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# GREENHOUSE GAS CONCENTRATIONS

CANADIAN ENVIRONMENTAL  
SUSTAINABILITY INDICATORS



Canada 

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Environment and Climate Change Canada  
Public Inquiries Centre  
12th Floor Fontaine Building  
200 Sacré-Coeur Blvd  
Gatineau QC K1A 0H3  
Telephone: 1-800-668-6767 (in Canada only) or 819-938-3860  
Fax: 819-938-3318  
Email: [ec.enviroinfo.ec@canada.ca](mailto:ec.enviroinfo.ec@canada.ca)

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# CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS GREENHOUSE GAS CONCENTRATIONS

**June 2021**

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## Greenhouse gas concentrations

Greenhouse gases (GHGs) are gases that absorb energy from the sun and trap heat in the Earth's atmosphere. Without GHGs, Earth's average temperature would be around -18 degrees Celsius, rather than the current average of 15 degrees Celsius. The Earth's natural greenhouse gas effect is one key parameter that makes the planet livable for humans. Human activities, such as the burning of fossil fuels, agriculture practices and industrialization, put more greenhouse gases into our atmosphere and are changing Earth's natural greenhouse effect. As concentrations of greenhouse gases increase in the atmosphere, more heat is trapped and atmospheric temperatures rise. The indicators present atmospheric concentrations as measured from sites in Canada and at a global scale for 2 greenhouse gases: carbon dioxide and methane.

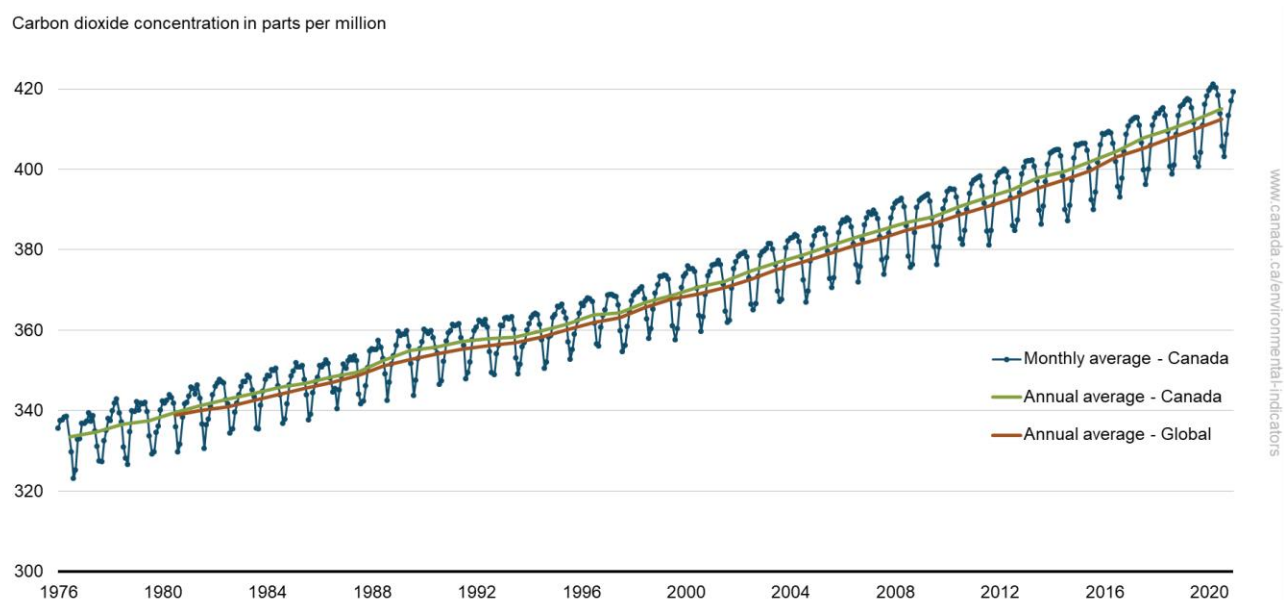
### Carbon dioxide concentration in the atmosphere

Carbon dioxide (CO<sub>2</sub>) is the single most important greenhouse gas. It is responsible for approximately 65 % of the radiative forcing that is currently observed.<sup>1</sup>

#### Key results

- Globally, annual average carbon dioxide (CO<sub>2</sub>) concentrations increased by 22%, from 338.9 parts per million (ppm) to 412.4 ppm between 1980 to 2020
- Over the period spanning 1976 to 2020, the annual average concentration of CO<sub>2</sub> increased by 24%, from 333.4 parts per million (ppm) to 415.0 ppm
- In 2020, the average concentration of CO<sub>2</sub> in Canada was 415.0 ppm, up from 412.3 ppm in 2019
- Annual changes of CO<sub>2</sub> concentrations observed in Canada are similar to changes observed globally

**Figure 1. Carbon dioxide concentration, Canada and global, 1976 to 2020**



[Data for Figure 1](#)

**Note:** From 1976 to 1999, averages were calculated based on data from 2 to 3 sampling stations. Since 1999, data from 5 sampling stations are used to represent CO<sub>2</sub> concentrations. Global annual averages are based on measurements from sampling stations that are part of the [Global Greenhouse Gas Reference Network](#).

<sup>1</sup> Earth's long-term climate is regulated by a balance between energy arriving from the sun and energy leaving the Earth through radiation. The radiative forcing is defined as the difference between incoming and outgoing radiation due to an external factor. If the incoming energy is greater than the outgoing, the radiative forcing is positive and the Earth will warm.

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#) and National Oceanic and Atmospheric Administration (2021) [Global Monitoring Laboratory - Trends in Atmospheric Carbon Dioxide](#).

In 2020, the global average concentration of CO<sub>2</sub> reached a new high of 412.4 ppm, up from 410.1 ppm in 2019. Prior to 1750, which was known as the pre-industrial era, global CO<sub>2</sub> concentrations were about 278 ppm.<sup>2</sup>

In Canada, the annual change in CO<sub>2</sub> has increased from around 1.5 ppm per year in the 1990s to over 2 ppm per year in the last decade. Seasonal cycles can also be observed with lower concentrations in summer due to photosynthetic uptake (plants remove CO<sub>2</sub> from the atmosphere) and higher concentrations in winter (plants release CO<sub>2</sub> by respiration).

