

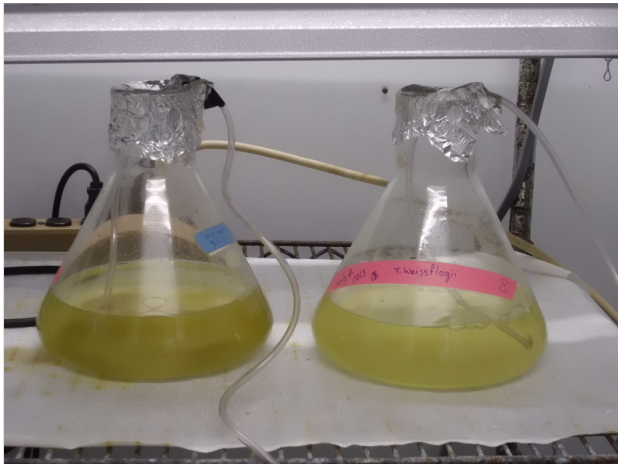


# Presenting the Carbon Cycle in a Biological Sciences Classroom

RET II – Summer 2014

By Catherine Borgard





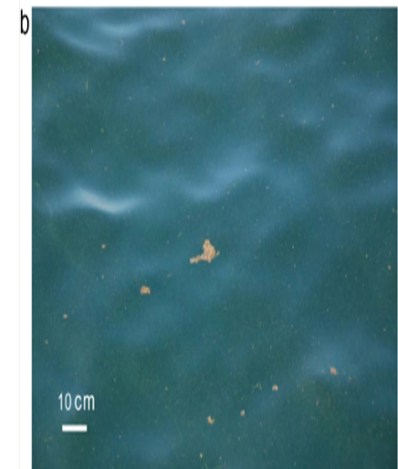
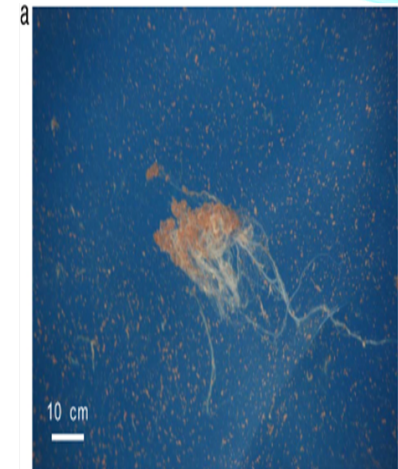
## INTRODUCING RET I

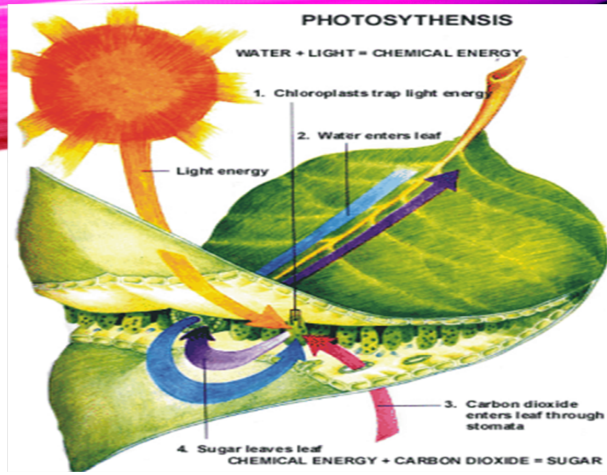
- Summer 2013: research with Dr. Uta Passow
- Simulate the growth of marine snow using conditions like the Deep Water Horizon Gulf oil spill.
- Successfully grew marine phytoplankton Thalassiosira weissflogii in the lab after making some modifications: the addition of higher concentrations of CO<sub>2</sub> and light as seen in the bottom slide.

