ClimateWest
Building Prairie Resilience

Winnipeg, Manitoba, 3 May 2023

Projected Changes in Climate for Alberta, Saskatchewan, and Manitoba

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THE UNIVERSITY OF WINNIPEG

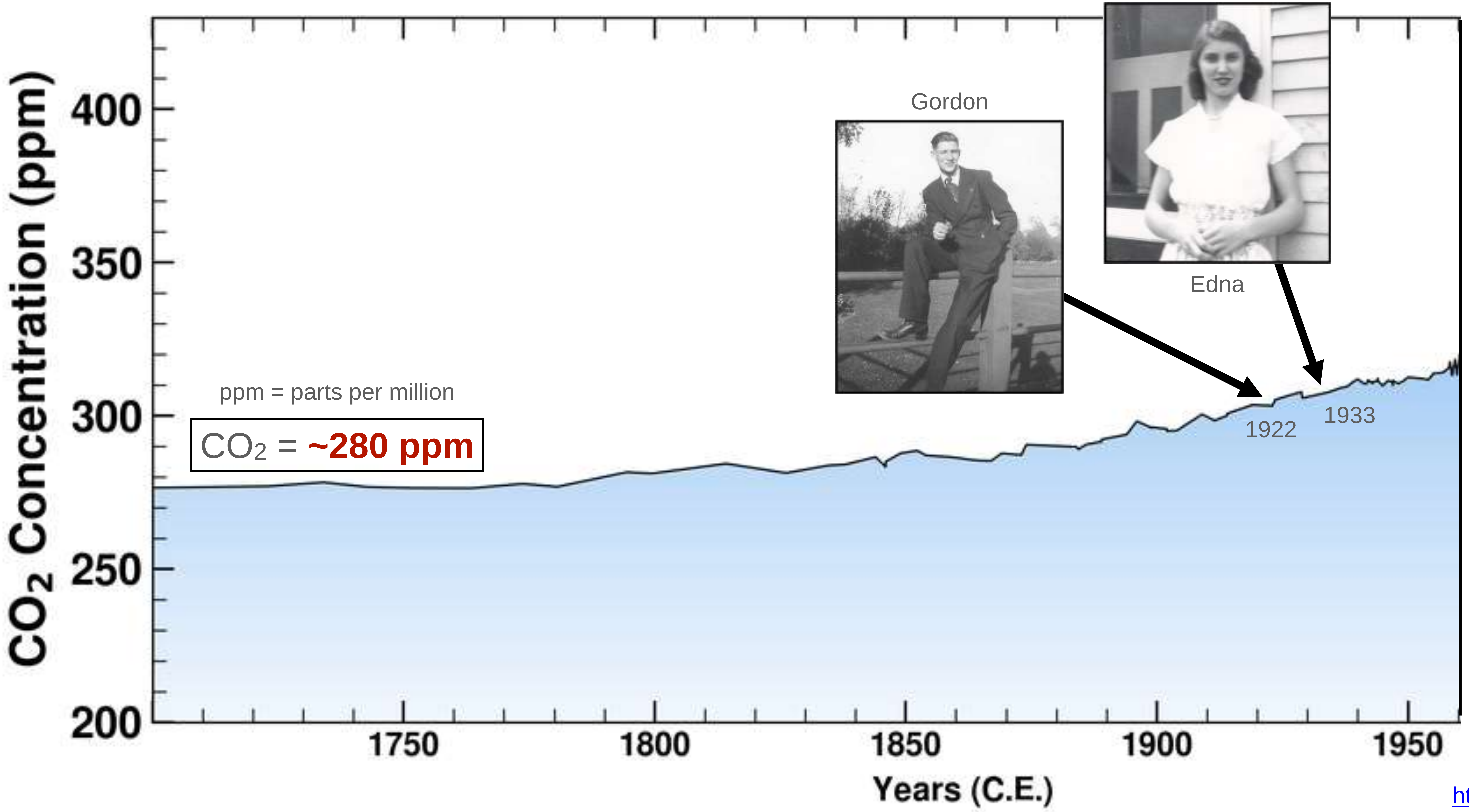
Prairie Climate Centre

Prairie
Climate Centre

We are storytellers

The Story I Tell, Quickly

Concentration of Atmospheric CO_2 since 1700



Dad was born in Indian Head, SK in 1922

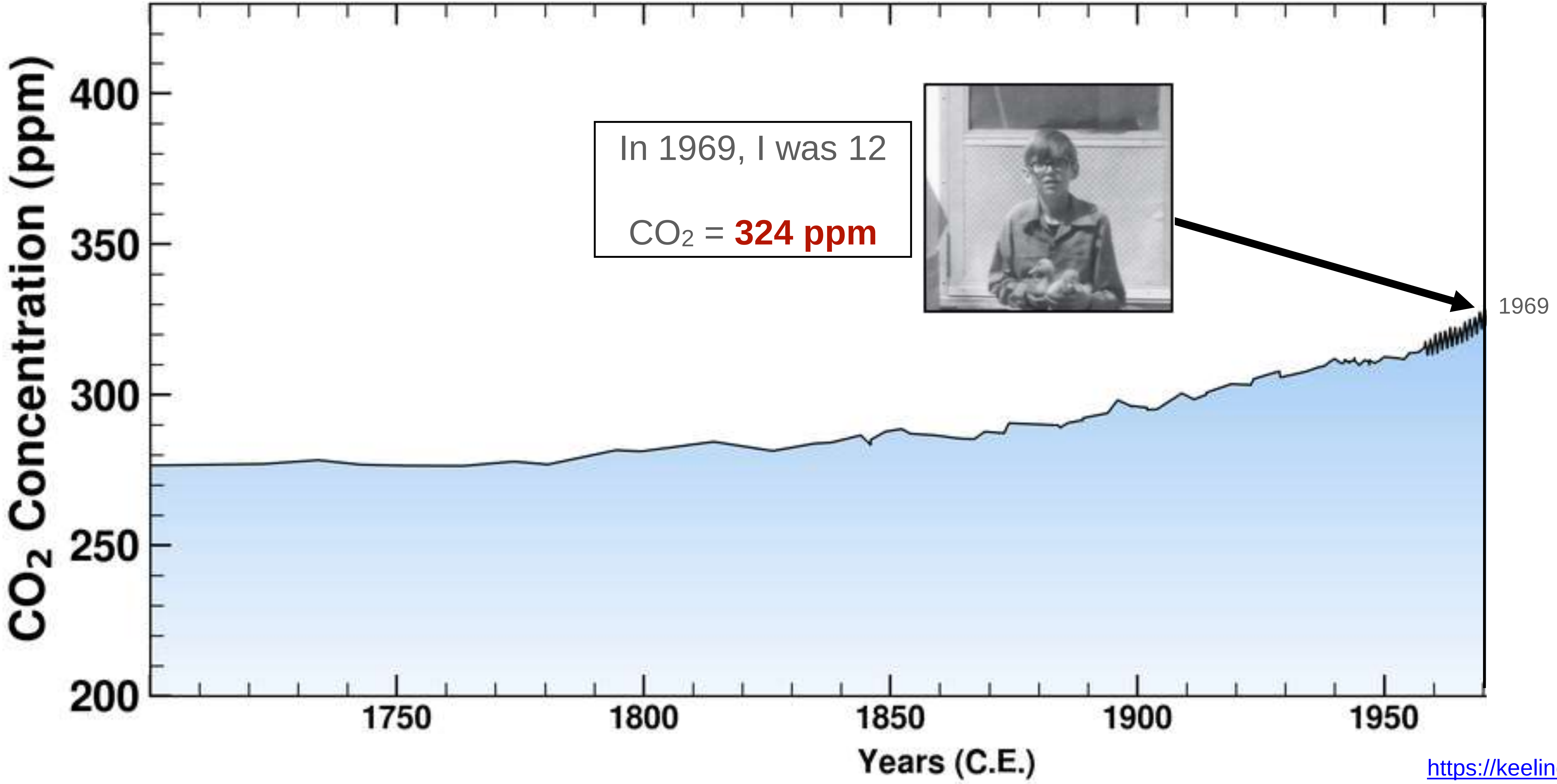
CO_2 = **303 ppm**

Mom was born in Yellow Grass, SK in 1933

CO_2 = **307 ppm**

https://keelingcurve.ucsd.edu/

Concentration of Atmospheric CO_2 since 1700



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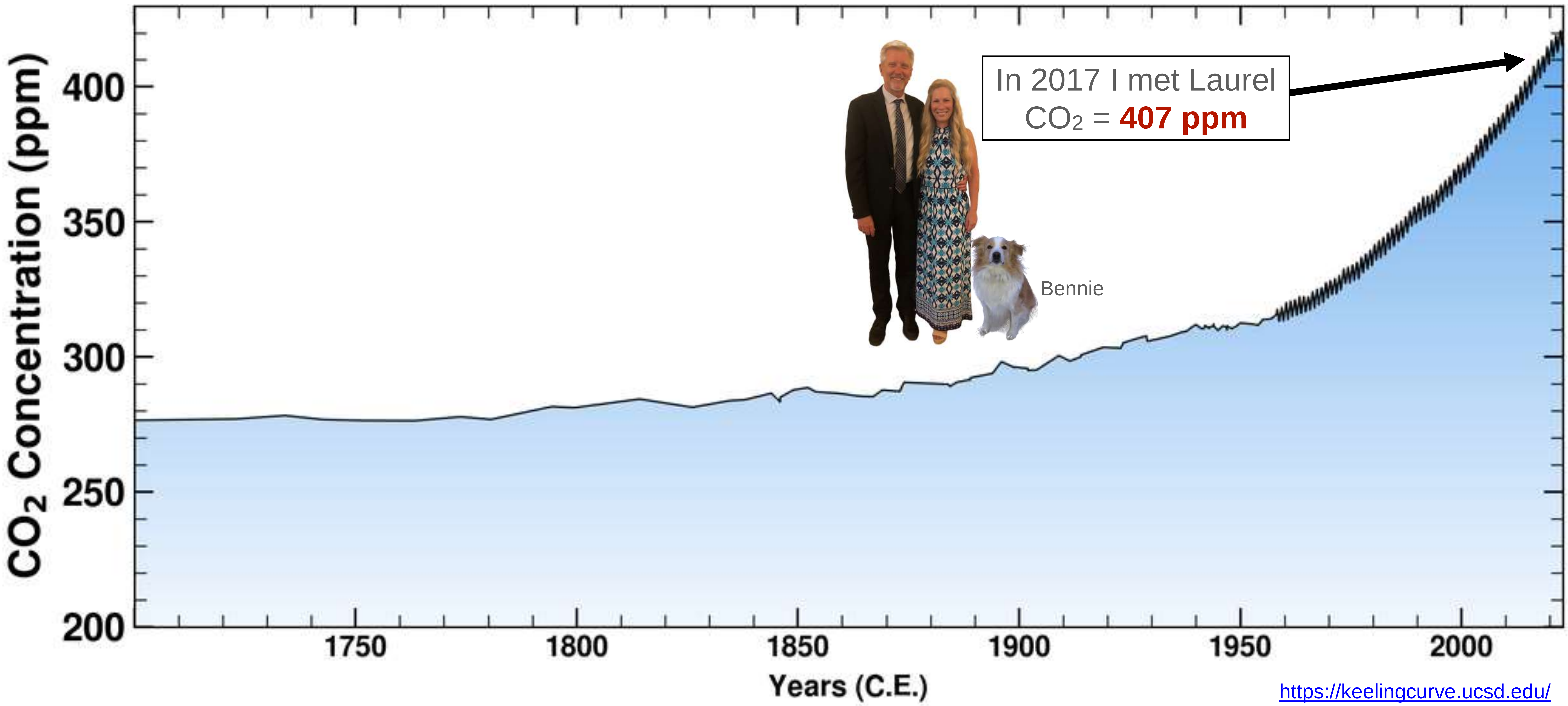
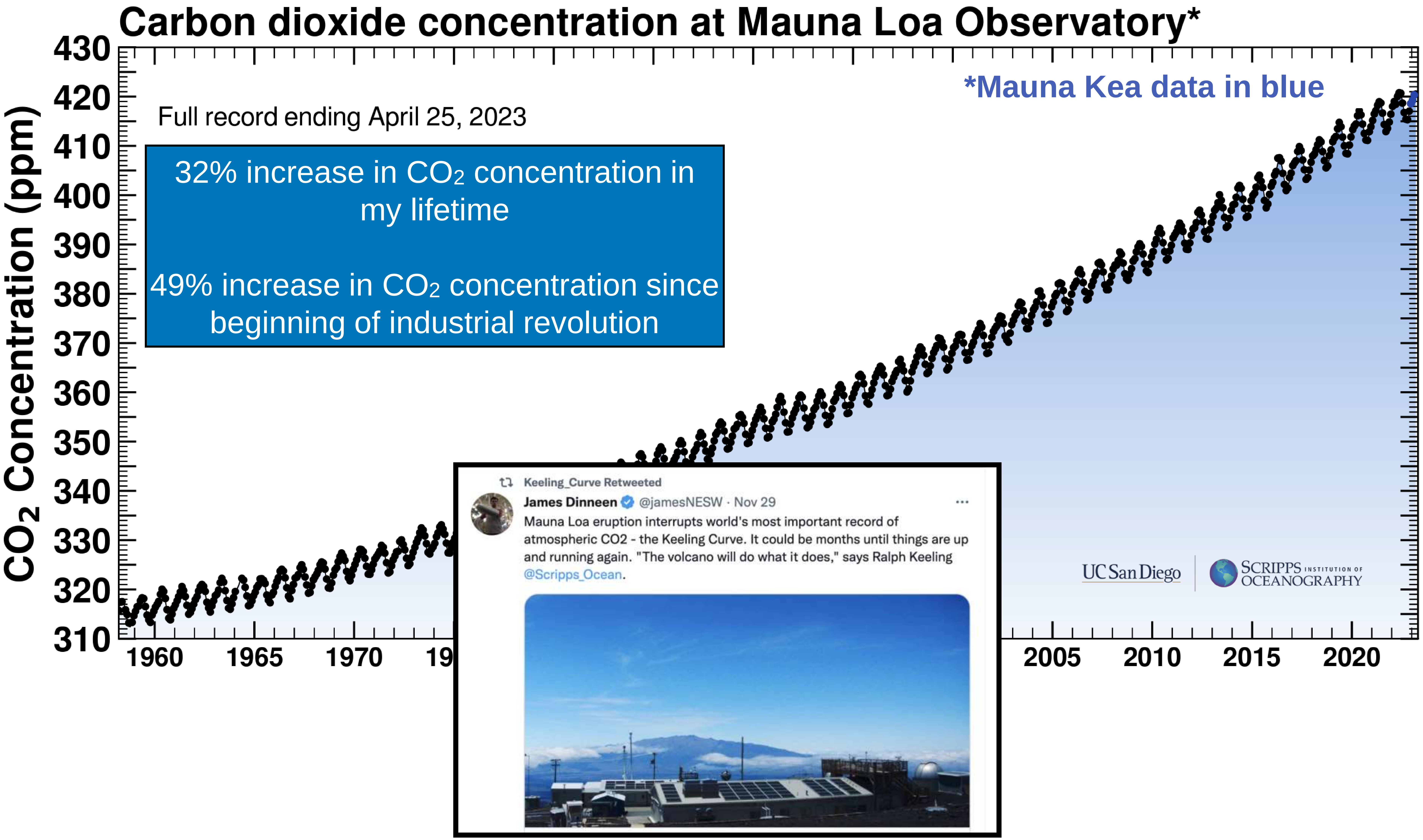
Concentration of Atmospheric CO_2 since 1700



https://keelingcurve.ucsd.edu/

The Keeling Curve

The pandemic lockdown did not have a substantial impact on the concentration of carbon dioxide in the atmosphere.

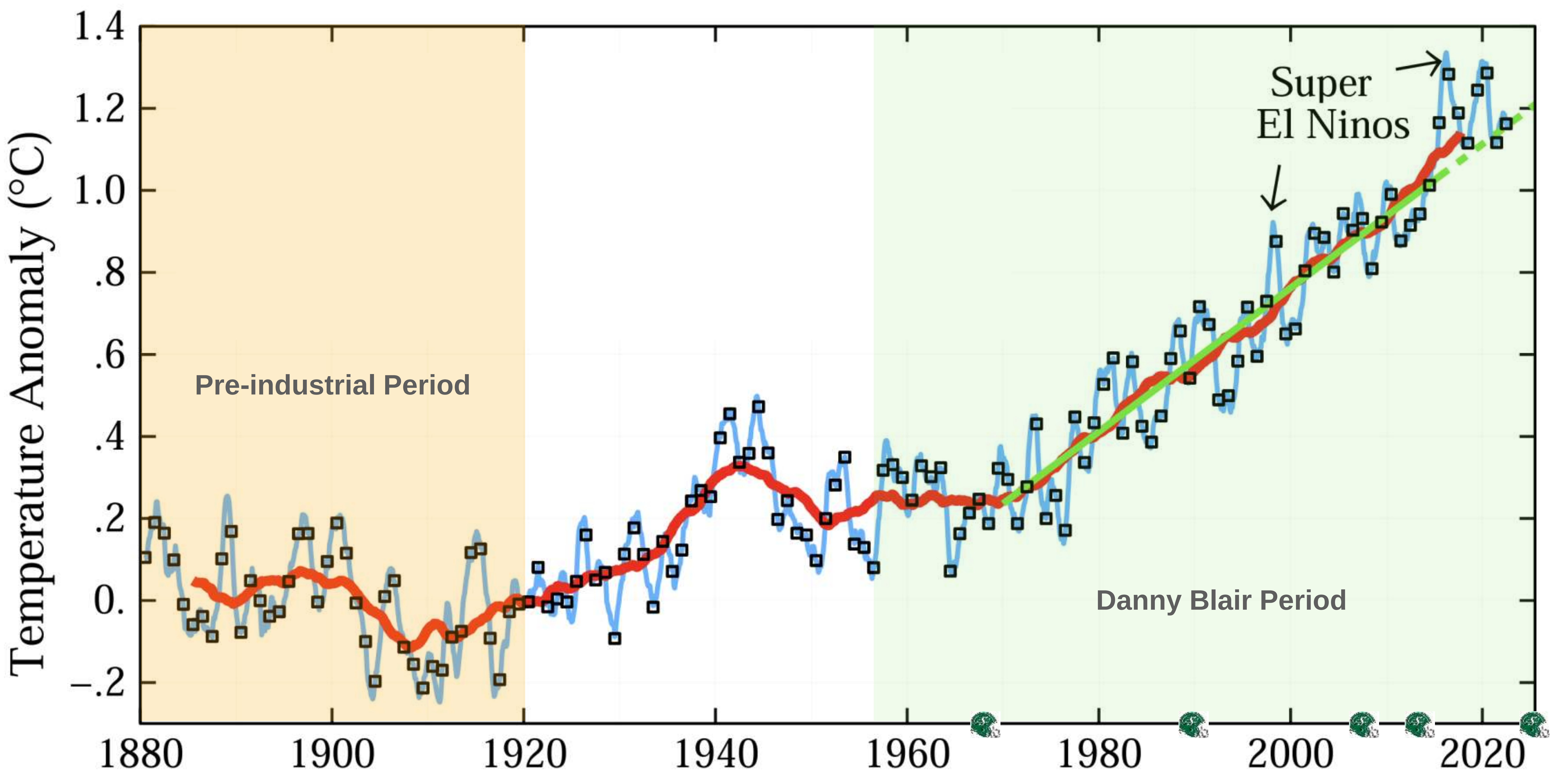


Average concentration in 2022 was **418.56 ppm**

https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt

https://keelingcurve.ucsd.edu/

Global Surface Temperature Relative to 1880—1920 Mean



Updated March 2023

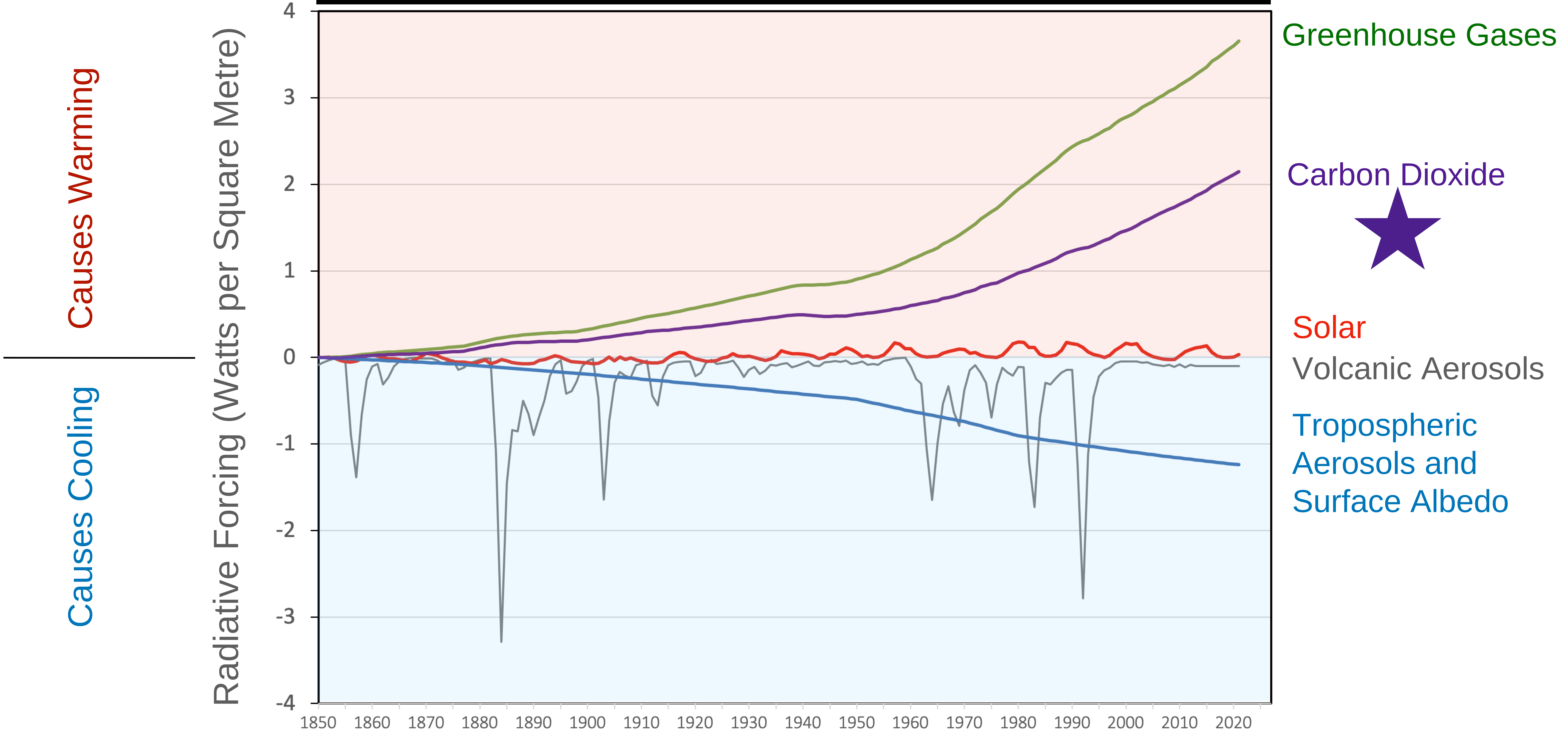
2022 tied for 5th warmest year (with 2015)

https://www.nasa.gov/press-release/nasa-says-2022-fifth-warmest-year-on-record-warming-trend-continues