The confinement measures introduced in 2020 due to the pandemic created an industrial slowdown and important reductions in travel by air and land. This new situation resulted in a reduction in anthropogenic CO<sub>2</sub> emissions. Preliminary estimates anticipate a reduction of between 4.2% and 7.5% compared to 2019 CO<sub>2</sub> emissions. However, such a reduction in emissions will not have a significant effect on the global CO<sub>2</sub> average concentration and will only slightly slow down the rate of increase of the global CO<sub>2</sub> concentration. The impact on the CO<sub>2</sub> concentration is expected to be smaller than, or at most, similar to the natural year-to-year fluctuations.<sup>3</sup>

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<sup>2</sup> World Meteorological Organization (2019) [WMO Greenhouse Gases Bulletin](#). Retrieved on October 27, 2020.

<sup>3</sup> World Meteorological Organization (2020) [WMO Greenhouse Gases Bulletin](#). Retrieved on January 26, 2021.

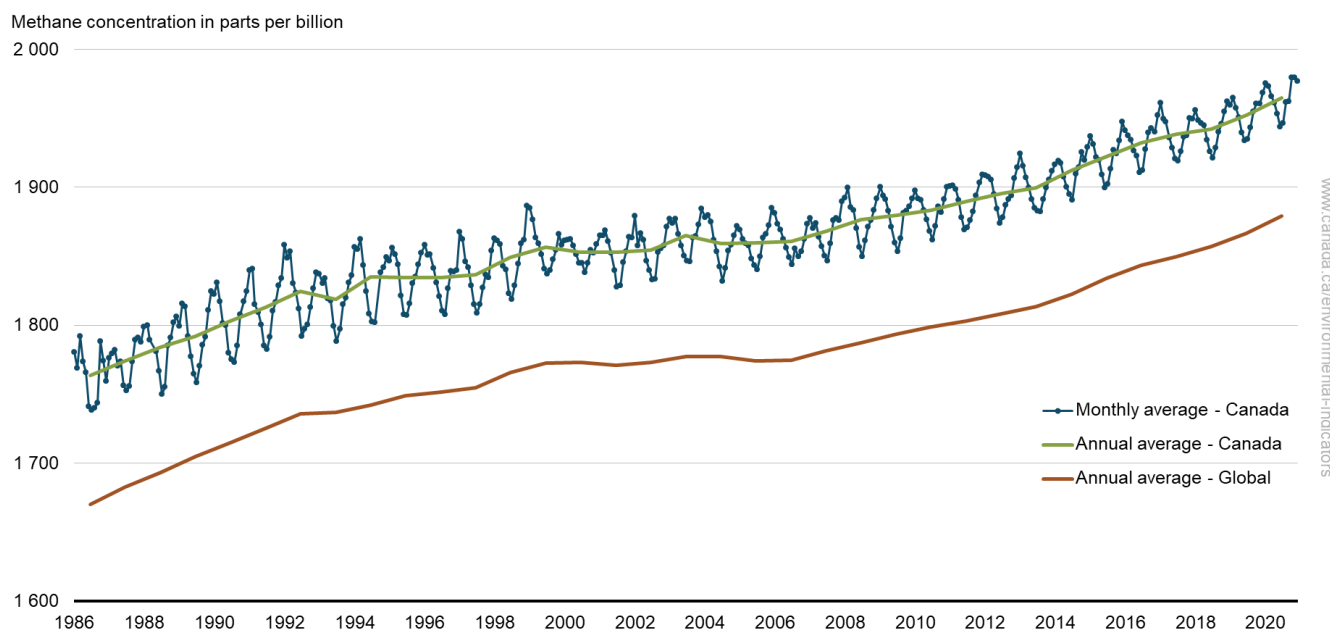
## Methane concentration in the atmosphere

Methane (CH<sub>4</sub>) is the second most important greenhouse gas generated by human activity. It is currently responsible for approximately 17 % of the radiative forcing.<sup>4</sup>

### Key results

- Globally, annual average methane (CH<sub>4</sub>) concentrations increased by 13%, from 1 670 parts per billion (ppb) to 1 879 ppb between 1986 to 2020
- Over the period spanning 1986 to 2020, the annual average concentration of CH<sub>4</sub> increased by 11%, from 1 764 ppb to 1 965 ppb at sites in Canada
- In 2020, the average concentration of CH<sub>4</sub> was 1 965 ppb, up from 1 952 ppb in 2019 in Canada
- Annual changes in observed CH<sub>4</sub> concentrations in Canada are similar to annual changes observed over the globe, but the magnitude is typically around 80 ppb higher, due to greater abundance of both natural- and human-caused sources of methane in the northern hemisphere

**Figure 2. Methane concentration, Canada and global, 1986 to 2020**



[Data for Figure 2](#)

**Note:** From 1986 to 1999, averages were calculated based on data from 1 to 2 sampling stations. Since 1999, data from 5 sampling stations are used to represent CH<sub>4</sub> concentrations. Global annual averages are based on measurements from sampling stations that are part of the [Global Greenhouse Gas Reference Network](#).

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#) and National Oceanic and Atmospheric Administration (2021) [Global Monitoring Laboratory - Trends in Atmospheric Methane](#).

In 2020, the global average concentration of CH<sub>4</sub> reached a new high of 1 879 ppb, an increase of 13 ppb from 2019. This increase is higher than the increase of 9 ppb observed in the period from 2018 to 2019 and the average annual increase over the past decade. Pre-industrial global CH<sub>4</sub> concentrations were about 720 ppb.<sup>5</sup>

<sup>4</sup> Earth's long-term climate is regulated by a balance between energy arriving from the sun and energy leaving the Earth through radiation. The radiative forcing is defined as the difference between incoming and outgoing radiation due to an external factor. If the incoming energy is greater than the outgoing, the radiative forcing is positive and the Earth will warm.

<sup>5</sup> World Meteorological Organization (2019) [WMO Greenhouse Gases Bulletin](#). Retrieved on October 27, 2020.

From 2007 to 2020, average increases in CH<sub>4</sub> in Canada were 8 ppb per year. Although no definitive causes have been identified to explain this increase, stable isotope<sup>6</sup> measurements of atmospheric CH<sub>4</sub> strongly suggest that increases in wetland emissions in the tropics may be responsible.

Methane concentrations are higher in the northern hemisphere because both natural and human caused sources of methane are more abundant there. Globally, approximately 40% of the CH<sub>4</sub> emitted to the atmosphere is from natural sources such as wetlands. The remaining 60% of emissions are due to anthropogenic (human caused) sources such as cattle ranching, agriculture, fossil fuels and landfills.

## About the indicators

### What the indicators measure

The indicators show the trends in concentrations for 2 greenhouse gases: carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Concentrations are presented on monthly and annual bases for Canada. The indicators also include the global annual average concentrations.

