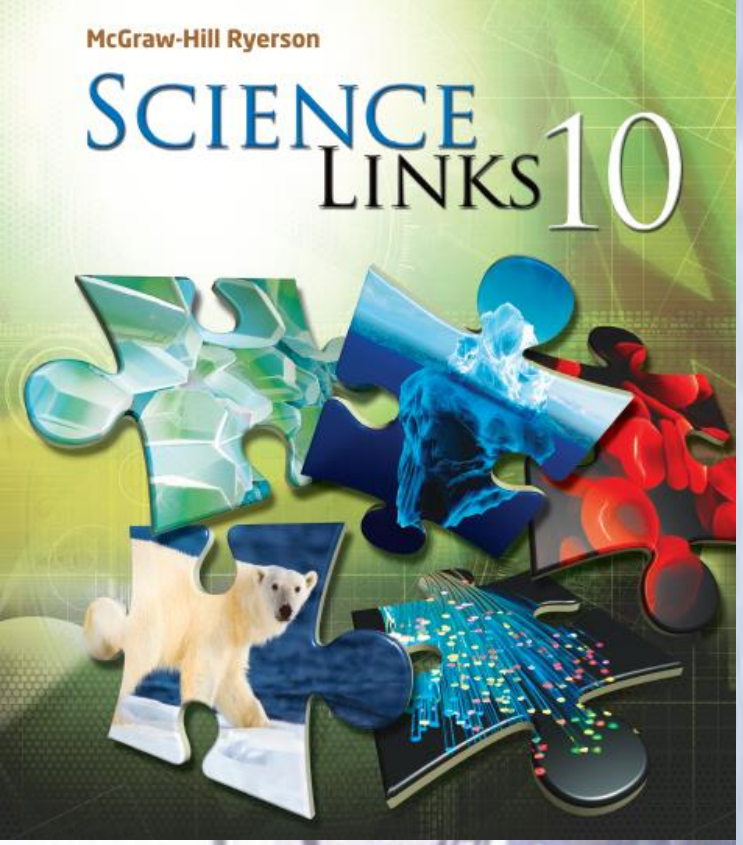


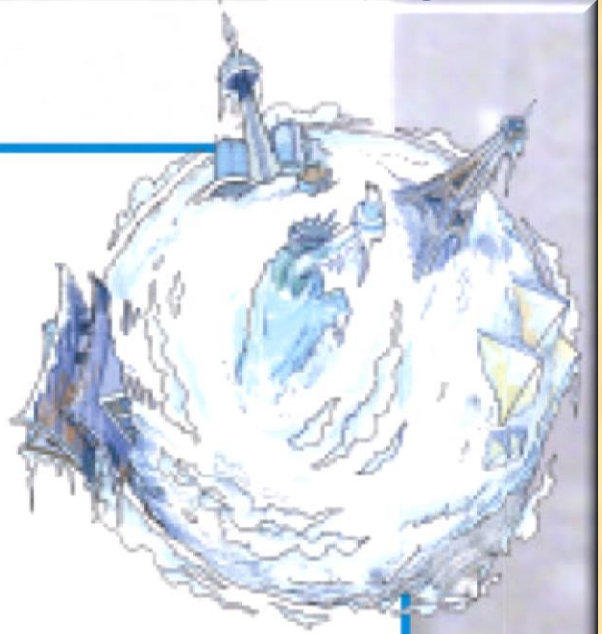
UNIT 3

Earth's Dynamic Climate

- ***Topic 3.1***: *What is climate, and how has it changed during Earth's history?*
- ***Topic 3.2*** : *Where are the effects of climate change felt, and what is their impact?*
- ***Topic 3.3***: *What natural factors affect climate, and how do they affect it?*
- ***Topic 3.4***: *How do human activities affect the natural greenhouse effect?*
- ***Topic 3.5***: *How can we assess present climate change and reduce our impact?*

Topic 3.1 What is climate, and how has it changed during Earth's history?

(Pages 192-201)



Key Concepts

- Climate is different from weather, but they are also linked.
- Climate has changed frequently throughout Earth's past.
- Climate is currently changing around the world.

What is climate, and how has it changed during Earth's history?

What do the headlines on the left have to do with climate change?

What is climate, and how has it changed during Earth's history?

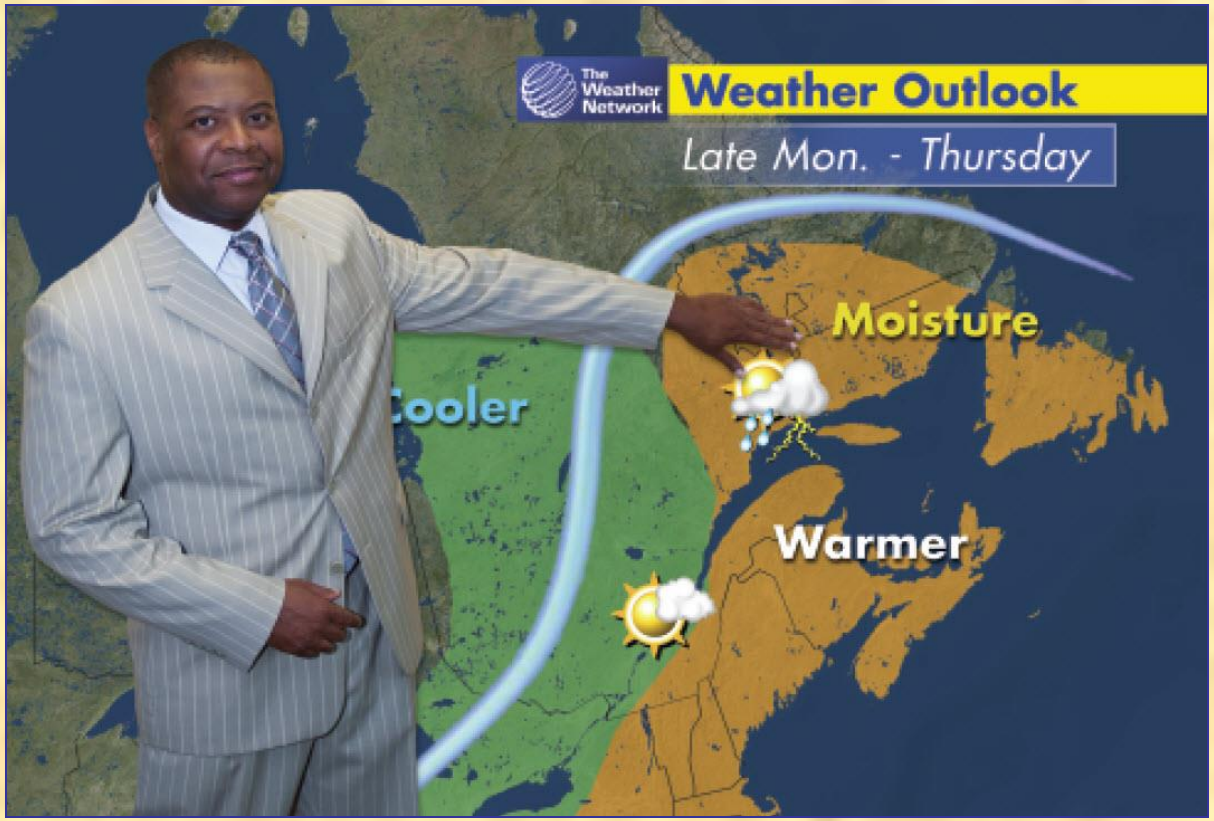
Which of the headlines refer to weather and which refer to climate?

Climate is different from weather, but they are also linked.

The **atmosphere** is the layer of gases that surrounds Earth.

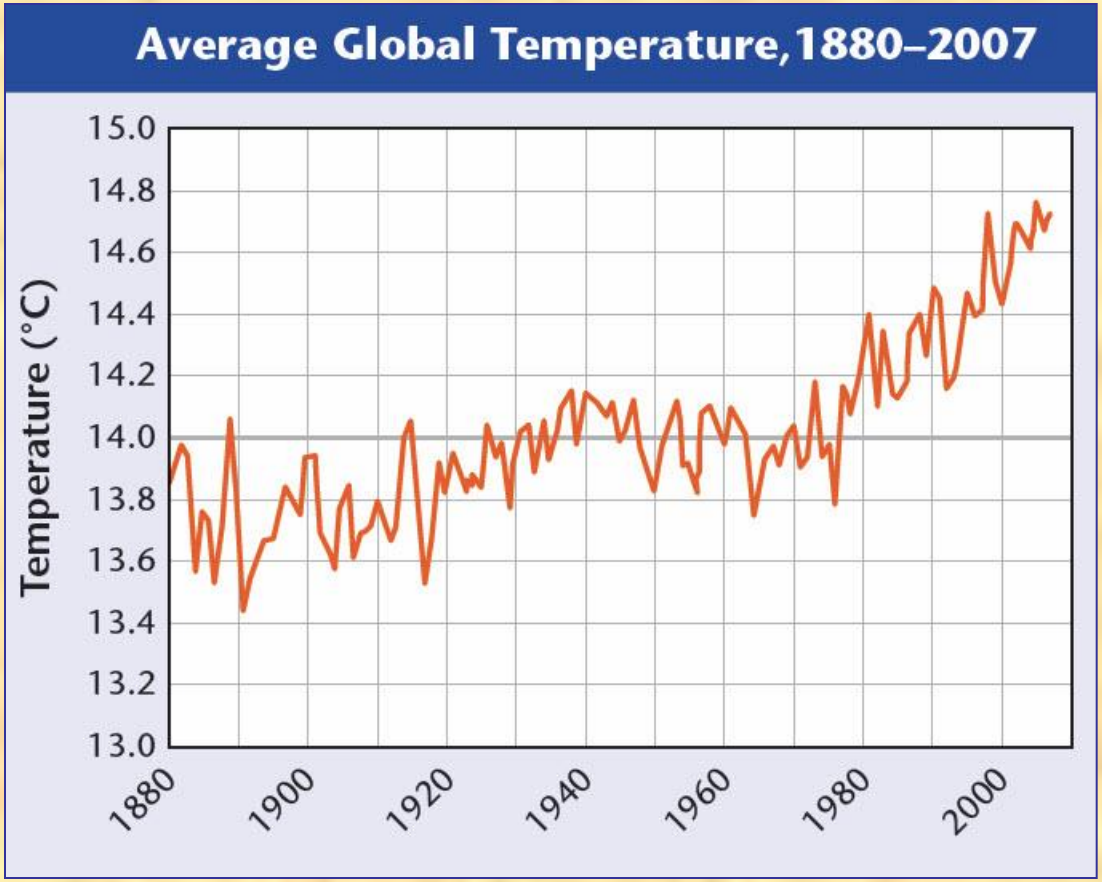
Weather is the conditions of the atmosphere for a specific place at a specific time.

The current **temperature**, **wind speed**, **humidity**, **cloud cover**, and **precipitation** are all used to describe the weather.



How Climate is Different from Weather

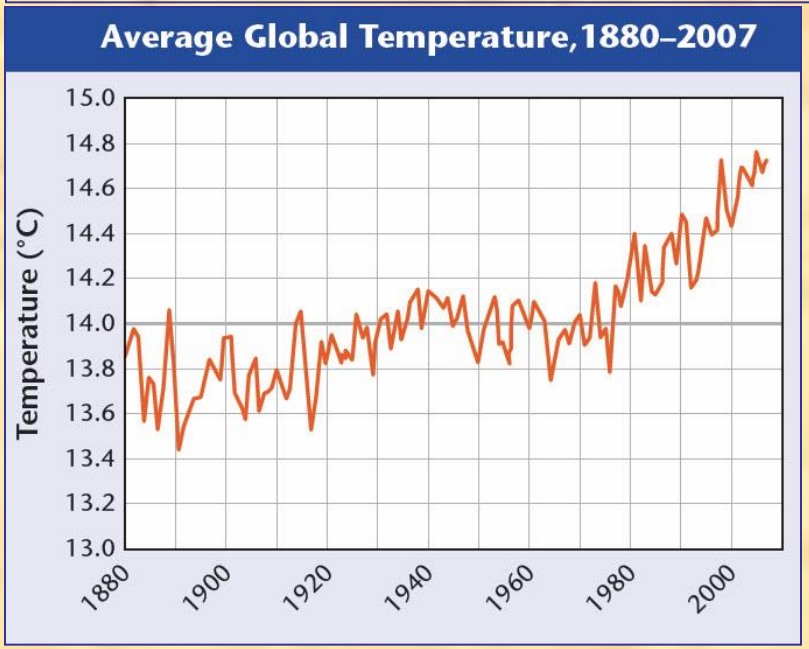
A region's **climate** is the pattern of weather conditions over a long period of time.



Climate studies track the characteristics of aspects of weather (temperature, wind speed, humidity, precipitation, and cloud cover) over a long period of time.

Climate Change and Global Warming Are Not the Same Thing

Global warming refers to an average increase in one part of weather (**air temperature**) as it affects the whole planet.



Climate change refers not only to changes in temperature but also to changes in other aspects of weather such as precipitation, wind, or the frequency and severity of storms.

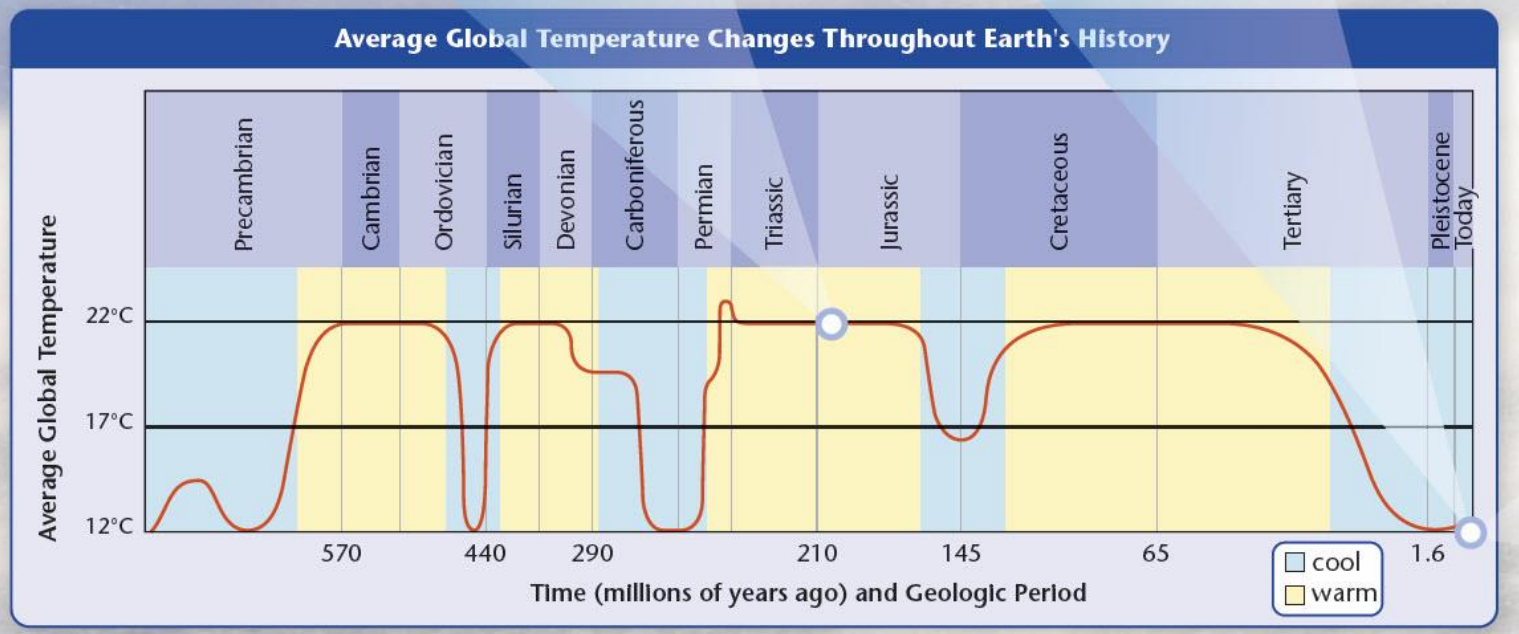
Climate has changed frequently throughout Earth's past.

