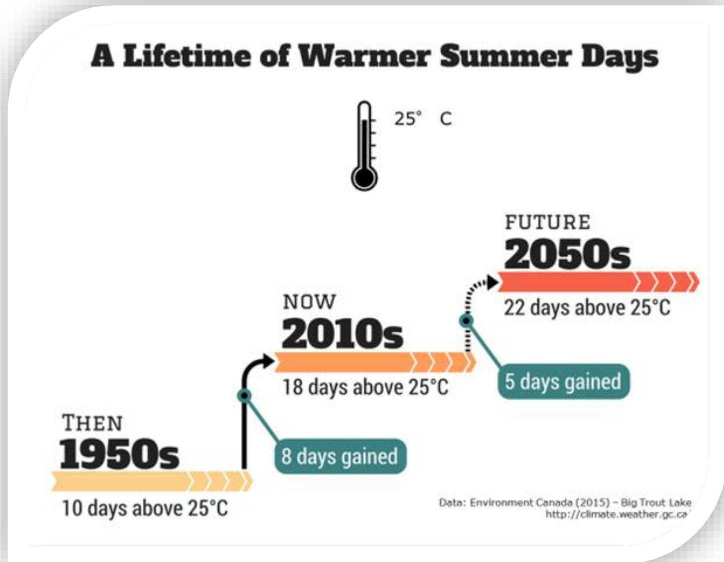

Science Climate Story

For consideration in preparing a community-based

Climate change adaptation plan

Draft: November 23, 2018

Edited version of November 23, 2018

UP NORTH ON CLIMATE

Climate Change Impact and Adaptation Study for the North of Ontario

Contents

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Background

Background

A landscape with an icy past and an uncertain future

All of us who live in the north live on a landscape shaped by extreme climate change. Less than 15,000 years ago there were no lakes or rivers, no forests, no Great lakes, no Hudson Bay. The land we know was covered by a sheet of ice. Slowly it melted away. Today we live on the landscape and under the warmer climate that Nature created in its place. Now, climate and landscape are changing again, but this time Nature is being pushed.

The changes in climate Elders have seen

Indigenous peoples have lived on the land and successfully adapted to changes for thousands of years. Todays Elders, who have lived with a lifetime of changes, speak with regret and concern about a future of ever more disruption of the traditional relationship of indigenous people with the land. Although much of the disruption is social and cultural, changing climate is adding another layer to the issues in Ontario, especially in remote northern communities. From changes in the migration patterns of wild food animals and the dangers of winter travel on thinner ice, to the impact of severe storms on homes and community infrastructure and the threat of wildfire, changing climate is bringing increasing disruption and risks to indigenous peoples in the north.

Records from the weather station in Kitchenumaykoosib Inninuwug, KI (Big Trout Lake) in the far north west of Ontario, show in numbers what Elders throughout the north have seen happening during their lifetimes since the 1950s.

One possibility for the future is that the speed and size of the changes in the seasons that Elders have seen will continue to grow at the same pace. On the other hand, they could slow down if international efforts to reduce the release of global warming gas pollution into the atmosphere are successful. If those efforts are not successful, changes will speed up and the consequences will become more severe.

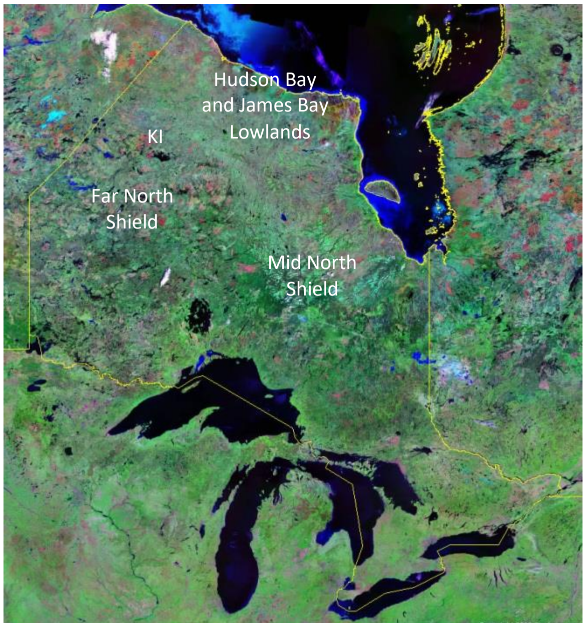

Figure 1 Ontario with the Kitchenumaykoosib Inninuwug (KI) weather station in the north west on the rocky landscape of the Far North Shield.

Background

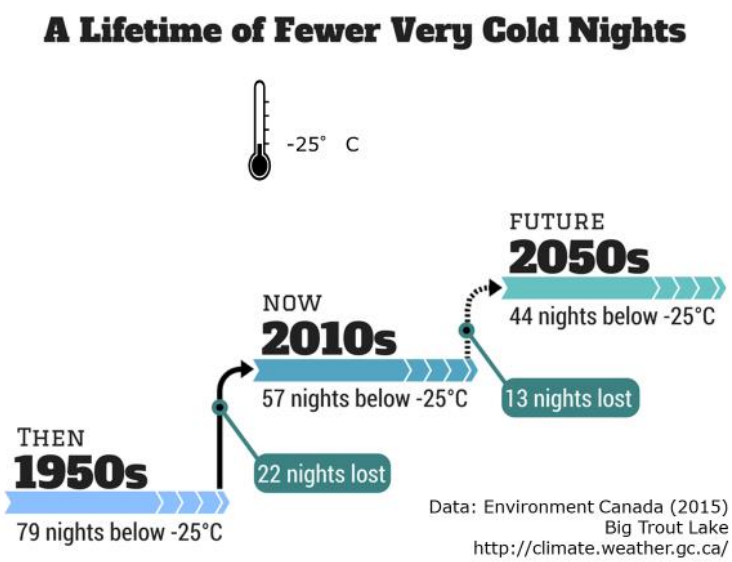

FIGURE 2: CHANGE IN THE NUMBER OF VERY COLD NIGHTS, BELOW MINUS 25°C, IN THE PAST, TODAY, AND IN THE FUTURE, IF CLIMATE CHANGE CONTINUES. NUMBERS FROM THE EC THE KITCHENUMAYKOOSIB INNINUWUG (KI) WEATHER STATION.

Elders frequently speak of there being fewer very cold winter nights, especially in December (Figure 2). This means that ice on lakes takes longer to become thick enough for safe snowmobile travel. Warmer winter nights have also made it more difficult to begin winter road construction. Winter road builders say that as many as ten very cold nights in a row are needed for the ice on lakes to freeze thick enough to allow flooding and thickening of the ice. Only then can roads on lakes be made safe for cars, trucks and especially transport trailers carrying fuel, supplies and building materials.

