
My NASA Data - Lesson Plans

An Earth System View of Earthrise



Overview

Students are introduced to the Earthrise phenomenon by seeing the Earth as the Apollo 8 astronauts

viewed our home planet for the first time from the Moon. They will analyze a time series of mapped plots of Earth science variables that NASA monitors to better understand the Earth System. Students will document changes of a variable over time as they create a new visualization. They will share this visualization with a peer who has monitored a different Earth System variable and work collaboratively to make observations about temporal and spatial change making inferences about how these variables may be related. As a result, they develop research questions which students may use in future investigations.

This lesson can be used as a launching activity for introducing Earth Systems or the phenomenon of Earthrise.

Learning Objectives

- Analyze the sequence of plots over time for different variables for changes
- Create visualization for showcasing key areas experiencing change over time
- Collaborate with peer to showcase changes and identify opportunities for future research
- Develop research questions

Why Does NASA Study This Phenomenon?

On Christmas Eve, 1968, none of the astronauts aboard Apollo 8 were prepared for the spellbinding moment when they would first see their home planet rise from behind the desolate lunar horizon. The vision of Earth provided them the first spot of color as they floated in the blackness of space, orbiting the lunar surface. "Earthrise" is the name given to a photograph of the Earth taken by William Anders during lunar orbit.

Essential Questions

1. How is the global system changing?
2. What other parts of the Earth System change over time?
3. Where do these changes tend to occur?
4. What variables appear to be correlated?

Cross-Curricular Connections

National Geography Standards:

- 8th Grade 7.1: The physical processes that shape the patterns of Earth's surface: The four components of Earth's physical systems (the atmosphere, biosphere, hydrosphere, and lithosphere) are interdependent
- 12th Grade 7.1: The physical processes that shape the patterns of Earth's surface: The interactions of Earth's physical systems (the atmosphere, biosphere, hydrosphere, and lithosphere) vary across space and time.

Materials Required

Per Student:

Virtual:

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- Interactive Google Slide
 - Earth System Satellite Images Google Slides
 - [Chrome Canvas](#): This is a chrome drawing app that allows you to create and use multiple layers in a drawing. For virtual learners, this app will be used in place of Student Data sheet: Earthrise Map Inventory.
 - [Image](#)

In person:

- [NASA Earthrise in photos](#): Photograph #1: and #2 (shown only one at a time) on projector
- Sticky notes
- Coloring pencils or crayons (six different colors)
 - red, yellow, green, blue, purple, brown
- Student Data sheet: Earthrise Map Inventory
- Earth System Satellite Images (Variable Full Set includes: Cloud Cover, Vegetation, Surface "Skin" Temperature, and Precipitation for dates: January, March, May, July, September, November)

Technology Requirements

- Internet Required
- One-to-One (tablet, laptop, or CPU)
- One-to-a-Group
- Teacher computer/projector only
- Visualization Tool Required
- Advanced technical equipment/expertise required