Earth's climate has been different in the past. Changes can occur over millions of years or over thousands or hundreds of years. These changes can be very dramatic or relatively minor.

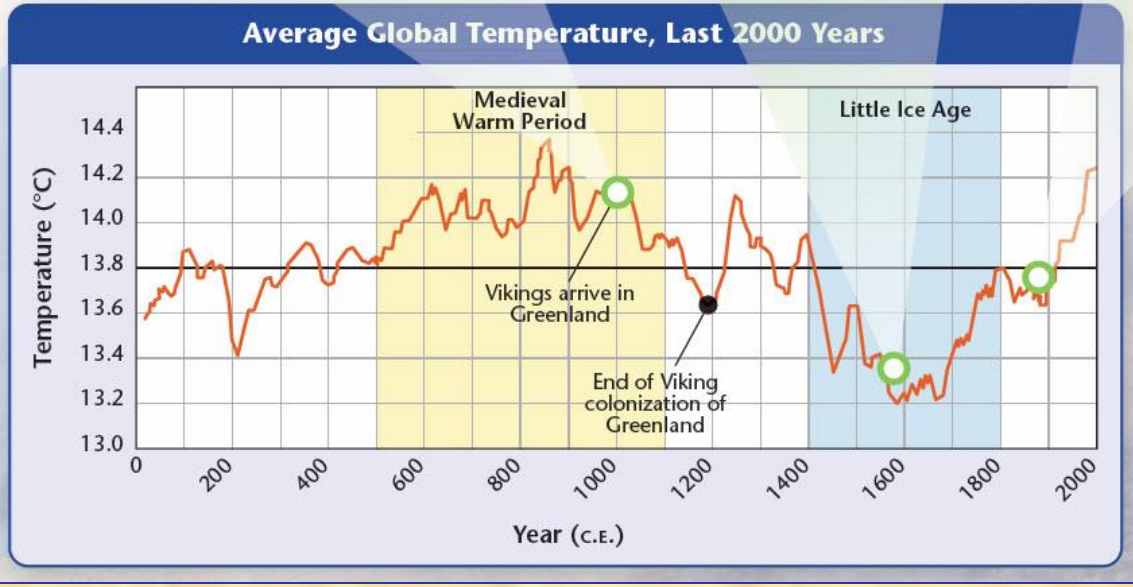
Warm Periods (Age of the Dinosaurs)

Cold Periods (Ice Ages)

Climate has changed frequently throughout Earth's past.

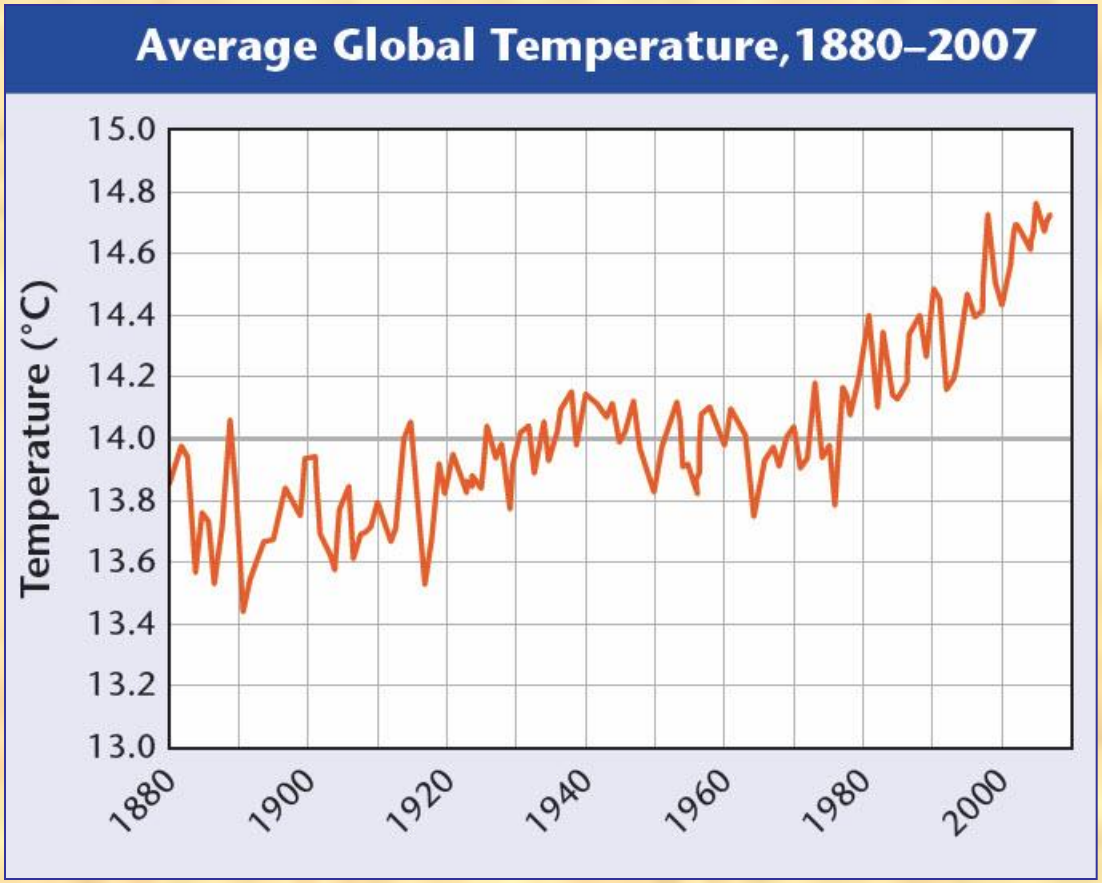


Climate has changed frequently throughout Earth's past.



Climate is currently changing around the world.

Scientists are concerned about current warming because it is occurring very quickly.



Based on their observations and the data they have analyzed, scientists have concluded that Earth's climate is being affected by human activities.

Climate is currently changing around the world.

The next three slides describe how climate has been changing in recent years with respect to three aspects of climate: **average temperature**, **precipitation**, and **severe storms**.

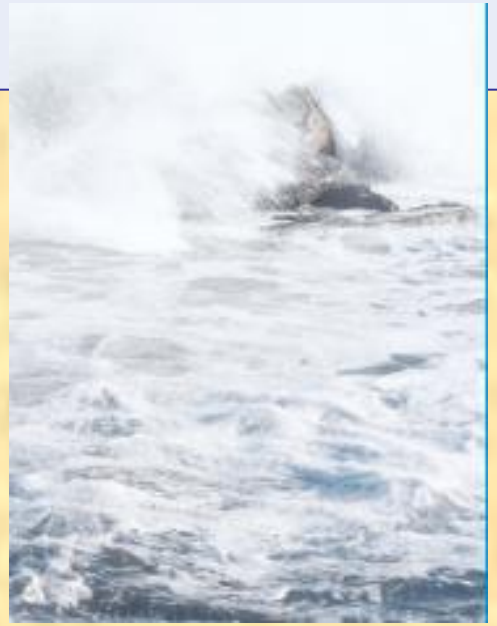
Rising Average Temperature Our planet is heating up, and it is doing so quickly. The average global temperature has risen almost 1°C since the 1800s. And scientists predict this trend will continue. Scientists estimate that Earth will warm several degrees by the next century. If this doesn't seem like such a big increase, consider this—the average global temperature during the last ice age was just 5°C cooler than it is now.

Climate is currently changing around the world.

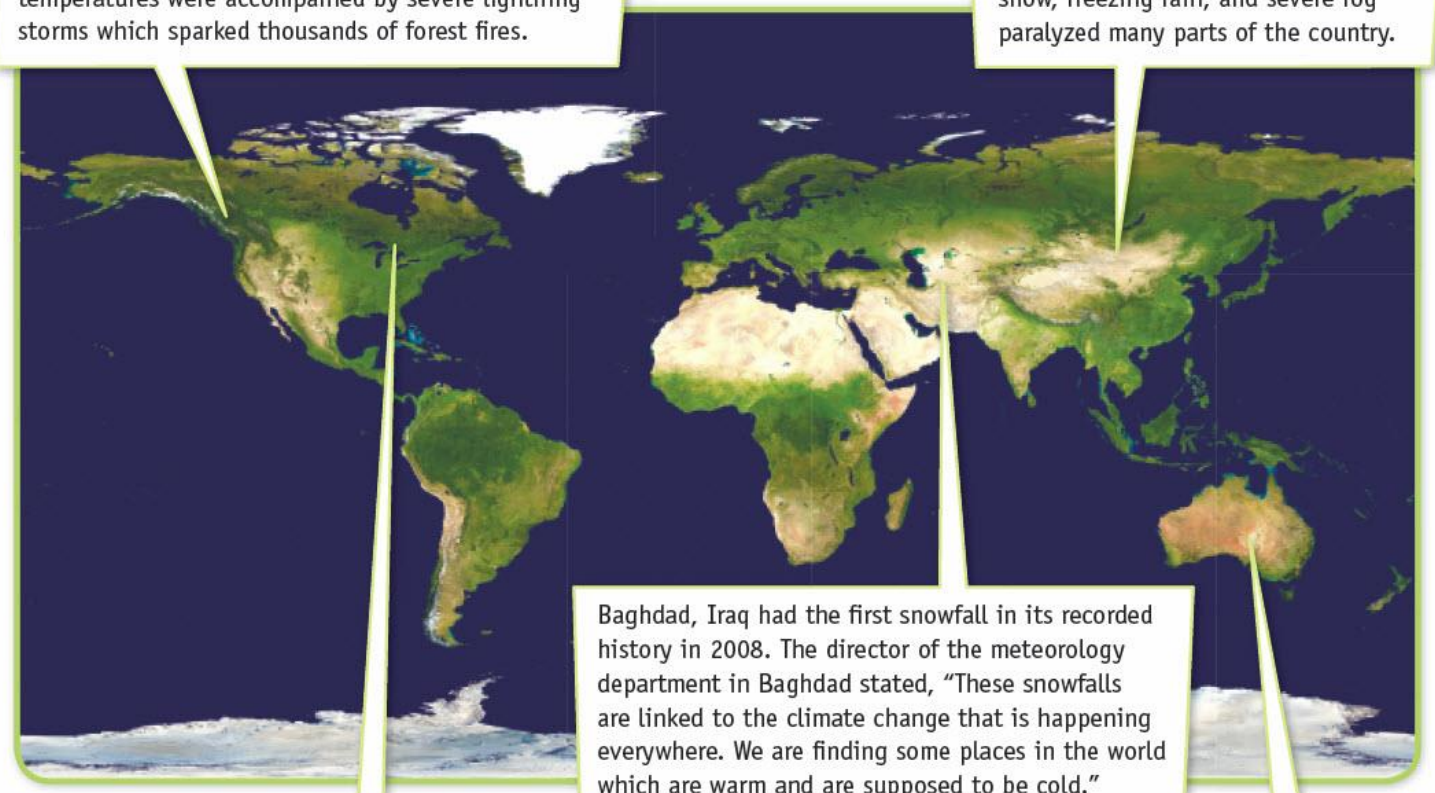
Changing Precipitation Warmer average temperatures increase evaporation. This has different effects in different regions. Closer to the equator, this generally means less rainfall. Polar regions, on the other hand, are experiencing uncommonly heavy precipitation.

Climate is currently changing around the world.

More Severe Storms As Earth's atmosphere warms, so do its oceans. This warming results in increased severity and frequency of ocean-based storms, such as hurricanes. Storms on land are also becoming more severe. For example, despite the increase in average global temperature, some regions have experienced record-breaking snowfalls over recent years.



Global Effects of Climate Change



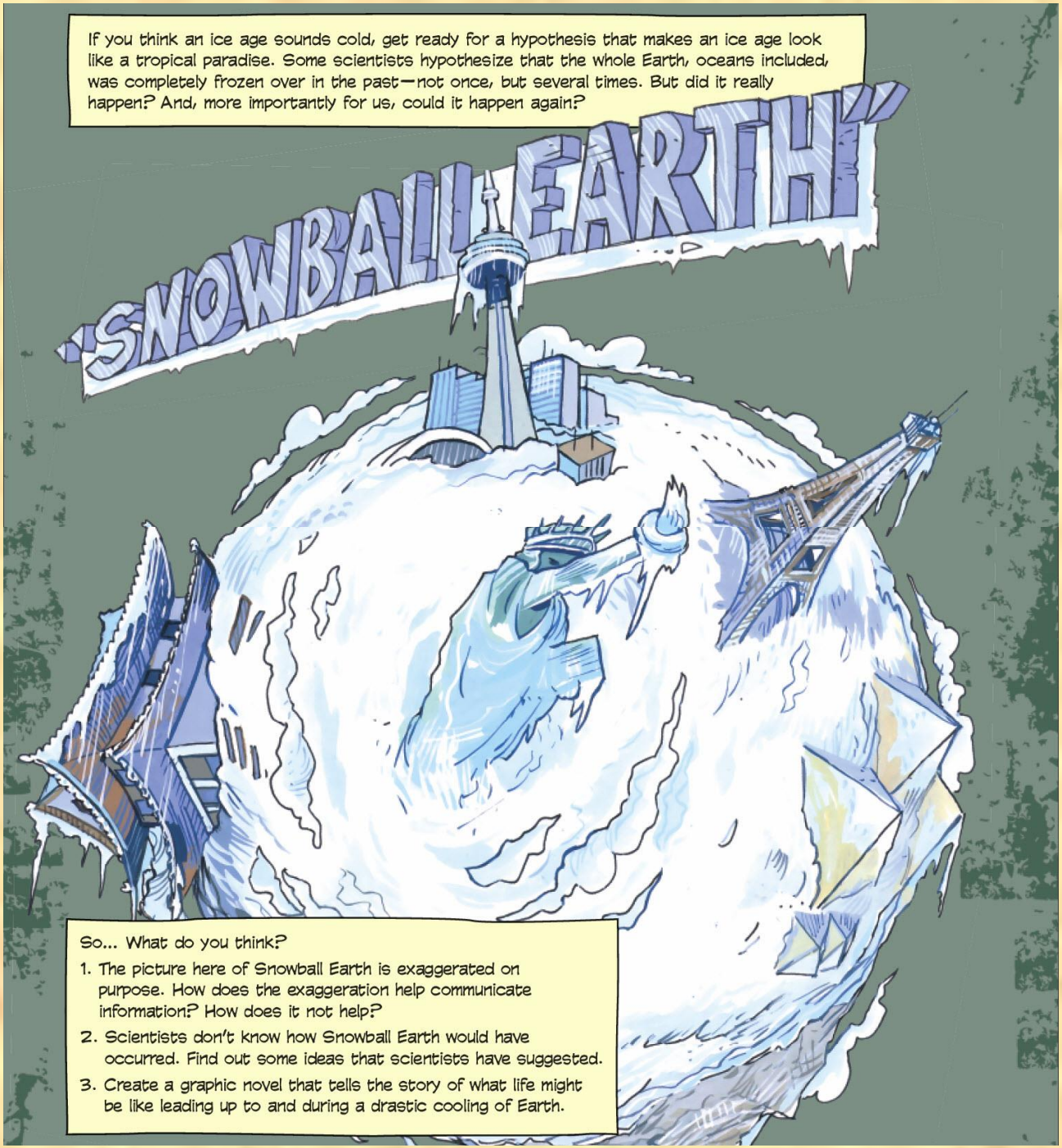
In 2009, many towns on Canada's west coast broke records with scorching summer temperatures. The high temperatures were accompanied by severe lightning storms which sparked thousands of forest fires.

In 2008, China experienced its coldest winter in 100 years. Low temperatures, snow, freezing rain, and severe fog paralyzed many parts of the country.

Baghdad, Iraq had the first snowfall in its recorded history in 2008. The director of the meteorology department in Baghdad stated, "These snowfalls are linked to the climate change that is happening everywhere. We are finding some places in the world which are warm and are supposed to be cold."

