



EARTH SYSTEMS SCIENCE

This lesson is taken from an education module developed for Challenger Center's *Journey through the Universe* program. *Journey through the Universe* takes entire communities to the space frontier.

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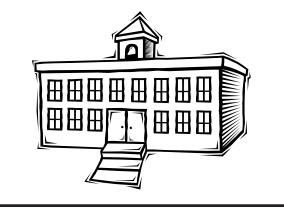
Funded by grants from NASA's Minority University Research and Education Division and Offices of Space Flight, Space Science, and Earth Science



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January 2002

Grade Level
K-4



Lesson 1: The Water Planet

Lesson Summary

In this lesson, students use NASA photographs and hands-on activities to compare the amounts of land and water on our planet. They discover that the world has five oceans, and that they cover 70 percent of Earth's surface. Students learn how this affects the entire Earth system.

Lesson Duration

Two 45-minute classes



ESSENTIAL QUESTION
Why is the Earth described as the "blue planet?"



OBJECTIVES

Students will be able to:

- ▶ Compare the amount of water to the amount of land on our planet.



CORE K-4 STANDARDS

NRC Standards

- STANDARD D1:** Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply.
- STANDARD F3:** Some resources are basic materials, such as air, water, and soil; some are produced from basic resources, such as food, fuel, and building materials; and some resources are nonmaterial, such as quiet places, beauty, security, and safety.

Science Overview

People take vacations all over the world to experience different landscapes, climates, and cultures. If you were to explore a section of land the size of the state of Delaware (5,294 km²) every day, it would take you 65 years to see every kilometer of land on Earth. There is a lot of land to explore! Have you ever thought about taking a vacation to the middle of the ocean? Just to see the oceans' surfaces, you would have to explore about two and a half times faster than you explored the land to fit it all in! Even though most of our vacations are to places on land, the Earth is covered mostly in water. In fact, about 70% of the surface of the Earth is water; over 362 million square kilometers.

Earth is truly a water planet. It is the only body in our Solar System with the unique feature of oceans. In order for liquid water to exist, certain temperature requirements must be met. If the area is too hot, water will evaporate and become steam. If a region is too cold, the water will freeze into ice. Earth is situated within the Solar System at just the right distance from the Sun for liquid water to exist on its surface.

Most of the Earth's water (97.24 %) is found in Earth's five oceans. Icecaps and glaciers hold 2.14% of the water, with the remaining 0.62% consisting of ground water, freshwater lakes, inland seas, soil moisture, water vapor, and rivers (in descending order). Of these resources, the only types immediately useable for human consumption are ground water, freshwater lakes, and rivers: 0.3% of the Earth's water.

Water Resource Water volume (km³) Percent of total water

Oceans	1,320,000,000	97.24%
Icecaps, Glaciers	29,000,000	2.14%
Ground water	8,000,000	0.61%
Freshwater lakes	125,000	0.009%
Inland seas	104,000	0.008%
Soil moisture	67,000	0.005%
Atmosphere	13,000	0.001%
Rivers	1,000	0.0001%

The Hydrologic Cycle

A pan of water on a window sill will evaporate. Water molecules jump around in the liquid and eventually some of the ones at the surface will pop out, if they have enough thermal energy. If provided plenty of thermal energy and fresh dry air, eventually all the water will be gone. So why do the oceans not dry up? They must be replenished somehow, and in fact, they are replenished by rain water. The rain water comes from ocean water that has evaporated and formed clouds. The hydrologic cycle on Earth, the exchange of water in every form between the Earth's systems, is part of what makes Earth so unique.

The Earth is made up of four interdependent systems: hydrosphere (water), atmosphere (air), geosphere (land), and biosphere (life). The hydrologic cycle is an example of how these four systems interact and depend on one another. It begins with the Sun and wind (atmosphere) evaporating water from the oceans (hydrosphere). The water vapor may cool and mix with air to become clouds. Clouds create precipitation, 77% of which falls directly back over the oceans. Rain water that falls on land (geosphere) flows into rivers which empty into the oceans. This cycle has been occurring for billions of years.