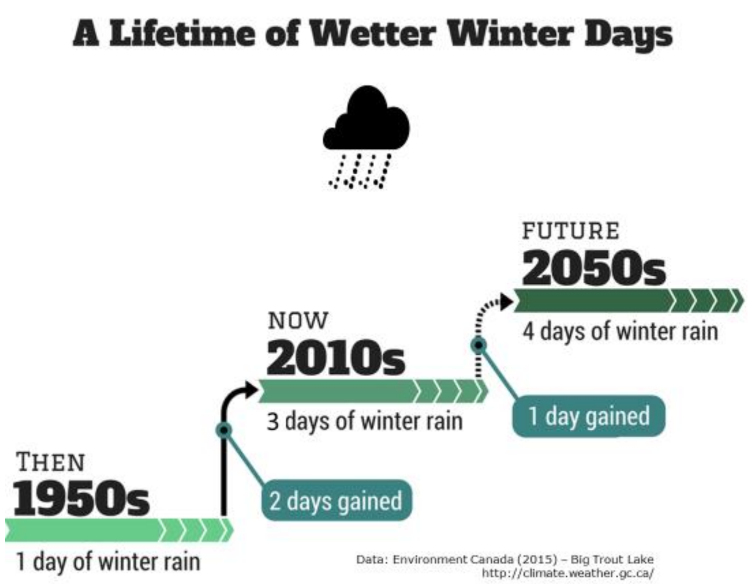

FIGURE 3: CHANGE IN THE NUMBER OF WINTER DAYS WHEN IT RAINS INSTEAD OF SNOWING, IN THE PAST AND TODAY, AS WELL AS IN THE FUTURE, IF CLIMATE CHANGE CONTINUES. NUMBERS FROM THE KITCHENUMAYKOOSIB INNINUWUG (KI) WEATHER STATION.

Rain in winter is becoming more common (Figure 3). When the ground is still frozen, rain runs off and floods low areas that might include the crawl spaces of homes. Culverts that are critical for good drainage in communities might be blocked by ice and frozen leaves and garbage, making the problem of flooding in communities worse.

Rain can quickly turn the surface of winter roads into slush for several days. When the weather turns cold again the slush freezes into deep ruts making ice road travel very slow and dangerous or even impossible until the road has been freshly graded with a heavy grader.

Freezing rain can coat surfaces like tree branches, power lines, and cars. It only happens when a wedge of warm air pushes into cold air so that falling snow melts to rain as it falls through the warm wedge (Figure 4). The raindrops then cool to freezing point just before they hit the ground or a tree or a structure like a hydropole, where they instantly turn to ice. Sometimes the weight of ice can break branches or bring down a hydropole not designed to take the extra load.

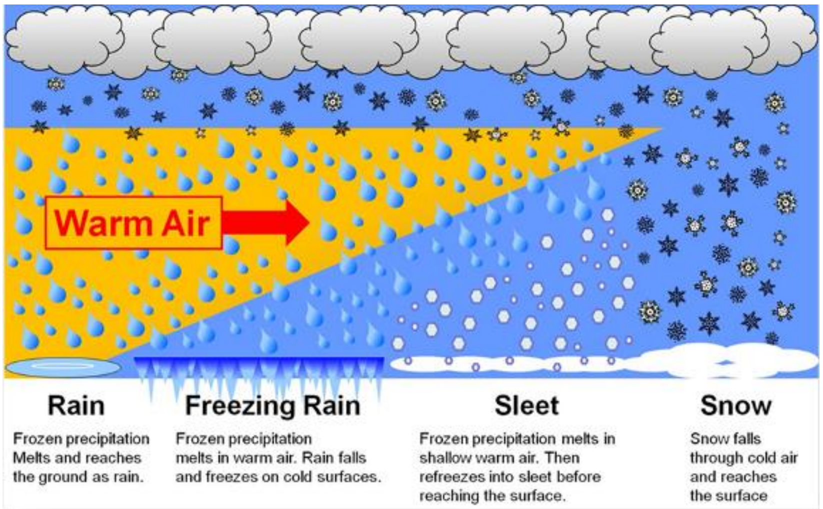

FIGURE 4: TYPES OF PRECIPITATION (IMAGE TAKEN FROM HTTPS://EN.WIKIPEDIA.ORG/WIKI/PRECIPITATION_TYPES)

Freezing rain is more common in valleys like the Ottawa valley than in the north, but freezing rain warnings have been issued all the way to the Hudson Bay coast. Important risks in the north are dangerous walking and driving conditions, as well as damage to infrastructure, homes and community buildings.

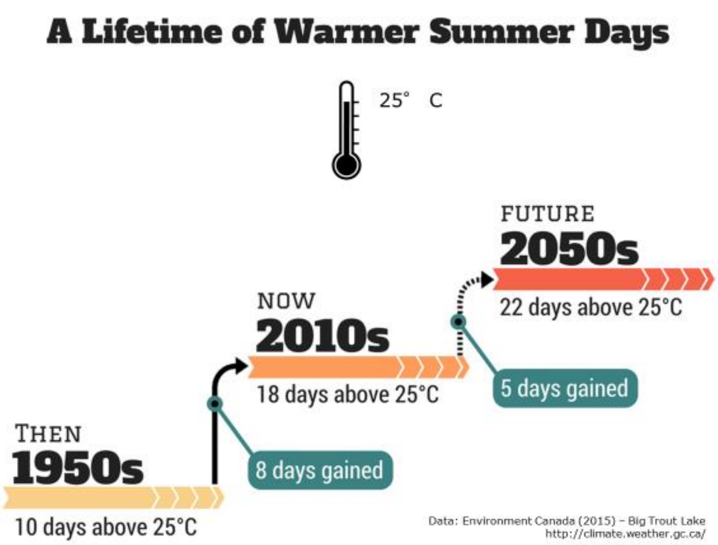

FIGURE 5: CHANGE IN THE NUMBER SUMMER DAYS ABOVE 25°C IN THE PAST, TODAY, AND IN THE FUTURE IF CLIMATE CHANGE CONTINUES. NUMBERS FROM THE KITCHENUMAYKOOSIB INNINUWUG (KI) WEATHER STATION.

Elders have noticed that summer is becoming warmer in the north (Figure 5). Heat waves of more than three very hot days along with nights when the temperature stays above 20˚C can be very stressful for Elders and very young children, to the point of being fatal if there is no cool place available. Heat waves also increase evaporation from lakes and rivers and can cause drought that can lead to increase in forest fires.

Shaped by ice: The landscape as science sees it

Earth has often been warmer or cooler than it is today, especially tens and hundreds of millions of years ago when very slowly sliding continents were nearer to the poles or the equator. In the much more recent past, while humans have been on Earth, we know that just 18,000 years ago a sheet of ice as much as 2 or even 3 kilometres thick covered almost all of Canada (Figure 6). This massive sheet of ice was formed by thousands of years of snow falling in winter and lasting through to the next winter where once it would have melted. Cooler summers south of the Arctic allowed the snow to survive and reflect more of the Sun's energy back into space, cooling the summer even more. As the snow accumulated it became ice under its own weight. Interestingly, small bubbles of air were trapped in the snow and then in the ice. We can tell what the atmosphere was like thousands of years ago by carefully sampling that ancient air in long cores of ice from Greenland as well as from Antarctica.

The ice over Ontario began to slowly melt away about 12,500 years ago and was completely melted from the north about 8,400 years ago. The edge of the sheet has been melting north ever since. Its remains still cover Greenland and the Arctic islands.

FIGURE 6: THE APPROXIMATE EXTENT OF THE ICE SHEET (WHITE) COVERING CANADA ABOUT 20,870 YEARS AGO, BEFORE MELTING BEGAN. THE OUTLINE OF THE FUTURE GREAT LAKES AND THE HUDSON BAY HELPS SHOW HOW FAR THE ICE EXTENDED.

