Growing Degree Days

CMSC6950 Project

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1 Introduction

The growing degree days (GDD) is a temperature index tool used in agriculture to predict the best planting season for a plant. GDD enhances predicting the best planting time of a crop to its maturity, in terms of high heat accumulated in the ground in regions conducive. GDD is used to predict and compare the growing rate of a plant from germination to yielding and predict future planting. Generally, GDD is calculated by adding the maximum (Tmax) and minimum (Tmin) temperature together dividing by two (2) and then subtracting the base temperature (Tbase).
When determining the GDD of a plant, each plant has a conducive temperature for development and so it has a base temperature (Tbase). The base temperature is the lowest temperature a plant can survive in. (Tbase) will be considered 0 degrees celcius for the calculation of GDD in this report.
The reference temperature for a given plant is the temperature below which its development slows or stops. For example, peas are planted during the cold season, where it has a reference temperature of 40 degrees fahrenheit while sweet corn and soybeans are planted during the hot season, where they have a reference temperature of 50 degrees fahrenheit.
Generally, GDD is calculated by adding the maximum (Tmax) and minimum (Tmin) temperature together dividing by two and then subtracting the base temperature (Tbase). When determining the GDD of a plant, each plant has a conducive temperature for development and so it has a base temperature (Tbase). The base temperature is the lowest temperature a plant can survive in. (Tbase) will be considered 0 °C for the calculation of GDD in this report.

2 Methodology

2.1 Data Collection

Required data for different cities have been obtained from the given website: https://climate.weather.gc.ca. Also needed columns including year, Min Temp, Max Temp and etc have been extracted for the selected cities and this data have been used to create the plots for defined tasks.
The main data selected was the monthly data for 2016 from stations located in Montreal, Victoria, and Ottawa. This data was used to complete the required Minimum Core Tasks.
For the regression analysis performed for the Secondary Tasks, data from 1950 to 2010 was selected from a weather station in Montreal.
Data was also selected from unique stations on the island on the Newfoundland based on the 6 different geographic regions. This data spans 10 years and covers the years 1995-2004. This data was used to compile the necessary files for the Final Task analysis which will be elaborated further in this report.

2.2 Scientific Results for Minimum Core Tasks

1. For our Core Tasks, we chose data from Montreal, Ottawa, and Victoria for the year 2016(Fig. 1)

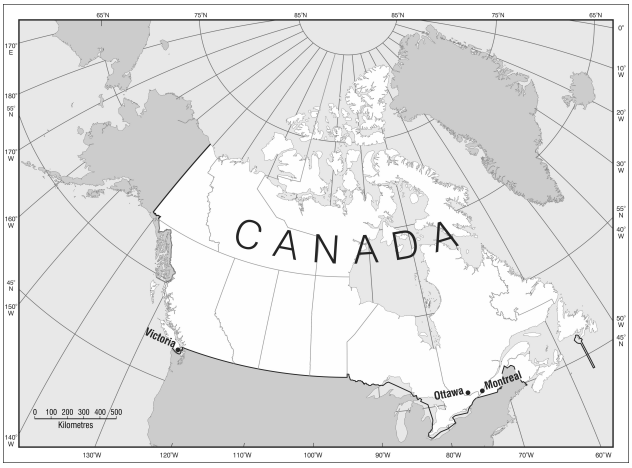

Figure 1

2. Showing annual cycle of min/max daily temperatures for selected Canadian cities. We did this analysis on Montreal, Victoria, and Ottawa for 2016.(Fig. 2)