The biosphere on Earth could not have evolved as it has without the hydrologic cycle acting as it does. The hydrosphere is home to 95% of the life on Earth, and the remaining 5% rely on it for nourishment. Since over 97% of the Earth's water is in the oceans, this is what we focus on in this lesson.

The Earth's Oceans

In reality, Earth has only one ocean that is divided into five regions by continents and human definitions. The oceans flow into one another continuously. The borders between them are fictitious, similar to divisions of countries on the land. The placements and relations of the oceans and continents have been changing slowly ever since Earth was very young, and will continue to change in the future. As the surface of the Earth crumples and stretches, the divisions, locations, and shapes of the oceans, seas, and continents will be modified as well.

The Pacific Ocean is located between Asia, Australia, North America, and South America. The largest of the five oceans, it covers about 28% of the global surface. The Pacific is the deepest

ocean (with an average depth of 4,188 meters), and with such a vast volume, it is easy to imagine the number of living creatures who call it home. It harbors many endangered marine species, and in 1996, provided over 60% of the world's fish catch.

Between Africa, Europe, and North and South America lies the Atlantic Ocean. It is second in size to the Pacific, but has less than half its area, and its deepest point lies almost 2,400 meters above the deepest point in the Pacific. The most noticeable feature of this ocean is the ridge that runs its entire length from north to south. Most of this Mid-Atlantic ridge lies below sea level, but protrudes above the surface at Iceland, the Azores, Ascension Island, and Tristan de Cunha.

Not much smaller than the Atlantic Ocean is the Indian Ocean, located between Asia, Australia, and Africa. The Middle East, Africa, and East Asia are connected with Europe and the Americas via shipping routes in this ocean. These access waterways include the Suez Canal in Egypt and the Strait of Malacca between Indonesia and Malaysia. Approximately 40% of the world's offshore oil production is from the Indian Ocean.

The Arctic Ocean lies between Europe, Asia, and North America, mostly north of the Arctic Circle. Although the smallest of the oceans, it is almost one and a half times the area of the United States. The Arctic has harshly cold winters with continuous night, and damp and foggy summers with continuous daylight. The winters make it almost impossible to use the waterways for shipping, and even in the summer there is not much travel by air, ocean, or land.

The decision to define a fifth ocean was made in the spring of 2000 by the International Hydrographic Organization. The Southern Ocean extends from the coast of Antarctica north to the 60° south latitude, including the southern parts of the Pacific, Atlantic, and Indian Oceans. It is the fourth largest of the world's five oceans, bigger than the Arctic Ocean. Sea temperatures range from -2° C to 10° C. Winds here are on average the strongest of any on Earth. Despite its harsh environment, the Southern Ocean is home to many sea creatures such as squid, whales, and seals.

The Continents

Earth's oceans are delineated by large land masses; these are the seven continents. Like the oceans, the continents have changed shape and location over geologic time scales. The continents of today are broken up from one continent that existed over 225 million years ago. The modern continents encompass many bodies of water including seas, lakes, ponds, streams, and rivers.

The largest continent in both size and population is Asia. This continent is home to about three-fifths of the world's people (3.7 billion), and covers almost one-third of the total land area on Earth (43.7 million km²). Its borders include the Pacific Ocean in the east, and Europe and Africa in the west. Both the highest point (Mount Everest) and the lowest point (Marianas Trench) on Earth are in Asia. It holds some of the world's longest rivers, including the Yangtze River which winds through China for almost 6,400 kilometers.

Africa is second to Asia in both size and population. Its 30 million square kilometers is an immense plateau, and includes terrain of many extremes. The largest desert in the world, the Sahara, is nearly the size of the entire United States. Africa also encompasses the Nile River, the world's longest river, flowing through the northern part of the continent for 6,670 kilometers.

