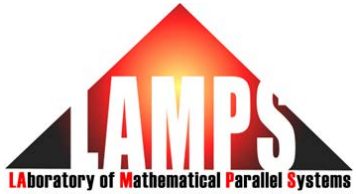
Climate change in Indigenous and Northern communities

Huaiping Zhu



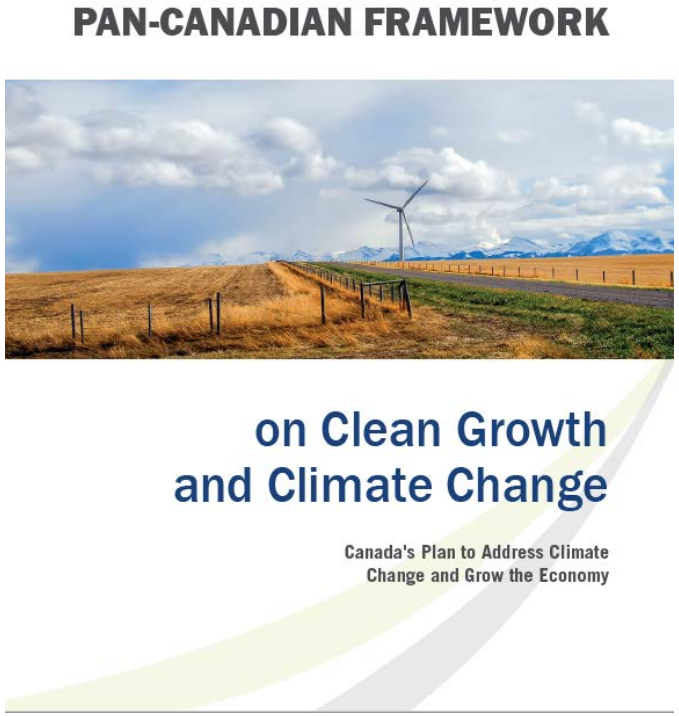
December 5, 2019, Canadian First Nation Climate Change Workshop

Outline

- Introduction
- Temperature change
  - Past (1948-2018)
  - Future projection (2005-2100)
  - Five residence locations (2005-2100)
    - Annual mean temperature
    - Monthly average of July maximum temperature
    - Monthly average of February minimum temperature
- Warming temperature and Impacts
- Summary

1. Introduction

Pan-Canadian Framework on Clean Growth and Climate Change



Key needs for Indigenous area [Marie-Ève Néron]

- Community-based climate monitoring
- Integration of Indigenous Knowledge with western science-based climate information and decision-making

Data

Data gap for Indigenous and northern communities

Impact of climate change:

Increasing risks for natural ecosystems, water availability/quality, food security, health and safety, coastal communities, infrastructure, and natural resource industries.

Climate change in Indigenous and northern communities

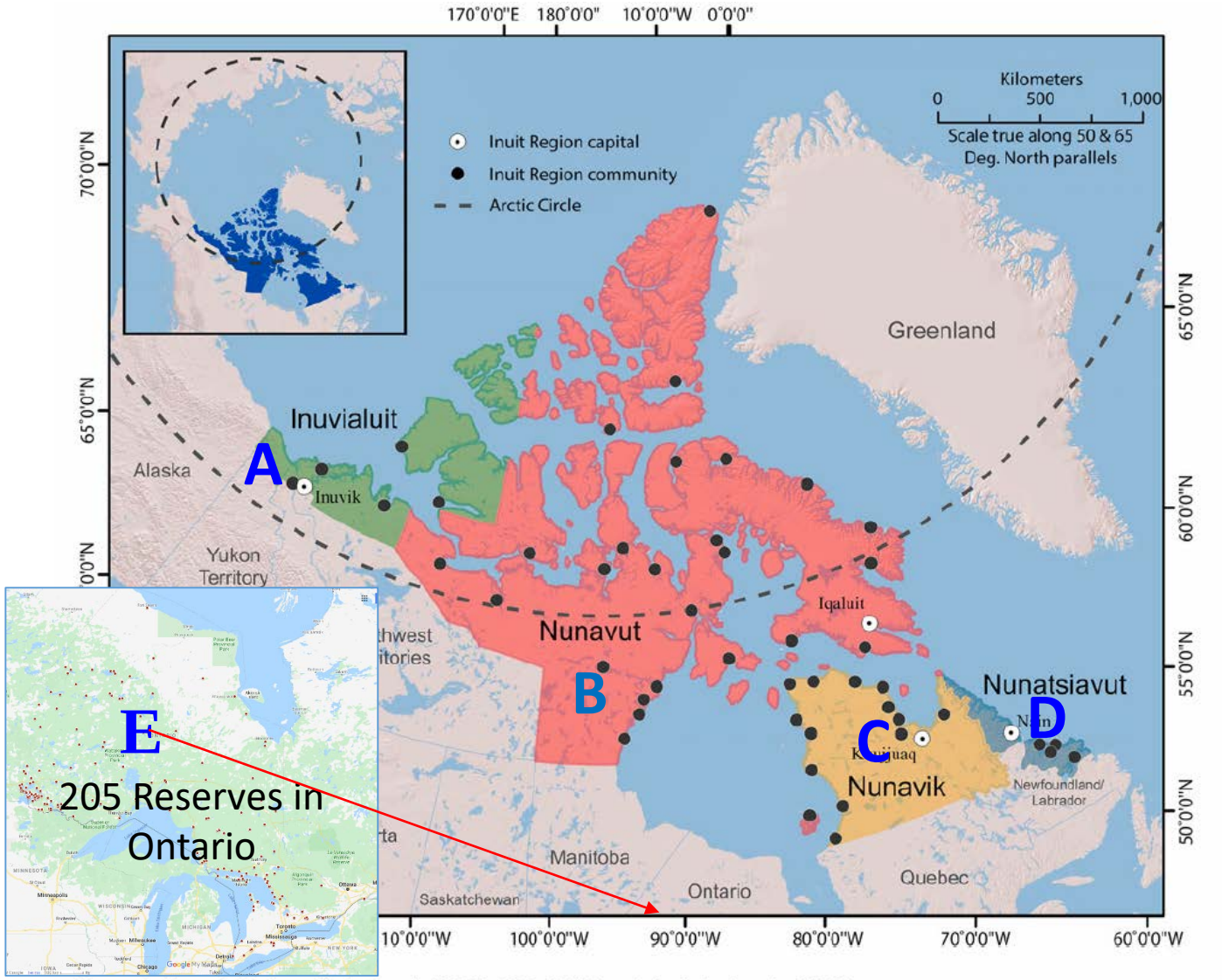
- **Warming is faster** at higher latitudes such as areas of indigenous and northern communities in Canada;
- At high latitudes, increasing winter base flow and mean annual stream flow resulting from possible permafrost thawing were reported in northwest Canada (St. Jacques and Sauchyn, 2009);
- Warming temperature are projected to increase the probability, duration, and severity of extreme weather events and their outcomes.
- Aboriginal populations, have been identified as highly vulnerable to these changes.
- ……

There are many qualitative analysis of the impacts of climate change on Aboriginal populations but quantitative study is not enough due to

short of data

Study area: Indigenous and Northern communities

A: Inuvialuit B: Nunavut C: Nunavik D: Nunatsiavut E: Reserves



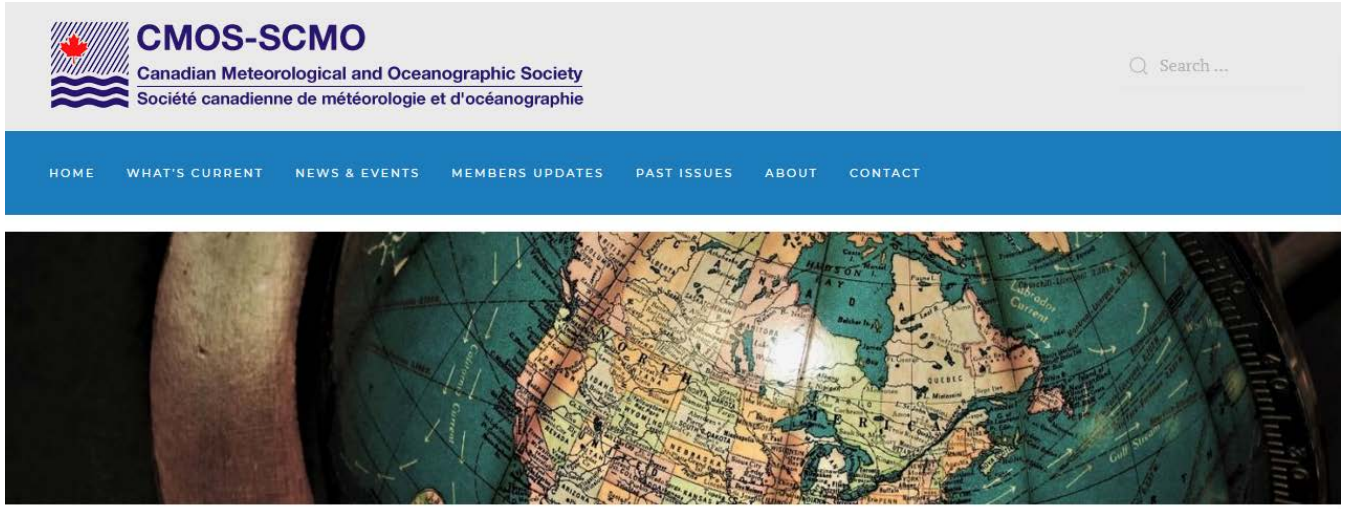
Source. Indian and Northern Affairs Canada (2008), ESRI (2012), and Statistics Canada (2006).

FIGURE 1—The Inuit Nunangat (Inuit homeland) in Canada.

Most communities are in coastal areas

Climate information/Data
Temperature (mean, minimum and maximum) changes over indigenous and Northern communities in Canada

- Intergovernmental Panel on Climate change (IPCC)
  Coupled Model Intercomparison Project, Phase 5 (CMIP5) Data Distribution Centre
- Ontario Climate Data Portal (OCDP) by LAMPS, York University:
  http://yorku.ca/ocdp
  https://bulletin.cmos.ca/ocdp/



Temperature in Indigenous and Northern communities

Reliable data source:

- Reanalysis data (NCEP/NCAR: observation)
- Ontario Climate Data Portal downscaled data(OCDP)
- IPCC CMIP5 GCMs(2° X 2° Lon X Lat)(robust large ensemble)
  - RCP2.6 (33 members): low emission scenario
  - RCP4.5 (43 members): middle emission
  - RCP6.0 (25 members): middle emission
  - RCP8.5 (40 members): high emission scenario

Note: RCPs(Representative Concentration Pathways)