Since 1948, average annual temperatures across Ontario have increased by as much as 1.4°C. Average precipitation has also increased over this period. In northern Ontario, snow has been falling more often and in greater amounts. In the summer of 2009, regions of Ontario received record-breaking levels of rainfall. With the rain came severe storms, including several tornadoes.

Between 2001 and 2008, Australia experienced periods with little rainfall. One period was considered the least rainfall in 1000 years.



Strange Tales of Science

Topic 3.1 Review

Key concepts to be reviewed:

- Climate is different from weather, but they are also linked.
- Climate has changed frequently throughout Earth's past.
- Climate is currently changing around the world.

Topic 3.2 Where are the effects of climate change felt, and what is their impact?

(Pages 202-11)

Key Concepts

- Climate change affects aquatic ecosystems.
- Climate change affects terrestrial ecosystems.
- Both positive and negative impacts of climate change are occurring worldwide.

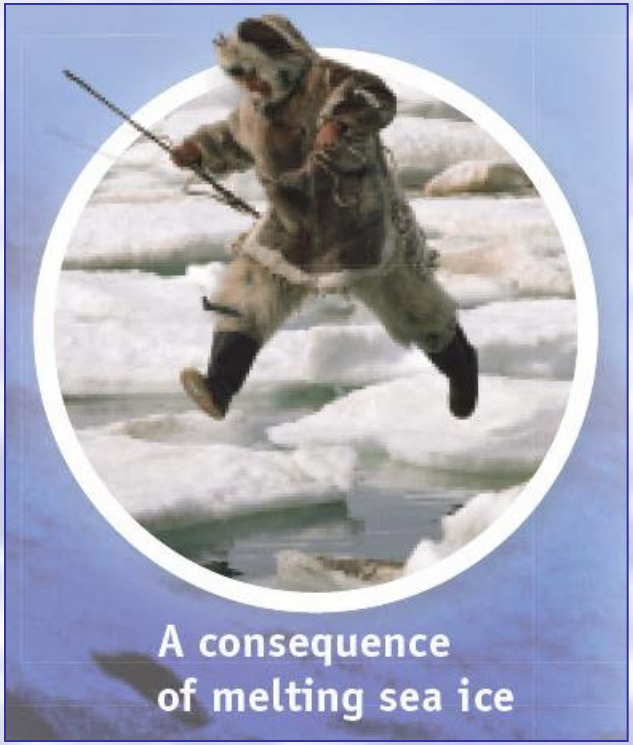
Where are the effects of climate change felt, and what is their impact?

Each day, the impacts of climate change affect millions of lives around the world.

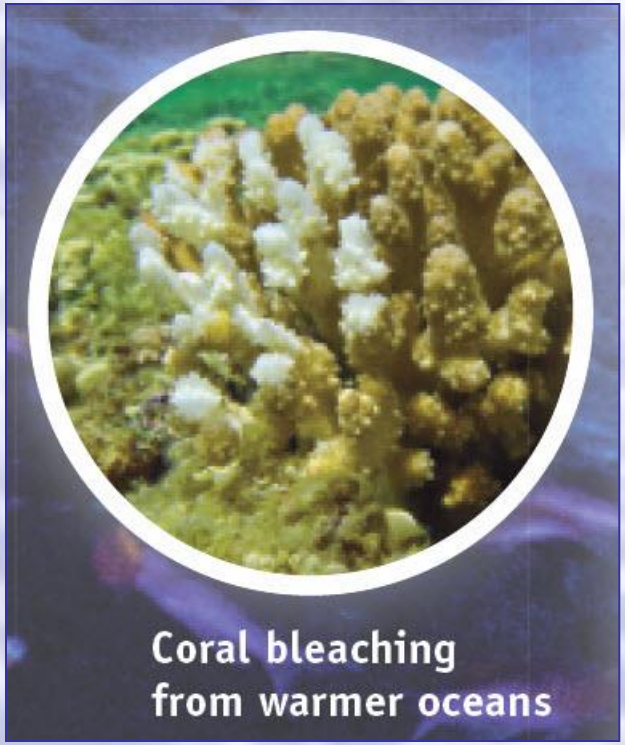
How could rising sea levels affect island nations like Tuvalu?

Climate change affects aquatic ecosystems.

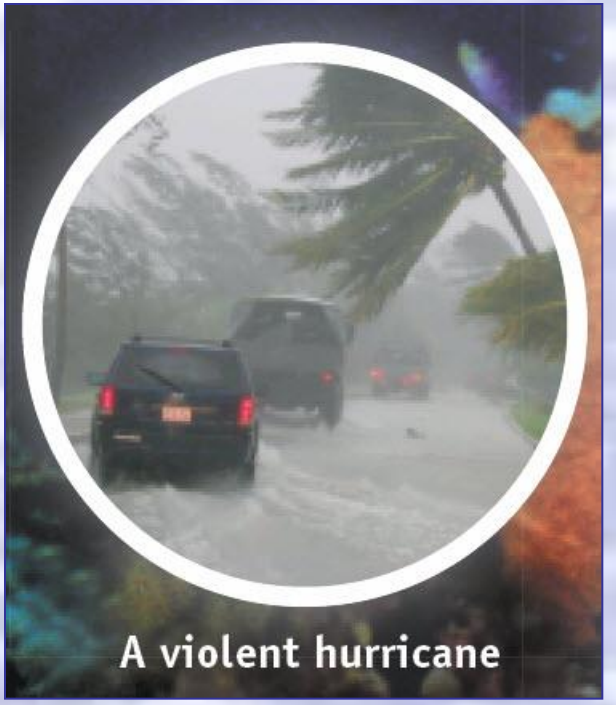
Oceans and the living things that inhabit them are being affected by climate change. The images below represent some of these effects.



A consequence of melting sea ice



Coral bleaching from warmer oceans



A violent hurricane

What impact would could each of the effects shown above have on humans and other organisms?

Climate change affects aquatic ecosystems.

Scientists are using tagged elephant seals to learn more about how climate change is affecting oceans. Each time the animal dives, the computerized tags record data about water temperature, salt level, and more.

Do you think it is right to use animals to learn more about climate change? Explain your answer.

Climate change affects terrestrial ecosystems.

Like the oceans, Earth's forests, deserts, prairies, and other terrestrial ecosystems are experiencing the impacts of climate change.

How could **melting land ice**, the **formation of new deserts**, and **more flooding** affect the organisms that live in those areas?

Climate change affects terrestrial ecosystems.

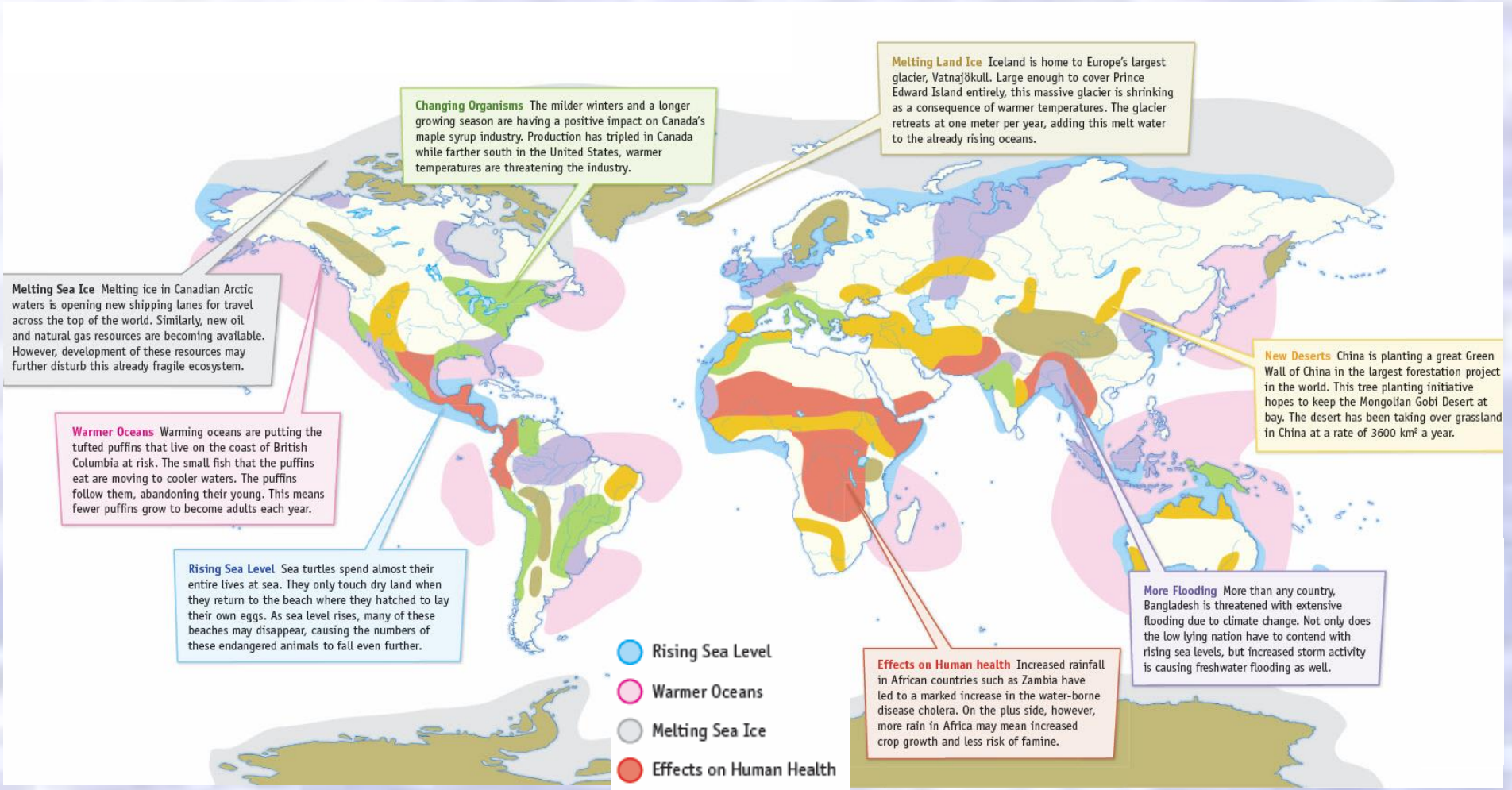
How can extreme weather events such as heat waves, floods, hurricanes, and severe storms affect human health?

Both positive and negative impacts of climate change are occurring worldwide.

Each day, the impacts of climate change affect millions of lives around the world. These impacts can be negative or positive.

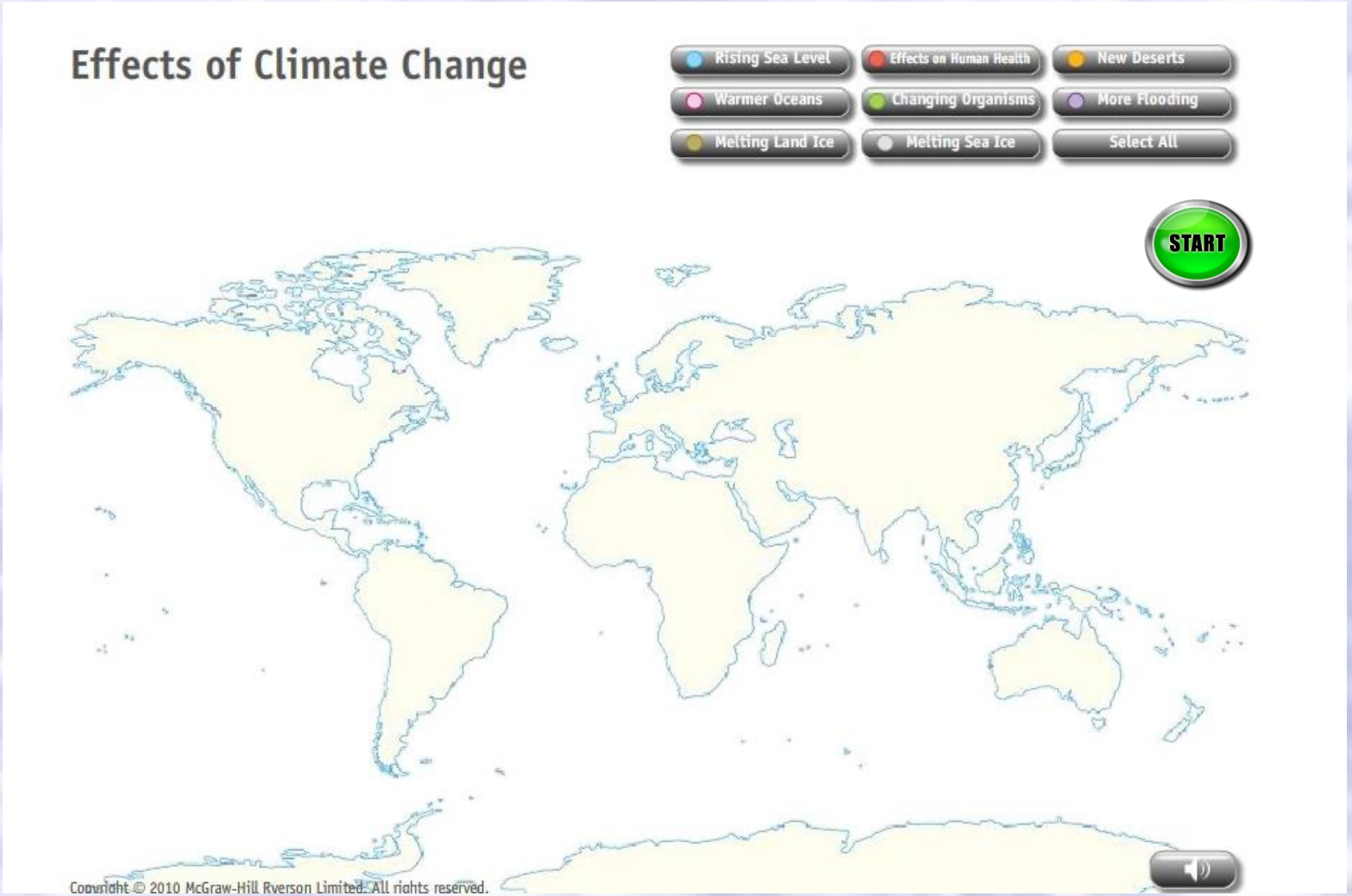
Examine the list of impacts to the left and the map on the next slide to see how different areas in the world are affected by climate change.

Negative and Positive Climate Change Impacts



Reviewing the Impacts of Climate Change

Click the "Start" button to review the impacts of climate change.



Topic 3.2 Review

Key concepts to be reviewed:

- Climate change affects aquatic ecosystems.
- Climate change affects terrestrial ecosystems.
- Both positive and negative impacts of climate change are occurring worldwide.

Topic 3.3 What natural factors affect climate, and how do they affect it?

(Pages 212-29)

Key Concepts

- Interactions of the Sun and Earth affect climate.
- The atmosphere affects climate around the world.
- The natural greenhouse effect moderates Earth's temperature, indirectly affecting climate.
- The hydrosphere affects global climate.
- Moving continents have a variety of effects on climate.
- The interaction of all natural factors affects climate in ways that are hard to predict.

What natural factors affect climate, and how do they affect it?