North America covers 24 million square kilometers, making it the third largest continent, but fourth in population, after Asia, Africa, and Europe. This continent is bordered almost completely by water, with the Arctic, Atlantic, and Pacific Oceans bordering its three sides. A narrow strip of land (Central America) connects it to South America. The five Great Lakes exist in the middle of the continent, holding one-fifth of the world's fresh surface water (95% of the United States supply).

The fourth largest continent in area, 17.6 million square kilometers, and fifth in population, is South America, which, like North America, is almost completely surrounded by water. The Pacific and Atlantic Oceans border much of South America, and the Drake Passage separates it from Antarctica in the south. The world's largest tropical rain forest exists in the basin of the Amazon River, the second longest river on Earth at 6,447 kilometers.

Bordered by the Southern Ocean, Antarctica would be last on the list of continent sizes if it were not for its icecap. The cap, which averages 2,164 meters thick, makes this southern-most continent fifth in size with 14 million square kilometers. The cold climate makes it nearly impossible for water to exist there in liquid form. Ice and snow cover 98% of the continent.

One-eighth of the Earth's population lives in Europe, making it third in population, but sixth in area (10 million square kilometers). Europe is part of the same land mass as Asia, which is why they are sometimes referred to collectively as Eurasia. The world's largest lake, or land-locked body of water, is the Caspian Sea at 371,000 square kilometers, and is one feature that separates Europe from Asia.

The smallest continent by area and sixth in population is Australia, the only country that includes a whole continent. Australia lies between the Indian and Pacific Oceans, and covers an area of 8 million square kilometers.

Lesson Plan

Warm-Up

Discuss with students the different types of Earth materials. Earth materials are solid rocks and soils, water, and the gases of the atmosphere. Have students bring from home different items that represent different types of Earth materials. Make a list of all the examples and tally the number of each Earth material.

Pre-assessment

Ask students the following questions based on their examples from the warm-up:

- ▶ Do you think our examples accurately represent the entire Earth?
- ▶ Do you think there is more land or water on Earth? How could we tell?
- ▶ Can we see the atmosphere? How?



TEACHER MATERIALS

Activity 1:

- ▶ Overhead Projector
- ▶ Color transparency of Figures 1-2

Activity 2:

- ▶ Globe removed from its frame or an Inflatable globe
- ▶ Grade-appropriate Globe Toss Game Tally Sheet
- ▶ plastic wrap
- ▶ marker

STUDENT MATERIALS

Activity 1:

- ▶ Student Worksheet 1
- ▶ Blue and brown crayons (one set per pair of students)

Activity 2:

- ▶ Student Worksheet 2
- ▶ 1 Post-it Note per student
- ▶ Blue and brown crayons (one set per pair of students)

ACTIVITY 1: Blue Planet

Preparation & Management

Make color transparencies of Figures 1 and 2.

Procedures

1. Read the following description to the class:
“Suddenly from behind the rim of the Moon . . . there emerges a sparkling blue and white jewel, a light, delicate blue sphere laced with slowly swirling veils of white, rising like a small pearl in a thick sea of black mystery. It takes more than a moment to fully realize this is Earth . . . home.”
2. Ask students to try to identify who might have described Earth in these words. (*Answer: They are the comments of astronaut Edgar Mitchell, who saw Earth from the Moon in 1971.*)
3. Show students Figure 1 and ask the following questions.
 - ▶ What is Astronaut Mitchell seeing that is a “delicate blue?” (*Answer: Earth’s oceans*)
 - ▶ What are the “swirling veils of white?” (*Answer: Cloud cover*)
 - ▶ What is the “thick sea of black mystery?” (*Answer: Space appears black because it cannot reflect any light from the Sun.*)
 - ▶ Why can’t we see the lower half of the Earth from space? (*Answer: It is the nighttime side of Earth.*)
4. Have the students use a globe to identify the five oceans (*Answer: Atlantic, Pacific, Indian, Arctic, and Southern*). Discuss where they are located in relation to the continents.
5. Show the transparency of Figure 2 and ask students to identify the oceans they can see in each photograph.
6. Have students look at Figure 1 again and ask how many have heard Earth called the “blue planet?” Why is Earth sometimes called this? (*Answer: From space, Earth looks blue because so much of its surface is water. Oceans cover about two-thirds, or most, of Earth’s surface, and more is covered by large seas and lakes.*)

