

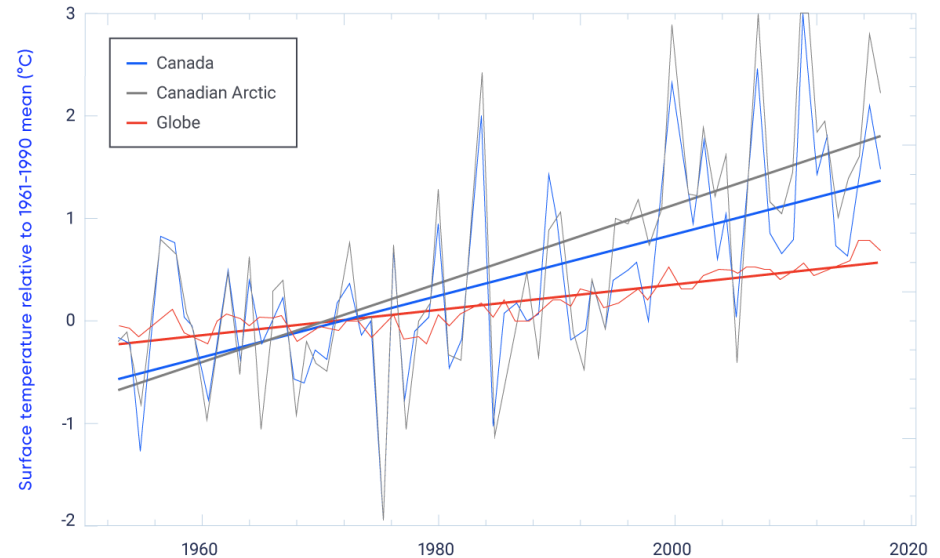
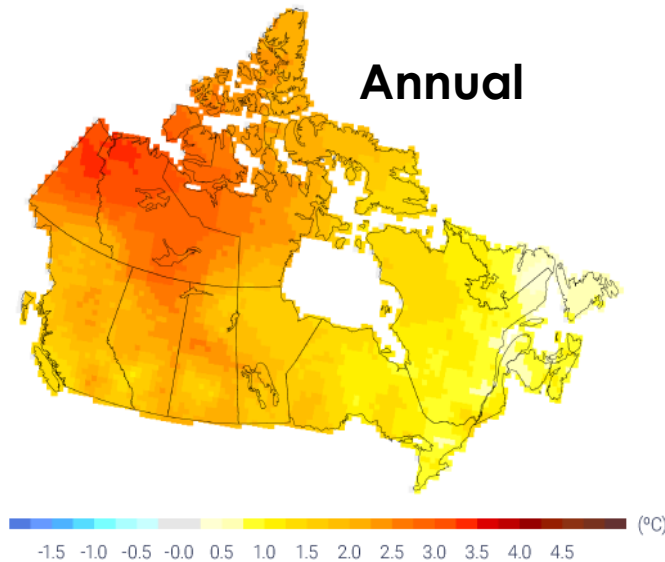
The cover image of the report is a composite of two photographs. The left half shows a dark, dense forest with a river or lake in the foreground, reflecting the surrounding greenery. The right half shows a snowy mountain landscape with a person standing on a snow-covered path, looking up at a steep, snow-covered slope. The title 'Canada's Changing Climate Report' is overlaid in large, bold, yellow text, with the word 'Changing' highlighted by a teal horizontal bar.

Canada's Changing Climate Report

A collaborative effort:
Environment and Climate Change Canada
Fisheries and Oceans Canada
Natural Resources Canada
University experts

Overview of the report

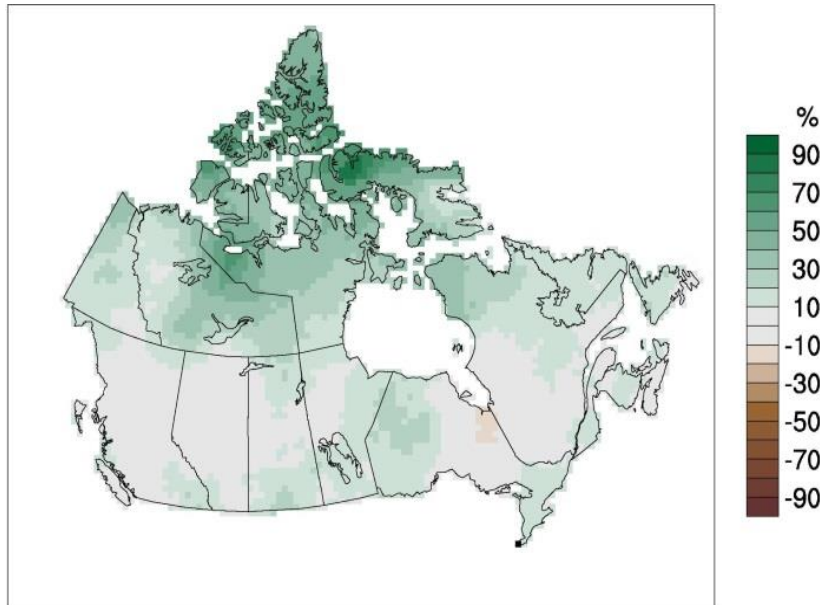
Canada has warmed, faster than the global average