Teacher Background Information

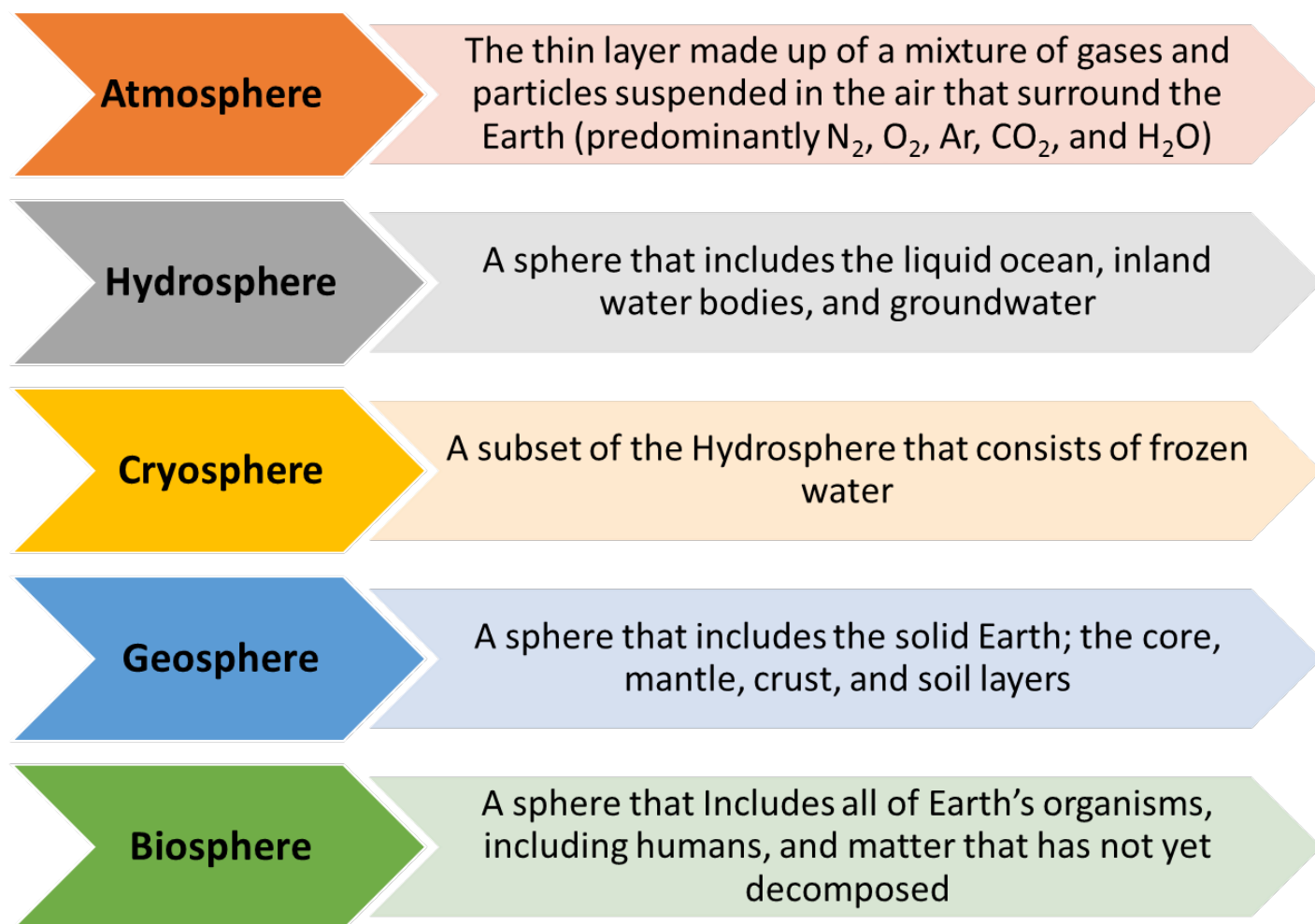
The "Earthrise" photograph became one of the most famous photos from all of the Apollo missions and one of the most reproduced space photographs of all time. It has been credited for inspiring the beginning of the environmental movement as this view underscored the need to better understand and protect the Earth. In Life Magazine's 100 Photographs that Changed the World edition, wilderness photographer Galen Rowell called Earthrise, "the most influential environmental photograph ever taken."

NASA is, and will continue to be, in the forefront of researching our planet's interconnected systems, from a global scale down to minute processes in the Earth System. NASA is focused on developing a scientific understanding of the Earth as a whole system and its response to natural or human-induced changes. NASA's research on the Earth focuses on the following five questions. Answering these questions is vital to understanding the Earth and protecting it for future generations.

- How is the global system changing?
- What are the primary forces of the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of change in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

The Earth is a system of interacting parts that work together to form our complex planet; it is made up of five major parts or subsystems: Atmosphere, Hydrosphere, Biosphere, Cryosphere, and

Geosphere which are connected to each other in a complex web of processes.



As students review the Earth System Satellite Images in their collaborative teams, help them to connect the different sphere interactions by highlighting the following interactions with the driving questions below to engage prior knowledge and activate learning.

