Environment and Climate Change Canada | Environnement et Changement climatique Canada

IS 2019 SPRING OTTAWA FLOOD CAUSED BY CLIMATE CHANGE?

Xuebin Zhang, Climate Research Division

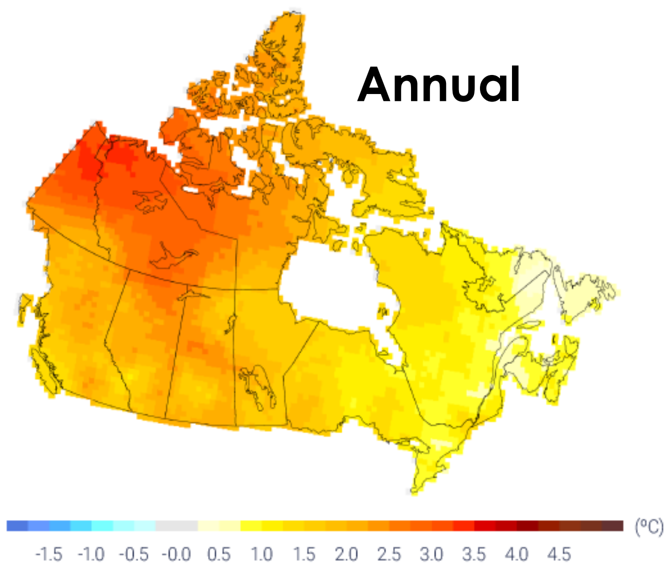
Canada

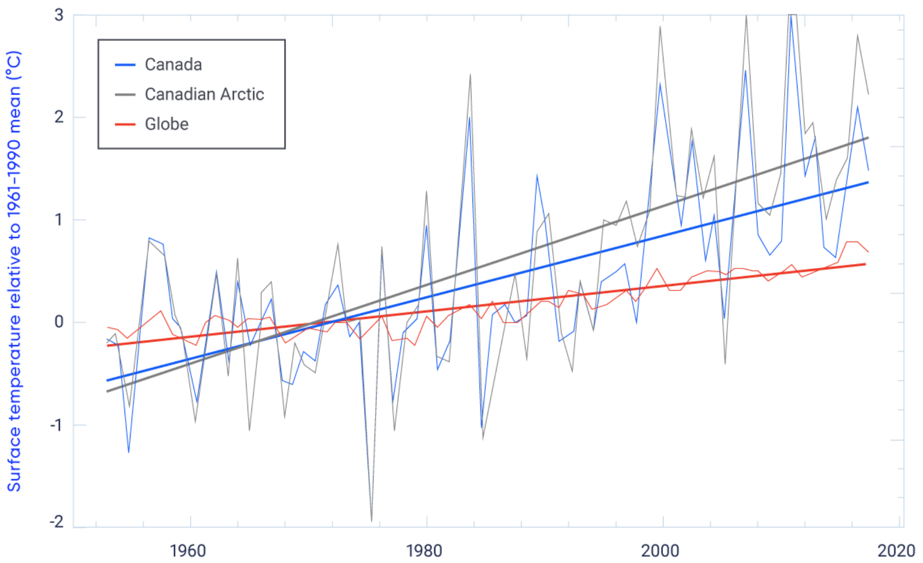
Is this due to climate change?

- A short answer: we don't know.
- A longer answer: there is no simple answer to this question (but this is not that useful at all).
- What do we know?

A woman walks through water at the corner of Rue Watt and Rue Sabourin in Gatineau's Lac-Beauchamp district on Wednesday, April 24, 2019. (David Richard/Radio-Canada)