The ice of a glacier or an ice sheet slowly slides downhill like thick, cold syrup. It grinds across the underlying rock at a few centimetres or even a metre or two a day, pulling fragments from the cracked surface. Those rock fragments scratch and polish the rock bed like grains in icy sandpaper, wearing it down and producing very fine rock flour. The rock in the north was polished by the sliding ice sheet for about 100,000 years before the ice began to melt. As the front of the ice sheet melted back by about 200 or 300 metres every year, occasionally slowing and even re-advancing during cold periods, it might have looked like the Canada Glacier in Antarctica looks today (Figure 7).

Meltwater draining from the ice collected in lakes at the edge of the sheet. They were small at first, like Lake Jökulsárlón in Iceland is today (Figure 8), but by 11,000 years ago meltwater had filled the Great Lakes that we know today. It is easy to imagine that some of the water deep in Lake Superior is still old glacial meltwater.

Southern Ontario might have looked like this 11,000 years ago as the ice sheet was melting.

FIGURE 7: THE FRONT OF THE CANADA GLACIER IN ANTARCTICA. PHOTO BY TERRY HEALY, UNIVERSITY OF WAIKATO, NEW ZEALAND. COURTESY OF GRAEME SPIERS, LAURENTIAN UNIVERSITY.

FIGURE 8 : JÖKULSÁRLÓN GLACIAL LAKE IN ICELAND WITH ICEBERGS BREAKING AWAY FROM THE GLACIER. PHOTO BY MARTIN PEEKS. APRIL 2007. HTTPS://COMMONS.WIKIMEDIA.ORG/W/INDEX.PHP?CURID=1888356

The greatest lakes of them all, Lake Agassiz and Lake Ojibway

Although the Great Lakes are very large and hold 21% of all the fresh water on the surface of the Earth, they are small compared to the huge lakes of meltwater created as the ice sheet melted back toward Hudson Bay. The reason that they were so big is that the weight of the ice sheet had pressed down the rocky surface of the Earth by as much as 280 metres into the hot, soft rock far below creating a very large depression[1].

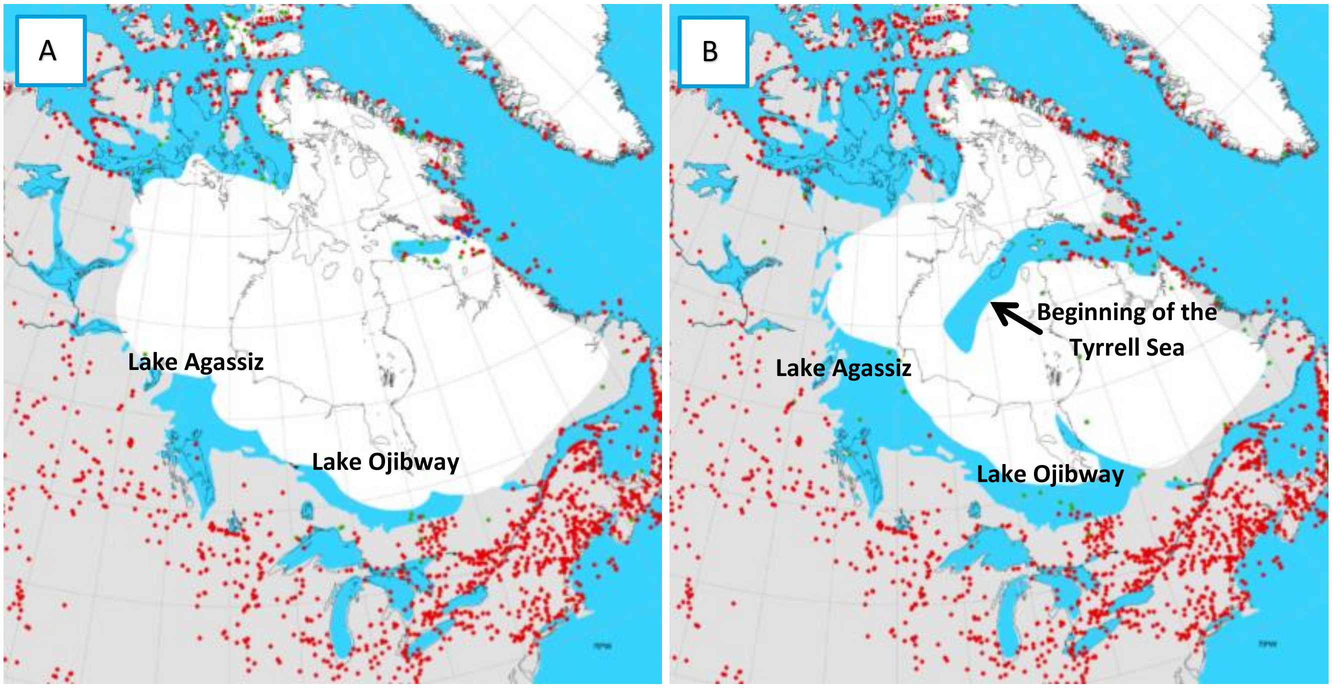

Figure 9: A. 9,100 years ago when Lake Agassiz extended from Saskatchewan to western Ontario where it connected with Lake Ojibway which extended across eastern Ontario into Quebec, together collecting meltwater in front of the ice sheet. B. 8,670 years ago. Salty ocean water worked its way into the centre of the ice sheet mixing with fresh meltwater, creating an iceberg-filled channel and slowly dividing the ice into two patches.

Red dots are locations where it has been possible to date when the ice sheet melted and left the land surface exposed. From Dyke, 2004.

As the edge of the ice sheet melted, it left a vast depression that collected water in two very large lakes, Lake Agassiz in the west from Saskatchewan through Manitoba into western Ontario, and Lake Ojibway in the east, from northeastern Ontario into Quebec (Figure 9A)[2]. By 9,100 years ago, the two lakes had grown enough to connect into a huge lake in front of about 4,000 km of the melting sheet.

At the same time as Lake Agassiz ran along the south edge of the shrinking sheet, ocean water was pushing into the north creating the Tyrrell Sea that was to become Hudson Bay (Figure 9B)[2].

