



Facts vs Fortune Telling

Alberta's Climate Future Report Review

Friends of Science Society

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Contents

Executive Summary.....	2
Alberta's Climate Future Report Review	5
Science and the Citizen	6
Failings of the Alberta's Climate Future Report Summarized:	7
What is "Climate Change"?	8
Basis of Alberta's Climate Future Report	8
What are the Representative Concentration Pathways (RCP)?	9
What is a Climate Model?	11
Premises on Climate Change	13
Climate Has Never Been Stationary; Human Adaptations to Flood Plains	15
Are Floods and Wildfires Getting More Frequent or Extreme?	16
Calgary Flood Historical Record	18
Wildfires	21
Dry Conditions.....	26
Extreme Cold Episodes Not Considered	29
Reliable Temperature Records	29
Carbon Dioxide and Greenhouse Gases - Driving Warming or Not?	30
Alberta's Many Changes	32
Temperature Stations Selected by Hayhoe & Stoner	34
Urban Heat Island Effect is Significant	35
Temperature Analysis	36
Correlation of Alberta Temperatures to Global Climate	38
Future Projection of Temperatures	39
Correlation of Alberta Temperatures to Global Climate	43
Selection Bias in Climate Investigation	44
Winter Temperature	46
Summer Temperature.....	48
Diurnal Temperature Patterns	49
Extreme Temperatures and Hot Summer Days	49
Climate Linear Trends or Cycles	50
Summary	52
Solar Influence on Climate	53
Questions of Objectivity.....	56
In Conclusion.....	61
Appendix I - Additional Graphs	62
Appendix II -Temperature Records from YourEnvironment.ca for Calgary.....	75
About.....	77

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Executive Summary

On February 26, 2020, Albertans were informed by Global TV that the “Alberta government took six months to release alarming climate report”, suggesting in the headline and through a comment by former NDP Environment Minister Shannon Phillips, some intention to hide the report from the public. The report, “[Alberta’s Climate Future](#)” was co-authored by Dr. Katharine Hayhoe and colleague Anne Stoner and had been commissioned by the previous NDP government’s environment minister, Shannon Phillips. However, in the Global TV story, lead author Katharine Hayhoe states the final draft was provided in August of 2019, but the supporting data was sent much later.

Page | 2

Dr. Hayhoe is a very high-profile climate scientist, having been named by [TIME Magazine](#) in 2014 as one of the 100 most influential people. In 2017, Dr. Hayhoe made several presentations in Alberta as part of the Intergovernmental Panel on Climate Change (IPCC) Cities Climate Conference in Edmonton, and the City of Calgary’s Climate Symposium.

The “Alberta’s Climate Future” report was paid for by Alberta taxpayers and many consequential decisions about funding for climate change projects, climate mitigation projects (like dams and berms for floodways), as well as public attitudes, concerns and fears about the future rest on the findings of the Hayhoe & Stoner report.

The objective of this rebuttal is to review the premises and evidence presented by authors Hayhoe & Stoner to see if their findings are indeed ‘alarming’ or even in concert with the evidence.

The Hayhoe & Stoner report relies on Alberta data from 1950 to 2013. From the late 1940s to 1970, global average temperatures cooled, despite an ongoing rise in carbon dioxide. Thus, any temperature assessment starting in 1950 begins in a period of lower temperatures, and thus is biased towards warming. Likewise, the Hayhoe & Stoner report ‘downscales’ climate models used by the IPCC to forecast for regional and local areas. Climate models are computer macro simulations of the larger global picture, which use a large gridded area of 30 to 200 km. Downscaling mathematically is a method that attempts to apply those broader modelled results to smaller areas. With climate models known to ‘run hot’ this can predict much hotter temperatures than those observed and documented.

In this analysis, we have used four long term temperature records in Alberta (~100 years) to evaluate the ‘alarming’ media claims in the Hayhoe & Stoner report. Using that, along with other historical records of floods and wildfires, we seek to evaluate Hayhoe & Stoner’s claims that there will be more such events in the future, or that there will be more extreme weather events than in the present, and to see if there is a clear causal link to the stated human influence on climate that the IPCC claims is evident since 1950.

An overview summary of our findings is as follows.

Hayhoe & Stoner’s “Alberta’s Climate Future” report fails in a number of ways. The report ignores climate cycles and instead forecasts continuing linear temperature increases based on global climate models, even when local trends may be quite different. The report only addresses trends from 1950, ignoring much warmer conditions in the past in the Province. Because records before 1950 were not considered, the report is misleading in stating that it fully considered the historical record when in fact, the authors only considered the last 63 years of a 100 to 137 year history. The report forecasts are based on a simple correlation with a global temperature forecast (which may be of suspect quality)

while ignoring the high-quality Alberta temperature record, with no consideration of how Alberta's past climate appears to be at odds with global patterns.

More concerning, "Alberta's Climate Future" is based on the use of unreasonably unlikely scenarios, such as Representative Concentration Pathway (RCP) 8.5. This computer simulation is a very extreme projection of the future where the world goes back to using more than five times the coal than is used today. Most mainstream scientists believe the RCP8.5 scenario to be a critically flawed benchmark for forecasting future climate. Likewise, these scenario simulations are not meant to be compared to one another, which is what the Hayhoe & Stoner report does throughout the document.

Hayhoe & Stoner make bold and unverified statements such as: "extreme high and low temperatures are projected to increase exponentially" without justification. The report creates alarm with discredited references to natural "Black Swan" events, ascribing human caused climate change as the driver of floods and fires. To make things worse, for an already misinformed public, the media appears guilty of over hyping the story. This is a clear example of enabling Climate Alarmism, as compared to good investigative journalism.

This independent review uncovers the fact that there are no 'dire' or 'alarming' findings in the Hayhoe & Stoner report. The media must report facts and not amplify fear. Good journalism requires critical thinking and as a starting point, needs to give climate allegations a skeptical view. Instead the media further misinforms with dramatic headlines that distort the report's content.

Many cycles govern our weather and climate. These cyclical factors seem to be ignored in the "Alberta's Climate Future" report. On the smallest scale, we all experience the diurnal cycle, the change from day to night. Here in Alberta the average diurnal cycle varies daily by 10 °C in winter and by 15 °C in summer. While the media claim a small degree of possible warming is 'alarming' and 'dire', do they put it into context of our annual seasonal cycle, where the January average temperatures vary from -25 to -3 °C and July temperatures from 30 to 8 °C. Winter to summer sees a maximum (average) difference of 55 °C!

Other major natural cycles also affect Alberta's weather and climate. The Solar Cycle is 11 years but there also are longer periodic cycles of solar intensity related to Grand Solar Maxima and Minima. Ocean-atmospheric cycles, such as ENSO (El Nino Southern Oscillation / La Nina), AMO (Atlantic Multi Decadal Oscillation) and PDO (Pacific Decadal Oscillation), influence temperatures over multi-decadal periods. From the climate record it is easily observed that the solar and ocean cycles combine to greatly influence temperatures daily, annually and over the long term, locally, within regions and across the Globe. These influences are not factored into the "Alberta's Climate Future" assessment.

In a commentary from several years ago, [Freeman Dyson](#), a renowned physicist, quite succinctly described influences consistent with our observations of Alberta's climate:

"In humid air, the effect of carbon dioxide on radiation transport is unimportant because the transport of thermal radiation is already blocked by the much larger greenhouse effect of water vapor. The effect of carbon dioxide is important where the air is dry, and air is usually dry only where it is cold. Hot desert air may feel dry but often contains a lot of water vapor. The warming effect of carbon dioxide is strongest where air is cold and dry, mainly in the arctic rather than in the tropics, mainly in mountainous regions rather than in lowlands, mainly in winter rather than in

summer, and mainly at night rather than in daytime. The warming is real, but it is mostly making cold places warmer rather than making hot places hotter. To represent this local warming by a global average is misleading.”

This quote closely describes the climate situation in Alberta. Alberta is dry, cold and at higher latitudes with significantly varying elevations. What Dyson says about cold places getting warmer and warming at night, is what this investigation verifies. However, there is more to than that. With winters and nights getting warmer, the summer daytime temperatures are not getting hotter.

Page | 4

This review shows how Hayhoe & Stoner misinform, how they did not use all available information, how they cultivate alarm regarding Black Swan events, while ignoring counter trends and evidence of cycles. Their report style demonstrates a false, absolute certainty, of knowledge, where due qualification of assumptions and other influences can alter results as reported. Facts and evidence, not fortune-telling, should guide public policy on climate and energy.

Facts vs Fortune Telling

Alberta's Climate Future Report Review

Page | 5

This is a plain language document, meant to help the general public and policymakers understand the complexities of climate change and forecasting.

On Feb. 26, 2020, Global TV announced the release of a climate report entitled “Alberta’s Climate Future” prepared by Dr. Katharine Hayhoe and colleague Anne Stoner of Atmos Research & Consulting. The report was commissioned by the previous NDP government and Global TV’s headline claimed that the “Alberta government took six months to release climate report”.

Global TV indeed reported some alarming claims.

But are these claims supported by the evidence in the report, or by the abundance of climate data in the province of Alberta and in Canadian climate and temperature records?

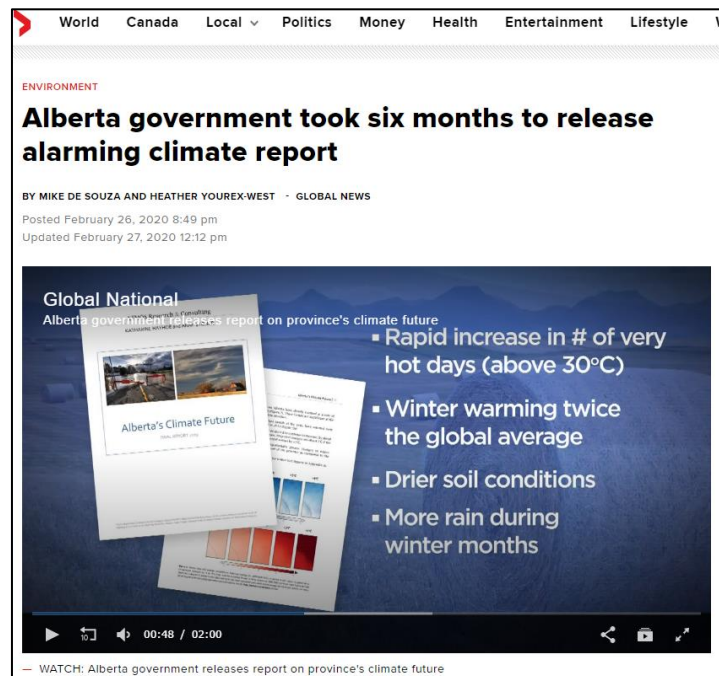
The report also claimed that these climate changes would have profound effects on Albertans.

“Alberta’s Climate Future” forecasts events out to 2100, or some 87 years hence (based on the assessment of trends from 1950 to 2013). How can we be sure that those trends will continue, if not reverse?

Trends have reversed in the past, many times. Is using a global climate model (a computer simulation) that is ‘downscaled’ to represent Alberta accurate? The Hayhoe & Stoner report states that the projected changes reported are “...appropriate... to inform long-term planning, education and outreach.” How reliable is the evaluation if all facts are not considered and forecasts rest on computer generated guesswork?

If we are going to tell the climate fortune of Alberta 87 years hence, should we not also review the historical trends of climate 87 years into the past, or more, if records exist, for comparative purposes? This was not done by Hayhoe & Stoner and it raises the question of ‘why not’? Their report claims to review the full historical record but only considers climate data from 1950 forward to 2013, a period of 63 years.

Climate change and extreme weather events happened due to natural variability throughout history. Though Hayhoe & Stoner repeatedly state that present climate change (since 1950) is due to “heat



trapping greenhouse gases from fossil fuel use”, what proof is there that this is the only influence? Climate policies based on such claims affect the lives of millions of people and billions of dollars of investment in societal infrastructure. Reports like this must accurately reflect observation. Climate models are based on a myriad of scientific and subjective assumptions. Those that use computers and do modelling know of GIGO (Garbage In - Garbage Out). That may be the case if modelling parameters are not well understood or miscalibrated. As climate modeller Syukuro Manabe has said: “The climate model is a very good tool for understanding climate, but a very bad tool for predicting climate”.

This review will challenge the claims of the Hayhoe & Stoner report with evidence and historical data, which demonstrate the many failings of the Alberta’s Climate Future report.

Science and the Citizen

“I would like to add something that’s not essential to the science, but something I kind of believe, which is that you should not fool the layman when you’re talking as a scientist. I’m talking about a specific, extra type of integrity that is not lying, but bending over backwards to show how you’re maybe wrong, that you ought to do when acting as a scientist. And this is our responsibility as scientists, certainly to other scientists, and I think to laymen.”

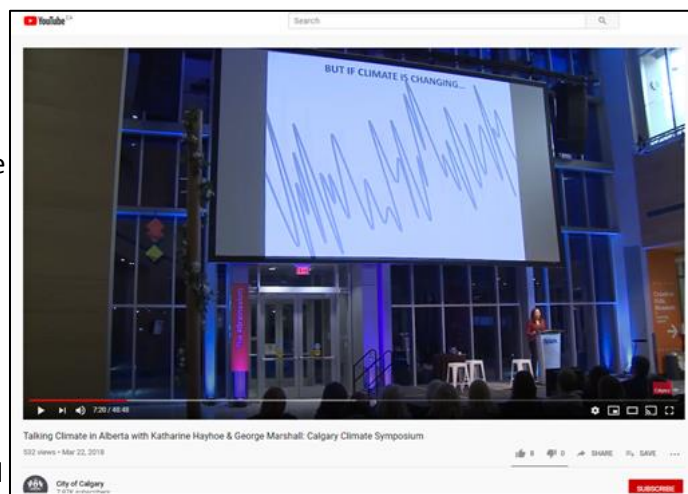
Richard Feynman, [Cargo Cult Science](#)

Climate science is a complex multidisciplinary field. It is easy to deceive the public and policymakers because many terms and concepts are outside of most people’s day to day understanding. We hope that this examination of the materials presented in “Alberta’s Climate Future” will help the public and policymakers make better sense of the assumptions supporting the authors’ assertions and other countervailing observations and evidence to what they are being told.

Dr. Hayhoe has made several climate presentations to Albertans. In her 2018 presentation at Telus SPARK during the Calgary Climate Change Symposium, Dr. Hayhoe made many statements about Alberta’s climate. She referenced the study of the 21 communities which are also the basis of the “Alberta’s Climate Future” report. Thus, it is critically important to evaluate whether or not the findings of Hayhoe & Stoner are credible on all fronts.

Hundreds of millions of tax dollars, and perhaps lives or livelihoods, may be at stake.

In the City of Calgary video, linked to the right, Dr. Hayhoe claims that society was built on the assumption that climate is stable. Anyone with a modicum of common-sense should be able to dispute that claim and present evidence to show that this is not supported by observation and evidence. “Alberta’s Climate Future” fails Albertans in numerous ways, many of which policymakers would likely not understand without the further insight offered herein.



youtu.be/LFY044CO3TY

Failings of the Alberta's Climate Future Report Summarized:

In essence, the Alberta's Climate Future report fails in a number of ways:

- It ignores the fact that climate is cyclical and instead it forecasts continuing linear temperature increases;
- It starts trends from 1950, ignoring much warmer conditions of the past;
- The report is misleading in stating that it fully considered the historical record because records before 1950 were ignored;
- It forecasts Alberta's warming based on a simple correlation with the global temperature record (which may be of suspect quality). The report ignores a high-quality Alberta temperature record and how the Alberta past climate appears to be at odds with alleged global patterns;
- The forecast is based on the use of unreasonably unlikely scenarios, such as the Representative Concentration Pathway 8.5 (RCP8.5);
- The report makes bold and unverified statements such as: *"extreme high and low temperatures are projected to increase exponentially"* without justification;
- The Hayhoe & Stoner report creates public alarm with unjustified references to "Black Swan" events like the Calgary flood of 2013, and the Fort McMurray wildfire of 2016, as if these are directly attributed to human-caused climate change. The Calgary flood was due to a rare confluence of meteorological events, described in good detail by the Weather Network¹; and the Fort McMurray wildfire started due to human negligence, then grew with extremely high winds during a very dry, known high-risk fire period in May, between winter snow melt and spring rain. All of these elements had been described as risks, along with the consequences of the end-of-life 50 year cycle of Alberta's forests, and were outlined in the 2013 Flat Top Fire Complex report on the similarly catastrophic May 2011 Slave Lake fires.² In that report, the province was advised to have fire crews and equipment ready by April 15th to address the likelihood of May wildfires. In spring 2016, the province was unprepared.

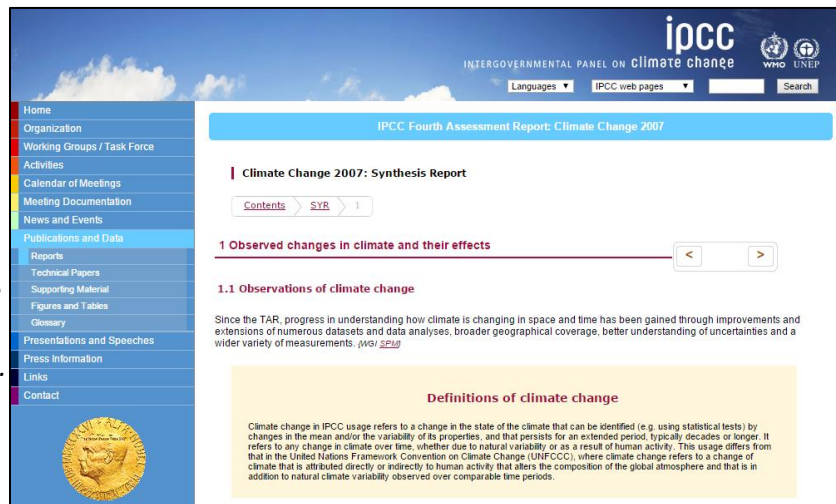
Page | 7

¹ theweathernetwork.com/news/articles/alberta-floods-why-is-there-so-much-rain/8124/

² wildfire.alberta.ca/resources/reviews/documents/FlatTopComplex-WildfireReviewCommittee-A-May18-2012.pdf

What is “Climate Change”?

Though the cause of contemporary climate change is often framed as ‘it’s us’ (humankind), the Intergovernmental Panel on Climate Change (IPCC), the UN body designated to assess human causation, defines climate change as *“a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its property, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability, or as a result of human activity.”*



Periods of naturally caused climate change are thus deemed relevant and are essential to proper evaluation of current changes in climate.

Basis of Alberta’s Climate Future Report

Reading of the report indicates the following:

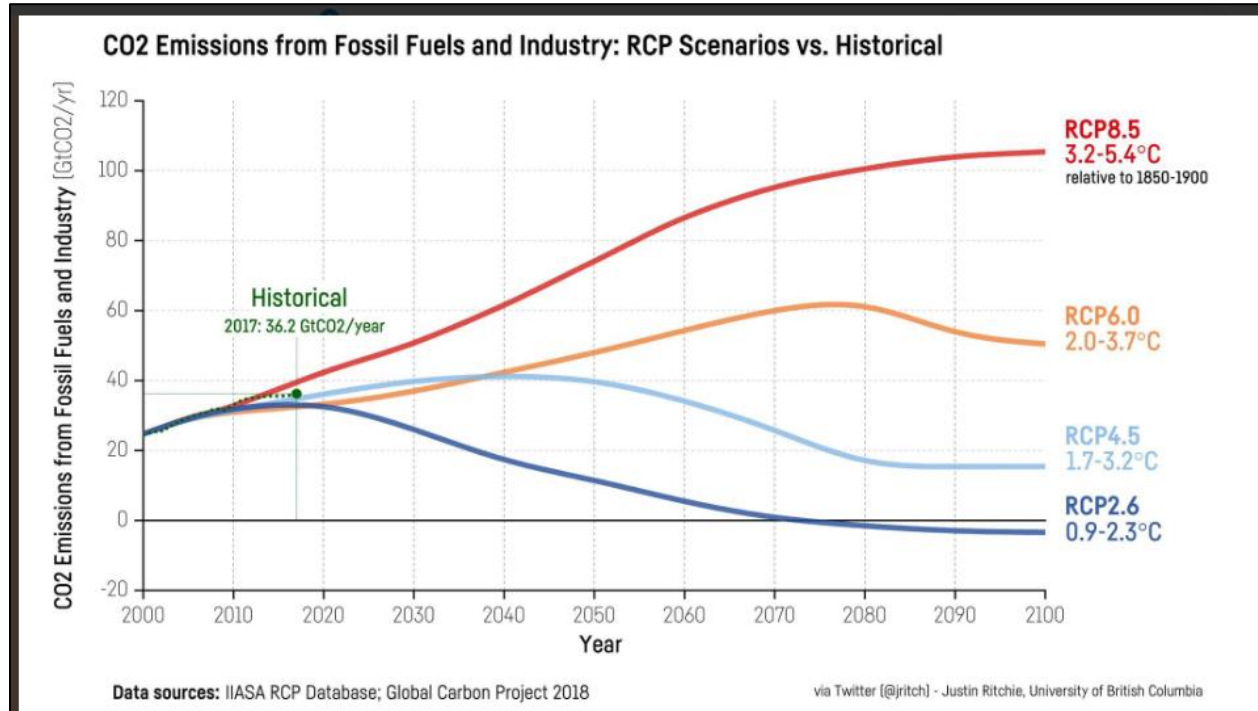
- The report is based on historical observations (from 21 weather stations across the Province);
- The report addresses temperatures from 1950 to 2013 (there are 38 references to this period this in the report);³
- The global temperature forecasts are based on the UN IPCC scenarios;
- Global temperature forecasts are based on studies such as:

“global annual averaged temperatures for 1986–2015 are likely much higher, and appear to have risen at a more rapid rate during the last 3 decades, than any similar period possibly over the past 2,000 years or longer” (Wuebbles et al. 2017)

- Therefore, Alberta’s climate forecasts are considered as correlated to global forecasts;
- The report references the IPCC RCP models as quoted: “based on a higher (RCP8.5) and lower (RCP4.5) future scenario”.

³ From 2019 back to 1950 is a time frame of 69 years. Some temperature time frames are from 1950-2013 or 63 years.

What are the Representative Concentration Pathways (RCP)?



Page | 9

Representative Concentration Pathways (RCP)⁴ are computer simulations that were developed to try and evaluate ‘what if’ and ‘how do’ certain factors affect possible global warming based on greenhouse gas emissions? RCP8.5 is a ‘what if’ scenario that entails the world going back to coal-based society with no mitigation.⁵ RCP8.5 would see the use of coal expand five times what the world presently uses and it does not include any climate policies to reduce emissions or the possibility of future technologies. RCP8.5 is seen as a completely unrealistic scenario and many scientists dismiss its use and call for researchers to stop using it as a basis for policy evaluation.⁶ It is certainly not “business-as-usual”. However, RCP8.5 prominently features in the Hayhoe & Stoner report, and is constantly compared to the RCP4.5 model, as if this is a ‘pathway of choice’.

The other RCPs are based on a world with 3 billion fewer people! This may be where some people’s push for depopulation comes from, but again, that was not the original intention of the modelling exercise. Likewise, none of them are seen as a pathway to addressing climate change influenced by humans; they were developed as a modelling tool, not as a proposed solution.

So, a person viewing the RCP chart might assume that these ‘pathways’ offer us ‘choices’ of how we should proceed, but according to the developers of the RCP methodology, these were never meant to be used as comparative choices. RCP simulations were simply an exercise in evaluating which factors caused what outcome in the projections for global warming.

⁴ link.springer.com/article/10.1007/s10584-011-0148-z

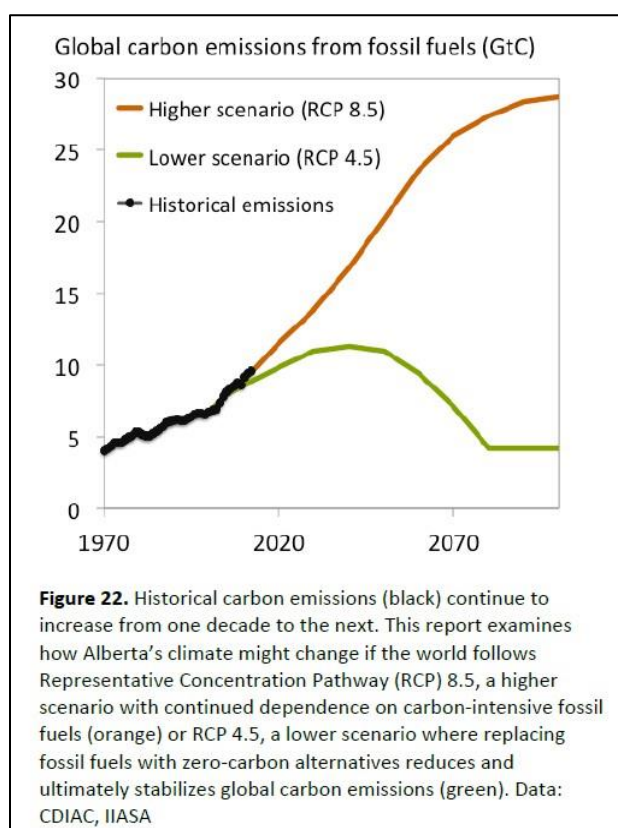
⁵ There is existing technology that can sequester carbon dioxide emissions, such as that in use at Boundary Dam in Saskatchewan; novel technologies to capture graphene from the coal stack are near market ready. Both such advances may mean there would be little accumulation of additional carbon dioxide (CO₂) in the atmosphere.

⁶ nature.com/articles/d41586-020-00177-3

More recently, Roger Pielke, Jr., a long-time climate policy analyst, exposed the fact that ‘green’ billionaires Thomas Steyer and Michael Bloomberg promoted “Risky Business”, a report and pattern of alarmism that is completely premised on the RCP8.5 scenario as the “business-as-usual” case.⁷ It is what Pielke calls “climate porn.”⁸ Unfortunately, the billionaires successfully sponsored and promoted events where this report received widespread attention, and now it is commonly repeated in scholarly and media reports. However, RCP8.5 is an extremely high emissions scenario and is extremely unlikely to happen.

Thus, it is disturbing in the Hayhoe & Stoner report that two RCPs – RCP8.5 and RCP4.5 are consistently referred to, often using the word ‘choice’. Further support is self-serving as these claims come from three papers written by Hayhoe as lead author. The scenarios both are infeasible and unlikely, and thus offer little to no relevance in consideration of climate forecasts.

While it is not improper to cite one’s own work in a paper, of the 29 references in the Alberta’s Climate Future report, seven are authored or co-authored papers of Dr. Hayhoe. Typically, independent evidence is sought to support a claim in order to present a more objective form of reporting and analysis. This is a clear example of “climate group think” or circular reasoning and the common practice of self and “pal” referencing of citations.



Likewise, Hayhoe & Stoner chose a graph for the report (left) with a compressed horizontal timescale and an exaggerated vertical scale to accentuate the magnitude of vertical separation. This presentation may mislead the general public by creating a false impression of potential threat and an imminent risky time frame.

⁷ forbes.com/sites/rogerpielke/2020/01/02/how-billionaires-tom-steyer-and-michael-bloomberg-corrupted-climate-science/#3c2c4fdd702c

⁸ forbes.com/sites/rogerpielke/2019/09/26/its-time-to-get-real-about-the-extreme-scenario-used-to-generate-climate-porn/#4d5d05b54af0

Here is what was recently conveyed by climate scientist Zeke Hausfather in Nature in a comment on January 28, 2020:

“RCP8.5 was intended to explore an unlikely high-risk future. But it has been widely used by some experts, policymakers and the media as something else entirely: as a likely ‘business as usual’ outcome. A sizeable portion of the literature on climate impacts refers to RCP8.5 as business as usual, implying that it is probable in the absence of stringent climate mitigation. The media then often amplifies this message, sometimes without communicating the nuances. This results in further confusion regarding probable emissions outcomes, because many climate researchers are not familiar with the details of these scenarios in the energy-modelling literature.

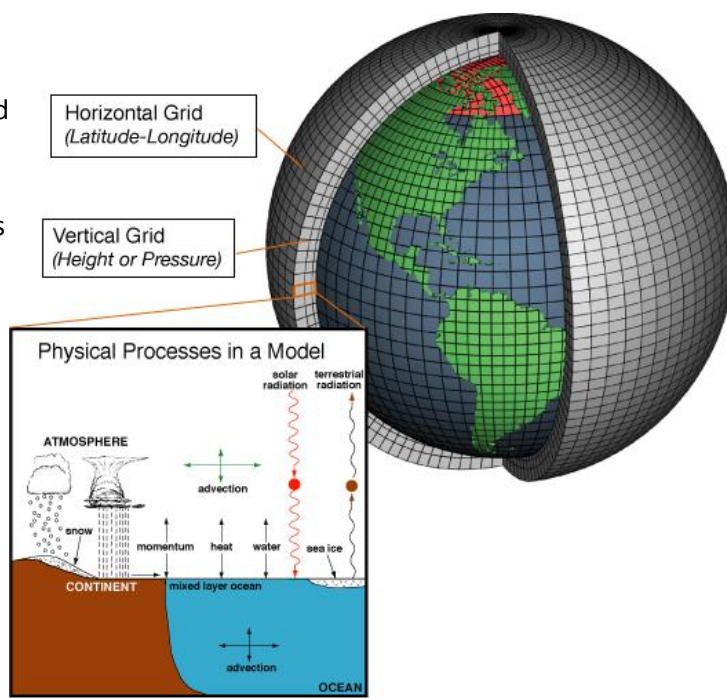
This is particularly problematic when the worst-case scenario is contrasted with the most optimistic one, especially in high-profile scholarly work. This includes studies by the IPCC, such as AR5 and last year’s special report on the impact of climate change on the Ocean and cryosphere. The focus becomes the extremes, rather than the multitude of more likely pathways in between.

Happily — and that’s a word we climatologists rarely get to use — the world imagined in RCP8.5 is one that, in our view, becomes increasingly implausible with every passing year. Emission pathways to get to RCP8.5 generally require an unprecedented fivefold increase in coal use by the end of the century, an amount larger than some estimates of recoverable coal reserves.”

The Alberta’s Climate Future report erroneously uses RCP8.5 as the basis of their future temperature forecasts.

What is a Climate Model?

This image shows the concept used in climate models. Each of the thousands of 3-dimensional grid cells can be represented by mathematical equations that describe the materials in it and the way energy moves through it. The advanced equations are based on the fundamental laws of physics, fluid motion, and chemistry. To "run" a model, scientists specify the climate forcing (for instance, setting variables to represent the amount of greenhouse gases in the atmosphere) and have powerful computers solve the equations in each cell. Results from each grid cell are passed to neighboring cells, and the equations are solved again. Repeating the process through many time steps represents the passage of time.



Source: climate.gov/file/atmosphericmodelschematicpng

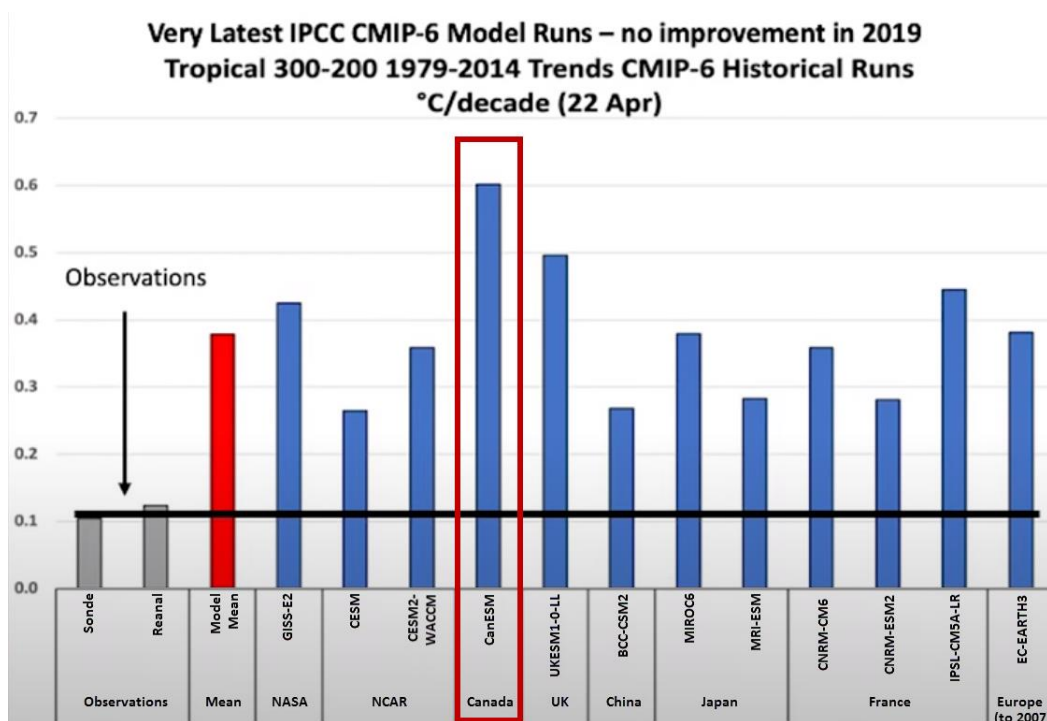
Climate ‘models’ are computer simulations that attempt to mathematically simulate and evaluate the myriad of dynamic factors that drive weather and climate change.

By adjusting various factors, such as the amount of carbon dioxide in the atmosphere, or the ‘climate sensitivity’ (warming effect) of carbon dioxide, various model ‘runs’, or simulations are performed to compare what global warming might be some years hence.

Page | 12

Though these are highly advanced simulations, many scientists say that climate models are useful for understanding climate, but useless for predicting climate, largely because the natural variations cannot be predicted, and models use mathematical shortcuts that do not fully represent climate behaviour.

