National Aeronautics and Space Administration

NASA eClips™
Educator Guide

NASA LAUNCHPAD:
Biomes

Educational Product	
Educators & Students	Grades 9-12

EG-2010-07-012-LaRC

www.nasa.gov

NASA LAUNCHPAD

Grade Level:
9-12

Subjects:
Biology, Oceanography

Teacher Preparation Time:
30 minutes

Lesson Duration:
two 55 minute class periods

Time Management:
Class time can be reduced to one period if students complete parts of the lesson at home.

National Standards:

National Science Education Standards (NSES)

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Life Science
- Interdependence of organisms

Science in Personal and Social Perspectives
- Environmental quality

National Council of Teachers of Mathematics (NCTM)

Representation
- Use representations to model and interpret physical, social, and mathematical phenomena

International Society for Technology in Education: National Educational Technology Standards (ISTE/NETS)

Research and Information Fluency
- Students apply digital tools to gather, evaluate, and use information

Digital Citizenship
- Advocate and practice safe, legal, and responsible use of information and technology

Lesson Overview:

In this lesson, students will learn about the Earth's ecosystems or biomes. Students will explore the six spheres within the Earth system and discuss how they are inter-related. Next they will focus on the individual biomes within the biosphere. Finally, students will examine coral reefs and investigate how they are affected by water temperature. This lesson is developed using a 5E model of learning and utilizes NASA eClips™ video segments.

Icons flag five areas of interest or opportunities for teachers.

- **TECHNOLOGY** highlights opportunities to use technology to enhance the lesson.
- **MODIFICATION** denotes opportunities to differentiate the lesson.

- **RESOURCES** relates this lesson to other NASA educator resources that may supplement or extend the lesson.

- **CONNECTIONS** identifies opportunities to relate the lesson to historical references and other topics or disciplines.

- **CHECK FOR UNDERSTANDING** suggests quick, formative assessment opportunities.

Materials List

ENGAGE
Per student
- Student Guide
- blank slip of paper

EXPLORE
Per group
- Computer with Internet access

EXPLAIN
Per group
- Coral Reef Card
- computer with Internet access
- blue and red colored pencils

Essential Questions

- How is Earth a system?
- How do scientists use data to understand the Earth system?

Instructional Objectives

Students will
- describe the interdependence of spheres and biomes within the Earth system;
- understand the place of biomes within the biosphere;
- compare key components of six biomes;
- investigate the effects of elevated temperature on the coral reef biome; and
- list 2 or more specific jobs associated with research and summarize one STEM career.

5E Inquiry Lesson Development

ENGAGE (20 minutes)

1. Give each student a blank slip of paper.
2. Ask students to respond (in writing or orally) to the following statement: " (blank) system". *(Students could respond with solar system, digestive system, subway system, etc.)*
3. Ask students to share their responses. Record the responses on the board.

(MODIFICATION) Have students work with partners or in groups to brainstorm as many different systems as possible on a sheet of paper for 30 seconds. Have each group give a system and if another group has it everyone must cross it off their list. Hold a contest to see which group can come up with the greatest number of unique answers.

(TECHNOLOGY) Use a graphic organizer or an on-line word cloud generator to organize student responses and project the results for the whole class to see. A word cloud generator produces a graphic of text provided by the user. The clouds give greater prominence to words that are used more frequently. Two examples of word cloud generators are Wordle, http://www.wordle.net/, and TagCrowd, http://tagcrowd.com/.

4. Ask students to compare and contrast attributes of systems. *(Students should see that each example is composed of several parts that work together to function.)*

(MODIFICATION) Select a system and have each student or group of students create a flow chart or graphic organizer to show the different parts required for the system to function. Select a student to draw the system on the board and ask other students to suggest alternate ways to assemble the system or additional parts required in the system drawing.

