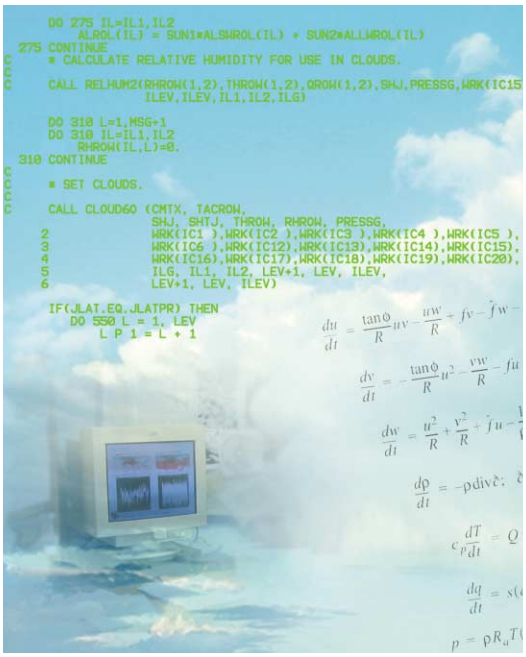
Taking action on climate change

Together, we can do it.

CLIMATE SCIENCE IN CANADA

climate modelling

The Government of Canada created the Climate Change Action Fund in 1998. The Science constituent within the Science, Impacts and Adaptation component of the Fund supports research to increase our understanding of the climate system, how it operates, and how it might change.



Greg Flato, Environment Canada

Climate models are advanced computer programs that give us a window on the world's future climate.

Climate Science

Mounting scientific evidence confirms that the Earth's climate is changing, fuelled by increasing atmospheric greenhouse gases produced by human activities.

How much change are we talking about? Climate monitoring indicates that the global average temperature has increased more in the last century than over the past 1,000 years at least. According to the *Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, released in 2001, the global average surface temperature is expected to further increase between 1.4 and 5.8°C in this century. This rate of change is unprecedented in at least the past 10,000 years.

Global averages give the big picture, but changes to regional climate help us understand how warming will affect Canadian society and the environment. And while regional changes are still difficult to predict, climate models already reveal that large parts of Canada will experience greater warming than the global average.

While there may be benefits in certain regions, warmer temperatures could also mean changes in water supply, leading to more drought in some areas and increased flooding in others. Extreme weather events, such as heat waves and storms, could also become more frequent and more severe, causing damage to property and endangering people's lives.

To make informed decisions on tackling climate change — by reducing greenhouse gas emissions and adapting to anticipated impacts, for instance — we need a better understanding of the climate system and how it responds to increasing levels of greenhouse gases. Through climate change

research, scientists track the climate, gain insight into how and why it is changing, and estimate future climate.