Climate models ‘run too hot’ compared to observed temperatures from radiosondes (weather balloons) and the reanalyses of global weather data. As explained by [Dr. John Christy of the University of Alabama Huntsville](#), “major weather centers around the world generate atmospheric conditions every six hours or so of the entire Earth at many vertical levels, called Reanalyses. These products use many sources of data, including satellites and balloons, and merge the observations with a continuously running general circulation model.” Why is it significant to note that models ‘run too hot’? Models are used to establish climate policy and economic models used to set carbon taxes are calibrated to these faulty computer simulations. So, carbon taxes are set too high. You can see below that models greatly exaggerate projected temperatures. The observed temperatures are the two small gray bars to the left, marked “Sonde” - radiosonde/weather balloons; “Reanal” - Reanalyses. Climate models are developed in different countries and climate research centers around the world. For a discussion about them, see the [American Physical Society Workshop Transcript](#). Some countries develop more than one model. The small gray bars show the observed temperature; the red bar is the average projection of all of the models herein, and the blue bars are different modeled projections. The red box highlights the projection of the Canadian climate model, “CanESM”, which has the highest projected warming rate of 5.4 times that of observed temperatures. Source: youtu.be/I8hdE3eZ6vs

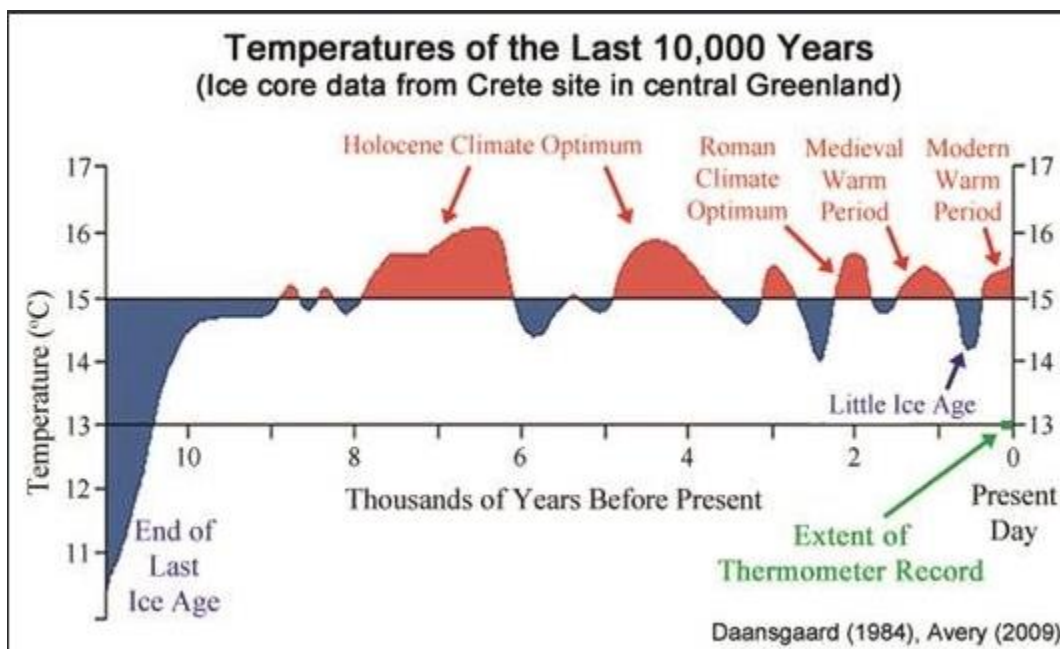


Premises on Climate Change

As noted in the “Alberta’s Climate Future” report, “*climate is the statistic of weather averaged over a relatively long period of time. The World Meteorological Organization (WMO) uses a 30 year period to define ‘climate normals’...*” which are reference points used to compare past and present trends.

Page | 13

Hayhoe & Stoner claim that there has been little change in climate over the past two thousand years, with the exception of the past 100 years (of human influence). This claim is not supported by the evidence of the Holocene period of the past 10,000 years, which shows a clear, repeating, cyclical pattern of warming and cooling every 1,000 to 1,500 years or so.



This Holocene graph refers to ice core data from central Greenland which some who support climate orthodoxy reject as not being relevant to human civilization, despite it depicting the last 10,000 years where mankind emerged from the ice age, invented agriculture and began the long road to our current day technological society.

Two excellent books by paleo climatologist Brian Fagan detail the differences in climate during “The Great Warming: The Rise and Fall of Civilizations”⁹ covering the Medieval Warm Period (MWP) 900 to 1300AD, also known as the “Medieval Climate Anomaly” (MCA), and that of the colder, Little Ice Age (LIA) 1300 to 1850AD. Fagan’s book “The Little Ice Age: How Climate Made History”¹⁰ is a study in contrasts to “The Great Warming”. During the MWP, civilization flourished, the great cathedrals and castles were built in a time of obviously reasonably stable clement weather patterns creating an abundance of food and affording the time for the construction of these edifices that stand to this day in Europe. In the same period, the southern western USA in the region of California today, saw 100 and 200 yearlong droughts. By contrast, the LIA was fraught with famine, due to long periods of cold, or extremely erratic weather patterns and terrifying storms. Starvation and riots were common. The Black

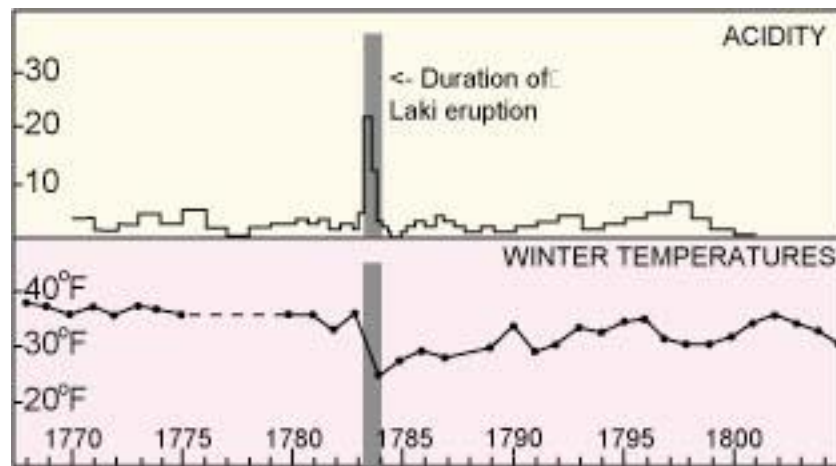
⁹ [amazon.ca/Great-Warming-Climate-Change-Civilizations/dp/159691601X](https://www.amazon.ca/Great-Warming-Climate-Change-Civilizations/dp/159691601X)

¹⁰ [amazon.ca/Little-Ice-Age-Climate-1300-1850/dp/0465022723](https://www.amazon.ca/Little-Ice-Age-Climate-1300-1850/dp/0465022723)

Death moved through Europe like the Grim Reaper. Thousands of unfortunate individuals, mostly women, were burned at the stake for the crime of “*weather cooking with the help of Satan*,” as explained by astrophysicist, Dr. Sallie Baliunas.¹¹

In the latter part of the Little Ice Age, a series of massive volcanic eruptions exacerbated conditions.

In 1783, Laki erupted in Iceland, with a low-lying, toxic cloud of sulphur dioxide infused gas that rolled almost 2,000 miles across the sea to England, killing workers, crops and farm animals; moving on to cause famine and death worldwide. “*In the eastern United States, the winter average temperature was 4.8 degrees C below the 225 year average. The estimate for the temperature decrease of the entire Northern Hemisphere is about 1 degree C.*”¹²



Laki eruption correlated to winter temperatures. Source: Oregon State Laki Iceland 1783

In April 1815, Mount Tambora erupted in Java, Indonesia. The local impact was catastrophic, with thousands of people dying from the eruption and lava flows, gases and ash, as well as the subsequent famine as crops could not grow under skies heavy with aerosols that shrouded the sun. The impacts were felt as far away as North America where 1816 became known as “the year without summer”.

The Little Ice Age also coincided with a drop off of solar activity, as evidenced by a lack of sunspots.

While the volcanic eruption events are short-term examples of extreme dips in temperature, these demonstrate that abrupt temperature changes are common due to natural causes and can have global impacts. Likewise, the long-term variation in global temperatures between the MWP and LIA is quite significant. Hayhoe & Stoner claim that the rise of less than one degree Celsius over the period of the past 100 years or so is ‘unprecedented’, in light of the evidence, this seems to be quite an exaggeration.

¹¹ youtu.be/wcAy4sOcS5M

¹² volcano.oregonstate.edu/laki-iceland-1783

Climate Has Never Been Stationary; Human Adaptations to Flood Plains

A fundamental premise of the Hayhoe perspective on climate appears to be the claim that “...human society is built on the implicit assumption that climate is largely stationary...” then going on to reference “...the hundred-year floodplains of our cities...” continuing to ask “What happens when that assumption is no longer valid?” Hayhoe and Kopp (2016)

Page | 15

These statements reflect a lack of historical observation. Throughout time, humans have repeatedly learned from and adapted to the confluence of climate change, extreme weather events and the consequences of “Mother Nature” in accepting their often ‘bad choice’ of residence.

As Roger Pielke, Jr. (2005) pointed out,¹³ if people do not build on flood plains, there is no climate risk. But people do build on flood plains. Some people misunderstand the term ‘100 year flood’ to mean this is the time interval of expected flooding. That is not the case. The term is meant to describe the probability of the recurrence interval of that magnitude of flood. It is not a predictor of the time frame of future potential flooding. You can have 100 year floods (or 500 year floods) in 2 or more consecutive years. The USGS offers a detailed explanation:¹⁴

“Statistical techniques, through a Process called frequency analysis, are used to estimate the probability of the occurrence of a given precipitation event. The recurrence interval is based on the probability that the given event will be equaled or exceeded in any given year. For example, assume there is a 1 in 50 chance that 6.60 inches of rain will fall in a certain area in a 24-hour period during any given year. Thus, a rainfall total of 6.60 inches in a consecutive 24-hour period is said to have a 50-year recurrence interval. Likewise, using a frequency analysis (Interagency Advisory Committee on Water Data, 1982) there is a 1 in 100 chance that a streamflow of 15,000 cubic feet per second (ft³/s) will occur during any year at a certain streamflow-measurement site.

Thus, a peak flow of 15,000 ft³/s at the site is said to have a 100 year recurrence interval. Rainfall recurrence intervals are based on both the magnitude and the duration of a rainfall event, whereas streamflow recurrence intervals are based solely on the magnitude of the annual peak flow.”

As for the claim that human society has held ‘assumptions that climate is largely stationary’, London, England was built on the banks of the Thames. It was massively flooded in the Little Ice Age and various times since, but after the great flooding of much of eastern England in the 1953 North Sea Surge, and following the engineering examples of the Dutch, (who had learned hard lessons in “Die Grote Mandrenke/Great Drowning of Men” of 1362^{15 16}), the massive, modern Thames Barrier was built, to keep vast storm surges at bay from London and all communities upstream of the Thames.^{17 18}

¹³ uvic.ca/research/centres/globalstudies/assets/docs/publications/RPielke.pdf

¹⁴ usgs.gov/special-topic/water-science-school/science/100-year-flood?qt-science_center_objects=0#qt-science_center_objects

¹⁵ medieval.eu/medieval-flooding/

¹⁶ medievalists.net/2015/02/great-wind-1362/

¹⁷ The Thames Barrier spans 520 metres across the River Thames near Woolwich, and it protects 125 square kilometres of central London from flooding caused by tidal surges. It has 10 steel gates that can be raised into position across the River Thames. When raised, the main gates stand as high as a 5-storey building and as wide as the opening of Tower Bridge. Each main gate weighs 3,300 tonnes. The barrier is closed under storm surge conditions to protect London from flooding from the sea. It may also be closed during periods of high flow over Teddington Weir to reduce the risk of river flooding in some areas of west London including Richmond and Twickenham gov.uk/guidance/the-thames-barrier

Neither London, England nor the Netherlands are planning on moving, so they have adapted to the challenges of living by the sea. The Dutch have berms and dykes across the country and operate a modern, advanced society, engaged in global trade. Some 68 million people fly in and out of Schiphol Airport every year, which is 3 meters (9.8 feet) below sea level. About [one third of the Netherlands is below sea level](#) with the lowest point being 6.7 meters (22 feet) below sea level.

In Canada, similar, stupendous adaptive measures have been taken to control seasonal flooding and protect the city of Winnipeg, Manitoba. The Red River Floodway was planned and built following the disastrous flood of 1950, when despite early periods of flooding there had not been a major flood for nearly a century. At first the project was the subject of mockery as “Duff’s Ditch” and “Duff’s Folly”, but this huge public works project has saved lives and property from flooding numerous times. Winnipeg is built in the basin of the vast glacial Lake Agassiz, so it will always be subject to threat of flooding, particularly in times of a rapid melt of heavy winter snow, coinciding with heavy spring rains. This amazing human adaptation to flooding is described below in some passages from the Manitoba Historical Society.¹⁹

The Red River Floodway has become a national symbol of what Canadian engineers and engineering works, in the tradition of public works engineering, can achieve in defending a major region of the country against the onslaught of potentially devastating natural disasters, and of the limits of what man can achieve. As expressed by the Winnipeg Free Press:

“The floodway is more than just a triumph of engineering resulting of an exemplary political vision. It is also a symbol of both our power to control the forces of nature and our impotence in the face of those elements. We can build a floodway to keep Winnipeg safe by turning the water aside, but that is all we can do. We cannot save the rest of the vulnerable areas; we cannot turn back the waters. They return almost every year to remind us of that.”

As such, the Red River Floodway represents an outstanding engineering achievement, a remarkable triumph of man over the vagaries of Nature; yet one fraught with lessons as to the uncertainties involved in all such works, and the unceasing effort required to sustain them. As expressed by Senator, and former Premier, Duff Roblin, following the Flood of the Century in 1997:

“We were reminded again this year of two immutable truths: the awesome power of mother Nature and the indomitable spirit of the human family.”

Are Floods and Wildfires Getting More Frequent or Extreme?

The Hayhoe & Stoner report references extreme natural events as harbingers of human-caused climate change, suggesting that by limiting the use of fossil fuels, society will be able to prevent such ‘occurrences’. There is no evidence to support such a contention, though climate pundits have theorized that extreme weather events may be an outcome of human-caused global warming, but this is

¹⁸ “North Sea Surge” Michael Pollard 1978

¹⁹ mhs.mb.ca/docs/mb_history/42/duffsditch.shtml

predicted for many decades hence and contingent on continued and rapid rise in temperatures based on computer model assumptions.

To ascertain present impacts, in 2012, the IPCC issued a Special Report on Extreme Weather (IPCC SREX). In 2013, the IPCC issued the AR5 report which stated that there had been no statistically significant warming for the 15 years prior to the report, despite a significant rise in carbon dioxide. In Dr. Judith Curry's testimony to the US Senate, she summarized the findings of these two reports, in relation to extreme weather and human causation as follows: *"the IPCC AR5 and SREX find little evidence that supports an increase in most extreme weather events that can be attributed to humans, and weather extremes in the U.S. were generally worse in the 1930's and 1950's than in recent decades."*²⁰ Dr. Curry's observation is likewise applicable to Alberta, as is shown by consideration of the province's full, historical temperature record.

The Alberta's Climate Future report referenced the Canada's Changing Climate Report 2019 (CCCR2019) study that says:

"Climate change alters the frequency and/or intensity of many of these extreme events, risks are also increasing"

The statement does not distinguish between human-causation or natural drivers. As noted above, the LIA was a period of dramatic climate change, but naturally caused.

Let's look at the facts:

- The CCCR 2019 report expresses 'confidence' levels;
- The Fort McMurray Fire is given Medium Confidence;
- *Medium confidence indicates that it is about as likely as not;*
- The Calgary Flood is given Low Confidence;
- *Low confidence means that it is extremely unlikely.*

When referring to increasing risk, why reference unfortunate circumstances that have no relationship to climate as is clearly documented in the CCCR 2019 report? Perhaps to create alarm?

Let's look into why there is such low confidence in these events being related to human caused climate change.

²⁰ curryja.files.wordpress.com/2014/01/curry-senatetestimony-2014-final.pdf

Calgary Flood Historical Record

As the Hayhoe & Stoner report notes, the WMO sees 30 years as a time frame for establishing 'climate normals' as reference points for comparing trends.



Page | 18

Aerial view of downtown core of Calgary 2013 flood. Source: CPS twitter feed.

The Weather Network reported that the 2013 Calgary flood was not an anomaly – despite the unusual meteorological patterns and ground conditions that made its volumes quite unique. In fact, eight of the worst floods in Calgary's history were before 1933, as represented in this chart of historic floods.

This is why it is important to review the fullest historical record available, so that faulty conclusions are not drawn about the cause or probability of weather patterns and events using a myopic view of data.

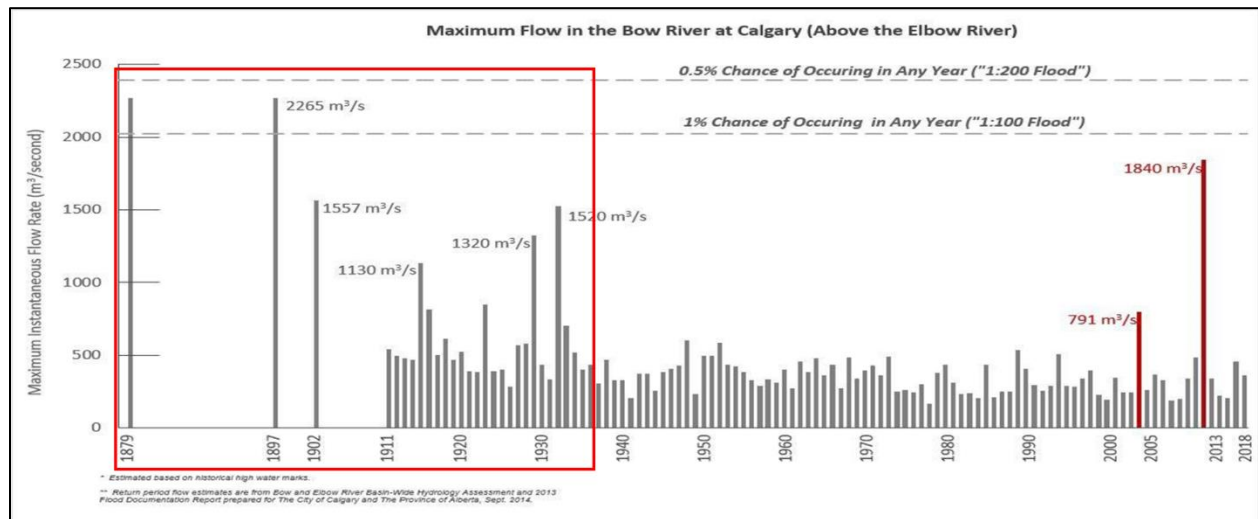
Year of historic Calgary floods ranked by peak flow.

	YEAR	PEAK FLOW	
1	1879	2265 m ³ /s	(estimate)
2	1897	2265 m ³ /s	(estimate)
3	2013	1740 m ³ /s	(estimate)
4	1902	1550 m ³ /s	(estimate)
5	1932	1520 m ³ /s	
6	1929	1320 m ³ /s	
7	1915	1130 m ³ /s	
8	1923	841 m ³ /s	
9	1916	810 m ³ /s	
10	2005	791 m ³ /s	

Source:

theweathernetwork.com/news/articles/calgary-floods-it-could-happen-again/8295

Calgary sits on the confluence of the Bow and Elbow Rivers which are fed by snowpack and glacial melt from the Rocky Mountains to the west. Flooding is a function of the depth of snow pack, the timing of snow melt (as to whether the ground is thawed or dry enough to absorb meltwater or precipitation), the volume and timing of spring precipitation, and the prevalence of ice jams in the rivers downstream near habitation. To date, no purpose-built dams or run-off areas have been built to control flooding in Calgary, though two existing structures offer nominal management of water flows.



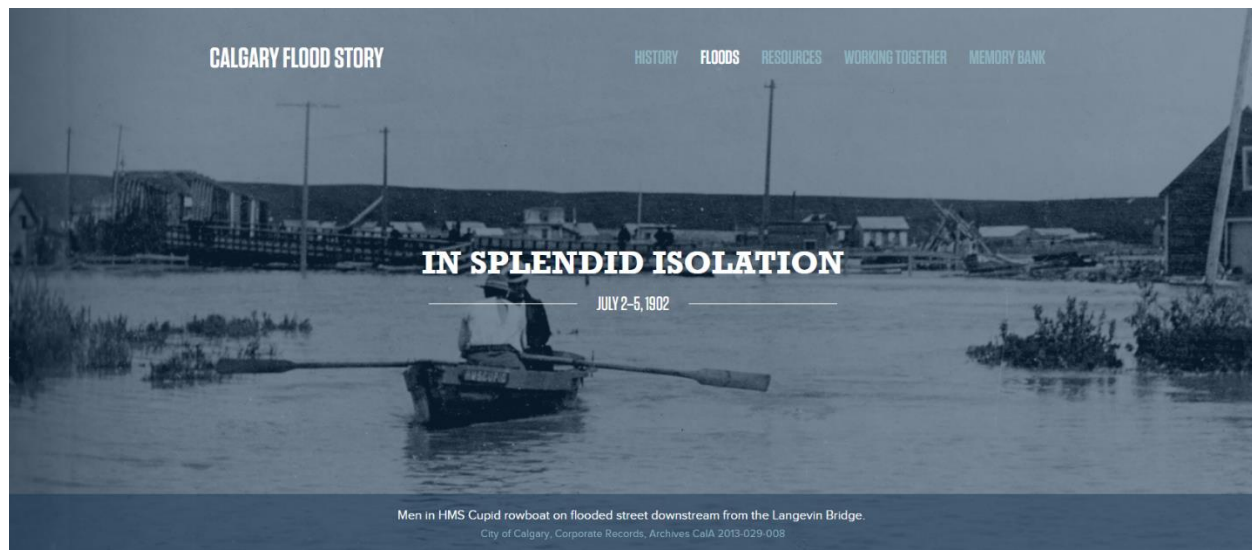
The red box on the graph above shows that the first 36 years of Calgary's history, from 1879 to 1933, was fraught with flooding. TransAlta built the Ghost Dam upstream on the Bow River in 1929 for hydroelectric power generation. The City of Calgary built the Glenmore Reservoir on the Elbow River in 1933 to create a reservoir to supply fresh drinking water for the growing city.

Without a detailed review of flood precursor conditions and precipitation records from the 1933 to 2005 period, it would be difficult to say if either or both of these human-built water control facilities prevented urban flooding in Calgary after their construction. But it is clear that one cannot attribute the outlier 2005 and extreme 2013 floods to human-caused climate change. Especially when the earlier >30-year period at the turn of the century shows that if anything, Calgary is in a natural flood plain. Curiously, Calgarians persist in building beautiful and extremely expensive real estate projects within the flood plain and along the banks of both rivers, with little to no flood mitigation features, such as elevated entry, no underground parking, no basements, etc.

Following the 2005 flood, the City did build up berms and walking paths along the downtown corridor of the Bow River, but these berms were overwhelmed and damaged in the massive 2013 flood. The Calgary Zoological Society was established in January of 1929 and a small collection of animals later died in the 1929 flooding. Yet in spite of this, the city went on to create a multi-million-dollar zoo facility in the same place at St. George's Island in midstream of the Bow River. During the 2013 flood, the facility was submerged, despite berms, initially due to ground water seepage and ultimately due to overflow. A zookeeper had to be positioned with a rifle and ready to kill the hippopotamuses in the event they swam out of the facility. Safety plans for wild and dangerous zoo animals consisted of potentially taking

them to downtown jail facilities although most of the jails in the courthouse were also swamped in the flood.²¹

The point of this lengthy discussion about Calgary flooding is that human-causation of climate change is irrelevant to the reality of Calgary's geographic and hydrological features. Calgary's flood history is well-known and there is even a website dedicated to these flood stories at the Calgary Public Library.



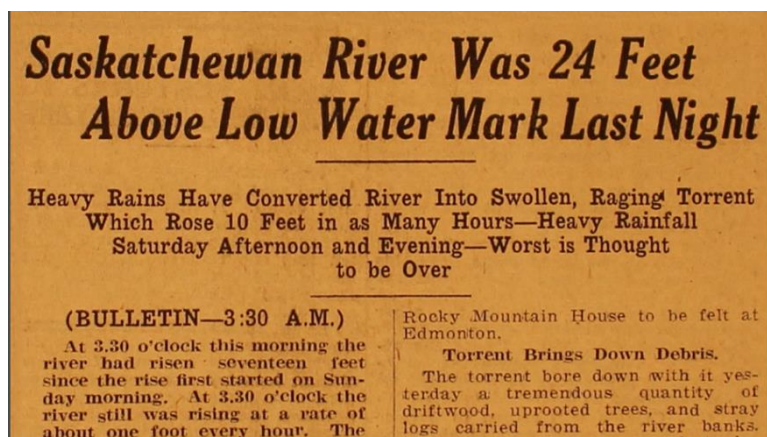
On July 2, 1902, the Bow River overflowed its banks near the Langevin Bridge. Two families were evacuated and the police were on standby to evacuate the rest of the area.

Source: Calgary Public Library website

Reducing greenhouse gas emissions will not stop the Bow and Elbow Rivers from flooding Calgary or other Alberta communities. Thoughtful infrastructure projects and establishing building codes and enforcing standards that mitigate any potential extreme flood would reduce losses, protect lives and mitigate the damage. Spending money on greenhouse gas reduction climate change initiatives in hope of stopping river flooding is a wasteful use of valuable public funds.

Most communities in Alberta have experienced flooding from time to time for various reasons – ice jams, heavy rainfall, poorly planned developments, and blocked or poorly planned drainage routes. Sometimes Mother Nature simply overwhelms whatever good plans humans have put in place.

edmonton.ca/ ///Flood_SaskRiver24Feet.pdf



²¹ "They planned to move the lions, tigers and leopards to holding cells at the Calgary Court Centre." theglobeandmail.com/news/national/will-calgary-zoo-animals-need-a-jail-house-ark/article12742568/

Tragically, after Fort McMurray residents suffered the massive wildfire of 2016, a crushing downturn in the economy and the drop in the price of oil, Mother Nature struck again in the spring of 2020 with flooding caused by a 25 km long ice jam.

How an Athabasca River ice jam forced thousands of people out of Fort McMurray

Page | 21

Ice jams start forming when ice blocks break up and flow downstream knocking more ice loose en route



The flooded Taiga Nova Eco-Industrial Park alongside the Athabasca River at the north end of Fort McMurray is shown on Tuesday, April 28, 2020. Officials in Fort McMurray are keeping a close eye on river levels after a 25-kilometre ice jam caused major flooding and forced about 12,000 people from their homes. Greg Halimda / THE CANADIAN PRESS

nationalpost.com/news/ice-jam-intel-how-the-athabasca-river-ice-buildup-is-flooding-fort-mcmurray

No amount of ‘climate mitigation’ or money would have prevented this disaster.

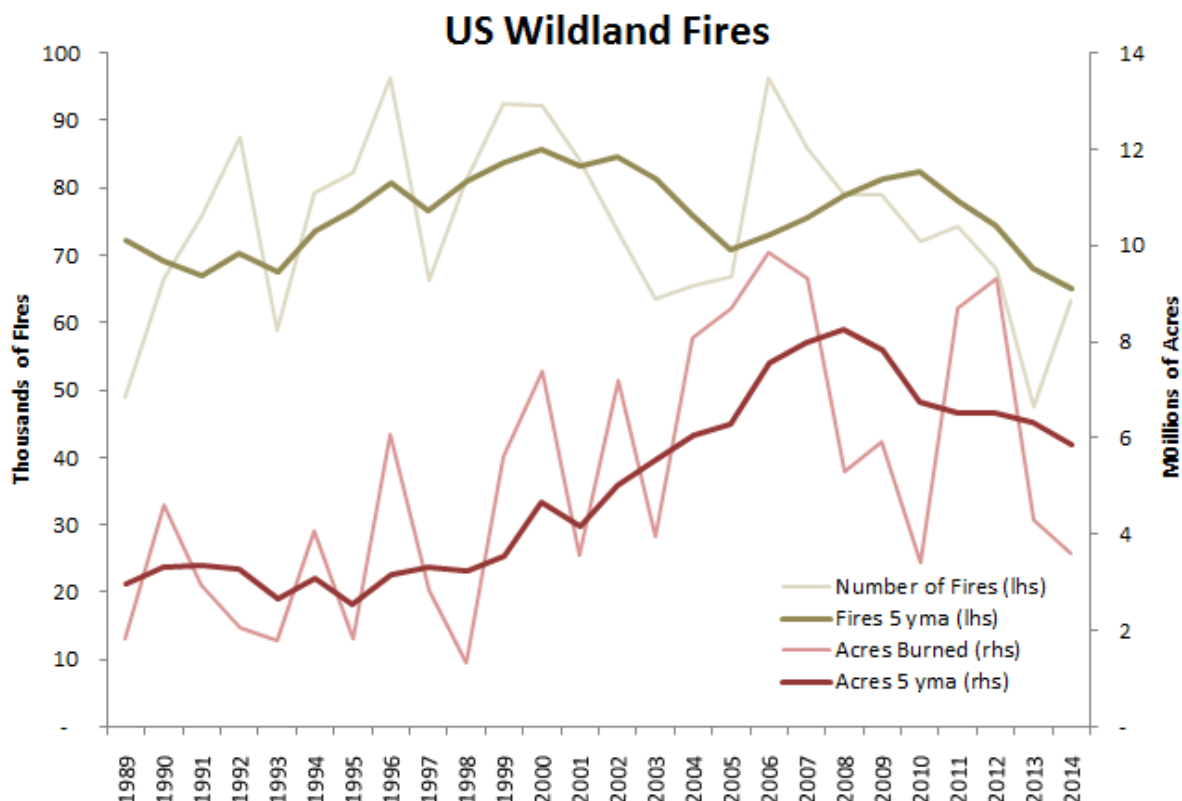
Wildfires

Referring to the US as an example of extreme events, Hayhoe & Stoner claim that *“the area burned by wildfire has doubled since the 1980s as a result of climate change (Gonzalez et al. 2018)”*

In fact, it is more likely that the area burned has increased due to the US Fire Service suppressing fires, and environmental groups preventing the clearing of fuel load from forests, leaving regions at risk of catastrophic fires. A 1999 US Government Accounting Office report outlined the problem:

“The most extensive and serious problem related to the health of national forests in the interior West is the over accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires. According to the Forest Service, 39 million acres on national forests in the interior West are at high risk of catastrophic wildfire. Past management practices, especially the Forest Service’s decades-old policy of putting out

wildfires on the national forests disrupted the historical occurrence of frequent low-intensity fires, which had periodically removed flammable undergrowth without significantly damaging larger trees. Because this normal cycle of fire was disrupted, vegetation has accumulated, creating high levels of fuels for catastrophic wildfires and transforming much of the region into a tinderbox.”



A recent, horrific example is California’s Camp Fire. To be blunt, California’s catastrophic Camp Fire wildfire was not a surprise to anyone living in the area, as the following editorial points out.²²

“There were overt signs.” Larry Mitchell, a retired former Paradise Post and Enterprise-Record reporter, recalls when a new fire chief was hired in the 1980s with strong credentials. He was immediately concerned about the fire danger. He took Mitchell on a tour of places that he said were especially dangerous. “He showed me places along the canyon edges where there were ravines full of brush and talked about how the fire could rush up them, like a chimney,” Mitchell wrote to us this week.

The chief didn’t last long. Mitchell said he got the impression one reason the man left was that he didn’t want to be fire chief of a town that could explode in flames.

With hounding, some residents did an excellent job of creating what firefighters call “defensive space” around their homes. Others weren’t about to touch their pines. And they didn’t like anyone else doing it either. When PG&E went into Paradise earlier this year to cut trees that were near

²² chicoer.com/2018/11/17/editorial-camp-fire-the-tragedy-we-were-all-warned-about/?fbclid=IwAR0FN2gbQHofavnd4bggoiVa2MSWYvV3kbiDnIWEoX8exiCwN6msOFJ1cxg

power lines, people complained. Pines were the very reason many people move to Paradise. They accepted the danger, despite warnings from so many people.

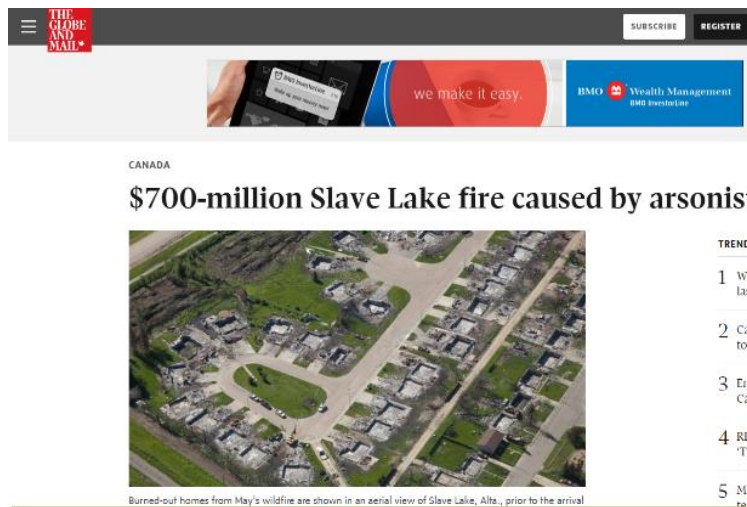
There are countless stories in our archives like this headline from 2003: “Firestorms not a matter of if, but when.” It’s not like our headline writer was prescient. That’s what everybody says up here, every year.

Page | 23

And it finally happened.”

Likewise, Alberta is no stranger to massive wildfires. The largest to date is the Chinchaga Wildfire of 1950 which burned through 3.4 million acres of forest in northern British Columbia and Alberta and exuded a smoke pall that was seen around the world.²³

Some of the largest Alberta wildfires, like the 2011 Slave Lake wildfire, are due to human-causation – arson – but not human-caused climate change.



Arsonists, human negligence, and the human-wildland interface are responsible for the vast majority of wildfires.



Slave Lake turned to ashes, thanks to arsonists, not climate change.