### Why these indicators are important

Greenhouse gases trap heat in the Earth's atmosphere, just as the glass of a greenhouse keeps warm air inside. Human activity increases the amount of GHGs in the atmosphere, contributing to a warming of the Earth's surface. This is called the enhanced greenhouse effect. The release of GHGs and their increasing concentrations in the atmosphere are having significant impacts on the environment, human health and the economy. Consult [Greenhouse gas emissions: drivers and impacts](#) for information on the human health, environmental and economic impacts of greenhouse gas emissions.

These indicators serve to identify trends and seasonal variability of carbon dioxide and methane concentrations in Canada. They provide a coherent and consistent picture of the current and past states of these 2 greenhouse gases in the atmosphere, as a result of changing atmospheric transport patterns, emissions from natural sources and emissions to the atmosphere due to human activities.

GHG measurements improve our understanding of natural and anthropogenic sources of GHGs, the role of GHGs in warming the atmosphere, as well as the processes that govern the transport and fate of GHGs in the biosphere. GHG measurements in the atmosphere complement other key indicators used to assess progress in mitigating climate change by reducing GHG emissions. Since GHGs are long-lived in the atmosphere, atmospheric measurements are an indicator of the global and domestic efforts to date to address GHG emissions.

### Related indicators

The [Greenhouse gas emissions](#) indicators report trends in total anthropogenic (human-made) GHG emissions at the national level, per person and per unit gross domestic product, by province and territory and by economic sector.

The [Global greenhouse gas emissions](#) indicator provides a global perspective on Canada's share of global GHG emissions.

The [Carbon dioxide emissions from a consumption perspective](#) indicator shows the impact of Canada's consumption of goods and services, regardless of where they are produced, on the levels of carbon dioxide released into the atmosphere.

The [Progress towards Canada's greenhouse gas emissions reduction target](#) indicator provides an overview of Canada's projected GHG emissions up to 2030.

The [Greenhouse gas emissions from large facilities](#) indicator reports GHG emissions from the largest GHG emitters in Canada (industrial and other types of facilities).

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<sup>6</sup> Chemical molecules are made of elements and each element can have different forms, called isotopes. The isotopes differ in mass and physical properties, but have the same chemical properties. Methane (CH<sub>4</sub>) contains two elements, carbon and hydrogen, each of which has two stable isotopes. The isotopes analysis can help determine the origin of the molecules.



## Data sources and methods

### Data sources

Concentration data used for these indicators were retrieved from the [Canadian Greenhouse Gas Measurement Program](#) of the Climate Research Division of Environment and Climate Change Canada. The indicators are calculated using the greenhouse gas concentrations measured at the Alert (NU), Sable Island (NS), Estevan/Cape St. James (BC), Fraserdale (ON) and Candle Lake/East Trout Lake (SK) monitoring stations. The final ambient concentrations of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) are averaged to estimate the annual and monthly indicators values.

Global average annual concentrations were obtained from the National Oceanic and Atmospheric Administration's [Global Monitoring Laboratory](#) (NOAA/GML), which developed the [Carbon Cycle Greenhouse Gases](#) research program.

### More information

#### Canadian Greenhouse Gas Monitoring Network

Environment and Climate Change Canada has been continually building a long-term observation network for atmospheric measurements of CO<sub>2</sub>, CH<sub>4</sub> and carbon monoxide (CO), which currently stands at 16 core continuous observational ground-based sites. These sites are spread across the country in coastal, interior and arctic regions, with the aim of providing high quality data to observe and monitor natural sources and sinks, and anthropogenic (human-caused) sources of greenhouse gases in Canada. [Table A.5](#) provides more specific information on each of the stations.

The data used for the indicators were measured at 3 coastal sites and 2 mid-continental forest sites that are part of the Canadian Greenhouse Gas Monitoring Network.

The coastal sites are located at:

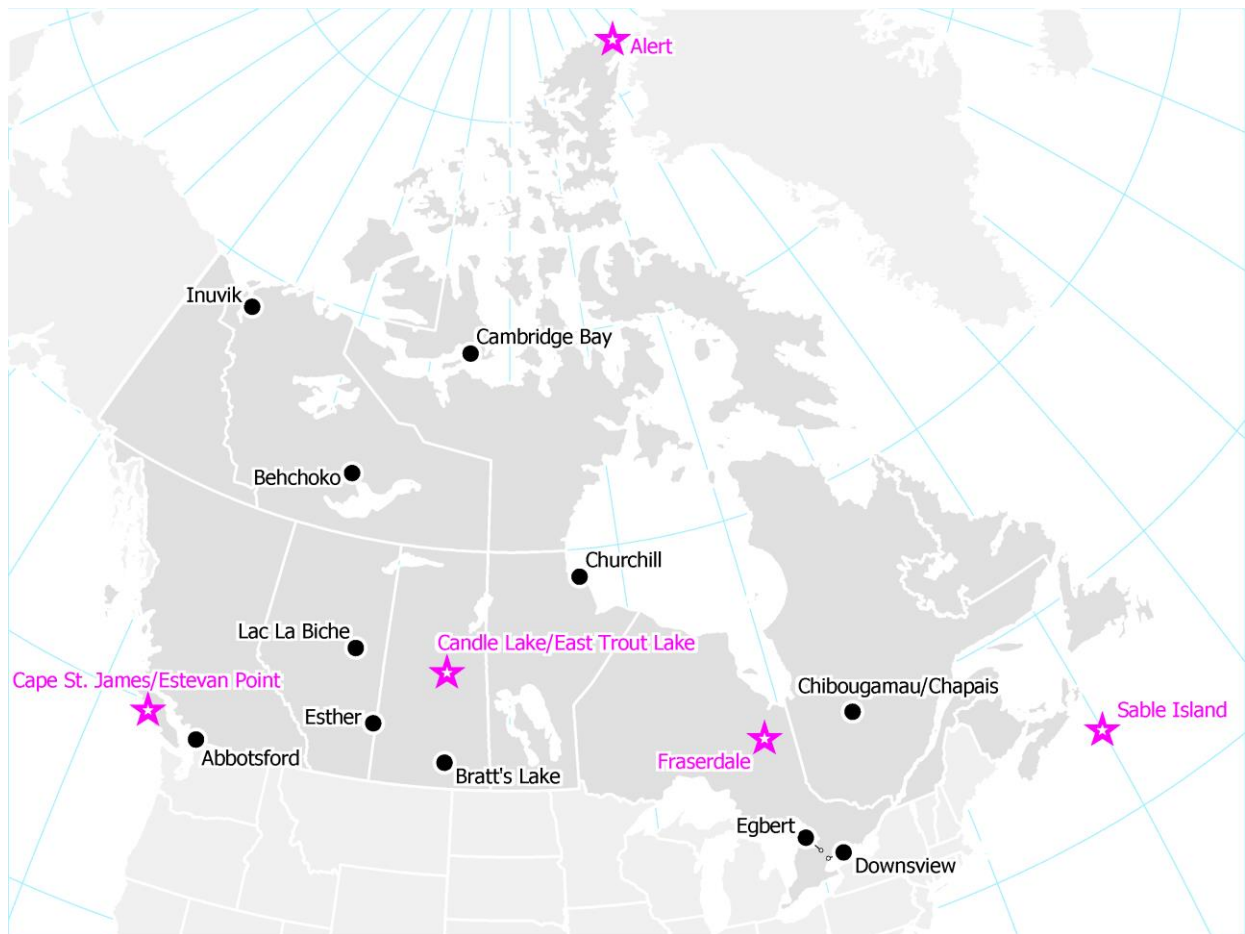
- Alert (NU), on Ellesmere Island in the Canadian high Arctic,
- Sable Island (NS), located in the Atlantic Ocean,
- Estevan Point (BC), a lighthouse station located on the coastline of Vancouver Island. Estevan Point became the replacement station for Cape St. James in 1992, when the weather station at Cape St. James was automated and no longer required a manned presence on site.

