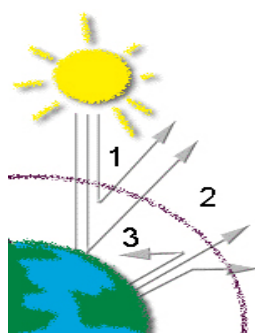


The Science of Climate Change

What is climate change?

Climate change is a shift in the "average weather" that a given region experiences. This is measured by changes in all the features we associate with weather, such as temperature, wind patterns, precipitation, and storms. Global climate change refers to change in the climate of the Earth as a whole. The global climate has always changed and will continue to change – the ice age is an example. However, the climate change we are seeing today differs from previous climate change in both its rate and its magnitude – it is happening much, much faster.

The Greenhouse Effect

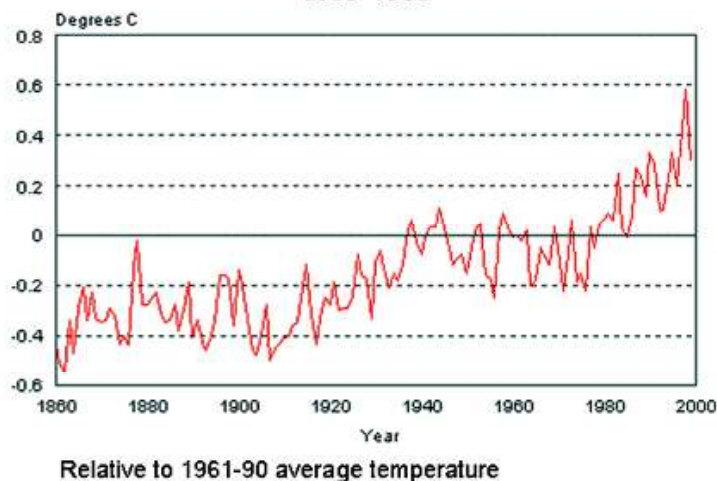


The temperature on Earth is regulated by a system known as the "greenhouse effect". "Greenhouse gases" (e.g., carbon dioxide, methane, water vapour, nitrous oxide) trap some of the heat from the sun near the earth's surface, acting like a blanket or like the glass in a greenhouse. Without this "natural greenhouse effect", the average temperature on Earth would be -18°C , instead of the current average of 15°C . Life as we know it would be impossible.

The Enhanced Greenhouse Effect – global warming

Rising levels of greenhouse gases in the atmosphere are trapping too much heat, enhancing the greenhouse effect and causing the global temperature to rise. This is referred to as "global warming". In the last 200 years or so (since the start of industrialization), CO_2 levels have risen by over 30%. As a result, global average temperature has risen by about 0.76°C in the last 100 years. Scientists predict that the global temperature will rise by about 1.4°C - 5.8°C by the year 2100, if current trends continue and no efforts are made to reduce emissions.¹ This may not seem like a lot but think about this: it was a change of about 5°C that brought the earth out of the last Ice Age, and since then global temperatures have varied by less than 1°C .

**Global Temperature Change
1860-1999**



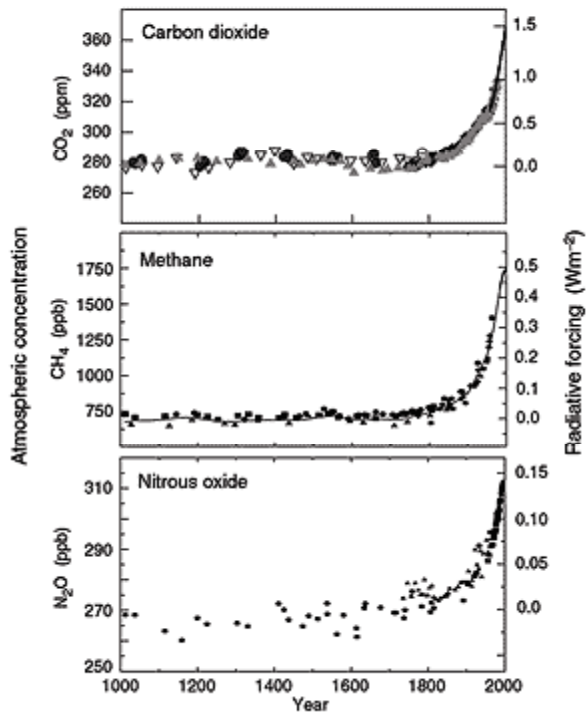
Source: Environment Canada. Climate Change Overview. http://www.ec.gc.ca/climate/overview_trends-e.html

