Municipality Of Chatham-Kent

Community Development

Planning Services

Information Report

To: Mayor and Members of Council

From: Gabriel Clarke MES, BA, Environmental Planner I

Date: April 12, 2021

Subject: Historical and Future Climate Analysis for Chatham-Kent

This report is for the information of Council.

Background

On July 15, 2019, Council approved a motion to declare a climate emergency in Chatham-Kent.

On November 4, 2019, administration provided Council with the "Update on Council's Climate Emergency Declaration" Information Report which outlined how administration proposed to fulfill the directions contained in the Climate Emergency Declaration.

On November 18, 2019, Council approved the Terms of Reference for completing a Climate Change Action Plan (CCAP) for Chatham-Kent. The scope of the Climate Change Action Plan includes identifying local actions for the Municipal Corporation and the community to mitigate and adapt to climate change.

On May 31, 2021, Council received a report regarding the CCAP Relaunch that provides an overview of the updated CCAP project framework, the revised engagement process and a modified project timeline.

Comments

An historical and future climate analysis for Chatham-Kent is completed. This report, titled, "Key Climate Indicators for Chatham-Kent" is attached as Appendix 1. This report provides background information that supports the development of the CCAP. It provides an analysis of historically observed local climate trends and an analysis of expected future local climate trends that is specific to the context of Chatham-Kent and is based on internationally-recognized climate models.

A summary of the report, Key Climate Indicators for Chatham-Kent, is below:

Purpose:

The purpose for developing the historical and future climate analysis is to understand the following at the Chatham-Kent level:

1. Based on local climate records, has Chatham-Kent's climate changed to date? If so, what has changed?

2. Is Chatham-Kent's climate expected to change in the future? If so, what is expected to change?

For each of these two main questions, the report also seeks to clarify the following:

1. How big is the degree of change (Big change? Small change?).

2. What is the rate of change over time (Fast change? Slow change?).

Data Sources:

The historical and future climate analysis for Chatham-Kent was informed by two types of climate information:

The historical climate analysis was based on local climate observations that were recorded and compiled by Natural Resources Canada between 1951 and 2013. This record contains daily maximum and minimum air temperatures and daily precipitation totals observed and recorded in Chatham-Kent during this 63 year period.

The future climate analysis was completed by running two future greenhouse gas emissions scenarios (a high emissions/business-as-usual scenario and a lower emissions scenario) through 24 Global Climate Models (GCMs) and averaging the results for each emissions scenario. Statistical downscaling was employed to produce data that is relevant to the context of Chatham-Kent. Additional details on the data sources and methodology employed in the historical and future climate analysis is contained in the report.

Key Climate Indicators:

19 Key Climate Indicators have been analyzed to understand the degree to which various aspects of Chatham-Kent's climate may have experienced change historically and how they are expected to change in the future. Each Key Climate Indicator focuses on one particular climate variable – such as annual average temperature, number of hot days per year, average annual precipitation, etc. When analyzed collectively, these indicators provide a more complete picture of climate change trends in Chatham-Kent than if the Key Climate Indicators were analyzed on their own.

Key Findings:

A Hotter Local Climate:

The average annual temperature experienced in Chatham-Kent between 1981 and 2010 is +0.5°C higher than the average annual temperatures recorded between 1951 and 1980.

A warming trend is expected to continue in the future: A local warming trend of between +3.5°C and +5.8°C is expected for Chatham-Kent by the end of the century, based on the low emissions and high emissions scenarios respectively. These trends would significantly exceed the internationally endorsed goal under the 2015 Paris Accord to keep average global temperature rises to below +1.5°C.

The impact of increasing outdoor temperatures on the amount of heating and cooling required to maintain comfortable indoor temperatures in Chatham-Kent is expected to be significant in the future. Rising temperatures have reduced heating demand by -4.5% between the 1981-2010 and the 1951-1980 time periods. Rising temperatures are expected to reduce heating demand by -37% by the 2080s under the world's current emissions trajectory. However, the same expected rise in outdoor temperatures has increased cooling demand by +9.1% between 1981-2010 and 1951-1980 and is expected to more than double the demand for cooling by the 2050s and triple cooling demand (+210%) by the 2080s under the existing emissions trajectory.

A Wetter Local Climate:

Chatham-Kent's climate has become wetter. This trend is expected to continue in the future. Annual precipitation levels recorded in the 1981-2010 time period were on average +49.8mm (almost +2 inches) higher than annual precipitation levels recorded during the 1951-1980 time period.

Looking towards the future, increases in average annual precipitation levels between +78.1mm (+3 inches) and +127.3mm (+5 inches) are expected by the 2080s under the low and high emission scenarios, respectively.

A Wilder and More Extreme Climate

Chatham-Kent's climate is expected to become wilder and more extreme throughout the 21st century. This is expected to include increases in the frequency and severity of major precipitation events, and longer heatwaves (representing an increase of +29.9 days or +832% by the 2080s compared to the average length of heatwaves recorded between 1951-1980). Over time, Summers are expected to become comparatively drier with increasing risks of drought. Fall, Winter and Spring are expected to become wetter.

Consultation

There was no consultation required for this report.

Financial Implications

By completing the historical and future climate change analysis for Chatham-Kent in house, the Municipality has avoided approximately $35,000.00 in consulting fees.

Prepared by:

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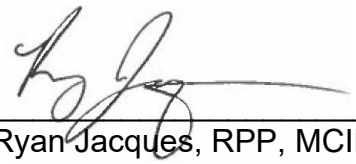
Reviewed by:



Ryan Jacques, RPP, MCIP
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Reviewed by:

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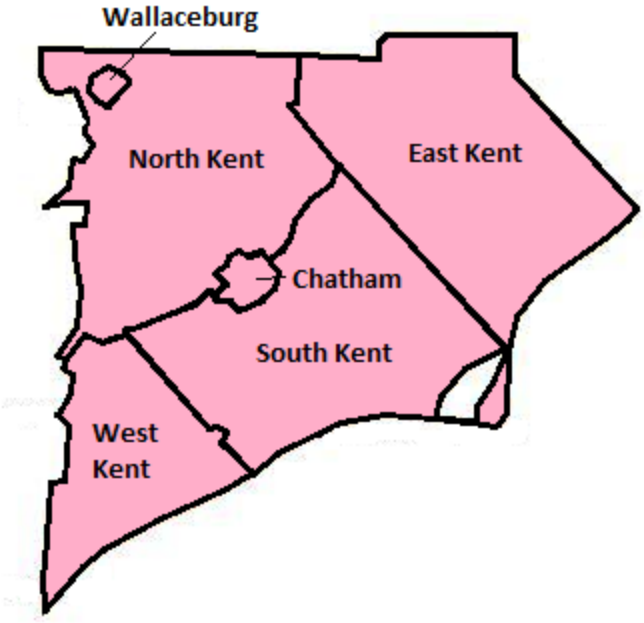
Attachment: Appendix A – Key Climate Indicators for Chatham-Kent

Key Climate Indicators for Chatham-Kent

Spring 2021



Gabriel Clarke MES, BA, Environmental Planner I

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Executive Summary

To support and inform the development of a climate change action plan for Chatham-Kent, municipal staff have completed a historical climate and future climate analysis for Municipality. The objective of the exercise is to understand the nature and extent of the changes in climate patterns that have been observed in the local climate record to date as well as the nature and extent of changes in climate patterns that are expected to occur in the future.

The historical climate analysis was completed by examining climate local daily weather observations measured and compiled by Natural Resources Canada. The historical data covers the years between 1951 and 2013.

The future climate analysis component was completed by employing two atmospheric greenhouse gas concentration scenarios that were developed for the United Nations Inter-Governmental Panel on Climate Change (IPCC) Assessment Report 5 that was published in 2014.

The first of the two greenhouse gas scenarios represents a high emissions or business-as-usual scenario where the global community makes no addtional effort to limit greenhouse gas emissions. The world's existing emissions trajectory is in line with this scenario.

The second greenhouse gas scenario represents a low emissions or low carbon economy scenario which assumes that the global community transitions to a lower carbon economy over the next few decades.

Each of these two greenhouse gas scenarios were inputted into 24 Global Climate Models (GCMs) and the results of each model were averaged to simulate future temperature and precipitation patterns for the world's climate to the year 2095. These results were then statistically downscaled to produce climate data that is relevant to the context and geography of Chatham-Kent.

In order to be able to observe trends over time, the historical and modeled climate data was averaged into four 30-year time periods and one 25-year time period, corresponding to the following:

- The years 1951-1980 are referred to in this report as the "baseline" time period.
- The years 1981-2010 are referred to as the "1990s" time period.
- The years 2011-2040 are referred to as the "2020s" time period.
- The years 2041-2070 are referred to as the "2050s" time period.
- The years 2071-2095 are referred to as the "2080s" time period.

Key findings from the climate analysis are listed below:

A Hotter Local Climate: The climate record shows that that annual average temperature in Chatham-Kent has already risen by +0.5°C in the 1990s time period compared to the 1951-1980 baseline time period. This warming has been unevenly distributed across the seasons and has had the most impact on average winter temperatures, which have risen by a full +1.0°C in the 1990s time period compared to average winter temperatures recorded for the baseline time period. With regards to future trends, a local warming trend of between +3.5°C to +5.8°C is expected by the 2080s, based on the low and high emission scenarios, respectively. This suggests that regardless of the emissions scenario, Chatham-Kent is expected to experience a local warming trend that significantly surpasses the 2015 United Nations Paris Accord goal of keeping global average temperature increases to under +1.5°C by the end of the century.

Outdoor Temperatures and Energy: Rising outdoor temperatures are expected to have a profound impact on the amount of energy required to keep buildings warm in the winter and cool in the summer. In the winter, heating demand for buildings is expected to decrease by anywhere between 24% and 37% by the 2080s, based on the low and high emissions scenarios. However, in the warmer months, the demand for air conditioning as a result of hotter outdoor temperatures is expected to double by the 2050s and triple by the 2080s under the world's current emissions trajectory. A major contributing factor for the projected increase in cooling demand is the number "tropical nights" (i.e. nights where the minimum temperature remains above +20°C) which are expected to increase by a factor of between 4 and 7 by the 2080s under the low and high emissions scenarios respectively, and this will substantively reduce the capacity of urban centres and individual buildings to shed the day's heat at night. This suggests that while the amount of energy required to keep buildings comfortable in the winter is expected to decrease, the amount of energy required to keep buildings cool in the summer is expected to rise such that any energy reductions in the winter will be more than offset by the increased energy demand during the warmer months of the year.

Outdoor Temperatures and Human health: Human health impacts from increasing temperatures are likely to rise substantially in Chatham-Kent over the coming years, especially for vulnerable populations, which due to factors like age, income, mobility and others will make it much harder for them to cope with a hotter climate than the rest of the general population.

A Wetter Local Climate: Chatham-Kent's climate has become wetter and this trend is expected to continue in the future. The local climate record shows that Chatham-Kent has experienced an average annual increase of +49.8mm (almost +2 inches) of precipitation during the 1990s time period compared to annual precipitation levels recorded during the 1951-1980 baseline time period. This increasing local precipitation trend is expected to continue – the low emissions scenario projects an increase of +78.1mm (+3inches) by the 2080s and the high emissions scenario projects an increase of +127.3mm (+5 inches) for the 2080s compared to the baseline. Summers are expected to become comparatively drier while the rest of the seasons are expected to become wetter as time passes.

Agriculture and Climate Change: The frost free season (the number of days between last spring frost and first fall frost) has increased by an average of 9.5 days in the 1990s time period compared to the baseline. It is expected that the frost free season will extend an additional +1.5 to +2.5 months by the 2080s compared to baseline under the low and high emission scenarios, respectively. This, combined with increasing precipitation levels and altered seasonal precipitation patterns are expected to gradually impact the economic viability of certain existing crops and modes of agricultural production while also proving beneficial to others. In other words, the changing local climate is expected to generate challenges for some agricultural sectors while also opening up new opportunities for agricultural production in Chatham-Kent as time passes.

A Wilder and More Extreme Local Climate: Chatham-Kent's climate is expected to become wilder and more extreme throughout the 21st century, with increases in the frequency and severity of major precipitation events, longer heatwaves, shorter winters and increasing risks of summer droughts even as overall annual precipitation levels increase. The amount of precipitation that falls on the single wettest day of the year is expected to increase by an average of 22% and the wettest 5-day period of the year is expected to see +29% more precipitation by the 2080's compared to levels recorded during the 1951-1980 baseline under the world's existing emissions trajectory.

Heatwaves are expected to increase in length by 832% by the 2080's compared to the 1951-1980 baseline under the world's existing trajectory. Seasonal precipitation patterns are expected to shift with summers becoming comparatively dryer while the other three seasons are expected to become wetter over time.

Equity and Climate Change: A hotter, wetter and wilder climate will impact everyone in Chatham-Kent, but none more-so then the community's most vulnerable populations. Populations that experience lower incomes, pre-existing health conditions, and improper housing for example will bear a much larger burden and be less able to adapt to Chatham-Kent's future climate than our more affluent populations. In this sense, climate change can be viewed as a threat multiplier – one that exacerbates and deepens existing inequities.

Background

On July 15th, 2019, Chatham-Kent's Council approved a motion to declare a climate emergency in the Municipality. The motion contained the following directions:

1. That the Municipality of Chatham-Kent Officially declare a climate emergency for the purposes of joining a national and international movement and to provide a lens through which all strategy, policies, action-items and opportunities can be viewed;
2. That staff work swiftly to identify target areas in municipal policy through which specific changes can have the greatest impact to reduce our individual and collective environmental impact;
3. That staff be challenged to work internally, as well as engage stakeholders and community members, to prepare information and recommendations for concrete and cost-effective initiatives to address the climate change emergency in CK ahead of the budget 2020 deliberations.

On November 4th 2019, administration provided Council with the "Update on Council's Climate Emergency Declaration" Information Report which outlined how administration proposed to fulfill the directions contained in the Climate Emergency Declaration. This included:

1. Developing Terms of Reference for the development of a Climate Change Action Plan for Chatham-Kent (approved by Council at the November 18th 2019 Council meeting);
2. Developing a Climate Lens to evaluate the 2020 Municipal budget (presented to Council at the January 28th 2020 Council meeting); and,
3. Developing a Climate Change Background Report that contains:
    a. Results from the Chatham-Kent historical and future climate analysis;
    b. An inventory of actions that the Municipality has undertaken to reduce emissions since 2014; and,
    c. An inventory of actions that the Municipality has undertaken to enhance resiliency to climate change.

This Report was developed to fulfill direction 3A listed above and provides an overview of observed climate trends for Chatham-Kent as well as a local analysis of future local climate trends based on internationally-recognized climate models.

This Report serves two purposes:

1. To illustrate historically observed and modelled future climate data for Chatham-Kent, and
2. To identify and highlight notable trends present in the historical climate record and future climate models.

The information contained in this Report will be used to inform the development of a Climate Change Action Plan (CCAP) for Chatham-Kent focused on reducing emissions and increasing local resiliency to climate change.

Historical Climate Data

The historical climate data employed in this climate analysis spans the years 1950-2013. This dataset was compiled by Natural Resources Canada and is comprised of daily maximum and minimum air temperature and daily precipitation totals for Chatham-Kent during this 64 year period.

Modelled Climate Data

The future climate analysis component was completed by employing two atmospheric greenhouse gas concentration scenarios developed for the United Nations Inter-Governmental Panel on Climate Change (IPCC) Assessment Report 5 that was published in 2014.

The first greenhouse gas scenarios, which the IPCC called Representative Concentration Pathway 8.5 (RCP 8.5) and referred as the "High Emissions" scenario in this report, represents a business as usual scenario where the global community makes no additional effort to limit greenhouse gas emissions. This scenario results in increasing levels of greenhouse gases in the atmosphere throughout the 21st century. The world's existing emissions trajectory is currently aligned with this scenario.

The second greenhouse gas scenario, called Representative Concentration Pathway 4.5 (RCP 4.5) by the IPCC and referred as the "Low Emissions" scenario in this report, represents a low carbon economy scenario which assumes that the global community makes a concerted effort to transition to a lower carbon economy. This scenario assumes that global greenhouse gas emissions would peak between 2040 and 2050 and stabilize thereafter.

Each of these two greenhouse gas scenarios were inputted into 24 Global Climate Models (GCMs) to simulate future temperature and precipitation patterns for the world's climate to the year 2095. The outputs of twenty four (24) climate models were combined and averaged into an "ensemble" dataset to gain a clear understanding of the converging climate trends. This "ensemble" approach has been shown to dramatically improve the predictive power of climate models because ensembles are able to better account for natural climate variability, they reduce the effects of modelling uncertainty, and are able to produce results that are not biased by the weaknesses or strengths of any one individual model.[1] The ensemble results were then statistically downscaled to produce climate data that is relevant to the context and geography of Chatham-Kent.

