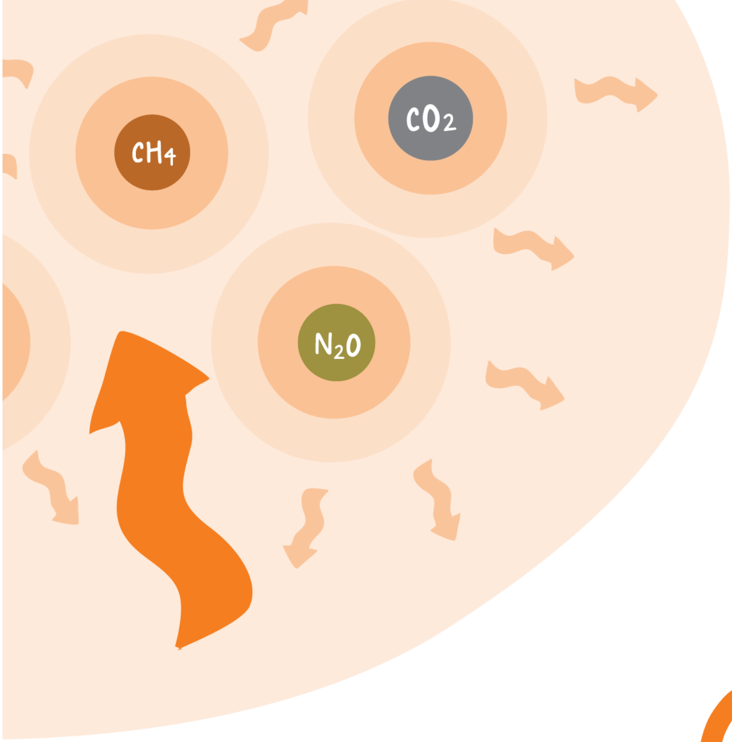

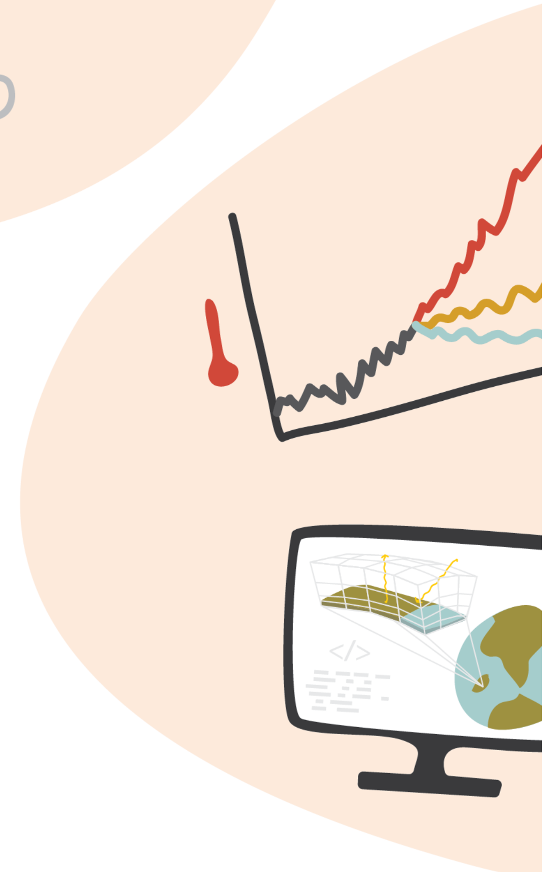

UP NORTH ON CLIMATE
Climate Change Impact and Adaptation Study for the North of Ontario

CLIMATE CHANGE

QUICK GUIDE

PICCA Partnership for Indigenous Climate Change Adaptation

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We welcome the use of this document for education or adaptation planning and kindly request it be referenced as follows:

Up North on Climate. (2022). *Climate Change Quick Guide*. Laurentian University, Ontario.
https://www.upnorthonclimate.ca/what-is-climate-change

UP NORTH ON CLIMATE
Climate Change Impact and Adaptation Study for the North of Ontario

Laurentian University
Université Laurentienne

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Building Climate Change Adaptation Capacity of First Nations in Far Northern Ontario Through Knowledge-Exchange and Collaboration

Natural Resources Canada | Ressources naturelles Canada

Canada

INTRODUCTION

Throughout the world, people are seeing and feeling the effects of human-caused climate change. In northern Ontario, this can mean impacts like warmer winters and shorter winter road seasons, hotter summer heatwaves, drought and wildfires, more frequent flooding, and more intense storms. But understanding how and why climate change is happening can be a challenge. The processes in our atmosphere that drive weather and climate are complex. Adding the effect of human pollution on those processes makes understanding future climate even more difficult.

The Climate Change Quick Guide is a series of graphics designed to present the scientific understanding of human-caused climate change in an approachable and easy-to-understand way. Co-developed by the members of Partnership for Indigenous Climate Change Adaptation (PICCA), the graphics were created with a First Nation audience in mind.