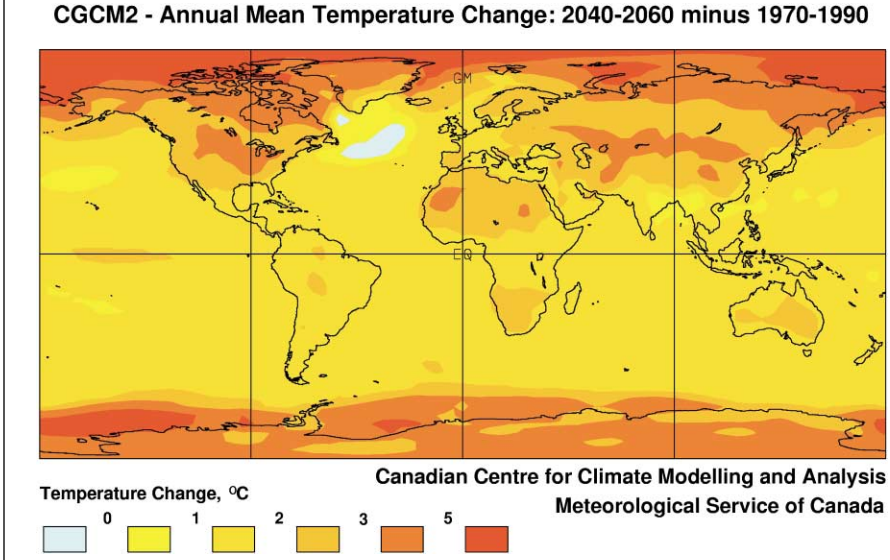
Climate Modelling

Scientists use computer simulations of the Earth's climate system to reproduce the past and current state of the climate, and to estimate how it will behave in the future. Today's most sophisticated climate models link atmospheric, oceanic and terrestrial processes – hence the term "Coupled Global Climate Models", or CGCMs. They are based on well-established laws of physics and a wealth of scientific observations. The models are very complex and are run on the most powerful super-computers in Canada.

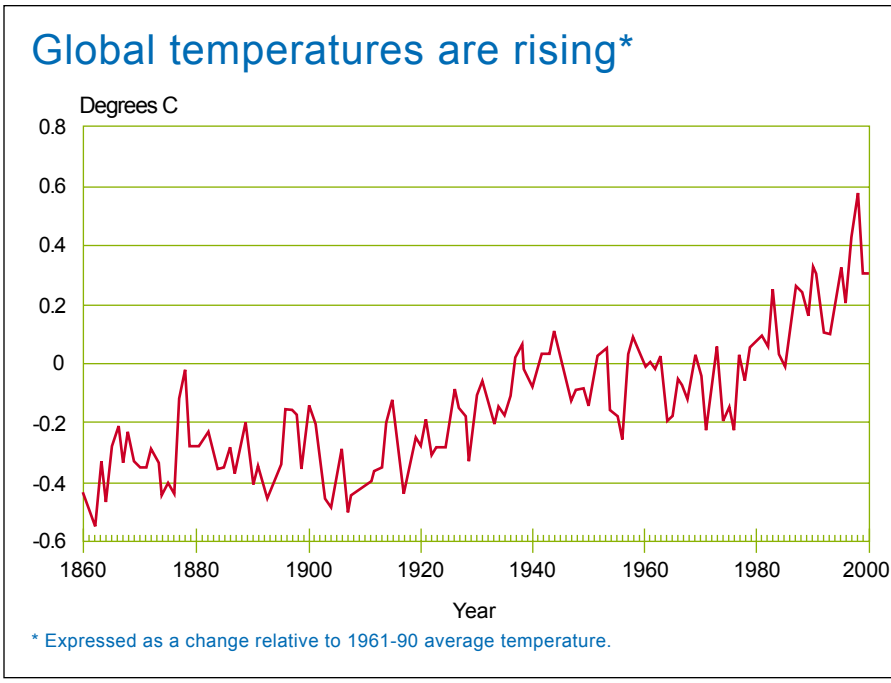
Climate models calculate temperature, wind, humidity and other climatic factors such as land surface and ocean conditions for thousands of points at regularly spaced locations, known as a grid, all over the surface of the globe and throughout the depths of the atmosphere and ocean.

Researchers specify historical observations of greenhouse gases and aerosols to test the model's ability to reproduce observed climate change over the past century. They then use various scenarios of future greenhouse gas and aerosol emissions to produce projections of future climate change.

The IPCC based its conclusions regarding future human influence on the climate system on the results of climate model simulations conducted by several research groups around the world, including Canada. Projections from the Canadian climate model suggest that much of Canada will warm by 5°C or more by year 2100, with greater warming likely over the Arctic. The Canadian model also projects a modest increase in precipitation for Canada, and a decrease for the southern United States, which could reduce soil moisture and increase the incidence of drought.



Change in annual mean temperature projected by CGCM2 for the middle of the 21st century relative to temperatures late in the 20th century. CGCM2 is the second-generation model developed by the Canadian Centre for Climate Modelling and Analysis.



