Climate Change "The Heat is On"

Theme

The Ocean stabilizes our respective climates. Global warming threatens to alter this delicate balance. We still have time to change our energy consumption patters to help reduce this threat

Objectives

- Understand Climate Change and its impacts on the world's oceans
- Realize that fossil fuel emissions are responsible for this warming trend
- Become familiar with alternative forms of energy, specifically renewable energy
- Take the challenge to reduce your energy consumption and encourage others to do the same

Did You Know?

- **The ten hottest years on record have occurred in the last two decades**
- **Current atmospheric concentrations of CO_2 are higher than they've been in the past 420,000 years and likely, for the past 20 million years**
- **The primary human-related causes of CO_2 release are fossil fuel combustion (mainly oil, coal and gas) and deforestation**
- **Sea level is projected to rise another meter or more by the end of this century**

Background Information Climate Change

Incoming energy from the sun is absorbed by the Earth and then redistributed by atmospheric and oceanic circulation before being radiated back to space. Naturally occurring 'greenhouse gases' in the Earth's atmosphere—water vapor (H_2O), carbon dioxide (CO_2), ozone (O_3), methane (CH_4) and nitrous oxide (N_2O)—absorb some of this outgoing thermal radiation, which is ultimately reflected back to warm the Earth's surface. This phenomenon is typically known as the 'greenhouse effect'. An enhanced greenhouse effect is now considered to be occurring, due to substantially higher concentrations of greenhouse gases in the atmosphere. This is causing global warming and climate change.

The oceans are not exempt. Sea level is rising, the oceans are becoming more acidic, species are changing habitats and migrating, corals are bleaching, and storms are becoming stronger and more frequent.

Did You Know?

- **When water temperatures get too high, corals expel the symbiotic algae that give coral their food and color, causing them to "bleach." If bleaching last long enough, corals can die**
- **Recent years have seen widespread and severe coral bleaching episodes around the world**
- **As the oceans warm, the location of the ideal water temperature may shift for many species and some have already begun migrating**
- **Species will face extinction if they are not able to move due to natural or man-made barriers**
- **Two (uninhabited) islands have already been submerged and a number of island nations exist at only a few meters above sea level**

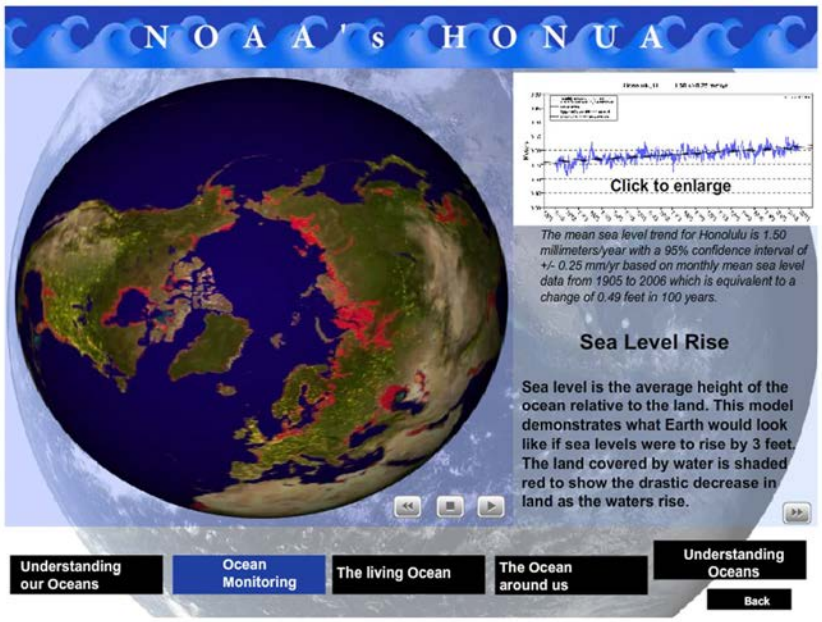
The current increase in global temperature of 0.7°C since pre-industrial times is already disrupting life in the oceans, from the tropics to the poles. The species affected include everything from plankton to corals**,** fish**,** polar bears, seals, penguins, and seabirds. Nearly half the CO_2 produced by human activities in the last 200 years has been absorbed by the ocean. The ocean is now becoming more acidic as a result. When CO_2 dissolves into water, it forms carbonic acid. As pH decreases (becomes more acidic), it decreases the ability of shellfish to make their shells and corals to build their skeletons.