Covering topics like What is Climate Change?, The Greenhouse Effect, Climate Change Then VS Now, and Climate Change Projections, each graphic has a highly-illustrated ‘front side’ as well as a text-based ‘reverse side’ to provide additional information. Use them as posters, handouts, or presentation slides when talking with community members, leadership, or youth.

Want to learn more?

Find the Climate Change Quick Guide as well as other climate change and adaptation resources at www.upnorthonclimate.ca including:

- The Climate Change Adaptation Quick Guide
- The Up North on Climate Adaptation Framework
- Climate Change Impact and Adaptation Infosheets
- The Science Climate Story

CLIMATE CHANGE QUICK GUIDE

WHAT IS CLIMATE CHANGE?

Climate change describes all the changes happening because humans are warming the planet.

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What is climate?

Climate is the average weather a place has over a long period of time. It tells us how much rain or snow or how hot or cold a place usually is.

1980 January ... 2000 January

Average January over 30 years =

Northern Ontario climate means we expect cold in the winter, and warm in the summer.

winter

summer

Why is climate changing?

Climate is changing because the Earth is getting warmer.

Human activity (like burning coal, oil and gas) has amplified the Earth's natural Greenhouse Effect by adding more and more greenhouse gases (GHGs) into the atmosphere.

nitrous oxide N_2O

carbon dioxide CO_2

methane CH_4

GHGs keep the Earth warm like the glass of a greenhouse traps heat.

How does warming impact climate?

Globally

Climate around the world is driven by large global air patterns and ocean currents.

Making the Earth warmer can change these patterns.

global warming

changes to air patterns

changes to ocean currents

Locally

In our communities, warmer air can mean:

higher temperatures

changes in wind

fewer cold days

Warmer air can also hold more water vapour, leading to:

changes in rain and snow

stronger storms

How can changes in climate impact our land and communities?

DROUGHT
- dry land
- low water for travel

ECOSYSTEMS
- shifting habitat for plants & animals
- permafrost thaw

FLOODING
- more heavy rain events
- winter flooding from thaw or rain

FOOD SECURITY
- changes in fish spawning
- changing migration patterns

HEALTH
- heat illness
- mental stress

INFRASTRUCTURE
- damage & power outages
- poor drinking water quality

TRANSPORTATION
- shorter winter road season
- ice conditions less predictable

WILDFIRE
- damage to the community
- poor air quality

Preparing for climate change can help us lessen the impacts on people & communities.

Q&A WHAT IS CLIMATE CHANGE?

What's the difference between global warming and climate change?

Global warming is the rapid rise in global temperature that's happening because human activities are adding greenhouse gases (GHGs) to the atmosphere. The added GHGs are amplifying the Earth's natural greenhouse effect, causing the planet to warm 30x faster than it did before the year 1900.

Climate change is the change in climate happening because of global warming. As the Earth gets warmer, the air patterns and ocean currents that drive climate can change, affecting things like how hot or cold places are, how much rain or snow falls, how severe storms are, or how often and where storms happen.

What does climate change mean for extreme weather?

There is a lot of evidence that climate change is causing extreme weather events, like heat waves, storms, and heavy rain, to happen more often and/or be more severe than in the past. This is because the air patterns and ocean currents that drive our weather can change as the Earth heats up.

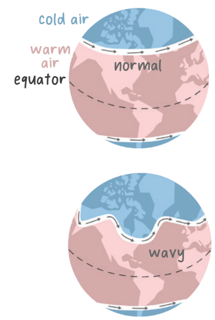
Warmer temperatures and more humid air can lead to heat waves that last longer due to slow moving air masses. A warmer atmosphere can hold more water vapour, which can make heavy rain events or big snow storms more likely. Changing air patterns mean storm systems or weather events can be brought to new/different places.

Yesterday was cold, what happened to global warming?

Just because a given day is cold, it doesn't mean that conditions over the long term (the climate) aren't getting warmer. When you ask "How cold is it today?" or "Is it raining out?", you're asking about the weather. Weather changes day to day, or even hour to hour. Climate, on the other hand, is the average weather a place experiences over a long period of time, like decades or a lifetime. Average global temperature is on the rise, with temperatures in the north rising twice as fast as other regions.

How do air patterns and ocean currents impact climate?

When heat energy from the Sun reaches the Earth, it isn't spread evenly around the globe. The middle of the Earth (the equator) faces the sun more directly so it gets warmer than the poles. This creates temperature and pressure differences that result in the movement of air, creating wind as air rises and falls and moves from areas of higher to lower pressure. These global winds are also bent by the spin of the Earth. As they blow over oceans, they drive ocean currents that are also shaped by the coasts of the continents.



Air patterns and ocean currents influence climate by moving warmth from the equator toward the poles. Air also carries and moves water vapour (water in its gas form) that creates clouds and falls as rain or snow. But global warming can change how air and ocean currents move. Research suggests that warming in the Arctic is causing the jet stream, an important air current in the northern hemisphere, to become wavier, allowing warm air to spread north and cold air south. Melting Arctic ice is also sending more freshwater into the North Atlantic, altering the flow of the Gulf Stream, an important ocean current the takes warm water north from the Gulf of Mexico.

