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Our Planet from Space: Pedagogical Implications of the DISH Earth Channel

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Abstract

A new camera attached to EchoStar 11, a geostationary communications satellite, recently started sending breathtaking and near real-time images of Earth. Available on one of DISH Network's channels, viewers can see our planet 24/7, including occasional appearances by the Sun, the Moon, Venus, and space debris. These images present an excellent opportunity to teach about the Sun-Earth-Moon system. The purpose of this article is to introduce the DISH Earth channel to science educators, to provide a teacher-tested sample lesson plan using DISH Earth channel videos, and to suggest additional topics that could be explored with this newly available resource.

1. INTRODUCTION

Ever since people first saw images of Earth taken from satellites and early spaceships, including the now famous Earthrise picture taken by the Apollo 8 crew on December 1968 (Figure 1), we have been fascinated by looking at our planet from space (NASA 2009). These days, commercial, government, and weather satellites commonly beam down images of Earth. Of course, K–12 science teachers are taking advantage of these pictures to create multiple teachable moments and explore a variety of earth and space science topics.

Interestingly, it was not until April 2009 that a commercial satellite captured and streamed real-time images of Earth from space onto satellite television. On April 22, 2009 DISH Network first announced the launch of DISH Earth Channel. Their press release, in part, says (DISH Network Corporation 2009):

> [This channel] offers dramatic live views of Earth 24 hours per day, including passing views of the Moon, Venus, and even unidentified flying objects… Six years in the making, the DISH Earth camera offers a 30 degrees by 22.4 degrees field of view that includes fascinating live full-disk views of the planet from a distance of approximately 22,300 miles above Earth. The regular night/day cycle, weather patterns, and seasonal changes in the western hemisphere are clearly visible via the "eyes" of the camera, which observe objects in the visible spectrum, similar to the human eye, with a resolution of about 20 km per pixel.

The camera is installed in the 5.5 ton American communications satellite EchoStar 11, which is owned by the DISH Network. Launched by this company on July 2008 and currently "parked" in a geostationary orbit at

Figure 1. Earth rising over the lunar horizon. This photo was taken by the Apollo 8 crew in December 1968, showing Earth for the first time as it appears from deep space. Source: NASA

110 degrees West at the Equator, it is expected that EchoStar 11 will continue its service until the year 2024. The EchoStar 11 camera has a fixed field of view of $30^\circ \times 22.4^\circ$ and a resolution of about 20 km/pixel. The output pixel resolution is 720×486 pixels (Space Services Inc. 2009).

What makes the DISH Earth channel so special? Unlike images available from other geostationary satellites, such as GOES and Meteosat, the images from EchoStar 11 are real-time, real-color, and are refreshed each 15 s. In addition, the point of view appears to be more distant. This wide perspective allows for an occasional direct observation of other celestial bodies in the background. Several DISH network subscribers have been able to create 1–3 min videos from the images which are available on several websites. These videos show the Sun, the Moon, and sometimes Venus appearing to move behind a still Earth in an eastward motion. Background stars are too faint to be captured by the camera and cannot be seen. Space debris was captured by the camera in August 2008, previous to the official launch of the DISH Earth channel. The finishing minutes of the July 2009 total solar eclipse were also visible to subscribers.

What do the images look like? It depends on the time of the day. When the Sun is facing the section of Earth that EchoStar 11 can see, a clear "big blue marble" picture of the United States, Central and South America, the Caribbean, and a large chunk of the Pacific Ocean appears breathtaking (Figures 2 and 3). Cloud systems are visible, as well. Early in the morning or late at night, lens flare due to sunlight results in decreased contrast. The viewer can distinguish between day and night but cannot discern any geographical details. When the Sun appears to pass behind Earth, depending on the season, either a thin light ring or a c-shaped region of light scattered by the atmosphere can be observed. Viewer created videos show a 24 h cycle in several minutes, looking strikingly similar to a movie.

As physical science teachers, the availability of these images on the internet and on TV sets of more than 30 million DISH Network subscribers presents interesting pedagogical opportunities. At the same time, the images might create new or reinforce old misconceptions among children (Danaia and McKinnon 2007; Hapkiewicz 1999; Hapkiewicz 1992; Hermann and Lewis 2003; Jones et al. 1987; Valanides *et al.* 2000; Wallace *et al.* 2007) and K–12 teachers (Kavanagh *et al.* 2005; Küçüközer 2008; Trumper 2006) about the Earth-Moon-Sun system. The purpose of this article is to inform science teachers about this resource, to suggest a teacher-tried lesson using the images, and to warn about potential misconceptions that might emerge from a casual view of the DISH Earth channel.