We possess all of the knowledge and technology needed to reduce our emissions. Some governments have begun to do their part and as a result, their economies have actually grown. There are lots of things you can do as an individual to reduce your own daily emissions and save money in the process.

More information/ animations

http://tinyurl.com/63yg4nl

Full URL: http://www.csc.noaa.gov/psc/magic-planet/for%20website/datavisMain406_test_planet.html



Lesson 1: Ocean Effects

Purpose

Through simple experiments students discover the effects of climate change on the ocean and discuss their impacts on marine life and people.

Inquiry Questions

Will climate change affect the ocean? What kind of changes will take place? Will climate change cause problems for marine life? Will it impact people who live on the coasts or even inland?

Duration: 1.5 hours

Level: Grades 5-12

Materials

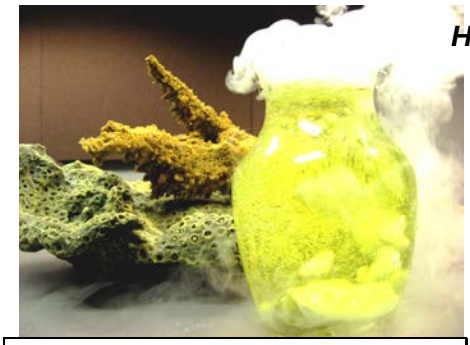
- 2 translucent containers (wide beakers or empty small tank)
- Water
- Salt (optional)
- Bromothymol blue 0.04% (acid/base indicator), indicator pH 6.0-7.6
- Dry ice
- Straw
- Ice (regular)
- Stove/Water heater
- Internet (optional)

Experiment 1: Increasing the Acidity of the Ocean

What happens to the pH of the ocean when you add carbon dioxide (CO_2)?

Procedure

1. Make an "ocean" by filling a beaker with water and adding a pinch of salt.
2. Add Bromothymol blue (or another pH indicator), it will turn **yellow if it is acidic**, **blue if it is not**. It should start out blue. (NOTE: make sure that pH indicator has adequate range, such as 7.6 and above= blue, and 6.0 and below=yellow.) Become familiar with and apply all the safety precautions needed before using any pH indicator.
3. Add a chunk of dry ice (cooled and compressed CO_2) to the "ocean" and watch as the color turns from blue to yellow. (NOTE: exercise great caution when handling dry ice. Dry ice can quickly cause damage if it comes into contact with unprotected skin or if it is ingested.)
4. Explain that as the dry ice **sublimates** (goes from a solid to a gas), CO_2 bubbles enter the ocean, which makes it more acidic.
5. Try the same experiment again, except instead of placing dry ice in the "ocean" use a straw to blow CO_2 into the water. You should see the same color change (from blue to yellow). (NOTE: Use safety goggles to avoid having pH-indicator splash into eyes.)
6. Explain that the ocean can hold a great deal of CO_2, but that today the levels are starting to change the chemistry of the ocean. The oceans are becoming more acidic, like the yellow "ocean," (but are still basic – just less so than before, and will not become acidic)

