

Choices



You Make the Difference

Global Warming Education Resource Guide



Serving Island, Skagit & Whatcom Counties



Printed October 2008

Introduction

This **Global Warming Education Resource Guide** was developed by the Northwest Clean Air Agency and RE Sources for Sustainable Communities. The Pacific International Section of the Air & Waste Management Association provided partial funding of the project.

This packet was specifically designed to be used with the **Choices - You Make the Difference** board game. The game was developed as part of an hour-long classroom presentation, delivered to 5th - 8th grade students on behalf of the Northwest Clean Air Agency.

Inside, you will find a multi-media CD called **Practical Solutions to Global Warming**. This CD contains a positive and empowering 20-minute presentation that explains the causes and solutions to global warming. People cause it. People can fix it.

Also included in this guide is background information on global warming, our classroom presentation script, pre- and post-game activities and lesson plans and game instructions.

We hope you enjoy using these learning materials. Thank you for making time to teach your students about this very important issue!

Table of Contents

Background Information	Page
Greenhouse Effect and Greenhouse Gases	4
Global Warming	5
Solutions to Global Warming	6
Effects of Global Warming	7
Atmosphere	8
Weather vs. Climate	8
Global Warming Presentation Script	9
Additional Lessons: Exploring the Issue in Your Classroom	
Create the Greenhouse Effect in a Bottle	15
Internet Scavenger Hunt 1 (Global Warming Background Information Review)	16
Changes on Noua's Island	17
Culture and Climate	17
Internet Scavenger Hunt 2 (Impacts in the Pacific Northwest)	18
Calculate Your Global Warming Emissions	19
Make New "Choices" Cards	20
Weather logs - What Do You Expect?	20
Homework: Talkin' About the Weather (& Climate)	22
Consider the Evidence	23
Appendix	
Global Warming Internet Resources	25
15 Things You Can Do to Reduce the Effects of Global Warming	28
Global Warming Crossword Puzzle and Definitions	App 1
Internet Scavenger Hunt 1 - Student Questions and Teacher Key	App 2
"Changes on Noua's Island" Story	App 3
Internet Scavenger Hunt 2 - Student Questions and Teacher Key	App 4
Global Warming Wheel Card	App 5
Blank "Choices" Cards	App 6



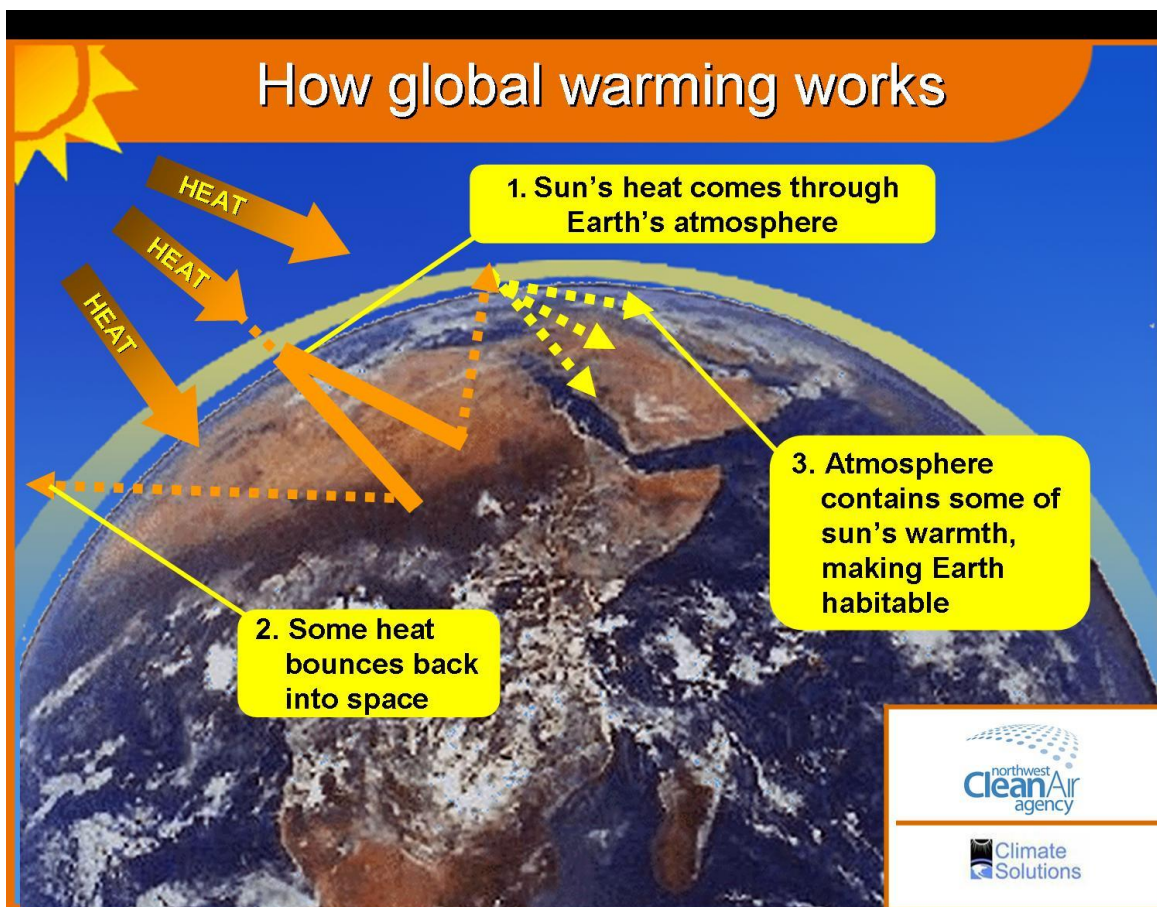
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Greenhouse Effect and Greenhouse Gases

Heat energy from the sun comes down through the Earth's atmosphere. Some of that heat hits the Earth's surface and bounces back into space through the atmosphere. It is as if the atmosphere is ventilating some of the sun's warmth so it doesn't overheat. But some of the warmth is also contained by the earth's atmosphere.

That is because certain gases in the atmosphere act as an insulation that holds in some of the heat – the greenhouse layer. Without that insulating layer of gases, Earth would be too cold to support life.

The heat-trapping and ventilating effects are well-balanced, creating a stable climate and supporting the rich diversity of life on the planet. This heat-regulating atmosphere is the main thing that distinguishes the Earth from all the other planetary bodies that scientists have studied.



Courtesy of the Northwest Clean Air Agency

Greenhouse gases include any gas in the atmosphere that is capable of absorbing infrared radiation or heat. Greenhouse gases include water vapor or moisture, carbon dioxide (CO₂), methane, nitrous oxide and ozone. Carbon dioxide is the primary gas influenced by humans.

Global Warming

Human activity is disrupting this natural balance. Over the last 250 years, humans have turned to fossil fuels to meet most of our energy needs. Fossil fuels – coal, oil, and natural gas – contain carbon that has been stored in the ground through natural processes over hundreds of millions of years.

Burning fossil fuels releases trapped carbon into the atmosphere as carbon dioxide, where it builds up and thickens the heat-trapping greenhouse layer around the Earth.