## IMAGES OF MARINE SNOW



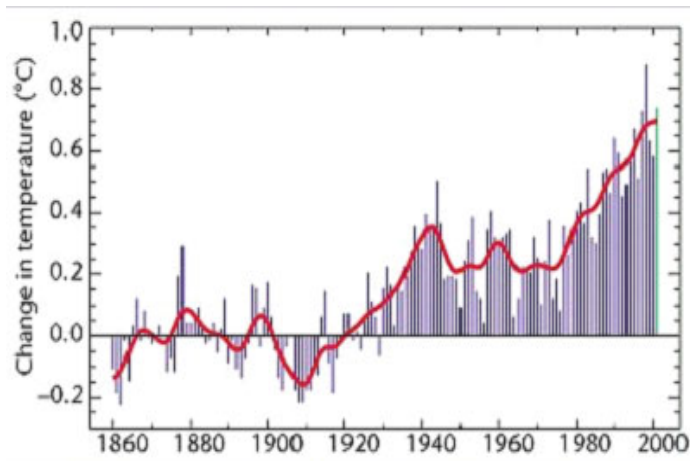
- Tank: marine snow grown in the lab.
- Gulf of Mexico: marine snow after Deepwater Horizon spill.
- I was unsuccessful at reproducing the quantity of marine snow, as seen in the image on the right, after the spill.





## CONNECTIONS

- Summer 2014
- Using a greater depth of knowledge from research in 2013 to teach:
  1. Photosynthesis
  2. Global Carbon Cycle
  3. Climate Change
  4. Student personal contribution to problem and solutions
- These lessons are designed for high school biology students grades 9 and 10 but can be adapted for younger students



## WHY?

- 2013 was a frustrating experience instructing students on the role carbon has on the planet.
- From a small scale, photosynthesis, to a global scale, the greenhouse effect there was a disconnect with the students. They showed no true engagement.



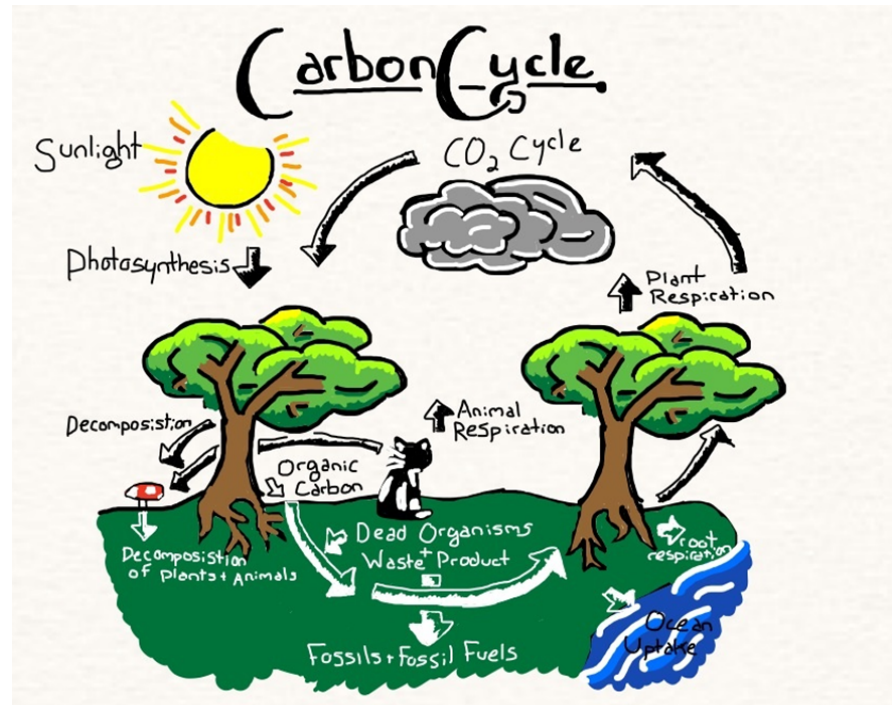
- After participating in research on “Carbon” and what an important role it has, I felt inspired and motivated to take on the challenge of changing students attitudes.
- I wanted to empower my students to participate in solutions in the real world right now.
- The following lessons hope to accomplish this goal.



