Changing Climates

Outreach Program Lesson Plan

WAAW foundation

Working To Advance STEM Education for African Girls

WAAW Foundation is non-profit organization dedicated to bringing hands-on STEM education to girls all over Africa.

Our Mission: To increase the pipeline of African women in Science, Technology, Engineering and Math (STEM) disciplines and to ensure this talent is engaged in African innovation.

Our Vision: To eradicate poverty in African through female education and science and technology innovation.

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Changing Climates

Class Description-

In this class, students will learn how greenhouse gasses and human production of carbon dioxide is having an effect on the earth's climate. They will participate in games and models to show how these phenomena work, and will put together their own presentations to illustrate how climate change is affecting different regions of Africa. At the end of class, they will brainstorm solutions to climate change problems.

Total class time: 90 minutes

Class Outcomes-

-Students will be able to describe how carbon dioxide molecules trap heat.
-Students will understand how the greenhouse effect works in our atmosphere.
-Students will understand human influence on the amount of heat being trapped in our atmosphere.
-Students will know some of the effects of climate change that are already being seen in their countries.

Materials List-

To teach this class you will need:
-Chalkboard/whiteboard chalk/dry-erase markers
-Printed out articles from appendix
-Student notebooks and pencils/pens

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Changing Climates

Pre-Class Preparation and Set-Up

Climate change can be a complicated subject for students to understand. Make sure you first read through and understand the information in this lesson plan, so that you can correctly relay it to students.

Print articles from the appendix (you can find the pdf appendix link right next to the lesson plan link on the WAAW Foundation website at http://www.waawfoundation.org/teaching-resources/ .) The articles will be updated about every 6 months to stay relevant, but feel free to supplement the articles with any that you find through your own research and resources.

Right before class, arrange classroom to allow for student group discussion and conversation. Draw greenhouse effect diagram on your board (or create poster before class) for all to see.

Introduction (5 minutes)

Ask your students: What have you heard about climate change or global warming? Are these words familiar to you? What role does Carbon Dioxide play? Today we are going to take a look at what is going on out there in our atmosphere and how humans have had an effect on it.

In recent years, we have become concerned about what we've been adding to our atmosphere. This is not just a concern for elements that could potentially be poisonous and bad for humans… It has become very clear that the gasses that we have been adding to our atmosphere can have an effect on the world as a whole.

Changing Climates

What's out there? (5 minutes)

If we are going to have a conversation about our atmosphere, we first need to understand what it is made of. Does anyone know of any gases that are in our atmosphere? As students to name some gases, and create a list on the board. Now, do these gasses all exist in the same amounts? No! Let's break it down into percentages. To turn this into a game, list the gas names and percentages in two columns in a random order, and challenge your students to try making the correct links.

Nitrogen (N_2) – 78.07%
Oxygen (O_2) – 20.95%
Argon (Ar) – 0.93%
Carbon dioxide (CO_2) – 0.04%
Other gases – less than 0.01%

But wait a minute… why are we so concerned with Carbon and the other greenhouse gasses? They take up SO LITTLE of our atmosphere, what could they possibly do? Actually, when you give some time to think about it, it makes sense. Since these gasses make up such a small part of the atmosphere, adding even a little bit more can change levels drastically and make a big difference.

The Greenhouse Effect (30 minutes)

But how do they make a difference? How do these little gas molecules have anything to do with trapping heat? It has to do with a special type of atomic bond that greenhouse gas molecules have. When infrared energy (or heat energy) comes in contact with a molecule of CO_2, it causes the CO_2's bonds to vibrate. This vibration gives the molecule kinetic energy, and sends it off, bumping into other molecules around it. This friction between molecules generates more heat and the cycle continues.

To break up the teacher-focus of this initial information, allow students to sit in small groups, discuss the questions that come up in the lesson, and make predictions. For example: Let them discuss how an element in small amounts could have a large effect. Let them share answers with the class.