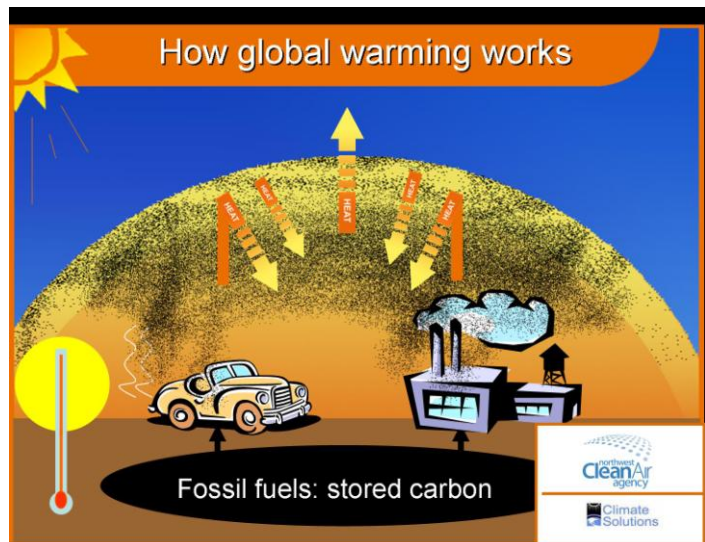
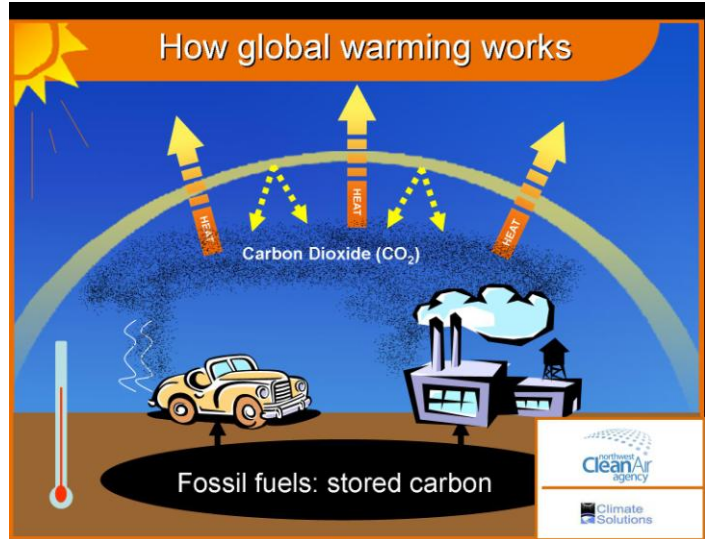
The heat builds up, the globe “warms”, and the atmospheric balance that keeps the climate stable is disrupted.

After about 250 years of this, the carbon dioxide has measurably increased the insulating effect of this atmospheric “blanket”. This thick blanket prevents heat from escaping.

This release of carbon is, by geologic standards, very sudden. The atmospheric concentration of carbon dioxide, for example, has increased by 35% since the 18th century, while levels of methane have more than doubled.

Approximately 6.6 tons of greenhouse gases are emitted per person every year in the United States. About 82% of these emissions are from burning fossil fuels to generate electricity and power our automobiles. The U.S. presently emits more greenhouse gases per person than any other country.

(Information adapted from The Encyclopedia of the Atmospheric Environment, <http://www.ace.mmu.ac.uk/eae/english.html> and the EPA Global Warming Site, <http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html> on October 28, 2004)



Solutions to Global Warming

Climate change is one global problem we actually know how to fix. People are causing it, and people can solve it.

Global warming solutions are, first and foremost, clean energy solutions. To stabilize the climate, we need to reduce fossil fuel use. Existing clean energy technologies include renewable resources like wind and solar; new technologies like the hydrogen fuel cell, and energy efficiency technologies that can get the most out of our power supplies.

Global warming solutions also include transportation solutions. And particularly in urban areas, transportation is one of our toughest challenges. The solutions fall into three broad categories:

- First - transportation choices. As traffic increases, more and more people are demanding alternatives to cars. Transportation investments will determine whether we become more car-dependent or whether we have more choices, like buses, trains and safe bike routes.
- Second - building more complete communities. Reducing sprawl by building lively, mixed-use communities is a great way to reduce transportation emissions and costs. Building such complete communities makes taking the bus, riding your bike or walking more feasible.
- Finally - cleaner cars, trucks, and fuels. Comfortable gas-electric hybrids are available now.

Another way to reduce carbon dioxide pollution and fight global warming is to reduce waste or use waste to provide energy needs. When we reduce waste, we also reduce emissions from energy consumption; reduce methane emissions from landfills; and increase storage of carbon in trees. For example, waste prevention and recycling of paper products allow more trees to remain standing in the forest, where they can continue to remove carbon dioxide from the atmosphere.

Also, methane from landfills, dairy farms, and sewage plants can be used to generate electricity. This reduces global warming in two ways – by reducing methane emissions and by reducing the need for fossil fuels to produce power.

To a great extent, the solutions are also local. Much of the action is in our communities, where we make decisions about how we use energy, what kinds of transportation investments we make, how much waste we generate, and how we handle growth.

See “15 Things You Can Do to Reduce the Effects of Global Warming” on page 28 to learn more.

(Adapted from the Northwest Clean Agency’s web site <http://www.nwcleanair.org>. See “15 Things You Can Do to Reduce Global Warming” for more information on page 27.)

Effects of Global Warming

In the Pacific Northwest, the most significant impact is on our water supply. Our power systems, drinking water supplies, salmon, farms, and forests all depend on snow pack. Our snow pack is projected to decline 50% by 2050 and 80% in this century.

Global warming also poses new threats to Northwest forests. Scientists project increases in pest infestations and intense forest fires as summer temperatures rise and snow pack declines. One major pest problem – the mountain pine beetle - is already destroying wide swaths of forest in British Columbia.

Forests may be unable to re-grow in some areas after these intense fires. This would leave some parts of the Northwest permanently deforested. Deforestation releases even more heat-trapping CO₂ into the atmosphere.

Global warming also increases the range of disease-carrying rodents and insects. Outbreaks of tropical diseases carried by mosquitoes have begun to spread into North America - like the West Nile Virus. It is a very serious public health issue, both here at home and internationally.

In addition, hotter temperatures are connected to more smog, more pollen and more severe respiratory problems - health problems that disproportionately affect kids and the elderly.

Global warming will have far-reaching impacts throughout the world, not just here at home. Many parts of the world may become uninhabitable due to drought or sea-level rise, leaving millions homeless. And recent events have shown clearly that this kind of trouble anywhere in an interdependent world can affect us all.

That's why countries world-wide are rising to the challenge by ratifying the Kyoto treaty, which calls for reductions in global warming pollution. 169 countries have ratified the treaty as of December 2006. There are only two advanced nations that have not signed the agreement – the United States and Australia. However, the Kyoto treaty is being put in to action across the United States in other ways.

The Cities for Climate Protection™ (CCP) Campaign enlists cities to adopt policies and implement measures to achieve reductions in local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. 152 local U.S. governments participate in the CCP, integrating climate change mitigation into their decision-making processes. Bellingham, Burien, King County, Olympia, Seattle, Spokane, Spokane County and Tacoma are participating in Washington State.

