Green Girls Curriculum
Lesson 1: Climate Change - The Science

Lesson Duration: 2.5 + hours

Standards:
Next Generation Science Standards: MS-ESS: 3-1, 3-3, 3-5; MS-ETS: 1-1, 1-3
New York State Science Learning Standards: MS-ESS: 3-1, 3-3, 3-5; MS-ETS: 1-1, 1-3

Purpose:
- In Climate Science Knowledge, students will:
  - Learn about the science behind the greenhouse effect
  - Understand how human impacts, including the greenhouse effect, are changing earth's climate
  - Create models of earth with varying levels of greenhouse gas impacts.

- In Socio-emotional skills building, students will:
  - Develop social connectedness through working in collaborative pairs or groups

- In Advocacy Skills, students will:
  - Increase their knowledge of how to protect the environment.

Essential Questions:
- What is the difference between weather and climate?
- What is the greenhouse effect?
- How is the greenhouse effect changing our climate?
- How have human actions contributed to the greenhouse effect?

Session Routine:

Activity	Time	Description
Starting Circle	40 min.	Welcome to Green Girls + Rocks/Paper/Scissor Challenge
SEL Activity	25 min.	Journal Prompt + 'The Wind Blows' Game
Activity 1	40 min.	Greenhouse Gas Models/Hypotheses/Data Collection
Activity 2	20 min.	The Greenhouse Gas Game
Final Circle	15 min.	Debrief Questions and Discussion

Materials:
General: Journals, writing utensils.
For the design project for each set of students you will need the following: 2 two liter soda bottles, Rubber stoppers for 2L bottles, 5 rubber bands, 5 ft of plastic wrap
A liter of water, Several pills of alka seltzer (creates CO2 when mixed with water), 2 balloons, 2 straws, Dirt (students may collect), Plants/grass (students may collect), 2 thermometers, tape, other assorted materials that educator deems useful in design project.
For Greenhouse Gas Game: Stack of printing paper or other objects to be used as "heat". Markers for labeling

Some things you should know before teaching this lesson:

- **The Keeling Curve**
- **Greenhouse effect**

Background:
When teaching climate change to students there are many misconceptions that are important to clarify. First, what is the difference between climate and weather? This distinction is key to understanding climate change. Weather is the short term variations in temperature and condition, e.g. Today it is 70F and sunny but tomorrow it will be 53F and thunderstorming. The variability in weather in this situation does not mean that the climate is changing, rather that the weather is just shifting. Climate change however indicates the long term changes in weather patterns in an area over a significant period of time, usually decades.

The greenhouse effect is the natural process that keeps earth at the balanced temperature that allows for life to survive on this planet. When the sun shines, solar radiation comes toward earth. Some of the solar radiation is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases in earth's atmosphere. Healthy levels of greenhouse gases (Carbon Dioxide, Methane, etc) help us keep a balanced level of heat in our atmosphere. However, when humans and companies extract and burn fossil fuels this process releases far more greenhouse gases than is healthy for our atmosphere. This process traps excessive amounts of heat in the atmosphere causing the phenomenon known as global warming.

Assessment
Formative:
Construction of Model In A Bottle experiment and hypothesis
Exit Ticket

Summative:

Model in a Bottle Sheet (accurate completion of all questions)*
Pre-Post Survey
*You may wish to adapt the project rubric for this to include both formative and summative assessment.

Opening Circle

ASK students: when seated in a circle, please share, 1 at a time:

- Name
- 1 thing they are excited for in Green Girls

Name Game 1: Rocks- Paper- Scissors Tournament (20 mins)

1. Have each member of the group pair up for the first round of rock, paper, scissors.
2. Ask pairs to play 3 games, and the best 2 out of 3 will be the winner. Educators can act as a referee during this time in case there are any disputes or confusions.
3. Instruct the winners of the first match to start cheering the name of the person who they beat to get to the tournament level. The players that lost will follow and cheer their winning teammate.
4. Have all the winners pair up and face off against each other. This face off will include the leader teammate that is facing off and their previous competitors. The leader will talk to the previous competitor to decide which sign to use for their first face off battle. When the group decides what sign to use, they will line up and use the sign together in their battles.
5. The winners will again cheer their competitors they beat and the competitors will line up behind the winner.
6. Repeat this process in elimination tournament style, until there are only two players left. Each should have a large group of people cheering them on from their previous wins. Let them play the final match. The game is over after one player wins the final match.