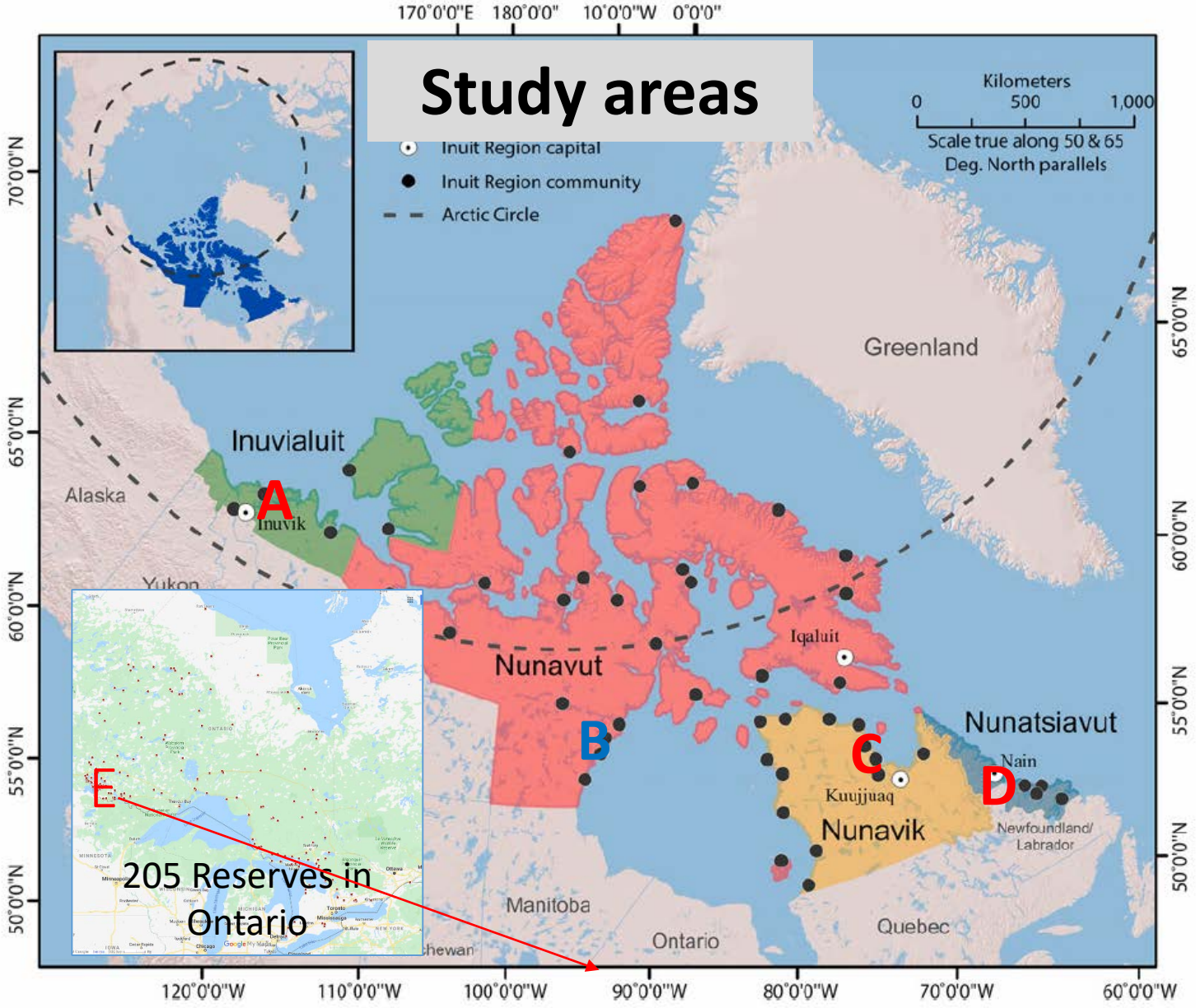
Temperature in Indigenous and Northern communities

- Method:
  Scientific modeling and computation
  - Ensemble mean (same as the IPCC AR5 report)
  - Trend analysis (selected 5 residence locations)
  - Annual, maximum(warmest: July), minimum(coldest: Feb)

Note: RCPs(Representative Concentration Pathways)

- Results (five areas, three variables)

  - Inuit homeland in Canada
    - ✓ A: Inuvialuit
    - ✓ B: Nunavut
    - ✓ C: Nunavik
    - ✓ D: Nunatsiavut
    - ✓ E: Reserves in Ontario
  - Three variables for Temperatures
    - ✓ Annual mean
    - ✓ Monthly mean of July maximum temperature
    - ✓ Monthly mean of Feb minimum temperature



Source. Indian and Northern Affairs Canada (2008), ESRI (2012), and Statistics Canada (2006).

FIGURE 1—The Inuit Nunangat (Inuit homeland) in Canada.

Five Areas:

A: Inuvialuit
Lon:-133.34
Lat: 68.33

B:Nunavut
Lon:-94.29
Lat: 61.61

C: Nunavik
Lon: -71.95
Lat:61.58

D: Nunatsiavut
Lon:-61.77
Lat:56.52

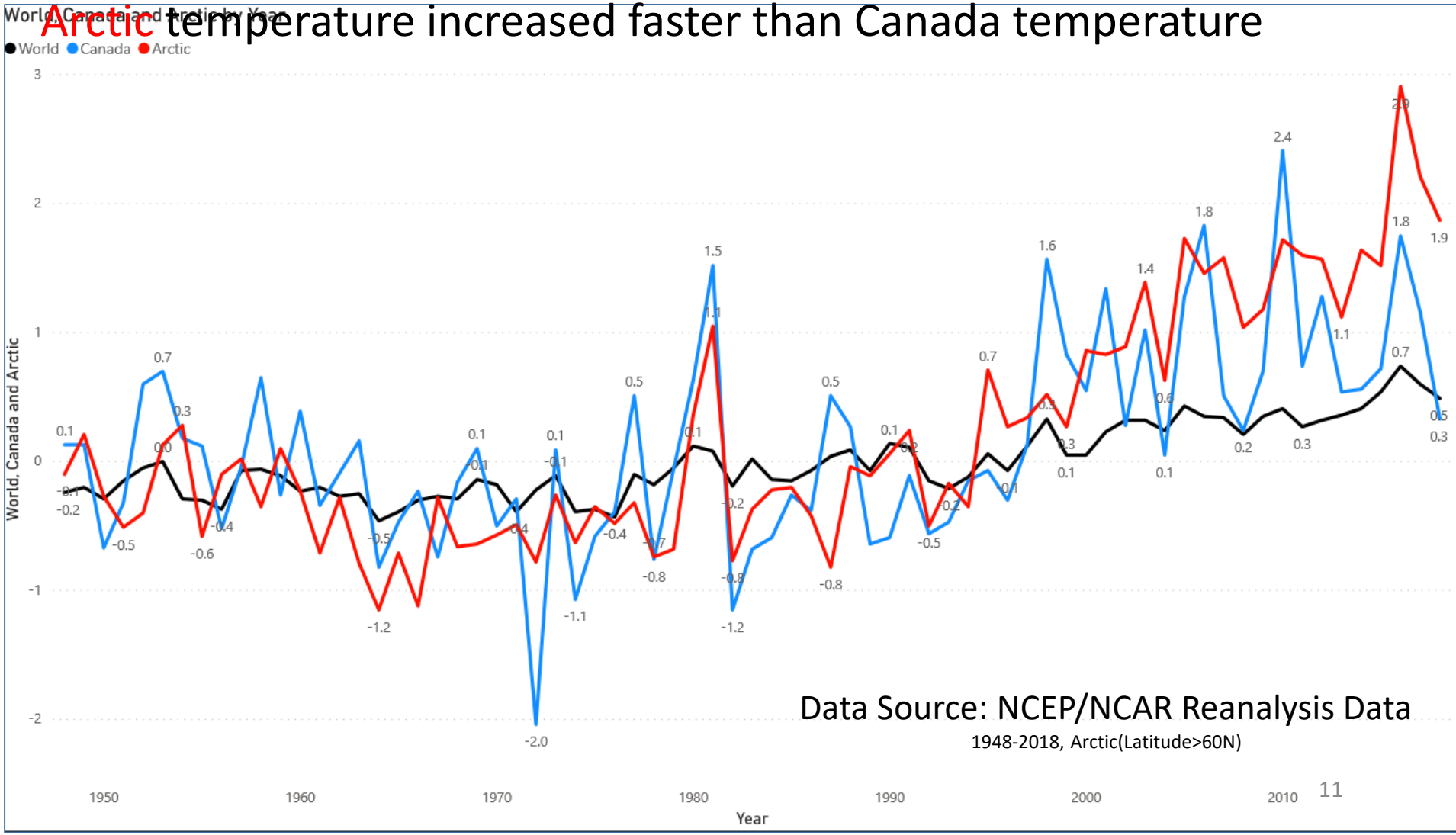
E: Reserves
Lon:-94.45
Lat: 49.37

Most communities are in coastal areas

Observation/historical temperature change(Annual temperature: 1948-2018):

Canada temperature increased faster than **global** temperature

Arctic temperature increased faster than Canada temperature

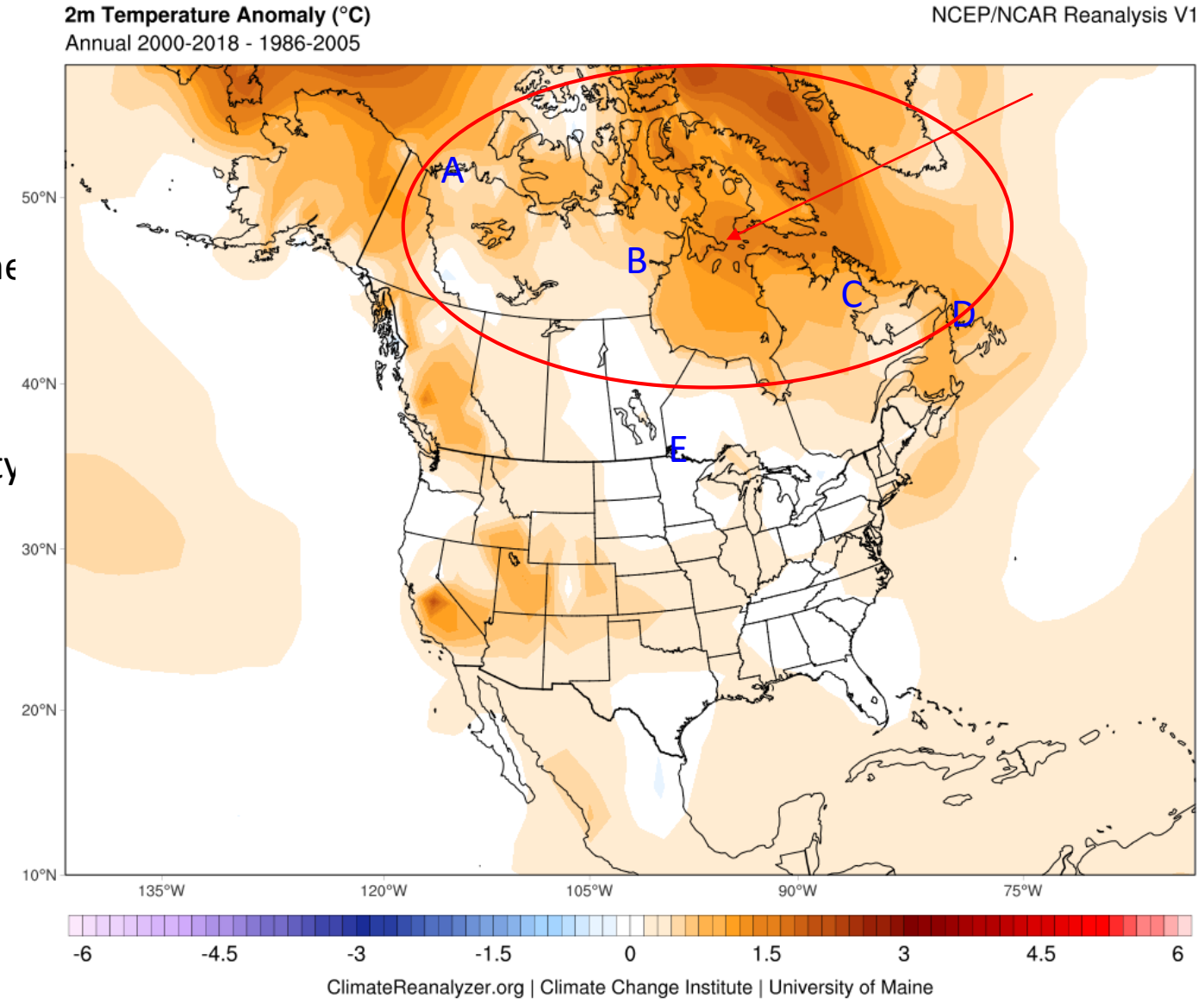


Data Source: NCEP/NCAR Reanalysis Data

1948-2018, Arctic(Latitude>60N)

Historical Period

- Temperature increased over the North America for the last 20 years
- Over the indigenous and north community areas, temperature increase faster than south regions
- Temperature increased about 0.5-1.5C



Observed change of annual mean temperature for period 2000-2018 relative to reference period 1986-2005