7. Compare the amount of land and water visible in each image. Note the Arctic and Antarctic icecaps. Explain that they contain so much ice that if they were to melt, the level of the oceans would rise and flood the present coastlines.
8. Using blue and brown crayons, have students draw a picture of Earth on Student Worksheet 1 as Mitchell saw it.

TEACHING TIP

- Explain that Figure 2 was created from many different images. Clouds are always present in the atmosphere, and it would be impossible to get one photograph that showed no clouds.

Reflection & Discussion

Discuss with students why it is helpful to look at the entire Earth in one picture. Have students share their pictures with the rest of the class and ask them the following questions:

- What Earth materials did you represent in your picture?
(Answer: Earth materials include rocks and soil, water, and gasses in the atmosphere.)
- Which Earth material is not always seen? How did you represent this in your picture? (Answer: Gases of the atmosphere are not always seen. They can be represented by clouds.)
- How do we use these Earth materials? (Answers will vary.)

Transfer of Knowledge

How do other planets compare to the Earth?

- Show students images of other planets from NASA's photojournal website: <http://www.photojournal.jpl.nasa.gov>
- Have students choose a planet and imagine that they are explorers that are going to visit that planet for the first time.
- Have students come up with a nickname for their planet like "blue planet."
- Let students use their creativity to write a description of their planet as if they are the first person to see the planet. Students should compare their planet to Earth. (See Student Worksheet 1.)



ACTIVITY 1: Blue Planet

ASSESSMENT

4 Points

- ▶ Student develops an accurate nickname for their planet.
- ▶ Student accurately describes the physical characteristics of their planet based on the images provided.
- ▶ Student compares their planet to the Earth.
- ▶ Student presents information in logical, interesting sequence which audience can follow.

3 Points

- ▶ Student completes 3 of the 4 above criteria.

2 Points

- ▶ Student completes 2 of the 4 above criteria.

1 Point

- ▶ Student completes 1 of the 4 above criteria.

0 Points

- ▶ No work is completed.

Placing the Activity Within the Lesson

Discuss with students that, by looking at the different pictures, we see that the Earth is made up of different types of materials. Show the students Figure 1 again. As a class, brainstorm ways you could determine whether there is more land or water on Earth. How would you determine the amount of cloud cover?

ACTIVITY 2: Globe Toss

Preparation & Management

- ▶ Obtain an inflatable globe or a regular globe taken out of its frame.
- ▶ Cover the globe with plastic wrap to represent the atmosphere, draw clouds over roughly half of the globe.

TEACHING TIP

- ▶ *Ideally, use an inflatable globe that also shows clouds in the atmosphere.*

Procedures

1. Have students sit or stand in a circle.
2. Ask students, what does the plastic wrap covering the globe represent? (*Answer: the plastic wrap represents the atmosphere.*) If students need a hint, draw their attention to the clouds.
2. Explain the following directions for the globe toss game to the students:

The globe is tossed or rolled to a student across the circle. The student receiving the globe will look at his/her right thumb to see where it has landed: on water or land. In addition, students should note if that location is covered by the atmosphere. (*Note: the atmosphere covers the entire Earth, just like the plastic wrap, even where clouds are not present.*) Students should give the information to the tally person.
3. Ask students to predict whether the final tally of the game will have more points for the land or water. (*For older students, have them calculate percentages and compare to actual percentages of land and water.*)
4. The student tallying the results will record the thumb landings on water, land, and atmosphere on the grade appropriate tally sheet.

