National Aeronautics and Space Administration

Educational Product	
Educators & Students	Grades 5–12

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Educational Brief

CASSINI SCIENCE INVESTIGATION

Unveiling Titan's Surface

Objective

To make measurements of topographic features and to draw maps based on these data. This will be done in a way that is analogous to making radar measurements of topography through vegetation (on Earth) or through clouds (on Venus, Titan, and Earth).

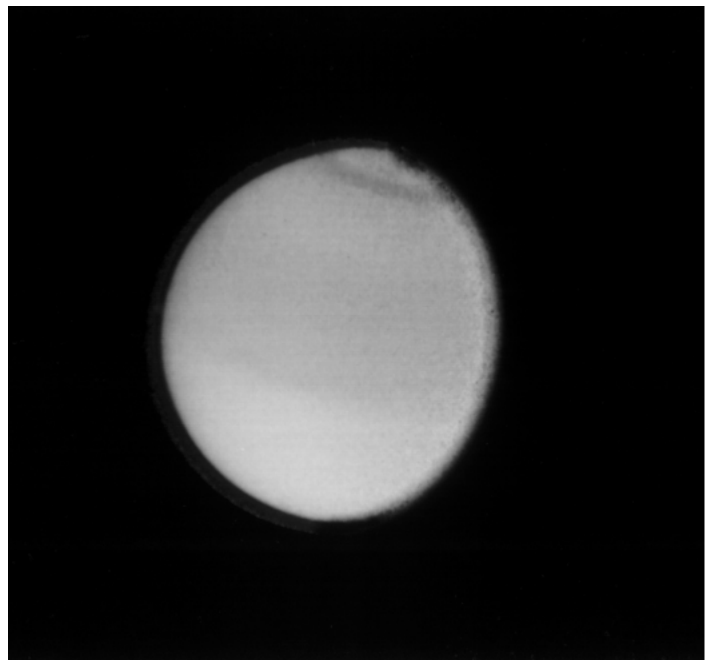
Time Required: 1–2 hours

Saturn System Analogy: Titan's surface unveiled by Cassini radar

Keywords: Contour Map, Radar, Relief, Topography

MATERIALS

- A sturdy cardboard shoe box, shipping carton with its top, or boot box
- Green styrofoam (commonly used in floral arrangements) cut to fit in the bottom of the box
- A tool for shaping the styrofoam (a large spoon will suffice)
- A sharpened pencil or similar object to punch holes in the box top
- A plastic coffee stirrer (about 5 inches long) or other long thin object like a bicycle spoke, a wooden kebab skewer, or a chopstick — to use as a depth gauge
- Adhesive tape and a ruler or tape measure
- A blank 3- by 5-inch index card
- Graph paper: several pieces with the same grid size



Titan, Saturn's largest moon, as seen by the Voyager 2 spacecraft.

Discussion

Titan's visibly opaque atmosphere shrouds the satellite's surface from our eyes. When the two Voyager spacecraft imaged Titan during their 1980 and 1981 flybys, scientists saw only the haze and cloud tops of the moon's thick, nitrogen-rich atmosphere.

Unlike a photographic camera that needs an outside light source, radar provides its own illumination. Cassini's radar will project pulses of radar energy toward Titan to strike the surface and echo back to the instrument. The amount of energy received by the instrument dictates how bright the resulting image is and is a function of the type of surface being measured. The round trip travel time of each energy pulse determines the location of the echoing surface. This technique, called synthetic aperture radar (SAR), is used to capture images of surfaces that are cloud shrouded (e.g., Titan, Venus, and Earth) or dark (e.g., the night side of Earth). SAR can even detect structures shrouded by rain forest vegetation. By supplying its own illumination and operating at radio frequencies that can penetrate the atmosphere and clouds, a radar instrument can image Titan's surface.

Procedure

Shape the top of the styrofoam into an irregular pattern. Spare pieces of styrofoam can be cemented on top to form mountains or plateaus. Place the styrofoam in the box. Tape a piece of graph paper over the box lid. Using the pencil or other sharp object, punch a hole at each intersection of the grid on the paper. The holes should be large enough for the depth gauge to fit through.

Preparing the Height Code Card

Pick any random hole in the graph paper–covered lid and insert the depth gauge into the box until it touches bottom. Place the index card next to the depth gauge and mark a line on the card where the top of the depth gauge is and label it with a zero. This is an arbitrary height reference, analogous to sea level on Earth. Beginning with the height reference, mark off and label 0.5-centimeter increments on the index card through 10 centimeters up and down from the arbitrary height reference.

