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Historic Climate Trends & Future Projections in Huron County

Photos by Maitland Valley Conservation Authority

The Corporation of the County of Huron | Climate Change & Energy

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1. Introduction

The following document provides a summary of the historical trends and future climatic changes that are projected to occur in Huron County. This information was integral to developing Rooted in Resilience: Huron's Climate Action Strategy, as it provides context for which priority areas are identified. Due to the geographic expanse of the County, one centralized location (Clinton, Ontario) was chosen for this analysis. All climate projections were obtained from ClimateData.ca (2024), unless otherwise stated.

In order to understand the climate trends in Huron County, the following analysis has been organized by climate variables. Each variable is briefly defined, followed by an analysis of the observed trends and future projections by reference period and emission scenario (further explained in Table 1 and 2). All definitions have been adapted from ClimateData.ca (2024) and the Climate Atlas of Canada (PCC, 2023). Each variable is expressed as a range of values (i.e. the average minimum and maximum expected for a given period), and a median (i.e. the average of the median values within each range).

The following analysis utilized climate scenarios from the Coupled Model Intercomparison Project Phase 6 (CMIP6) global climate models (GCMs) which was used by the Intergovernmental Panel on Climate Change (IPCC) in their latest Assessment Report (AR6). CMIP6 projections are based on the Shared Socio-economic Pathway (SSP) scenarios.

Table 1. Reference periods as adapted from ClimateData.ca (2024).

Name of Period	General Reference Period	Specific Years of Reference
Baseline or Historic	1960s	1951-1980
Baseline or Historic	1990s	1981-2010
Near Term	2020s	2011-2040
Mid-Century	2050s	2041-2070
Late- or End of Century	2080s	2071-2100

Table 2. Emissions scenarios and representative concentration pathways (RCPs), as defined by ClimateData.ca.

Emissions Scenario	RCP	Characteristics
Low emissions scenario	RCP 2.6	• Assumes that greenhouse gas emissions will continue to increase until mid-century and then decline significantly by late-century • Level of emissions required to ensure the success of the Paris Agreement

Emissions Scenario	RCP	Characteristics
Moderate emissions scenario	RCP 4.5 or 6.0	• Assumes that greenhouse gas emissions will continue to increase (more slowly than they are today) until mid-century and then stabilize towards the end of the century
High emissions scenario	RCP 8.5	• Assumes that greenhouse gas emissions will continue to increase rapidly throughout the century • Described as the “business as usual” scenario • This pathway results in the most severe global warming and climate change

2. Climate Variables: Temperature

2.1 Mean Temperature

The mean temperature is the average temperature over a given period of time and is usually obtained by averaging the daily maximum and minimum temperatures. As the below data indicates, temperatures are rising in Huron County, and are projected to continue increasing under all emissions scenarios. If emissions continue to intensify, Huron County could expect an average annual temperature of close to 14°C (a 7-degree increase from historic levels) by 2100.

Table 1. Historic changes in mean temperature (°C) for Clinton, Ontario.

Parameter	1960s	1990s
Median	7.0	7.6
Range	6.0-8.0	6.7-8.7

Table 2. Projected changes in mean temperature (°C) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	8.9	10.0	10.1
Range	8.6-9.3	8.7-11.3	8.7-11.9

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	9.2	10.5	11.3
Range	9.0-9.3	9.2-11.8	10.0-13.1

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	9.2	11.3	13.7
Range	9.1-9.3	10.0-13.0	12.1-16.0

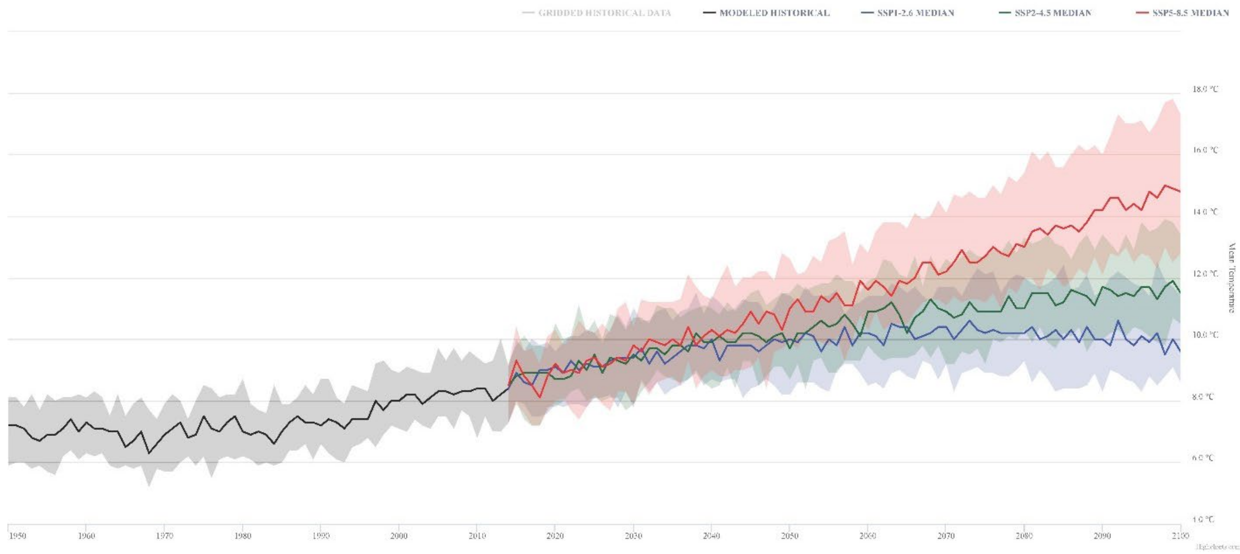

Figure 1. Projections of mean temperature (°C) in Clinton, Ontario under future emissions scenarios.

2.2 Minimum Temperature

The minimum temperature represents the average lowest temperature for a given time period and is derived by averaging all the daily minimum temperatures. The below data shows that minimum temperatures have risen in Huron County, and could see an increase of over 6°C by the end of this century under the highest emission scenario.

Table 3. Historic changes in minimum temperature (°C) for Clinton, Ontario.

Parameter	1960s	1990s
Median	2.4	3.1
Range	1.4-3.5	2.1-4.2

Table 4. Projected changes in minimum temperature (°C) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	4.4	5.4	5.5
Range	4.1-4.7	4.2-6.7	4.3-7.2

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	4.6	5.9	6.8
Range	4.4-4.7	4.7-7.2	5.6-8.5

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	4.7	6.8	9.2
Range	4.6-4.7	5.6-8.3	7.7-11.5

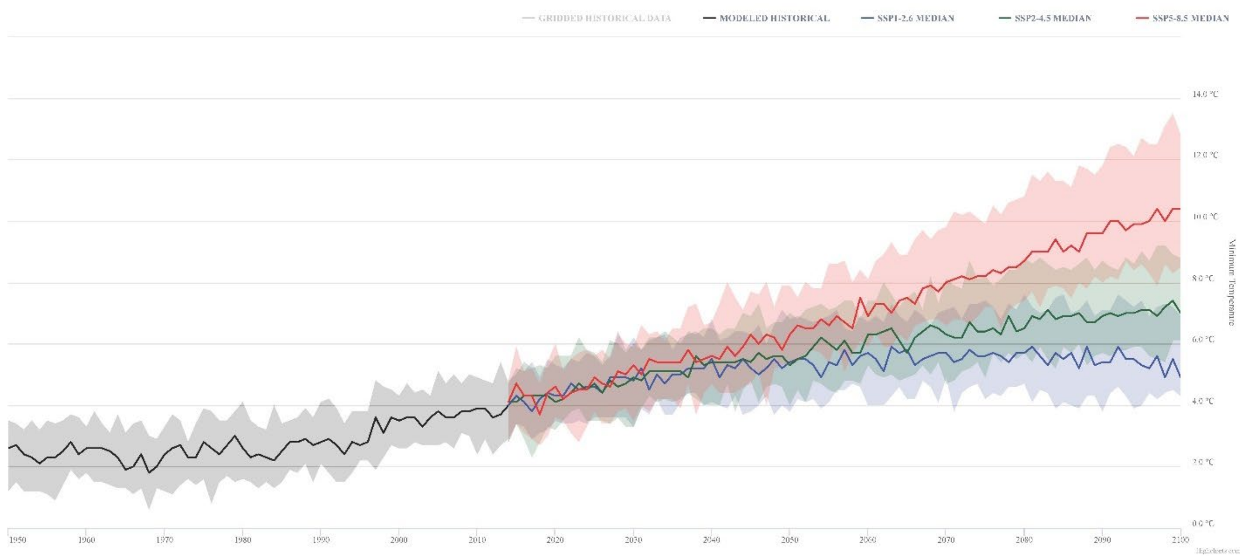

Figure 2. Projections of minimum temperature (°C) in Clinton, Ontario under future emissions scenarios.

