Decadal Trends in Crop Heat Units for Ontario and Quebec from 1951 to 2010

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Background and procedures

Crop Heat Units (CHU) are temperature-based units that are related to the rate of development of corn and soybeans. Cool temperatures delay progress to maturity while warm temperatures hasten it. CHU have been used for many years as an indexing system to help producers select the hybrids and varieties that are best suited to their climatic region. It is customary to use climatic normals for the latest 30-year period to produce maps describing the availability of CHU in each locality. Procedures for calculating CHU from daily maximum and minimum air temperatures are available in Brown and Bootsma (1993).

Changes in climate over decadal periods may significantly impact the availability of CHU. Thus it is of interest to examine decadal trends in CHU from at least three applications: i) to determine if crop hybrid and variety trials are being conducted under environmental conditions which are significantly different from the "average"; ii) to determine if available CHU are increasing, possibly as a result of global warming, and if therefore it might be feasible to select corn hybrids and soybean varieties for production that have a higher CHU requirement (and possibly higher yield potential); iii) to determine if there is potential for growing corn and soybeans in areas where these crops have not been traditionally grown due to lack of heat.

In previous reports, decadal trends in CHU were presented for periods from the early to mid 1940's to the year 2005 in Ontario (Bootsma, 2011) and for as far back as 1898 to 2007 for Quebec (Bootsma, 2008a). This report examines the decadal trends in CHU for the period from 1951 to the end of 2010. To avoid changes introduced into the climate record through activities such as station relocation, changes in observing practices, etc., we utilized the Second Generation of Homogenized Temperature datasets of the Adjusted and Homogenized Canadian Climate Data (AHCCD) prepared by Environment Canada (2012). This version of monthly average maximum and minimum air temperature was produced using new procedures from the previous version to derive adjustments as described by Vincent et al. 2012. Only stations which had relatively complete data to the end of 2010 in the AHCCD datasets were selected for these analyses. Estimates of missing data were made by using data from the AAFC daily climate archive when available or from nearby stations. Corrections were applied to the raw climate data by comparing monthly temperatures for several years surrounding the missing month(s).

Monthly average maximum and minimum air temperatures were averaged for each decadal period. Stations were only used if all decadal monthly averages included at least 9 years of data after missing values were estimated. Average CHU were then computed from the monthly decadal average temperatures using the procedures described in Bootsma et al. 2004, with a slight modification of the method used to determine the ending date for accumulating CHU. CHU begin to accumulate when the average mean daily air temperature first exceeds

12.8 ºC in the spring. This date corresponds close to the average planting date for corn in each region. The ending date was based on an estimate of the average date of first fall occurrence of 0ºC (which is approximately equivalent to the 10% probability of the first occurrence of -2ºC). This date is estimated from other climatic and astronomical factors as described by Sly et al. (1971). Development of this procedure for calculating CHU is documented in a report (Bootsma, 2008b).

Results

Decadal trends in CHU are shown in Figures 1 to 3 for Ontario and Figures 4 and 5 for Quebec. At almost all locations, there was a trend of increasing CHU from the 1960's to the decade ending in 2010. The last decade had the highest available CHU at every location with the exception of Ridgetown, Ontario. Increases in CHU were due to a combination of longer and warmer growing seasons. On average, the growing season length increased by 12 days from the 1961-70 decade to the 2001-10 decade.

The average increase in CHU from the 1960's decade to the latest decade was 344 CHU (excluding Ridgetown from the average). The increases ranged from a high of 522 at Windsor, Ontario to a low of 44 CHU at Wiarton, Ontario. The average increase in CHU per decade beginning from the decadal period starting in the 1960's was 86 CHU/decade (not including Ridgetown), but ranged from a high of 131 CHU/decade at Windsor, Ontario to a low of 44 CHU/decade at Wiarton, Ontario.

Decreasing CHU at Ridgetown in the last two decades may be due to inhomogeneities that have not been corrected for in the data, since this trend was not observed at any of the other locations. Ridgetown was converted from a manual to an automatic recording station in May, 1986. CHU trends for a nearby station (New Glasgow) located approximately 25 km northeast of Ridgetown did not have a downward trend in CHU (Figure 6). The New Glasgow results were based on Environment Canada data (2012) that were not adjusted for possible inhomogeneities.