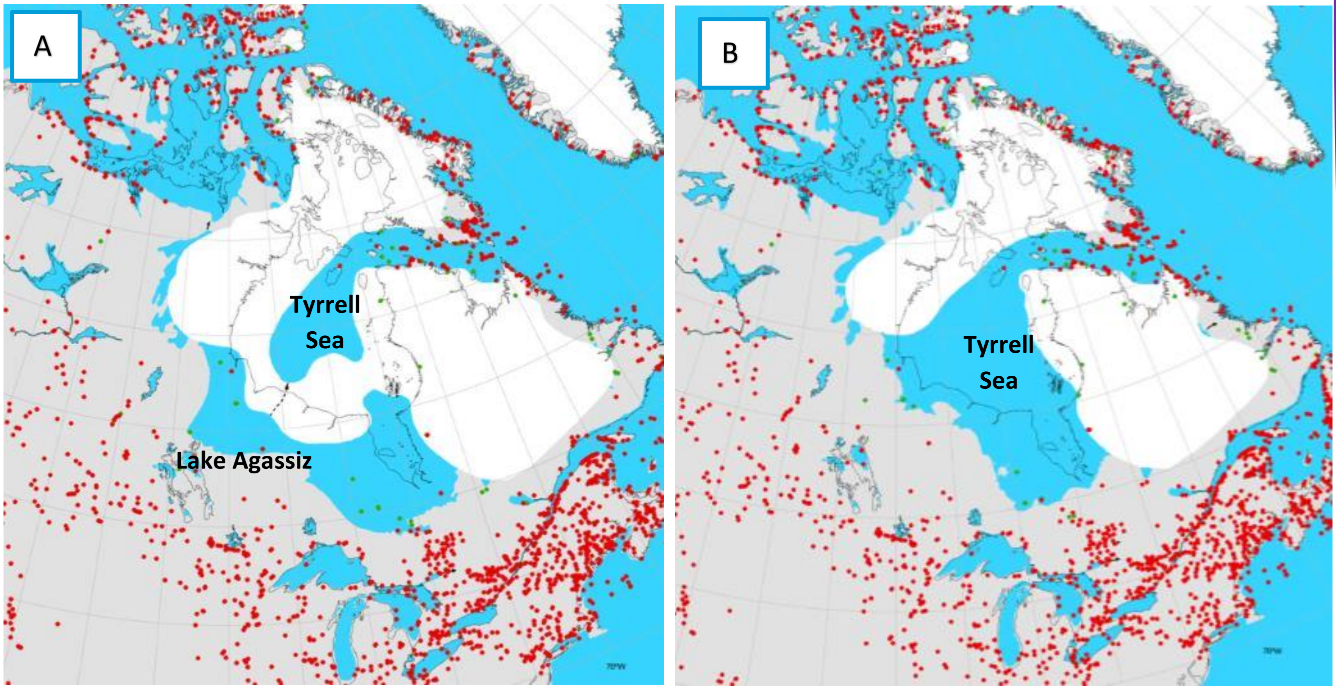

FIGURE 10: A. 8,520 YEARS AGO WHEN MELTING ALLOWED WATER FROM THE NORTH ATLANTIC TO WORK ITS WAY SOUTH AT THE SAME TIME AS AN ICE DAM STILL HELD BACK LAKE AGASSIZ FROM FLOWING NORTH. :B. 8,470 YEARS AGO. SALTY WATER FROM THE ATLANTIC OCEAN FLOODED INTO LAKE AGASSIZ FROM THE NORTH CREATING THE TYRRELL SEA.

RED DOTS ARE LOCATIONS WHERE IT HAS BEEN POSSIBLE TO DATE WHEN THE ICE SHEET MELTED AND LEFT THE LAND SURFACE EXPOSED. FROM DYKE, 2004.

By 8,520 years ago only a narrow barrier of ice separated the fresh water lakes from the salty bay referred to as the Tyrrell Sea (figure 10 A)[2]. Eventually the ice dam broke and was washed away about 8,470 years ago (figure 10 B)[2]. It must have been a spectacular event with ice bergs carried by a deluge of water over a waterfall into the Tyrrell Sea. Tracks cut into the mud on the floor of the Tyrrell Sea have been found on the bottom of Hudson Bay that show what the deluge might have been like. The sea flooded today's Hudson and James Bay Lowlands, covering almost all bedrock with sand and clay. Remembering that Lake Agassiz was still being fed by melting ice, it may have taken hundreds of years for the huge lake to completely drain into the Tyrrell Sea.

So much ice-cold freshwater from Lake Agassiz poured into the Tyrrell Sea and then into the Atlantic Ocean that it disrupted ocean currents in the Atlantic and was very possibly responsible for a cooling of the climate for a thousand years.

FIGURE 11: NORTH EAST OF SANDY LAKE. 53° 30′ N 92° 28′ W. THREE LINES OF SAND AND GRAVEL, NOW COVERED WITH TREES, MARKING 8,650 TO 8,550 YEAR OLD SHORELINES OF LAKE AGASSIZ. WAVES WASHED THE SHORE OF THIS ISLAND OF SAND AND GRAVEL BUILDING SHORELINE BLUFFS.

Lakes in the far north west today, like Big Trout Lake, are the remains of Lake Agassiz while silty clay soils in the Clay Belt of Cochrane, Constance Lake and Kapuskasing are sediments from the bed of Lake Ojibway in the east. In some places, near the community of Sandy Lake for example, the shorelines of these ancient lakes are still evident on the landscape (Figure 11).

As melting progressed, the land, now free of the weight of the ice sheet, began to rise like a boat does when its cargo is unloaded. Even after several thousand years, this process, known as “rebound”, is still not quite over (Figure 12). From Fort Severn to Peawanuck near the Hudson Bay coast, the land is rising by over a metre (3 feet) in 100 years.

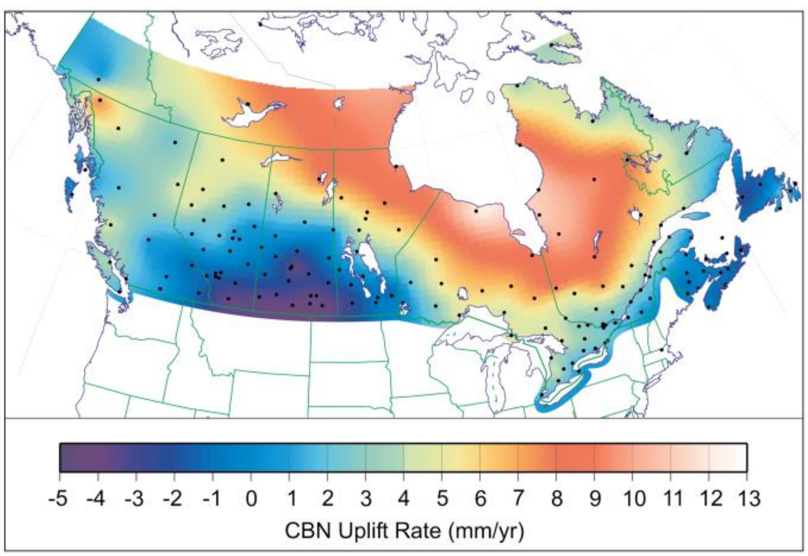

FIGURE 12: PATTERN OF PRESENT DAY POST-GLACIAL UPLIFT FROM THE CANADIAN BASE NETWORK (CBN) OF GPS PILLARS (BLACK DOTS) HTTPS://WWW.NRCAN.GC.CA/SITES/WWW.NRCAN.GC.CA/FILES/EARTHSCIENCES/PDF/GEOMAGNICA.PDF

The area flooded by the Tyrrell Sea has since become known as Hudson Bay and James Bay. Evidence of glacial rebound can be seen when flying over the far north. As the shore has risen, more than a hundred old sandy beaches have been left high and dry running across the landscape, parallel to the coast for more than 200 km inland (Figure 13). The sand was brought by rivers like the Severn and Winisk and washed into place as beaches near the sea during storms [3].

Figure 13: Shrub covered ridges of beach sand running parallel to the shore of Hudson Bay near Fort Severn. The valley of the Severn River is visible in the foreground underneath the plane. March 21, 2012.

The grinding and polishing of the rock by the ice sheet produced grey clay made of rock flour which often lies under the sand. It was once mud on the bottom of the salty Tyrrell Sea. Sea shells in the clay are witnesses to that early sea. The sand and silt near the surface of the land comes from far inland where it was washed in to the sea by rivers, then pushed by waves onto the land near the mouth of the river. As the land rose these areas became costal flats. The layers are clearly seen in the banks of the Severn River and other rivers that cross the Lowlands (Figure 14).