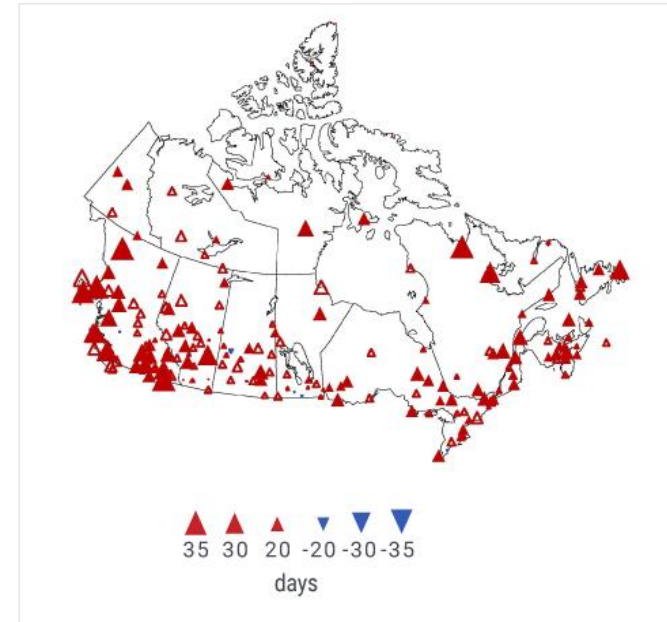
- Annual average temperature in Canada has increased by 1.7°C between 1948 and 2016.
- Canada has warmed about two times the global rate.
- Warming is not uniform across Canada. Northern Canada has warmed by 2.3°C, about three times global warming.
- Most of the observed increase in annual average temperature in Canada can be attributed to human influence.

The effects of widespread warming are evident across many indicators.

Changes in annual precipitation
1948-2012

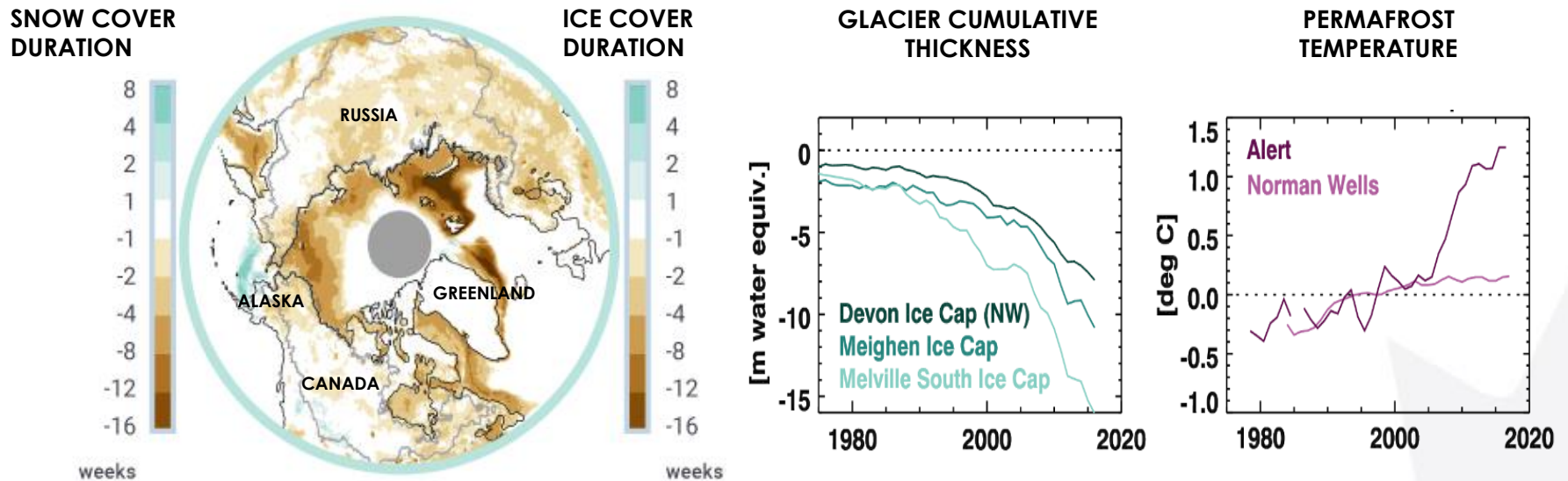


Length of growing season (days)