Canada has warmed, faster than the global average

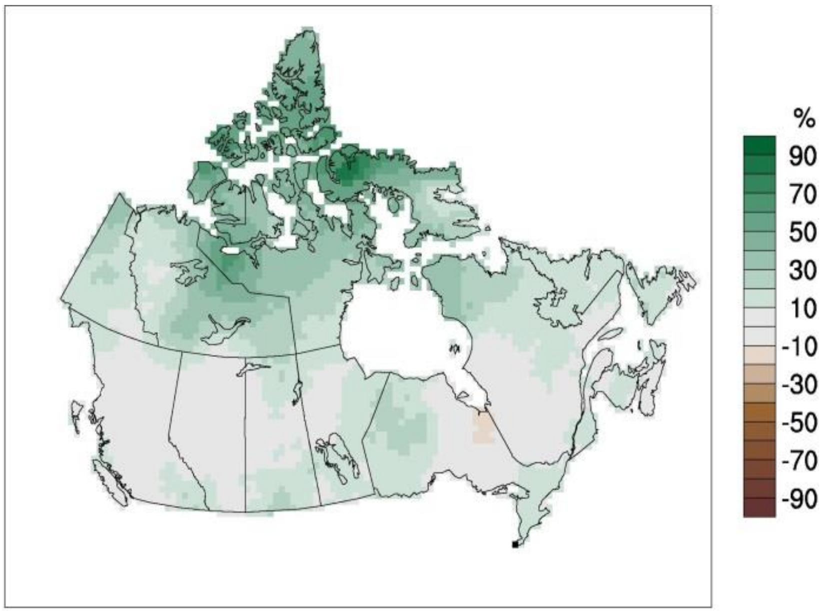




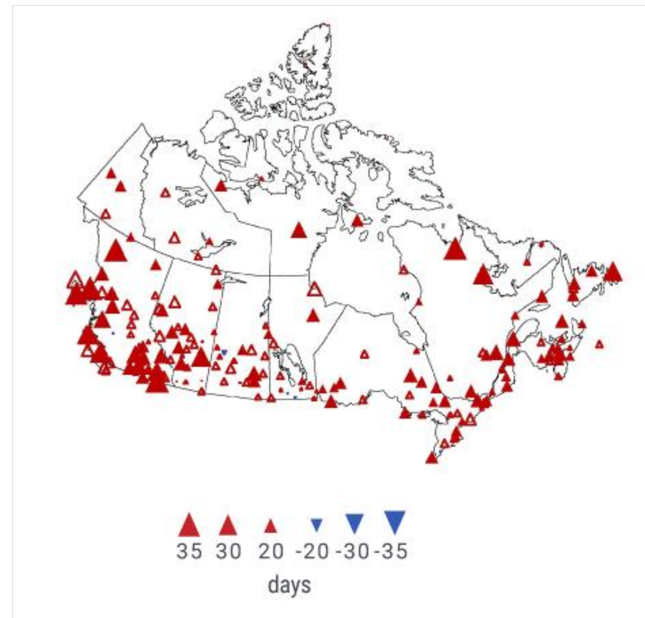
- Annual average temperature in Canada has increased by 1.7°C between 1948 and 2016.
- Canada has warmed about two times the global rate.
- Warming is not uniform across Canada. Northern Canada has warmed by 2.3◦C, about three times global warming.
- Most of the observed increase in annual average temperature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

THE EFFECTS OF WIDESPREAD WARMING ARE EVIDENT ACROSS MANY INDICATORS.

Changes in annual precipitation
1948-2012

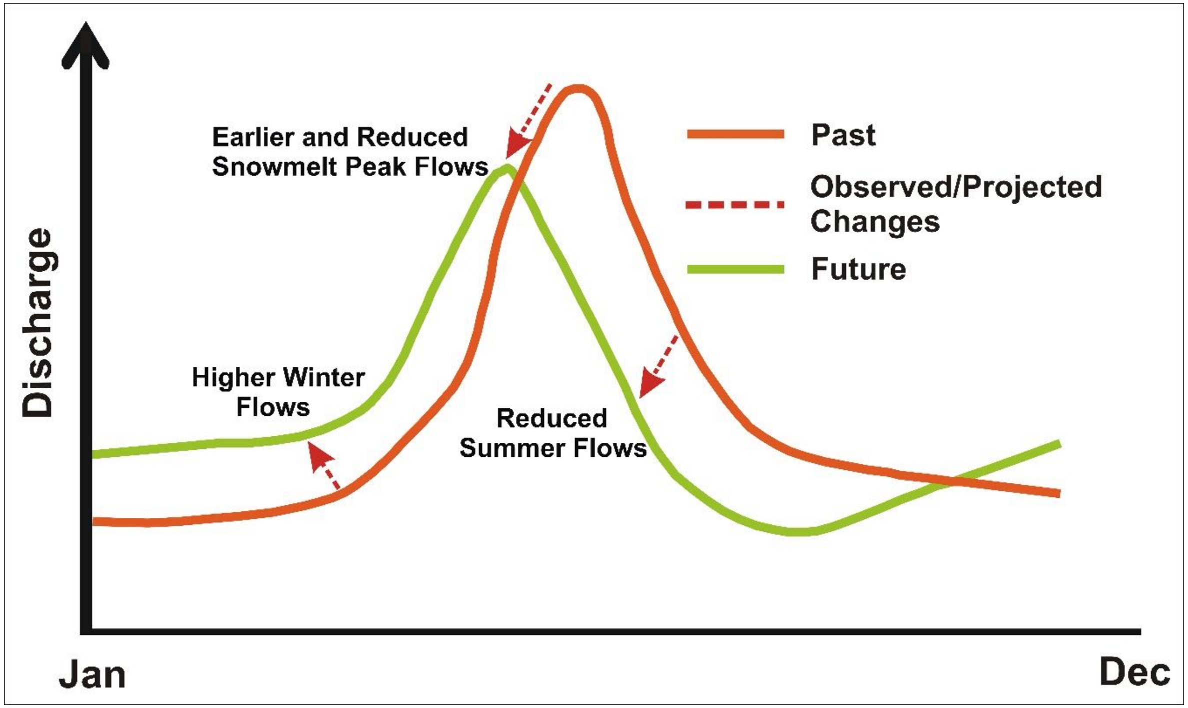


Length of growing season (days)



- 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.

