A collaborative effort:

Environment and Climate Change Canada

Fisheries and Oceans Canada

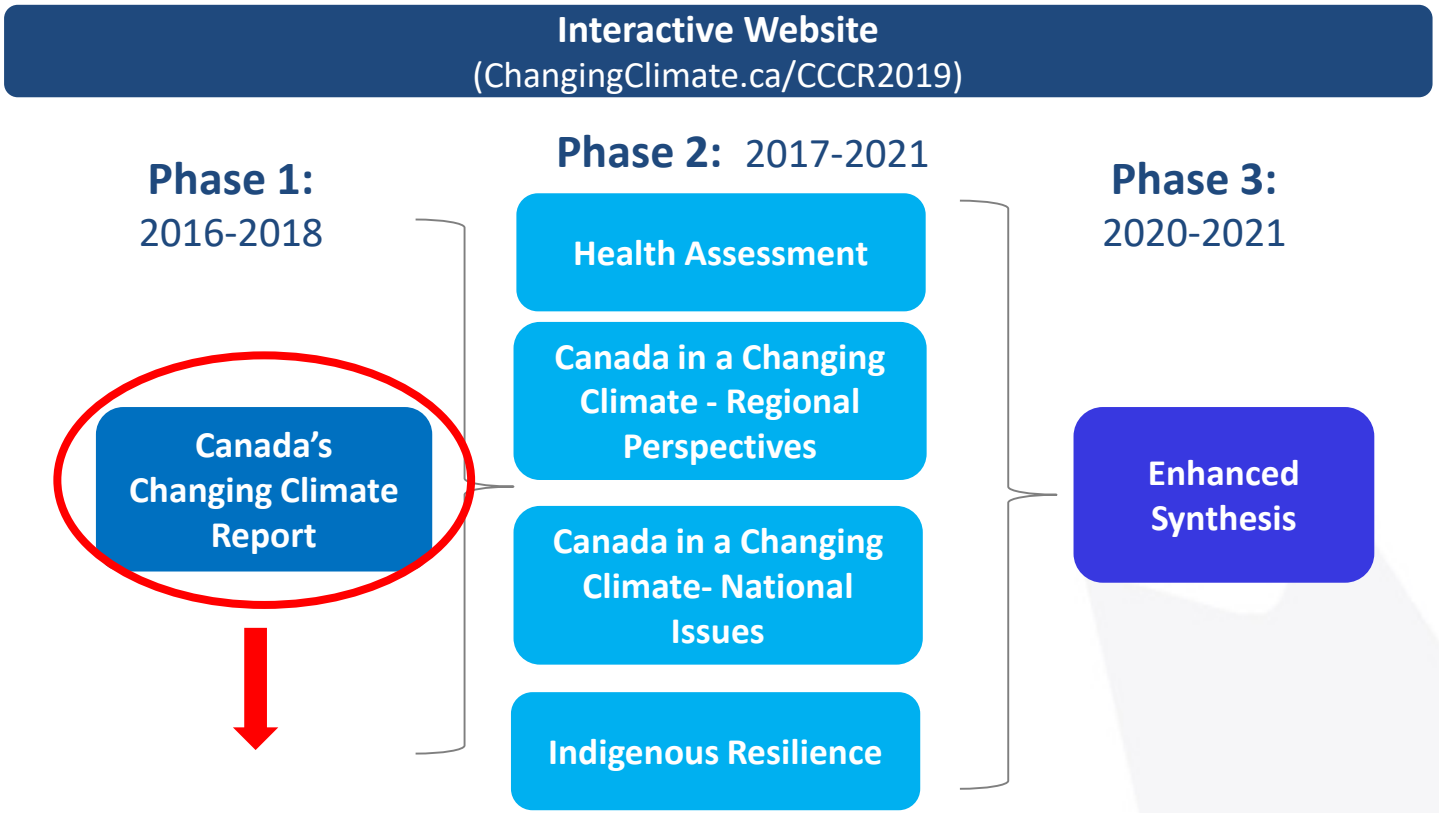
Natural Resources Canada

University experts

Overview of the report

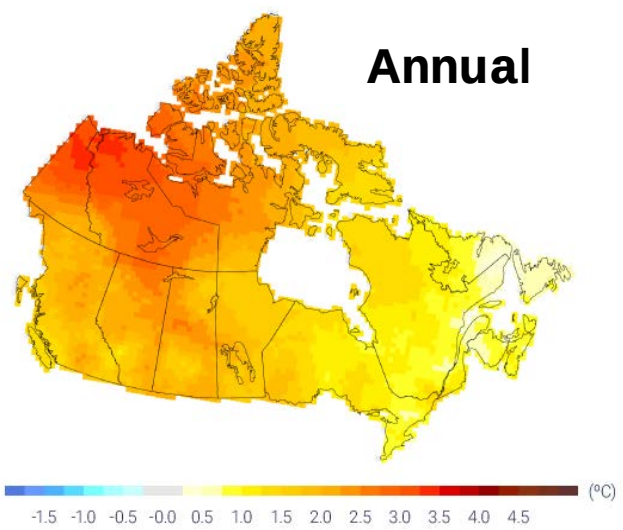
Canada's National Assessment on Climate Change