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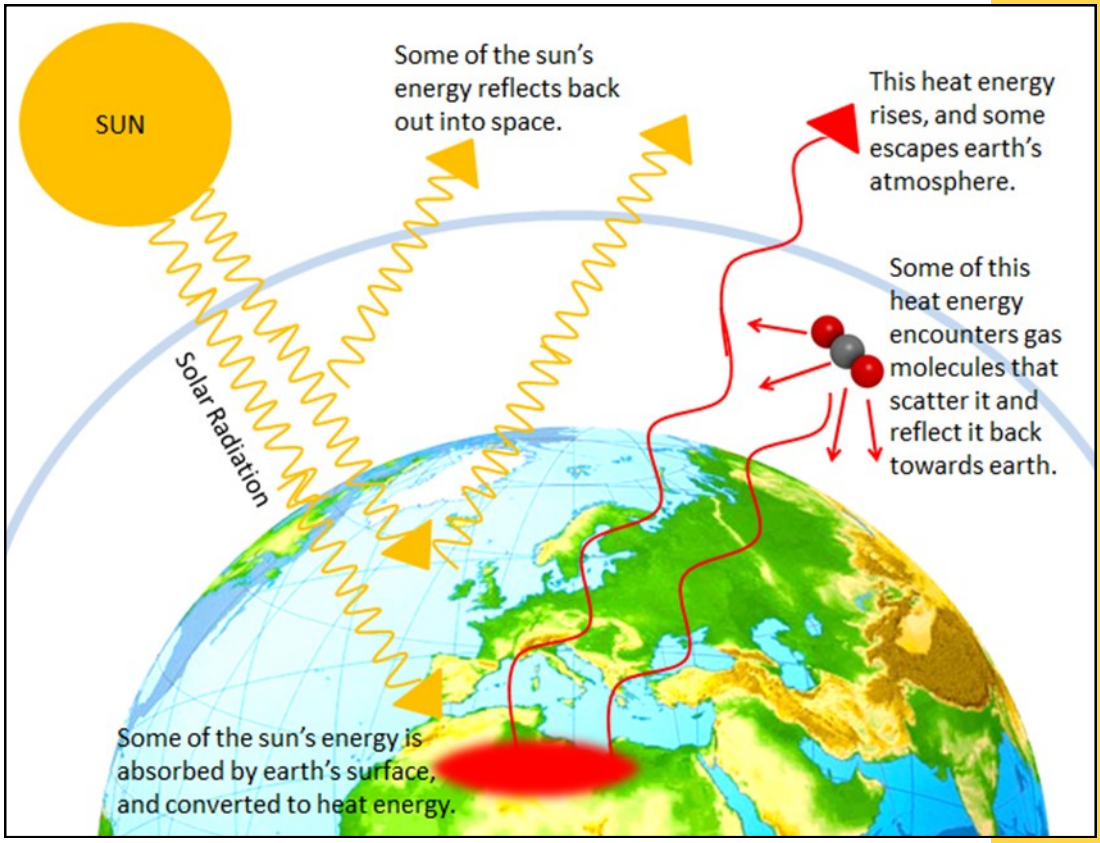
Changing Climates

The Greenhouse Effect (continued...)

So, where is this heat originally coming from? Draw a diagram on the board to help demonstrate. Energy from the sun enters through the atmosphere and hits the surface of the earth. Some of the energy bounces off and reflects back out into space. Some of it (the part we're concerned with) converts to heat energy. This heat energy (or infrared heat) starts to rise back through the atmosphere. As it does, some does not encounter any greenhouse gasses, and escapes back out into space. Some however, hits greenhouse gas molecules, starting chains of vibrating molecules that heat up the atmosphere and the earth below.

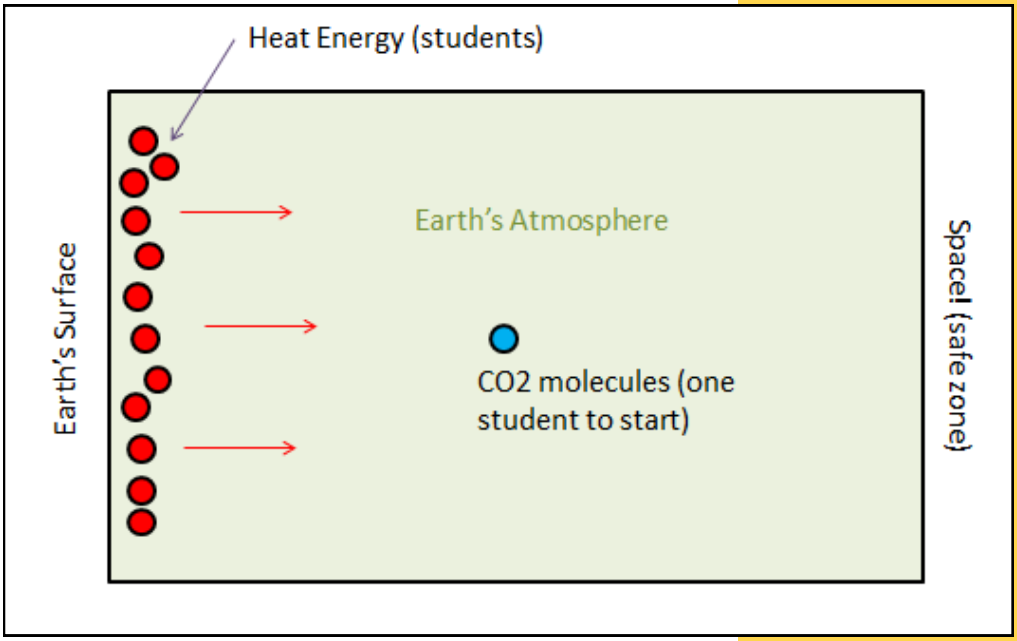
Since the diagram is intricate, you may want to create a poster before class to take with you and show to students. This may save you time and board space in the classroom.



