Lesson One - Climate Science and Policy
Lesson Planning Tool for Climate Change

Title of Lesson: Changing carbon levels in Earth's Atmosphere and how the IPCC is working to address this problem.

Grade Level: 11th and 12th
Subject: Environmental Science

Source(s) of the lesson: Carbon dioxide data from Mauna Loa observatory. http://www.esrl.noaa.gov/gmd/ccgg/trends/

The IPCC (Intergovernmental Panel on Climate Change) "Fragile Framework" graphic comic found in Nature. http://www.nature.com/news/the-fragile-framework-1.18861

Essential Question(s): How does carbon emissions affect the atmosphere? What are global leaders doing to address this problem?

Massachusetts Curriculum Frameworks Science Standards:
HS-LS2-1 Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.
HS-LS2-5 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Content Objectives	Practice Objectives	Language Objectives
Weather Extremes (ENSO/droughts/ hurricanes/etc..) HS-LS2-2	1. Asking questions (for science) and defining problems (for engineering) 4. Analyzing and interpreting data	SWBAT- summarize in writing how weather extremes are affecting the planet.

Important Vocabulary: Climate change, albedo, acidification, feedback loops, atmosphere, precipitation, carbonic acid, carbon dioxide, methane, ozone, greenhouse effect, mitigation, anthropogenic, urban heat island, permafrost

Materials Needed: IPCC Nature Fragile Framework (link included)
Mauna Loa Observatory data (link included)
NASA's "A year in the life of Earth's CO2" video https://svs.gsfc.nasa.gov/11719
Handout

Other Resources: (websites, videos, books, etc.)

Background Information for Teacher: Understand the carbon cycle, and how anthropogenic sources of carbon emissions are altering Earth's atmosphere.

Background Information the Student Needs to Access the Lesson: What prerequisite knowledge should the students have?
Basic understanding of the cyclical patterns in nature.

Lesson Structure

Lesson Launch (Do Now)	Students view NASA's "A year in the life of Earth's CO2" video https://svs.gsfc.nasa.gov/11719 Students are asked to make a claim based on what they observe during the video, using the claims, evidence and reasoning (CER) format.
Background Instruction (pre-activity)	Review the basics of the carbon cycle, fossil fuel combustion, and the greenhouse effect. Provide students the graphic comic "The Fragile Framework" and allow them the opportunity to read through it in its entirety.
Activity	Complete the attached document.
Discussion/ Debrief	Review and discuss the correct answers to the accompanying handout.
Formative Assessment	Students complete a "ticket to leave" (TTL) and submit a response explaining one new piece of information learned during the lesson.

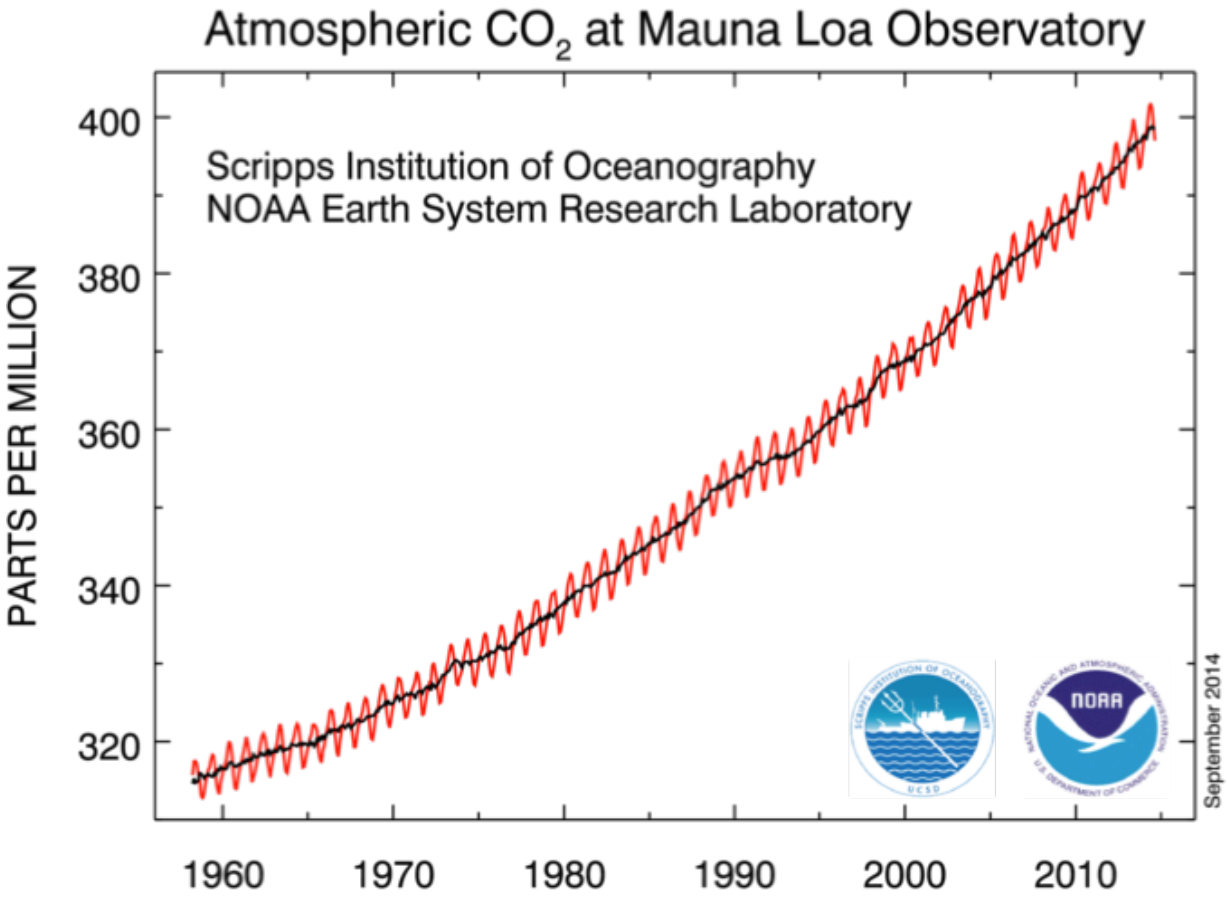
Notes: Below is the attached worksheet.