[1] https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch10s10-5-4-1.html

Key Climate Indicators

A number of Key Climate Indicators have been included in this report to illustrate how Chatham-Kent's climate has evolved historically and is projected to change in the future. Each key climate indicator focuses on one particular climate variable – such as average temperature, the number of hot days per year, average annual precipitation etc. which, when analyzed collectively provides a more complete picture of local climate trends in Chatham-Kent than if they are analyzed in isolation.

For example, looking at the projected number of "frost free days" in isolation may be interpreted to suggest that climate change will have a negligible or positive overall impact on the agricultural industry due to the increasing length of growing seasons. However, when the increases in "very hot days", increasing annual precipitation levels and the altered seasonal precipitation patterns (wetter falls, wetter winters, wetter springs, dryer summers) are also considered, the challenges posed by climate change on existing modes of agricultural production become clearer, and consequently so does the potential for climate change to have a disruptive impact on this key economic sector over time.

The following key climate indicators are included in this Report:

- Average Annual Temperature
- Average Seasonal Temperature
- Summer Days
- Tropical Nights
- Very Hot Days
- Frost-Free Season
- Longest spell of +30°C Days
- Annual Maximum High Temperature
- Annual Minimum Low Temperature
- Frost Days
- Icing Days
- Heating Degree Days
- Cooling Degree Days
- Total Annual Precipitation
- Average Seasonal Precipitation
- Precipitation Days 10mm
- Precipitation Days 20mm
- Maximum 1 Day Precipitation
- Maximum 5 Day Precipitation

Time Periods

In order to identify trends over time, the historical and modeled data analyzed in this Report were averaged into four 30-year time periods and one 25 year time period. The first time period spans from 1951-1980 and represents the observed "baseline" from which subsequent time periods are compared against. The second time period – "the 1990s" – spans from 1981-2010 and provides more recent climate observations. The third time period – "the 2020s" – spans from 2011-2040 and contains both historical data for 2011-13 and modeled data for 2014-2040. The 2020s represents climate projections for the near future. The "the 2050s" time period spans from 2041-2070 represents mid-century modeled projections. The "2080s" time period spans from 2071-2095 is the only 25 year period contained in this Report because the modeled data used only goes to 2095. The 2080s timeframe represents climate projections for the end of the 21st century.

Variability of Observed vs. Modelled Data

It is important to note that many key climate indicators studied in this report show significant year-to-year variability in the historically-observed climate record whereas the modelled data projections show a lower year-to-year variability. This is because while the observed line shows what was actually

recorded at the weather stations, the projected numbers are (as mentioned in the Modelled Climate Data section above page 6) an average of the outputs of 24 Global Climate Models which smooths out the higher year-to-year variabilities that are contained in the outputs of each individual climate model.

Average Annual Temperature

Average Annual Temperature is a measure of the daily temperatures for Chatham-Kent averaged across a calendar year. Figure 1 (below) shows the average annual temperature observations (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 2 shows average temperatures for each of the five time periods analyzed in this Report.

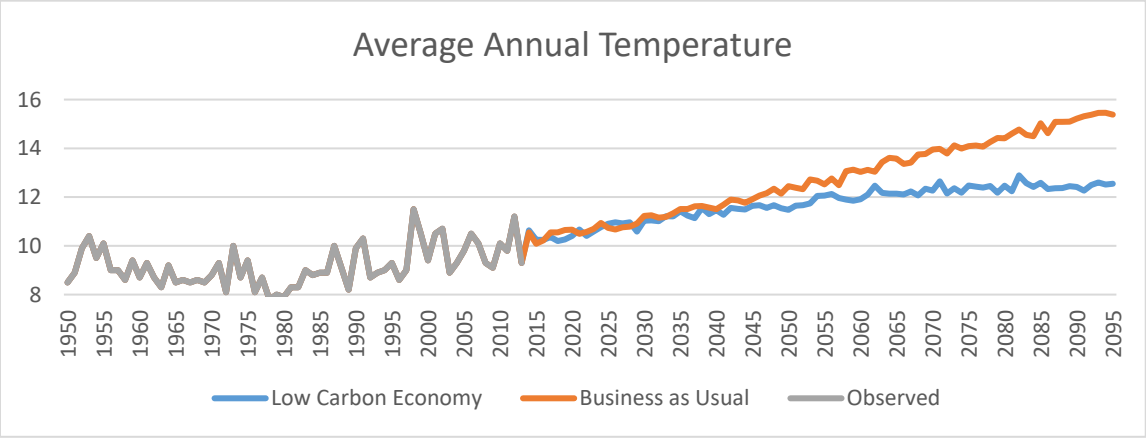

Figure 1: Average Annual Temperature for Chatham-Kent

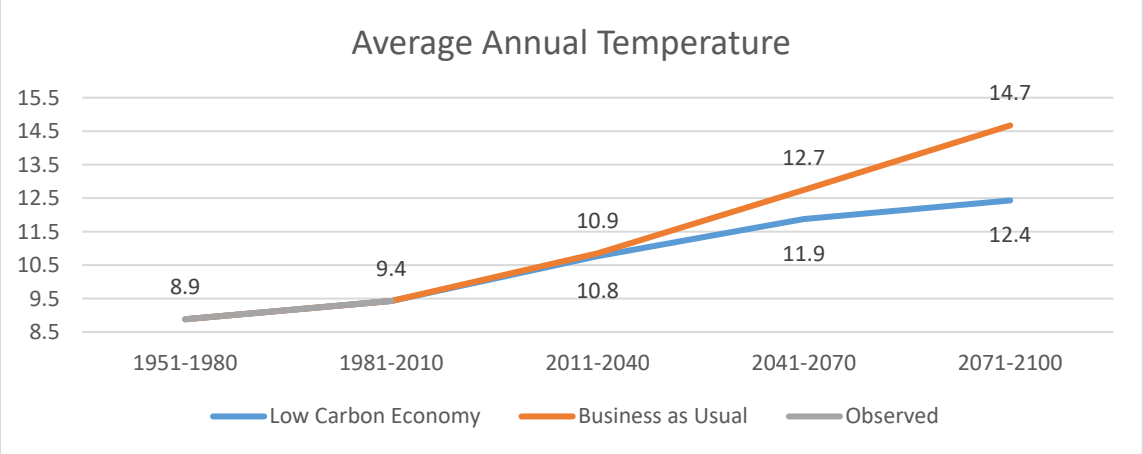

Figure 2: Average Temperature Trends for Chatham-Kent

Figure 2 shows that the observed average annual temperature in Chatham-Kent for the 1990s time period has risen by +0.5 °C compared to the 1951-1980 baseline. The low emissions scenario models project a temperature rise of +1.9°C by the 2020s, +3 °C for the 2050s and +3.5°C for the 2080s compared to the baseline time period. The high emissions scenario models project a temperature rise of +2°C by the 2020s, +3.8°C by the 2050s and +5.8°C by the 2080s. Of note, the goal of the 2015 Paris Agreement under the United Nations Framework Convention on Climate Change is to keep global

average temperature increases to under +1.5 degrees by 2100. Due to Chatham-Kent's location within the northern hemisphere, even the low carbon scenario projections for the 2080s significantly exceed the target that has been set at the global level.

Average Seasonal Temperature

Average Seasonal Temperature is a measure of the daily temperature for Chatham-Kent averaged across an entire season. Figure 3 shows the observed average seasonal temperature for the baseline (1951-1980) and the 1990s (1981-2010) time periods as well as projections for the 2020s, 2050s and 2080s for the low emissions scenario. Figure 4 shows the same observed averages for the baseline and 1990s time periods as well as future seasonal projections for the high emissions scenario.

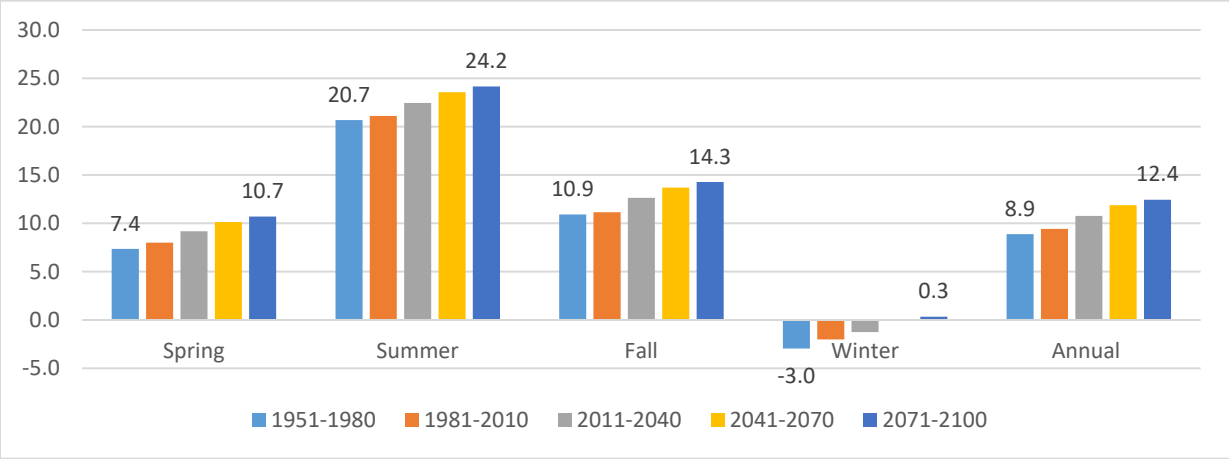

Figure 3: Average Seasonal Temperature - Low Emissions Scenario (RCP 4.5)

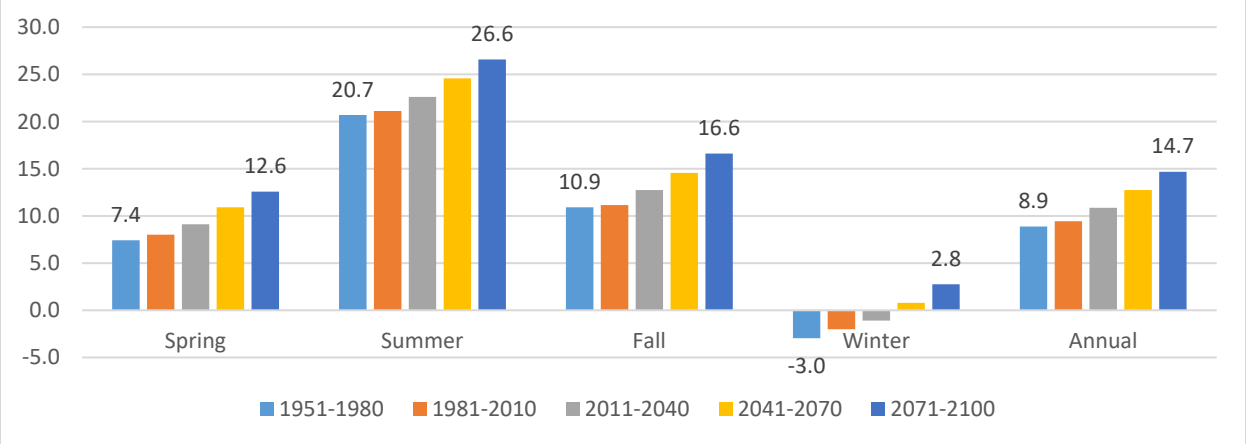

Figure 4: Average Seasonal Temperature – High Emissions Scenario (RCP 8.5)

The historical climate record shows the following increases in average seasonal temperatures:

- Average spring temperature for the 1990s is +0.6°C higher compared to the baseline time period
- Average summer temperature for the 1990s is +0.4°C higher than the baseline average
- Average Fall temperature for the 1990s is +0.3°C higher than the baseline average
- Winter average temperature for the 1990s is +1.0 degree higher than the baseline average

Although the historical climate record shows an overall increase in average temperature across all seasons, the historical warming trend is most amplified in the winter and spring seasons.

Future average seasonal temperatures for the 2080's time period under the low emissions scenario project a fairly consistent increase across the seasons: +3.3°C for the spring season, a rise of +3.5°C for summer, a rise of +3.4 °C for fall, and +3.3°C for the winter season compared to the baseline. The high emissions scenario projects a much higher but also fairly consistent increase in average temperature across the seasons for the 2080s, with an average seasonal rise of +5.2 °C for spring, an increase of +5.9°C in the summer, a +5.7°C rise in the fall, and a +5.8°C rise for the winter months compared to the baseline.

Summer Days

Summer days represent the number of days in a given year when the daily high temperature meets or exceeds +25°C. Figure 5 (below) shows the number of observed summer days per year present in the Chatham-Kent climate record (grey line) as well as summer day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 6 (below) shows summer day trends for each of the five time periods leading to 2095.

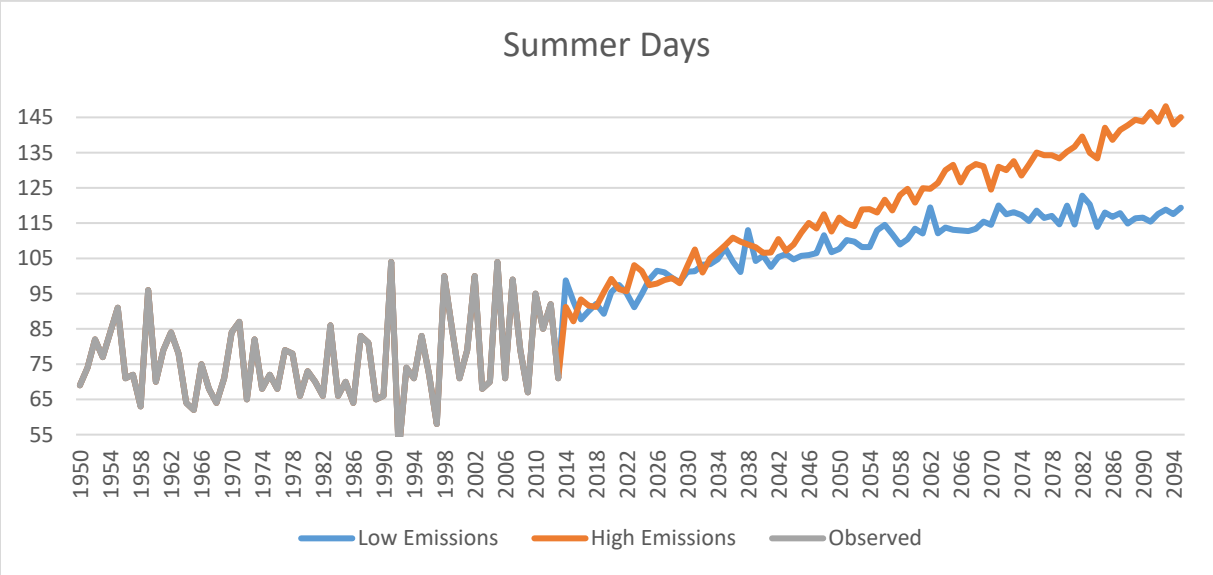

Figure 5: Number of Summer Days per Year for Chatham-Kent

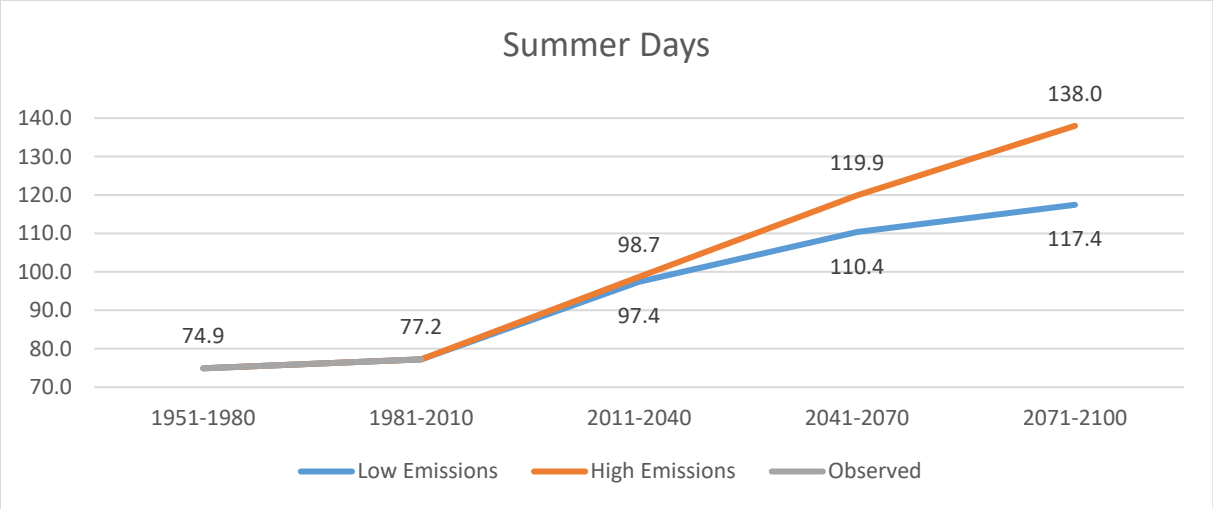

Figure 6: Summer Day Trends for Chatham-Kent

The observed climate record shows that the number of summer days that Chatham-Kent experienced in the 1981-2010 time period increased by +2.3 days compared to the 1951-1980 baseline. Under the low emissions scenario, the number of summer days are projected to further increase by +22.5 days by the 2020s, +35.5 days by the 2050s and +42.5 days by the 2080s compared to the baseline. Under the high emissions scenario, the number of summer days per year are projected to increase by +23.8 days by the 2020's, +45 days by the 2050s and +63.1 days by the 2080's compared to the baseline time period, which would represent just over a 2 month increase in the number of days per year when daily high temperature meets or exceeds +25°C compared to the historically-observed baseline.