The mid-continental forest monitoring stations are situated in:

- Fraserdale (ON), located 150 km north of Timmins (ON),
- Candle Lake (SK), located 150 km north-east of Prince Albert (SK). After 3 years of operation, East Trout Lake became the replacement station for Candle Lake in 2005.

The Alert Station is also an official World Meteorological Organization Global Atmosphere Watch Program (WMO-GAW) station, one of 26 global stations around the world. Alert is the most northerly site in the WMO-GAW Network. The Alert site is also one of three sites, along with Mauna Loa and Cape Grim, which have been identified by the WMO-GAW as official greenhouse gas intercomparison sites.

**Figure 3. Greenhouse gas concentration monitoring stations in Canada, 2020**



**Note:** The map displays the 16 primary long-term greenhouse gas concentration monitoring stations in Canada. The 5 sites of Alert (NU), Sable Island (NS), Fraserdale (ON), Candle Lake/East Trout Lake (SK) and Cape St. James/Estevan Point used in the indicators are shown using pink stars. The 3 terminated stations of Cape St. James, Candle Lake and Chibougamau are also shown.

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#).

### Temporal coverage

The indicator presenting the carbon dioxide (CO<sub>2</sub>) concentrations covers the period from 1976 to 2020. However, no data on global CO<sub>2</sub> concentrations were available from 1976 to 1980.

The methane (CH<sub>4</sub>) concentrations were calculated using data for the years 1986 to 2020.

### Data availability

Greenhouse gas observations at the 5 monitoring stations are all currently monitored continuously and provide hourly, daily and monthly data. Prior to 1988, carbon dioxide (CO<sub>2</sub>) observations were monitored using weekly grab (flask) sampling procedures.

Data availability varies by station and by greenhouse gas over time. Table 1 shows the time periods for which data are available for each greenhouse gas at the 5 monitoring stations.

**Table 1 Data availability by greenhouse gas and monitoring station**

Greenhouse gas	Time period	Monitoring stations
Carbon dioxide	1976 to 2020	Alert and Sable Island
Carbon dioxide	1979 to 2020	Cape St. James/Estevan Point
Carbon dioxide	1999 to 2020	Fraserdale
Carbon dioxide	2002 to 2020	Candle Lake/East Trout Lake
Methane	1985 to 2020	Alert
Methane	1990 to 2020	Fraserdale
Methane	1999 to 2020	Sable Island, Cape St. James/Estevan Point
Methane	2002 to 2020	Candle Lake/East Trout Lake

**Global concentrations from the Carbon Cycle Greenhouse Gases research program**

The [Carbon Cycle Greenhouse Gases](#) (CCGG) research program from the National Oceanic and Atmospheric Administration's Global Monitoring Laboratory operates the [Global Greenhouse Gas Reference Network](#), measuring the atmospheric distribution and trends of the 3 main long-term drivers of climate change, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), as well as carbon monoxide (CO).

**Methods**

The monthly and annual concentrations are an average of the daily values over the corresponding period of time.

**More information****Carbon dioxide**

The continuous measurement of carbon dioxide (CO<sub>2</sub>) follows the set of [principles and protocols](#) established by the World Meteorological Organization (WMO). The atmospheric CO<sub>2</sub> observational programs at Alert, Fraserdale, Candle Lake/East Trout Lake, Sable Island and Cape St. James/Estevan Point were all initially based on non-dispersive infrared (NDIR) methodology. A rigorous set of measurement calibrations and data processing are in place to obtain valid ambient 5 minute data measurements. Hourly, daily, monthly and annual data are then estimated from the 5 minute values. Starting in 2009, Cavity Ring-Down Spectrometer (CRDS) analytical setups for CO<sub>2</sub> were beginning to be introduced to the network. The CRDS instruments provide similar measurement precision as NDIR methodology, however, the CRDS systems contain an overall simpler design, are simpler to operate and require much less effort to maintain. In addition, the measurements of methane (CH<sub>4</sub>) and carbon monoxide (CO) are available on the same single CRDS system. Hourly, daily, monthly and annual data are estimated from the 1 minute CRDS values. All CO<sub>2</sub> measurements are directly traceable to the international absolute WMO x2007 mole fraction scale maintained by the WMO Central Calibration Laboratory (CCL) at the National Oceanic and Atmospheric Administration's Earth System Research Laboratories calibration facilities in Boulder, Colorado.

For the earlier parts of the record, CO<sub>2</sub> was also sampled weekly with flasks using NDIR methodology. As for the continuous method, many calibration steps are executed in order to obtain the final measured values. For more information on the flask CO<sub>2</sub> NDIR and continuous CO<sub>2</sub> NDIR and CRDS measurement procedures and data processing please consult the [parameter metadata](#) section for the Environment and Climate Change Canada network on the World Data Centre for Greenhouse Gases website.