Changing Climates

The Greenhouse Effect (continued...)

Now, we're going to play a game to illustrate how this works in our atmosphere. To play this game you'll need a roughly rectangular court (about the size of a volleyball court) with clear "end zones" (either walls or lines drawn in the dirt, etc.) Have students line up at one end of the court. Ask for a volunteer, and have this student stand in the middle of the court. This student is a molecule of CO2. The rest of the students are infrared heat ready to try to escape from the surface of the earth, through earth's atmosphere, and out into space. On your "Go", the infrared heat will try to run through the atmosphere (the court), while the CO2 molecule tries to trap them. If they are tagged by the CO2, they have been trapped. If they reach the opposite end of the court without being tagged, they have escaped.



Now it's time to set up our scenario:

This first run, with only one molecule of CO2, represents our atmosphere before the industrial revolution. Run the activity once: How much heat was captured? What would happen if there hadn't been any CO2 in the atmosphere? Our world would be really cold! CO2 exists naturally in our atmosphere, and we need it to survive. What are some naturally occurring things that produce CO2? Geological events like volcanos add CO2 to our atmosphere each year, but not nearly as much as humans have added in recent years. We do need some CO2 in order for there to be life on earth, but the question is- how much is too much?

Changing Climates

The Greenhouse Effect (continued...)

For the next trial, have the students that were captured join the middle as more molecules of CO2 (3-6 molecules should be in the middle.) This round represents our atmosphere just a little while after the start of the industrial revolution. The industrial revolution took place from the late 1760s to the early 1820s, and saw the beginning of burning fossil fuels to run engines and improve industry. Run the activity again: Is it getting harder for the heat to escape? Why?

If students are enjoying the game, feel free to play it again. Introduce a new concept or ask a question about the model between each game.

Again, have all of the captured heat become new CO2 molecules in the middle for the next round. There should be about equal amounts of heat and CO2 molecules. This represents the CO2 in the atmosphere today. Run the activity again. Was any heat able to escape?

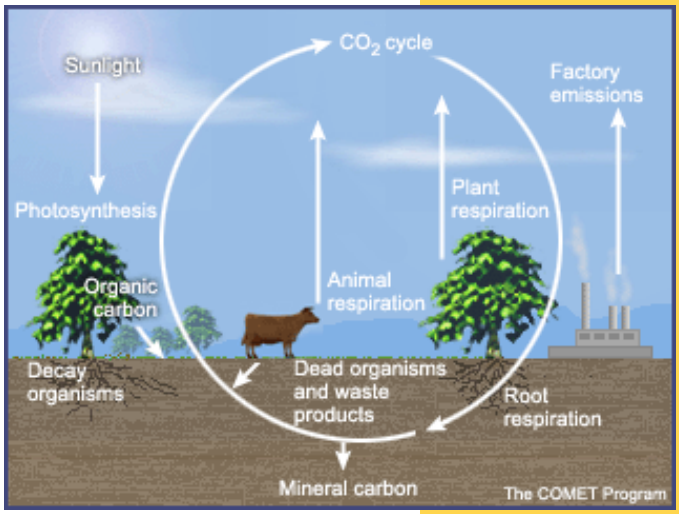
Run the activity until no heat energy is able to escape. Then bring the class together to discuss what you observed. Ask some questions:

- What would happen if there were no CO2 molecules in the middle? ALL the heat would escape, and that wouldn't be very good would it? We need some greenhouse gasses, or our world would be very cold!
- When was it easiest for heat to escape? When was it hardest? Why?
- What was it that started adding more greenhouse gasses to the atmosphere?

Changing Climates

Fossil Fuel Frenzy (30 minutes)

From the last activity, when did humans start adding a lot of carbon dioxide to the atmosphere? During the industrial revolution. Around this time, humans started burning fossil fuels for vehicles, factories, heating, cooking, etc. So what is a fossil fuel, and how was it different from what had been used before? Prior to the last 200 years, there was a fluctuating, yet relatively steady amount of carbon in our atmosphere. Many factors play into a complicated system of plants, animals, land, and oceans that generate and recycle carbon in and out of the atmosphere. This system is called the carbon cycle.



Fossil fuels put a kink in the complex carbon cycle. Fossil fuels are derived from forms of carbon that have been stored underground for a very long time. They come from biological material that has been forming for millions of years under the earth's surface. When we burn these materials, we are releasing new amounts of carbon that have not been part of the cycle for millions of years. The natural cycle can not balance out the large amounts of carbon being added.