2022 was **1.16°C warmer** than pre-industrial (excluding short-term variability)

http://www.columbia.edu/~jeh1/mailings/2023/Temperature2022.12January2023.pdf

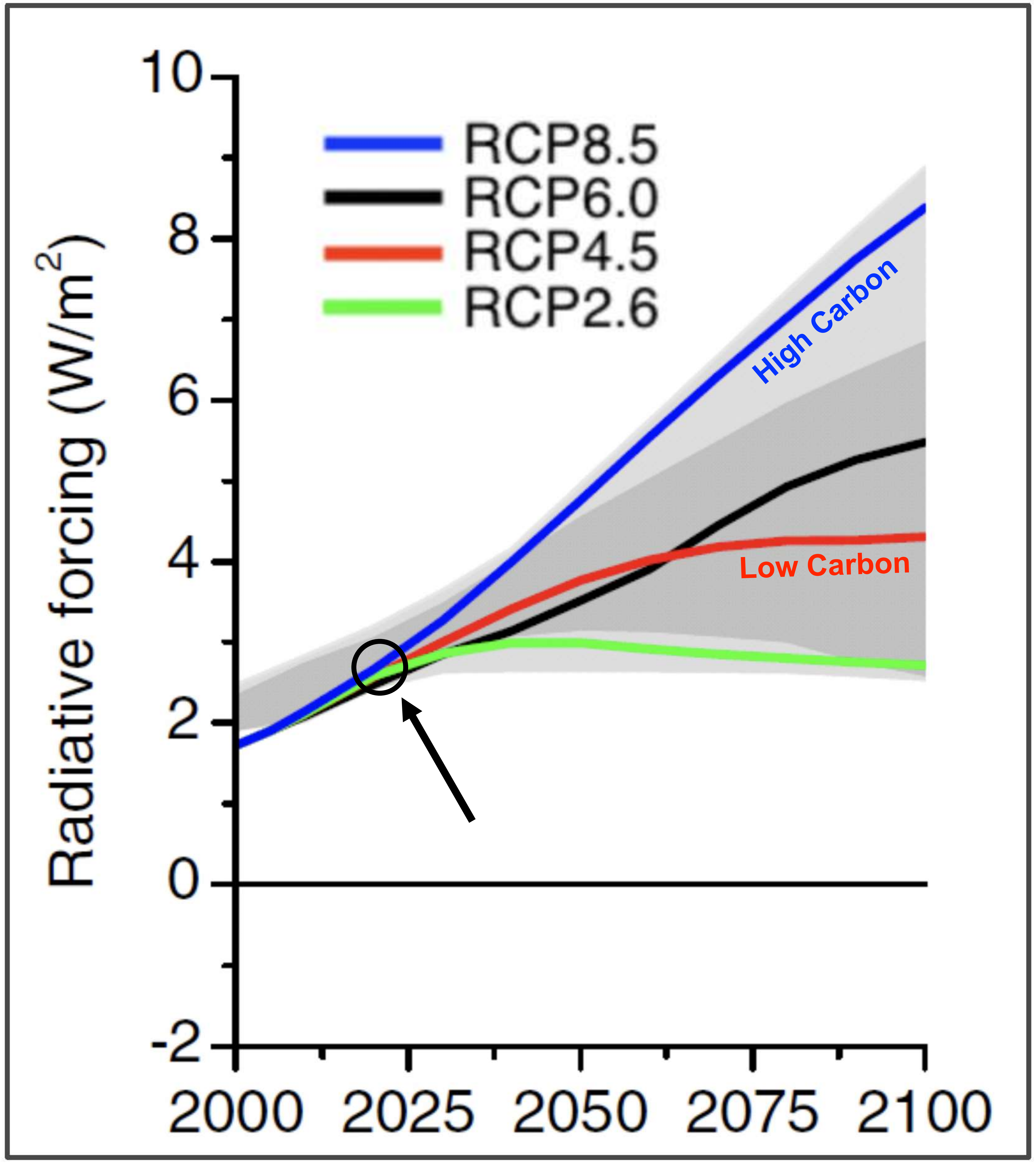
Radiative Forcings 1950-2021



http://www.columbia.edu/~mhs119/Burden/Table.A1.ann.txt

Our Future Climate

Depends on Emissions



So far, we have increased the radiative forcing by about **2.7 W/m^2** mostly from carbon dioxide emissions

Which carbon emissions scenario will we follow?

RCP = Representative Concentration Pathway

RCPs have been replaced by SSPs (Shared Socioeconomic Pathways)

After: van Buren et al. (2011)

Global surface temperature change relative to 1850-1900, under five different ‘carbon scenarios’

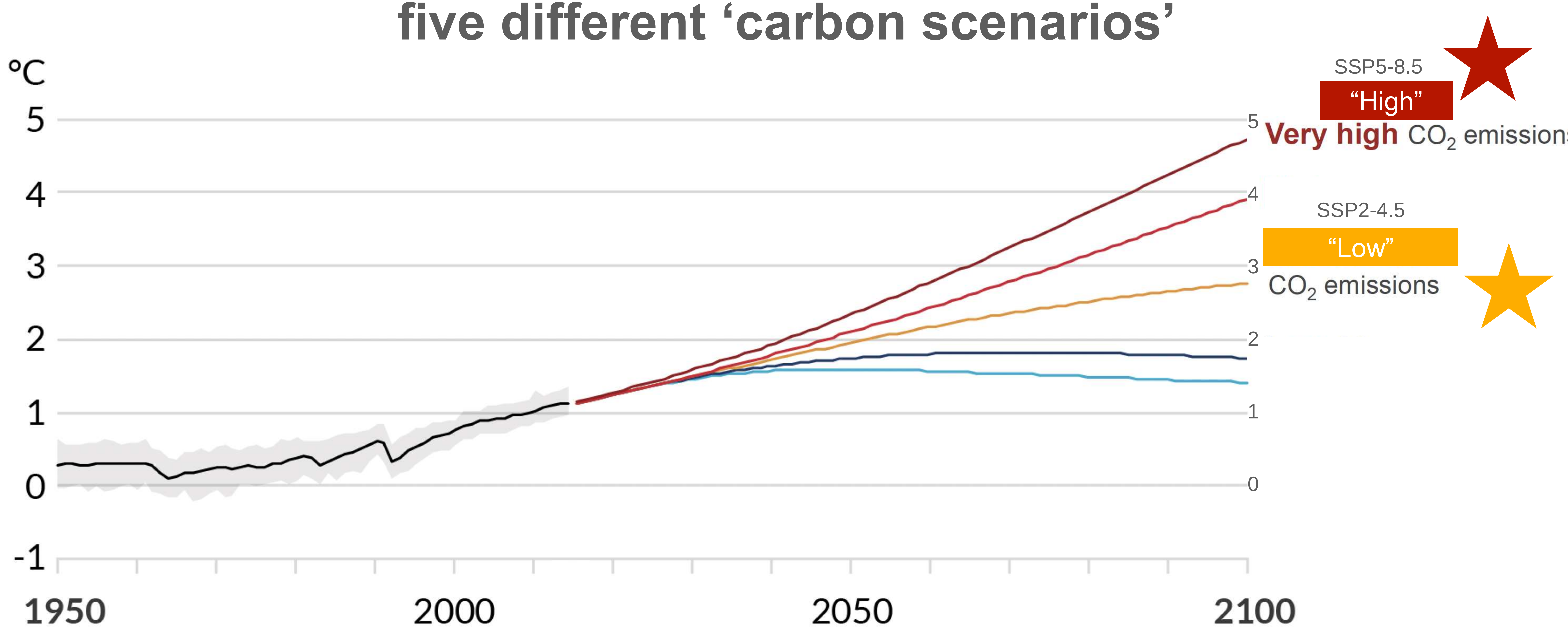
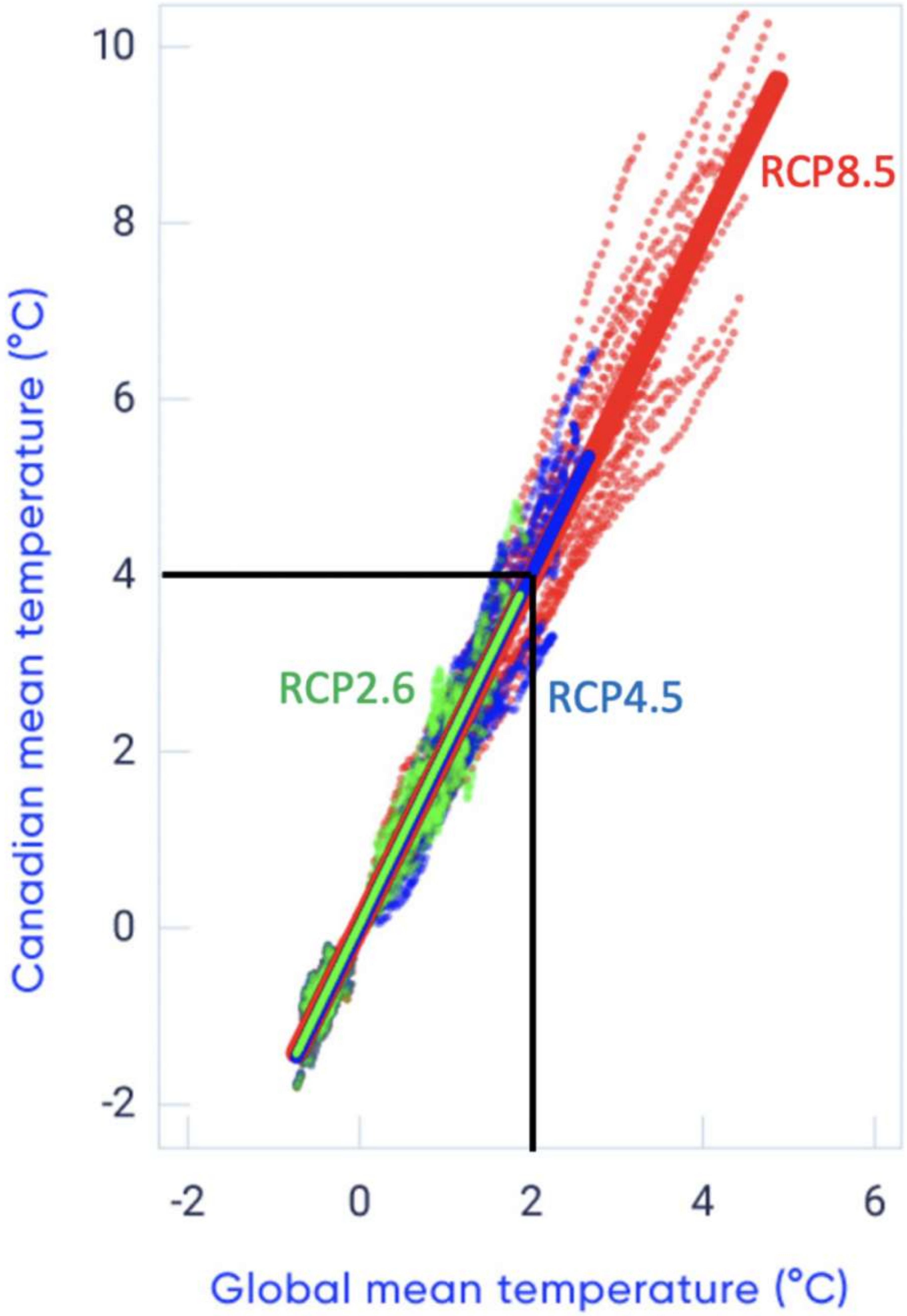


Figure SPM.8



Relationship between Global Mean Temperature Change and Canadian Mean Temperature Change

Canada is warming at about double the global rate

And will continue to do so in the coming decades

The Arctic is warming at about 3 times the global rate

Why?
- Snow-ice albedo feedback (lower reflectivity)
- Lapse-rate feedback (stronger in high latitudes)
- Planck feedback (proportionally less outward emission)
- Cloud feedback (cloud keeps heat in)

After: Fig. 4.9

Observed and Projected Temperature

Prairie Climate Centre

Climate Atlas of Canada

climateatlas.ca

The University of Winnipeg


MENU
MAP
Average value (Days)
0
50
Very Hot Days (+30°C)
High Carbon → More climate change • 2051-2080
HELP
TOUR
SHARE
Fr
Large grid
Average
Cities and Municipalities
Indigenous
Settings
Yellowknife
Fort McMurray
Grande Prairie
Edmonton
Saskatoon
Calgary
Regina
Winnipeg
Thunder Bay
Quebec
Ottawa
Montreal
Oshawa
Toronto
St Catharines
London
Halifax
Find me
CLIMATE CHANGE
LESS
MORE
TIME PERIOD
RECENT PAST
2021-2050
2051-2080
Municipality
WINNIPEG
Projected change in mean
Number of +30 °C days
High Carbon → More climate change
1976-2005
2051-2080
14.3 → 52.1
Up
+37.8
Number of +30 °C days
Year
Ensemble mean
Historical Values
1950-2005
2006-2095
This graph shows values from 24 climate models as well as their yearly mean (average) values.
Show historical values
More Details
Low
Mean
High
1976-2005 3.9 14.3 27.6
2051-2080 25.1 52.1 77.4
This table summarizes the range of values across the 24 climate models for each 30-year period. "Low"
Hot Weather
Cold Weather
Temperature
Precipitation
Agriculture
v2

MENU
MAP
Change (Days)
-40
40
Very Hot Days (+30°C)
High Carbon → More climate change • 2051-2080
HELP
TOUR
SHARE
Fr
Large grid
Change
Cities and Municipalities
Indigenous
Settings
Fort McMurray
Grande Prairie
Edmonton
Red Deer
Saskatoon
Calgary
Regina
Lethbridge
Winnipeg
Thompson
Vancouver
Victoria
Thunder Bay
Sault Ste. Marie
Québec
Ottawa
Montréal
Oshawa
Toronto
St. Catharines
London
Moncton
Saint John
Halifax
Find me
CLIMATE CHANGE
LESS
MORE
TIME PERIOD
RECENT PAST
2021-2050
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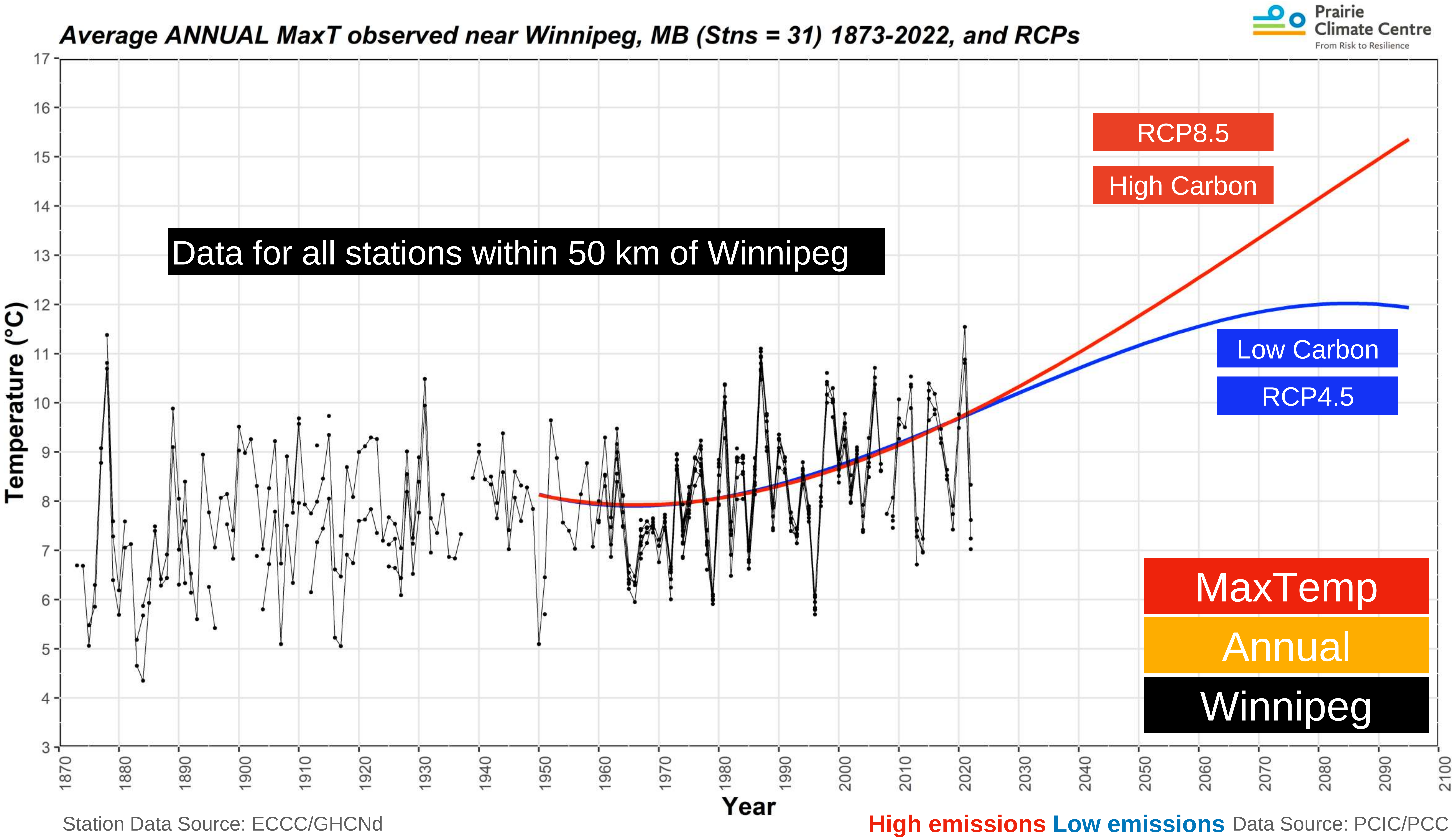
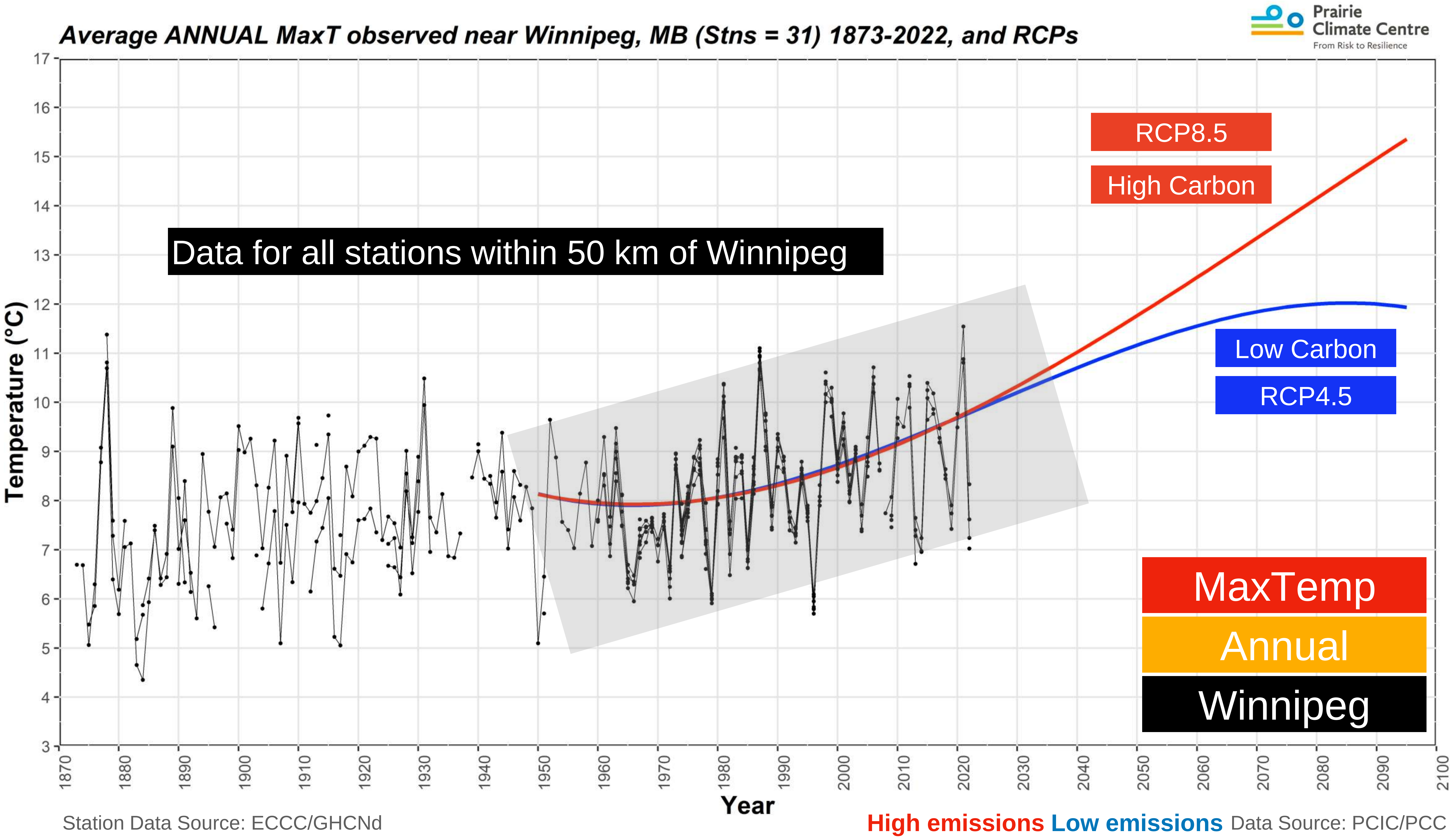
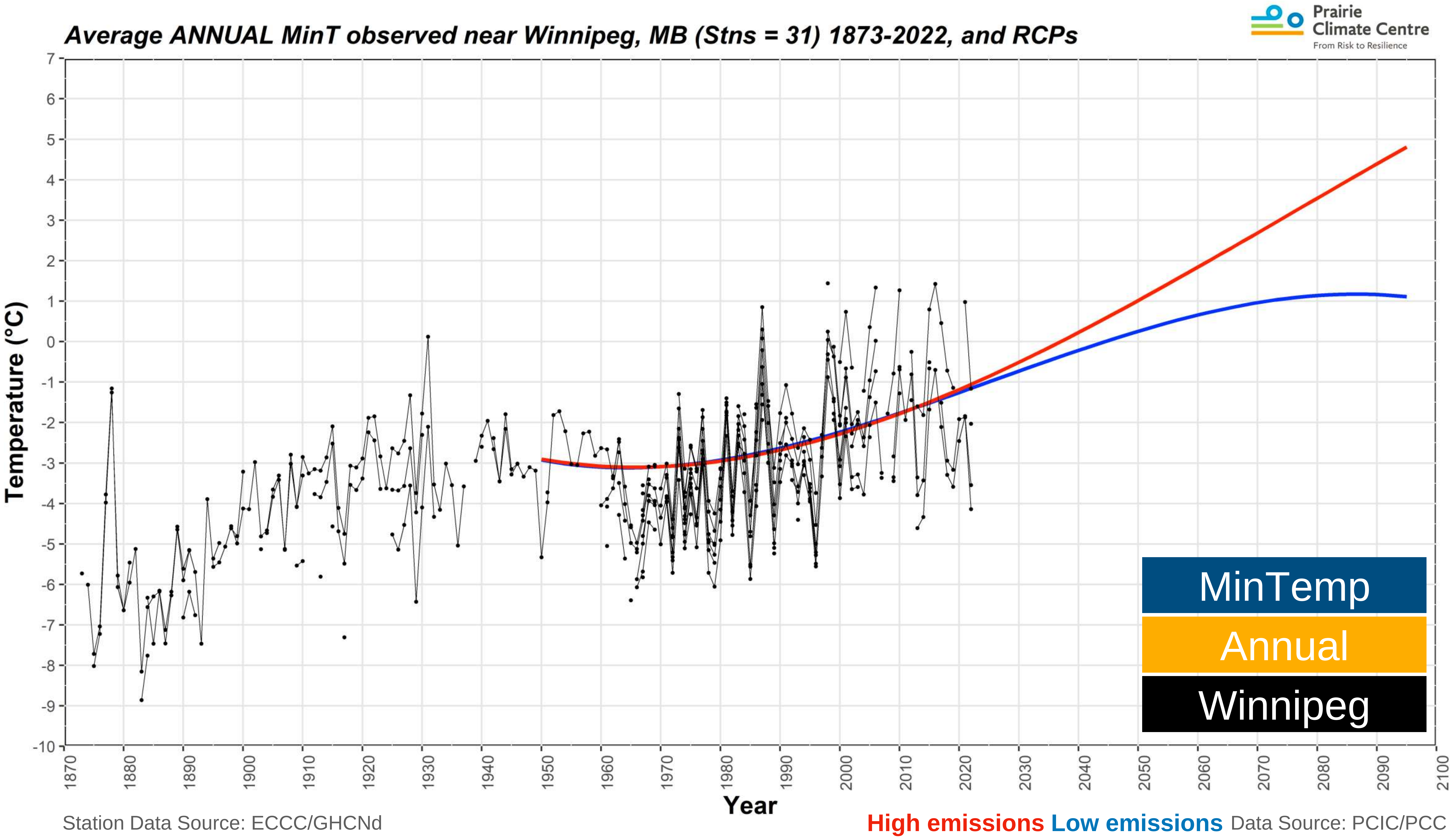
Hot Weather
Cold Weather
Temperature
Precipitation
Agriculture
v2