5. Ask students to read the background information on page 1 of the Student Guide.

(CHECK FOR UNDERSTANDING) Ask students to share relationships they see between the six main spheres. Use these questions to help guide the discussion:

   a. Compare and contrast the qualities of each sphere. *(Answers will vary.)*
   b. Which sphere(s) could not exist without the others? Explain. *(Answers will vary. One example may be that the biosphere could not exist without the geosphere, atmosphere, cryoshpere, and hydrosphere.)*
   c. Consider the water cycle. Identify the role each sphere plays in the cycle. *(Answers will vary.)*

EXPLORE (35 minutes)

1. Ask students to read the information on biomes on pages 2 and 3 of the Student Guide.
2. Have students create a graphic organizer such as a vocabulary book or foldable to help them learn the vocabulary presented on page 2 of the Student Guide.
3. **(TECHNOLOGY)** Show the NASA eClips™ video segment Launchpad: NASA and Biosphere 2 (6:12) to the students. This segment can be found on the NASA eClips™ page of the NASA web site:

   http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=%22Biosphere%22&category=0010

   The video may be streamed or downloaded from the nasa.gov web site; a captioned version is also available at the nasa.gov site.

   (MODIFICATION) This video may be streamed from the NASA eClips YouTube™ channel: http://www.youtube.com/user/NASAeClips#p/c/D7BEC5371B22BDD9/5/qBBto9OrZXs
4. Group students into teams of two or three, assign each group a biome to research, and have them collect information to answer questions on page 4 of the Student Guide. Assigning biomes by drawing the biome name from a hat is one way to ensure that biomes are randomly assigned to groups.

   (TECHNOLOGY) Direct students to the following web site to conduct their research:

   http://www.ucmp.berkeley.edu/exhibits/biomes/index.php
5. Ask the students to give a brief presentation to the class on the biome they researched. Remind students to refer to the grading rubric on page 5 of the Student Guide as they conduct research and prepare their presentation.

   (CONNECTIONS) Explain to students that global warming is part of global climate change. The amount of precipitation, wind speed, cloud cover, and change in the strength of storms are also components of global climate change. Ask students to explain how climate change may affect their assigned biome.

   (MODIFICATION) To make this lesson more student centered, conduct the EXPLORE activity as a jigsaw activity. Once each group has completed the research on the assigned biome, rearrange the groups to create new groups with one member representing each biome. Within these groups, ask each student to present their biome to the others in the group.

   (MODIFICATION) Have students create a biome book using the research information page as the basis for the book. Students can create an illustrated front cover for the research. They can add pictures of the biome, interesting facts about the biome they learned during their research, a story about a specific animal or group of people who live in the biome, and coping habits and adaptations of the flora and fauna of the biome.
6. Once all biomes have been presented, lead a class discussion about the interconnections between biomes and the effects of global climate change. Use the following questions to guide the discussion:
   a. Based on class presentations, what are some possible effects of global climate change across multiple biomes?
   b. How might a change in one biome affect other biomes?

EXPLAIN (30 minutes)

1. Prior to class, cut out and laminate the coral reef location cards found on page 7.
2. Divide the class into eight groups and give each group a coral reef location card.
3. Ask students to complete the procedure on page 6 of the Student Guide.
4. Once all students have completed their work, ask one student from each group to share the latitude, longitude, and number of days above 30°C for their assigned location.
5. Ask students to identify a pattern between the number of days above 30°C and the location of the coral reef. *(Students should notice that the coral reefs between 19°N and 25°N had the greatest number of days of water temperature above 30°C).*

EXTEND (25 minutes)

1. Data sets for weekly sea surface temperature ranging from 1997 to 2010 are available within the Oceans data set in the Live Access Server (Advanced Edition) at My NASA Data http://mynasadata.larc.nasa.gov Ask students to investigate the sea surface temperature from 1997 to 2010 of the coral reef they investigated during the EXPLAIN activity. Ask students to identify recurring patterns or cycles in the data where coral is in danger of bleaching.
2. Students should answer the questions found below EXTEND on pages 7 and 8 of the Student Guide.