Projected future temperature change over the indigenous areas

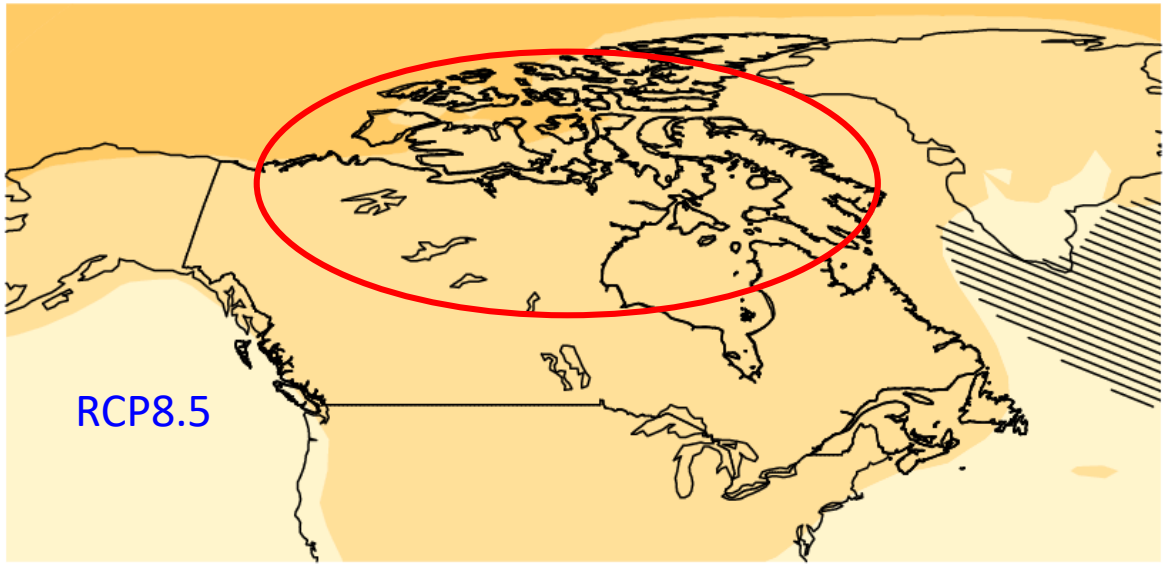
- Compare observed change and projected change for the last 20 years
- Compare among temperature changes for global, Canada and arctic area
- Focus on projected temperature changes at the **five** locations under the four RCPs

Observed situation is worse than the IPCC AR5 worst scenario (---2019)

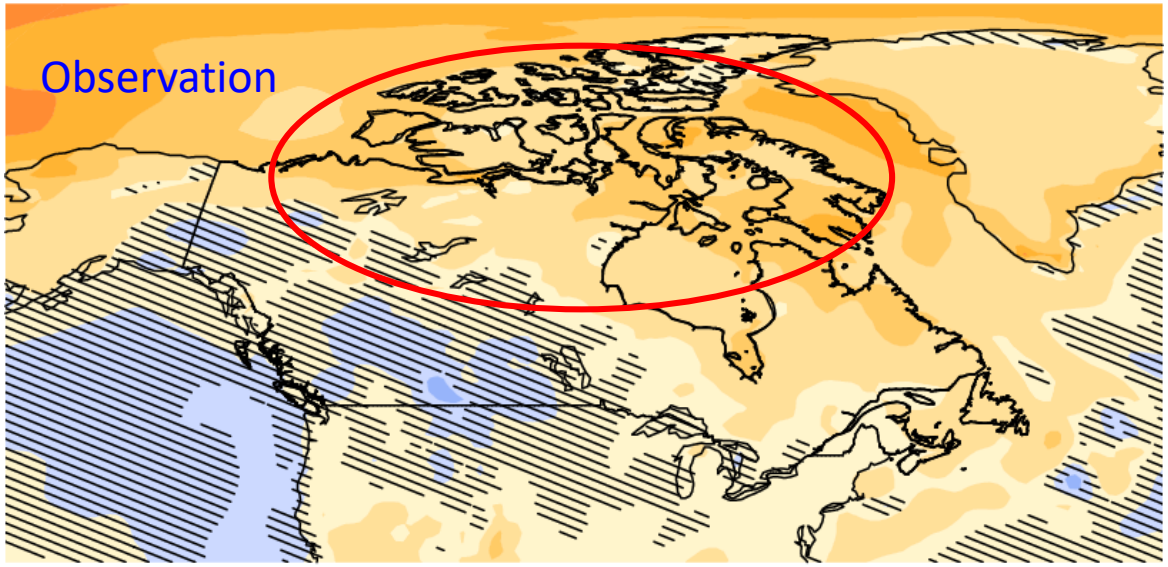
2000-2019(20 Yrs)-1986-2005(20 Yrs), projection vs observation

- Observed warming in north of Canada (aboriginal areas) is faster than the warming of the worst scenario (RCP8.5)
- 0-0.5C (RCP8.5 projection) vs 0.5-1.5C (observation)

mean rcp85 temperature 2000-2019 minus 1986-2005 Jan-Dec AR5 CMIP5 subset



mean temperature 2000-2019 minus 1986-2005 Jan-Dec ERA-interim

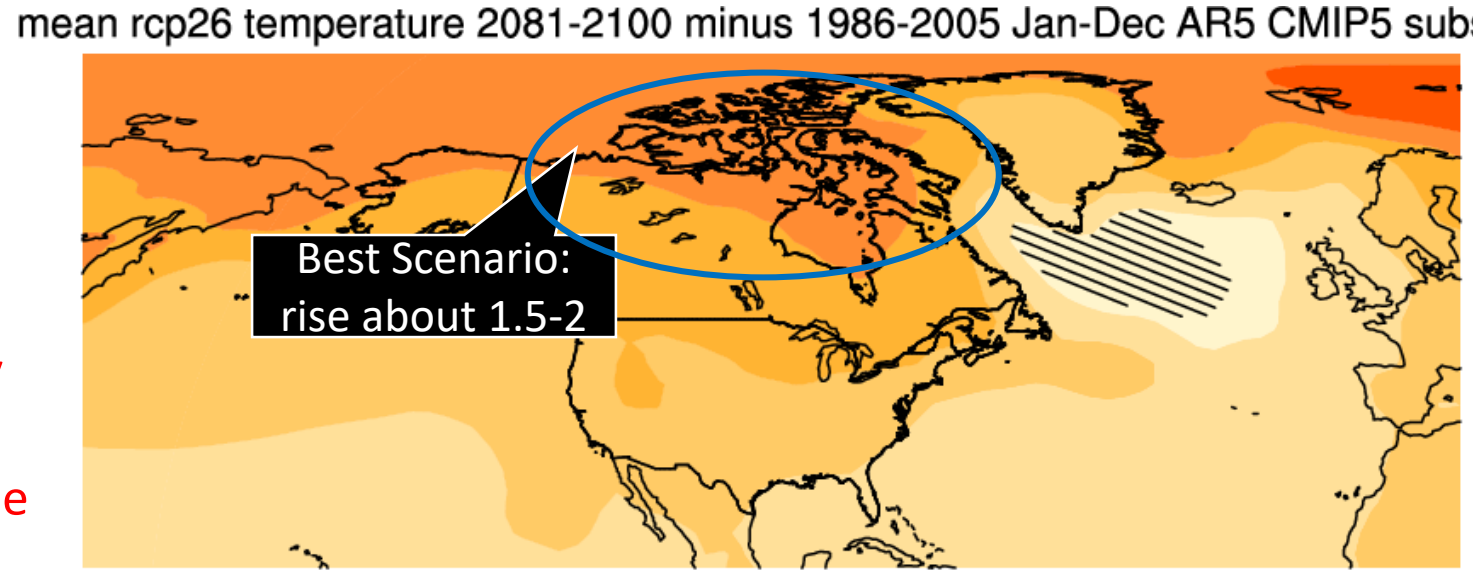


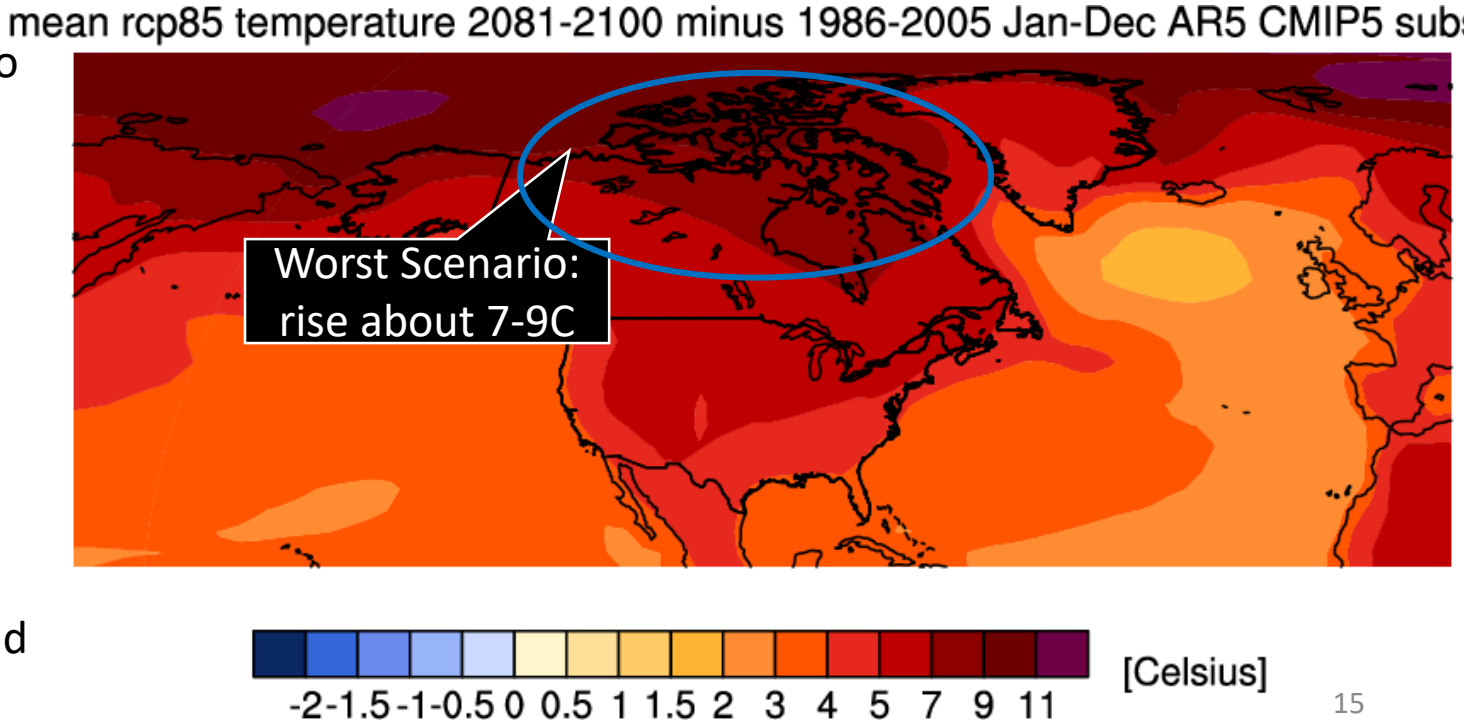
Note: 2019.10-2019.12 observation used 19yrs averages, hatched areas no significant change

Projected North America

----2100

Under the worst scenario annual temperature may increase about 7-9°C in 2080s in the indigenous areas





- The best scenario can control the temperature increase in the range of 1.5- 2°C in 2080s relative to the reference period

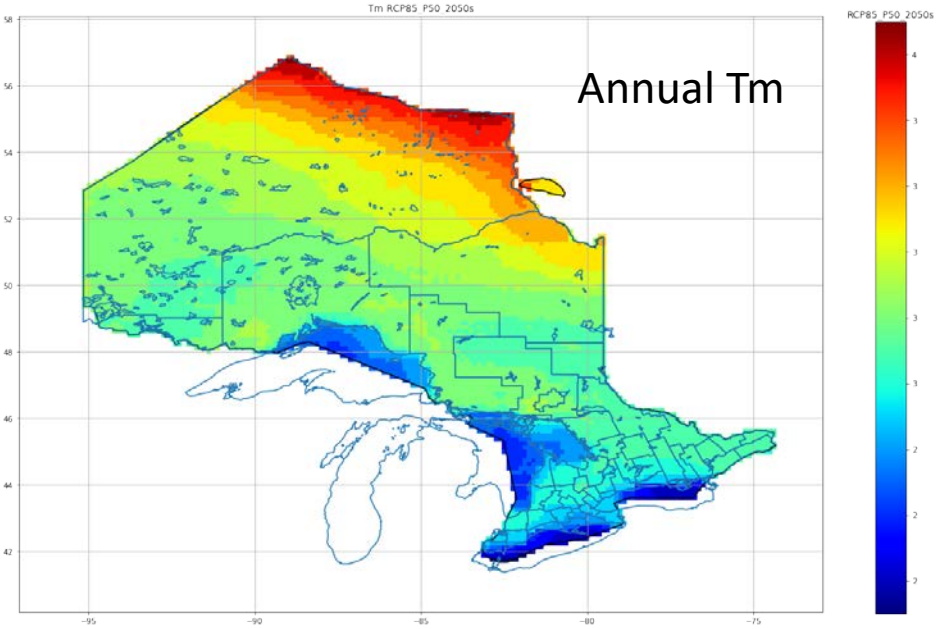
- The worst scenario may lead to 7-9°C temperature

