



GRACE Education Curriculum Intro – Facts	
Teachers	Grades 5-12
Science, Geography & Math	

## Grace Map the Facts

**Background Information:** Will GRACE predict the weather? GRACE will provide critical information for predicting global weather. Each day the GRACE mission will provide several hundred measurements of how the signals from Global Positioning Satellites (GPS) are affected as they travel through the atmosphere.

GRACE measures gravity! Gravity is the force that pulls two masses together. Since the earth has varied features such as mountains, valleys, and underground caverns, the mass is not evenly distributed around the globe.

The primary goal of the GRACE mission is to map the Earth's gravity field more accurately than has ever been done before. How will GRACE do this? Two identical spacecraft will fly about 200 kilometers apart. As the two GRACE satellites orbit the Earth they are pulled by areas of higher or lower gravity and will move in relation to each other. The satellites are located by GPS and the distance between them is measured by microwave signals. The two satellites do not just carry science instruments, they become the science instrument. The gravity field changes when the mass distribution changes within the Earth's atmosphere, ocean, land, or frozen surface.

Here's an example of how it works. The two GRACE satellites are traveling in space, both 500 kilometers above the earth. As the front satellite approaches an area of higher gravity, it will be pulled toward the area of higher gravity and speed up. This increases the distance between the two satellites. As the satellites straddle the area of higher gravity, the front satellite will slow down and the trailing satellite will speed up. As the trailing satellite passes the area of higher gravity, it will slow down and the lead satellite will not be affected. As the satellites move around the Earth, the speeding up and slowing down of the satellites will allow scientists to measure the distance between the two satellites, and, therefore, map the earth's gravity field.

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**Objectives:** At the end of the lesson, students will be able to:

- Model the GRACE mapping technique.
- Identify strong and weak areas of Earth’s gravity.
- Accurately answer questions about the Gravity Recovery and Climate Experiment.

**Standards:** Science: unifying concepts and processes; earth and space science; science and technology; physical science  
Geography: the world in spatial terms; places and regions  
Math: measurement; problem solving

**Vocabulary:** kilometer                      gravity                      mass

**Materials:** Information about the Gravity Recovery and Climate Experiment: GRACE lithograph, GRACE Fact Sheet, GRACE brochure, or the official GRACE web site: <http://www.csr.utexas.edu/grace> and links.  
World Topographic Map  
State Map  
Construction paper  
Tissue paper  
Colored pencils

**Directions to the Teacher:**

Provide information to the students about how GRACE will travel around the Earth and how it will map gravity. Provide measurements: how far apart the satellites travel and how high above the earth. Discuss how gravity is related to mass. Give examples of topographic features on earth where the mass changes: mountain, prairie, cavern, ocean, icecap, etc.

1. Have students cut out two shapes from a piece of construction paper that will represent the two GRACE satellites.
2. Distribute copies of a topographic map. Copies may be found at: [http://www.lib.utexas.edu/maps/world\\_maps/world.html](http://www.lib.utexas.edu/maps/world_maps/world.html)
3. Draw vertical lines at various intervals on the map. Number the lines.
4. Have the students “fly” on a line. What will they fly across that would cause the gravity field to change? Mark areas of high gravity, medium, low.
5. Lay a piece of tissue paper on top of the map. Using map colors make a color key and draw a gravity map of the world. This is your gravity field map.

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6. Distribute a map of your area or state. You may copy maps from:  
<http://www.mapquest.com/>
  7. Determine the distance between the two satellites. Calculate in kilometers and miles. Select a starting place for one of the GRACE satellites. Find a location on the map where the other GRACE satellite should be as it travels through space.

**Extensions:**

- Research why gravity is important.
- Find a story about GRACE in the news. Report to the class.
- Think of a question to ask a GRACE scientist. Email the question to the Ask-a-Scientist at: <http://www.csr.utexas.edu/grace/>

**References / Resources:**

The following materials are available from the GRACE web site:

<http://www.csr.utexas.edu/grace>

GRACE Facts Sheet

GRACE news articles

Videos

GRACE Brochure

GRACE Lithograph

Animations