Figure 14: The bank of the Severn River about 7 km upstream from Fort Severn showing a typical succession of grey silty clay, once on the floor of the Tyrrell Sea (now Hudson Bay), covered by sand and silt washed in by rivers near the old river mouth August 18, 2018.

Warming up from an icy past

Are the changes seen by Elders just another step in the end of the Ice Age ?

A good question to ask is - are the changes seen by Elders and the warming of the climate everyone is experiencing around the planet now, just a continuation of the warming that melted the old ice sheet or are we facing something new ? The answer lies in comparing how slowly the ice sheet melted with how fast the Earth is warming today.

Why do Ice Ages come and go ?

We know from many years of carefully measuring the position of stars in the night sky and the angle of the Sun above the horizon during the day, that the Earth's orbit, or path around the Sun, as well as its tilt toward the Sun are always changing, but very, very slowly.

The Earth's journey around the Sun, its orbit, is not a perfect circle. Instead it is an oval, like a stretched elastic band, so that the Earth is closer to the Sun at one end of its orbit than at the other (Figure 15-Eccentricity). That means that right now we are closer to the Sun in January (147 million km) than we are in June (152 million km). Remembering that January is our winter in the north, it might seem wrong that we are closer to the Sun in winter, but it isn't.

It's not the shifting distance to the Sun that changes our northern weather between the seasons. The reason lies in the tilt of the axis of the Earth around which we slowly spin like a spinning top. In Ontario, we are warmer in June because in that part of our orbit the axis of the Earth is pointing toward the Sun. We see the Sun more face on and we enjoy longer days. In the winter, on the other end of the Earth's orbit, the axis is pointed away from the Sun, the north pole is dark all day, we have shorter days and face the Sun at a low angle. That's why January is cooler than July and why our seasons are different.

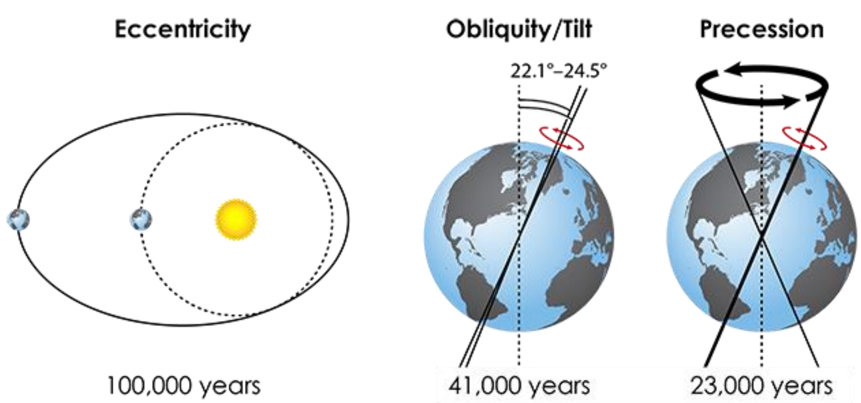

FIGURE 15: THE WAYS IN WHICH THE ECCENTRICITY OR STRETCH OF THE EARTH'S ORBIT; THE TILT OR WOBBLE OF ITS AXIS, AND ITS SPIN OR PRECESSION, SLOWLY CHANGE OVER TENS OF THOUSANDS OF YEARS. THE NUMBER OF YEARS NOTED UNDER EACH MEASURE IN THE DIAGRAM IS HOW LONG IT TAKES FOR THE ORBIT TO CHANGE FROM EXTREMELY OVAL TO ALMOST CIRCULAR (ECCENTRICITY); AND FOR EACH OF THE TILT AND PRECESSION TO COMPLETE A CHANGE FROM MAXIMUM TO MINIMUM AND BACK TO MAXIMUM.

The angle of the tilt of the Earth towards the Sun changes by an extremely tiny amount every year, taking about 40,000 years to increase from just over 22 degrees to 24 ½ degrees and then back again (Figure 15-Tilt). To make things more complicated, the axis of the Earth slowly spins like a top (Figure 15-Precession). So, the Earth can be tilted more directly or less directly toward the Sun when it's either close to or far from the Sun. Each of these changes takes thousands of years and there are many possible combinations.

Careful calculations of how those very slow changes affect the warmth of the Sun received in the north have shown that sometimes spring and summer weather could become cool enough to very slowly, over hundreds of years, allow winter snow and ice to last all year round. When it builds up for thousands of years, it can become an Ice Age ice sheet and eventually grow to as much as 2 or even 3 km thick and last 100,000 years. Careful study of long cores of ice from Greenland show that there have probably been eleven very large ice sheets over Canada in the last three million years (Figure 16).

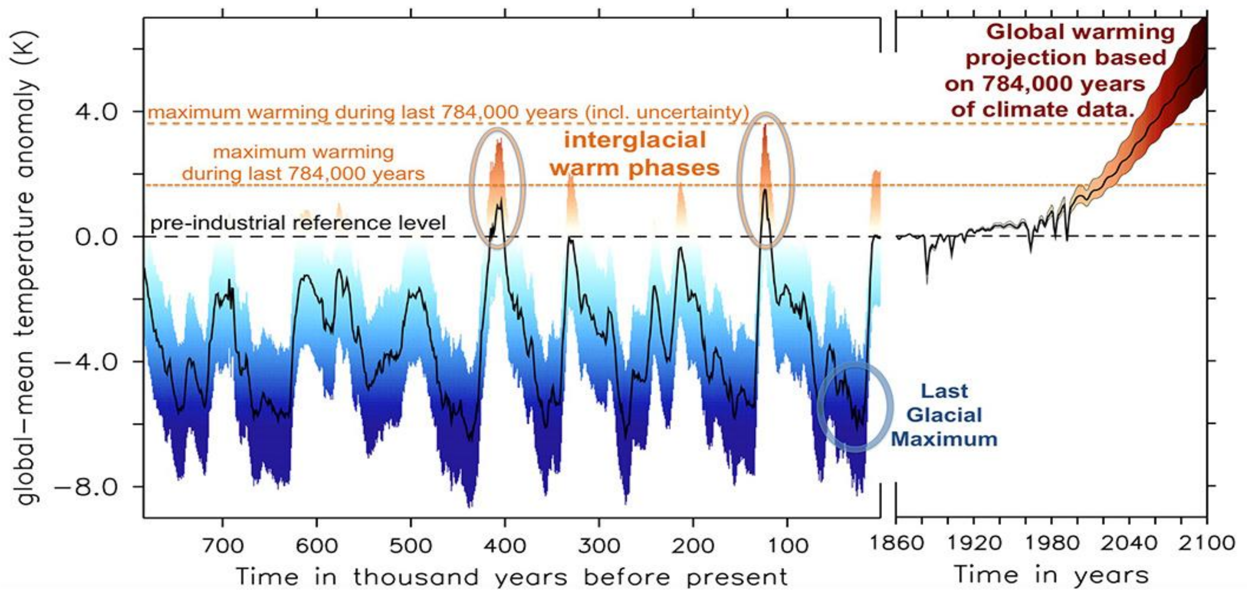

FIGURE 16: GLOBAL MEAN TEMPERATURE ANOMALY WITH RESPECT TO PREINDUSTRIAL REFERENCE LEVEL.