# BIOLOGICAL CARBON CYCLE

Next Generation Science Studies

- LS1.C: Organization for Matter and Energy Flow in Organisms
- ESS3: Earth and Human Activity
- PS3D: Energy in Chemical Processes and Everyday Life
- ETS1: Engineering Design



# EVIDENCE OF PHOTOSYNTHESIS

## **Experiment:** Indicators

Introducing CO<sub>2</sub> indicators using Bromothymol Blue

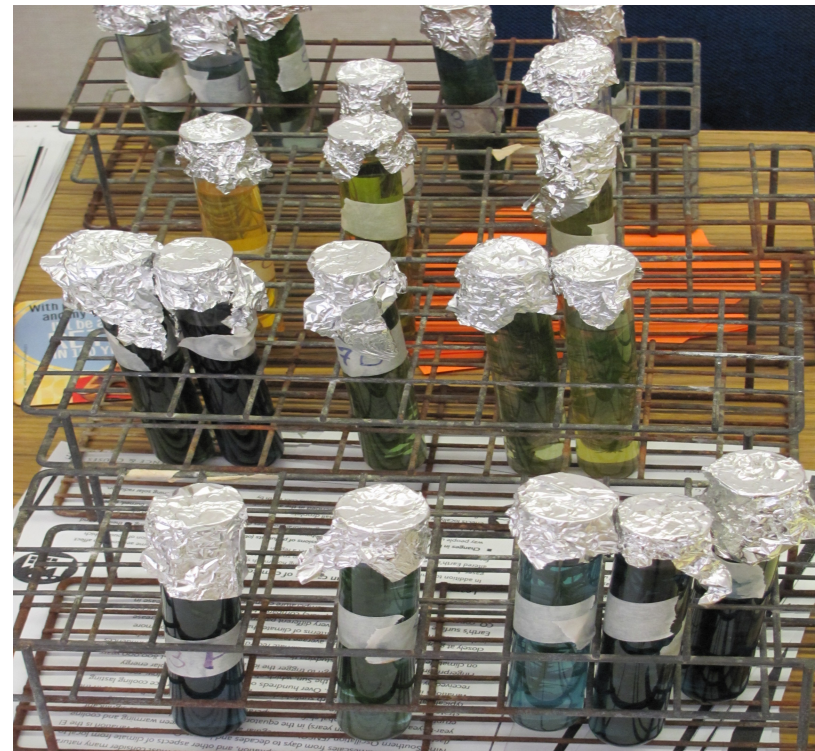
- Students will test the indicator BTB with acid, carbonated soda, their exhaled breath, and smoke.
- Students will be able to determine if CO<sub>2</sub> is present by the color change in BTB and that CO<sub>2</sub> is acidic.



# EVIDENCE OF PHOTOSYNTHESIS

## **Experiment:** Elodea and BTB

- Fill 3 test tubes with yellow BTB and 1 with blue BTB.
- Place a strand of Elodea in 2 of the yellow test tubes and the blue.
- A yellow test tube with elodea goes in the dark and all of the others in the light.
- Observe 2 - 3 days later.
- The removal of an acid,  $\text{CO}_2$ , will turn the BTB from yellow back to blue. This is evidence of photosynthesis occurring.