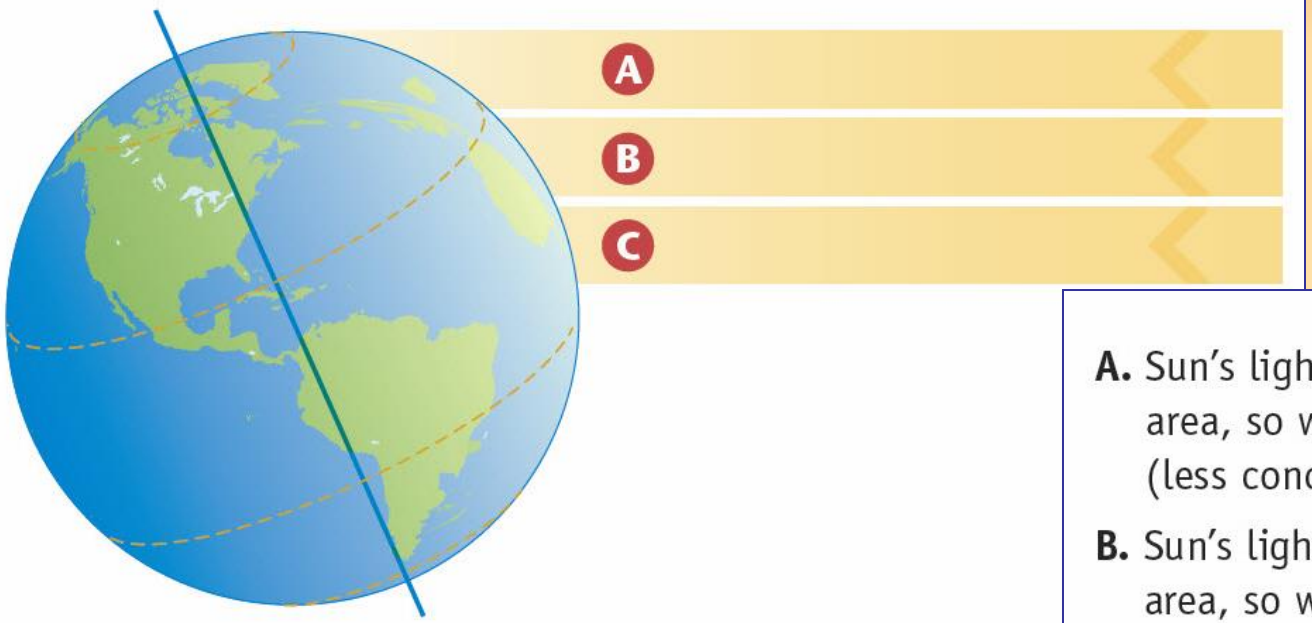
Even though the Sun is 150 million kilometres away, the energy it produces and how Earth interacts with this energy have a powerful effect on Earth's climate.

How the Sun's Energy Affects Climate

The amount of **solar energy** (light and other forms of energy) that the Sun gives off varies from decade to decade. When the Sun is very active, more energy is given off and temperatures on Earth increase. The opposite is also true. A less active Sun leads to lower temperatures.

How Earth's Curved Surface Affects Climate

Due to Earth's round shape, solar energy strikes the curved surface at different angles. As a result, the concentration of light that warms Earth's surface is unequal.



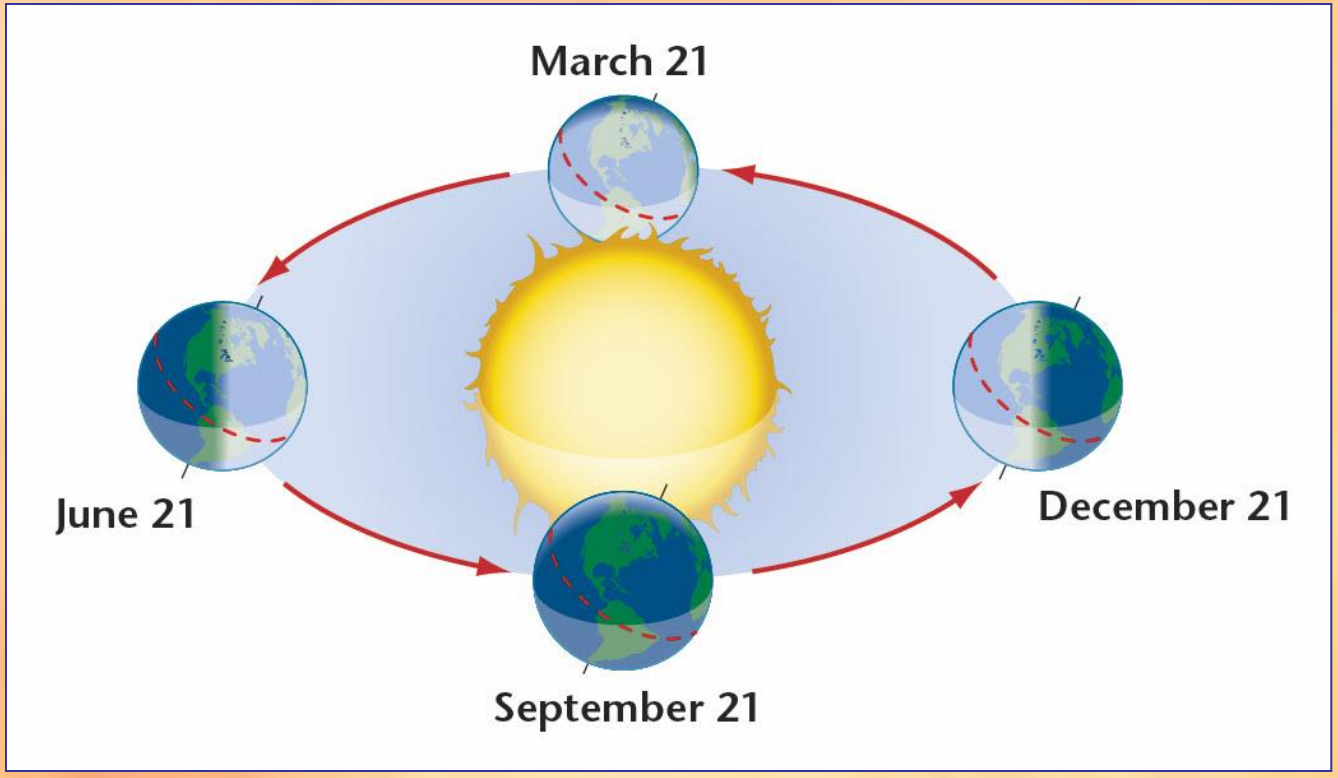
A. Sun's light is spread out over a large area, so warming is more diffuse (less concentrated).

B. Sun's light is spread out over a smaller area, so warming is more concentrated than in A, but less than in C.

C. Sun's light is very concentrated over a small area, so warming is much more concentrated than at B and A.

How Earth's Tilt Affects Climate

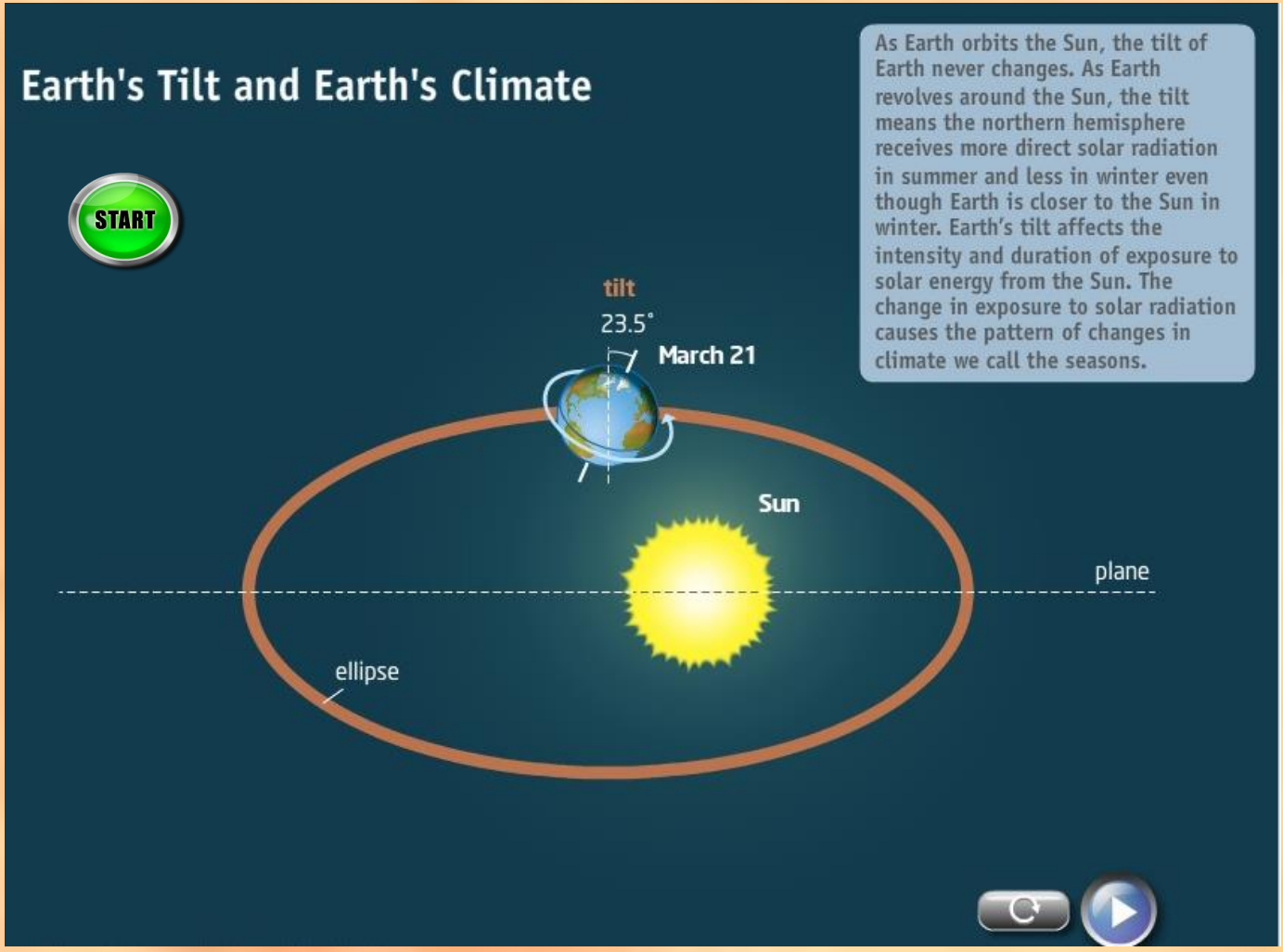
Earth's tilt causes the annual pattern of changes in climate that we call seasons.



As Earth orbits the Sun, the northern hemisphere is sometimes tilted toward the Sun. During this period we experience summer. When Earth is tilted away from the Sun, the northern hemisphere experiences winter.

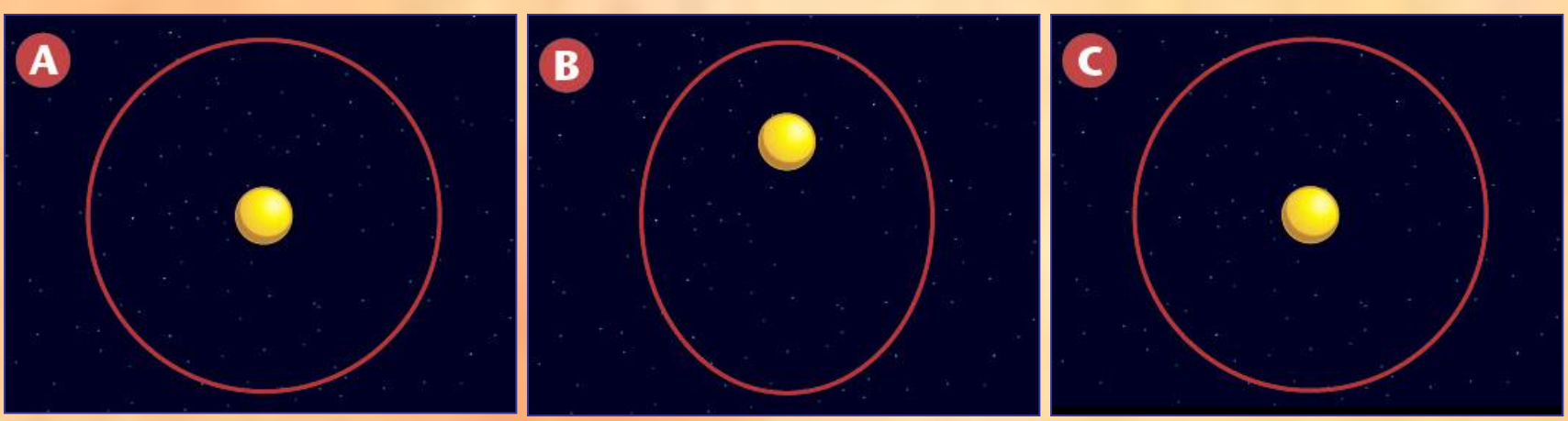
Reviewing Earth's Tilt and Earth's Climate

Click the "Start" button to review Earth's tilt and its effect on climate.



How Earth's Orbit Affects Climate

The shape of Earth's orbit affects how much solar energy our planet receives. Earth's orbit around the Sun changes over a period that lasts 100 000 years. The orbit's changes from circular to oval and back again are shown in the images below.

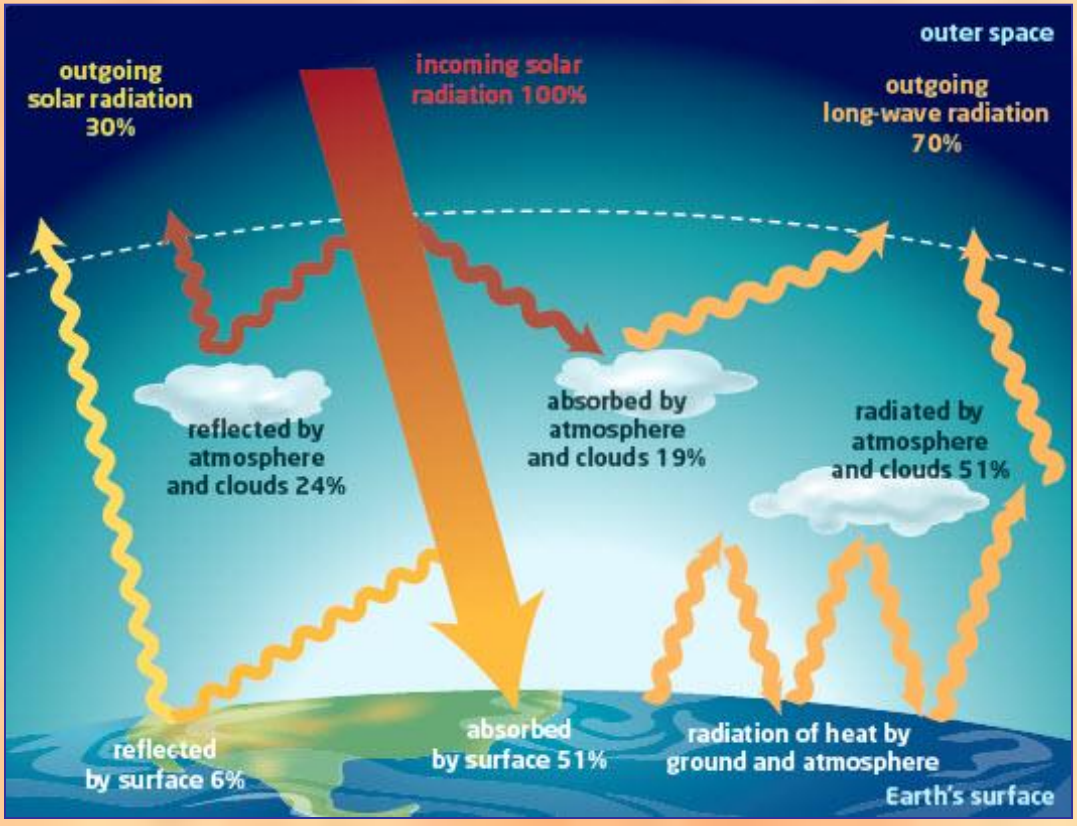


When the orbit is oval, Earth gets much more solar energy when it is nearest the Sun than when it is farther away. The length of seasons is affected by these changes.

The atmosphere affects climate around the world.

Earth's atmosphere affects climate in two major ways.

