A Students Guide to GLOBAL CLIMATE CHANGE

Learn the Basics

See the Impacts

Think Like a Scientist

Be Part of the Solution!

Explore the Issues of Climate Change!

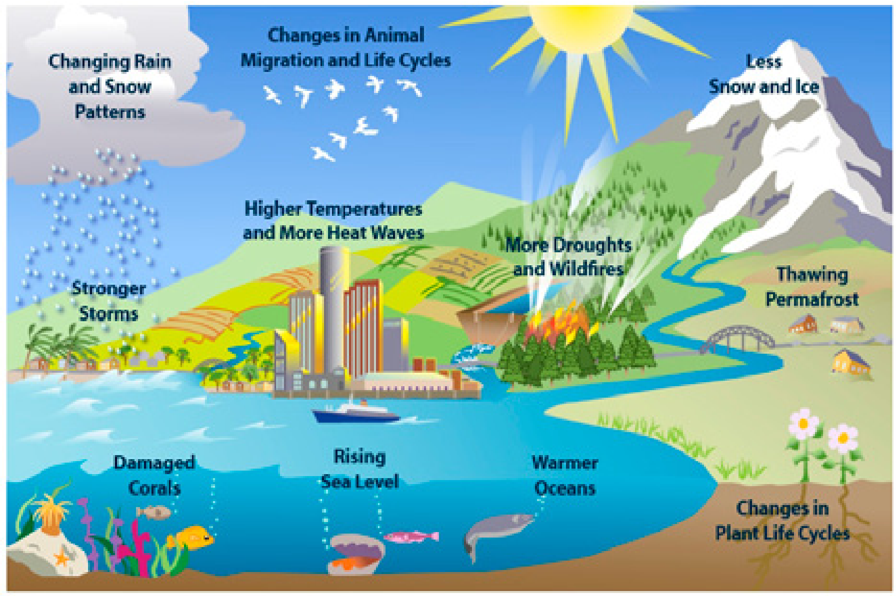
DID YOU KNOW? The Earth's climate has changed before, but this time is different — people are mainly responsible.

LEARN THE BASICS

The Earth's climate is changing, and people's activities are the main cause.

Our world is always changing. Look out your window long enough, and you might see the weather change. Look even longer, and you'll see the seasons change. The Earth's climate is changing, too, but in ways that you can't easily see.

The Earth is getting warmer because people are adding heat-trapping gases to the atmosphere, mainly by burning fossil fuels. These gases are called greenhouse gases. Warmer temperatures are causing other changes around the world, such as melting glaciers and stronger storms. These changes are happening because the Earth's air, water, and land are all linked to the climate. The Earth's climate has changed before, but this time is different. People are causing these changes, which are bigger and happening faster than any climate changes that modern society has ever seen before.



Climate Concepts

Climate is what we expect, weather is what we get. – Mark Twain

Climate refers to the average weather conditions in a certain place over many years. For example, the climate in Minnesota is cold and snowy in the winter, and the climate in Honolulu, Hawaii, is warm and humid all year long. The climate in one area, like the Midwest or Hawaii, is called a regional climate. The average climate around the world is called global climate.

When scientists talk about global climate change, they're talking about the global climate and a pattern of change that's happening over many years. One of the most important trends that scientists look at is the average temperature of the Earth, which has been increasing for many years. This is called global warming.

Rising global temperatures lead to other changes around the world, such as stronger hurricanes, melting glaciers, and the loss of wildlife habitats. That's because the Earth's air, water, and land are all related to one another and to the climate. This means a change in one place can lead to other changes somewhere else. For example, when air temperatures rise, the oceans absorb more heat from the atmosphere and become warmer. Warmer oceans, in turn, can cause stronger storms.

Weather Versus Climate

Weather is a specific event or condition that happens over a period of hours or days. For example, a thunderstorm, a snowstorm, and today's temperature all describe the weather.

Climate refers to the average weather conditions in a place over many years (usually at least 30 years).

Weather conditions can change from one year to the next. For example, Minneapolis might have a warm winter one year and a much colder winter the next. This kind of change is normal. But when the average pattern over many years changes, it could be a sign of climate change.

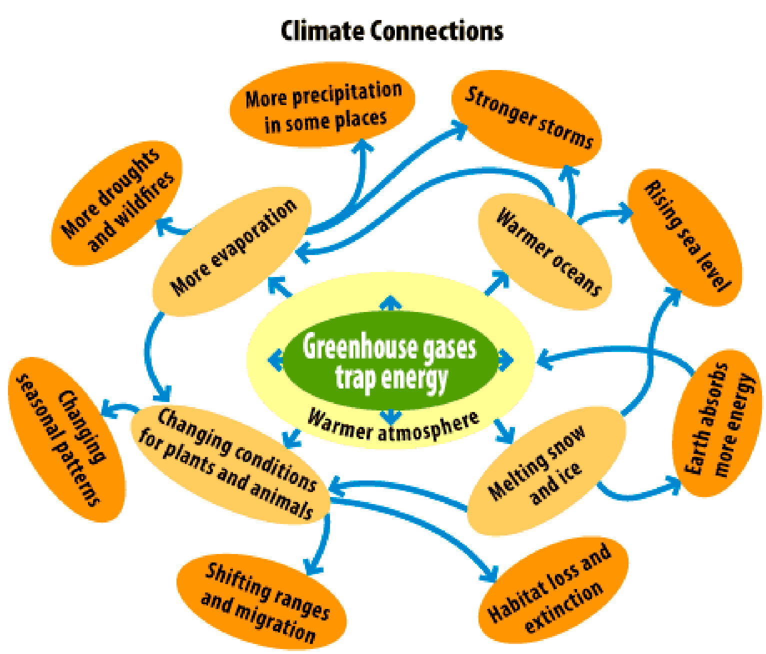
Here's an easy way to remember the difference between weather and climate: Climate helps you decide what clothes to buy, and weather helps you decide what clothes to wear each day.

If last summer was much hotter than usual where you live, is this a sign of climate change? No. The weather naturally varies from year to year, and some years are hotter than others.

If almost every summer for the past decade has been hotter than usual, is this a sign of climate change? Yes. Climate change occurs over many years, so a pattern of many hotter summers could be a sign of climate change. This is especially true if the same pattern is happening in many places around the world.

Today's Climate Change

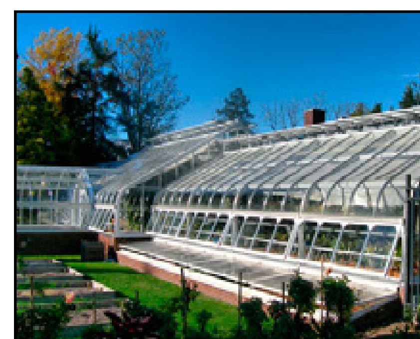
More than 100 years ago, people around the world started burning large amounts of coal, oil, and natural gas to power their homes, factories, and vehicles. Today, most of the world relies on these fossil fuels for their energy needs. Burning fossil fuels releases carbon dioxide, a heat-trapping gas, into the atmosphere, which is the main reason why the climate is changing.



WHICH OF THE FOLLOWING STATEMENTS ARE TRUE?

- The Earth's average temperature has increased since the late 1800s, when people started burning a lot of coal, oil, and natural gas.
- Worldwide, 2001–2010 was the warmest decade ever recorded.
- In the United States, seven of the top 10 warmest years on record have occurred since 1990.

They're all true!



What's in a Name? The "Greenhouse Effect"

A greenhouse is a building made of glass that allows sunlight to enter but traps heat inside, so the building stays warm even when it's cold outside. Because gases in the Earth's atmosphere also let in light but trap heat, many people call this phenomenon the "greenhouse effect." The greenhouse effect works somewhat differently from an actual greenhouse, but the name stuck, so that's how we still refer to it today.

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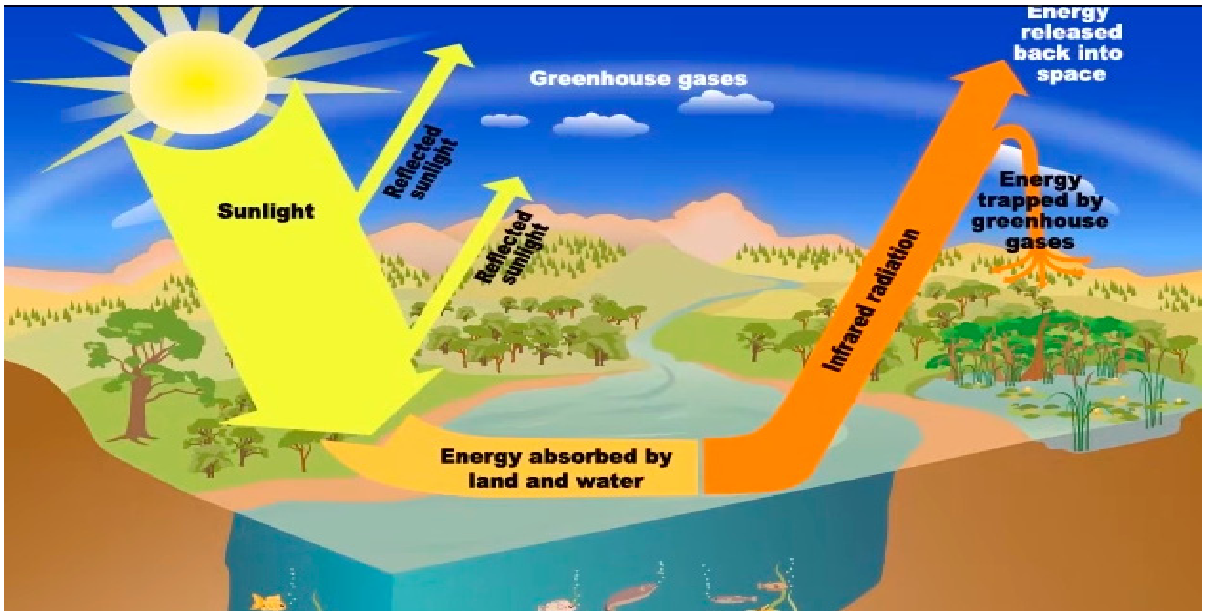


The Earth gets energy from the sun in the form of sunlight. The Earth's surface absorbs some of this energy and heats up. That's why the surface of a road can feel hot even after the sun has gone down — because it has absorbed a lot of energy from the sun. The Earth cools down by giving off a different form of energy called infrared radiation. But before all this radiation can escape to outer space, greenhouse gases in the atmosphere absorb some of it, which makes the atmosphere *warmer. As the atmosphere gets warmer, it makes the Earth's surface warmer, too.*

Global Warming Potential (GWP):

A measure of how much heat a substance can trap in the atmosphere. GWP can be used to compare the effects of different greenhouse gases. For example, methane has a GWP of 21, which means over a period of 100 years, 1 pound of methane will trap 21 times more heat than 1 pound of carbon dioxide (which has a GWP of 1).

Heat-trapping gases are also called greenhouse gases. They exist naturally in the atmosphere, where they help keep the Earth warm enough for plants and animals to live. But people are adding extra greenhouse gases to the atmosphere. These extra gases are causing the Earth to get warmer, setting off all sorts of other changes around the world — on land, in the oceans, and in the atmosphere. And these changes affect people, plants, and animals in many ways.

The Greenhouse Effect

If it were not for greenhouse gases trapping heat in the atmosphere, the Earth would be a very cold place. Greenhouse gases keep the Earth warm through a process called the greenhouse effect.

Greenhouse Gases

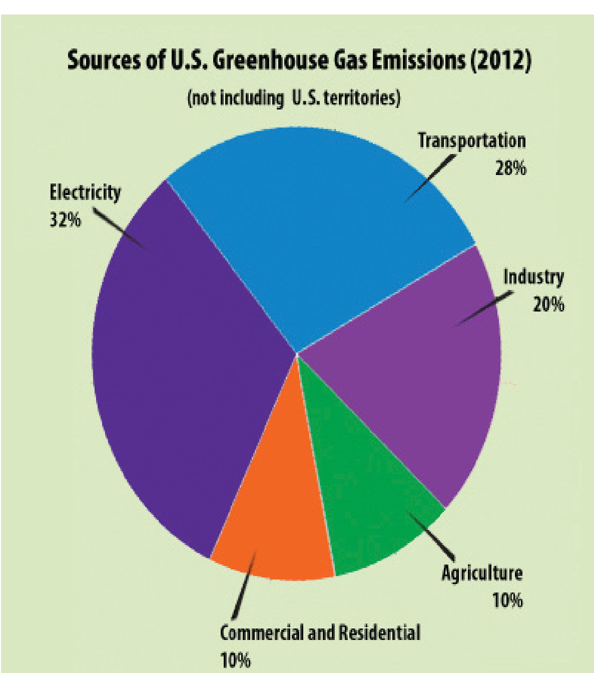
Greenhouse gases trap heat in the atmosphere, which makes the Earth warmer. People are adding several types of greenhouse gases to the atmosphere, and each gas's effect on climate change depends on three main factors:

How much — People produce larger amounts of some greenhouse gases than others. Carbon dioxide is the greenhouse gas you hear people talk about the most. That's because we produce more carbon dioxide than any other greenhouse gas, and it's responsible for most of the warming.