<u>Key Interactions</u>	<u>Driving Questions about Interconnections Among Components of an Earth System</u>
Atmosphere–Hydrosphere Interconnection	
<ul style="list-style-type: none"> • Water evaporates from the stream into the air. (hydrosphere – atmosphere) • Gases move between the atmosphere and the water. • Rain and snow from the atmosphere goes into the surface water. 	<ul style="list-style-type: none"> • How does the presence of a stream, pond, lake, or ocean affect the air temperature nearby? • How does a rainstorm affect rivers and streams?
Atmosphere–Geosphere Interconnection	
<ul style="list-style-type: none"> • Rain and snow from the atmosphere goes into the soil. • Gases from volcanoes go into the atmosphere. 	<ul style="list-style-type: none"> • Does the amount of moisture in the soil change? How? • How does the presence of large areas of rocks or asphalt affect the air temperature nearby? (Rocks and soil are part of the geosphere. Asphalt is man-made but is made up of natural materials.)
Atmosphere–Biosphere Interconnection	
<ul style="list-style-type: none"> • Animals inhale oxygen from the air, and exhale carbon dioxide. • Plants take in carbon dioxide and let out oxygen. • Microorganisms take some gases from the air, and some gases are transported from microorganisms to the air. For example, some bacteria take nitrogen from the air. • Aquatic animals breathe dissolved oxygen in the water. • Heat in the air warms animals, plants, and microorganisms. • The amount of precipitation helps determine where species of plants and animals live. 	<ul style="list-style-type: none"> • What do plants, animals, and other organisms obtain from the air? What is transported from each of those groups of organisms into the air? • Where does heat in the soil and in the air come from? Did you know that the sun mainly warms the air only indirectly? (The soil is warmed by the sun, which heats the air, and not the other way around.)
Hydrosphere–Geosphere Interconnection	
<ul style="list-style-type: none"> • Rain and snow drop water onto the ground. Some of it flows away, and some of it seeps into the ground. • Rain wears away little bits of rock. These become part of the soil. • Rain beats down on soil near the stream, and some of it carries soil away (erosion). 	<ul style="list-style-type: none"> • Is moisture present in the soil? How does it get there?
Hydrosphere–Biosphere Interconnection	
<ul style="list-style-type: none"> • Trees take in water through their roots. • Water evaporates from leaves of trees and other plants. • Animals breathe out some water. • Animals drink water. 	<ul style="list-style-type: none"> • How does water get from the stream (or pond, lake, canal, or ocean) to the trees? • How does the presence of a stream (or pond, lake, canal, or ocean) affect plants and animals? What are differences among species that live in it, species that live adjacent to it, and species that live 20 meters or more away from it?
Biosphere–Geosphere Interconnection	
<ul style="list-style-type: none"> • Waves wear away pieces of shells and break shells up into bits. These become part of the soil (sand). • Soil erosion makes the water more turbid, which reduces the depth to which sunlight can penetrate the water. This diminishes the ability of plants to carry out photosynthesis, thus affecting their ability to grow. • Plants take nutrients from the soil. When they die, they put nutrients into the soil. • Earthworms consume parts of the soil. 	<ul style="list-style-type: none"> • How do leaves become part of the soil? • Does water carry soil? When and how? • How do plants affect the soil? • How do animals affect the soil? Remember, there are animals living in the soil as well as on its surface. • How do bacteria and other microorganisms affect the soil? How are they affected by the soil?

For more information:

- GLOBE's [Connecting the Parts of the Earth System](#) for more information on system interactions.
- NASA EO Kids: [60 Years of Looking at Earth from Above](#)
- [Blue Marble Matches](#) Lesson Plan/Activity, Grade Levels: 3-12
- This 5-E lesson connects the shape of Earth's surface (and the names of the features that correspond to those shapes and textures) to the processes that form them. It also introduces students to how scientists use Earth to gain a better understanding of other planetary bodies in the solar system.

Procedure

Introduce Earthrise



Photograph 1.

Earthrise in black and white (1968)

Display the iconic Earthrise Photograph #1 (black and white) to the class. Present the following questions to students to answer:

1. What are the main features of the picture?

The Earth is rising over the lunar surface. The illuminated side of the Earth is rising above the horizon, showing the land, oceans, and swirling clouds that are part of the Earth system.

1. Describe the different environments displayed in the photograph.
 - How are they similar?

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- *Solid rocky surfaces both exist on the Earth and the Moon.*
 - How are they different?
 - *The Moon's gray cratered surface contrasts sharply with the black of space. On the other hand, the Earth has many different shades and patterns.*
2. Have students work with a partner to analyze the image and share their observations.
 3. Next, students work with their partner to make inferences about the photograph by presenting the following questions to answer:
 1. Where is this picture taken from? How do you know? The Moon. This is a natural planetary object and is close to Earth like the Moon.
 2. What is happening in the picture? The Earth sits beyond the Moon's horizon. The Moon orbits the Earth.
 3. What is most notable about these environments? The Earth rests in the emptiness and darkness of space; its surface is differentiated with white and dark features. The Moon's surface has a bumpy texture with light and dark materials.
 4. Now, present Earthrise photograph #2 (in color) and have them observe the photo for new observations and inferences.



Photograph 2. Earthrise in color (1968)

5. Describe the different environments displayed in the photograph.
 1. How are they similar? There are similar shades of brown on the lunar and Earth surface
 2. How are they different? Earth's color palette is more striking with more colors. The texture of the surfaces is hard to compare since the Moon is closer to the camera.
 3. What is most notable about these environments when viewing in color? Earth's coloration includes shades of white, blue, brown, reds, and greens, whereas the Moon's surface is monotonous of white, grey, and browns.

6. Explain to students that Photograph #1 and 2 were captured on December 24, 1968, from astronauts aboard Apollo 8, the first ever manned satellite of another world. Although it is not

the first image of Earth taken from space, it is the first image of the Earth taken from the perspective of Earth rising above the horizon of another world. Apollo 8 astronauts Frank Borman, James Lovell, and William Anders were coming around from the far side of the Moon on their fourth orbit. William Anders photographed the Moon from the right side window of the spacecraft and exclaimed: "Oh my God, look at that picture over there! There's the Earth comin' up. Wow, is that pretty!"