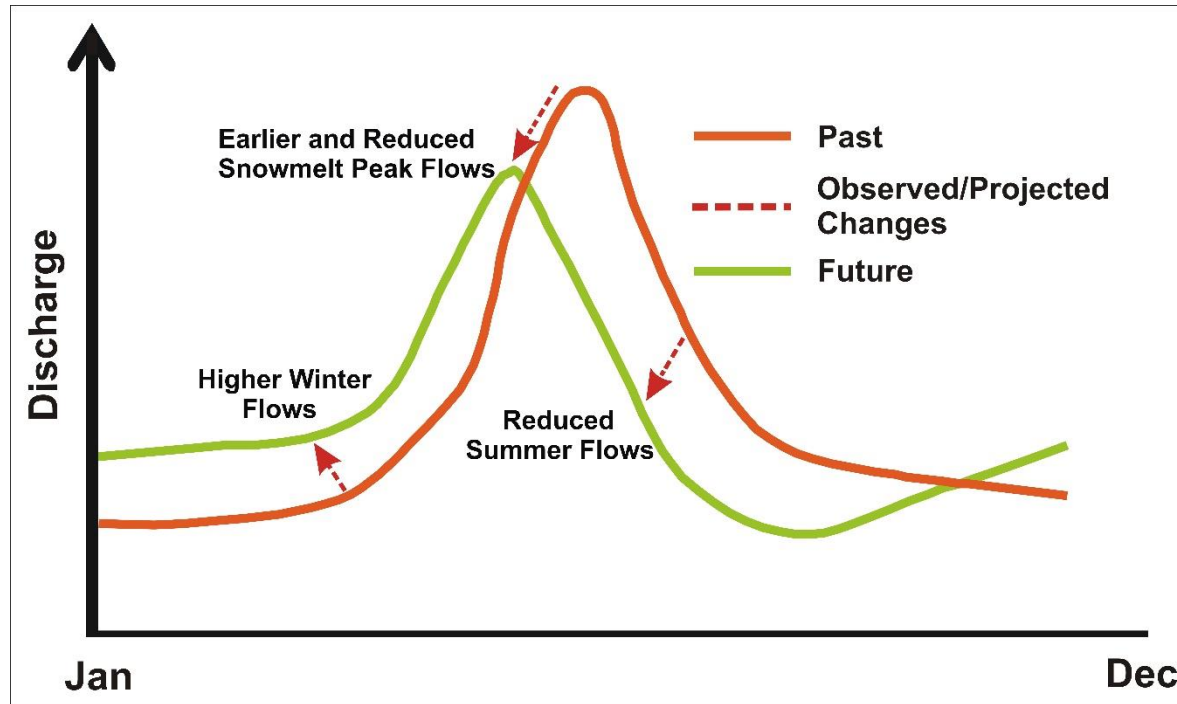
- Annual precipitation has increased in many regions since 1948.
- Averaged over the country, normalized precipitation has increased by about 20% from 1948 to 2012.
- An increase in growing season length of about 15 days between 1948 and 2016 has been observed.

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.