5. For a more visual comparison of land and water, make a bar graph of the tally sheet as a class. Give each student a post-it note. Have them label it water or land, depending on where their thumb landed during the globe toss game. Create the skeleton of the graph on the board. Ask students to put their post it notes in the correct column on the graph.

TEACHING TIP

- ▶ *For K–2 students, have them hand you the post-it note and you can place it on the graph in the correct column.*
6. Have students complete Student Worksheet 2.

TEACHING TIP

- ▶ *For K–2 students, the bottom section of the Log may be eliminated.*

Reflection & Discussion

Ask students, what covers most of the surface of the Earth. (*Answer: water cover two-thirds or most of the surface*) Ask students what covers the rest of Earth's surface. (*Answer: land covers one-third or the rest of the surface*) Ask students where the atmosphere is. (*Answer: it is everywhere, it can be seen as clouds*)

Transfer of Knowledge

Have students complete Student Worksheet 2 after the Globe-Toss game.

**ACTIVITY 2: Globe Toss****ASSESSMENT***4 Points*

- Students accurately completed a bar graph for the tally sheet.
- Students accurately and completely answered all questions on Student Worksheet 2.

3 Points

- Students accurately completed a bar graph for the tally sheet.
- Students accurately and completely answered most questions on Student Worksheet 2.

2 Points

- Students attempted to complete a bar graph for the tally sheet.
- Students accurately and completely answered some questions on Student Worksheet 2.

1 Point

- Students attempted to complete a bar graph for the tally sheet.
- Students accurately and completely answered a few questions on Student Worksheet 2.

0 Points

- No work completed.

Placing the Activity Within the Lesson

Have students go back and look at the pictures they drew of the Earth. After graphing the amount of water versus land on Earth have students evaluate whether their drawings were accurate. Would they make any changes? Why or why not? (*Answer: Students should determine if they have too much or too little water. Students should also note if they represented the atmosphere with clouds.*)

Lesson Closure

Earth materials are solid rocks and soils, water, and the gases of the atmosphere. In the warm-up, students brought in different items that represent different types of Earth materials and hypothesized whether their examples accurately represented the percentage of Earth materials. Have students go back and look at the percentages from the warm-up and determine how much of each material would be needed to represent that one-third of Earth's surface is covered with land and about two-thirds (or most) with water.

Supplemental Resources

Figure 1 online version

<http://images.jsc.nasa.gov/images/pao/AS8/10074963.jpg>

Figure 2 online version

<http://www.fourmilab.ch/cgi-bin/uncgi/Earth>

How much water is there on (and in) the Earth?

<http://ga.water.usgs.gov/edu/earthhowmuch.html>

How Stuff Works

<http://www.howstuffworks.com/question157.htm>

NASA Photojournal

<http://www.photojournal.jpl.nasa.gov>

Water Science for Schools

<http://www.ga.usgs.gov/edu/mearth.html>

Student Worksheet 2 Answer Key

1. Earth has much more water than land.
2. Rain from the clouds in the atmosphere.
3. Oceans: Atlantic, Pacific, Indian, Arctic, and Southern
4. Continents: Africa, Antarctica, Asia, Australia, Europe, North America, South America



GLOBE TOSS GAME TALLY SHEET K-2



	Water	Land	Is the atmosphere over this spot?
Toss 1			
Toss 2			
Toss 3			
Toss 4			
Toss 5			
Toss 6			
Toss 7			
Toss 8			
Toss 9			
Toss 10			
Toss 11			
Toss 12			
Toss 13			
Toss 14			
Toss 15			
Toss 16			
Toss 17			
Toss 18			
Toss 19			
Toss 20			
Total			



GLOBE TOSS GAME TALLY SHEET 3-4



	Water	Is the Atmosphere over this spot? Yes or No		Land	Is the Atmosphere over this spot? Yes or No
Atlantic Ocean			Africa		
Arctic Ocean			Antarcica		
Indian Ocean			Asia		
Pacific Ocean			Australia		
Southern Ocean			Europe		
Other			North America		
			South America		
Total			Total		



STUDENT WORKSHEET 1 - BLUE PLANET



Name _____ Date _____

Draw a picture of the Earth as Astronaut Edgar Mitchal saw it.