LEFT PANEL: RECONSTRUCTION OF LAST 784,000 YRS. RIGHT PANEL: GLOBAL WARMING PROJECTION TO 2100 BASED ON NEWLY CALCULATED PALEOCLIMATE SENSITIVITY. ADAPTED FROM FRIEDRICH, ET AL (2016). HTTPS://PHYS.ORG/NEWS/2016-11-CLIMATE-SENSITIVE-ATMOSPHERIC-CO2.HTML

We have evidence that when ice last covered Canada, the average temperature of the Earth was about 5 – 7°C colder than it is today. Eventually, as the tilt of the Earth and its path around the Sun changed, summers in the north became warmer and the ice sheet began to melt. That is what has been happening for the last 12,000 years. When we remember that the ice on the Arctic islands and Greenland is part of that Ice Age ice sheet, we see that it is still going on. But the memories of Elders, the work of scientists, and records from weather stations tell us that what is happening now is different from the past. Earth is warming much faster today.

Why has warming speeded up ?

It took over 10,000 years for the Earth's temperature to rise by 5 - 7°C after the last Ice Age. That's about 1°C every 1,500 years. Since 1901, the Earth's average surface temperature has risen by almost 1° C and the rate of warming has nearly doubled since 1975 according to the international *State of the Climate in 2017* report[4]. That's nearly 30 times faster than the increase at the end of the Ice Age. The ten warmest years since we began to record temperature have all been since 1998, and the four warmest have been since 2014[5].

The acceleration in warming cannot be explained by what we know about slow changes in the Earth's orbit or in the tilt of its axis. Today's combination of "stretch, wobble and roll" of the Earth does not show a reason for the faster warming we are experiencing in the north and over the whole of the Earth. Today's warming is not just the next step in Nature's way of melting of the ice sheet.

Capturing the Sun's energy in the atmosphere

Earth's natural "greenhouse effect"

Earth's temperature begins with the Sun. Roughly a third of sunlight that arrives on Earth is reflected back into space by bright surfaces like clouds and ice. Of the remaining two thirds, most is absorbed by the land and ocean, and the rest is absorbed by gases and dust in the atmosphere.

As rock and soil, lakes and oceans are warmed by the Sun, they radiate "heat" energy back toward the sky and into space. From the surface, this energy travels into the atmosphere where most of it is absorbed by so called "greenhouse gases" such as carbon dioxide and methane, and also by water vapour. Greenhouse gases get that name because they keep the Earth warm in a way that seems similar to the way that glass traps heat in a greenhouse and warms the air inside.

When tiny molecules of greenhouse gases and water vapour absorb the energy radiating from Earth's surface, they turn into tiny heaters. Like the rocks around a fire pit, they radiate heat even after the fire goes out. They radiate in all directions. The energy that radiates back toward Earth heats both the atmosphere and the surface, adding to the heating we get from direct sunlight. We call this the "Greenhouse Effect" (Figure 17).

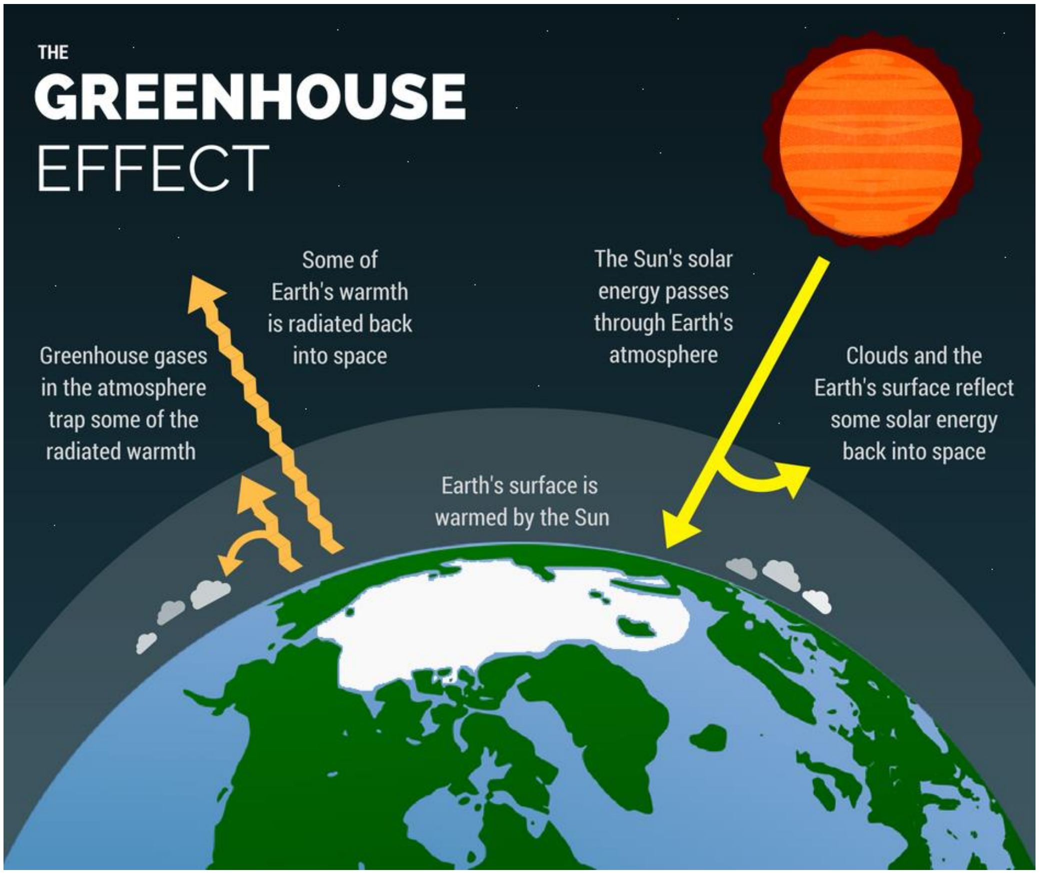

FIGURE 17: ENERGY FROM THE SUN WARMS THE LAND AND THE OCEANS OF EARTH. MOST OF THE ENERGY RADIATED FROM THE WARM EARTH BACK INTO SPACE IS TRAPPED BY "GREENHOUSE GASES" IN THE ATMOSPHERE.

This absorption and radiation of heat by the atmosphere—the natural greenhouse effect—is very important for life on Earth. Without the greenhouse effect, the Earth's average surface temperature would be much colder, about -18°C instead of the comfortable +15°C that it is today. However, the more greenhouse gas there is in the atmosphere the hotter the Earth becomes.

Global Warming

Over the past 260 years, humans have been increasing the volume of greenhouse gas in the atmosphere at an ever-rising rate, mostly through carbon dioxide in pollution released into the air from industries burning oil, natural gas, and coal, and from vehicles. Cutting down forests has also contributed because living trees take carbon dioxide out of the atmosphere to build into wood. Since 1750, carbon dioxide in the atmosphere has increased by 45%. Methane, another important greenhouse gas, has increased by 150%.

Climate change or "global warming" is used to describe this unusually rapid increase in Earth's average surface temperature. It has risen by just a little less than 1°C since 1901 and the rate at which temperature is increasing has nearly doubled since 1975 (Figure 18).

