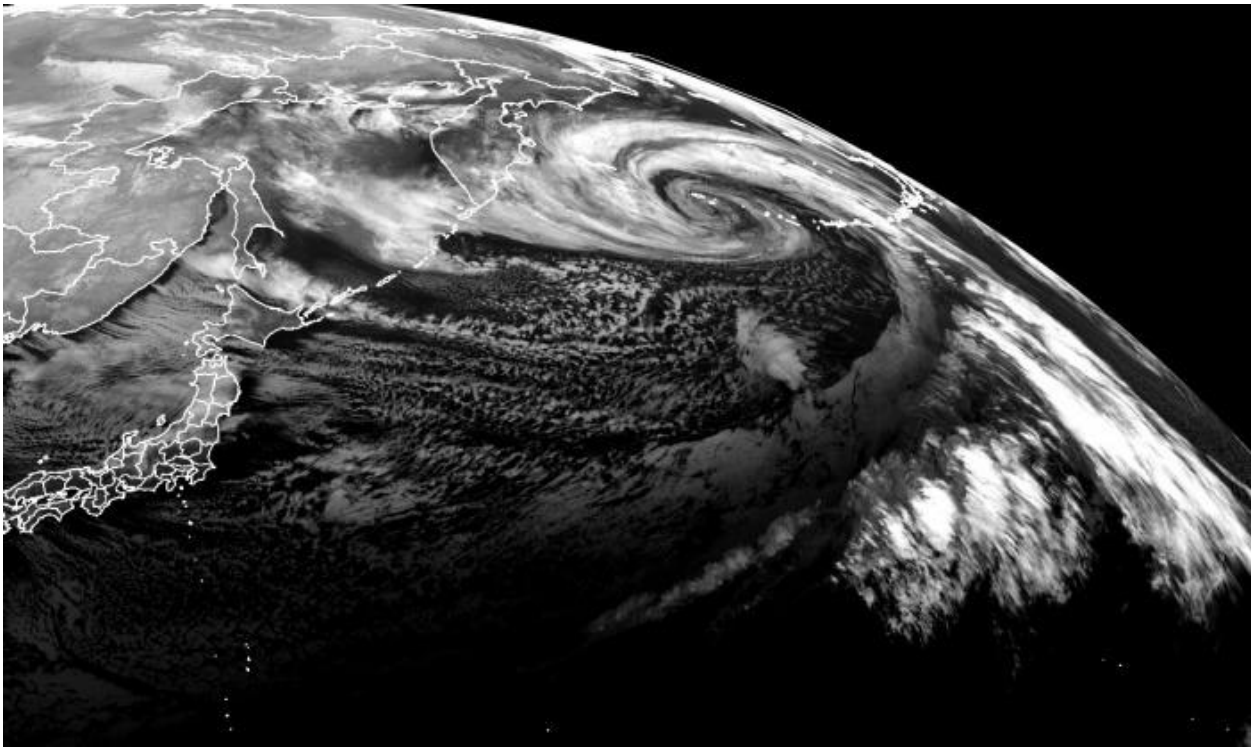
# CLIMATE CHANGE

## Is Climate Change Making Storms More Severe?



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## Introduction

On December 31, 2020, a record-breaking storm moved across the Aleutian Islands and into the Gulf of Alaska. The storm had a low surface pressure at its centre of 921 mb. There were surface winds over the ocean of nearly 150 km/h and waves as high as 58 feet. This led to many comments in the media that storms were becoming stronger due to climate change.

This storm was not a tropical storm, typhoon or hurricane, although the winds were of similar strength.

While tropical cyclones are powered by warm ocean surface temperatures and minimal wind shear higher in the atmosphere, cyclones of the type that set the record over the Aleutians derive their energy from contrasting cold and warm air. It is no coincidence that the deep cyclone occurred at the same time record cold was reported over Mongolia, along with some of the highest atmospheric pressures ever recorded.

This powerful cyclone then, resulted from an atmospheric circulation that contrasted deep cold over land with much warmer air over the ocean. The impact of climate change on this storm is unclear.

To answer the question of whether or not storms were becoming more intense, an analysis of weather systems affecting Canada was undertaken.