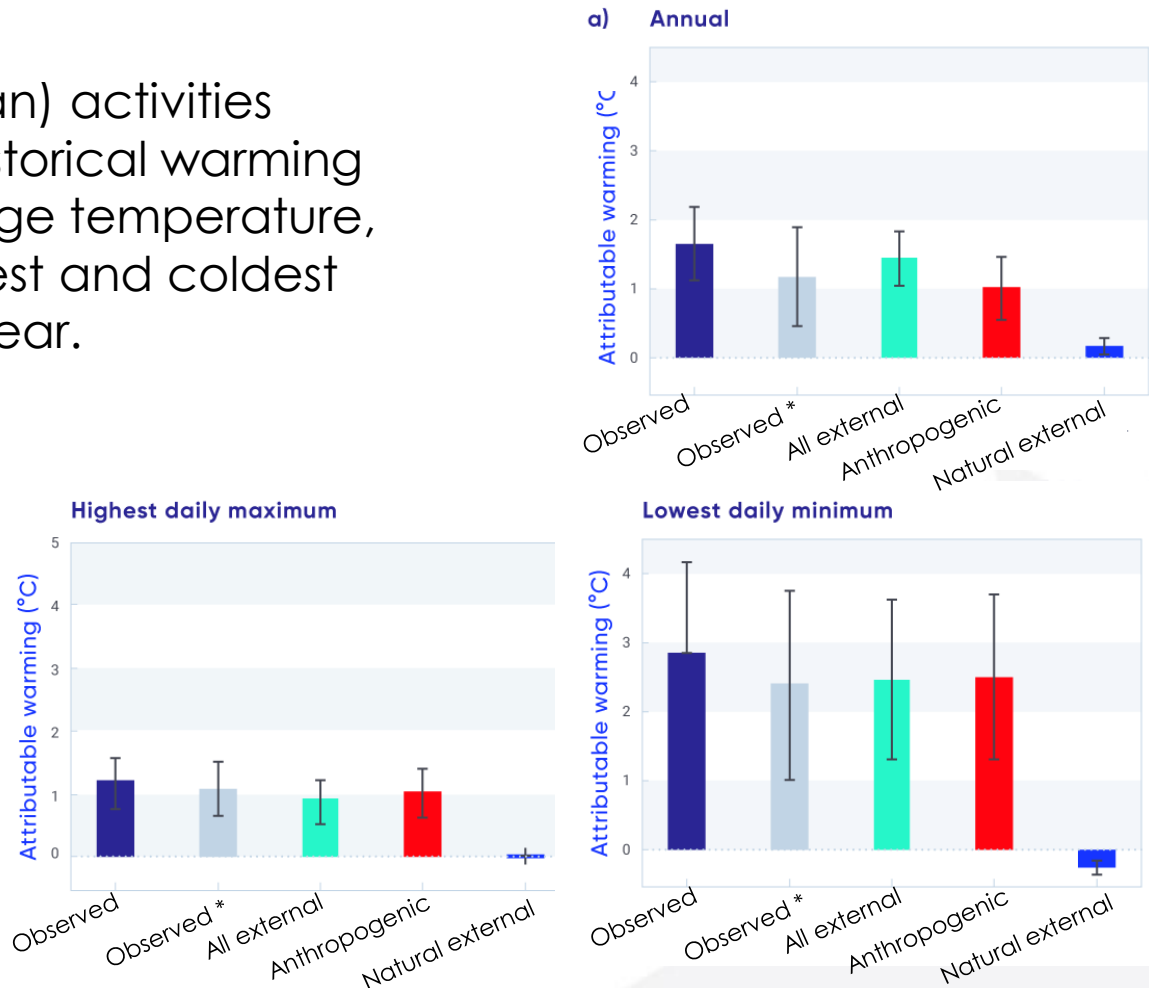
The seasonal timing of peak streamflow has shifted, driven by warming temperatures.



- Over the last several decades, spring peak streamflow following snowmelt has occurred earlier, with higher winter and early spring flows. In some areas, reduced summer flows have been observed.
- Seasonal changes projected to continue, with shifts from more snowmelt-dominated regimes toward rainfall-dominated regimes.

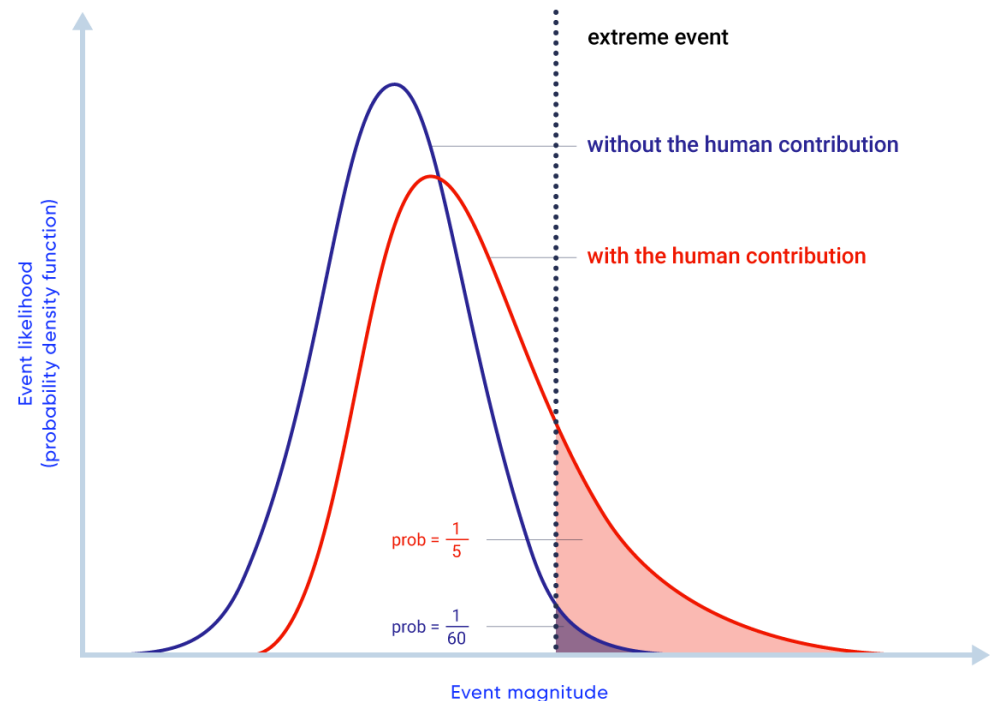
Most of the observed temperature increase can be attributed to human influence

- Anthropogenic (human) activities explain most of the historical warming trend in annual average temperature, as well as for the hottest and coldest temperatures of the year.
- Natural external factors (solar and volcanic activity) play a very minor role.