Figure 2. Screenshot from a YouTube video showing the Sun illuminating the Earth's side that is facing EchoStar 11

Figure 3. Screenshot from a YouTube video showing North and South America early in the morning, Eastern Time. Diffuse reflection prevents the viewer from observing geographic features

2. A SAMPLE SCIENCE LESSON USING DISH EARTH VIDEOS

A lesson designed to explore the Sun-Earth-Moon system using manipulatives and the DISH Earth channel images available online was created by one of the authors and tested at a professional development workshop for K–12 teachers at the 2009 Kentucky Association of Science Teachers (KSTA) Conference in Lexington, KY (see Appendix).

The lesson started with several questions that explored the participants' prior knowledge of the seasons, the phases of the Moon, and the movements of the Sun, Earth, and Moon. These questions were answered with A–E response cards, a low-technology technique of interactive engagement similar to clickers. After answering a question individually, participants were organized into groups of individuals who had different answers to the question. Their group discussions led to a consensus and, in most cases, those with the incorrect answers recognized the correct one. This process continued for the remainder of the introductory questions.

The second part of the lesson used a Styrofoam ball and a coffee stirrer to represent the Earth and the location of the geostationary satellite. A worksheet guided the participants through the process of hypothesizing what could and could not be seen of Earth and its surroundings from a geostationary satellite during the summer solstice. After the whole group of participants discussed their responses, the instructor showed the DISH Earth channel videos as a way to support or reject their hypotheses.

The third part of the lesson was similar to the second, except that a new worksheet was used and the spring equinox was used as a time frame for the teachers to hypothesize about what could and could not be seen of Earth and its surroundings. More discussion was promoted, followed by new DISH Earth channel images. Participants discussed similarities and differences between the summer solstice and spring equinox videos, supporting or rejecting their hypotheses based on the visual data.

The last section of the lesson asked participants to think about what potential misconceptions the images might create among uninformed viewers. An important reason why some viewers might not get correct knowledge from the images is that they are observed from the viewpoint of a geostationary satellite. Unlike low-Earth orbiters that can observe different views of Earth at different time intervals, EchoStar 11 has a period of revolution that exactly matches Earth's 24 h rotation. Consequently, from Earth, the satellite will appear at the same point in the sky. Conversely, the satellite sees exactly the same side of Earth 24/7.

Echoing the literature on alternate conceptions about the Sun-Earth-Moon system, some of the misconceptions mentioned by science teachers at the KSTA workshop included the following.

The Earth is stationary. The first thing participants noticed about the EchoStar 11 videos is that the Earth appears not to rotate. Furthermore, with no background stars visible for reference, a young viewer will likely also assume that Earth is not moving in space. The problem is further compounded by the apparent daily motion of both the Sun and Moon around Earth!