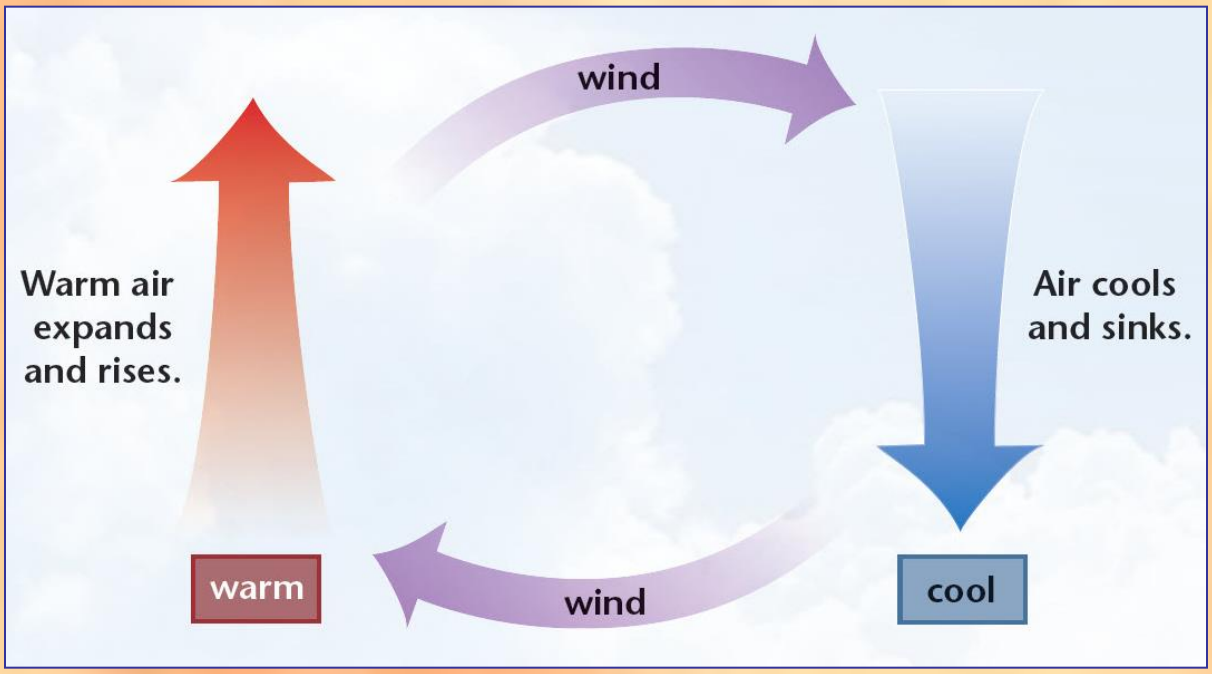
1. The atmosphere helps to moderate (even out) temperatures so they are not too extreme.



Earth's atmosphere is a **heat sink** that can absorb and store heat.

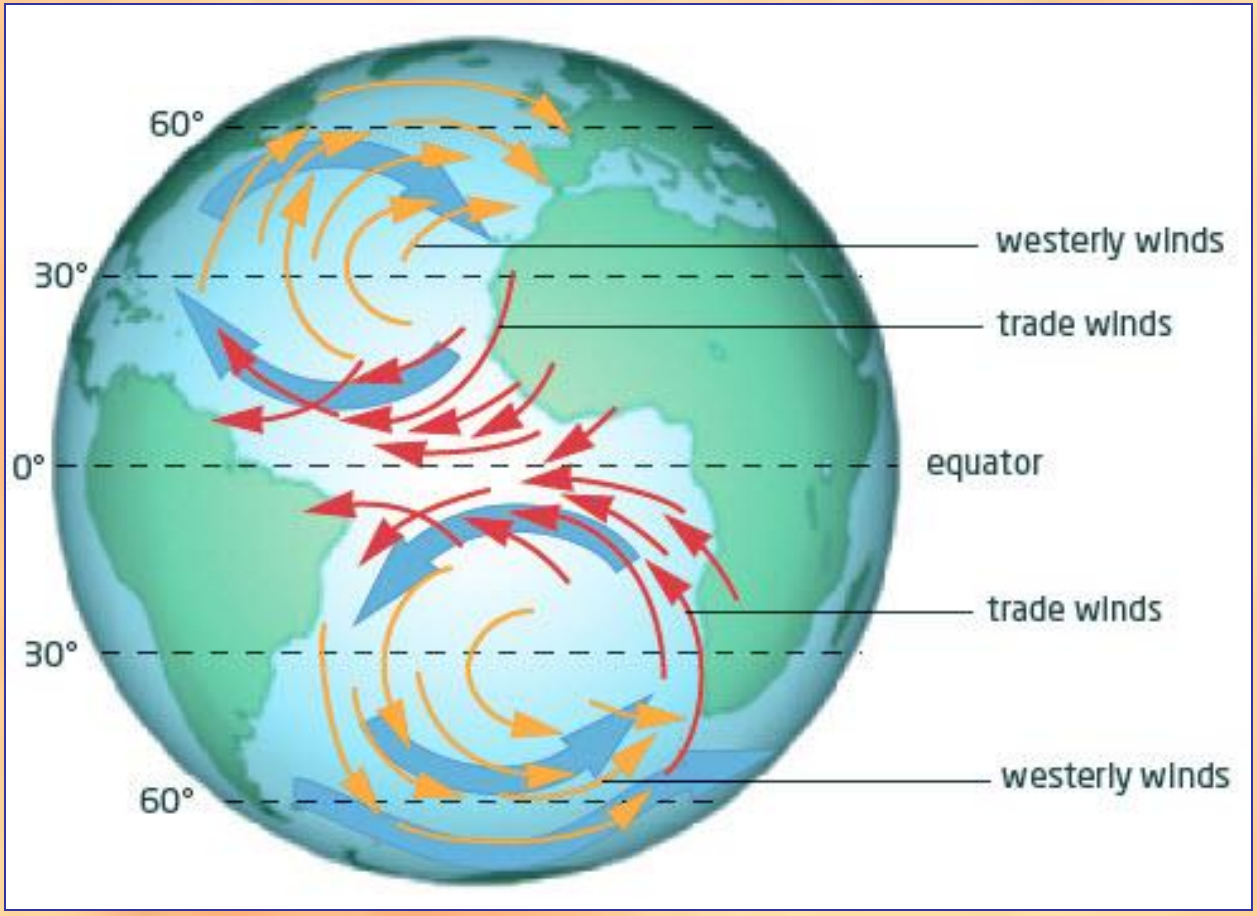
The atmosphere affects climate around the world.

2. Since Earth receives more solar energy at lower latitudes than at higher latitudes, the atmosphere heats up unevenly. This unequal heating causes air in the atmosphere to move, that is, it causes **wind**.



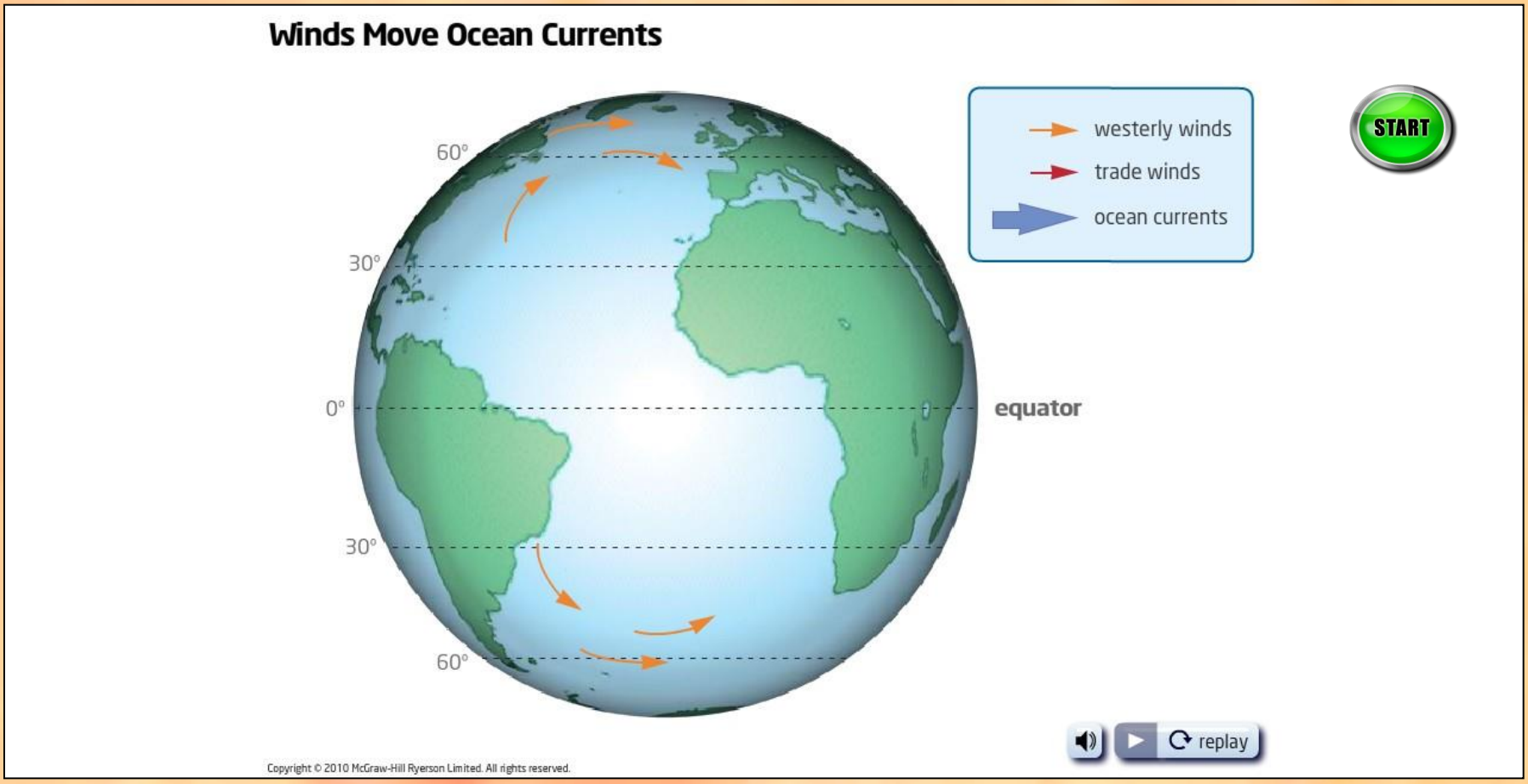
The atmosphere affects climate around the world.

Earth's winds move heat around the planet. Global wind patterns are shown below.



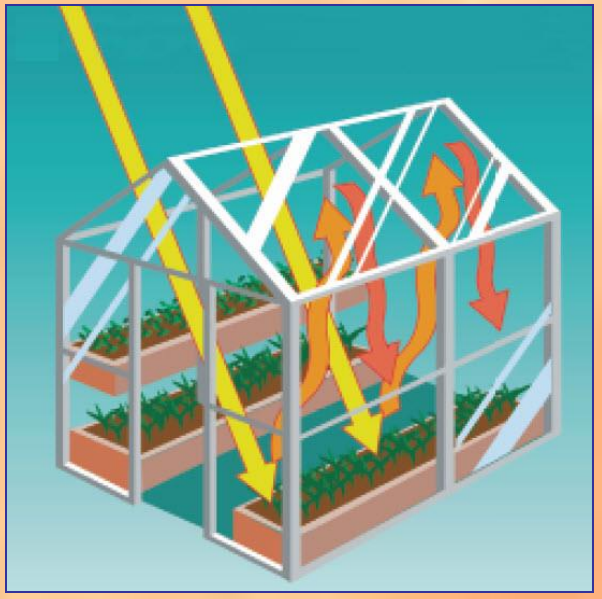
Reviewing Global Wind Patterns

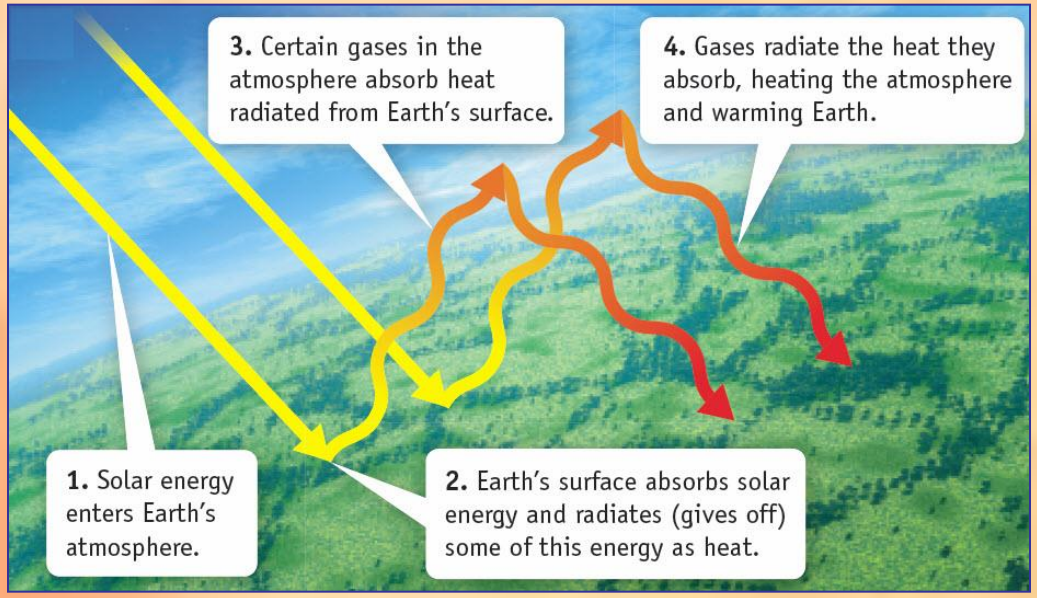
Click the "Start" button to review global wind patterns.



The natural greenhouse effect moderates Earth's temperature.

The **greenhouse effect** is a process in which certain gases in Earth's atmosphere absorb heat from the Sun and heat radiated from Earth's surface.





Certain "greenhouse gases" in Earth's atmosphere act like the glass or plastic panels in a greenhouse, letting heat into the greenhouse but not letting it out.

Natural Greenhouse Gases

Many greenhouse gases occur naturally in the atmosphere. Examples of these gases are listed on the next two slides.

Type of Greenhouse Gas	Common Sources	Other Details
water vapour	• evaporation from water • given off by plants, animals, and other organisms	• most abundant greenhouse gas • scientists believe it accounts for about 70 percent of the greenhouse effect • amount in the atmosphere varies with temperature (higher temperatures result in more water vapour) • produced during cellular respiration and certain plant processes
carbon dioxide	• living organisms • volcanoes, forest fires, decaying organisms, release from oceans	• second-most-abundant greenhouse gas • produced in and by the cells of most living organisms through cellular respiration

Natural Greenhouse Gases

Type of Greenhouse Gas	Common Sources	Other Details
methane	• certain species of bacteria and other microorganisms that live in and around bogs, wetlands, melting permafrost • certain species of bacteria that live in the gut of some animals such as cows and termites • vents and other openings in Earth's crust on land and the ocean floor	• a byproduct of certain types of cellular processes that enable some species of microorganisms to extract energy from food in the absence of oxygen
nitrous oxide	• bacteria that live in oceans and wet, warm soils such as those in the tropics	• produced when certain species of bacteria break down nitrogen-rich compounds for food

The hydrosphere affects global climate.

The **hydrosphere** is the water on Earth in all of its different forms (water vapour, liquid water, snow, and ice).

The hydrosphere, like the atmosphere, both moderates temperatures and transfers heat.