²³ [amazon.ca/Chinchaga-Firestorm-When-Moon-Turned/dp/1772120030](https://www.amazon.ca/Chinchaga-Firestorm-When-Moon-Turned/dp/1772120030)

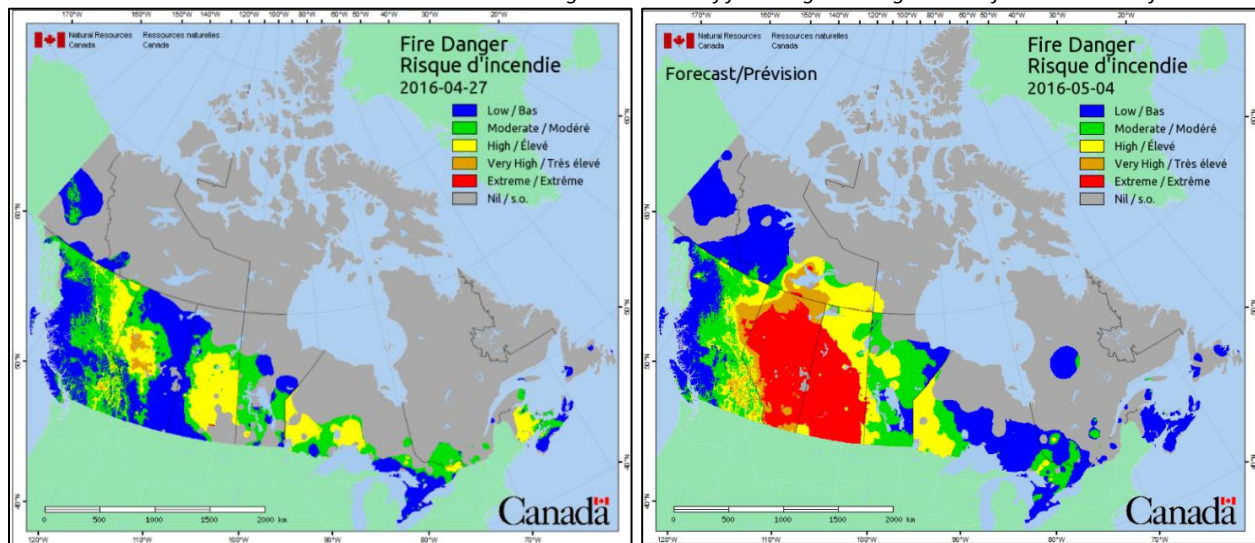
Though the Hayhoe & Stoner report cites the federal government's CCCR2019 report that human induced climate change *"has increased the likelihood of some types of extreme events, such as the 2016 Fort McMurray wildfire (medium confidence)..."* (Bush and Lemmen, 2019), this statement ignores the evidence that Alberta is subject to dramatic winter/spring drying conditions due to numerous natural factors, ranging from El Nino to Chinook winds.

Canadian Wildland Fire Information System

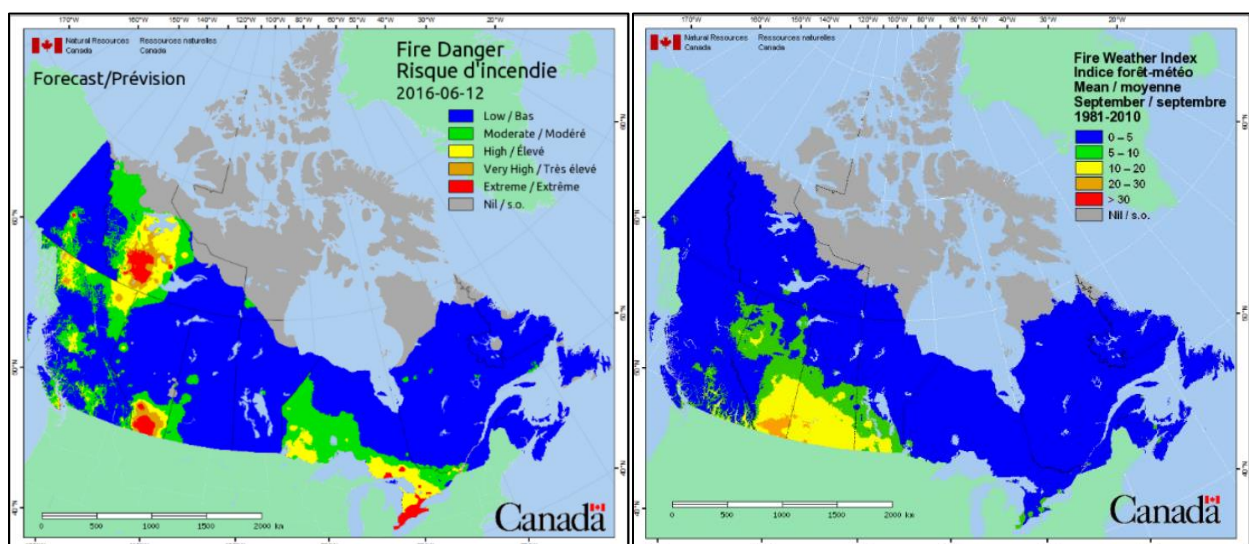
Fire Weather Maps

Fire Danger 2016 April 27 Retrieve Map

The Fire Weather Index is a component of the Canadian Forest Fire Weather Index (FWI) System. It is a numeric rating of fire intensity. It combines the Initial Spread Index and the Buildup Index. It is suitable as a general index of fire danger throughout the forested areas of Canada.



The images above are from the Canadian Wildland Fire Information Service which prepares daily forecasts of fire danger risk. One can clearly see that the risk of fire as of April 27, 2016 was low across most of Alberta, with some higher risk areas in the North West and toward the Rocky Mountains. By May 04, 2016, conditions had changed dramatically to extreme fire danger across almost the entire province. That is the day 2,400 Fort McMurray homes burned down. An estimated ninety thousand people had to literally run for their lives, through a region with few roads in or out, and surrounded by wildfire danger in almost all directions of escape.



By June 12, 2016, there were only a few spots in Canada with extreme fire risk. The 29 year mean, as of September of 2016, does not show an increase in fire risk in Canada. The Palliser Triangle region of the prairies is clearly reflective of normally dry conditions.

Rather than attempting to ascribe the [Fort McMurray wildfire to human-caused climate change](#), where is the consideration in the Hayhoe & Stoner report of the natural El Nino conditions of that year?²⁴

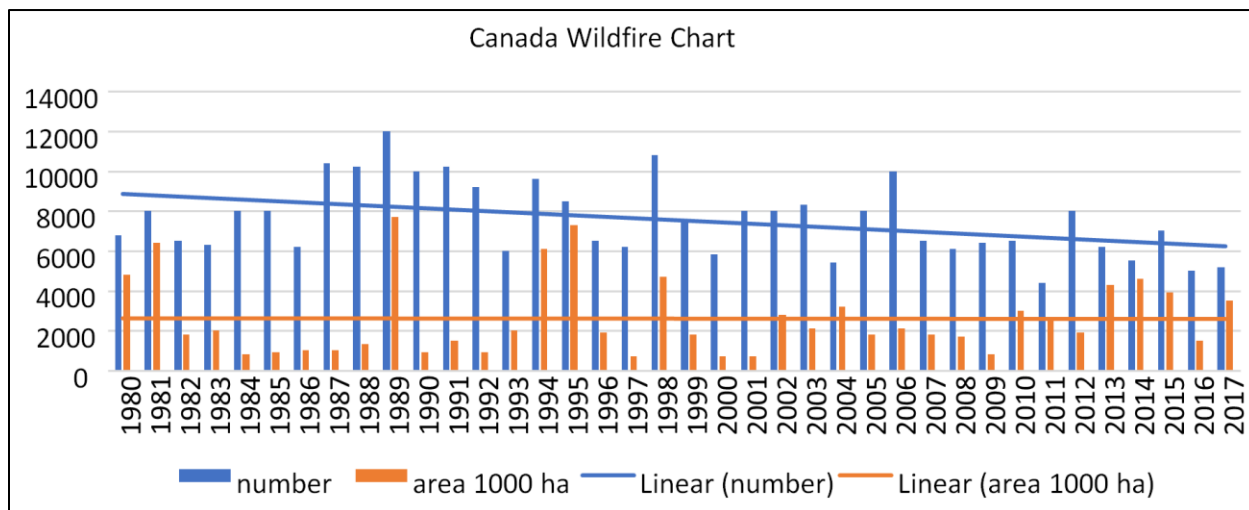
Page | 25

El Niño summary: 2015 to 16

In terms of sea surface [temperature anomalies](#) in the Equatorial Pacific, the great El Niño of 2015-16 equalled the El Niño episode registered in 1997-1998. These two episodes are the strongest El Niño events observed in the recent decades. However, when measuring additional parameters, such as shifts in atmospheric deep convection and subsurface ocean temperatures, the 2015-16 event is considered to be weaker than the great El Niño of 1997-98. These two parameters are regarded as critical for El Niño's impact on remote regions such as Canada or the United States. Yet, the 2015-16 boreal winter had most of the characteristics of a typical [El Niño](#) winter, based on El Niño historical events.

- The 2015-16 El Niño officially started in March 2015 and ended in May 2016, according to the [National Oceanic and Atmospheric Administration \(NOAA\) El Niño Advisories](#).
- Over Canada, winter 2015-16 (Dec-Jan-Feb) was one to five degree Celsius warmer than normal across all provinces with especially unseasonal warmth in Quebec, the central Prairies, and Yukon. Subsequently, the 2016 spring remained warmer than normal in the western Canada and the Prairies, while an inflow of cold Arctic air led to colder than normal conditions over Eastern and Northeastern Canada.
- The 2015-16 El Niño brought moderate relief to the severe drought that has persisted in California since 2011, except in the southern part of the state where precipitation remained below normal.
- By shifting the convection centers in the Equatorial Pacific, the 2015-16 El Niño contributed to a weaker Indian monsoon in summer 2015, drought in Central America during summer 2015, drought in Indonesia during the fall 2015 and flooding in northern Peru in fall 2015.
- The year 2015 was the warmest year recorded since sufficiently accurate observations became available in the late 1800s, according to several meteorological agencies. This was due to the combined influences of the 2015-16 El Niño and the overall warming trend of the Earth's climate. Furthermore, the previous temperature record established in 2014 was broken by the highest margin recorded to date.

The World Meteorological Organization (WMO) has produced [an animation](#) that explains the 2015-16 El Niño event.



In Canada, the evidence shows that the trend in the number of wildfires is declining and the trend in the number of hectares burned is static.

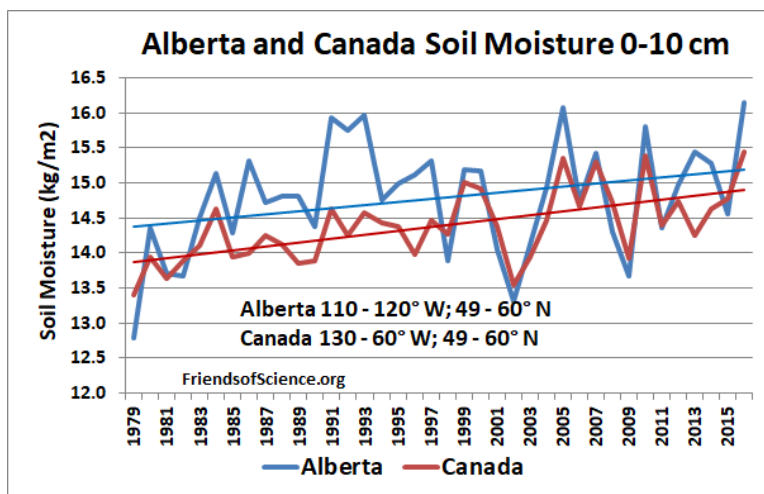
²⁴ canada.ca/en/environment-climate-change/services/el-nino.html

Dry Conditions

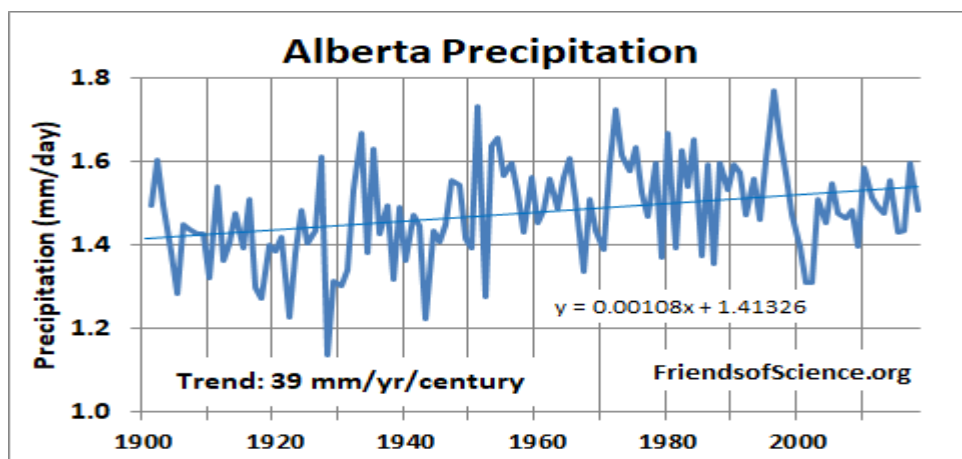
“Little change is expected in average precipitation and in the number of dry days during the growing season (May-Aug). However, temperature during the growing season is projected to increase and soil moisture is projected to decrease, increasing the risk of dry conditions as global temperature increases.” Hayhoe & Stoner (2019) “Alberta’s Climate Future”

Page | 26

If we examine the historical record, we find that such claims are not supported by the evidence. Over the period 1979 to 2016 the soil moisture content in Alberta increased by 5.6% calculated from the best fit line to the data, from 14.4 to 15.2 kg/m³. Warming, by any cause, appears to cause a wetter world.



Global precipitation increased 21 mm/year per century over the period 1900 to 2018. The Alberta precipitation trend over the same period is 39 mm/year/century. Increasing precipitation elevated soil moisture. This rise was greater than whatever reduction in moisture might have been caused by evaporation due to increasing temperatures. The increasing soil moisture and precipitation is helpful for Alberta's agriculture. Also, the increased carbon dioxide concentration enhances crop yields.



The Hayhoe & Stoner report forecasts an ‘increased risk of dry conditions’ but never directly addresses the fact of drought on the prairies. According to Marchildon et al (2007) *“During the past 100 years, at least 40 droughts have occurred in the Canadian Prairie Provinces.”* While Marchildon et al also note

that the IPCC 2007 report forecasts a 66% increase in the area affected by drought, this is not reflected in the Hayhoe & Stoner report, which is said to be based on “downscaling” of global climate model forecasts.²⁵

Perhaps one of the more enlightening features of the Marchildon et al paper is the exploration of how provincial and federal governments pro-actively addressed the drought calamity of the Great Depression. In Alberta, several institutions were established to address both the human needs of relief, and the long-term management of the fragile, drought-prone region of the province that lies within the Palliser Triangle. Much of this land was put under management of [Special Areas authorities](#) which govern the land use of over 2.1 million hectares in southern Alberta.

While these semi-arid regions in the Palliser Triangle were homesteaded and cultivated early in the province’s establishment, and wheat farming had successfully taken place, the inherently fragile characteristics of the soil and region, the drying nature of Chinook winds, the deep plow methods of early farming, and lack of agricultural insights of today meant that these areas went from riches to disaster in the space of a few years. Recognizing that the land could not support wheat farming, as part of the government relief program, farm families were assisted to move to other parts of the province with better agricultural land. The Palliser Triangle areas, for the most part, became reserved for ranching, and only by permission of the Special Area authorities. In addition, in conjunction with provincial programs, the federal Prairie Farm Rehabilitation Act (PFRA) established various agricultural experimental farms to explore *“soil surveys, crop improvement projects and experimentation, analysis of mechanical cultivation and harvesting techniques as well as soil and water conservation techniques. To this work would be added so-called cultural work: encouraging farmers to adopt new farming methods designed to counteract the negative effects of soil drifting and soil erosion as well as new methods to conserve surface water as well as a concerted effort to construct dugouts for stock watering on thousands of prairie farms. In addition, the PFRA initiated a comprehensive soil survey at one-mile intervals through the Palliser Triangle.”*

The PFRA also engaged in developing citizen farmers employing new techniques to show regional farmers ‘how to’ implement new methods, and invested substantial sums in developing dams, irrigation ditches, and dugouts to address the chronic water shortages of semi-arid Palliser Triangle.

Again, this discussion points to the value of human beings pro-actively taking measures to understand and adapt to climate and weather conditions where they live – even if sometimes that requires outmigration. The success of the several programs addressing the Great Depression drought and collapse of farming in the Palliser Triangle illustrate that sound public policy, along with thoughtful application of science and technology can be used to better manage natural resources to retain or enhance inherent qualities, to mitigate damage to the land and to reduce the economic risks to human society. Most important, such analytical and adaptive work can prevent or mitigate the damage to families who ultimately must pay the price when Mother Nature strikes a blow.

²⁵ Downscaling techniques can be divided into two broad categories: dynamical and statistical. Dynamical downscaling refers to the use of high-resolution regional simulations to dynamically extrapolate the effects of large-scale climate processes to regional or local scales of interest. Statistical downscaling encompasses the use of various statistics-based techniques to determine relationships between large-scale climate patterns resolved by global climate models and observed local climate responses. These relationships are applied to GCM results to transform climate model outputs into statistically refined products, often considered to be more appropriate for use as input to regional or local climate impacts studies. gfdl.noaa.gov/climate-model-downscaling/

The other relevant point made by this historical reference is that climate change is not simply a factor of carbon dioxide emissions from fossil fuel use. As the IPCC Houghton (1996) definition of climate change points out, human activities that affect climate include land use, water diversion, deforestation, agriculture, and as we know today, Urban Heat Island effect. Climate scientist Roger Pielke, Sr. has done a great deal of work on the influence of land use changes on regional climate.²⁶

Page | 28

However, since human beings live on earth, we will continue to engage in activities of clearing, planting, growing food and cattle, harvesting, building dams and diverting rivers (sometimes to save lives and property damage as shown above), cutting trees for fuel and construction, and building roads to and from places and building beautiful towns and cities to live in. Just as beavers cut trees, dam rivers and build homes,²⁷ thus changing the face of the earth, so do humans.

The Telegraph

9:42AM BST 04 May 2010

World's biggest beaver dam can be seen from space

This woodland construction is the world's biggest beaver dam, which at 2,790ft is more than twice the length of the Hoover dam and can be seen from space.



Image 1 of 2

The dam is located on the southern edge of Wood Buffalo National Park in Northern Alberta, Canada Photo: BNPS

²⁶ atmo.arizona.edu/students/courselinks/spring17/atmo336/lectures/sec5/Pielke_PhysicsToday_2016.pdf

²⁷ telegraph.co.uk/news/worldnews/northamerica/canada/7676300/Worlds-biggest-beaver-dam-can-be-seen-from-space.html

Extreme Cold Episodes Not Considered

Coincident to the writing of this report, Dr. Madhav Khandekar and Ray Garnett published a paper on the rise and economic losses of extreme cold events worldwide.²⁸ This evidence or possibility is not considered in the Hayhoe & Stoner report. In subsequent sections of the report, long-term evidence will be presented of a slight summer maximum temperature cooling trend for parts of Alberta. This may be significant for an agricultural society and economy. Cooling trends have historically been common when there is a solar minimum; we are presently entering such a solar cycle.

Page | 29

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Increasing Cold Weather Extremes since the New Millennium: An Assessment with a Focus on Worldwide Economic Impacts

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Abstract: Since the new Millennium, numerous cold weather extremes (CWE) accompanied by heavy snow falls have been witnessed which have inflicted substantial economic losses worldwide. Among some of the notable cold weather extremes in Canada in the last five years have been: several heavy winter snowfalls in eastern Canada during 2015-2017, one of the heaviest snowfalls in recorded history in Vancouver and vicinity during December 2016 and the Calgary (Alberta) floods linked to sudden melting of heavy snow accumulation during the winter of 2013. These and many other such extreme cold events have inflicted heavy economic losses locally as well as on the regional scale in eastern and western Canada.

This paper examines CWE in Canada and elsewhere and assesses their economic impacts. This is an overlooked issue in the present climate change debate, which has been focused primarily on Warm Weather Extremes (WWE) like heat waves, floods, droughts and their possible linkage to the warming of the earth's climate. The paper further analyzes impact of large-scale atmosphere-ocean circulation patterns and the possible impact of the approaching solar grand minimum on increasing CWE of recent years. Finally, implications of our analysis for projecting future economic losses over Canada and elsewhere are considered.

Key words: cold weather extremes, costs, solar activity

Reliable Temperature Records

The modern temperature record goes back to 1880. Therefore, Alberta has quality records on par with the USA and Europe over that time period.

²⁸ opastonline.com/wp-content/uploads/2020/04/global-warming-extreme-weather-link-are-cold-extremes-on-the-rise-eesrr-20-.pdf

Temperature records going back further are available, but many worldwide records are sparse and/or have inconsistent collection methodologies and standards.



Although there are good records in other parts of the globe, it is difficult to reconstruct a global temperature record before 1880. Records after 1880 largely rely on better North American and European records, supplemented by other sparse data from elsewhere, where quality have improved over time.

Temperature reconstructions prior to 1880 generally rely on proxy methodologies. Local or regional temperatures are inferred from proxy inferences from tree rings, sediments and other markers. This is not the same as temperature readings!

Carbon Dioxide and Greenhouse Gases - Driving Warming or Not?

The Hayhoe & Stoner report states:

"The Second Volume of the U.S. National Climate Assessment expands on this, stating, "observational evidence does not support any credible natural explanations for this amount of warming [referring to the observed 1 °C increase in global mean temperature from 1901 to 2016]; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat trapping gases, as the dominant cause" (Hayhoe et al. 2018)."

When one examines the historical record (see below), two periods of global average warming nearly mirror each other, but one occurs from 1895 to 1946, which is prior to the time in which human-caused emissions are said to drive global warming. The other period falls within the time frame used by Hayhoe & Stoner (their time frame is 1950 to 2013 and what is shown is 1957 to 2008) which is often assumed to be almost solely influenced by anthropogenic warming.

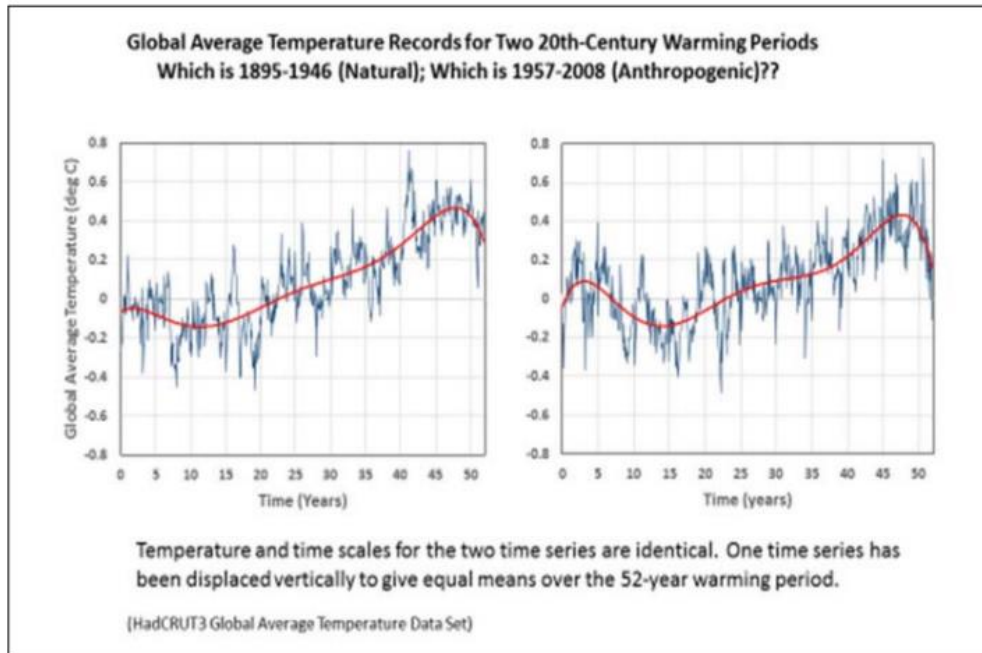
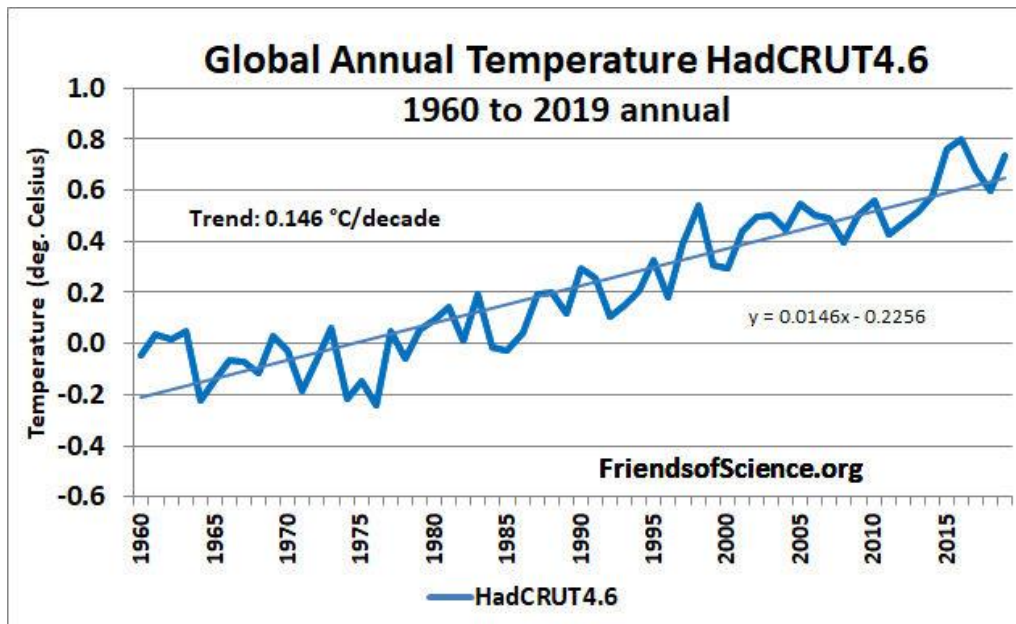


Figure 7. Global temperature observations suggest that recent warming (left panel) looks nearly the same as warming before the 1940s, even though increasing CO₂ could not be responsible for the earlier period.

Source: co2coalition.org/wp-content/uploads/2019/12/Lindzen_On-Climate-Sensitivity.pdf

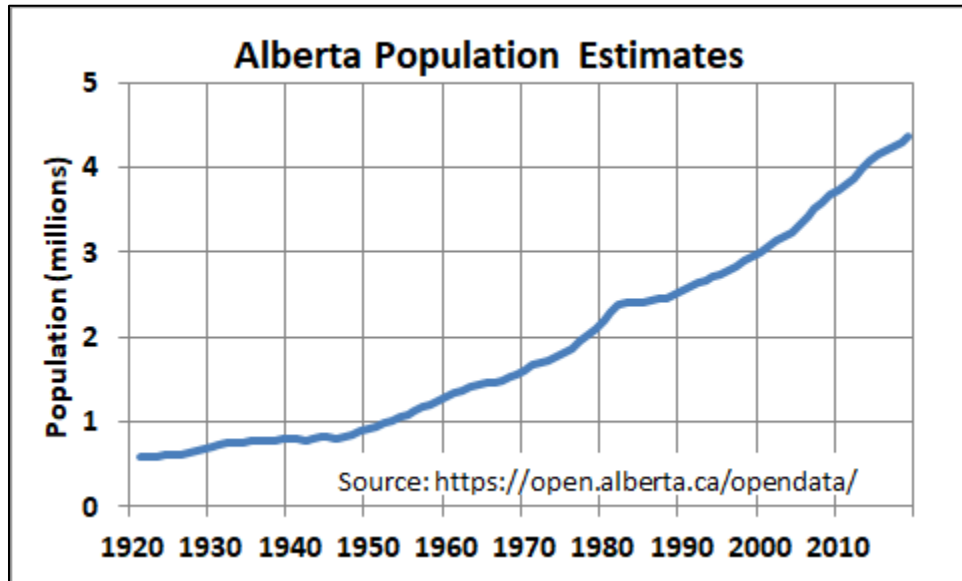
Based on these trends, one would have to say there must be some natural variability affecting warming. The Hadley Climate Research Unit Temperature (HadCRUT) data, shown below, identifies a global annual temperature trend of 0.146 °C/decade.



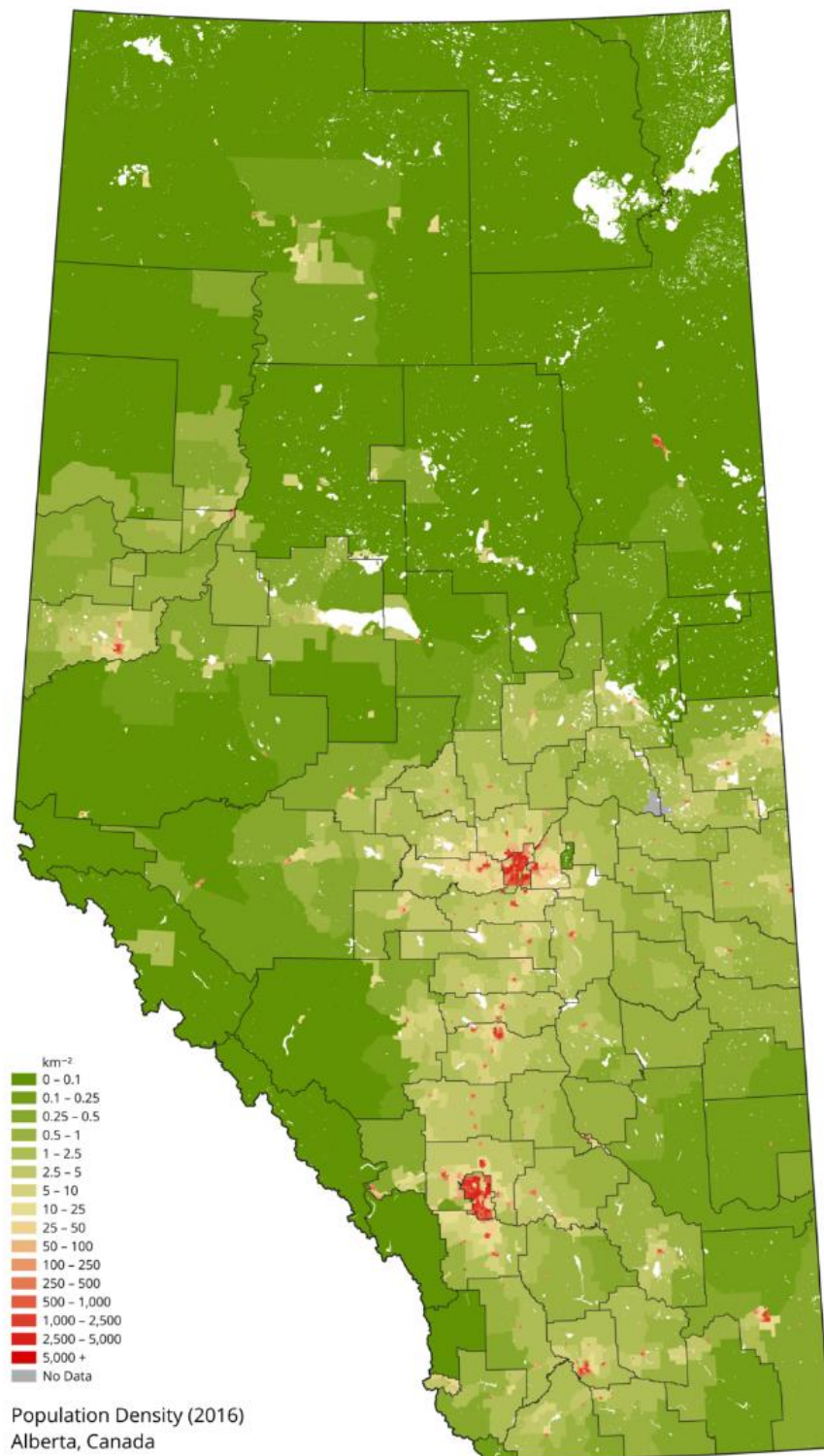
Alberta's Many Changes

Aside from emissions, human activity in general affects regional climate. Alberta has grown rapidly since the 1950's. Much of the productive farmland is cultivated. As noted earlier, dams, irrigation ditches and cattle ponds were created. Villages have turned into towns and towns into cities, each with its own Urban Heat Island. Two international airports and the Cold Lake air base keep Alberta's skies busy. Industrial development and jobs of all kinds have drawn people to Alberta from around the world.