# WHAT'S UP WITH AIR?

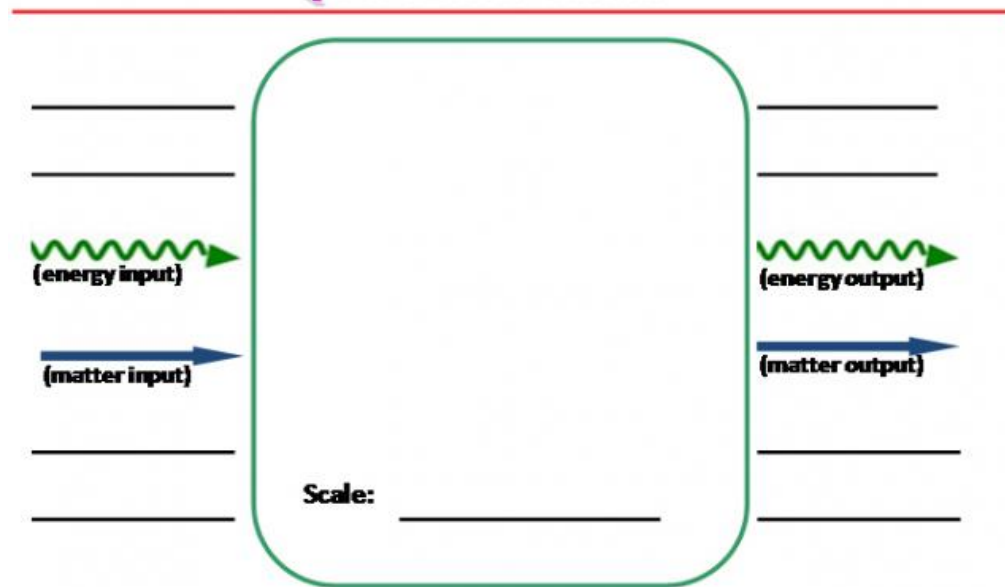
- Students have difficulty conceptualizing that carbon dioxide in the air can be rearranged to form sugars and ultimately the mass of a tree.
- To facilitate this reality I introduced an activity where the students have to think through the evidence presented in a demonstration and determine that air has mass.




# PHOTOSYNTHESIS AND RESPIRATION

## ANALYSIS OF TWO EXPERIMENTS

process tool





## ANALYSIS OF TWO EXPERIMENTS PHOTOSYNTHESIS & RESPIRATION

- Photosynthesis: analysis of “van Helmont’s Willow” experiment
  - Half the students work in pairs on this experiment
  - Use the “Processing Tool” to help track the flow of matter and energy
  - Students join the next day, organize themselves to work as an efficient team
  - Goal is for everyone to present the findings using visual and auditory methods
- Photosynthesis: analysis of “Mice in a Box” experiment
  - Half the students work in pairs on this experiment
  - Use the “Processing Tool” to help track the flow of matter and energy
  - Students join the next day, organize themselves to work as an efficient team
  - Goal is for everyone to present the findings using visual and auditory methods

# EXAMINING PHOTOSYNTHESIS & RESPIRATION IN PRACTICE

- Prepare for this lab 10 days in advance either with the students or by yourself.
- Create enough samples or stations for students to work this out in small groups – no more than 4 students in a group.









## EXPERIMENTS THAT DEMONSTRATE SOME OF THE EFFECTS OF GLOBAL WARMING

- These experiments work best if multiple trials are performed.
- Data can then be compiled and analyzed for variation.
- Demonstrating the importance of multiple trials using the scientific method validates that results must be reproducible.
- This might be necessary as the experiment with temperature and various gases can be tricky for students
- I have six periods of biology and so compiled all six class sets of data for analysis.

# OCEAN STRATIFICATION

## EFFECTS OF CLIMATE CHANGE

- **Experiment:** Ocean Stratification via Temperature
- Fill 2 jars with hot red water
- Fill 2 jars with cold blue water
- Glitter to represent marine snow (nutrients)
- Place hot water on top of cold water
- Place cold water on top of hot water