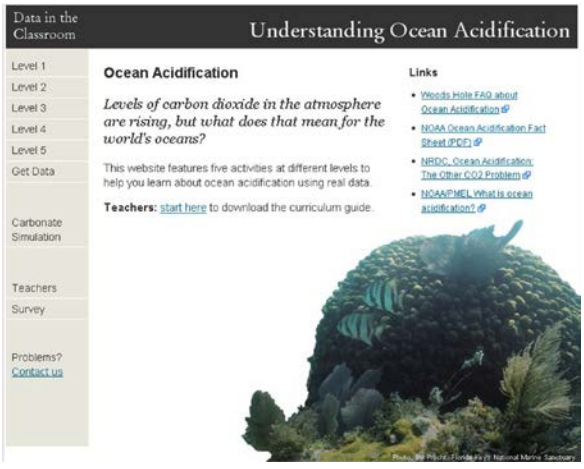


EXTENSION

The ocean helps to stabilize the world climates. Changes to major ocean currents like the Thermohaline Conveyor belt, or the North Atlantic current, would cause significant climate changes in places like Eastern North America and Western Europe. Research the causes and effects of disrupting these currents.

For teaching ocean acidification using real data (HS level), go to:

http://www.dataintheclassroom.org/content/oa/



***How does this chemical change affect marine life*?**

7. Explain that the marine life that are most vulnerable to an acidic ocean are those that use calcium carbonate ($CaCo_3$), such as mollusks that have shells and coral which use calcium carbonate to make reefs.
9. Discuss the implications of a less-basic, more acidic ocean on marine life that depends on calcium carbonate.

Experiment 2: Melting Glaciers and Polar Icecaps

Why will global warming increase sea level?

Procedure

1. Make an "ocean" by filling a wide beaker (or an empty fish tank, if available) with water and adding a pinch of salt. (Note: Salt is optional and will not affect experiment.)
2. Place a few ice cubes ("icebergs/polar ice cap") in the wide beaker/tank, so ice cubes are floating, and take note of the water level (use tape or a marker if it is not a measured container). This watermark will be your "sea level." Ensure that ice cubes are floating freely, and not touching the bottom of the container (touching the walls is OK).
3. Ask students if they think that the water level (sea level) will change when the ice melts. (Will sea level rise when the polar ice cap melts?)
4. Set "ocean" with ice aside, (you can place it under a heat lamp "sun" to increase the rate of melting).
5. Take another wide beaker or empty tank and place the same amount of water and salt in to this container.
6. Place a smaller inverted beaker inside the first one. If you are using an empty tank, you can place an inverted bowl inside the tank. Make sure that this second, inverted, beaker/bowl protrudes from the

water and is not entirely submerged. Mark the “sea level” at this point.

7. Place ice cubes in the top of the inverted beaker or bowl, and explain to the students that the bowl represents Greenland and/or Antarctica, and that the ice/glaciers there and in this experiment are not floating in the ocean.
8. What will happen to the “sea level” when the ice sitting in the top of the inverted beaker/bowl (Greenland/Antarctica) melts and runs into the “ocean”? (NOTE: Make sure to have enough ice cubes to noticeably affect water level!)
9. Wait for the ice to melt in the bowl, and note the new “sea level.”
10. Discuss the difference between the impacts of the polar icecaps melting versus the glaciers on landmass. Which will cause sea level to rise more? (ice in landmass). Why doesn’t the melting of icebergs/icecap change the sea level? (Ice in water is already displacing that amount of water).

Experiment 3: Thermal Expansion

What is *thermal expansion* and how why does it lead to sea level rise?

Procedure

1. Make an “ocean” by filling a beaker (container) with water and adding a pinch of salt.
2. Take note of the water level (“sea level”).
3. Ask students if they thing that the “sea level” will decrease or increase when it is heated? Explain how climate change is increasing the temperature of the ocean, what will happen to the ocean as sea level changes?
4. Heat the water and take another measurement. Has the sea level risen? Use caution when heating the water.

   Note: As water is heated, it will create steam which leads to the reduction of water level. Avoid heading water to boiling point.

5. How will sea level rise affect people living on the coasts? What kinds of threats do people face because of increasing sea level?
6. Warmer oceans lead to stronger and more frequent storms. What can we do to protect our coasts and ourselves?