   (MODIFICATION) To make this activity more open-ended, have students answer the following questions in place of the questions on pages 7 and 8 of the student guide:

   a. Based on the data presented in the graph, has coral bleaching occurred at any time? Explain how you arrived at this answer. *(Answers will vary based on the coral reef assigned. If water temperature was above 30°C, then coral bleaching occurred.)*

   b. List at least three possible effects of coral bleaching. *(Answers will vary but may include extinction of marine species, loss of diversity of fish populations; reefs deteriorate and can no longer act as storm protection; loss of producers at the bottom of the food chain; and loss of a possible source for new medicines.)*
3. Have students investigate another case study about how global climate change affects biomes.
   a. Divide the class into six groups and assign each group a biome to investigate.
   b. Have each group select a specific ecosystem within their assigned biome and research the effects of global climate change on the ecosystem. The group investigating the marine biome should select an ecosystem other than coral reefs.
   c. Have each group make a presentation to the class on their research. Students can create posters or multimedia presentations for the class presentation.

EVALUATE (15 minutes)

1. Use questions, discussions, and student handouts used throughout the lesson to assess students' understanding.
2. Ask students to summarize their learning by answering these journal questions:
   a. What other data could one use to identify causes of coral bleaching? Why would these data be helpful?

      (Answers will vary, but may include a discussion of wind patterns and how wind affects the movement of ocean surface water or cloud cover since clouds keep some of the heat from the Sun from reaching the surface of Earth.)

   b. Why is Earth considered a system? What is the interdependence of the biomes on Earth?

      (The Earth is composed of many components - the geosphere, atmosphere, biosphere, hydrosphere, cryosphere, and anthrosphere. These components work together to form the Earth system. Each sphere interacts with and affects what happens in the other spheres.)

   c. How do scientists use data to understand the Earth system?

      (Scientists study climate and other data collected by satellites to look for patterns that indicate cycles within the Earth system, such as sea surface temperature data. They can then look for relationships between the cycles and phenomena such as coral bleaching.)
3. Ask students to brainstorm a list of careers related to the study of biomes. Have each student choose a career from the list and research it. Students can summarize their research in a short paper or multi-media presentation. For a list of some possible careers related to Earth Science, visit http://kids.earth.nasa.gov/archive/career/.

Coral Reef

Location Cards

Grand Cayman Island Lat: 19.3567 N Long: 81.3211 W	La Pargurera, PR Lat: 17.9213 N Long: 67.1048 W
Nassau, Bahamas Lat: 25.0118 N Long: 77.3982 W	Woman Key, FL USA Lat: 24.5034 N Long: 81.9349 W
British Virgin Islands Lat: 18.7162 N Long: 64.3529 W	Bermuda Lat: 32.3057 N Long: 65.0185 W
Key Largo, FL USA Lat: 24.8313 N Long: 80.6623 W	Turks and Cacaos Island Lat: 21.7423 N Long: 72.0031 W

Essential Questions

- How is Earth a system?
- How do scientists use data to understand the Earth system?

Background

Earth is a complex, dynamic system we do not fully understand. The **Earth system**, like the human body, is made up of many components that interact in complex ways. Our planet is changing and NASA's Earth science program is working to develop a scientific understanding of this changing system. Scientists hope to understand how the Earth's system responds to natural events as well as human-induced changes. Data collected should improve the prediction of climate, weather, and natural events.

Earth's Spheres

There are six major interacting systems which comprise the Earth system. They are the **geosphere**, **hydrosphere**, **atmosphere**, **cryosphere**, **anthrosphere**, and **biosphere**. The geosphere, which contains the lithosphere, includes the continental and oceanic crust as well as the solid layers of Earth's interior. The hydrosphere includes all of the liquid water on Earth. The atmosphere is the gaseous layer surrounding Earth. It contains a mixture of gases, primarily nitrogen and oxygen. Other gases include water vapor and carbon dioxide. The cryosphere contains all of the frozen water of Earth (e.g., glaciers and ice caps). All parts of the Earth made or modified by humans, such as cities, roads, and dams make up the anthrosphere. Finally, the biosphere includes all living things on Earth. While each part of the Earth system can be studied individually, it is the examination of all the spheres interacting together which gives us the best understanding of weather, ocean currents, droughts, earthquakes and sea ice melting.