Why does climate change matter?

Our land and communities have been shaped by the climate. The plants and animals we find on the land survive and thrive because the climate provides the conditions they need. Buildings, roads, and other community infrastructure have been designed for the climate expected for the region.

But as climate changes, and extreme events happen more often, plants and animals can find themselves struggling to survive in conditions that no longer give them what they need. Climate is also changing so quickly that they have little chance to adapt. Community infrastructure, like roads, water systems, and power lines, can also be challenged. Preparing now for climate change can help lessen the impacts and risks.

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The GREENHOUSE EFFECT

Earth's natural greenhouse effect keeps us comfortable, but adding more greenhouse gases heats things up.

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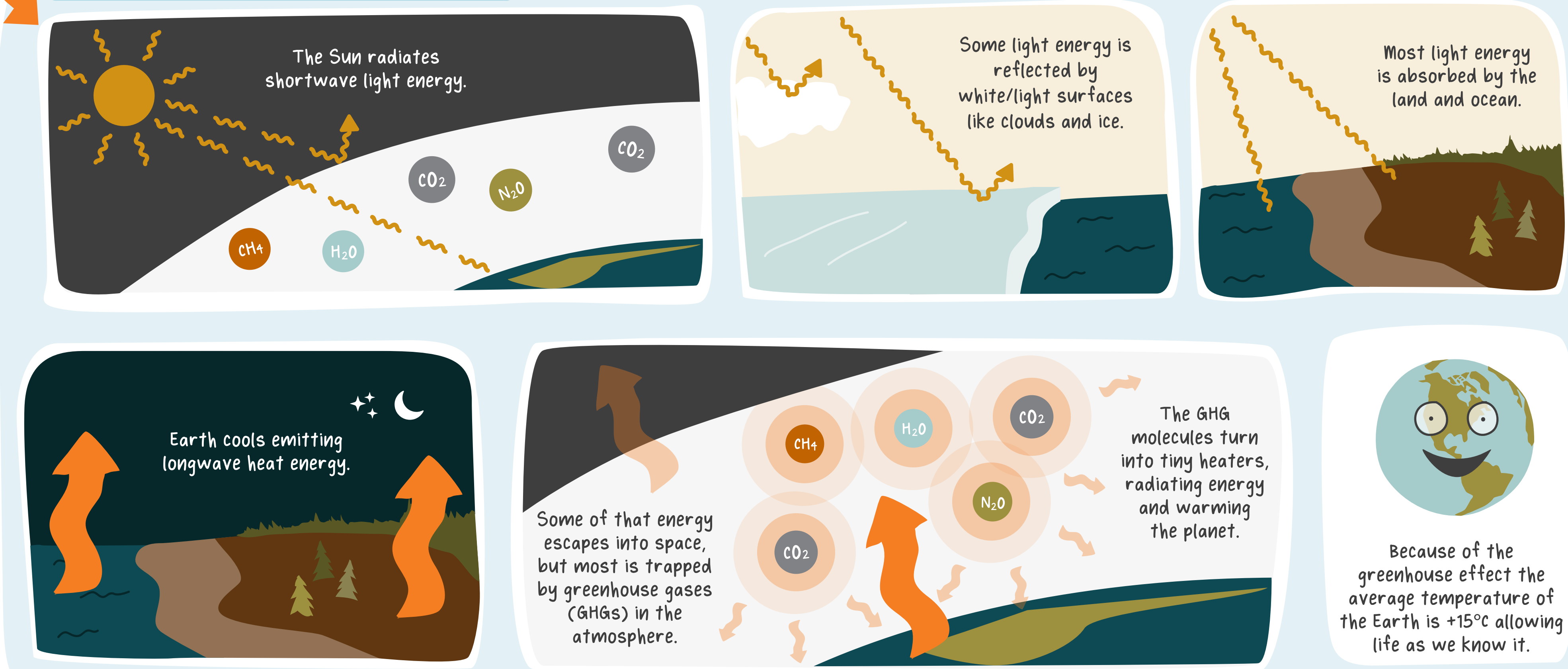
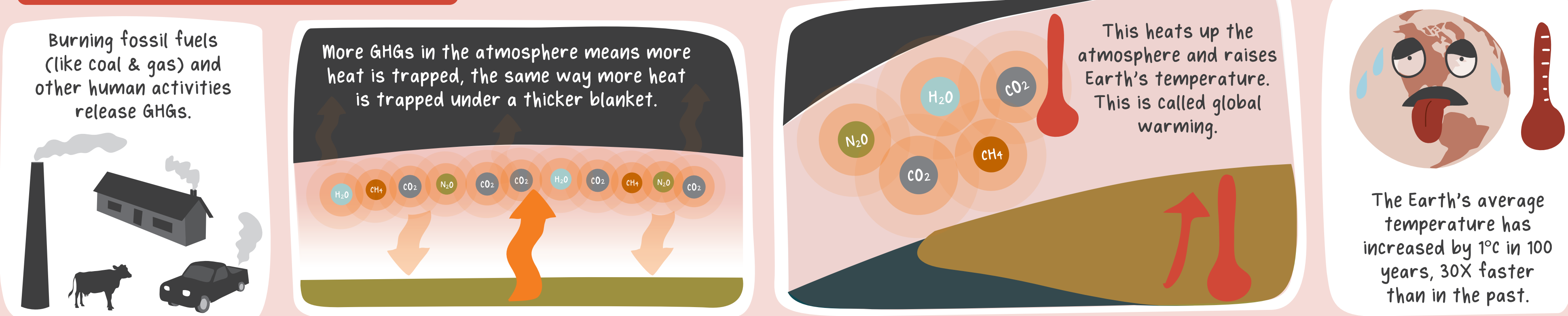
The Natural Greenhouse Effect