2.3 Maximum Temperature

The maximum temperature represents the average highest temperature for a given time period and is derived by averaging all the daily maximum temperatures. The trends indicate that the maximum temperature has increased in Huron County, and it is projected to further increase by 6°C by 2100 under the highest emission scenario.

Table 5. Historic changes in maximum temperature (°C) for Clinton, Ontario.

Parameter	1960s	1990s
Median	11.6	12.2
Range	10.5-12.6	11.2-13.3

Table 6. Projected changes in maximum temperature (°C) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	13.5	14.6	14.7
Range	13.1-13.8	13.1-16.1	13.1-16.6

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	13.7	15.0	15.8
Range	13.5-13.8	13.6-16.5	14.4-17.8

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	13.8	15.8	18.2
Range	13.6-13.9	14.3-17.6	16.4-20.7

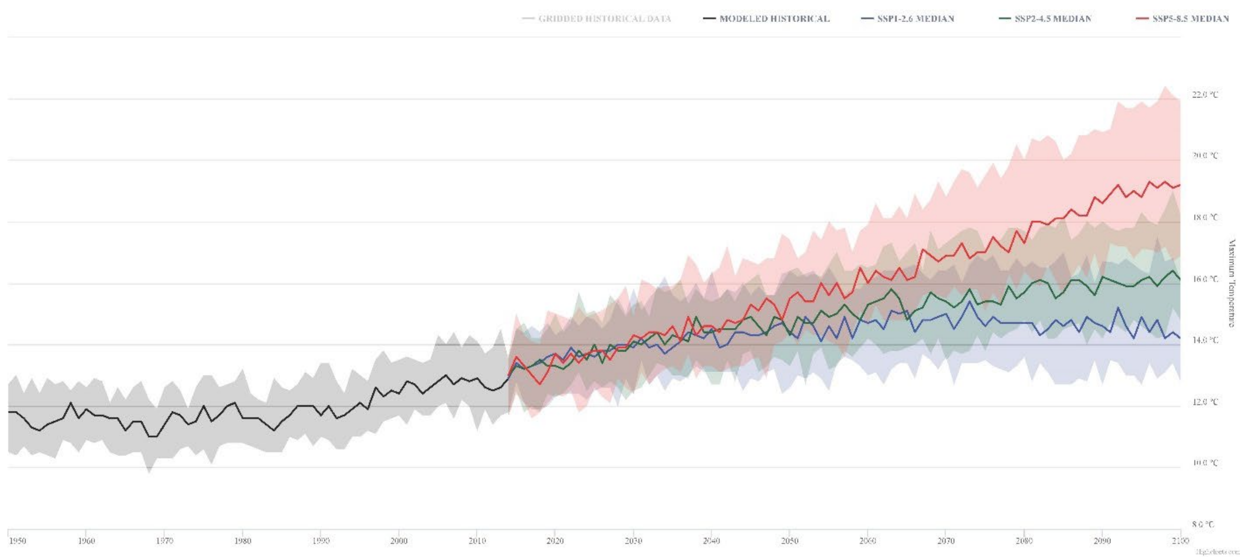

Figure 3. Projections of maximum temperature (°C) in Clinton, Ontario under future emissions scenarios.

2.4 Hottest Day

Hottest days refer to the highest maximum temperature within a given period. The data indicates that the temperature of the hottest day is increasing in Huron County and the hottest day could exceed 42°C by the end of the century, representing over a 10-degree increase from historic levels.

Table 7. Historic changes in the hottest day (°C) for Clinton, Ontario.

Parameter	1960s	1990s
Median	31.7	32.5
Range	30.2-33.8	30.8-34.4

Table 8. Projected changes in the hottest day (°C) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	33.9	34.9	34.8
Range	33.2-34.4	32.7-37.9	32.7-37.9

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	34.2	35.4	36.2
Range	33.8-34.3	33.2-38.2	34.0-39.7

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	34.2	35.9	38.6
Range	34.0-34.4	33.8-39.5	35.8-43.2

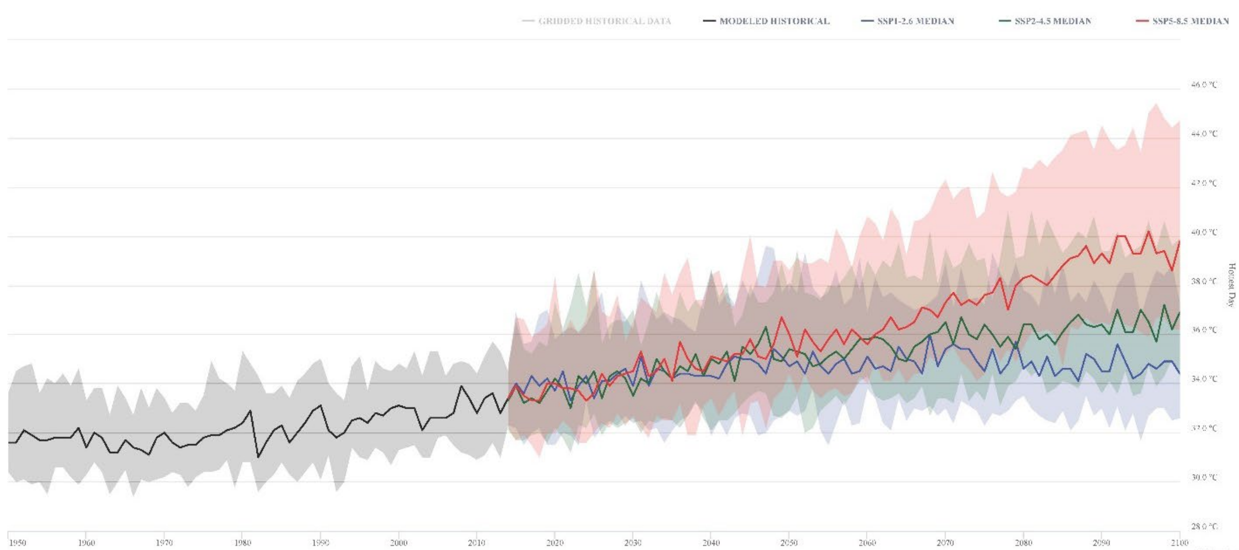

Figure 4. Projections of the hottest day (°C) in Clinton, Ontario under future emissions scenarios.

2.5 Coldest Day

Coldest days represent the lowest minimum temperature value within a given period. The data indicates that the coldest day is getting warmer in Huron County. Under a high emissions scenario, the coldest day is projected to increase by over 11 degrees by late century.

Table 9. Historic changes in the coldest day (°C) for Clinton, Ontario.

Parameter	1960s	1990s
Median	-23.2	-21.9
Range	-27.4-(-19.0)	-26.1-(-17.8)

Table 10. Projected changes in the coldest day (°C) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	-19.2	-17.4	-16.8
Range	-20.8-(-18.3)	-22.4-(-11.6)	-22.3-(-11.0)

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	-18.8	-16.1	-14.2
Range	-19.6-(-18.6)	-21.5-(-11.0)	-19.6-(-8.1)

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	-18.7	-14.2	-9.7
Range	-19.2-(-18.6)	-19.6-(-8.0)	-14.9-(-3.4)

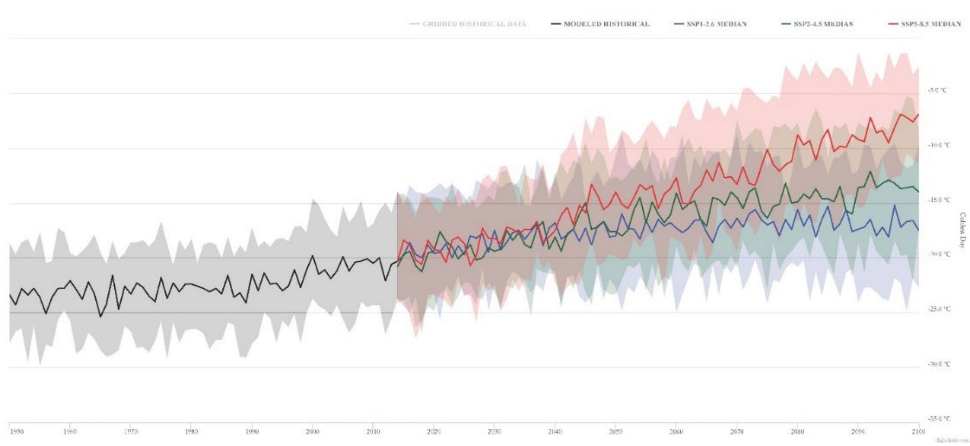

Figure 5. Projections of the coldest day (°C) in Clinton, Ontario under future emissions scenarios.