The trends towards increasing CHU in recent decades suggest increased corn and soybean yields are being achieved in part by selection of hybrids/varieties that are better adapted to a changing climate. Results from a previous study suggest that an average increase of 344 CHU since the 1960's may potentially impact yields by as much as 2 t/ha in corn and 0.45 t/ha in soybeans (Bootsma, et al. 2005).

If this warming trend continues, it may be possible in the future to select later maturing (and potentially higher yielding) corn hybrids and soybean varieties in areas where these crops are presently grown. Also, some areas presently unsuitable for corn or soybeans due to lack of heat may become suitable for production of these crops in the future.

References

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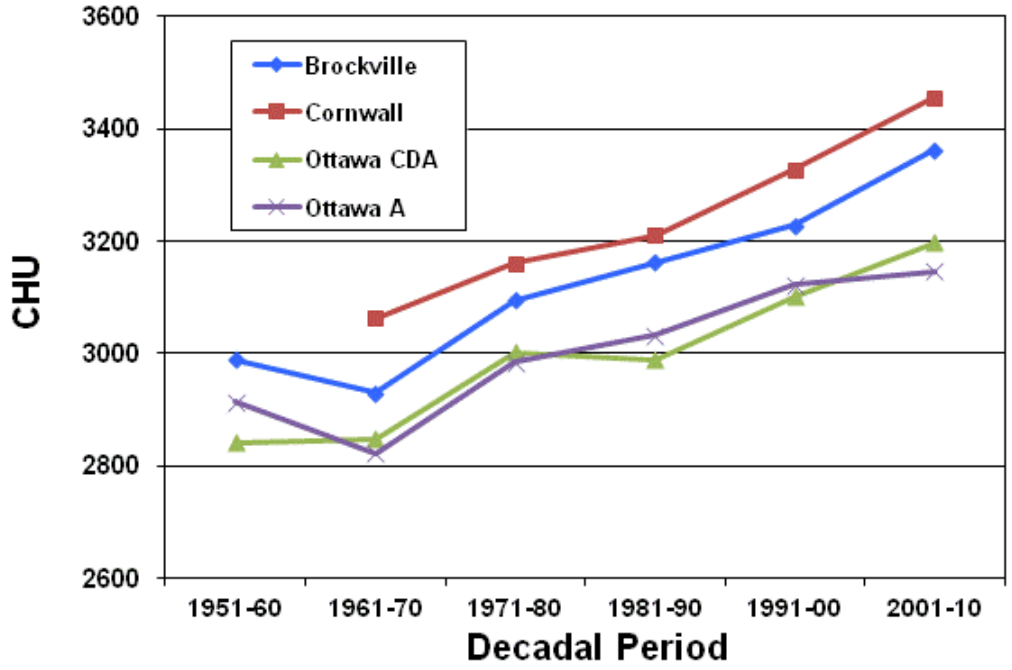

Figure 1. Decadal Trends in Crop Heat Units at four locations in Ontario (based on homogenized data from Environment Canada, 2012).