Another quality of fossil fuels is that they do not regenerate quickly. Because of the length of time they take to form, they are considered non-renewable energy sources, and if we continue to use them at our current worldwide rate, they will disappear.

So what are some fossil fuel examples? What are some possible alternatives? Each fuel has its pros and cons, and produce different amounts of energy, but for now let's look only at weather or not they classify as fossil fuels. As a class, generate 2 lists: fossil fuels and non-fossil fuels.

Fossil Fuel Examples: coal, oil, gasoline, natural gas

Non-Fossil Fuel Examples: biomass (wood, charcoal, peat), solar, wind, geothermal, hydroelectric, nuclear

Changing Climates

Fossil Fuel Frenzy (continued...)

Now, we know that these fossil fuels are adding excessive amounts of CO2 to the atmosphere (26 giga-tons per year!) so why do we use them? Unfortunately, there are a lot of factors that play into the energy equation. In their groups, have students brainstorm factors that could play into decisions about energy sources. They can be general (ex: cost of each energy source) or specific (ex: sunlight levels can limit the use of solar power.)

After 5 minutes or so, bring the class together to discuss:

- What factors did you think of?
- Do you think it's easy or difficult to switch to a new energy source? Think about the time and money and distribution systems already in place…
- Is there a perfect source for our world's energy needs? No! How would you decide what to use where you live?

Who cares if it's hotter? ()

So who cares if it's a little hotter outside? What difference can it make? The truth is that our earth has some very delicately balanced systems, and big changes are happening due to the rise in atmospheric temperature. Across the globe, scientists predicted (and are already seeing!) some effects that this temperature change will have:

- Rising ocean levels: As our atmosphere warms, ice melts from our glaciers and poles. This water, which in frozen form would be contained on land or floating, now adds to the ocean.
- Ecosystem shift: Due to different temperatures and long-term weather pattern shifts, some animals and plants will need to adapt or move, and if they cannot do those things, they may not survive.
- Natural Disaster shifts: Storms (like hurricanes) are likely to become stronger. Fires and droughts will become more common.
- People will be displaced as coastlines recede, growing seasons and conditions change, and fresh water sources disappear.

Changing Climates

What does this mean for Africa? (30 minutes)

In this next activity, we are going to explore what climate change might mean for our own countries. WAAW Foundation is currently operating in 5 African countries: Ghana, Nigeria, Malawi, Kenya, and South Africa. Let's take a look at the changes that might happen in these regions.

This activity will be "Each-one-teach-one" meaning that the students will be the instructors! Divide your students into 5 groups, and give each group an information packet from the appendix (you'll find the appendix as a separate pdf document on the "Teaching Resources" page http://www.waawfoundation.org/teaching-resources/) The packet contains recent articles and news stories from each of the 5 countries. Each group has about 15 minutes to read through the information on their assigned country, and create a 1-2 minute presentation to teach the class about the effects that may take place in that country. Encourage groups to be creative with their presentations! They could act things out, draw pictures or diagrams, etc.

If you have time and access to computers, students can go online to do their own research, and gather more information.

Encourage students to answer some questions about the information they've gained: Did you learn anything about climate change's effect on: ecosystems, a specific species, crops, water, economics, diseases, etc.? Did you find anything about what that country is doing to combat climate change? How much has this country contributed to greenhouse gas emissions? All the packets are different, so groups should have unique stories to tell.

Once everyone has had some time to prepare, bring the class back together and have groups come up to present one at a time. The class should get a sense of what is happening due to climate change all over Africa!

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So what do we do? (10 minutes)

At this point, it's clear that change is coming our way. Can we prepare for it? Can we limit the amount of change in the future? Allow students time to discuss things that they can do to find solutions. Bring everyone together to share ideas.

Some possible answers to discuss:

- Limit your energy usage: Walk or ride a bike when possible. Turn off lights and appliances when not in use.
- Make your voice heard: Government policy dictates how resources are used, and how people prepare for change.
- Explore alternative energy sources: You don't need to be a top scientist to learn about and use renewable energy! (The Boy Who Harnessed the Wind!)
- EDUCATE OTHERS! Many are unaware of, or don't understand what Climate Change means for our world. Pass on what you know!

Encourage students to come up with solutions beyond what is listed here, that are specific to their country and their situation.

Conclusion (10 minutes)

Bring your students together for one final review and discussion. Ask some questions:

- How do greenhouse gasses, like carbon dioxide, trap heat in our atmosphere?
- Why is there so much concern now about these greenhouse gasses? What adds carbon dioxide to our atmosphere?
- We do need some carbon dioxide… why?
- What are some changes that we might see and some problems that could arise (or have already) that scientists are predicting?
- What can we do about it?