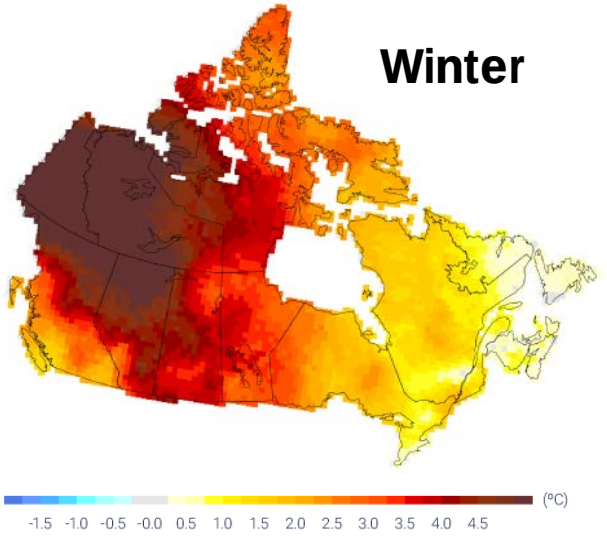
Canada in a Changing Climate: Advancing our Knowledge for Action



Laying a climate science foundation for the forthcoming reports of the national assessment.

Large warming in Canada is evident, especially in winter





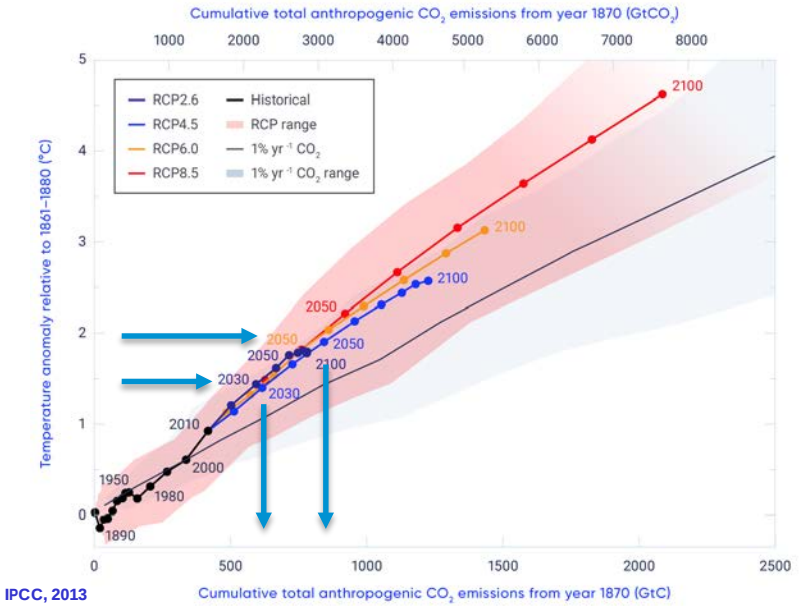
- Annual average temperature in Canada has increased by 1.7ºC between 1948 and 2016, while average winter temperature has increased by 3.3ºC
- Warming has not been uniform across Canada
- Most of the observed increase in annual average temperature in Canada can be attributed to human influence

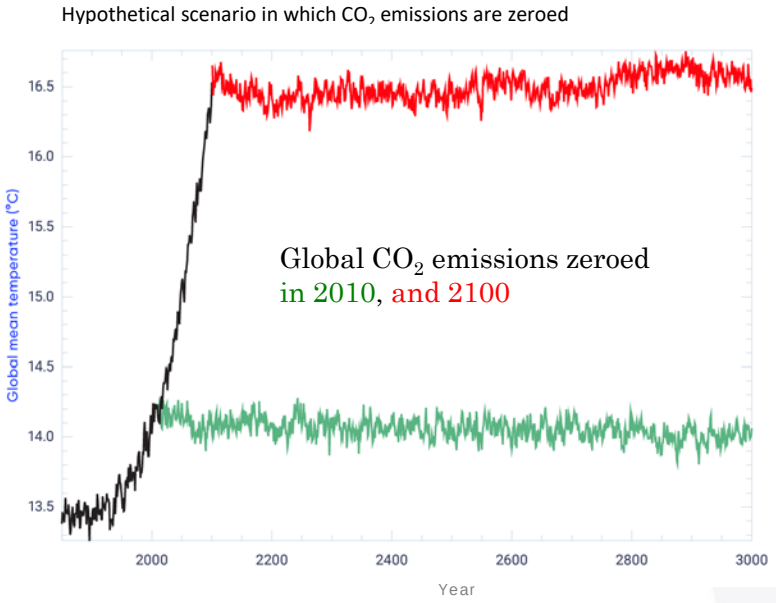
Headline Statement

Canada's climate has warmed and will warm further in the future, driven by human influence.

- Global emissions of carbon dioxide from human activity will largely determine how much warming Canada and the world will experience in the future.
- This warming is effectively irreversible.

