

# Is climate changing?

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# Climate has been an important factor in Canada's history and will influence its future

**Heating up fast: the 1960s and 1990s**

Over the past 100 years, Earth's atmosphere has warmed. The temperature increase has been steady, but since the 1980s, warming has accelerated. Scientists are concerned that we are entering a period of unprecedented global warming caused by humans.

**Front-page news**

Weather is the most recent subject of atmospheric conditions, such as temperature, precipitation, wind, clouds, and air pressure. Climate is the expected or general pattern of weather for a place or region over extended periods of time. Climate change is a change in the average weather conditions that a region experiences over a long period of time.

**A much different future**

This map shows predicted differences in global surface temperatures between 2010 and 2040. The greatest differences are predicted to be at high latitudes and in the interior of continents. This ocean-colored by a climate model "experiment" shows an amount of cooling in eastern Newfoundland and Labrador.

**Nature's thermometers**

Glaciers record slow climate shifts and they show when it happens. The margin of Westward Glacier, near Whistler, B.C., has retreated hundreds of metres over the last few decades, due mainly to melting during winter months. Scientists are using this as evidence that climate is warming.

**10 000 years of stability**

Scientists believe that Earth's climate has been more stable over the last 10 000 years than at any other time in the last 100 000 years. This stability is due to the fact that the amount of solar radiation that Earth receives has remained relatively constant. Even so, there has been change in climate over this period with far-reaching effects.

**Wings settled Greenland during a warm period, when the temperature was 10°C warmer than today. Climate models predict that the temperature will be 10°C warmer than today by the year 2100. This means that the climate will be 20°C warmer than today by the year 2100.**

# Climate has always changed

Thousands of years ago, glaciers that covered the northern part of the continent had retreated to the northern base line. Offshore, several islands existed (shown as green). The map shows the extent of the Laurentide ice sheet, which covered most of North America and Europe. The ice sheet melted about 10 000 years ago because of rising sea levels. The ice sheet melted about 10 000 years ago because of rising sea levels. The ice sheet melted about 10 000 years ago because of rising sea levels.

**How can we be sure that the warming of the atmosphere is not related to the natural variability of climate?**

Global temperature change over the last 1000 years. The temperature has generally increased over the last 1000 years, with a significant increase in the last 100 years.

**Did you know?**

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# The greenhouse effect

**Greenhouse gases: the big three**

The main energy source for Earth is the Sun. The Sun's energy is reflected back into space by clouds and the Earth's surface. The greenhouse effect is the process by which the Earth's surface is warmed by the atmosphere. The greenhouse effect is the process by which the Earth's surface is warmed by the atmosphere.

**The carbon balance**

Carbon is present in the atmosphere and in living organisms. The carbon cycle is the process by which carbon is exchanged between the atmosphere, land, and oceans. The carbon cycle is the process by which carbon is exchanged between the atmosphere, land, and oceans.

**The Earth's solar energy budget**

Just as some of the incoming solar radiation from the Sun is reflected back into space by clouds and the Earth's surface, the remainder is absorbed by the Earth and its atmosphere. The balance between the incoming solar radiation and the outgoing terrestrial radiation is the Earth's solar energy budget.

**Did you know?**

Venus, our planetary neighbor, has an atmosphere that is 96% CO<sub>2</sub>. Due to the extreme greenhouse effect, Venus is the hottest planet in our solar system.

# The air we breathe

**AIR POLLUTION HEALTH EFFECTS PYRAMID**

How our health can be harmed

Burning fossil fuels such as gasoline, oil, and coal for energy is one of the main ways we add to air pollution. Driving cars, heating homes, using appliances, or running factories and power plants, all release pollutants into the atmosphere, which contribute to smog.

**What is smog?**

A mix of pollutants, including nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs), which react together in sunlight to make ozone (O<sub>3</sub>). At ground level, where we can breathe it, ozone is harmful to health.

**Did you know?**

In Atlantic Canada, about 75% of our smog comes from vehicles. Reducing our own emissions helps in controlling other provinces and the United States to reduce pollution.