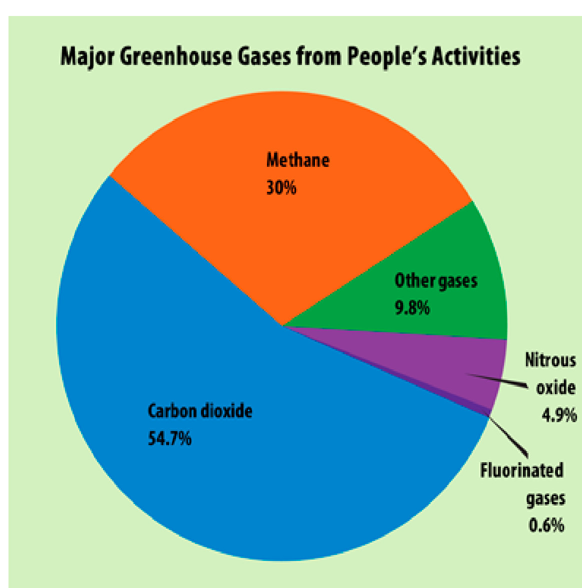
How long — Some greenhouse gases stay in the atmosphere for only a short time, but others can stay in the atmosphere and affect the climate for thousands of years.

How powerful — Not all greenhouse gases are created equal! Some trap more heat than others. For example, one pound of methane traps about 21 times as much heat as one pound of carbon dioxide.

Greenhouse gases come from all sorts of everyday activities, such as using electricity, heating our homes, and driving around town. The graph shows which activities produce the most greenhouse gases in the United States.



Source: EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (2014).



The size of each piece of the pie represents the amount of warming that each gas is currently causing in the atmosphere as a result of emissions from human activities. Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, 2007.

These greenhouse gases don't just stay in one place after they're added to the atmosphere. As air moves around the world, greenhouse gases become globally mixed, which means the concentration of a greenhouse gas like carbon dioxide is roughly the same no matter where you measure it. Even though some countries produce more greenhouse gases than others, emissions from every country contribute to the problem. That's one reason why climate change requires global action. The world's total greenhouse gas emissions are continuing to increase every year.

Carbon dioxide stays in the atmosphere anywhere from 50 to 1,000 years and comes from:

- Burning fossil fuels for electricity, heating, and to run vehicles
- Cutting down and burning trees and other vegetation
- Some industrial processes

Methane stays in the atmosphere about 12 years. It traps 21 times more heat than the same amount of carbon dioxide. It comes from:

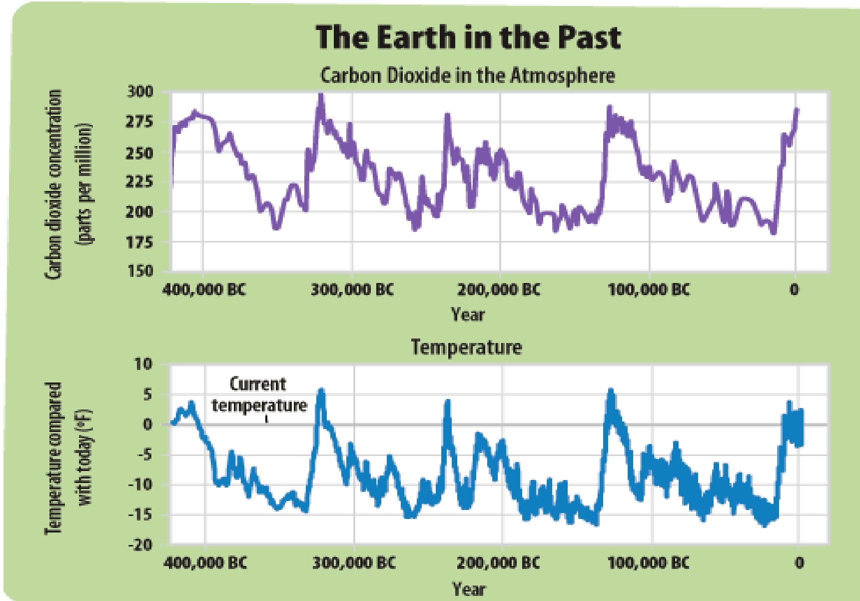
- Landfills produce methane as trash decays
- Livestock, especially cows and sheep, produce methane as they digest food. Their manure also releases methane as it decays.
- Natural gas production releases methane. Sometimes there are leaks from storage containers.
- Mining coal often releases methane that is ventilated out of the mine.

Nitrous oxide stays in the atmosphere for about 114 years. It traps 298 times more heat than the same amount of carbon dioxide. It comes from:

- Burning fossil fuels.
- Farming practices that add extra nitrogen/fertilizer to the soil. Bacteria in the soil turn the nitrogen into nitrous oxide.
- Some industrial processes.

Fluorinated gases vary in how long they stay in the atmosphere. They trap heat anywhere from a few hundred to 23,000 times that of carbon dioxide. They are smaller amounts, but are increasing faster than other emissions of greenhouse gases. They come from:

- Coolant leaks from air conditioning systems in homes, cars, and refrigerators.
- Some industrial processes like producing computer chips.



These graphs are based on the Vostok ice core from Antarctica. They do not include the most recent increases in carbon dioxide and temperature caused by humans. Notice the strong connection between carbon dioxide and temperature. Source: EPA's Climate Change Indicators (2014) and Petit et al. (2001).

All About Carbon Dioxide

Carbon is an element that's found all over the world and in every living thing. Oxygen is another element that's in the air we breathe. When carbon and oxygen bond together, they form a colorless, odorless gas called carbon dioxide, which is a heat-trapping greenhouse gas. Whenever we burn fossil fuels such as coal, oil, and natural gas — whether it's to drive our cars, use electricity, or make products — we are producing carbon dioxide.

The atmosphere isn't the only part of the Earth that has carbon. The oceans store large amounts of carbon, and so do plants, soil, and deposits of coal, oil, and natural gas deep underground. Carbon naturally moves from one part of the Earth to another through the carbon cycle. But right now, by burning fossil fuels, people are adding carbon to the atmosphere (in the form of carbon dioxide) faster than natural processes can remove it. That's why the amount of carbon dioxide in the atmosphere is increasing, which is causing global climate change.

The Earth's Climate in the Past

The Earth was formed about 4.5 billion years ago — that's a very long time ago! It's hard to say exactly what the Earth's daily weather was like in any particular place on any particular day thousands or millions of years ago. But we know a lot about what the Earth's climate was like way back then because of clues that remain in rocks, ice, trees, corals, and fossils.

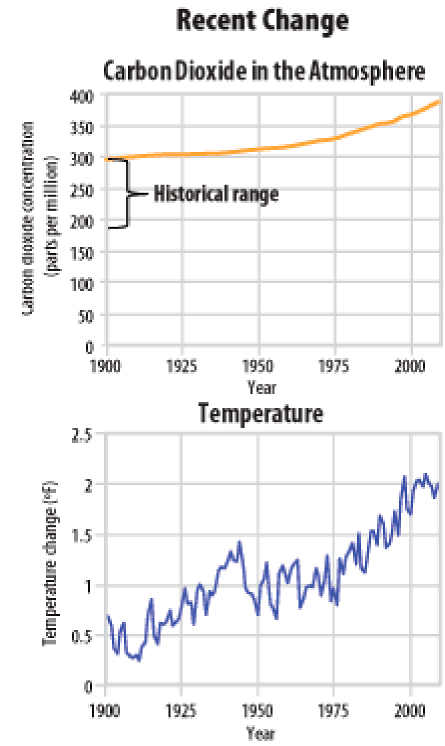
These clues tell us that the Earth's climate has changed many times before. There have been times when most of the planet was covered in ice, and there have also been much warmer periods. Over at least the last 650,000 years, temperatures and carbon dioxide levels in the atmosphere have increased and decreased in a cyclical pattern. Can you see this pattern in the graph.

Today's climate change is different from past climate change in several important ways:

• Natural causes are not responsible. None of the natural causes of climate change, including variations in the sun's energy and the Earth's orbit, can fully explain the climate changes we are seeing today.

• People's activities are the main cause. By burning lots of fossil fuels like coal, oil, and natural gas, people are overloading the atmosphere with carbon dioxide and adding to the greenhouse effect. People are also adding other heat–trapping greenhouse gases, such as methane and nitrous oxide, to the atmosphere.

• Greenhouse gases are at record levels in the atmosphere. For hundreds of thousands of years, the concentration of carbon dioxide in the atmosphere stayed between 200 and 300 parts per million. Today, it's up to nearly 400 parts per million, and the amount is still rising. Along with other greenhouse gases, this extra carbon dioxide is trapping heat and causing the climate to change.



Source: EPA's Climate Change Indicators (2014).

Water Vapor: It's a natural greenhouse gas!

Water can take the form of an invisible gas called water vapor. It is naturally present in the atmosphere and has a strong effect on weather and climate.As the planet gets warmer, more water evaporates from the Earth's surface and becomes vapor in the atmosphere. Since water vapor is a greenhouse gas, more of it leads to even more warming. This is an example of a positive feedback loop, which happens when warming causes changes that lead to even more warming.

See the Impacts

Scorching summers... Melting glaciers... Stronger storms... The signs of global climate change are all around us.

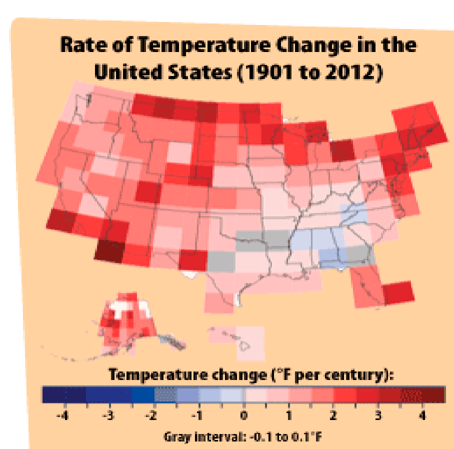
The Earth's climate is getting warmer, and the signs are everywhere. Rain patterns are changing, sea level is rising, and snow and ice are melting sooner in the spring. As global temperatures continue to rise, we'll see more changes in our climate and our environment. These changes will affect people, animals, and ecosystems in many ways.

Less rain can mean less water for some places, while too much rain can cause terrible flooding. More hot days can dry up crops and make people and animals sick. In some places, people will struggle to cope with a changing environment. In other places, people may be able to successfully prepare for these changes.

The negative impacts of global climate change will be less severe overall if people reduce the amount of greenhouse gases we're putting into the atmosphere and worse if we continue producing these gases at current or faster rates.

The Signs of Climate Change

The average temperature of the Earth is rising, but that's not the only way we can tell the climate is changing. In fact, the signs are all around us! Observations and measurements from all over the world provide strong evidence that the climate has already started to change.