Scientists agree that the climate is warming. They point to increases in the global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea levels. Eleven of the last twelve years (1995-2006) have been the warmest on record, since records started being kept in 1850. There is strong evidence that most of the global warming observed over the last 50 years is a result of human activities that have dramatically and rapidly increased the levels of GHGs in the atmosphere. Scientists have concluded that:

- concentrations of GHG have increased markedly as a result of human activity since 1750 and now far exceed pre-industrial levels;
- the concentration of carbon dioxide in the atmosphere in 2005 exceeds by far the natural range over the last 650,000 years;
- much of the increase in atmospheric carbon dioxide is due to burning fossil fuels and changes in land use (such as deforestation).⁶

Indicators of the human influence on the atmosphere during the Industrial Era

(a) Global atmospheric concentrations of three well mixed greenhouse gases



What are the “greenhouse gases” and where do they come from?

The main greenhouse gases are:

- water vapour;
- carbon dioxide (CO₂);
- methane;
- nitrous oxide (NO_x);
- ozone; and
- industrial gases (e.g., CFCs).

All of these, except for the industrial gases, are produced by natural processes (e.g., plant respiration, evaporation, volcanic eruptions, fires). But it is human activities, such as combustion of fossil fuels, deforestation, coal mining and natural gas production that are largely responsible for the rapid rise in GHG over the last 200 years. Currently, about one-half of the methane emissions and one-third of NO_x emissions are a result of human-activities; about three-quarters of the CO₂ emitted as a result of human activities comes from combustion of fossil fuels.² Of the warming caused by the “enhanced” greenhouse effect, CO₂ is responsible for about 60%, methane for 20%, industrial gases for about 14% and NO_x about 6%.³

Canada's Contribution to Climate Change

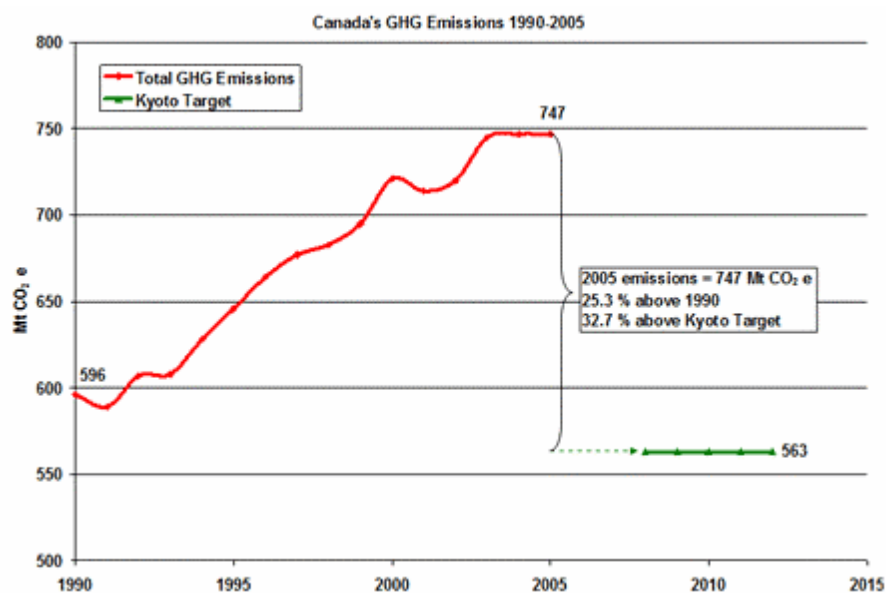
In 2004, Canada emitted about 747 Mt of GHG per year – 25% more than in 1990. We emit 2% of the world's total GHG emissions, despite having less than 0.5% of the world's population. In 2004, we emitted almost 24 tonnes per capita – a 10% increase from 1990. This per capita increase is more than any other G8 nation. ⁴

Table 1. Canada's Greenhouse Gas Emissions for Selected Sectors 1990 and 2005

| Sector | Mt CO ₂ Equivalent | | % of total emissions |
|--------------------------|-------------------------------|------------|----------------------|
| | 1990 | 2005 | |
| Total | 596 | 747 | 25.3% |
| Energy | 473 | 609 | 28.6% |
| Transportation subsector | 150 | 200 | 32.8% |
| Industrial Processes | 53.5 | 53.3 | -0.4% |
| Agriculture | 46 | 57 | 23.6% |
| Waste | 23 | 28 | 20.7% |