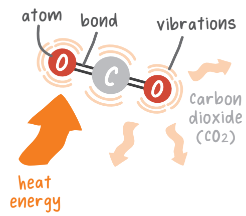


Amplified Greenhouse Effect



Q&A THE GREENHOUSE EFFECT

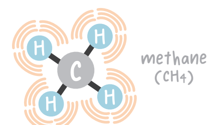
How do GHGs create the greenhouse effect?



Earth's atmosphere is made of invisible gases. Some gases like oxygen (O_2) and nitrogen (N_2) don't trap much heat energy, but others, like carbon dioxide (CO_2) and methane (CH_4), do. Gases that are good at trapping heat are called greenhouse gases (GHGs).

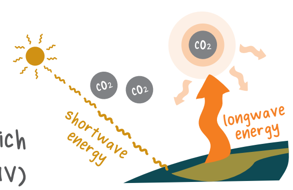
GHGs trap heat because of the way their molecules are put together – they are made of more parts (called atoms) and have more bonds (the force that holds atoms together) than gas molecules that don't trap heat. When heat energy radiated from the Earth hits a GHG molecule it begins to vibrate, as if the bond are little springs. As vibrations slow, the molecules gradually release heat in all directions like tiny heaters. Heat energy moves around the atmosphere, from one GHG molecule to another, or even back down to the surface, like a ball in a pinball machine.

Do some GHGs trap more heat than others?



The number and strength of a molecule's bonds determines how much it vibrates and how much heat energy it can hold. Some greenhouse gases (GHGs) hold more heat than others. But scientists also consider how long a GHG stays in the atmosphere and how much of it there is when looking at its effect on warming.

Why do GHGs only trap outbound energy?



Sunlight enters our atmosphere as shortwave energy, which includes visible light (that we can see) and ultraviolet (UV) light that causes sunburns. This type of energy is not trapped by gas molecules in the atmosphere. When sunlight hits the Earth's surface, that energy is absorbed and re-emitted as longwave energy (called infrared energy) that we can't see but can feel as heat. Longwave energy is a type of energy that can be trapped by greenhouse gases.

Why is the greenhouse effect important?

15°C

Earth's atmosphere acts like a blanket holding warmth from the Sun. Without it, the Earth's average temperature would be -18°C. By trapping the heat energy released by the Earth, the natural greenhouse effect warms Earth to an average of 15°C, allowing life as we know it.

How are humans amplifying the greenhouse effect?

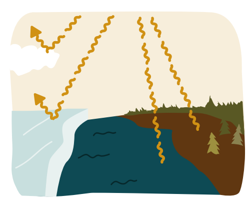
Humans are affecting the natural greenhouse effect by adding greenhouse gases (GHGs) to the atmosphere. Carbon dioxide (CO_2), the most abundant GHG, comes from burning fossil fuels like coal and gas. Methane (CH_4) is released by cattle and landfills and is the main component of natural gas. Nitrous oxide (N_2O) comes mainly from fertilizers and agriculture. All these added GHGs have caused Earth's average temperature to rise nearly 1°C in the last 100 years, a rate much faster than the natural warming that has happened in the past.

Is water vapour a GHG?

Water vapour (H_2O) is water in its gas form, like the steam that rises from a pot of boiling water. It's an important part of the atmosphere, forming clouds and falling as rain and snow. It's also a greenhouse gas (GHG), trapping longwave heat energy emitted by the warmed Earth.

Water vapour isn't a human pollutant like other GHGs. Instead, the amount of water in the atmosphere depends on the temperature, with warmer air holding more water than colder air. As the Earth warms, the atmosphere can hold more water vapour, which causes more warming, which leads to more water vapour, and so on.

Which surfaces absorb/reflect the Sun's energy?