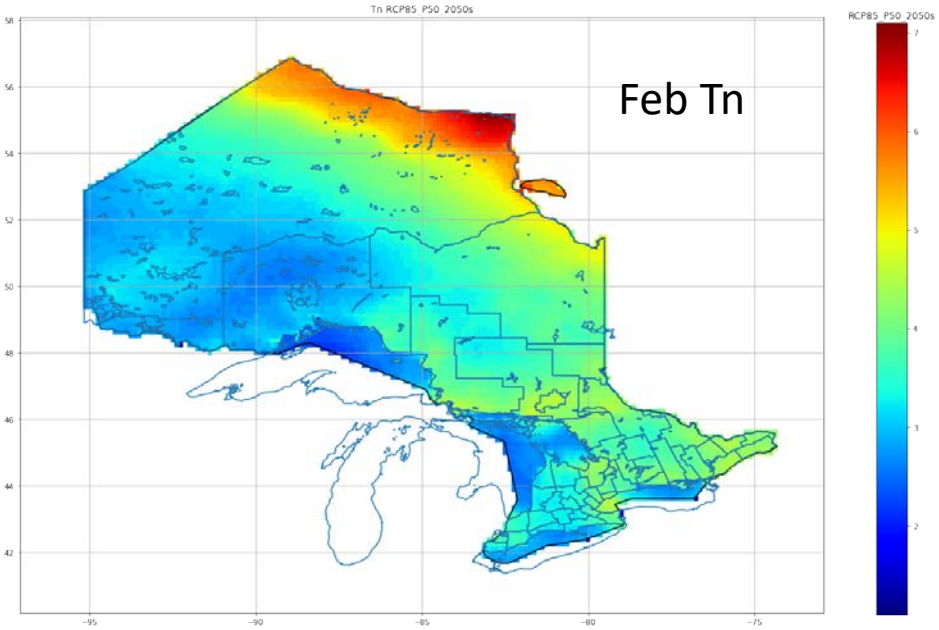
Ontario

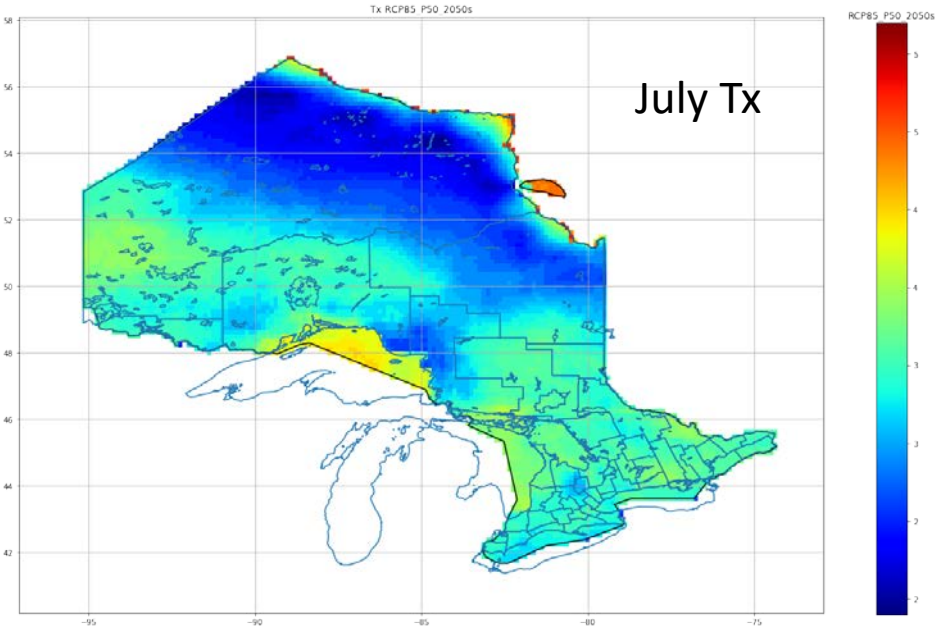
Relative to reference period (1986-2005), in the 2050s (2040-2069) under the worst scenario (RCP8.5)

- Annual temperature may increase about 2-5°C
- July maximum temperature may increase about 2-5°C

- February minimum temperature may increase 2~7°C



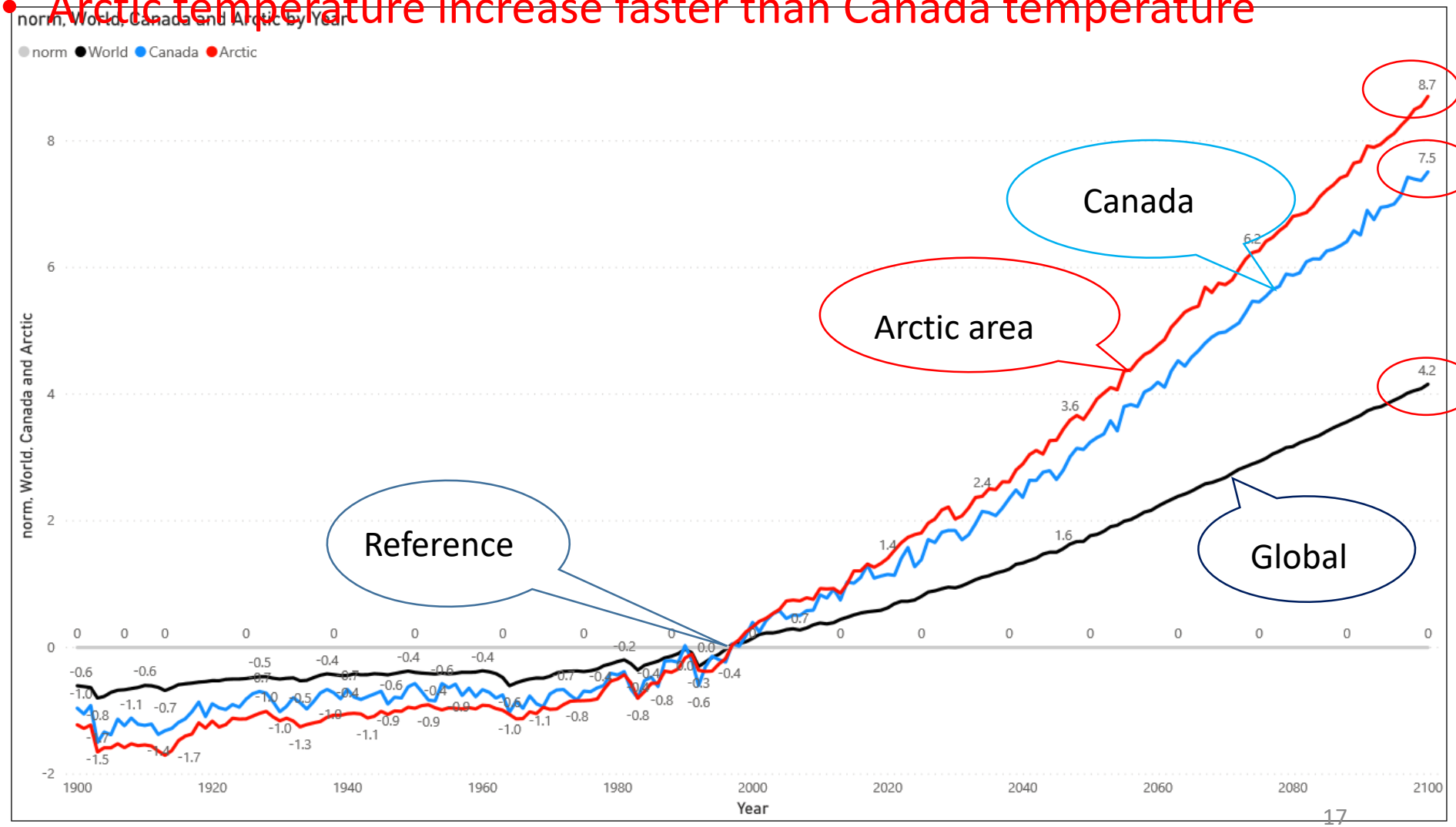


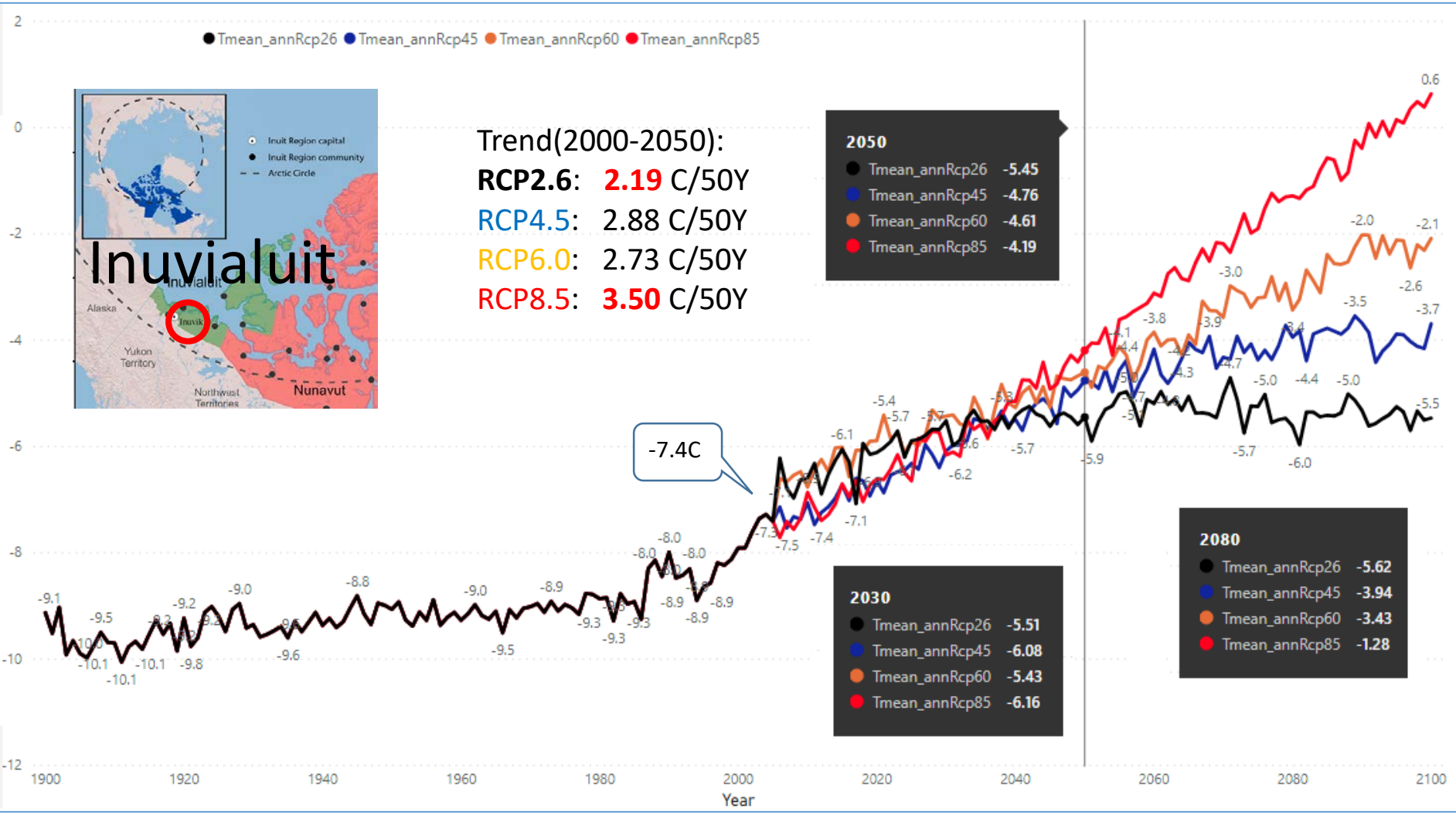


Note: to show the full range of values we used full color range, see the value range of color bar

Based on IPCC AR5 worst scenario ensembles (RCP8.5) Lamps **Projected future**

- Canada temperature increase faster than Global temperature
- Arctic temperature increase faster than Canada temperature