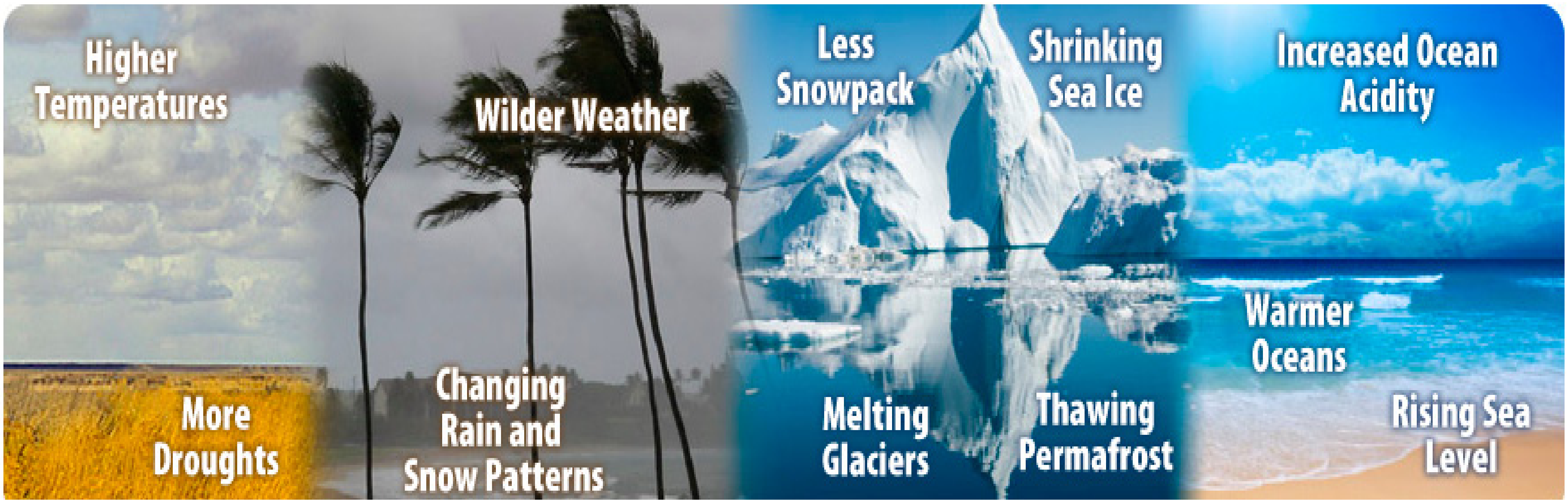
In most parts of the United States, the average air temperature has increased since the early 20th century. Source: EPA's Climate Change Indicators (2014).

Higher Temperatures

Greenhouse gases are trapping more heat in the Earth's atmosphere, which is causing average temperatures to rise all over the world.

What's happening now? Temperatures have risen during the last 30 years, and 2001 to 2010 was the warmest decade ever recorded. As the Earth warms up, heat waves are becoming more common in some places, including the United States. Heat waves happen when a region experiences very high temperatures for several days and nights.

What will happen in the future? The choices we make now and in the next



These are the signs of global climate changes and increasing changes we'll see in the future.

few decades will determine how much the planet's temperature will rise. While we are not exactly sure how fast or how much the Earth's average temperature will rise, we know that:

If people keep adding greenhouse gases into the atmosphere at the current rate, the average temperature around the world could increase by about 4 to 12°F by the year 2100. If we make big changes, like using more renewable resources instead of fossil fuels, the increase will be less — about 2 to 5°F.

Why does it matter? Higher temperatures mean that heat waves are likely to happen more often and last longer, too. Heat waves can be dangerous, causing illnesses such as heat cramps and heat stroke, or even death.

Warmer temperatures can also lead to a chain reaction of other changes around the world. That's because increasing air temperature also affects the oceans, weather patterns, snow and ice, and plants and animals. The warmer it gets, the more severe the impacts on people and the environment will be.

Check out the major effects that higher temperatures have on people and the environment:

Agriculture

The crops that we grow for food need specific conditions to thrive, including the right temperature and enough water. A changing climate could have both positive and negative effects on crops. For example, the northern parts of the United States have generally cool temperatures, so warmer weather could help certain crops grow. In southern areas where temperatures are already hot, even more heat could hurt crop growth. Global climate change will also affect agriculture and food supply in many other ways such as crop losses due to droughts.

Energy

Global climate change will affect how much energy we need and when we need it. As temperatures rise, more people will need to keep cool by using air conditioning, which uses a lot of electricity. However, some people might need less energy to heat buildings in the winter because it may not get as cold as it used to be. Climate change could also make it harder to produce certain types of electricity, such as hydropower. More heat waves will increase the need for air conditioning causing a further strain on our electric infrastructure.

Water Supplies

Climate change is affecting where, when, and how much water is available for people to use. Many parts of the world already have very little water, and climate change could make this problem worse. Rising temperatures, changing precipitation patterns, and increasing droughts will affect the amount of water in lakes, rivers, and streams, as well as the amount of water that seeps into the ground to replenish ground water. Less snowpack and earlier snowmelt will reduce the amount of water flowing into many rivers.

Health

Heat waves, severe storms, air pollution, and diseases linked to climate already threaten people's health in many areas of the world. Global climate change will increase these threats. Some people will be particularly at risk, especially those who are poor, very young or elderly, or disabled, or those who live in coastal areas or big cities. Ways to prepare are:

- Set up warning systems to alert people about heat emergencies
- Set up emergency cooling centers for people without air conditioning

- Make cities "cooler" by planting more trees and creating more parks
- Track cases of infectious disease to see if they are spreading
- Make sure people get proper health care and vaccines
- Track allergy hotspots
- Reduce air pollution

Plants, Animals, and Ecosystems

Most plants and animals live in areas with very specific climate conditions, such as temperature and rainfall patterns, that enable them to thrive. Any change in the climate of an area can affect the plants and animals living there, as well as the makeup of the entire ecosystem. Some species are already responding to a warmer climate by moving to cooler locations. For example, some North American animals and plants are moving farther north or to higher elevations to find suitable places to live. Climate change also alters the life cycles of plants and animals. For example, as temperatures get warmer, many plants are starting to grow and bloom earlier in the spring and survive longer into the fall. Some animals are waking from hibernation sooner or migrating at different times.

Forests

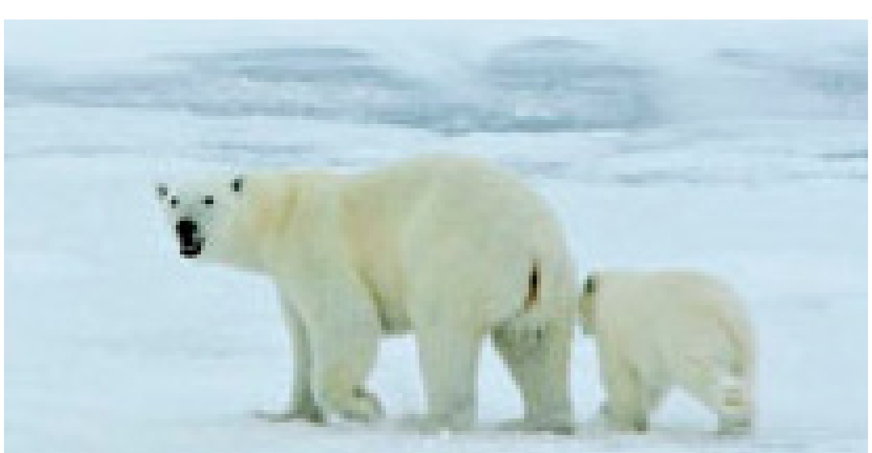
Forests provide homes for many kinds of plants and animals. They also protect water quality, offer opportunities for recreation, and provide people with wood. Forests are sensitive to many effects of climate change, including shifting weather patterns, drought, wildfires, and the spread of pests like the mountain pine beetle. Unlike some animals, trees can't just get up and move when the temperature gets too hot or other conditions change!

Recreation

In addition to causing all sorts of problems, such as heat waves, droughts, and coastline damage, warmer temperatures could also affect people's jobs, recreational activities, and hobbies. For example, in areas that usually experience cold winters, warmer temperatures could reduce opportunities for skiing, ice fishing, and other winter sports. Also, rising sea level could wash away beaches.

Coastal Areas

Global climate change threatens coastlines and the buildings and cities located along them. Hundreds of millions of people around the world live in low–lying areas near the coast that could be flooded as the sea level rises. Rising sea level will also erode beaches and damage many coastal wetlands. Rising sea level and stronger storms caused by warmer oceans could completely wipe out certain beaches and islands.



More Droughts

A drought is an extended period of dry weather caused by a lack of rain or snow. As temperatures rise due to global climate change, more moisture evaporates from land and water, leaving less water behind. Some places are getting more rain or snow to make up for it, but other places are getting less.

What's happening now? Since the 1970s, droughts have become longer and more extreme worldwide, particularly in the tropics and subtropics.

What will happen in the future? Droughts are expected to keep getting longer and more severe. The U.S. Southwest is at particular risk for increasing droughts.

Why does it matter? A drought means there's less water available for drinking, watering crops, making electricity at hydroelectric dams, and other uses. For example, an ongoing drought in the U.S. Southwest is straining water supplies in states like Nevada and California, where water is already scarce.

To Prepare for the Future...

- Plant crops and grasses (for livestock) that can handle drought
- Landscape your yard with plants that don't require a lot of water
- Use water–efficient appliances and fixtures in your home
- Avoid building homes in extremely fire–prone areas
- Build homes that are more fire resistant
- Plant fire–resistant shrubs and trees around homes

Warmer Oceans

The atmosphere affects oceans, and oceans influence the atmosphere. As the temperature of the air rises, oceans absorb some of this heat and also become warmer.

What's happening now? Overall, the world's oceans are warmer now than at any point in the last 50 years. The change is most obvious in the top layer of the ocean, which has grown much warmer since the late 1800s. This top layer is now getting warmer at a rate of 0.2°F per decade.

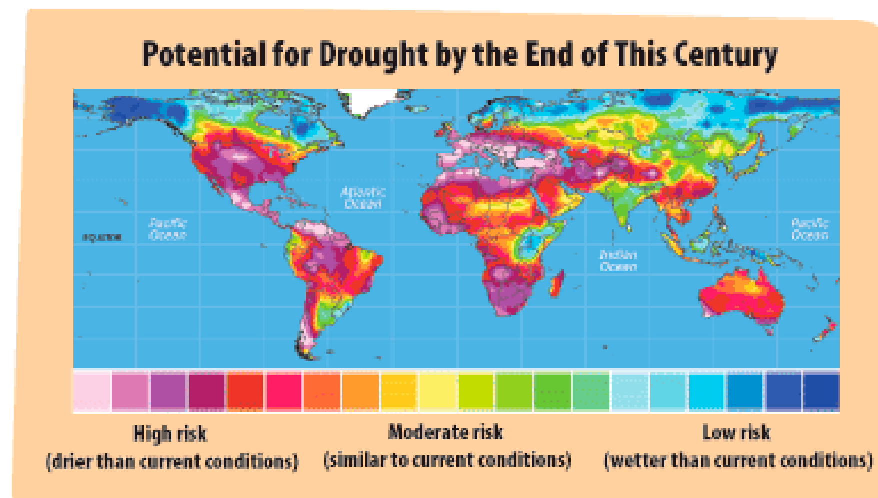
What will happen in the future? Oceans are expected to continue getting warmer — both in the top layer and in deeper waters. Even if people stop adding extra greenhouse gases to the atmosphere now, oceans will continue to get warmer for many years as they slowly absorb extra heat from the atmosphere.

Why does it matter? Warmer oceans affect weather patterns, cause more powerful tropical storms, and can impact many kinds of sea life, such as corals and fish. Warmer oceans are also one of the main causes of rising sea level.

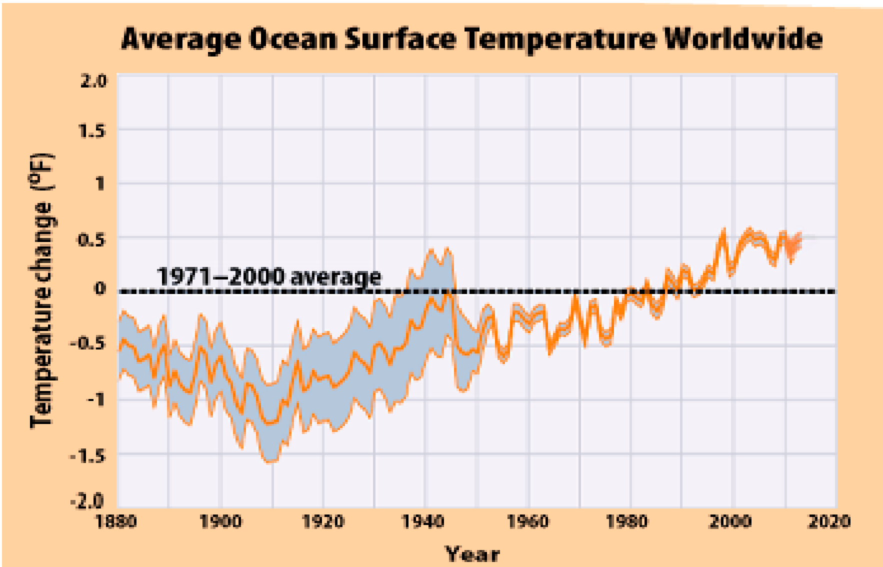
Rising Sea Level

As water gets warmer, it takes up more space. Each drop of water only expands by a little bit, but when you multiply this expansion over the entire depth of the ocean, it all adds up and causes sea level to rise. Sea level is also rising because melting glaciers and ice sheets are adding more water to the oceans.