White surfaces, like clouds, snow, and ice, reflect the Sun's energy; dark surfaces, like water, rocks, and soil absorb it. When warming temperatures melt reflective ice and snow in the Arctic, more energy is absorbed by the open ocean. This warms the water, impacting weather in the north and even affecting the polar front (an air pattern important to global climate). Less ice also means more dark ocean to absorb energy, leading to more warming and even less ice.

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CLIMATE CHANGE THEN vs NOW

Earth's climate has changed before, how do we know today's climate change is human caused?

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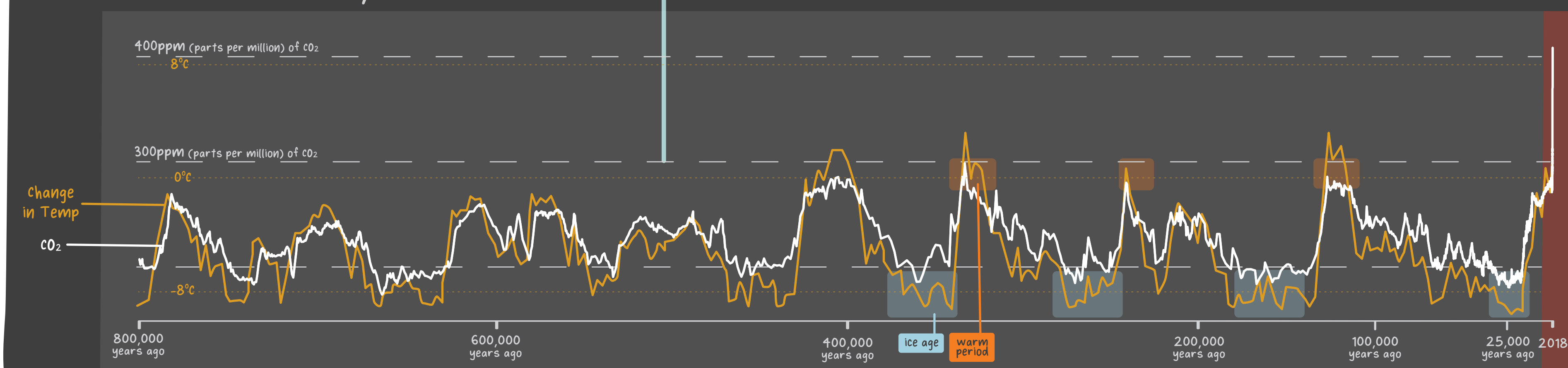
Information from ancient dust and air bubbles trapped in ice cores tells us about Earth's climate over the last 800,000 years. Past changes happened very slowly, with Earth's temperature rising by 1°C every 1,500 years & carbon dioxide (CO_2) never going above this line.

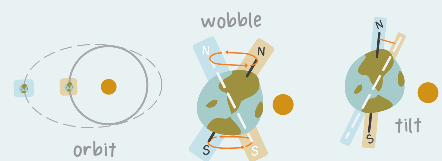
In only 100 years, Earth's temperature has risen by nearly 1°C, a rate that is 30 times faster! No natural event explains this much faster rate of warming.

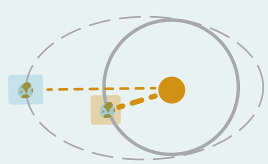


* For past climate, this graph uses CO_2 and temperature values calculated from Antarctic ice cores. Starting in 1958, measurements of CO_2 in the atmosphere have been taken at the Mauna Loa observatory in Hawaii.

Why did Earth's climate change in the past?

Changes in climate in the last 800,000 years were driven mostly by changes in the Earth's orbit, wobble & tilt, called the Milankovich cycles.

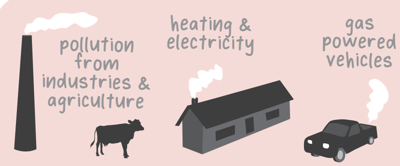




These cycles, which happen very slowly, change how much sunlight (ie. heat energy) reaches the northern part of the Earth.

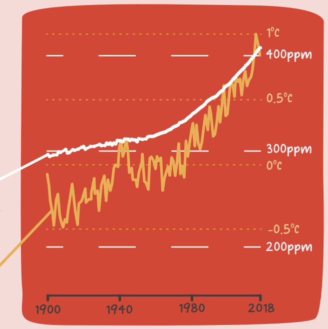
With less heat energy, snow can slowly build up, leading to an ice age. With more heat energy, the snow slowly melts again (warm period).

Why is Earth's climate changing so fast now?



As humans started burning more coal, oil & gas (fossil fuels), the amount of carbon dioxide (CO_2) & other greenhouse gases in the atmosphere got higher & higher.

The rise in CO_2 has been closely followed by a rise in global temperature.



*Temperature difference from 1951-1980 global average

There is still time to act! We can replace fossil fuels with other energy options to lower CO_2 emissions and plan for climate challenges with community adaptations!

Q&A CLIMATE CHANGE THEN vs NOW

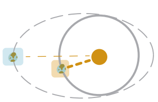
How do ice cores tell us about past climate?