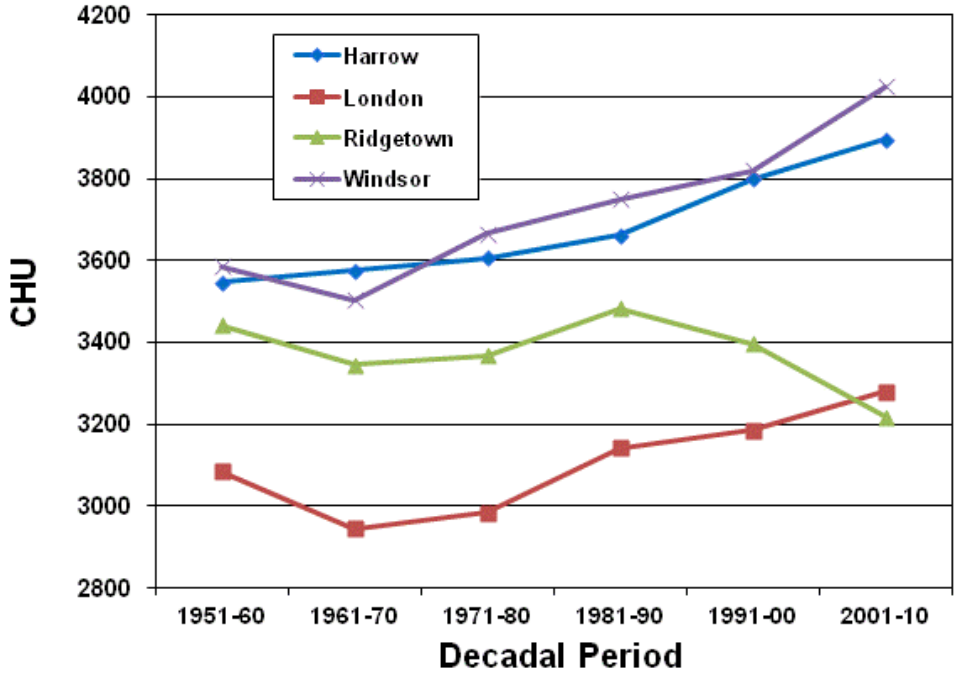

Figure 2. Decadal Trends in Crop Heat Units at four locations in Ontario (based on homogenized data from Environment Canada, 2012)

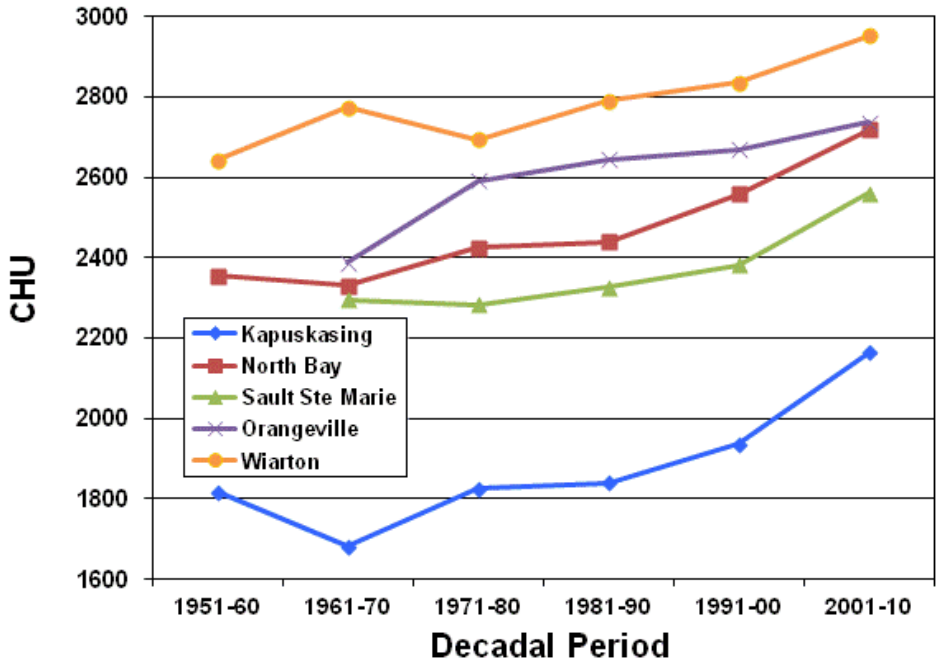

Figure 3. Decadal Trends in Crop Heat Units at five locations in Ontario (based on homogenized data from Environment Canada, 2012)