2.6 Very Hot Days

Very hot days refer to the number of days when the daily maximum temperature is greater than 30°C. This indicator is commonly used to measure the likelihood of heat-related health effects during summer months. The data indicates that the number of very hot days has increased in Huron County and is projected to continue increasing under all emissions scenarios. If emissions continue to rise, Huron County could experience over 32 more hot days each year.

Table 11. Historic changes in the number of days exceeding 30°C for Clinton, Ontario.

Parameter	1960s	1990s
Median	6.1	9.6
Range	1.6-14.1	3.2-19.5

Table 12. Projected changes in the number of days exceeding 30°C for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	17.4	27.1	27.7
Range	14.1-21.9	12.2-50.2	12.7-52.9

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	20.7	33.3	42.3
Range	18.7-22.2	16.2-56.9	23.6-72.4

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	21.4	41.9	74.2
Range	20.1-22.5	22.3-74.8	46.5-112

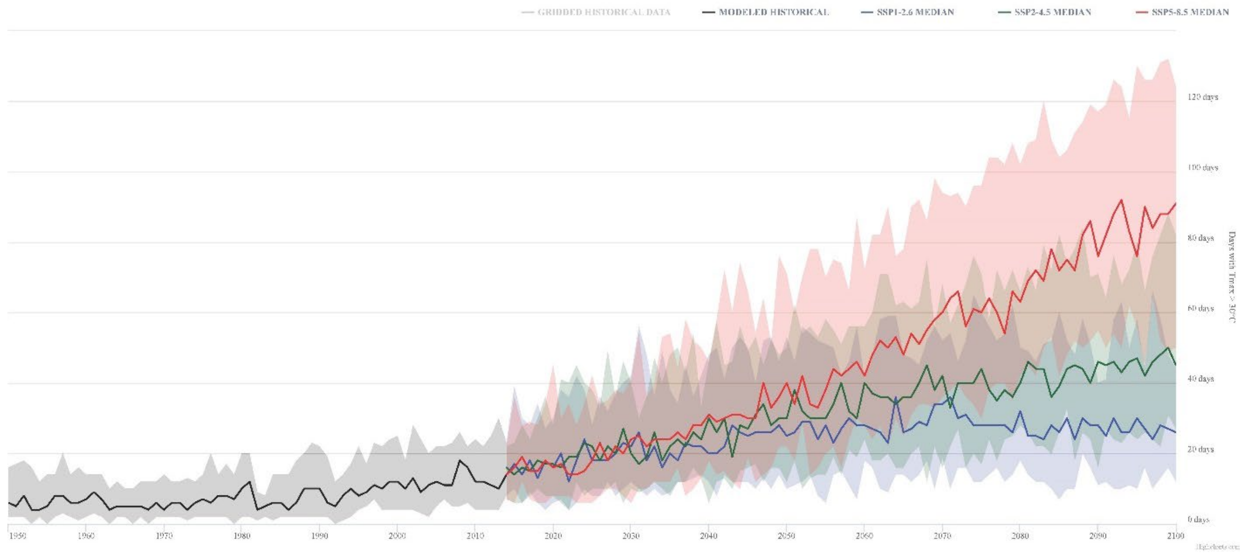

Figure 6. Projections of very hot days in Clinton, Ontario under future emissions scenarios.

2.7 Heat Waves

Heat waves are defined as a period of at least 3 consecutive days with temperatures above 30°C. Two parameters are of importance when analyzing this variable, including the average number of heat waves expected in a year, as well as the average length of time the heat wave is projected to last. Similar to very hot days, this indicator is commonly used to determine the likelihood of heat-related health effects.

The following data was obtained from the Climate Atlas of Canada (PCC, 2023). Due to variations in climate models, this data is representative of the Kitchener region and is expressed as median values.

The data indicates that historically, this area has experienced on average 1 heat wave a year, lasting approximately 2 days. Under future emissions scenarios, the frequency and duration of heat waves are projected to increase. By late century, Huron County could experience 7 heat waves a year, each of which has the potential to persist for 9 days.

Table 13. Historic changes in the average number and length of heat waves for Kitchener, Ontario.

Parameter	1960s	1990s
Number	1.1	1.0
Length	2.2	2.1

Table 14. Projected changes in the average number and length of heat waves in Kitchener, Ontario.

A. RCP 4.5

Parameter	2020s	2050s	2080s
Number	3.0	4.5	5.2
Length	4.3	5.2	6.0

B. RCP 8.5

Parameter	2020s	2050s	2080s
Number	3.1	5.5	7.1
Length	4.5	6.4	9.3

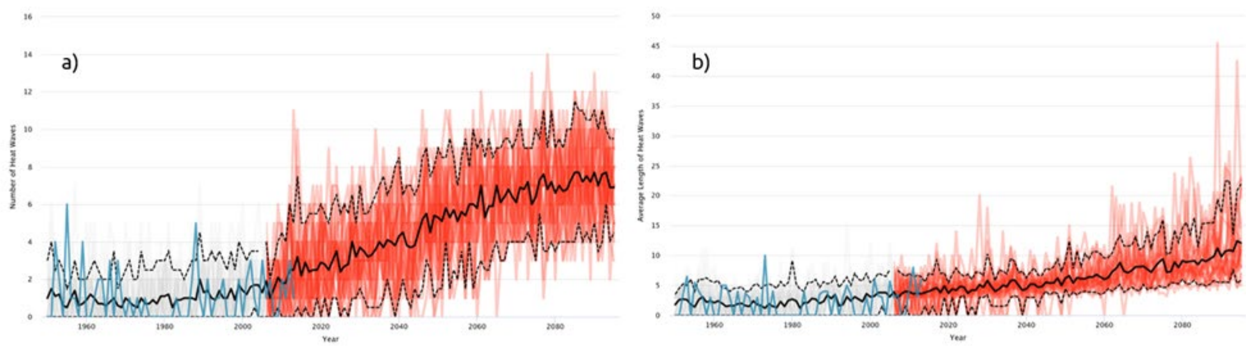

Figure 7. Projections of the average number (a) and length (b) of heat waves under future high emissions scenarios in Kitchener, Ontario.

3. Climate Variables: Precipitation

3.1 Total Precipitation

Total precipitation is the total amount of precipitation (including rain and snow) accumulated over a given period. Precipitation is commonly measured over the span of a year and referred to as the annual or total precipitation. For Huron County, total precipitation has increased since the 1960s, and it is projected to increase by over 120 mm by the end of the century.

Table 1. Historic changes in total precipitation (mm) for Clinton, Ontario.

