Webinar Questions

Canada in a Changing Climate Report – An Overview

April 18, 2019 from 1:00pm-2:00pm ET

Presented by: Elizabeth Bush
Facilitated by: Don Lemmen

Warming Trends

Question 1: Given the accelerated warming all over Arctic regions (not happening only in Canada) isn't it unrealistic to expect any progress re. Paris Agreement?

- Response: The warming in the Arctic region as a whole, and in Canada's Arctic, is amplified (much larger than) relative to global average warming. There is no indication that Arctic warming is accelerating. The pattern of amplified Arctic warming is projected to continue. Collective action to limit emissions of greenhouse gases from human activity, particularly carbon dioxide, will limit the magnitude of climate warming globally, and regionally, including in the Arctic.

Question 2: Global warming of 0.8 C since 1948 includes oceans, which have been warming substantially less than land surfaces. The CCCR refers to land surface warming. Is warming in Canada really double of global land surface temperatures?

- Response: No it is not. Globally, surface air temperatures over land have warmed more quickly than surface ocean temperatures. Warming in Canada is about twice the global mean temperature calculated from combined surface air temperatures over land and sea surface temperatures, but not twice the global "land temperature". Canada, and other northern high latitude countries, have warmed more than the averages of the rest of land areas due to multiple climate feedbacks (see CCCR FAQ 3.1: Why is Canada warming faster than the world as a whole?), including that due to the loss of snow and ice, and the consequent reduction in surface albedo.

Question 3: Do we understand why observed warming was the highest over Canada's northwest while projected future warming is the greatest over the Northeastern part of Canada?

- Response: see response to Q4 below.

Question 4: Amplified warming in Canada relative to the globe is expected to continue. Does that mean that the regional imbalances are expected to continue (e.g. the west will experience significantly greater than 6C warming by 2100?)

- Response: The dominant cause of the increasing temperature trends over Canada is human emissions of greenhouse gases (GHGs). Stronger warming in Canada relative to the globe, and towards the north within Canada, is expected to continue largely due to the snow/ice albedo feedback (the loss of ice and snow increases the absorption of solar radiation at the surface). Superimposed on the human-induced warming trend is internal climate variability, demonstrated in the variations from year to year and from decade to decade. This internal variability enhances the human-induced warming in some regions and reduces it in others in different time periods. Temperature trends due to internal variability of the global change will change depending on the phase of internal variability. The combination of the two determines the spatial patterns of the observed or projected changes in temperature. Projected warming in annual mean temperature over Canada is stronger in the north than the south, but is not stronger in the west than the east. Median annual mean warming is projected to exceed 6 C over much of northern Canada by 2100 under a high emissions scenario. See CCCR Figure 4.8: https://changingclimate.ca/CCCR2019/graphics/#pr_604.

Question 5: Less extreme cold is projected - does this consider impacts of warming on the polar vortex?

- Response: Projected changes in extremes in Canada's Changing Climate Report are based on the CMIP5 climate models. These models include, with varying degrees of realism, a representation of the polar vortex. The influence of Arctic warming on periodic incursions of cold Arctic air into southerly latitudes is an active research topic currently. While the frequency of such incursions may be impacted by climate warming, more generally, warming of cold extremes is robustly projected. Note that a stronger projected warming of cold extremes than warm extremes over Canada is consistent with trends observed to date.

Precipitation Trends

Question 6: Future increases in the frequency and intensity of extreme events (slide 18)...i.e., we'll have more or less rain, depending on your specific location, but the precipitation that falls will increasingly fall as extreme events?

- Response: Averaged across Canada, normalized precipitation (values for precipitation at a location divided by the long-term mean at that location) is projected to increase. In the near-term (up to mid-century), most regions and seasons are projected to see increases in average precipitation as well, though some changes are very small. In the long-term (end of century) increases in precipitation are also projected, except for southern Canada during summer and under a high emission scenario. We have high confidence that extreme precipitation will increase everywhere in Canada under a range of future

warming scenarios. In contrast to average precipitation, the change in heavy precipitation is more closely tied to a change in temperature, owing to warmer air containing more moisture. Even where very small changes or decreases in average precipitation are projected, robust increases in extreme precipitation are projected.

Question 7: With the expected changes in precipitation, does it make sense to start planning for seasonal storage of freshwater especially in southern Canada?

- Response: Given the projected changes to high-elevation snow and ice, the projected increases in summer temperature, and the potential for reduced summer precipitation under higher emission scenarios, there is concern about reductions in freshwater availability in summer. Appropriate adaptation measures may need to be considered.

Question 8: Curious about confidence in precipitation changes considering contrasting current trends and the very low number of running precipitation stations.

- Response: We have *medium confidence* that there has been an increasing trend in observed precipitation over Canada, as increasing trends are consistent across most of the stations. However, we have *low confidence* in the magnitude of the trend for Canada due to low spatial coverage, large interannual variability, and measurement uncertainties.

Coastal Flooding

Question 9: How confident are you in the coastline numbers? NOAA recent projections for the west coast were higher?

