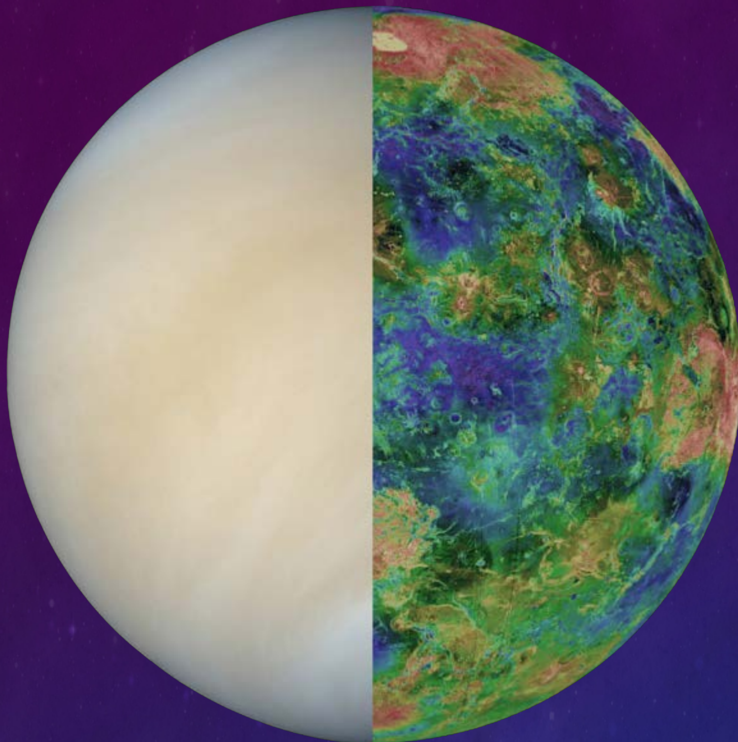
2020



SECRET SURFACE

Prepared by
Zoe Learner Ponterio, SPIF Manager
Revati Athavale, SPIF Student Assistant

SPIF

SPACECRAFT PLANETARY IMAGING FACILITY | 317 Space Sciences Building, Ithaca, NY 14853

SUPPLIES

- shoebox or similarly sized box
- objects of various sizes and heights small enough to fit inside the box
- skewer
- different colored markers
- tape
- paper with grid lines spaced 1/2" to 1" apart

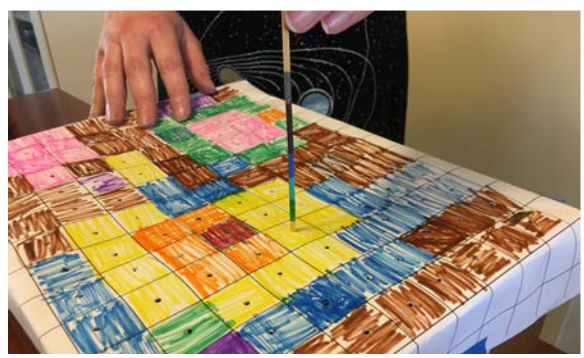
PREPARATIONS

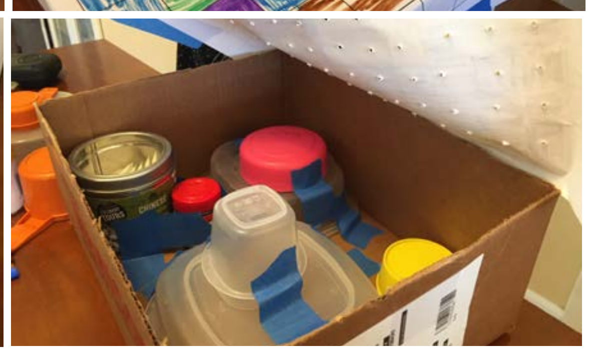
- Remove the lid of the box
- Tape the objects to the bottom of the box so that they create a “terrain” with different elevations
- Tape the gridded paper over the top of the box, grid side up, hiding the contents inside
- Color the skewer with different colors along the length, starting at the pointed end, going far enough up the skewer to cover the depth of the box