# Freshwater issues

**PREDICTED CHANGES IN HYDROLOGY**

**Labrador:** Less runoff, higher flows earlier than present, reduced flows in the summer.

**Island of Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick:** More runoff, highest flows earlier than present (April rather than May). Summer flow less than present and earlier.

**Churchill Falls (Labrador):** More runoff, higher flows earlier than present (April rather than May). Summer flow less than present and earlier.

**The Saint John River: a glimpse of the future?**

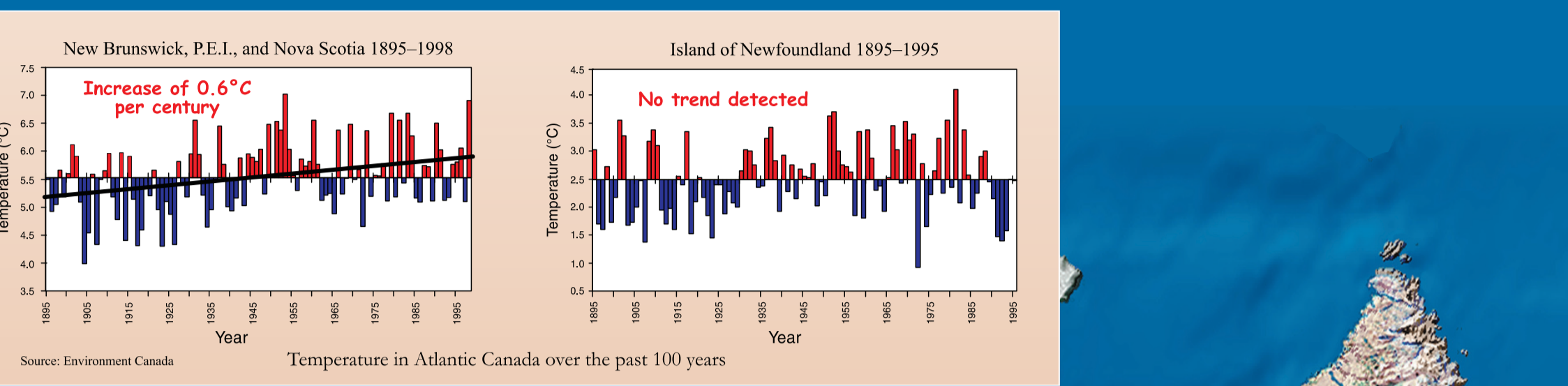
Because of changing climate, the amount of water in our rivers — the runoff — will change. The example of the Saint John River illustrates the complexity of change in our cold climates.

**Hydro-electricity is by far the largest source of renewable electricity in Atlantic Canada. How will it be affected by climate change?**

Labrador's Churchill Falls has been harnessing power from hydro-electricity. Electricity is used by electric utilities whose power requirements are greater in summer than in winter.

# THE TIDES OF CHANGE

## Climate Change in Atlantic Canada



# Forests in peril?

**Blowdown**

Blowdown may increase with climate change as storms become more frequent and intense. Blowdown is the process by which trees are uprooted or snapped by strong winds.

**Hardwood decline**

Under climate change, periods of drought may become more frequent and extended. This may lead to a decline in hardwood species, which are more sensitive to drought than softwood species.

**NO THAW EXTENDED THAW**

Spring snow melt is occurring earlier and is staying longer. This is due to warmer temperatures and less snow cover.

**What will happen to our forests with an increase in winter freeze as our winters become warmer?**

Warmer winters may lead to less snow cover, which can lead to more frequent freeze-thaw cycles and increased soil erosion.

# Invasive insects

**Gypsy moth, Ips typographus (I.T.)**

I.T. is one of the most introduced insect pests in Atlantic Canada. The map shows the distribution of the I.T. in Atlantic Canada from 1880-1996.

**Did you know?**

More than 500 introduced pests are employed in the fur Atlantic province producing goods valued at more than \$5 billion in 1996.