(Adapted from the Northwest Clean Agency's web site, <http://www.nwcleanair.org>, the United Nations Framework Convention on Climate Change web site, http://unfccc.int/kyoto_protocol/items/2830.php, and ICLEI—Local Governments for Sustainability web site, <http://www.iclei.org/index.php?id=811>)

Atmosphere

The atmosphere surrounds the earth and is a mixture of different gases, particles and aerosols collectively known as air. The atmosphere protects us by filtering out deadly cosmic rays, powerful ultraviolet (UV) radiation from the sun, and even meteors on a collision course with the earth. Air is well mixed throughout the atmosphere; however the atmosphere does differ in temperature and altitude, defining a number of atmospheric layers. These layers include the troposphere, stratosphere, and mesosphere. Another well-known layer is the ozone layer, which is located in the stratosphere and protects life from the harmful effects of UV radiation. Although traces of atmospheric gases have been detected well out into space, 99% of the mass of the atmosphere lies below about 15.5 to 18.6 miles altitude, while 50% is concentrated in the lowest 3.1 miles (less than the height of Mount Everest).

Air remains remarkably uniform in composition and is the result of efficient recycling processes and turbulent mixing in the atmosphere. The two most abundant gases in air are nitrogen (78% by volume) and oxygen (21% by volume), and together they make up over 99% of the lower atmosphere. In addition to nitrogen and oxygen, air contains a number of trace gases, including the noble gases argon, neon, helium, krypton and xenon, the greenhouse gases and ozone.

During the last 200 years, humankind has begun to significantly alter the composition of the atmosphere through pollution. Although air is still made up mostly of oxygen and nitrogen, some of the levels of trace gases have been increasing, in particular the concentrations of greenhouse gases, which contribute to global warming.

(Adapted from The Encyclopedia of the Atmospheric Environment, <http://www.ace.mmu.ac.uk/eae/english.html>, on October 28, 2004)

Weather vs. Climate

Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation in a given location. In most places, weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. The weather can change a lot within a very short time.

Climate describes the average of all weather occurring over a period of time in a given place. This includes average weather conditions, regular weather sequences (like winter, spring, summer, and fall), and special weather events (like tornadoes and floods). For example, San Diego is known as having a mild climate, New Orleans a humid climate, Buffalo a snowy climate, and Seattle a rainy climate.

A simple way of remembering the difference is that 'climate' is what you expect (e.g., cold winters) and 'weather' is what you get (e.g., a blizzard).

(Adapted from the EPA Kids Global Warming Site - <http://www.epa.gov/globalwarming/kids/climateweather.html> on October 28, 2004)

Climate Change Presentation Script

(Grades 5-8, 1 hour)

A project of the Northwest Clean Air Agency

Objective: Introduce subject of climate change/global warming and prepare students to play the "Choices – You Make the Difference" board game. (Questions to students are underlined in the script.)

Introduction

Hello, my name is _____. I am here today on behalf of the Northwest Clean Air Agency. NWCAA helps protect and improve the quality of air for people living in our area. (Optional: How many of you have heard of the Environmental Protection Agency? You may have heard it called the EPA. Well, that organization is responsible for creating environmental laws for the entire country.) NWCAA is in charge of the air quality in Skagit, Whatcom and Island Counties. With NWCAA I get to speak with students all over our area. And that's why I've come to visit you today. We're going to talk about air pollution and how it is related to some of the problems we're experiencing on our planet – mainly, how air pollution is changing our climate. Today we will talk about the problem of climate change and then play a fun game to help us come up with some solutions that will help us keep the air clean.

You may already know about a lot of the things that cause air pollution such as cars, factories and burning. You may also know that air pollution can make it hard to breathe, make us sick, even damage plants, animals and buildings. The kind of air pollution we're going to talk about today does affect plants, animals, and humans, but it also affects the whole earth, including our climate. That's why you sometimes here it called climate change. Now, you may have also heard of it referred to as global warming, but, I like to use climate change because climate change is a bit more accurate. Yes, the earth is warming, but that also causes the climate to change. It's kind of like if you have a fever (that's a symptom) and the fever causes you to sweat or shiver.

Weather and Climate

When we talk about the topic of climate change, it is important for us to understand what climate is, and how it is different from weather.

What is weather? What is climate? How is climate different from weather? What is our climate like here in the winter? How about in the summer? Do we ever have sunny or warm weather in the winter? How about rain in the summer? Sure! So, climate is what you expect (e.g. cold winters) and weather is what you get on a day to day basis (e.g. a blizzard or rain or sunshine). Climate is the overall, big picture of weather. When we talk about climate change we are talking about changes to the overall, big picture of the earth's climate.

Greenhouse Layer

The atmosphere is a thin layer of gasses that surrounds the earth. We wouldn't be able to survive here on earth without the atmosphere and the atmosphere plays a big role in our weather and climate. Let me explain...

(Draw the diagram below on the board as you explain)

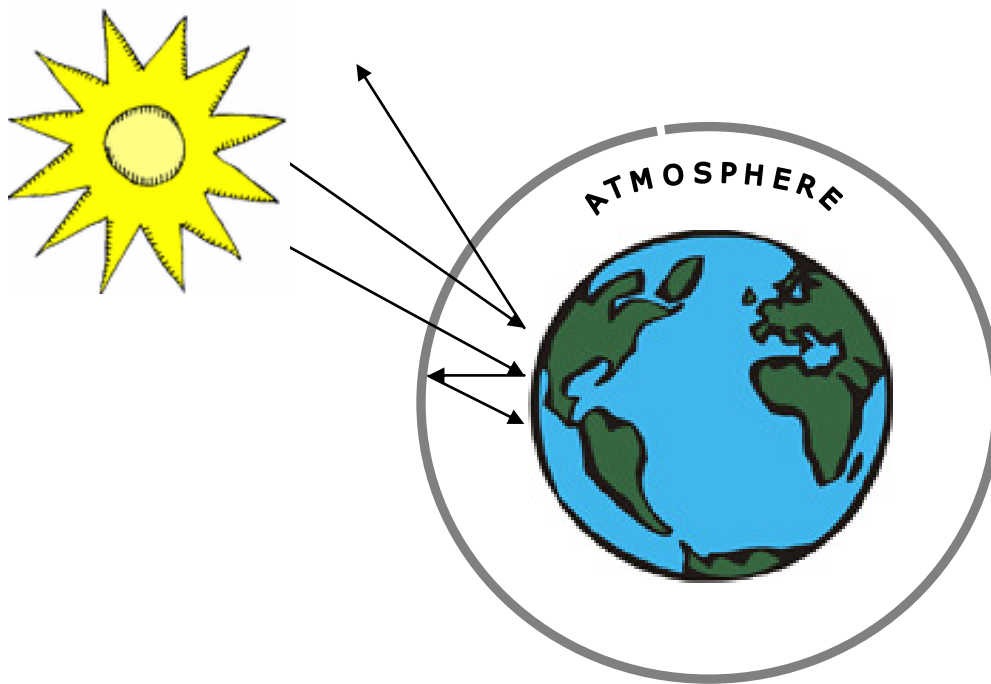
Basically, the atmosphere is a thin layer of gases that surrounds the earth. Think of it like the peel on an orange. If the earth was an orange, the atmosphere would be as thick as the peel. That's not very thick!

It's made up of different kinds of gases like nitrogen, oxygen, and carbon dioxide and makes it possible for us to live here on Earth – it's nature's way of keeping the earth just the right temperature for us to survive.