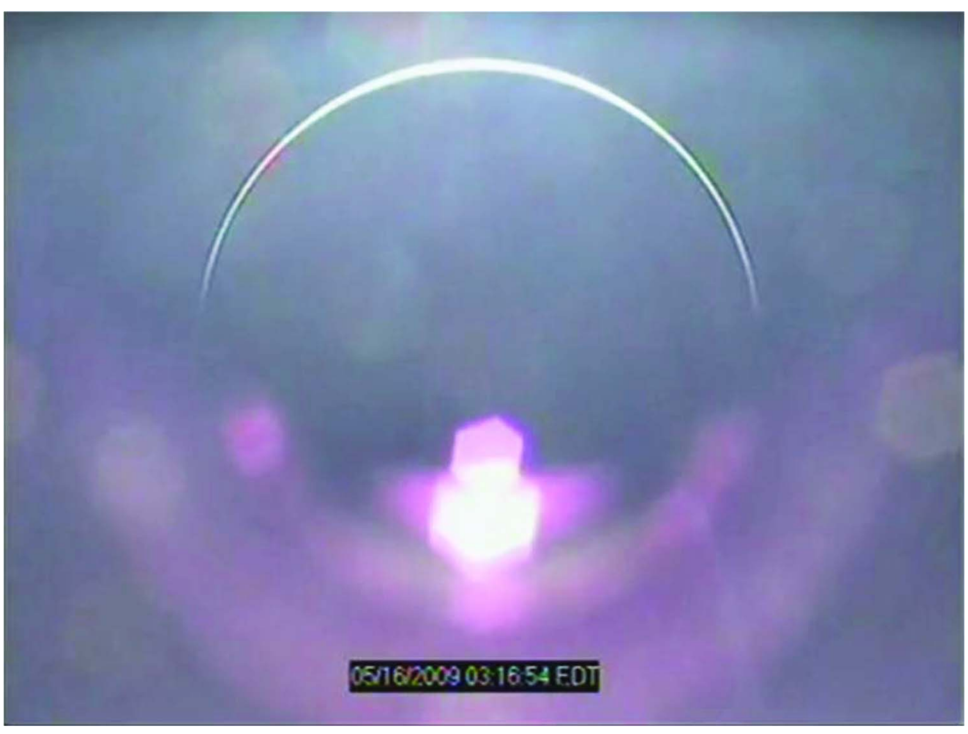


Figure 4. Screenshot from a YouTube video showing Earth at night as seen from EchoStar 11

Day and night result from the Sun's daily motion around Earth. The DISH Earth channel videos showed the Sun appearing to travel around the Earth over the course of a 24 h period. As the Sun passes "behind" the Earth, the side of Earth facing EchoStar11 is plunged into darkness, that is, we experience night (Figure 4). Thus, younger observers may falsely conclude that it is the Sun's daily motion around the Earth that is responsible for the day/night cycle.

The Moon orbits the Earth once each day. The Moon is clearly seen disappearing behind Earth and reappearing during the spring equinox videos. The Moon appeared right below Earth moving west to east on the summer solstice video. Similarly to the Sun, this could also give the false impression that the Moon makes one complete orbit around Earth in single 24-h period.

The phases of the Moon are caused by Earth's shadow. Not only is the Moon visible briefly in both videos, one can even see the correct lunar phase. If the Earth's shadow truly caused Moon phases, viewers should see a full Moon all the time, except during a few hours when the Moon passes inside Earth's shadow. This is clearly not what the images show (Figure 5).

Figure 5. This screenshot shows the Moon as it appears to move behind Earth. Note that the Moon's phase is identical to Earth's as seen from EchoStar 11, providing evidence that their location with respect to the Sun is responsible for phases

The Moon is very small compared with Earth. As the Moon appears on screen, it looks tiny compared with Earth. This might led students to believe that those are really the relative sizes of Moon and Earth. This is an illusion produced by the perspective viewpoint of the two bodies. Earth is closer to EchoStar 11 so it appears bigger.

Seasons are produced by a change in the distance from the Earth to the Sun. Because of the students' everyday experience with heat, many think that the Earth-Sun distance is the cause of the seasons. The DISH Earth videos provide the correct explanation as they show the northern hemisphere receiving more light in the summer solstice video and both hemispheres receiving the same amount of sunlight in the spring equinox video. The infamous direct-indirect sunlight explanation that is commonly used to describe the seasons is unnecessary since the images are so compelling.

This is not a real satellite image: there are no stars visible; just a black, empty background! Readers might recall that this is one of several arguments used by those who insist that the Moon landings were a hoax (Plait 2002). The same reasoning applies here as with the Apollo astronaut photos. The stars are not visible on any DISH Earth channel videos because the long exposure time required to image these celestial bodies would severely overexpose the main subject of observation, Earth.

3. PEDAGOGICAL IMPLICATIONS

It is important to briefly discuss other instructional ideas science teachers can apply using the DISH Earth channel videos or the real-time images from the DISH Earth channel.

Phases of the Earth. Although the cycle of lunar phases is studied as early as elementary school and as late as freshman general education at universities courses, few students are introduced to the idea of Earth's phases. A "daylight rotation on Earth" as recorded by EchoStar 11 shows a cycle of phases of Earth over a 24 h period. Teachers can freeze the video at various Earth "phases" and have students diagram the relative positions of the Sun, Earth, and the artificial satellite. This can be further extended by asking students if the Earth might go through a cycle of phases if viewed from the Moon and, if so, how would the cycle of phases differ from those observed by EchoStar 11. The discussion can be reinforced by showing Apollo images showing various phases of Earth!

Lunar phase and visibility from Earth. Students often assume that the Moon is only visible during the night time hours, regardless of phase. In physical science or astronomy classes, students can be challenged to determine when and where the Moon will be visible during a particular phase. Rather than simply having students determine this from a diagram, the available videos or images from EchoStar 11 can be used over the course of one full month to have students record both the lunar phase and the lunar visibility from Earth. For example, students can note that on the day of full Moon, only night time observers will observe the Moon while on days of waxing crescent, the Moon mostly visible during the daylight hours and only for a few brief hours after sunset.