Human influence on global climate





- Human emissions of CO_2 are the main determinant of future warming
- Different temperature limits have different 'carbon budgets' – total remaining cumulative CO_2 emissions

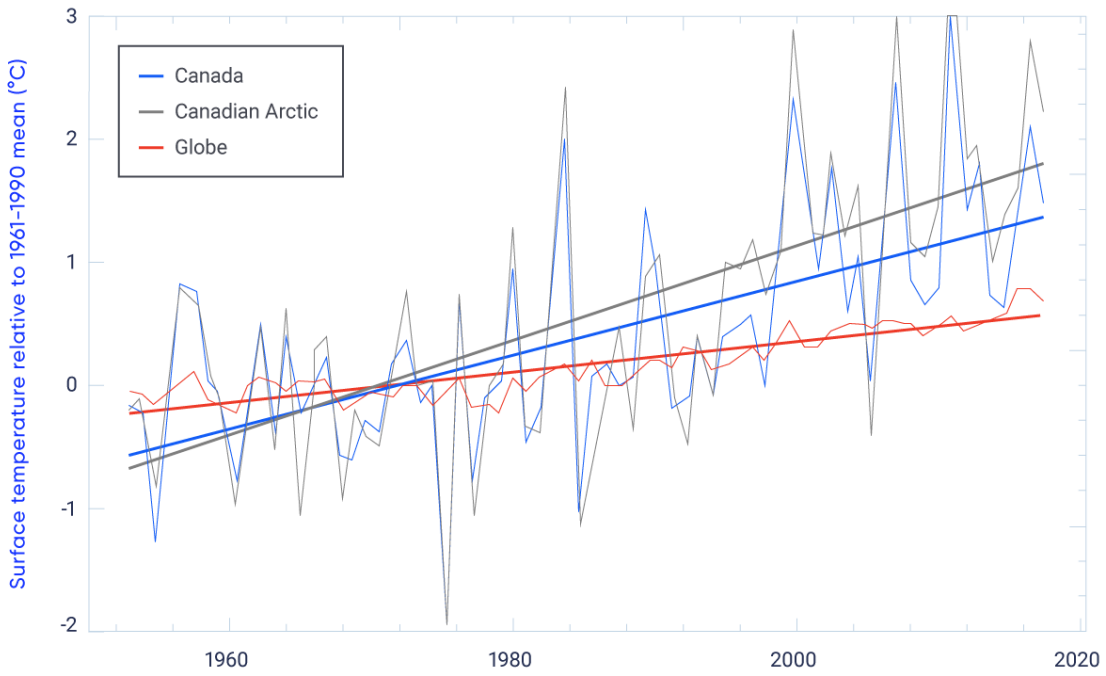
- A finite carbon budget implies CO_2 emissions must achieve 'net zero'
- Global warming will persist for centuries to millennia after emissions are zeroed

Headline Statement

Both past and future warming in Canada is, on average, about double the magnitude of global warming.

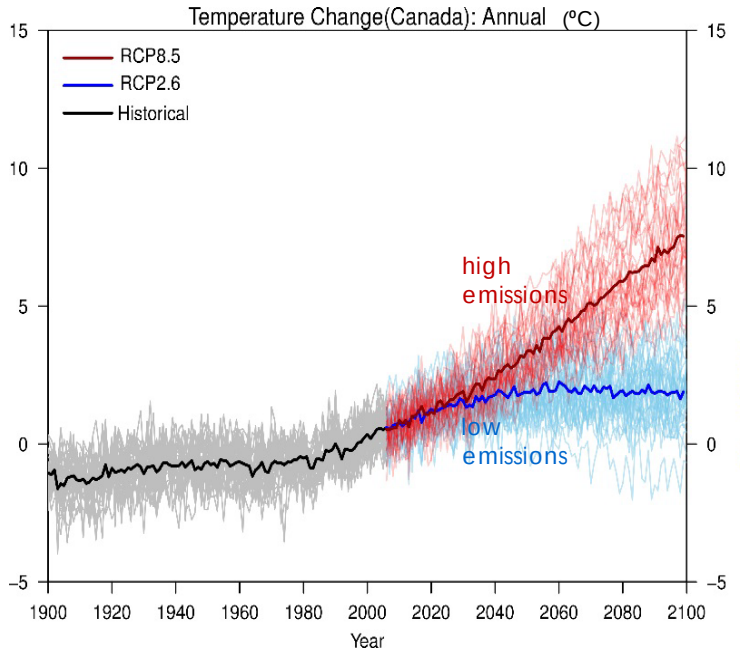
- Northern Canada has warmed and will continue to warm at even more than double the global rate.

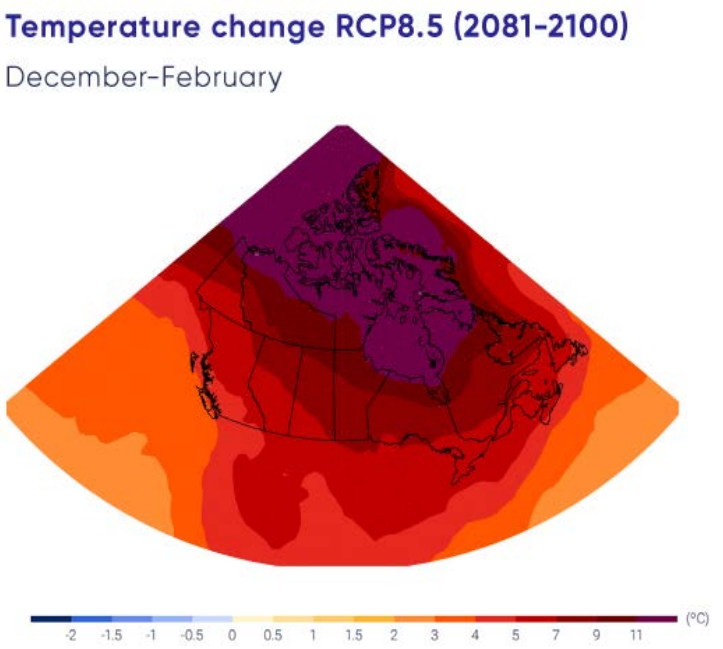
Amplified warming in Canada is consistent with amplified high latitude warming globally