Climate Modelling Activities in Canada

In Canada, climate modelling is carried out primarily by government scientists, collaborating with university colleagues over the past several years through a variety of networks and projects, sharing information and working on research. By working together to better understand key climate processes, they are developing better models and more reliable projections of climate change, especially at a regional scale. This collaborative approach allows Canadian scientists to pool their expertise and train future climate researchers.

The focal point for Canada's climate modelling activities is Environment Canada's Canadian Centre for Climate Modelling and Analysis in Victoria, British Columbia. Canada's global climate modelling team has developed one of the most advanced models of the climate system now available. They run these models for policy purposes, analyze and publish the results, and share model findings with the scientific community in Canada and abroad.

Canadian researchers are highly respected in the international scientific community. Environment Canada's global climate model was used in the recent U.S. National Assessment of the Potential Consequences of Climate Variability and Change, and by the IPCC in its series of assessment reports.

Climate Change Action Fund: Improving the Models

Although Canadian climate models are among the best in the world, there are still areas that need improvement at both the global and regional scales. Scientists are working on improving our ability to represent the influences of surface features like mountains, snow-covered ground and vegetation as well as the effects of certain types of clouds and of aerosols — tiny particles in the atmosphere. Scientists are also trying to improve the representation of the ocean circulation that is included in climate models.

The Climate Change Action Fund (CCAF) has provided funding to address these gaps and has supported advances in climate modelling, with a focus on the key climate processes that feed into the global, regional and ocean models.

Clouds and Aerosols

Researchers developed new approaches to representing clouds and aerosols. Five CCAF research projects focused on:

- investigating how the many sizes and shapes of ice crystals that make up ice clouds can be more accurately represented in climate models in order to better simulate clouds, precipitation and cloud-radiation interactions;
- improving the representation of sulphate aerosols (atmospheric particles containing sulfur) in climate models, which will lead to a better understanding of how human-related sources (primarily

from burning fossil fuels) and natural sources (primarily from biological sources in the ocean) interact with the climate system;

- improving the representation of convection (a process that produces thunderstorms) in climate models in order to more accurately represent the effects of physical processes and cloud variations that occur on a small scale.

Oceans

Two projects funded by the CCAF have led to a better representation of ocean properties in climate models by:

- improving how the mixing of different water masses is represented in climate models;
- enhancing the way that sea ice, including its formation, melt and motion, is represented in climate models.

Land surface

Two research projects focused on representing surface conditions more accurately by:

- developing a detailed set of climate data over snow-covered terrain for different regions and seasons that can be used to validate the climate model;
- improving the way in which various aspects of snow, such as how it changes in character with age, are represented in climate models.

Roger Dekbrey, Environment Canada

Chris Hopkinson, Queen's University

What's Next

The CCAF has funded important improvements in climate models, but there is still work to be done if Canada is to produce the best possible estimates of future climate. These estimates are needed for national policy development and for climate impact studies. To achieve this goal, we need to incorporate new knowledge from the rapidly expanding science into our models.

In particular, there is a need for improvement in how models deal with ocean circulation, the land surface, and biological and chemical processes. Future CCAF funds will be targeted towards engaging new climate modelling experts in these critical areas to work at the Canadian Centre for Climate Modelling and Analysis. Plans include working with the Canadian university community and taking advantage of other funding programs such as the Canadian Foundation for Climate and Atmospheric Sciences. The addition of highly qualified climate modellers in emerging areas of climate science will also attract top students and help to prepare the next generation of climate scientists in Canada. As well, to help ensure Canada has the scientific tools and capacity to tackle climate change over the longer term, a Climate Science Agenda for Canada is being developed. Addressing climate model uncertainties and providing regional scale climate information are priority areas in the *Climate Change Plan for Canada.*

Visit www.cccma.bc.ec.gc.ca for more information on Canadian global and regional climate models and to learn more about the Canadian Centre for Climate Modelling and Analysis.

This fact sheet is one in a series describing key topics in climate science and Canada's activities.