Ice sheets, like those in the Antarctic and Greenland, are made up of snow that has collected over thousands of years. New snow layered on top of old snow and eventually turned into ice under its own weight, creating layers of ice that provide a historical timeline, with the oldest layers at the bottom and the newest on top. Within the layers of the ice core are bubbles of air and particles of dust from the atmosphere that became trapped as the layers formed.

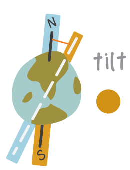
Scientists drill into ice sheets and remove ice cores, cylinders of the ice sheet that let them study the layers in detail. By measuring oxygen, carbon dioxide and other gases in the bubbles, we can get an idea of what past climate was like. Ice cores from Antarctica give us the longest climate record, with layers dating as far back as 800,000 years.

What are the Milankovich cycles and how do they drive climate?

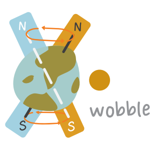
How the Earth moves as it travels around the Sun has a big influence on how much of the Sun's heat energy reaches different parts of the planet.



Earth's orbit (its path around the Sun) stretches and contracts like an elastic band. It changes from being nearly a circle to being a bit of an oval every 100,000 years. When the Earth's orbit is more oval, Earth is closer to the Sun (and warmer) at one end of its orbit compared to the other.



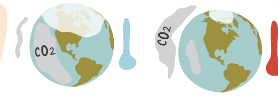
Earth's axis (around which we turn, giving us day and night) is tilted, which points one part of the Earth towards the Sun. Summer in the north happens because the tilt of the axis points us towards the Sun giving us more heat. The degree of this tilt also slowly shifts over about 40,000 years.



As the Earth turns, it wobbles a bit around its axis, like a spinning top. This wobble also changes the tilt of the Earth, pointing it more directly or less directly towards the Sun. One wobble takes about 23,000 years.

Combinations of these movements have led to times where parts of the planet get less of the sun's warmth and become cool enough that snow stays on the ground even in summer. Over hundreds of years, the snow builds up, leading to more cooling and, eventually, an ice age. As the Earth's orbit and axis continue to shift, the Earth warms again and the ice sheet slowly melts.

If ice ages were triggered by Milankovich cycles, why did CO_2 change?



When changes in Earth's orbit and axis make the planet cooler, Earth's oceans absorb more carbon dioxide (CO_2) from the atmosphere. This is because cold water can hold more CO_2 than warm water. With less CO_2 in the atmosphere, the Earth cools even more. As the orbit and axis continue to change, Earth eventually gets enough heat from the sun that a warming period begins. This heats the oceans and leads to a release of CO_2, which causes even more warming. As warming melted the ice sheets over the north, forests grew. This pulled CO_2 from the atmosphere and helped keep it from rising above 300ppm.

What is parts per million (ppm)?

Parts per million (ppm) is a measurement of the amount of something. Imagine a herd of 1 million caribou. If you replace one caribou with a wolf, the wolf represents 1 part per million. A measurement of 300ppm would mean 300 caribou were replaced by wolves. Similarly, a measurement of 300ppm of carbon dioxide means that if you looked at 1 million molecules in the atmosphere, 300 of them would be carbon dioxide.

Why does going from 300ppm CO_2 to 415ppm CO_2 matter?

Just like adding more wolves to a herd of caribou has an impact, adding more carbon dioxide (CO_2) to the atmosphere impacts Earth's climate. CO_2 levels have changed over the past 800,000 years but have never been above 300 ppm. In the past 100 years, CO_2 levels have risen to 415ppm and the average global temperature has increased by 1°C. 1°C may not seem like much but it has led to the climate impacts we see today, and more warming will mean more severe impacts. For example, a heat wave that only happened once every 50 years could happen every 10 years at 1°C warming, every 3 or 4 years at 2°C warming, or every 1 to 2 years at 4°C warming. If CO_2 keeps rising, we could reach 500ppm in 50 years and see average global temperature increase by 3°C or more, with temperatures in the north rising even higher.

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CLIMATE CHANGE PROJECTIONS

What could future climate look like in northern Ontario?

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Climate models are complex computer programs that mimic how the Earth behaves.