- Canada has warmed by 1.7ºC between 1948 and 2016, about two times global warming
- Northern Canada has warmed by 2.3 ºC, about three times global warming

Future warming in Canada depends directly on global emissions





- Low emission scenario: an additional annual warming of about 2ºC is projected by mid-century, with temperatures steady after that
- High emission scenario: temperature increases will continue, reaching more than 6 ºC by late century

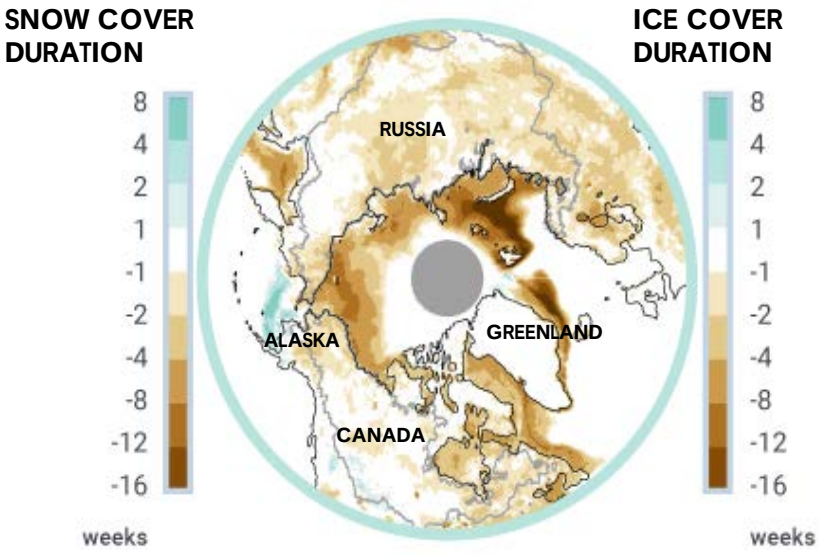
- Consistent with observed warming, future warming will be strongest in winter and in northern Canada
- Changes shown are for the late 21st century, under a high emission scenario, relative to the 1986-2005 reference period

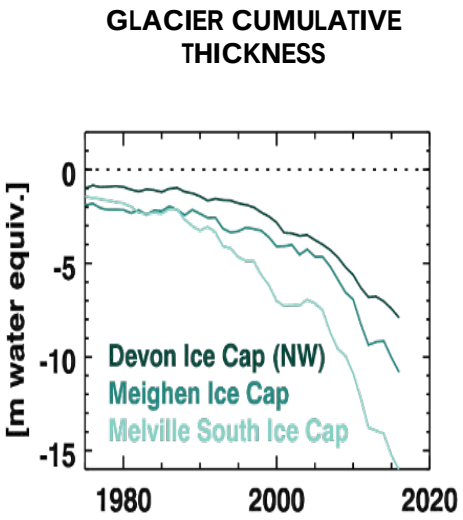
Headline Statement

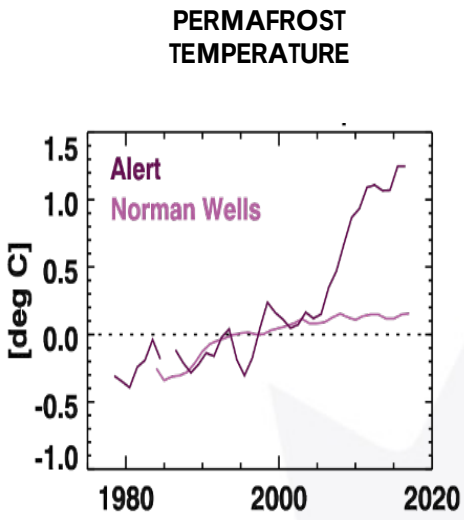
The effects of widespread warming are evident in many parts of Canada and are projected to intensify in the future.

- In Canada, these effects include more extreme heat, less extreme cold, longer growing seasons, shorter snow and ice cover seasons, earlier spring peak streamflow, thinning glaciers, thawing permafrost and rising sea level.
- Because some further warming is unavoidable, these trends will continue.