Heat energy from the sun comes in through the atmosphere. The heat bounces off the surface of the earth and some of it stays trapped inside the atmosphere to help keep the earth warm. Some of the heat escapes back through the atmosphere. This is a good thing because if it all stayed trapped inside the atmosphere the earth would get very hot – too hot for anything living to survive.

Think about it like a plant greenhouse, or like sitting inside a car on a sunny day. The sun's rays come through the windows of the car and warm you, the seats, and the dashboard. If the windows are rolled up, the heat can't escape and it gets hotter and hotter inside the car. If you roll down the windows the heat can get out and the inside of the car cools down.

You can also think of the atmosphere as a blanket around the earth. The greenhouse effect is a good thing for us. It's something that nature intended and it's keeping our planet warm enough for life to survive.

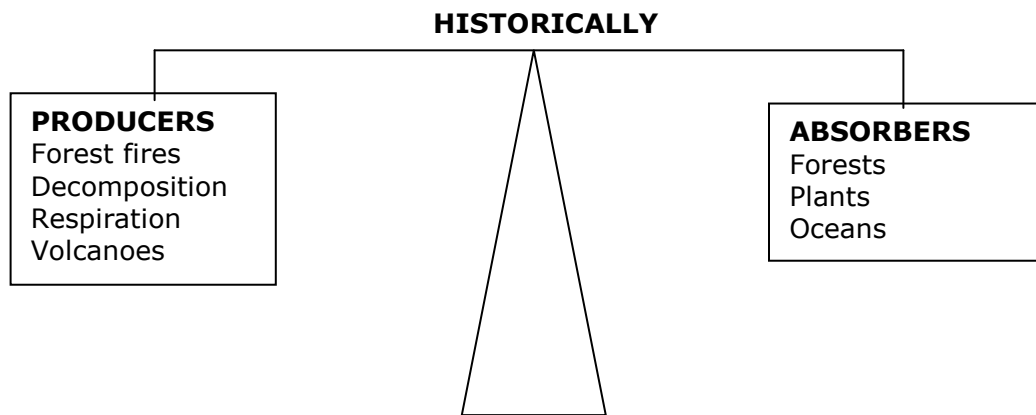


The bad thing is that air pollution made by humans is adding more gasses to the atmosphere. These gases, called greenhouse gases, are things like carbon dioxide. And with more of these gases, the atmosphere is getting thicker and thicker. It's like we're

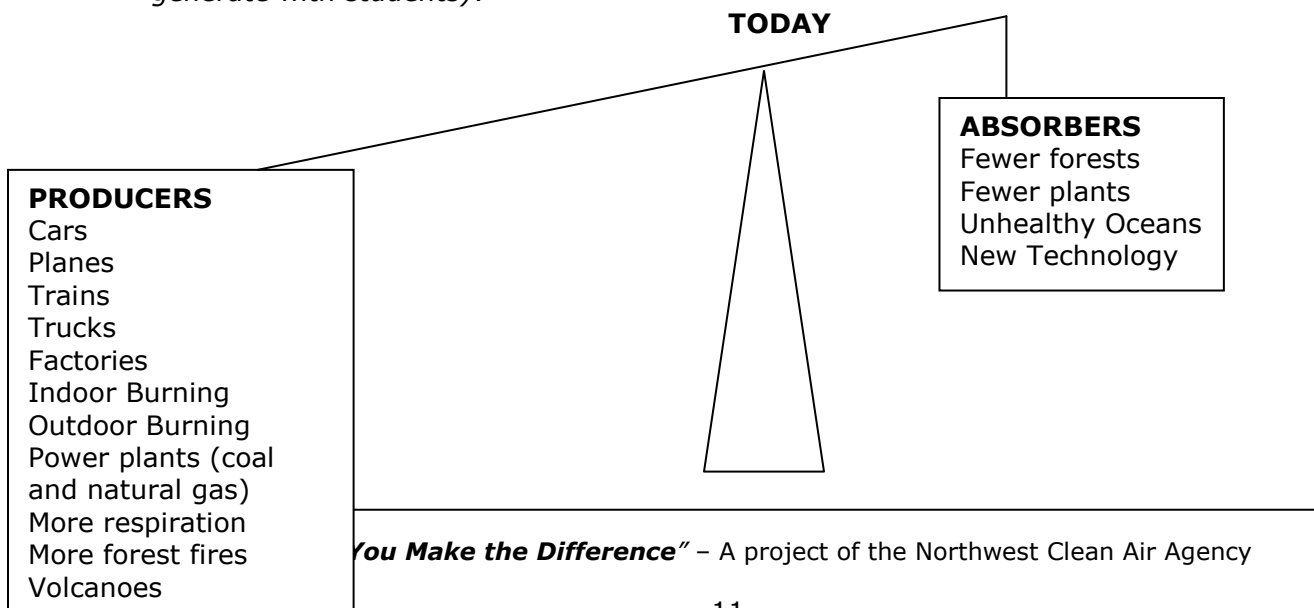
adding a thicker blanket around the earth. And, what do you think happens as the blanket gets thicker? It causes the earth to warm up.

Like I said, the greenhouse effect is nature's way of keeping the planet just the right temperature for us to live here, so why is this just now becoming a problem? Here's how...

We've always had natural sources of greenhouse gases on earth. Let's talk about some of them. Look at this scale. (*Display the "greenhouse gas balance" overhead*) The things that emit greenhouse gases are on the "producers" side. At the same time, there have always been things to "absorb" the gases produced by the forest fires, volcanoes, etc. The "absorbers" side of the chart will be for our list of things that keep the greenhouse gases balanced and in check. Things like: forests, plants, and our oceans. The absorbers use the carbon dioxide and make new oxygen, this helps take some of the carbon dioxide out of the air. There was a balance.



The greenhouse gases that were produced naturally were absorbed by forests and oceans. Nature kept this system in balance pretty well on its own. BUT about 2-3 hundred years ago, humans started doing some things that added more and more greenhouse gases to the environment. As humans became more "industrialized" they started burning things such as coal, natural gas, and oil to power engines and factories. With every increase in this type of technology, we added more and more greenhouse gases. Let's add these new producers to the scale. (*Display the list on overhead or generate with students*).



You Make the Difference – A project of the Northwest Clean Air Agency

So, now we have more things making greenhouse gases. And are there are many forests and natural spaces as there used to be? Are the oceans as healthy? No - there are fewer green spaces/forests and the planet's oceans aren't as healthy, so these things are not as good at absorbing greenhouse gases as they used to be.

Look at the balance now. We now have many more producers than absorbers and the absorbers just can't keep up. The balance is no longer balanced.

You may also notice that I added new technology in the "absorbers" column. Now, I don't want this to be confusing because we haven't figured out a way to absorb greenhouse gases. I did this because we are starting to figure out how to limit our greenhouse gases by using things such as hybrid cars and fluorescent light bulbs, but that doesn't mean we've developed ways to absorb greenhouse gases.

All these greenhouse gases are just hanging out in the atmosphere, trapping more and more of the sun's heat and keeping it close to the earth. Now this might seem like no big deal...everyone likes warmer weather, right? But the crazy thing is that even though we might get a little bit warmer *weather*, like I said before, we're also going to have a change in *climate*. How do you think that could affect us here? It could mean less snow in the mountains, more flooding in the low lands, more rain in the winter, more drought in the summer. It means that we're going to see things happening where they shouldn't.