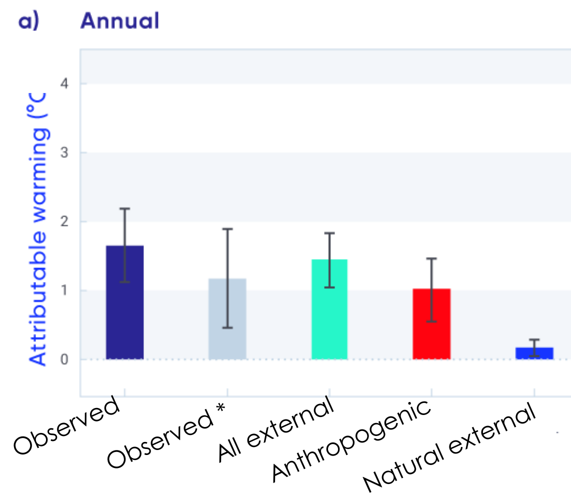
The seasonal timing of peak streamflow has shifted, driven by warming temperatures.



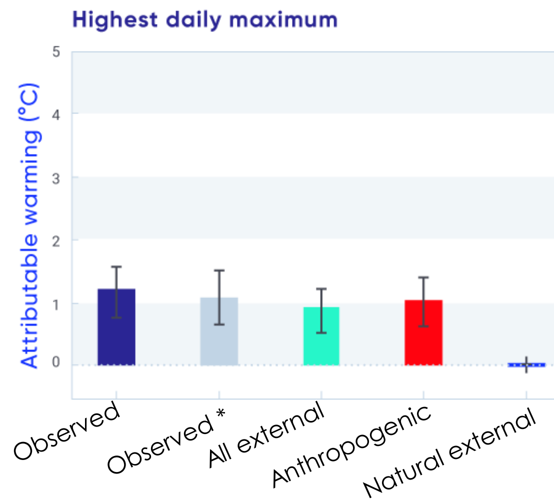
- Over the last several decades, spring peak streamflow following snowmelt has occurred earlier, with higher winter and early spring flows. In some areas, reduced summer flows have been observed.
- Seasonal changes projected to continue, with shifts from more snowmelt-dominated regimes toward rainfall-dominated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

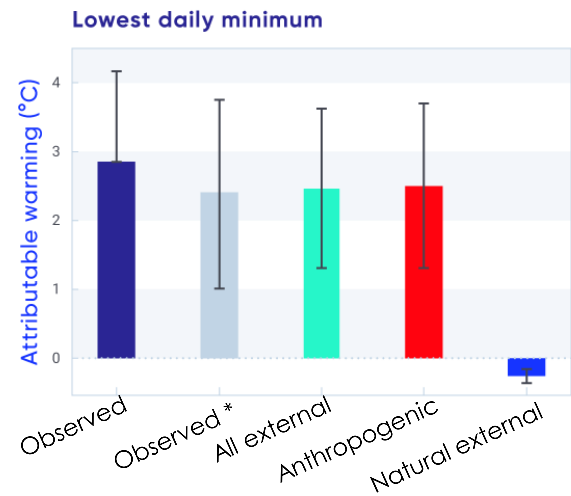
Most of the observed temperature increase can be attributed to human influence

- 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



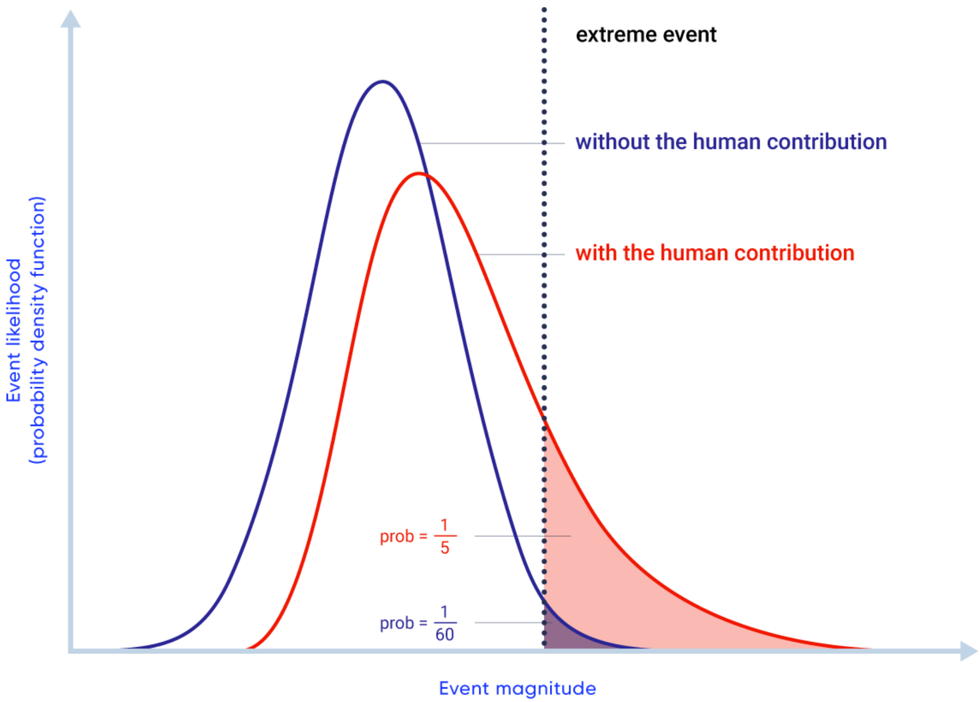
- Natural external factors (solar and volcanic activity) play a very minor role