Parameter	1960s	1990s
Median	951.3	961.6
Range	826.5-1083.7	829.6-1102.0

Table 2. Projected changes in total precipitation (mm) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	1010.0	1021.8	1036.3
Range	946.5-1020.7	878.0-1179.0	878.8-1208.4

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	1011.7	1034.1	1058.4
Range	984.3-1016.1	887.9-1209.0	904.6-1237.1

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	1012.4	1050.7	1096.3
Range	994.6-1015.4	891.5-1218.0	933.4-1297.9

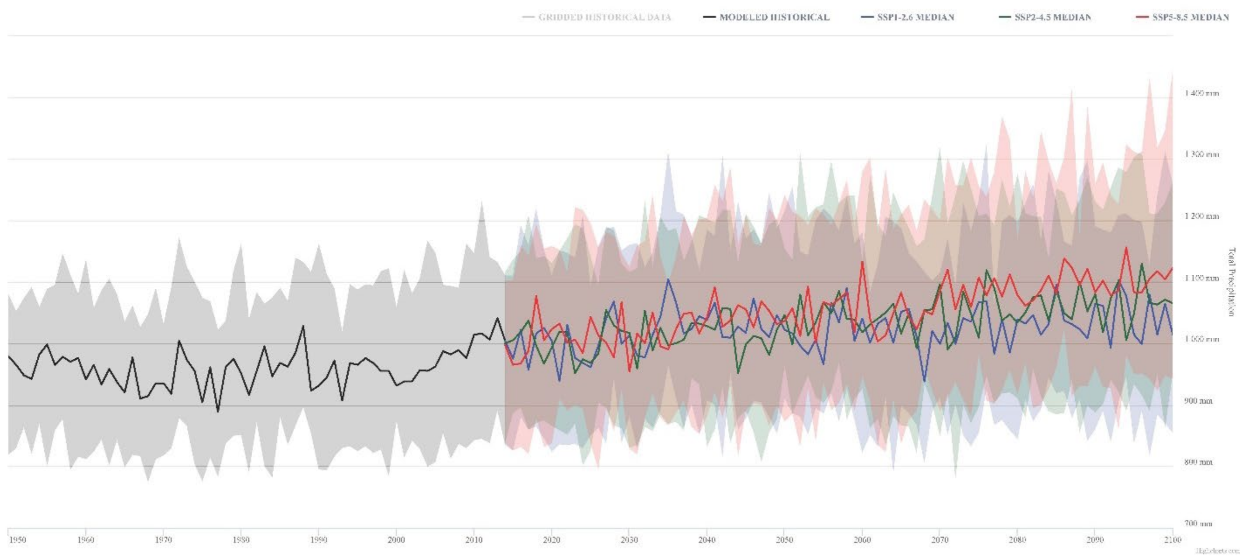

Figure 1. Projections of total precipitation (mm) in Clinton, Ontario under future emissions scenarios.

3.2 Maximum 1-Day Total Precipitation

Maximum 1-day total precipitation is a measure of the largest precipitation total on a single day. This indicator is particularly useful for analyzing the localized impacts of heavy rain events, including flooding and runoff. The data indicates that the maximum 1-day total precipitation in Huron County is projected to increase slightly under future scenarios, with a potential 8 mm increase by 2100.

Table 3. Historic changes in maximum 1-day total precipitation (mm) for Clinton, Ontario.

Parameter	1960s	1990s
Median	36.1	37.1
Range	26.9-54.7	27.0-56.8

Table 4. Projected changes in maximum 1-day total precipitation (mm) for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	40.5	39.9	40.5
Range	35.5-43.3	28.5-62.6	29.4-64.8

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	41.8	41.5	42.3

Parameter	2020s	2050s	2080s
Range	39.4-43.6	29.5-62.1	31.0-68.3

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	42.8	42.3	45.9
Range	41.1-43.6	30.6-65.4	32.7-70.2

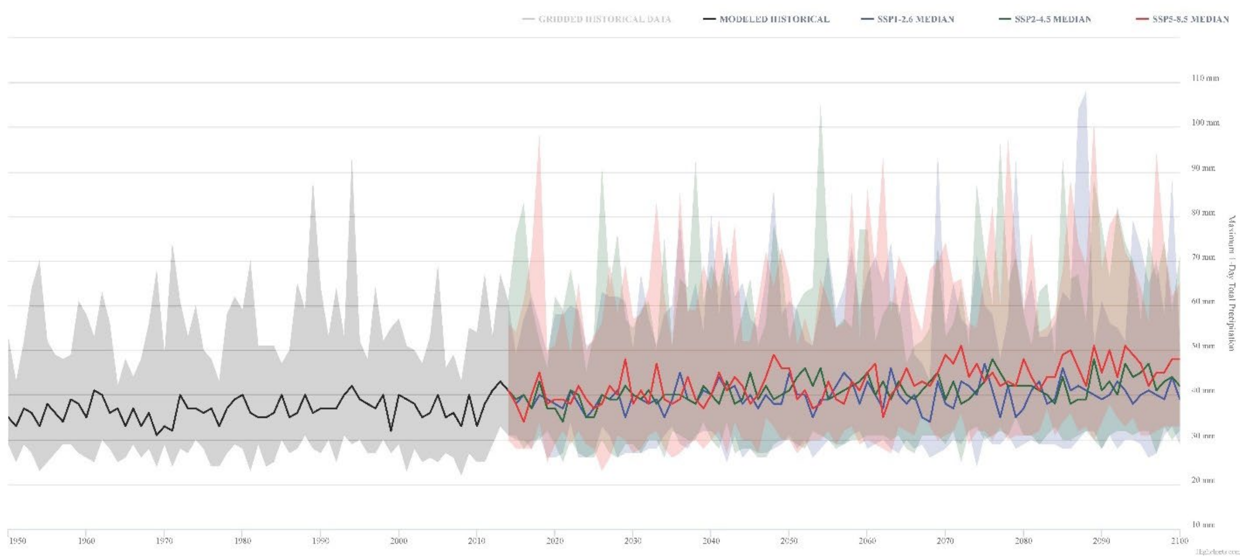

Figure 2. Projections of maximum 1-day total precipitation (mm) in Clinton, Ontario under future emissions scenarios.

3.3 Wet Days

Wet days represent the number of days with daily precipitation totals exceeding 10 or 20 mm. These days are also referred to as heavy precipitation days, and similar to the previous variable are useful for determining risks associated with heavy rain events. This variable is separated by differing intensities as the enormity of future projections depends on the historic rainfall of a given location. For example, some areas rarely experience 10 mm of rain, while others commonly exceed this threshold.

In regards to wet days in Huron County, it appears that both intensities have experienced slight increases over the baseline period, with historically fewer days of precipitation exceeding 20 mm. Under future emissions scenarios, the number of wet days is projected to increase by over 5 days with 10 mm and 3 days with 20 mm, by the end of the century.

Table 5. Historic changes in the number of wet days over 10 and 20 mm for Clinton, Ontario.

A. 10 mm

Parameter	1960s	1990s
Median	26.5	27.0
Range	20.4-32.7	20.6-33.8

B. 20 mm

Parameter	1960s	1990s
Median	5.2	5.7
Range	2.8-8.5	3.1-9.0

Table 6. Projected changes in wet days over 10 mm for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	28.6	29.5	29.7
Range	25.9-29.4	22.0-36.5	22.7-38.1

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	29.0	30.3	30.8
Range	27.7-29.1	23.2-37.8	23.8-38.8

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	28.9	30.8	32.8
Range	28.0-29.0	23.8-38.2	25.5-41.3

Table 7. Projected changes in wet days over 20 mm for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	6.7	6.7	7.0
Range	5.5-7.0	3.9-10.4	4.1-10.6

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	6.8	7.1	7.7
Range	6.2-6.9	4.1-10.9	4.5-11.7

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	6.9	7.6	8.9
Range	6.5-7.0	4.0-11.4	5.4-13.5