The Fragile Framework: Can Nations Unite to Save Earth's Climate?

Background

The Keeling curve is a graph based on continuous measurements of carbon dioxide (CO_2) in the atmosphere taken at the Mauna Loa Observatory (MLO) in Hawaii. This experiment began in 1958 under the direction of Charles David Keeling, and showed the first significant evidence of rapidly increasing levels of CO_2 in the atmosphere. With the advancing threat of changing

climate due to human activity, the Keeling curve is often credited with bringing worldwide attention to the problems associated with increased levels of CO_2 in the atmosphere.



Global CO_2 concentration

The global concentration of CO_2 in the atmosphere reached 400 parts per million (ppm) for the first time in recorded history, according to data from MLO in Hawaii. The world surpassed the 400 ppm CO_2 threshold for the first time on May 9th 2013, and April of 2014 was the first full month with an average CO_2 level above 400 ppm.

1. What is the rate of increase of CO_2 in Earth's atmosphere for each decade between the 1960's and the 2010's? Is this rate increasing or decreasing? What accounts for this change?

2. Why is the concentration of CO_2 in our atmosphere changing? How do we know this?
3. If CO_2 continues to increase at the current rate (2000-2010), at what year will the concentration exceed 450 ppm? 500ppm?

Looking at the Keeling Curve:
4. Based on the rate of increase predict what the CO2 concentration will be in 2050. 2100?
5. What does this mean for biodiversity and ecosystem functioning on earth?

The Fragile Framework

After Reading the Fragile Framework create a timeline of global climate action, indicating the following:

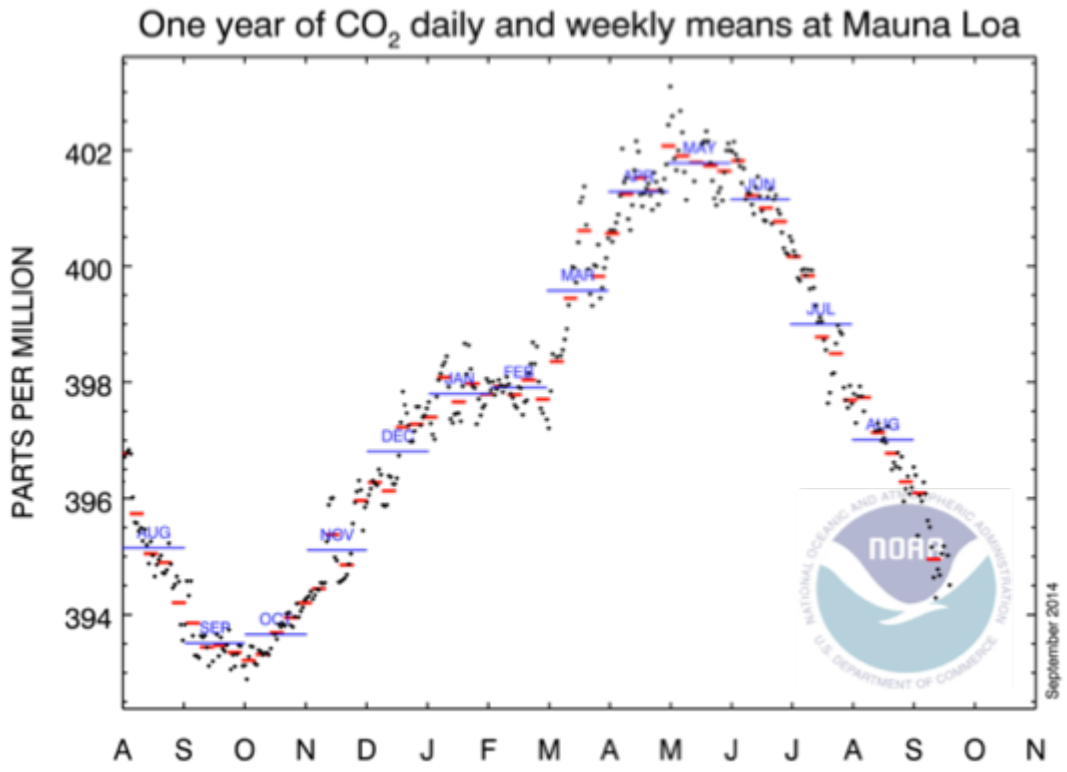
Year	Location	Meeting Milestones	Global Disaster

Yearly Fluctuations

Examining the Keeling curve closely, it is easy to notice that there is a fluctuation in the rate of increase. The CO_2 concentration follows a seasonal ebb and flow while still following a steady rate of increase. The concentration typically peaks in the month of May, and reaches its lowest point in October.