Page | 32



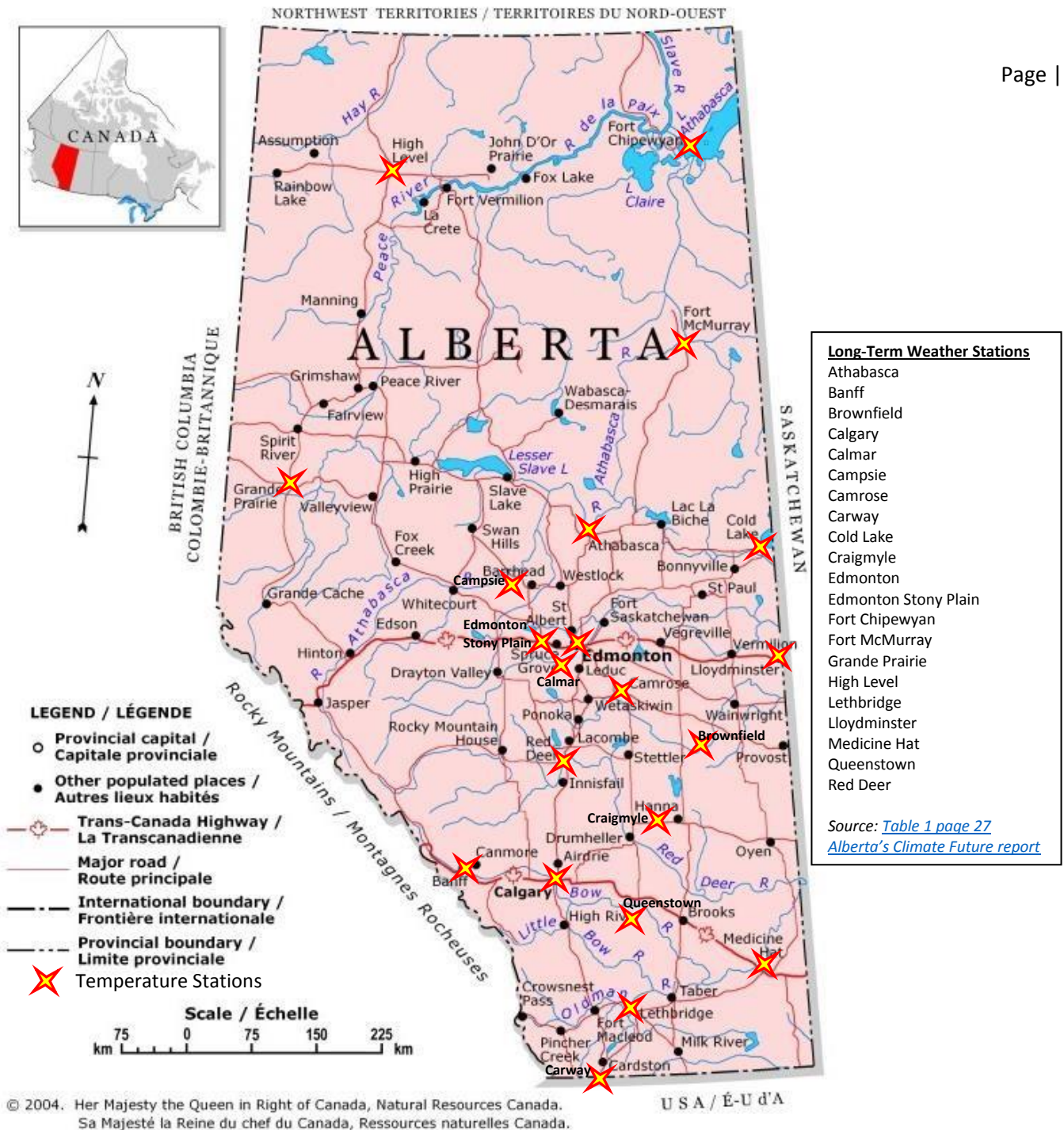
Population density is a factor in considering temperature trends because the Urban Heat Island effect (UHI) can significantly affect temperature readings. The Urban Heat Island refers to the retained heat in an urbanized area, generated by human activity and the absorption of sunlight. Paved roads, building materials, HVAC units, illumination and traffic contribute to this 'bubble' of retained heat due to land use and wasted heat energy. The map adjacent shows the population density of Alberta in 2019. Compare this map to the locations of temperature monitoring stations selected by Hayhoe & Stoner (next page). Of the 21 stations selected, 14 are located within urban, densely populated locations. Has the siting of these stations skewed results?



Source: commons.wikimedia.org/File:Canada Alberta Density 2016.png

A temperature data analysis comparison between large US urban centres and small towns found that significant warming is attributable to the growth in human activity and settlement. Similar urbanization bias was found by Soon et al (2015).

Temperature Stations Selected by Hayhoe & Stoner



Background Map Source: collegealberta.info/alberta_map.html

Urban Heat Island Effect is Significant

In their report Hayhoe & Stoner claim:

- Alberta's climate is changing. Since 1950, winter temperatures have increased by +0.5 to +1 °C per decade across the province and
- Across much of the province, summer temperatures have increased by +0.1 to +0.3 °C per decade.

Page | 35

This is inconsistent with graphs of Alberta's annual, winter and summer temperature anomalies using HadCRUT4.6 surface and UAH lower troposphere air temperatures, using the area 50 to 60 N, 110 to 120 W for HadCRUT4.6, and 49 to 60 N, 110 to 120 W for UAH LT 6.0. This includes the SE British Columbia triangle.

Here are the results:

Alberta 1950 to 2019; Trend °C/decade		
Season	K. Hayhoe Claim	HadCRUT4.6
Annual	na	0.27
Summer	0.1 to 0.3	0.17
Winter	0.5 to 1.0	0.56

Winter temperatures have increased much more than summer temperatures, likely at least in part due to the Urban Heat Island Effect (UHIE). The summer temperature comparison is near the middle of the Hayhoe & Stoner's range, but the winter temperature comparison is at the low end of their range.

The amount of UHIE contamination of the surface temperature record is often estimated by comparing the satellite troposphere (the first 10 km above the earth's surface) record to the surface temperature, as the ground temperatures can be biased by the UHIE, but not the lower troposphere. The difference is shown below:

Alberta 1979 to 2019; Trend °C/decade				
Season	HadCRUT4.6	UAH LT 6.0	HadC/UAH	Multi-model
Annual	0.155	0.055	2.82	0.304
Summer	0.205	0.102	2.01	
Winter	0.360	0.093	3.87	

Note: HadCRUT4.6 is a near-surface temperature dataset and UAH LT 6.0 is a lower troposphere (LT) air temperature dataset

The annual near-surface measured temperature (HadCRUT) trend is 2.82 times that of the UAH satellite record of the lower troposphere. The winter surface (HadCRUT) measured trend is 3.87 times that of

the UAH lower troposphere. The projected mean trend of all climate model forecasts is almost double the historical annual HadCRUT4.6 surface trend (0.304 versus 0.155), which means that climate models are running hotter than the measurements.

Temperature Analysis

A number of points were made in the “Alberta’s Climate Future” report with respect to temperature. The report summary states the following:

“Alberta’s climate is already changing and many of these changes are projected to continue and even increase over the rest of this century. This report summarizes observed and projected changes in temperature and precipitation for the province and 21 of its cities and towns. It compares historical observations and trends to projected changes through 2100, and quantifies expected changes as the world warms by +1, +1.5, +2, +3 and +4 °C. Since 1950, almost every part of the province has experienced significant increases in winter temperature (from +0.5 to +1 °C per decade) and decreases in the frequency of cold days, heating degree-days, and the proportion of winter precipitation falling as snow. Over half of the province has also experienced significant increases in summer temperature (from +0.1 to +0.3 °C per decade), and some parts have also seen significant increases in warm days over 25 and 30 °C.

Many climate indicators for Alberta are projected to increase nearly linearly as global average temperature increases, though at a greater rate of change than the global average. Per degree of global mean temperature increase, projected changes for Alberta include:

- *A 2 °C increase in average winter and 1.5 °C increase in average summer temperature.*
- *An increase of about 3 °C in the temperature of the coldest day of the year and an increase of about 2 °C in the temperature of the warmest day of the year.*
- *A two-week lengthening of the frost-free season, and between a two to four-week lengthening of the growing season, with greater changes for more southern locations.*
- *A 5-10% increase in Sept-Apr precipitation, with between 5-10% more falling as rain compared to snow.*
- *A 50% increase in the number of very wet days (more than 25mm in 24 hours) and a 20% increase the amount of precipitation on the wettest day of the year.*
- *Proportional decreases in heating degree-days and increases in growing degree-days and other cumulative heating indices.*

Changes in the actual number of days per year experiencing extreme high and low temperatures are projected to increase exponentially, rather than linearly, as global mean temperature increases. For many Alberta locations, the number of days per year above 30 °C, for example, could double per degree of global warming.

Little change is expected in average precipitation and in the number of dry days during the growing season (May-Aug). However, temperature during the growing season is projected to

increase and soil moisture is projected to decrease, increasing the risk of dry conditions as global temperature increases. Projected changes will profoundly impact Alberta's natural environment, and have the potential to affect the province's agriculture, infrastructure, and natural resources, as well as the health and welfare of its inhabitants. For both temperature and precipitation, the changes reported here are consistent with those projected to occur throughout northcentral North America in response to human-induced climate change.

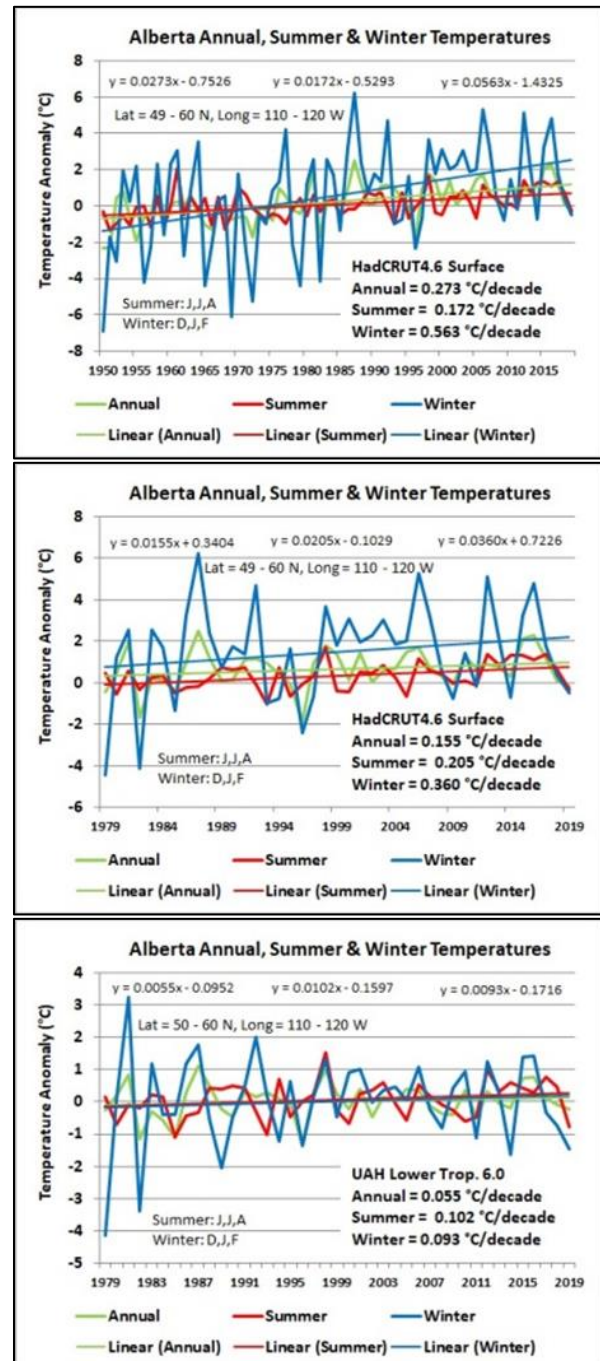
They are appropriate for use in scientific analyses to quantify the impacts of a warming planet on both human and natural systems, and to inform long-term planning, education, and outreach."

The figures, on the right, show the timeframes of historical information considered in the study. The first graph shows the Alberta surface temperature record over the timeframe of the study. The next two graphs show the Alberta temperature records over the satellite era, 1979 to 2019. The third uses the UAH Lower Troposphere 6.0 record. The increase in the temperature trend is significantly lower as measured by the atmospheric satellite data. The satellite trend increase is 1/3 (one third) of the 1950 to 2019 surface record rate and 1/5 (one fifth) of the 1979 to 2019 rate (the same baseline duration). It is quite interesting to note that surface temperatures and resultant trends appear to be quite different than atmospheric trends.

The daily temperatures used to construct the annual, summer and winter data are the average of the daily maximum temperature (Tmax) and the daily minimum temperatures (Tmin).

The summer temperatures and trend lines are shown in red and the winter temperatures and trend are shown in blue.

A number of the assumptions in the "Alberta's Climate Future" report's assessments require examination. Analysis of results, assumptions and selection of inputs to the study lead to forecasts that warrant review, once it is understood how the data was analyzed and presented by Hayhoe & Stoner.



The points warranting reassessment arising from review are addressed in this section. Each quote, recommendation, summary or forecast from the “Alberta’s Climate Future” report is investigated considering the historical record and application of well-known observations and climate influences. Quotes from the “Alberta’s Climate Future” report are in italics.

“Alberta’s climate is already changing and many of these changes are projected to continue and even increase over the rest of this century”

Page | 38

The statement that climate is changing is quite true. Nobody would dispute that climate changes over time. Climate is based on a complex chaotic system that has many, many inputs. The second part of the assertion requires review. The statement that changes will continue is correct, but the assumption that all changes increase temperature (presumably by CO₂ warming) requires further examination. This is addressed in the Future Projection of Temperatures section below.

“This report summarizes observed and projected changes in temperature and precipitation for the province and 21 of its cities and towns. It compares historical observations and trends to projected changes through 2100, and quantifies expected changes as the world warms by +1, +1.5, +2, +3 and +4 °C.”

This statement is a spin-off from the first assertion that Alberta’s climate, presumably like in other parts of the world, is geared to rises and falls consistent with global temperatures. With global temperatures forecast to increase, Hayhoe and Stoner also forecast temperature increases for Alberta. On page 10, in the “Alberta’s Climate Future” report, temperature projections are compared to Canada’s average temperatures from the Canada’s Changing Climate Report 2019 (CCCR2019) which also incorrectly compares the RCP8.5 and the RCP4.5 scenarios. As we have pointed out these were never meant to be used in this way. The use of a great deal of bright red coloration in the Hayhoe & Stoner report images falsely alarms the reader. The methodology and findings of CCCR2019 are disputed. In 2019, Friends of Science issued [Climate Change Your Mind](#) as a rebuttal to the CCCR2019.

Correlation of Alberta Temperatures to Global Climate

“Since 1950, almost every part of the province has experienced significant increases in winter temperature (from +0.5 to +1 °C per decade) and decreases in the frequency of cold days, heating degree-days, and the proportion of winter precipitation falling as snow.”

This statement has two parts. The first is in regard to the question of are winter temperatures increasing? The second question is why only examine the temperature record from 1950 to 2013? Would a wider view change show a different pattern? The section on Winter Temperature will examine historical winter temperature trends.

“Over half of the province has also experienced significant increases in summer temperature (from +0.1 to +0.3 °C per decade), and some parts have also seen significant increases in warm days over 25 and 30 °C.”

This statement again has two parts. Both deserve attention. Is Alberta seeing significant increases in summer temperatures and what is meant by ‘significant’? Secondly, is the Province seeing increases in

warm days over 25 and 30 °C? The Summer Temperature section will address this statement in the report.

Many climate indicators for Alberta are projected by Hayhoe & Stoner to increase nearly linearly as global average temperature increases, though at a greater rate of change than the global average.

This is a key, important point regarding temperatures increasing linearly as the global temperature increases. Does global temperature increase in a linear fashion? Has Alberta's temperature changed in a linear fashion over time in such a way which would support that assumption going forward into the future? The Climate Linear Trend or Cycles section will assess this assertion.

"Changes in the actual number of days per year experiencing extreme high and low temperatures are projected to increase exponentially, rather than linearly, as global mean temperature increases. For many Alberta locations, the number of days per year above 30 °C, for example, could double per degree of global warming."

The statement that warm days will increase exponentially is quite a bold forecast. It is unclear how that would arise given that Hayhoe & Stoner forecasts linear temperature increases. If increase in temperature is linear, why would we see a doubling of hot days going forward? Perhaps the past records will show a pattern upon which to base this forecast. The Hot Summer Days section will address this point.

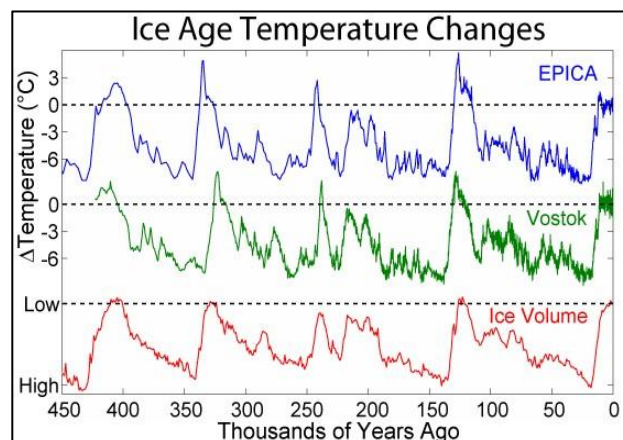
"Projected changes will profoundly impact Alberta's natural environment, and have the potential to affect the province's agriculture, infrastructure, and natural resources, as well as the health and welfare of its inhabitants. For both temperature and precipitation, the changes reported here are consistent with those projected to occur throughout northcentral North America in response to human-induced climate change. They are appropriate for use in scientific analyses to quantify the impacts of a warming planet on both human and natural systems, and to inform long-term planning, education, and outreach."

This summary will be reviewed at the end of this investigation, based on the individual analysis of each of the above noted separate inquiries.

Future Projection of Temperatures

In order to understand the future, one must look at the past. Has climate changed in a steady way that can help forecasting and what were temperatures over various timeframes?

The chart on the right, reconstructed from ice cores, gives a picture of temperature over the last, almost half million years. This depicts the ice age we are currently still within. We are living in what is called an interglacial period. As the image demonstrates, temperature has cycled from hot to cold to hot, over and over again. When it is

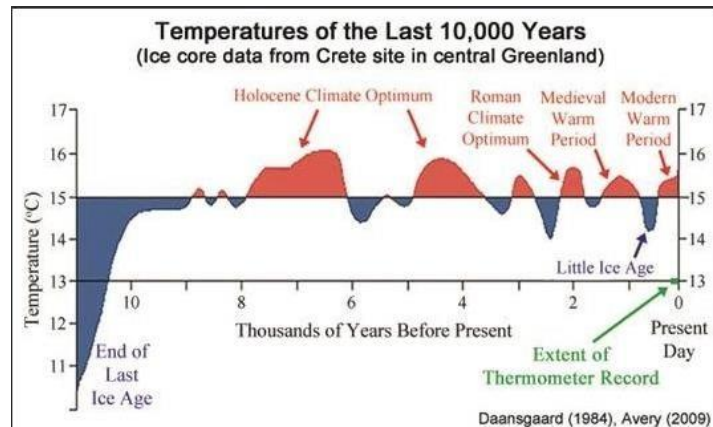


hot, glaciers recede, and they return when things cool. From five to six warm periods are evident in the graph, with the far-right warm period being the interglacial period we currently occupy.

So, in the long-term, climate has changed with cycles of warm and cool periods. Mankind came into dominance on the planet 10,000 years ago as the earth warmed from the depths of the last long, cold period. What has happened more recently?

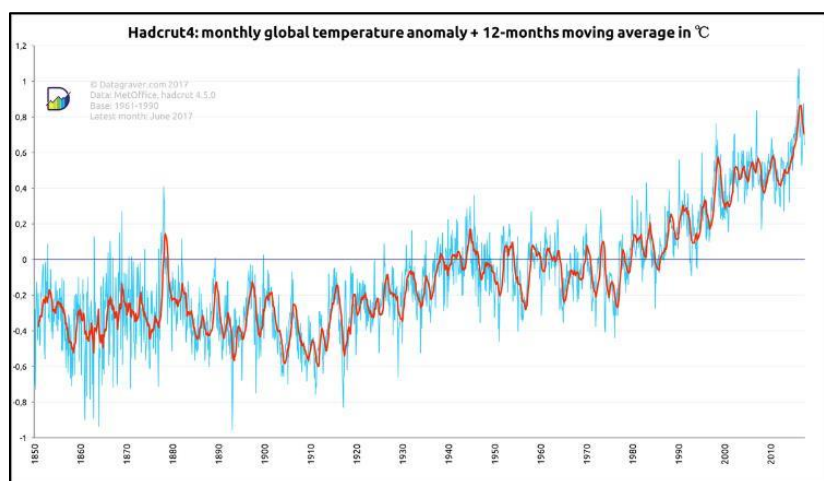
Page | 40

The image to the right shows a reconstruction of temperature, based on proxy sources, from when the earth came out of the ice age. It shows more detail regarding the current interglacial period we are in. As our planet exited the ice age, climate became more moderate, with temperatures fluctuating around a median global temperature of about 15 °C. Just after this last deep cold period was the Holocene Climate Optimum, a time of relatively warmer climate than today. As



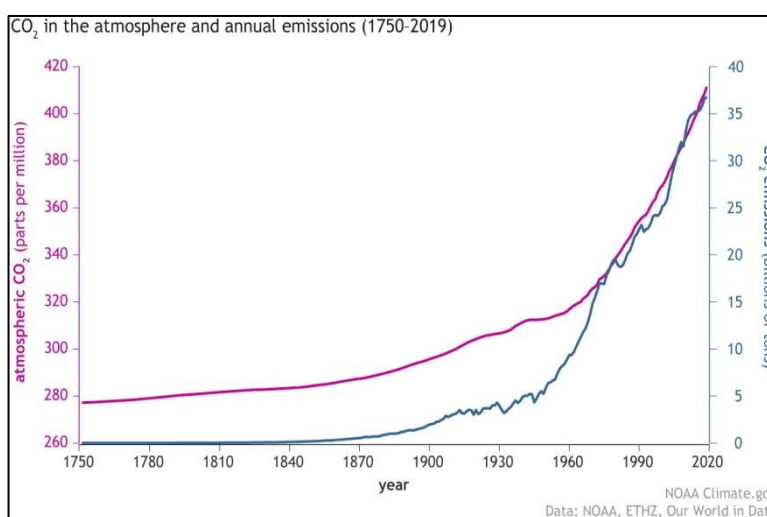
ancient civilizations developed, they flourished in warmer times and were challenged by cooler climates in between. The Modern Warm Period we are in, at least according to this proxy record, is similar to other past warm periods and cooler than the Holocene Climate Optimum. What is known as the Little Ice Age (LIA) immediately preceded our current warm period. The surface temperature datasets generally start in 1850, near the end of the LIA (1300 to 1870). The LIA was the coldest period of the last 10,000 years and was a horrible time for humanity, characterized by famine, disease and extreme weather. It makes no sense to assume that the climate around 1850 is a preferred or optimum climate. Regardless, this shows how climate always changed in the past.

The figure adjacent shows a final resolution of temperatures over time, from 1850 to 2019 as we came out of the Little Ice Age. Here we see relatively stable temperatures from 1850 to 1910, at least on a global basis. Subsequent to 1910, we see two periods of increasing global temperature, one from 1910 to 1950 and a second from 1980 to 2019. Common climate orthodoxy attributes the first warming period to natural causes and the second solely to anthropogenic sources, meaning man-made warming. Visually, both show a similar slope or trend. Certainly, this graph shows climate changing, with an upward trend in temperatures recently.

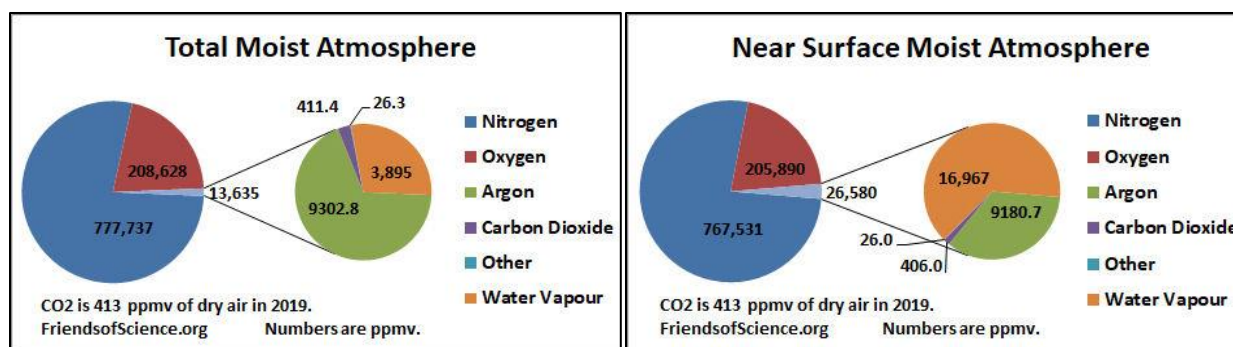


A key question is what is driving the increase in temperature over time. Are we in an upward trend or are we within a longer-term cycle? Can we expect the increase in temperature to continue or move downwards at some future point in time? Certainly, the past historic long-term record favors variability, as opposed to a steady continued upward trend in temperatures in the shorter-term record. This is the nexus of debate regarding anthropogenic versus natural forcing of climate. Climate orthodoxy supports the theory that climate is almost solely controlled by CO₂ from human industry, and if it rises, so do temperatures. Let's look at that from an objective point of view.

This chart represents CO₂ over time from 1750 to 2019. In magenta is atmospheric CO₂ and in blue are CO₂ emissions. There is no question that industry and other man-made sources have increased CO₂ in the atmosphere; as have natural emissions of CO₂ that are a result of a warming world, as oceans and the soil degas CO₂ along with other natural emissions like that from wildfires. The question is what is the impact of CO₂ as opposed to other factors? There



are two parts to this point. The first is that CO₂ is just one of many “greenhouse” gases. In fact, CO₂ exists in relatively minor proportions in the atmosphere, currently just over 400 parts per million (ppm). The main greenhouse gas is water vapor. The two pie charts below, demonstrate that in the near surface layer, water vapour is 42 times that of CO₂ by volume and is 9.5 times that of CO₂ in the total atmosphere. With that said, there are other factors at play, let's look at CO₂ and temperature over time.



The CO₂ graph above shows the main increase in man-made CO₂ starting at around 1950, with a reasonably steady and consistent increase (by eyeballing the slope) over time to 2019. Contrast that with the temperature record shown previously. It shows global temperatures rising from 1910 to ~1945, and then falling to ~1980, before temperatures started increasing again. There is also what is known as ‘the pause’, where global temperature increase stagnated from 1998 to 2014. This demonstrates a lack of correlation between CO₂ and temperature from 1950 to 2019, where CO₂ increased, and at least for a few decades, temperatures held steady or dropped.

Another interesting observation is the global temperature trends from 1910 to 1950. Temperature increased significantly over that period as well, and it occurred without the benefit of material increases in CO₂. Orthodoxy explains this by claiming the earlier temperature rise was all natural and the recent changes are anthropogenic. This does contradict the claim that current temperature increases by CO₂ are unprecedented, as a similar increase in temperature is readily apparent in the 1910 to 1950 record. The orthodoxy's attribution of temperature forcings between natural and man-made causes may be questioned.

The big question is why temperatures decreased from 1950 to 1980, when the rate of CO₂ emissions really ramped up. If CO₂ is a "control knob for temperature", it was not working over that 30-year period. Orthodoxy says that the rates of forcings changed over time from natural to man-made. Parameterizations in computer models balance these sometimes opposing and at other times supporting forcings, but models are tuned to calibrate temperature to CO₂. That is like rigging a question to suit an answer that you already think you know. Is there really a full understanding of the various forcings? Models are based on often sketchy, inferred or proxy data of temperature estimates prior to 1850. A credible alternative is that there are many, many influences on temperature, not just man-made CO₂. That includes other greenhouse gasses, such as methane, ozone and chlorofluorocarbons. There are many natural causes of climate change, including the Milankovitch, solar and ocean circulation cycles and atmospheric aerosols. It is not unreasonable to be skeptical that CO₂ plays the dominate role in temperature. It is valid to question computer models, as many input parameters are assumptions, guesses or have a limited understanding or validation by demonstrated scientific observation. Looking at climate, we are dealing with a complex, chaotic system.

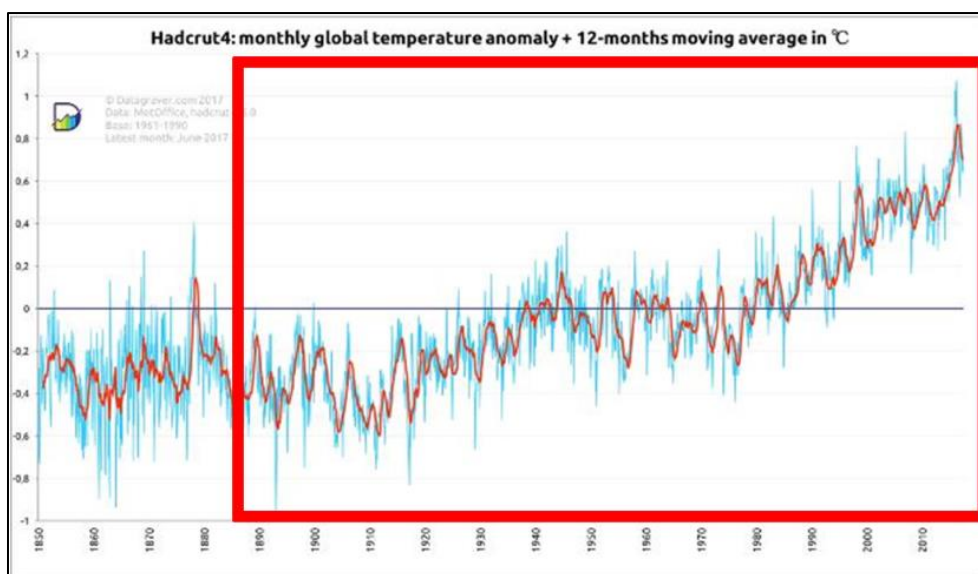
Looking at climate from these multiple perspectives, the review refutes the claim that recent temperatures increases are unprecedented. It is also reasonable to question forecasting continued linear growth in temperature over time. In the past, CO₂ and temperature did not exhibit that behaviour. Climate is defined by cycles and oscillations. It is complex and much of the science is not fully understood, such as the ocean cycles, the impact of solar variation and cosmic rays, and how volcanos and atmospheric aerosols disrupt climate.

Now that we have looked at global and historic trends, let's look at past trends in Alberta as can be observed in the historic record.

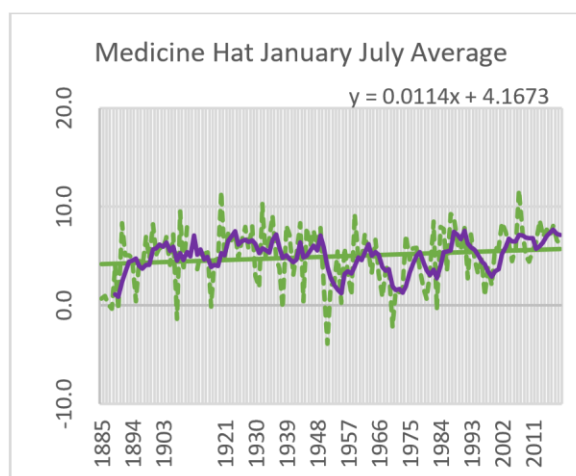
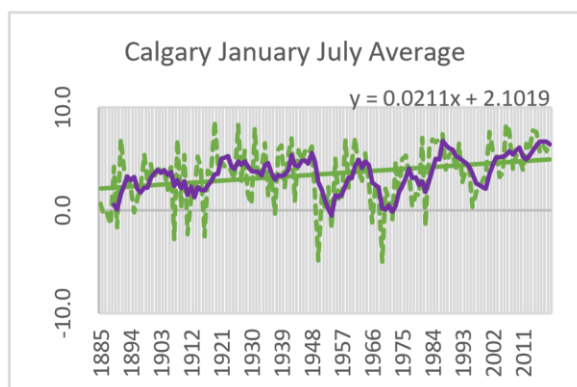
Correlation of Alberta Temperatures to Global Climate

Below is the HadCRUT temperature series. It depicts the change in global temperatures over time. The red box outlines the time series from 1884 to 2019. As you can see in this estimate from adjusted measurements, worldwide temperatures stay cool until 1910 and then increase markedly until sometime just before 1950. Then there is steady or slightly dropping temperatures until about 1980, after which, temperatures rise until 2019 at a similar rate as the 1910 to 1950 change.

Page | 43



Below are graphs of the Calgary and Medicine Hat averages for January to July temperatures, an approximate means to average temperature over time. It is difficult to correlate the graphs below to the HadCRUT data above, due to different scales and parameters. However, it is informative to look at the shape of the graphs which relate relative temperature over time. Unlike the global trend, both Calgary and Medicine Hat warm immediately after 1884 into the early 1890s then gradually warm from there, with a few cycles, until about 1948. The 1920 to 1945 temperature peaks in both cases are similar to 2000 to 2020 temperature levels.



The pause or temperature drop from 1950 to 1980 in the HadCRUT data is not the same in the Alberta graphs, where cycles of high and low decades change along an upwards trend line. One can see that although there are similarities, there also are significant differences between the global and local climate trends. Vertical exaggerations and scales make real temperature comparisons difficult to reconcile, but the HadCRUT shows an extreme vertical exaggeration to accentuate the increase.

In summary, local conditions may have some resemblance to global trends, but based on observation the likelihood of extrapolating global to local trends in any sort of realistic fashion appears imprudent.

Selection Bias in Climate Investigation

Alberta has quite good records for temperatures reaching back into the early 1900's and at times to late 1800's. Some examples of record duration for Alberta climate stations used in the Hayhoe report:

- | | | | |
|------------------|--------------|----------------|--------------|
| • Calgary | 1884 to 2019 | • Edmonton | 1884 to 2019 |
| • Calmar | 1914 to 2018 | • Lethbridge | 1908 to 2019 |
| • Campsie | 1910 to 2013 | • Medicine Hat | 1884 to 2019 |
| • Grande Prairie | 1943 to 2019 | • Red Deer | 1938 to 2014 |

Despite this, the Hayhoe & Stoner report bases the historical analysis and review ONLY from 1950 to 2013. It appears that they ignored or disregarded the past, well documented historical records of the temperature in the Province. Reading the report, this is possibly due to the Hayhoe & Stoner team's assertions on Page 7 of their report. There it indicates that CO₂ has influenced global warming since the start of the 1900s, but particularly since 1950. The report goes on to show the "Human, Natural and Combined" forcings on climate. The graphs on page 7 of the Hayhoe report show a significant departure between natural and human forcings in 1950 dependent on the theorized increasing influence of CO₂. Perhaps that is why 1950 was chosen for the Hayhoe & Stoner report timeline. It is asking the question to the answer they believe they already know. It may also have been in keeping with NASA GISS preference for this framework. NASA GISS justifies this time frame as: *"It is also a period when many of today's adults grew up, so it is a common reference that many people can remember."*²⁹ But few people can remember accurately what past temperatures were like. This is why we retain historical climate data. Just as Hayhoe & Stoner claim past temperatures were 'stable' – climate data shows that anecdotal claim to be false.

However, good science does not ignore all data. As Richard Feynman noted in the earlier quote, integrity and responsibility requires that a scientist also must note where they may be wrong. Let's go back and see what we can observe in the past record not considered by Hayhoe & Stoner. To do this, we can look at temperatures for Calgary and Medicine Hat, which have records going back to 1884. We can compare trends for these longer durations to the 1950 to 2013 trends by Hayhoe & Stoner.