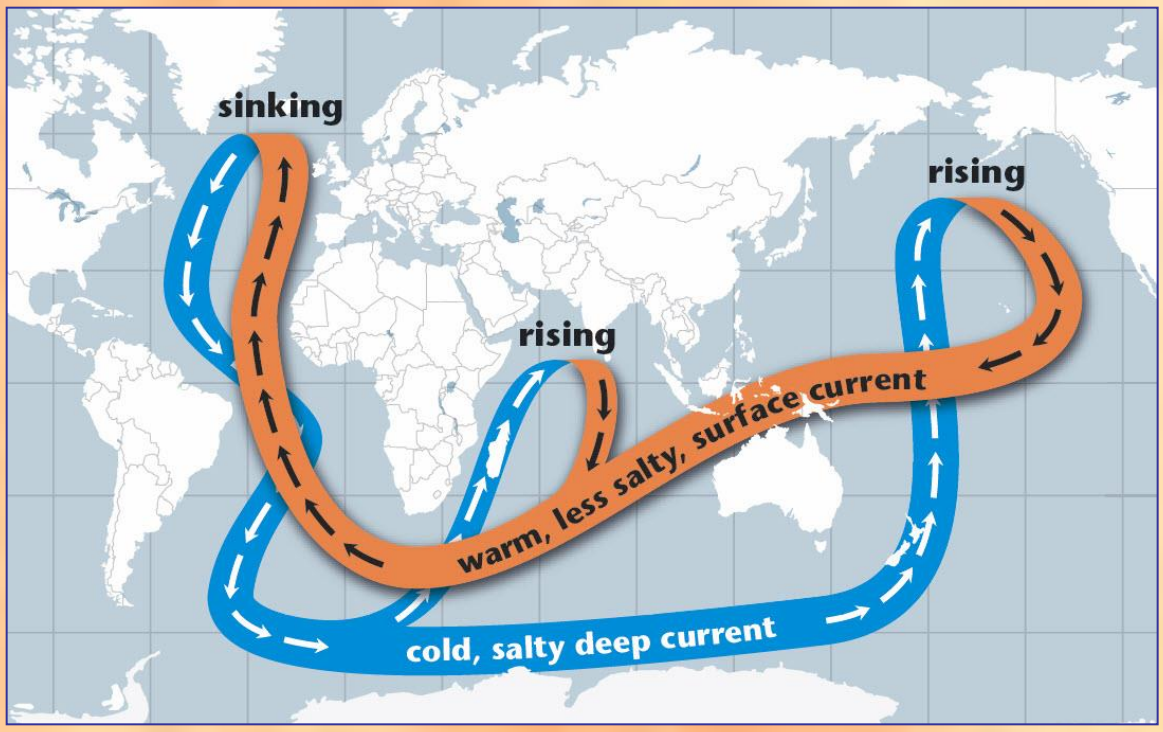
How the Hydrosphere Moderates Temperature

It takes much more heat to increase the temperature of a certain amount of water than it does to increase the temperature of the same amount of air. This means that the hydrosphere can absorb a lot of heat without causing a significant increase in air temperature.

In addition, the hydrosphere (especially oceans) acts as a **carbon sink** (an activity or mechanism that absorbs and stores carbon dioxide), thus removing large amounts of a major greenhouse gas (CO_2) from the atmosphere.

How the Hydrosphere Transfers Heat

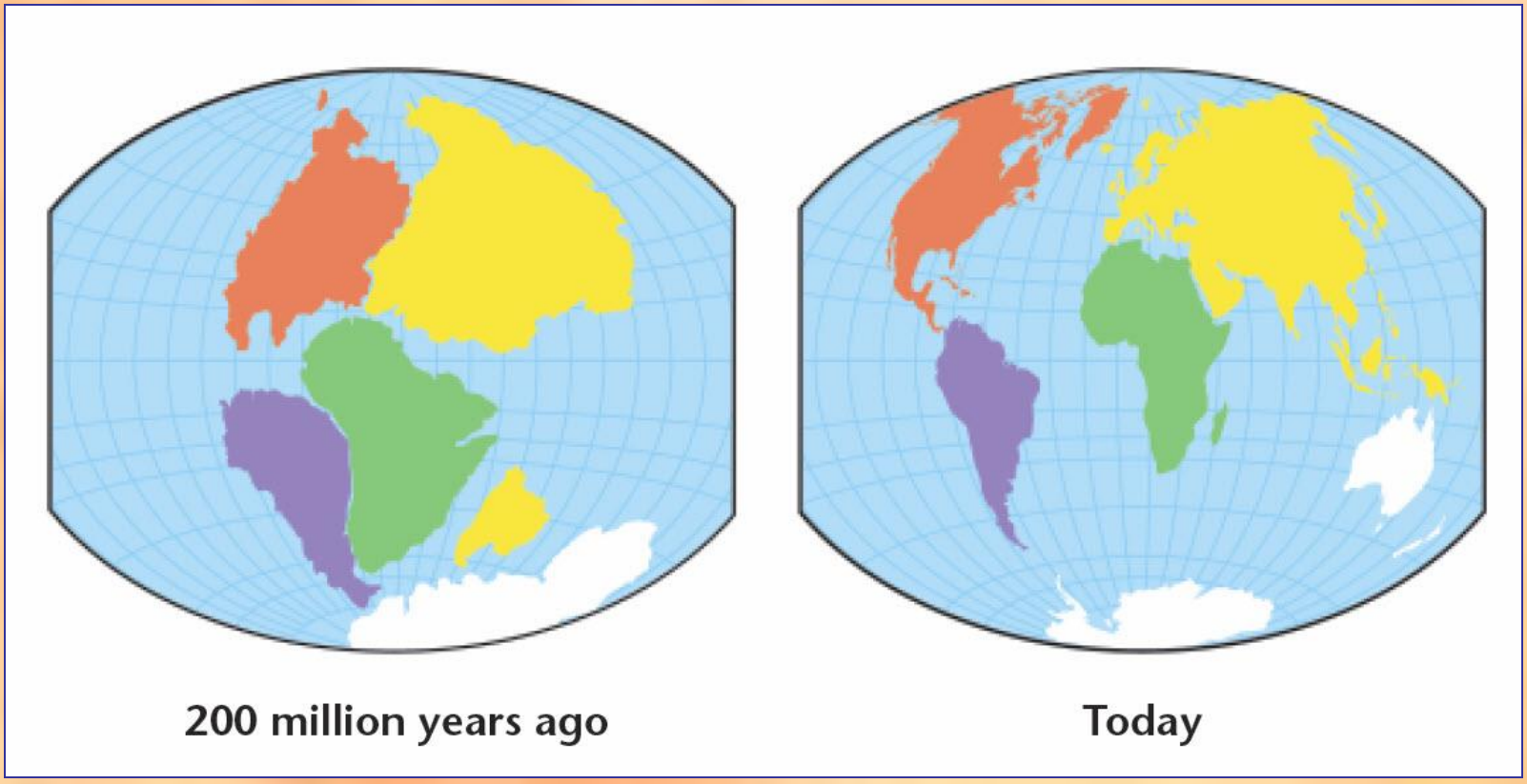
Cold water is more dense than warm water; therefore it sinks, while warm water rises. Saltier water is more dense than less salty water. Therefore *it* sinks, while the less salty water rises to the surface. These two motions in the hydrosphere produce the massive system of deep-water currents called the **great ocean conveyor belt**.



This belt of moving water carries heat around the whole world.

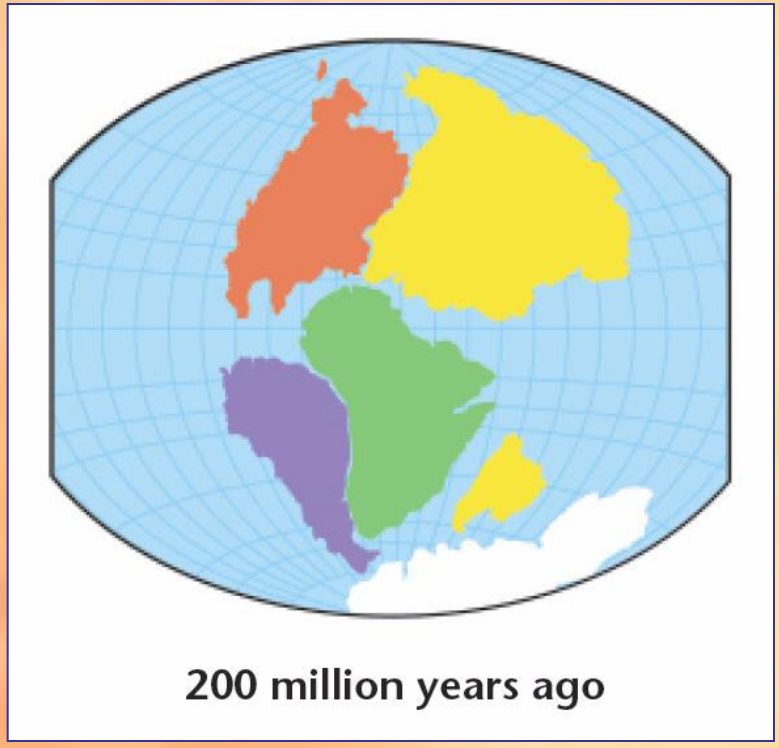
Moving continents have a variety of effects on climate.

Earth's crust and the continents that are attached to it move at a rate of about 2.5 cm a year. Over Earth's 4 billion years, these movements have been quite substantial.



Moving continents have a variety of effects on climate.

200 million years ago, when the continents were grouped together at the equator, they were much warmer. These warmer continents radiated their heat back into the atmosphere, raising global temperatures.



Moving continents have a variety of effects on climate.

Today, the continents are spread apart, and there are land masses at Earth's poles. The presence of land masses at the poles has a cooling effect on the atmosphere.

Moving continents have a variety of effects on climate.

Mountain ranges that affect the path of moisture-carrying winds are created when continent-carrying crustal plates collide. This affects precipitation, which affects climate.

Moving continents have a variety of effects on climate.

Moving continents lead to increases or decreases in volcanic activity as crustal plates move together or apart. Volcanic activity can release greenhouse gases into the atmosphere and contribute to global warming. It can also release massive clouds of dust and gas that linger in the atmosphere and block incoming solar energy. This has a cooling effect.

The interaction of all natural factors affects climate in ways that are hard to predict.

Earth's climate is a very complex system that is affected by a large variety of factors and the interactions between them. All of these interactions make it hard to predict how the climate will change in the future.

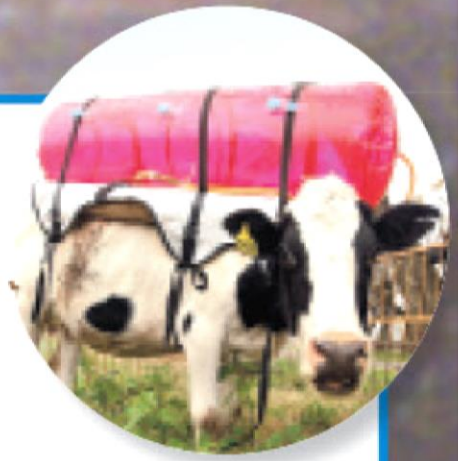
Topic 3.3 Review

Key concepts to be reviewed:

- Interactions of the Sun and Earth affect climate.
- The atmosphere affects climate around the world.
- The natural greenhouse effect moderates Earth's temperature, indirectly affecting climate.
- The hydrosphere affects global climate.
- Moving continents have a variety of effects on climate.
- The interaction of all natural factors affects climate in ways that are hard to predict.

Topic 3.4 How do human activities affect the natural greenhouse effect?

(Pages 230-41)



Key Concepts

- Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.
- Canadians add to the increase of greenhouse gases in the atmosphere.

How do human activities affect the natural greenhouse effect?

Methane, one of the most powerful greenhouse gases, is produced in large amounts by cattle when they burp or "pass gas."

We raise cattle for food, and Canada's cattle produce 72% of our emissions of methane.

What other human activities contribute to the production of greenhouse gases?

Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

The **anthropogenic greenhouse effect** is a process in which human-produced greenhouse gases in Earth's atmosphere absorb heat energy from the Sun and Earth's surface.

The anthropogenic greenhouse effect is linked to the start of the industrial revolution more than 300 years ago, and the practice of burning carbon-rich fuels like coal.

Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

Since the industrial revolution, people have been adding more and more greenhouse gases to the atmosphere.

Carbon Dioxide (CO_2)

Most anthropogenic CO_2 comes from the **burning of fossil fuels**. Fossil fuels are burned to run industrial processes, generate electricity, heat homes, and power vehicles.

In addition, logging of forests reduces the number of trees available to remove CO_2. (Burning trees also produces CO_2.)

Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

Methane (CH_4)

CH_4 is produced when bacteria break down vegetation in an oxygen-free environment. CH_4 is a greenhouse gas 25 times more potent than CO_2. Farming is the main human activity that produces methane.

Livestock produce CH_4 in their guts. Flooded rice fields produce methane when the submerged plants decompose. Garbage decomposing in landfills gives off CH_4, and so does the extraction of fossil fuels.

Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

Nitrous Oxide(NO_2)

NO_2 is 12 times more potent than CH_4, and it absorbs 300 times more heat than CO_2 does. This greenhouse gas is produced by crop and livestock farming, the use of fertilizers, and vehicle exhaust.

Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

Halocarbons

Halocarbons are the only greenhouse gases produced solely by human beings. They are industrial chemical compounds. Halocarbons are thousands of times more potent than CO_2. **Chlorofluorocarbons** (**CFCs**) are the best known. CFCs were used as solvents and as coolants in refrigerators. They were banned many years ago.

Canadians add to the increase of greenhouse gases in the atmosphere.

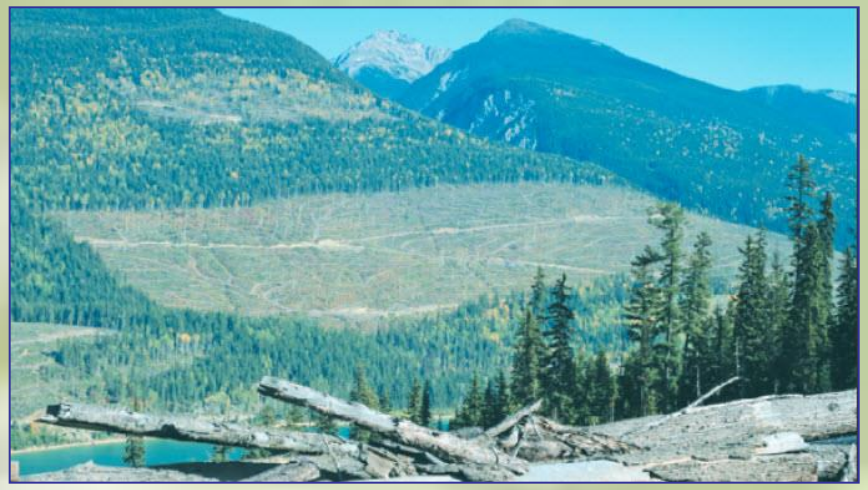
With less than 1% of the world's population, Canada contributes about 2% of the world's greenhouse gas emissions. How do Canadians contribute to greenhouse gas emissions?

Home Heating Canada is one of the coldest countries in the world. We generate a great deal of greenhouse gases as we burn wood and fossil fuels to keep our homes, schools, and workplaces warm.

Canadians add to the increase of greenhouse gases in the atmosphere.

Deforestation Forestry is a major industry in British Columbia, as well as in Ontario and other heavily forested provinces. Harvesting trees means less carbon dioxide is removed from the air by photosynthesis. Burning leftover vegetation also emits greenhouse gas.

Oil Sands The Alberta oil sands are the second-largest reserve of oil in the world. They are also the fastest-growing source of greenhouse gases in Canada. Producing one barrel of oil from oil sands generates three times as much greenhouse gas as producing one barrel of conventional oil.



Canadians add to the increase of greenhouse gases in the atmosphere.

Land Travel On average, one tree absorbs about one tonne of carbon dioxide in its lifetime. In a forested country such as ours, road construction clears a lot of trees that would otherwise absorb carbon dioxide. The cars and trucks that drive on Canadian roads also burn fossil fuels, producing carbon dioxide and nitrous oxide.

Urbanization The border between Canada and the United States is the most urbanized region in Canada. Urbanization (the spread of cities into rural areas) involves clearing land, building roads, and increased transportation. All of these activities produce greenhouse gases.