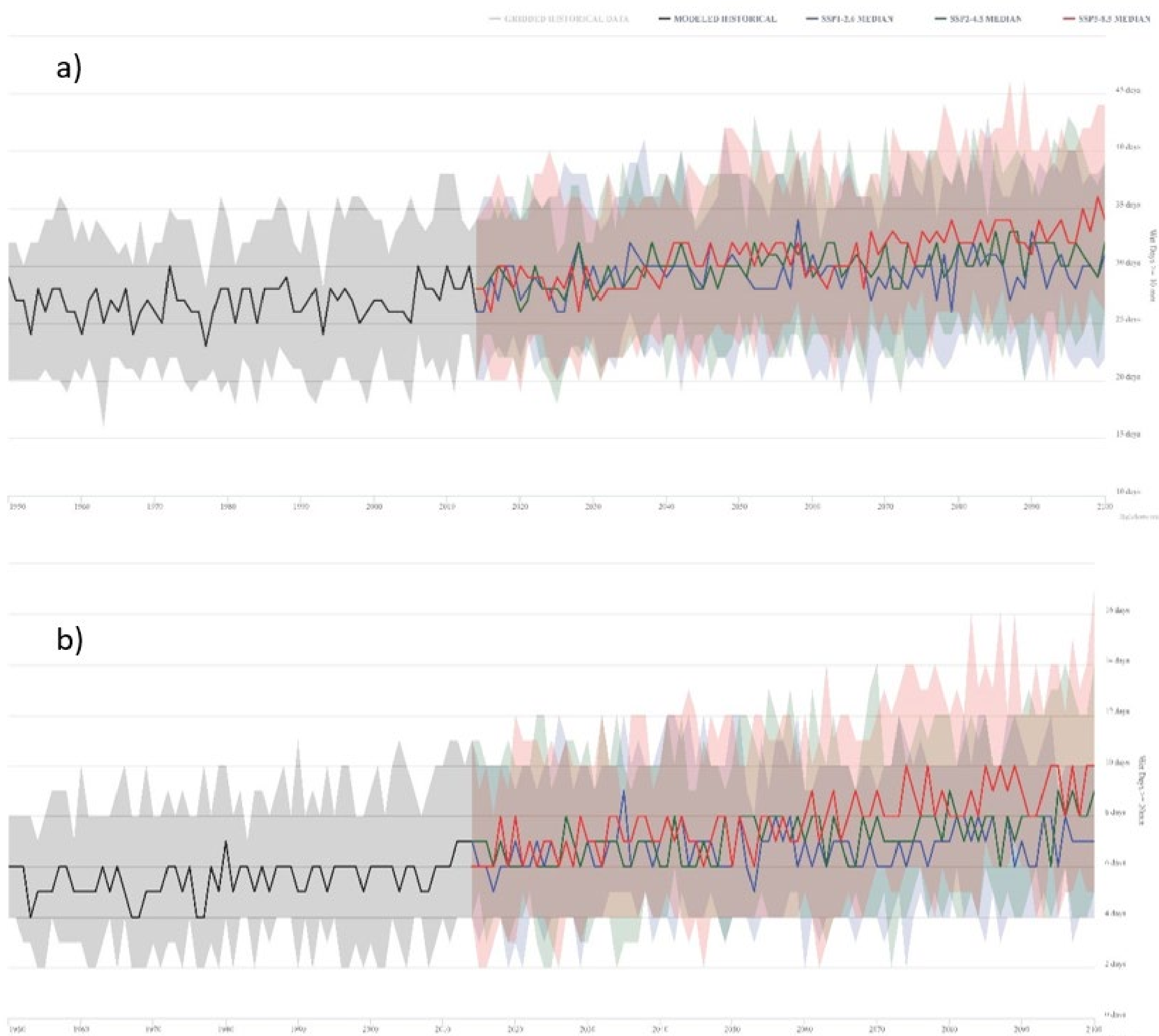

Figure 3. Projections of wet days over 10 (a) and 20 mm (b) in Clinton, Ontario under future emissions scenarios.

4. Climate Variables: Other Parameters

4.1 Frost Days

Frost days refer to the number of days with daily minimum temperatures less than 0°C, which indicates when conditions are below freezing. This is useful as it represents the duration and intensity of winter, which may affect the growing season and other factors related to everyday life (i.e. human health, transportation, and outdoor activities).

The data indicates that the number of frost days in Huron County is decreasing and is projected to decrease by over half by the late century under a high emissions scenario.

Table 1. Historic changes in the number of frost days for Clinton, Ontario.

Parameter	1960s	1990s
Median	147.9	140.1
Range	132.8-163.0	124.1-154.5

Table 2. Projected changes in the number of frost days for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	125.6	112.8	112.0
Range	116.1-123.6	89.3-130.5	81.2-130.4

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	123.1	106.3	94.5
Range	119.2-122.6	81.7-126.8	57.3-116.0

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	122.4	95.7	62.4
Range	119.7-121.8	58.6-116.1	19.1-91.0

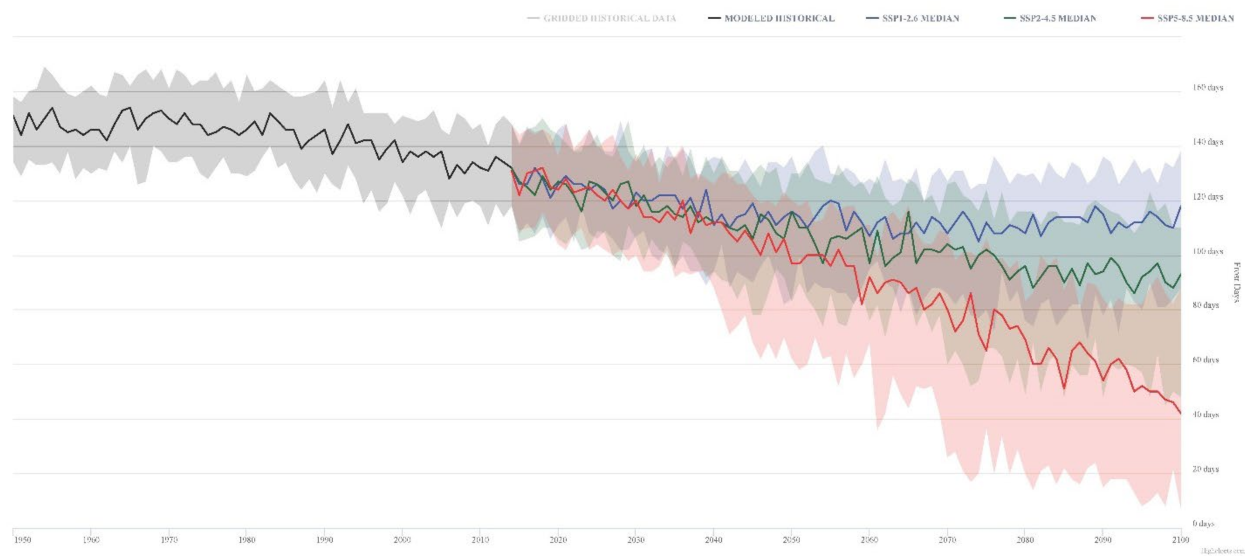

Figure 1. Projections of the number of frost days in Clinton, Ontario under future emissions scenarios.

4.2 Cooling Degree Days

Cooling degree days (CDD) are equal to the number of degrees a given day's mean temperature is above 18°C. For example, a daily mean temperature of 21°C would result in a CDD value of 3. CDDs are useful as they indicate the amount of air conditioning that may be required to maintain comfortable indoor temperatures during warmer months. Furthermore, an increase in CDD values implies rising temperatures, which may impact energy demand and human health.

For Huron County, the below data indicates that CDDs have risen over the baseline period, which suggests a rise in mean temperatures during the summer months. Under all emissions scenarios, CDDs are projected to increase, with the potential for this value to almost quadruple by late century.

Table 3. Historic changes in cooling degree days for Clinton, Ontario.

Parameter	1960s	1990s
Median	190.9	242.5
Range	123.9-278.2	165.9-335.2

Table 4. Projected changes in cooling degree days for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	335.2	430.3	449.3
Range	306.0-372.9	301.4-604.5	301.8-635.3

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	361.3	488.3	581.6
Range	344.0-374.0	342.6-670.3	420.4-822.3

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	367.8	569.4	911.3
Range	356.7-378.9	417.9-835.1	631.0-1327.9

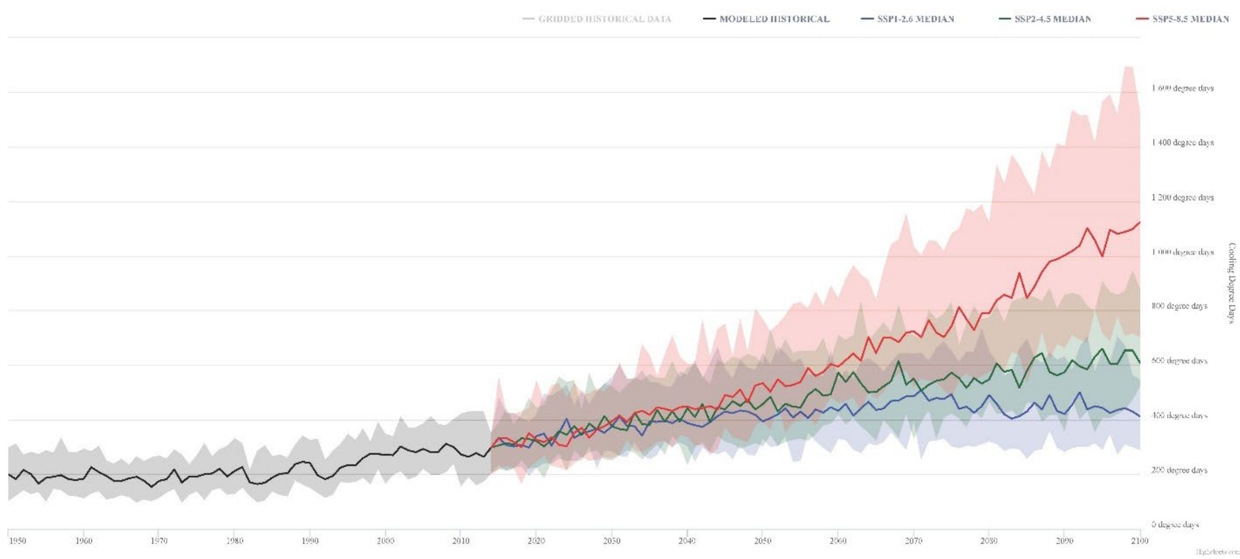

Figure 2. Projections of cooling degree days in Clinton, Ontario under future emissions scenarios.