- Response: The sea-level projections provided in the CCCR are based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The AR5 provided projections for a range of scenarios, but acknowledged the possibility of larger amounts of sea-level rise because of uncertainty regarding the behavior of marine-based portions of the Antarctic ice sheet. Based on papers cited by the AR5, NRCan developed an additional enhanced scenario to include the larger amount of projected global sea-level rise, thought to be unlikely, but possible. The enhanced scenario gives 1.39 m of sea-level rise by 2100, and the impact of this amount of global sea level rise on changes in relative sea level at some Canadian locations is shown in Figure 7.17 of the CCCR. The high-end scenarios of the US National Climate Assessment, led by NOAA, provide even larger amounts of sea-level rise, but the probability of these scenarios is thought to be very low. Nevertheless, projected sea-level rise larger than the enhanced scenario is not ruled out, as indicated in Figure 7.15 of the CCCR.

General Projections

Question 10: Is RCP8.5 a BAU scenario, or does it represent an increase in emissions from the current trend?

- Response: RCP 8.5 is a fossil-fuel intensive scenario in which annual emissions of CO_2 and most other greenhouse gases increase throughout the 21st century (Meinshausen et al., 2011; https://link.springer.com/article/10.1007%2Fs10584-011-0156-z). Up to 2018, annual global fossil fuel CO_2 emissions have increased steadily so in this sense, RCP8.5 is sometimes referred to as a Business As Usual pathway. However, this pathway does not include recent government commitments to reduce such emissions, as conveyed through the Nationally Determined Contributions pledged under the Paris Agreement.

Question 11: Are there any graphics that show these projections at near-future (2031-2050)?

- Response: Yes. Figures 4.6, 4.7, 4.8 (projected temperature changes over Canada) and Figures 4.17, 4.18 and 4.19 (projected precipitation changes over Canada) include maps for changes projected for the period 2031-2050. Figure 5.4 shows projected snow and sea ice trends to 2050.

Question 12: Was any statistical downscaling considered when estimating future changes in extreme values for temperature and precipitation?

- Response: The assessment of numerous temperature-based extremes utilized statistically downscaled and bias-corrected model simulations. For precipitation, however, limitations in the representation of physical processes in coarse resolution climate models and spatially sparse observations reduce our confidence in statistically downscaled precipitation. Instead, precipitation extremes are summarized from the earth system models.

Question 13: Are expected increases in methane emissions from permafrost thaw of bogs and peatlands in Canada's northwest being take into account?

- Response: Methane and carbon dioxide emissions from thawing permafrost were not included in the CMIP5 simulations on which the projections in Canada’s changing climate report are based. Accounting for these processes would increase the level of warming for any level of emissions, or equivalently reduce the amount of anthropogenic emissions consistent with holding global warming to a specified level. The IPCC Special Report on Global Warming of 1.5C, which was published after the literature cut-off date for inclusion in Canada’s Changing Climate Report, assesses this effect. This report concludes that, accounting for methane and carbon dioxide emitted from thawing permafrost, would reduce the cumulative anthropogenic carbon dioxide emissions, consistent with keeping global mean warming below 1.5C, by up to 100 GtCO2 over the 21st century. This value can be compared with a median total remaining cumulative carbon dioxide emissions budget of 580 GtCO2. ECCC is currently working to include methane and carbon dioxide emissions from thawing permafrost in the Canadian Earth System Model.

Other Impacts

Question 14: You mentioned that with the extreme heat the vulnerable populations will indeed be most affected. What does the research show on the impact that it has had up to date and what the impact means with the projections in more practical terms for these populations?

- Response: Health Canada is undertaking a focused assessment on climate change and human health as a contribution to the National Assessment. To follow the progress of reports that are part of the National Assessment please visit this website: https://www.nrcan.gc.ca/environment/impacts-adaptation/19922

Question 15: How will future climate change result in a lengthening of the crop growing seasons?

- Response: The growing season refers to the time of year with plant growth and determined by the local climate. With a warming climate, we will see temperatures tolerable for plant growth starting earlier in the spring and lasting later into the fall. In this report, we use a general growing season definition, where the growing season begins after the first occurrence of six consecutive days with daily mean temperatures above 5C and ends when temperatures drop below, and remain below, this threshold. In Canada, the growing season increased in length by about 15 days between 1948 and 2016.

Question 16: Is there analysis on variability in future growing season length or frost-free season? Increased variability in frost-free season could remove much of the potential benefit of longer growing seasons.

- Response: An analysis of variability of the growing season length or of the temperatures around the start of the growing season was not included in this report. However, work is currently being done at ECCC to assess this. The lengthening of growing season indicates a general improvement in heat conditions for crops. The potential benefit of the lengthening of growing season depends on many factors, including water availability and cultivar. These aspects are not assessed in the CCCR.

Question 17: What is expected to happen to water flowing from the Great Lakes through the St Lawrence?

- Response: In the future, overall lake levels in the Laurentian Great Lakes and resultant flow through the St. Lawrence may decline as a result of higher evaporation in a projected warmer climate, exceeding projected increases in precipitation. However, there is considerable uncertainty in this projection.