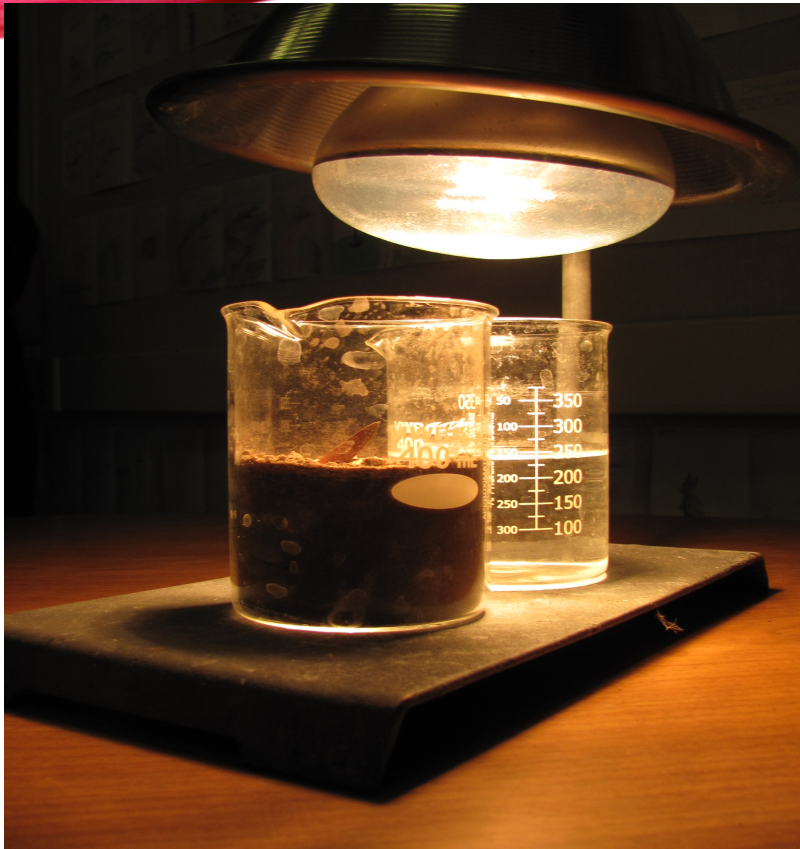




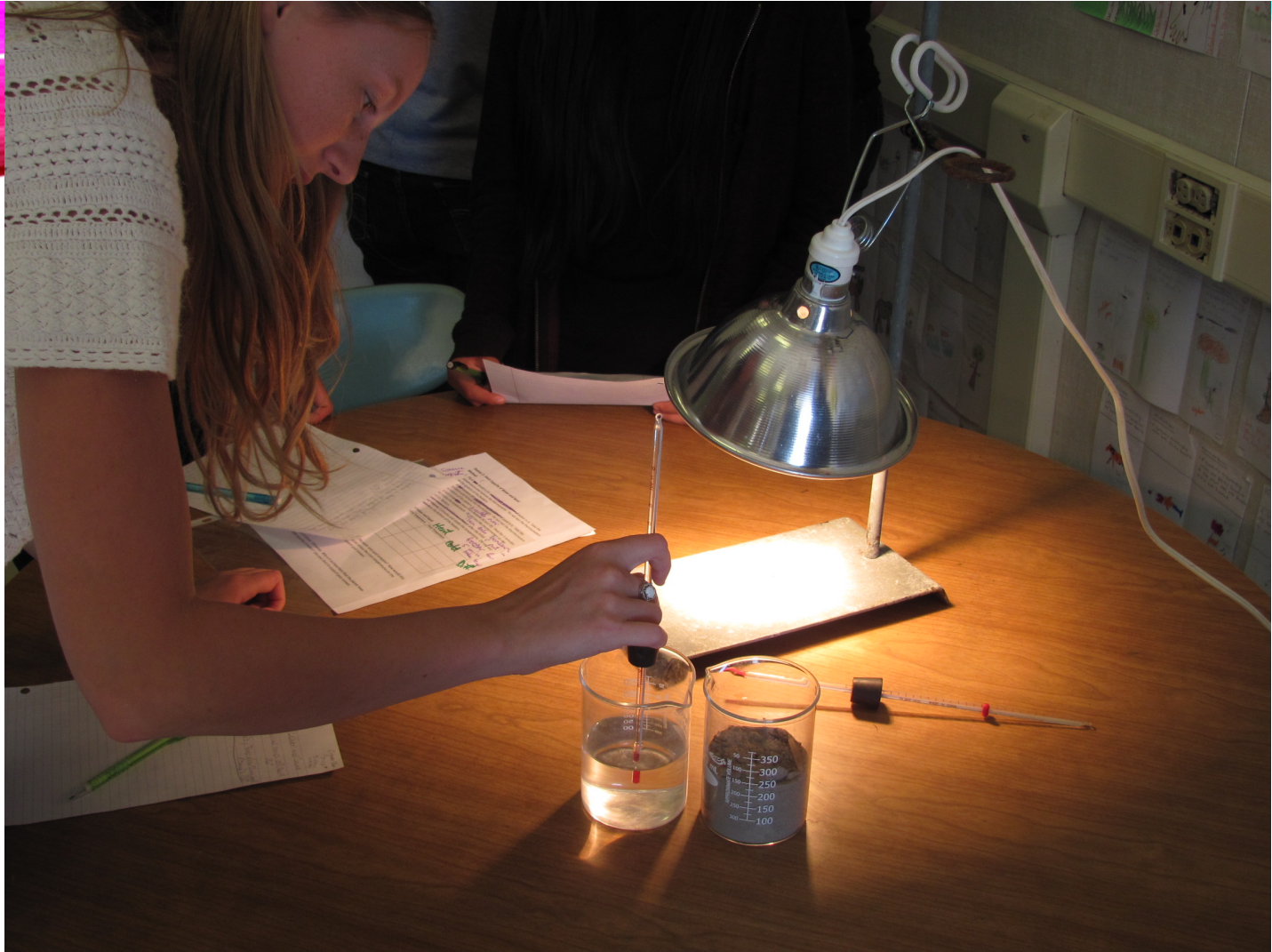


# TEMPERATURE FLUCTUATIONS BETWEEN EARTH AND WATER

## EFFECTS OF CLIMATE CHANGE

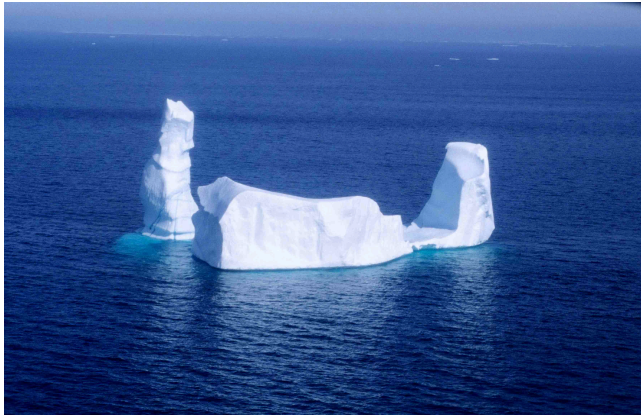


- Comparison of temperature between earth and water after 5 minutes of heat.
- Comparison of temperature between earth and water after 5 minutes of cooling.



# SEA ICE VS. GLACIERS

## EFFECTS OF CLIMATE CHANGE



- Beaker A: pour 150 mL of water and add several ice cubes to simulate sea ice (icebergs).
- Beaker B: fill with ice to 150 mL. Pour water into beaker until it reaches 150 mL to simulate a glacier flowing on top or into ocean.
- Melt ice completely using a hot plate.
- Compare water levels.

# SEA ICE VS. GLACIERS EFFECTS OF CLIMATE CHANGE



- Yes, it was Halloween when the students performed this lab.



# TEMPERATURE FLUCTUATIONS BETWEEN GASES

## EFFECTS OF CLIMATE CHANGE

- The goal of this experiment is to demonstrate how global warming gases work.
- Carbon dioxide is not the only global warming gas. Methane and water vapor will also trap heat as do other gases.
- In this experiment normal air is compared to carbon dioxide and water vapor.
- The water vapor is important to help understand feed back loops.