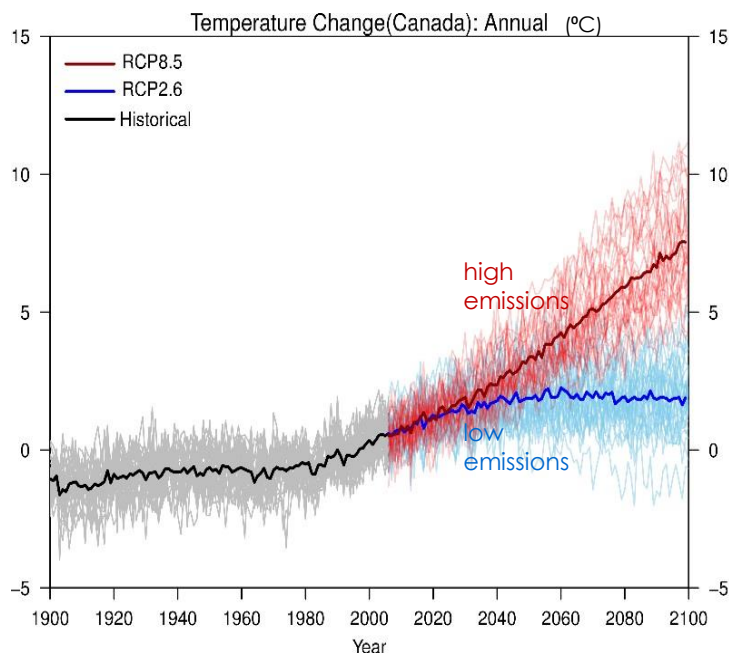


Anthropogenic climate change has increased the likelihood of some types of extreme events.

- Canada is already seeing the impacts of human-caused climate change in extreme events.
- The 2013 Alberta floods: increased likelihood of extreme rainfall.
- The 2016 Alberta wildfire: increased likelihood of extreme wildfire risk and length of the fire season.