NASA runs the **Earth Observing System**, or **EOS**, to collect data on many variables within systems. EOS is comprised of a series of coordinated polar-orbiting satellites that monitor and help us understand key components of the climate system and their interactions through long-term global observations. The EOS satellites collect data directly related to the following climate science areas: radiation, clouds, water vapor, and precipitation, plus data on the six biomes. Over the coming decade NASA and its research partners will be analyzing EOS data to characterize, understand, and predict variability and trends in Earth's system for both research and applications.

Resources

NASA Science - Earth
http://nasascience.nasa.gov/earth-science

Earth Orbiting System
http://eospso.gsfc.nasa.gov/eos_homepage/mission_profiles/index.php

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Vocabulary

anthrosphere – The **anthrosphere** is the part of the environment that is created or modified by humans for use in human activities and human habitats.

atmosphere – The **atmosphere** is the envelope of gases surrounding Earth.

biome – A **biome** is a major biotic community characterized by distinct climate and dominant forms of flora and fauna.

biosphere – The **biosphere** is the region of the Earth's surface and atmosphere where living organisms exist.

Biosphere 2 – **Biosphere 2** is a model of Earth's biosphere located north of Tucson, AZ.

cryosphere – The **cryosphere** is the component of the Earth's system that is frozen water.

Earth Orbiting System – The **Earth Orbiting System**, or EOS, is a series of satellites that orbit Earth and collect various types of data.

Earth system – The **Earth system** is a unified system comprised of six spheres: the anthrosphere, atmosphere, biosphere, cryosphere, geosphere, and hydrosphere.

geosphere – The **geosphere** is the solid portion of Earth and the processes that shape Earth's surface.

hydrosphere – The **hydrosphere** is the part of Earth that is composed of water.

EXPLORE

Earth's Biomes

The interactions between spheres have profound influences on the types of life that can flourish in any particular location. The biosphere is made up of smaller divisions called **biomes**. Biomes are regional ecosystems characterized by distinct types of vegetation, animals, and microbes that have developed under specific soil and climate conditions. The six major biomes are freshwater, marine, desert, forest, grassland, and tundra. Each organism in a biome has specific environmental requirements. Biomes have changed or moved many times during the history of life on Earth. Human activity has drastically altered the environment affecting these communities. Part of NASA's mission is to monitor changes within the Earth System which may negatively affect interactions within the biosphere

Biosphere 2

In 1991, **Biosphere 2**, a small scale model of the Earth's biosphere was created. Glass walls were built to enclose a self-contained complex housing replicas of the six major biomes found on Earth – including an ocean the size of an Olympic swimming pool. Researchers investigated how changes in each biome affected the overall enclosed system.

Resources

Biosphere 2
http://astrobiology.arc.nasa.gov/news/expandnews.cfm?id=1372

Terrestrial Biomes
http://earthobservatory.nasa.gov/Experiments/Biome/

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Research Information

Biome Name	World Locations

Climate Characteristics

Temperature:

Rainfall:

Other:

Keystone Flora and Fauna

Flora:

Fauna:

Example of a food chain in this biome:

Other biome characteristics not mentioned above:

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Grading Rubric for Biomes Research and Presentation

Criteria/Task List	Score
Research Page (36 points possible)	
Four Climate Characteristics included / accurate	
All World Locations included / accurate	
All World Locations marked on map / accurate	
Keystone Fauna included / accurate	
Keystone Flora included / accurate	
Detailed food chain example included / accurate	
Four other biome characteristics included / accurate	
Relationship between flora/fauna/environment/climate included / accurate	
Appropriate inclusion/pronunciation of new vocabulary	
Research Page (36 points possible)	
Speaking Skills - Frequent eye contact / Audible throughout room	
Visuals - Easy to read and understand / Support presentation	
Organization - Logical format - Clear and concise - Completed within allotted time	
Participation - All group members contributed to presentation materials - All group members able to answer questions	
Total Score (maximum of 52 points)	**pts**
Percent = 100 x (points earned/52)	**%**