# TEMPERATURE FLUCTUATIONS BETWEEN GASES EFFECTS OF CLIMATE CHANGE



- Global warming gases
- Comparison of temperature fluctuations due to heating and cooling.
- Compared gases: air, carbon dioxide and water vapor.



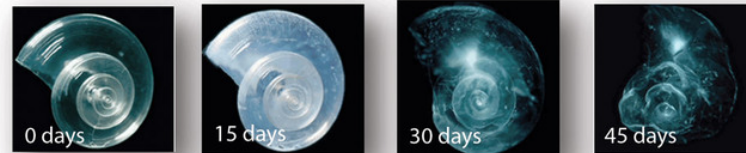




# ARTICLE SUMMARY

## WHAT IS OCEAN ACIDIFICATION?

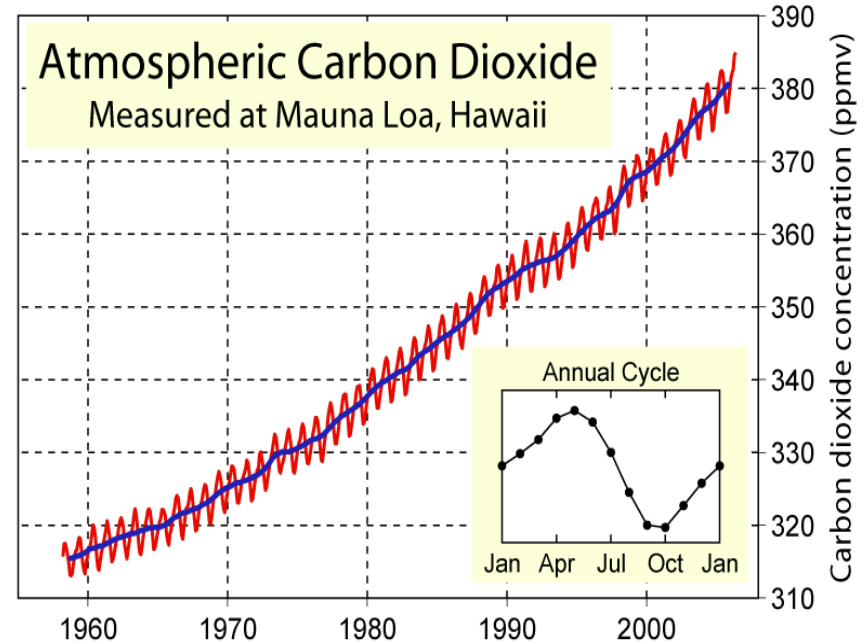
- One goal of NGSS is to increase student analytical processes.
- Another goal is to communicate their analysis.
- Article summaries offer an opportunity to hone these skills.
- Students view a demonstration on the effects of sea shells (substituting chalk) and acid.
- They then continue with the summary.



# ANALYZING DATA THE KEELING CURVE

## Keeling Curve

- Students analyze Keeling's data on increasing levels of atmospheric carbon dioxide.
- The students graph the data. Data provided: <http://cdiac.ornl.gov/ftp/ndp001/maunaloa.co2>
- Students answer discussion questions based upon their analysis of the Keeling Curve



# COSMOS: A SPACE-TIME ODYSSEY

This video with Neil deGrasse is excellent at walking through:

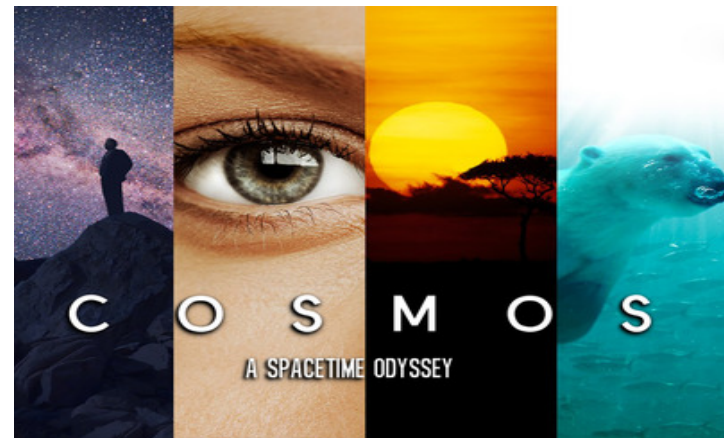
- What are contributing factors to climate change.