Sometimes I get really discouraged when I think about the problem of climate change. It seems like such a big problem and it affects our whole planet, not just us here in Western Washington. But, the good news is that since humans are playing a role in creating greenhouse gases, humans can really help cut down on these emissions. Sure, we're already seeing some of the effects of climate change – glaciers are melting in the mountains, floods, sea level rise...but it doesn't have to continue that way. As humans we have the power to stop climate change. And, there are many simple things we all can do. Let's play a game and see how many solutions we can come up with.

Here's how the game works:

Preparation

Place the game board on a table. Put the blue choices cards, yellow game cards and money on their allotted spaces on the board. Each player chooses one of the *people of the world* game pieces from the globe container and places it on the yellow, "start here" square. Each player begins with \$50.

To Play

Each player, in turn, throws two dice and moves his/her game piece, in the direction of the arrow, the number of spaces indicated on the dice.

If you land on a:

1. **Bicycle:** Take the top card from the yellow "game cards" pile and read aloud the paragraph under the heading, "transportation." Follow the directions and then return the card to the bottom of the pile.
2. **Light bulb:** Take the top card from the yellow "game cards" pile and read aloud the paragraph under the heading "energy." Follow the directions and then return the card to the bottom of the pile.

3. **Recycle symbol:** Take the top card from the yellow "game cards" pile and read aloud the paragraph under the heading, "solid waste." Follow the directions and then return the card to the bottom of the pile.
4. **"Choices – You Make the Difference":** Take the top card from the blue deck and hand it to another player to read to you. If you answer the question correctly, collect \$30. If you get the question wrong, your turn is over. Return the card to the bottom of the pile.
5. **"Start Here, Collect \$50":** Each time a player's game piece lands on or passes over this square, whether by throw of the dice or by drawing a card, he/she will collect \$50. However, \$50 is paid only once each time around the board.

Have the students **write down at least ten solutions** in their group so they can share them with the class. Some solutions are bolded on the yellow "game cards."

Goals:

There are two goals to the game:

1. Personal goal → make the most money
2. Group goal → come up with the most solutions to climate change

Special notes:

- ✓ Two or more players' game pieces may rest on the same space at the same time.
- ✓ If you run out of money, you may borrow from another player.
- ✓ Players only get one turn. If their card tells them to move ahead a few squares, they do not get to read another card – they're just further along for their next turn.
- ✓ Before starting, agree upon a time limit when the game will end. A minimum of 15 minutes is recommended.
- ✓ Each member of the group can be assigned a role, for example – banker, supply manager (keeps all the equipment organized/set-up and cleaned-up), recorder, etc.

Lesson Closure:

20-30 minutes later...

Let's hear some of the solutions you wrote down...*brainstorm list on board.*

Who had something they didn't expect?

Let me hear some solutions you discovered that you are excited about.

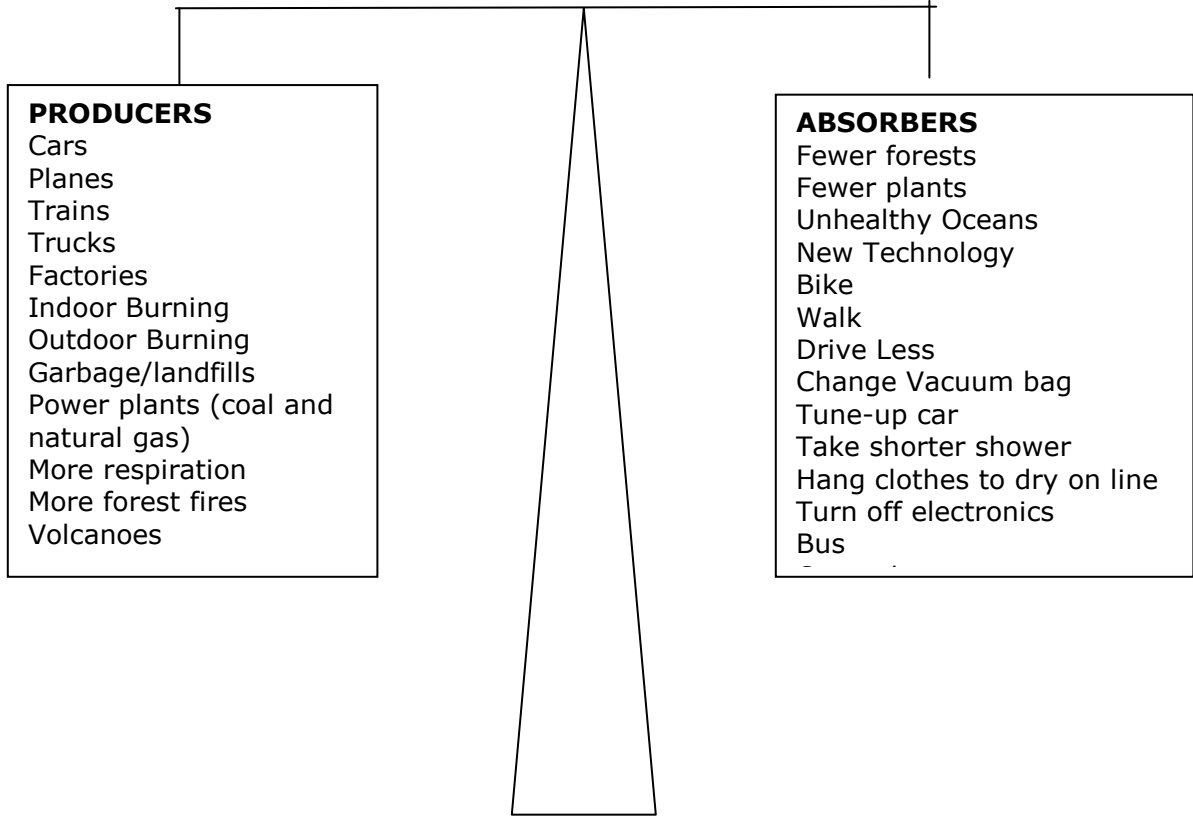
What solutions can you share with your family?

Wow! This is an impressive list. I think it's great that such a big problem can be solved if everyone started making smarter choices about transportation, garbage and energy. Remember, individual actions, repeated millions of times, helped create the problem which means collective, individual actions can get us out. It's all about choices and you can make the difference.

I hope you take some of these solutions home and share them with your family. If we choose to take action to stop climate change, we will also conserve natural resources, save money and all enjoy a happier and healthier society for generations to come.

Additional Closure Option:

Revisit the scale and add the solutions the students brainstorm to the absorbers side. This will help balance it out and seem less overwhelming.



Exploring the Issue in Your Classroom

The following activities are designed to accompany the "Choices – You Make the Difference" board game and the preceding classroom presentation. They can be used as separate assignments or group projects in rotating stations.

1. Create the Greenhouse Effect in a Bottle

Compare how temperature changes in an enclosed space (bottle or jar) vs. an open space when placed in the sun or near a lamp.

Station Suggestion: If you are using this activity as a part of a series of stations, perform the experiment as an entire class. Set the experiment up at the beginning of the session and have different student groups check on the temperature and record the data as the day progresses.

