Manitoba Planning Conference, Brandon MB, 20 May 2016

Planning for a New Climate

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climateatlas.ca
The Issue

• Global climate is changing rapidly
• Major climate change is coming to the Prairie Provinces
• We must reduce our emissions and we must prepare adaptation strategies

• Adaptation strategies must be based on informed decision making
• The planning community must envision and build resilient futures
1880-2015 Global Temperature Change (°C)

2015 was by far the warmest year on record

~1°C warming over the past 100 years

~0.8°C since 1971

Anomalies Relative to 1951-1980

Source: http://data.giss.nasa.gov/gistemp/graphs_v3/
Seasonal Global Temperature Anomalies: 1880-2016

Winter 2015/16: +1.2°C

Anomaly Baseline: 1951-1980

Data source: http://data.giss.nasa.gov/gistemp/
Monthly Zonal Temperature Anomalies: Winter 2015/16

Anomaly Baseline: 1951-1980

Latitude

Zonal Temperature Anomaly (°C)

Data Source: http://data.giss.nasa.gov/gistemp/maps/
Unprecedented string of 9 record monthly temperature anomalies (March 2016 set all-time anomaly record)

Data Source: https://www.ncdc.noaa.gov/monitoring-references/faq/anomalies.php
March Sea Surface Temperature (SST)

- Globally-averaged SST was **higher than in any other March** (1880-2016)
- SST departure from normal in March was 6th highest out of all 1,635 months
- The **7 highest** monthly global ocean temperature departures have all occurred in **last 7 months**

April 2016 was warmest April on record

https://www.ncdc.noaa.gov/sotc/global/201603
Global Average Surface Temperature Change for High and ‘Low’ Carbon Emissions Scenarios

Source: Adapted from IPCC’s latest report
The Paris Agreement’s goal is to limit additional global warming to 1 °C and ideally 0.5 °C.

To do so, we must drastically reduce our global carbon emissions.
We need to **reduce** our global emissions.
Largest amount of warming projected in higher latitudes and over land.

Source: Adapted from IPCC’s latest report
In general, wet areas projected to get wetter, and dry areas get drier.

Source: Adapted from IPCC’s latest report
Not many people really understand what all of this **means to them**, in part because it is too **far away**, spatially and temporally.
Many think that climate change *so far* has generally been a *good thing*.
Recent improvement and projected worsening of weather in the United States

Patrick J. Egan1* & Megan Mullin2*

Here we show that in the United States from 1974 to 2013, the weather conditions experienced by the vast majority of the population improved. Using previous research on how weather affects local population growth to develop an index of people’s weather preferences, we find that 80% of Americans live in counties that are experiencing more pleasant weather than they did four decades ago. Virtually all Americans are now experiencing the much milder winters that they typically prefer, and these mild winters have not been offset by markedly more uncomfortable summers or other negative changes.
If we want government, communities, industry, citizens, and planners to prepare...

they need to know what to expect
We need to bring climate change information home.
Prairie Climate Centre and the Prairie Climate Atlas

Visualizing Climate Change Projections for the Canadian Prairie Provinces

climateatlas.ca
About Us

Dr. Danny Blair
- Science Director, Prairie Climate Centre
- Climatologist
- Associate Dean, Faculty of Science
- Principal, Richardson College for the Environment
- Professor, Department of Geography
- University of Winnipeg

Dr. Ian Mauro
- Communications Director, Prairie Climate Centre
- Film maker, environmental scientist
- Associate Professor, Department of Geography
- University of Winnipeg

Ryan Smith, MSc
- Research Associate, Prairie Climate Centre
- Climate researcher, computer programmer and map designer
- University of Winnipeg

Dr. Hank Venema
- Planning Director, Prairie Climate Centre
- Policy analyst, International Institute for Sustainable Development
- Professional engineer
- Climate, water, energy, ecosystem management, environmental economics, agriculture policy expert
Role of the Prairie Climate Centre

- Mobilize knowledge about climate change
- To translate the science of climate change into language that can be understood by all
- To make the climate data relevant and engaging:
  - Localize and visualize the data
  - Tell stories using words and film
Role of the Prairie Climate Centre

• Make climate change data **accessible** to all
• Inform **policy** and develop **solutions**
• Inspire **adaptation** and **mitigation**
• Build decision making **tools**
• Produce peer-reviewed **research** results
• Foster Prairie-wide **collaborations** and **partnerships**
• Conduct workshops and **training** sessions
How is the prairie climate expected to change?

It depends on: models, emissions, time.
We use data from 12 downscaled global climate models to produce ensemble (average) projected conditions for the region.

Downscaled data was produced by the Pacific Climate Impacts Consortium (PCIC) in Victoria, BC.

Projections using two Carbon Emissions Scenarios are used to represent the uncertainty associated with future concentrations of greenhouse gases.