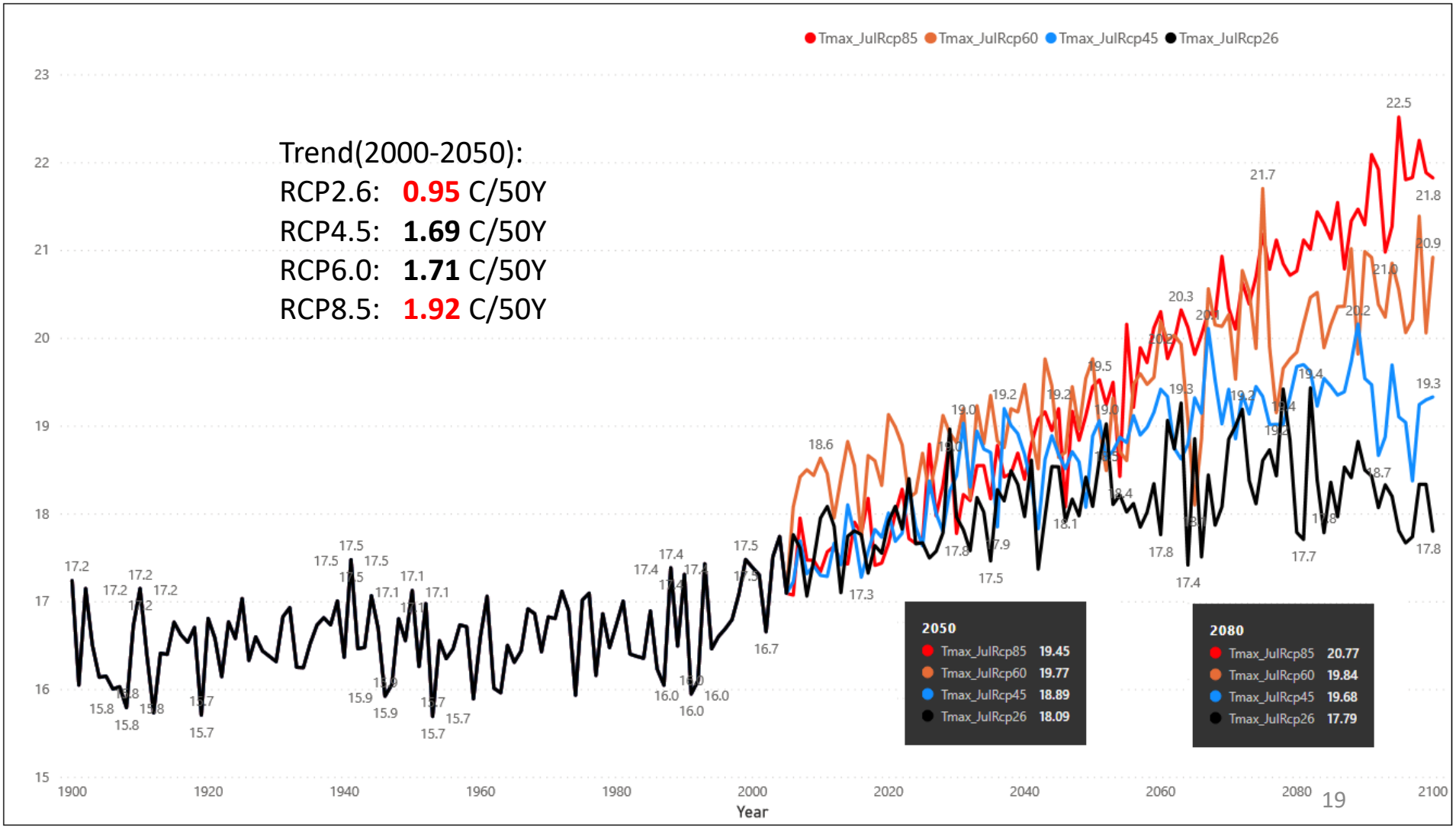




- **In A area** (Inuvialuit) temperature may increase 2.19~3.50°C/50-Year before 2050
- After 2050, it may keep stable under RCP 2.6 and 4.5, continue increase under RCP6.0, 8.5
- Temperature may increase ~7°C by 2100 relative to 2005 under RCP8.5
- LAMPS OCDP

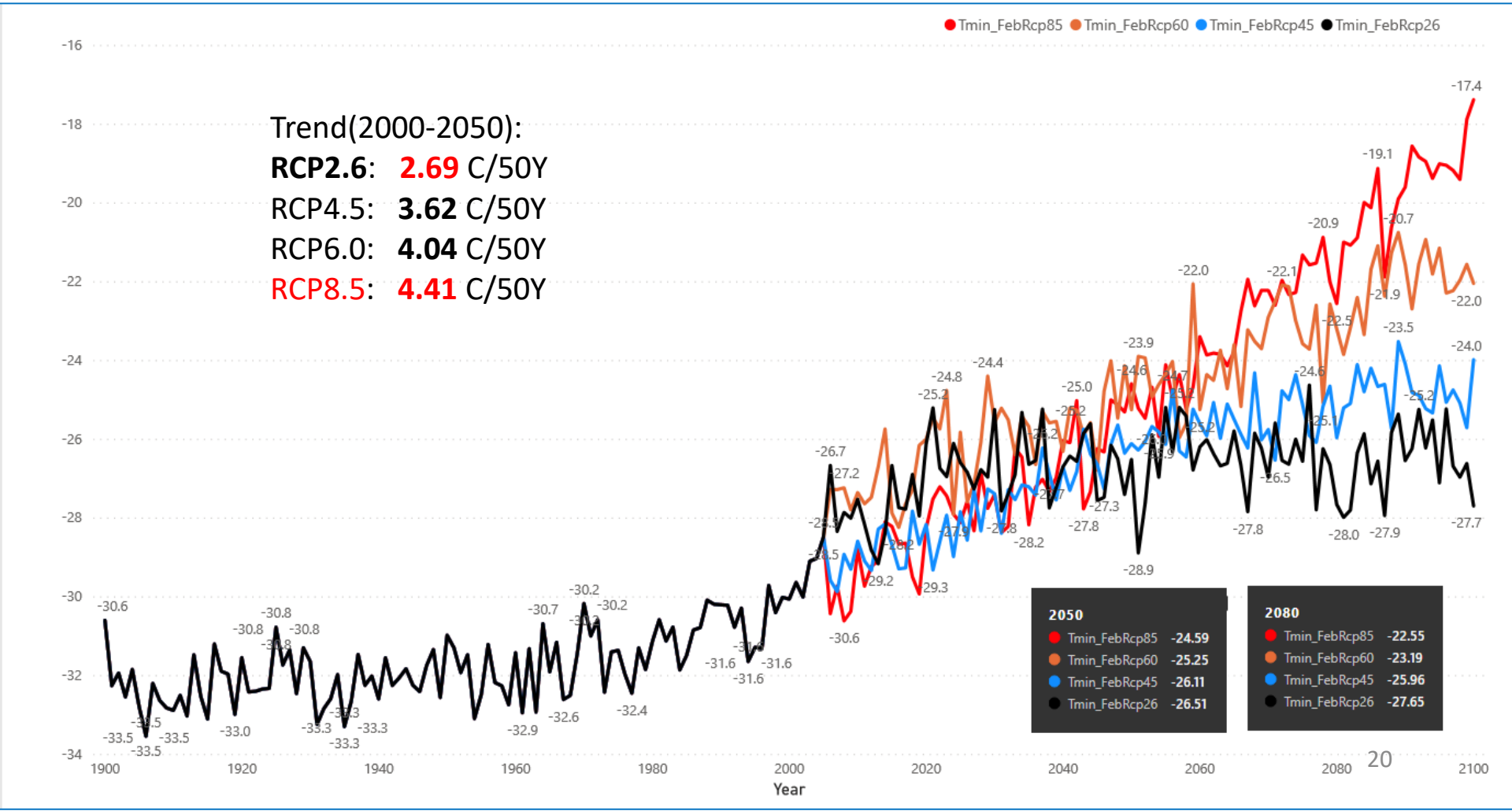
- July monthly average of maximum temperature(Tx) my increase with trend 0.95-1.92°C/50-Year, less than annual average

- By the end of this century, Tx may increase 5°C under the worst scenario (RCP 8.5)



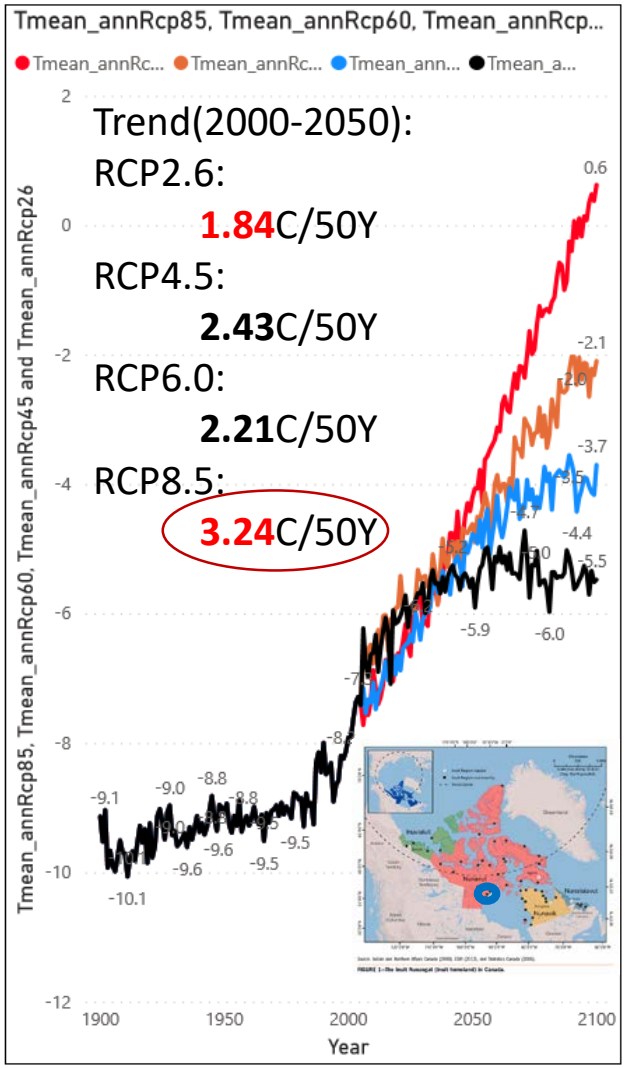
- February monthly average minimum temperature (Tn) may increase with a trend of 2.69-4.41C/50-Year, larger than annual temperature warming trend

- By the end of this century, Tn may increase ~10°C, is it terrible?

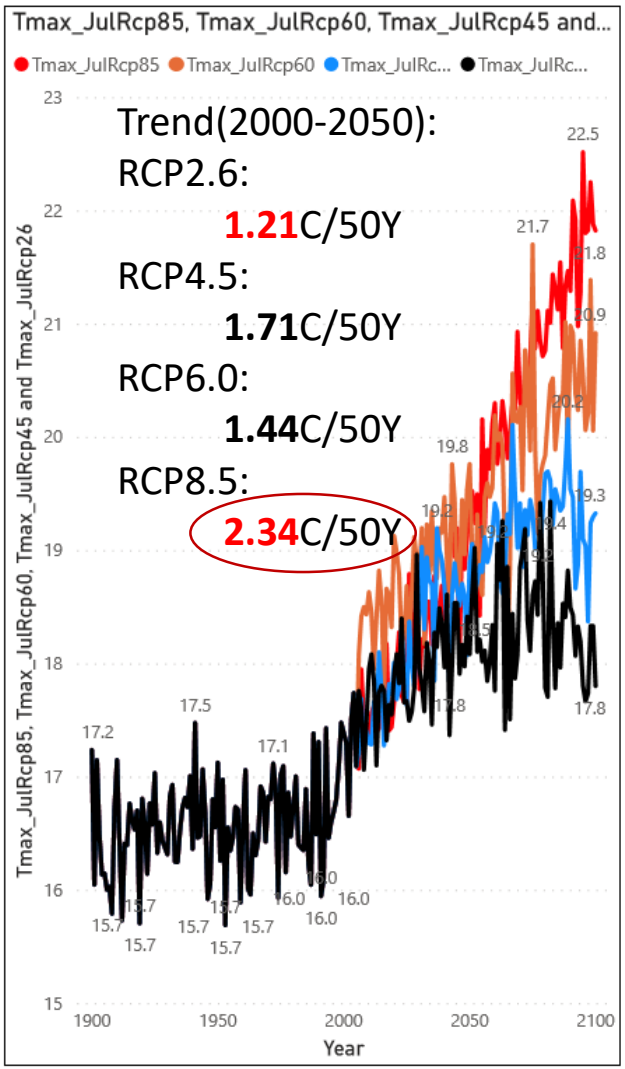


B area: **Nunavut**, Keewatin (61.61,-94.29)