A warmer world - declines in snow, ice and permafrost







- Over the past three decades, the proportion of Canadian land and marine areas covered by snow and ice have decreased, permafrost temperatures have risen, and Arctic and alpine glaciers have thinned at rates unprecedented for several millennia

Headline Statement

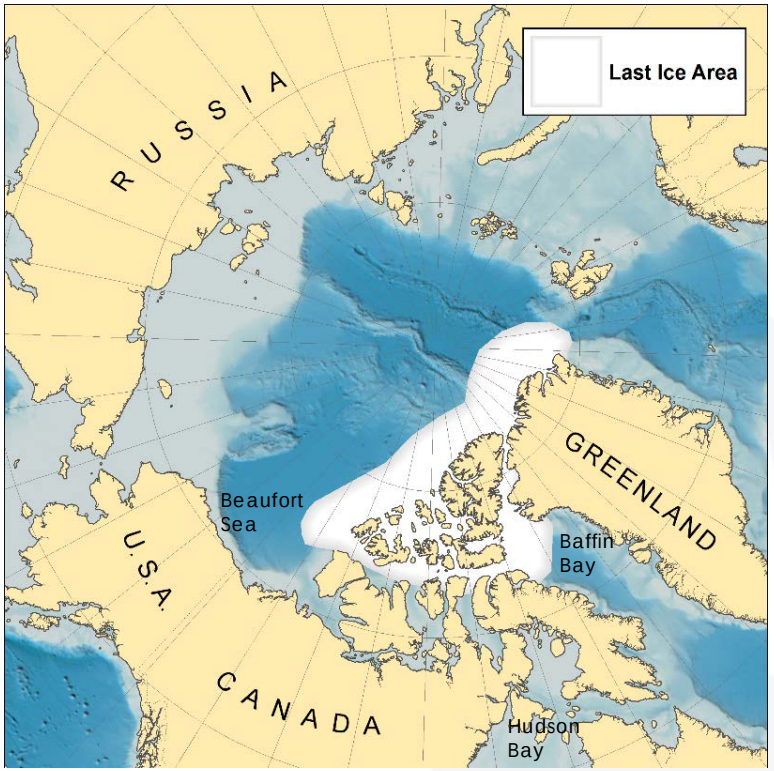
Canadian areas of the Arctic and Atlantic Oceans have experienced longer and more widespread sea ice-free conditions.

- Canadian Arctic marine areas are projected to have extensive ice-free periods during summer by mid-century.
- The last area with summer sea ice is projected to be within and north of the Canadian Arctic Archipelago.
- This area will be an important refuge for ice-dependent species and an ongoing source of potentially hazardous ice which will drift into Canadian waters.

Canadian Arctic Archipelago – a refuge for summer sea ice

- The likelihood of summer ice-free conditions in the central Arctic rises with the magnitude of global temperature increases
- Most Canadian Arctic marine regions could be sea ice–free for at least one month in the summer by 2050, but sea ice will continue to be found along the northern coast of the Canadian Arctic Archipelago (CAA)

Schematic of the last ice area of the Arctic Ocean

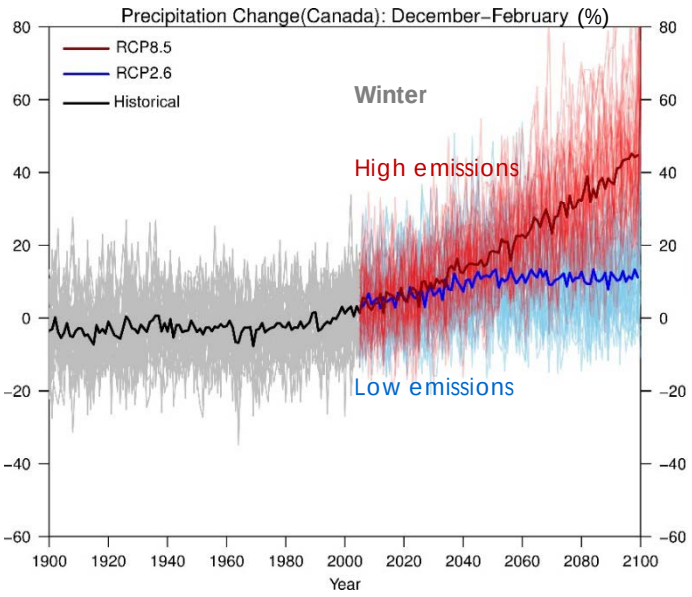


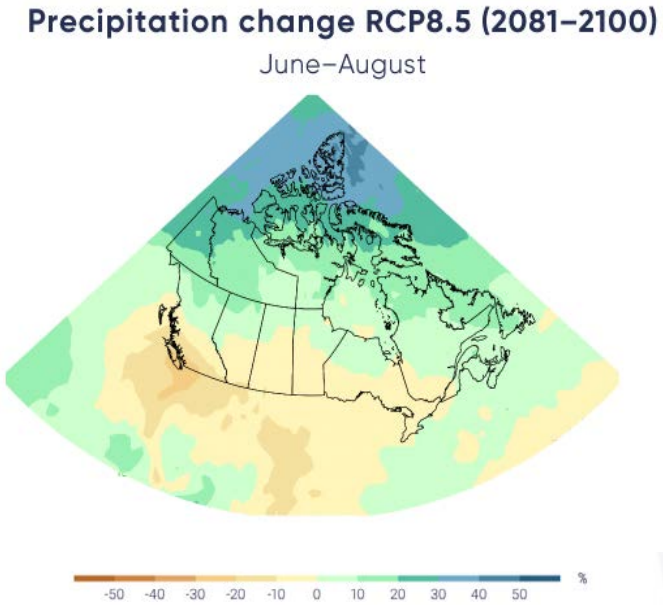
Headline Statement

Precipitation is projected to increase for most of Canada, on average, although summer rainfall may decrease in some areas.