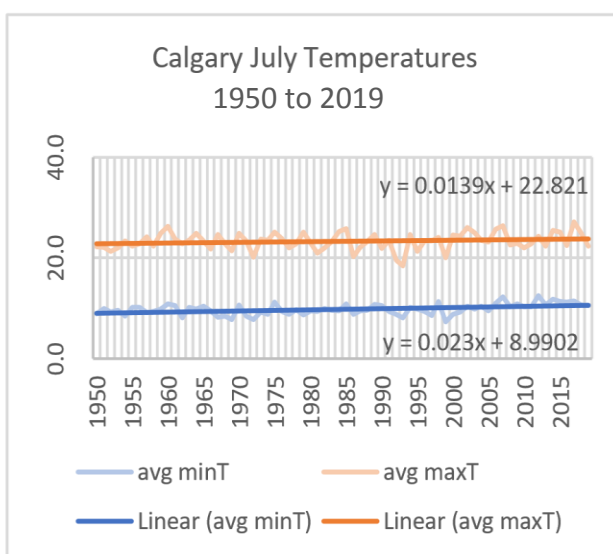
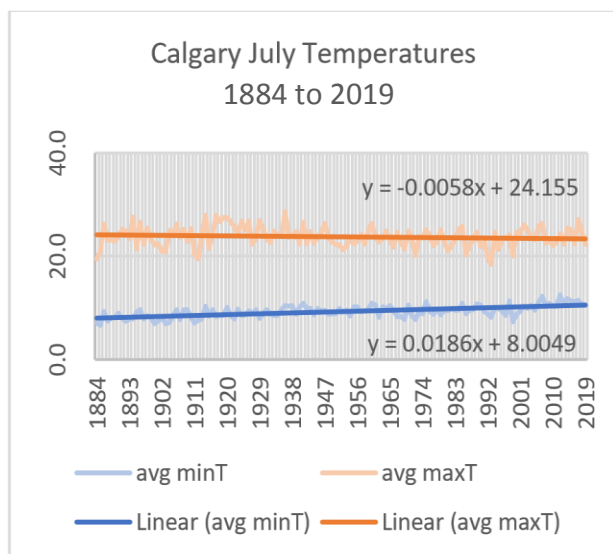
Two graphs are shown below. Both use the same data. The first is the full temperature record for Calgary July temperatures, 1884 to 2019, with the resulting trend analysis. The second graph shows July

²⁹ earthobservatory.nasa.gov/world-of-change/global-temperatures

temperatures from 1950 to 2019, a similar period to that used in the Hayhoe & Stoner report (1950 to 2013). Comparing both graphs shows:

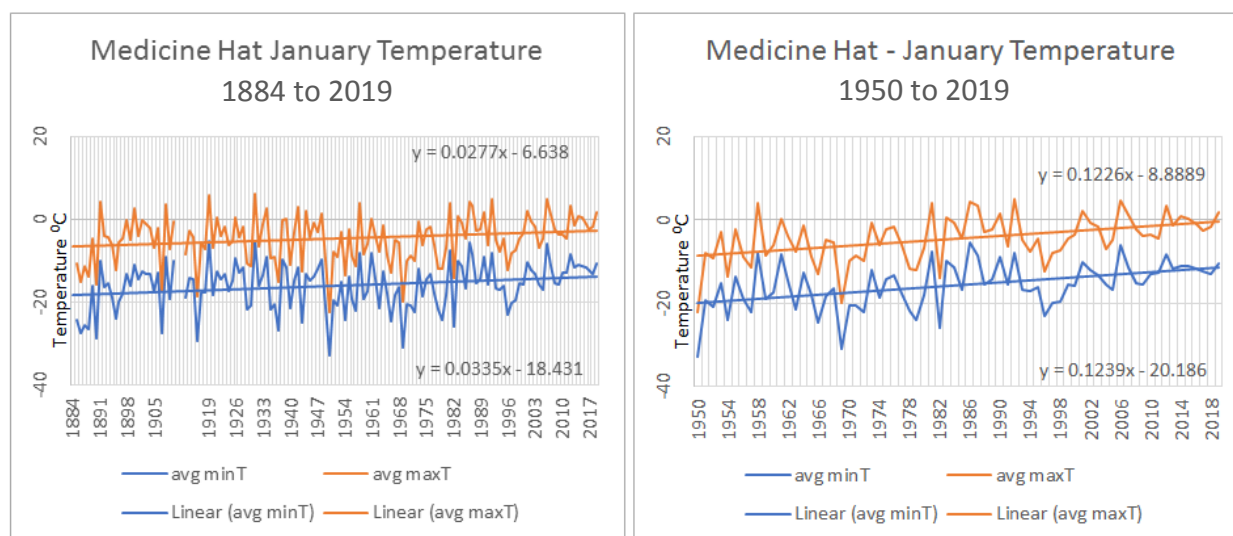
Calgary July Daily Average Temperature Trends			
Data Timeline	Review Assessment		
	1884 to 2019	1950 to 2019	difference
	<i>°C per decade</i>	<i>°C per decade</i>	<i>°C per decade</i>
Daily Maximum Temperature (maxT)	-0.058	0.14	0.20
Daily Minimum Temperature (minT)	0.19	0.23	0.04

Page | 45



It is clear that the period chosen for analysis by Hayhoe & Stoner affects the result. We have a contradiction in that we have a long-term decreasing trend in daily maximum temperatures but the Hayhoe & Stoner report only addresses the shorter-term increasing trend, despite a significant contrary observation on a different time scale.

Two additional graphs are shown below. Again, both use the same data. The first is the full temperature record for Medicine Hat January temperatures, 1884 to 2019, with the resulting trend analysis. The second graph is a subset of the same record, for Medicine Hat January temperatures from 1950 to 2019.



Medicine Hat January Daily Average Temperature Trends			
Data Timeline	Review Assessment		
	1884 to 2019	1950 to 2019	difference
	°C per decade	°C per decade	°C per decade
Daily Maximum Temperature (maxT)	0.28	1.2	0.92
Daily Minimum Temperature (minT)	0.34	1.2	0.86

The shorter time frame shows almost a four times increased temperature trend than the longer-term period. Which is the real or realistic trend in temperature increase?

Both examples go to the old saying of “lies, damn lies and statistics” often attributed to Mark Twain. It reflects on the power of statistics to bolster a weak argument. Which trend is correct? In a certain way, both are correct given that they are based on the same data. However, presentation and results are misleading at a minimum and possibly disingenuous. Science needs honesty with numbers and how data is used. Conclusions can embellish a certain point of view or present contradictory observations for consideration. This contradiction is important and is addressed in the section on Linear Trends and Cycles.

Winter Temperature

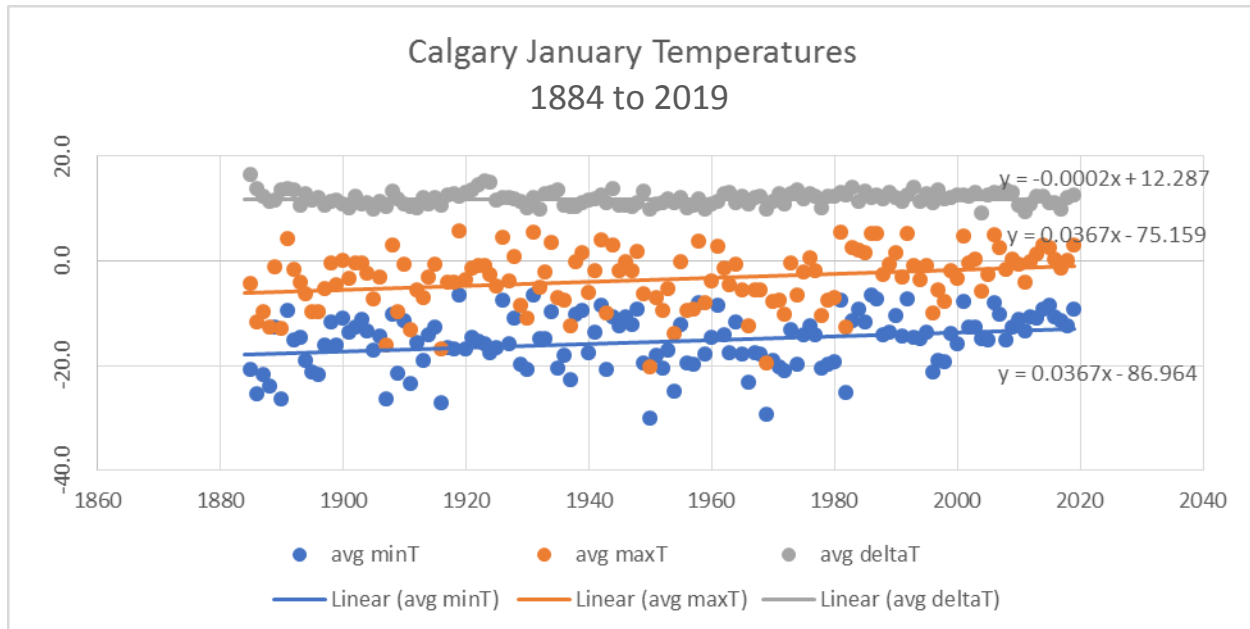
In their report Hayhoe & Stoner state:

“Since 1950, almost every part of the province has experienced significant increases in winter temperature (from +0.5 to +1 °C per decade) and decreases in the frequency of cold days, heating degree-days, and the proportion of winter precipitation falling as snow.”

Review of results from stations located in Grande Prairie, Edmonton, Calgary and Medicine Hat show the following changes over time of January average temperatures:

Alberta January Daily Average Temperature Trends					
Data Timeline	Review Assessment				
	1884 to 2019	1950 to 2019	difference	1884 to 2019	difference
	Calgary & Medicine Hat	Calgary & Medicine Hat		All 4 Stations	
	^o C per decade	^o C per decade	^o C per decade	^o C per decade	^o C per decade
Daily Maximum Temperature (maxT)	0.30	1.30	1.00	0.53	0.77
Daily Minimum Temperature (minT)	0.35	1.25	0.90	0.58	0.67

Page | 47



The supporting graphs of winter (January) temperatures, similar to the example above, are in the Appendix.

Considering the full temperature record, the increase in the winter temperature (maxT/minT) trend is overstated in the “Alberta’s Climate Future” report. The increase is 0.30 to 0.58 °C per decade, not 0.5 to 1.0 °C per decade as claimed. However, if only the 1950 to 2013 temperature record is considered, the rate of winter temperature increase is different. The main consideration is the difference in magnitude between the long term (1884 to 2019) and short term (1950 to 2013) trends. The short-term trend is almost four times the warming trend of the longer-term trend. How can that be correct?

What cannot be disputed is that winters in Alberta are getting warmer when looking at the temperatures. The rate of warming is overstated based using a short-term analysis, as the longer trend contradicts this result. Far less warming is evident when the hot early decades of the 1900’s are considered.

Summer Temperature

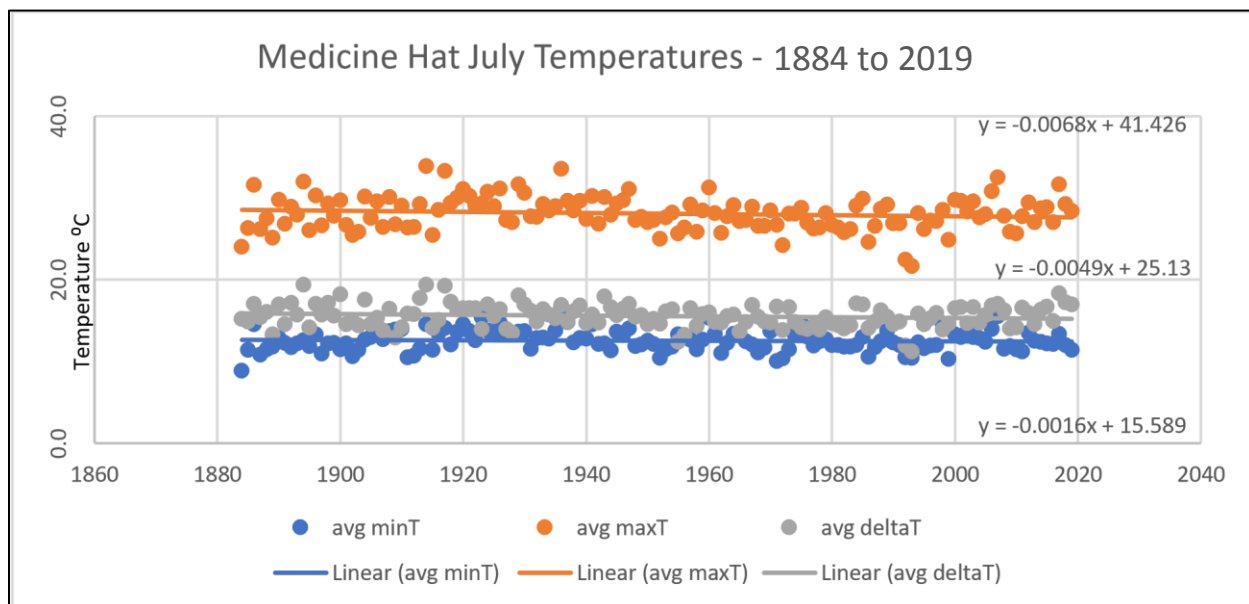
In their report Hayhoe & Stoner state:

“Over half of the province has also experienced significant increases in summer temperature (from +0.1 to +0.3 °C per decade), and some parts have also seen significant increases in warm days over 25 and 30 °C.”

Page | 48

Review of results from stations show the following changes over time of July average temperatures:

Alberta July Daily Average Temperature Trends					
Data Timeline	Review Assessment				
	1884 to 2019	1950 to 2019	difference	1884 to 2019	difference
	Calgary & Medicine Hat	Calgary & Medicine Hat		All 4 Stations	
	°C per decade	°C per decade	°C per decade	°C per decade	°C per decade
Daily Maximum Temperature (maxT)	-0.06	0.16	0.22	0.00	0.16
Daily Minimum Temperature (minT)	0.08	0.13	0.05	0.14	-0.01



The supporting graphs of summer (July) temperatures trends, example above, are in the Appendix.

Hayhoe & Stoner significantly overstate that summer temperatures increased by claiming it is +0.1 to +0.3 °C per decade. The stations investigated show a range from -0.06 to 0.14 °C per decade for maxT/minT readings. To be clear, they suggest the change is warming by one tenth to 3 tenths of a degree Celsius; our review of the same stations show the warming to be in the hundredths of degrees, from *minus* 6 hundredths of a degree (i.e. cooling) to a warming of only 14 hundredths of a degree. This does not constitute a crisis of any kind. Two of the four Alberta cities showed a long-term decreasing maximum temperature trend (over the full historical record). The other two had little to no change in July maximum temperature readings.

What cannot be disputed is that summers in Alberta are not getting warmer when looking at the maximum daily average temperature record. The rate in which warming occurs is overstated due to use of a short-term analysis. The longer-term trend contradicts this result.

Diurnal Temperature Patterns

Each of the July and January graphs in the Appendix show the maxT, minT and deltaT trends. The deltaT trend is the difference in temperature between the average of day and the average of night temperatures. The change between day and night is noticeable. In all cases, the difference between January daytime highs and nighttime lows is decreasing by 0.06 to 0.14 °C per decade, so nights are cooling less from the daily maximums. In July, all stations are seeing warmer nights, except for Grande Prairie. At the southern locations, the trend is reversed.

One explanation to the narrowing of the diurnal range, particularly in winter, is likely a combination of the Urban Heat Island (UHI) effect, along with a greenhouse effect that slows nighttime cooling.

Extreme Temperatures and Hot Summer Days

In their report Hayhoe & Stoner state:

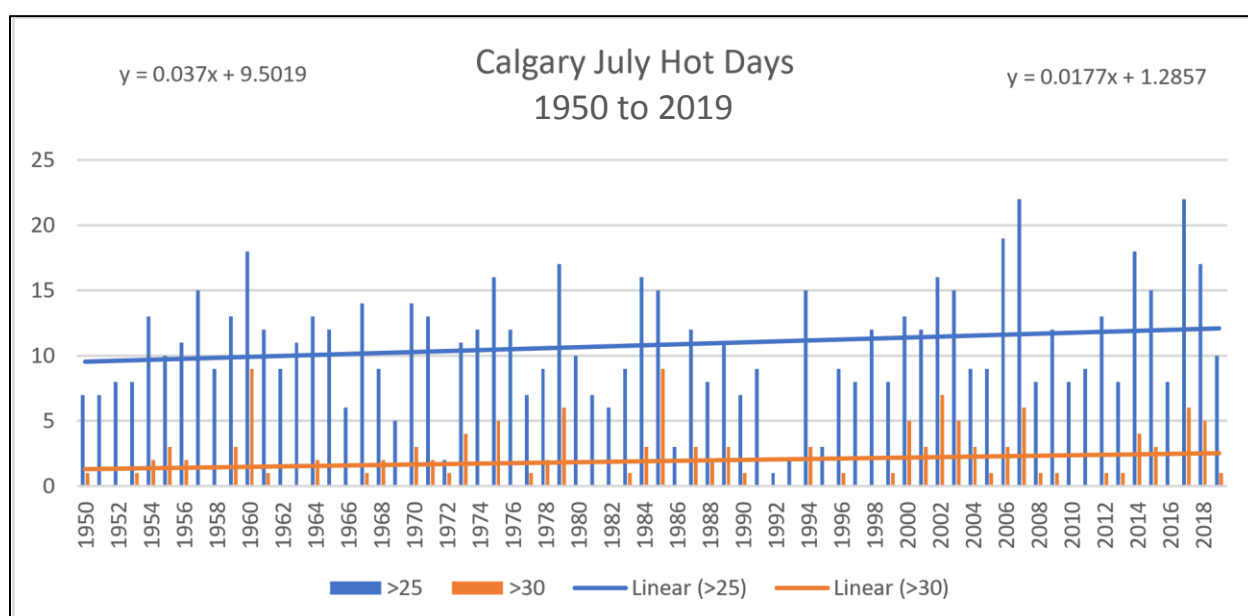
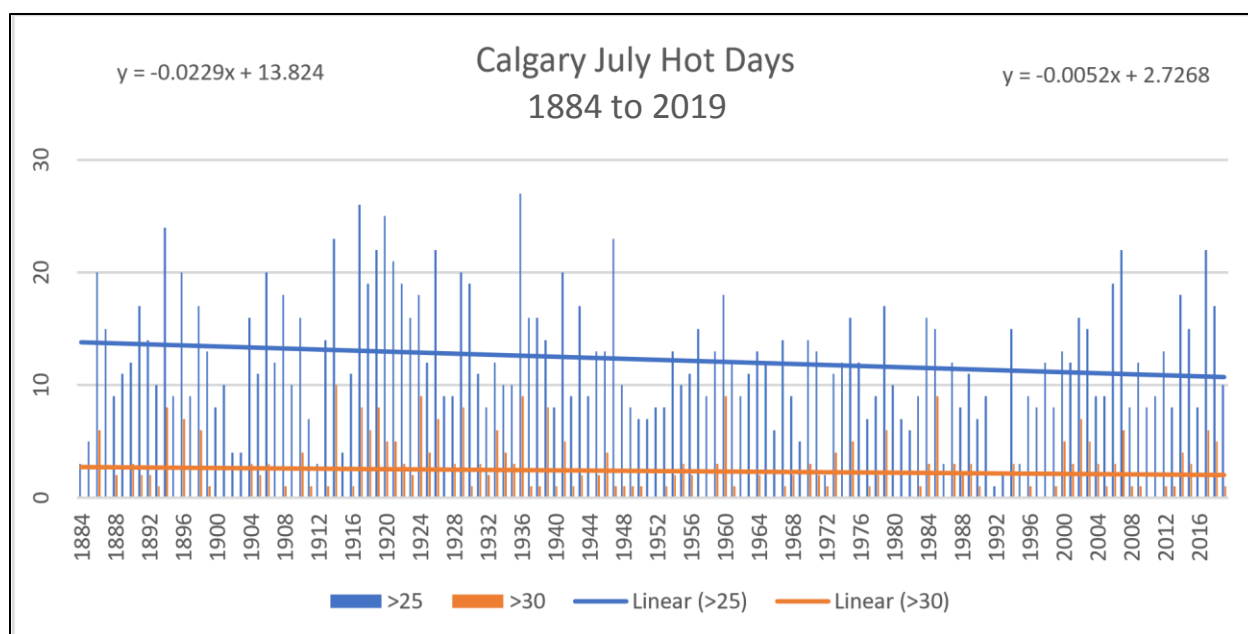
“Changes in the actual number of days per year experiencing extreme high and low temperatures are projected to increase exponentially, rather than linearly, as global mean temperature increases. For many Alberta locations, the number of days per year above 30 °C, for example, could double per degree of global warming.”

This above is a bold statement. There is no evidence of exponential growth in the historical records showing that the number of days over 25 or 30 °C is increasing, let alone exponentially. Contrary to that suggestion, the two northerly stations show small increases in the number of days over 25 °C and almost no change in the number of days over 30 °C. That is little to no increase.

For the two southerly stations investigated, the results are even more significant. Calgary shows a significant decline in hot days over the full, 1884 to 2019, temperature record. However, if you ignore the first 66 years of measurement, the 1950 to 2019 temperature record shows a small increase in hot days. In the Calgary case, and the same applies to Medicine Hat, use of the 1950 to 2013 timeframe creates a bias in the result by ignoring the warmer decades from 1910 to 1949.

As we see, selection bias is observed to give different results. This is often a concern with studies on climate. Rather than using the full record, a limited perspective is used to show an opposing result. This is misleading as it bypasses legitimate questions when one can easily observe that it was much hotter in the 1884 to 1950 period than the last two decades, at least in Medicine Hat and Calgary.

Refer to the Calgary example below or the additional graphs in the Appendix which shows this result.



Climate Linear Trends or Cycles

In their report Hayhoe & Stoner state:

“Many climate indicators for Alberta are projected to increase nearly linearly as global average temperature increases, though at a greater rate of change than the global average.”

Hayhoe & Stoner are shown to be correct in that average and winter temperatures are warming. That is mostly due to winters warming and less cooling at night. However, the report misses the mark on summertime warming. Summers are warming a bit on average, but days are not getting hotter. That is

demonstrated by the temperature record which shows no significant increase and, in two locations, decreases in the maximum July average temperatures. This is also supported by the Extreme Temperature and Hot Summer Days section analysis.

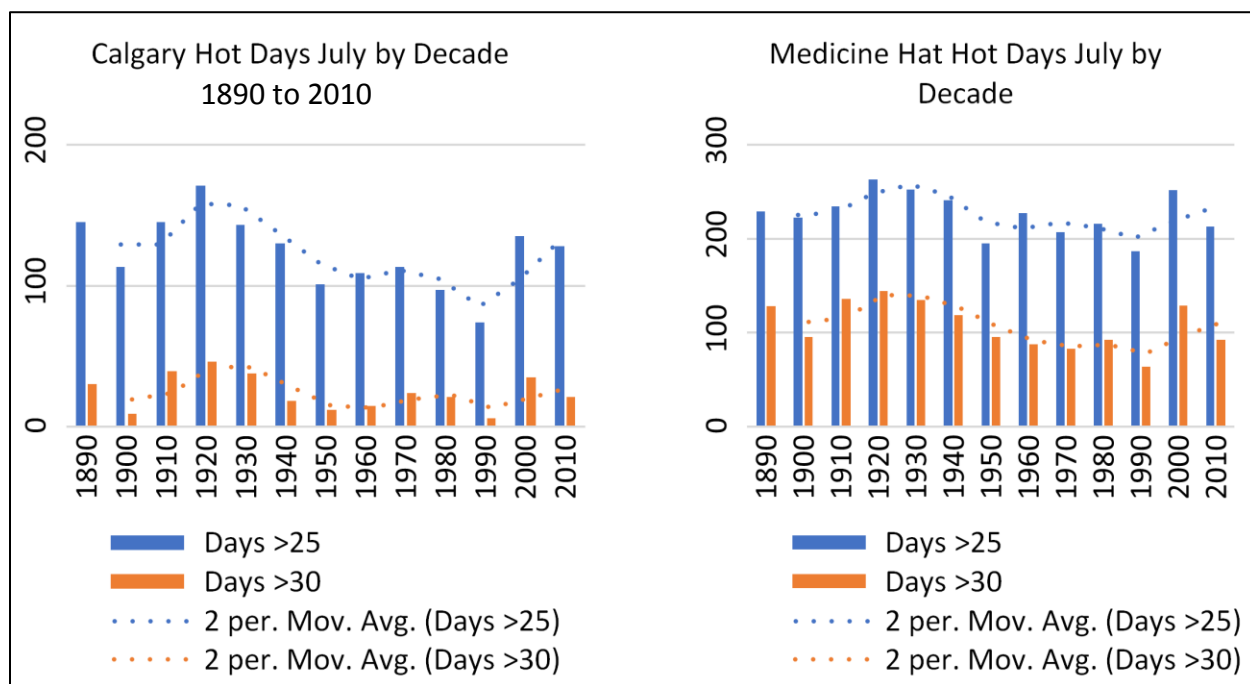
This poses a few questions:

- With all CO₂ emissions since 1950, why were there far warmer days from 1910 to 1950?
- Why are there no significant summer temperature trend increases and July maximum temperature trend decreases for Calgary and Medicine Hat?
- Why is it that the Hayhoe & Stoner report forecasts a linear increase in temperature when the charts show great variability (or cycles) and no increase in maximum temperatures?

Page | 51

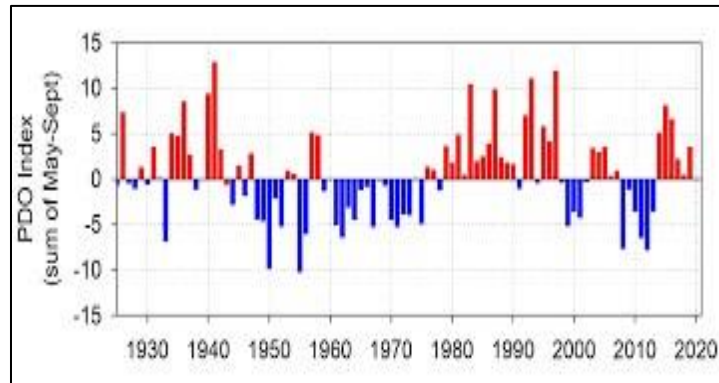
This goes to climate orthodoxy. CO₂ is considered to have been significant since 1950 and prior to that, climate changed largely due to natural causes. Somehow, natural forcings are assumed to cease in 1950 and man-made CO₂ has immediately taken over. What calls this into question are observations on both a local and a global basis that warming occurred in the first half of the 20th century, similar to that which has occurred since 1970. The current warming is not unprecedented no matter what the cause and a CO₂ to temperature linkage is not evident in the Alberta record.

The next question relates to forecasting linear increases, when one observes variability in the climate record. Perhaps there are other factors at play which influence temperature. Let's look at summer temperatures on a decadal basis.



The pattern in Hot Days above shows indication of cycles in the historic record. There are times of warming and times of cooling. Science regularly acknowledges the many factors that contribute to cyclic climate patterns. We noted orbital, solar and ocean cycles previously. We also see on a regular basis, day-night and seasonal cycles. In Alberta the average day to night cycles undergo temperature oscillations of 10 to 15 °C. Alberta also undergoes average seasonal variations from winter to summer

of 25 to 35 °C. These are far greater swings in temperature than what is occurring due global warming. The changes in the decadal Hot Days graph above shows climate variations over time. The decades from 1910 to 1949 were as hot as or hotter than 2000 to 2019. That is why the long-term trends are quite different than the truncated 1950 to 2013 period as used in the Hayhoe & Stoner study.



Page | 52

The above decadal pattern suggests evidence of cycles in climate, generally attributed to ocean patterns such as El Nino (ENSO), the Pacific Decadal Oscillation (PDO) and the Atlantic Multi Decadal Oscillation (AMO). Given the prevailing weather movement from west to east, Alberta is most influenced by the Pacific Ocean cycles. That means the ENSO and the PDO most likely directly affect Alberta's climate. Certainly, the PDO appears to coincide with the warm decades in the early 20th century.

These observations support climate changes in the past, and possibly into the future, based on cycles. To expect linear trends of increasing temperature continuing unabated going forward is like expecting the Stock Market to keep on increasing. It is not realistic or probable given past history and the observed cyclic influences on Alberta's climate. The reason for the contradiction in trends between the long and short timelines is that the 1950 to 2013 trends pick up on the most recent upcycle. The longer-term timeframe cuts across a series of up and downtrends associated with climate cycles.

Summary

In their report Hayhoe & Stoner state:

"Projected changes will profoundly impact Alberta's natural environment, and have the potential to affect the province's agriculture, infrastructure, and natural resources, as well as the health and welfare of its inhabitants. For both temperature and precipitation, the changes reported here are consistent with those projected to occur throughout north central North America in response to human-induced climate change. They are appropriate for use in scientific analyses to quantify the impacts of a warming planet on both human and natural systems, and to inform long-term planning, education, and outreach."

Weather and temperature always profoundly affect the natural environment. However, the statement underlined above relies on linear forecast of Alberta's climate based on global computer model forecasts. This review calls a number of the report findings into question. Of note are:

- misleading or incorrect observations on warming in the "Alberta's Climate Future" report regarding a forecast exponential growth in hot days;

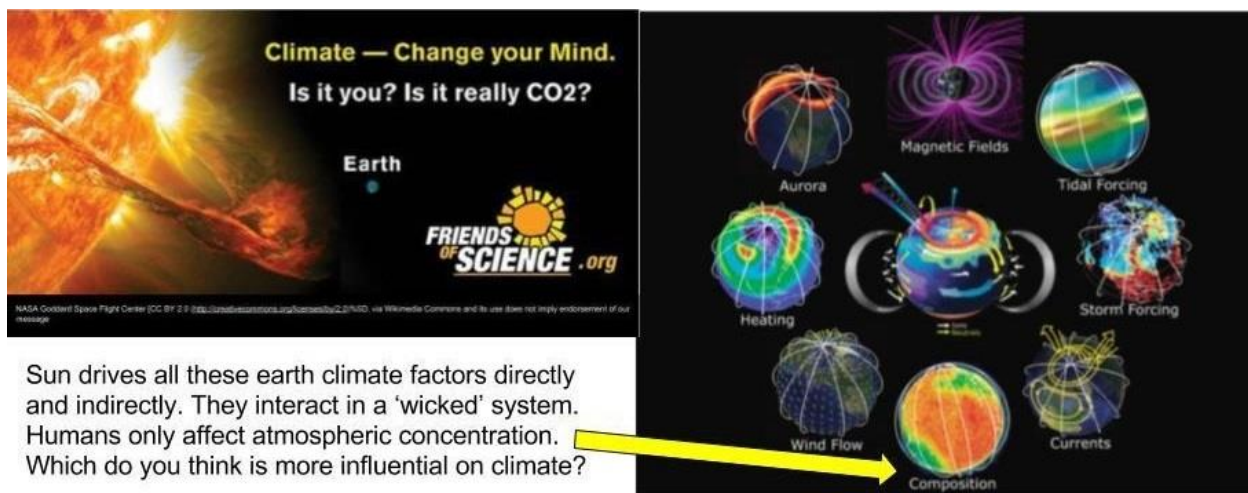
- forecast increases in hot days forecast when the observed long-term trend is decreasing hot days;
- the observed lack of increase in summer maximum average daily temperatures;
- forecasts based on the most extreme, unrealistic RCP8.5 scenario which is acknowledged as inappropriate for such use;
- biased trends by the ignoring of climate events before 1950; and
- forecasting based on a linear trend with no consideration of well-known and observed climate cycles.

Based on this review, the report conclusions are not “Dire” or “Alarming”. What is alarming is how the report frames the situation to fit a specific narrative and selects data to only support that message. While winters are warming and nights are less cool, our summer days are not getting hotter. We are seeing less severe weather. We are getting warmer nights. Summers appear not to be getting hotter or colder. Current summer temperatures are not too hot and maximum summer temperatures are not unprecedented. In many locations in Alberta, the 1910 to 1949 period was warmer than today. Temperature differences are changing with nighttime and winter warming, where summer-winter extremes are reduced by 4 to 6 °C and day-night differences are reduced by 0.5 to 1.5 °C, over the last century. It could be said that our climate is moderating.

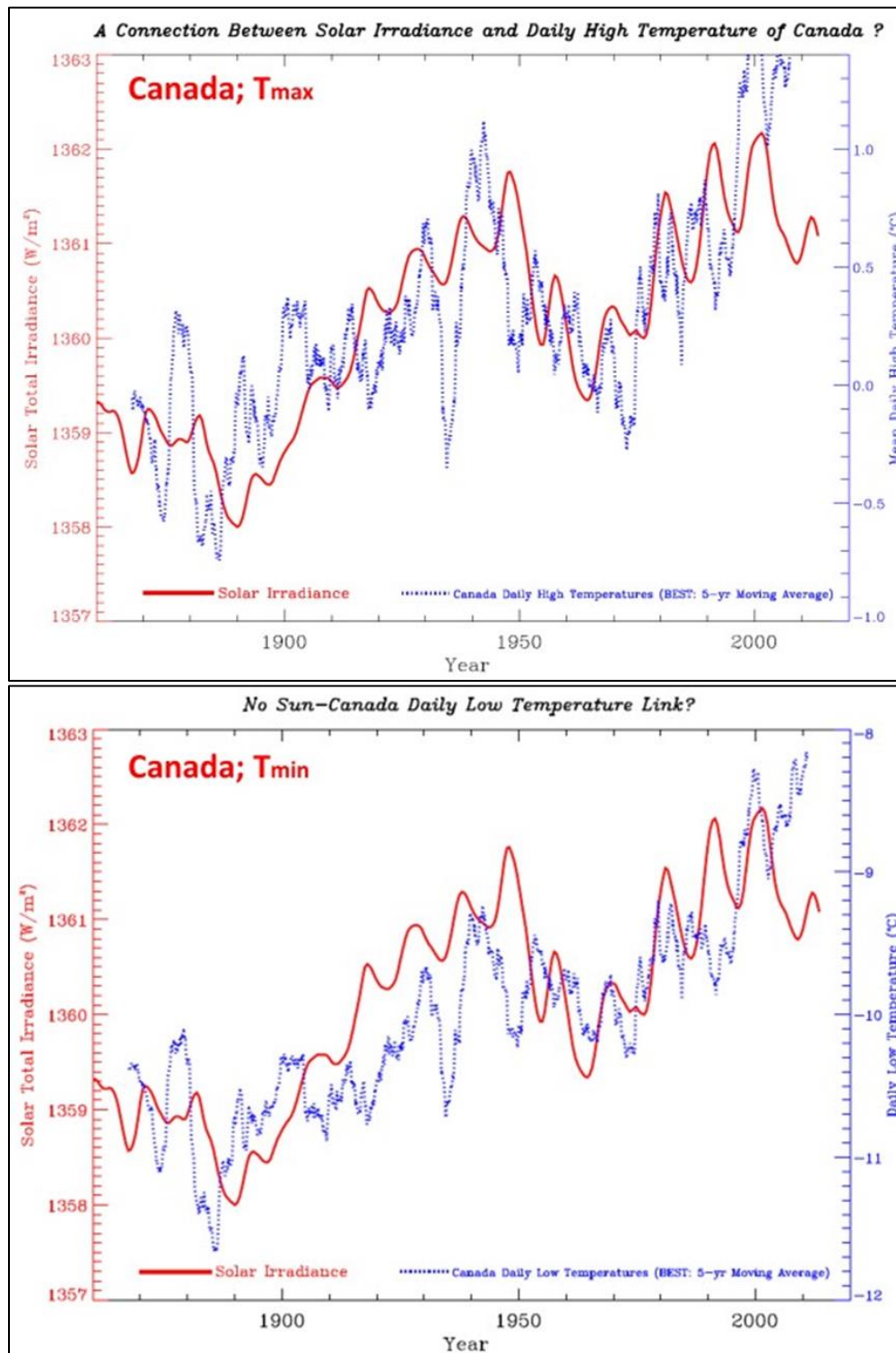
We are not “Burning Up” and it certainly remains to be seen if temperatures will rise on a linear basis or if hot days will increase on an exponential basis. Such changes cannot be seen in the past and it is unlikely to happen in the future. With a complex, chaotic system, we cannot rely on climate models. They are indicative tools to test assumptions, which are not suitable for forecasting. Cycles of climate are clearly evident in the past. Subject to some modest warming by CO₂ forcing, cycles are likely to continue to dominate climate going forward. Perhaps our harsh climate will continue to become a little less harsh, without summers overheating.