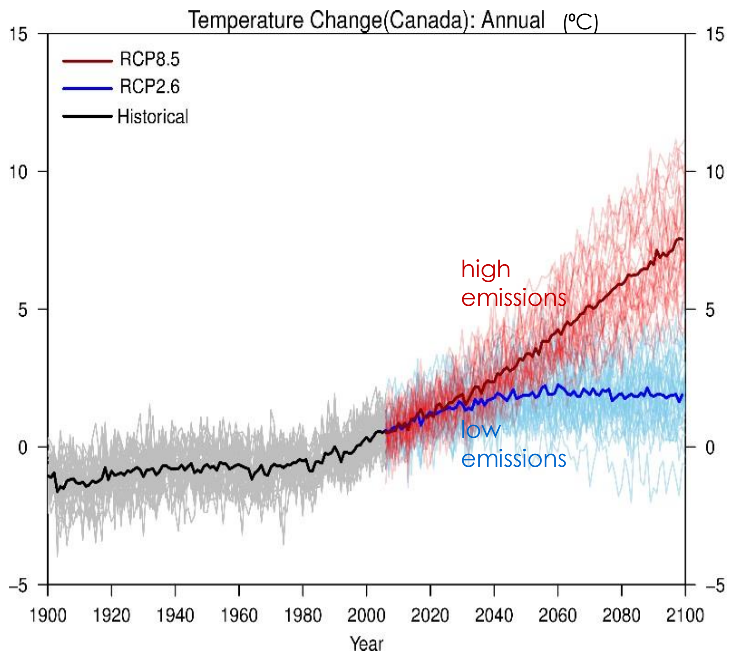


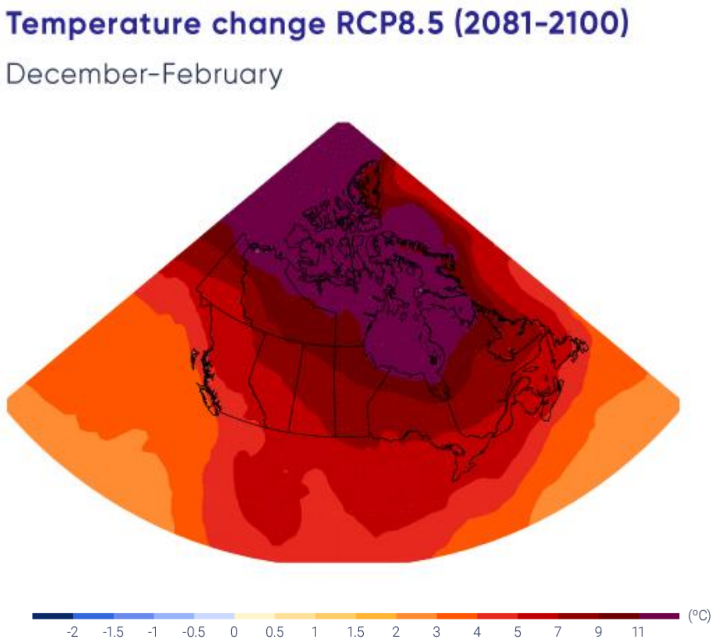
ANTHROPOGENIC CLIMATE CHANGE HAS INCREASED THE LIKELIHOOD OF SOME TYPES OF EXTREME EVENTS.

- 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



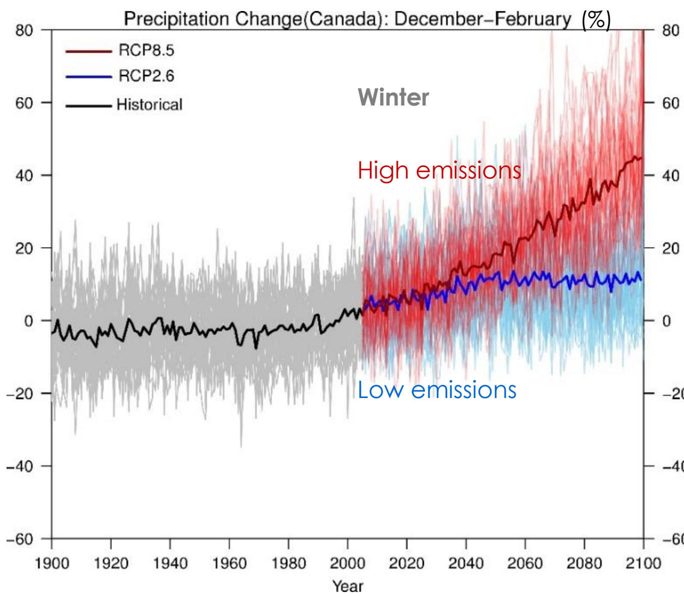
Future warming in Canada depends directly on global emissions