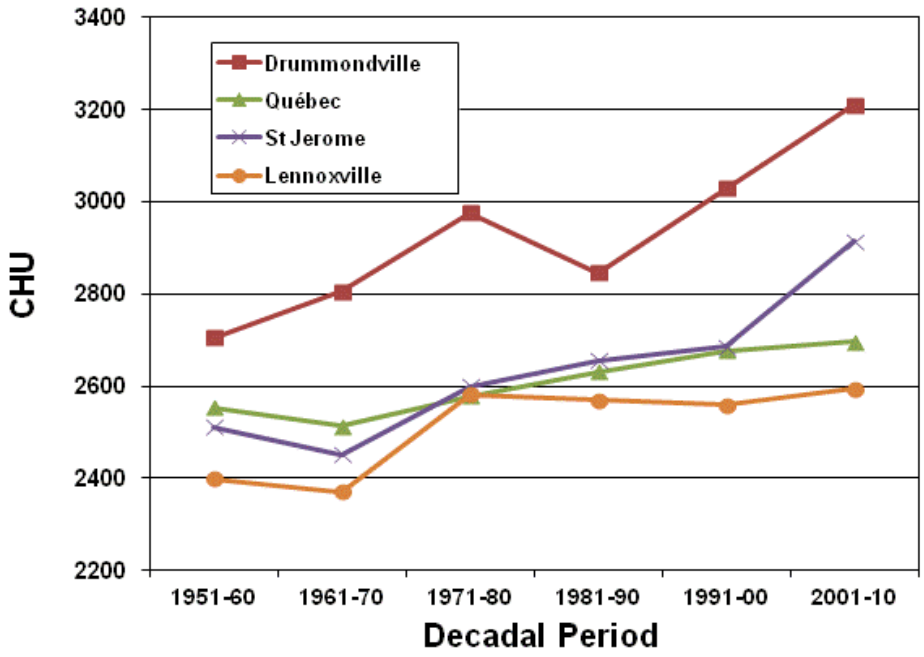

Figure 4. Decadal Trends in Crop Heat Units at four locations in Quebec (based on homogenized data from Environment Canada, 2012)

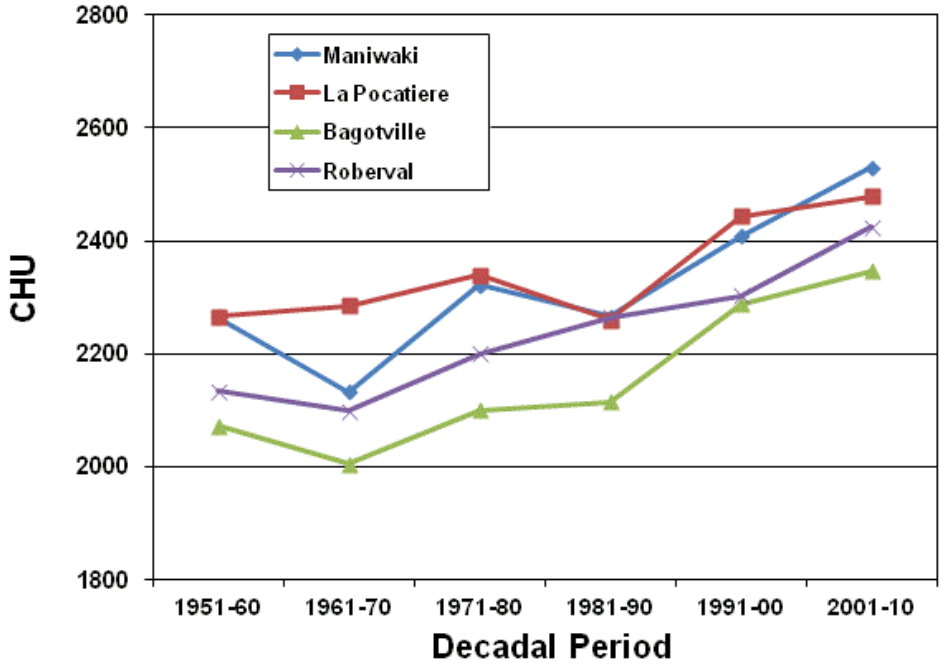

Figure 5. Decadal Trends in Crop Heat Units at four locations in Quebec (based on homogenized data from Environment Canada, 2012)

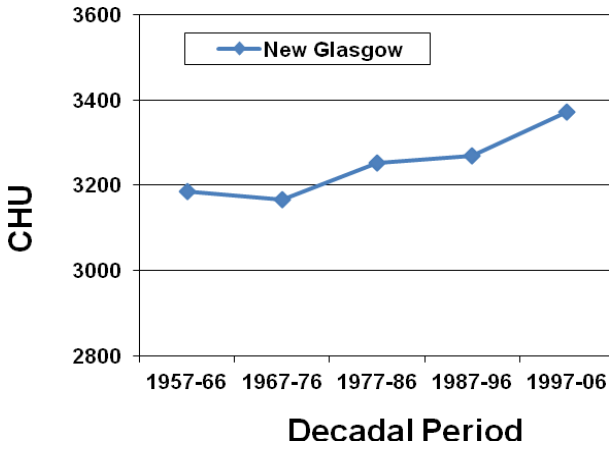

Figure 6. Trends in Crop Heat Units at New Glasgow, Ontario (based on raw unhomogenized data from Environment Canada, 2012b).