Canadians add to the increase of greenhouse gases in the atmosphere.

Industry and Manufacturing Industry and manufacturing centres such as southern Ontario produce carbon dioxide, methane, nitrous oxide, and halocarbons in various production processes.

Agriculture Clearing land for farming, using fertilizers (both natural and human-made), and raising crops and livestock all produce greenhouse gas.

Hydroelectric Dams Hydroelectric dams generate greenhouse gases. Flooding of land to build the dams and large volumes of standing water are sources of methane. The dams also produce significant amounts of carbon dioxide.

Canadians add to the increase of greenhouse gases in the atmosphere.

Coal-fired Power Plants The majority of the electrical energy produced in the Maritimes, as well as in Alberta and Saskatchewan, comes from burning coal, which releases greenhouse gas.

Landfills Landfills in numerous communities in every province and territory generate greenhouse gases. The main offender is methane.

Air Travel Canada is a country of vast distances. The fastest way to cover these distances is by plane. Unfortunately, air travel burns up large amounts of fossil fuel. It is the fastest growing source of greenhouse gas emissions globally.

Case Study: Can Biofuel Solve the Problem of Climate Change?

A **biofuel** is any fuel derived from living (or recently living) plant material. Biofuels are renewable and only release as much CO_2 as the source plants took in.

The plants used to produce biofuels are also used as food staples in many countries. Can we produce enough crops to supply both food and fuel? The mass production of biofuels from corn could lead to food shortages or cause the price of food to rise beyond what many people can afford.

Case Study: Can Biofuel Solve the Problem of Climate Change?

The clearing of forested land to grow crops to be used to produce biofuels will have the net effect of enhancing the greenhouse effect. Can you explain why?

Using nitrogen fertilizer to grow plants for biofuel generates a lot of NO_2. When this is taken into account, the production of biofuels emits more greenhouse gases than the production of fossil fuels does.

Topic 3.4 Review

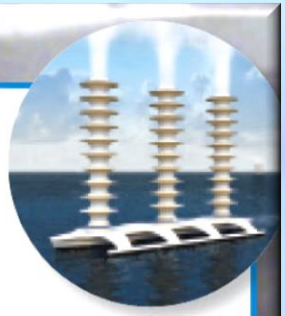
Key concepts to be reviewed:

- Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.
- Canadians add to the increase of greenhouse gases in the atmosphere.

Topic 3.5

How can we assess present climate change and reduce our impact?

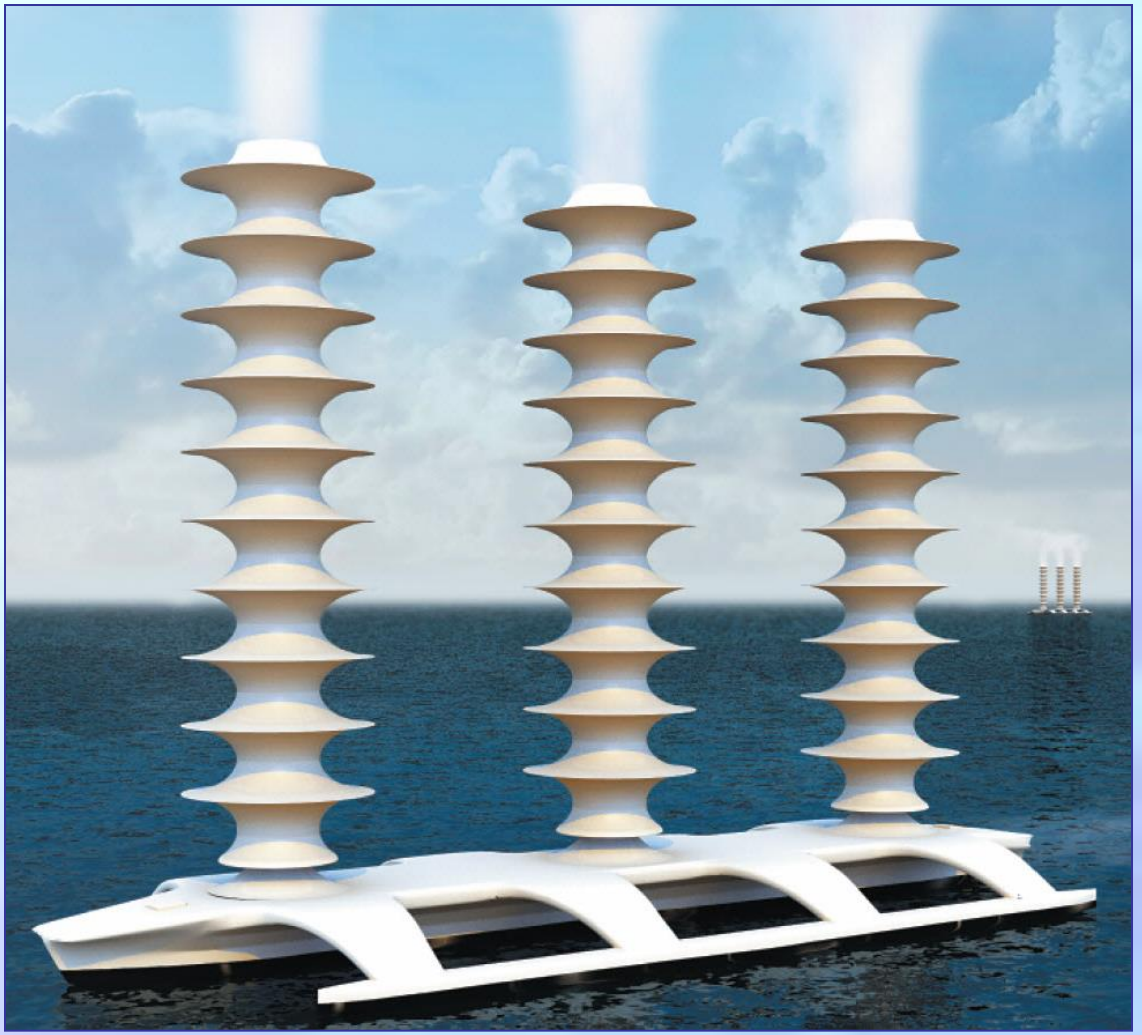
(Pages 242-59)



Key Concepts

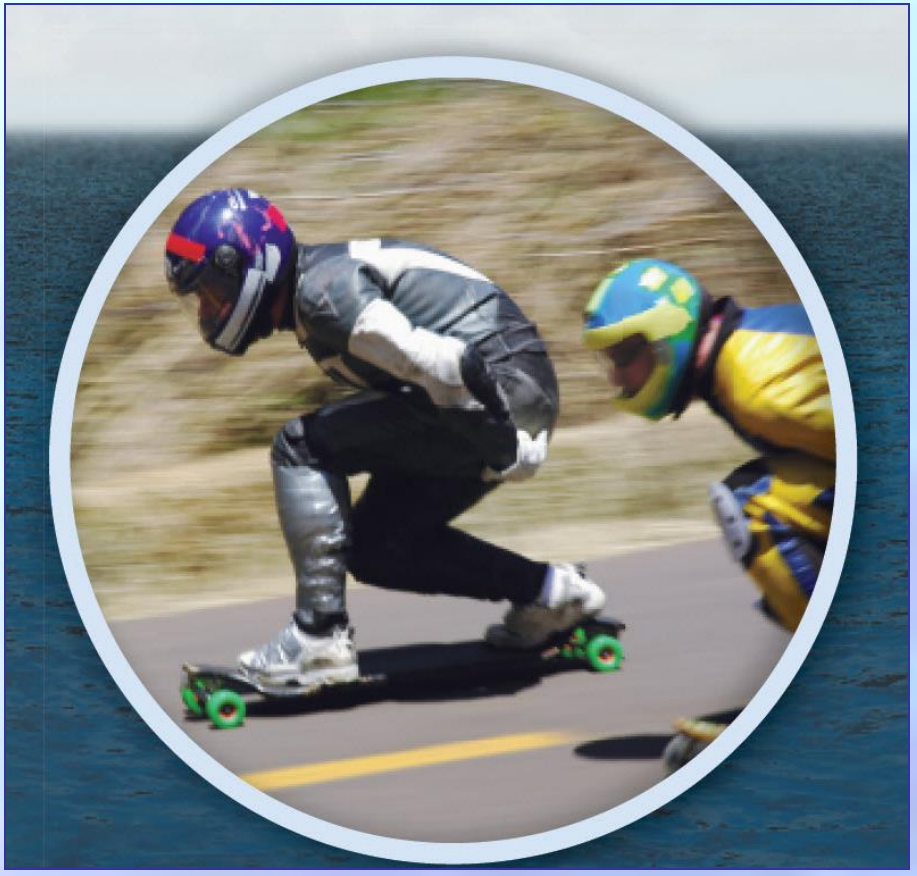
- Studying past climates helps us understand how climate changes over time.
- We use various instruments to collect data to help us assess present climate change.
- We use computer models and projections to estimate future climate change.
- We can use our ingenuity to reduce our impact on climate change.
- We can make personal choices that reduce our impact on climate change.

How can we assess present climate change and reduce our impact?



One proposed solution to reduce climate change is to build fleets of large ships that spew salt water into the atmosphere. The particles in salt water would help form heat-reflecting clouds in the lower atmosphere.

How can we assess present climate change and reduce our impact?

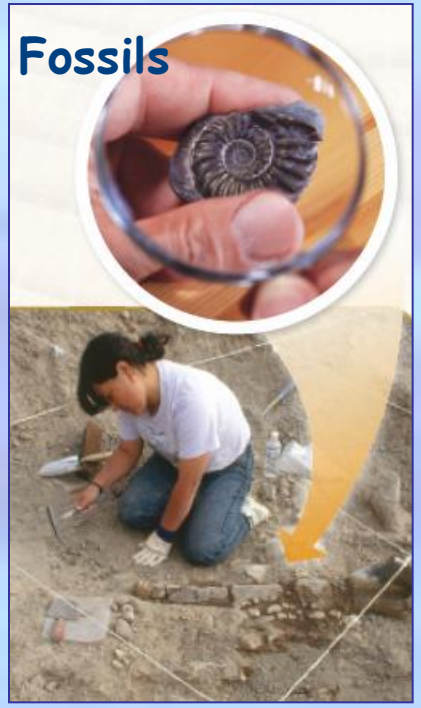


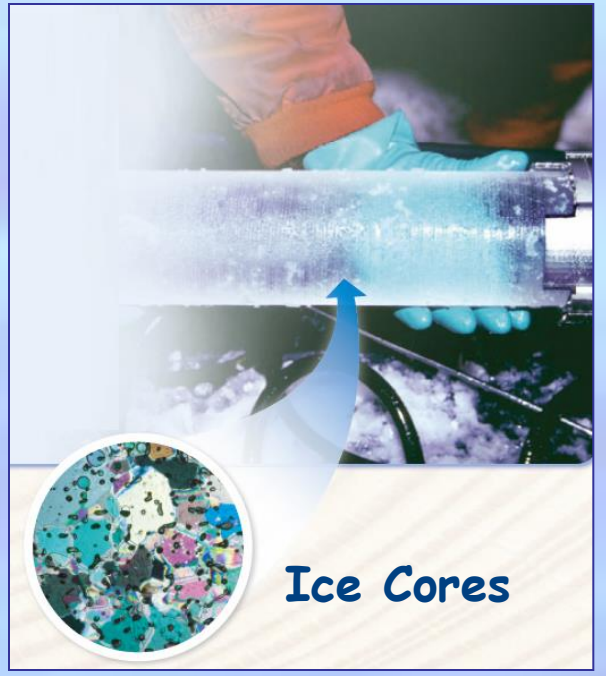
Some innovators propose constructing skateboards, furniture, doors, and other products from biodegradable, sustainable materials that produce fewer greenhouse gases.

Many of these products are currently made from materials that come from petroleum products, a source of greenhouse gases.

Studying past climates helps us understand how climate changes over time.

Scientists often look to the past to help them understand today's climate. By identifying how and when Earth's climate changed in the past, they gain a better understanding of how today's climate responds to change. The best sources of information about past climate are **trees**, **ice**, and **fossils**.



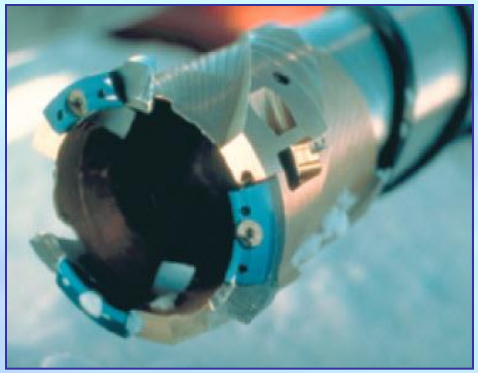


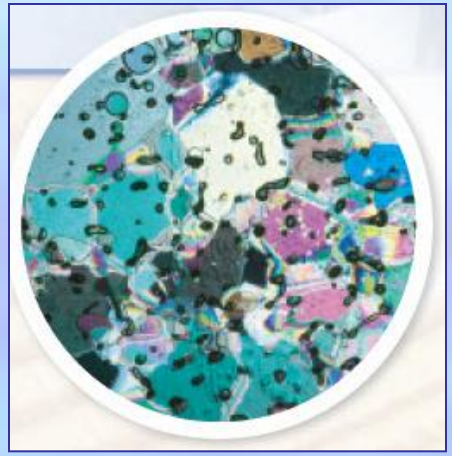
Studying past climates helps us understand how climate changes over time.

1. Tree Rings Tree rings help scientists piece together climate events in the past such as drought, flooding, and forest fires. As a tree grows, it adds two new layers of wood under its bark each year. These layers of wood are visible to us as tree rings. The light-coloured ring represents rapid spring growth, when growing conditions are more favourable. The dark-coloured ring represents slower summer growth, when conditions are drier and hotter. A skilled observer can "read" the size, shape, and colour of the rings to infer what was happening in the environment as the tree was growing. Since trees can be hundreds (and sometimes thousands) of years old, tree rings are a valuable source of information about the recent past.

Studying past climates helps us understand how climate changes over time.

2. Ice Cores If researchers want to know what Earth's climate was like 100 000 years ago, trees can't help. Instead, they need to head to Earth's polar regions. Permanent ice fields in the Arctic and Antarctica have existed for hundreds of thousands of years. Each year, a new thin layer of ice is deposited. Each ice layer holds a record of what the atmosphere was like when the ice formed. This record of the past can be retrieved with special drills that take core samples from the ice. Dust and ash trapped in the ice indicate events such as volcanic eruptions and forest fires. Plant pollen tells the species of plants alive at the time. Temperature and humidity can be inferred from the size and shape of the ice crystals. Air bubbles trapped in the ice can be analyzed to show how much oxygen, carbon dioxide, and other gases were in the atmosphere at the time the ice formed.





Studying past climates helps us understand how climate changes over time.

3. Fossils The oldest ice on Earth is about one million years old. To learn what Earth's climate was like farther in the past, scientists can use the remains or traces of ancient organisms: fossils. Because all organisms are adapted to their environment, the type of fossil in a certain place tells scientists what the climate must have been like there during that period. For example, a fossil of a tropical fish found in the rock of an Arctic island would tell scientists that climate for that island in the past was much warmer than it is now. Even the layers of the rock in which fossils are found provide a record of climate change, because climate affects the way that some rocks form.

We use various tools to collect data to help us assess present climate change.

Scientists use many tools to record the daily state of the hydrosphere and aspects of Earth's climate. Direct measurements of temperature, humidity, precipitation, and other data have been collected for about 200 years.

Weather balloons carry mini weather stations that measure the **temperature**, **air pressure**, and **humidity** at different heights—up to 30 000 m. Tracking the balloon also provides information about **wind direction** and **speed** at different altitudes.