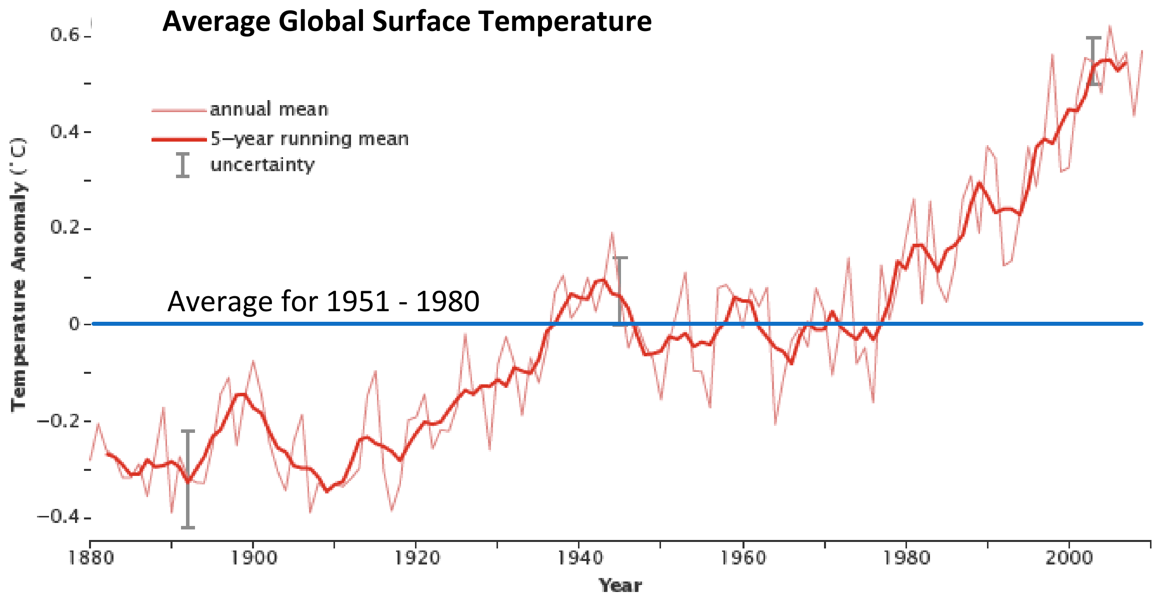

FIGURE 18: DESPITE UPS AND DOWNS FROM YEAR TO YEAR, THE AVERAGE TEMPERATURE AT THE SURFACE OF THE EARTH IS RISING. BY 2001 EARTH'S TEMPERATURE WAS ROUGHLY 0.5 DEGREES CELSIUS ABOVE THE AVERAGE FOR 1951–1980. (NASA FIGURE ADAPTED FROM GODDARD INSTITUTE FOR SPACE STUDIES SURFACE TEMPERATURE ANALYSIS)

How do we know what to expect in the future ?

During the last twenty years it has become possible to use very powerful computers and extremely complex computer programs to predict (scientists prefer to say "project") the climate of the future. Scientists first create realistic working models of the Earth with its oceans, continents and circulating atmosphere, and then add the growing pollution from warming greenhouse gases such as carbon dioxide. Complex computer programs then estimate how warm the Earth will become in the future and how the rest of the climate, such as rainfall, will change. One way of checking projections of the future is to ask the computer to calculate the climate of the last thirty years and compare the result with what actually happened. Those checks show that models are becoming more accurate, as long as there are no surprises such as changes in the circulation of the atmosphere or the oceans.

What might weather in the north be like in the 2050s ?

The computer projections we have used for this report have been developed by Environment Canada and can easily be found on line at http://climate-scenarios.canada.ca/?page=main .

Environment Canada's projections show that the temperature in Ontario will increase by 1 to 5°C depending on the season and the location (Figure 19). The highest increase in temperature is projected for winter which can affect the safety of travel on lakes and rivers and on winter roads. More snow in winter is projected for the north, however, due to warmer temperatures from fall to spring, winter snow depth overall could be lower by as much as 15%. As many community members have observed, this may impact winter travel and wildlife. Detailed projections suggest the north will be in a region where there may be a great deal of variation in snowfall from year to year. Some winters might include some very heavy snow days.

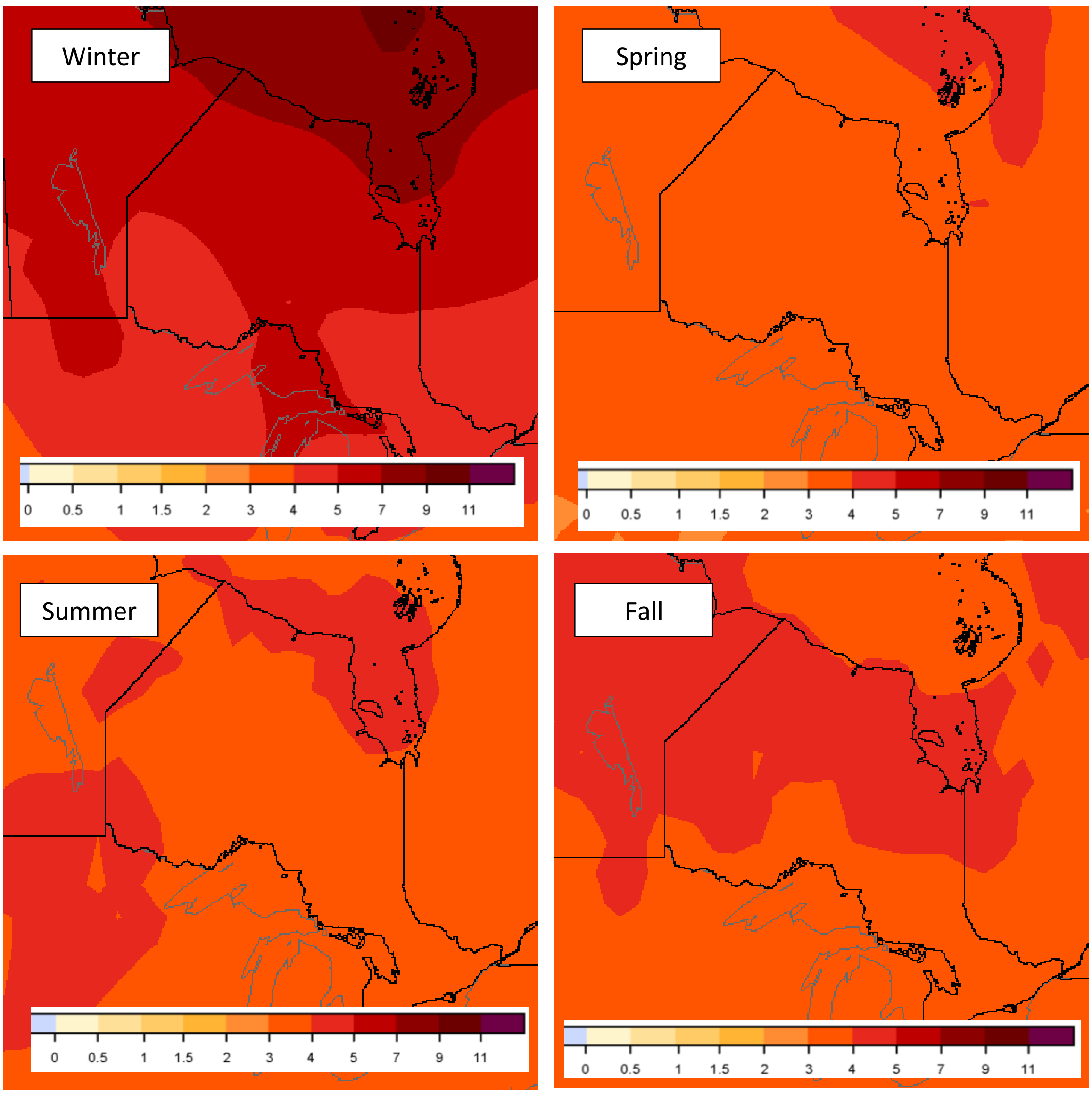

Figure 19: The predicted increases in temperature in Ontario for each season by the 2050s. Plots from http://climate-scenarios.canada.ca/?page=main. For more detailed information about predicted changes for your community see the *What to Expect in the 2050s* section of this report.