Annual Temperature

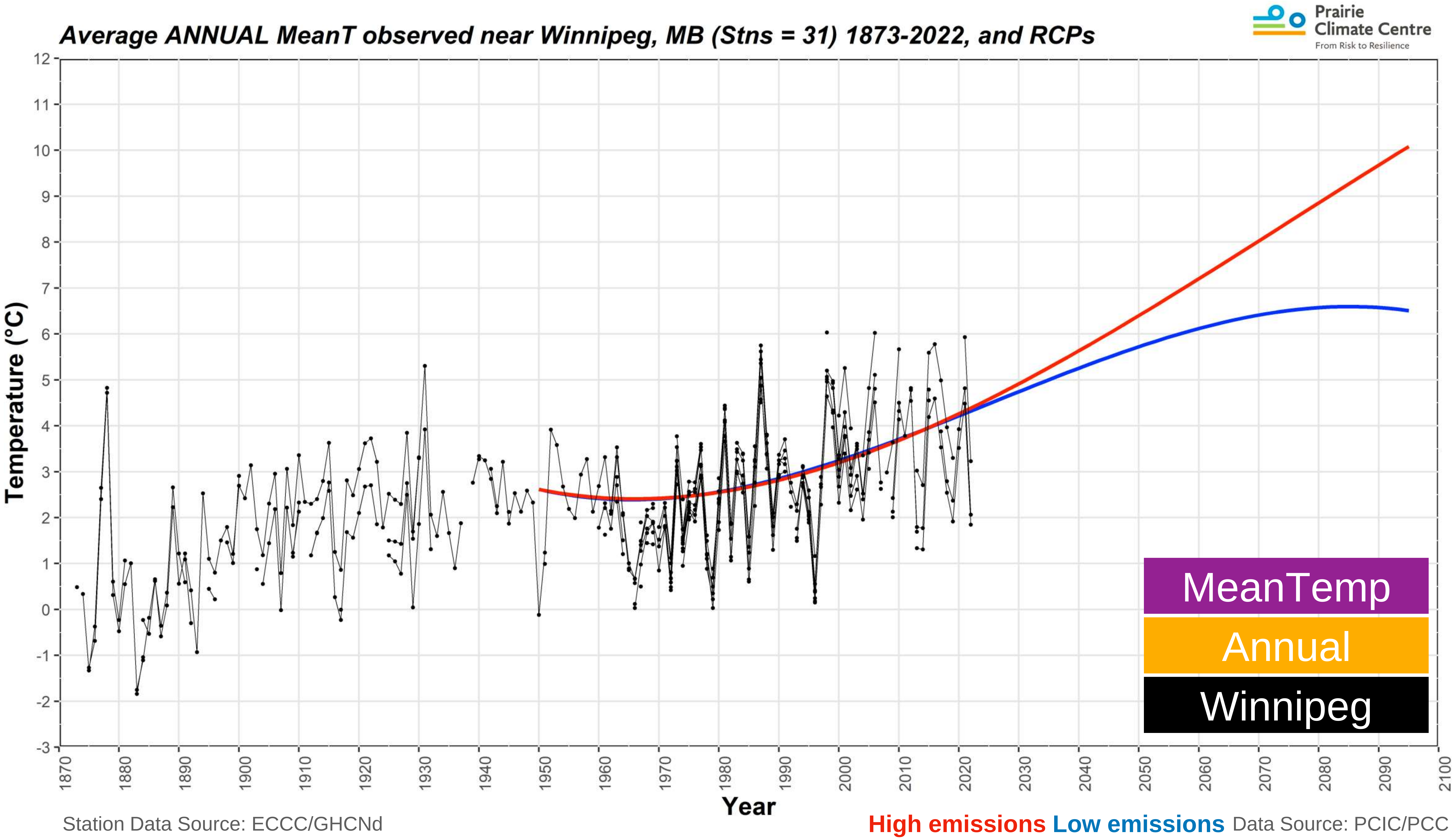


Prairie Climate Centre
From Risk to Resilience
Average ANNUAL MaxT observed near Winnipeg, MB (Stns = 31) 1873-2022, and RCPs
Temperature (°C)
Year
Data for all stations within 50 km of Winnipeg
RCP8.5
High Carbon
Low Carbon
RCP4.5
MaxTemp
Annual
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

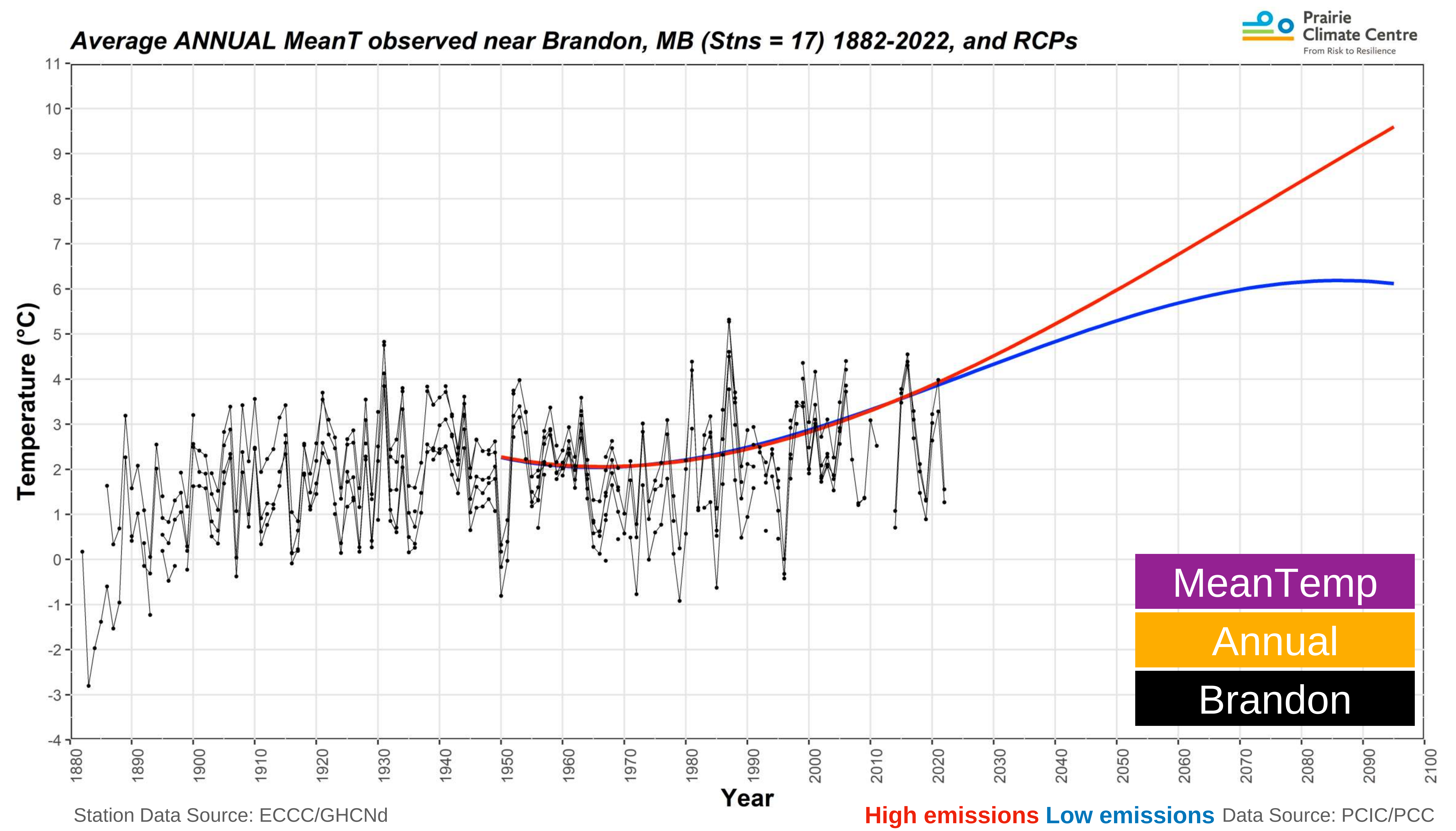

Average ANNUAL MaxT observed near Winnipeg, MB (Stns = 31) 1873-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Data for all stations within 50 km of Winnipeg
RCP8.5
High Carbon
Low Carbon
RCP4.5
MaxTemp
Annual
Winnipeg
Temperature (°C)
Year
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC



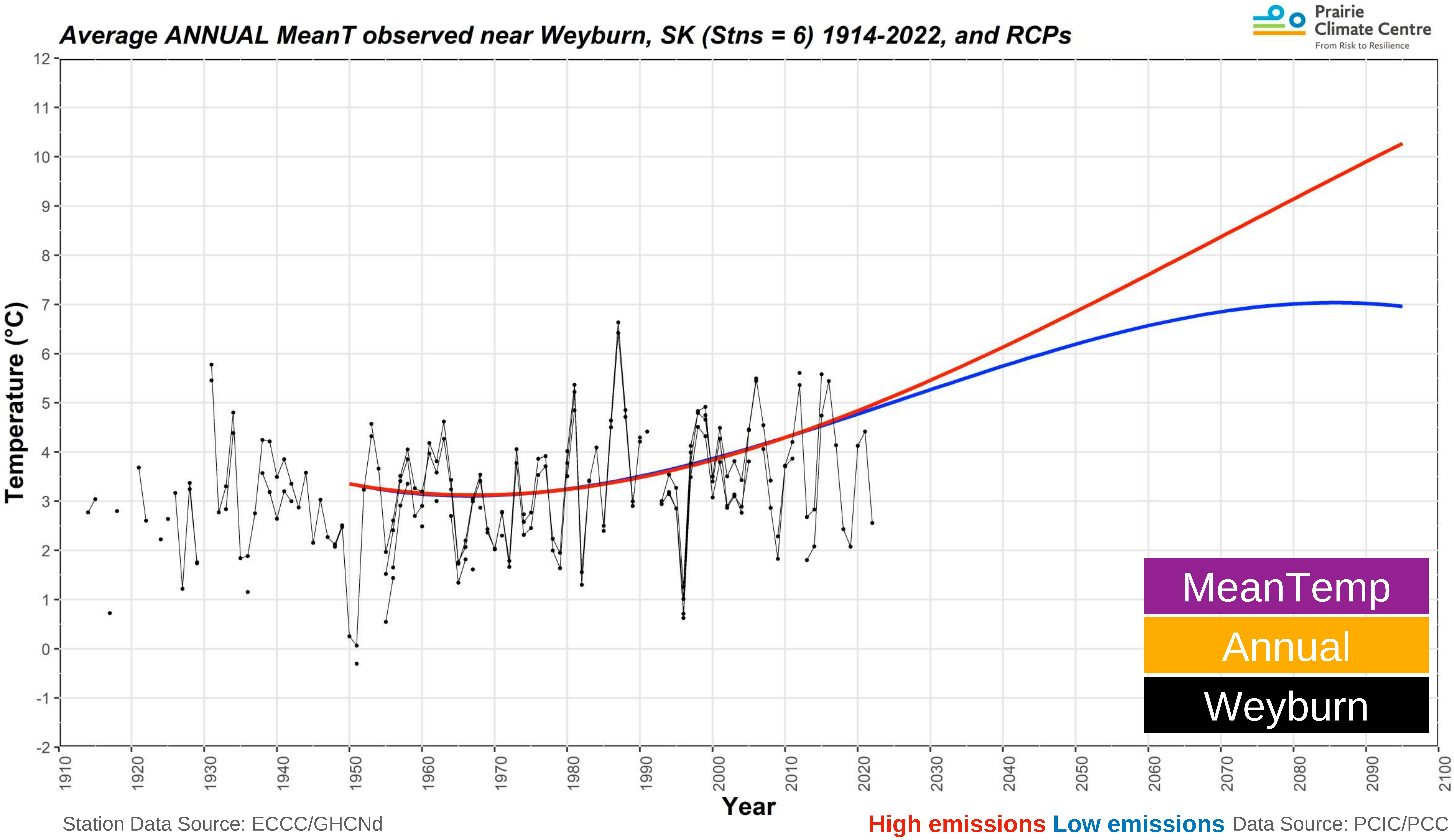
Average ANNUAL MinT observed near Winnipeg, MB (Stns = 31) 1873-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
Year
MinTemp
Annual
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

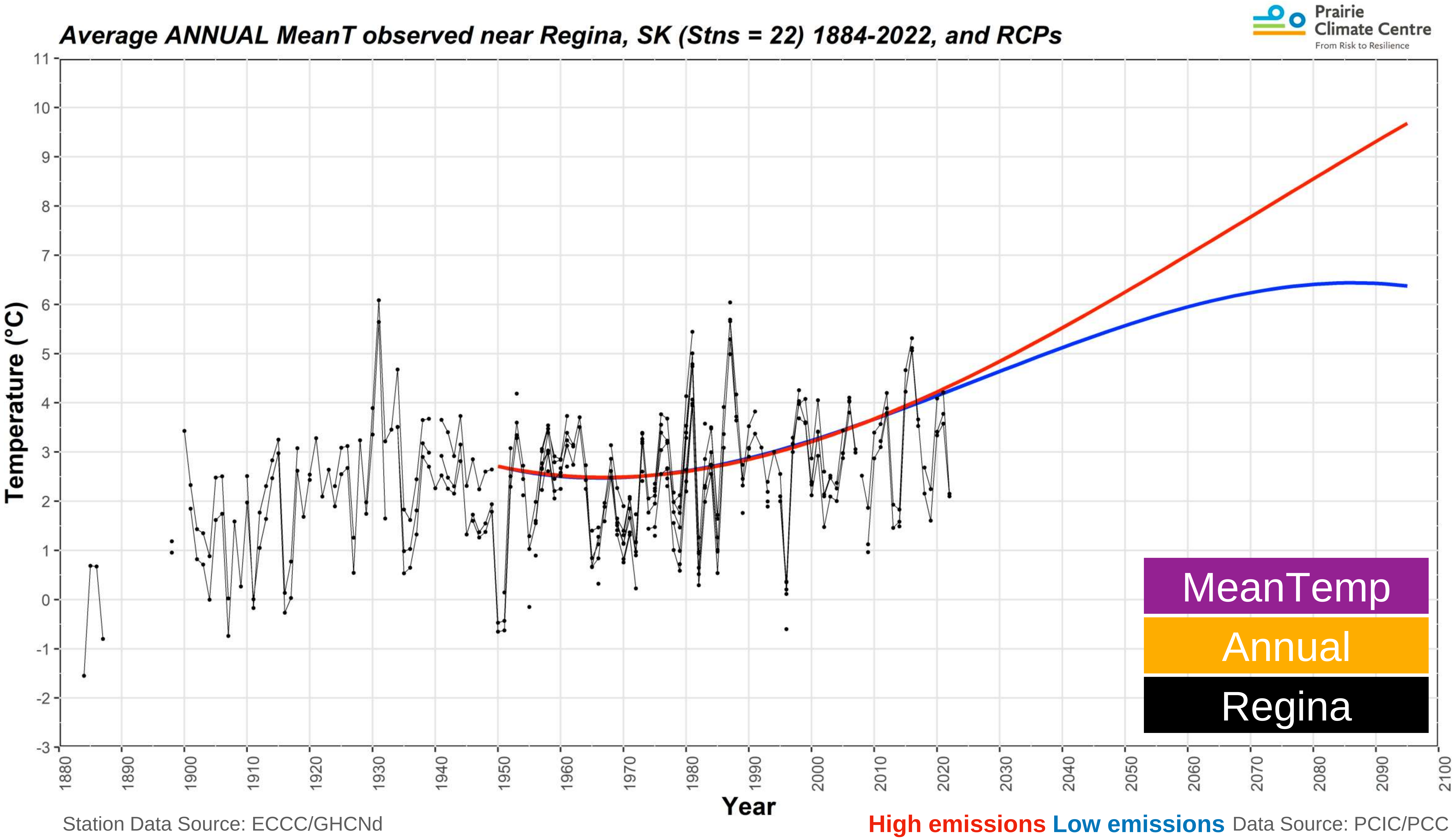


Prairie Climate Centre
From Risk to Resilience
Average ANNUAL MeanT observed near Winnipeg, MB (Stns = 31) 1873-2022, and RCPs
Temperature (°C)
Year
MeanTemp
Annual
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions
Low emissions
Data Source: PCIC/PCC

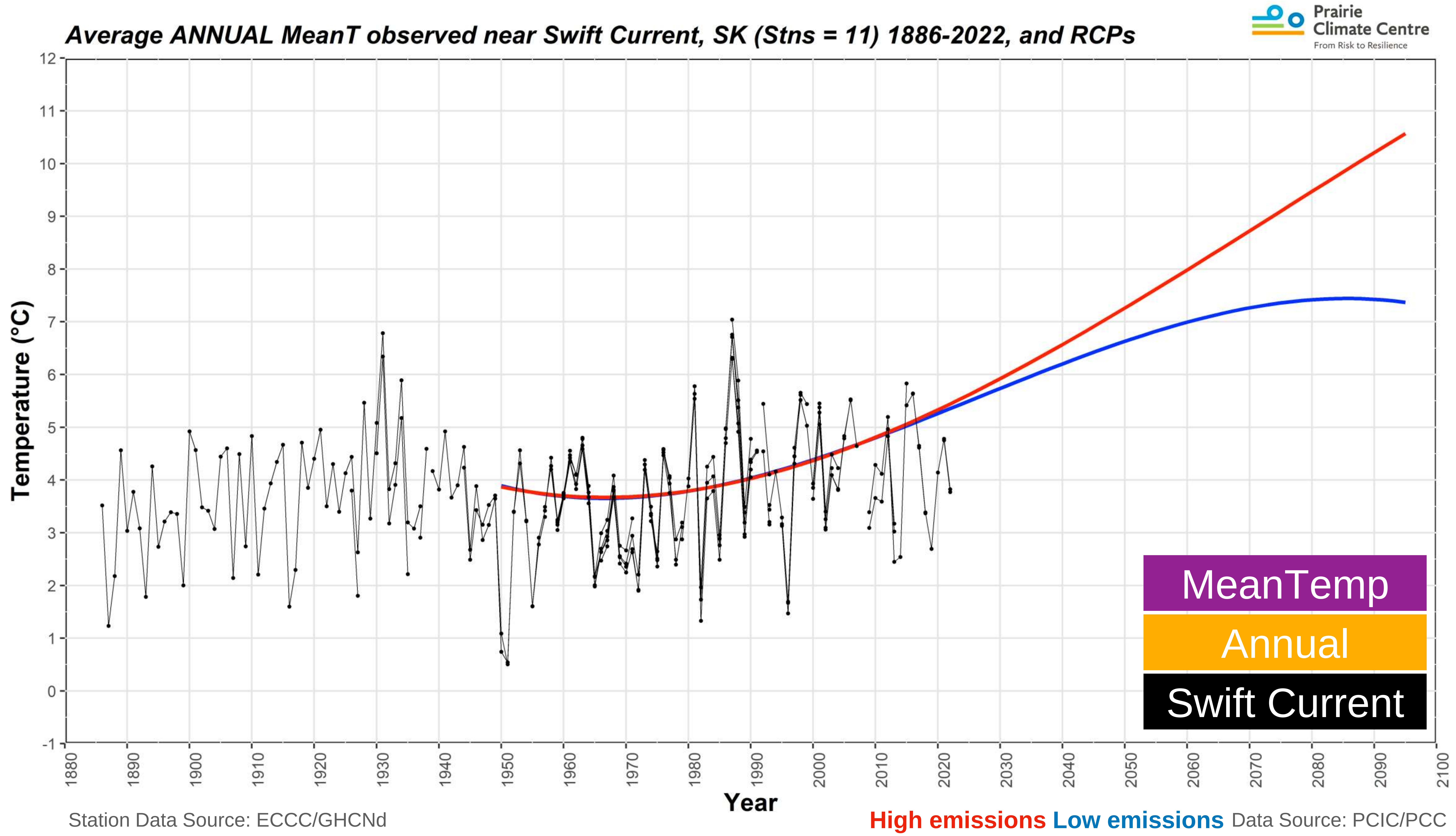


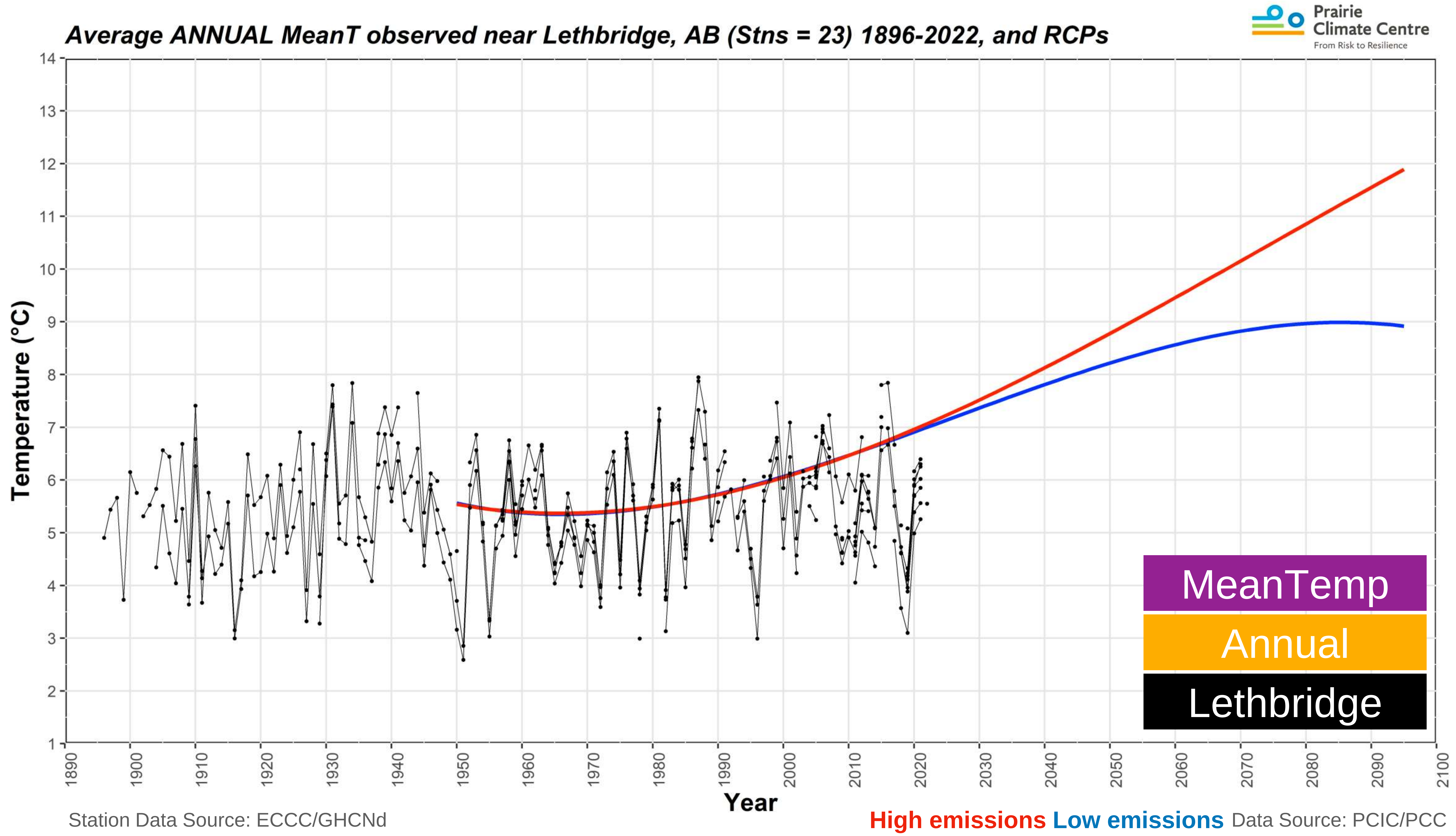
Average ANNUAL MeanT observed near Brandon, MB (Stns = 17) 1882-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
MeanTemp
Annual
Brandon
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC


Prairie Climate Centre
From Risk to Resilience
Average ANNUAL MeanT observed near Weyburn, SK (Stns = 6) 1914-2022, and RCPs
Temperature (°C)
Year
MeanTemp
Annual
Weyburn
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

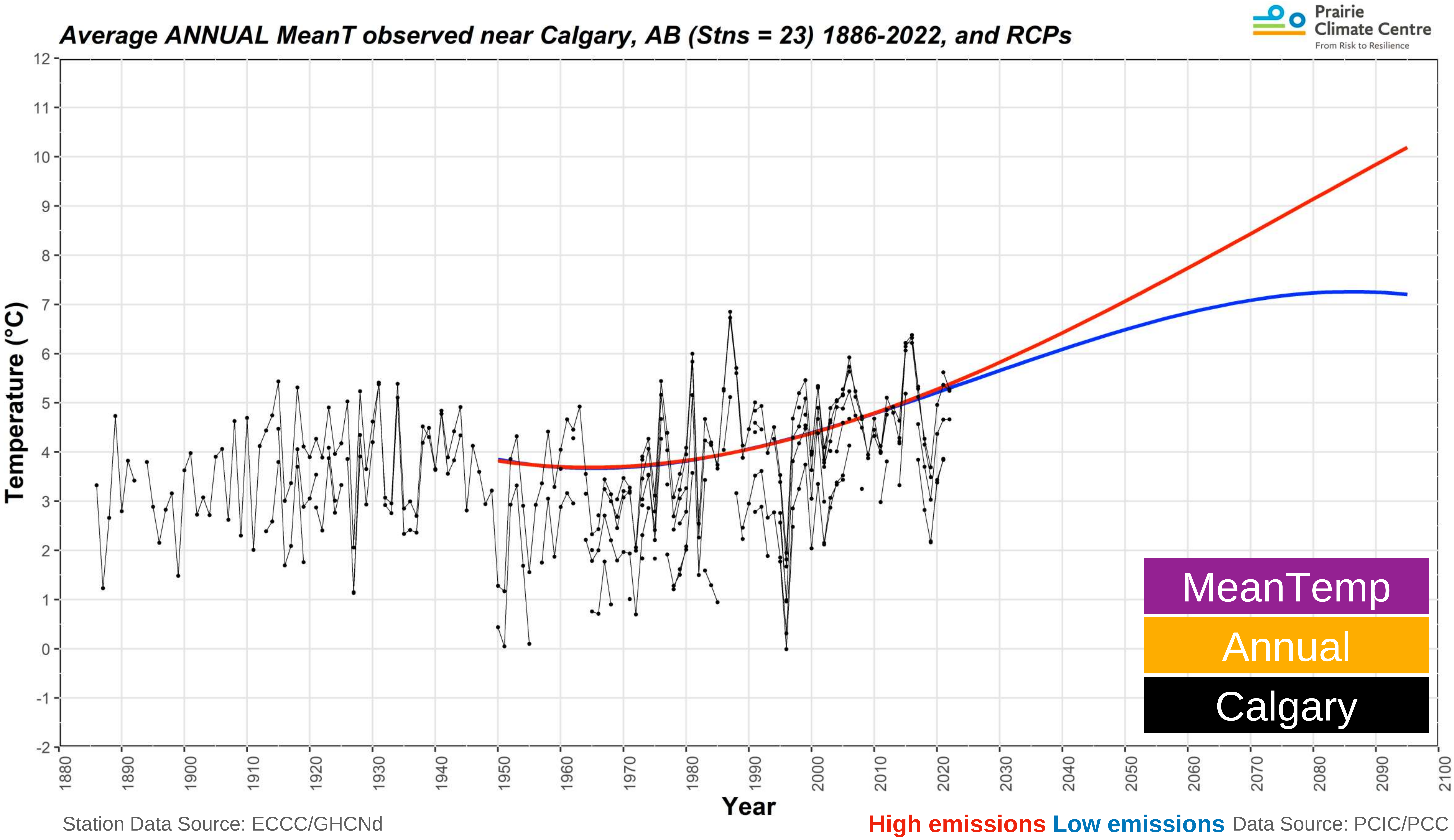


Prairie Climate Centre
From Risk to Resilience
Average ANNUAL MeanT observed near Regina, SK (Stns = 22) 1884-2022, and RCPs
Temperature (°C)
Year
MeanTemp
Annual
Regina
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC


Average ANNUAL MeanT observed near Swift Current, SK (Stns = 11) 1886-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
Year
MeanTemp
Annual
Swift Current
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

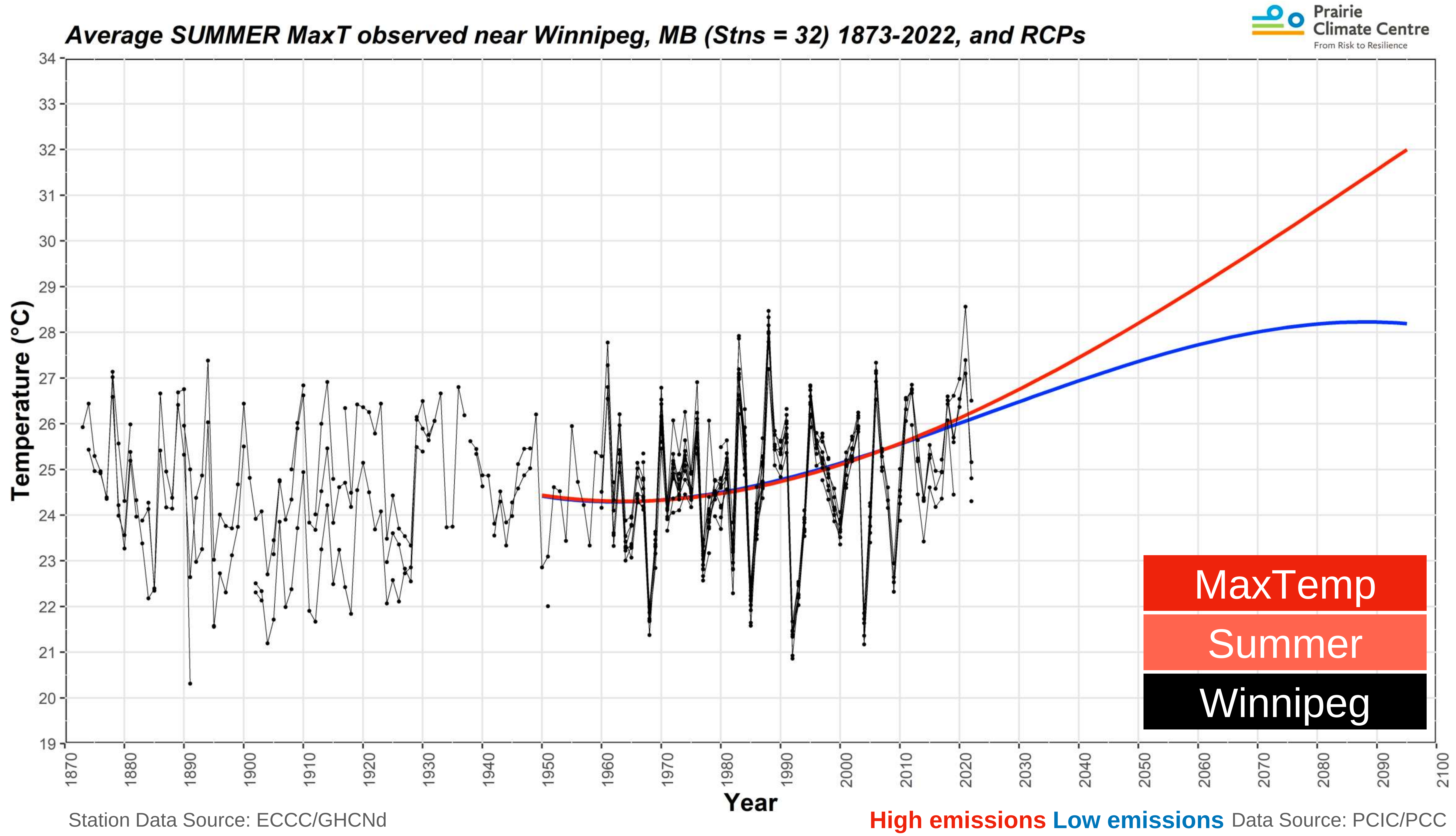


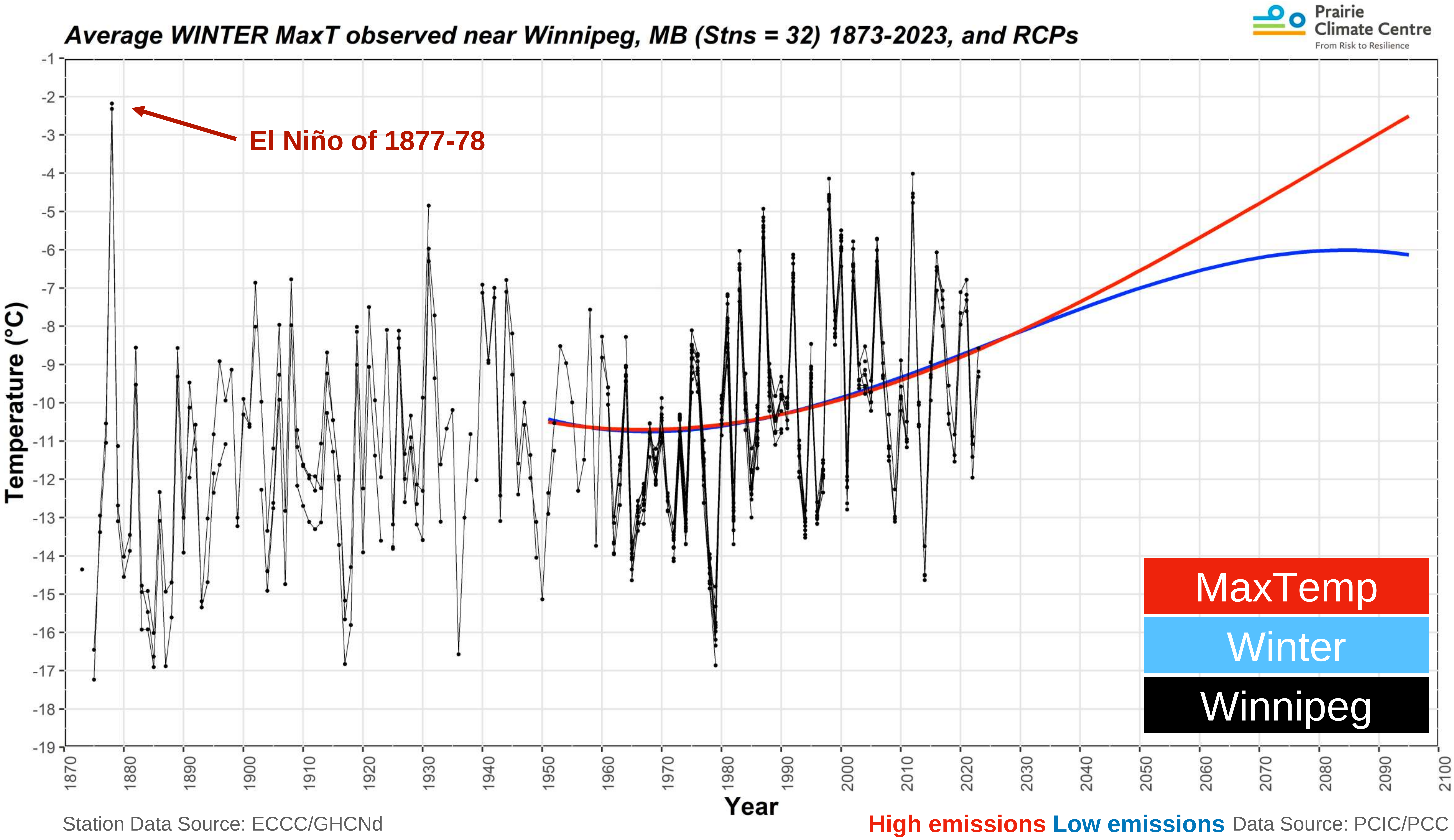
Average ANNUAL MeanT observed near Lethbridge, AB (Stns = 23) 1896-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
Year
MeanTemp
Annual
Lethbridge
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

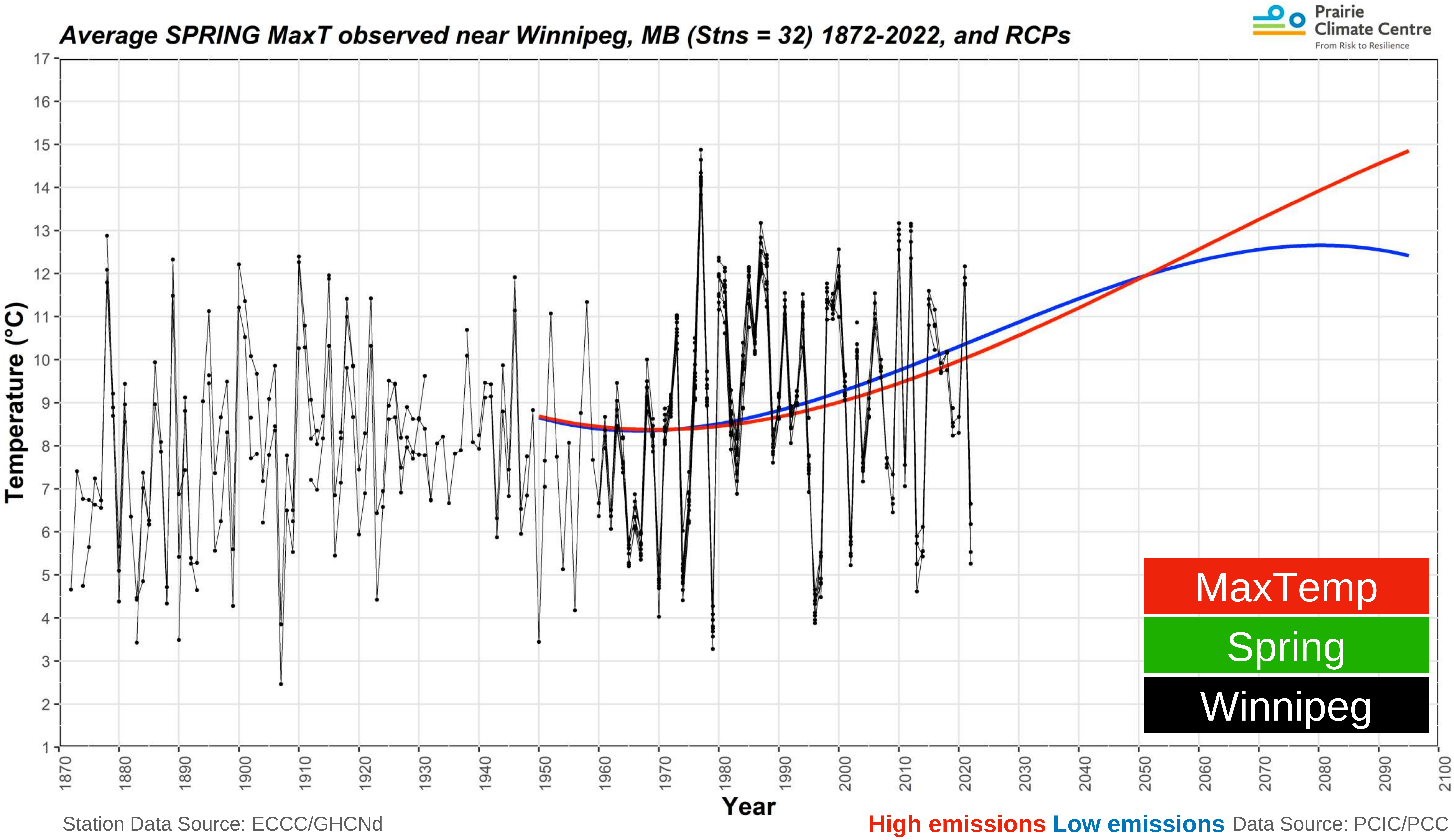


Average ANNUAL MeanT observed near Calgary, AB (Stns = 23) 1886-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
MeanTemp
Annual
Calgary
Station Data Source: ECCC/GHCNd
High emissions
Low emissions
Data Source: PCIC/PCC

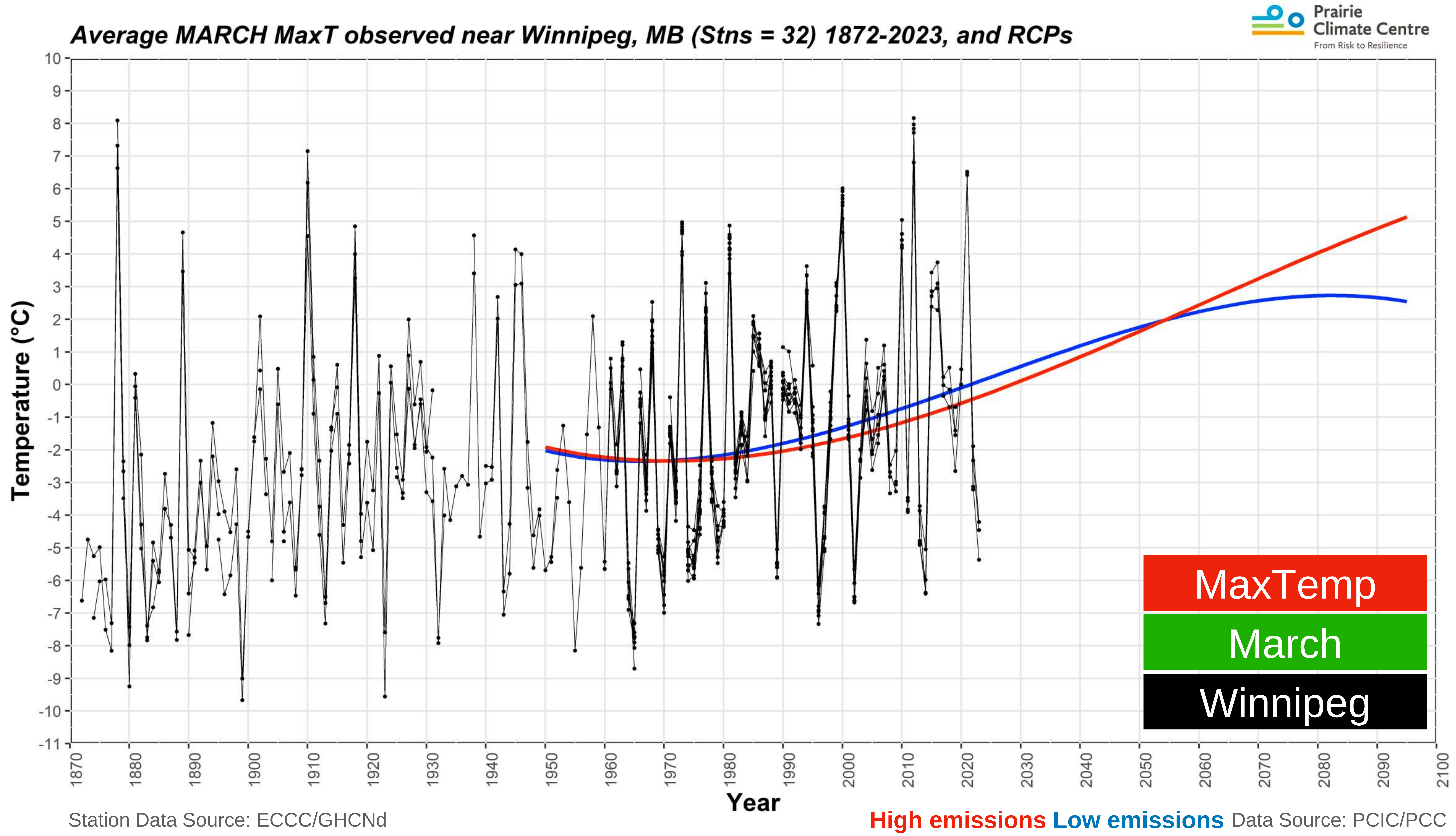

Seasonal
Temperature


Average SUMMER MaxT observed near Winnipeg, MB (Stns = 32) 1873-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
MaxTemp
Summer
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC


Average WINTER MaxT observed near Winnipeg, MB (Stns = 32) 1873-2023, and RCPs
Prairie Climate Centre
From Risk to Resilience
El Niño of 1877-78
Temperature (°C)
Year
MaxTemp
Winter
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

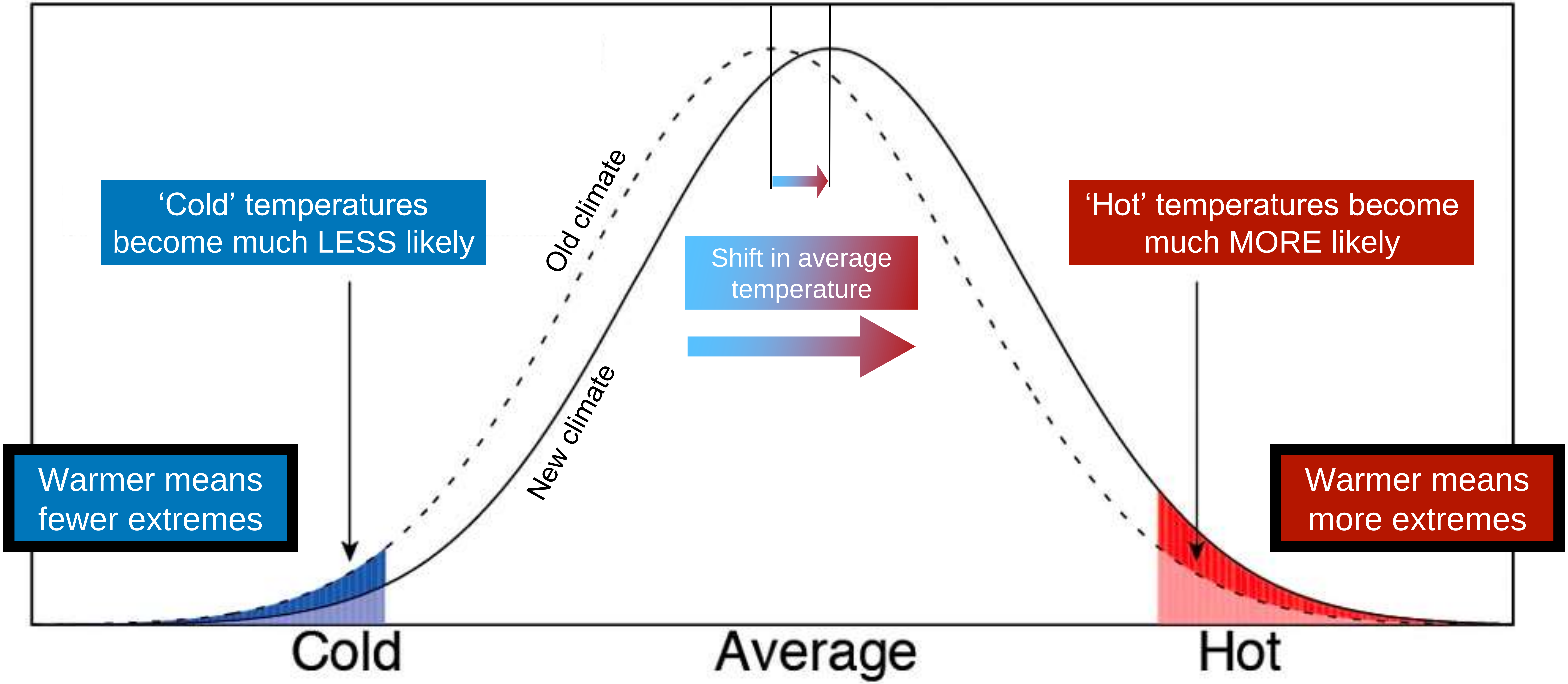


Average SPRING MaxT observed near Winnipeg, MB (Stns = 32) 1872-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Temperature (°C)
Year
MaxTemp
Spring
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