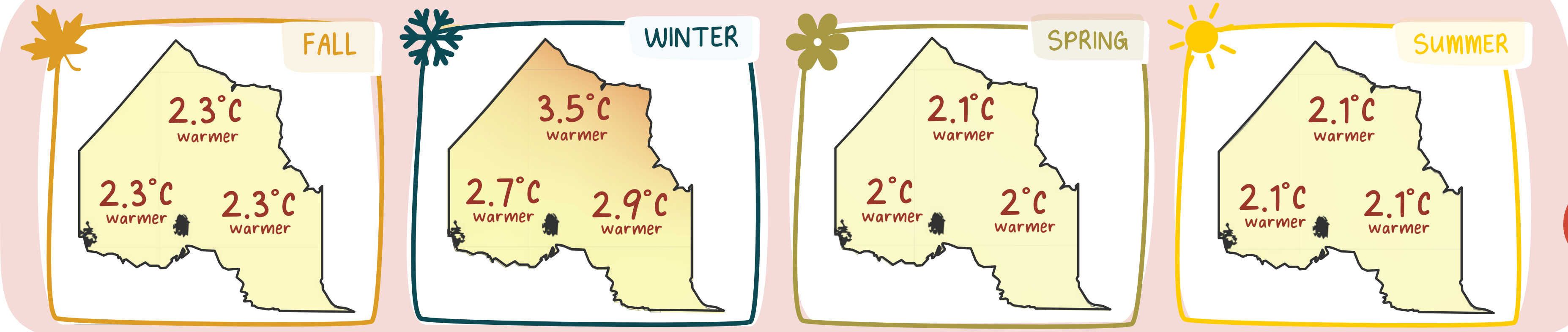
CH_4 methane
CO_2 carbon dioxide
N_2O nitrous oxide

Scientists can use these models to predict what future climate might be like if we emit lots of greenhouse gases (GHGs) or if we emit fewer.

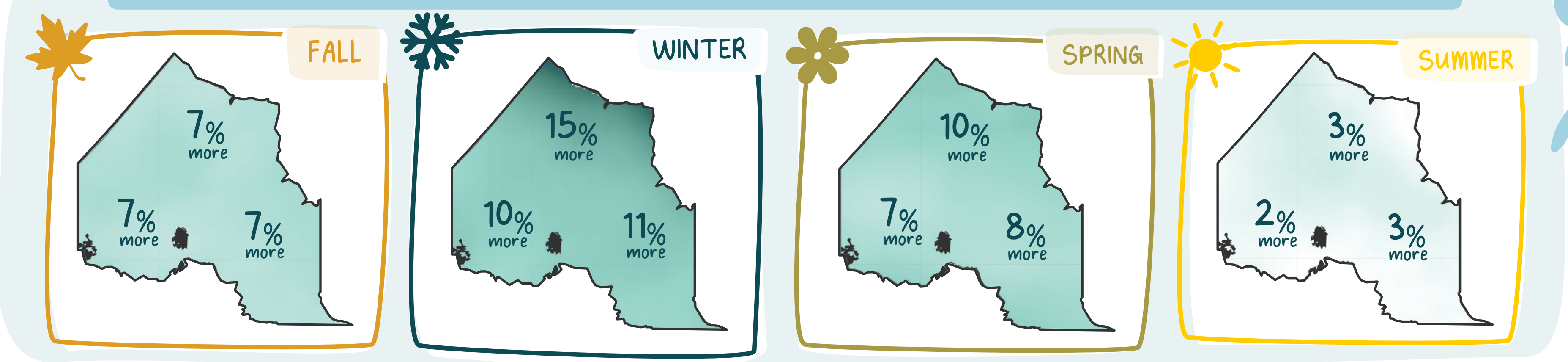
If we keep emitting GHGs at the rate we are now, our climate will likely follow the path predicted in the "high emissions" climate model.

Maps below show temperature & precipitation (rain & snow) for a high emissions future.

How much warmer could the future (2021-2050) be compared to the past (1976-2005) ?



How much more rain & snow could the future (2021-2050) have compared to the past (1976-2005) ?



What could these changes mean?

FALL
- later snowfall
- longer fire season

WINTER
- more winter rain
- thinner ice

SPRING
- faster melt
- more flooding

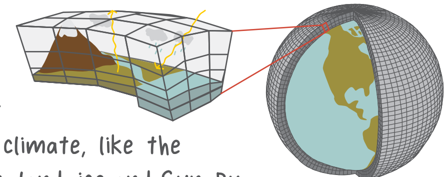
SUMMER
- more drought
- more wildfire

Climate projections can help us plan adaptations. Adaptations that plan for high emissions can help protect people and communities from climate change impacts even if we follow another path.

* Maps & data from: climateatlas.ca

Q&A CLIMATE CHANGE PROJECTIONS

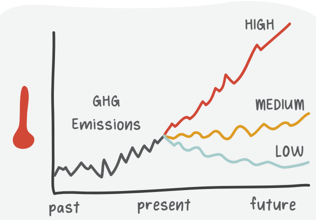
How do climate models work?



Climate models are computer programs that simulate the processes that drive Earth's climate, like the interactions between the atmosphere, oceans, land, ice and Sun. By first dividing the Earth into a grid of thousands of cubes that reach up into the atmosphere and down into the oceans, climate models use mathematical equations and the laws of physics to model processes like wind or the temperature of the air or water in each cube. They also take into account how what's happening in one cube affects neighbouring cubes. Climate models that look decades into the future are so complex they are run on large "super computers".

To model how climate might change because of pollution, scientists can run the models with more or less greenhouse gas (GHG) in the atmosphere to predict measures of future climate like temperature and rainfall. These predictions (called climate projections) are calculated for a range of possible GHG futures.

What are the future climate pathways?