An increase in rain instead of snow in the winter should be expected because of warmer temperatures especially near the end of winter. While the ground is still frozen, rapid run-off can quickly raise the risk of flooding on low lying property, as well as flooding of ditches, especially those with culverts that are damaged or blocked by frozen debris. A serious consequence of late winter or early spring rain, accompanied by a rapid snow melt, is the potential for rivers and lakes to flood communities.

Higher temperatures cause more evaporation from lakes and rivers during ice free periods and from the surface of the land, lowering water levels. Warmer summer temperatures will also dry leaf litter and the ground in the bush. This will raise the risk of wildfires spreading more easily.

Warmer air can hold more water but, within just a few days, it can condense into clouds and fall as rain. Rainfall in the north is projected to increase 5 to 20% in spring, 0 to 10% in summer, and 5 to 15% in the fall, by the 2050's compared to today. However, it is difficult to predict, at a community level, how these changes in precipitation will be felt.

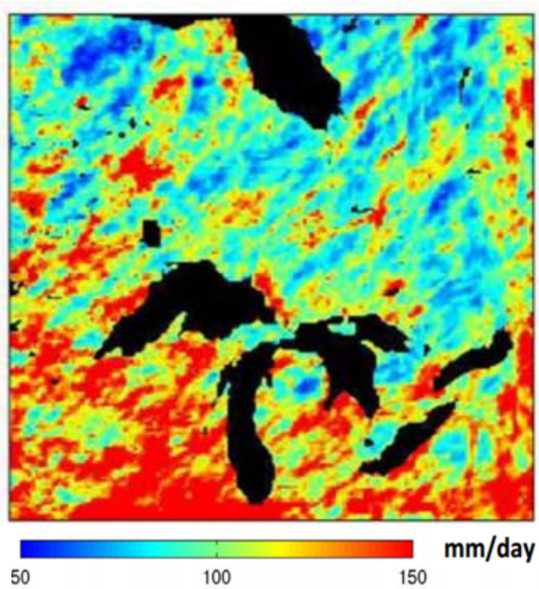

Figure 20: Projected future changes in extreme rainfall in 2045-2060. D'Orgeville and Peltier, JGR – Atoms. 2014 University of Toronto

A more damaging change projected change between now and the 2050s is an increase in heavy and severe rainfall, with longer dry periods between those events. More research is needed but one set of detailed projections predicts an increase of 14-29% in extreme rainfall events. The University of Toronto models predict a pattern of scattered storms delivering between 50 to 150 mm in a day (Figure 20). What that might mean is that a severe rainstorm that would have been experienced in a community once in fifty years might, in the future, occur once in twenty-five or even once every fifteen years.

For more detailed information of the projected changes in temperature and precipitation for your community, refer to the *What to Expect in the 2050s* section of this report.

And after 2050 ? How bad might it get ? Should we prepare for the worst ?

The amount of change our children and grandchildren will experience after 2050 will depend on our generation reducing the volume of global-warming greenhouse gases we release into the atmosphere, especially carbon dioxide and methane. We must change our habits to slow down our demand for energy and resources; we must replace the coal and oil burning technology used to generate energy and power our industries and replace it with renewable sources; and we have to limit how much forested land we clear for farming. We know what needs to be done. The question is, do we have the resolve and the vision to do it?

If we can collaborate internationally and implement immediate and extensive reduction of greenhouse gases, then the Intergovernmental Panel on Climate Change (IPCC) projects that future average global temperature might only increase by 1°C in the last half of this century compared with today (Figure 21 - RCP 2.6). On the other hand, if we carry on as if there is no problem, little international collaboration and hardly even a slowdown in the release of greenhouse gases in the next 20 years, then the scientists of the IPCC project an increase in the global average temperature of between 3 and 5.5°C by the end of the century compared with today (Figure 21 - RCP 8.5). That might be a hundred times faster than the warming when the ice sheet of the Ice Age was melting.

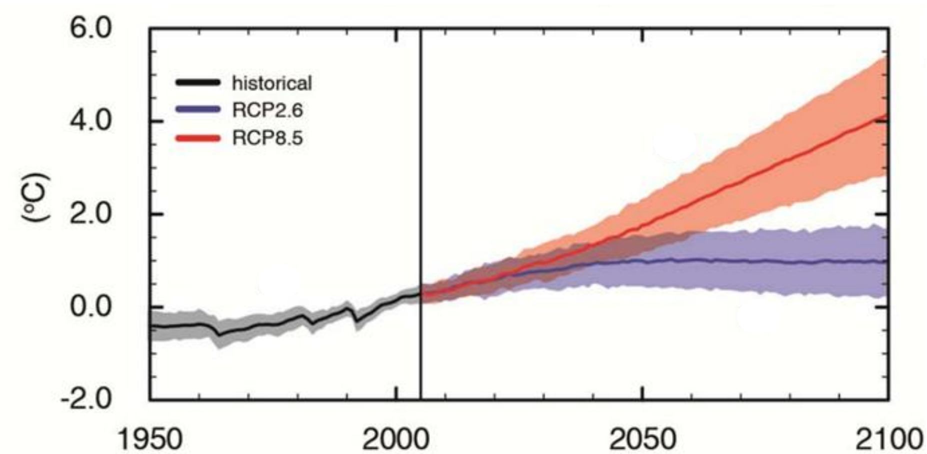

Figure 21: Earth's future average temperature increase for the rest of this century if we reduce our greenhouse gas emissions (RCP 2.6) with the future average global temperature only increasing by 1°C and if we continue on the same path of increasing our greenhouse gas emissions (RCP 8.5) which will result in between 3 and 5.5°C increase in the global average temperature. RCP: Representative Concentration Pathway)

Northern Ontario is already warming at twice the global average and there are no reasons to expect that pattern will change. Although we can hope that large industrial nations will greatly reduce the amount of greenhouse gases they release, we believe it will be better for everyone, including First Nations, to prepare for the worst. The temperature and precipitation projections for the 2050s prepared by Environment Canada and used in this report are based pathway RCP 8.5, in other words they assume little reduction in the release of warming greenhouse gases in the next 20 years. Until there are clear signs that we are moving to a better path, we have to begin considering the impacts of temperatures along the path of RCP 8.5.