

GRACE Educational Curriculum OCEANS	
Teachers	Grades 6-8
Science	

GRACE Mission - "As the Waters Warm"

Background Information:

If global temperatures rise, an increase in the sea level is a likely secondary effect. As global atmospheric temperatures rise, the oceans will absorb heat and expand (thermal expansion) leading to a rise in sea level. GRACE is the name of a pair of satellites that will measure the gravity field of the Earth. GRACE stands for Gravity Recovery and Climate Experiment. GRACE will help study problems in geophysics, oceanography, and atmospheric science. GRACE will be able to detect sea level rising due to ice and snow melt as well as thermal expansion.

Objective: Students will conduct an experiment that demonstrates the effect of thermal expansion on water level.

Standards: Science: science as inquiry; earth & space science

Vocabulary: thermal expansion
global warming
sea level
erosion
inundate

Materials: Conical flask
Two-hole cork for flask
Thin, glass tube
Long thermometer
150-Watt floodlight
Dye
Portable, clamp-on reflector lamp

Directions to the Teacher:

1. After putting the students into small groups, have them fill the flask completely with very cold water. Include two drops of dye for visibility.
 2. Slide the thermometer and glass tube into the holes in the cork. Place the cork into the neck of the flask. The water will rise a short way up the tube. Have students record the temperature of the water and the water level of the glass tube in their student data table.
 3. Ask students to predict what will happen to the water level when exposed to heat. Have them record these predictions in their data table.
 4. Place the flask under the lamp. Turn on the lamp and record measurements every two minutes.
 5. Use graph paper to show the thermal expansion data. Write a summary of the following questions:
 - Why did the level of water in the flask change?
 - [Answer: As water warms, it expands.]
 - What does this experiment suggest might occur if the oceans get warmer?
 - [Answer: If the ocean temperatures warm sufficiently to cause expansion, sea level would rise and inundate coastal wetlands and other coastal low-lying areas.]
 6. Challenge your students to consider the possible impacts of a rising sea level in areas like South Florida or Bangladesh.
 7. If global warming is not sufficient enough to cause significant snow and ice melt, would you expect this thermal expansion to be enough to cause coastal flooding and erosion problems?
 - [Answer: No, it will likely be enough to measure, but not enough to cause significant coastal problems.]
 - Which would you expect to have a greater affect on sea level - the melting of the North Polar or South Polar ice caps? Would it make a difference? Why?
 - [Answer: North Polar melting would have little effect on sea level. That ice is already floating, thus displacing its volume in water. If the South Polar ice cap melted, the water would run off the Antarctic continent into the ocean, thereby increasing the ocean volume (and sea level) substantially.]
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6. If you were to buy a summer home, list five locations that would not be wise purchases and five locations that would be wise choices due to thermal expansion of the oceans.

Extensions:

- Research global warming. Write a paper about your findings.
- Write to a scientist that studies global warming.
- Develop a chart about effects of global warming.
- Find a news article or story about global warming. Report on it to the class.

References / Resources:

<http://www.cnn.com/SPECIALS/2001/globalwarming/>

<http://www.epa.gov/globalwarming/index.html>

<http://grads.iges.org/pix/head.html>

As the Waters Warm Worksheet Gravity Recovery and Climate Experiment

Procedure:

1. Fill the flask completely with very cold water.
2. Add 2 drops of dye for visibility.
3. Slide the thermometer and glass tube in the holes of the cork.
4. Place the cork in the neck of the flask.
5. Record the temperature of the water and the water level of the glass tube in the data table below.
6. Predict what will happen to the water level when exposed to heat.
7. Record your predictions in the data table.
8. Place the flask under the lamp. Turn the lamp on.
9. Record measurements every 2 minutes.
10. Use graph paper to show thermal expansion.

TIME	WATER LEVEL	TEMPERATURE

Why did the level of water in the flask change?

What implications does this experiment suggest might occur if the oceans warm?

What are possible impacts if the sea level rises in areas such as South Florida or Bangladesh?

If global warming is not sufficient enough to cause significant snow and ice melt, would you expect this thermal expansion to be enough to cause coastal flooding and erosion problems?

Which would you expect to have a greater affect on sea level – the melting of the North Polar or South Polar ice caps?

You are going to buy a summer home. Complete the chart below for wise and unwise choices due to thermal expansion of the oceans.

WISE CHOICES	UNWISE CHOICES