GATHER students back in a quiet circle.

TELL students:
Welcome to Green Girls! This year we are going to be taking a deep look into several aspects of our environment. We will learn about the ways humans impact our natural environment and how we can work together to make sure our earth, all the people and animals on earth can be best taken care of.

Introduce the Journal:
In this class you will have a journal for the semester. You'll be asked to brainstorm and write answers to questions, things you want to remember and to record your ideas here. You should feel free to write or draw your thoughts and responses whenever you have them. You can also collect different items you find outdoors such as leaves and flowers or print photos and stick them in. Remember to include the date and place for each new entry!

Journal Pair Share:
If you could change any one thing about the environment, your community or the world, what would it be? What is one idea of the change you would make and how to make it?

1. Answer the question in your journal with writing or drawing.
2. Find a partner, try to make sure it is someone you don't know very well and discuss
3. Share out with the rest of the group

Leadership Opportunity ** - Educator/intern or student volunteer should feel free to write both challenges and solutions on the board to keep as a living document for the semester.

Example notetaker charts:

Community/Environmental Issues	Our Solutions

GET students up and get into a big standing circle for another icebreaker.

Name Game 2

This is a great ice breaker for the first day. Take a look at the directions in the following link.

The Wind Blows

GATHER students back in a quiet circle. Ask a student or peer mentor or both to record answers on a board or large sheet of paper. Another can lead the discussion. The answers recorded here are some responses you can provide to students. You are welcome to add or include your own knowledge of the subject.

TELL students, today's topic is climate change.

ASK: What have you heard about climate change?

ASK: What is the difference between climate and weather?

Weather is a daily event in which the atmosphere (troposphere) changes everyday and is different in parts of the world. This change is typically within hours and the temperature can be different from one another.

When taking the average weather temperatures of a specific area over a long period of time, typically 10 years (or a decade), it is calculating the regional climate. For example, In the north east of the USA, it experiences four consistent seasons, periods of the year where it is warm, hot, cold and rainy - also known as a temperate climate. On the other hand, the regional climate in South America towards the equator is tropical, which only experiences hot average temperature all year round.