And

- What are not contributing factors to climate change.
- Hope and responsibility are included.
- Video may need to be paused to check for understanding especially if there are EL students.

- [Cosmos Space-Time Odyssey - Instantly Watch Free Episodes.](#)
- [sharetv.com/cosmos\\_space\\_time](http://sharetv.com/cosmos_space_time)

- Episode 12: The World Set Free



## ARTICLE SUMMARY

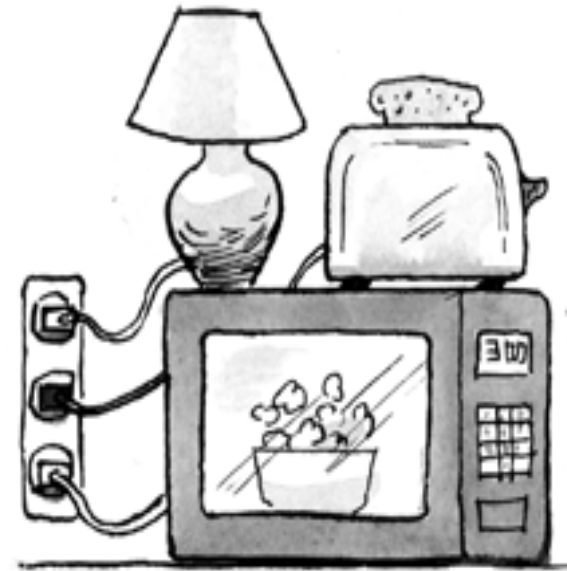
# CHINA AND KAZAKHSTAN COMPETE FOR CARBON NEUTRAL OLYMPICS

- Environmental factors are being taken into consideration for development.
- An example: whom will host the 2022 Winter Olympics.
- Students will see proposed evidence to offset carbon emissions.
- Point of discussion could be: *“What are the differences between offsetting carbon emissions and reducing carbon emissions”?*



## FINAL ASSESSMENT *YOUR ENERGY AUDIT*

- What are **your** personal carbon dioxide emissions every year?
- In this modified activity from *NOVA: the Big Energy Gamble*, students calculate their own emissions of carbon dioxide.
- The students then convert these emissions to equivalences of their own body mass. This makes the quantity more personal and relevant to themselves.
- At the end, students strategize methods to reduce carbon dioxide emissions and implement them.



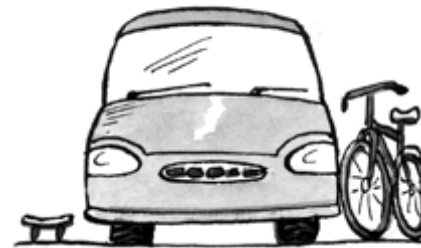
# WHAT IS YOUR CARBON FOOTPRINT? YOUR ENERGY AUDIT

Have students bring in energy use statements a month before this activity. Having a variety of statements available is preferable.

Energy statements include: electricity, gas (space and water heating), and transportation.

If students do not know consumption of gasoline a “guestimate” handout is included.

Sample statements are available on line but do not reflect their homes.





# WHAT WILL YOU DO TO MAKE AN IMPACT?

- The final part of ***The Big Energy Gamble*** is to find solutions.
- Students need to feel empowered now and for their future.
- Students should work in pairs to discover solutions.
- These should include time lines.
- They then present their solutions for comments and feedback.





THANK YOU