# Down on the farm

**There is uncertainty about how agriculture in Atlantic Canada would be affected by climate change, making it difficult to plan. For optimistic farmers, climate change might be a good thing; for pessimists, the future looks gloomy!**

**WINNERS**

Larger harvests would lengthen the growing season. Larger, warmer growing seasons mean higher yields of many winter crops (corn, soybean, grapes).

**AND LOSERS...**

Larger and warmer summers could result in more drought and greater need for irrigation. Warmer, wetter summers increase insect pests. Warmer winters in the growing season may also mean warmer pests to destroy.

**With warmer temperatures, vineyards could be more common.**

# Changing ecosystems

**Changes in forest and grassland climate zone boundaries**

Present day vs. Doubled CO<sub>2</sub> atmosphere (about the year 2060). Climate zones shift northward and become narrower.

**Will climate change affect bird migration?**

As ecosystems are disrupted, some components will move north, but others will stay. Invasive and colonizing species will move first; sensitive species will not be able to move. Some wildlife populations will go extinct.

**Semipalmated sandpiper:** In the fall, semipalmated sandpipers fly south from New Scotia Bay to Florida to South America. Good weather is needed to make the trip. Poor weather could affect their migration.

**Changes in river flow — earlier breakdown, stronger spring freshet, and reduced summer flow — could impact the endangered Harlequin duck of Labrador.**

# The ocean

Ocean currents (see right) have a major influence on climate. The Gulf Stream carries 50 million cubic metres of water past Atlantic Canada every second at speeds up to 15 km/h. The Labrador Current transports cold Arctic water southward at a rate of 6 million cubic metres per second, at an average speed of only 1 km/h.

**Sea surface temperature 1-15 May 1999 composite**

Map showing sea surface temperature anomalies in the Atlantic Ocean.

**Fish growth rates are sensitive to water temperature.**

Map showing fish growth rates in the Atlantic Ocean.

**Did you know?**

Along the coast of Labrador and Newfoundland between 1900 and 1950, warmer temperatures allowed cod to move northward. When water temperatures cooled in the 1950s, they returned southward. Cod fish stocks have declined since the 1950s. This is due to overfishing and climate change.

# Sea ice and... icebergs

**Sea ice limits**

Map showing sea ice limits in the Atlantic Ocean. Sea ice is melting and retreating.

**Iceberg limits**

Map showing iceberg limits in the Atlantic Ocean. Icebergs are melting and retreating.

**Why are icebergs a problem for fish?**

Icebergs can damage fish and disrupt their feeding habits.

# Let's meet the challenge

**The risks**

The magnitude and rate of future climate change are not known. However, the risks are high. We may be facing unprecedented changes in climate that will affect how we live. It would seem wise to avoid such a future if we can.

**Our choice**

Will we choose a path that leads to a high future? Or will we choose a path that leads to a low future?

**How to reduce greenhouse gas emissions**

Most greenhouse gas emissions come from burning fossil fuels (oil, gasoline, diesel, natural gas, propane, coal). Anything that uses fossil fuels releases greenhouse gas emissions. Increased use of renewable energy, public power, energy efficiency, energy conservation, and wind energy — all reduce greenhouse gas emissions.

**Atlantic Canada's greenhouse gas emissions**

91% Fossil fuel energy, 9% All other sources.

**How do we measure up?**

Canada has a 36% renewable energy generation. We need to increase this to 50% by 2010.

# Rising sea level and vanishing coasts

**Rising sea level**

Map showing rising sea levels in the Atlantic Ocean. Sea levels are rising and coasts are vanishing.

**Vanishing coasts**

Map showing vanishing coasts in the Atlantic Ocean. Coasts are eroding and disappearing.

**Did you know?**

Creation of a new beach by beach nourishment may help beach users, but it does not address the underlying problem of sea level rise.

# Storm surges and coastal flooding

**Greater floods to come!**

Map showing greater floods to come in the Atlantic Ocean. Floods are increasing and coasts are vanishing.

**Carrier waves**

Map showing carrier waves in the Atlantic Ocean. Carrier waves are increasing and coasts are vanishing.

**Treatened areas: some examples**

Map showing treated areas in the Atlantic Ocean. Treated areas are increasing and coasts are vanishing.

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