## Methane

The atmospheric methane (CH<sub>4</sub>) observational measurements at Alert, Fraserdale, Candle Lake/East Trout Lake, Sable Island and Cape St. James/Estevan Point were all initially made using a gas chromatography technique equipped with a flame ionization detector (FID). As noted, starting in 2009 Cavity Ring-Down Spectrometer (CRDS) analytical setups for CH<sub>4</sub> were being introduced to the network. All CH<sub>4</sub> measurements are reported in 10<sup>-9</sup> mol CH<sub>4</sub> per mol of dry air [nmol/mol] or parts per billion [ppb] and directly traceable to the international absolute WMO x2004 CH<sub>4</sub> mole fraction scale maintained by the WMO Central Calibration Laboratory (CCL) at the National Oceanic and Atmospheric Administration's Earth System Research Laboratories calibration facilities in Boulder, Colorado.

For more information on the continuous CH<sub>4</sub> measurements procedures and data manipulation please consult the [parameter metadata](#) section for the Environment and Climate Change Canada network on the World Data Centre for Greenhouse Gases website.

### Global annual concentrations

The global estimate is based on measurements from a subset of network sites. Only sites where samples are predominantly of well-mixed marine boundary layer (MBL) air representative of a large volume of the atmosphere are considered. Measurements from sites close to anthropogenic and natural sources and sinks are excluded from the global estimate.

Global averages are constructed by first fitting a smoothed curve as a function of time to each site, and then the smoothed value for each site is plotted as a function of latitude for 48 equal time steps per year. A global average is calculated from the latitude plot at each time step. For more details on the methodology used, please consult National Oceanic and Atmospheric Administration's [Global Monitoring Laboratory](#) website.

## Caveats and limitations

Given greenhouse gas (GHG) are long-lived in the atmosphere and are transported globally from the site of emission, these indicators are an integrated measure of global and domestic GHG emissions to the atmosphere. For more information on Canada's emissions, and to assess Canada's progress in reducing its emissions, please refer to the [related indicators](#) which present information on greenhouse gas emissions in Canada.

For both carbon dioxide and methane concentrations, the number of monitoring stations used in the analyses increased in 1999. The change in the number of monitoring sites may have influenced calculations of the average values and make it difficult to compare trends prior and post 1999. In the particular case of methane concentrations, values prior to 1999 were based on data from 1 station and may not be representative of the concentrations over Canada.

## Resources

### References

Environment and Climate change Canada (2017) [Canadian Greenhouse Gas Measurement Program](#). Retrieved on November 19, 2020.

Intergovernmental Panel on Climate Change (2013) [Climate change 2013: The physical science basis. contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change](#). Retrieved on November 19, 2020.

National Oceanic and Atmospheric Administration (2020) [Carbon cycle greenhouse gases](#). Retrieved on November 19, 2020.

National Oceanic and Atmospheric Administration (2021) [Global monitoring laboratory - Trends in atmospheric carbon dioxide](#). Retrieved on June 1, 2021.

World Data Centre for Greenhouse Gases (2018) [Data archive](#). Retrieved on November 19, 2020.

World Meteorological Organization (2019) [WMO Greenhouse Gases Bulletin](#). Retrieved on October 27, 2020.

World Meteorological Organization (2020) [Global Atmosphere Watch](#). Retrieved on November 19, 2020.

World Meteorological Organization (2020) [WMO Greenhouse Gases Bulletin](#). Retrieved on January 26, 2021.

### Related information

[Canada's action on climate change](#)

[Canada's changing climate report](#)

[Climate change](#)

[Greenhouse gas emissions](#)

[Greenhouse gas emissions: drivers and impacts](#)

## Annex

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

- Table A.1. Annual data for Globally, annual average carbon dioxide (CO<sub>2</sub>) concentrations increased by 22%, from 338.9 parts per million (ppm) to 412.4 ppm between 1980 to 2020
- Over the period spanning 1976 to 2020, the annual average concentration of CO<sub>2</sub> increased by 24%, from 333.4 parts per million (ppm) to 415.0 ppm
- In 2020, the average concentration of CO<sub>2</sub> in Canada was 415.0 ppm, up from 412.3 ppm in 2019
- Annual changes of CO<sub>2</sub> concentrations observed in Canada are similar to changes observed globally

**Figure 1. Carbon dioxide concentration, Canada and global, 1976 to 2020**

Year	Carbon dioxide concentration - Canada (parts per million)	Carbon dioxide concentration - Global (parts per million)
1976	333.4	n/a
1977	334.6	n/a
1978	336.5	n/a
1979	337.5	n/a
1980	339.6	338.9
1981	341.2	340.1
1982	342.8	340.9
1983	344.2	342.5
1984	345.8	344.1
1985	346.9	345.6
1986	348.4	347.0
1987	349.5	348.7
1988	352.6	351.2
1989	355.0	352.8
1990	355.8	354.1
1991	357.2	355.4
1992	357.8	356.1
1993	358.3	356.8
1994	359.8	358.3
1995	361.6	360.2
1996	363.8	361.9
1997	364.4	363.1
1998	366.9	365.7

Year	Carbon dioxide concentration - Canada (parts per million)	Carbon dioxide concentration - Global (parts per million)
1999	368.6	367.8
2000	370.7	369.0
2001	372.1	370.6
2002	374.7	372.6
2003	376.8	375.1
2004	378.7	377.0
2005	380.9	379.0
2006	383.1	381.1
2007	385.0	382.9
2008	386.8	385.0
2009	388.2	386.5
2010	390.9	388.8
2011	393.0	390.6
2012	395.0	392.7
2013	397.9	395.4
2014	399.5	397.3
2015	401.9	399.7
2016	404.6	403.1
2017	407.8	405.2
2018	409.9	407.6
2019	412.3	410.1
2020	415.0	412.5

**Note:** n/a: not available. From 1976 to 1999, averages were calculated based on data from 2 to 3 sampling stations. Since 1999, data from 5 sampling stations are used to represent CO<sub>2</sub> concentrations. Global annual averages are based on measurements from sampling stations that are part of the [Global Greenhouse Gas Reference Network](#).

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#) and National Oceanic and Atmospheric Administration (2021) [Global Monitoring Laboratory - Trends in Atmospheric Carbon Dioxide](#).