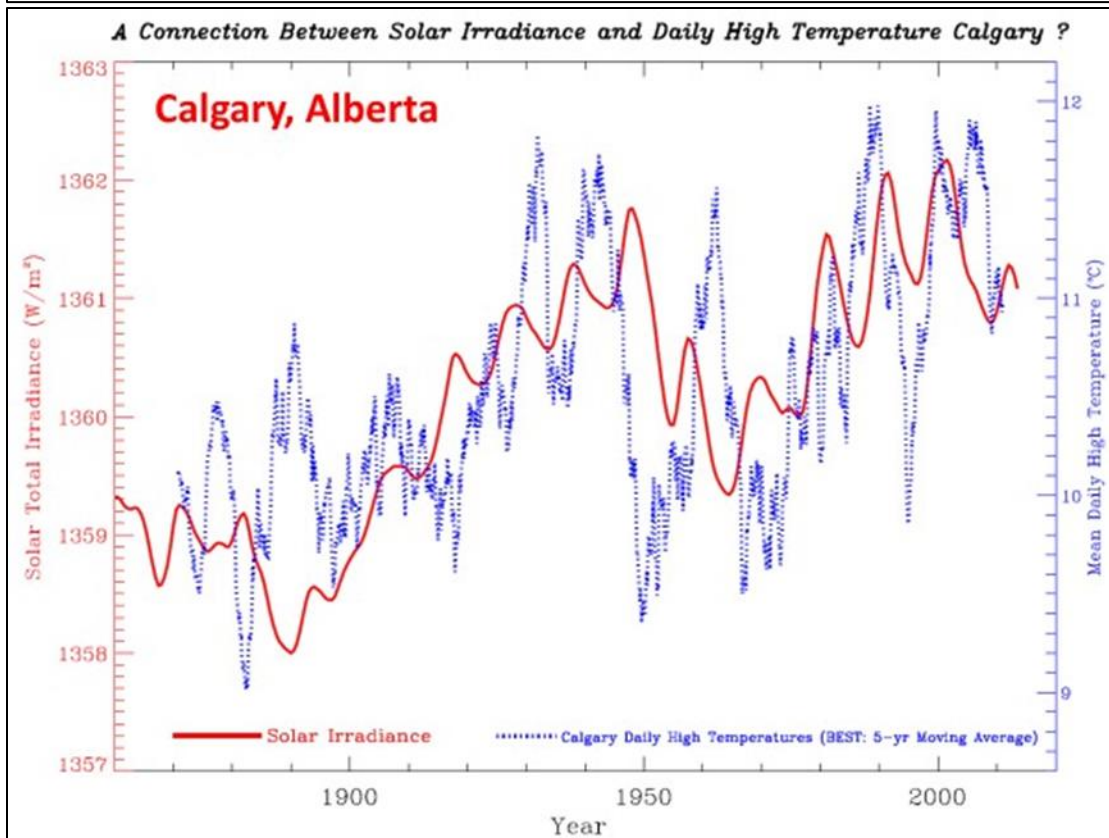
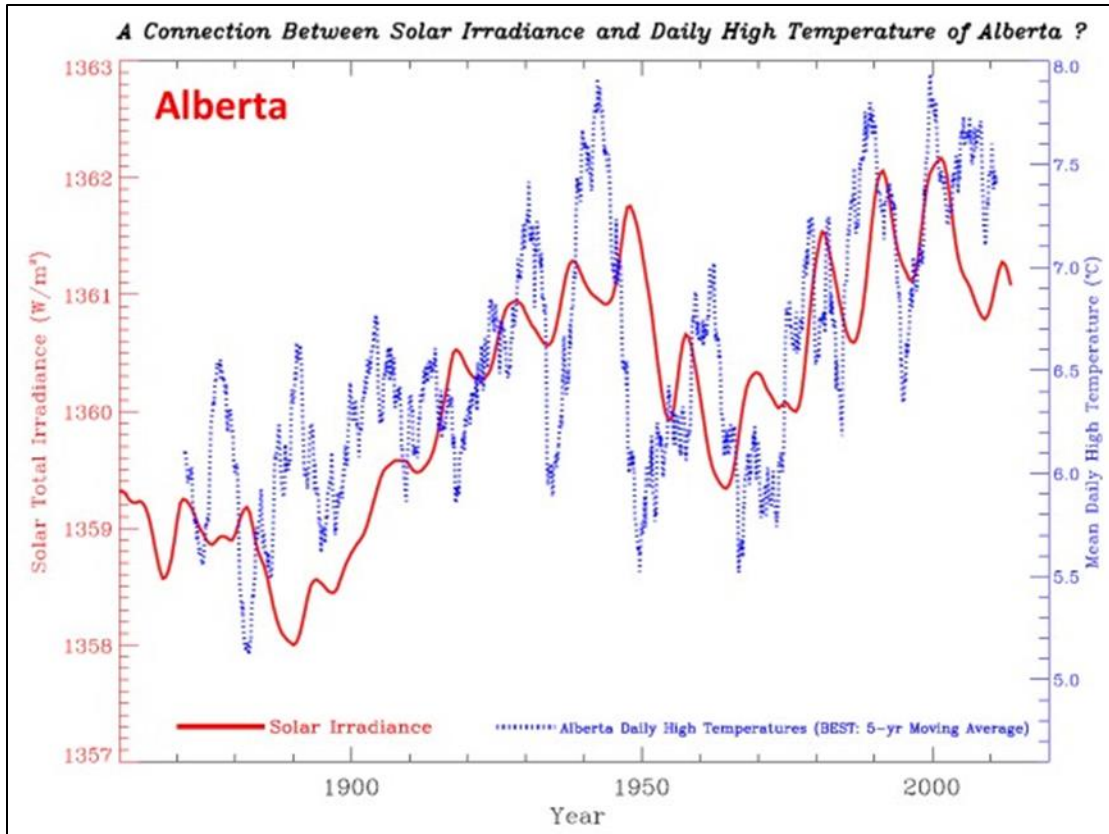
Solar Influence on Climate

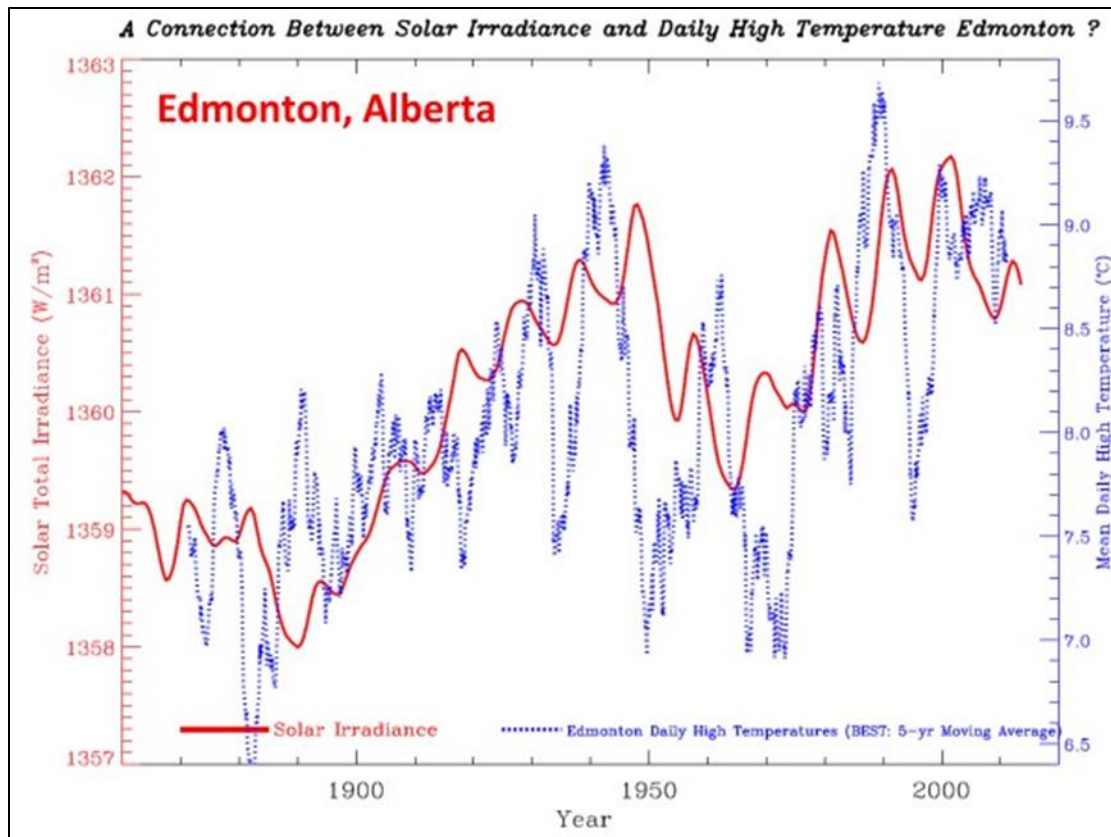
In numerous papers, public statements and presentations, Dr. Hayhoe has dismissed out of hand that natural variability of solar influence could be driving climate change.



In his 2019 presentation to the Friends of Science Society, Dr. Willie Soon showed the close correlation between fluctuations in solar irradiance and daily high temperature changes in Canada and Alberta. While correlation does not conclusively mean that this is the causative factor, when there is no correlation, it means there is no evidence of causation. As you will see in the analysis below, changes in solar irradiance do seem to correlate with Alberta temperature changes.







Questions of Objectivity

Scientists typically comment on scientific matters and reserve judgement on policy. Dr. Hayhoe is a noted public speaker, and frequently in the midst of climate discussions, her comments turn to energy policy. Perhaps Dr. Hayhoe is simply a personal advocate of renewable energy, but her presentation at the University of Calgary on March 6, 2018, is concerning. As in the “Alberta’s Climate Future” report, she used the comparative example of RCP8.5 as a ‘business-as-usual’ trajectory, and RCP4.5 as a pathway of choice. She said:

“We are just starting now to curve off the higher scenario. If you notice here, that we are just here, we are just starting to curve off the higher scenario.”

When I say ‘we’ – I actually mean it’s mostly... get this... it’s mostly been China. China has more wind and solar energy than any other country in the world.

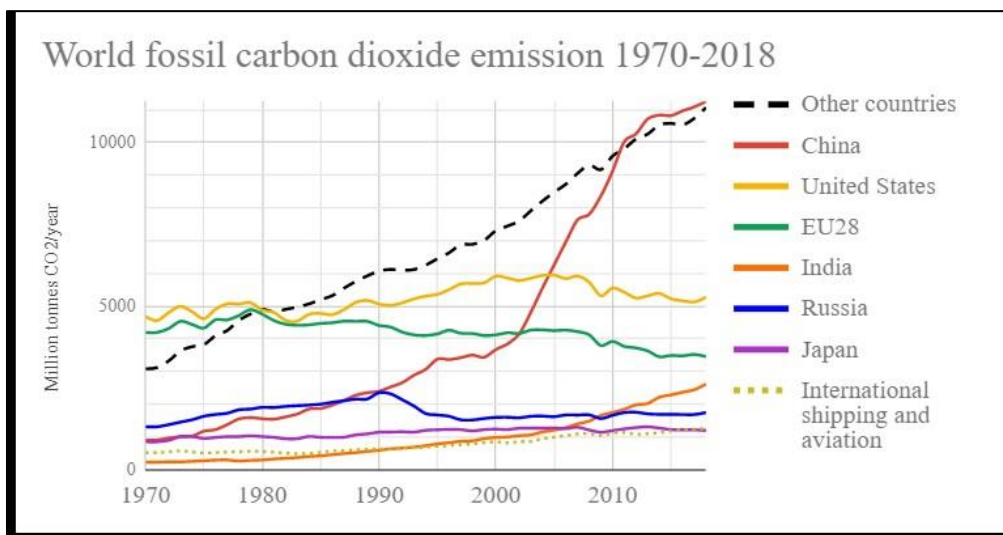
And, you know, I’m not 100% confident in their emissions estimates, so take this



with a bit of a grain of salt ... But at least what we are working with at the global level suggests is that we are starting to peel off the higher scenario but not fast enough to get down to a lower scenario or meet the Paris targets.”

Contrary to Dr. Hayhoe’s claims, China is the highest emitter of all greenhouse gases in the world and continues to increase CO₂ emissions. In no way is China contributing to reduced global CO₂ levels. In fact, the USA has done a better job in reducing emissions recently, primarily by substituting natural gas for coal energy generation. By some accounts, the US has reduced CO₂ emission by 14% since 2005.

Page | 57



China is the largest user of coal in the world, by many factors.

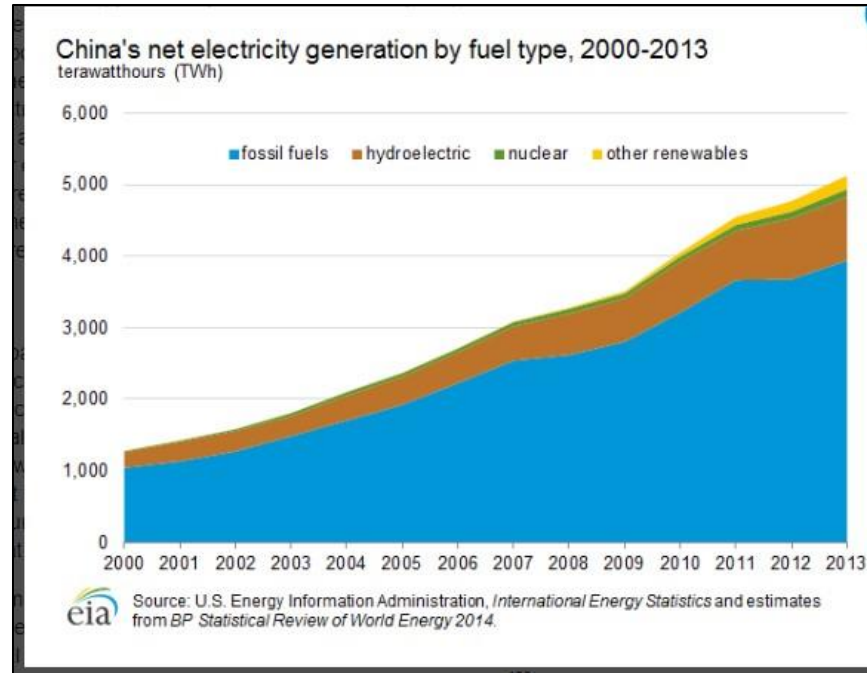
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Home > Energy

Coal Consumption by Country

Product	Rank	Country	Consumption (Thousand Short Tons)
Crude Oil	1	China	4,361,427.00
Natural Gas	2	United States	924,442.00
Liquids	3	India	886,052.00
Motor	4	Germany	270,404.00
Gasoline	5	Russian Federation	229,820.00
Jet Fuel	6	Japan	222,304.00
Kerosene	7	South Africa	190,085.00
Distillate Fuel	8	Poland	160,817.00
Oil	9	Korea, Republic Of	142,464.00
Residual	10	Australia	132,565.00
Fuel Oil			
Liquefied			
Petroleum			
Gases			
Other			

China’s renewables may be large in terms of installed capacity, but they are on par with global power generation – nominal and completely outclassed by conventional fuels. China’s renewables are certainly not reducing world greenhouse gas emissions.



In other words, Dr. Hayhoe's statements made at the University of Calgary about China and global emissions reductions do not appear to be supported by the evidence.

In the van Vuuren et al (2011) development of the RCP simulations, fossil fuels continue to be part of the energy mix, even in the lowest simulation. As noted by energy expert and author, Prof. Emeritus Vaclav Smil, "To Get Wind You Need Oil."

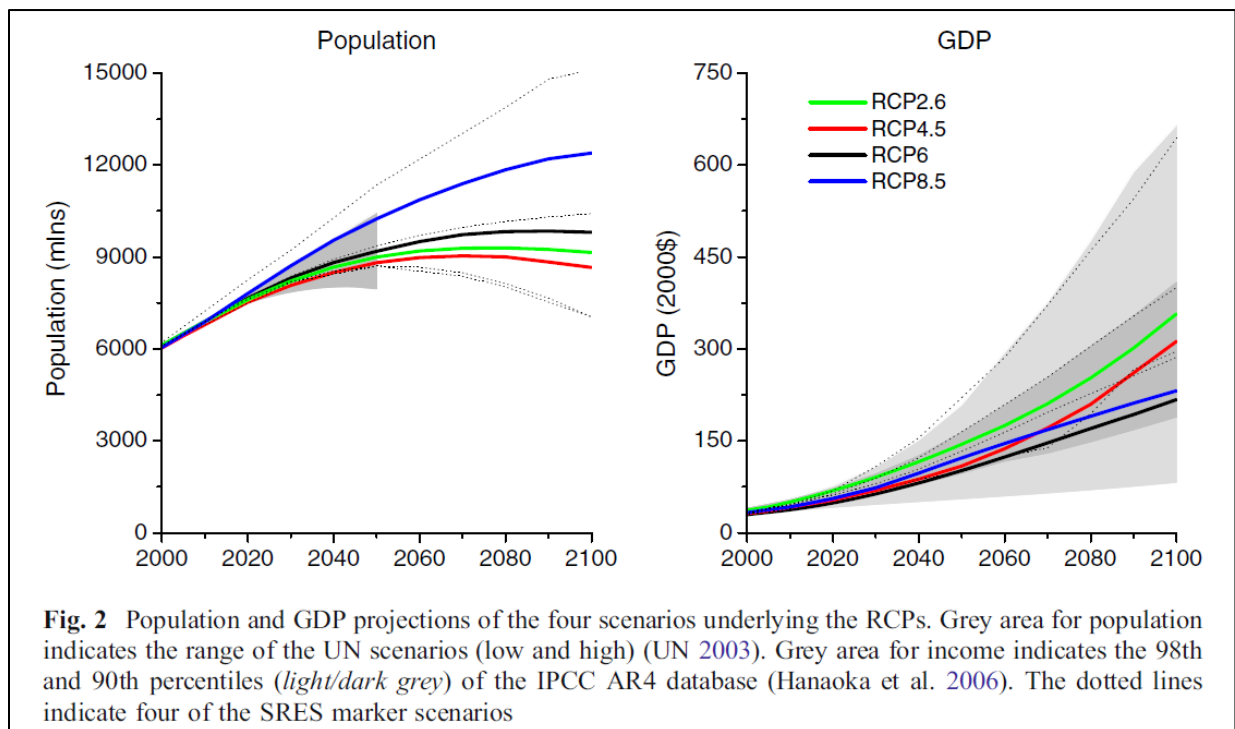
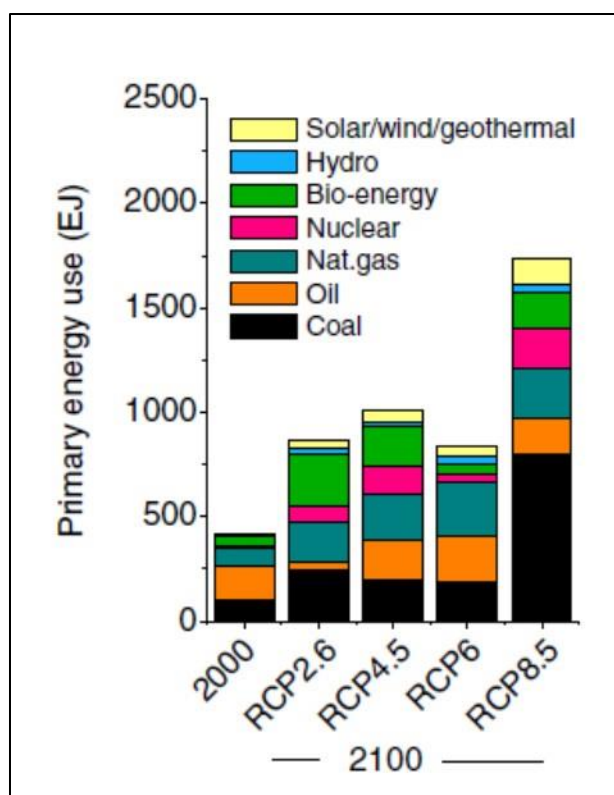


Fig. 2 Population and GDP projections of the four scenarios underlying the RCPs. Grey area for population indicates the range of the UN scenarios (low and high) (UN 2003). Grey area for income indicates the 98th and 90th percentiles (light/dark grey) of the IPCC AR4 database (Hanaoka et al. 2006). The dotted lines indicate four of the SRES marker scenarios

Source: van Vuuren et al (2011) Primary energy forecasts



Source: van Vuuren et al (2011) Primary energy forecasts

Roger Pielke, Jr. has raised concerns about conflicts of interest in regard to the fact that Dr. Hayhoe is a co-author of Fourth National Assessment on Climate, released in November of 2018, but it was not revealed in that document that Dr. Hayhoe also has a for-profit consulting business on climate. Pielke, Jr. notes that this possible conflict of interest should have been made clear.

Interestingly, in the Global TV news item about the “Alberta’s Climate Future” report, Dr. Hayhoe is interviewed by Skype and she tells viewers that:

“In a warming world, wildfires, which always happened naturally, are burning greater areas. Floods, which always happened naturally, are much more intense, with a lot more rainfall associated with them...”

Likewise, in the same Global TV news story, NDP MLA Shannon Phillips, former Environment Minister who commissioned the Hayhoe & Stoner report, is reported to have claimed that:

“Phillips said that the government can no longer afford to ignore these issues after insurance companies paid record payouts following major weather-related events such as the Fort McMurray wildfires of 2016 and southern Alberta floods of 2013.”

“Investors are very, very clear. Global capital flows are increasingly sending us signals that we cannot ignore and weather events are more frequent and more severe,” said Phillips.

Roger Pielke, Jr. and Dr. Madhav Khandekar and Robert Muir, Professional Engineer present evidence that disagrees with that assessment.

Pielke, Jr. has tracked weather disasters and insurance costs for over 25 years. His book [“The Rightful Place of Science: Disasters and Climate Change”](#), shows there is no increase in extreme weather events or losses when proportionately calculated.

Dr. Madhav Khandekar, research scientist for 40 years with Environment Canada, past IPCC expert reviewer, WMO regional expert and acknowledged world expert on El Nino Southern Oscillation presented on [“Climate Change and Extreme Weather: Perception vs Reality”](#) showing that there are no trends to more extreme weather; such events are integral to climate change. In 2002, Dr. Madhav Khandekar had been commissioned by the Alberta government to conduct a literature review on the science behind the Kyoto Accord. His report was entitled [“Uncertainties in Greenhouse Gas Induced Climate Change.”](#) Twenty years later, [in an interview](#), Dr. Khandekar noted that today there are many more uncertainties.

Robert Muir, Professional Engineer, [forced CBC to retract stories that repeated Insurance Bureau of Canada claims](#) about more intensity of precipitation and flooding because the evidence does not support such claims.

“The observance of correlation is too often used to declare causation, such as IBC claiming rain intensity as the cause of greater flood losses. While IBC may be confident in its loss numbers (even though 1990s values are [not as robust](#) as values compiled since 2008), it cites absolutely no rain data to correlate with those losses. Thus, IBC skipped right over correlation and claimed causation.

This is not science.

If losses have doubled since the 1990s, we must also look to the science of hydrology for an explanation. Unlike storm trends, [urbanization and intensification](#) have increased by significant factors for many decades and logically explain greater urban runoff and flood risk. We must accurately characterize the true causes of flooding to focus on the most effective solutions. If engineers ignore the facts and design flood mitigation infrastructure according to IBC’s falsely claimed frequency shift of 40 to six years, or the new unfounded claim that storms are more intense since 2009, scarce public resources would be diverted to over-designed, unnecessary works, delaying or even preventing implementation of reasonably sized infrastructure that is greatly needed.”

As shown in this report, Alberta weather events are not more frequent or severe or related to human caused climate change.

Thinking that catastrophes like major hurricane landfalls, massive forest fires etc. will be ‘cured’ by eliminating fossil fuel emissions is laughable. Well its not really funny. Thinking that eliminating fossil fuel emissions will ‘solve’ the problem of extreme weather events is very sad, sort of on the level of doing rain dances. Every thing that goes wrong, they blame on fossil fuel driven climate change.

*Imagine how surprised they would be if we were ever to be successful at eliminating fossil fuel emissions, and then we still had bad weather! –
[Dr. Judith Curry, Atmospheric Scientist](#)*

In Conclusion

“Alberta’s Future Climate” report is not a reliable source of information upon which to base climate, energy, agricultural or municipal policy. It ignores the long-term historical record, it relies upon the extreme, outlier RCP8.5 scenario, it attempts to forecast local and regional climate >80 years hence based on global climate models (which are known to run ‘too hot’). These have no relevance to the region of Alberta where unique temporary phenomenon like Chinook winds dramatically affect many aspects of seasonal weather and agricultural factors like the drying of soil, and where natural cyclical factors like El Nino can have significant, unpredictable, warming effects on the region.

General Circulation Models (GCM) for global climate cannot forecast an El Nino nor can they properly model clouds.

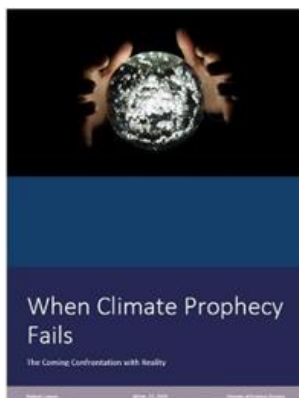
We believe this review of the historical record of climate and various extreme weather events in Alberta shows that pro-active, realistic mitigation and adaptation efforts have worked well for Albertans in the past. Those policies were based on lived experience and practical forward planning – not nebulous climate models/simulations extrapolating subjective inputs 100 years hence.

Climate prophecies have failed for over thirty years. Ideological dreams of a 100% renewable society are crashing down across Europe as the reality of poor performance of wind and solar, the exorbitant costs and the limited reduction of CO₂ by renewables hit home.

It is time to reject climate catastrophe hype and do more due diligence on climate emergency claims.

We do have time. There is no climate emergency. And we should be prepared for either warming or cooling cycles, as history has shown that both cycles are the reality.

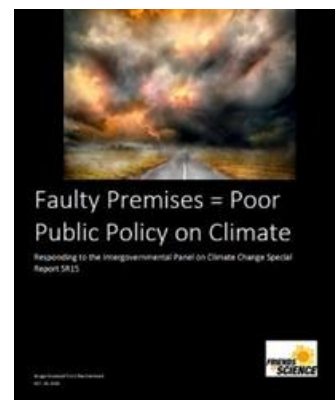
Additional Resources:



[When Climate Prophecy Fails](#)



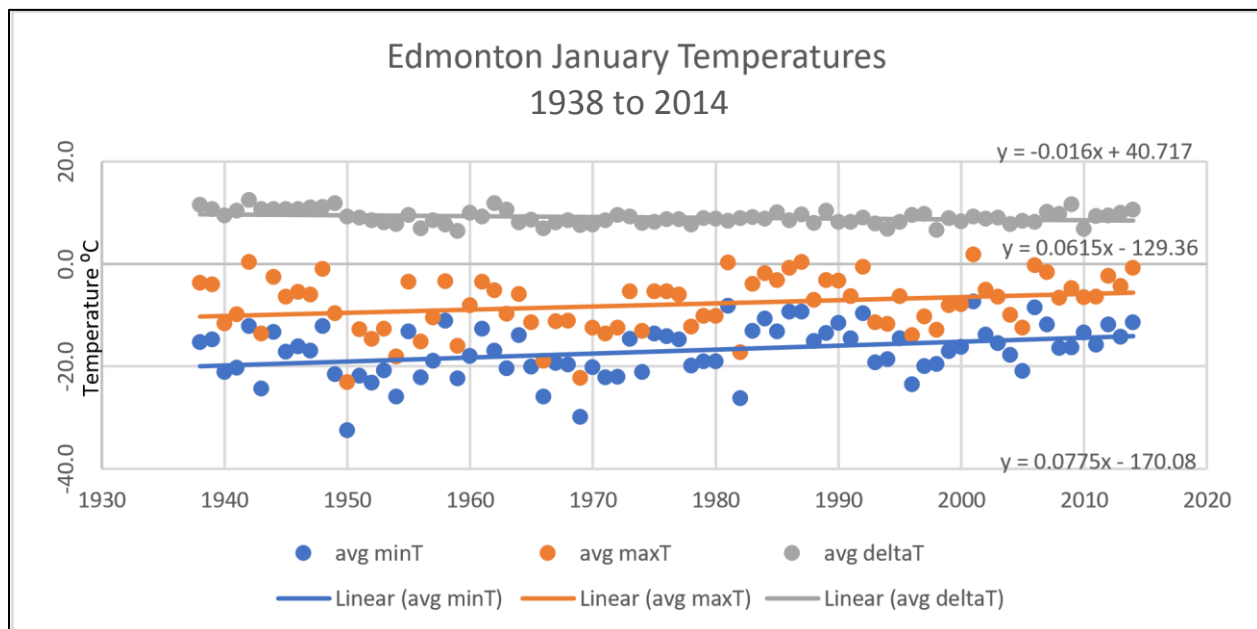
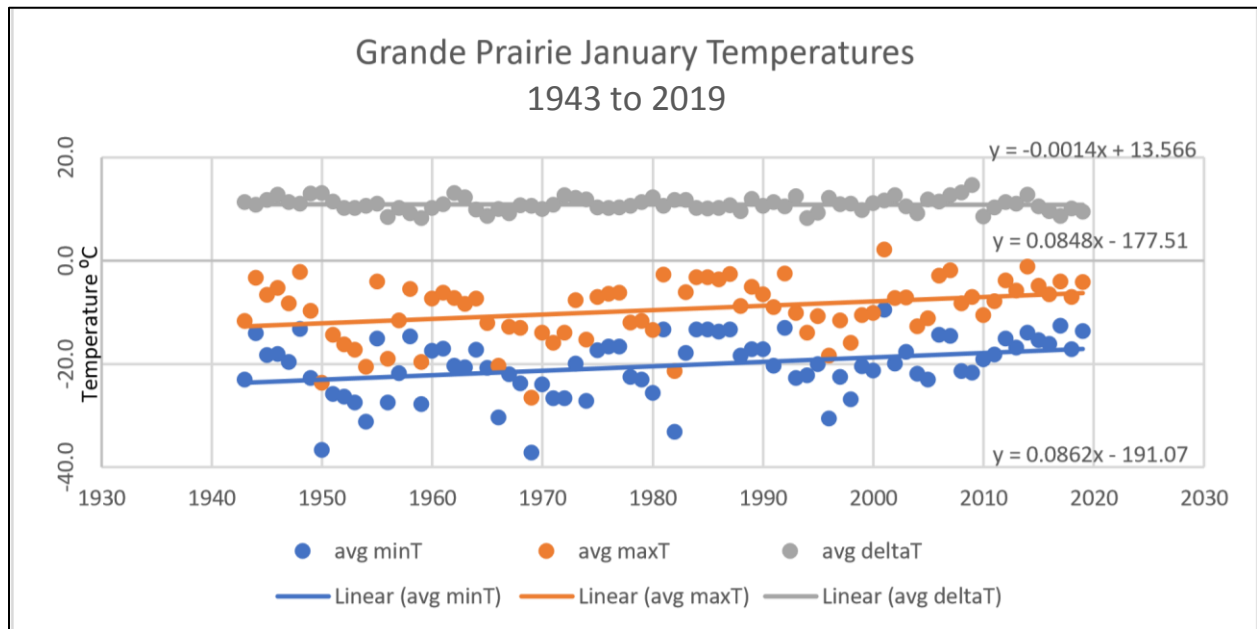
[In the Dark on Renewables](#)