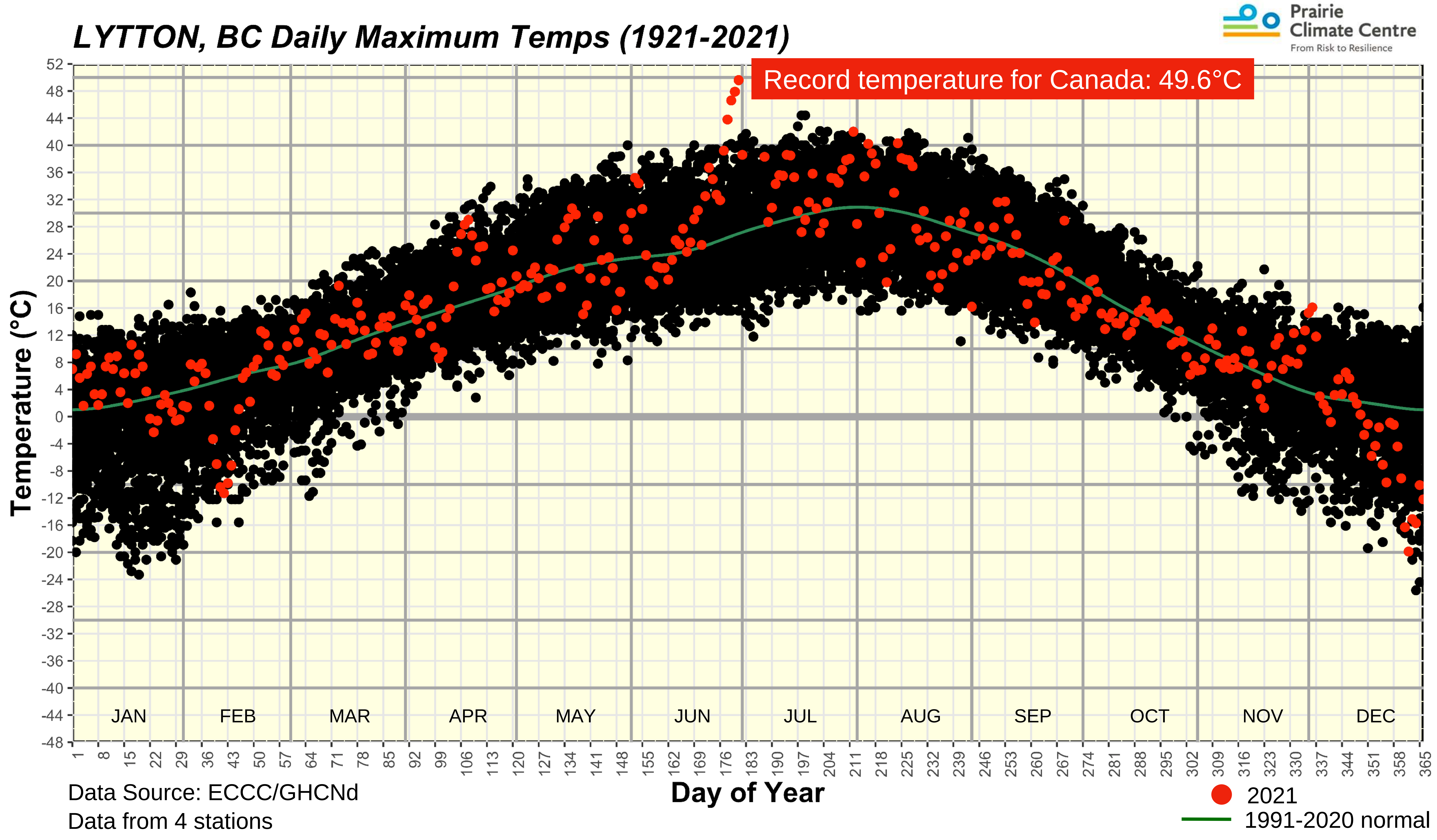


Prairie Climate Centre
From Risk to Resilience
Average MARCH MaxT observed near Winnipeg, MB (Stns = 32) 1872-2023, and RCPs
Temperature (°C)
Year
MaxTemp
March
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions Low emissions Data Source: PCIC/PCC

The Consequences of Raising the Average Temperature



https://ipcc.fandom.com/wiki/151.3.3_Extreme_Events


LYTTON, BC Daily Maximum Temps (1921-2021)
Prairie Climate Centre
From Risk to Resilience
Record temperature for Canada: 49.6°C
Temperature (°C)
Day of Year
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Data Source: ECCC/GHCNd
Data from 4 stations
2021
1991-2020 normal

The Clausius-Clapeyron relationship predicts an increase in the water holding capacity of air of approximately:

7% per degree Celsius rise in temperature

Higher temperature → More vapour in air → More rainfall potential

Extreme daily precipitation is expected to increase at close to the 7 percent per °C increase in the near-surface atmospheric moisture holding capacity determined by the Clausius-Clapeyron equation

IPCC AR6, Chapter 8

Generally Wetter Everywhere
Except Slightly Drier
In Southern Canada
In the Summer
Especially with High Carbon

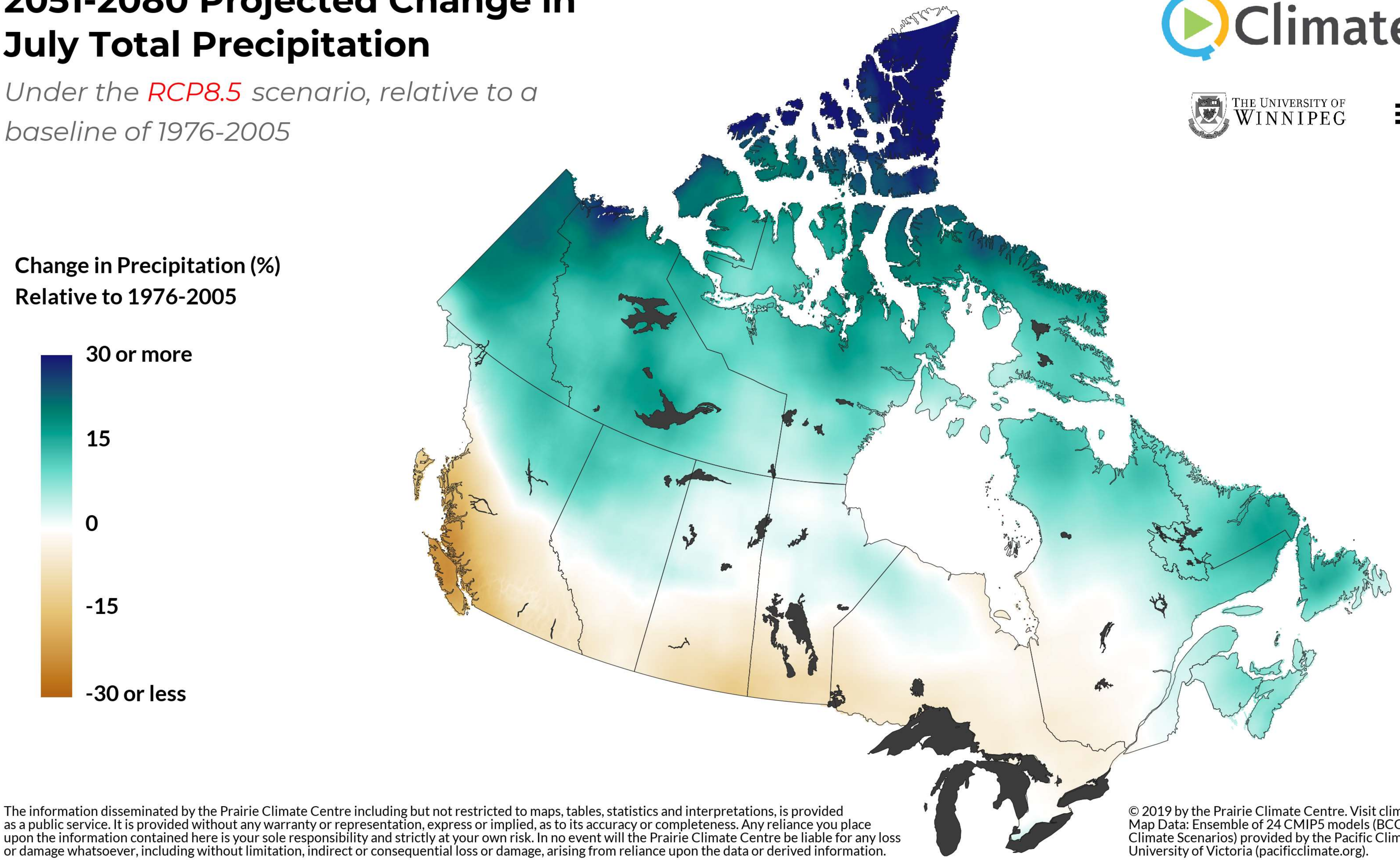
2051-2080 Projected Change in July Total Precipitation

Under the RCP8.5 scenario, relative to a baseline of 1976-2005

ClimateAtlas.ca

The University of Winnipeg

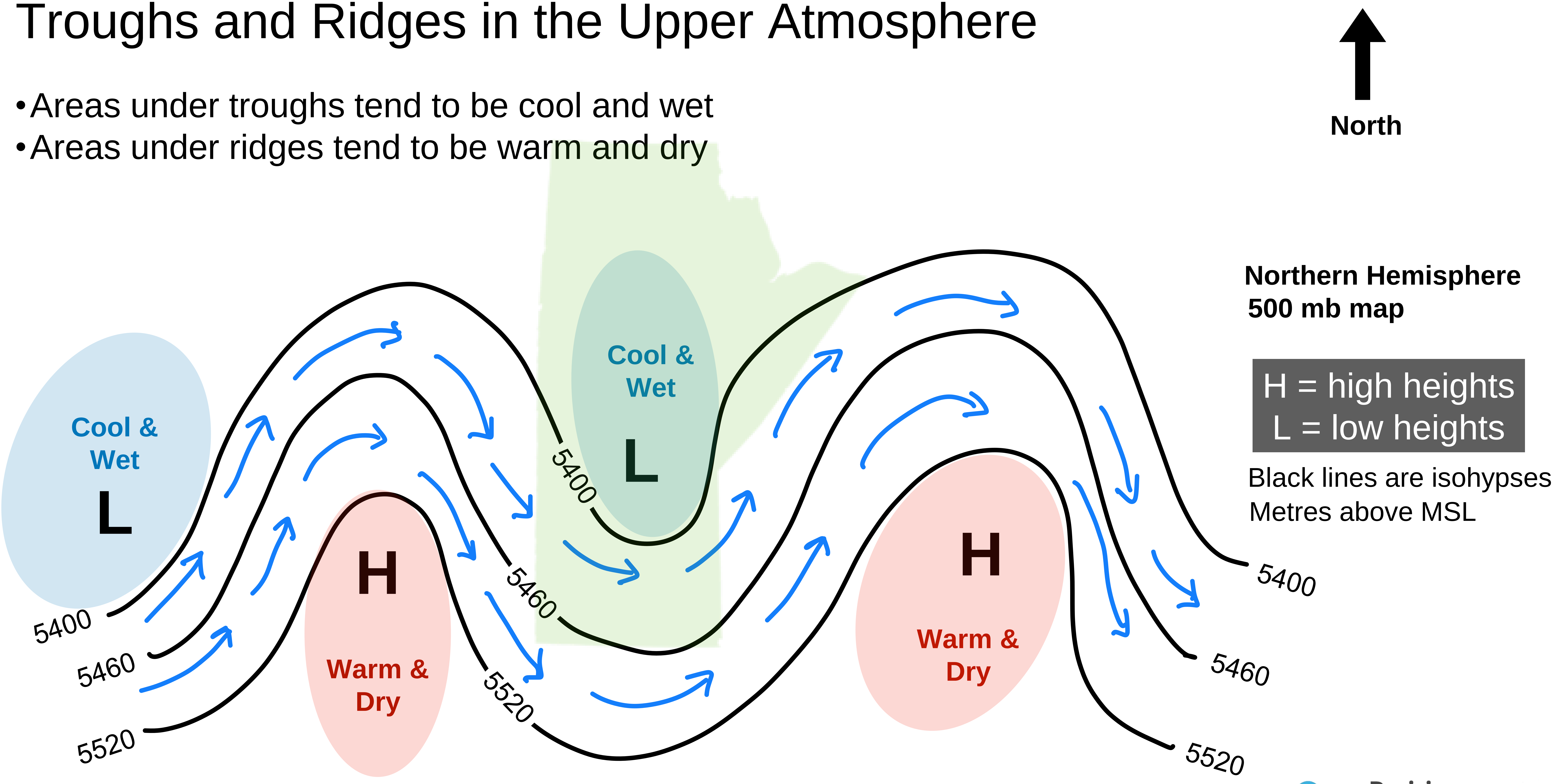
Prairie Climate Centre
From Risk to Resilience



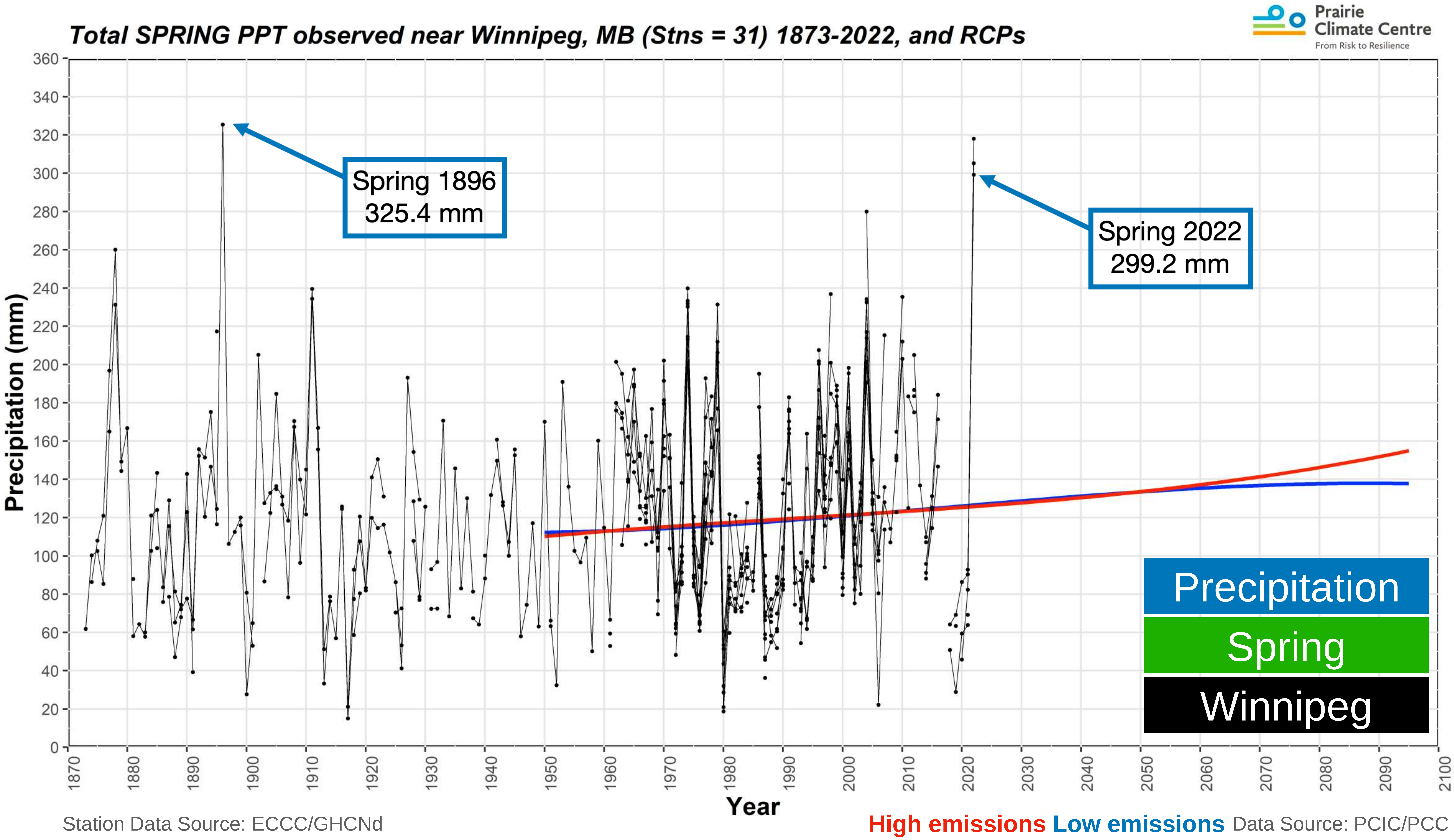
Map Data: Ensemble of 24 CMIP5 models (BCCAQv2 Statistically Downscaled Climate Scenarios) provided by the Pacific Climate Impacts Consortium, University of Victoria (pacificclimate.org).

Troughs and Ridges in the Upper Atmosphere

- Areas under troughs tend to be cool and wet
- Areas under ridges tend to be warm and dry



Prairie Climate Centre



Total SPRING PPT observed near Winnipeg, MB (Stns = 31) 1873-2022, and RCPs
Prairie Climate Centre
From Risk to Resilience
Precipitation (mm)
Year
Spring 1896
325.4 mm
Spring 2022
299.2 mm
Precipitation
Spring
Winnipeg
Station Data Source: ECCC/GHCNd
High emissions
Low emissions
Data Source: PCIC/PCC

What the Prairies Should Expect in the Coming Years:

- Climate change will continue for decades and beyond
- Climate changes are more pronounced under the higher carbon scenarios

- Higher temperatures
- Shorter, warmer winters
- Longer, hotter summers
- More frequent heat waves
- More frequent droughts
- More intense rainfalls
- Changing hydrological seasons
- Occasional severe cold events, still
- Climates marching northward
- Even more variability in the weather
- Surprises

There are definitely some positive aspects for the Prairies

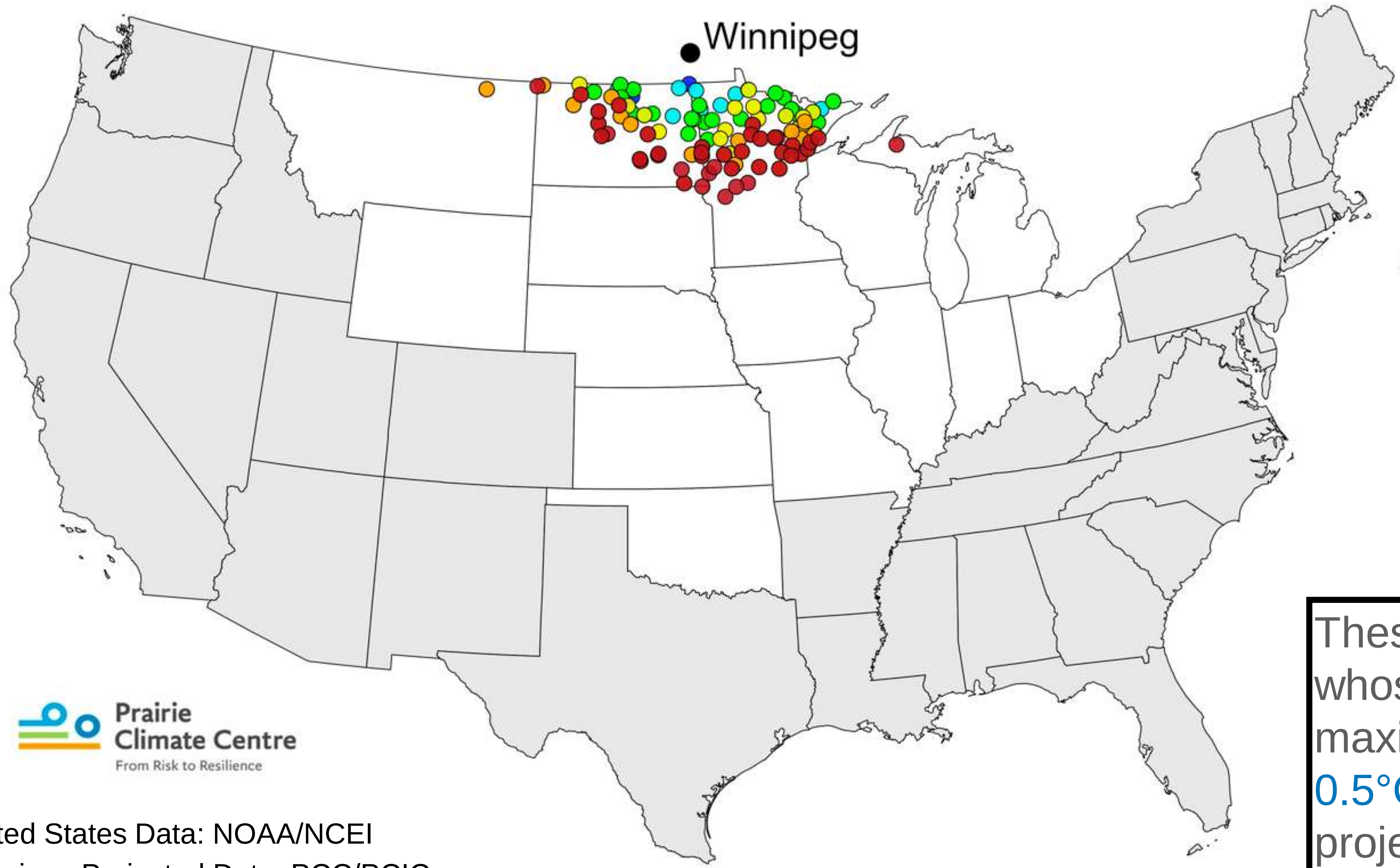
Much more potential for floods, droughts, wildfires, extreme storms, and unanticipated events

Prairie Climate Centre
From Risk to Resilience

Thermal Climate Migration

Whose Climate Will We Get?