Variations of Solar and Lunar "elevation" with respect to Earth's equator. Earth's rotational axis is tilted 23.5 degrees with respect to its orbital plane about the Sun. As viewed from the Earth, the solar elevation varies with the time of year. Students can observe the elevation of the Sun with respect to the equator over the course of several months using DISH Earth channel images. A long-term examination of these images will lead students to the conclusion that the solar elevation is higher during the summer and lower during the winter. On the other hand, the Moon's orbital plane about the Earth is tilted by 5.2 degrees relative to the Earth's orbital plane about the Sun. By studying the images over the course of a few months, students can observe how the Moon's position varies relative to Earth's equator: half of the month, the Moon lies above the equator, and on the other half, it lies below the equator.

Ring around the "new Earth." Near the fall and spring equinoxes, when the Sun is behind the Earth, the scattered sunlight from Earth's atmosphere can be seen. Students and teachers alike can see how thin the atmosphere appears relative to the rest of planet.

UFO's: Aliens, Asteroids, or Space Junk? There have already been a couple of observations of unidentified objects passing between EchoStar 11 and Earth. What are these objects? Rather than simply dismissing UFO claims, instructors can use these "transits" as teachable moments. This is an opportunity for teachers and students to develop quantitative ways of examining these objects. In general, if the object moves in a straight line and at a constant speed this might support the space debris hypothesis. If an object shows either an increase or decrease in speed or a change in direction without the presence of an external force, this might support the alien spaceship hypothesis because space debris does not behave this way. Also, this analysis will help teachers transition into a discussion on near Earth orbiters (Miller *et al.* 2008).

4. CONCLUSION

As technologies to examine our planet improve, new opportunities for quality science education will emerge. These opportunities must be cautiously used to avoid creating new misconceptions or reinforcing old ones. Science teachers must keep their science content knowledge updated and devoid of alternate conceptions, while embracing new ways to see the Sun-Earth-Moon system and guiding students in the correct direction. Images such as those available on the DISH Earth channel, if used judiciously, can be a definite asset in the teaching of earth science and astronomy concepts.

5. RESOURCES

1. EchoStar 11 Satellite information, images, and video: http://www.givetheworld.com/aboutEchoStar11.asp.
2. Orbital Debris Graphics from NASA: http://orbitaldebris.jsc.nasa.gov/photogallery/beehives.html#leo.
3. Minor Planet Tracking: http://www.jpl.nasa.gov/multimedia/neo/index.cfm.
4. Asteroid and Comet Impact Hazards: http://impact.arc.nasa.gov/.
5. Apollo 11 Image Gallery: http://history.nasa.gov/ap11ann/kippsphotos/apollo.html/.
6. Moon Phase Image Calculator: http://tycho.usno.navy.mil/vphase.html.
7. Moon Phases: http://www.astrosociety.org/education/publications/tnl/12/12.html/.
8. Solar and Lunar Altitude Calculator: http://aa.usno.navy.mil/data/docs/AltAz.php.
9. Solar Altitude/Elevation Calculator: http://www.srrb.noaa.gov/highlights/sunrise/azel.html.

Appendix: The Sun-Earth-Moon System Using Echostar 11 Geostationary Imagery

Overview: This lesson will challenge preconceived ideas of the Sun-Earth-Moon system using a combination of group work, guided inquiry, and videos of Earth from space available on the Internet.

SCIENCE THEMES

1. *Systems, order, and organization*—The Earth, Sun, and Moon can be considered a structured system that can be examined scientifically. These celestial bodies move in an understandable and orderly pattern.
2. *Evidence, models, and explanations*—The motion of the Earth, Sun, and Moon are explained by their gravitational connection as described by Newton's laws. Evidence of this motion is sometimes confounded by our viewpoint within the system. As a consequence, mental models of the Sun-Earth-Moon system must be examined and challenged using available evidence.
3. *Constancy, change, and measurement*—The Sun-Earth-Moon system demonstrates constancy and long-tem changes in its behavior. Measurements made by scientists can help students discriminate between these behaviors.

NATIONAL SCIENCE EDUCATION STANDARDS (5–12)

1. *Science as Inquiry*: (a) Use appropriate tools and techniques to gather, analyze, and interpret data; (b) develop descriptions, explanations, predictions, and models using evidence; (c) think critically and logically to make the relationship between evidence and explanation; (d) recognize and analyze alternative explanations and predictions.
2. *Physical Science*: (a) Motion and forces.
3. *Earth and Space Science*: (a) Earth in the Solar System.

KENTUCKY PROGRAM OF STUDIES (4–12)

Academic expectations: (a) Students understand scientific ways of thinking and working and use those methods to solve real life problems; (b) students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict possible future events.