**Table A.2. Monthly data for Figure 1. Carbon dioxide concentration, Canada, 1976 to 2020**

<b>Year/ Month</b>	<b>January (parts per million)</b>	<b>February (parts per million)</b>	<b>March (parts per million)</b>	<b>April (parts per million)</b>	<b>May (parts per million)</b>	<b>June (parts per million)</b>	<b>July (parts per million)</b>	<b>August (parts per million)</b>	<b>September (parts per million)</b>	<b>October (parts per million)</b>	<b>November (parts per million)</b>	<b>December (parts per million)</b>
1976	335.6	337.5	337.6	338.3	338.5	n/a	329.6	323.1	325.2	332.8	332.9	336.8
1977	336.8	337.3	339.3	337.3	338.7	334.8	331.0	327.3	327.3	332.5	335.1	337.9
1978	337.4	339.9	341.9	342.8	339.3	337.1	330.9	328.1	326.6	334.7	339.9	339.8
1979	342.2	340.0	341.8	341.6	342.0	339.8	333.6	329.2	329.6	334.5	336.1	340.1
1980	342.3	341.9	342.6	343.8	343.2	341.9	335.8	329.7	331.7	338.3	341.7	342.0
1981	343.5	345.8	345.5	344.0	346.4	343.0	336.6	330.6	336.4	337.8	341.1	344.0
1982	346.0	346.8	347.6	347.2	346.8	342.6	341.7	334.4	335.3	339.5	341.8	343.9
1983	346.0	347.2	347.2	348.7	348.3	345.1	343.4	335.5	335.3	341.3	344.8	347.7
1984	348.8	348.6	350.1	350.0	350.5	346.1	343.9	336.8	337.8	341.7	346.3	348.6
1985	349.8	351.9	350.9	350.8	351.1	347.8	343.8	337.6	339.0	344.3	347.1	348.2
1986	351.2	350.8	351.4	352.6	351.7	348.1	344.6	345.4	340.4	345.0	348.5	351.4
1987	350.5	352.4	353.3	352.6	353.7	352.4	344.1	341.6	342.3	346.1	350.7	354.7
1988	355.3	355.2	355.2	357.3	355.7	352.9	349.1	342.6	347.1	351.5	353.5	356.2
1989	359.7	358.6	358.9	359.0	359.8	355.9	351.7	343.7	347.5	352.9	355.3	357.1
1990	360.1	359.7	359.0	359.8	358.2	355.7	354.2	346.5	347.4	352.1	357.2	359.3
1991	359.9	361.3	361.1	361.2	361.5	358.1	356.1	347.9	349.5	352.0	357.5	359.9
1992	360.8	362.4	362.1	361.4	362.5	360.6	354.5	349.4	348.9	354.1	356.2	361.2
1993	361.1	363.0	363.2	362.8	363.2	360.2	353.1	349.1	351.5	355.9	356.9	360.0
1994	361.6	363.2	363.9	364.1	363.8	361.4	357.5	350.5	352.1	358.3	358.6	363.1
1995	363.8	365.9	365.7	366.3	364.5	363.0	357.1	352.7	355.1	358.9	362.3	364.2
1996	366.6	366.0	367.3	367.9	367.7	367.0	361.8	356.5	356.0	360.7	363.6	365.1
1997	368.7	368.9	368.8	368.4	368.3	366.2	359.9	354.7	356.2	360.8	364.6	367.2
1998	368.6	369.3	369.6	370.2	370.8	367.8	362.8	357.9	360.4	365.2	369.1	371.2
1999	373.3	373.4	373.6	373.4	372.6	368.3	361.0	357.6	360.4	366.4	370.5	373.3
2000	373.9	375.9	375.3	375.3	374.5	370.4	363.7	359.6	363.3	368.8	373.5	374.5
2001	376.1	376.2	376.4	377.3	376.3	371.4	364.6	361.8	362.5	370.3	375.3	376.9
2002	378.4	378.9	379.1	379.5	378.1	373.1	366.5	364.9	366.5	373.4	378.6	379.4
2003	379.7	380.3	381.5	381.4	380.0	376.3	369.6	367.1	367.6	375.5	380.4	382.1

Year/ Month	January (parts per million)	February (parts per million)	March (parts per million)	April (parts per million)	May (parts per million)	June (parts per million)	July (parts per million)	August (parts per million)	September (parts per million)	October (parts per million)	November (parts per million)	December (parts per million)
2004	382.8	383.1	383.7	383.4	382.0	378.3	372.4	366.9	369.7	377.1	381.1	383.5
2005	384.7	385.2	385.0	385.4	383.7	379.6	372.8	370.5	372.9	379.9	384.2	386.6
2006	387.4	387.0	387.9	387.4	385.6	381.5	376.3	371.9	375.7	382.5	386.2	388.0
2007	389.3	388.8	389.9	389.0	387.7	383.2	377.5	373.9	378.1	384.2	387.9	390.4
2008	391.5	392.0	392.3	392.7	390.6	385.9	378.4	375.6	376.2	384.2	390.4	392.2
2009	392.8	393.1	393.4	393.7	392.1	387.9	380.8	376.3	380.6	385.9	390.2	392.3
2010	394.4	395.1	394.9	395.0	393.1	389.1	382.7	381.4	384.8	389.9	394.0	396.4
2011	397.3	397.6	397.9	398.3	395.9	391.6	384.7	381.2	384.7	391.2	396.7	398.4
2012	399.2	399.5	399.9	399.5	397.9	392.9	386.0	384.8	387.4	394.1	398.9	400.5
2013	401.8	402.1	402.1	402.3	400.7	397.0	389.8	386.2	390.8	396.9	401.2	404.0
2014	404.3	404.7	404.9	404.9	403.3	398.3	390.0	387.2	391.0	397.3	402.7	406.0
2015	405.9	406.2	406.5	406.4	404.7	400.2	392.3	390.0	394.3	401.8	406.0	408.9
2016	408.6	409.0	409.4	409.0	406.5	401.9	395.7	393.1	397.8	404.3	408.6	410.8
2017	412.0	412.5	412.8	412.8	410.8	406.6	399.8	396.2	400.0	406.0	410.9	412.8
2018	413.9	413.9	414.7	415.3	413.4	409.4	400.8	398.7	401.1	408.6	413.3	415.5
2019	416.1	416.9	417.4	417.1	415.3	411.6	403.0	400.6	404.2	410.9	416.2	418.1
2020	419.5	420.2	421.1	420.3	418.4	413.9	405.7	403.2	408.7	413.4	417.0	419.2

**Note:** From 1976 to 1999, averages were calculated based on data from 2 to 3 sampling stations. Since 1999, data from 5 sampling stations are used to represent CO<sub>2</sub> concentrations.

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#).