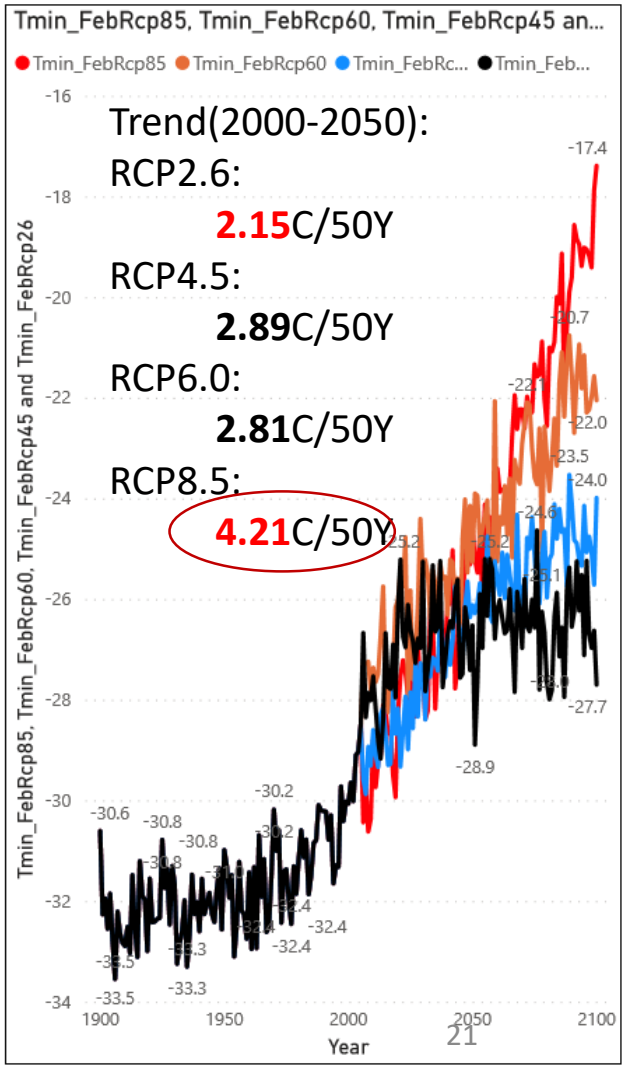
Tmean



Tmax_July

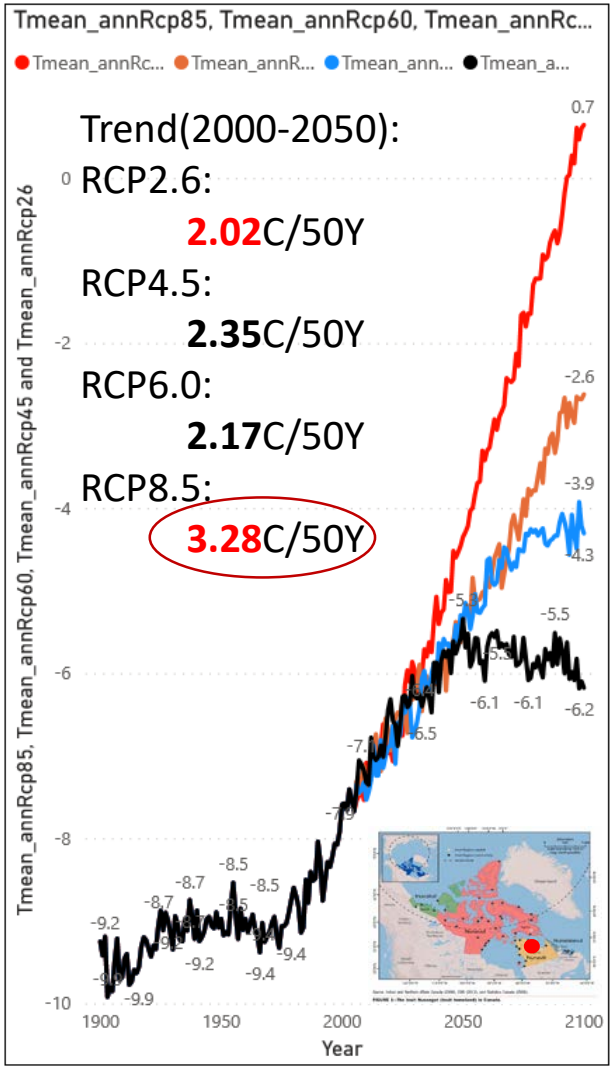


Tmin_Feb

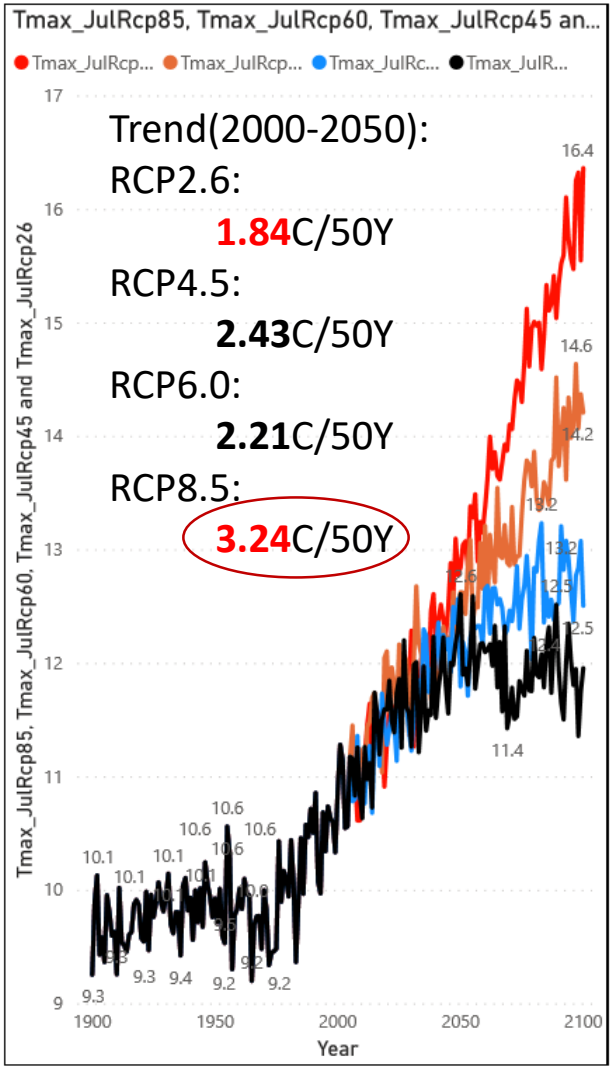


C area: **Nunavik** area, Kangisujuaq(61.68,-71.95)

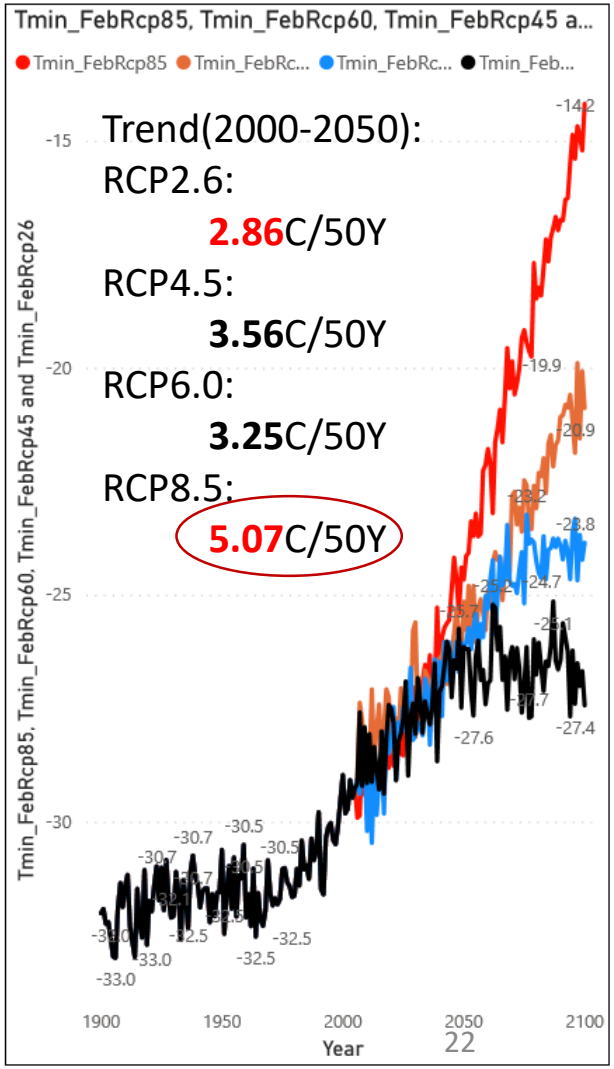
Tmean



Tmax_July

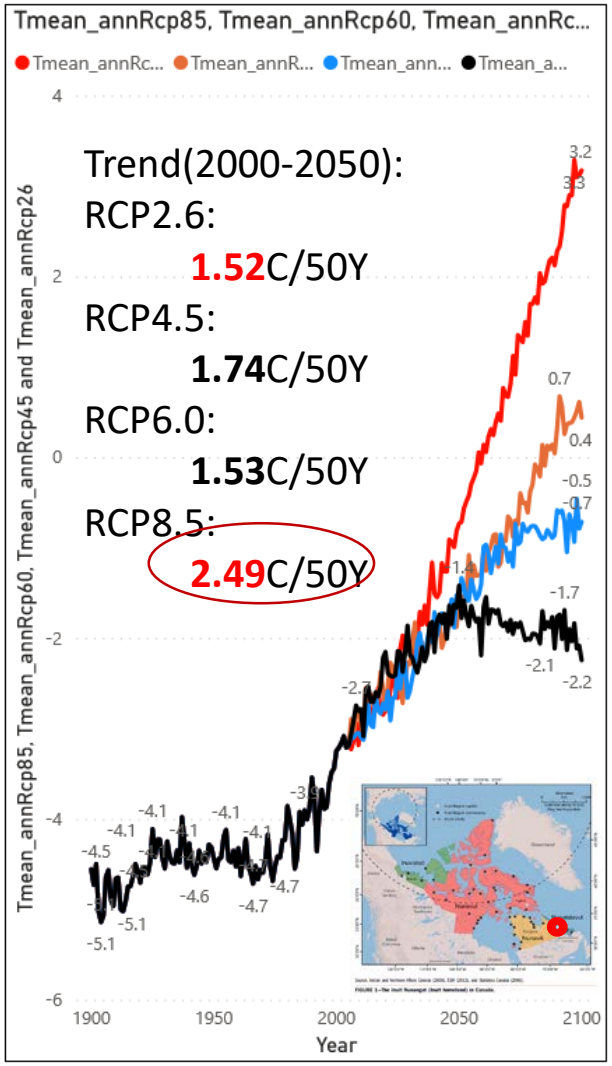


Tmin_Feb

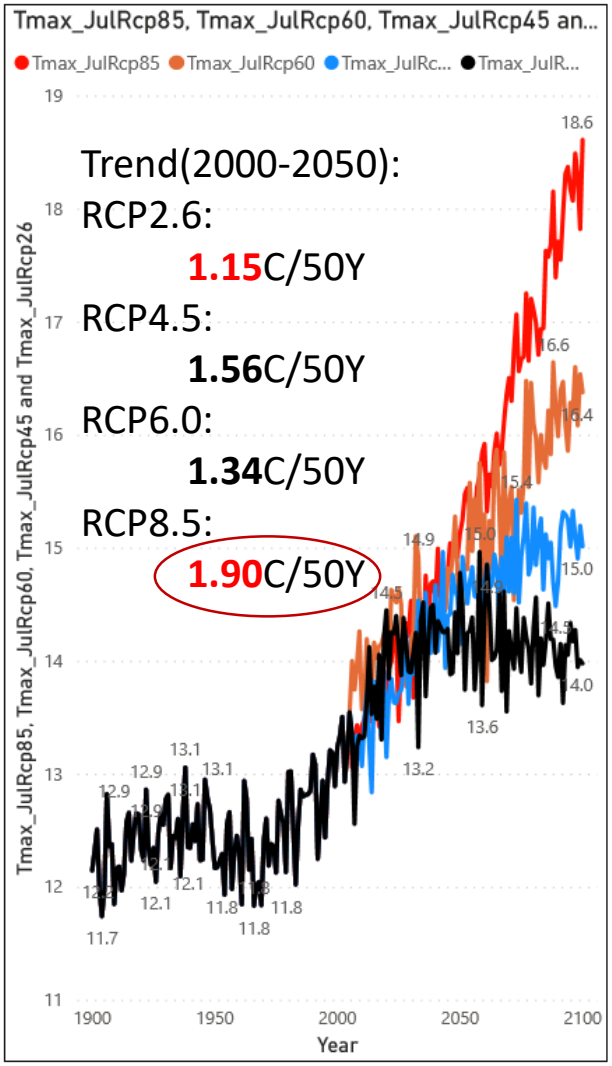


D area: **Nain** (56.52,-61.77)