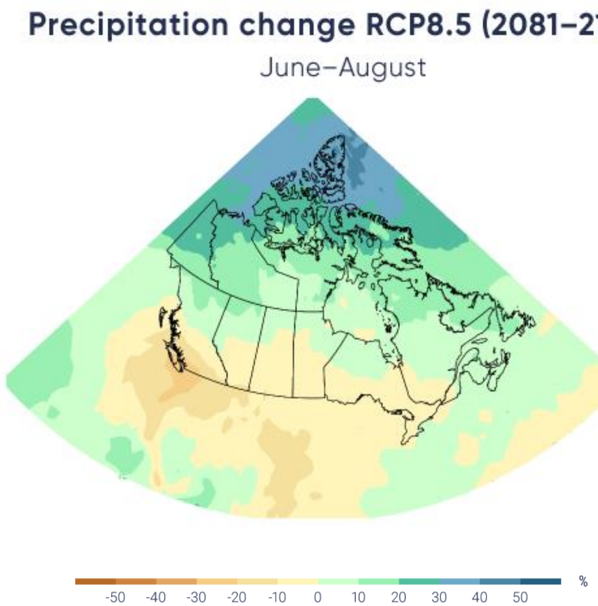




- Low emission scenario: an additional annual warming of about 2ºC is projected by mid-century, with temperatures steady after that
- High emission scenario: temperature increases will continue, reaching more than 6 ºC by late century
- Consistent with observed warming, future warming will be strongest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

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

More intense rainfalls will increase urban flood risks

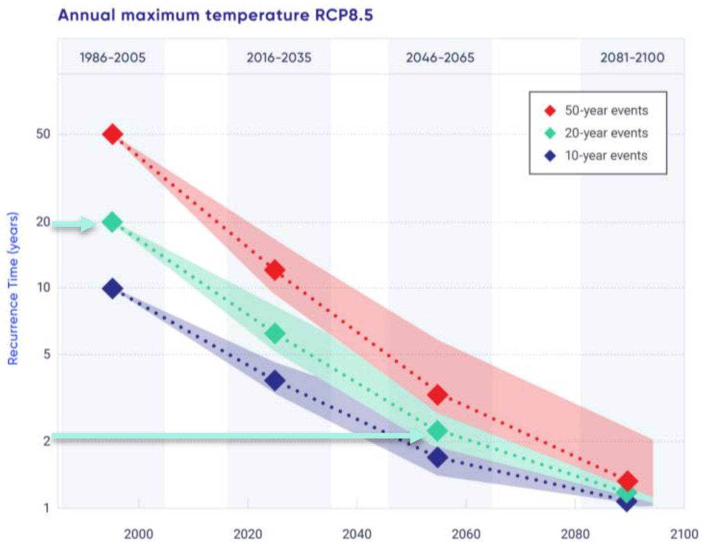
- Projected increases in extreme precipitation are expected to increase the potential for future urban flooding.

- 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.

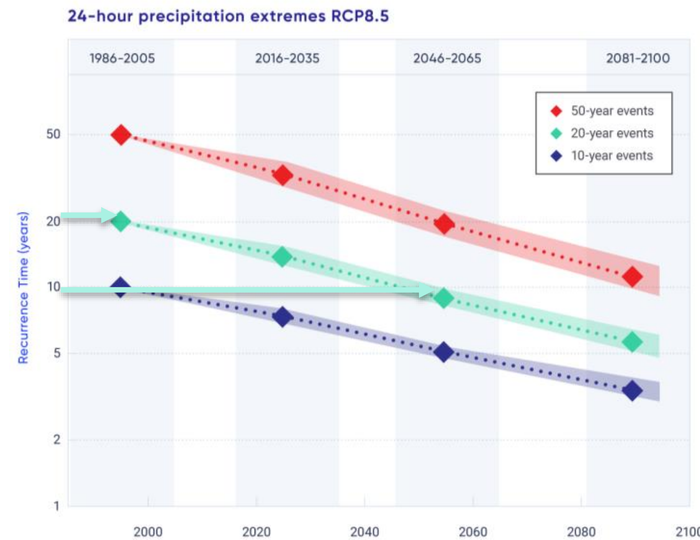
Future increases in the frequency and intensity of extreme temperature and precipitation events