## How Would You Determine if Storms Are Getting Stronger as the Climate Warms?

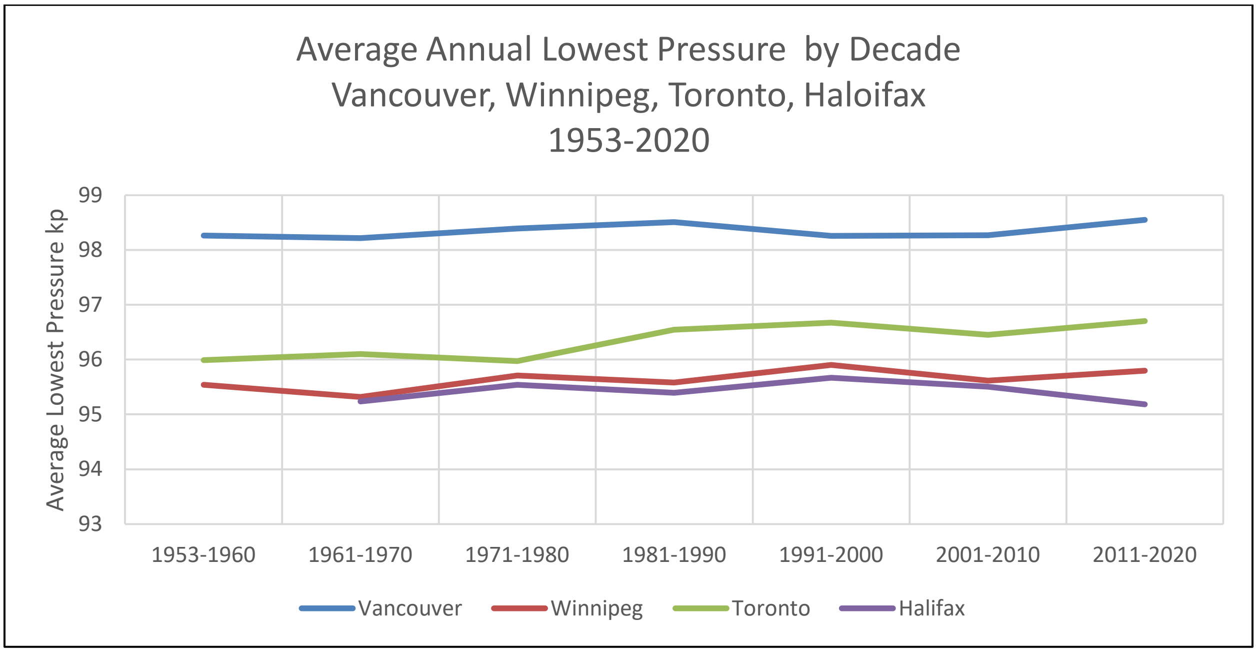
To answer that question, it is first necessary to define what is meant by "storms" and "getting stronger". For simplicity, storms can be categorized as "synoptic scale", i.e. ~1500 km in diameter, or "mesoscale", ~ 10-100 km in diameter. This study is only considering synoptic scale storms. One of the characteristics of a strong synoptic scale storm is its low central pressure. Generally, a strong storm would have a low central pressure, creating a strong pressure gradient between the centre of the storm and within a 1500 km radius of the storm centre. Therefore, an analysis of central pressures over time and over various geographic areas should reveal a trend towards lower central pressures, if indeed storms are becoming more intense. Secondly, more intense gradients would lead to higher winds around the storm systems. By examining the lowest pressures and the strongest winds over a period of time, any trend towards stronger storms should become evident.

## Results of An Analysis

Four stations with considerable historical data were selected in Canada, one on each coast and two in the centre of the country. Vancouver, Winnipeg, Toronto and Halifax each have pressure and wind records going back 60 years or more. The three locations also represent weather systems that originate over the Pacific Ocean, the Atlantic Ocean, and those that originate in mid-continent. Vancouver, Toronto and Winnipeg have records dating back to 1953, and Halifax has records dating back to 1961.

Surface MSL  pressures are recorded every hour, and therefore this provides a record of over 500,000 observations at each location. Surface pressures vary with the location of the station, and therefore, the baseline values of station pressures will not be comparable, however, the trends should be.