- Table A.3. Annual data for Globally, annual average methane (CH<sub>4</sub>) concentrations increased by 13%, from 1 670 parts per billion (ppb) to 1 879 ppb between 1986 to 2020
- Over the period spanning 1986 to 2020, the annual average concentration of CH<sub>4</sub> increased by 11%, from 1 764 ppb to 1 965 ppb at sites in Canada
- In 2020, the average concentration of CH<sub>4</sub> was 1 965 ppb, up from 1 952 ppb in 2019 in Canada
- Annual changes in observed CH<sub>4</sub> concentrations in Canada are similar to annual changes observed over the globe, but the magnitude is typically around 80 ppb higher, due to greater abundance of both natural- and human-caused sources of methane in the northern hemisphere

**Figure 2. Methane concentration, Canada and global, 1986 to 2020**

Year	Methane concentration - Canada (parts per billion)	Methane concentration - Global (parts per billion)
1986	1 764	1 670
1987	1 774	1 683
1988	1 784	1 693
1989	1 792	1 705
1990	1 803	1 715
1991	1 813	1 725
1992	1 824	1 735
1993	1 819	1 737
1994	1 835	1 742
1995	1 834	1 749
1996	1 835	1 751
1997	1 836	1 755
1998	1 849	1 766
1999	1 857	1 773
2000	1 853	1 773
2001	1 853	1 771
2002	1 855	1 773
2003	1 865	1 777

Year	Methane concentration - Canada (parts per billion)	Methane concentration - Global (parts per billion)
2004	1 859	1 777
2005	1 860	1 774
2006	1 861	1 775
2007	1 868	1 781
2008	1 877	1 787
2009	1 880	1 794
2010	1 883	1 799
2011	1 889	1 803
2012	1 895	1 808
2013	1 900	1 813
2014	1 912	1 822
2015	1 922	1 834
2016	1 932	1 843
2017	1 938	1 850
2018	1 942	1 857
2019	1 952	1 866
2020	1 965	1 869

**Note:** From 1986 to 1999, averages were calculated based on data from 1 to 2 sampling stations. Since 1999, data from 5 sampling stations are used to represent CH<sub>4</sub> concentrations. Global annual averages are based on measurements from sampling stations that are part of the [Global Greenhouse Gas Reference Network](#).

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#) and National Oceanic and Atmospheric Administration (2021) [Global Monitoring Laboratory - Trends in Atmospheric Methane](#).

- Table A.4. Monthly data for Globally, annual average methane (CH<sub>4</sub>) concentrations increased by 13%, from 1 670 parts per billion (ppb) to 1 879 ppb between 1986 to 2020
- Over the period spanning 1986 to 2020, the annual average concentration of CH<sub>4</sub> increased by 11%, from 1 764 ppb to 1 965 ppb at sites in Canada
- In 2020, the average concentration of CH<sub>4</sub> was 1 965 ppb, up from 1 952 ppb in 2019 in Canada
- Annual changes in observed CH<sub>4</sub> concentrations in Canada are similar to annual changes observed over the globe, but the magnitude is typically around 80 ppb higher, due to greater abundance of both natural- and human-caused sources of methane in the northern hemisphere

**Figure 2. Methane concentration, Canada and global, 1986 to 2020**

Year/ Month	January (parts per billion)	February (parts per billion)	March (parts per billion)	April (parts per billion)	May (parts per billion)	June (parts per billion)	July (parts per billion)	August (parts per billion)	September (parts per billion)	October (parts per billion)	November (parts per billion)	December (parts per billion)
1986	1 780	1 769	1 792	1 773	1 766	1 741	1 738	1 740	1 744	1 788	1 774	1 759
1987	1 776	1 779	1 782	1 771	1 774	1 756	1 753	1 756	1 773	1 789	1 791	1 788
1988	1 799	1 800	1 789	n/a	1 781	1 767	1 750	1 755	1 785	1 791	1 802	1 806
1989	1 800	1 815	1 813	1 792	1 777	1 764	1 758	1 771	1 785	1 791	1 811	1 825
1990	1 822	1 831	1 817	1 801	1 800	1 780	1 775	1 773	1 785	1 808	1 817	1 825
1991	1 840	1 841	1 815	1 809	1 800	1 785	1 782	1 791	1 810	1 817	1 829	1 834
1992	1 858	1 849	1 854	1 830	1 823	1 812	1 792	1 797	1 800	1 813	1 826	1 838
1993	1 837	1 830	1 834	1 819	1 818	1 799	1 788	1 797	1 815	1 820	1 831	1 836
1994	1 857	1 855	1 862	1 844	1 824	1 808	1 803	1 802	n/a	1 838	1 842	1 849
1995	1 846	1 856	1 852	1 844	1 821	1 808	1 807	1 816	1 830	1 835	1 844	1 852
1996	1 858	1 851	1 851	1 841	1 831	1 821	1 811	1 808	1 827	1 839	1 839	1 840
1997	1 867	1 862	1 846	1 842	1 829	1 815	1 809	1 815	1 827	1 837	1 834	1 854
1998	1 863	1 861	1 859	1 843	1 840	1 823	1 819	1 829	1 844	1 859	1 862	1 887
1999	1 885	1 876	1 863	1 859	1 851	1 841	1 837	1 840	1 848	1 855	1 866	1 858
2000	1 861	1 862	1 862	1 858	1 851	1 845	1 845	1 838	1 845	1 854	1 852	1 859
2001	1 865	1 865	1 869	1 861	1 852	1 840	1 828	1 829	1 845	1 853	1 864	1 863
2002	1 879	1 858	1 866	1 862	1 847	1 840	1 833	1 833	1 853	1 855	1 858	1 871
2003	1 877	1 874	1 877	1 866	1 857	1 850	1 847	1 846	1 863	1 864	1 873	1 884
2004	1 878	1 880	1 875	1 862	1 853	1 842	1 832	1 841	1 854	1 858	1 865	1 872
2005	1 869	1 862	1 859	1 858	1 848	1 843	1 840	1 850	1 863	1 866	1 872	1 885
2006	1 881	1 873	1 869	1 862	1 856	1 849	1 844	1 855	1 850	1 854	1 862	1 873
2007	1 878	1 870	1 874	1 864	1 857	1 850	1 846	1 859	1 876	1 878	1 876	1 890