4.3 Heating Degree Days

Heating degree days (HDD) are equal to the number of degrees a given day's mean temperature is below 17°C. For example, a daily mean temperature of 12°C would accrue an HDD value of 5. HDDs are useful as they provide an indication of the amount of heating that may be required to maintain comfortable indoor temperatures during colder months. A decrease in HDD values is indicative of shorter and less severe winters. For Huron County, the below data indicates that HDDs have decreased over the baseline period, which suggests a rise in mean temperatures during winter months. This trend is projected to continue under all future emissions scenarios.

Table 5. Historic changes in heating degree days for Clinton, Ontario.

Parameter	1960s	1990s
Median	4204.6	4019.1
Range	3877.6-4554.1	3684.1-4339.1

Table 6. Projected changes in heating degree days for Clinton, Ontario, relative to the baseline.

A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	3647.8	3355.5	3321.1
Range	3453.1-3595.1	2966.9-3744.9	2834.2-3726.8

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	3588.9	3246.8	3023.9
Range	3511.2-3573.8	2868.1-3614.8	2527.4-3383.7

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	3569.8	3024.9	2463.4
Range	3516.7-3559.8	2599.9-3404.9	1992.6-2830.1

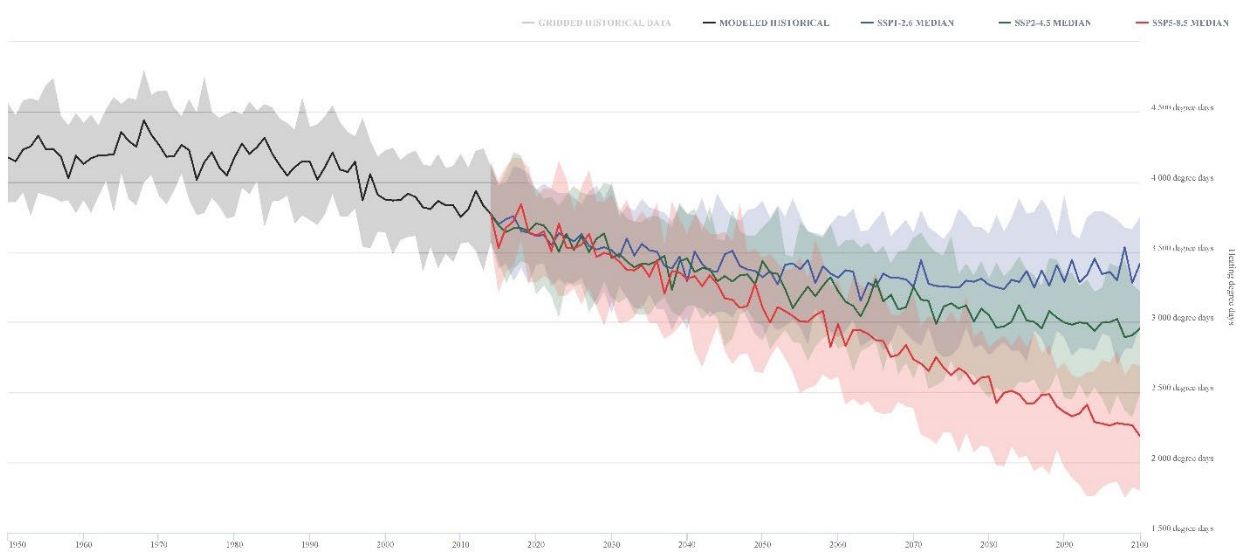

Figure 3. Projections of heating degree days in Clinton, Ontario under future emissions scenarios.

4.4 Growing Degree Days

Growing degree days (GDD) provide an index of the amount of heat available for the growth and maturation of plants and insects. Various base temperatures (or thresholds) are used to analyze GDDs, as different organisms require varying amounts of heat to thrive. GDDs accumulate when the daily mean temperature is above the specified threshold. A threshold of 5°C is often used to assess the growth of canola and forage crops, while 10°C is more appropriate for corn and beans. This indicator is useful when assessing future risks to agriculture.

Similar to the analysis of heat waves, the following data was obtained from the Climate Atlas of Canada (PCC, 2023) and is representative of the Kitchener region. The below data indicates that GDDs for both base temperatures are on the rise, and they are projected to continue rising under all future emissions scenarios. Given the sensitivity of agriculture to climatic conditions, this could have implications for agricultural management in Huron County.

Table 7. Historic changes in growing degree days above 5 and 10°C for Clinton, Ontario.

A. 5°C

Parameter	1960s	1990s
Median	2029.4	2072.8

B. 10°C

Parameter	1960s	1990s
Median	1100.2	1205.4

Table 8. Projected changes in growing degree days above 5°C for Kitchener, Ontario, relative to the baseline.

A. RCP 4.5

Parameter	2020s	2050s	2080s
Median	2395.6	2637.6	2777.5

B. RCP 8.5

Parameter	2020s	2050s	2080s
Median	2423.4	2849.1	3333.7

Table 9. Projected changes in growing degree days above 10°C for Kitchener, Ontario, relative to the baseline.

A. RCP 4.5

Parameter	2020s	2050s	2080s
Median	1415.6	1609.1	1720.4

B. RCP 8.5

Parameter	2020s	2050s	2080s
Median	1441.5	1783.1	2179.3

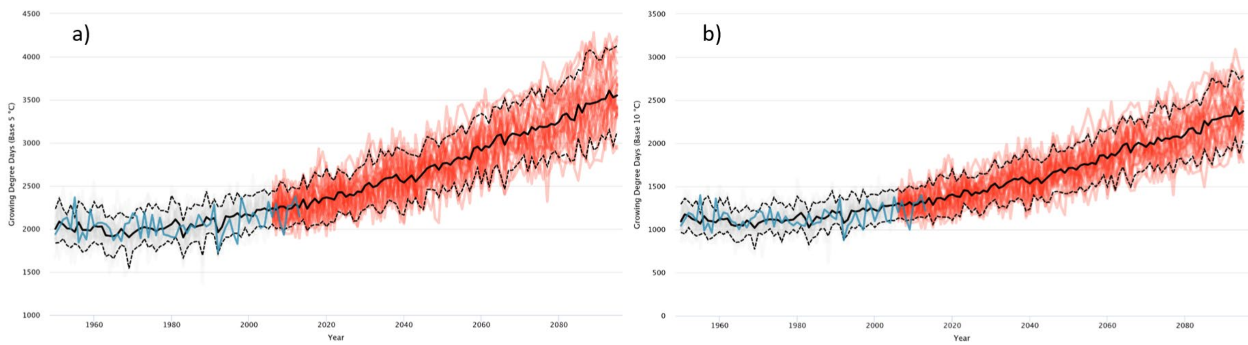

Figure 4. Projections of growing degree days above 5 (a) and 10°C (b) in Kitchener, Ontario under future emissions scenarios.

4.5 Frost-Free Season

The frost-free season is the approximate length of the growing season, during which temperatures remain above freezing. An increase in the length of the frost-free season indicates a longer growing season, and consequently a shorter period of cold weather. This indicator is important to agricultural management and may apply to other activities, including transportation and road maintenance.

The data shows that historically, this region has had a frost-free season of approximately 165 days. Under future scenarios, the length of the frost-free season is projected to increase by almost 70 days by the end of the century.

Table 10. Historic changes in the frost-free season for Kitchener, Ontario.