1. *Grade 4 understandings*—(a) An object's motion can be described as its change in position over time and can be represented in a variety of ways; (b) things vary greatly in their motion. Some things move so fast they cannot be seen, while others are so slow that we cannot see that they are moving at all. Technology enables people to observe these fast or slow movements; (c) a variety of models of the Sun, Earth, Moon system are needed to explain the observed patterns of their relative motions, since people are not able to see from the outside how this system is constructed.
2. *Grade 4 skills and concepts*—(a) Use tools and resources, such as stopwatches, sonic rangers, microscopes, computer simulations/animations, and video clips to observe motions that are hard to see or quantify and compare the usefulness/limitations of such tools; (b) explore, design and evaluate a number of models of Earth-Sun and Earth-Sun-Moon systems for benefits, limitations, and accuracy (e.g., scale, proportional relationships).
3. *Grade 6 understandings*—(a) regular and predictable movements of the Sun, Moon, and Earth are responsible for many observed phenomena on Earth, (e.g., day/night, year, Moon phases, eclipses). The regular patterns of these phenomena can be predicted using data or models.

4. *Grade 6 skills and concepts*—(a) investigate, create, and identify the limitations of models, which can be used to substantiate and predict the actual results (e.g., Moon phases, seasons, eclipses) of the interactions of the Sun, Moon, and Earth.
5. *Grades 9–12 understandings*—(a) all motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion; (b) scientists rely on increasingly sophisticated methods of measurement in order to investigate a variety of phenomena that were previously immeasurable.
6. *Grades 9–12 skills and concepts*—(a) create conceptual and mathematical models of motion and test them against real-life phenomena; (b) explain how technological solutions permit the study of phenomena too faint, small, distant, or slow to be directly measured.

KENTUCKY CORE CONTENT FOR ASSESSMENT (4–12)

Elementary grades: SC-EP-1.2.2; SC-EP-2.3.3; SC-04–2.3.4; SC-EP-2.3.4; SC-04–2.3.5.
Middle and high school grades: SC-06–2.3.1; SC-HS-1.2.1.

BASIC SCIENCE PROCESS SKILLS

1. *Observing*—Students will observe (in a video) how the Earth, Moon, and Sun look from a geostationary satellite during one or two times of the year.
2. *Inferring*—Students will use their video observations to create inferences that will confirm or disconfirm their prior knowledge and assumptions about how the Earth, Moon, and Sun look from a point in space.
3. *Predicting*—Students will predict how the Earth looks like from a geostationary satellite daily and during the solstices and equinoxes. Students will predict how the Moon looks like over the course of one month and its possible location with respect to Earth's equator over the course of a year. Students will predict how the Sun looks like daily and during the solstices and equinoxes.
4. *Formulating hypothesis*—Early in the lesson, participants will formulate hypothesis about the apparent motions of the Earth, Sun, and Moon as seen from a geostationary satellite.
5. *Identifying variables*—Students will identify seasonal variables as possible explanations for the motions of the Earth, Moon, and Sun.

OBJECTIVES

After completing the lesson, students will be able to:

1. Describe the Earth, the Moon, and the Sun as seen by a geostationary satellite.
2. Compare and contrast their prior knowledge of the Sun-Earth-Moon system with the information presented during the lesson.
3. Justify the apparent motions of the Earth, Moon, and Sun based on their plane of motion.

MATERIALS

1. Spheres to represent the Sun, Earth, and Moon.
2. Thin wood rod (kabob stick) to represent satellite viewpoint.
3. Worksheets.
4. Multiple choice response sheet-colored paper (A, B, C, D, E, and ?).
5. Videos from the EchoStar 11 satellite.

PROCEDURE

1. After providing participants with a response sheet, the participants (first individually and, if needed, in pairs) will answer questions about the apparent and real motions of Earth, Moon, and Sun, the phases of the Moon, and the seasons. These questions will be:

(i) Which of the following is <u>incorrect</u>?
  A. Earth rotates on its axis once every 24 h.
  B. The Moon does not rotate on its axis.
  C. Earth revolves around the Sun once every year.
  D. The Moon rotates around the Sun once every year.

(ii) What causes the Sun to appear to rise in the East-ish direction and set in the West-ish direction?
A. The Sun revolves around Earth.
B. The Earth rotates on its axis.
C. The Earth revolves around the Sun.
D. The Sun rotates on its axis.

