seasons are defined as winter (December, January, and February), spring (March, April, and May), summer (June, July, and August) and fall (September, October, and November).

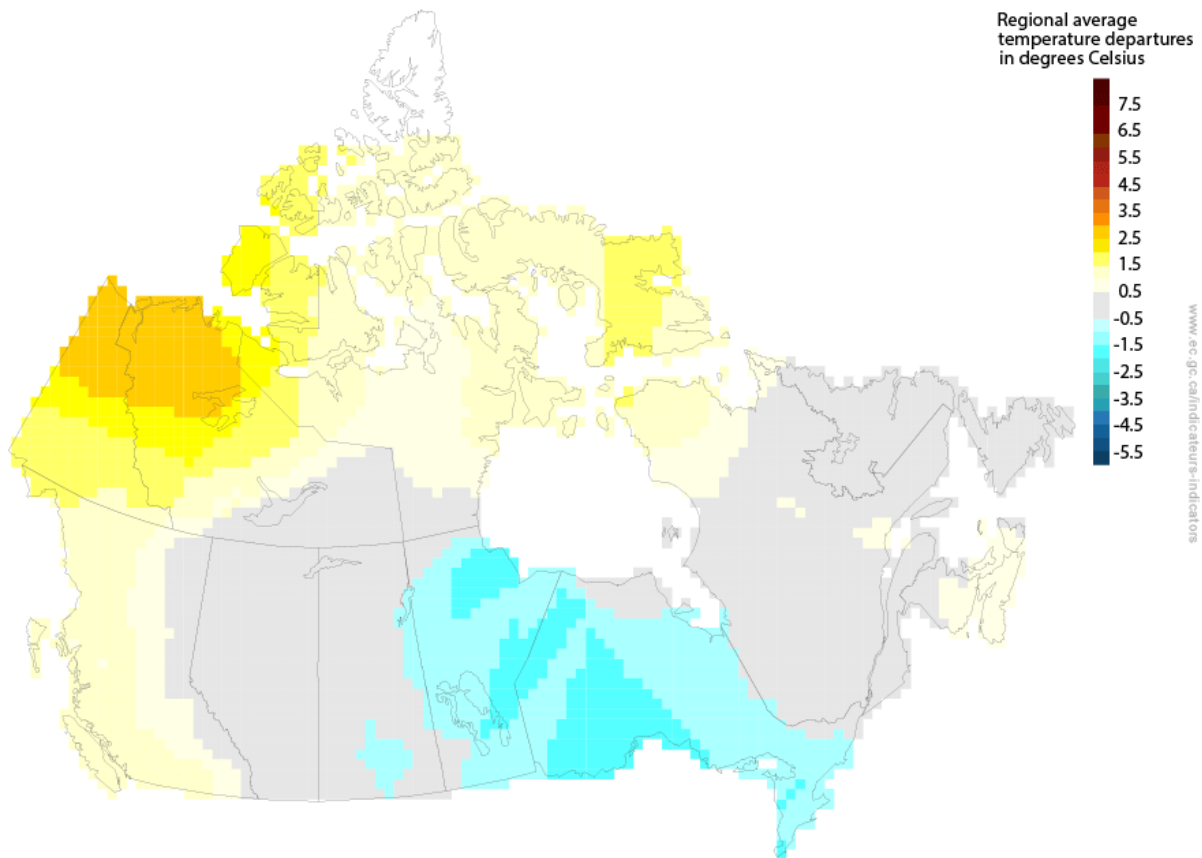
⁵ Winter 2010 includes the months of December 2009, January 2010 and February 2010.

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

Regional temperature change

In 2014, British Columbia, the territories and some areas in northern Quebec and the Maritimes had temperatures above the 1961–1990 reference value, while parts of Saskatchewan, Manitoba and Ontario had temperatures below the reference value. The rest of the country experienced temperatures near the reference value.

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



Note: Annual average temperature departures were computed for 338 weather stations across Canada and were then interpolated to a 50-kilometre spaced grid.

Source: Environment and Climate Change Canada (2015) [Canadian Gridded Temperature and Precipitation Anomalies](#) (CANGRD).