Parameter	1960s	1990s
Median	161.4	170.7

Table 11. Projected changes in the frost-free season for Clinton,

Ontario. A. RCP 2.6

Parameter	2020s	2050s	2080s
Median	183.6	195.9	198.2
Range	174.4-188.1	168.3-223.3	168.9-228.0

B. RCP 4.5

Parameter	2020s	2050s	2080s
Median	186.6	199.9	211.7
Range	182.1-188.6	176.4-230.8	181.8-243.0

C. RCP 8.5

Parameter	2020s	2050s	2080s
Median	187.5	211.3	240.9
Range	184.8-188.6	181.2-243.2	207.0-291.6

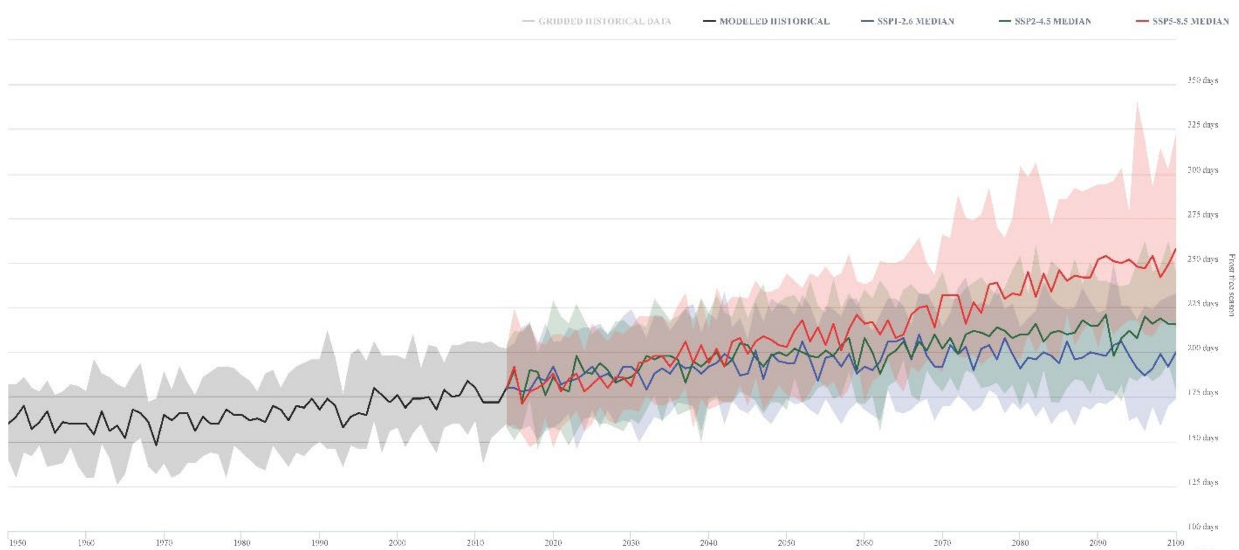

Figure 5. Projections of the frost-free season under future emissions scenarios in Kitchener, Ontario.

4.6 Lake Huron: Lake Levels, Lake Ice, & Other Projected Changes

Due to the County's proximity to Lake Huron, it is important to consider how climate change may impact the Great Lakes. Unfortunately, concrete predictions of lake conditions under future climate scenarios are difficult to obtain as the Great Lakes have a large degree of natural variation, much of which is influenced by global atmospheric processes (Bush & Lemmen, 2019). Although limited, the research that has been done in this area may indicate the future state of Lake Huron. This is important, as Lake Huron influences drinking water supply, tourism, agriculture, transportation, and local weather, and may impact the extent of some climatic changes in the area (Douglas & Pearson, 2022).

4.6.1 Lake Levels

Lake levels in the Great Lakes are directly influenced by climate change through changes in precipitation, and evaporation due to changing temperatures, and ice cover (Douglas & Pearson, 2022). Earlier studies projected that Lake Michigan-Huron could experience a decrease of 1.7-3.9% in net basin supply by mid-century which may result in a 0.1-0.5 m reduction in lake levels by 2050 (Bush & Lemmen, 2019). However, a more recent study used a more sophisticated regional climate modeling system and found that Lake Michigan-Huron could experience a 0.44m increase in lake levels by 2050 due to increases in over-lake precipitation and runoff combined with a smaller increase in evaporation (Kayastha et al., 2022). Additionally, a recent study projected that future water levels in Lake Michigan-Huron will continue to vary, with more extreme high and low levels under future emission scenarios (Seglenieks & Temgouat, 2022).

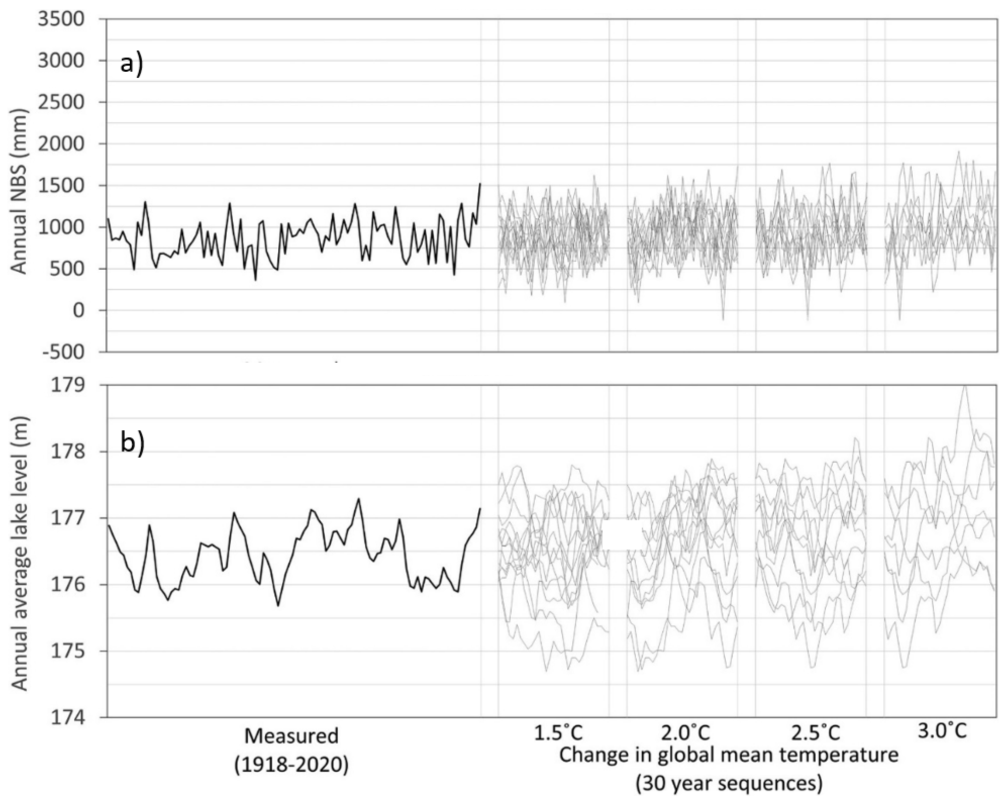

Figure 6. Forecasts of water levels in Lake Michigan-Huron under future changes in global mean temperature scenarios relative to historic averages. Figure adapted from Seglenieks & Temgoua (2022).

4.6.2 Lake Ice & Temperature

Climate change has contributed to a decline in seasonal lake ice accumulation in the Great Lakes, and from 1973 to 2010, there was a 71% decrease in annual ice cover (Bush & Lemmen, 2019; Douglas & Pearson, 2022). Over this period, Lake Huron, Superior, and Erie saw a larger decrease in ice cover. This trend is anticipated to continue under future emissions scenarios, and by mid-century, it is projected that the duration of seasonal lake ice could decrease by 25-50 days. Furthermore, the seasonal thickness of the ice is predicted to decline by 10-50cm by 2050 (Derksen et al., 2019).

Changes in the duration and extent of seasonal ice, combined with the influence of rising temperatures, have increased surface water temperatures in the Great Lakes (Bush & Lemmen, 2019). As a result, Lake Huron's average surface temperature in 2021 was 1.21°C higher than it was historically between 1995-2020 (ECCC & NOAA, 2022). Under the future high emissions scenario, it is projected that the average annual surface water temperature in Lake Huron (historically 8.9°C) could increase by an average of 1.35°C by mid-century and by an average of 3.85°C by the end of the century (ECCC & NOAA, 2022; Xue et al., 2022; GLISA, 2024). This warming has been and will continue to be most evident in the spring and summer months within the Great Lakes, which greatly influences seasonal water cycles and ultimately leads to an increased period of summer stratification (Xue et al., 2022).