- Precipitation has increased in many parts of Canada, and there has been a shift toward less snowfall and more rainfall.
- Annual and winter precipitation is projected to increase everywhere in Canada over the 21st century.
- However, reductions in summer rainfall are projected for parts of southern Canada under a high emission scenario toward the late century.

A warmer climate will bring more precipitation on average





- Annual and winter precipitation is projected to increase everywhere in Canada over the 21st century, with larger changes under a high emission scenario
- Larger percent changes are projected for northern Canada

- Unlike for temperature, which is projected to increase everywhere in every season, precipitation has patterns of increase and decrease
- Summer precipitation is projected to decrease in southern Canada under a high emission scenario toward the end of the century

Headline Statement

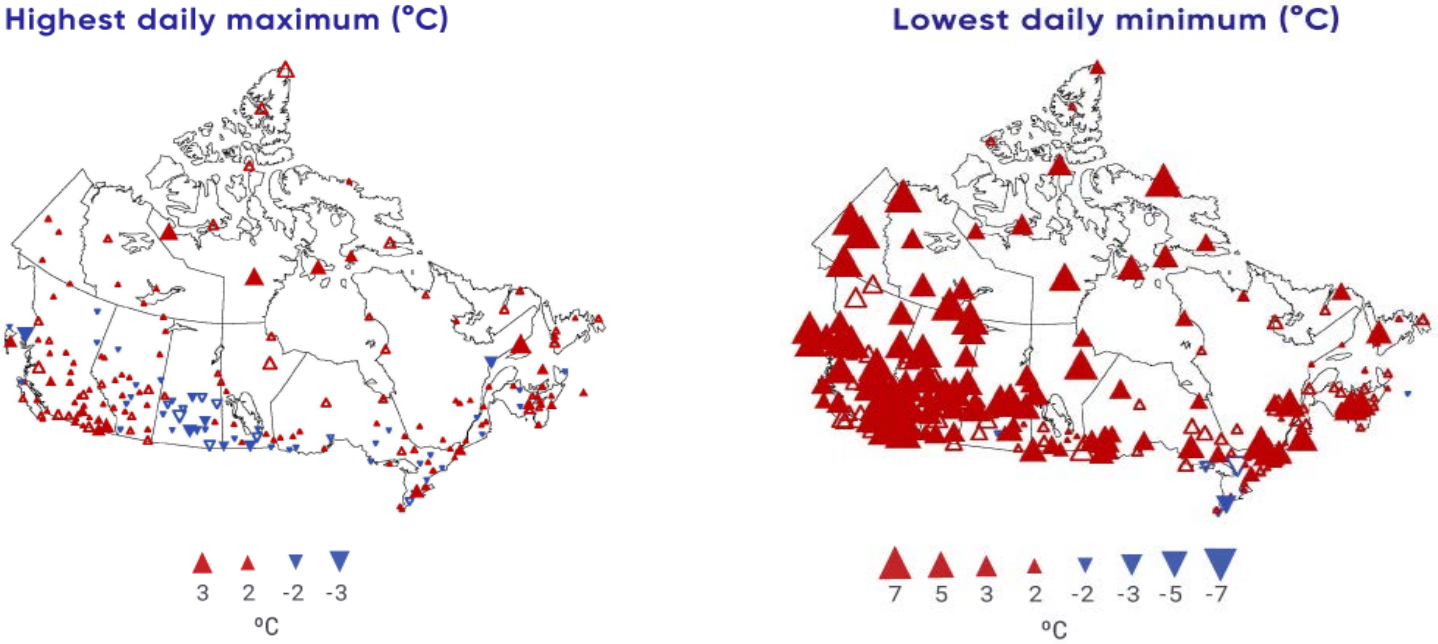
The seasonal availability of freshwater is changing with an increased risk of water supply shortages in summer.

- Warmer winters and earlier snowmelt will combine to produce higher winter streamflows
- Smaller snowpacks and loss of glacier ice this century will combine to produce lower summer streamflows.

Spring freshet at Eakin Creek in BC

- Warmer summers will increase evaporation of surface water and contribute to reduced summer water availability in the future despite more precipitation in some places.

More extreme heat and less extreme cold have been observed in Canada



- The annual highest daily maximum temperature, averaged over Canada, increased by 0.61ºC between 1948 and 2016
- The annual lowest daily minimum temperature, averaged over Canada, increased by 3.3 ºC between 1948 and 2016
- Most of the observed increase in the coldest and warmest daily temperatures in Canada can be attributed to human influence

Headline Statement

A warmer climate will intensify some weather extremes in the future.