Tropical Nights

The tropical nights KCI represents the number of nights in a year when the minimum night time temperature stays at or above +20°C. This indicator illustrates the changing capacity of the built urban environment to shed the days heat at night which directly affects the urban heat island effect and the energy required to keep buildings cool (via air conditioning). Figure 7 shows the number of tropical nights per year observed in the Chatham-Kent climate record (grey line) as well as tropical night projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 8 (below) shows tropical night trends for each of the five time periods to 2095.

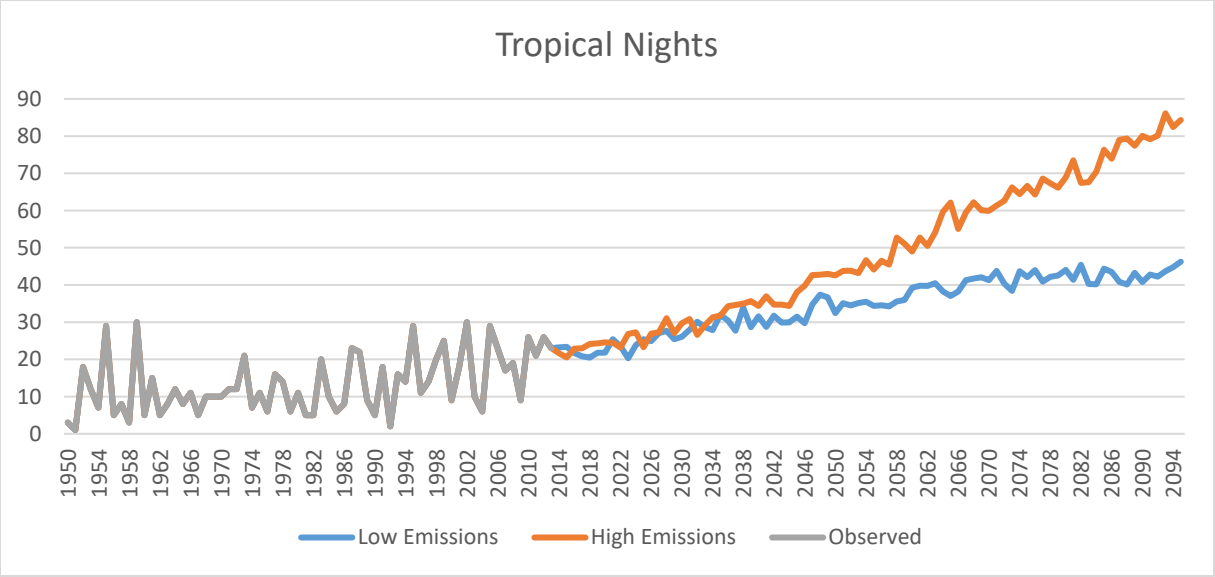

Figure 7: Number of Tropical Nights per Year for Chatham-Kent

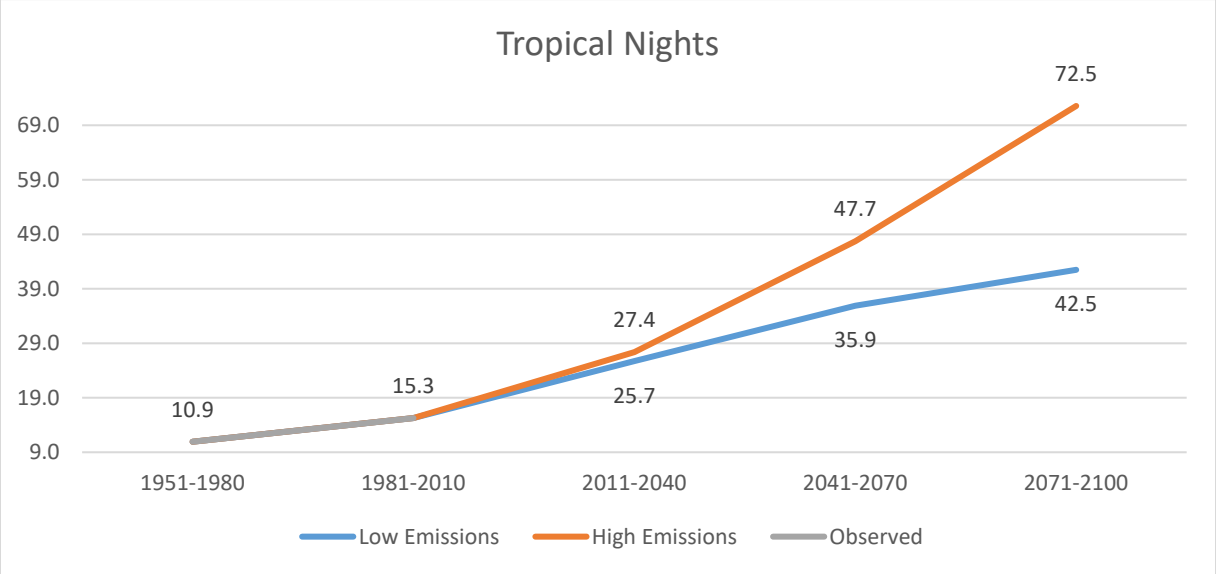

Figure 8: Tropical Night Trends for Chatham-Kent

The observed climate record shows that the annual number of tropical nights that Chatham-Kent experienced in the 1981-2010 time period increased by an average of +4.4 days compared to the 1951-1980 baseline. This change represents a 40.1% increase in tropical nights between the 1990s and the baseline and is the one key climate indicator where the biggest rate of change has been observed.

Under the low emissions scenario, the number of tropical nights are projected to increase by +14.8 days by the 2020s, +25 days by the 2050s and +31.6 days by the 2080s compared to the baseline. Under the high emissions scenario, the number of tropical nights are projected to increase by +16.5 days by the 2020's, +36.8 days by the 2050s and +61.6 days by the 2080's compared to the baseline time period, which for the 2080s represents a +563.5% increase in the number of tropical nights days per year compared to the numbers recorded in the 1951-1980 baseline.

Very Hot Days

The very hot days indicator measures the number of days in a year where the maximum daily high temperature meets or exceeds +30°C. Very hot days have an impact on the amount of energy used during tomes of peak electricity demand to cool buildings and their increasing frequency have been associated with negative health impacts, particularly for vulnerable populations. Figure 9 shows the number of observed very hot days per year present in the Chatham-Kent climate record (grey line) as well as very hot day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 10 (below) shows very hot day trends for each of the five 30-year time periods leading to 2095.

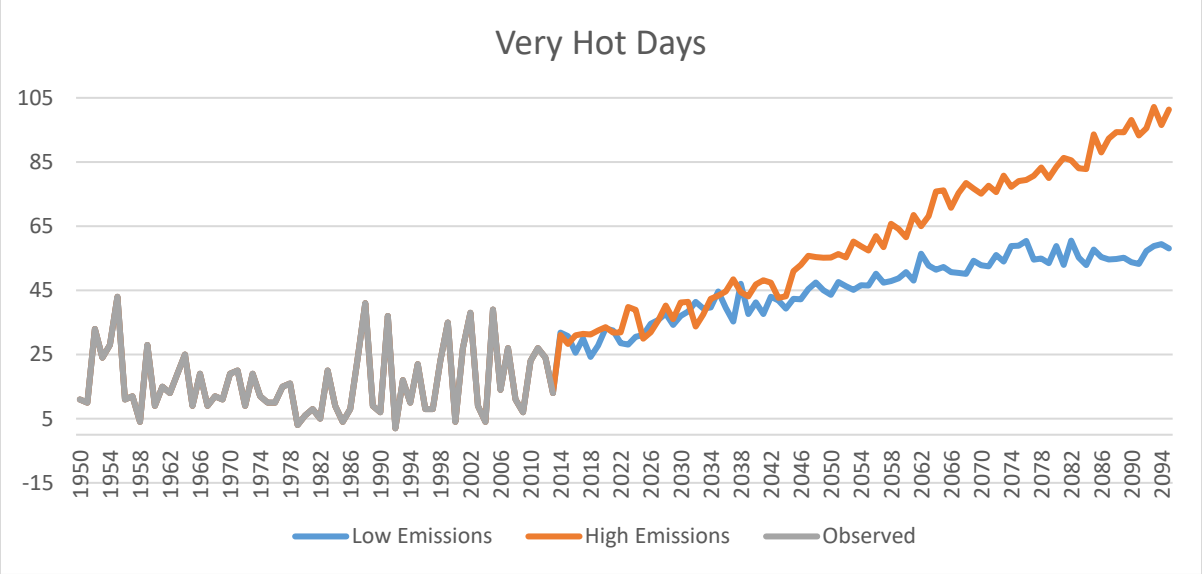

Figure 9: Number of Very Hot Days per Year for Chatham-Kent

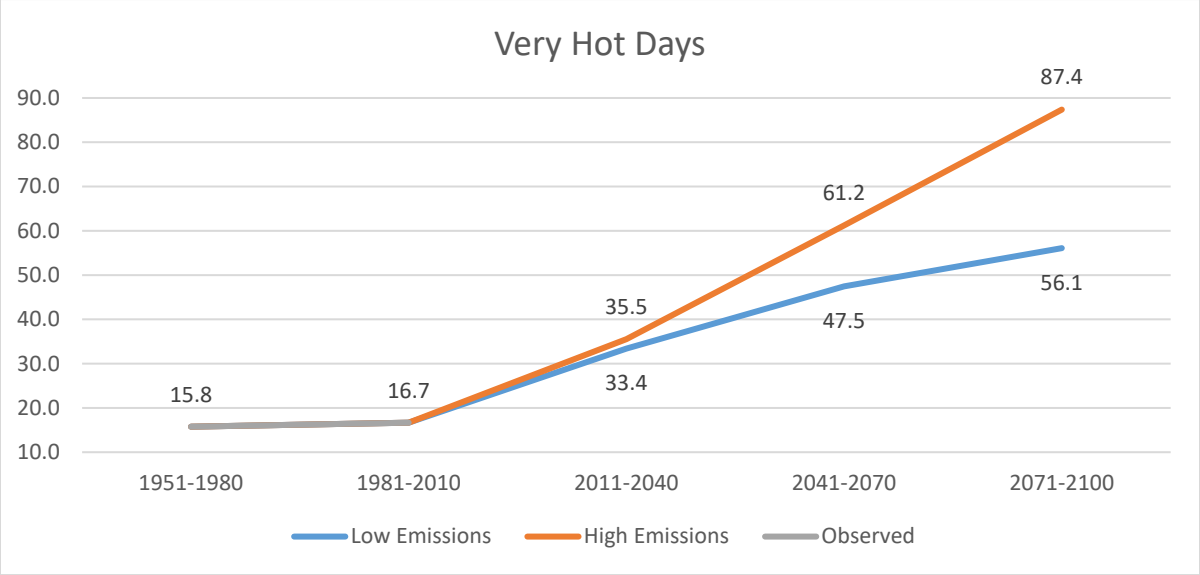

Figure 10: Very Hot Day Trends for Chatham-Kent

The historical climate record shows that the number of very hot days that Chatham-Kent experienced in the 1981-2010 time period increased by an average of +0.9 days compared to the 1951-1980 baseline.

Under the low emissions scenario, the number of very hot days are projected to increase by +17.6 days by the 2020s, +31.7 days by the 2050s and +40.3 days by the 2080s compared to the baseline. In other words, under this scenario Chatham-Kent can expect a 3 fold increase in the number of very hot days by the 2080s, totalling just under 2 months of the year where the daily high temperature meets or exceeds +30°C.

Under the high emissions scenario, the number of very hot days are projected to increase by +19.7 days by the 2020's, +45.4 days by the 2050s and +71.6 days by the 2080's compared to the baseline time period. The high emission models are projecting a +454% increase in the number of very hot days by the 2080s compared to the baseline time period, totalling just under 3 months of the year where the daily high temperature meets or exceeds +30°C.

Frost-Free Season

The frost-free season represents the number of days between the date of the last spring frost and the date of the first fall frost, equivalent to the number of consecutive days during the 'summer' without any daily minimum temperatures falling to or below 0°C. Changes in the length and timing of the frost-free season affect plant and animal life, but also our social, psychological, and physical experience of the changing seasons. The average length of the frost-free season also has major implications for agricultural production because it impacts which crops varieties will thrive vs. those that will struggle in a given region.

Figure 11 shows the observed length of the frost-free season as recorded in the Chatham-Kent climate record (grey line) as well as frost-free season projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 12 (below) shows frost-free season trends for each of the five time periods leading to 2095.

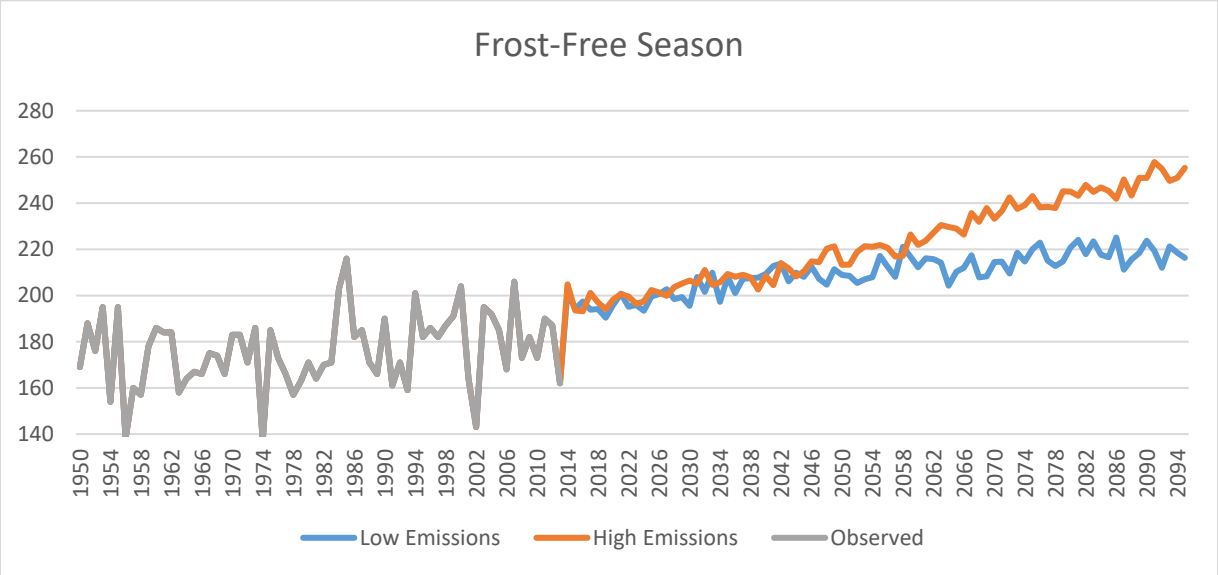

Figure 11: Frost-Free Season for Chatham-Kent

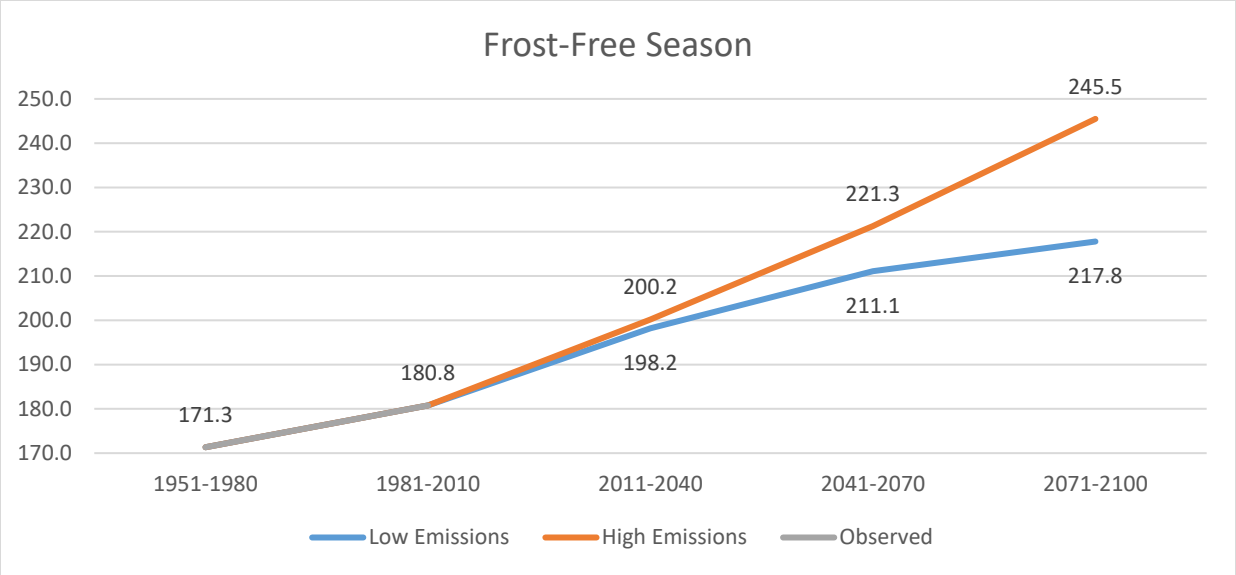

Figure 12: Frost-Free Season Trends for Chatham-Kent

The observed climate record shows that the frost-free season in Chatham-Kent has increased by +9.5 days in the 1990s time period compared to the 1951-1980 baseline.