Time:
40-90 minutes

Materials:
quart jar or a 2-liter plastic bottle, thermometer, cardboard, rubber bands, sunshine or heat lamp, data sheet

Goal: Students will understand that the sun's energy warms things up and the greenhouse layer holds the heat in.

Objectives:

- Students will measure the effects of sunlight warming conditions on the inside and outside the bottle or jar.
- Students will make graphs of their data and compare temperatures inside and outside of the model of a greenhouse.

Set up

- Affix thermometers to the pieces of cardboard with a rubber band.
- Place one thermometer in the jar and put the lid on it.
- Place the jar in a sunny spot or next to a heat lamp with the other thermometer outside the jar right next to it. Make sure the thermometers are shaded from direct light by the cardboard and that they are the same distance from the light source.

Activity:

1. Ask students if they have ever been in a greenhouse and have them discuss what it feels like (*hot!*) and what makes it feel that way. *On one hand the basic idea of the greenhouse effect is very simple—it's like being in a car on a sunny day with the windows rolled up. On the other hand, scientists have been working for decades to try to understand how the greenhouse effect may be changing the earth's climates and how much of that effect is impacted by human activities. Scientists have made a lot of progress in learning about the atmosphere, climates, and how different changes affect each other - particularly with the development of really powerful computers that help model what can happen.*
2. Explain that in this activity, they will model the greenhouse effect and compare temperatures on the inside and outside.

3. Discuss the student's prediction of what will happen during this experiment.
4. Record temperatures, such as every ten minutes for two hours. At the end of the session, make a graph of the data and interpret the results.
5. Discuss the results with the class. Talk about the Earth's greenhouse layer.

See the presentation script for more ideas on discussing the greenhouse effect with students.

2. Crossword Puzzle

Use the crossword puzzle (pg. 30) to get familiar with Global Warming vocabulary.

3. Internet Scavenger Hunt 1 (Global Warming Background Information Review)

Surf the net to discover more information about global warming and solutions to the problem.

Time:
30-40 minutes

Materials:
scavenger hunt questions
(pg. 33)

Goal: Students will learn more about the issue of global warming and available internet resources.

Objectives:

- Students will become familiar with the EPA's global warming web site.
- Students will go on an "electronic scavenger hunt" to answer questions about global warming.

Activity:

1. Set students up on the EPA Global Warming Kids Site (<http://www.epa.gov/globalwarming/kids/>) and have them search for information (suggested questions on page 33).

4. Changes on Noua's Island

Consider the large-scale effect of global warming and some of the issues and dilemmas our global society faces in dealing with these effects.

Reproduced from LHS GMS – Global Warming and the Greenhouse Effect, 1997, Regents of the University of California

Time:
20-30 minutes

Materials:
Noua's Story (pg. 35)

Goal: Students will be introduced to the possible effects global warming will have on the lives of people in different places on earth.

Objective:

- Students will gain insight into the effects of global warming on a society and culture very different from their own by reading or listening to "Noua's Island."

Activity:

1. Read, or have the students read, "Noua's Story."
 - ⇒ Ask students to imagine themselves in a developing country that may be affected by increased sea levels. Although people in that country contribute very little to the cause of global warming – increased carbon dioxide – they will be affected by it as much as any of the industrialized nations, and in some cases the effects will be even greater.
 - ⇒ Explain that the story is not about an actual person, but it does describe a real situation for millions of people who live on islands or low coastal areas around the world. The story uses predictions by researchers concerning how people in these areas are likely to be affected by rising sea levels if global temperatures increase by just a few degrees Fahrenheit.
2. Have the students consider and write about or discuss the following questions:
 - ⇒ In Noua's dream, how did global warming affect his island home?
 - ⇒ If you were Noua, how would you be feeling?
3. The following "Culture and Climate" activity can be used as an extension to this activity.

5. Culture and Climate

Make a collage of another culture and its climate.

Time:
30-60 minutes

Materials:
references,
photos, magazines to
cut,
scissors,
glue

Goal: Students will learn how climate affects different people and their cultures.

Objectives:

- Students research another region's climates and cultural adaptations.
- Students assemble a collage of climate and cultural adaptations depicting influence of climate on culture.

Activity:

"Choices - You Make the Difference" – A project of the Northwest Clean Air Agency

1. Ask students to choose a culture to highlight.
2. Use old magazines such as National Geographic and direct students to form a pictorial representation of that climate's influence on its people.
3. Ask students to imagine that they live in that culture and to think about what weather they might expect and how the climate might influence them (as an individual), other people and the country as a whole.
4. Questions to ask: *How do people use and depend on their natural surroundings? What clothes do people wear? What crops or foods are produced? What kinds of industries are impacted by climate?*
5. Post student work around the class and/or have students briefly present their collage.

6. Internet Scavenger Hunt 2 (Impacts in the Pacific Northwest)

Surf the net to discover how life in Western Washington might be affected by global warming.

Time:
30-40 minutes

Materials:
scavenger hunt
questions and web sites
on pg. 38

Goal: Students will learn about the potential effects of global warming on their region and community.

Objectives:

- Students will become familiar with regional global warming websites.
- Students will go on an "electronic scavenger hunt" to answer questions about the topic.

Activity:

1. Give students the list of websites and the scavenger hunt questions and have them search for information.

7. Calculate Your Global Warming Emissions

Find out how many pounds of carbon dioxide your family emits every year and discover how you can create less.

Go to: http://www.keystonecurriculum.org/html/emissions_calculator.HTM for more information on bringing this concept into your classroom.

Time:
20-30 minutes

Materials:
wheel card handout (pg. 40), scissors, glue, paper fasteners, calculator (optional)

Goal: Students will learn how much carbon dioxide is emitted by their family's transportation, home heating, electricity, and waste disposal choices.

Objectives:

- Students make a global warming wheel card that will help them estimate the amount of carbon dioxide their family creates annually.
- Students examine how many pounds of carbon dioxide are saved when various energy-saving actions are taken.

Activity:

1. Distribute global warming wheel card handout (make one-sided copies of the 4 pages), scissors, glue, and paper fasteners.
 2. Have students create a wheel card by following the directions listed on the handout.
 3. Ask students to write their answers to the questions on the "What's Your Score" side in the space provided.
 4. Ask students to explore the "What Can You Do?" side and select which solutions their families can participate in. Write those answers in the space provided.
 5. Encourage students to take the wheel card home and share it with their families.
- ⇒ A similar activity and logical extension is conducting a home audit. These often involve dollars spent or saved by estimating how much each activity contributes to the household's power bill.
- A home audit can be conducted by visiting the Home Energy Saver website, <http://hes.lbl.gov/> or through the website of your region's power company, such as <http://www.pse.com/> for Puget Sound Energy. These sites also allow the user to make choices to reduce energy use and calculate dollars saved.

8. Make New "Choices" Cards

Create new quiz questions related to global warming and the associated solutions for possible use in the "Choices – You Make the Difference" game.

Time:
20-40 minutes

Materials:
print or internet
resources, blank cards
(pg. 44)

Goal: Students will learn more about global warming by designing their own "Choices" game questions.

Objectives:

- Students formulate questions and possible answers for use in the "Choices" game.
- Students research global warming by exploring print and internet resources.