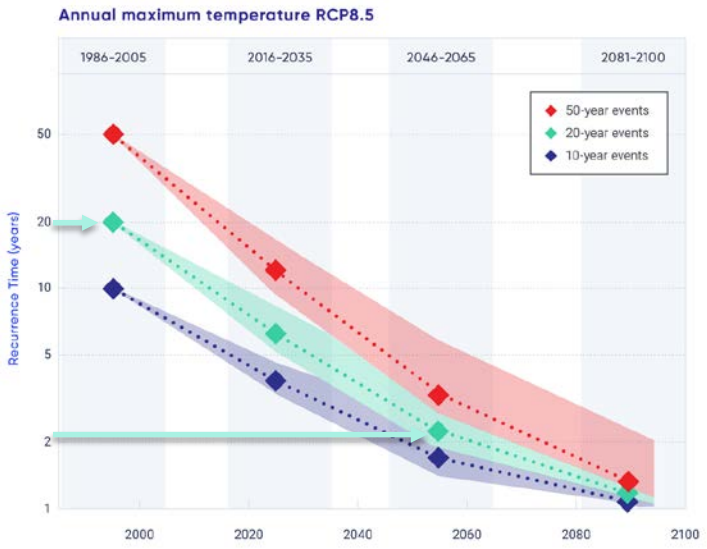
- Extreme hot temperatures will become more frequent and more intense. This will increase the severity of heatwaves, and contribute to increased drought and wildfire risks.
- While inland flooding results from multiple factors, more intense rainfalls will increase urban flood risks.
- It is uncertain how warmer temperatures and smaller snowpacks will combine to affect the frequency and magnitude of snowmelt-related flooding.

HEAT WAVES

WILDLAND FIRES

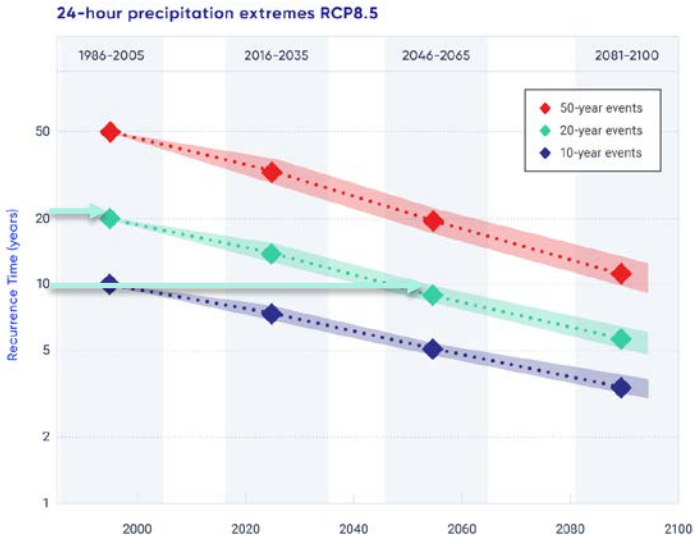
Future increases in the frequency and intensity of extreme events

Change in temperature extremes
High emission scenario



- A current 1 in 20-yr hot extreme will become a once in 2-year event by mid-century under a high emission scenario (a ten-fold increase in frequency)

Change in precipitation extremes
High emission scenario

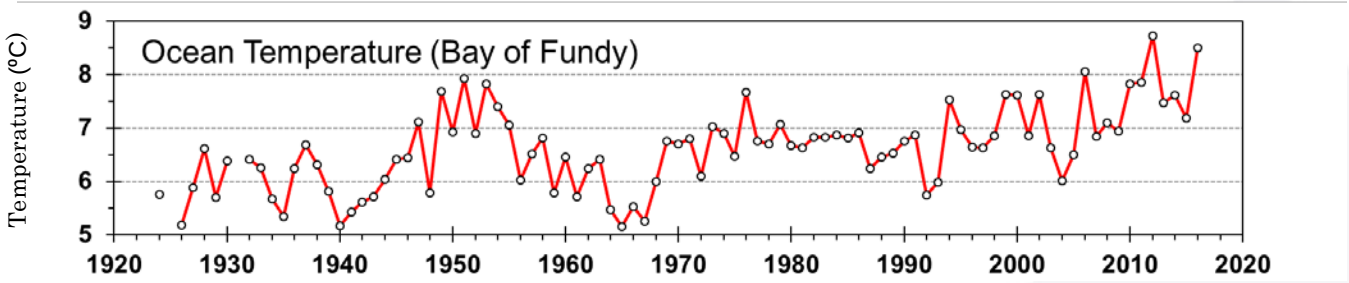


- A current 1 in 20-yr rainfall extreme will become a once in 10-yr event by mid-century under the high emission scenario (a two-fold increase in frequency)

Headline Statement

Oceans surrounding Canada have warmed, become more acidic, and less oxygenated, consistent with observed global ocean changes over the past century.

- Ocean warming and loss of oxygen will intensify with further emissions of all greenhouse gases.
- Ocean acidification will increase in response to additional carbon dioxide emissions.
- These changes threaten the health of marine ecosystems.