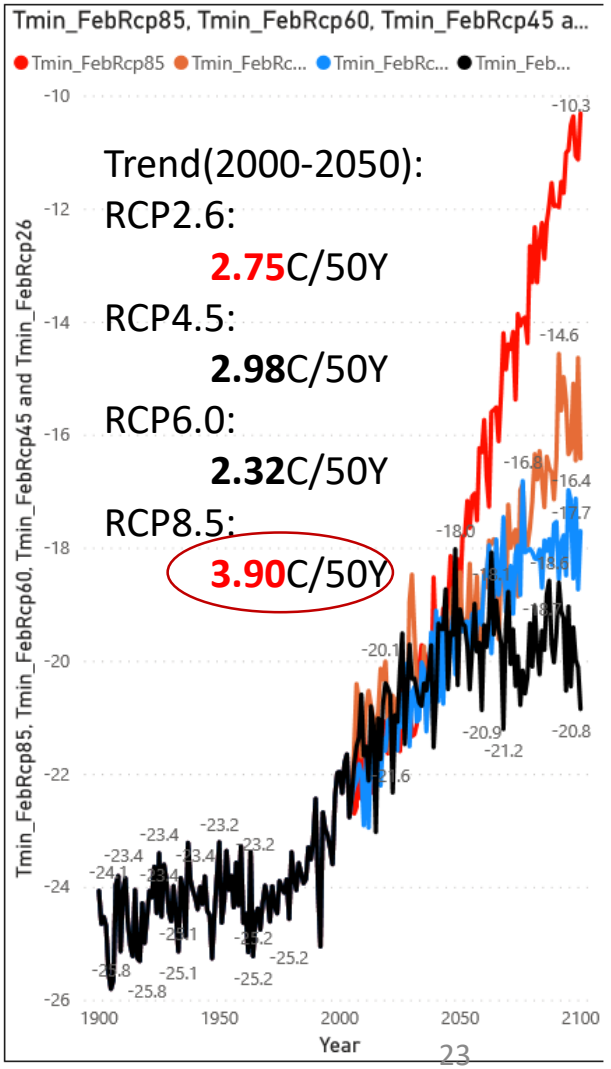
Tmean



TmaxJuly

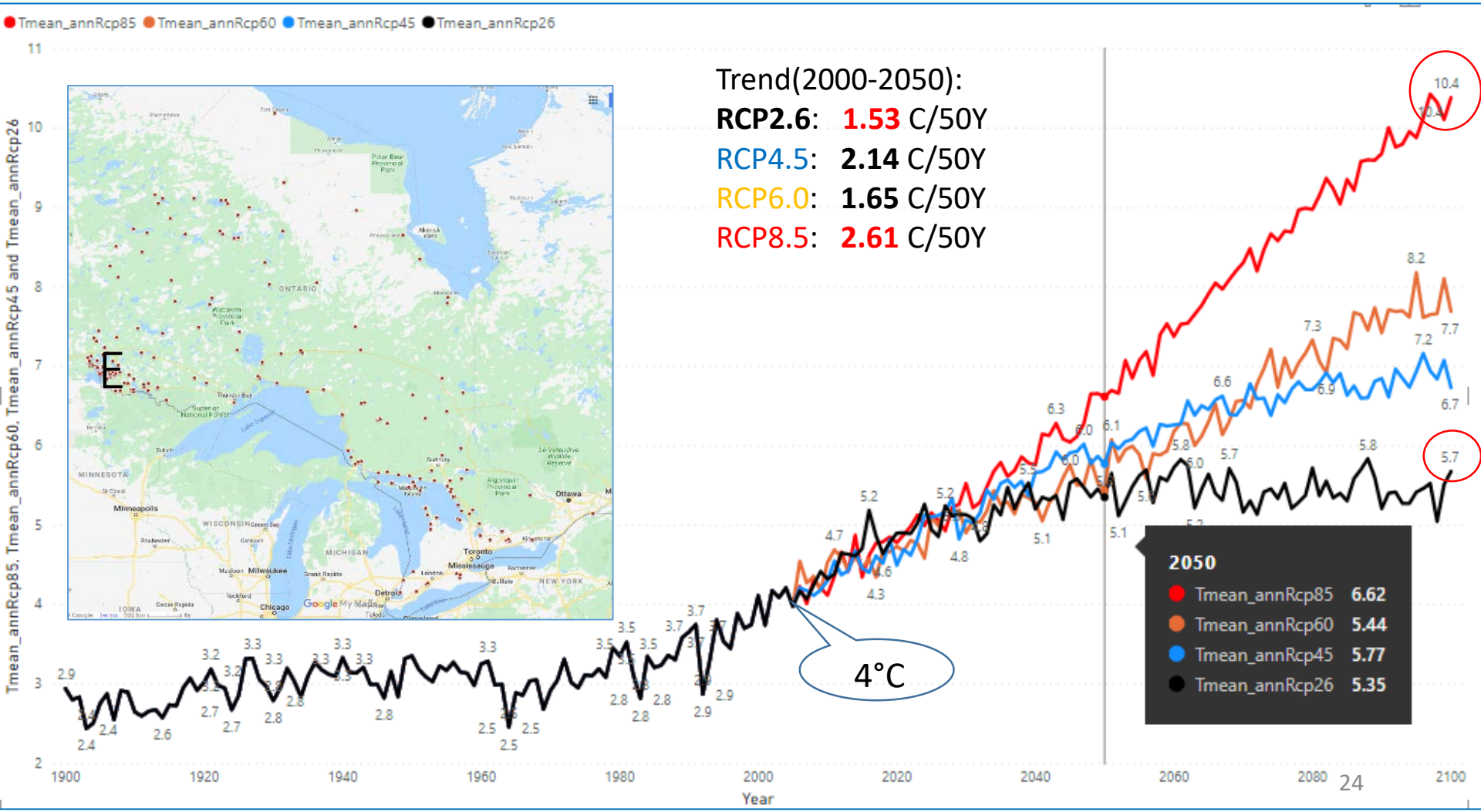


TminFeb

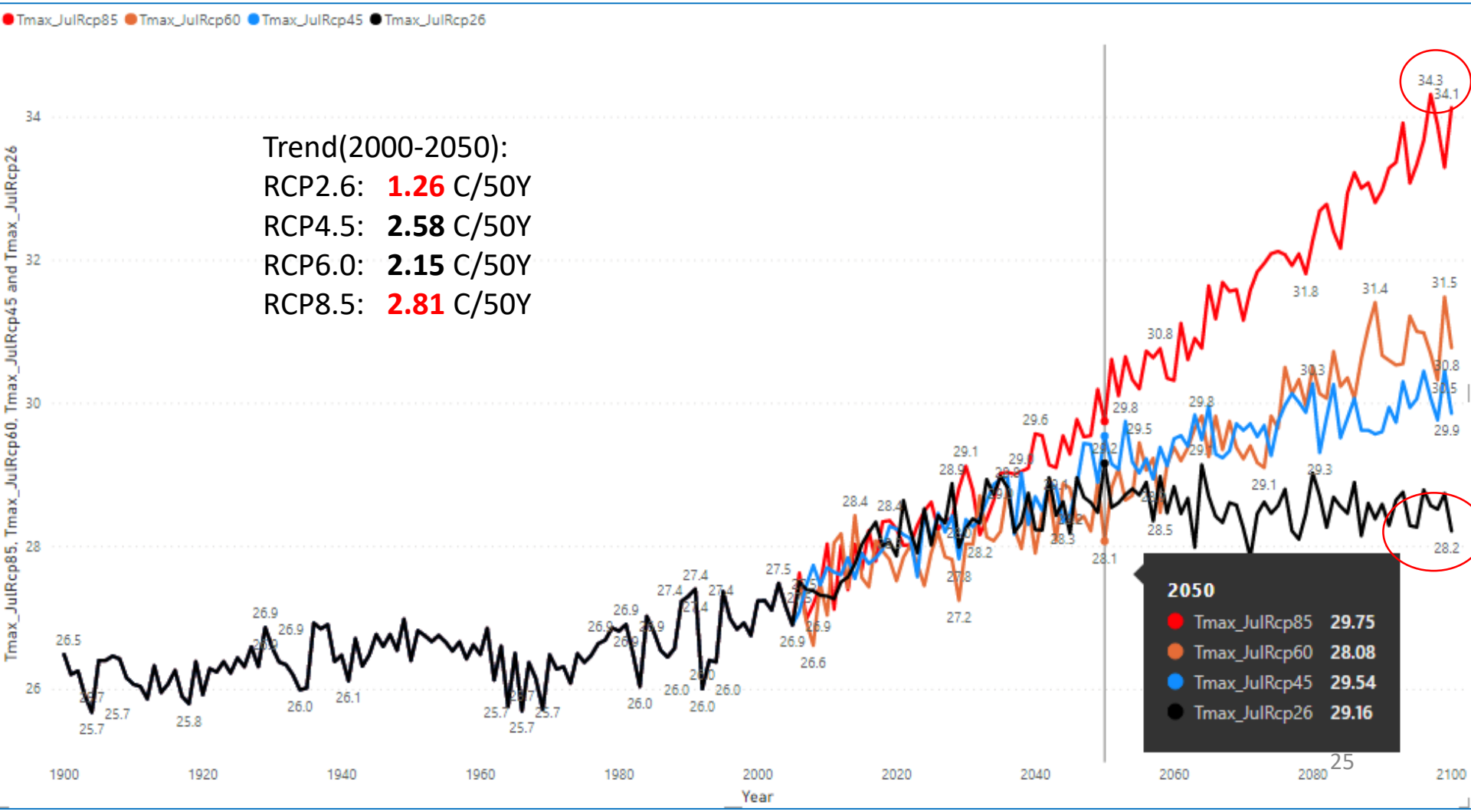


E area: **Lake of the Woods Indian Reserves in Ontario**

- Annual temperature(Tm) trend 1.53-2.61°C/50-Year
- By the end of this century Tm may increase ~ 6°C under the RCP8.5

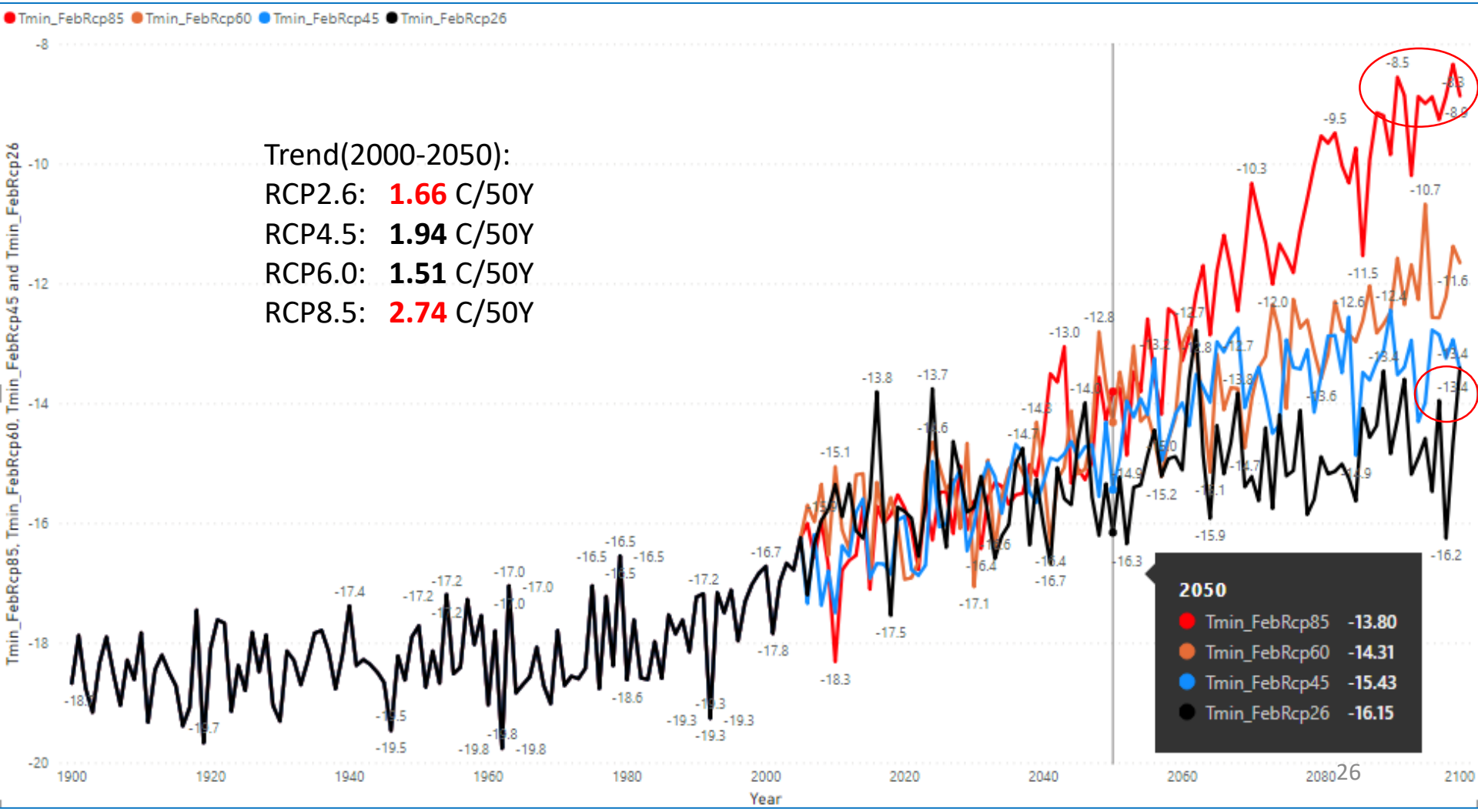


- July monthly average of maximum temperature may increase with trend 1.26-2.81/50-Year
- By the end of this century Tx may increase ~7C under the worst scenario (RCP8.5)



February monthly average minimum temperature may increase with trend 1.66-2.74°C/50-Year

By the end of this century, February Tn may increase about 8°C



Impacts: what does such significant temperature change mean to us?