(iii) What causes the Moon to rise in the East-ish direction and set in the West-ish direction?
A. The Moon revolves around Earth.
B. The Earth rotates on its axis.
C. The Earth revolves around the Moon.
D. The Moon revolves around the Sun.

(iv) What causes the phases of the Moon?
A. The position of the Moon and Sun as seen from Earth.
B. Clouds blocking part of the Moon.
C. The shadow of the Earth.
D. The Moon's rotation.

(v) What causes the seasons?
A. How close or far is the Earth from the Sun.
B. Periodic global warming and cooling on Earth.
C. The blocking of sunlight by the Moon.
D. Whether the Earth's rotation axis points toward or away from the Sun.

(vi) What is a geostationary satellite?
A. A satellite that revolves around Earth once every day.
B. A satellite that revolves around Earth once every 12 h.
C. A satellite that rotates on its axis as it revolves around Earth once every day.
D. A satellite that is stationary is space as the Earth rotates.

2. Participants will be divided in groups of 3–4. With the assistance of the guiding questions on "worksheet 1" they will have to predict how the Sun-Earth-Moon system looks from a geostationary satellite near the summer solstice.
3. Participants will compare and contrast their answers in a teacher-guided discussion.
4. Participants will observe a video of Earth recorded by a geostationary satellite near the summer solstice. Based on the video, participants will discuss and revise their answers. The teacher will explain concepts that might still be unclear.
5. Participants will be divided in groups of 3–4 again. With the assistance of the guiding questions on "worksheet 2" they will have to predict how the Sun-Earth-Moon system looks from a geostationary satellite near the spring equinox.
6. Participants will observe a video of Earth recorded by a geostationary satellite near the spring equinox.
7. Based on the video, participants will discuss and revise their answers.
8. Participants will discuss and record on "worksheet 3" possible misconceptions that might arise from using Earth images recorded from a geostationary satellite. Some misconceptions that participants might describe include (a) the Earth is stationary, (b) day and night result from the Sun's daily motion around Earth, (c) the Moon orbits the Earth once each day, (d) the phases of the Moon are caused by Earth's shadow, (e) the Moon is very small compared with Earth, (f) seasons are produced by a change in the distance from the Earth to the Sun, (g) there are many stars in our solar system, and (h) this is not a real satellite image: there are no stars visible, just a black, empty background!
9. Participants will watch two more short videos of Earth from space, one about a solar eclipse and one about an unknown flying object.
10. To close the lesson, participant will watch a video of the sky from Earth. In small groups, they will apply the knowledge acquired in the workshop to compare, contrast, and explain what they observed.

RESOURCES

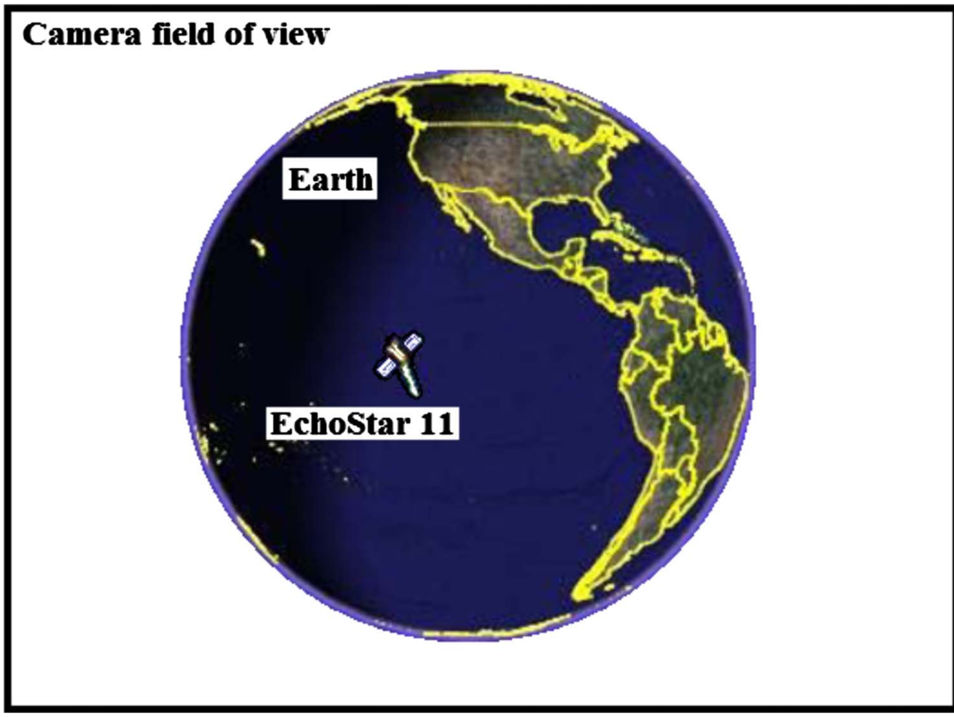
1. EchoStar 11 website with videos: http://www.givetheworld.com/aboutEchoStar11.asp.