Activity:

1. Ask students to write a question they have regarding the issue of global warming and then use internet and/or print resources to find the answer.
 - ⇒ Alternatively, students may explore internet or print resources first to look for information of interest and then write a quiz question.
 - ⇒ Ultimately the quiz questions should include multiple choice answers or have a true or false answer.
2. Blank copies of the cards used in the "Choices – You Make the Difference" game can be supplied to students who have completed a quiz question with answers.
 - ⇒ The question is written on the card along with answer options (such as "a, b, c or d") and the answer is written at the bottom of the card. Additional information of interest may be added to the answer (e.g. "the city is so polluted that the trees are dead and even the mayor won't live there")

9. Weather logs - What do you expect?

Students keep a weather record for one week and compare with expectations.

Understanding the difference between weather and climate is important for grasping the concept of climate change. While the difference can be simply explained – the weather is what the conditions of the atmosphere are like on that day, climate is normal weather for a region over time (about 30 years). Observing weather over time and comparing it with other regions, helps us define or describe our climate.

Time:
Set-up: 20 minutes for
5 minutes each day
Wrap-up: 20 min

Materials:
data record sheet,
outdoor thermometer,
rain gauge or local
weather report

Goal: Students will recognize variability in weather, and compare the weather to what is typical for the climate.

Objectives:

- Measure and record the temperature, precipitation, and other weather conditions.

the Difference" – A project of the Northwest Clean Air Agency

- Compare weather data with historical climate averages.

Activity:

1. Explain to students that they will begin learning about our climate with a challenge to try to predict the weather. You might announce that there will be a contest to see who can make the best prediction for the next week (or whatever length of time you choose). The activity could be done in small groups or all-together at the beginning or end of each class.
2. Prepare a table or have students draw a data table in their notebooks with 4 columns and enough rows for each day of the challenge.
3. Ask students to try to predict the weather for each day of the upcoming week.
4. Make a plan with students for recording the weather. Measurements should be taken at the same time and location (classes could compare different times - for example, morning vs. afternoon). Set up a rain gauge and thermometer outside. If weather reports are used, choose high temperature, low temperature or both.
5. Have students conduct the measurements.
6. At the end of the week, have students determine the averages for each column at the bottom.
7. Compare results with predictions:
 - ⇒ *Was the weather like you predicted? What led you to make the predictions you did? How did the weather vary from one day to the next? Would you change your prediction if you did it again? Why or why not?*

Data Table			
Day	Temp	Precip.	Conditions
Pre-diction			

1. Make your prediction
2. Measure and record the temperature
3. Observe and record the conditions (sunny, cloudy, rainy, snowy)
4. Measure and record any precipitation

Part 2: Does our weather match the climate?

1. Show students a graph of the historical climate data for your area. These are available on websites such as www.weatherunderground.com. Compare the class results to historical averages.
2. Compare/contrast observed weather with the average conditions in recorded history.
 - ⇒ *What is the average temperature for that date? For the month? What is the average precipitation for that date? For the season? For the whole year? What were the conditions usually?*

Extension: Explore other climate questions that impact people: For example: *How many days of sunshine do you get a year? How long is the growing season?*

10. Homework: Talkin' About the Weather (& Climate)

Students talk with grandparents, family or friends and compare climates.

Time:
20–30 minutes and
homework

Materials:
notebook

Goal: Students will recognize that climates differ across regions and possibly over time.

Objectives:

- Students will interview another person about weather.
- Students will compare or contrast the current local climate with what was typical in another place or time.

Activity:

1. Have students think about:
 - ⇒ someone they know who lives in a different climate,
 - ⇒ grandparents who can talk about the weather when they were young, and/or
 - ⇒ parents who used to live in another climate region.
2. Help students formulate questions to learn about the climate:
 - ⇒ *What is/was the weather usually like? (temperature, precipitation, conditions)*
 - ⇒ *How are the seasons different today?*
 - ⇒ *How does/did it affect the way you lived?*
 - ⇒ *Do you remember anything different about the weather compared to now?*
3. Students conduct interviews at home.
4. Back in class, have students write a sentence comparing the two climates and then share with the class. Help formulate generalizations and talk about what their interviewee's likes or dislikes were about the different climates. Some of the interviewees might have remembered specific events – storms or dry years – more than general climates; discuss the value of recorded data compared to memories.

11. Consider the Evidence

How do we know the climate is changing? Comparing evidence of from climates over hundreds of years tells us how climate changes over time. Simply comparing our current climate records with those from over a century ago can give us an idea of possible change over time. Scientists have figured out creative ways of determining climates over time - from comparing what crops early civilizations were able to grow to examining air bubbles trapped Antarctic ice sheets.

Interpret evidence in graphs and tree rings (tree "cookies", if available) to see how climate has changed in the past.

Time:
40-90 minutes

Materials:
graphs,
tree cookies (optional)

Goal: Students will understand that there is evidence that our climate has changed over time.

Objectives:

- Students interpret graphs showing global temperature change over time.
- Optional: students study tree rings on tree "cookies" looking for evidence of rapid or slowed growth.

Activity:

1. Show a graph of the average temperature over time and help students interpret what each axis means. *How has the average global temperature changed since 1865?* Students may notice variability but also should notice a general trend upward.
2. Ask: *How can we know what the climate was like thousands of years ago?* Discuss the evidence in glacial ice from the area or fossils of trees that only grow in a different climate.
3. You may decide to do the optional activity "*What Do the Trees Say?*" described below.
4. Show a graph of average temperature over the last 400,000 years (Paleoclimate graphs). Note that scientists study samples of ice from places like Antarctica that are that old. They can tell by snow layers that build up like tree rings. Scientists have figured out how to tell how old the ice is and what temperature the oceans were at that time. *How have conditions varied over the last 400,000 years?*
5. Explain that the cool periods were the ice ages when large glaciers covered much of North America. Note that we are already in a warm period. The ice ages were only 9-10 degrees Fahrenheit cooler on average. Some scientists think global warming

Web sources of climate change graphs:

ChemConnections Site: Temperature Anomalies Relative to 1961-1990 Mean

<http://chemistry.beloit.edu/Warming/moviepages/global.htm>

EPA Site: Global Temperature Changes (1880-2000)

<http://yosemite.epa.gov/OAR/globalwarming.nsf/content/Climate.html>

Paleoclimate Graphs

<http://www.brighton73.freemove.co.uk/gw/paleo/paleoclimate.htm>

Paleoclimate and Carbon Dioxide

<http://www.brighton73.freemove.co.uk/gw/paleo/400000yrfig.htm>

might make the global climate 5-10 degrees warmer than it already is. (*Looking at a graph, one might think that the temperatures would eventually cool off as part of this cycle, but that would take several thousand years. Now temperatures are getting warmer because of human activities. Some think the earth might get warmer than it has ever been in its history.*)

Related Activity - Tree Cookies: What Do the Trees Say?

Slices of tree trunks, or cookies, showing growth rings are another way to investigate climate history. Tree cookies reveal the many different layers that make up a tree. And each layer can tell us something about the tree's life and the climate in which it grew.

1. Show the students tree cookies. (You can find good images and additional lesson ideas at the following web site: <http://www.idahoforests.org/cookie1.htm>)
2. By looking at the different widths of the rings students can see years when a tree had a good growing season and years when it was stressed. Ask students to hypothesize what conditions would stress a tree (drought in spring growing season can be the worst). Using weather records that match the tree's region of origin, students can compare records of the climate and tree growth.
3. Scientists have studied growth rings on trees as old as 4,900 years! (Add to that dead, preserved trees going back almost 9000 years!) People can also learn about climate by looking at what plants could survive. In some desert regions, such as in Nevada, people a thousand years ago were able to grow corn and other crops for food, but as the climate got warmer and drier, they abandoned these villages.
 - ⇒ Do some research. There are many ways research has revealed past climates, students could explore websites and other resources to see what people have done.