- From point of view of annual temperature change, in the warming world, climate of the five aboriginal areas may like some areas much southern of these areas, this change may cause significant impacts on life of the residence.

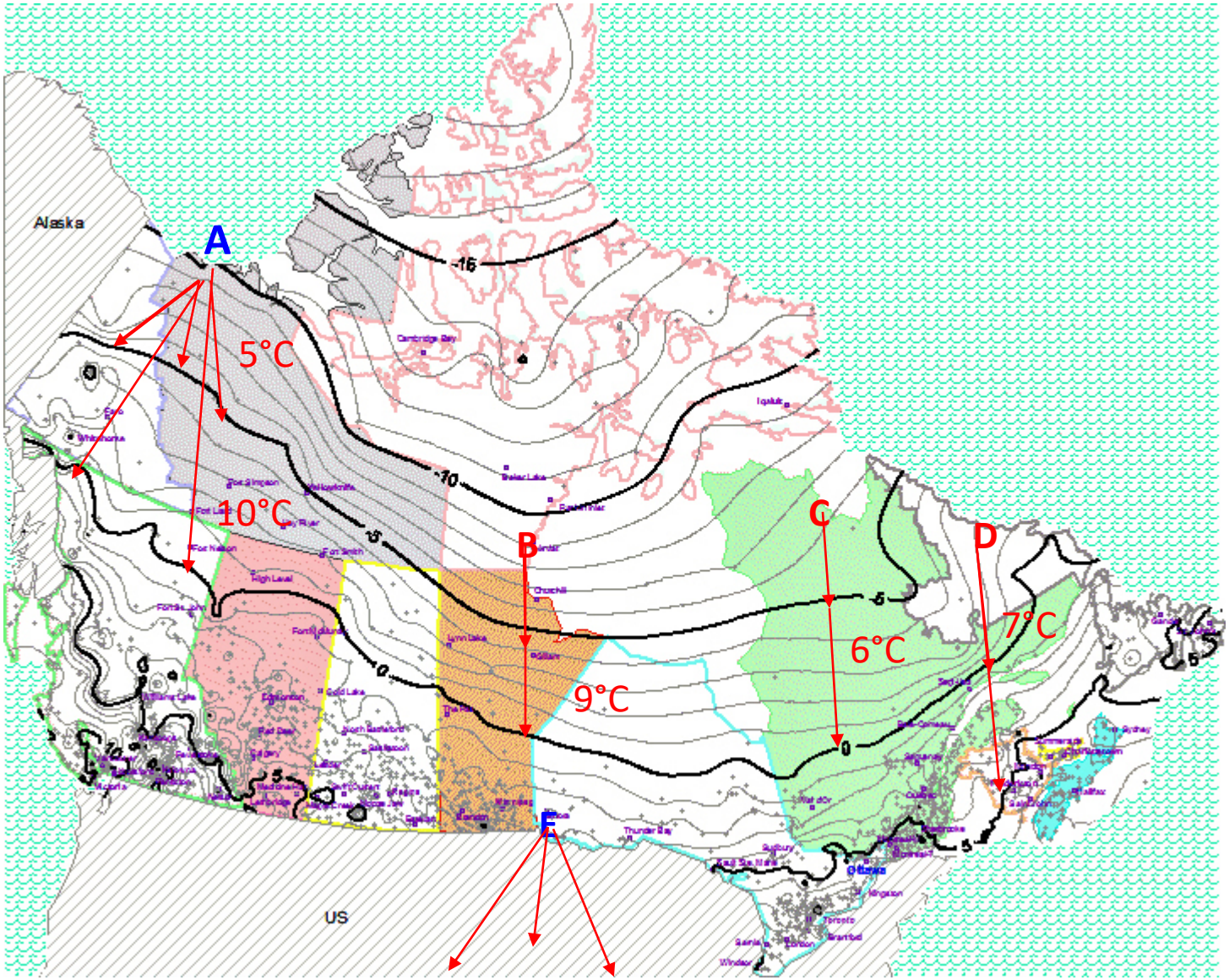
- For the much larger winter warming, the impacts will be more severe, Impacts include:

  sea ice become thinner; the extent of the sea ice in spring and summer decrease; snow cover decrease; permafrost extent decrease; permafrost melt; loss of villages and lands in coastal arctic indigenous communities; new diseases may establish in these areas, and ……

According to average temperature gradient along latitude at high latitude area:

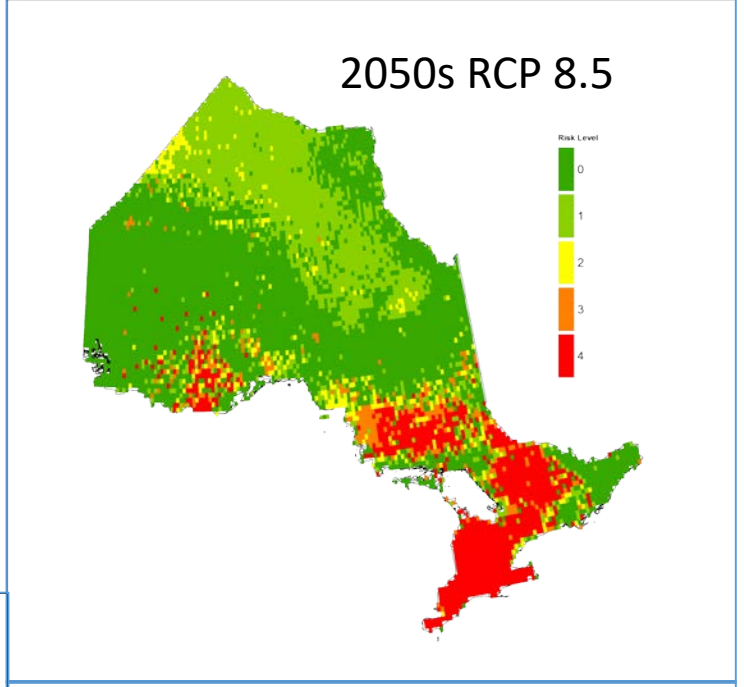
Temperature increase ~1°C is equivalent to ~1 degree south ward movement, also equivalent to ~110km southward movement (the value is spatial dependent)

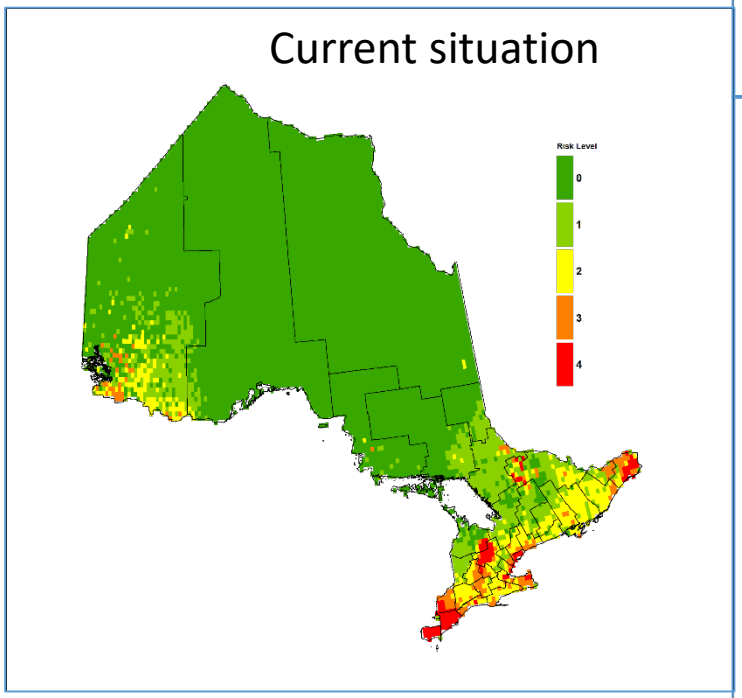
~1C change
~1Deg Latitude
~ 110km

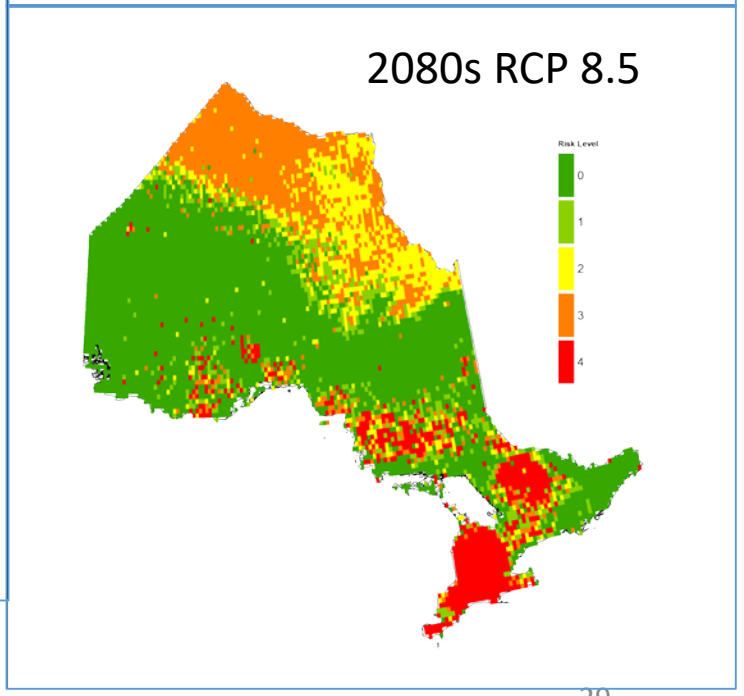


Average annual temperature 1981 to 2010(EC)

Mosquitoes and mosquito-borne diseases: Warming temperature will drive *culex* mosquitoes to move north and bring infectious diseases (West Nile virus) to indigenous and Northern communities.







Summary

- In the indigenous and north community areas, temperature has increased significantly for the historical period.

- In the last 20 years, temperature increased with higher amplitude than the IPCC AR5 worst scenario (RCP 8.5).

- In the five selected locations,
  - Annual temperature may increase about 2-4°C by 2050 and 6-8°C by 2080,
  - July maximum temperature may increase 1-2°C by 2050 and 5-6°C by 2080,
  - February minimum temperature my increase 2-5°C by 2050 and 7-10°C by 2080s.

- These changes may significantly affect life of residence in these areas and the people will have to face a variety of risks

- All countries should take action quickly to mitigate climate change and local government and residence must take action quickly to adapt the changes

Maps:

Thousands visually-appealing, inform
ensemble of climate projection datas

Figures

asic climate variables and climate extreme indices tell us how
ıging at various spatial levels.

Thanks!

Data

Large ensembles of high resolution historical observations and future projected climate data for climate change and impact researches.

Many PDF formate reports or web pages about special climate change topics including factsheets, present and future climate condition analyses.

FAQ

Answers of some questions about all aspects related to the OCDP including data sources, methodology, products and our future researches.

About

Brief introduction of the climate change group at LAMPS, York University and the works we did and will do in the future.