4.7 Storms & Extreme Events

As temperature and precipitation patterns transform under the influence of climate change, the frequency, duration, and intensity of weather events are expected to change. It is not yet known how the likelihood of extreme events will alter with climate change (Bush & Lemmen, 2019). However, the combination of climate projections and localized knowledge allows the intensity of extreme events to be inferred for Huron County. This is important as it indicates anticipated future events, which enables better preparedness.

4.7.1 Extreme Events: Droughts & Flooding

Global hydrologic cycles are projected to intensify with climate change, increasing the intensity of hazards associated with wet and dry extremes (Council of Canadian Academies, 2019; Warren & Lemmen, 2014). At a global scale, atmospheric processes are shifting which influences localized weather events. For example, the jet stream in the Northern Hemisphere is weakening. As a result, weather systems are moving more slowly allowing undesirable events, such as heat waves and droughts, to persist (Arctic Council, 2024).

In regards to temperature, it is projected that maximum temperature extremes will continue to increase under future emissions scenarios. This has the potential to lengthen the duration of dry spells, which could result in droughts. However, the intensity and duration of dry events are difficult to anticipate, as increased precipitation could offset these impacts in some areas (Bush & Lemmen, 2019).

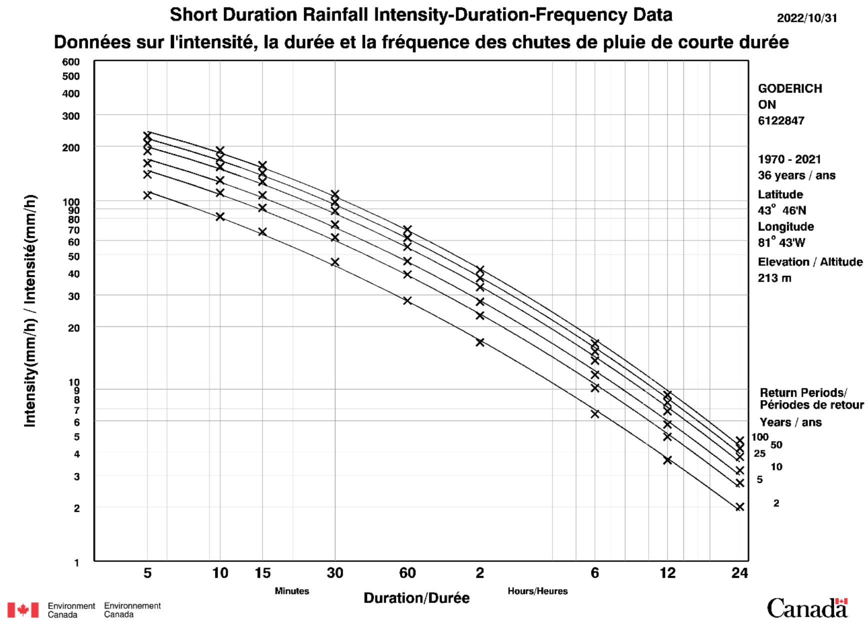

Figure 7. Intensity-duration-frequency (IDF) curve for Goderich, Ontario (ClimateData.ca, 2024).

In relation to precipitation, extreme rainfall events are projected to increase and have the potential to become twice as frequent by mid-century (Bush & Lemmen, 2019). This could likely increase localized flood events. However, it is important to note that in Huron County, floods are not necessarily intensifying or getting bigger. Rather, rain events are happening more quickly and exceeding the capacity of the natural environment to infiltrate precipitation (Beard & Jackson, 2019; Dickinson et al., 2018). Furthermore, the seasonal patterns of flooding are shifting due to an increase in rain-generated flooding, as well as changing freeze-thaw cycles. As a result, floods that historically occurred in the spring are happening earlier and persist into other times of the year (Beard & Jackson, 2019; Bush & Lemmen, 2019; Dickinson et al., 2018).

The intensity-duration-frequency (IDF) curve for Goderich, Ontario has been included above (Figure 7). This data is particularly useful in preparing for future flood events, as it indicates the projected frequency of short-duration rainfall intensity (ClimateData.ca, 2024). This information is important for future adaptation efforts.

4.7.2 Ice & Snow Storms

Both ice and snowstorms are projected to increase in frequency and intensity within the short term in Huron County. In regards to ice storms, warming winter temperatures and a shift in the ratio of precipitation from snow to rain present the ideal conditions for the development of ice events (Beard & Jackson, 2019; Bush & Lemmen, 2019; Notaro, Bennington & Vavrus, 2015). This is an important consideration in planning for climate change as ice events impact road maintenance, transportation, and other activities related to everyday life.

In regards to snowstorms, snowfall has increased in lake-effect areas due to a reduction in seasonal ice cover (Burnett et al., 2003; Gula & Peltier, 2012). As previously mentioned, a reduction in lake ice accumulation in winter months leads to increased water temperatures. When a cold air mass moves across warmer water, it encourages evaporation. The evaporated water ultimately leads to increased snowfall as this air mass reaches land. As lake ice continues to decline and winter temperatures warm with climate change, lake-effect snowfall is projected to increase as long as winter temperatures are cold enough (Burnett et al., 2003; Gula & Peltier, 2012). However, there is the potential for lake-effect snow events to decrease significantly by the end of this century if climate change results in fewer days below freezing (Burnett et al., 2003; Notaro, Bennington & Vavrus, 2015).

4.7.3 Wind Events

The frequency and magnitude of wind gust events are variable and can be difficult to predict with a changing climate as they are regionally influenced. As indicated below, compared to the historic averages (1994-2007), the frequency of wind gusts greater than 40 km/h has been projected to increase by 10-20% and those greater than 70 km/h could increase by 20-40% by the end of the century (Cheng et al., 2012). Alternatively, studies have found that there will be a higher frequency of stagnant winds by the end of the century (Morris et al., 2024). Both considerations are important for future adaptation planning, as high winds can be detrimental to physical infrastructure and minimal wind could pose risks to human health.

Table 12. Projected increase in the frequency of hourly wind gust events for the period of 2081-2100 in Ontario.

Wind Gusts	Projected Increase
> 28 km/h	10-15%
> 40 km/h	10-20%
> 70 km/h	20-40%

5. Summary

Table 1. Summary of future climate projections (RCP 8.5) for Huron County.

Climate Variable	Summary of Projections
Temperature	• Annual average temperatures are rising in Huron County. The average temperature in the 1990s was 7.6°C. Temperatures are projected to increase to 9.2°C by the 2020s, 11.3°C by the 2050s, and 13.7°C by the 2080s. Warming is occurring in all seasons. • The number of very hot days (days above 30°C) is projected to increase which will increase the frequency and duration of heat waves. Historically, Huron County has experienced 1 heat wave a year. This is projected to increase to 3 by the 2020s, 5 by the 2050s, and 7 by the 2080s. • The number of frost days (days with daily minimum temperatures below 0°C) is projected to decrease from 140 days in the 1990s to 62 days by the end of the century. This indicates that winters are becoming shorter in Huron County.
Precipitation	• Average precipitation totals are projected to increase in Huron County. From 1981-2010 annual precipitation was 962 mm. This is projected to rise by 5.3% by the 2020s, 9.3% by the 2050s, and 14.1% by the 2080s. • Trends indicate that maximum 1-day total precipitation and wet days (days with 10-20 mm of precipitation) are projected to increase.
Lake Huron	• Research indicates that lake levels will continue to vary with more extreme high and low levels under all emission scenarios • Seasonal lake ice accumulation has declined by 71% from 1973 to 2010. It is projected that the extent and duration of lake ice will continue to decline with rising temperatures. • Surface water temperatures are projected to increase by an average of 3.85 degrees by the end of the century.
Extreme Events	• Projected increases in the intensity, frequency, and duration of extreme rainfall events could result in more localized flooding. • A reduction in the accumulation of seasonal lake ice in combination with rising temperatures is projected to increase the intensity of lake-effect snow events by mid-century. • As a result of warming winter temperatures and a shift in the ratio of precipitation from snow to rain, it is projected that ice storms will become more frequent and severe in Huron County. • The frequency and magnitude of wind gust events are projected to increase by the end of the century.

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