American Climate Analogues for Winnipeg Projected Temperatures



Winter
Average MinT
Low Carbon

Analogue Years (Average Temp)

- 1991 – 2005 (-19.4°C)
- 2006 – 2020 (-18.4°C)
- 2021 – 2035 (-17.4°C)
- 2036 – 2050 (-16.2°C)
- 2051 – 2065 (-15.2°C)
- 2066 – 2080 (-14.8°C)
- 2081 – 2095 (-14.3°C)

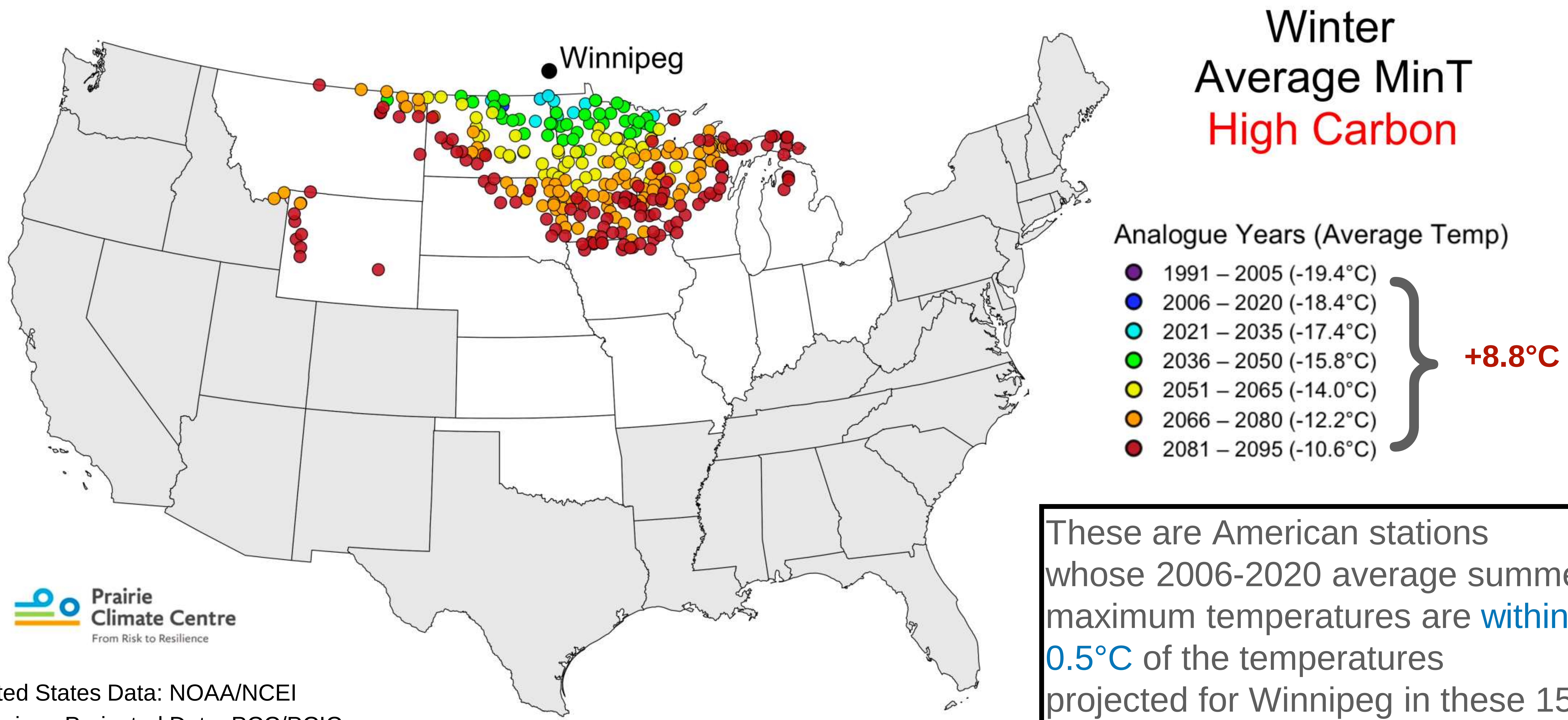
+5.1°C

These are American stations whose 2006-2020 average summer maximum temperatures are within 0.5°C of the temperatures projected for Winnipeg in these 15-year periods.

Prairie Climate Centre
From Risk to Resilience

United States Data: NOAA/NCEI
Winnipeg Projected Data: PCC/PCIC

American Climate Analogues for Winnipeg Projected Temperatures



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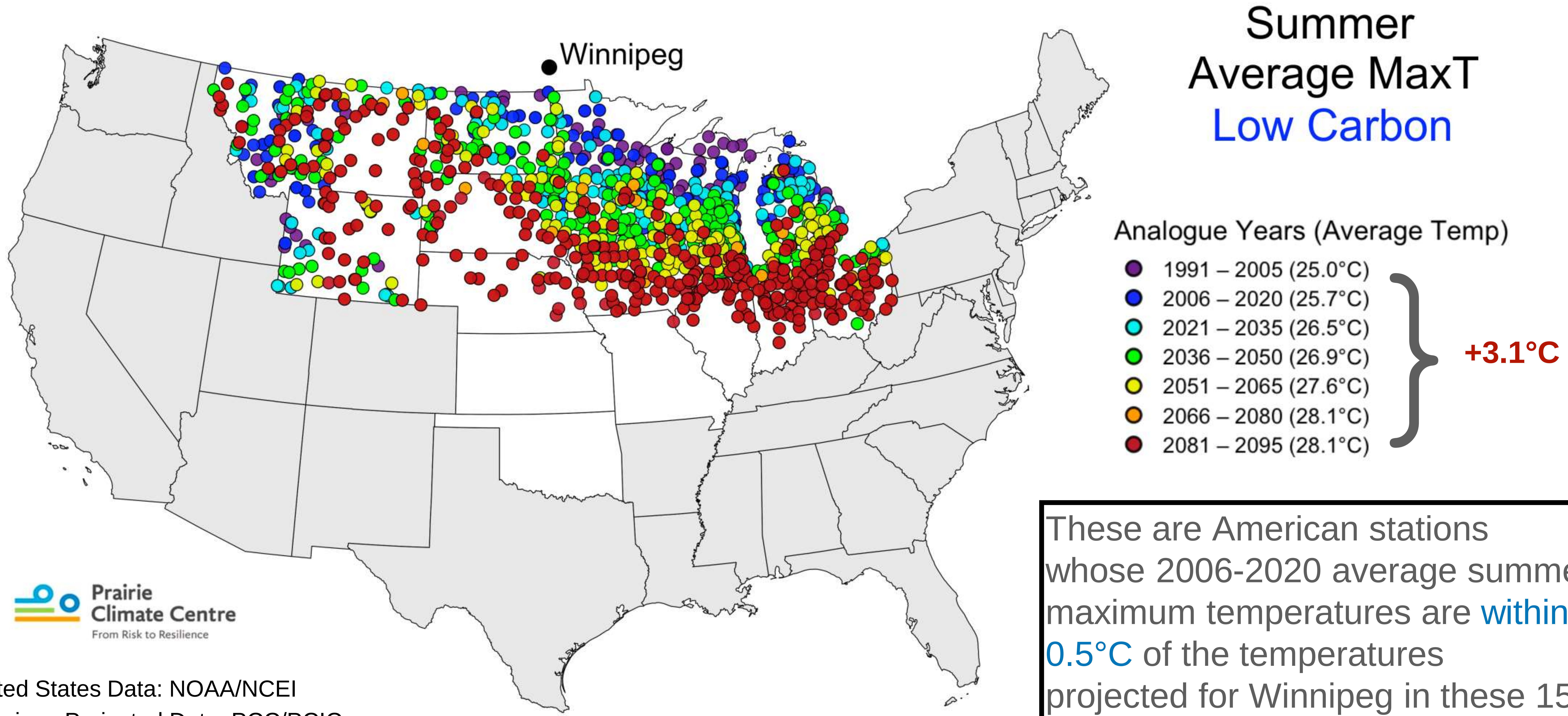
American Climate Analogues for Winnipeg Projected Temperatures



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From Risk to Resilience

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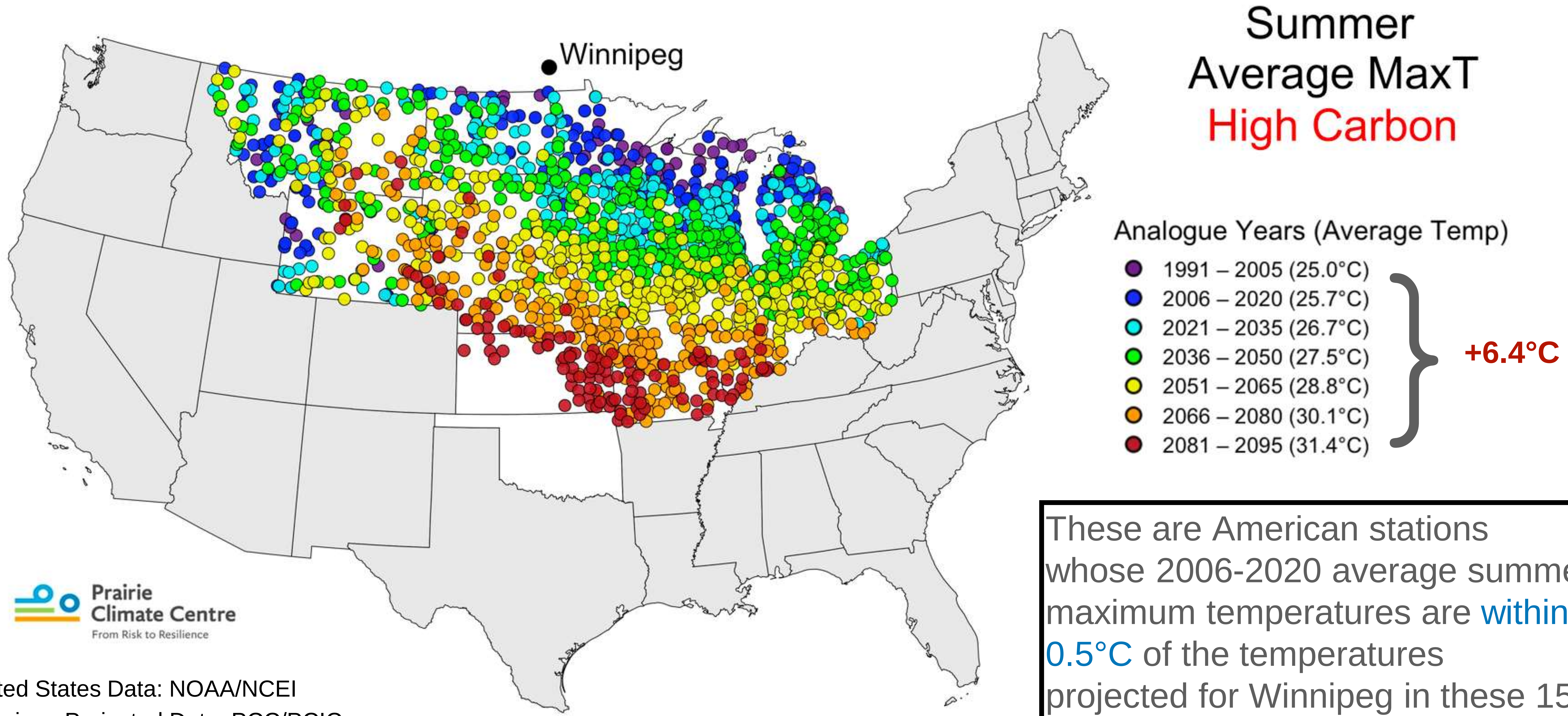
Winnipeg Projected Data: PCC/PCIC

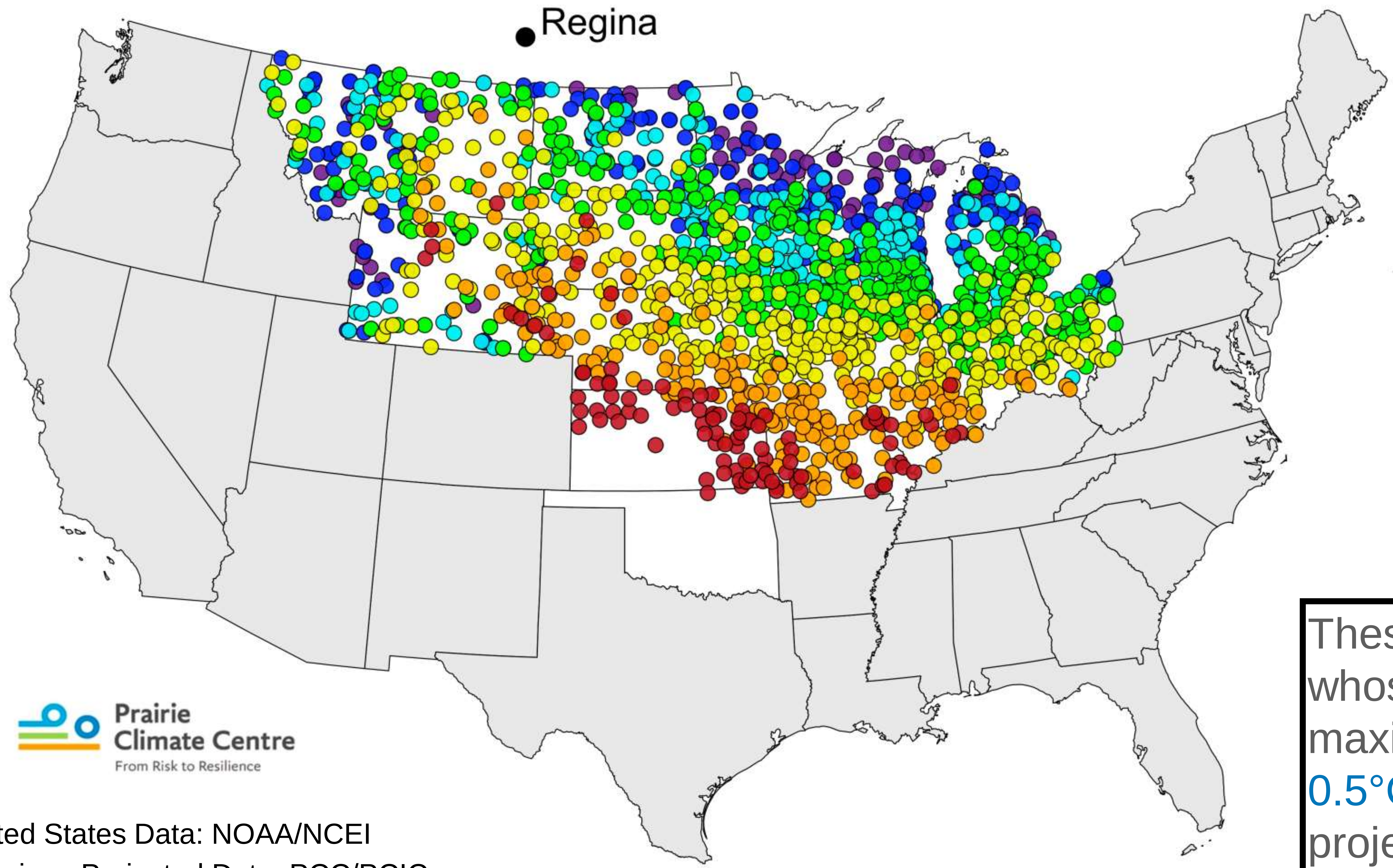
American Climate Analogues for Winnipeg Projected Temperatures



These are American stations whose 2006-2020 average summer maximum temperatures are within 0.5°C of the temperatures projected for Winnipeg in these 15-year periods.

United States Data: NOAA/NCEI
Winnipeg Projected Data: PCC/PCIC

American Climate Analogues for Regina Projected Temperatures



Summer
Average MaxT
High Carbon

Analogue Years (Average Temp)

- 1991 – 2005 (25.1°C)
- 2006 – 2020 (25.8°C)
- 2021 – 2035 (26.7°C)
- 2036 – 2050 (27.5°C)
- 2051 – 2065 (28.9°C)
- 2066 – 2080 (30.2°C)
- 2081 – 2095 (31.6°C)

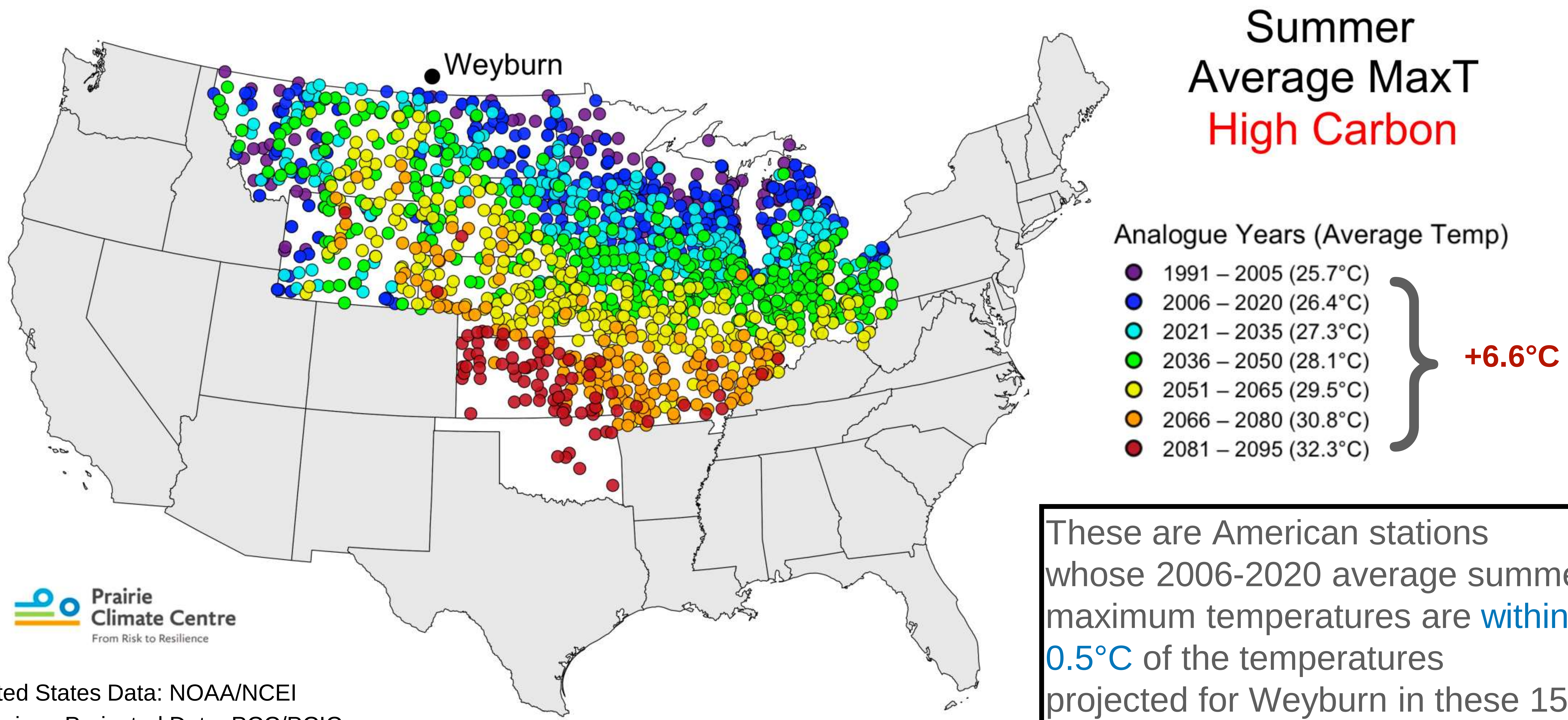
+6.5°C

These are American stations whose 2006-2020 average summer maximum temperatures are within 0.5°C of the temperatures projected for Regina in these 15-year periods.

Prairie Climate Centre
From Risk to Resilience

United States Data: NOAA/NCEI
Winnipeg Projected Data: PCC/PCIC

American Climate Analogues for Weyburn Projected Temperatures

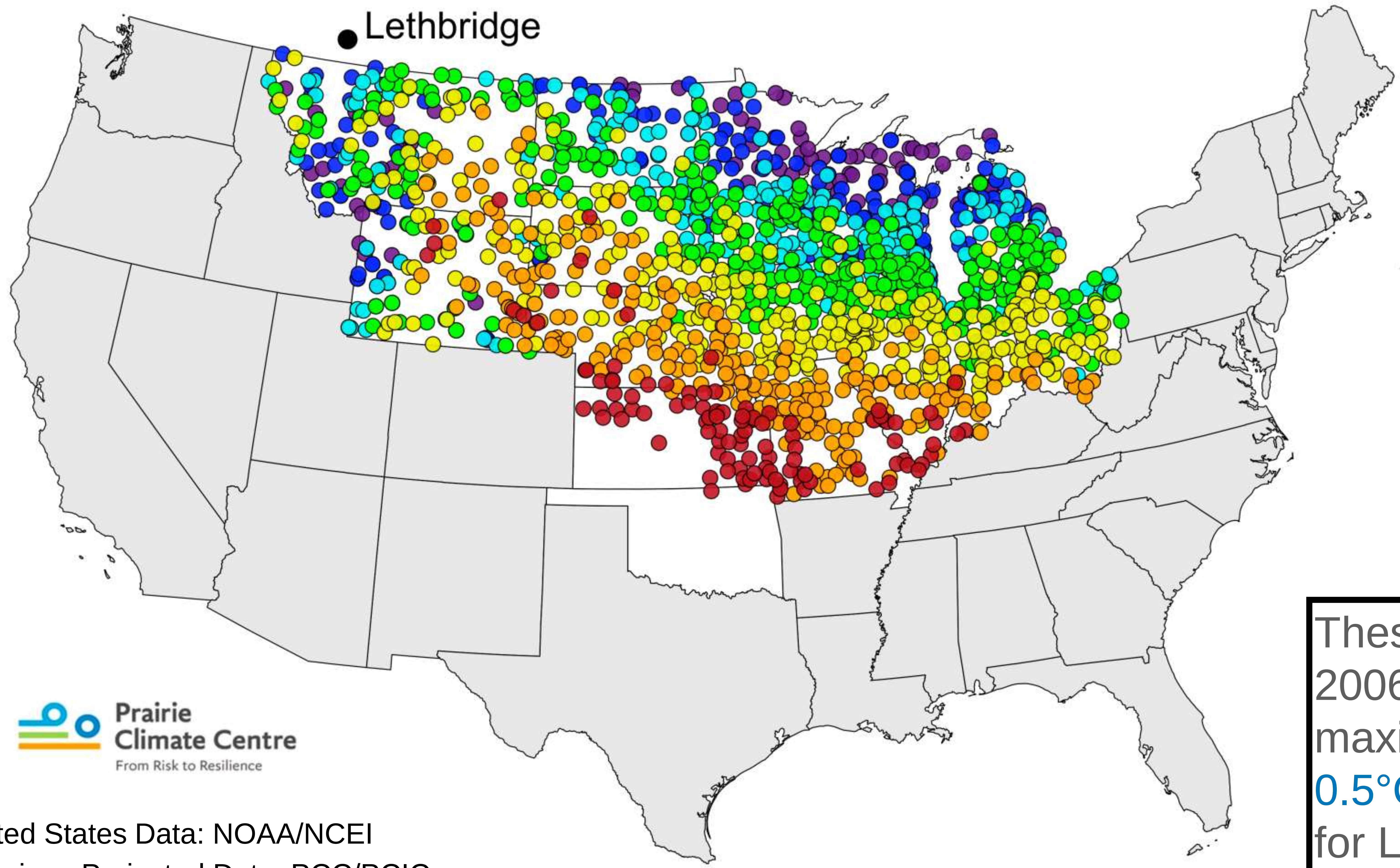


These are American stations whose 2006-2020 average summer maximum temperatures are within 0.5°C of the temperatures projected for Weyburn in these 15-year periods.