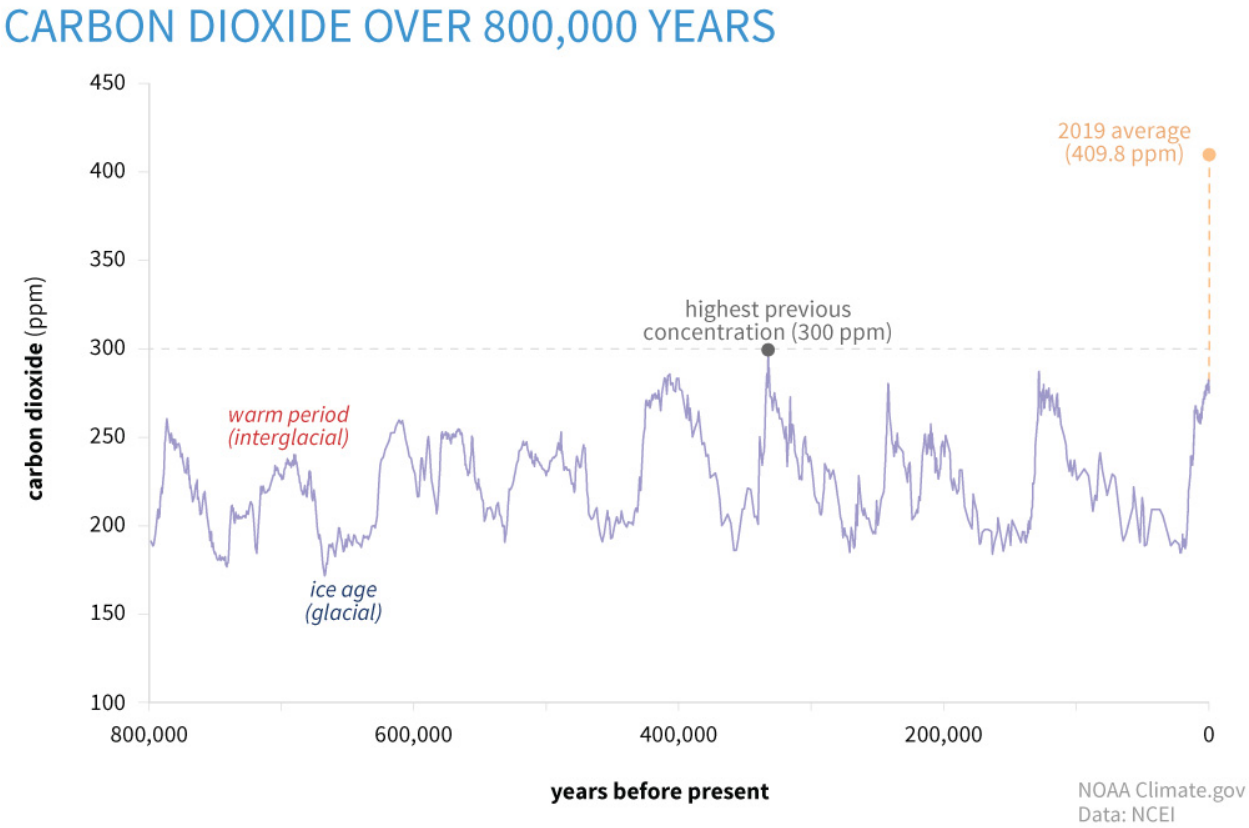
ASK: Have you ever heard of the Greenhouse Effect? How does a greenhouse work?

When the sun shines during the day, the energy goes through the atmosphere and heats up earth's surface. Some of the sun's energy returns back to space but the rest of the energy gets trapped by the atmosphere gases and absorbed by land and oceans. Greenhouse gases such as carbon dioxide, methane and ozone are found in the atmosphere and help trap some of the energy back to earth. This is important because these are the gases that help earth stay warm even when the sun is not shining and help sustain life by keeping an average temperature of 58F.

ASK: What are fossil fuels and where do they come from?

Fossil fuels are the non-renewable fuel sources that are made out of prehistoric plants and animals that died and are buried deep into earth's ocean and land layers. Some examples are coal, petroleum and natural gas. These substances are extracted when humans want to burn them to be used as power. The burning of fossil fuels releases greenhouse gases in the atmosphere.

ASK: How do humans impact the amount of greenhouse gasses in the environment?



800,000 years of Ice-core Data: Image source

Scientists used ice-cores from Antarctica and analyzed the carbon dioxide gases trapped in the cores, which provided clues on how our past climate's used to look like.

In the ice core graph above we can see the normal fluctuations of carbon dioxide in earth's atmosphere. If you notice the end of the graph, around the time of the industrial revolution and increased burning of fossil fuels, the quantity of carbon dioxide in the atmosphere began to increase drastically. Because of the burning of fossil fuels, earth now has the highest measured amount of carbon dioxide in all of geological history.