Projections are shown for two future time periods: near future (2021-2050) and far future (2051-2080). Changes often shown relative to 1981-2010 baseline period (modeled).

Temperature

Range within Current Climate

Range within High Carbon Projections (RCP8.5)

Range within Low Carbon Projections (RCP4.5)

Climate projections were extracted from:

- 12 Global Climate Models, each using
- 2 Carbon Emissions Scenarios
BCSD-downscaled climate data supplied by:

Pacific Climate Impacts Consortium, University of Victoria, (Jan. 2015). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org

THANK YOU PCIC

AdaptWest Project. 2015. Gridded current and projected climate data for North America at 1km resolution, interpolated using the ClimateNA v5.10 software (T. Wang et al., 2015). Available at adaptwest.databasin.org
This graph shows multi-model projected changes (relative to 1951-80) of mean annual temperature for the Prairie Provinces vs the Globe, using the medium/low carbon (RCP4.5) and high carbon (RCP8.5) emissions scenarios. For both scenarios the Prairie Provinces warm much more than the globe as a whole.

Data Sources: PCIC (prairies: 12 models) & KNMI (globe; 42 models)
Historic and Projected (RCP4.5/8.5) Winter Temperature: Winnipeg
Historic and Projected (RCP 4.5/8.5) Winter Precipitation: Winnipeg
Spring Precipitation
This is the type of image that is on our website.

Draped over scalable Google Earth image.

Major centres are clickable, to obtain data details.

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation
Projected Changes in Total Spring Precipitation

StaticallyDownscaled Climate Scenarios. Downloaded from pacificclimate.org.

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation

Projected Changes in Total Spring Precipitation

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation
Projected Changes in Total Spring Precipitation

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Prairie Precipitation
Projected Changes in Total Spring Precipitation

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Summer Precipitation
Prairie Precipitation
Projected Changes in Total Summer Precipitation

Recent Past	Near Future	Far Future

High Carbon

Low Carbon

1981-2010 Total Summer Precipitation (mm)

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation
Projected Changes in Total Summer Precipitation

Recent Past  Near Future  Far Future

High Carbon  Low Carbon

2021-2050 Total Summer Precipitation (mm)

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation
Projected Changes in Total Summer Precipitation

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.

Table:

<table>
<thead>
<tr>
<th></th>
<th>Recent Past</th>
<th>Near Future</th>
<th>Far Future</th>
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<tbody>
<tr>
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<td></td>
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</tr>
<tr>
<td>Low Carbon</td>
<td></td>
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</table>

**2021-2050 Total Summer Precipitation (mm):**

- 70
- 90
- 110
- 130
- 150
- 170
- 190
- 210
- 230
- 250
- 270
- 290+
Prairie Precipitation
Projected Changes in Total Summer Precipitation

Recent Past  Near Future  Far Future

High Carbon

Low Carbon

2051-2080 Total Summer Precipitation (mm)

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Prairie Precipitation
Projected Changes in Total Summer Precipitation

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
2051-2080 $\Delta T$: RCP8.5

![Temperature change graph showing data for Edmonton, Regina, and Winnipeg from 2051-2080.](graph.png)
Days -30°
or Colder
Shifting Extremes
Change in the Number of Very Cold Days

This is the type of image that will be on our website.

Draped over scalable Google Earth images.

Major centres will be clickable, to obtain data details.

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Five different versions of maps for each variable will be presented:

- **1981-2010**
- **2021-2050 (RCP4.5)**
- **2021-2050 (RCP8.5)**
- **2051-2080 (RCP4.5)**
- **2051-2080 (RCP8.5)**

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Shifting Extremes
Change in the Number of Very Cold Days

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Shifting Extremes
Change in the Number of Very Cold Days

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Days +30° or Warmer
Shifting Extremes

Change in the Number of Very Hot Days

Recent Past Near Future Far Future

High Carbon

Low Carbon

1981-2010 Annual number of days ≥ 30 °C

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
**Shifting Extremes**

*Change in the Number of Very Hot Days*

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Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
Recent Past  Near Future  Far Future

High Carbon

Low Carbon

2021-2050 Annual number of days ≥ 30 °C

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.
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## Tailor-made Reports

### Winnipeg

#### High Carbon Emissions (RCP8.5)

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>Season</th>
<th>1981-2010 (Baseline)</th>
<th>2021-2050 Projections</th>
<th>2021-2050 +/-</th>
<th>2051-2080 Projections</th>
<th>2051-2080 +/-</th>
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<td>L</td>
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<tr>
<td>Mean Temperature</td>
<td>Annual</td>
<td>-2.9 °C</td>
<td>4.3 °C</td>
<td>5.1 °C</td>
<td>5.8 °C</td>
<td>6.1 °C</td>
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<tr>
<td></td>
<td>Winter</td>
<td>-15.0 °C</td>
<td>-13.2 °C</td>
<td>-12.0 °C</td>
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<td>-11.1 °C</td>
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<td>4.7 °C</td>
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<td>5.3 °C</td>
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<td>20.0 °C</td>
<td>20.5 °C</td>
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<td>21.7 °C</td>
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<td>Fall</td>
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<td>7.0 °C</td>
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<td>8.0 °C</td>
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# Tailor-made Reports