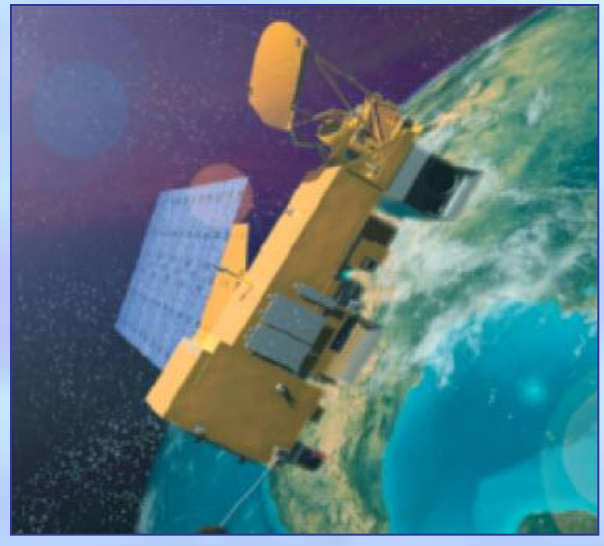
We use various tools to collect data to help us assess present climate change.

Weather radar's main function is to detect **precipitation** that is forming inside clouds and, thus, to track storms.

Pulses of microwaves bounce off water droplets and ice crystals in the atmosphere back to a receiver on Earth. Computers then analyze the data.

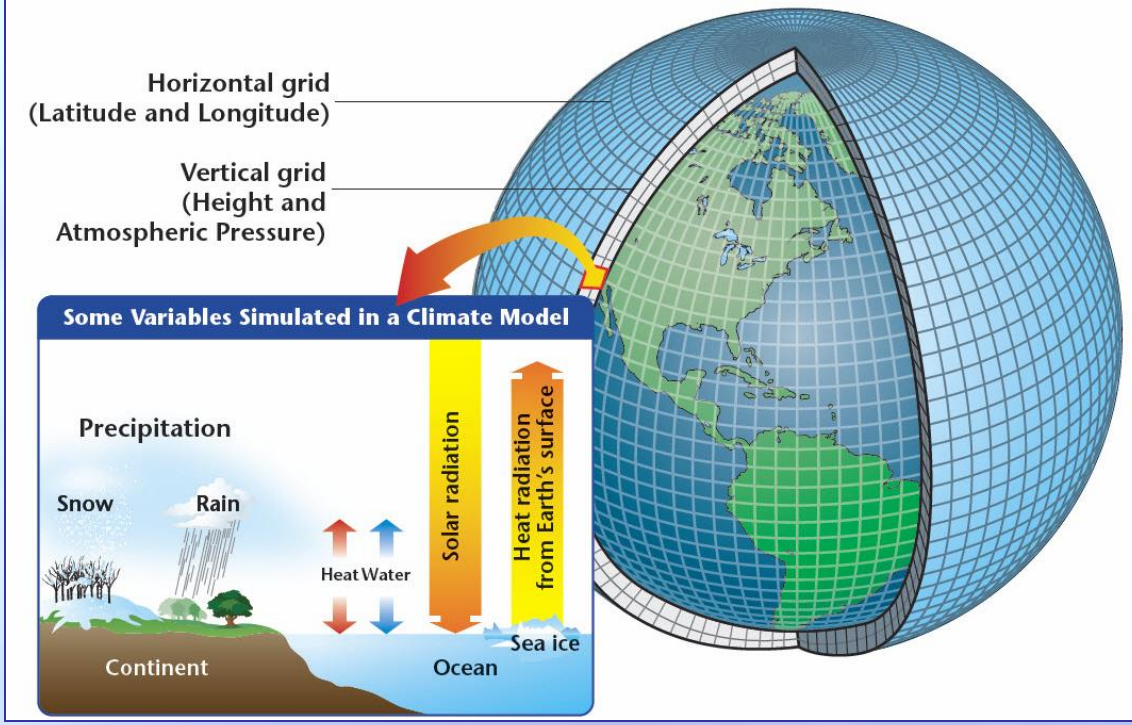
We use various tools to collect data to help us assess present climate change.

Climate-related satellites launched into space make up the **Earth Observing System (EOS)**. The satellites monitor changing conditions on land and in the atmosphere.



We use models and projections to estimate future climate change.

Climate scientists depend on computer models to help them understand trends in global climate change.

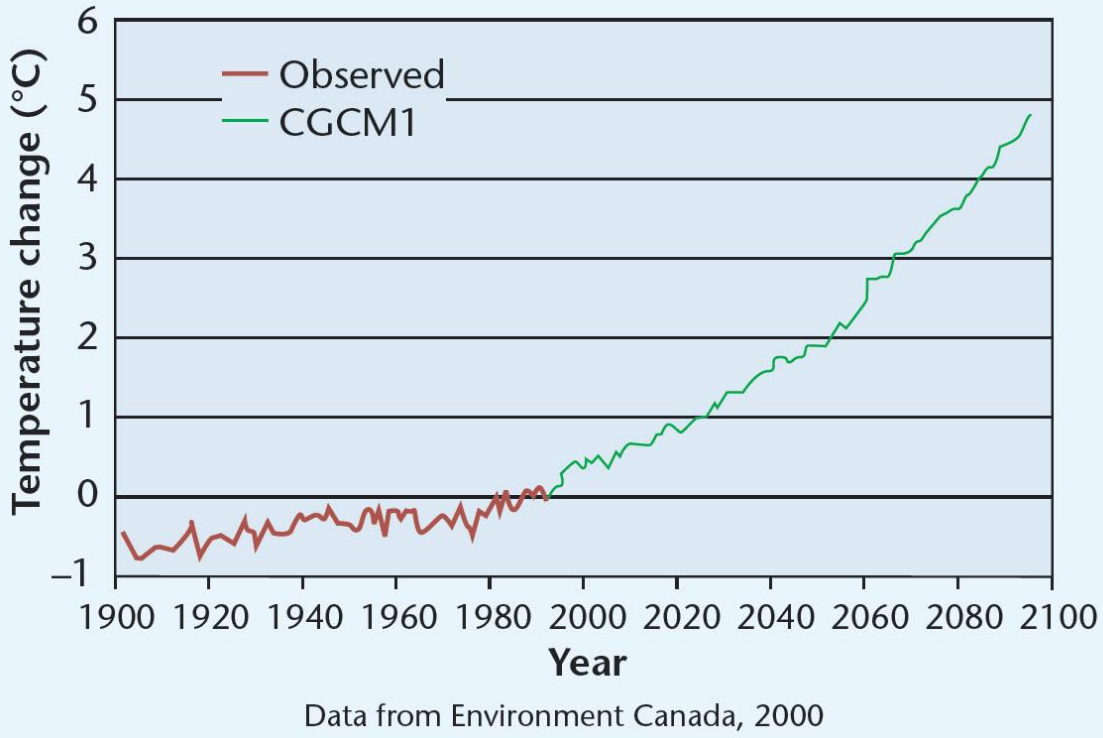


The **global climate model** is a computer program that uses mathematical equations to help scientists understand and estimate changes in Earth's climate.

The model considers interactions of winds, temperature, humidity, and other climate-related factors.

Uncertainties in Climate Models

Using climate models to make predictions about future climate changes can be tricky because of the uncertainties involved. It is impossible to take every climate variable (and its impact on other variables) into account.



Data from Environment Canada, 2000

It is uncertain how natural systems will respond to change.

We are also uncertain about how humans will behave in the future.

We can use our ingenuity to reduce our impact on climate change.

Human ingenuity may or may not have the desired results with respect to solving the problem of climate change. The next two slides show innovations that have been proposed and invented.

Carbon-Capturing Bacteria

In Quebec, Canadian scientist Dr. Sylvie Fradette is using a protein produced by a type of bacteria found in the human colon to keep Earth cool. The bacteria capture carbon dioxide from industrial smokestacks. The protein helps transform carbon dioxide into calcium carbonate. The calcium carbonate can be collected from a filter in the smokestack and used in other industrial processes.

We can use our ingenuity to reduce our impact on climate change.

CO_2 Removing Artificial Trees

Artificial trees (the paddle-shaped structures in this photo) would remove carbon dioxide from the atmosphere, faster and in larger amounts than real trees do. Once captured, what do we do with all this carbon dioxide? Burying it may be the answer. It's already being dealt with this way in Saskatchewan, where 30 millions tonnes are buried each year.

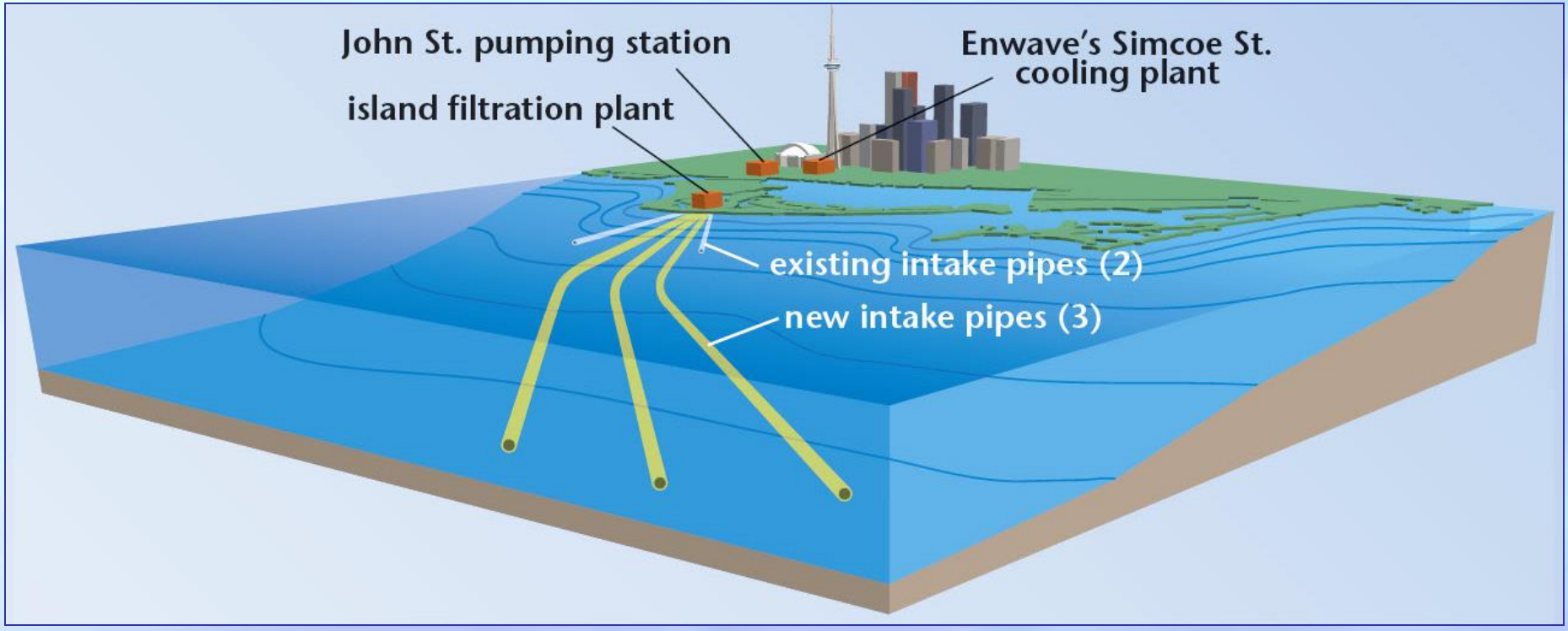
We can use our ingenuity to reduce our impact on climate change.

Zero Emissions Houses

Riverdale NetZero is a house in Edmonton, Alberta that is completely self-sufficient. It's called a NetZero house, because it produces all the energy that it needs—even more, in fact—mainly through solar power generation. The house is built with local materials that are renewable.

We can use our ingenuity to reduce our impact on climate change.

Deep Water Cooling Systems



Using icy water from deep in Lake Ontario to cool city buildings during the summer could reduce summer energy use by 90%.

We can use our ingenuity to reduce our impact on climate change.

Clotheslines to Dry Clothes

Not all innovations are high-tech, and not all need to be invented. Here's a simple, old device that's reducing greenhouse gas emissions in backyards and off balconies across Canada—the old fashioned clothesline.

We can use our ingenuity to reduce our impact on climate change.

Painting Roofs White

Painting the roofs of houses and apartments white and using reflective pavement in the world's 100 largest cities could drop Earth's temperature several degrees. How does it work? White roofs reflect solar energy, cooling the planet. As an added plus, the cooling effect of white roofs cuts down on air conditioning too, reducing greenhouse gas production.

We can make personal choices that reduce our impact on climate change.

Individuals can choose to act in ways that harm our environment or in ways that heal it.

A **carbon footprint** is the total amount of greenhouse gas emissions caused by an individual, company, or organization.

How does riding a bike reduce your carbon footprint?

We can make personal choices that reduce our impact on climate change.

The products you choose to buy may or may not have an impact on climate change.

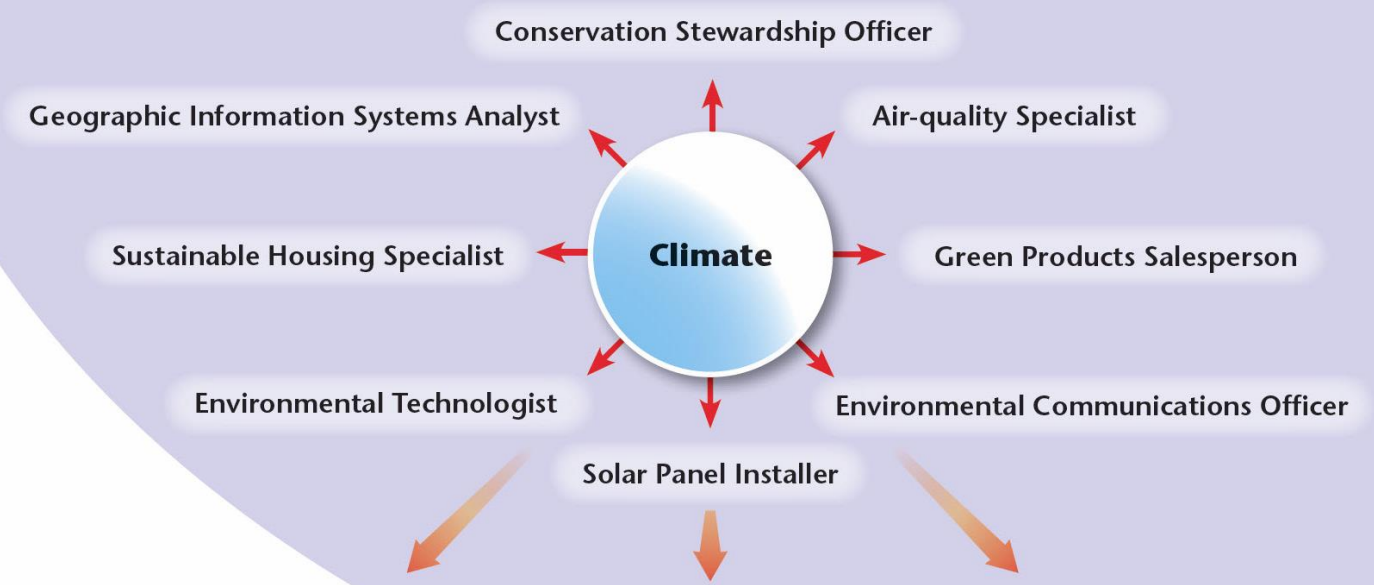
What product-buying choices can you make to reduce your carbon footprint?

Assessing Climate Change Articles

When reading newspaper, magazine, or internet articles about climate change, how can you determine whether the information is accurate and/or biased toward a certain point of view?

Put Science to Work

The study of climate contributes to these careers, as well as many more!



▲ Environmental technologists gather soil, air, and water samples, inspect pollution control systems, and check to see if companies are following environmental laws.

▲ Solar panel installers must train as residential electricians or as mechanical engineers or roofers. They must also know the regulations in Ontario's *Clean Energy Act*.

▲ Environmental communications officers use their written, verbal, and interpersonal skills to promote public awareness of environmental issues.

Topic 3.5 Review

Key concepts to be reviewed:

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