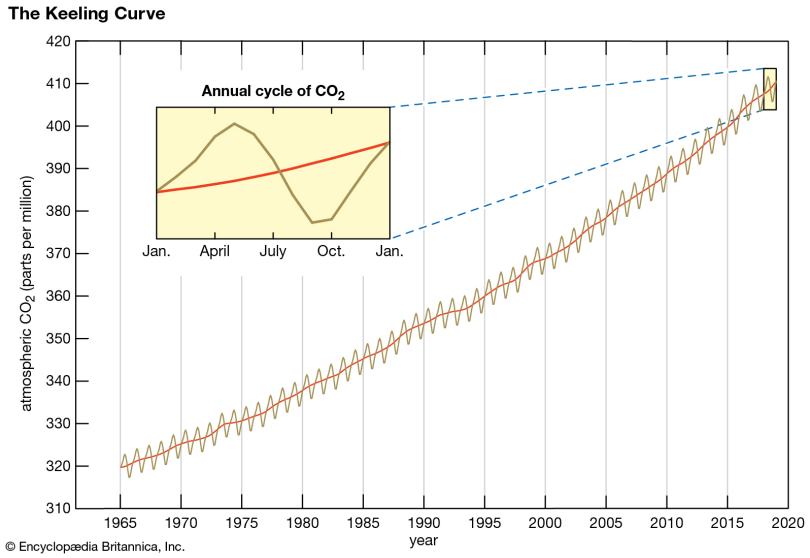


Image source

The Keeling Curve is another important graph that records the change in carbon dioxide in the atmosphere from Mauna Loa, a volcano in Hawaii. Similarly to the ice-core graph, the Keeling Curve shows dips, which represents the seasonal changes in which plants die and grow. Carbon dioxide decreases during spring and summer due to having plants grow and undergoing photosynthesis, and increase during the fall and winter because the number of plants decrease.

Understanding the natural sources of carbon dioxide, these graphs display how humans make an impact when we add more carbon dioxide to the atmosphere than there already is. Humans primarily add **additional** carbon dioxide to the atmosphere through the burning of fossil fuels which include the burning of coal, natural gas and oil. By comparing the data on the Ice-Core graph and Keeling Curve, we can compare the current levels of atmospheric carbon dioxide to past climate maximum value and trends, respectively. The Keeling Curve specifically shows that as humans continue to burn fossil fuels, the level the carbon dioxide in our atmosphere will continue to rise.

TELL students that today we are going to go outside into the sunlight to do a small experiment and play a game to help us learn about the greenhouse effect.

Activity 1 - Greenhouse Gas Engineering Design Project (Model In A Bottle)

TELL students that they are all going to act as climate engineers to figure out what will happen to earth's temperature if we add extra greenhouse gases to the atmosphere.

You will work in pairs to create an experiment to model two different earths.

1 model should represent earth without extra GHGs and the other model will represent earth with extra GHGs. By the end of the experiment, we want to be able to test the temperature of both of your models.

Each group will receive the following materials:

2 two liter soda bottles
Rubber stoppers for 2L bottles
5 rubber bands
5 ft of plastic wrap
A liter of water
Several pills of alka seltzer (creates CO2 when mixed with water)
2 balloons
2 straws
Dirt (you may collect)
Plants (you may collect)
2 thermometers
tape

Student Worksheet

TELL students: You have 10 minutes to design an experiment in both bottles to model two different climates. Make sure to fill out all the questions on your experiment design sheet and make sure to draw pictures of the models you plan on making.

Peer mentors or interns can rotate amongst the groups to assist with problem solving.

REMIND students: This experiment is complicated! It is okay if it doesn't turn out a specific way. The main purpose is to create two different models and form hypotheses about what we think will happen! It is fine if you don't get the results you're hoping for because there are many different factors.

If there is time: Show students this video of a successful version of the greenhouse gas experiment or of course, feel free to replicate it yourself.

Experiments that influenced engineering design project:

1. https://sealevel.jpl.nasa.gov/files/archive/activities/ts1hiac1.pdf
2. https://scied.ucar.edu/activity/carbon-dioxide-sources-and-sinks-activity

** You can do the next activity as students are waiting for their models to sit in the sun.

Activity 2 - Greenhouse Gas Game

TELL students: To learn a little bit more about Earth's atmosphere we're going to play a short game created by the Climate Centre. *See link below.*

https://www.climatecentre.org/downloads/modules/games/Greenhouse%20Gas%20Game.pdf

Closing Circle - led by a peer mentor or intern

Get students seated in a quiet circle

ASK students: What was a highlight from today? What was a challenge? What do you hope to do more of next week?

Exit Ticket:
Where do greenhouse gasses come from?
What is the impact of increased Greenhouse gasses in the atmosphere?