2. EchoStar 11 video–Spring Equinox: http://www.youtube.com/watch?v=hDvaU-GyIYE.

3. EchoStar 11 video–Summer Solstice: http://www.youtube.com/watch?v=H-REzr7HB9E.

EARTH FROM SPACE – EXPLORATION 1: NEAR SUMMER SOLSTICE

It is mid-May. A geostationary satellite sends a video of Earth as seen from space over a 24 h period. The diagram below shows the video's field of view and Earth's position.



Before you observe the video, predict what you should see by selecting with a check mark (✓) the box closest to your group's consensus answer.

EARTH	YES				??				NO
1. Will you see the Earth rotating on its axis?	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. When it is "day," will you see the surface of Earth?	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Will you see background stars at all?	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Will you see planets other than Earth?	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Will the Northern Hemisphere get more sunlight?	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Will clouds appear to be gray?	☐	☐	☐	☐	☐	☐	☐	☐	☐

MOON (SUPPOSE THE MOON IS VISIBLE IN THE VIDEO)

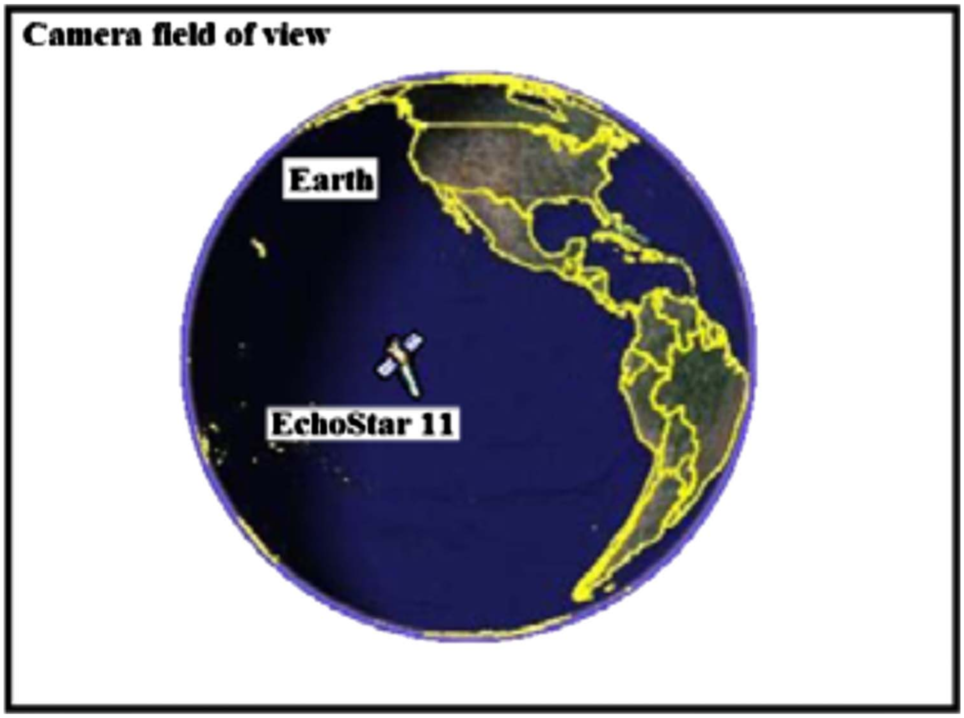
___1. Will you see the Moon for (a) an instant, (b) a short period of time, or (c) a long period of time?
___2. Will you see (a) one phase of the Moon, (b) several phases, or (c) none?
___3. Compared with Earth's size, will the size of the Moon be (a) a point of light, (b) a small object, or (c) a medium-sized object.
___4. Which direction do you predict the Moon will appear to move? (a) W→E, (b) E→W, (c) N→S, or (d) S→N?
___5. Will you see the Moon (a) in front of Earth, (b) behind Earth, (c) above Earth, or (d) below Earth?

SUN

___1. Will you see the Sun, yes or no?
___2. Will you see any sunlight?

EARTH FROM SPACE – EXPLORATION 2: NEAR SPRING EQUINOX

It is mid-March. A geostationary satellite sends a video of Earth as seen from space over a 24-h period. The diagram below shows the video's field of view and Earth's position.