Under the low emissions scenario, the frost-free season is projected to increase by an average of +26.9 days by the 2020s, +39.8 days by the 2050s and +46.5 days by the 2080s compared to the baseline. This change translates into a +1.5 month increase in the frost-free season by the 2080s.

Under the high emissions scenario, the frost-free season is projected to increase by +28.9 days by the 2020s, +50 days by the 2050s and +74.2 days by the 2080s, which represents a +2.5 month increase in the frost-free season by the end of the 21st century compared to the baseline time period.

Annual Maximum High Temperature

The annual maximum high temperature is the extreme highest temperature experienced in a calendar year. When outdoor temperatures are very high, vulnerable populations – especially the very young and elderly – are much more likely to experience negative health impacts such as heat exhaustion and heat stroke. High outdoor temperatures also have a direct impact on our ability to keep buildings cool and the amount of energy required to maintain comfortable indoor temperatures.

Figure 13 shows the observed maximum highest temperature recorded per year in the Chatham-Kent climate record (grey line) as well as maximum highest temperature projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 14 (below) shows annual highest temperature trends for each of the five time periods examined in this report leading to 2095.

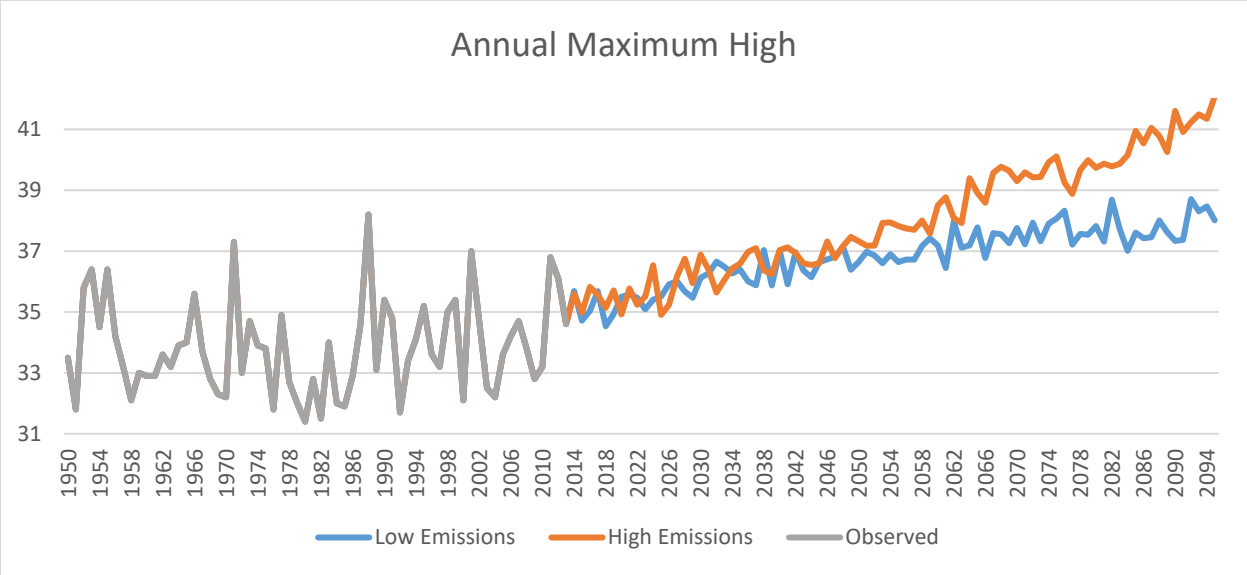

Figure 13: Annual Highest High for Chatham-Kent

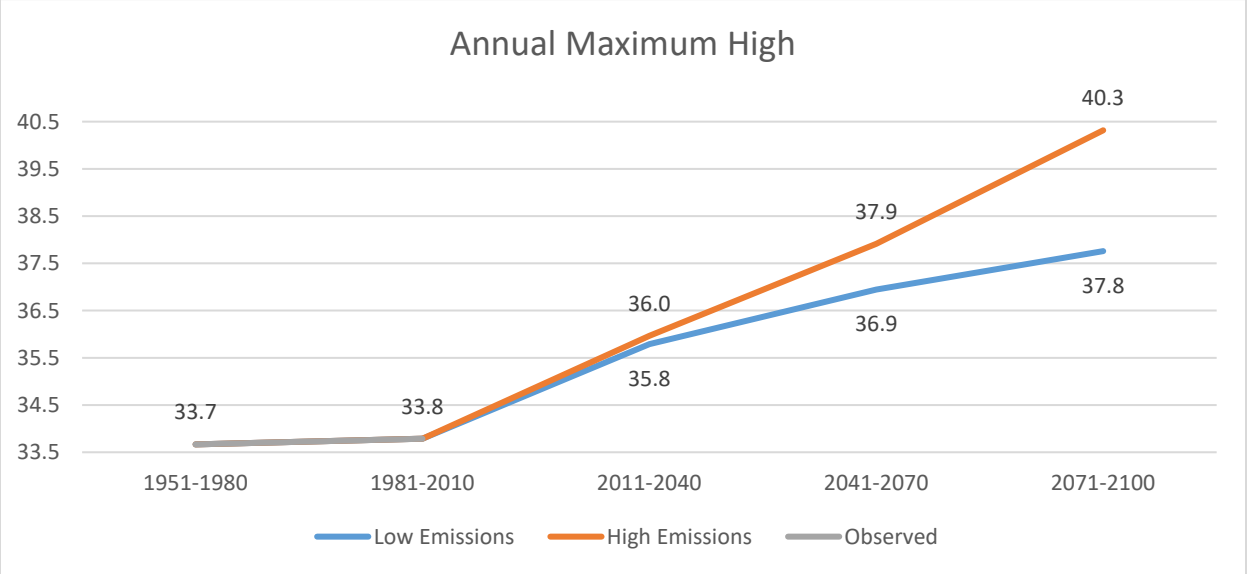

Figure 14: Annual Maximum High Trends for Chatham-Kent

The observed climate record shows that the highest annual temperature experienced in Chatham-Kent has increased by an average of +0.1°C in the 1981-2010 time period compared to the 1951-1980 baseline. For the future, both emission scenarios are projecting similar increases for the 2020s time period and then diverge as the 21st century progresses.

Under the low emissions scenario, the annual highest high is projected to increase by +2.1°C by the 2020s, +3.2°C by the 2050s and +4.1°C by the 2080s compared to the baseline time period.

Under the business as usual scenario, the annual maximum high temperature is projected to increase by +2.3°C by the 2020s, +4.2°C by the 2050s and +6.6°C by the 2080s and routinely surpass +40°C by the end of the 21st century assuming the global community maintains its existing emissions trajectory.

Annual Lowest Minimum Temperature

The annual lowest minimum temperature is the extreme lowest temperature recorded in a year. Outdoor temperatures have a direct impact on the amount of energy required to heat buildings and maintain comfortable indoor temperatures.

Figure 15 shows the observed lowest temperature recorded per year in the Chatham-Kent climate record (grey line) as well as annual lowest temperature projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 16 (below) shows annual minimum low temperature trends for each of the five time periods examined in this report.

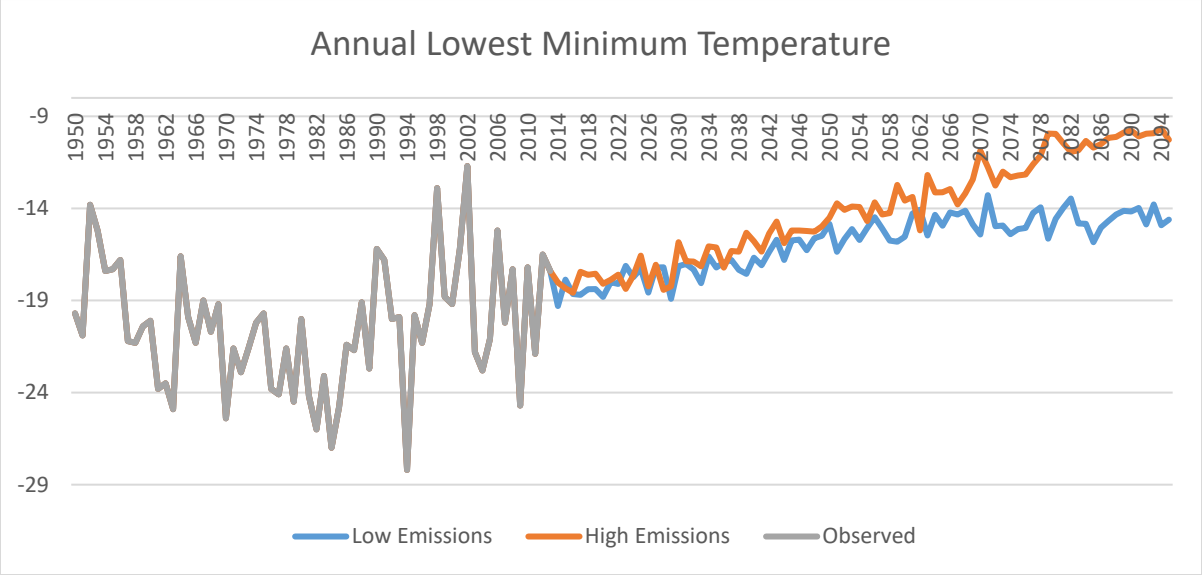

Figure 15: Annual Lowest Minimum Temperatures for Chatham-Kent

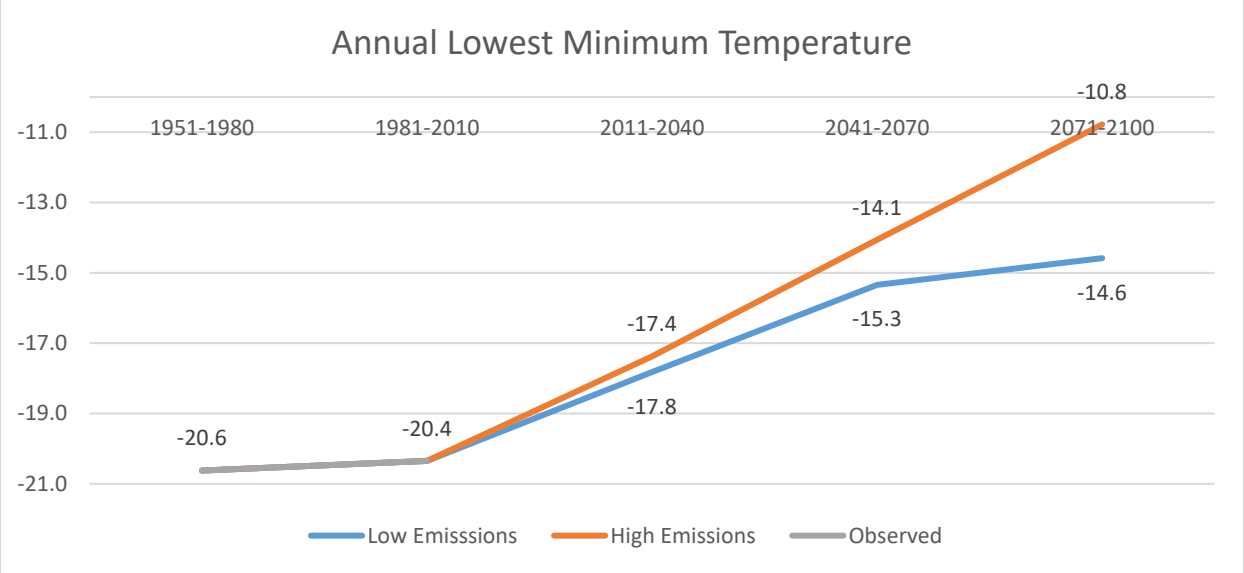

Figure 16: Annual Lowest Minimum Temperature Trends for Chatham-Kent

The historical climate record shows that the absolute minimum temperature experienced in Chatham-Kent has increased by an average of +0.2°C in the 1981-2010 time period compared to the 1951-1980 baseline. However, similar to the annual maximum high temperature KCI discussed above, both emissions scenarios are projecting similar increases in temperature for the 2020s time period and then diverge as the 21st century progresses.

Under the low emissions scenario, the annual lowest minimum temperature is projected to increase by and average of +2.8°C by the 2020s, +5.3°C by the 2050s and +6°C by the 2080s compared to the baseline time period.

Under the high emissions scenario, the annual lowest minimum temperature is projected to increase by +3.2°C by the 2020s, +6.5°C by the 2050s and +9.8°C by the 2080s compared to the baseline time period, which for the 2080s represents a +48% increase over the baseline annual minimum and suggests that the annual lowest minimum temperature will regularly remain above -10°C by the end of the 21st century.

Frost Days

Frost Days represents the number of days in a year when the daily low temperature falls below freezing (0°C) for a period of time.

Figure 17 shows the number of frost days recorded per year in the Chatham-Kent climate record (grey line) as well as annual frost day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 18 (below) shows annual frost day trends for the five time periods examined in this report.