Year/ Month	January (parts per billion)	February (parts per billion)	March (parts per billion)	April (parts per billion)	May (parts per billion)	June (parts per billion)	July (parts per billion)	August (parts per billion)	September (parts per billion)	October (parts per billion)	November (parts per billion)	December (parts per billion)
2008	1 892	1 900	1 885	1 883	1 870	1 856	1 849	1 861	1 871	1 876	1 883	1 892
2009	1 900	1 894	1 891	1 883	1 871	1 859	1 854	1 863	1 881	1 883	1 886	1 892
2010	1 897	1 892	1 891	1 883	1 876	1 868	1 862	1 872	1 886	1 882	1 891	1 900
2011	1 901	1 901	1 899	1 891	1 878	1 869	1 871	1 876	1 882	1 894	1 903	1 909
2012	1 909	1 907	1 905	1 895	1 885	1 874	1 878	1 887	1 891	1 894	1 906	1 914
2013	1 924	1 915	1 907	1 899	1 891	1 885	1 883	1 882	1 891	1 900	1 906	1 912
2014	1 916	1 919	1 918	1 907	1 900	1 895	1 891	1 909	1 914	1 926	1 920	1 929
2015	1 937	1 931	1 922	1 919	1 909	1 900	1 902	1 913	1 927	1 924	1 934	1 947
2016	1 941	1 938	1 934	1 926	1 923	1 911	1 912	1 927	1 939	1 943	1 940	1 952
2017	1 961	1 950	1 947	1 936	1 928	1 921	1 919	1 926	1 936	1 938	1 950	1 949
2018	1 956	1 948	1 946	1 945	1 934	1 926	1 921	1 928	1 940	1 946	1 955	1 962
2019	1 960	1 965	1 958	1 951	1 939	1 934	1 935	1 943	1 955	1 961	1 961	1 969
2020	1 975	1 973	1 966	1 961	1 953	1 944	1 947	1 961	1 962	1 980	1 979	1 977

**Note:** From 1986 to 1999, averages were calculated based on data from 1 to 2 sampling stations. Since 1999, 5 sampling stations are collecting CH<sub>4</sub> concentrations data.

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#).

Table A.5. Data for

**Figure 3. Greenhouse gas concentration monitoring stations in Canada, 2020**

Start Date	Site Name (3 Letter Station Code)	Coordinates	Elevation (asl)	Intake Height	Insitu Parameters	Insitu Instrumentation	Flask Sampling Frequency (for CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub> )
March, 1975	<a href="#">Sable Island, Nova Scotia (WSA)</a>	43.932237N, 60.009275W	5m	25m	CO <sub>2</sub> , CH <sub>4</sub> , CO	NDIR, GC, CRDS	Single flask every three days
July, 1975	<a href="#">Alert, Nunavut (ALT)</a>	82.450833N, 62.507222W	200m	10m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O	NDIR, GC, CRDS OA-ICOS	One pair of flasks each week
January, 1990	<a href="#">Fraserdale, Ontario (FRD)</a>	49.875222N, 81.570083W	210m	40m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub>	NDIR, GC, CRDS	Single flask once per week (in the afternoon)
June, 1992	<a href="#">Esteron Point, British Columbia (ESP)</a>	49.382954N, 126.544101W	7m	40m	CO <sub>2</sub> , CH <sub>4</sub> , CO	NDIR, GC, CRDS	One pair of flasks once per week
June, 2002	<a href="#">Candle Lake, Saskatchewan (CDL)</a>	53.987108N, 105.117939W	600m	30m	CO <sub>2</sub> , CH <sub>4</sub> , CO	NDIR, GC	
October, 2003	<a href="#">Downsview, Ontario (DWN)</a>	43.780491N, 79.468010W	198m	20m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub> , CO <sub>2</sub>	NDIR, GC, CRDS, OA-ICOS	Single flask once per week
March, 2005	<a href="#">Egbert, Ontario (EGB)</a>	44.231037N, 79.783834W	251m	3m, 25m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub> , Radon, CO <sub>2</sub>	NDIR, GC, CRDS	One pair of flasks every other week
August, 2005	<a href="#">East Trout Lake, Saskatchewan (ETL)</a>	54.354130N, 104.986835W	493m	105m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub>	NDIR, GC, CRDS	Single flask once per week (in the afternoon)
April, 2007	<a href="#">Churchill, Manitoba (CHU)</a>	58.737885N, 93.819403W	29m	60m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	Single flask twice per week (in the afternoon)
April, 2007	<a href="#">Lac La Biche, Alberta (LLB)</a>	54.953851N, 112.466646W	540m	10m, 50m	CO <sub>2</sub> , CH <sub>4</sub> , CO	NDIR, GC, CRDS	NOAA Sampling
August, 2007	<a href="#">Chibougamau, Quebec (CHB)</a>	49.692510N, 74.342296W	393m	30m	CO <sub>2</sub> , CH <sub>4</sub> , CO	NDIR, GC	
October, 2009	<a href="#">Bratt's Lake, Saskatchewan (BRA)</a>	50.201683N, 104.711268W	595m	35m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	Single flask once per week
January, 2010	<a href="#">Esther, Alberta (EST)</a>	51.670681N, 110.206009W	707m	3m, 50m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	
October, 2010	<a href="#">Behchoko, Northwest Territories (BCK)</a>	62.798087N, 115.919426W	160m	60m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	
December, 2011	<a href="#">Chapais, Quebec (CPS)</a>	49.822317N, 74.975274W	391m	8m, 40m	CO <sub>2</sub> , CH <sub>4</sub>	CRDS	Single flask once per week
February, 2012	<a href="#">Inuvik, Northwest Territories (INK)</a>	68.317817N, 133.534232W	113m	10m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	Single flask once per week

Start Date	Site Name (3 Letter Station Code)	Coordinates	Elevation (asl)	Intake Height	Insitu Parameters	Insitu Instrumentation	Flask Sampling Frequency (for CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, SF <sub>6</sub> )
December, 2012	<a href="#">Cambridge Bay, Northwest Territories (CBY)</a>	69.128418N, 105.057709W	35m	12m	CO <sub>2</sub> , CH <sub>4</sub> , CO	CRDS	Single flask once per week
March, 2014	<a href="#">Abbotsford, British Columbia (ABT)</a>	49.011386N, 122.335332W	60m	33m	CO <sub>2</sub> , CH <sub>4</sub> , CO, N <sub>2</sub> O, Radon	CRDS, OA-ICOS	Single flask once per week

**Source:** Environment and Climate Change Canada (2021) Climate Research Division, [Canadian Greenhouse Gas Measurement Program](#).

Additional information can be obtained at:

Environment and Climate Change Canada  
Public Inquiries Centre  
12th Floor Fontaine Building  
200 Sacré-Coeur Blvd  
Gatineau QC K1A 0H3  
Telephone: 1-800-668-6767 (in Canada only) or 819-938-3860  
Fax: 819-938-3318  
Email: [ec.enviroinfo.ec@canada.ca](mailto:ec.enviroinfo.ec@canada.ca)