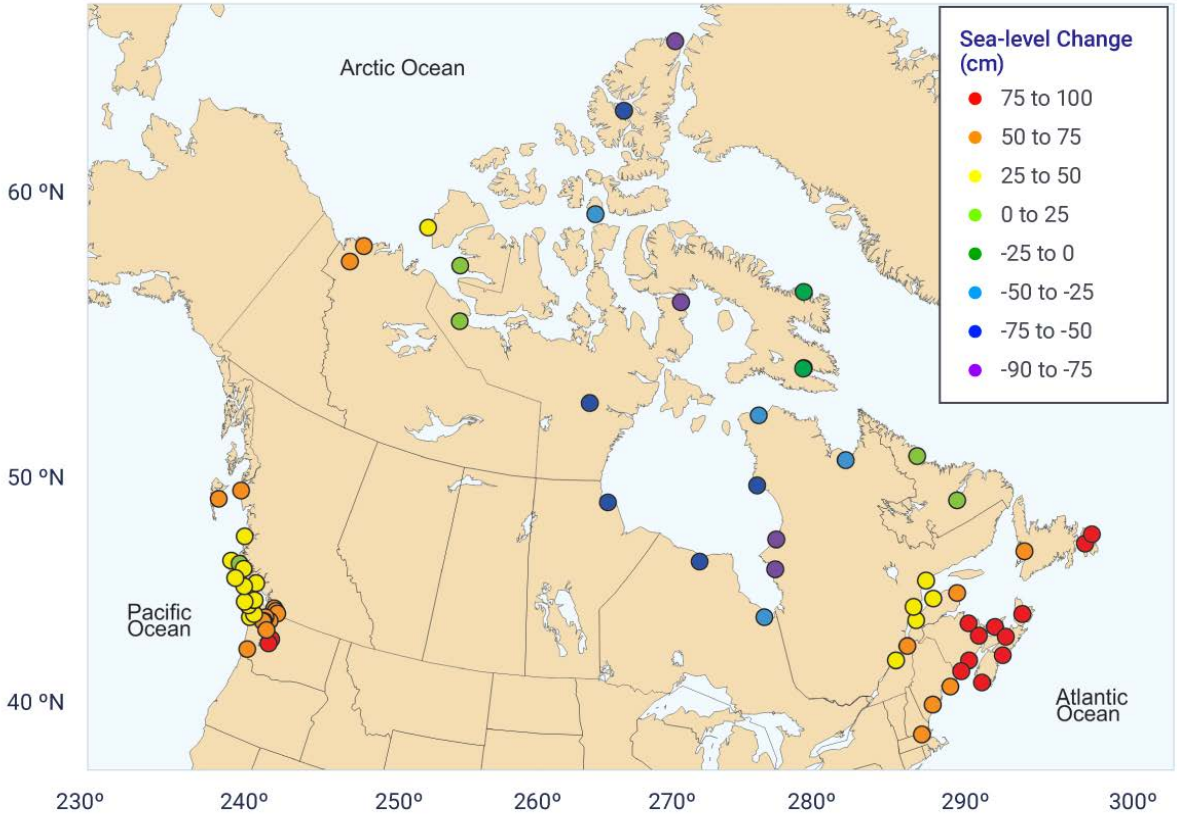


Headline Statement

Coastal flooding is expected to increase in many areas of Canada due to local sea level rise.

- Changes in local sea-level are a combination of global sea level rise and local land subsidence or uplift.
- Local sea level is projected to rise, and increase flooding, along most of the Atlantic and Pacific coasts of Canada and the Beaufort coast in the Arctic where the land is subsiding or slowly uplifting.
- The loss of sea ice in Arctic and Atlantic Canada further increases the risk of damage to coastal infrastructure and ecosystem due to larger storm surges and waves.

Global mean sea level is projected to rise, but along Canada's coastlines, sea level will rise in some places, fall elsewhere



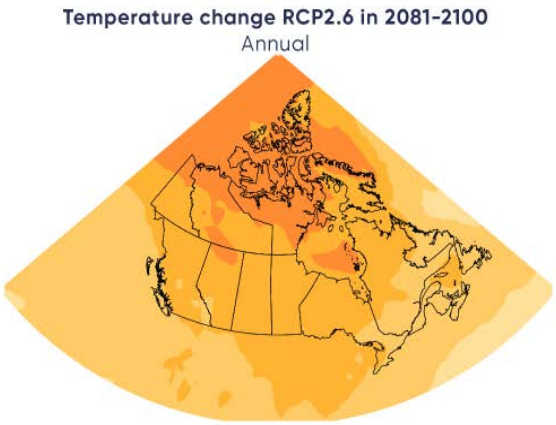
- End-of-century projected relative (local) sea-level change under a high emission scenario, relative to 1986-2005 reference period

Headline Statement

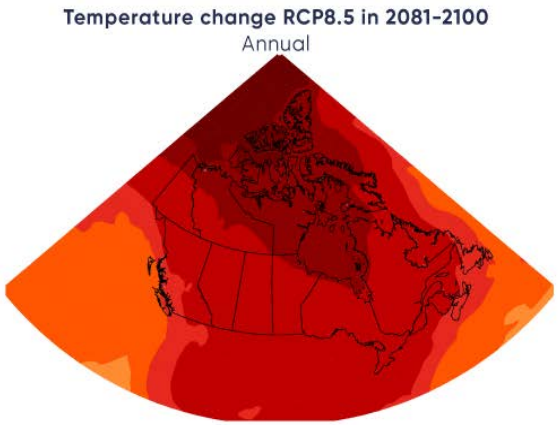
The rate and magnitude of climate change under high versus low emission scenarios project two very different futures for Canada.

- Scenarios with large and rapid warming illustrate the profound effects on Canadian climate of continued growth in greenhouse gas emissions.
- Scenarios with limited warming require Canada and the rest of the world to reduce carbon emissions to near zero early in the second half of the century.

Low global emissions limited warming



High global emissions large warming



http://www.changingclimate.ca/CCCR2019

https://www.nrcan.gc.ca/environment/impacts-adaptation/21177