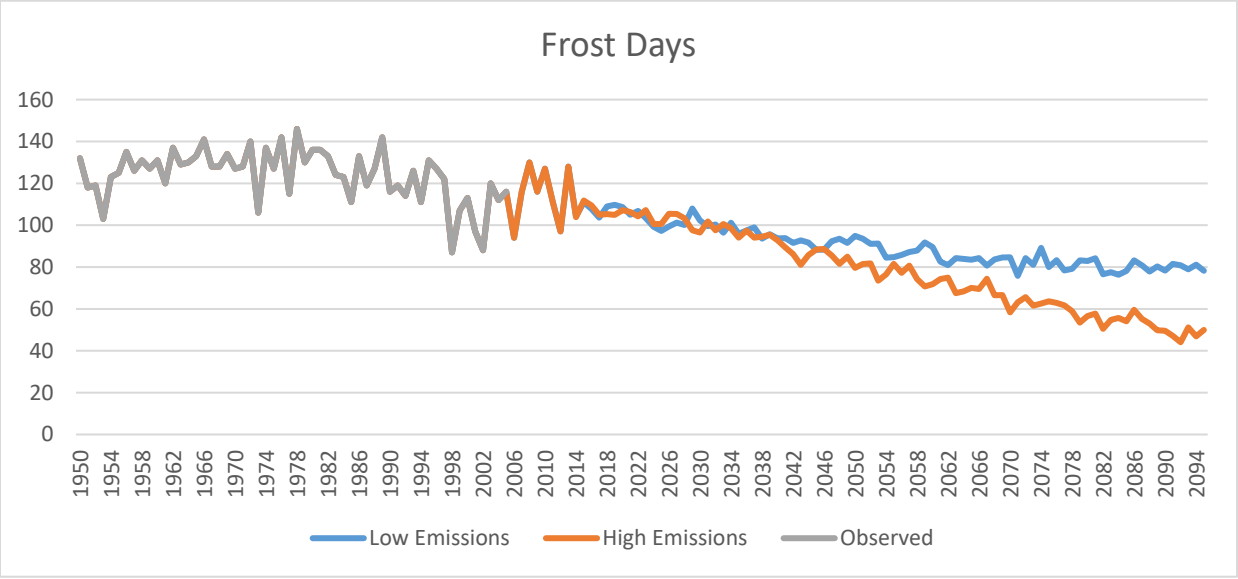

Figure 17: Frost Days per Year for Chatham-Kent

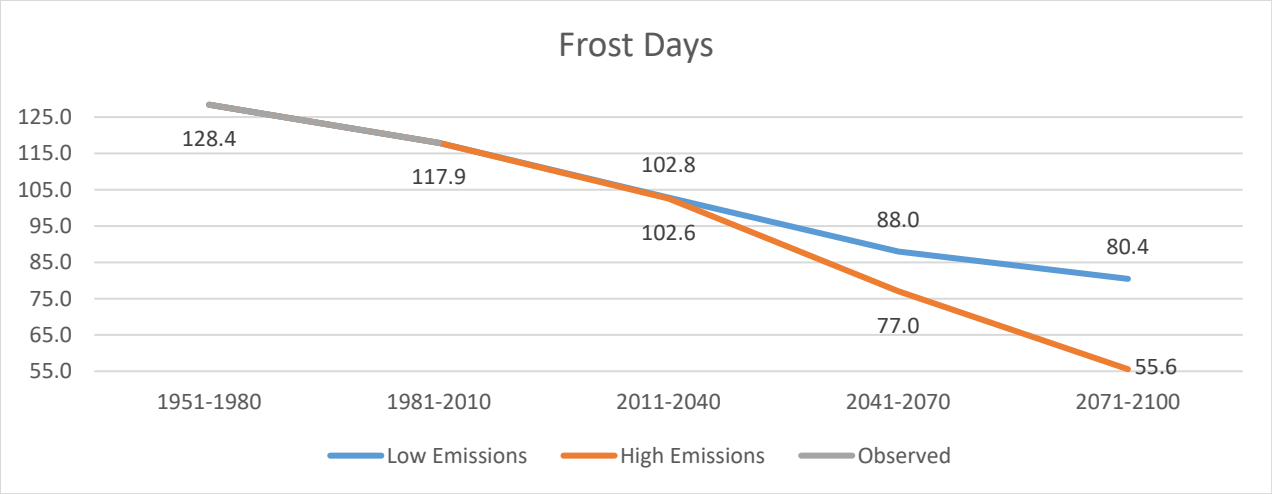

Figure 18: Frost Day Trends for Chatham-Kent

The observed climate record shows that the number of frost days experienced in Chatham-Kent has decreased by -10.5 days in the 1981-2010 time period compared to the 1951-1980 baseline.

Under the low emissions scenario, the number of frost days are projected to further decrease by an average of -25.6 days by the 2020s, -40.4 days by the 2050s and -48 days by the 2080s compared to the baseline time period, which for the 2080s represents a -37% decrease.

Under the high emissions scenario, the number of frost days are projected to decrease by an averages of -25.8 days by the 2020s, -51.4 days by the 2050s and -72.8 days by the 2080s compared to the baseline time period. This change represents a -57% decrease for the 2080s compared to the average number of frost days experienced during the baseline time period.

Icing Days

Icing Days represents the number of days in a year where the daily high temperature stays below 0°C. Icing days are similar to frost days in so far as they identify the number of days in a year where some sort of freezing can be expected, but are different in so far as icing days count the number of days in a year where the temperature stays below 0°C for the entire day, whereas frost days count all the days where the daily low falls below 0°C even if it increases beyond 0°C at another point in the day.

Figure 19 shows the number of icing days recorded per year in the Chatham-Kent climate record (grey line) as well as annual icing day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 20 (below) shows annual icing day trends for the five time periods examined in this report.

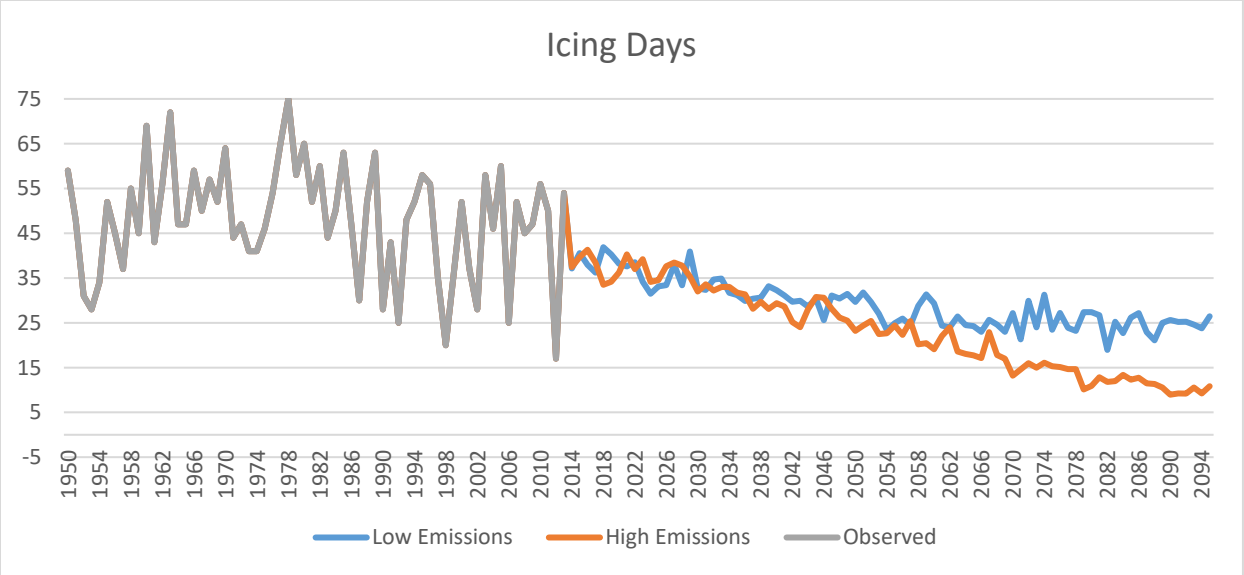

Figure 19: Icing Days for Chatham-Kent

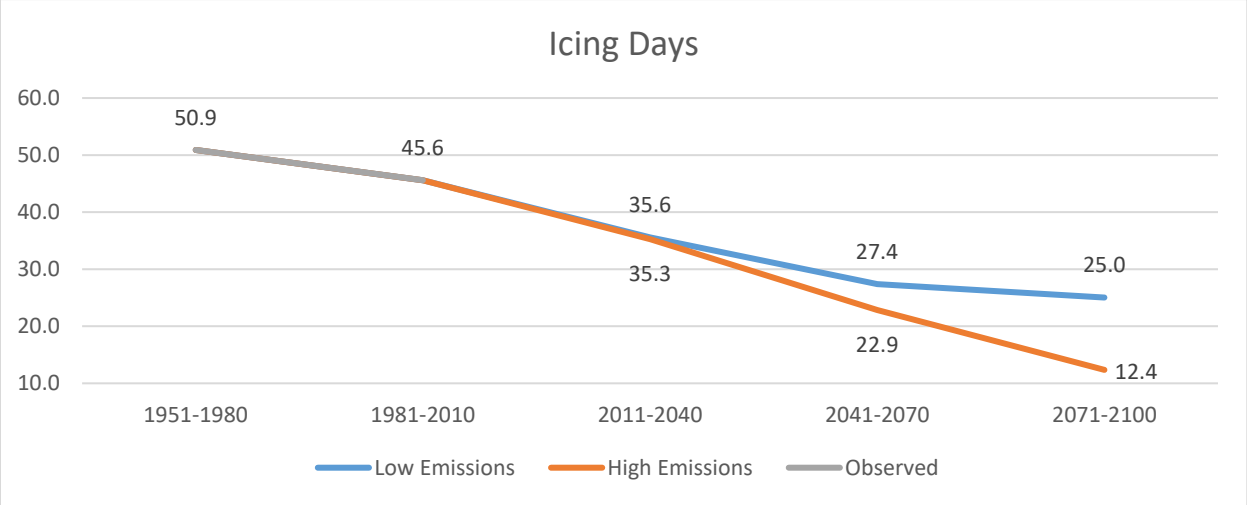

Figure 20: 30-Year Icing Day Trends for Chatham-Kent

The historical climate record shows that the number of icing days experienced in Chatham-Kent has decreased by -5.3 days in the 1981-2010 time period compared to the 1951-1980 baseline.

Under the low emissions scenario, the number of icing days are projected to decrease by an average of -15.3 days per year by the 2020s, -23.5 days per year by the 2050s and -25.9 days by the 2080s compared to the baseline time period. This translates to a projected decrease of -51% in the number of icing days for the 2080s when compared to baseline.

Under the high emissions scenario, the number of icing days are projected to decrease by an average of -15.6 days by the 2020s, -28 days by the 2050s and -38.5 days by the 2080s compared to the baseline time period, which represents a -76% decrease by the 2080s compared to the baseline. This suggests that by the end of the century, Chatham-Kent is expected to regularly experience years with less than 14 days total where the temperature stays below 0°C for the entire day.

Longest Spell of +30°C Days

The longest spell of +30°C days measures the length of heat waves and represents the longest period in a year when daily maximum high temperatures meet or exceed +30°C.

Figure 21 shows the longest spell of +30°C days per year in the Chatham-Kent climate record (grey line) as well as heat wave projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 22 shows heat wave trends for the five time periods examined in this report.

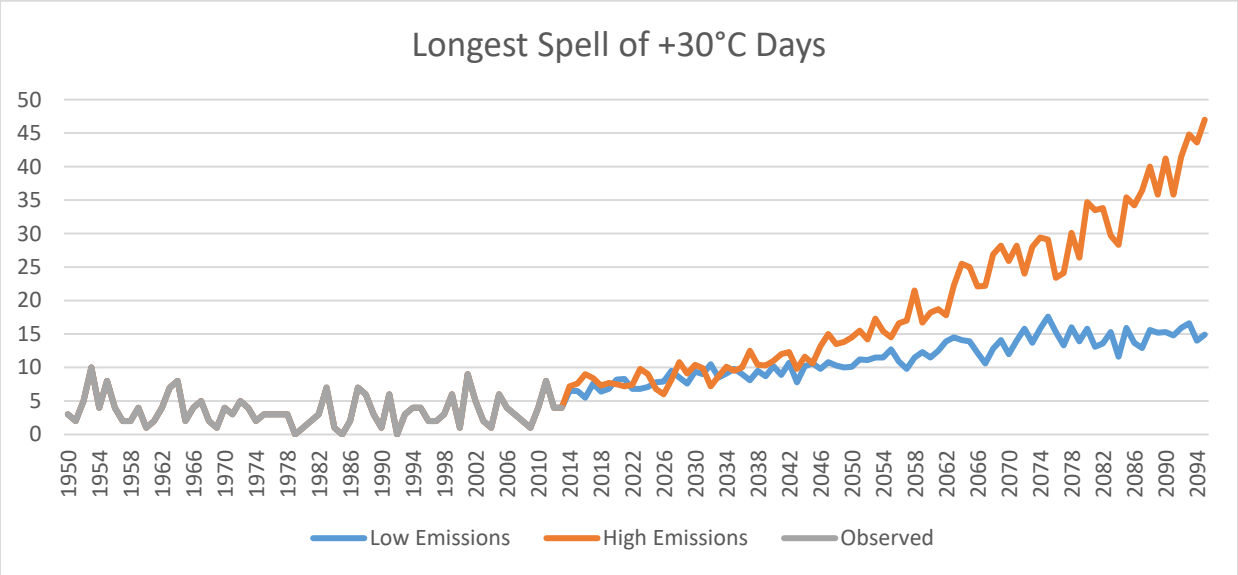

Figure 21: Longest Spell of +30°C Days for Chatham-Kent

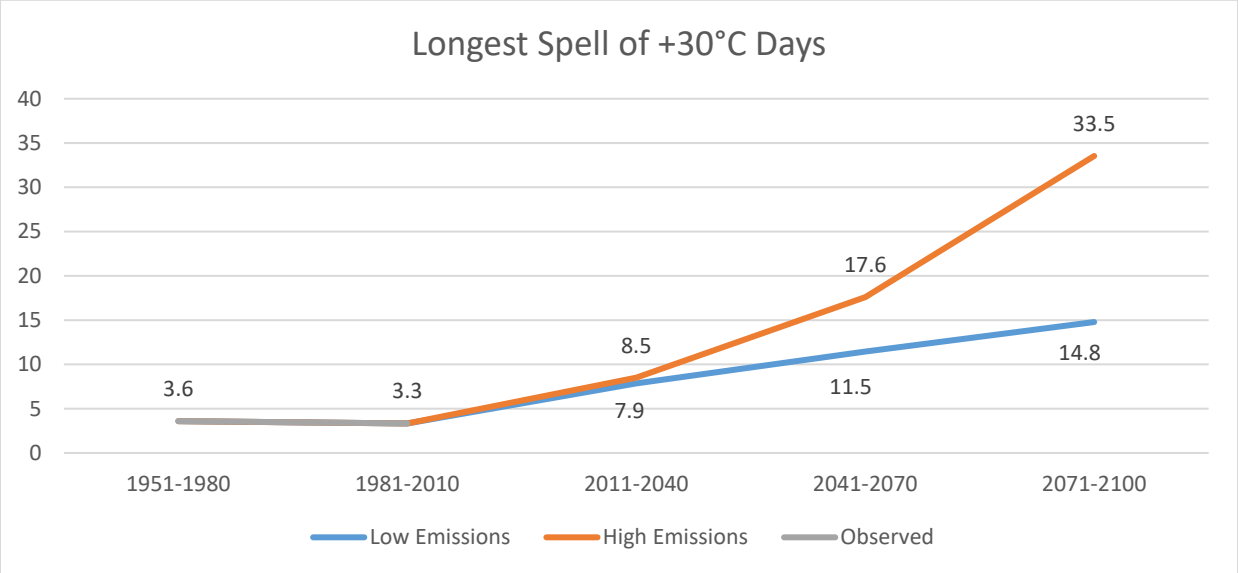

Figure 22: Heatwave Trends for Chatham-Kent

Interestingly, the historical climate record actually shows a small -0.3 day decline in the average length of heatwaves for Chatham-Kent in the 1990s time period compared to the 1951-1980 baseline. However, Ontario as a whole experienced an increase of +0.43 days in heatwave length during this time and the projected increases in the average length of heatwaves for Chatham-Kent for the latter half of the 21st century are significant for both emission scenarios studied in this report.

Under the low emissions scenario, heatwaves are projected to increase by an average +4.3 days per year by the 2020s, +7.9 days per year by the 2050s and by +11.2 days in the 2080s compared to the baseline time period. The projections for the 2080s under this scenario represents a 310% increase in the length of heatwaves compared to the baseline time period.

Under the high emissions scenario, the length of the average heatwave is projected to increase by an average of +4.9 days by the 2020s, +14 days by the 2050s and by +29.9 days by the 2080s compared to what Chatham-Kent experienced during the baseline time period. The projections for the 2080s under this scenario represents a +832% increase in the length of heatwaves compared to the baseline time period and suggests that heatwaves will routinely last for over a month's time.

Heating Degree Days (HDD10)

Heating Degree Days is an engineering concept that looks at the impact that outdoor temperatures have on the heating demand for buildings. It is based on the fact that cold outdoor temperatures increase heating demand for buildings whereas warmer outdoor temperatures decrease the amount of heat required to keep a building comfortable. In technical terms, Heating Degree Days 10 (or HDD10) is the sum of the difference between daily average temperatures and a base temperature of +10.0°C. Only days for which the mean temperature is less than +10.0°C are counted.

Figure 23 shows historical heating degree days per year in the Chatham-Kent climate record (grey line) as well as heating degree day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 24 (below) shows heating degree day trends for each of the five time periods examined in this report.