Scoring

4 Tasks accomplished completely; well-polished/attractive presentation

3 75% complete; usually neat and organized presentation

2 50% complete; somewhat disorganized presentation

1 Only 25% of work finished; disorganized presentation

0 No evidence of criteria; off task behaviors during project time

EXPLAIN

The Coral Reef Biome

Coral reefs are collections of tiny marine creatures that live inside a calcium carbonate skeleton attached to rocks on shallow ocean floors. Corals are primarily found in tropical waters, less than 30° north or south of the equator. Coral reefs are some of the most biologically productive, diverse, and economically valuable ecosystems on Earth. The reefs provide protection to the shorelines of islands, provide a home for marine organisms, and offer recreational opportunities. Recent discoveries of powerful antibiotic, anti-cancer and anti-inflammatory medications derived from corals may benefit the entire human race.

Coral reefs are threatened by natural processes like hurricanes and human activities such as pollution. The force of a hurricane can break down the reef. The increased precipitation from the storms can wash sediment into the reef and temporarily lower the salinity of the water.

Human activities produce point and nonpoint source pollution which adversely affect the health of the reef. Reefs are also damaged through poor land management, careless tourists, dragging anchors from boats, oil spills, and through commercial collection for aquarium suppliers.

Figure 1. Bleached coral. Image credit: NOAA

One of the greatest threats to the health of coral reefs stems from high sea water temperature. When the water temperature is too warm, the symbiotic alga on which coral depend die and the coral turns a whitish color. This phenomenon is called coral bleaching. The coral may die if the warm water conditions remain for an extended time. Although the threshold for coral bleaching varies by region and coral species, data indicate that coral bleaching may occur when the sea surface temperature, or SST, exceeds 30°C for an extended period of at least a week.

One of the predicted outcomes of climate change is an increase in SST. SST data are collected by the Polar Operational Environmental Satellites, or POES, developed jointly by NASA and the National Oceanic and Atmospheric Administration, or NOAA. This data is combined with other observations to create a product called the Multi-Channel Sea Surface Temperature, or MCSST.

During late 2005, a major coral bleaching event occurred when higher sea surface temperature conditions existed in the Caribbean Sea. In this lesson you will analyze SST data during this event using the My NASA Data Live Access Server.

Resources

http://earthobservatory.nasa.gov/Features/Coral/coral.php

http://www.cotf.edu/ete/modules/coralreef/CRmain.html

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Procedure

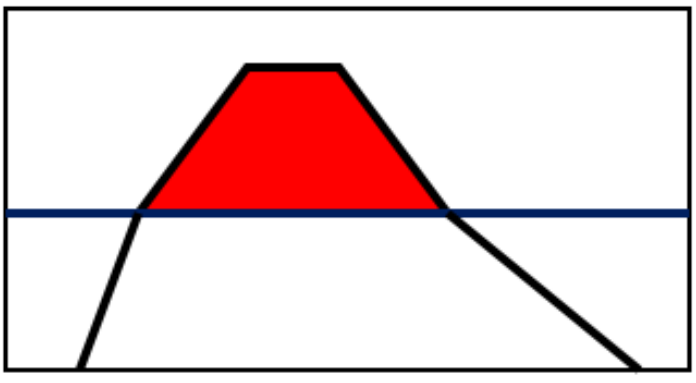
1. Your teacher will give you an information card that contains the name and location of a coral reef in the Caribbean Sea for you to study. Your team will work as research scientists to gather and display data.
2. Open an Internet browser on your computer and go to the My NASA Date site at http://mynasadata.larc.nasa.gov
3. Click on the +DATA ACCESS button.
4. Select Live Access Server (Advanced Edition).
5. Select Oceans and then Daily Sea Surface Temperature (MCSST). Click on the word Next on the right side of the screen
6. Under the dropdown menu for Select View, pick Time series.
7. To the right of the map there are four boxes. Type the latitude, including the letter N, in the top box. Type the longitude, including the letter W, in the left box.
8. Using the drop down menus under the map, set the time range for June 1, 2005 to September 30, 2005.
9. Click the word Next on the right side of the screen.
10. A pop-up window should appear with your line plot. The line may be missing in spots. Breaks in the line represent time periods for which data is unavailable.
11. Print your graph.