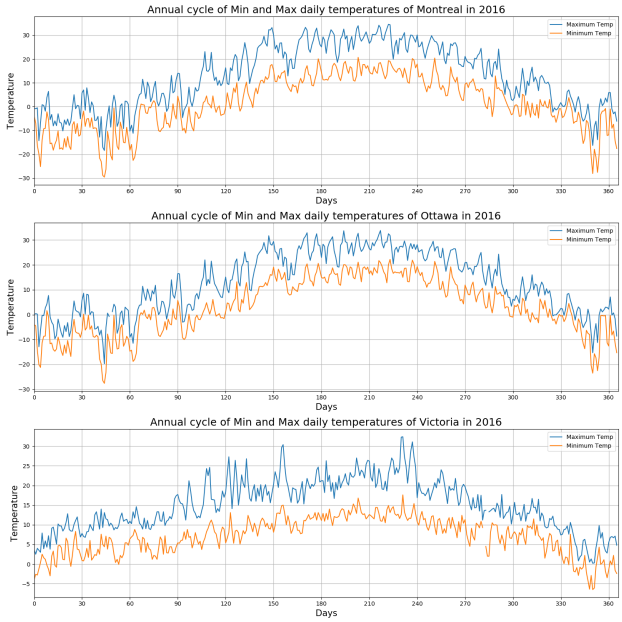

Figure 2: Min/Max temps for Montreal, Ottawa and Victoria in 2016

3. Calculating and storing GDD to analyze via the command line.
4. Showing accumulated GDD vs time for some selected cities (Fig. 3)