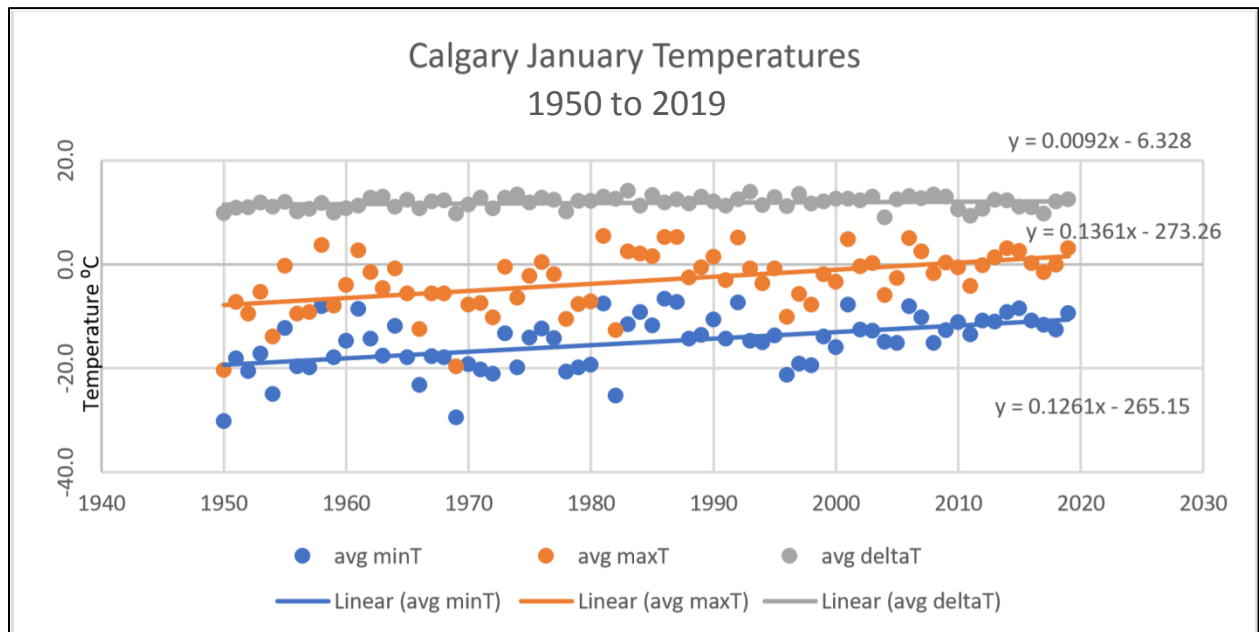
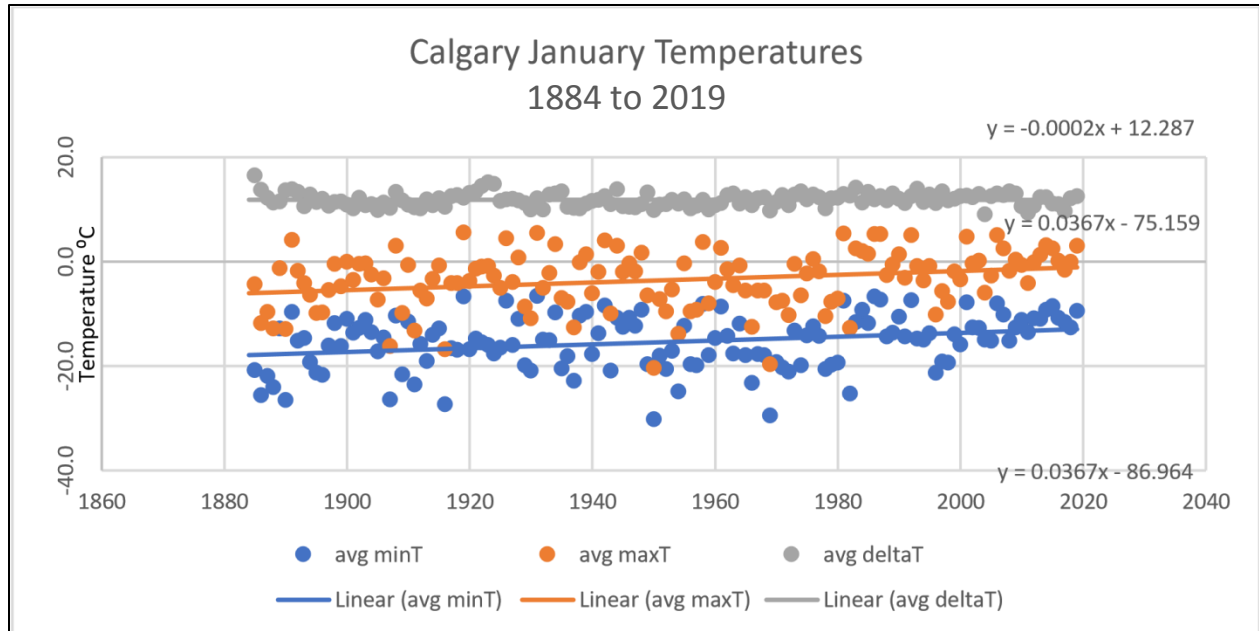


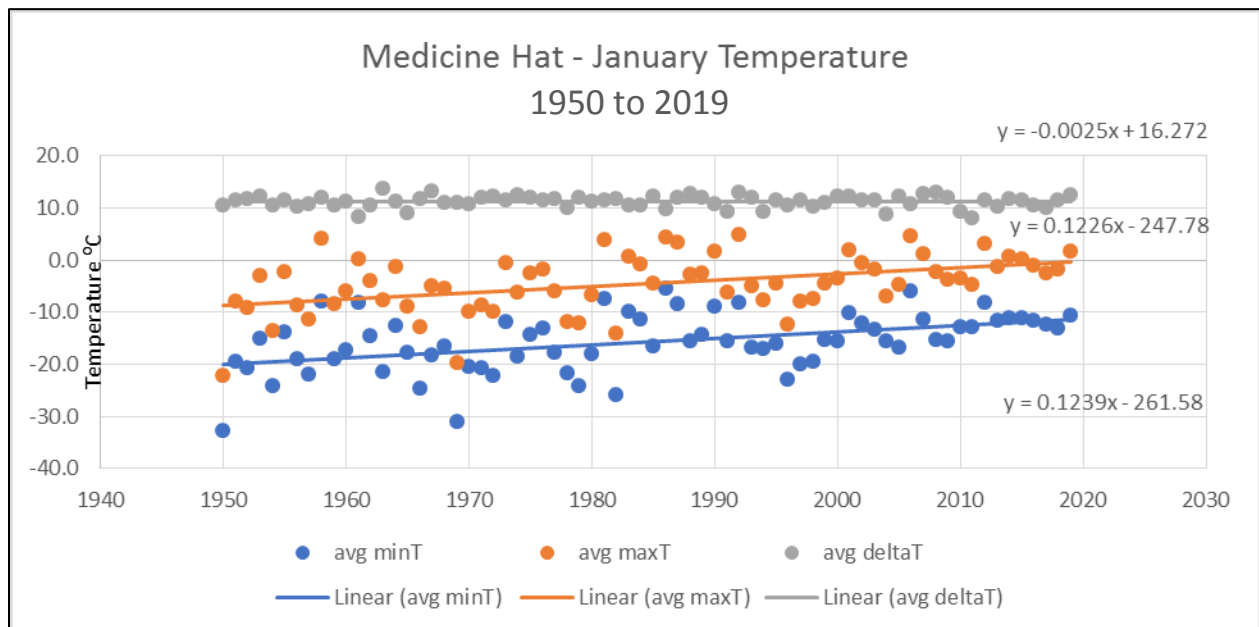
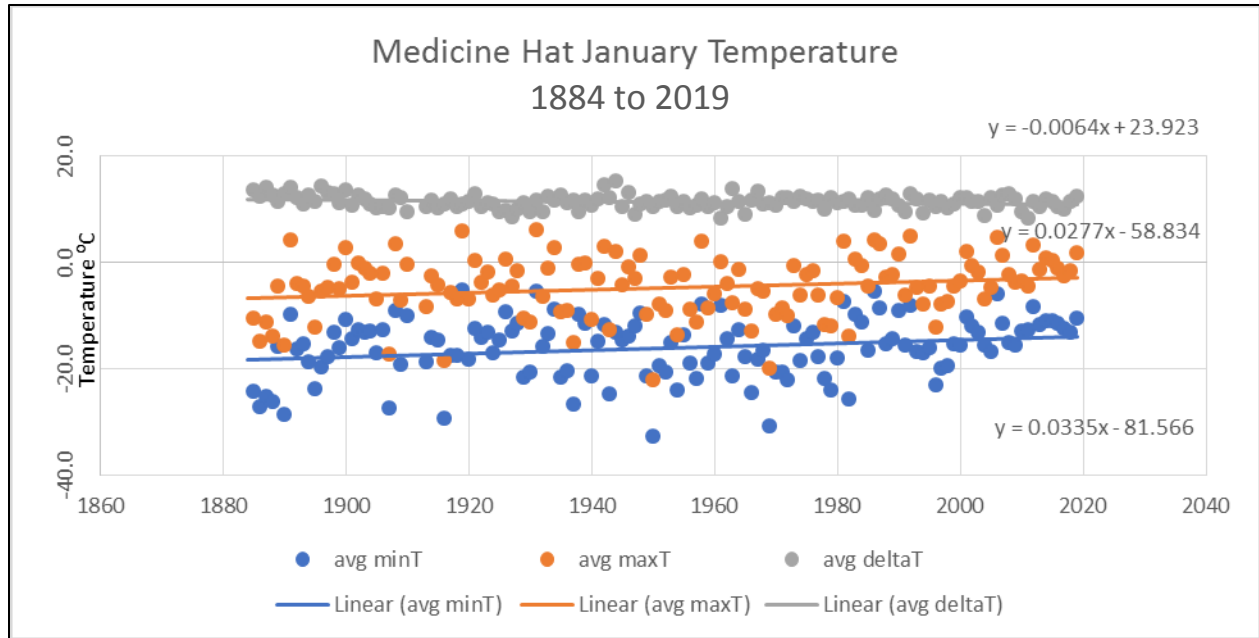
[Faulty Premises=Poor Public Policy](#)

Appendix I - Additional Graphs

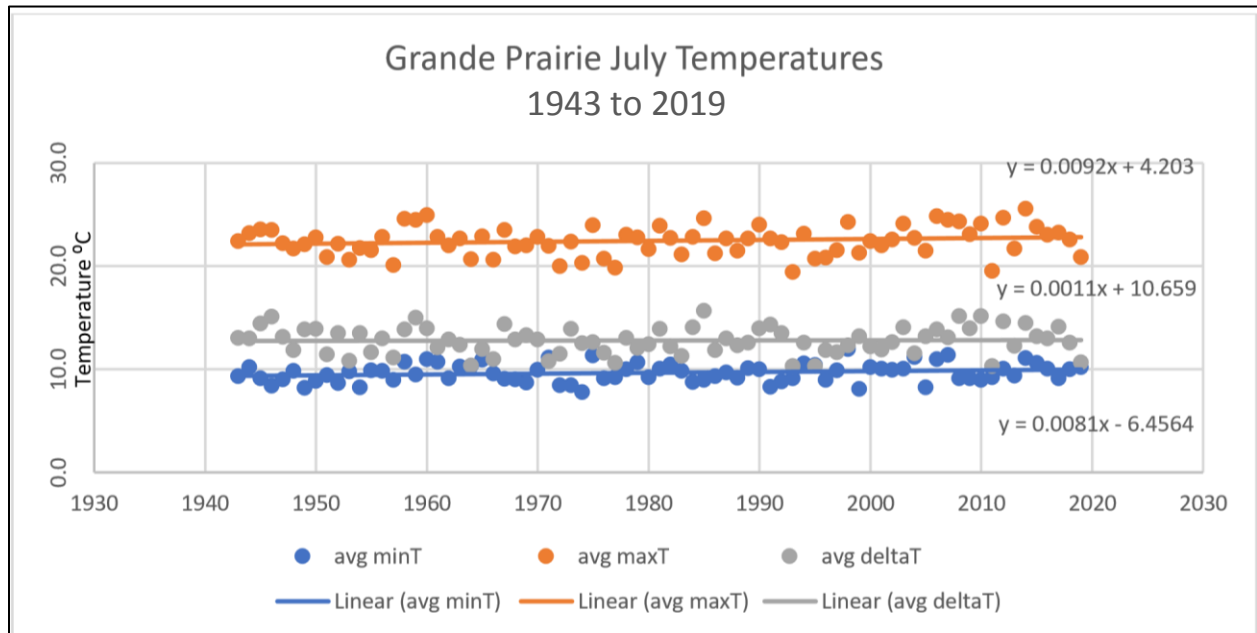
Winter (January) Temperature Trends



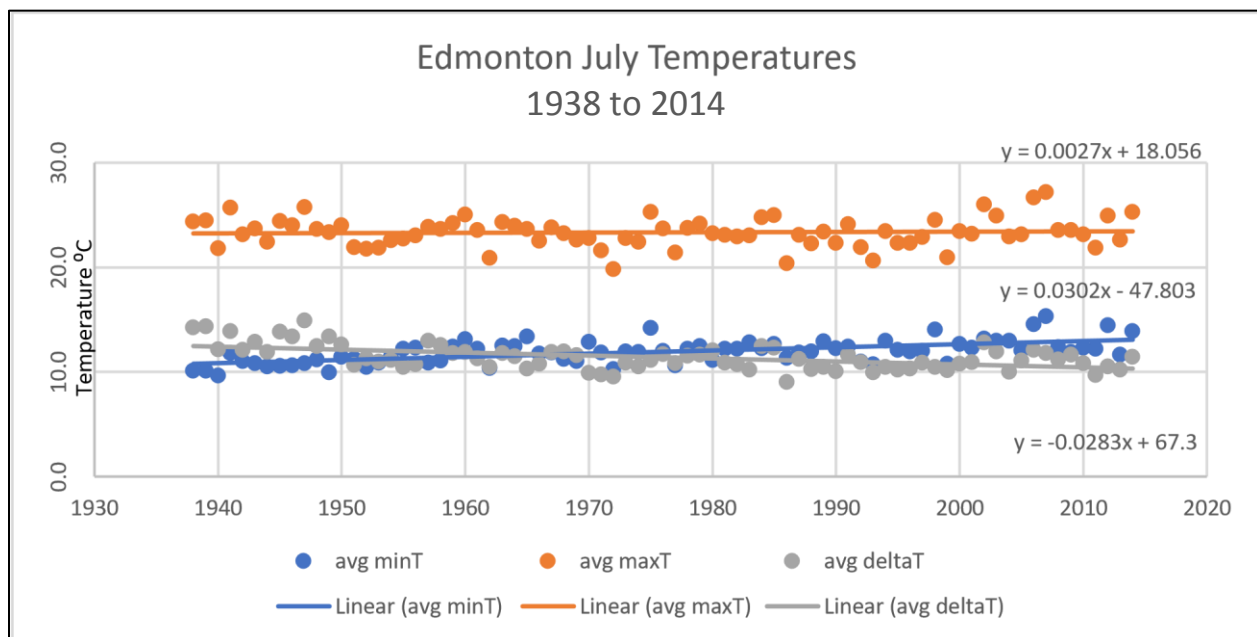


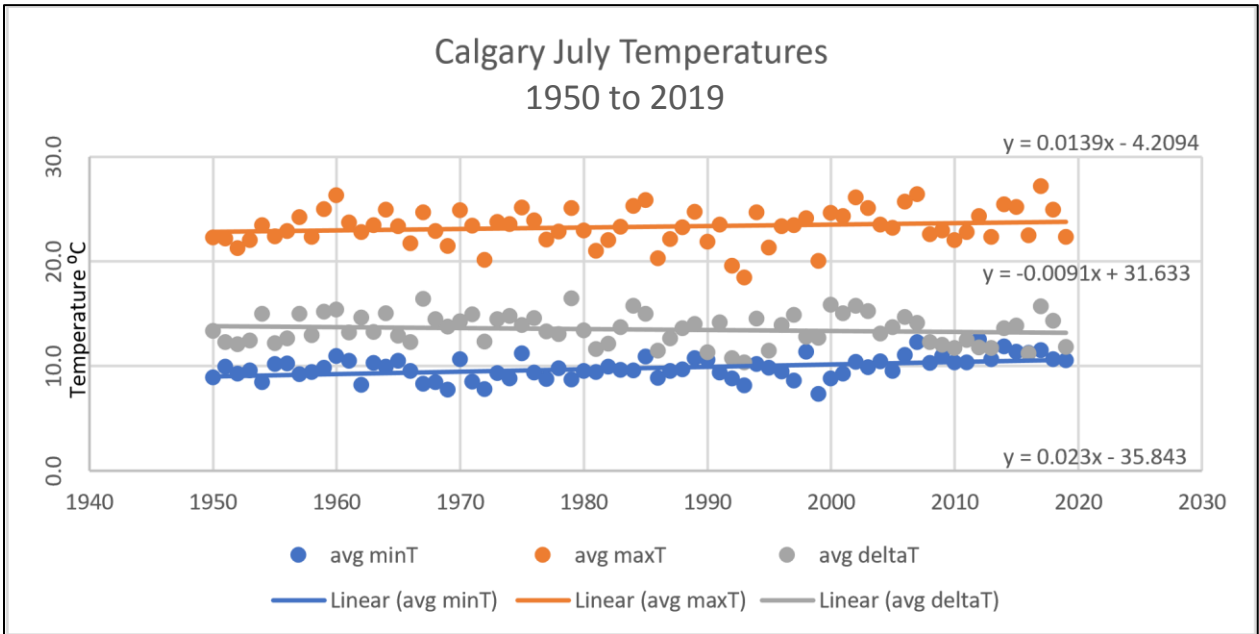
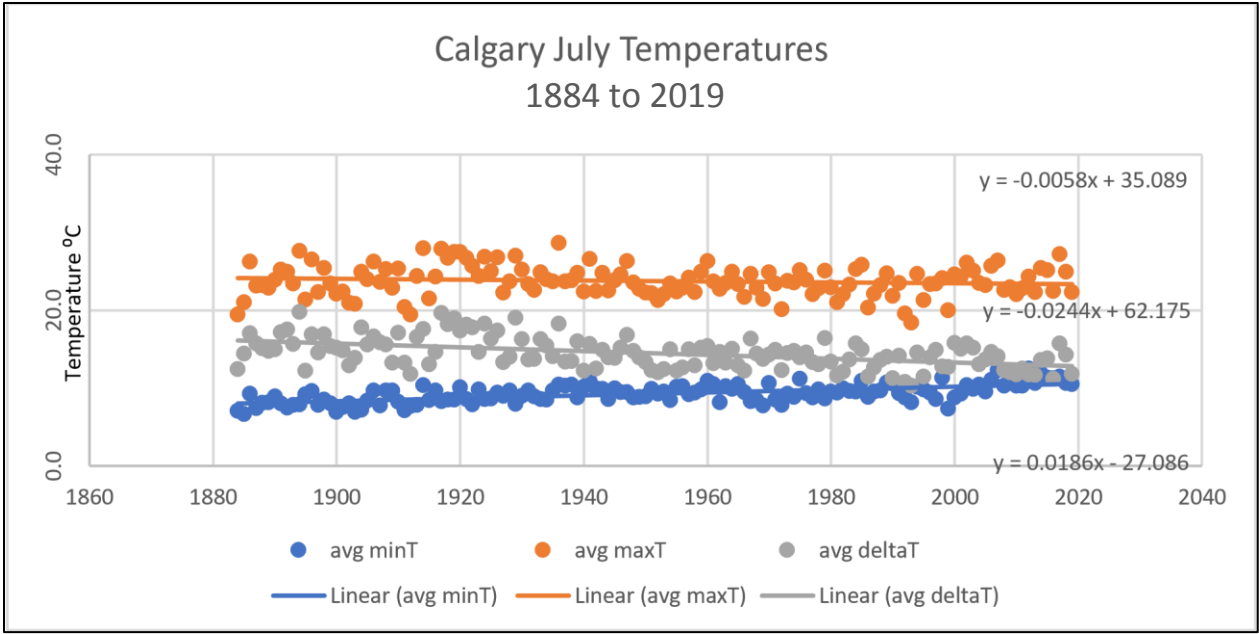


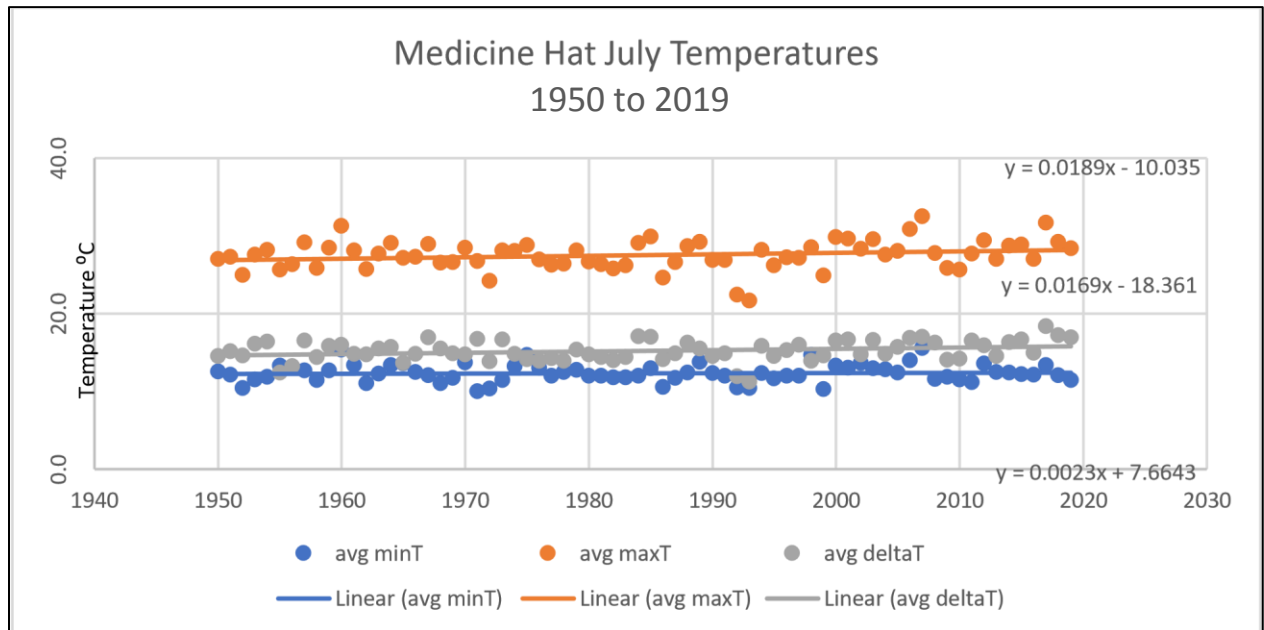
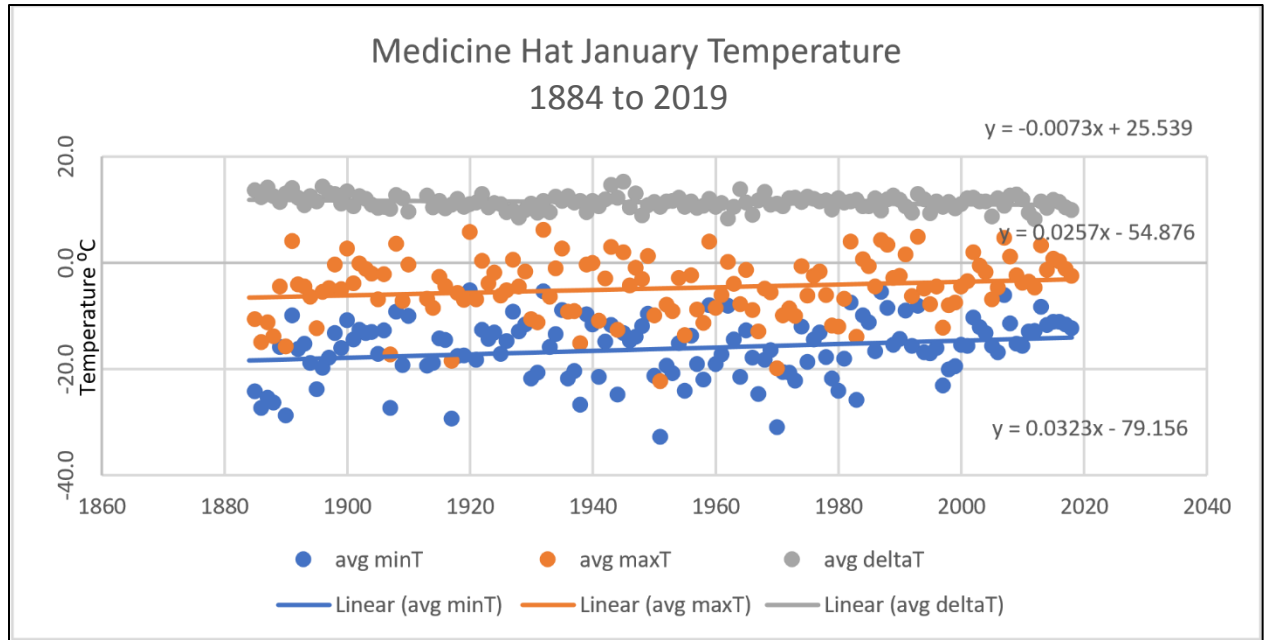
Summer (July) Temperature Trends



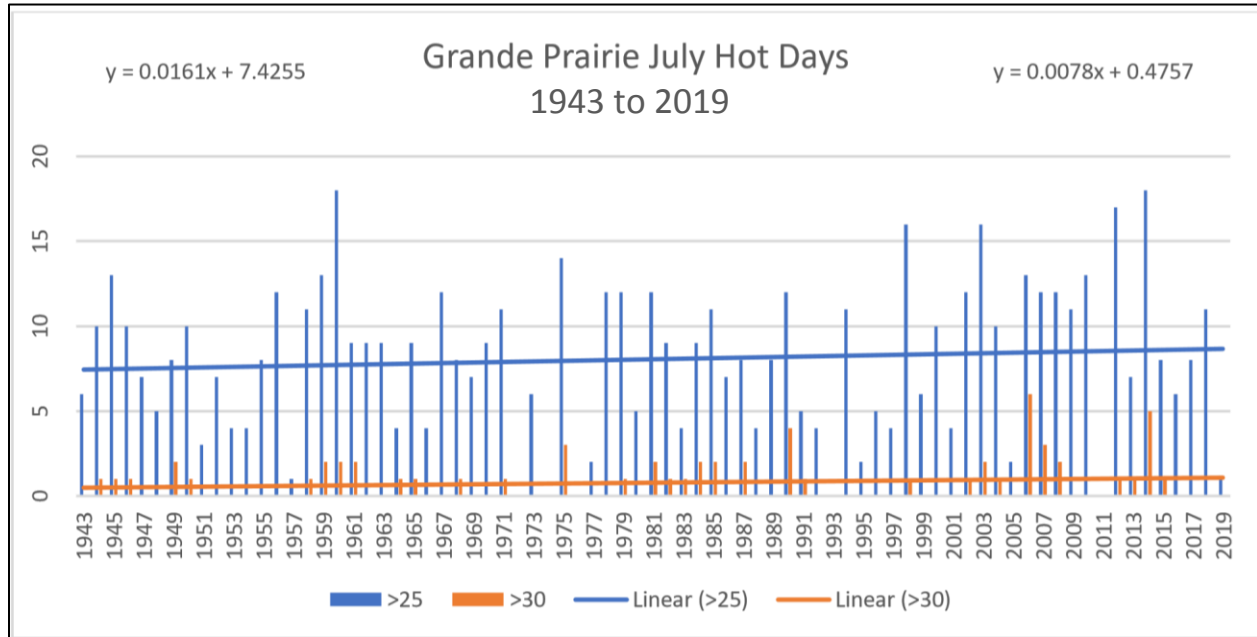
Page | 65



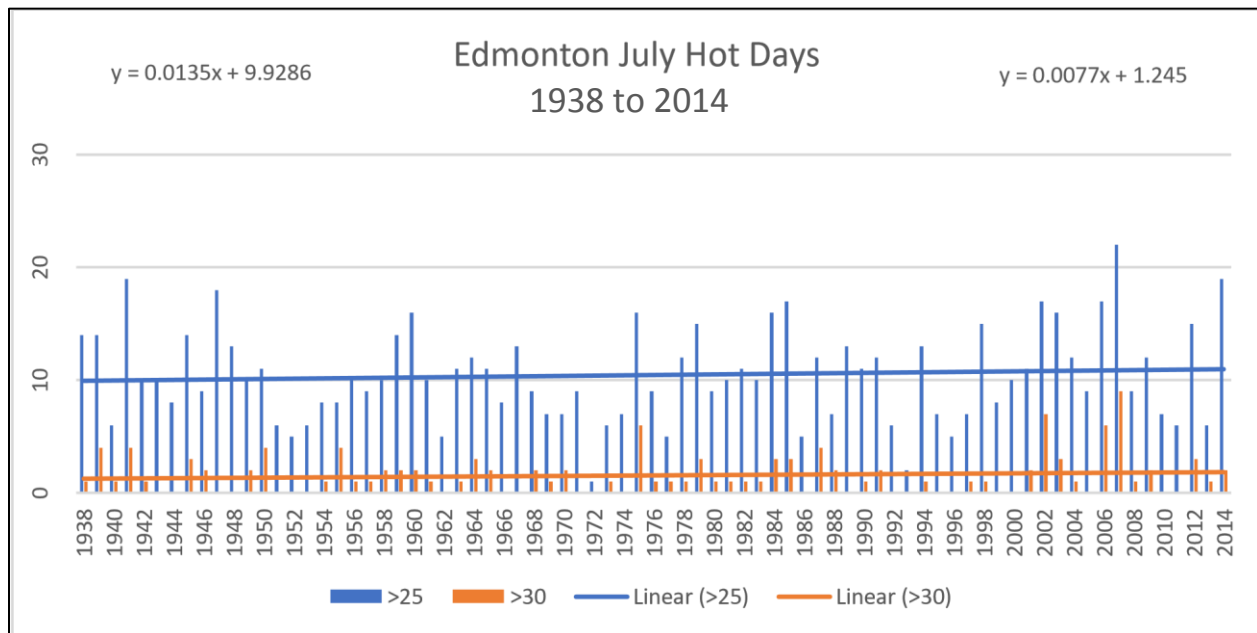


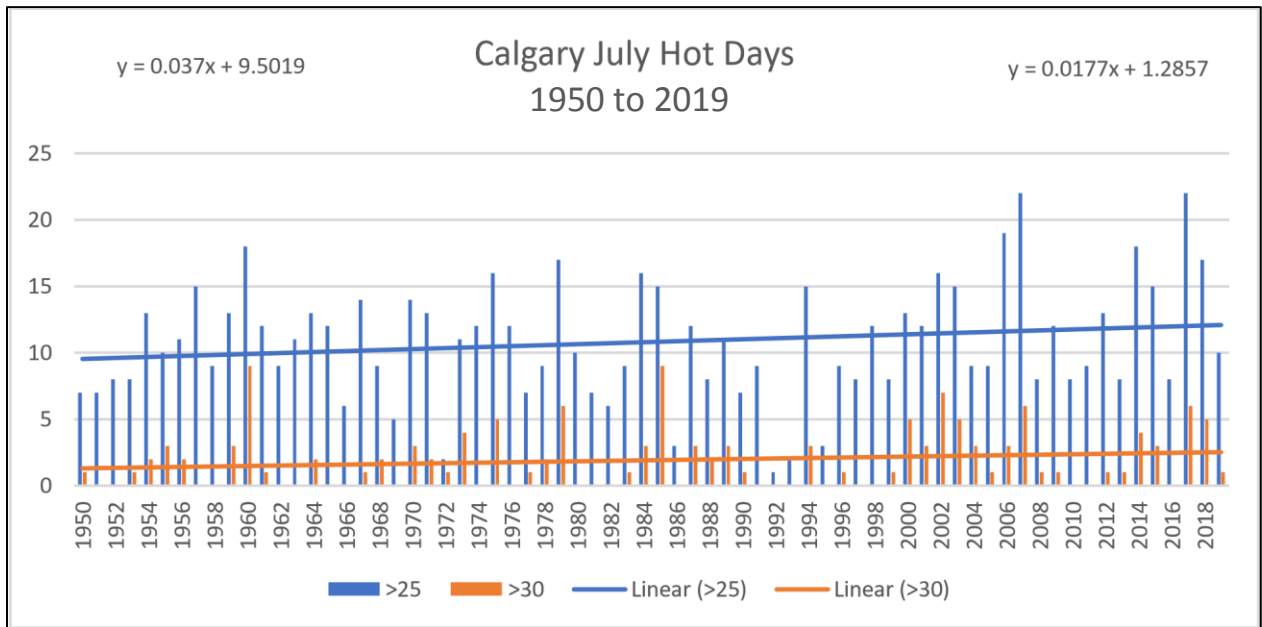
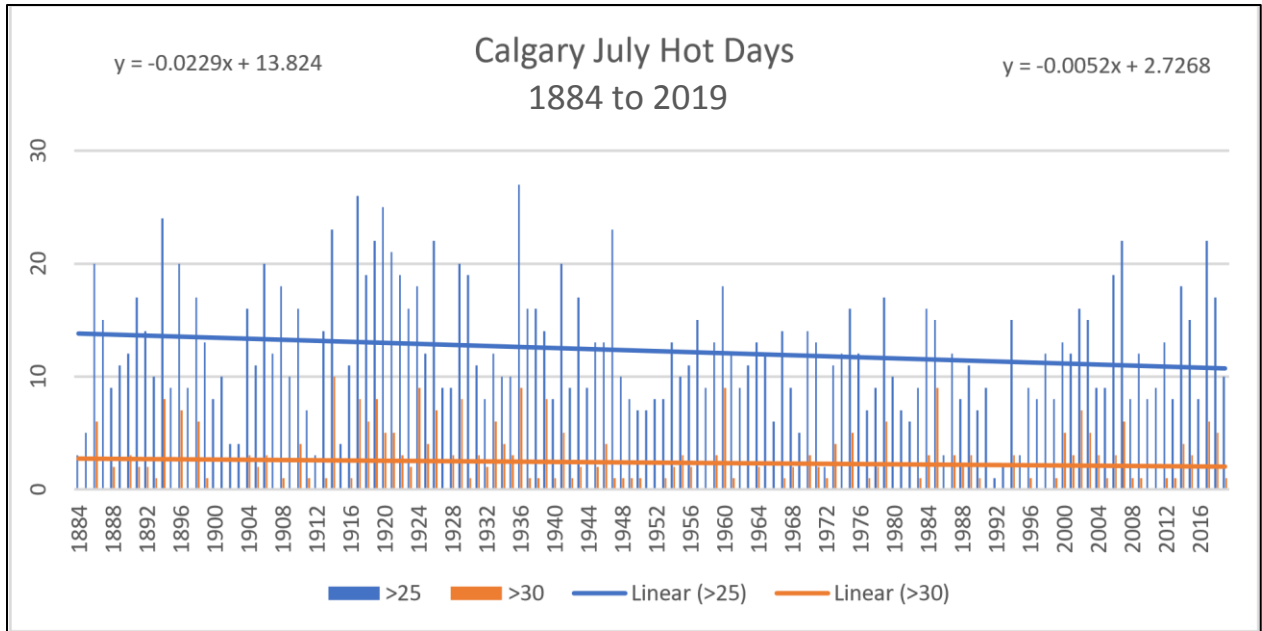