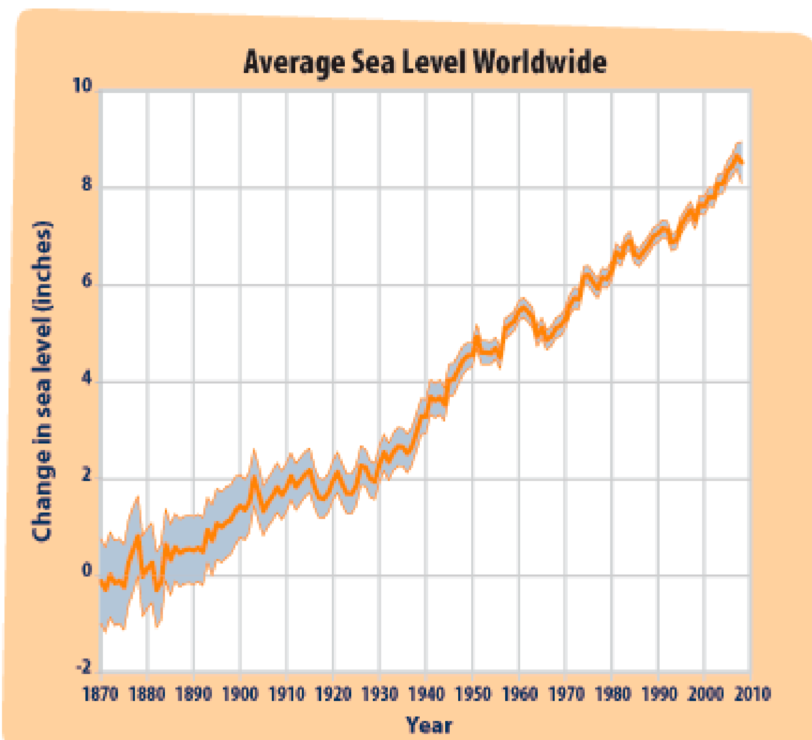
Hundreds of millions of people around the world live in low–lying areas near the coast that could be flooded as the sea level rises. Rising sea level will also erode beaches and damage many coastal wetlands. Places like Miami; New York City; New Orleans; and Venice, Italy, could flood more often or more



This map shows the results of computer models that have projected the risk of drought for the years 2090 to 2099. Source: Adapted from Dai (2011).



The surface of the world's oceans has become warmer overall since 1880. In this graph, the shaded band shows the likely temperature range, which depends on the number of measurements and the methods used at different times. Source: EPA's Climate Change Indicators (2014).



severely. If that happens, many people will lose their homes and businesses.

Average sea level around the world has been rising for many years. In this graph, the shaded band shows the likely range of sea level, which depends on the number of measurements and the methods used at different times. Source: EPA's Climate Change Indicators (2012).

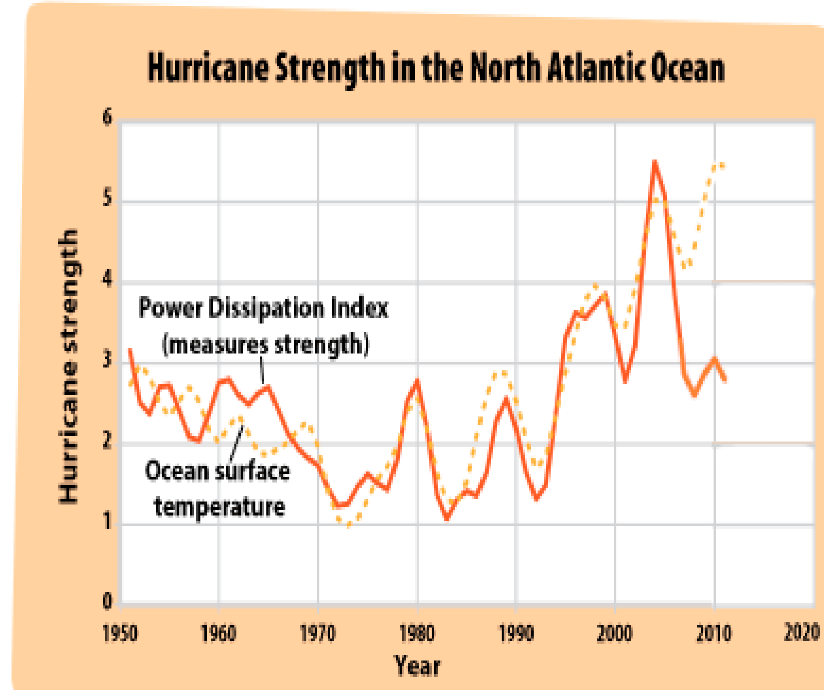
What's happening now? Over the past 100 years, the average sea level around the world rose by nearly 7 inches. Sea level can actually change by different amounts in different places.

What will happen in the future? If people keep adding greenhouse gases to the atmosphere, the average sea level around the world by the end of this century (the year 2099) could be anywhere from 7 to 23 inches higher than it was in 1990. Sea level could rise even more if the big ice sheets in Greenland and Antarctica melt faster.

Why does it matter? Rising sea level is a threat to people who live near the ocean. Some low-lying areas will have more frequent flooding, and very low-lying land could be submerged completely. Rising sea level can also harm important coastal ecosystems like mangrove forests and coral reefs.

To Prepare for the Future...

- Preserve wetlands and floodplains that protect coastlines from flooding and damage
- Protect barrier beaches and reduce erosion
- Improve drainage systems
- Elevate existing structures or build protective barriers in certain places



Hurricanes in the northern half of the Atlantic Ocean have become stronger over the last few decades. This graph shows the Power Dissipation Index, which measures total hurricane power each year based on the number of hurricanes and their wind speed. The graph also shows how hurricane strength is related to water temperature. Source: EPA's Climate Change Indicators (2014).

- Build houses further from the shoreline and other areas that could flood easily

Wilder Weather

Hurricanes and other tropical storms get their energy from warm ocean water. As the top layer of the ocean gets warmer, hurricanes and other tropical storms grow stronger, with faster winds and heavier rain. Because of higher temperatures and increased evaporation, climate change causes other types of storms to get stronger, too.

What's happening now? Over the past 20 years, hurricanes and other tropical storms in the Atlantic Ocean have become stronger. Since the 1980s, the United States has also experienced more intense single-day storms that are dumping a lot more rain or snow than usual.

What will happen in the future? As the climate gets warmer, heavier rainstorms and snowstorms (with more precipitation than normal) are expected to happen more often, and hurricanes around the world could keep getting stronger.

Why does it matter? Hurricanes and other storms can cause flooding; damage buildings, roads, and other structures; harm crops; and put people's lives in danger.

To Prepare for the Future...

- Build houses that can withstand strong storms
- Don't build in areas that are likely to flood
- Set up reinforced shelters for people who cannot evacuate
- Preserve natural barriers like sand dunes that provide protection against storms
- Preserve wetlands and other places that can store water

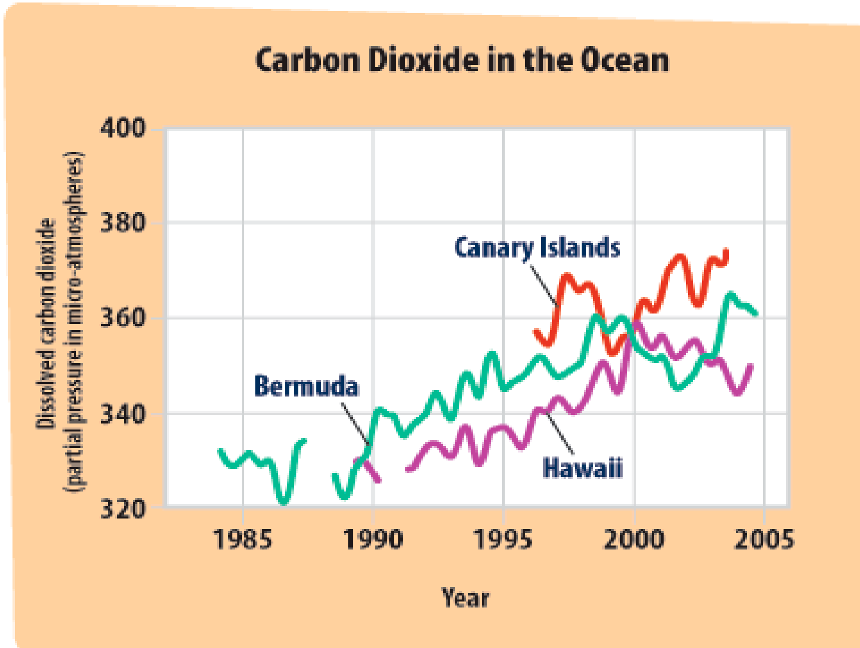
Increased Ocean Acidity

Carbon dioxide is added to the atmosphere whenever people burn fossil fuels. Oceans play an important role in keeping the Earth's carbon cycle in balance. As the amount of carbon dioxide in the atmosphere rises, the oceans absorb a lot of it. In the ocean, carbon dioxide reacts with seawater to form carbonic acid. This causes the ocean to become more acidic.

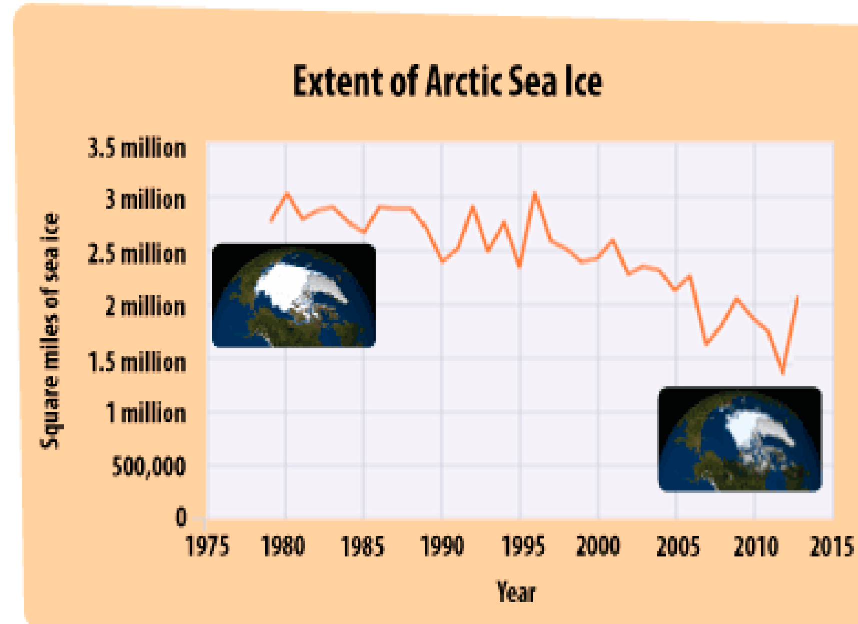
What's happening now? Over the last few decades, the amount of carbon dioxide dissolved in the ocean has increased all over the world, and so has ocean acidity.

What will happen in the future? As long as we keep putting extra carbon dioxide in the atmosphere, the ocean will continue to become even more acidic.

Why does it matter? Increasing acidity will make it harder for corals to build skeletons and for shellfish to build the shells they need for protection. Corals are particularly important because they provide homes for many other sea creatures.



The world's oceans are absorbing more carbon dioxide, as shown by the three sets of measurements in this graph. More carbon dioxide means more acidity (lower pH). Source: EPA's Climate Change Indicators (2010).



The number of square miles covered by sea ice in the Arctic Ocean has been decreasing. This graph shows data from September of each year, which is when the amount of ice is usually the smallest. Source: EPA's Climate Change Indicators (2014).

Shrinking Sea Ice

The Arctic Ocean around the North Pole is so cold that it is usually covered with ice. In the winter, the area covered by ice gets bigger, and in the summer it gets smaller. If the air and water are warmer than usual, Arctic sea ice will melt more than usual during the summer.

What's happening now? The amount of summer ice in the Arctic Ocean in recent years was the smallest it's been since scientists started using satellites to measure the area covered by ice back in the 1970s. The ice is also getting thinner.

What will happen in the future? Overall, Arctic sea ice will continue to shrink in the coming decades. However, the amount of sea ice may vary from year to year depending on factors such as local temperatures, wind patterns, and ocean currents.

Why does it matter? Many animals depend on sea ice for their homes and hunting grounds, and native people in the Arctic need these animals as a source of food. In addition, ice and snow reflect a lot of sunlight back out to space and help keep the planet from getting too warm. If there's less ice, the Earth will absorb more energy from the sun and get even warmer. This is an example of a positive feedback loop, which happens when warming causes changes that lead to even more warming.

Melting Glaciers

Glaciers are large sheets of snow and ice that are found on land all year long. They're found in the western United States, Alaska, the mountains of Europe and Asia, and many other parts of the world. Warmer temperatures cause glaciers to melt faster than they can accumulate new snow.