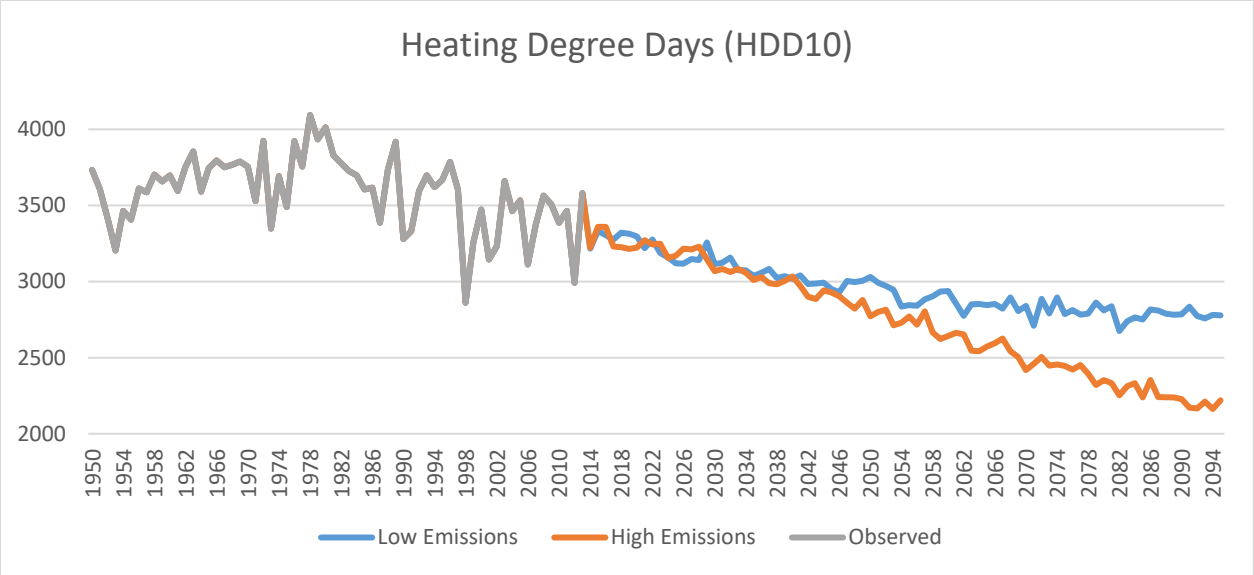

Figure 23: Annual Heating Degree Days for Chatham-Kent

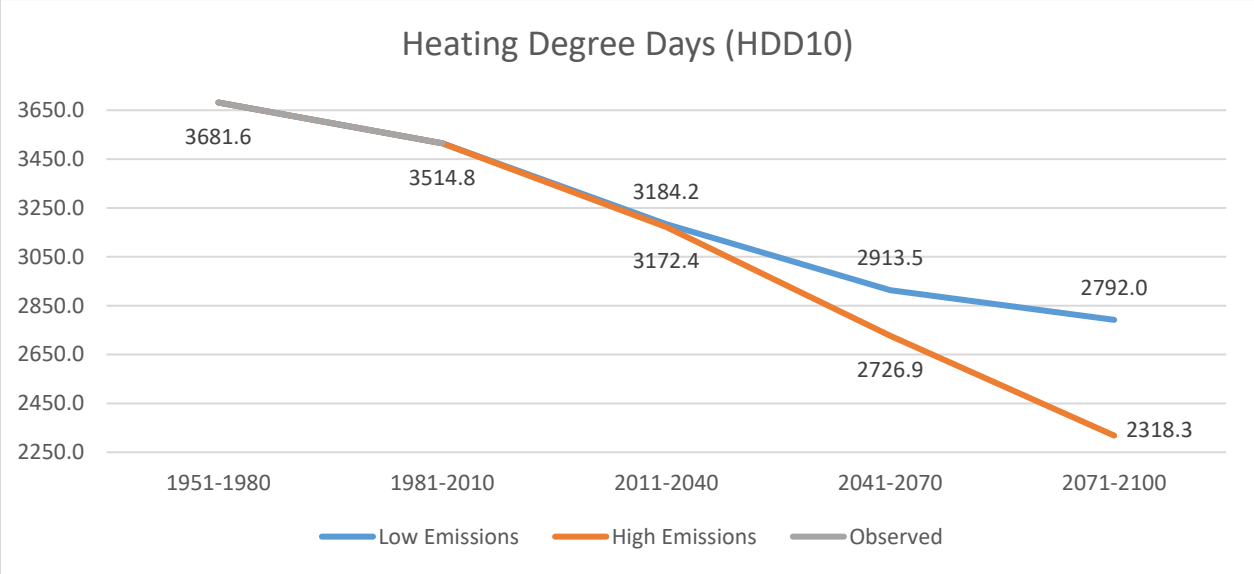

Figure 24: Heating Degree Days Trends for Chatham-Kent

The historical climate record shows that heating degree days in Chatham-Kent have decreases by -166.8HDD10 (-4.5% decrease) in the 1981-2010 time period compared to the 1951-1980 baseline.

Under the low emissions scenario, heating degree days are projected to decrease -13.5% by the 2020s, -20.9% by the 2050s and -24.16% by the 2080s compared to the baseline time period.

Under the high emissions scenario, heating degree days are projected to decrease by -13.8% by the 2020s, -25.9% by the 2050s and -37% by the 2080s compared to the baseline time period.

Cooling Degree Days (CDD18.3)

Similar to Heating Degree Days, Cooling Degree Days is another engineering concept, but one that quantifies the impact of outdoor temperatures on cooling demands for buildings. It is based on the fact that hot outdoor temperatures increase cooling demand on buildings whereas cooler outdoor temperatures decrease the amount of cooling required to keep a building comfortable. In technical terms: Cooling Degree Days +18.3 (or CDD18.3) is the sum of the difference between daily average temperatures and a base temperature of +18.3°C. Only days for which the mean temperature is greater than +18.3°C are counted.

Figure 25 shows observed cooling degree days per year in the Chatham-Kent climate record (grey line) as well as cooling degree day projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 26 (below) shows cooling degree day trends for each of the five time periods examined in this report.

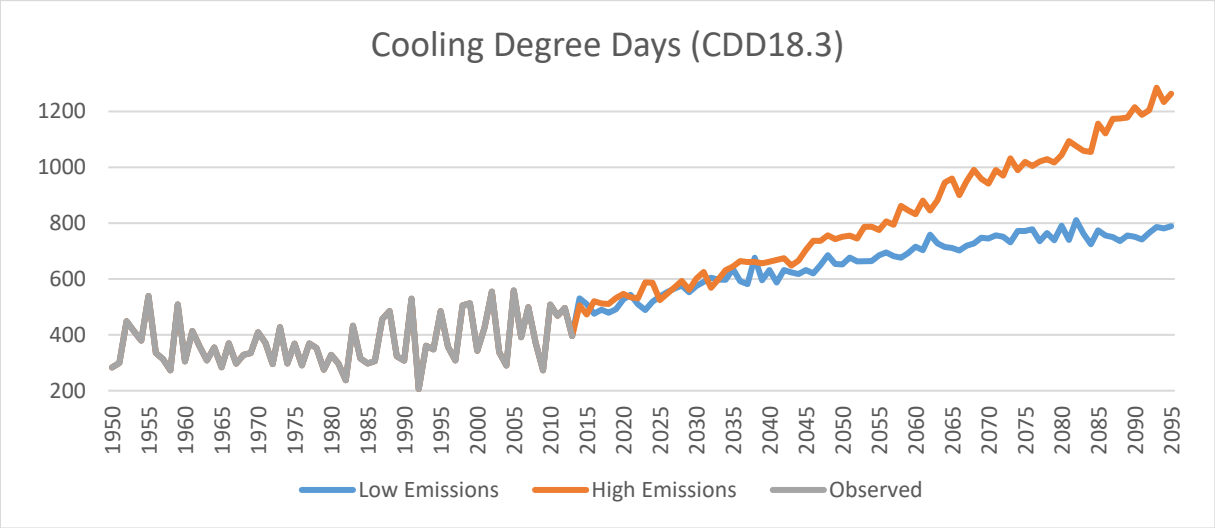

Figure 25: Annual Cooling Degree Days for Chatham-Kent

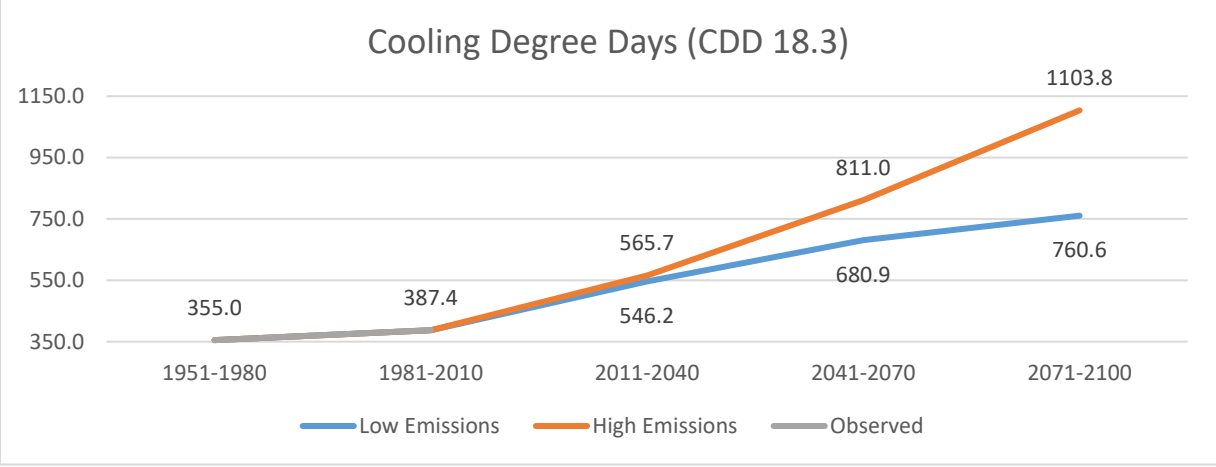

Figure 26: Cooling Degree Day Trends for Chatham-Kent

The historical climate record shows that cooling degree days have increased by an average of +9.1% in the 1981-2010 time period compared to the 1951-1980 baseline.

Under the low emissions scenario, cooling degree days are projected to increase by +53.8% change by the 2020s, +91.8% change by the 2050s and +114% change by the 2080s compared to the baseline. In other words, the low emission models are projecting more than a doubling of cooling loads in Chatham-Kent by the 2080s.

Under the business as usual scenario, cooling degree days are projected to increase by and average of +59.4% by the 2020s, +129% by the 2050s and +211% by the 2080s, which represents a tripling in cooling demand by the end of the 21st century compared to the baseline time period and suggests that air conditioners and other building cooling technologies are going to have to become 3 times as more productive to keep up with this increase in the demand for building cooling.

Total Annual Precipitation

Total annual precipitation adds up all forms of precipitation (i.e. rain, snow, sleet, hail etc.) that falls at a given location across a calendar year. Snow is added to the annual precipitation total as liquid water to make up the fact that snow is much less dense than rain.

Figure 27 shows total annual precipitation observations (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 28 shows average precipitation levels for each of the five time periods analyzed in this report.

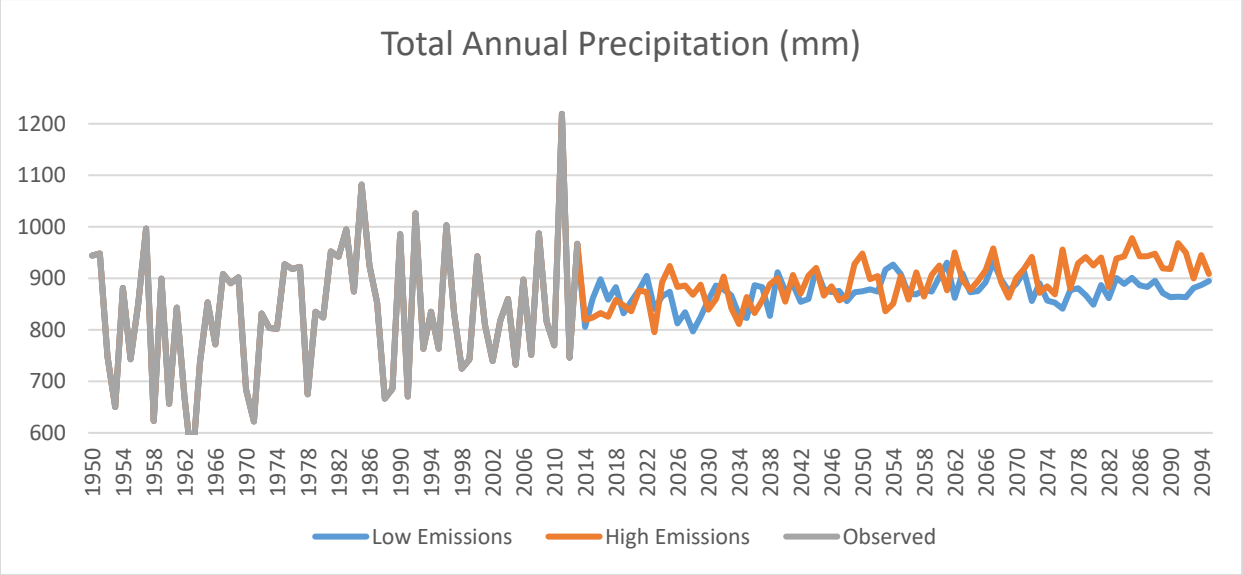

Figure 27: Total Annual Precipitation Levels for Chatham-Kent

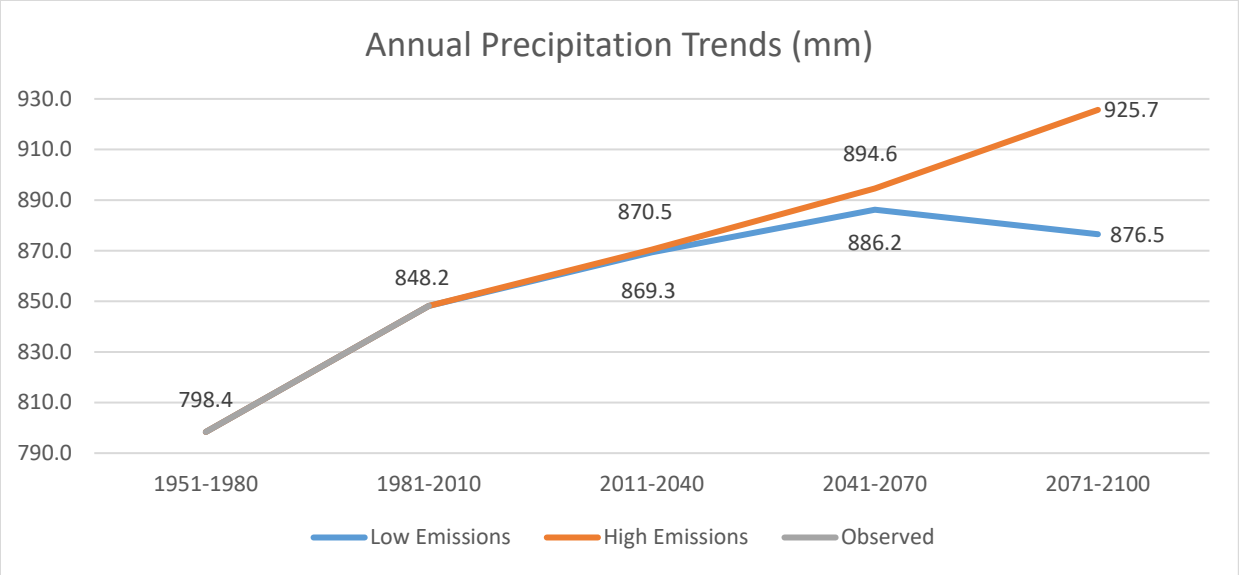

Figure 28: Total Annual Precipitation Level Trends for Chatham-Kent

Figure 28 shows that average total annual precipitation levels for the Municipality of Chatham-Kent were observed to be +49.8mm (+1.96 inches) higher in the 1990s time period compared to the 1951-1980 baseline.

Under the low emissions scenario, the climate models are projecting an increase in precipitation of +70.9mm by the 2020s, +87.8mm by the 2050s and +78.1mm by the 2080s compared to the baseline time period. Interestingly, the low carbon model projections suggest that annual precipitation levels would peak during the 2050s time period and then subsequently begin to trend downwards. In contrast, the high emission scenario models are projecting continued increases in precipitation levels throughout the 21st century.

The high emission models are projecting a +72.1mm rise in average annual precipitation levels by the 2020s, +96.2mm by the 2050s and +127.3mm (+5 inches) by the 2080s compared to the precipitation levels experienced in Chatham-Kent during the baseline time period.

Average Seasonal Precipitation

Average Seasonal Precipitation is a measure of the average precipitation levels across a season.

Figure 29 shows the observed average seasonal precipitation levels for the baseline (1951-1980) and the 1990s (1981-2010) time periods as well as projections for the 2020s, 2050s and 2080s under the low emissions scenario. Figure 30 shows the same historical seasonal precipitation levels shown in Figure 29 along with future seasonal precipitation projections for the high emissions scenario.