1. Explain why the CO_2 concentration fluctuates during the year.

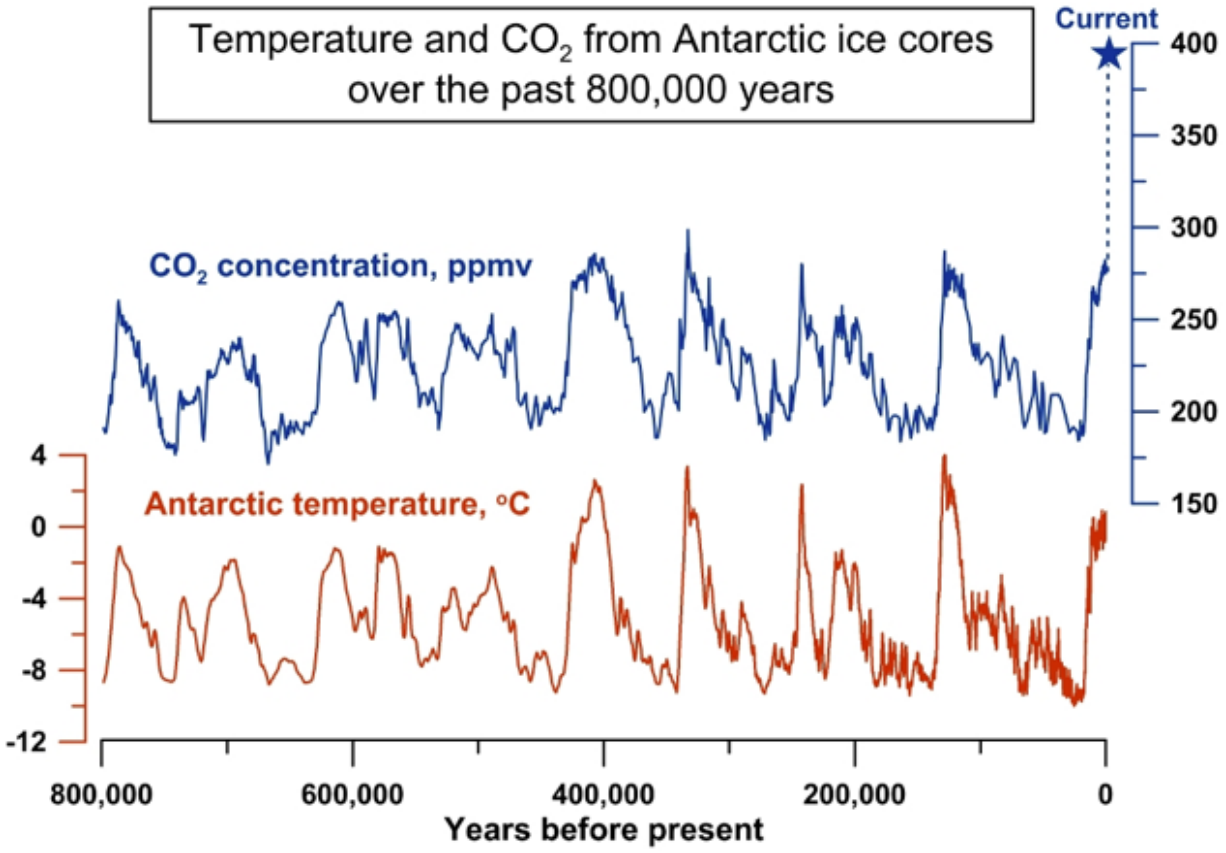
2. If the concentrations decrease from May to October, where does the carbon go if it leaves the atmosphere? If the concentrations increase from October to May, where does the carbon come from?
3. Even though the yearly CO_2 concentrations ebb and flow, what accounts for the steady rate of increase? Where is all of the carbon coming from?



Ice Core Record

1. There were no experiments tracking the concentration of CO_2 in our atmosphere prior to 1958. How can scientists definitively connect an increase in CO_2 concentration to human activity?

2. In other words, what was the concentration of CO_2 in our atmosphere in 1750 AD? 1250 AD? How do we know?


Temperature and CO_2 from Antarctic ice cores over the past 800,000 years
Current
400
350
300
250
200
150
CO_2 concentration, ppmv
4
0
-4
-8
-12
Antarctic temperature, °C
800,000
600,000
400,000
200,000
0
Years before present