ACTIVITY

- Take the skewer and poke through the paper in the center of a grid space
- Note the color on the skewer that is showing right above the paper
- Remove the skewer and color the square on the paper that color
- Repeat for every grid space until each square is colored
- Have the participant describe what they think the "terrain" looks like
- Remove the paper and compare the topographic map on the paper to the actual "terrain" inside the box

Watch a video demonstration with tips and age modifications



OBJECTIVES

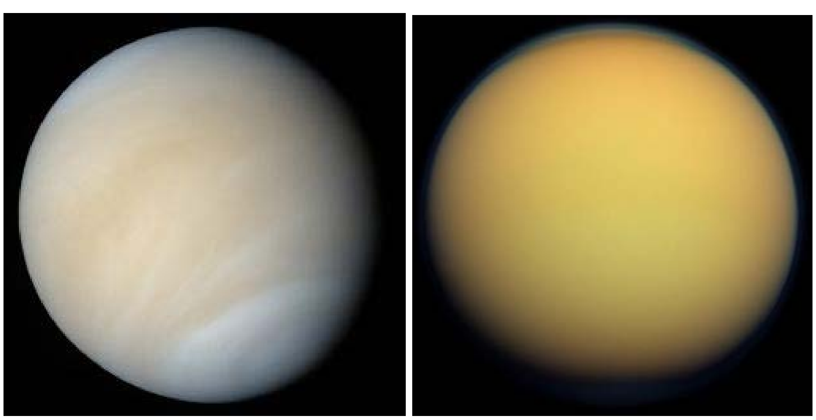
Participants will learn how scientists use radar instruments aboard orbiting spacecraft to create topographic maps showing elevation and terrain on worlds whose surfaces are obscured by clouds, like the planet Venus and Saturn's moon Titan. This information can be used to understand the past and current geology of the world, allowing us to compare it to the Earth. These same methods are also used to create Digital Terrain Models (DTMs), which are computer generated 3D models of a surface, for all worlds with solid surfaces, including the Earth. Even if the surface is not cloud-covered, this method still provides the best way of mapping an entire globe.

BACKGROUND

The word "radar" was originally an acronym, RADAR, which stands for RAdio Dectection And Ranging. It uses at kind of light called radio waves that we cannot see with our eyes. It is a "color" that is far past the red edge of the rainbow. Because radio waves are much longer than light we can see, they can pass through thick clouds easier. This is also why you can receive AM radio stations from farther away than FM radio stations - AM radio uses longer waves and so they can travel farther through the air.

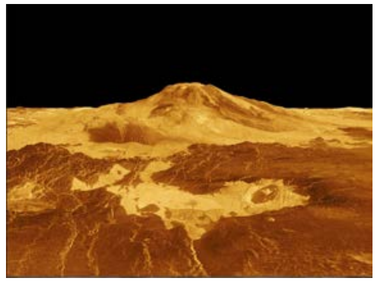
By sending radio waves toward a surface and then measuring how long it takes them to bounce back, and how much of it bounces back, we can learn a lot about that surface.

- The time it takes to bounce back tells us how far away the surface is, and this is how we can map elevation. When radar is used in this way, the waves are sent straight down to the surface perpendicular to it so that they bounce straight back to the spacecraft.
- How much of the radio waves bounce back depends on how smooth or rough the surface is. This is how we can tell if there are rugged mountains or smooth plains. For this method, the waves are sent down to the surface at an angle. If the surface is smooth, most of the waves will bounce off at an angle in the opposite direction like a mirror, and so not much will return and be detected. However, if the surface is rough, the radar waves will bounce off in all directions so that some of them will return and be detected. So when you see a radar image of a surface, dark means smooth and bright means rough.