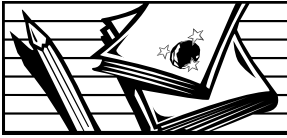
How do other planets compare to the Earth?

Choose a planet from the pictures your teacher shows you.

Imagine that you are an explorer going to visit that planet for the first time!

Planet Name: _____ Nickname your Planet: _____

Write a description of your planet as if you are the first person to see it.



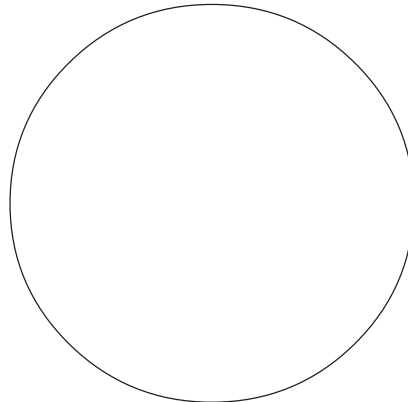
STUDENT WORKSHEET 2 - GLOBE TOSS GAME



Name _____ Date _____

1. What did the plastic wrap surrounding the globe represent? _____
2. Water is removed from the oceans by living things and evaporation, how is it replenished?

3. If all the land was moved together, to the top of the globe, how much of Earth's surface would be covered by water? Your job now is to color with your blue crayon how much of Earth is covered by water.



4. Write the names of the oceans and continents on the lines below. Your teacher will help you.

Water

Oceans

1. _____
2. _____
3. _____
4. _____
5. _____

Land

Continents

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____



FIGURE 1 - BLUE PLANET



Figure 1: Earthrise

Source: <http://images.jsc.nasa.gov/images/pao/AS8/10074963.jpg>



FIGURE 2 - BLUE PLANET



Figure 2: Earth without shadows or clouds

Source: <http://www.fourmilab.ch/cgi-bin/uncgi/Earth>

Challenger Center Programs



The internationally acclaimed **Challenger Learning Center** Network currently consists of state-of-the-art, innovative educational simulators located at 49 sites across 29 states, Canada, and the United Kingdom. Staffed by master teachers, the core of each Center is a two-room simulator consisting of a space station, complete with communications, medical, life, and computer science equipment, and a mission control room patterned after NASA's Johnson Space Center. See www.challenger.org for information.

A joint initiative of Challenger Center for Space Science Education, the Smithsonian Institution, and NASA, *Voyage — A Journey through our Solar System* is a space science exhibition project that includes permanent placement of a scale model solar system on the National Mall in Washington, DC, and at locations all over the world. See www.voyageonline.org for information.



Space DaySM launches new *Design Challenges* created by Challenger Center each school year. The inquiry-based challenges are designed to inspire students in grades 4-8 to create innovative solutions that could aid future exploration of our solar system. See www.spaceday.org for information.

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The **MESSENGER** spacecraft (MErcury Surface, Space ENvironment, GEOchemistry and Ranging) is to be launched in 2004 and go into Mercurian orbit in 2009. Challenger Center is one of the partner organizations charged with MESSENGER education and public outreach activities. See www.messenger.jhuapl.edu for information.

Through the Challenger Center **Speakers Bureau, Voyages Across the Universe**, staff members speak to student audiences of 30-1,000, conduct workshops for 100-300 educators, give keynote and featured presentations at conferences, as well as conduct Family Science Nights at the National Air and Space Museum, and other facilities across the nation, for audiences of 300-1,000 parents, students, and teachers. See www.challenger.org/speakers for information.

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