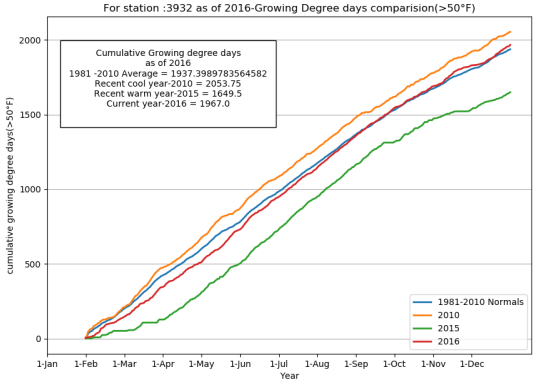

Figure 3: accumulated GDD

2.3 Scientific Results for Secondary Tasks

1. Create a plot showing GDD as given example.

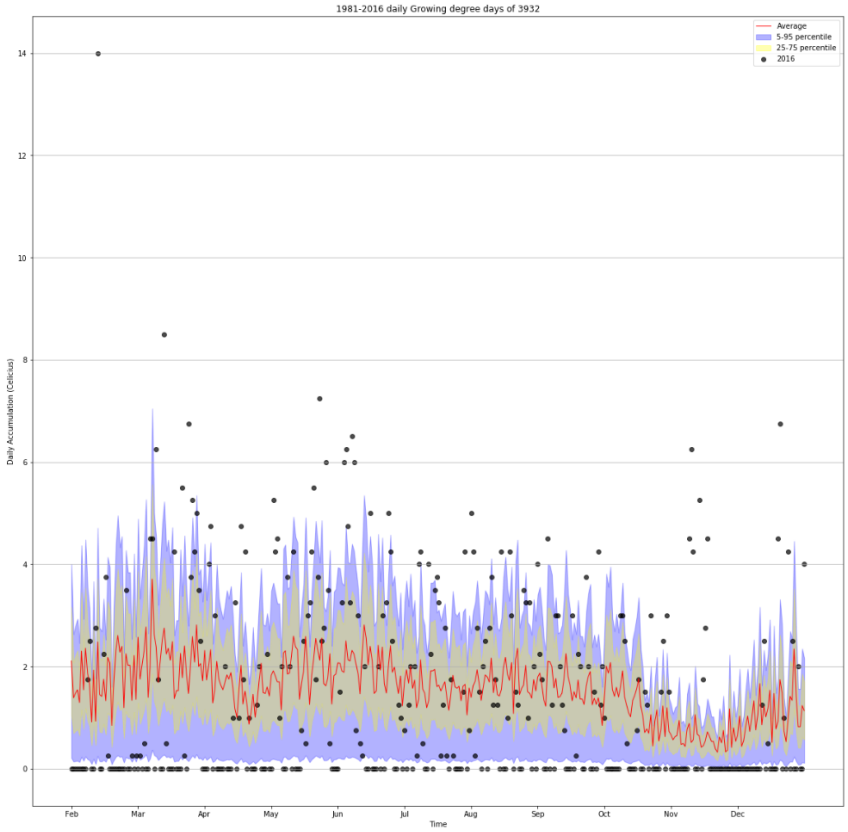

Figure 4: Daily growing degree days from station ID 3932, from 1981 to 2016

2. Standalone Bokeh Plots 5)

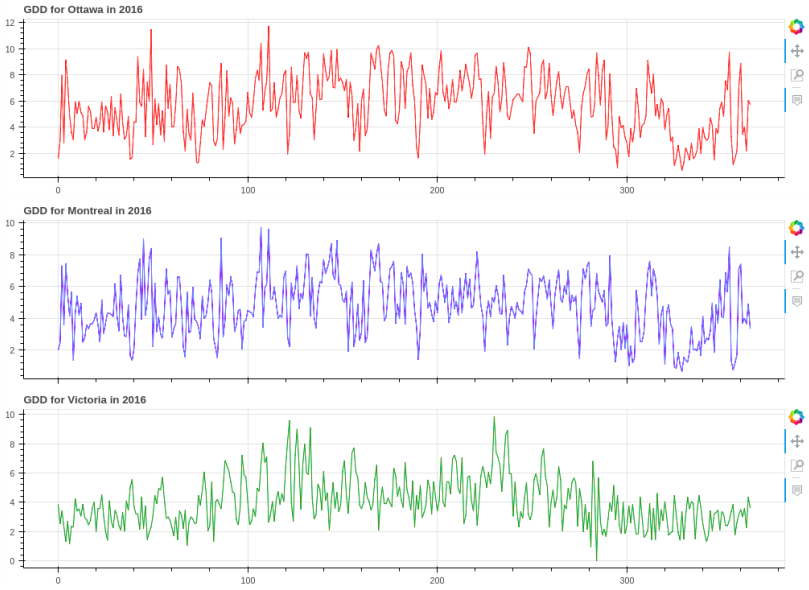

Figure 5: Bokeh plot

3. Comparing GDD year-over-year for Montreal between 1950 to 2010(Fig. 6).

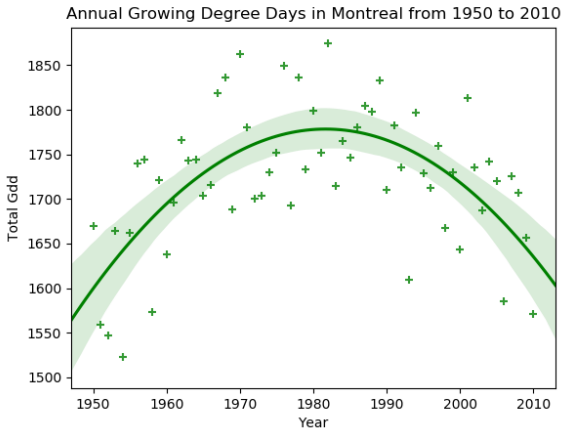

Figure 6: Regression between total GDD and years

2.4 Final Tasks

The island of Newfoundland was divided into 6 geographic regions; North, South, East, West, Central, and The Avalon(Fig. 7).

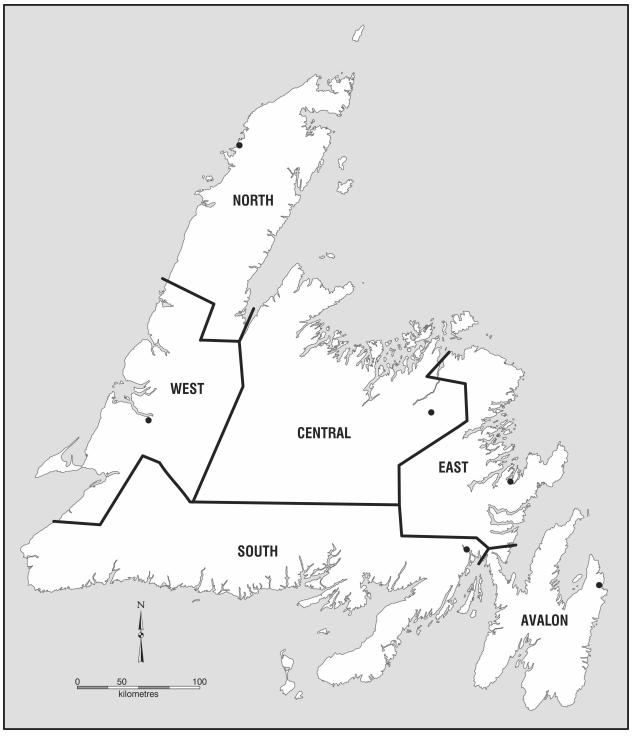

Figure 7: Newfoundland regions

A station from each region was selected: Plum Point (North), Swift Current (South), Charleston (East), Corner Brook (West), Gander (Central), St. John's (The Avalon) (Fig. 8).