Before you observe the video, predict what you should see by selecting with a check mark (✓) the box closest to your group's consensus answer.

EARTH	YES				??				NO
1. Will you see the Earth rotating on its axis?	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. When it is "day," will you see the surface of Earth?	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Will you see background stars at all?	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Will you see planets other than Earth?	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Will the Northern Hemisphere get more sunlight?	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Will clouds appear to be gray?	☐	☐	☐	☐	☐	☐	☐	☐	☐

MOON (SUPPOSE THE MOON IS VISIBLE IN THE VIDEO)

___1. Will you see the Moon for (a) an instant, (b) a short period of time, or (c) a long period of time?
___2. Will you see (a) one phase of the Moon, (b) several phases, or (c) none?
___3. Compared with Earth's size, will the size of the Moon be (a) a point of light, (b) a small object, or (c) a medium-sized object.
___4. Which direction do you predict the Moon will appear to move? (a) W→E, (b) E→W, (c) N→S, or (d) S→N?
___5. Will you see the Moon (a) in front of Earth, (b) behind Earth, (c) above Earth, or (d) below Earth?

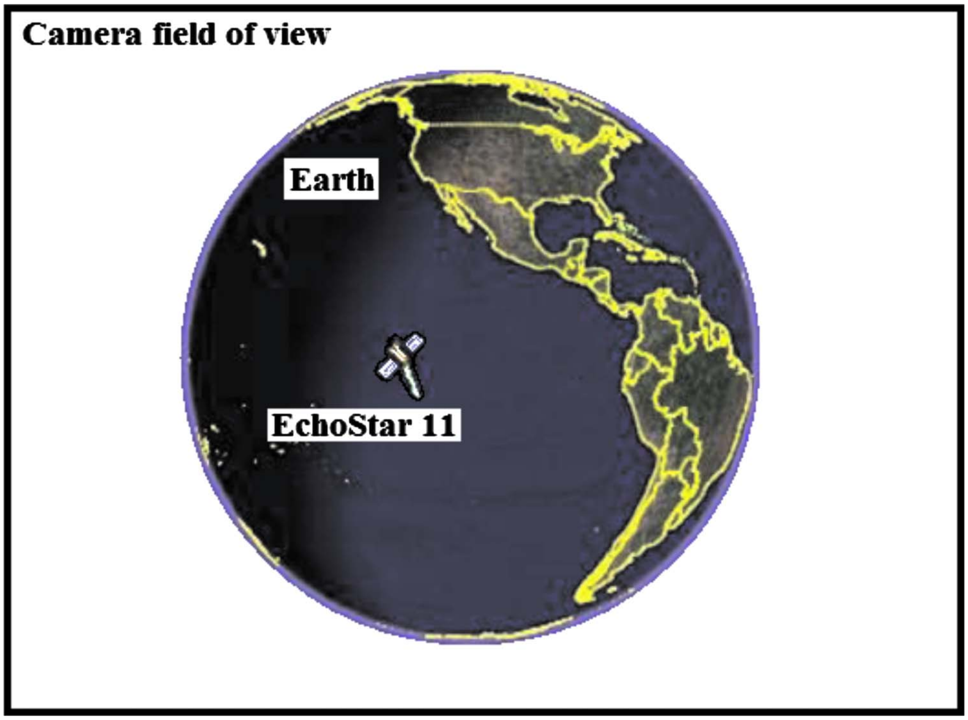
SUN (SUPPOSE THE SUN IS VISIBLE IN THE VIDEO)

___1. Will you see the Sun for (a) an instant, (b) a short period of time, or (c) a long period of time?
___2. Will you see (a) one phase of the Sun, (b) several phases, or (c) none?
___3. Compared with Earth's size, will the size of the Sun be (a) a point of light, (b) a small object, or (c) a medium-sized object.

___4. Will the Sun appear to move (a) W→E, (b) E→W, (c) N→S, or (d) S→N?
___5. Will you see the Sun (a) in front of Earth, (b) behind Earth, (c) above Earth, or (d) below Earth?

EARTH FROM SPACE – EXPLORATION 3: POSSIBLE MISCONCEPTIONS

A geostationary satellite sends a video of Earth as seen from space over a 24-h period. The diagram below shows the video's field of view and Earth's position.



Because of the satellite's viewpoint, the apparent motions of the Sun, Earth, and Moon are not consistent with their real astronomical motion.

What misconceptions about Earth might this video promote?

What misconceptions about the Moon might this video promote?

What misconceptions about the Sun might this video promote?

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