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

Introduction

The Temperature 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 Temperature Change in Canada indicator

Description

The Temperature Change in Canada indicator measures the yearly and seasonal surface air temperature departures for the years 1948 to 2014. An annual departure (or anomaly) is the difference between the value for a given year and a baseline value. The baseline values used in this indicator are the annual and seasonal temperature averages for the reference 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 temperature departures are measured in degrees Celsius (°C) and calculated using data from weather stations across Canada with sufficiently long data records to allow for a meaningful trend calculation.

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 Temperature Change in Canada indicator helps show how Canada's surface air temperature 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) uses surface air temperature, among other variables, to assess long-term changes in climate. Surface air temperature is considered by the WMO – Global Climate Observing System 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 Temperature 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 previous year, January and February), spring (March, April and May), summer (June, July and August) and fall (September, October and November).

Data completeness

The indicator is calculated using data from climate stations across Canada for the period 1948 to 2014. 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).

Data timeliness

The data are current up to 2014.

Methods

The Temperature Change in Canada indicator is based on the Environment and Climate Change Canada's gridded temperature 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.

The annual average temperature 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.

National and seasonal temperature departures were computed for 338 weather stations across Canada and were then interpolated to a 50-kilometre spaced grid. Grid points values were averaged together to produce the annual and seasonal time series of temperature departures representing the entire country. More information about the calculation method for annual average temperature departures can be found in the [Climate Trends and Variations Bulletin](#) documentation.

Statistical linear trends at the 95% confidence level were obtained by using the Mann-Kendall and SEN's methods (Kendall-tau).

Caveats and limitations

Breaks in the data can be a concern. To mitigate this, the Temperature Change in Canada indicator uses homogenized and adjusted station data for temperature. These data have been adjusted to account for discontinuities in the data from non-climatic factors, such as changes in observation methods or station location. Observations from nearby co-located stations are sometimes merged to produce longer time series.

Part 3. Annexes

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

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

Year	Temperature departure (degrees Celsius)	Warmest year ranking
1948	-0.2	49
1949	-0.2	50
1950	-1.3	66
1951	-0.6	61
1952	0.8	16
1953	0.8	17
1954	0.0	40
1955	-0.2	48
1956	-0.8	64
1957	-0.3	56
1958	0.5	26
1959	-0.4	57
1960	0.4	28
1961	-0.2	52
1962	0.0	42
1963	0.2	33
1964	-0.6	60
1965	-0.6	62
1966	-0.3	55
1967	-0.4	58
1968	0.2	35
1969	0.4	32
1970	-0.2	53
1971	0.0	41
1972	-2.0	67
1973	0.6	20
1974	-0.8	63
1975	-0.1	45
1976	0.0	38
1977	1.0	12
1978	-0.5	59
1979	-0.2	51
1980	0.4	29
1981	2.0	4
1982	-1.0	65
1983	0.1	36

Year	Temperature departure (degrees Celsius)	Warmest year ranking
1984	0.2	34
1985	0.0	43
1986	0.0	39
1987	1.5	9
1988	0.8	18
1989	-0.2	54
1990	-0.1	47
1991	0.4	30
1992	-0.1	46
1993	0.4	31
1994	0.5	27
1995	0.6	23
1996	0.0	44
1997	0.6	22
1998	2.3	3
1999	1.7	7
2000	0.9	13
2001	1.8	6
2002	0.5	24
2003	1.1	11
2004	0.0	37
2005	1.6	8
2006	2.4	2
2007	0.8	14
2008	0.6	21
2009	0.8	15
2010	3.0	1
2011	1.4	10
2012	1.8	5
2013	0.7	19
2014	0.5	25

Note: Annual average temperature 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 temperature 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 temperature departures compared with the 1961–1990 reference value, Canada, 1948 to 2014