What's happening now? Glaciers all over the world have been melting for at least the last 50 years, and the rate of melting is speeding up. Many glaciers in Alaska and other parts of the United States have shrunk dramatically.

What will happen in the future? If temperatures keep rising, glaciers will continue melting, and some could disappear completely.

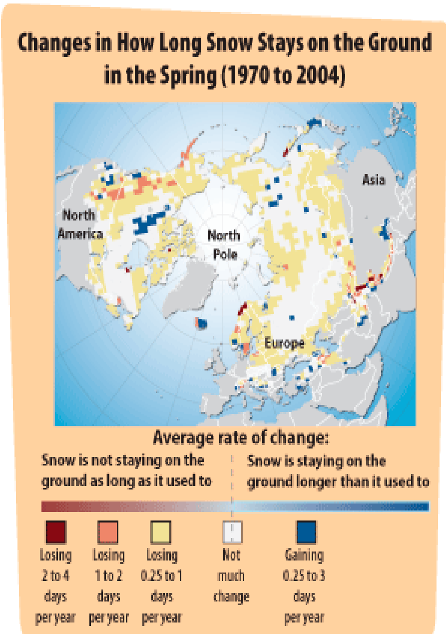
Why does it matter? As glaciers and the giant ice sheets on Greenland and Antarctica melt, they add more water into the ocean, which causes sea level to rise. Glaciers are a source of fresh water for many people and nations around the world and the water is also used to irrigate crops to grow food.

Less Snowpack

Snowpack refers to the total amount of snow and ice on the ground. In high mountain ranges and other cold places, snowpack builds up in the winter and melts in the spring and summer. As the world gets warmer, some places will get more rain instead of snow, so the snowpack won't be as deep. Plus, when the air is warmer, snow melts faster.

Photographs of McCall Glacier, Alaska (1958 and 2003)

Source: Post (1958) and Nolan (2003), National Snow and Ice Data Center.



Source: Adapted from United Nations Environment Programme/GRID–Arendal (2007).

What's happening now? Many places have less snowpack than they used to, and this snowpack is melting earlier. For example, the map shows that in many parts of North America, Europe, and Asia, snow doesn't stay on the ground in the spring as long as it used to.

What will happen in the future? As temperatures keep getting warmer, snowpack is expected to continue to shrink in most of North America and around the world.

Why does it matter? When snowpack melts in spring and summer, it provides fresh water for rivers and streams, and it fills reservoirs that supply drinking water to cities and towns. Snowpack is also important for winter sports like skiing and snowboarding.

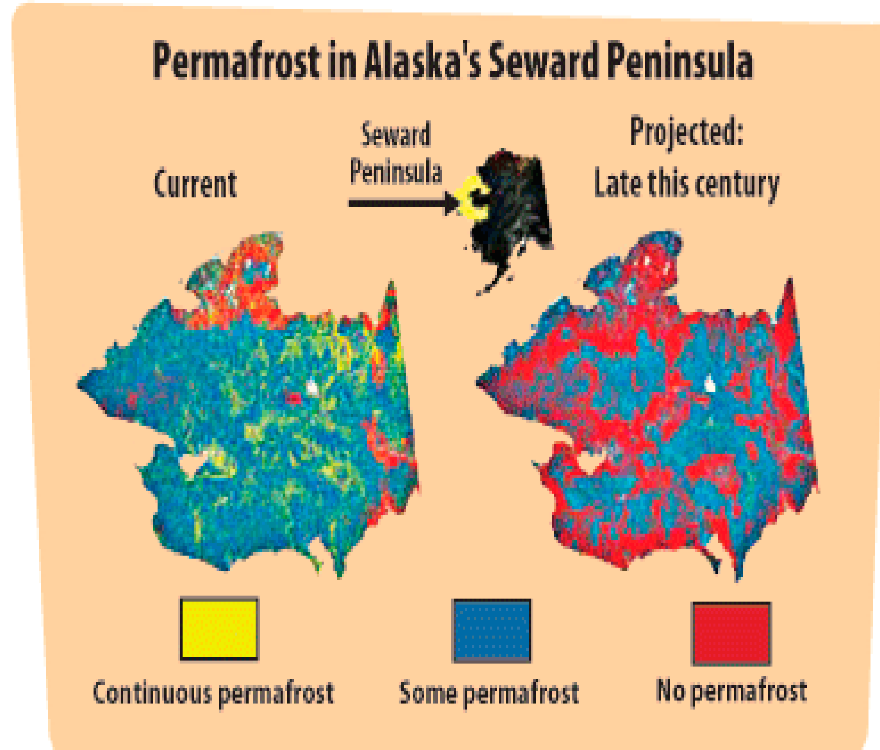
Thawing Permafrost

Permafrost refers to a layer of soil or rock that is frozen all year round. Permafrost is found throughout much of Alaska, Russia, parts of Canada, and other countries in the far north. You might think a place with permafrost would be barren, but plants can still grow in the soil at the surface, which is not frozen during warmer parts of the year. However, there may be a thick layer of permafrost underneath. As air temperature rises, so does the temperature of the ground, which can cause permafrost to thaw (or melt).

What's happening now? Ground temperatures have increased throughout Alaska since the late 1970s, and permafrost has already thawed in many places.

What will happen in the future? As temperatures keep getting warmer, permafrost will continue to thaw. For example, the map shows how permafrost in northwestern Alaska could change by the year 2100.

Why does it matter? When permafrost melts, the land above it sinks or changes shape. Sinking land can damage buildings and infrastructure such as roads, airports, and water and sewer pipes. It also affects ecosystems such as trees leaning or falling over because the permafrost underneath them has melted.



Source: Adapted from U.S. Global Change Research Program (2009).

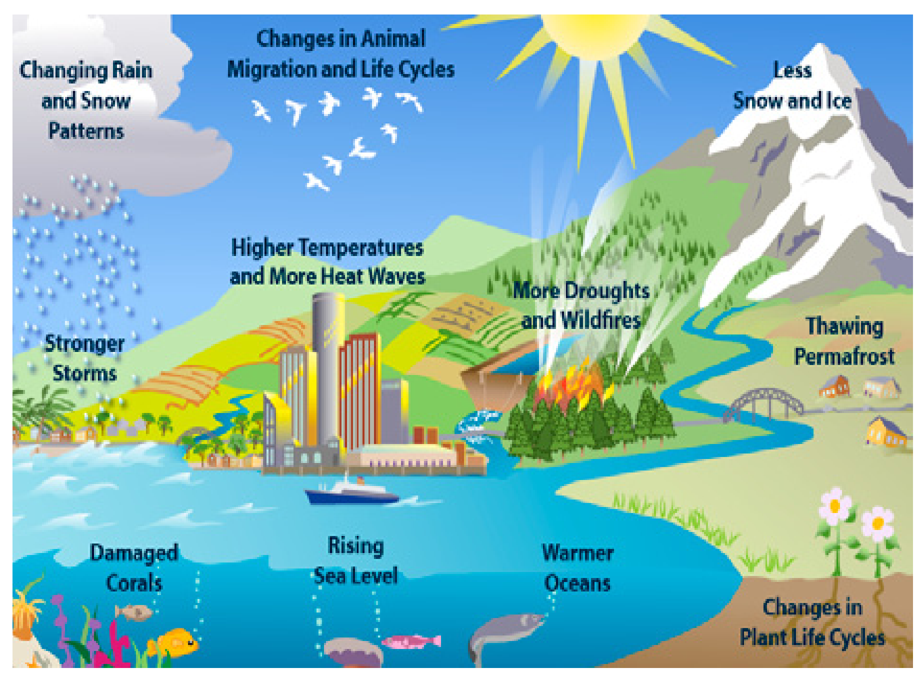
Another reason to be concerned about permafrost is because it has a lot of carbon trapped inside. As permafrost thaws, this carbon is released to the atmosphere in the form of methane, a powerful greenhouse gas. This process leads to more climate change and is an example of a positive feedback loop, which happens when warming causes changes that lead to even more warming.

Think Like a Scientist

Uncover the cause of today's global climate change.

Did you know that thousands of measurements of the Earth's air, water, and land are taken every day? These measurements come from weather stations, airplanes, ships, satellites, and many other sources all around the globe. Taken all together, these measurements and other observations tell us that the Earth's climate is warming, people are the main cause, and impacts on society and the environment are already happening.

Here are eleven signs of climate change.



Scientists measure the amount of greenhouse gases in the atmosphere in several ways. They use satellites and other instruments to measure the amount of greenhouse gases in the air all around the world. They also collect samples of air from specific places and then analyze these samples in a laboratory.

The Earth also gives us clues about the levels of greenhouse gases that existed in the past. For example, ancient air bubbles trapped deep in the ice of Greenland and Antarctica reveal how much carbon dioxide was present long ago.

Scientists have carefully examined all this evidence and made a startling discovery. There's more carbon dioxide in the atmosphere now than at any other time in at least 650,000 years! And the amount of carbon dioxide and other greenhouse gases is continuing to increase.

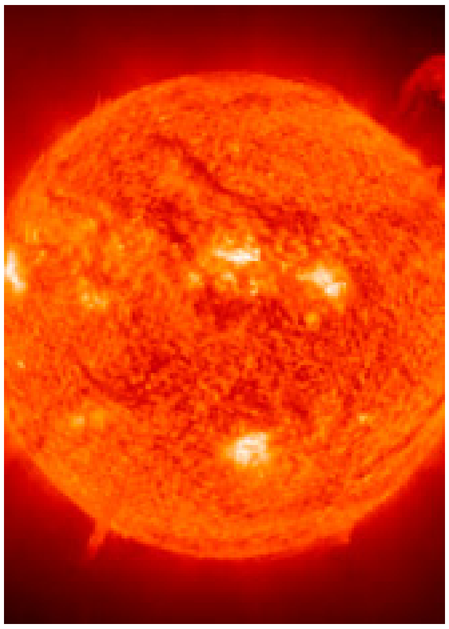
Ruled Out

We can rule out natural factors as the main causes of today's climate change.

Many factors, such as the sun, the Earth's orbit, and sometimes even volcanic eruptions, can affect the Earth's climate. Scientists use climate models to look at all these factors and determine what is causing climate change. They find that there's only one clear explanation for what's happening now: Extra greenhouse gases in the atmosphere are warming the Earth.

The Sun: Since the 1970s, the sun has been cooling slightly. Over this same time period, the Earth has gotten warmer. Most of the warming has occurred in the lower atmosphere near the Earth's surface.

Could the sun be responsible for today's climate change? No. If the sun were the cause of climate change, the Earth's temperature would be cooling, not warming! Also, if the sun were respon-



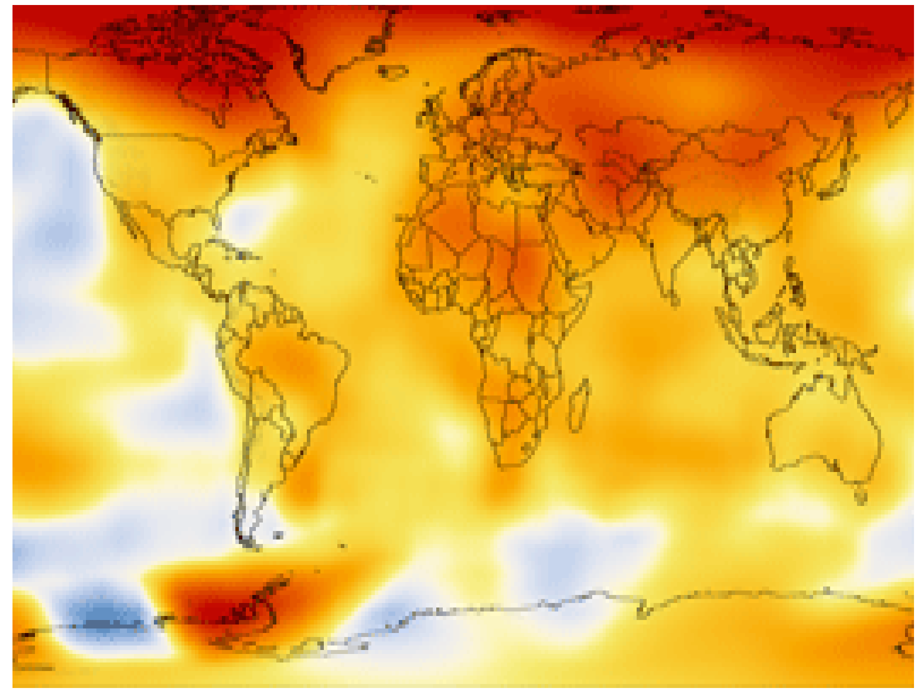
sible for the increased warming, it would occur throughout the entire atmosphere. So, the sun is NOT the cause of today's climate change.