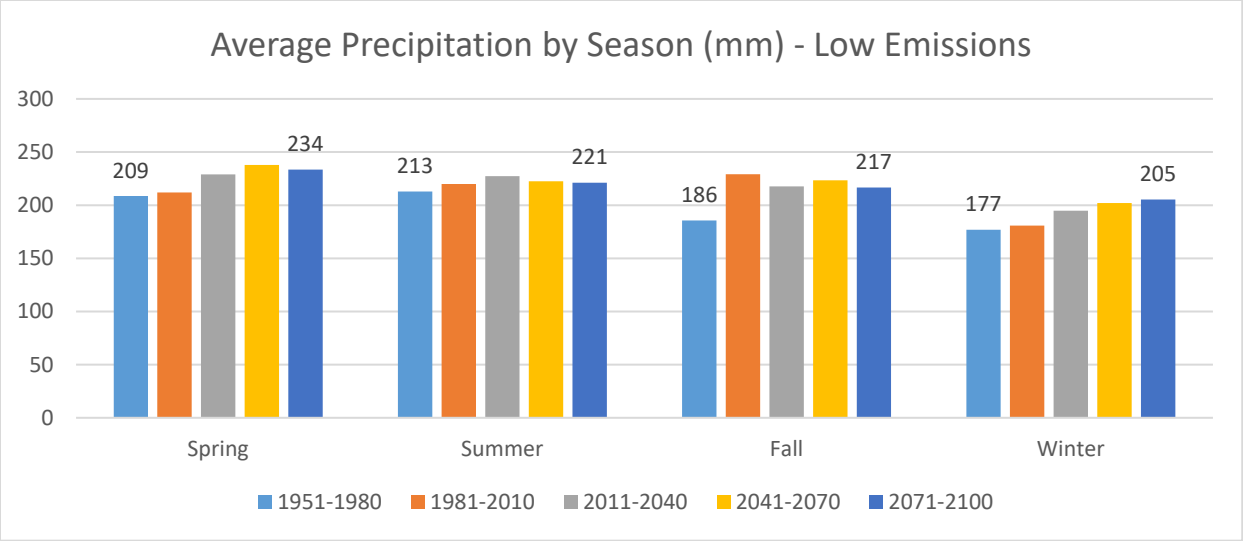

Figure 29: Average Seasonal Precipitation - Low Emission Scenario

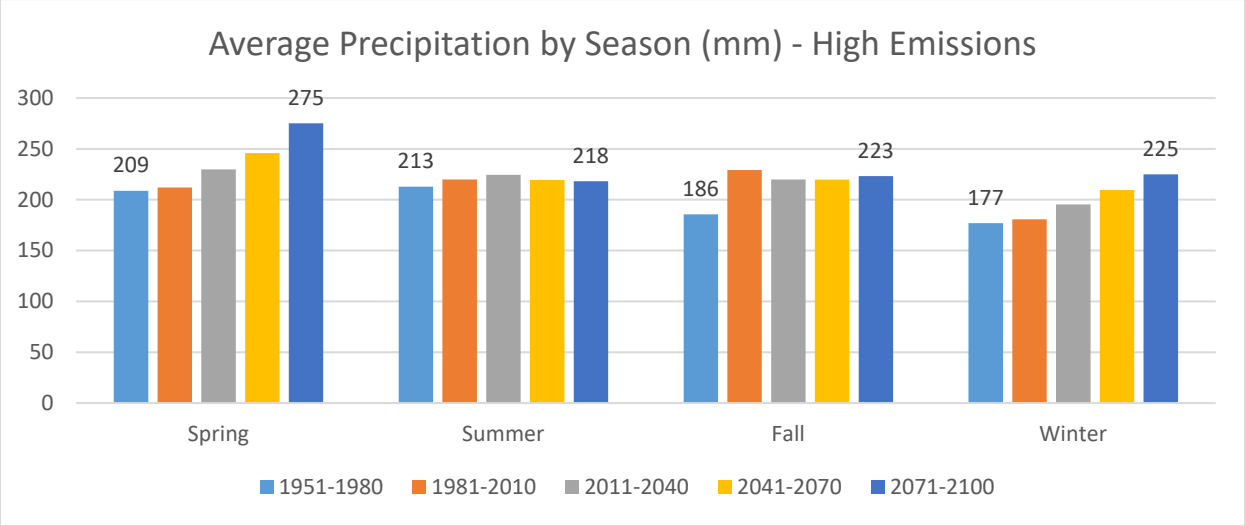

Figure 30: Average Seasonal Precipitation - High Emission Scenario

The historical climate record shows the following changes in average seasonal precipitation levels between the 1990s time period and the 1951-1980 baseline:

- Average spring precipitation is +3mm higher
- Average summer precipitation is +7mm higher
- Average Fall precipitation is +43mm higher
- Winter average precipitation levels is +4mm higher

Figure 31 shows the rate of change for seasonal precipitation levels between the 1990s and the baseline time periods. The majority of the increase in precipitation that Chatham-Kent has experienced during this time has occurred in the fall, which were comparatively much wetter than the other three seasons of the year.

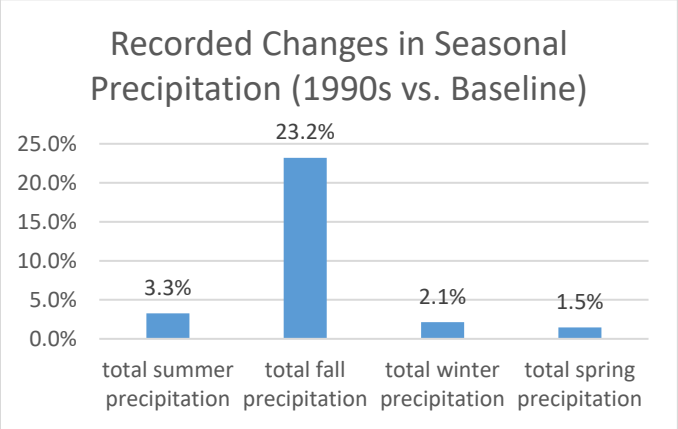

Figure 31: Recorded Changes in Seasonal Precipitation Levels - 1990s and Baseline Time Periods

With regards to climate projections for the low emissions scenario, the climate models are projecting that precipitation levels for all seasons except winter will peak at some point in the 21st century and then begin to slightly decrease thereafter. Average springtime precipitation levels are projected to peak at 238mm (+29mm over average baseline levels) during the 2050s and then decrease moderately to 234mm (+25mm over average baseline levels) per spring by the 2080s. Summer time average precipitation levels are projected to peak at 227mm (+14mm over average baseline levels) during the 2020s time period and then to 221mm (+8mm over average baseline levels) per summer by the 2080s. Fall time precipitation levels are actually projected to have peaked during the observed 1990s time period at 229mm (+43mm over average baseline levels) and are then expected to oscillate between 217-223mm (+31 to +37mm over average baseline levels) for the rest of the 21st century. Winter precipitation levels are projected to steadily increase from 177mm in the baseline time period to an average of 205mm (+28mm) per winter by the 2080s.

The high emissions scenario projects an increase in average springtime precipitation of +66mm, a summertime increase of only +5mm, a fall time increase of +37mm, and a winter time increase of +48mm by the 2080s compared to average precipitation levels recorded in the baseline time period.

Figure 32 shows the projected rate of change in the seasonal distribution of precipitation for both emission scenarios for the 2080s compared to those observed in the baseline time period. Under the low emissions scenario, the biggest increase in precipitation is expected occur in the fall at +17%, followed in by winter (+16%), spring (+12%) and summer (+4%). Much bigger increases in precipitation levels are expected for all seasons under the high emissions scenario except for summer. Springs are expected to experience the biggest increases at +32%, followed by winter (+27%), fall (+20%), and summer (+2%). In sum, summers are

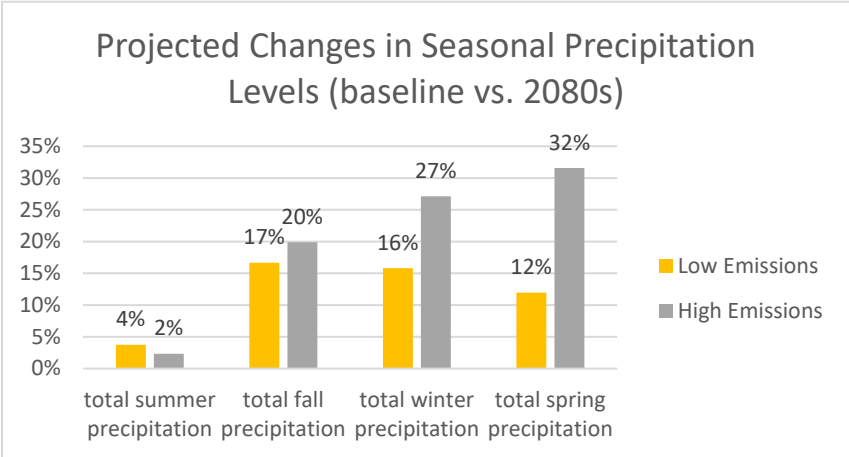

Figure 32: Projected Rate of Change in the Seasonal Precipitation Levels between the 2080s and the Baseline Time Period for both Emission Scenarios

expected to become comparatively dryer throughout the 21st century and planting and harvesting seasons are projected to become wetter as time goes by under both emissions scenarios, and especially so under the high emissions scenario.

Precipitation Days ≥ 10mm

Precipitation Days ≥ 10mm represents the number of days in a year when total daily precipitation levels in all forms meets or exceeds 10mm in liquid form.

Figure 33 shows the number of precipitation days ≥ 10mm observed on an annual basis (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 34 shows precipitation days ≥ 10mm trends for each of the five time periods analyzed in this report.

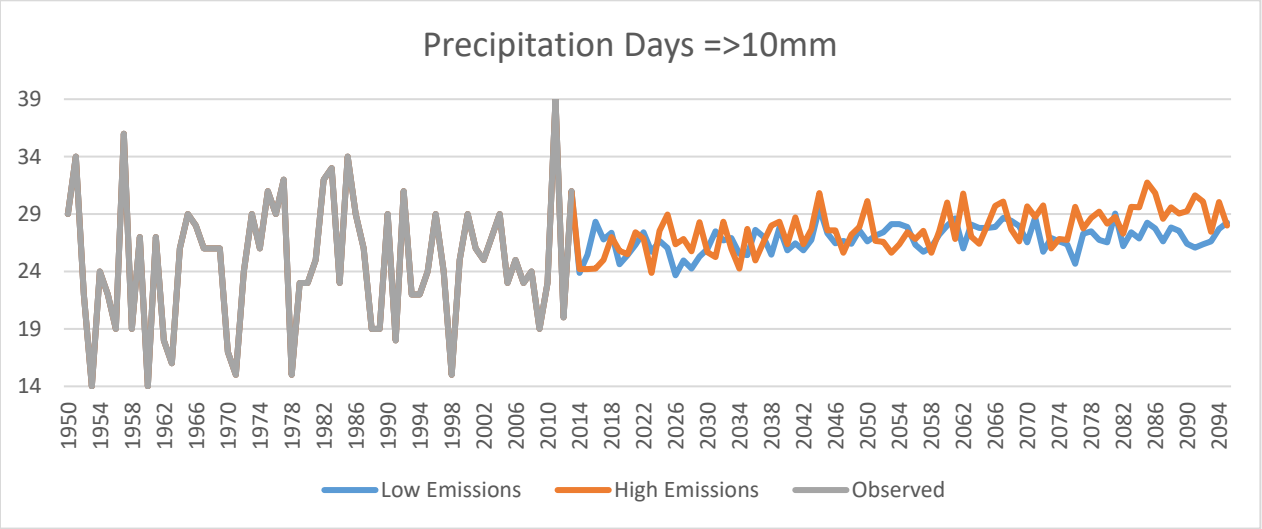

Figure 33: Precipitation Days ≥ 10mm for Chatham-Kent

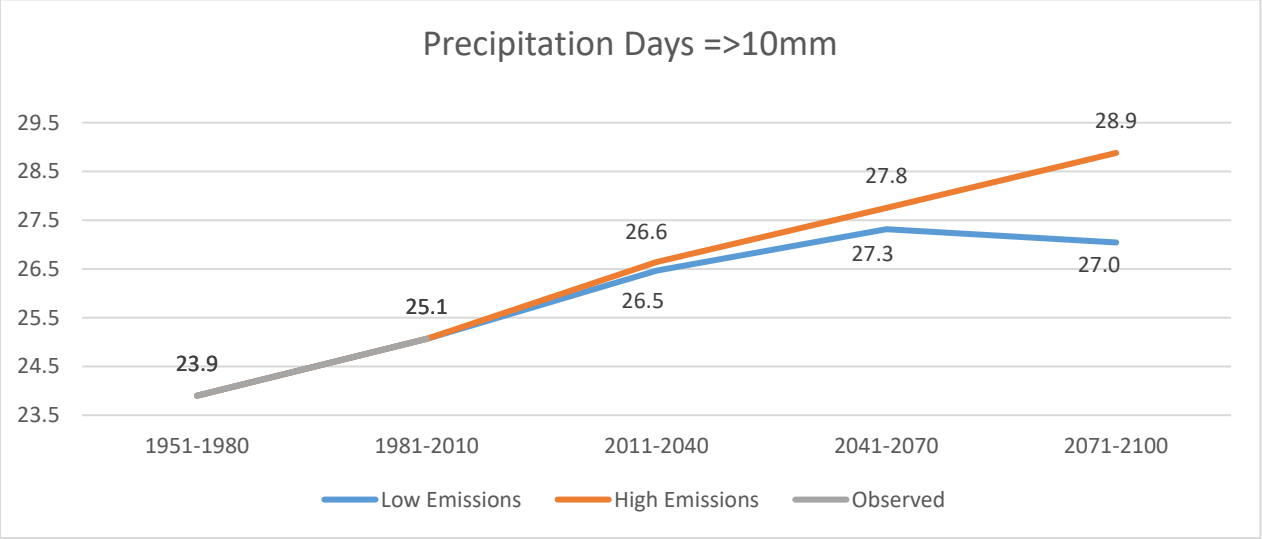

Figure 34: Precipitation Day ≥ 10mm Trends for Chatham-Kent

The historical climate record shows that the number of days where precipitation levels equaled or exceeded 10mm has increased from an average of 23.9 days per year in the baseline time period to an average of 25.1 days per year in the 1990s, a +1.2 day increase.

Under the low emissions scenario, precipitation days ≥ 10mm are projected to increase by an average of +2.6 days by the 2020s compared to the baseline, before peaking at an average of 27.3 days per year by the 2050s (a +3.4 day increase over the baseline) and then decreasing to 27 days per year by the 2080s (+3.1 day increase over the baseline). This finding is consistent with the total annual precipitation projections for the low emissions scenario discussed above which suggests that annual total precipitation levels should peak during the 2050s and then begin to trend downward.

Under the business as usual scenario, precipitation days ≥ 10mm are projected to increase throughout the 21st century. This includes a rise of by +2.7 days by the 2020s, +3.9 days by the 2050s and +5 days by the 2080s when compared to the baseline time period.

Precipitation Days ≥ 20mm

Precipitation days ≥ 20mm represents the number of days in a year when daily precipitation totals in all forms (rain, snow, hail, sleet etc.) meet or exceed 20mm in liquid form. Precipitation days ≥20mm provide an indication of the number of heavy rain and/or snow storms that Chatham-Kent experiences in a given year.

Figure 35 shows the number of precipitation days ≥ 20mm observed on an annual basis (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 36 shows precipitation days ≥ 20mm trends for each of the five time periods analyzed in this report.