Source: Environment Canada. 2005. Canada's 2005 Greenhouse Gas Inventory: A Summary of Trends. National Inventory. Adapted from Table: Sectoral Greenhouse Gas Emission Summary. Available online at http://www.ec.gc.ca/pdb/ghg/inventory_report/2005/2005summary_e.cfm

Canada's GHG Emissions 1990-2005



Source: Environment Canada. 2005. Canada's 2005 Greenhouse Gas Inventory: A Summary of Trends. National Inventory. Available online at http://www.ec.gc.ca/pdb/ghg/inventory_report/2005/2005summary_e.cfm

Did you know?

- In the 10,000 years prior to industrialization, CO₂ levels varied by less than 10%. In the 200 years since the start of industrialization, CO₂ levels have increased by over 30%. Models predict that CO₂ levels will rise by 75-350% by the year 2100.¹
- The present CO₂ concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. The current rate of increase is unprecedented during at least the past 20,000 years.³
- Combustion of fossil fuels accounts for about 80% of CO₂ emissions from human activities and about 20% of methane emissions.⁵
- We have cleared more land for human use in the past 100 years than in all of prior human history.¹ Deforestation is the second largest source of carbon dioxide.⁵
- Livestock account for 30% of the methane emissions from human-related activities.
- In Canada, about 78% of our GHG emissions are CO₂, 15% are methane and 6% are nitrous oxide.⁴
- In Canada, from 1990 to 2005 emissions from transportation increased by about 48.8 Mt (32.8%); 23.2Mt of this was from light duty trucks (including SUVs).⁴

Sources and Useful Links

Arctic Climate Impact Assessment. 2004. Impacts of a Warming Arctic. Highlights brochure and complete synthesis report are available online at:
<http://www.acia.uaf.edu/pages/overview.html> (checked August 2007).

Environment Canada. Frequently asked questions about the science of climate change. Available online at:
http://www.msc.ec.gc.ca/education/scienceofclimatechange/understanding/FAQ/index_e.html (checked August 2007).

Environment Canada. Climate change overview. <http://www.ec.gc.ca/climate/overview-e.html> (checked August 2007).

Intergovernmental Panel on Climate Change. 2007. Summary for Policy Makers. *In* Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Available online at:
http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Pub_SPM-v2.pdf (checked August 2007).

Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: The Scientific Basis. Available online at: <http://www.ipcc.ch/pub/reports.htm> (checked August 2007).

UNFCCC Climate Change Information Kit (Information sheets 1-8). Available online at:
http://unfccc.int/essential_background/background_publications_htmlpdf/climate_change_information_kit/items/305.php (checked August 2007).

UNFCCC. Feeling the heat. Available online at:
http://unfccc.int/essential_background/feeling_the_heat/items/2917.php (checked August 2007).

Gateway to the UN System's Work on Climate Change. Fact Sheets. Available online at:
<http://www.un.org/climatechange/bg.shtml#facts>

¹ UNFCCC. Climate Change Information Sheet 1: An Introduction to Climate Change. Available online at:
http://unfccc.int/essential_background/background_publications_htmlpdf/climate_change_information_kit/items/60.php (checked August 2007).

² Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: The Scientific Basis. Available online at: <http://www.ipcc.ch/pub/reports.htm> (checked August 2007).

³ UNFCCC. Climate Change Information Sheet 30: Data on greenhouse gas emissions and sources. Available online at:
http://unfccc.int/essential_background/background_publications_htmlpdf/climate_change_information_kit/items/278.php (checked 2007).

⁴ Government of Canada. 2006. National Inventory Report 1990-2004. Greenhouse Gas Sources and Sinks in Canada. Available online at:
http://www.ec.gc.ca/pdb/ghg/inventory_report/2004_report/toc_e.cfm (Checked August 2007).

⁵ UNFCCC. Climate Change Information Sheet 22: How human activities produce greenhouse gases. Available online at:
http://unfccc.int/essential_background/background_publications_htmlpdf/climate_change_information_kit/items/293.php (checked August 2007).

⁶ IPCC 2007. Summary for Policy Makers. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Available online at: http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Pub_SPM-v2.pdf (checked August 2007).