The Earth's Orbit: The way the Earth tilts on its axis and the way it circles the sun can influence the amount of the sun's energy that reaches the planet. As a result, changes in the Earth's orbit can cause the climate to change, but these changes happen very slowly, over tens to hundreds of thousands of years.

Could the Earth's orbit be responsible for today's climate change? No. Cycles in the Earth's orbit happen so slowly that they cannot account for the rapid warming we are seeing today. Also, the current position of the Earth's orbit should result in cooler temperatures, but instead, the opposite is happening — the average temperature of the Earth is getting warmer. So, the Earth's orbit is NOT responsible for today's climate change.

Volcanoes: When volcanoes erupt, they add a small amount of greenhouse gases into the atmosphere. They also release dust, ash, and other particles called aerosols. Some volcanic explosions are so strong that they throw these aerosols high enough into the atmosphere that they block some sunlight from reaching the Earth.

Could volcanoes be responsible for today's climate change? No. Although volcanoes do add some carbon dioxide (a greenhouse gas) into the atmosphere, people add about 100 times more! The amount of carbon dioxide that comes from volcanoes has not increased, and it's not enough to cause global warming. Actually, the main way volcanoes can change the Earth's climate is by causing a temporary cooling effect. After a very large eruption, particles from the eruption can stay in the atmosphere for as long as a few years, where they block sunlight and make the planet a little bit cooler. This has happened several times in the last 40 years — most recently in 1991 with the eruption of Mount Pinatubo in the Philippines. So, volcanic eruptions are NOT responsible for today's climate change.



A Model Approach

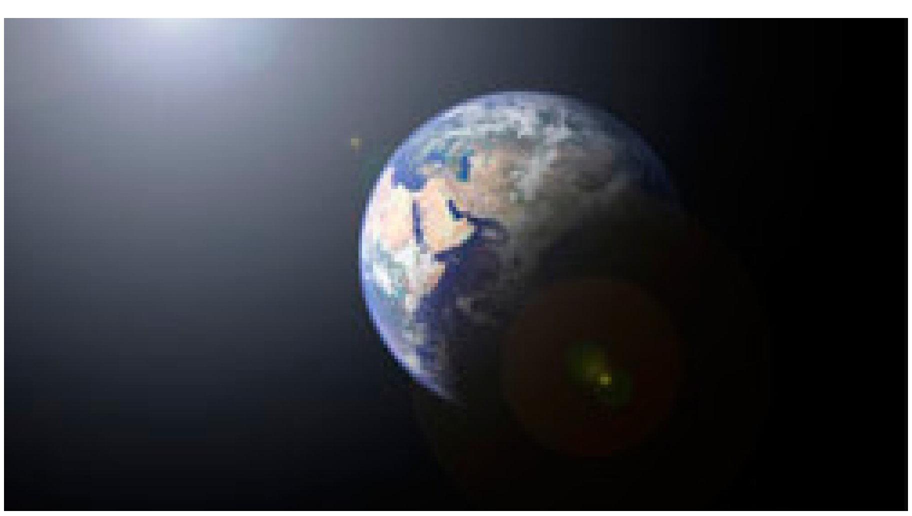
Scientists use models to learn more about current and future changes in the Earth's climate. A climate model is a computer program that uses math equations to describe how the land, the atmosphere, oceans, living things, and energy from the sun affect each other and the Earth's climate. Using these equations, models can predict how a change in one part of the climate system, such as increasing greenhouse gases or decreasing Arctic sea ice, will affect other parts of the Earth in the future.

Some people are concerned that climate models can't mimic how the world really works. But scientists have worked on these types of models for more than 40 years to make sure they get the most important things right. In the same way that video games have improved from simple graphics to very realistic scenery and action, climate models have improved to include details like how clouds form and where it might rain more.

Scientists test their models by comparing the results with real measurements. They only use models that have proven to be useful in understanding past and present changes in the Earth's climate, such as the global temperature changes recorded over the last century.

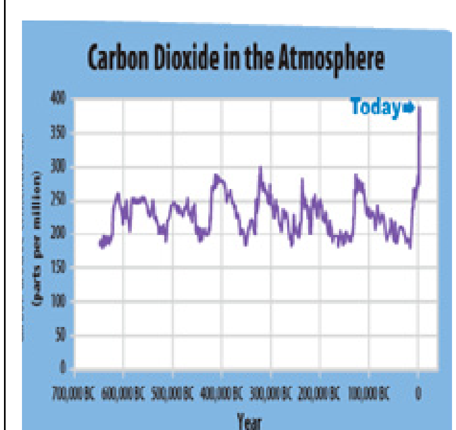
As time goes on, climate scientists will have more and more data to work with, and computers will continue to become more and more powerful and get even better at predicting future climate change.

Present models agree that extra greenhouse gases will cause warmer temperatures. Improved models are not likely to change this basic prediction.



The Proof Is in the Atmosphere

Here's how we know the amount of greenhouse gases in the atmosphere is increasing.



Scientists can compare the amount of carbon dioxide in the atmosphere today with the amount of carbon dioxide trapped in ancient ice cores, which show that the atmosphere had less carbon dioxide in the past. Source: EPA's Climate Change Indicators (2014).

Putting the Pieces Together

By piecing together the evidence, scientists can say that extra greenhouse gases building up in the atmosphere are the main reason for global climate change. But how do they know where the extra greenhouse gases are coming from?

To find out, let's look at carbon dioxide, the most common greenhouse gas. The top graph shows the actual amount of carbon dioxide in the atmosphere from the year 1750 until today. The graph shows how much extra carbon dioxide people around the world have been putting into the atmosphere since 1750. Can you see the connection?

The amount of carbon dioxide started to increase a few hundred years ago during the Industrial Revolution, when people started burning a lot of fossil fuels like coal, oil, and natural gas for energy. You can also see that people are burning even more fossil fuels today, which explains why the amount of carbon dioxide in the atmosphere has continued to rise.

Other major greenhouse gases, such as methane, nitrous oxide, and fluorinated gases, are increasing in a similar way.

The Missing Pieces

Scientists know a lot about climate change, and they know that the Earth will continue to get warmer as people add more greenhouse gases to the atmosphere. But there's still more to learn.

Here are some of the questions that scientists are still investigating:

What amount of greenhouse gases will be added to the atmosphere?

The amount of greenhouse gases in the atmosphere in the future will depend on the choices people make. For example, if we continue to depend on coal, oil, and natural gas for most of our energy, the amount of greenhouse gases in the atmosphere will continue to increase. If we decide to switch to more renewable energy sources or use less energy through efficiency or conservation, the amount of greenhouse gases could stop rising and eventually decrease.

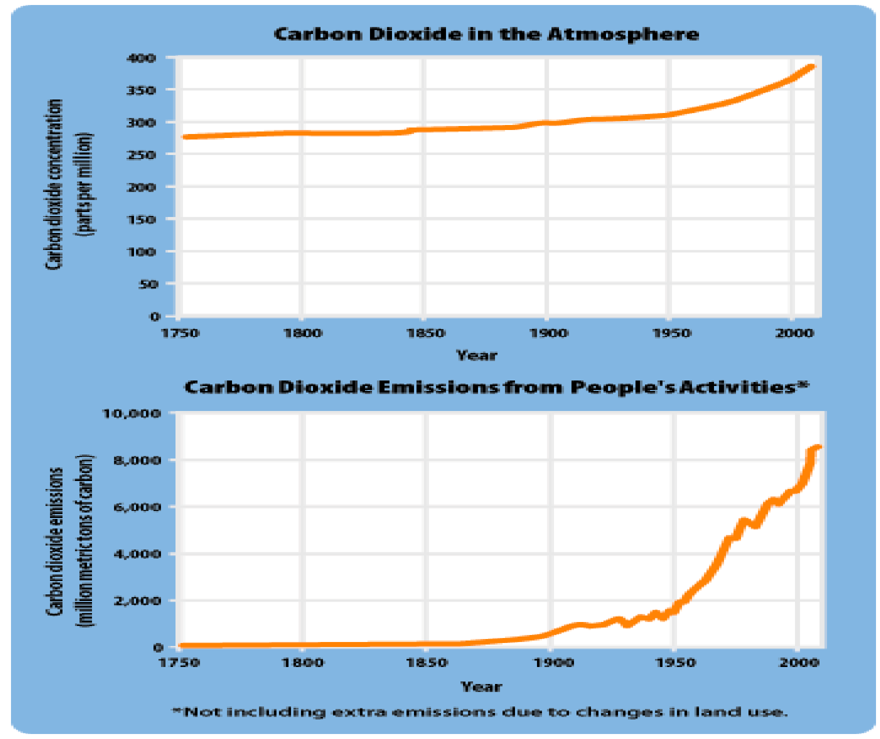
How warm will the Earth become?

The Earth's climate is very complicated. Even with advanced computer models, we don't know exactly how all of the Earth's different systems will behave and interact with one another as greenhouse gases increase. So scientists give a range of temperature increases that could occur. They predict that:

If people keep adding greenhouse gases into the atmosphere at the current rate, the average temperature around the world could increase by about 4 to 12°F by the year 2100.

If we make big changes, like using a lot more renewable resources instead of fossil fuels, the temperature increase will be less — about 2 to 5°F.

Either way, scientists agree that temperatures will increase. They're just not sure by exactly how much, but they are sure that even a 2°F change means that the global climate in the future will be different from today.



Source: EPA's Climate Change Indicators (2014) and the Carbon Dioxide Information Analysis Center (2010).

How much and how quickly will warmer temperatures lead to other changes?

Scientists know that rising temperatures will cause other changes around the world, and some of these changes have already begun. For example, we know that ice sheets and glaciers are melting, but we don't know exactly how fast or how much more they will melt in the future. But we do know that in general, the more the temperature changes, the more negative the impacts will be. As scientists collect more information, they will be able to make more accurate predictions.

How will climate change affect specific places?

Right now, scientists are better at estimating changes across big areas rather than small areas. For example, they can predict average temperature increases for the whole United States, but they can't say exactly how the temperature might change in your city or town. By collecting more data, scientists are getting better at predicting how climate change will affect specific places.

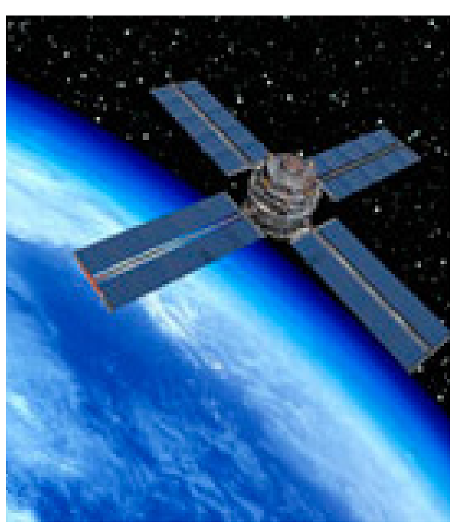
Climate Scientist Toolkit

Satellite

What is it? An instrument that orbits the Earth and collects a wide variety of information. The satellites in orbit today can gather information like the temperature of the atmosphere or ocean, sea level, and the amount of different gases in the atmosphere. Satellites can also take detailed pictures of the Earth's surface.

How is it used? Scientists use temperature data and other measurements from satellites to track climate change trends. They use satellite maps to figure out how much of the Earth is covered by snow and ice at any given time.

How much information does it give scientists? Scientists have been using satellites to learn about the Earth's climate for roughly the last 30 years. Satellites can take continuous measurements.



Weather Station

What is it? A collection of weather monitoring tools, such as thermometers, barometers, and rain gauges, that send information to scientists about local weather conditions.

How is it used? Scientists use the information from weather stations to track climate trends.