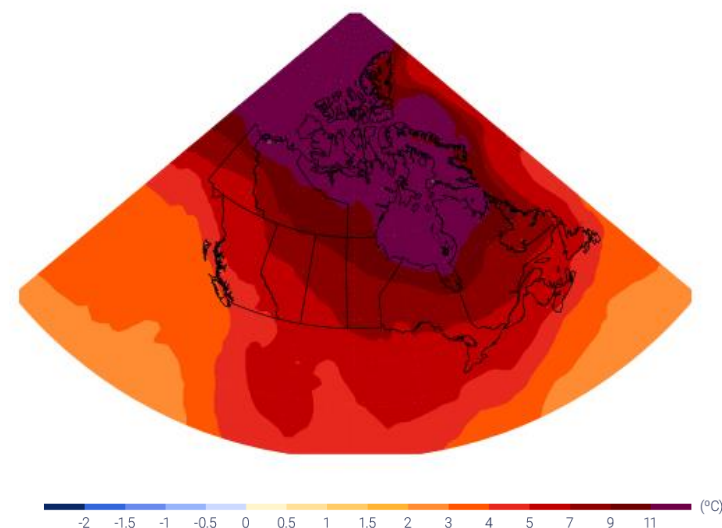


Future warming in Canada depends directly on global emissions



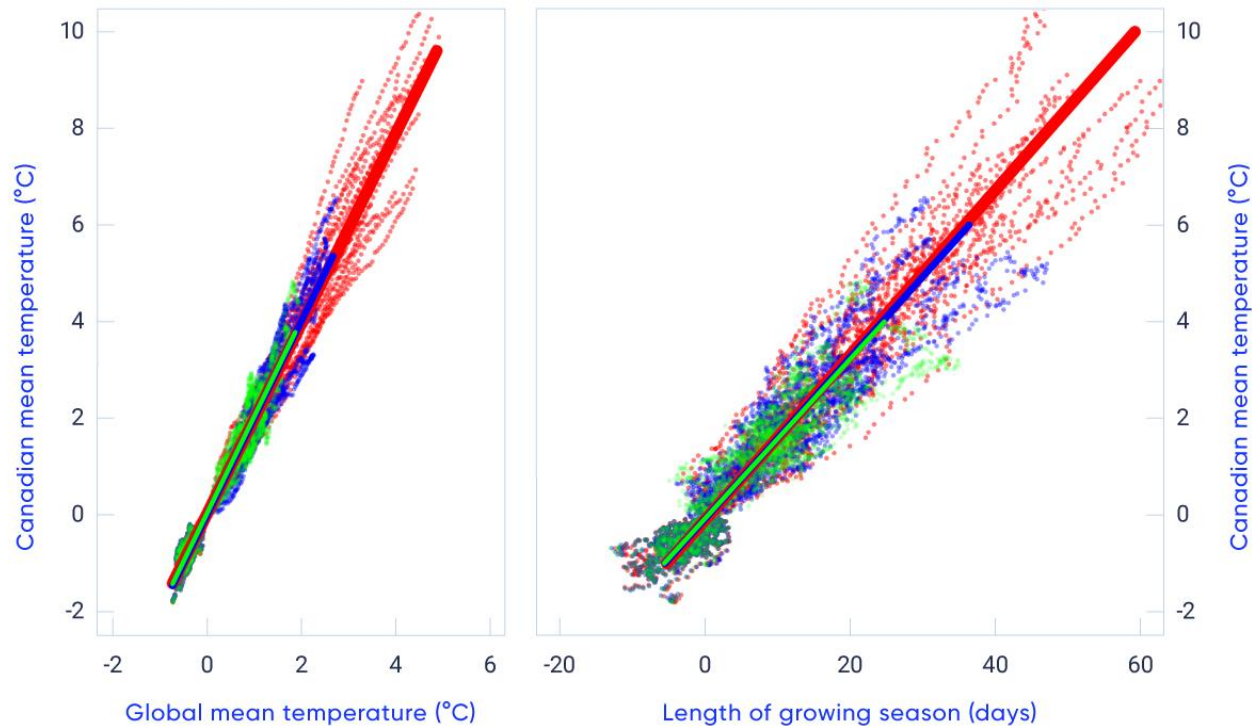
Temperature change RCP8.5 (2081-2100)

December-February



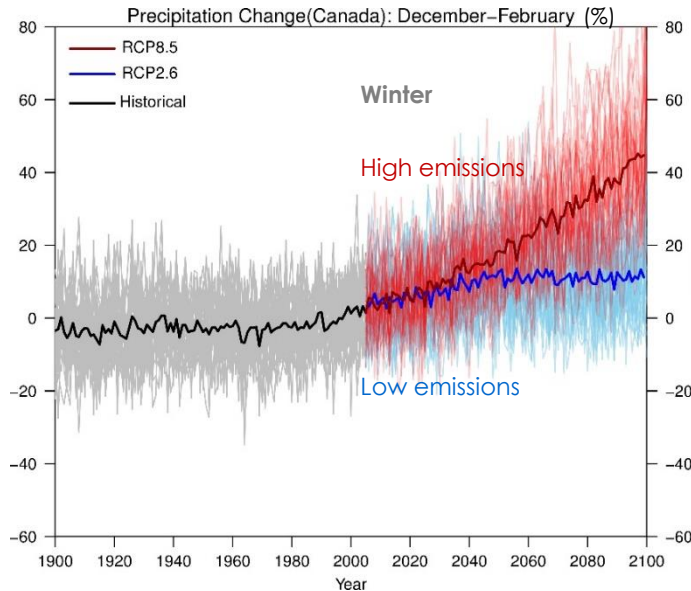
- Low emission scenario: an additional annual warming of about 2°C is projected by mid-century, with temperatures steady after that.
- High emission scenario: temperature increases will continue, reaching more than 6 °C by late century.
- Consistent with observed warming, future warming will be strongest 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.

Regional climate changes, such as for Canada, are closely related to change in the global mean.



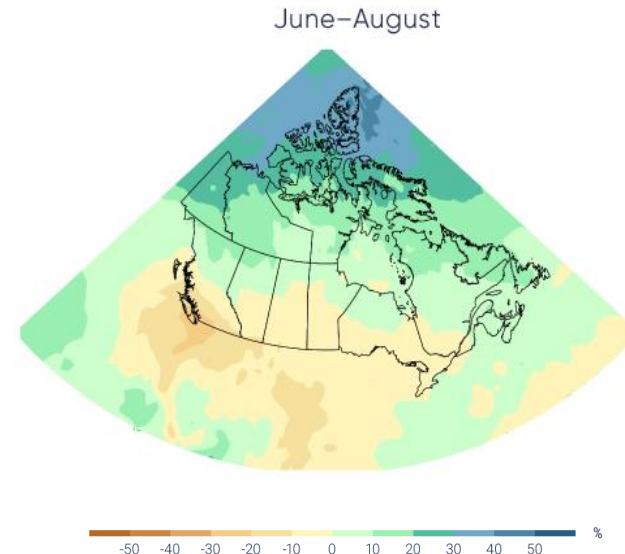
- Canada is projected to warm at twice the global rate, regardless of the emissions scenario.
- Many impacts-relevant metrics, such as growing season length, scale with temperature.