Appendix

Global Warming Internet Resources

Interactive sites offering challenges for the classroom:

ARM Education

<http://education.arm.gov/>

Activities for kids to do online or for teachers to download and print. [Atmospheric Radiation Measurement (ARM) Program is part of the U.S. Department of Energy (DOE) research on global warming.]

Ecological Footprint Quiz

<http://www.myfootprint.org/>

Ever wondered how much "nature" your lifestyle requires? Find out here.

Emissions Calculator Lesson Plans

http://www.keystonecurriculum.org/html/emissions_calculator.HTM

EPA – Global Warming Kids Page

<http://www.epa.gov/globalwarming/kids/>

Perhaps the best site with information and diagrams for kids.

Encyclopedia of the Atmospheric Environment

<http://www.ace.mmu.ac.uk/eae/english.html>

Rich in information with both "young person's text" and technical options

Global Warming: Early Warning Signs

<http://www.climatehotmap.org/>

Maps depicting predicted effects of global warming. Good for middle & high school students.

Natural Resources Defense Council Kid's Links

<http://www.nrdc.org/reference/kids.asp>

Lots of great environmental education links for young people.

Northwest Clean Air Agency's

Climate Change webpage - <http://www.nwcleanair.org/climateChange/index.htm>;

Teacher Resources - <http://www.nwcleanair.org/resources/teachers.htm>.

Hippo Works

<http://www.hippoworks.com/animalsearth/>

A series of entertaining "cartoonlets" about global warming.

Thinkmtv.com

http://www.mtv.com/thinkmtv/?source=TLD_thinkmtv.com#/thinkmtv/environment/resources.jhtml

MTV's site regarding global warming. It is geared towards teenagers and offers excellent information and solution-based resources.

Other recommended global warming sites:

Campaign Earth!

<http://www.campaignearth.org>

Campaign Earth is a website where you can sign up to receive a monthly global warming solution challenge. It also includes a tutorial on climate change.

Campus Climate Challenge

<http://www.campusclimatechallenge.org/>

Learn about the college campuses across the US and Canada that are running and winning clean energy campaigns on their campuses.

Cities for Climate Protection

<http://www.iclei.org/index.php?id=1118>

International organization guiding cities through emissions estimation and planning ways to reduce emissions. Does your city or county participate?

Clean Air - Cool Planet

<http://www.cleanair-coolplanet.org/>

Good information source regarding global warming. Clean Air-Cool Planet is dedicated to finding and promoting solutions to global warming.

Climate Solutions Home Page

<http://www.climatesolutions.org/>

Regional organization of the Pacific Northwest states working toward solutions.

EPA Global Warming Site

<http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html>

Loads of information plus "Visitor Center" with section of resources for educators.

EPA Global Warming, Where You Live – Washington State Site

<http://yosemite.epa.gov/oar/globalwarming.nsf/content/us-Washington.html>

Find out how Washington State could be impacted by global warming.

Focus on the Nation

<http://www.focusthenation.org>

Focus the Nation is a major educational initiative that is coordinating teams of faculty, students and staff at over a thousand colleges, universities and high schools in the United States, to collaboratively engage in a nationwide, interdisciplinary discussion centered around the theme of "Stabilizing the Climate in the 21st Century."

Global Warming - Undo it.

<http://www.undoit.org/index.cfm>

Legislation-action oriented website with information, petition signing, etc.

"An Inconvenient Truth" Website

<http://www.climatecrisis.net/takeaction/>

The official website for Al Gore's film on climate change. Great information and lots of links on the subject.

Smart Trips

<https://www.whatcomsmarttrips.org/login.aspx>

Whatcom Smart Trips is an ongoing partnership between local government, public agencies, employers, and schools to promote transportation by bicycling, sharing rides, and riding the bus.

StopGlobalWarming.org

<http://www.stopglobalwarming.org/default.asp>

Join the virtual march on global warming.

Union of Concerned Scientists: Citizens and Scientists for Environmental Solutions

http://www.ucsusa.org/global_warming/science/global-warming-materials-for-educators.html#gulf

A good resource for global warming materials for educators.

World Wildlife Fund's Climate Change Campaign

http://www.panda.org/about_wwf/what_we_do/climate_change/index.cfm

<http://www.panda.org/campaign/powerswitch/index.cfm>

Information about global warming and the WWF campaign to stop it.

Students taking action for the environment:

Roots and Shoots

<http://www.rootsandshoots.org>

The Roots & Shoots program inspires youth of all ages to make a difference by becoming involved in their communities.

Earth Force

<http://www.earthforce.org>

Earth Force engages young people as active citizens who improve the environment and their communities now and in the future.

Student Environmental Action Coalition

<http://www.seac.org>

Since 1988, the Student Environmental Action Coalition has been empowering students and youth to fight for environmental and social justice in our schools and communities.

Free the Planet!

<http://www.freetheplanet.org>

The mission of Free The Planet! is to expand and strengthen the student environmental movement, provide resources for student activists, and work with students to win campaigns for strong environmental protections.

15 THINGS YOU CAN DO TO REDUCE GLOBAL WARMING

Solution		Carbon Dioxide Reduction
15	Use a push mower to cut your lawn instead of a power mower.	80 lbs./year
14	Buy food and other products with reusable or recyclable packaging.	230 lbs./year
13	Wash clothes in warm or cold water, not hot.	500 lbs./year
12	Turn down your water heater thermostat; 120 degrees is usually hot enough.	500 lbs./year (for each 10-degree adjustment)
11	Buy energy-efficient compact fluorescent bulbs for your most-used lights.	500 lbs./year (by replacing one frequently used bulb)
10	Install a solar thermal system to help provide your hot water.	720 lbs./year
9	Recycle all of your home's waste newsprint, cardboard, glass, and metal.	850 lbs./year
8	Wrap your water heater in an insulating jacket.	1000 lbs./year
7	Caulk and weather-strip around doors and windows to plug air leaks.	1000 lbs./year
6	Leave your car at home two days a week (walk, bike or take public transportation to work instead).	1,590 lbs./year
5	Ask your utility company for a home energy audit to find out where your home is poorly insulated or energy-inefficient.	potentially 1000's of lbs./year
4	Insulate your home, tune up your furnace, and install energy-efficient shower heads.	2,480 lbs./year
3	Drive a fuel-efficient car (rated up to 32 mpg or more) or buy a new hybrid gasoline electric vehicle which gets 50 to 70 mpg.	5,600 lbs./year
2	Tell your representatives what you think. Your elected officials make critical decisions in your name that either hurt or help the fight against global warming. Your representatives in Congress and in the statehouse need to hear that you want action!	
1	Learn more and tell your friends and family. Together we can make the difference.	

If your family did all of the items above, you could cut CO2 emissions by more than 15,000 lbs. a year!

(Taken from the North West Clean Air Agency web site at: <http://www.nwcleanair.org>)

"Choices - You Make the Difference" – A project of the Northwest Clean Air Agency