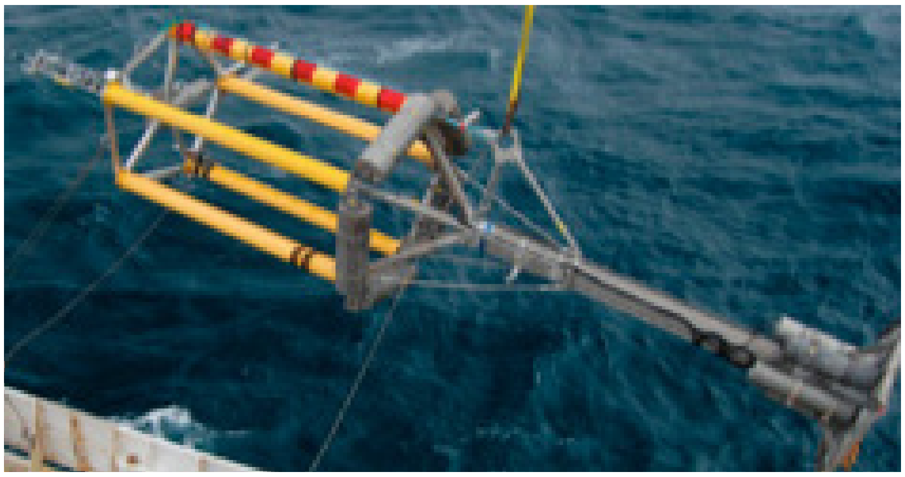
How much information does it give scientists? Weather stations have been recording climate data for roughly the last 100 years. People used to record data by hand only twice a day, but newer automated instruments can report data several times each hour.

Weather Balloon

What is it? Large balloons that launch daily from hundreds of locations around the world, carrying weather-monitoring instruments into the upper atmosphere. The instruments send data back to scientists using a radio transmitter.

How is it used? Scientists use the data they receive from the transmitter to study the temperature of different layers of the Earth's atmosphere.

How much information does it give scientists? Weather balloons have been used to record climate data for roughly the last 100 years. Most locations launch these balloons once or twice each day.



Ocean Buoy

What is it? A weather station that floats on a buoy in the ocean. It records the air and water temperature, air pressure, and other measurements and then sends this information to scientists.

How is it used? Scientists use the temperature data they receive from ocean buoys to track climate trends.

How much information does it give scientists? Ocean buoys have been used to record climate data for roughly the last 100 years. They can take continuous measurements.

Historical Records

What are they? Almanacs, diaries, and historical archives contain information about past temperatures and other weather data.

How are they used? Scientists and historians use historical weather data to figure out past climate trends.

How much information do they give scientists? It depends on the source. Most historical weather records only go back a few hundred years, but some go back for 1,000 years or more. Some records provide hourly or daily information, but others provide only monthly or yearly data.

Tree Rings

What are they? Trees add a new layer of wood every year. When you cut across the trunk, each layer looks like a ring.

How are they used? Scientists examine the width and chemical makeup of each tree ring to learn about past climate trends. Rings generally grow wider in warm, wet years and thinner in cold, dry years.

How much information do they give scientists? Tree ring records can go back hundreds to thousands of years, depending on when the tree lived and how old it was. Each ring represents one year.

Coral Core

What is it? A cross-section (slice) of coral. Like trees, corals grow by building new layers every year.

How is it used? By studying the width, density, and chemical makeup of each layer, scientists can tell what the water temperature and other conditions were like in the past.

How much information does it give scientists? Coral core records can go back hundreds to thousands of years. Each layer of coral represents one year.

Ice Core

What is it? A tube of ice that scientists drill out of a glacier or an ice sheet. Ice forms in layers and sometimes traps air bubbles, pollen, and dust. Ice cores are usually a few inches wide and can be thousands of feet deep.

How is it used? Scientists examine ice cores for many things. For example, the thickness of a layer indicates the amount of snow that fell. Scientists use trapped air bubbles to determine the levels of gases that were present in the atmosphere in the past, and they can examine the water molecules in the ice itself to get information about historical temperatures. Trapped pollen and dust also provide clues about the climate.

How much information does it give scientists? Ice core records can go back up to 800,000 years. The top (most recent) layers of an ice core can provide information on individual seasons or years. The deeper, older layers are more compacted, and scientists have to estimate the date of each layer.

Sediment Core

What is it? A tube of sediment (sand and mud) that scientists drill from the floor of an ocean or lake. Sediment builds up in layers over time. Rocks and fossils stuck in the sediment provide clues about past climate trends.

How is it used? Plants and animals often prefer specific climate conditions, so the types of fossils in the sediment core can provide clues about what the climate was like in the past. Scientists can also find out what the water temperature was like in the past by studying the chemical makeup of ancient shells. Other clues about the past might come from layers of pollen, volcanic ash, or large rocks left behind by a glacier.

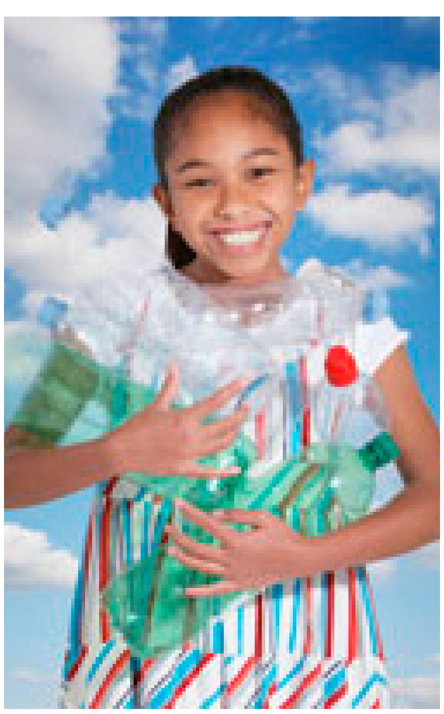
How much information does it give scientists? Sediment cores can record climate data going back millions of years. Each distinct layer may represent hundreds of years or more.

Climate Models

What is it? A computer program that uses hundreds of mathematical equations to describe how the Earth's climate system works. Scientists run these models on powerful supercomputers to see how one change — like extra greenhouse gases in the atmosphere — can affect the whole planet.

How is it used? Scientists use models to understand how and why the Earth has changed in the past and predict what the Earth will be like in the future.

How much information does it give scientists? Models can be used to look just a few years into the future or many years down the road.



Be Part of the Solution!

Do something today to reduce greenhouse gas emissions!

Reducing greenhouse gas emissions is the key to solving global climate change. A major way these gases get into the atmosphere is when people burn coal, oil, and natural gas for energy. Everyone uses energy, and everyone can be part of the solution!

But don't forget that climate change is already happening. We're seeing some of the impacts now, and we'll experience more in the future. So we need to prepare and plan for the changes we know are coming.

Technologies

To successfully combat climate change, people will have to switch from getting most of their energy from burning fossil fuels to getting most of their energy from a wide variety of clean energy sources.

Many of these technologies are already available today, while others are still being developed and tested. Clean energy technologies like wind and solar power produce energy without burning fossil fuels. Other technologies reduce greenhouse gas emissions through energy efficiency or by capturing these gases before they can enter the atmosphere.

Here are clean energy resources and other technologies that reduce the amount of greenhouse gases being put into the atmosphere:

Solar

Why is daytime brighter and warmer than nighttime? The answer is simple: solar energy — the light and heat that come from the sun.

People can harness the sun's energy in a few different ways:

Photovoltaic cells convert sunlight into electricity. Do you have a solar calculator or watch? These items are powered by photovoltaic cells. A photovoltaic cell absorbs light and uses a semi-conductor to converts it directly into electricity. A group of photovoltaic cells is known as a solar panel.

Solar thermal power plants use heat from the sun to create steam, which can then be used to turn generators to make electric-

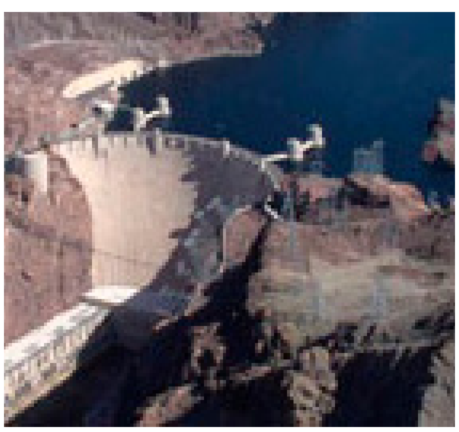
ity. On a smaller scale, solar panels that harness thermal energy can be used for heating water in homes, other buildings, and swimming pools.

Passive solar heating can be as simple as letting the sun shine through windows to heat the inside of a building. People can design or remodel buildings to take advantage of heat from the sun during the winter.

Water Energy

If you've ever stood in a fast–moving stream, under a waterfall, or on the ocean shore as waves come crashing in, then you've felt the power of the water. The energy from moving water can be used to create electricity in several different ways. For example:

A hydroelectric dam captures energy from the movement of a river. Dam operators control the flow of water and



Hoover Dam is a hydroelectric dam on the Colorado River.

the amount of electricity produced. Dams create reservoirs (large bodies of calm water) behind them, which can be used for recreation, wildlife sanctuaries, and sources of drinking water.

Wave power captures energy from waves on the surface of the ocean using a special buoy or other floating device.

Tidal power captures the energy of flowing waters with the help of turbines as tides rush in and out of coastal areas.

Nuclear Energy

Atoms are tiny particles that make up every object in the universe. The bonds that hold atoms together contain a huge amount of energy. When atoms are split apart, this energy can be used to make electricity. This process is called nuclear fission.

In a nuclear power plant, fission takes place inside a reactor. Most nuclear power plants use uranium as fuel because its atoms are easily split apart. Uranium is a metal found in rocks all over the world. Although uranium is not a renewable resource, fairly large quantities of it still exist, and it only takes a small amount to produce a lot of energy.

Because nuclear power plants don't

Nuclear cooling towers

burn fossil fuels, they don't produce greenhouse gases. But mining and refining uranium requires large amounts of energy. In addition, nuclear power plants produce waste that is radioactive. This waste has to be handled and disposed of according to special regulations designed to protect people and the environment.

In a nuclear reactor, fuel rods full of uranium pellets are placed in water. Inside the fuel rods, uranium atoms split, releasing energy. This energy heats water, creating steam. The steam moves through a turbine, which turns a generator to create electricity. The steam cools back into water, which can then be used over again. At some nuclear power plants, extra heat is released from a cooling tower.

Geothermal Energy

If you were to dig a big hole straight down into the Earth, you would notice the temperature getting warmer the deeper you go. That's because the inside of the Earth is full of heat. This heat is called geothermal energy.

Geothermal power plants use heat from deep inside the Earth to generate steam to make electricity. At a geothermal power plant, wells are drilled 1 or 2 miles deep into the Earth to pump steam or hot water to the surface. You're most likely to find one of these power plants in an area that has a lot of hot springs, geysers, or volcanic activity, because these are places where the Earth is particularly hot just below the surface.

Geothermal heat pumps tap into heat close to the Earth's surface to heat water or provide heat for buildings. Geothermal heat pumps can do all sorts of things — from heating and cooling homes to warming swimming pools. These systems transfer heat by pumping water or a refrigerant (a special type of fluid) through pipes just below the Earth's surface, where the temperature is a constant 50 to 60°F.

During the winter, the water or refrigerant absorbs warmth from the Earth, and the pump brings this heat to the building above. In the summer, some heat pumps can run in reverse and help cool buildings.

Biomass/Biofuel Energy

Biomass is a fancy name for material from plants and animals. Some kinds of biomass can be burned to produce energy. One common example is wood.

Biomass contains stored energy. That's because plants absorb energy from the sun through the process of photosynthesis. When biomass is burned, this stored energy is released as heat.

Burning biomass releases carbon dioxide. However, plants also take carbon dioxide out of the atmosphere and use it to grow their leaves, flowers, branches, and stems. That same carbon dioxide is returned to the air when the plants are burned.

Many different kinds of biomass, such as wood chips, corn, and some types of garbage, are used to produce electricity. Some types of biomass can be converted into liquid fuels called biofuels that can power cars, trucks, and tractors. Leftover food products like vegetable oils and animal fats can create biodiesel, while corn, sugarcane, and other plants can be fermented to produce ethanol.

Methane Capture and Use

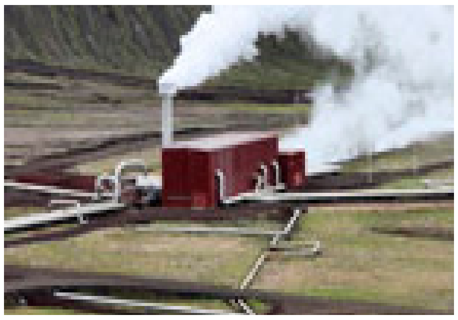
You've probably heard about the three R's. While it's important to reduce, reuse, and recycle as much as you can, it's hard to avoid throwing out some trash every week. Trash that cannot be recycled or reused often ends up in landfills, where it produces methane as it decomposes.

Methane is a very powerful greenhouse gas. One pound of methane traps 21 times more heat in the atmosphere than a pound of carbon dioxide. Methane is also the main ingredient in natural gas. Because methane can be captured from landfills, it can be burned to produce electricity, heat buildings, or power garbage trucks. Capturing methane before it gets into the atmosphere also helps reduce the effects of climate change.