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.

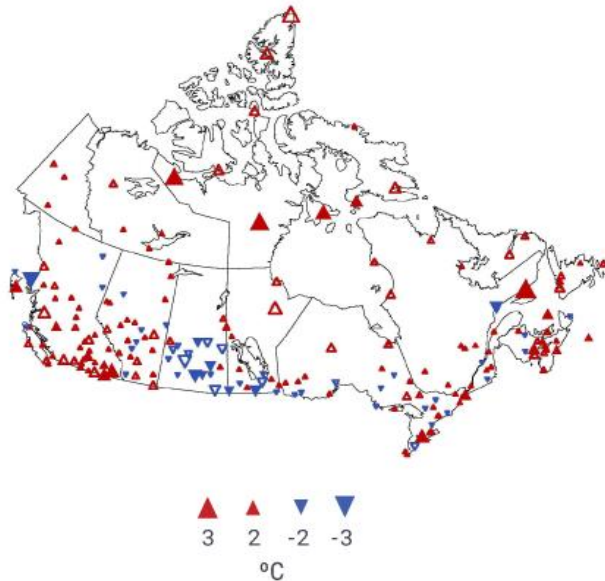
Precipitation change RCP8.5 (2081-2100)



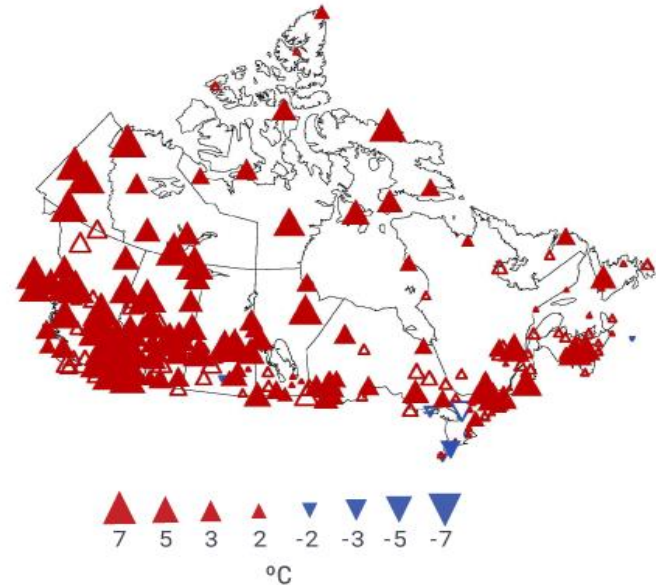
- Unlike for temperature, which is projected to increase everywhere in every season, precipitation has patterns of increase and decrease.
- Summer precipitation is projected to decrease in southern Canada under a high emission scenario toward the end of the century.

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

Highest daily maximum (°C)



Lowest daily minimum (°C)



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

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.
- Future droughts and soil moisture deficits are projected to be more frequent and intense across the southern Canadian Prairies and interior British Columbia during summer, and to be more prominent at the end of the century under a high emission scenario.

HEAT WAVES



WILDLAND FIRES



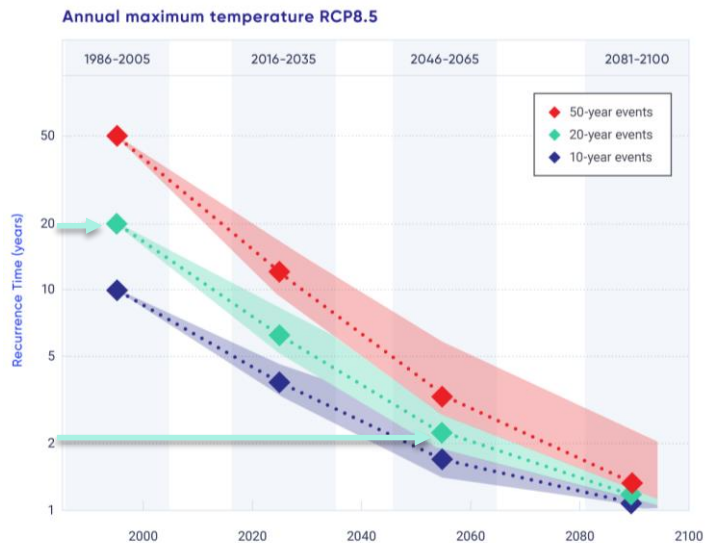
More intense rainfalls will increase urban flood risks

- Projected increases in extreme precipitation are expected to increase the potential for future urban flooding.
- Projected higher temperatures will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events.
- It is uncertain how projected higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of future snowmelt-related flooding.