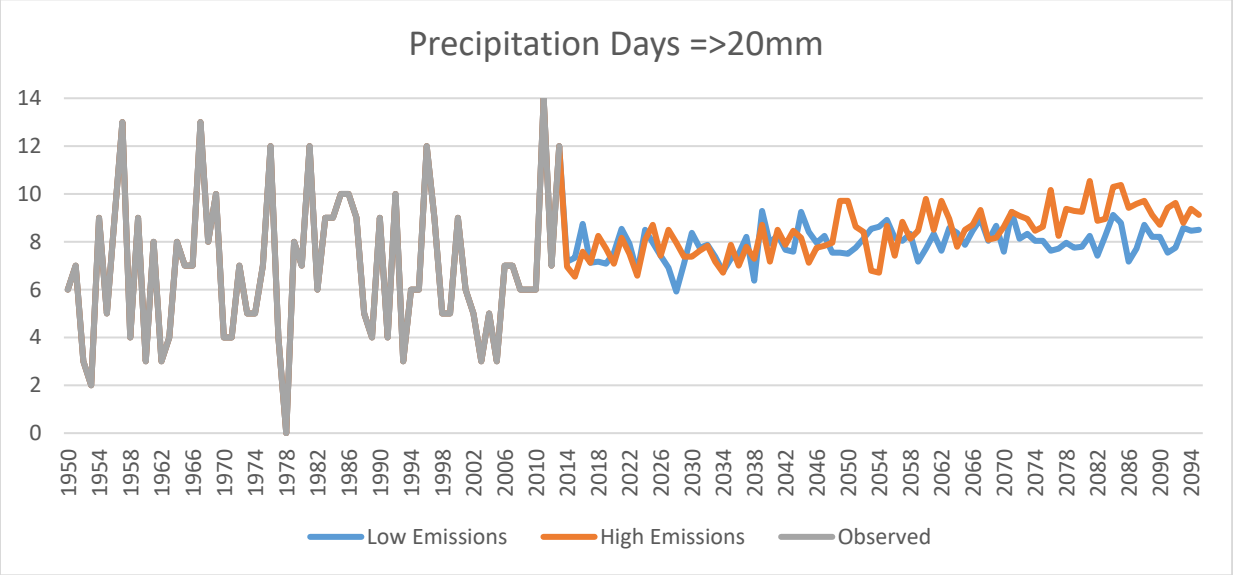

Figure 35: Precipitation Days ≥ 20mm for Chatham-Kent

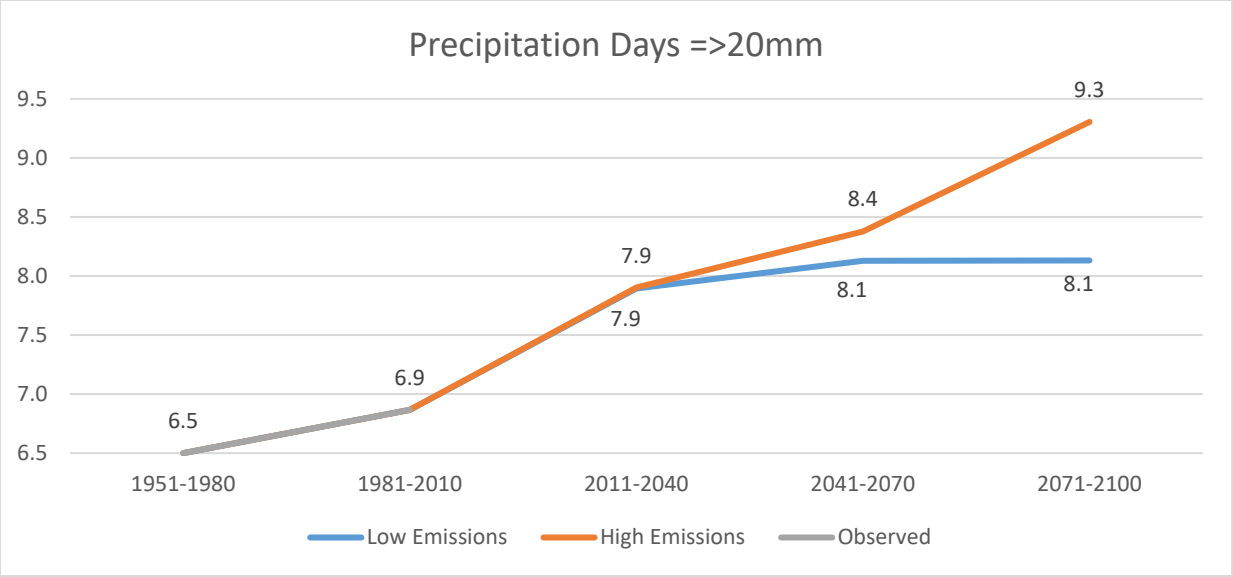

Figure 36: Precipitation Day ≥ 20mm Trends for Chatham-Kent

The historical climate record shows that Chatham-Kent experienced an average of 6.9 heavy precipitation days in the 1990s time period, an increase of +0.4 days from the average recorded during the 1951-1980 baseline time period.

Under the low emissions scenario, heavy precipitation days are projected to increase by +1.4 days per year for the 2020s time and then level off at 8.1 days per year for the rest of the 21st century. While the numerical increase between the number of heavy precipitation days between the baseline and the 2080s may seem relatively small at +1.6 days, this nevertheless represents a +25% increase in the average number of heavy precipitation days per year – a statistically significant increase.

Under the high emissions scenario, the number of heavy precipitation days are projected to increase by +1.4 days per year by the 2020s – the same increase as projected by the low emissions scenario – but are then projected to continue rising as the 21st century progresses rather than stabilizing by the 2050s as the low carbon scenario suggests will occur. The high emissions projects an increase of +1.9 days per year for the 2050s and an increase of +2.8 days per year by the 2080s compared to the baseline, which for the 2080s time period represents a +43% increase over the baseline.

Maximum 1-Day Precipitation

The Maximum 1-day precipitation climate indicator represents the amount of precipitation that falls on the single wettest day of a given year.

Figure 37 shows the amount of precipitation that was recorded on the single wettest day of the year (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 38 shows maximum 1-day precipitation trends for each of the five time periods analyzed in this report.

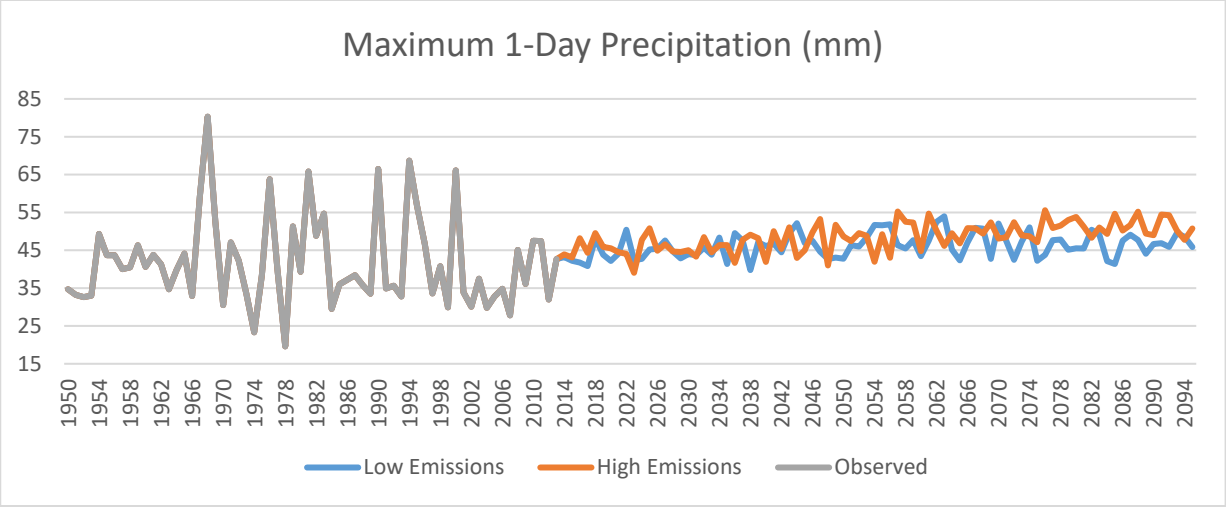

Figure 37: Maximum 1-Day Precipitation Levels for Chatham-Kent

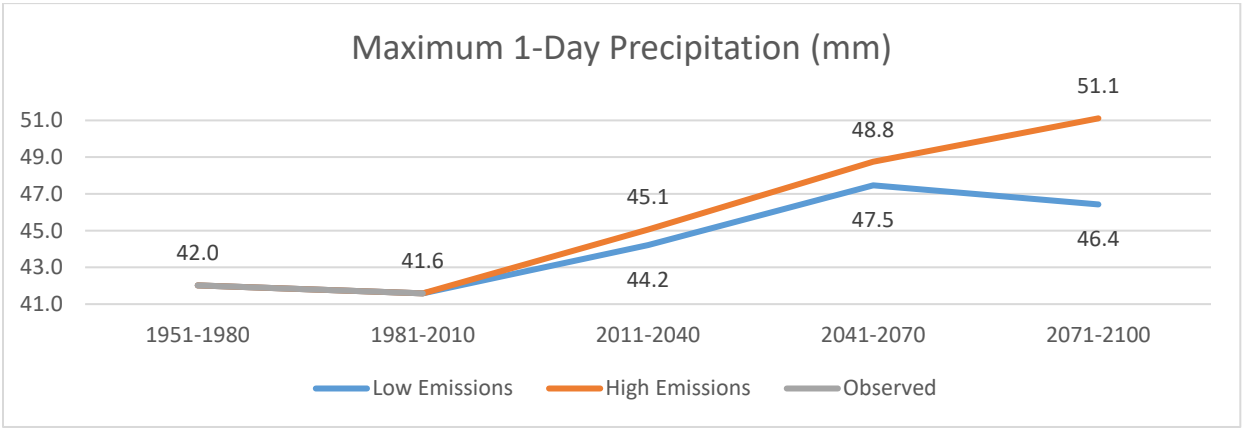

Figure 38: Maximum 1-Day Precipitation Level Trends for Chatham-Kent

The historical climate record shows that the average amount of precipitation that fell on the wettest day of the year in Chatham-Kent during the 1990s time period was -0.4mm lower then the average recorded during the 1951-1980 baseline. However, Ontario as a whole experienced an increase of +2.1mm in average maximum 1-day precipitation during this time. Both emission scenarios also project precipitation increases for Chatham-Kent for the 2020s and later time periods.

Under the low emissions scenario, the average maximum amount of precipitation received on the single wettest day of the year is projected to increase by an average of +2.2mm by the 2020s before peaking at +5.5mm above the baseline average in the 2050s and then subsequently declining to an average of +4.4mm over baseline by the 2080s. This finding is consistent the projections for the "average annual precipitation" indicator, the "precipitation days ≥ 10mm" indicator and the "precipitation days ≥20mm indicator" discussed previously which all suggest that the impacts of climate change on precipitation levels in Chatham-Kent will be more limited under a low emissions scenario than if the world maintains its existing emissions trajectory.

Under the high emissions scenario, the maximum 1-Day precipitation levels are projected to increase by an average of +3.1mm by the 2020s, +6.8mm by the 2050s and an average of +9.1mm by the 2080s compared to the baseline time period.

Maximum 5-Day Precipitation

The maximum 5-day precipitation indicator represents the amount of precipitation (in millimeters) that fall during the wettest 5-day period in a calendar year. This provides an indication of the severity of multi-day storm systems that Chatham-Kent has historically experienced and is projected to experience in the future.

Figure 39 shows the amount of precipitation that was recorded on the wettest 5-day period of the year (grey line) and projections for Chatham-Kent under the high emissions scenario (red line) and the low emissions scenario (blue line) from 1951 to 2095. Figure 40 shows maximum 5-day precipitation trends for each of the five time periods analyzed in this report.

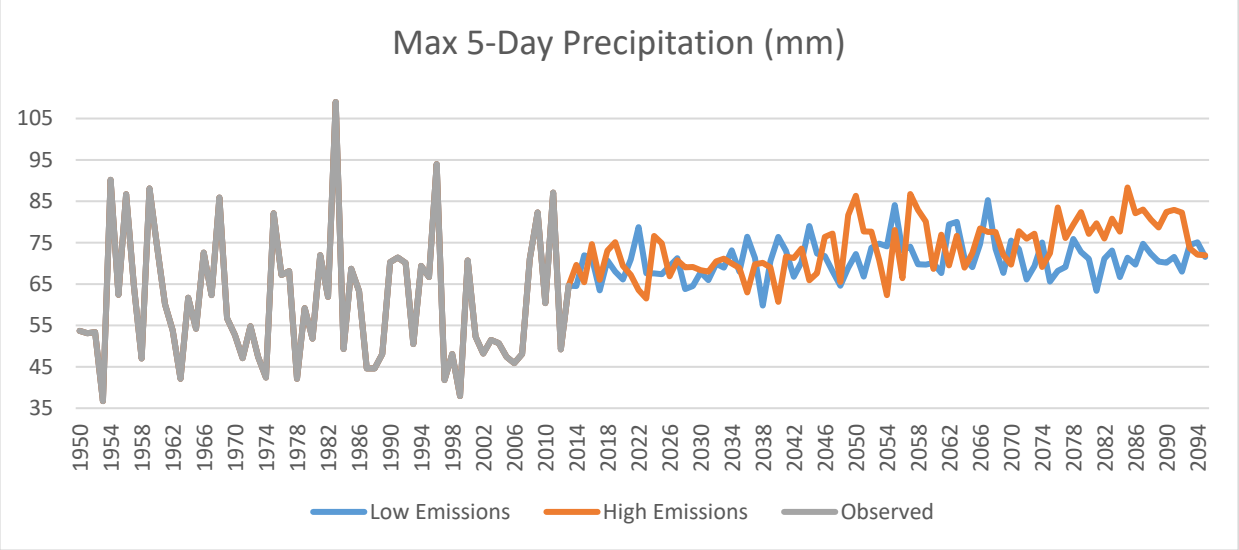

Figure 39: Maximum 5-Day Precipitation Levels for Chatham-Kent

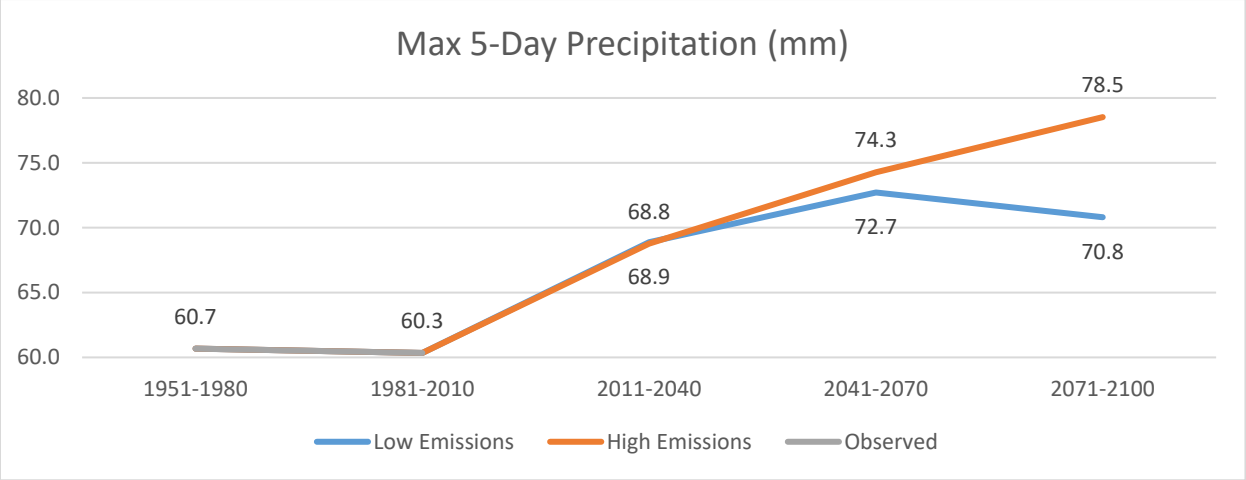

Figure 40: 30-Year Maximum 5-Day Precipitation Trends for Chatham-Kent

As with the Maximum 1-Day Precipitation indicator, the historical climate record does show a slight decline of -0.4mm in the amount of precipitation experienced by Chatham-Kent during the average wettest 5-day period for the 1990s time period compared to the baseline time. However, Ontario as a whole experienced an increase of +3.1mm in average maximum 5-day precipitation during this time and the climate models are projecting increases for Chatham-Kent under both emission scenarios as the century progresses.

Maximum 5-Day precipitation levels under the low emissions scenario are projected to increase by an average of +8.2mm by the 2020s before peaking at +12mm above the baseline time period in the 2050s and then subsequently declining to +10.1mm above baseline in the 2080s. Nevertheless, the change in precipitation levels projected for the 2080s does represent a +17% increase over the precipitation levels recorded during the baseline time period.

Under the high emissions scenario, the maximum 5-Day precipitation levels are projected in increase by an average of +8.1mm by the 2020s, +13.6mm by the 2050s and +17.8mm by the 2080s compared to the baseline. The increase projected for the 2080s represents a +29% increase in the amount of precipitation that is projected to fall in the wettest 5-day period in a year over the baseline time period.

Notes and Limitations

Although the future climate projections that are included in this report are based on recent internationally-recognized climate models, it is important to note that it is impossible to predict with absolute certainty that a specific projected change will occur. Much like financial projections made from economic models, climate models must factor in a host of variables that can affect the future. Any expectation of absolute confidence in economic, climate or any other modelled projection is in many ways unrealistic. That said, the level of confidence in climate models can be augmented by building more complex climate models as computing power and climate science evolve, using ensemble datasets (discussed previously) and comparing climate projections against what actually happens over time.

A recent paper publish in the Geophysical Research Letters in December of 2019 compared climate projections generated by several climate models developed between the 1970s and late 2000s against actual climate observations. The researchers found that they were "generally quite accurate in predicting global warming, (which) should increase our confidence that models are accurately projecting global warming"[2].

One of the ways that this analysis can be employed is to help to identify areas of higher and lower concern based on how big the change is expected to be, and how fast the change is expected to occur. When employed this way, this analysis can help inform the development of climate change action plans.

Data Sources

All climate data used to complete this analysis was obtained through https://climateatlas.ca/ and was valid as of July 10th 2019.

[2] https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019GL085378