Methane can also be captured from farm digesters, which are big tanks that contain manure and other waste from barns that house livestock such as cows and pigs.

Carbon Capture and Underground Storage

Currently, most of our electricity is generated at large power plants that burn coal and other fossil fuels that add lots of carbon dioxide to the atmosphere. It will likely be many decades before we can get most of our electricity from renewable resources that emit little or no carbon



dioxide. In the meantime, scientists are developing ways to capture carbon dioxide from power plants and factories and safely store it underground so that it can't go into the atmosphere.

Carbon dioxide emissions from a power plant or factory are captured so they are not released into the atmosphere. The captured carbon dioxide is sent through a pipeline to a place where underground rock formations can store the carbon dioxide safely and permanently. The carbon dioxide is pumped deep underground (often more than half a mile down). The site is monitored to make sure the stored carbon dioxide doesn't leak back up to the atmosphere or into underground sources of drinking water.

Green Vehicles

How do you get to where you need to go? In the United States, vehicles that burn gasoline and diesel fuel are the main form of transportation for most people. Cars, trucks, buses, airplanes, trains, and other vehicles account for almost one-third of the energy consumed in the United States and they also produce almost one-third of our greenhouse gas emissions.

While past generations were only able to buy gasoline–powered cars, you will have many more options! Vehicles are now available that use less energy and are better for the environment, and even more of these vehicles will be available in the future.

Fuel-efficient cars use less gasoline than other cars to travel the same distance. When less gasoline is burned, less carbon dioxide ends up in the atmosphere.

Alternative fuel vehicles run on fuels

other than gasoline. Burning natural gas produces less carbon dioxide than gasoline or diesel, and burning hydrogen produces no carbon dioxide at all!

Flexible fuel vehicles can run on gasoline, but they can also use a blend of up to 85 percent ethanol (a fuel produced from corn, sugar cane, or other types of biomass)

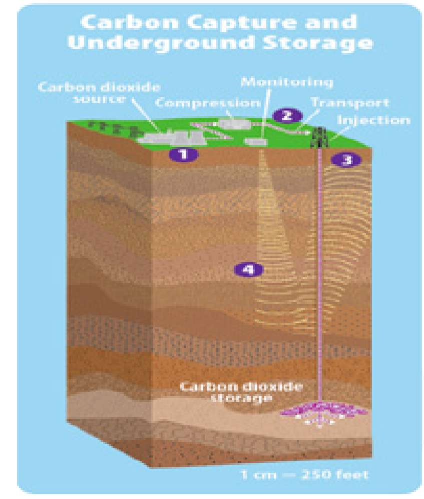
and 15 percent gasoline, known as E85. These cars have been produced since the 1980s.

Electric vehicles are powered by an electric motor instead of a gasoline engine. From the outside, you might not be able to tell if a car is electric, but you'll see the difference if you look under the hood! Large batteries store energy to power the car, and you just plug it in to refuel. Electric vehicles emit no direct pollution, and if sources like wind and solar are used to generate the electricity, their total carbon dioxide emissions can be very small. You'll see more and more of these cars on the road in the years to come.

Hybrid-electric vehicles combine the benefits of gasoline engines and electric motors. A hybrid car can go up to twice as far on a gallon of gasoline as a typical gasoline-powered car.

Energy–Efficient Buildings & Systems

Every day, people flip on light switches, turn on their computers, and use energy



in many other ways in their homes, offices, and schools. Using all that power leads to greenhouse gas emissions, especially if the energy is generated from fossil fuels. In fact, the buildings where we live and work account for 30 percent of all greenhouse gas emissions in the United States. Technologies such as more efficient heating, air conditioning, and lighting enable buildings to use less energy, which helps reduce greenhouse gas emissions.

ENERGY STAR is a U.S. Environmental Protection Agency voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency. For example, ENERGY STAR qualified compact fluorescent light bulbs (CFLs) use about 75 percent less energy than standard incandescent bulbs and last up to 10 times longer. Learn more at: www.energystar.gov.

What You Can Do

Can one person help stop global climate change? Yes! Especially when the simple steps you, your friends, and your family take are multiplied by millions of people all over the world.

Switch to Clean Energy: When we get electricity from renewable energy sources like wind and solar power, we avoid the carbon dioxide emissions that would have come from burning fossil fuels like coal, oil, or natural gas.

Choose green power: Talk with your family and school about switching to renewable energy. Explore your options at the Green Power Network's website at: http://apps3.eere.energy.gov/greenpower.

Generate your own power: Can your school or home generate its own renewable energy? Talk with your family and school about the possibility of installing solar panels, a solar water heater, or even a wind turbine.

Use Less Energy: Most of the energy you use at home and at school comes from burning fossil fuels. Using less energy means burning fewer fossil fuels and putting less carbon dioxide into the atmosphere.

Power down: Did you know that some appliances and electronics plugged into an outlet still use power, even when they're turned off? Unplug energy vampires like video game consoles, cell phone chargers, and MP3 players whenever you can. Or consider buying a "smart" power strip, which automatically cuts off power when you turn off an appliance. Learn more at the ENERGY STAR website for kids at: http://tinyurl.com/k9w8bgq.

Do the math: An energy audit can help you calculate how much energy your family uses at home and identify ways to reduce your energy use. Talk with your family about hiring a professional to figure out how your home might be losing energy through leaky doors and windows, poor insulation, and more. Start by contacting your local electric company to see if they'll do an audit for a discounted fee or even for free. Your family can also "do

it yourself" with help from the ENERGY STAR Do It Yourself Guide at: http://tinyurl.com/kf8lohh

Look for the label: Energy–efficient appliances and electronics typically use between 10 and 50 percent less energy than regular models. If you're shopping for a TV, computer, DVD player, or other electronic device or appliance, look for products that display the ENERGY STAR label.

Learn more at the ENERGY STAR Qualified Products page at: www.energystar.gov/products/certified-products

Be energy-wise at school: Schools can partner with EPA's ENERGY STAR program to reduce their energy use. Talk with your school about what ENERGY STAR schools are doing to save energy, and find out how your school can join at: http://tinyurl.com/lm23uby.

Travel Green: Cars, trucks, airplanes, and other kinds of vehicles are responsible for about one-third of the greenhouse gas emissions in the United States. Smart transportation choices can make a big impact on reducing emissions.

Walk, bike, skateboard, rollerblade, or take a bus to school: Just make sure to stay safe. Ask your school to get involved in the Safe Routes to School program at: http://www.saferoutesinfo.org.

Give the car a break: Encourage your family to make one big trip to run all their errands at once, instead of making lots of small trips. Consider sharing rides with others, and use public transportation like buses or trains whenever you can.

Use your buying power. When it's time to buy a new car, help your family choose one that's fuel-efficient or electric. You'll use less gas, reduce emissions, and save money.

Clean up the bus: Through EPA's Clean School Bus USA program, schools can replace or upgrade older buses so they are more fuel–efficient or run on cleaner fuels. Learn more at: http://epa.gov/cleanschoolbus.

Don't idle: Your family car or school bus idles when the engine is running but the isn't moving: for example, when your parent or bus driver is waiting to pick you up after school. Running the engine burns fuel, which not only wastes gasoline, but also produces greenhouse gases and other kinds of air pollution.

Watch Your Water Use: Saving water saves energy, which in turn reduces greenhouse gas emissions. It takes a lot of energy to treat the water you use every day to make it safe to drink and to deliver it to your house. It takes even more energy to turn it into hot water. Did you know that letting your faucet run warm water for five minutes uses about as much energy as leaving a 60-watt light bulb on for 14 hours?

Be water-wise: Turn the water off while brushing your teeth, and try taking shorter showers. Learn more ways you can save water at: www.epa.gov/watersense/pubs/waterenergy.html

Fix that faucet: A faucet that leaks at a rate of one drip per second can waste more than 3,000 gallons of water in a year.

Look for leaks: If your toilet has a leak, you could be wasting 200 gallons of water a day. Try putting a drop of food coloring

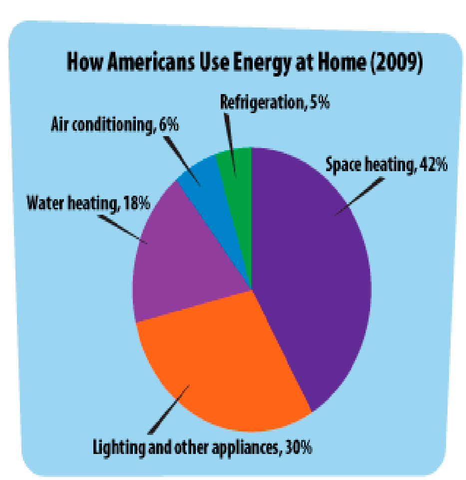
in the toilet tank. If the color shows up in the bowl without flushing, you have a leak!

Keep it cool: Wash only full loads of laundry, and use cold water instead of hot. About 90 percent of the energy used for washing clothes is for heating the water.

Go low-flow: Talk with your family about installing water-efficient appliances and plumbing fixtures like low-flow showerheads.

Reduce Waste

Most people don't realize that reducing, reusing, and recycling can help slow climate change. How? To begin with, every



product has a life cycle, and every step, from manufacturing to disposal, leads to greenhouse gas emissions. Reducing, reusing, and recycling means you buy (and throw away) less stuff, and that helps reduce the amount of greenhouse gases we're adding to the atmosphere. You can reduce greenhouse gas emissions if you:

Reduce: Reduce the amount of new stuff you buy. To reduce waste, buy things that have less packaging.

Reuse: Try to borrow or rent things you'll only need for a short amount of time, and reuse the things you already have. When you have things you no longer need, give them to others who can use them. Use reusable bags when you go shopping.

Recycle: Remember to recycle whatever materials you can, like bottles, cans, and paper, so they can be collected and remade into new products. Recycling also created new green jobs.

Buy recycled: Choose products made from recycled materials whenever you can.

Teach your school the three R's: Schools can save energy, preserve natural resources, and prevent greenhouse gas emissions by reducing, reusing, and recycling.

More Ways to Make a Difference

You can take many other actions to help reduce greenhouse gas emissions and global climate change.

Plant a tree: Trees help to slow climate change because they absorb carbon dioxide during photosynthesis. Trees also provide shade, which helps keep streets and houses cooler in the summertime and reduces the need for air conditioning.

Consider buying locally grown food: The further your food travels, the more greenhouse gas emissions are produced in transporting the food from the farm to your plate. You can find locally grown food at a farmers market and even at some grocery stores.

Reduce your carbon footprint: Find out how big your own carbon footprint is, and explore ways you can reduce it at: www.epa.gov/climatestudents/calc/index.html

Spread the word: Give a presentation to your family, school, or community group that explains how their actions can cause or reduce climate change.

Schools Work Together: If one school can make a difference, then lots of schools working together can make a huge difference. Learn what others are doing and share ideas by getting involved with some of these green programs:

Green Schools Alliance
www.greenschoolsalliance.org/

Green Cup Challenge
www.greencupchallenge.net

National Wildlife Federation's Eco–Schools
www.nwf.org/Eco-Schools-USA.aspx

Climate Change Web Resources

A Student's Guide to Global Climate Change was developed by the EPA to help provide students (and educators!) with clear, accurate information about the causes and effects of climate change — as well as the steps we can all take to help solve the problem. You can access more resources at: www.epa.gov/climatestudents/resources/index.html

Take an Online Climate Change Expedition!
www.epa.gov/climatestudents/expeditions/index.html

Get your passport ready! It's time to go on a trip around to world to explore the effects of climate change.

Activity Book: Discover Your Changing World with NOAA
http://oceanservice.noaa.gov/education/discoverclimate/

This free activity book will introduce you to the principles of climate science, help you learn about the Earth's climate system, the factors that drive and change it, the impacts of those changes, and what you can do to explore, understand, and protect our Earth.

Climate Classroom

www.climateclassroom.org

Learn how you can help fight climate change while making money with a green career or meeting friends with a green volunteering opportunity. (National Wildlife Federation)

Climate Kids: NASA's Eyes on the Earth
http://climatekids.nasa.gov
http://climate.nasa.gov/resources/education/

Travel back in time to learn about climate change or fly along with a NASA satellite to check on the planet's vital signs. You can also view climate videos and play various games.

SciJinks
http://scijinks.jpl.nasa.gov

Explore the world of weather through games, videos, and downloadable posters, bookmarks, and more. (NASA)

Study Hall–Resources for Students
http://education.arm.gov/studyhall

Still have unanswered questions about climate change? Visit the Study Hall Web site, and send your questions to a real climate scientist. (U.S. Dept. of Energy)