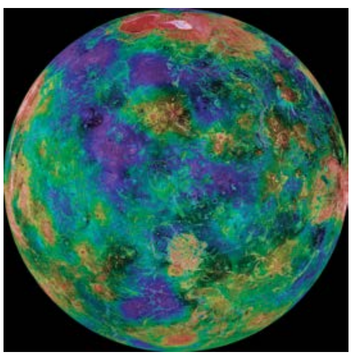
True color (visible light) images of Venus (left) and Saturn's moon Titan (right). Both worlds have solid surfaces like the Earth, but have thick atmospheres that completely hide the surface from our eyes beneath many layers of clouds and haze.
Venus: NASA/Mariner 10 Spacecraft
Titan: NASA/Cassini Spacecraft

A radar image of a crater on Venus showing the rough terrain around the rim and the smooth basin inside. *NASA/Magellan Spacecraft*

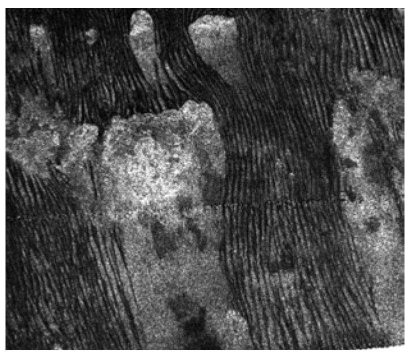


A DTM (not an actual image) of a mountain on Venus, created using radar data. The orange color is false, added because our eyes cannot see radar light. *NASA/Magellan Spacecraft*

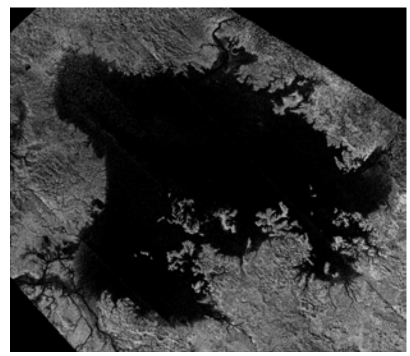
An actual, true color (visible light) image taken by one of the few spacecraft to successfully land on the surface of Venus. *Soviet Space Program/ Venera 14 Probe*



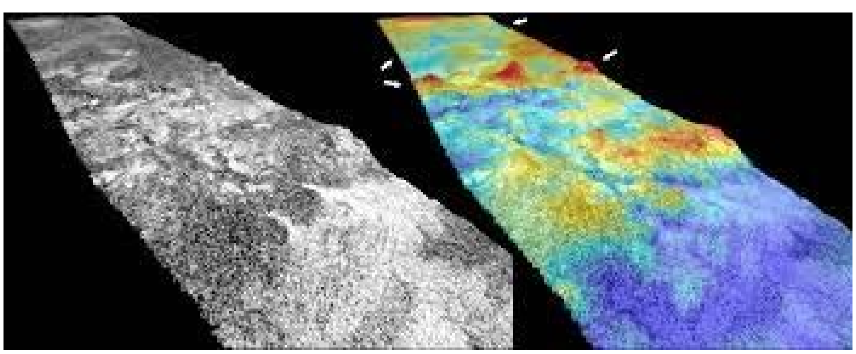
A topography map of Venus. Red and white are the highest elevations, while blue and purple are the lowest elevations. *NASA/Magellan Spacecraft*



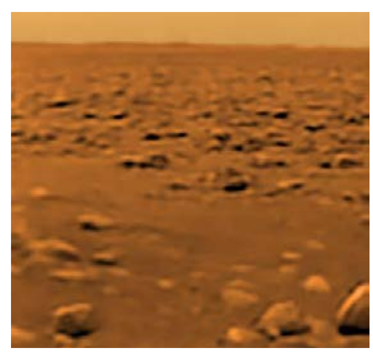
A radar image showing a dune field on Saturn's moon Titan. These look very similar to dune fields in Namibia on Earth. *NASA/Cassini Spacecraft*



A radar image showing Ligeia Mare on Saturn's moon Titan, a sea of liquid methane bigger than Lake Superior on Earth. The surface of the sea is very smooth, and so ut is very dark in radar. *NASA/Cassini Spacecraft*



A DTM and topography map of a region on Saturn's moon Titan. Red is higher elevations and blue is lower elevations. *NASA/Cassini Spacecraft*



An actual, true color (visible light) image taken by the only spacecraft to land on Titan, the Huygens probe. *NASA/Cassini Spacecraft/ Huygens Probe*