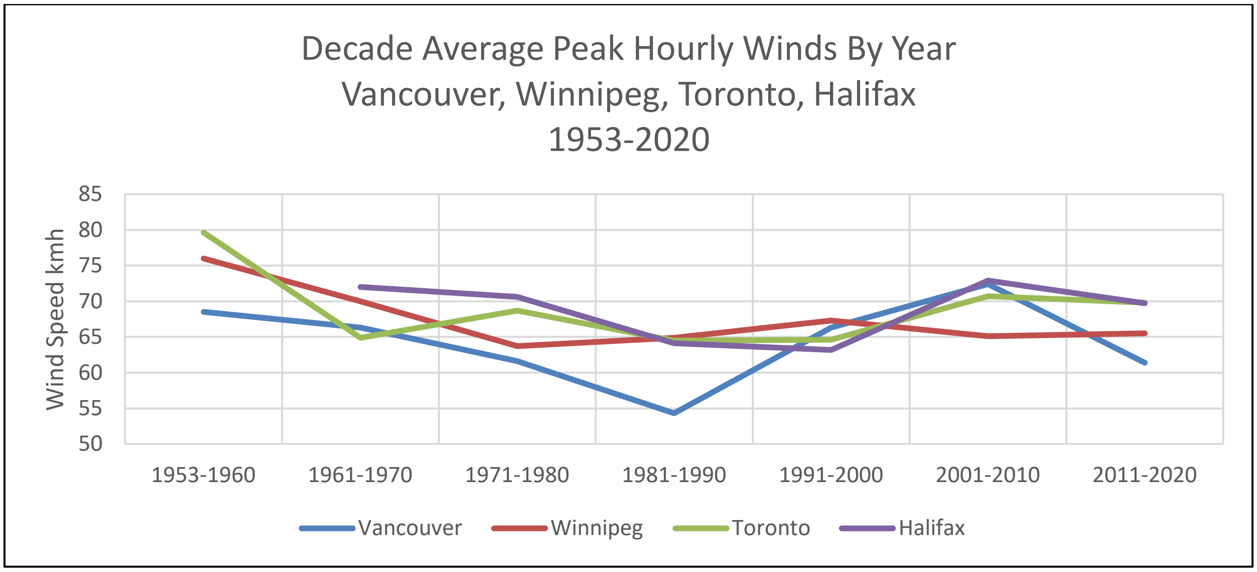
**Figure 1 - Lowest Annual Surface Pressures Vancouver, Halifax, Toronto and Winnipeg**




The trends are plotted on a chart in Figure 1 for all four sites. The data is the lowest observed pressure at each station in a given year, averaged over each decade. There is virtually no change in the annual lowest pressure values over the period of record 1953-2020. Three of the stations reported slight increases and one a slight decrease. If storms were becoming more intense, the trend should show a downward trend in the lowest pressure observed at the four stations.

This process was also followed to examine peak hourly winds at the same four stations over the same period. The hourly winds on record are the two-minute mean wind speeds observed on the hour or slightly before. Currently, wind speeds are measured in 5 second averages, and the hourly wind speed represents the average of these 5 second winds over two minutes. Prior to the digital wind measuring instruments, analogue anemometers recorded instantaneous winds and the human observer estimated the average two minute mean wind speed from the recording chart. The change from analogue anemometers with an approximate 2 second response time, to digital anemometers that measure wind speed in 5 second averages, would account for a decrease in peak wind gusts but should not affect the two-minute means observed on the hour.

Figure 2 - Maximum Hourly Winds By Year - Vancouver, Winnipeg, Toronto and Halifax




The analysis of peak hourly wind speeds at Vancouver, Winnipeg, Toronto and Halifax is shown in Figure 2. The trend over the 67 years is uneven, in that the winds were stronger in the 1950's and 60's, then it appears Canada went through a fairly docile period of winds in the 1970's and 80's and then wind speeds picked up again after 2000, but dropped slightly in the last decade.

## Conclusions

It is possible that storms are becoming more intense due to climate change, however, the evidence from lowest annual pressures and highest wind speeds does not support that trend. In fact, the data from four stations across Canada would suggest the opposite may be the case. It is possible a study of a larger sample of stations would yield different results. A previous study of peak wind gusts and extreme precipitation events at ten stations in Canada also showed little if any trend towards more extreme storms. This is consistent with the conclusions of the Canada's Changing Climate Report of March 2019 published by Natural Resources Canada: "*Extreme precipitation is also projected to increase in the future, although the observational record has not yet shown evidence of consistent changes in short-duration precipitation extremes across the country*." (p. 119)

A more difficult study would involve the analysis of mesoscale storms. It is more difficult because the scale of these storms likely escapes the observational network in Canada, which is spaced at intervals greater than the size of mesoscale storms. For example, a severe thunderstorm that dumps 100 mm of rain in two or three hours on an urban area may be missed entirely by the observational network. Furthermore, the observational network is becoming less dense, particularly with respect to severe weather factors such as precipitation and wind. Therefore, while severe weather impacts may be greater than ever because of urban population density, the observational network has lagged far behind in its ability to report severe weather. Insurance losses are climbing at a steep rate, however, increases in insurance losses may be more a reflection of the vulnerability and exposure of urban development than increases in the occurrence of severe weather.

Climate warming would seem to lead to more severe weather in that the summer severe weather season would be longer, just as the hurricane season now extends into May and November. Warmer weather may provide more energy for severe thunderstorms, which are often associated with localized flooding and wind damage. In parts of Canada, local ice storms may be more prevalent as winter temperatures hover closer to the freezing point, meaning more precipitation would fall as freezing rain than snow.

We now have several decades of warming temperatures, and further analysis of mesoscale events is required to determine if these smaller scale storms are becoming more intense.