Collecting the Data

Students should record height data, intersection-by-intersection, inside a corresponding square on their own graph paper. It is convenient to have students work in small groups so that several equivalent data sets are produced for the continuation of this activity. (Alternatively, each individual can make several copies of his/her data set as he/she goes along.)

Begin measuring heights at one corner of the topography box and proceed in a systematic manner around the grid. Students insert the depth gauge into each hole and measure the corresponding height on the height code card. Students should round heights to the nearest 0.5 centimeter and record them on their graph paper.

Constructing the Contour Map

In order to better visualize the surface being studied, mapmakers prepare contour maps that show elevation variations. This is accomplished by first picking a contour interval. For this exercise, try an interval of 2 centimeters or 1 centimeter.

Instruct the students to draw lines (curving, if necessary) connecting points of equal elevation, rounding X.5-centimeter values up to (X+1) centimeter consistently around the map. Students should be instructed that contour lines may not cross, but can close on themselves, indicating hills or basins. Students can compare their completed maps with the shaped styrofoam.

Extension

Use a finer grid pattern and a depth gauge with smaller increments to make a higher resolution set of measurements and contour map. (The area of higher resolution measurement may need to be limited to save time.)

Use a millimeter ruler for a height code "card," collect data, and make a new contour map with the original grid and/or the finer grid.

What is the effect if the depth gauge is not vertical? The map will be the same if the angle and orientation of the gauge are the same for each measurement point. If the angle and orientation vary, the map will be distorted. Advanced students can perform an analysis using trigonometric functions.

Education Standards

A visit to the URL http://www.mcrel.org yielded the following standards and included benchmarks that may be applicable to this activity.

Science Standards

12. Understands the nature of scientific inquiry.

LEVEL 1 (GRADES K–2)

Knows that learning can come from careful observations and simple experiments.

Knows that tools (e.g., thermometers, magnifiers, rulers, balances) can be used to gather information and extend the senses.

LEVEL 2 (GRADES 3–5)

Plans and conducts simple investigations (e.g., formulates a testable question, makes systematic observations, develops logical conclusions).

Uses appropriate tools and simple equipment (e.g., thermometers, magnifiers, microscopes, calculators, graduated cylinders)to gather scientific data and extend the senses.

LEVEL 3 (GRADES 6–8)

Establishes relationships based on evidence and logical argument (e.g., provides causes for effects).

Geography Standards

1. Understands the characteristics and uses of maps, globes, and other geographic tools and technologies.

LEVEL 2 (GRADES 3–5)

Interprets topography using aerial photos and maps.

Uses map grids (e.g., latitude and longitude or alphanumeric system) to plot absolute location.

LEVEL 3 (GRADES 6–8)

Knows the characteristics and purposes of geographic databases (e.g., databases containing census data, land-use data, topographic information).

LEVEL 4 (GRADES 9–12)

Transforms primary data into maps, graphs, and charts (e.g., charts developed from recent census data ranking selected information on various topics, cartograms depicting the relative sizes of Latin American countries based on their urban populations).

Teachers — Please take a moment to evaluate this product at http://ehb2.gsfc.nasa.gov/edcats/educational_brief. *Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank you.*

Student Worksheet — Unveiling Titan’s Surface

Procedure

1. Shape the styrofoam with mountains, valleys, craters, and other landforms, and then place it inside the box.

2. Tape graph paper over the box lid.

3. Using the pencil, punch holes in the box lid at the grid intersections of the graph paper.

4. Prepare the height code card by inserting the depth gauge into the box lid until it touches the bottom. This fixes an artificial “sea level” on a “planet” that has no ocean.

5. Place the index card next to the depth gauge and mark where the top of the gauge is on the card. Mark this as zero.

6. Beginning with the zero mark, measure off and mark 0.5-centimeter increments on the index card.

7. By following a systematic pattern across the box lid, measure the height of the depth gauge as it is inserted at different intersections across the box lid.

8. Record the data at the corresponding intersections on another piece of graph paper.

9. Using the graph paper with the recorded height values, draw lines connecting the points with the same height reading. How does the contour map compare with the measured surface? How could the map be improved to better match the actual surface?