Change in temperature extremes
High emission scenario



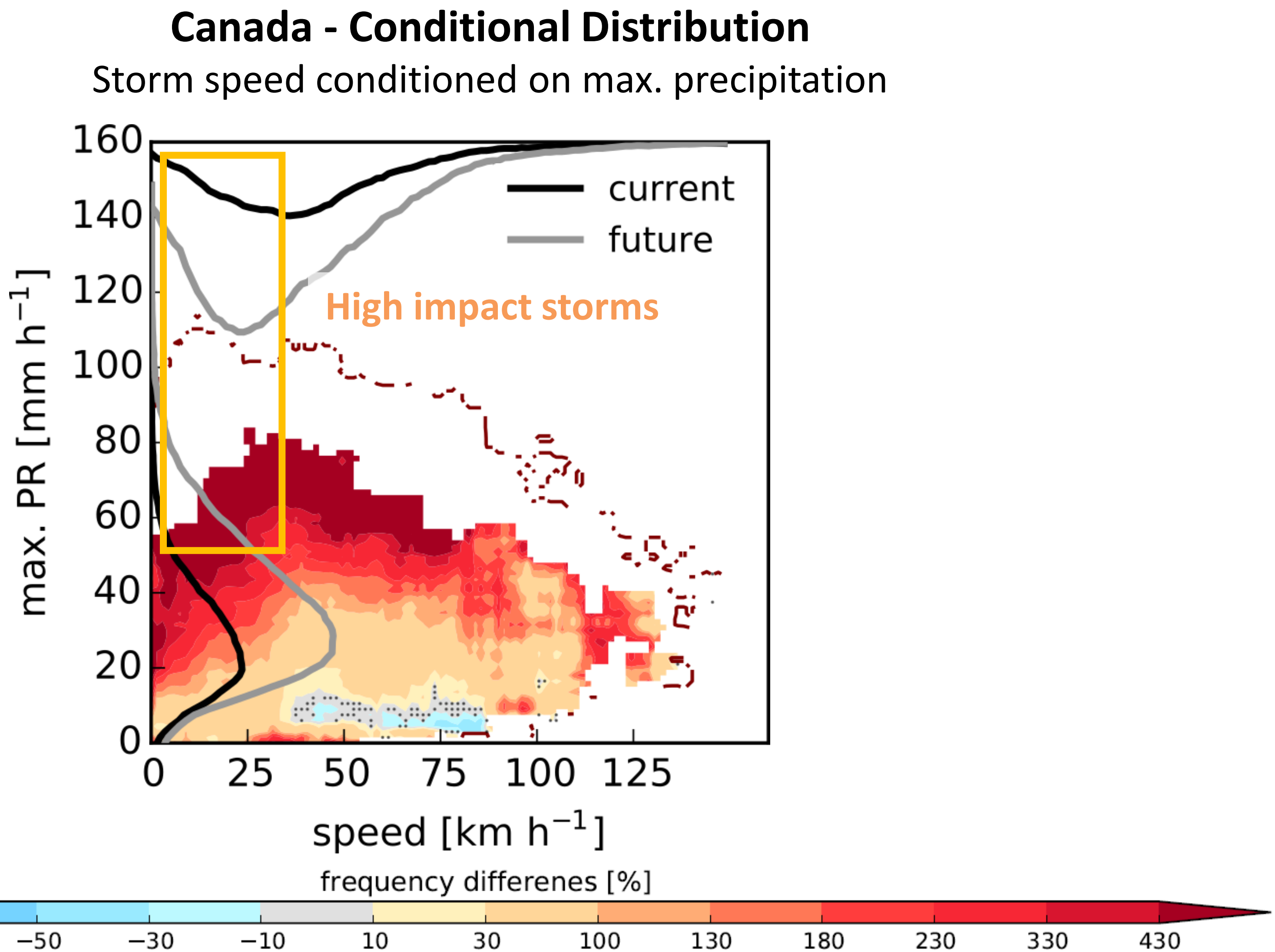
- A current 1 in 20-yr hot extreme will become a once in 2-year event by mid-century under a high emission scenario (a ten-fold increase in frequency)

Change in precipitation extremes
High emission scenario



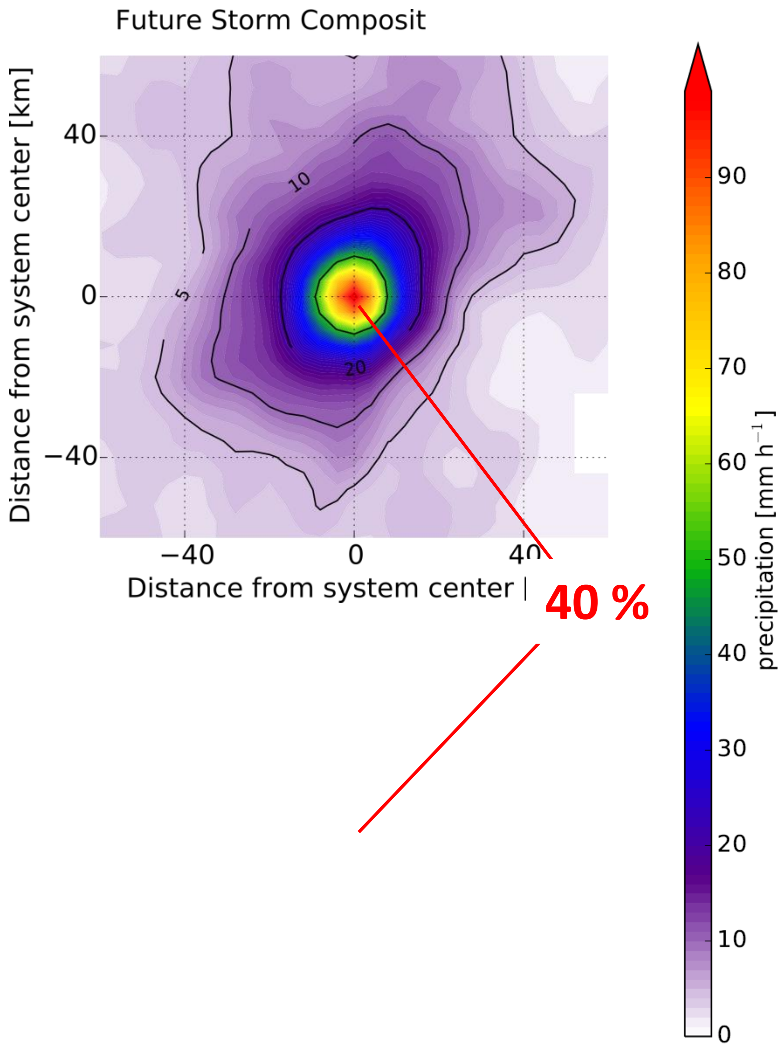
- A current 1 in 20-yr rainfall extreme will become a once in 10-yr event by mid-century under the high emission scenario (a two-fold increase in frequency)