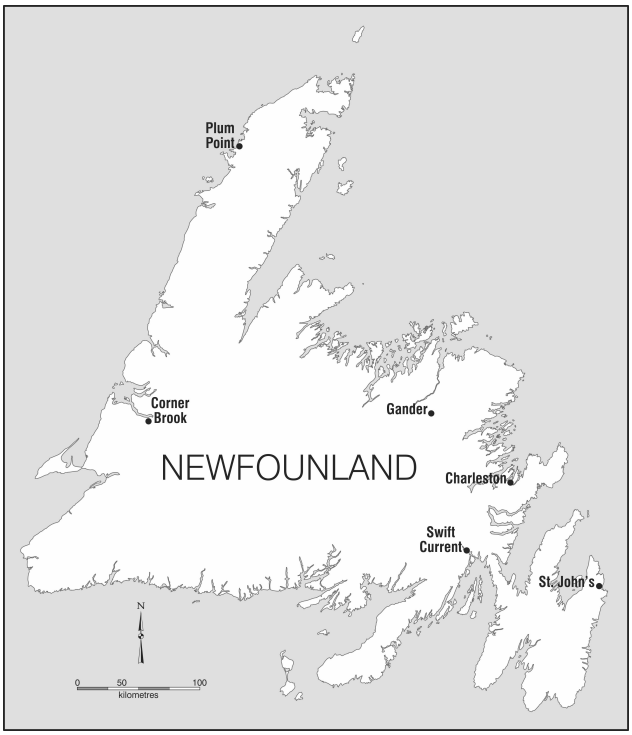

Figure 8: Selected stations in Newfounland

The 10 Year Average Annual GDD was calculated and compared to the minimum GDD for 3 types of wheat[1]. From the analysis, based solely on GDD, parts of Newfoundland could sustain wheat production(Fig. 9).

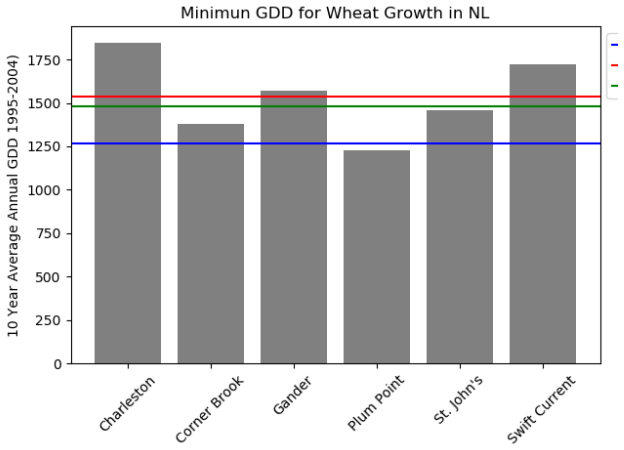

Figure 9: Wheat growth analysis based on GDD in Newfoundland

Using the 10 Year Average Annual GDD calculation again, the results were compared to the minimum GDD for 6 types of seeds[2]. From the analysis, based solely on GDD, parts of Newfoundland could sustain wheat production(Fig. 10).

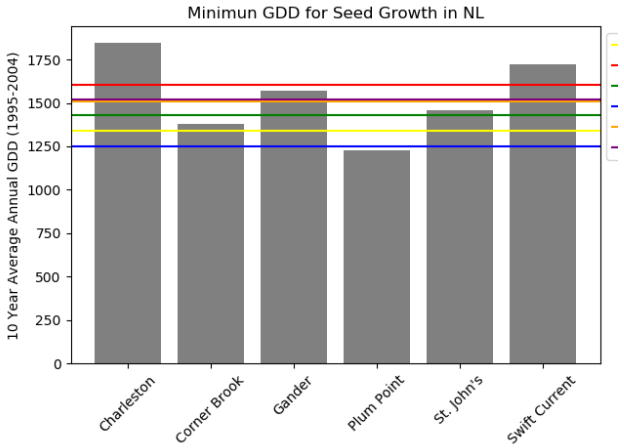

Figure 10: Seeds growth analysis based on GDD in Newfoundland

References

[1] http://store.msuextension.org/publications/agandnaturalresources/mt200103ag.pdf

[2] http://store.msuextension.org/publications/agandnaturalresources/mt200103ag.pdf