Year	Winter temperature departure (degrees Celsius)	Spring temperature departure (degrees Celsius)	Summer temperature departure (degrees Celsius)	Fall temperature departure (degrees Celsius)
1948	0.2	-1.8	0.5	1.7
1949	-2.0	0.3	-0.2	0.8
1950	-3.0	-0.9	-0.8	-0.9
1951	-0.3	0.2	-0.3	-0.6
1952	-1.5	1.6	-0.1	0.7
1953	2.0	1.2	-0.1	1.3
1954	-0.4	-1.4	0.2	1.2
1955	0.8	-0.6	0.7	-0.3
1956	-0.4	-1.4	-0.5	-0.6
1957	-2.1	0.2	-0.5	0.5
1958	1.2	1.2	-0.2	0.1
1959	-0.9	-0.8	-0.5	-1.1
1960	2.5	-0.7	0.3	0.2
1961	0.6	-0.9	0.6	-0.4
1962	-1.6	-0.2	0.1	0.9
1963	0.5	-0.5	0.1	1.1
1964	1.3	-2.0	-0.6	-0.1
1965	-2.0	0.1	-0.7	-0.9
1966	-0.4	-0.1	0.2	-0.7
1967	-0.7	-2.0	-0.1	0.5
1968	0.5	0.7	-1.0	1.4
1969	0.3	-0.2	-0.4	0.2
1970	1.4	-0.4	0.4	0.2
1971	-1.2	0.5	0.1	0.5
1972	-3.6	-1.3	-0.8	-1.8
1973	-1.3	0.9	0.8	0.6
1974	-1.1	-2.0	-0.1	-0.5
1975	0.1	-0.1	0.7	0.1
1976	-0.5	0.3	0.0	0.2
1977	1.6	2.0	-0.2	0.7
1978	0.3	-0.8	-1.0	-1.5
1979	-1.7	-0.2	-0.2	0.7
1980	1.8	1.3	0.0	0.3
1981	2.4	1.6	0.5	1.5
1982	-0.9	-1.3	-0.5	-0.5
1983	0.2	-0.8	0.6	1.1
1984	0.0	0.9	0.7	-0.7
1985	-0.4	0.2	-0.3	-1.1
1986	1.8	0.4	-0.8	-1.8
1987	3.1	0.9	0.0	1.2

Year	Winter temperature departure (degrees Celsius)	Spring temperature departure (degrees Celsius)	Summer temperature departure (degrees Celsius)	Fall temperature departure (degrees Celsius)
1988	1.6	1.8	0.7	0.4
1989	0.0	-0.7	0.9	-0.6
1990	-1.0	1.2	0.4	-0.8
1991	-0.6	1.1	0.8	-0.5
1992	1.0	-0.1	-0.9	-0.2
1993	-0.1	1.2	0.2	-0.5
1994	-1.6	0.9	0.8	1.5
1995	1.7	0.8	0.7	0.1
1996	-0.5	-0.5	0.5	-0.3
1997	0.6	-0.7	0.6	0.8
1998	2.8	2.8	1.8	2.5
1999	2.5	2.5	0.6	1.2
2000	2.5	1.3	0.2	0.8
2001	1.3	1.7	0.9	1.6
2002	2.4	-1.8	0.5	0.9
2003	2.1	0.1	0.8	1.6
2004	1.5	-0.5	-0.2	0.7
2005	0.4	2.0	0.6	1.9
2006	3.9	3.0	1.3	1.1
2007	3.1	0.3	0.8	0.8
2008	0.4	0.3	0.9	1.6
2009	0.1	-0.5	0.3	1.9
2010	4.1	4.0	1.2	2.3
2011	2.5	-0.1	1.1	2.1
2012	3.7	1.6	1.8	1.2
2013	1.6	0.5	0.8	1.3
2014	-0.4	-0.6	1.0	0.5

Note: Seasonal average temperature 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. Seasonal grid points values were averaged together to produce a seasonal time series of temperature departures representing the entire country. Seasons are defined as winter (December, January, and February), spring (March, April, and May), summer (June, July, and August) and fall (September, October, and November).

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

Annex B. References and additional information

References and further reading

Environment and Climate Change Canada (2015) [Adjusted and Homogenized Canadian Climate Data](#) (AHCCD). Retrieved on January 25, 2016.

Environment and Climate Change Canada (2016) [Climate Trends and Variations Bulletin](#). Retrieved on January 25, 2016.

Environment and Climate Change Canada (2015) [Climate Trends and Variations Bulletin – Annual for 2014](#). Retrieved on January 25, 2016.

Related information

[American Meteorological Society – State of the climate in 2014](#)
[Precipitation Change in Canada](#)

www.ec.gc.ca

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