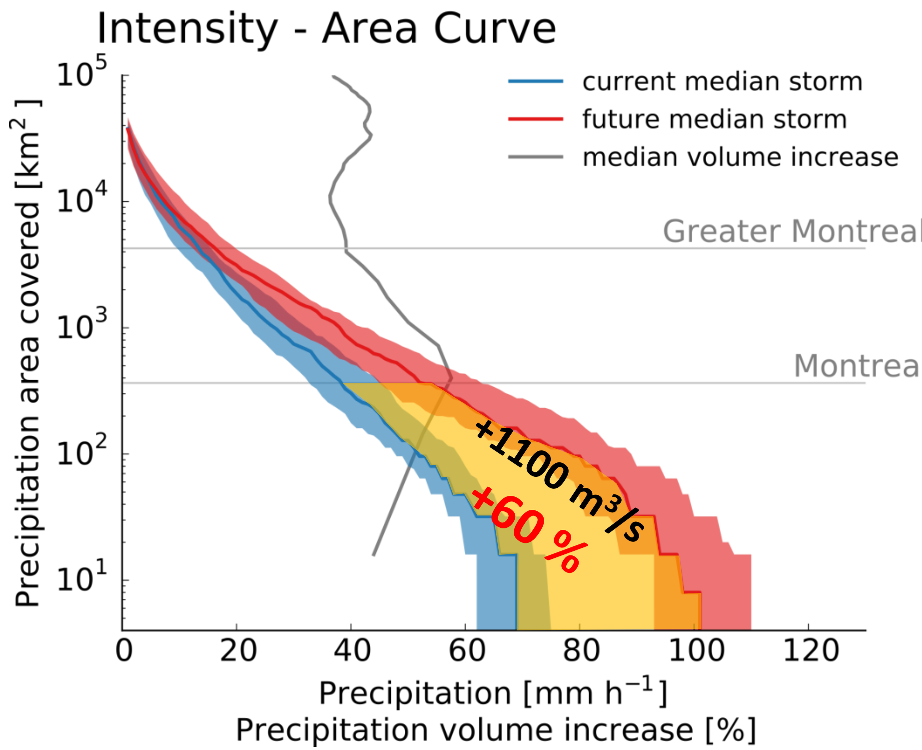
Changes in Storm speed



From Andreas Prein

Storm rain volume – Canada





From Andreas Prein

Now back to the Ottawa flood: A study of a similar flood

Investigation of the mechanisms leading to the 2017 Montreal flood

Bernardo Teufel[1] · L. Sushama[1,2] · O. Huziy[1] · G. T. Diro[1] · D. I. Jeong[3] · K. Winger[2] · C. Garnaud[3] · R. de Elia[4] · F. W. Zwiers[5,6] · H. D. Matthews[7] · V.-T.-V. Nguyen[1]

Received: 27 December 2017 / Accepted: 30 July 2018 / Published online: 14 August 2018