Climate models simulate different climate futures (called "pathways") based on how much greenhouse gas (GHG) continues to be added to the atmosphere by human activity. Two systems have been developed:

1. RCP (Representative Concentration Pathway) scenarios look at how GHGs affect radiative forcing, or heat energy trapped in the atmosphere by GHGs. The higher the number, the more energy is trapped and the more the Earth heats up.

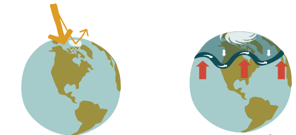
2. SSP (Shared Socioeconomic Pathway) scenarios look beyond radiative forcing and try to include how factors like population size, economic growth, and new technologies might influence GHG emissions, and therefore climate warming, into the future. SSP scenarios are numbered 1 to 5.

High Emissions Pathways
(like RCP8.5 and SSP5) assume that we keep using more fossil fuels. They predict the biggest changes in climate.

Medium Emissions Pathways
(like RCP4.5 and SSP2) assume we start to replace fossil fuels with green energy and, in the near future, emit less GHGs than we are now.

Low Emissions Pathways
(like RCP2.6 and SSP1) assume we dramatically cut fossil fuel use now.

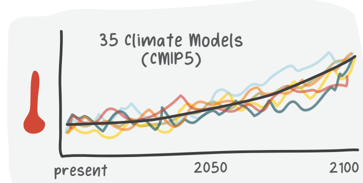
Why are northern Ontario projections higher than the global average?



Many countries, including Canada, joined the 2015 Paris Agreement to keep average global temperature rise below 2°C by 2100. But high emission projections show warming for northern Ontario of 3.5°C in winter as early as 2050 and as high as 9°C in winter in 2100.

Global warming does not mean the same amount of warming everywhere. Some places are warming more, and more quickly, than others. The Arctic and northern regions are warming more quickly because more warm air is being carried north by large weather systems. The loss of ice reflecting sunlight and more open ocean also means that more of the Sun's heat is being absorbed by the dark water. This faster warming means that when planning adaptations in northern Ontario, we have to look beyond the global averages and use predictions for northern communities.

Why do scientists trust climate models?



To see how well climate models work, scientists test them against climate data from the past. If the model can correctly predict past climate trends, then we expect it to be good at predicting future climate. To get the best results, projections are based on many models developed by scientists all over the world using slightly different calculations for Earth's processes. Canada's climate projection maps come from a group of 35 climate models called CMIP5.

Where can I find climate projections for my community?

The Climate Atlas of Canada (www.climateatlas.ca) is a user-friendly website that provides climate projections for all of Canada. Use the Indigenous button on the interactive map to highlight First Nation, Inuit, and Métis communities and view or download future projections. The numbers on this graphic are from Climate Atlas.

Grand Council Treaty #3 · Keewaytinook Okimakanak · Matawa First Nations Management · Mushkegowuk Council · Nokiiwin Tribal Council · Shibogama First Nations Council · Laurentian University / Université Laurentienne

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Climate Change Impact and Adaptation Study for the North of Ontario

www.upnorthonclimate.ca


CLIMATE CHANGE IMPACTS
warmer temperatures
changing rain & snow
more storms / more severe storms
SHIFTING ECOSYSTEMS
invasive species in new places
change in temperature-driven events
changing ecosystems
permafrost thaw
berries, trees, plants & animals under stress
warmer lakes/rivers
changes in vegetation
earlier spring
warmer winters
more wildfire
DROUGHT
berries & plants under stress
dry land
poor drinking water quality
low water
dusty conditions
more evaporation from plants, land & water
INFRASTRUCTURE
more heavy rains
severe storms
heavy wet snow loads
wastewater lagoon leakage
building damage
road flooding & damage
damage to energy infrastructure causing power outages
Drinking Water Systems
contaminated drinking water source
WILDFIRE
poor air quality
higher risk of accidental ignition
drier land (fire fuel)
evacuations & stress
more lightning (fire ignition)
longer fire season
damage to the community
more dead/fallen trees (fire fuel)
HEALTH
mold in homes & smoke in air
flooding & fires
respiratory issues
evacuations
mental stress
more pollen
allergies
hot days
heat illness
ticks & mosquitoes in new places
lyme disease west nile virus
TRANSPORTATION
delay in winter road opening
change in ice quality
higher cost to fly in goods
social isolation
shorter winter road season
ice conditions less predictable
water routes obstructed
food & energy insecurity
severe storms make travel less safe
FOOD SECURITY
change in fish spawning
shifting ranges for plants & animals
changing migration patterns
N
plants & animals moving north
cold-water fish under stress
FLOODING
changes in river ice
more heavy rain events
more winter rain
more mid-winter thaws
spring melt flooding
lakes/rivers overflow banks
changes in ice jams
faster spring melt
flooding from heavy rain
winter flooding from thaw or rain
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CLIMATE CHANGE IMPACTS EVERYONE

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What changes have you seen on the land & in your community? What actions can be taken? Share your ideas in the white spaces below.

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