LIVE INTERACTIVE LEARNING @ YOUR DESKTOP

NASA/UCAR: Effects of Climate Change: Oceans and Ice

Presented by: Dr. Lisa Gardiner

Wednesday, April 14, 2010
6:30 p.m. - 8:00 p.m. Eastern time
Effects of Climate Change: Oceans and Ice

A web seminar for the NSTA community
By the UCAR Office of Education and Outreach, with support from NASA.
Overview

- Melting snow and ice on land
  - Glaciers Then and Now activity
- Rising sea level
  - Thermal expansion activity
- Possible changes to ocean circulation
- Ocean acidification

Presenter:
Dr. Lisa Gardiner
Educational Designer
UCAR
Office of Education and Outreach
Melting Snow and Ice on Land
(with an activity about glaciers)
Glaciers and Ice Sheets

- Continental glaciers (also called ice sheets) cover large areas at high latitudes.
- Alpine glaciers (mountain glaciers) cover smaller, high altitude areas at all latitudes.
- To be considered a glacier, the ice must be moving.
Changes in Glacial Ice

What can we say about this graph?

IPCC AR4 Working Group 1: The Physical Science Basis, Figure 4.13
“All glaciers are shrinking.”

A. True
B. False
C. Can’t tell from this graph
We can’t tell if all glaciers are melting because this graph is showing us averages for each region. (However, almost all glaciers are shrinking.)
“Starting around 1850, average glacier length declined.”

A. True
B. False
C. Can’t tell from this graph
This statement is true and can be deduced from this graph. Glaciers in all regions have been getting smaller since the mid-19th Century.
The map at left shows in orange/red areas where there were higher than average number of melt days in 2007.

- There is evidence that both the rate of ice melt and area of ice melt are increasing.
- There is evidence that melt water under the ice is increasing glacier movement towards ocean (basal slip).
Antarctica has been losing more than 100 cubic kilometers (24 cubic miles) of ice per year since 2002.

http://www.nasa.gov/topics/earth/features/20100108_Is_Antarctica_Melting.html
Mountain Glaciers

Part of a special section of the NASA’s Global Climate Change Web Site called “State of Flux, Images of Change”

http://climate.nasa.gov/stateOfFlux/
How Glaciers Change

- **Glacial advance:** Glaciers become larger when more snow falls than melts.
- **Glacial retreat:** Glaciers become smaller when more snow melts than falls.
Activity: Glaciers Then and Now

- Students compare photographs of glaciers to observe how Alaskan glaciers have changed over the last century.

http://www.windows2universe.org/teacher_resources/teach_glacier.html
Muir Glacier

Glacier Bay National Park, Alaska

Photos courtesy of NSIDC
Carroll Glacier
Glacier Bay National Park, Alaska

1906

Photos courtesy of USGS
Carroll Glacier
Glacier Bay National Park, Alaska

Photos courtesy of USGS
Let’s Pause Two Minutes for Questions?
Rising Sea Level

(with an activity about thermal expansion)
How much is sea level rising?

Since 1900 sea level has risen 10-20 cm.
(During the previous 3000 years, sea level stayed essentially the same.)
How much sea level rise is predicted?

- Currently, global sea level is rising about 3mm per year.
- Sea level is expected to rise 18-59 cm over the 21st Century.

Why is there a range in estimates?
Post your thoughts in the chat.
Web Tour: Exploring the NASA Climate Time Machine!

Click on Sea Level

http://climate.nasa.gov/ClimateTimeMachine/climateTimeMachine.cfm
If the Greenland Ice Sheet melted completely, raising sea level 6 meters, which cities labeled in the “Climate Time Machine” would be underwater?

Write your answer above with the text tool.
Why is sea level rising?

- Melting glaciers and ice sheets add water to ocean.
- Sea water expands as it warms.

Activity:
Thermal Expansion and Sea Level Rise

- With a simple model, students investigate how thermal expansion of water can affect sea level.
- Students will be able to describe the change in water level when the water is exposed to heat.

http://www.windows2universe.org/teacher_resources/teach_thermalexpand.html
Setting up the model

1. Completely fill the flask with very cold water

2. Place thermometer and glass tube into the cork and place cork into the mouth of the flask. The water should rise a short way up the glass tube.

3. Have a student report the temperature of the water and mark the water level in the glass tube.
Testing what happens as water warms:

1. Ask students to predict what will happen to the water level when exposed to heat. Form a hypothesis or multiple hypotheses.

2. Place the flask under a lamp to warm the water. Within 5-10 minutes the water level in the glass tube will have risen.
Questions about sea level rise?
Possible Changes to Ocean Circulation
What is thermohaline circulation?

Large scale pattern of water movement through the world’s ocean basins due to changes in water temperature and salinity, which lead to differences in density.
How likely is this?

http://www.youtube.com/watch?v=3niR_-Kv4SM
Arctic sea ice decline may impact ocean circulation.

- Decline in Arctic ice cover 1980 to 2003
- Influx of fresh water from melting ice is making Arctic Ocean water less dense.
- Less dense water may not sink as much as it does today, disrupting ocean circulation.
Questions about ocean circulation?
Ocean Acidification
Measurements of atmospheric CO2
(Keeling Curve)

Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii

Image courtesy: www.globalwarmingart.com, See also: www.esrl.noaa.gov/gmd/ccgg/trends/
Carbon dioxide gets dissolved in the ocean.

- Up to half the carbon dioxide released from burning of fossil fuels gets into the ocean.
- In ocean water, CO2 forms carbonic acid which makes it difficult for animals to form CaCO3 (limestone) shells.
How will ocean acidification affect marine life?

- In experiments, doubling the amount of CO2 dissolved in seawater decreased calcification rates in corals an average of 30%.

- Note that the rate at which corals build their skeletons is affected by many other factors too (such as temperature, light, and nutrients).
Vinegar + Shell = ?

- Vinegar is acidic.
- The shell is made of calcium carbonate.
- What will happen to a shell left in vinegar?
- Write your hypothesis in the chat.

The shell in the picture is the clam *Codakia obicularis*, but any clam or snail shell will work. (Shell only! Not alive!)
Results...
Shell in vinegar (left), control shell (right)

After 3 hrs –
shell in vinegar fragile, color gone, edges crumbling

After 4 hrs –
shell in vinegar broken, very thin, crumbling
The ocean is not vinegar. (but a little change in pH can make a big difference)

- Vinegar has a pH of about 3
- The pH of seawater varies between 7 and 8
- Since the start of the Industrial Revolution, pH of seawater has dropped about 0.1.
- In the next century, it is expected to drop another 0.1-0.35.

Great Barrier Reef
Courtesy of NASA
Questions about ocean acidification?
Climate and Global Change on Windows to the Universe

http://www.windows2universe.org
Climate Discovery

A series of online professional development courses for middle and high school educators

CD 501 – Introduction to Climate Change
CD 502 – Earth System Science: A Climate Change Perspective
CD 503 – Understanding Climate Change Today

http://ecourses.ncar.ucar.edu
Join the conversation on Facebook!
Thanks!

Lisa Gardiner
egardine@ucar.edu
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