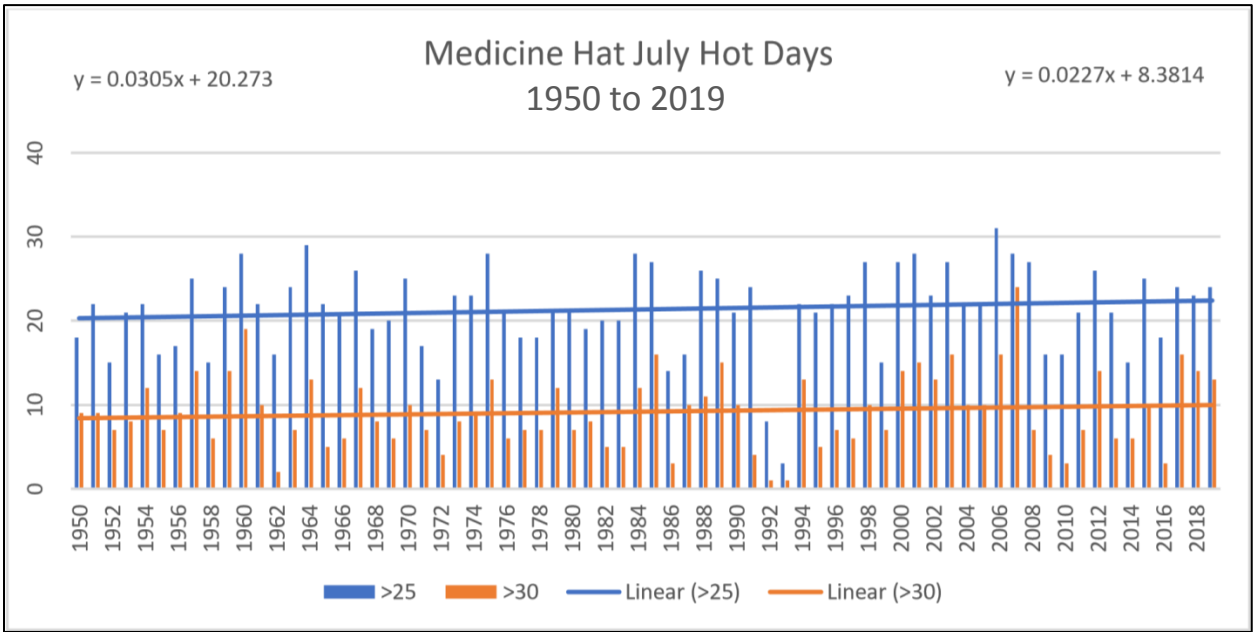
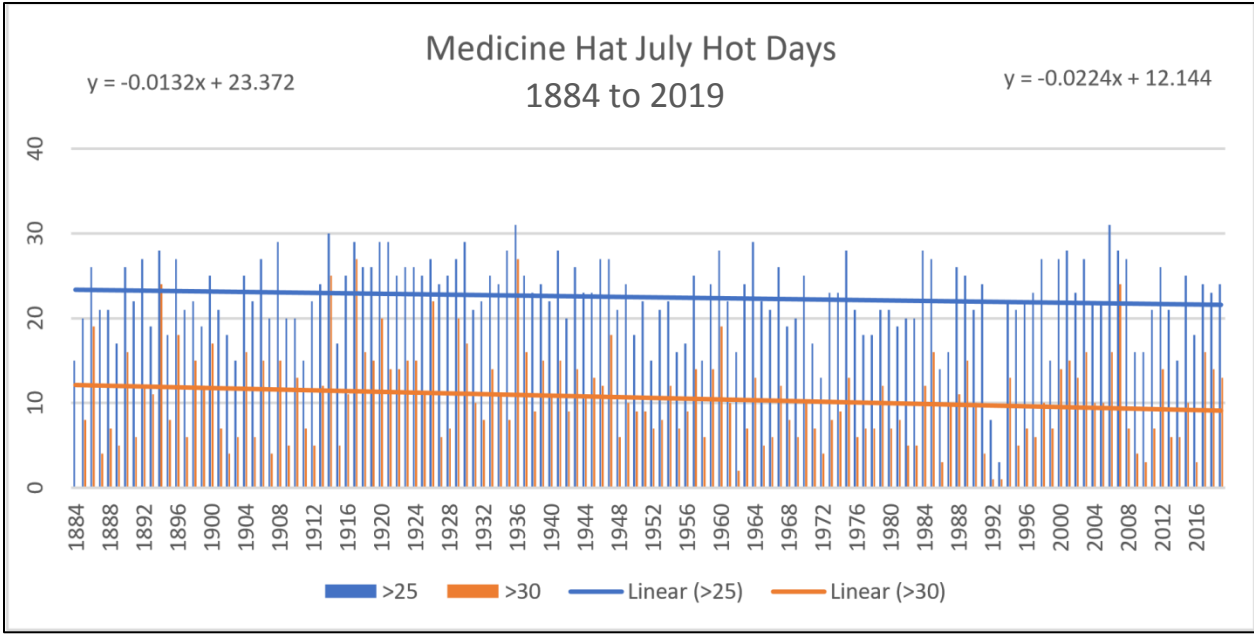
July Hot Days



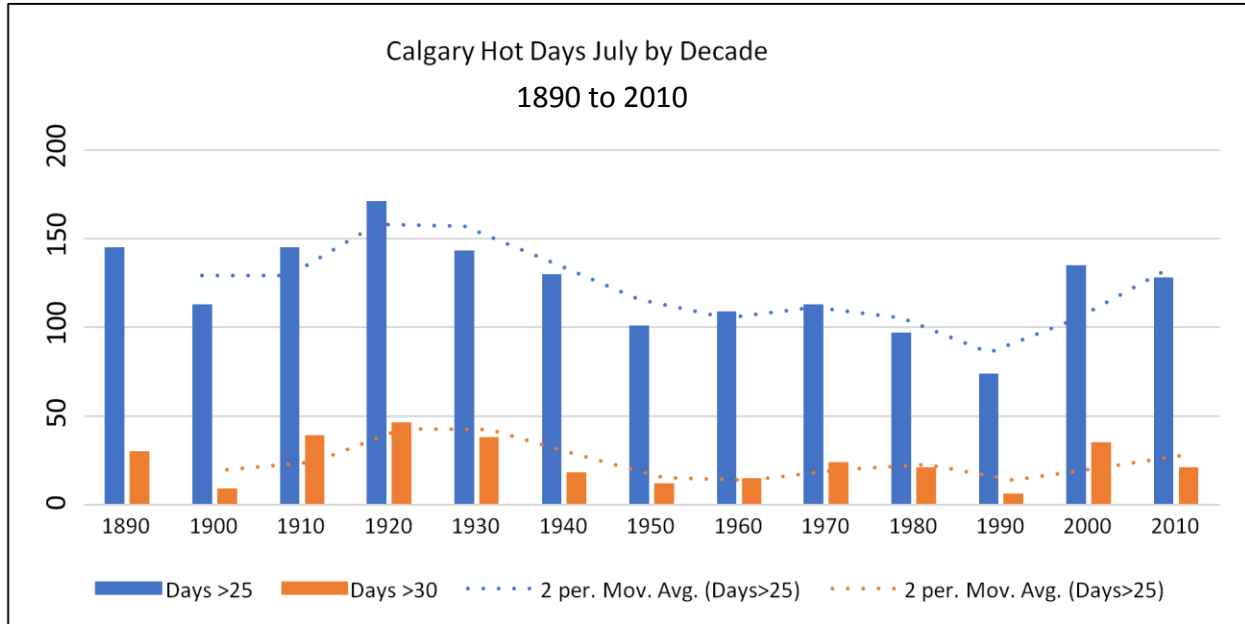
Page | 68



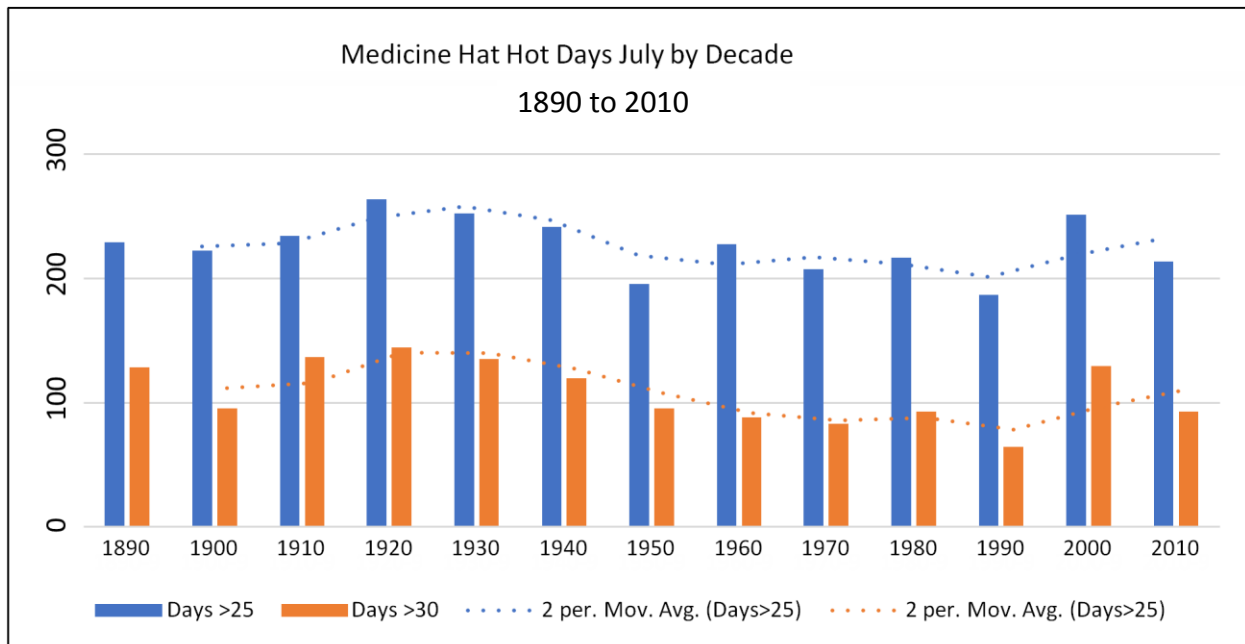




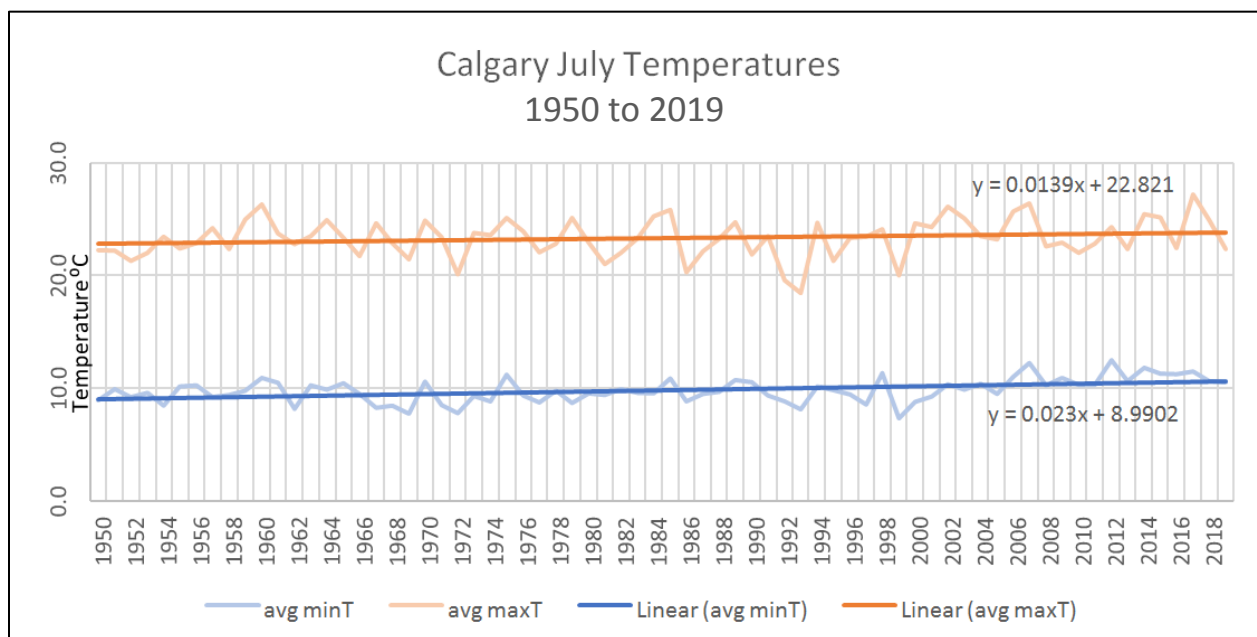
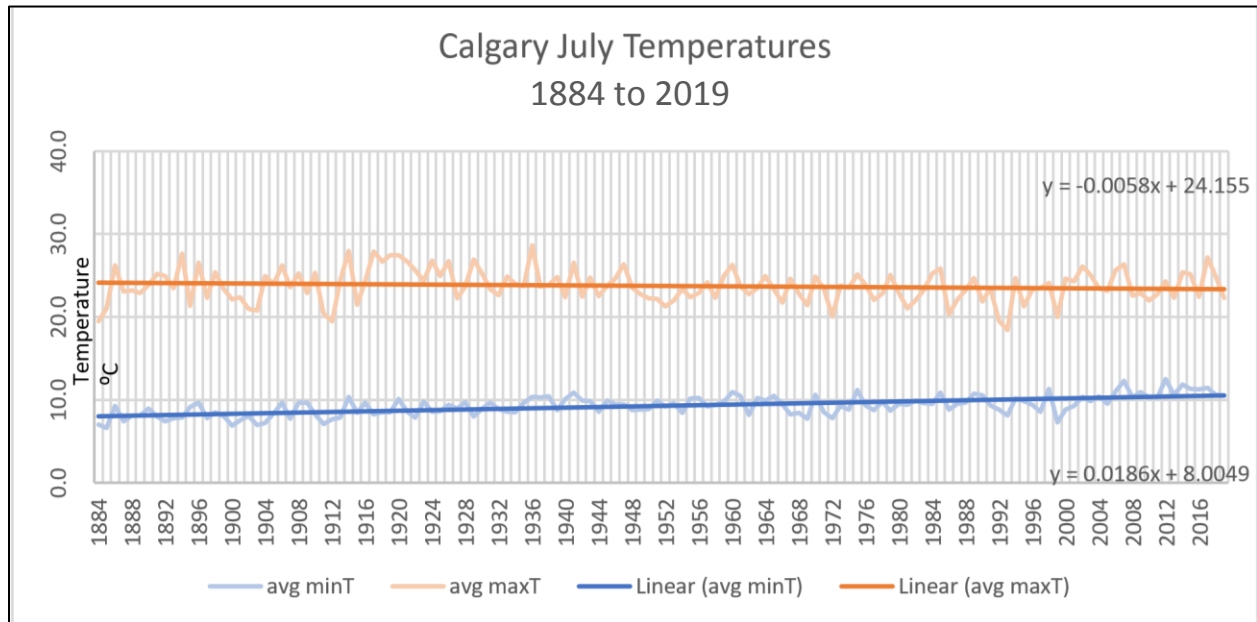
July Hot Days by Decade



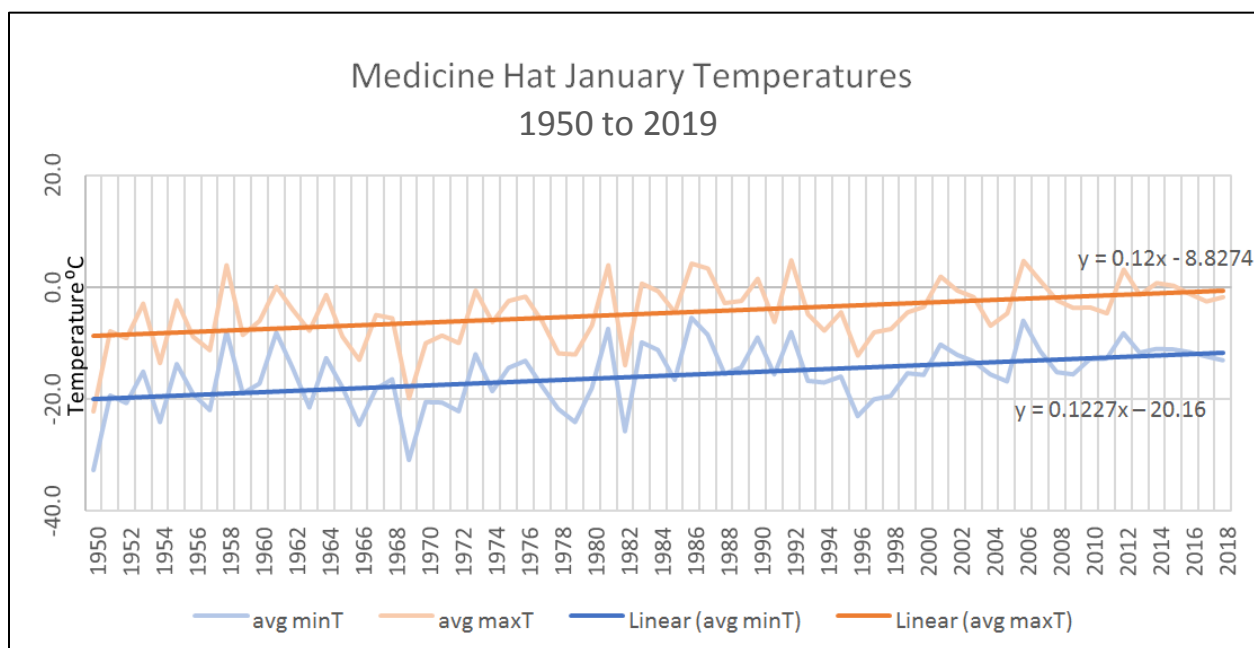
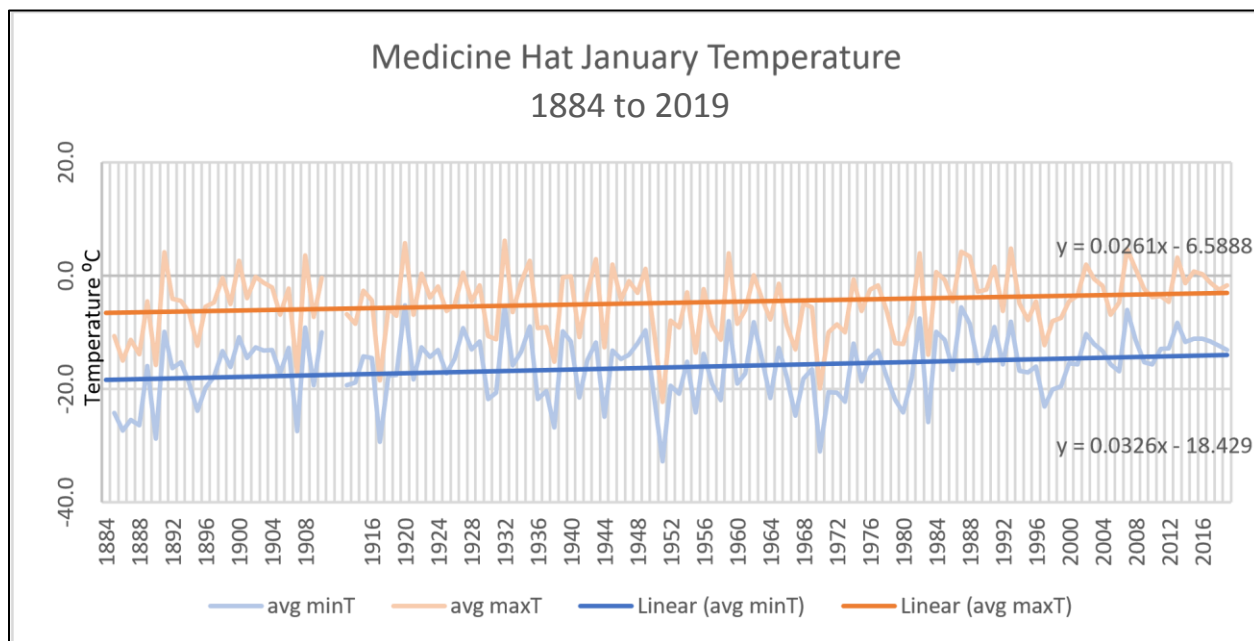
Page | 71



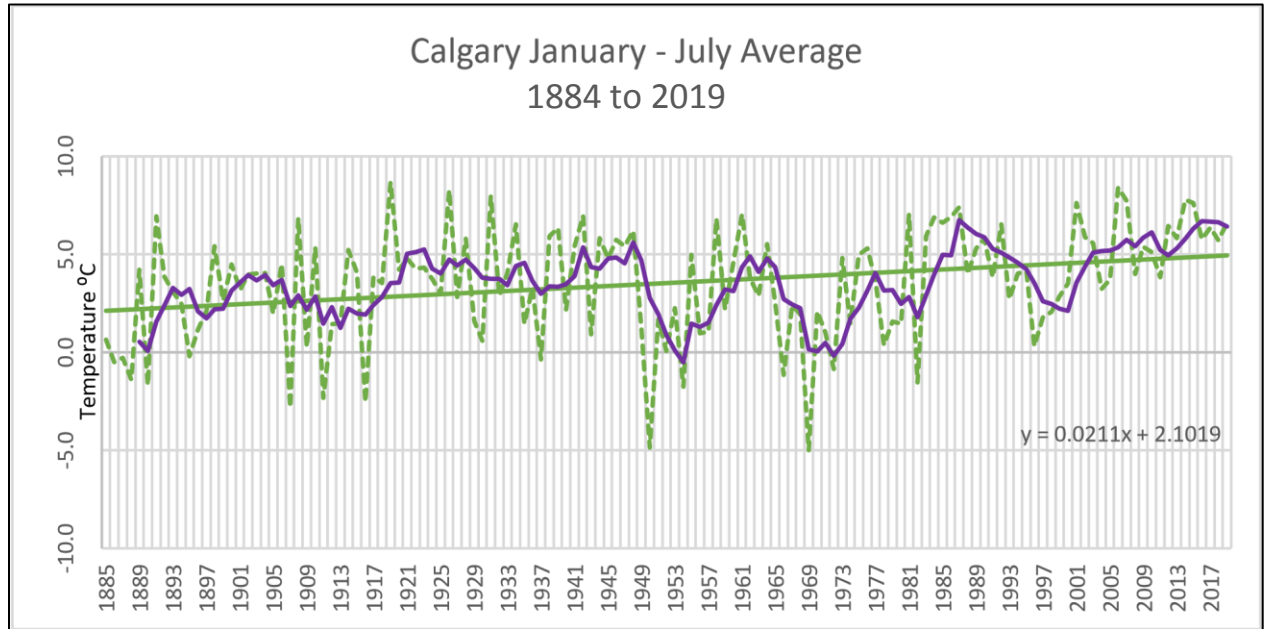
Calgary July Temperatures – 1884 to 2019 and 1950 to 2019



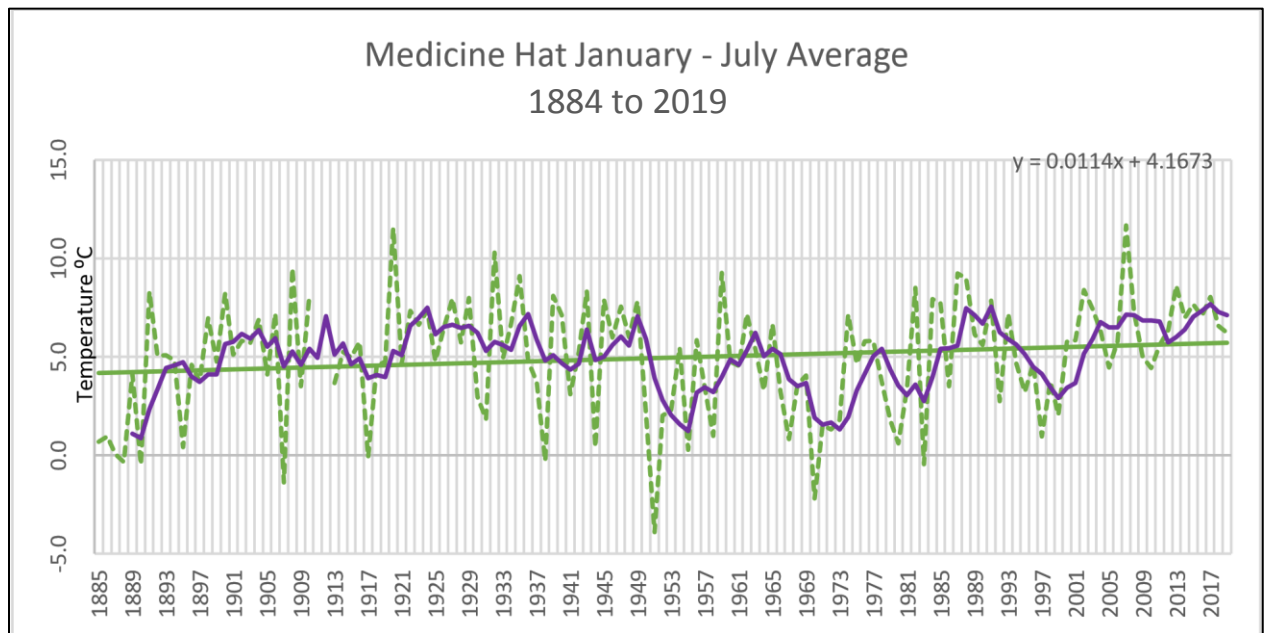
Medicine Hat January Temperatures – 1884 to 2019 and 1950 to 2019



January to July Average Temperatures – 1884 to 2019

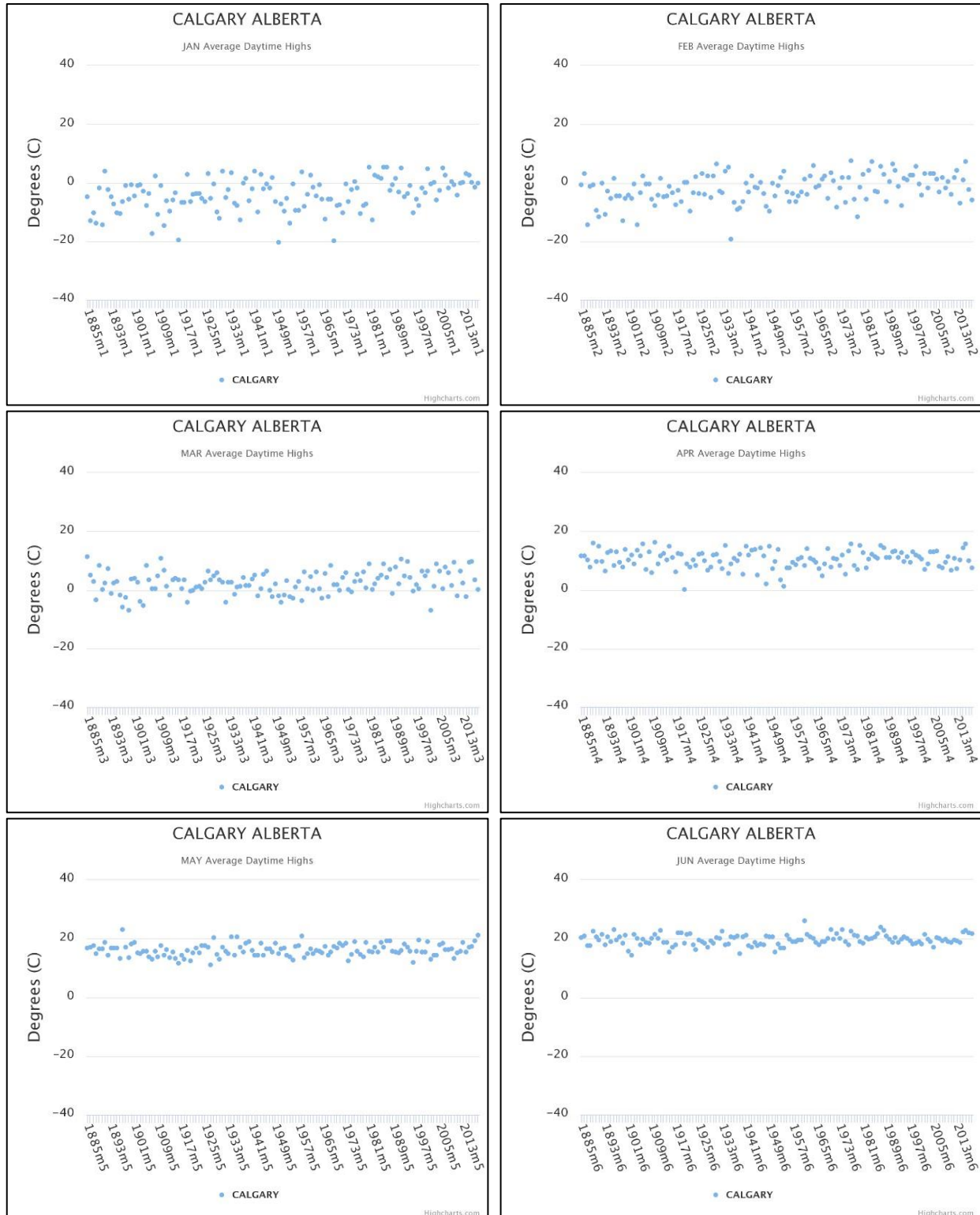


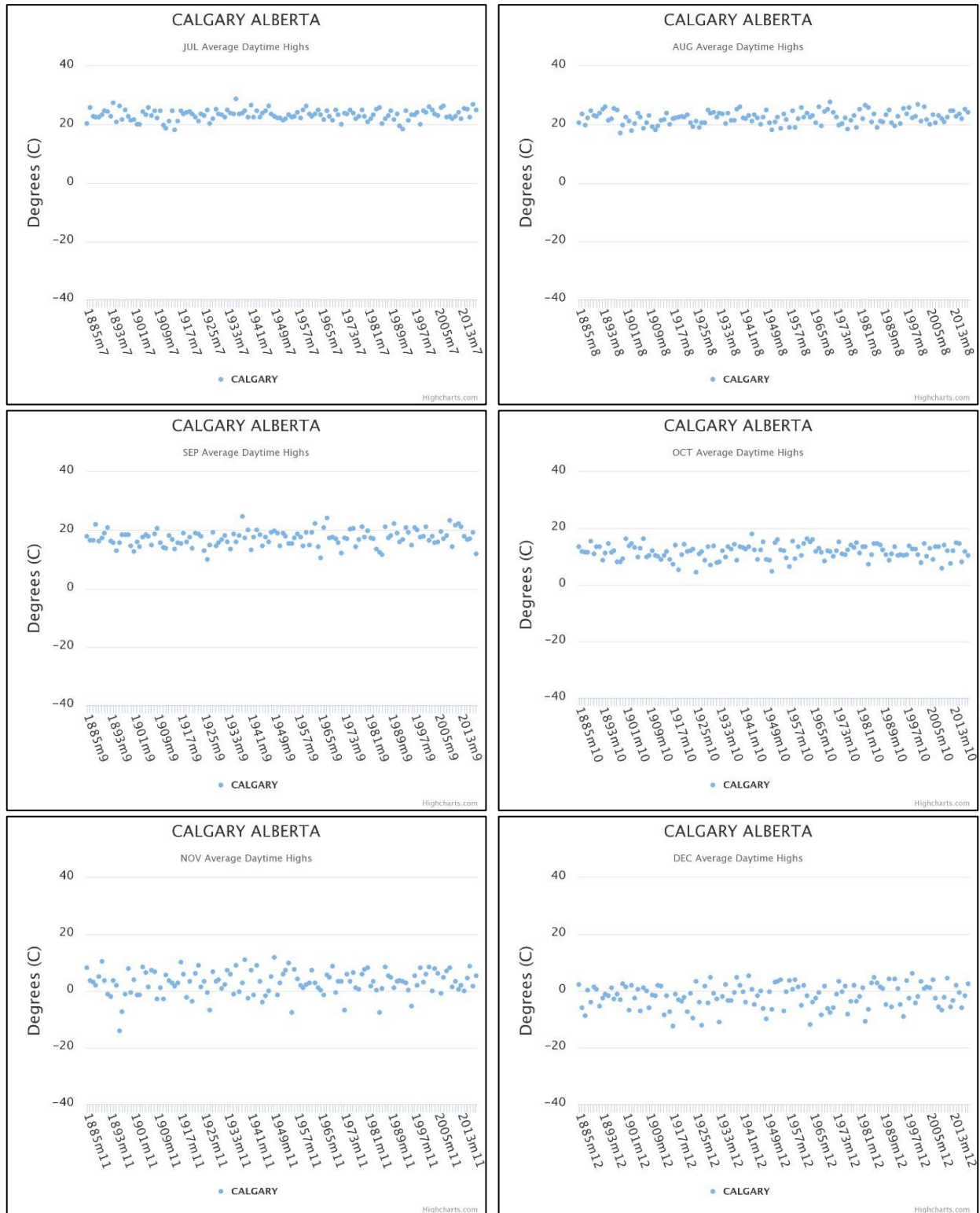
Page | 74



Appendix II -Temperature Records from YourEnvironment.ca for Calgary

The temperature data, air quality and precipitation records for virtually all Canadian cities and large communities are available on YourEnvironment.ca





About

Friends of Science Society is an independent group of earth, atmospheric and solar scientists, engineers, and citizens that is celebrating its 18th year of offering climate science insights. After a thorough review of a broad spectrum of literature on climate change, Friends of Science Society has concluded that the sun is the main driver of climate change, not carbon dioxide (CO₂).

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