Prairie Climate Centre
From Risk to Resilience

United States Data: NOAA/NCEI
Winnipeg Projected Data: PCC/PCIC

American Climate Analogues for Lethbridge Projected Temperatures



Summer
Average MaxT
High Carbon

Analogue Years (Average Temp)

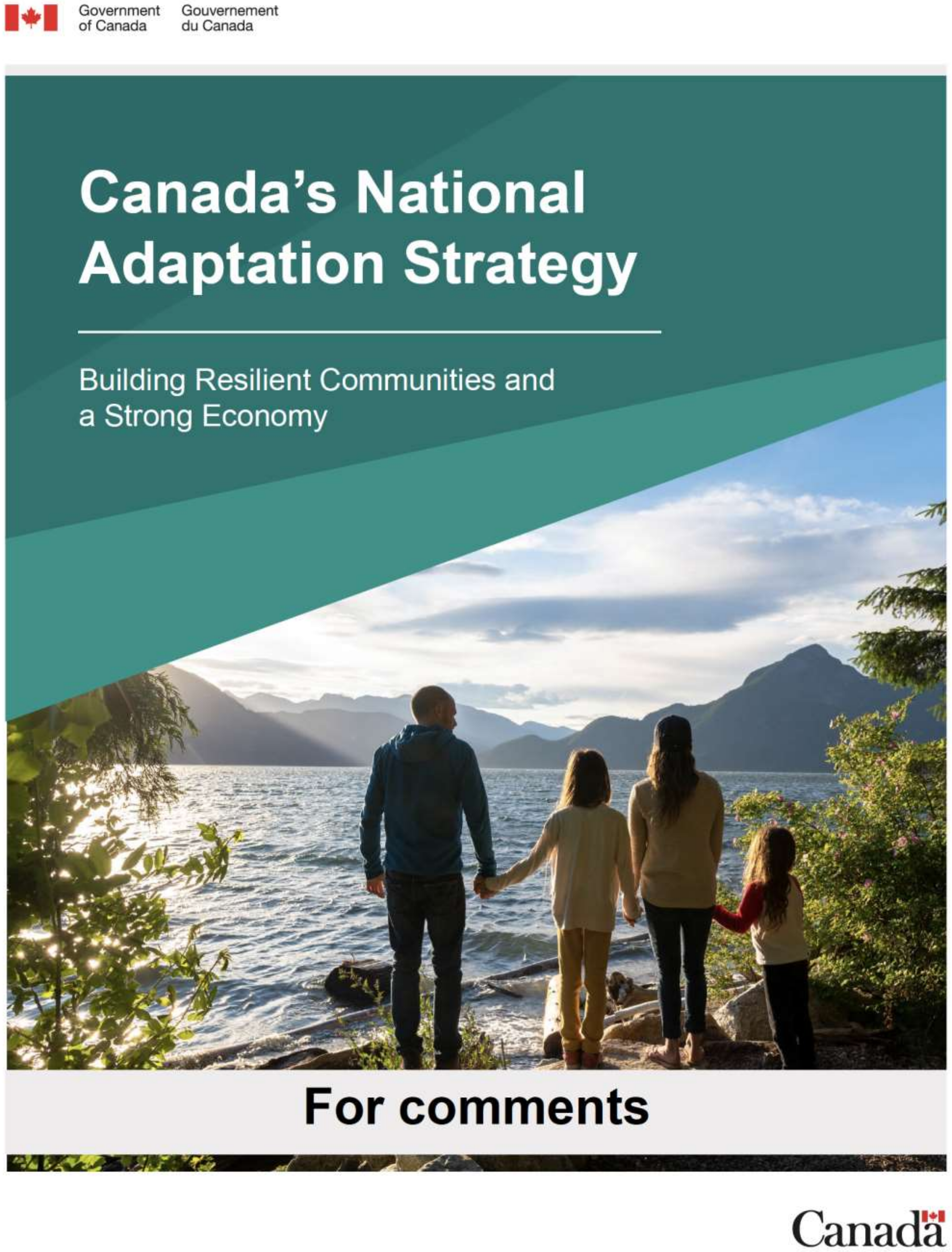
- 1991 – 2005 (24.8°C)
- 2006 – 2020 (25.5°C)
- 2021 – 2035 (26.5°C)
- 2036 – 2050 (27.3°C)
- 2051 – 2065 (28.7°C)
- 2066 – 2080 (30.0°C)
- 2081 – 2095 (31.6°C)

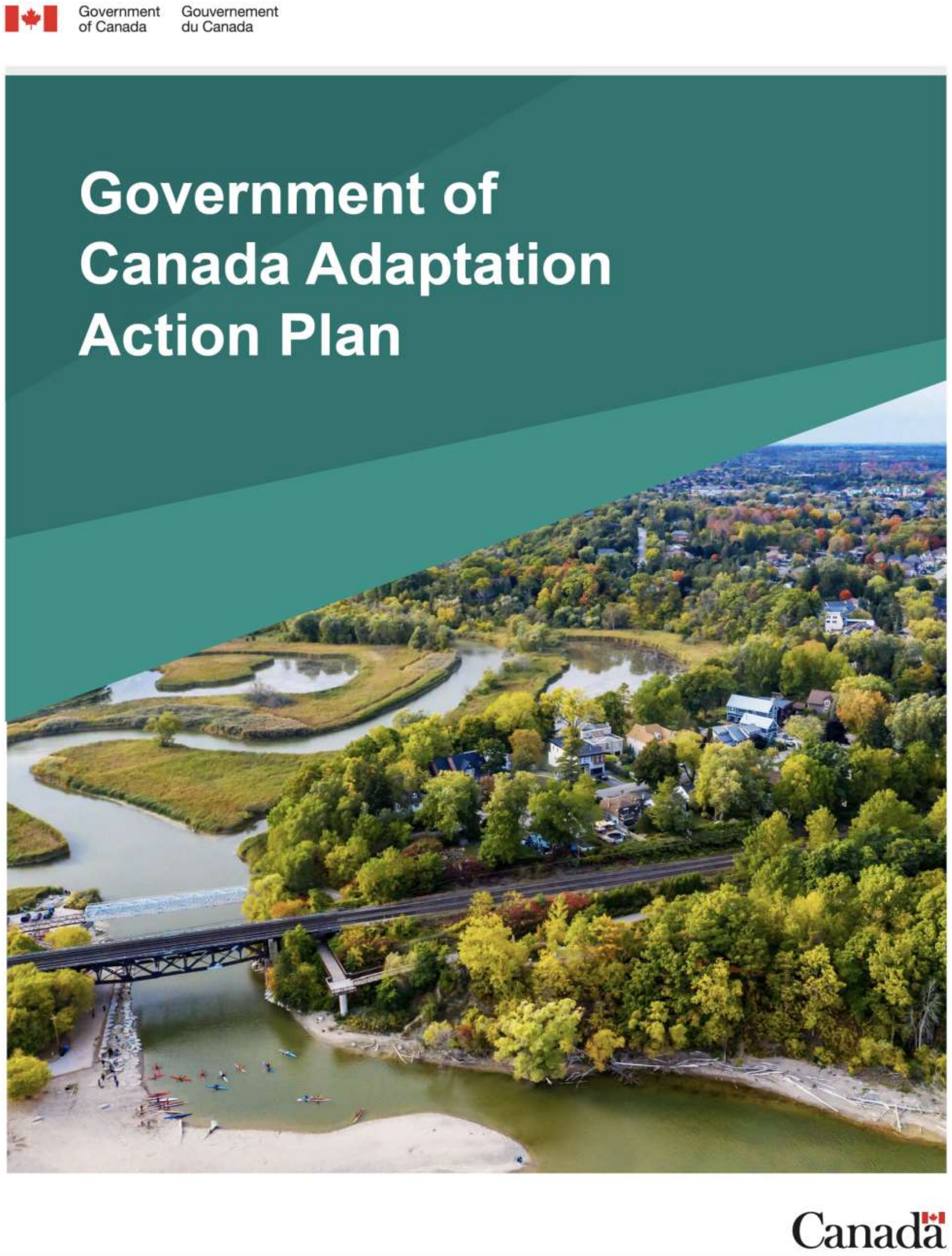
+6.8°C

These are American stations whose 2006-2020 average summer maximum temperatures are within 0.5°C of the temperatures projected for Lethbridge in these 15-year periods.

Prairie Climate Centre
From Risk to Resilience

United States Data: NOAA/NCEI
Winnipeg Projected Data: PCC/PCIC


Government of Canada
Gouvernement du Canada
Canada's National Adaptation Strategy
Building Resilient Communities and a Strong Economy
For comments
Canada


Government of Canada
Gouvernement du Canada
Government of Canada Adaptation Action Plan
Canada

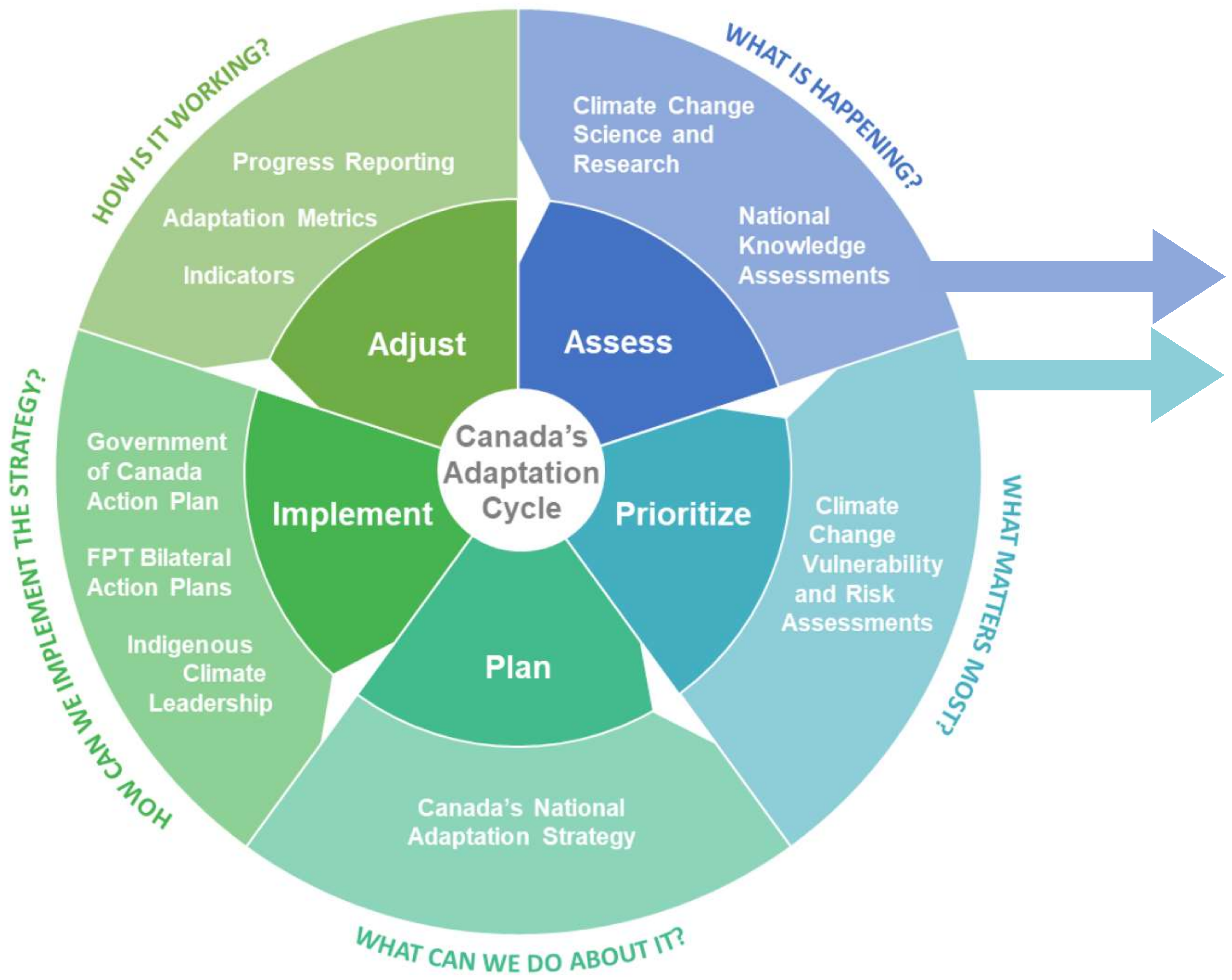
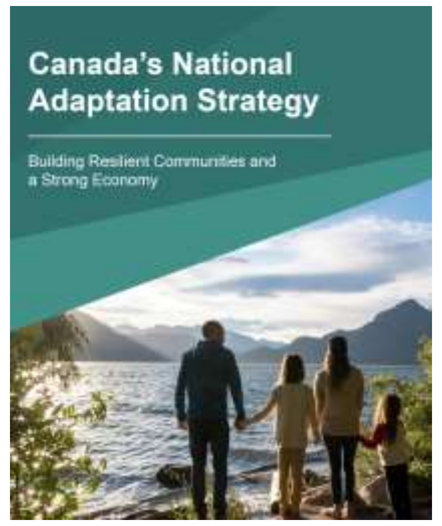


Figure 5. Canada's adaptation cycle

Prairie Climate Centre

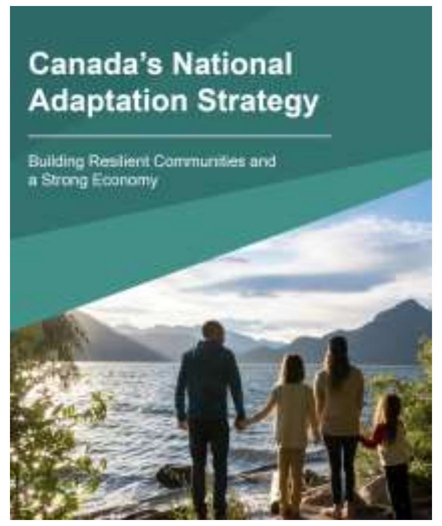


Academic institutions, researchers, scientists, and non-governmental organizations play a key role in generating and sharing knowledge on climate change adaptation and helping to mobilize adaptation action, including by:

- Incorporating adaptation in the curriculum for professional programs.
- Including adaptation as an eligible specialty for co-op programs and internships.
- Convening and leveraging research networks nationally and internationally.
- Undertaking climate adaptation research including in innovative solutions and adaptive management.
- Raising awareness of climate change and adaptation.
- Working with governments and other partners to understand, assess, and mobilize knowledge about climate impacts and develop new technology and innovative solutions.

Illustrative action: Data, Research, and Knowledge Mobilization

The Prairie Climate Centre (PCC), at the University of Winnipeg, brings an evidence-based perspective to communicating the science, impacts, and risks of climate change through high-quality maps, documentary video, research reports, and plain-language training, writing, and outreach. The PCC's goal is to inspire citizen participation, to support communities in making meaningful and effective adaptation and mitigation decisions for current and future generations, and to help Canadian society move from risk to resilience. The flagship project of the PCC is the Climate Atlas of Canada.



Every Weather-Affected Community and Business Should:

- Conduct an assessment of their **vulnerabilities**
    - Based on **experience** and **projections**
- Identify **opportunities**
- Identify highest **risks**
    - Based on **potential impacts** and **consequences**

- Of course, to do so requires:
    - Financial resources
    - Personnel
    - Expertise
    - Data
    - Time

Prairie Climate Centre
From Risk to Resilience
https://prairieclimatecentre.ca/

ClimateWest
Building Prairie Resilience
https://climatewest.ca/

ClimateWest
Building Prairie Resilience

Winnipeg, Manitoba, 3 May 2023

Did I Leave Time for Questions?