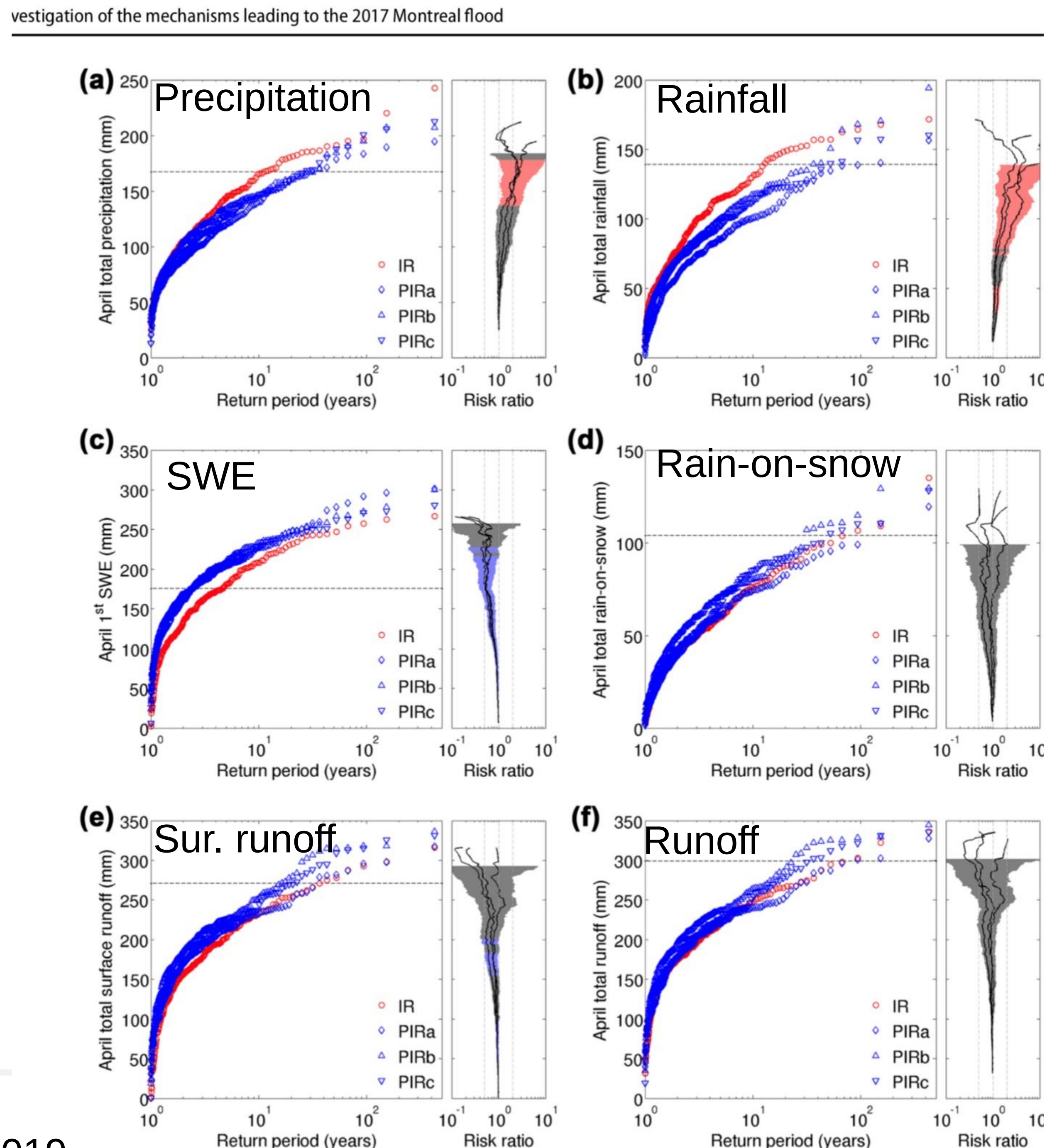
Climate Dynamics
(2019) 52:4193-4206

Abstract
Significant flood damage occurred near Montreal in May 2017, as flow from the upstream Ottawa River basin (ORB) reached its highest levels in over 50 years. Analysis of observations and experiments performed with the fifth generation Canadian Regional Climate Model (CRCM5) show that much above average April precipitation over the ORB, a large fraction of which fell as rain on an existing snowpack, increased streamflow to near record-high levels. Subsequently, two heavy rainfall events affected the ORB in the first week of May, ultimately resulting in flooding. This heavy precipitation during April and May was linked to large-scale atmospheric features. Results from sensitivity experiments with CRCM5 suggest that the mass and distribution of the snowpack have a major influence on spring streamflow in the ORB. Furthermore, the importance of using an appropriate frozen soil parameterization when modelling spring streamflows in cold regions was confirmed. Event attribution using CRCM5 showed that events such as the heavy April 2017 precipitation accumulation over the ORB are between two and three times as likely to occur in the present-day climate as in the pre-industrial climate. This increase in the risk of heavy precipitation is linked to increased atmospheric moisture due to warmer temperatures in the present-day climate, a direct consequence of anthropogenic emissions, rather than changes in rain-generating mechanisms or circulation patterns. Warmer temperatures in the present-day climate also reduce early-spring snowpack in the ORB, offsetting the increase in rainfall and resulting in no discernible change to the likelihood of extreme surface runoff.

Return times for different variables in present-day (red) and pre-industrial ensembles (blue), over the Ottawa River basin.

Black dashed lines correspond to the mean of the CRCM5 reference ensemble for April 2017. Risk ratios calculated from each of the pre-industrial ensembles are shown as black solid lines, along with their 95% confidence intervals (CI).

Red shading is used when the lower bound of the CI exceeds one, blue shading is used when the upper bound of the CI is less than one, and grey shading is used otherwise



Teufel et al. 2019

Take home messages

- Canada has warmed and most of the warming is due to human emission of greenhouse gases
- The magnitude of future warming will be determined by the extent of future GHG (principally, CO_2) emissions or mitigation
- 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 project future changes in locally-relevant climate extremes.
- Impacts of climate change on different flood types differ.