EXTEND

Now your team will work as Oceanographers and examine the data collected for the specific coral reef you were assigned.

1. On the graph you printed out, use a ruler and blue colored pencil to draw a horizontal line at the 30°C value. Did the sea surface temperature exceed 30°C at any time during your time series?

2. To highlight the times when the water temperature was above 30°C, shade the area between the line on the graph and the blue line you drew with the red colored pencil. See the diagram below.



Close up of graph

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3. If your location had temperatures greater than 30°C, estimate the number of days the temperature was above 30°C. Based on what you learned in the background information about corals, was this enough time to cause coral bleaching?

4. Think of some other factors that impact coral reefs. Conduct a literature review to find data that explain human impact on coral reefs.

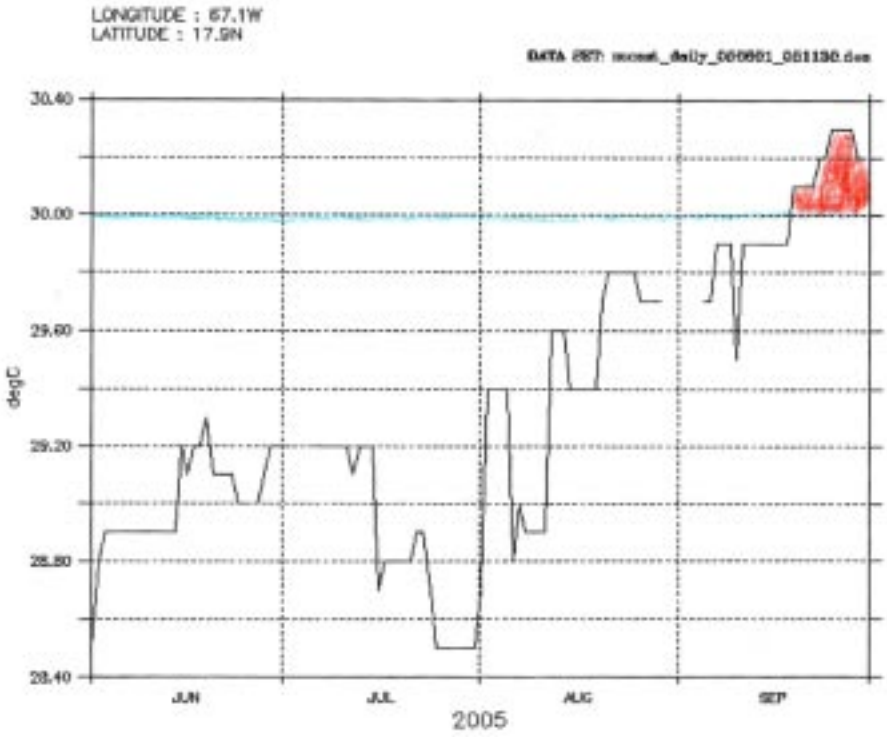
EXPLAIN

1. On the graph you printed out, use a ruler and blue colored pencil to draw a horizontal line at the 30°C value. Did the sea surface temperature exceed 30°C at any time during your time series?

   (Surface temperature exceeds 30°C for all graphs except Bermuda.)

2. To highlight the times when the water temperature was above 30°C, shade the area between the line on the graph and the blue line you drew with the red colored pencil.

Sample graph



La Pargurera, PR

3. If your location had temperatures greater than 30°C, estimate the number of days the temperature was above 30°C. Based on what you learned in the background information about corals, was this enough time to cause coral bleaching?

   (The sample graph shows about 10 days at temperatures above 30°C. Since damage occurs after about a week, some coral bleaching probably occurred.)

answerkey