Danny Blair, PhD
climateguy@gmail.com
d.blair@uwinnipeg.ca

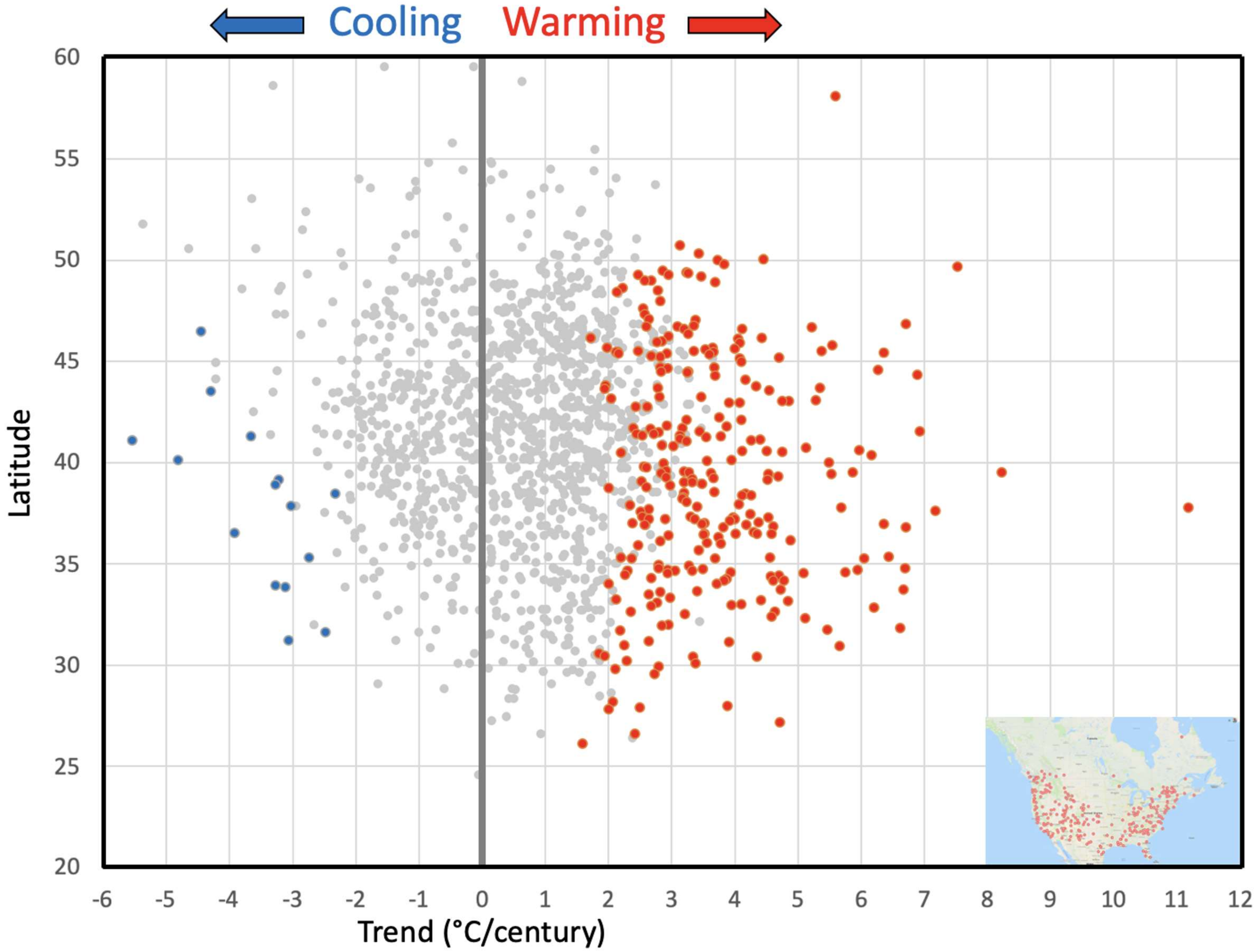
THE UNIVERSITY OF WINNIPEG

Prairie Climate Centre

ClimateWest

Building Prairie Resilience

Winnipeg, Manitoba, 3 May 2023



SPRING

1970-2018

Canada and U.S.
Mean Temperature
Linear Trends
°C per century

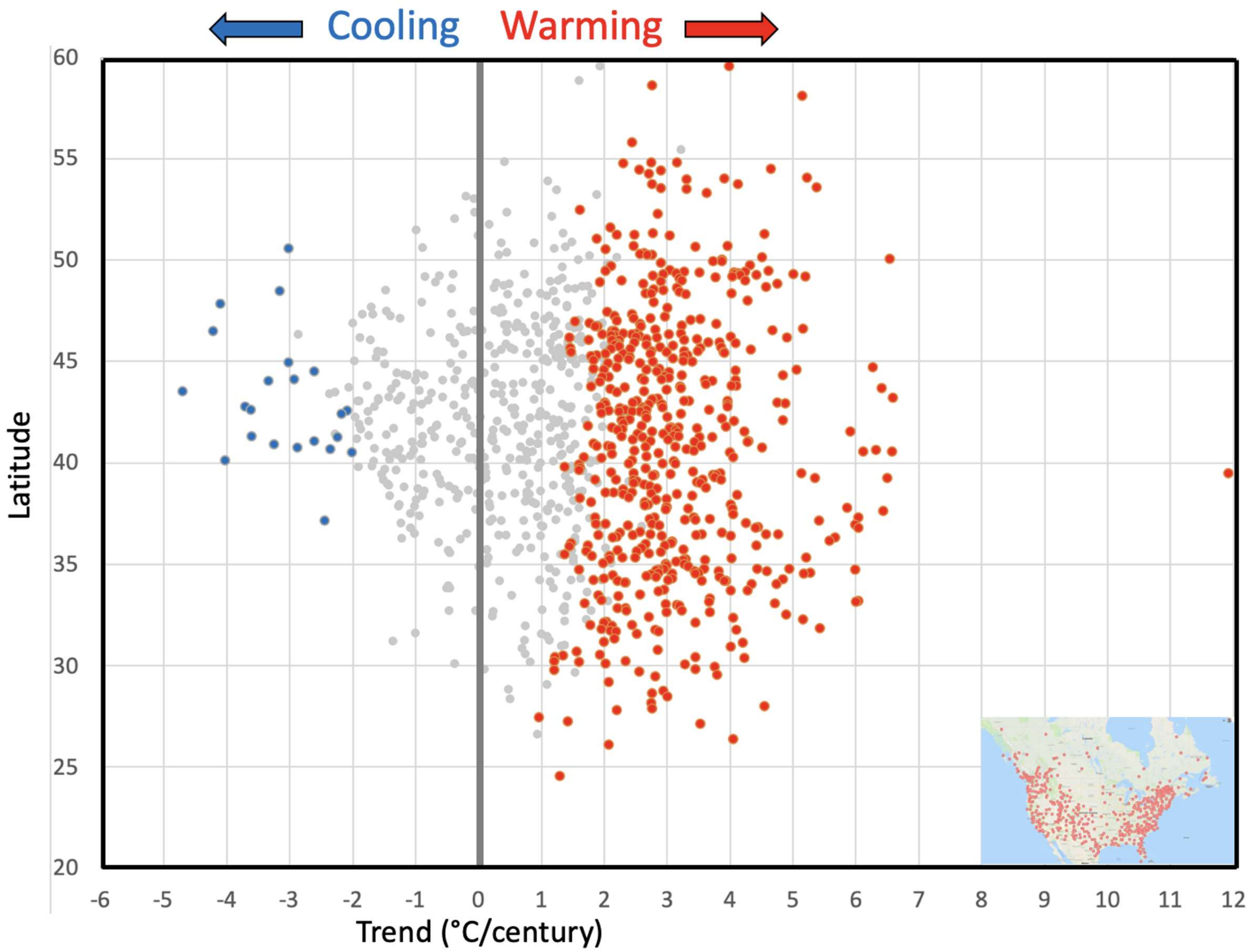
Significant POS trend: n = 266

Significant NEG trend: n = 15

Not significant: n = 1175

Data Source: GHCN

Prairie Climate Centre



SUMMER

1970-2018

Canada and U.S.
Mean Temperature
Linear Trends
°C per century

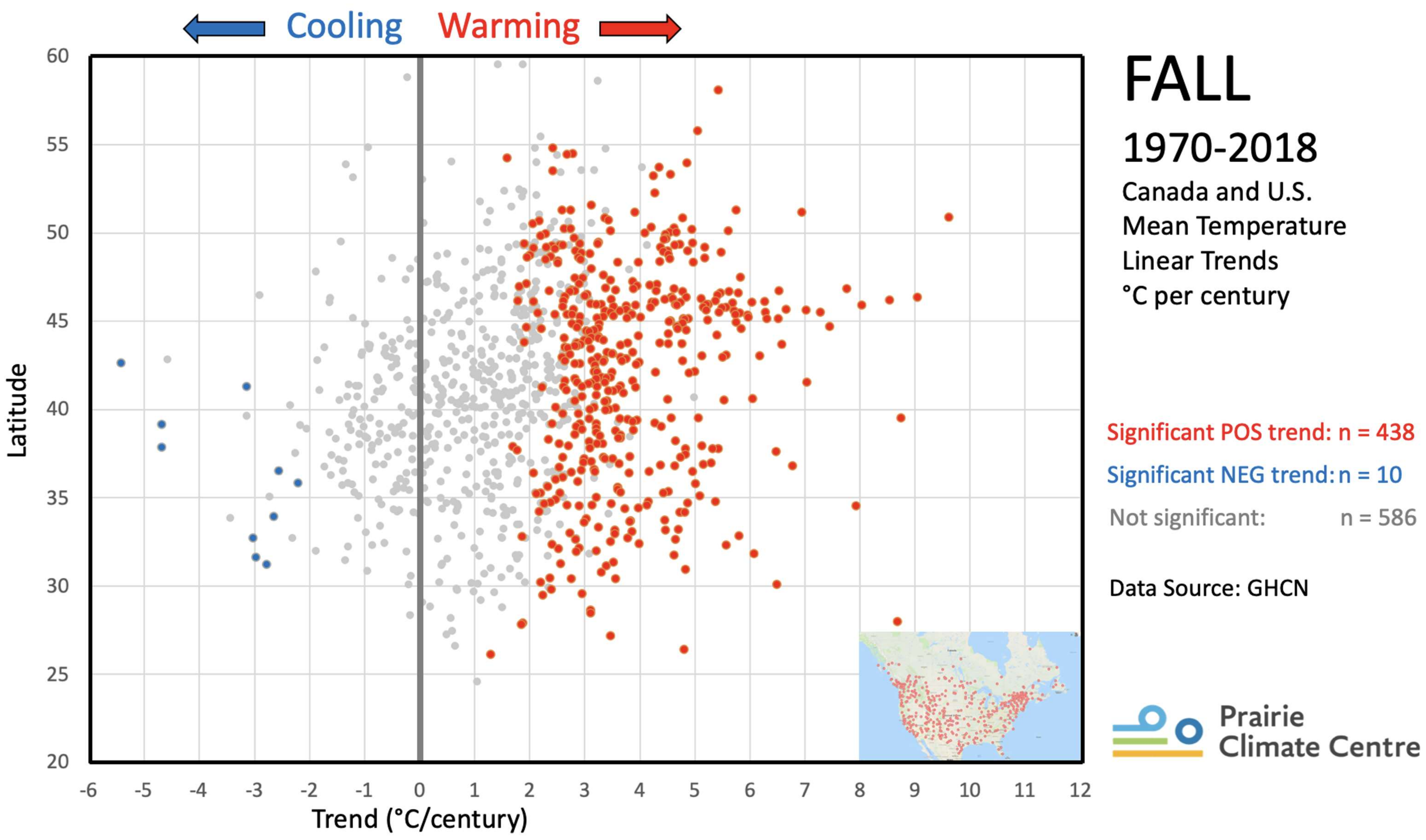
Significant POS trend: n = 535

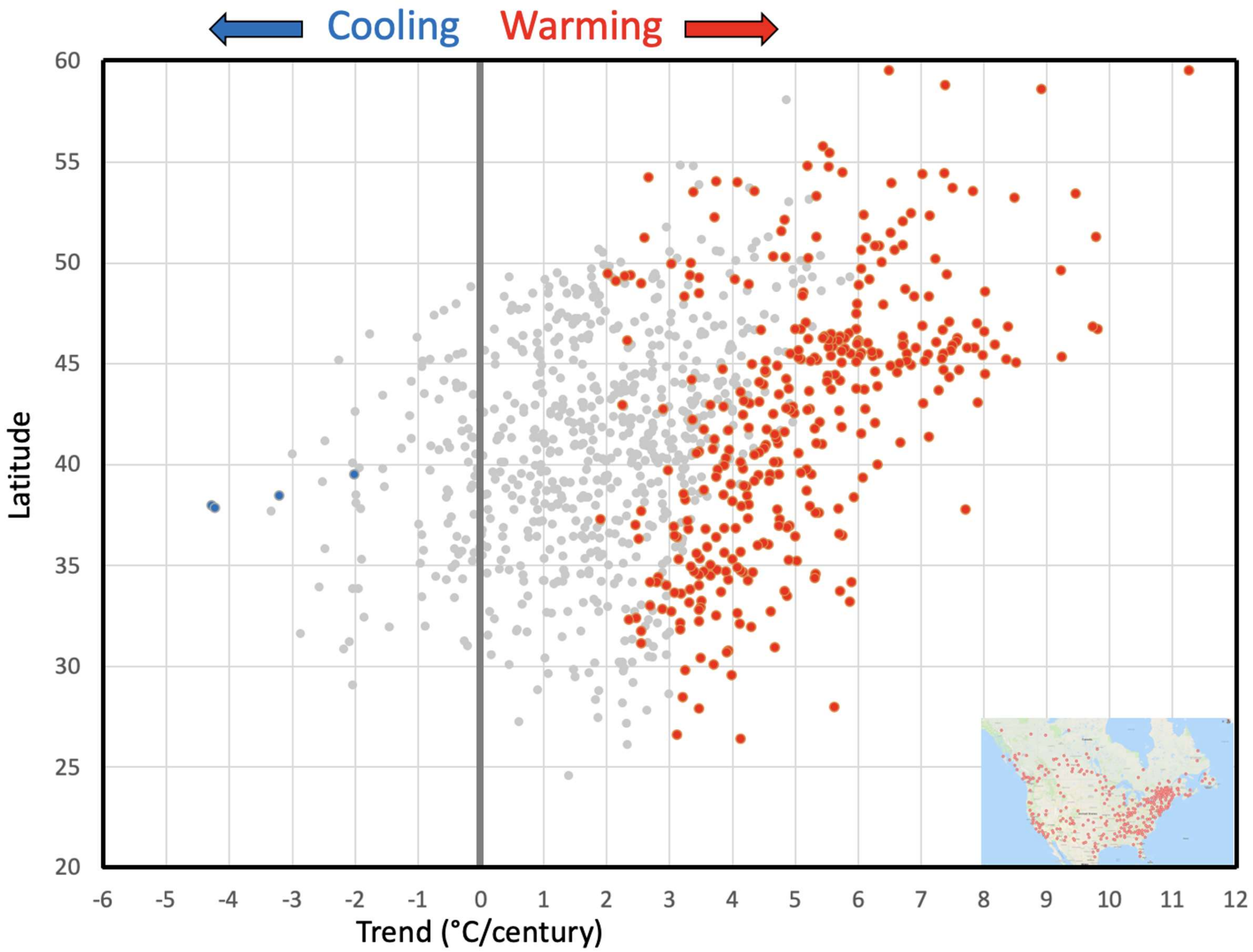
Significant NEG trend: n = 22

Not significant: n = 482

Data Source: GHCN

Prairie
Climate Centre


Cooling
Warming
FALL
1970-2018
Canada and U.S.
Mean Temperature
Linear Trends
°C per century
Significant POS trend: n = 438
Significant NEG trend: n = 10
Not significant: n = 586
Data Source: GHCN
Latitude
Trend (°C/century)
60
55
50
45
40
35
30
25
20
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
Prairie Climate Centre



WINTER

1970-2018

Canada and U.S.
Mean Temperature
Linear Trends
°C per century

Significant POS trend: n = 354

Significant NEG trend: n = 4

Not significant: n = 680

Data Source: GHCN

Prairie Climate Centre

Ratio of Local Warming to Global Warming:1950-1920

Location	Latitude	Annual	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CHURCHILL	58.73	1.5	4.1	1.9	2.0	-0.5	-1.5	2.4	2.6	1.4	2.6	1.3	-1.4	5.3
LYNN_LAKE	56.85	0.7	4.6	0.1	0.6	-2.7	-1.2	0.2	1.4	0.9	2.5	0.4	0.2	5.3
GILLAM	56.35		4.4	1.1	1.7	-0.3	-0.4	1.3	1.7	1.6	3.1	1.4	0.5	5.8
THOMPSON	55.80	1.0	4.1	0.6	1.2	-1.4	-1.4	0.3	1.0	1.0	2.6	0.5	0.1	4.4
FLIN_FLON	54.68	1.9	5.2	0.6	1.0	-0.8	-1.6	1.0	2.2	1.9	3.3	0.9	1.2	5.8
THE_PAS	53.97	1.1	5.0	0.7	1.1	-0.3	-1.3	0.5	1.7	1.3	2.6	-0.1	0.2	5.0
GRAND_RAPIDS	53.18	0.8	5.0	0.4	0.9	-0.6	-1.5	-0.4	0.7	0.4	1.9	0.0	0.4	4.6
SWAN_RIVER	52.12	0.6	4.7	-0.7	1.0	-0.1	-1.6	-0.6	0.1	0.3	1.5	-0.9	-0.4	3.7
DAUPHIN	51.10	1.4	5.4	0.5	1.7	0.4	-1.4	0.3	0.9	0.9	2.1	-0.7	0.9	5.1
GIMLI	50.63		4.4	-0.4	1.6	0.4	-0.5	0.6	0.4	0.2	1.8	-0.1		4.4
GREAT_FALLS	50.52			0.6		-0.7	-1.7	0.1	0.2	0.6	2.2			
SHOAL_LAKE_CS	50.45	0.8	4.8	-0.3	0.3	-0.1	-1.2	0.2	0.9	0.4	2.1	-0.4	0.4	3.4
PIWA	50.18	2.2	5.1	1.0	2.6	0.5	0.1	2.0	2.1	2.4	3.1	0.8	1.5	5.6
WINNIPEG	49.92	1.3	4.9	0.1	1.5	0.2	-1.6	0.5	0.4	0.9	2.2	-0.1	1.4	4.6
BRANDON	49.90	0.7	4.7	-1.3	0.4	-0.6	-1.7	-0.2	0.7	0.0	1.6	-1.1	0.0	3.0
PORTAGE_SOUTHPORT	49.90	1.8	5.6	0.3	1.9	0.5	-1.1	0.4	0.6	1.2	1.9	0.3	1.4	5.1
INDIAN_BAY	49.62	1.2	5.4	1.0	2.1	-0.6	-1.4	-0.1	-0.1	0.1	1.9	-0.3	1.2	4.9
CYPRESS_RIVER	49.57	2.5	6.6	1.1	2.9	0.8	-0.5	1.1	1.8	1.6	3.0	-0.1	1.6	5.8
DEERWOOD_RCS	49.40		5.5	0.6	2.3	1.2	-1.5	0.5	0.8	1.6	3.1	0.4		4.7
MELITA	49.28	2.0	6.7	0.2	1.9	1.1	-0.2	1.1	1.8	1.7	3.0	0.3	1.7	4.9
MORDEN_EXP_FARM	49.18	0.9	4.8	-0.3	1.5	-0.4	-1.8	-0.1	0.4	0.1	1.7	-0.6	0.7	3.9
SPRAGUE	49.02	2.7	5.9	1.0	2.4	0.1	0.5	2.1	2.3	2.1	3.3	1.0	2.9	5.9
EMERSON	49.00		4.4	-1.0	0.2	-1.0	-2.1	-0.3	-0.1	-0.5	1.4	-1.2	1.3	

Manitoba

Mann and Blair, in progress

Ratio of Local Warming to Global Warming:1950-1920

Location	Latitude	Annual	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WHITESAND-SOUTHEND	56.33		7.4	1.7	0.9	-2.7	-1.6	0.4	1.1	1.4	2.3	0.3	0.5	5.7
BUFFALO_RROWS	55.83	1.4	5.2	0.9	2.2	-0.9	-0.1	0.8	1.7	1.9	2.3	-0.4	1.1	5.0
ISLAND_FALLS	55.53	1.3	5.7	2.2	2.1	-1.3	-1.5	-0.5	0.2	0.5	2.0	-0.4	-0.2	6.0
LA_RONGE	55.15	1.3	5.2	0.9	1.4	-1.1	-1.0	0.2	1.2	1.6	1.9	-0.3	1.3	5.3
MEADOW_LAKE	54.13	0.9	6.2	0.1	0.9	-1.6	-2.0	-0.1	0.6	0.3	1.2	-1.4	1.0	4.8
WASKESIU_LAKE	53.92		5.3	-0.4	2.8	0.3	0.2	1.0	2.2	2.4	3.5	0.3	1.2	
NIPAWIN	53.33	0.6	5.0	-0.4	1.3	-0.7	-1.8	-0.5	0.1	0.6	1.7	-0.9	0.4	4.9
PRINCE_ALBERT	53.22	1.4	6.2	0.5	1.5	-0.9	-0.9	0.0	1.1	0.8	1.9	-0.7	1.0	5.5
WASECA	53.13		6.5	0.9	1.0	-0.5	0.0	0.6	1.5	1.1	2.1	-0.8	1.5	4.7
HUDSON_BAY	52.82	1.2	5.3	0.4	1.2	0.0	-1.1	-0.6	1.0	1.1	1.8	-0.7	0.5	5.4
MELFORT	52.82	1.2	5.2	0.0	1.1	-0.6	-1.2	-0.3	0.5	0.7	2.1	-0.8	0.5	5.0
NORTHBATTLEFORD	52.77	0.4	5.9	-0.3	0.5	-1.0	-2.0	-0.9	-0.1	-0.4	1.1	-1.5	0.5	4.2
SCOTT	52.37	0.8	6.2	0.0	0.8	-0.3	-1.1	-0.6	0.5	-0.1	1.4	-1.3	1.1	3.9
MUENSTER	52.33		6.3	0.5	1.3	0.2	-1.3	-0.2	0.5	0.6	2.4	-1.2	0.4	5.5
SASKATOON	52.17	1.0	6.4	-0.7	1.3	-0.2	-0.9	-0.4	0.4	0.0	1.7	-1.4	0.8	4.2
WYNYARD	51.77	0.8	5.8	-0.9	0.7	-1.0	-1.5	-0.4	0.9	0.6	1.9	-1.3	0.5	4.2
WATROUS	51.67	1.3	6.5	-0.6	1.6	-0.4	-0.7	-0.2	0.5	0.4	2.1	-1.0	0.7	4.2
ROSETOWN	51.57		5.8	-0.2	1.7	-0.4	-1.1	-0.5	0.2	-0.3	1.6	-1.4	1.2	4.3
KINDERSLEY	51.52	0.7	5.7	-1.3	1.2	-0.6	-0.3	-0.9	-0.2	0.1	1.5	-1.3	0.9	2.1
OUTLOOK	51.48	0.9	7.4	-0.2	1.3	-0.7	-1.0	-0.9	-0.2	-0.4	1.3	-1.4	1.1	4.4
YORKTON	51.27		6.1	-0.1	1.9	0.2	-0.6	0.0	1.1	1.0	2.4	-0.6	0.5	4.6
KELLIHER	51.25	1.9	6.0	0.4	1.5	0.2	0.0	0.5	2.0	1.8	2.9	-0.1	0.3	4.3
LEADER	50.92	0.4	6.0	-1.0	1.9	-1.1	-1.1	-0.7	0.1	0.0	1.6	-1.7	0.9	1.7
BEECHY	50.83	1.2	7.1	0.3	1.8	-0.1	-0.5	-0.7	0.5	0.2	2.0	-0.7	1.2	3.8
QU_APPELLE	50.57	1.8	6.8	0.9	2.6	0.9	-0.1	0.1	1.2	1.6	3.2	0.3	1.6	5.7
INDIAN_HEAD	50.55	1.2	6.0	0.1	1.4	-0.6	-0.7	-0.1	-0.4	0.3	2.3	-0.8	0.6	4.6
REGI	50.43	0.7	5.6	-0.8	0.9	-0.4	-1.0	-0.7	-0.2	-0.2	1.8	-1.0	0.5	3.8
BROADVIEW	50.37	0.9	6.1	-0.4	1.1	-0.3	-0.9	-0.1	0.5	0.4	2.0	-0.8	0.4	4.2
MOOSE_JAW	50.33	0.8	6.8	-0.8	1.4	-0.3	-0.9	-0.5	-0.6	-0.5	1.6	-1.2	0.9	3.4
SWIFT_CURRENT	50.30	1.4	6.4	-0.2	1.7	0.1	0.2	-0.5	0.7	1.0	2.4	-0.2	1.8	2.9
SWIFT_CURRENT_CDA	50.27	1.0	6.1	-0.3	1.4	-0.5	-0.7	-0.7	0.3	0.3	1.6	-1.2	1.3	2.7
KIPLING	50.20	1.2	6.4	0.2	1.8	0.0	-1.1	-0.6	0.0	0.9	2.6	-0.7	0.8	4.6
MAPLE_CREEK	49.90		7.4	0.0	1.7	0.0	-0.1	0.2	2.0	1.5	2.0	-0.9	1.7	3.2
YELLOW_GRASS	49.82		5.8	0.1	2.7	0.1	-0.4	0.1		1.0	3.0	-0.8	0.8	5.1
WEYBURN	49.70	1.7	5.6	-0.4	1.5	0.6	-0.2	0.6	1.2	1.5	2.9	-0.4	1.1	3.9
KLINTONEL	49.43		4.6	-2.6	-0.1	-1.0	-0.8	-1.3	0.7	1.0	2.3	-0.9	1.1	1.0
ESTEVAN	49.22	1.3	5.9	-0.9	1.7	0.7	-0.1	0.6	0.4	0.8	2.3	-0.2	1.6	3.4
VAL_MARIE	49.07		5.9	-0.2	1.7	0.2	-0.9	-1.2	-0.1	-0.2	1.8	-0.2	1.7	2.6

Saskatchewan

Mann and Blair, in progress

Ratio of Local Warming to Global Warming:1950-1920

Location	Latitude	Annual	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FORT_CHIPEWYAN	58.77		5.4	1.4	0.9	-1.6	-1.1	0.5	1.4	1.0	1.2	0.1	1.9	4.8
HIGH_LEVEL	58.62	1.6	6.4	2.0	1.0	-0.8	0.2	0.6	1.8	1.4	1.7	0.6	0.7	5.0
FORT_MCMURRAY	56.65	1.2	5.3	1.2	0.5	-1.6	-1.1	0.6	1.7	1.1	1.6	-0.5	1.5	5.9
CLEARDALE	56.32		7.1	3.8	2.1	0.5	1.5	1.3		1.7	1.9	0.3		6.0
PEACE_RIVER	56.23	1.2	6.7	1.4	0.2	-1.1	0.3	0.7	1.1	0.9	1.4	-0.6	1.3	4.1
FAIRVIEW	56.08			2.8	1.1	0.6	2.4	1.6	1.6	1.6	2.5		2.1	
SLAVE_LAKE	55.30	1.3	5.1	1.4	0.3	-1.3	-0.1	0.9	1.9	1.4	1.9	-0.4	1.4	4.3
BEAVERLODGE	55.20	0.8	6.0	1.9	-0.6	-0.9	0.5	0.5	0.7	0.3	0.8	-1.3	0.1	3.5
GRANDE_PRAIRIE	55.18	0.7	5.6	1.6	-0.8	-1.2	0.0	0.3	1.1	0.6	1.2	-1.1	0.5	3.8
ATHABASCA	54.63		7.0	1.5	1.0	-1.2	-0.5	0.3	1.5	1.1	1.8	-1.2	1.7	5.9
COLD_LAKE	54.42	1.4	5.8	1.3	1.6	-0.9	-0.3	0.7	1.9	1.4	2.3	-0.7	1.7	5.1
FORT_ASSINIBOINE	54.42		6.7	0.5	-0.6	-0.4	0.1	0.9	1.2	1.1	2.0	-0.5	1.6	5.2
CAMPSIE	54.13	1.7	5.8	0.9	-0.1	-0.5	0.0	0.5	1.5	1.2	2.1	-0.9	1.2	4.4
VEGREVILLE	53.50	1.5	7.0	0.9	1.6	-1.1	0.0	0.9	1.6	1.2	1.8	-1.1	1.4	4.4
RANFURLY	53.42	1.1	6.1	0.3	0.6	-1.3	-0.2	0.3	1.4	0.9	2.0	-1.0	0.9	4.3
ENTRANCE	53.40		5.7	1.8	-0.2	-1.0	1.1	1.4	2.2	1.4	1.7	-0.8	0.2	
EDMONTON	53.30	0.6	5.1	0.0	-0.3	-1.4	-0.5	0.1	0.9	0.2	1.5	-1.2	0.9	2.4
CAMROSE	53.05	1.7	6.3	0.9	1.6	-0.2	0.5	0.8	1.7	1.2	2.1	-0.5	1.7	4.1
JASPER	52.93	1.2	5.8	0.3	0.5	-0.5	0.4	0.3	0.8	-0.2	1.4	-0.5	2.2	3.1
NORDEGG	52.50		6.0	-0.5	1.3	-0.8	0.7	0.8	1.9	1.4	2.6	0.2	1.8	2.4
LACOMBE	52.45	1.3	5.7	0.9	1.1	-1.0	-0.4	-0.1	0.9	0.9	1.4	-1.0	1.0	3.2
ROCKY_MTN_HOUSE	52.42	0.2	5.1	-1.1	0.1	-1.1	-0.6	-1.2	0.3	-0.3	0.6	-1.2	0.6	2.2
STETTLER_NORTH	52.35	2.4	7.5	1.8	2.3	0.3	1.1	1.1	2.1	2.3	3.0	0.7	1.5	4.2
RED_DEER_A	52.18	1.0	5.3	0.2	0.6	-1.0	-0.4	-0.1	1.1	0.6	1.4	-0.9	1.5	2.9
COROTION	52.07		7.7	2.0	2.6	0.5	0.8	0.4	1.3	1.4	2.6		2.6	4.9
OLDS	51.77		5.5	0.1	0.5	-0.1	0.4	0.4	1.7	1.6	2.1	-0.2	1.8	2.3
BANFF	51.20	1.5	6.3	0.2	1.3	0.1	0.0	-0.4	0.9	0.9	1.6	-0.3	2.0	3.1
CALGARY	51.12	0.9	5.6	-0.8	0.5	-0.7	0.1	-0.4	1.2	1.3	1.6	-1.0	1.4	2.4
KASKIS	51.03	0.9	5.0	-0.1	1.1	0.2	1.0	0.3	1.7	1.4	1.7	-0.8	0.7	0.1
GLEICHEN	50.93		8.9	2.1	1.7				-0.7	-0.4	1.2	-0.6	2.6	5.2
MEDICINE_HAT	50.03	1.0	6.2	-0.2	1.4	-0.3	-0.8	-0.8	1.0	0.4	1.8	-0.4	1.6	2.2
TABER	49.80		5.7	-0.5	1.3	-0.1	-0.1	-0.5	0.6	0.6	1.6	-0.8	0.6	1.6
LETHBRIDGE_A	49.63	1.4	6.5	0.2	1.7	0.2	0.1	-0.2	0.6	0.8	2.0	-0.4	2.3	2.9
PINCHER_CREEK	49.52	0.9	5.6	-0.6	0.3	0.0	-0.2	-0.6	0.0	0.3	1.3	-1.2	1.2	1.7
FOREMOST	49.48		5.2	1.8	2.1	1.0	0.7	0.0	1.6	1.8	2.6	0.5	2.5	2.7
CARDSTON	49.20	1.4	6.0	-0.1	1.8	-0.1	0.3	0.1	1.7	1.4	1.7	-1.0	1.2	2.6
CARWAY	49.00		5.3	-0.1	0.6	-0.3	0.3	0.2	1.8	1.1	1.1	-1.1	1.6	1.4

Alberta

Mann and Blair, in progress