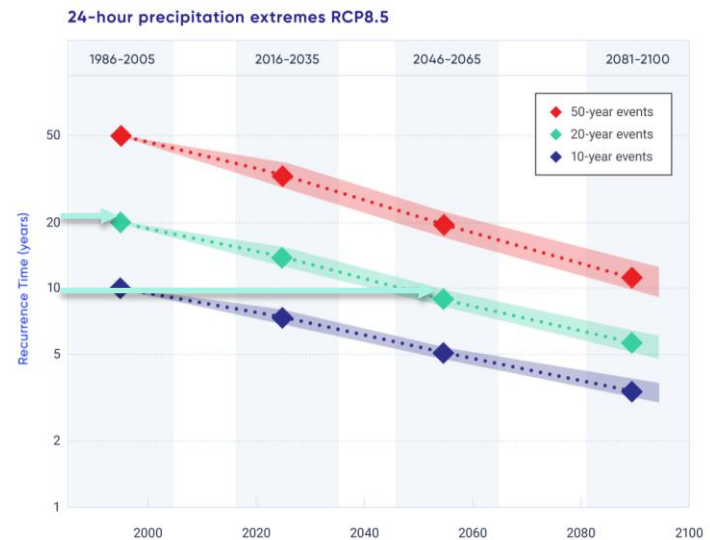
Future increases in the frequency and intensity of extreme temperature and precipitation events

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).

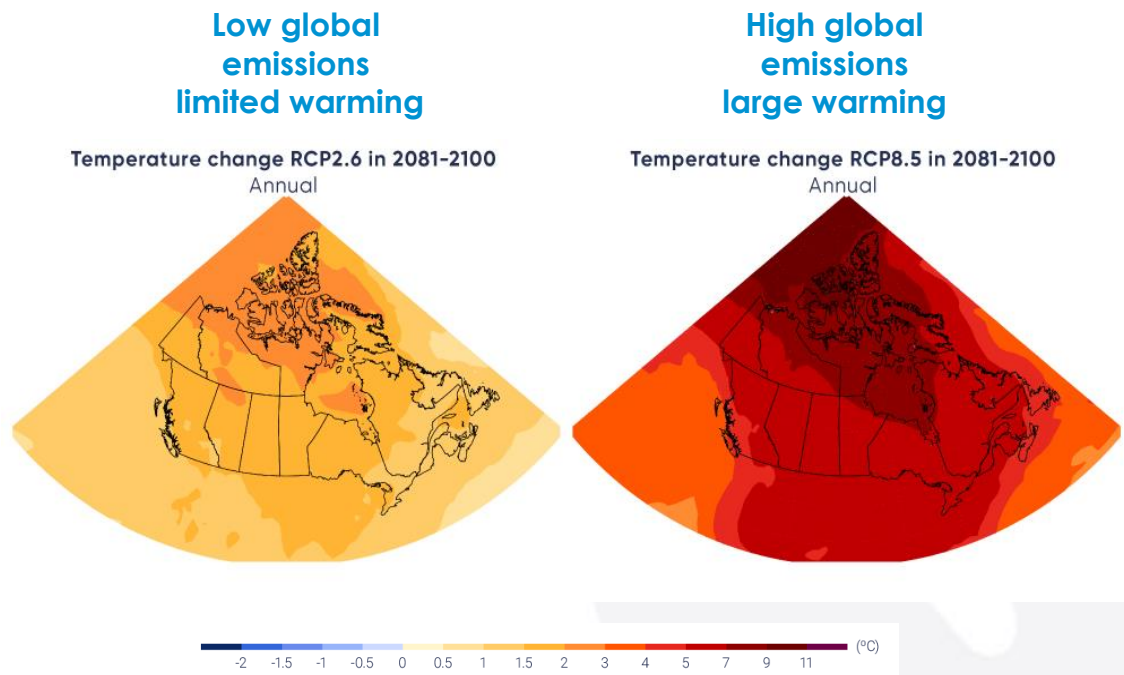
Change in precipitation extremes High emission scenario



- 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).

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.



Take home messages on extremes.....

- The magnitude of future warming will be determined by the extent of future GHG (principally, CO₂) emissions or mitigation.
- Across Canada, we have already observed increases in the hottest temperatures and larger increases in the coldest temperatures.
- Substantial future changes are projected in temperature extremes. There will be more hot and fewer cold temperature extremes.
- Warmer temperatures are accompanied by an increase in atmospheric moisture, which increases extreme precipitation.
- Although we cannot focus on individual locations, we can use robust large-scale projections and theoretical understanding to understand future changes in locally-relevant climate extremes.



Thank you Questions?

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www.changingclimate.ca/CCCR2019

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