## Winnipeg

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<td>552.6 mm</td>
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## Tailor-made Reports

### Prairie Climate Centre

### Winnipeg

#### High Carbon Emissions (RCP8.5)

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<tr>
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<tr>
<td>Days ≥ 30 °C</td>
<td>Annual</td>
<td>11.0 days</td>
<td>19.0 days</td>
<td>25.6 days</td>
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<td>Nights ≥ 20 °C</td>
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<td>2.0 days</td>
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<td>-</td>
<td>May-19</td>
<td>May-02</td>
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<td>Freeze-Thaw Cycles</td>
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<td>5 °C Degree Days</td>
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<td>Max 1-day Precip</td>
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<td>Max 3-day Precip</td>
<td>Annual</td>
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<td>118.2 mm</td>
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<td>PET</td>
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<td>632.2 mm</td>
<td>658.7 mm</td>
<td>672.3 mm</td>
</tr>
<tr>
<td>P-PET Ratio</td>
<td>Annual</td>
<td>0.83</td>
<td>0.76</td>
<td>0.82</td>
</tr>
</tbody>
</table>

**L** = Low Projection (10th Percentile)  **M** = Mean Projection  **H** = High Projection (90th Percentile)

- **2021-2050**
  - Days ≥ 30 °C: +14.6 days
  - Days ≤ -30 °C: -5.3 days
  - Last Spring Frost: -8 days
  - Frost-Free Period: +17.4 days
  - First Fall Frost: +9 days
  - Frost Period: -45.9 days
  - Frost Days: -19.2 days
  - Icing Days: -13.6 days
  - Freeze-Thaw Cycles: -4.6 cycles
  - 5 °C Degree Days: +362.9
  - 10 °C Degree Days: +295.9
  - 16 °C Degree Days: +180.5
  - Max 1-day Precip: +12.5%
  - Max 3-day Precip: +14.6%
  - PET: +6.3%
  - P-PET Ratio: +0.01

- **2051-2080**
  - Days ≥ 30 °C: +35.4 days
  - Days ≤ -30 °C: -7.5 days
  - Last Spring Frost: -17 days
  - Frost-Free Period: +33.1 days
  - First Fall Frost: +16 days
  - Frost Period: -53.5 days
  - Frost Days: -38.0 days
  - Icing Days: -31.1 days
  - Freeze-Thaw Cycles: -5.6 cycles
  - 5 °C Degree Days: +775.4
  - 10 °C Degree Days: +624.9
  - 16 °C Degree Days: +423.2
  - Max 1-day Precip: +15.6%
  - Max 3-day Precip: +20.3%
  - PET: +12.9%
  - P-PET Ratio: -0.04
Tailor-made Reports

We can generate reports for any shape-file area.
Climate Analogues
AdaptWest data was used to identify whose climates we will have in the future, using seasonal temperature and precipitation projections.
Similarity index:

- Mean temperature within 1 °C
- Total snow within 15%
Similarity index:

- Mean temperature within 1 °C
- Total snow within 15%
Winnipeg
Summer Climate Analogues

High Carbon
Low Carbon

Summer
Winter

2020s 2050s 2080s
Similarity index:

- Mean temperature within 1 °C
- Total precipitation within 20%
Similarity index:

- Mean temperature within 1 °C
- Total precipitation within 20%
A New Climate

• Shifting seasons
• Shorter, warmer winters
• Longer, hotter summers
• More precipitation in winter, spring, fall
• Less precipitation in summer
• More intense precipitation events
• More severe weather
• More heat waves
Some Benefits

- Longer *growing* season
- New *crop* varieties
- Lower winter *heating* costs
- Fewer extreme *cold* events
Many Risks

- Floods and droughts
- Water resource management
- Shortening of return periods
- Winter melting
- Extreme heat events
- Human health
- Crop failure
- Invasive species
- Forest fires
- Even more variability and instability
Exceptionally meridional jet stream on 5 May 2016

Record May 5 temperatures of 35.2 °C in Winnipeg and 34.3 °C in Brandon
Planning Issues

- Infrastructure resilience
- Urban design
- New building codes
- Disaster management and response
- Heating and cooling
- Summer energy demand
- Winter roads
- Freeze/thaw cycles
- Wind loads?
- Insurance
- Litigation?

Integrating Mitigation
Thank You