For more information about the Apollo 8 mission and the Earthrise photograph, check out the Earthrise: What It's Like to Escape Our Planet | Op-Docs in the Recommended Resources (section on Earthrise photo, as explained by the NASA astronauts on Apollo 8, 14:05-16:45).

The second image is the first photograph of Earth in color taken as Earth rose above the lunar horizon. This photograph became one of the most famous photos from all of the Apollo missions and one of the most reproduced space photographs of all time. It has been credited for inspiring the beginning of the environmental movement as this view underscored the need to better understand and protect the Earth. In Life Magazine's 100 Photographs that Changed the World edition, wilderness photographer Galen Rowell called Earthrise, "the most influential environmental photograph ever taken."

7. Ask students to brainstorm and share what new information the color photograph provides about our home planet. What may these colors represent? What sphere in the Earth System do they belong? Direct students to connect their descriptions of the natural phenomena to the observed color, as well as to the name of the sphere in the Earth System which they belong.
- Blues: Answers may include but not limited to...Oceans and other water bodies as part of the Hydrosphere
 - Whites: Answers may include but not limited to...Clouds, snow, and ice as part of the Cryosphere; white coloration may also indicate urban environments belonging to the Geosphere.
 - Reds: Answers may include but not limited to...Deserts and other landforms as part of the Geosphere; the ocean may also be observed by the appearance of certain algal blooms belonging to the Biosphere.
 - Browns: Answers may include but not limited to...Deserts and other landforms in the Geosphere; brown coloration of waterways may also be observed by the appearance of silt-laden water in the Hydrosphere; brown may also be observed on land due to changes of leaf color in temperate forests in the autumn season as part of the Biosphere.
 - Greens: Answers may include but not limited to...Forests and vegetated landforms, as part of the Biosphere.

Activate Prior Knowledge

Now that you have explored the Earthrise photographs depicting Earth from a point of view of the moon, let's explore what you know about Earth from your own perspective.



Credit: Ed.gov

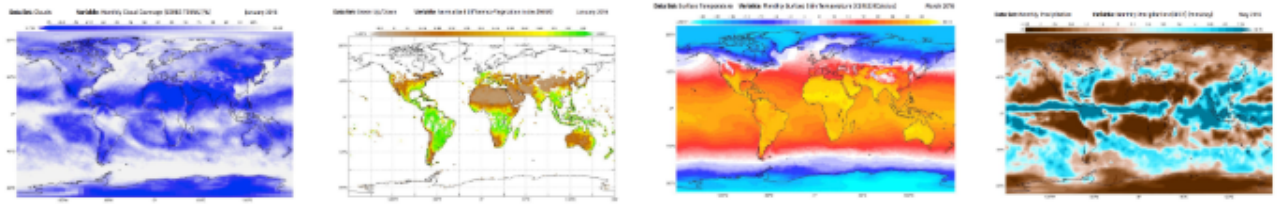
1. Present the following question, “What did you see outside in nature on your way to school today?”
2. Students work in their teams to brainstorm the various parts of the system that you’ve encountered today.
 - Students will write each idea on a sticky note.
3. Have students come to the front of the board and place their sticky note.
4. As a class, review and sort their ideas about different parts of nature that they have encountered into the four major spheres of the Earth System. NOTE: During this activity, we will focus on the Atmosphere, Biosphere, Geosphere, and Hydrosphere. For the purpose of this activity, we will consider the Cryosphere as part of the Hydrosphere.
 - Organize the notes under the following headers, after the students have identified the spheres through class discussion.

			
Atmosphere	Biosphere	Geosphere	Hydrosphere





Part 1: Explore Time Series Satellite Images

Building from your observations on your way to school, use the satellite images to observe these variables on a longer time scale and from a different perspective just like NASA scientists do. Earth System Satellite Images are tools that help us observe change in certain scientific variables among different Earth System spheres.

1. Distribute satellite images of the four variables among students.



Review the variables being researched:

			
Cloud Cover	Vegetation	Surface "Skin" Temperature	Precipitation
<p>Cloud Cover is the amount of Earth's surface covered by clouds related to the part of Earth not covered by clouds shown as a percentage (%).</p>	<p>These values represent global measures of the "greenness" of vegetation across Earth's landscapes.</p>	<p>The Surface Skin Temperature is the temperature (in degrees Celsius) right at Earth's surface, including the plant coverage. Land surfaces with less vegetation tend to get warmer in the sunlight and cooler at night as compared to surfaces covered with plants.</p>	<p>Precipitation data show monthly rainfall estimates from rain gauge stations, satellites, and sounding observations across the Earth.</p>

2. Each student should receive the satellite images of the following months and associate colored pencils to review and analyze:

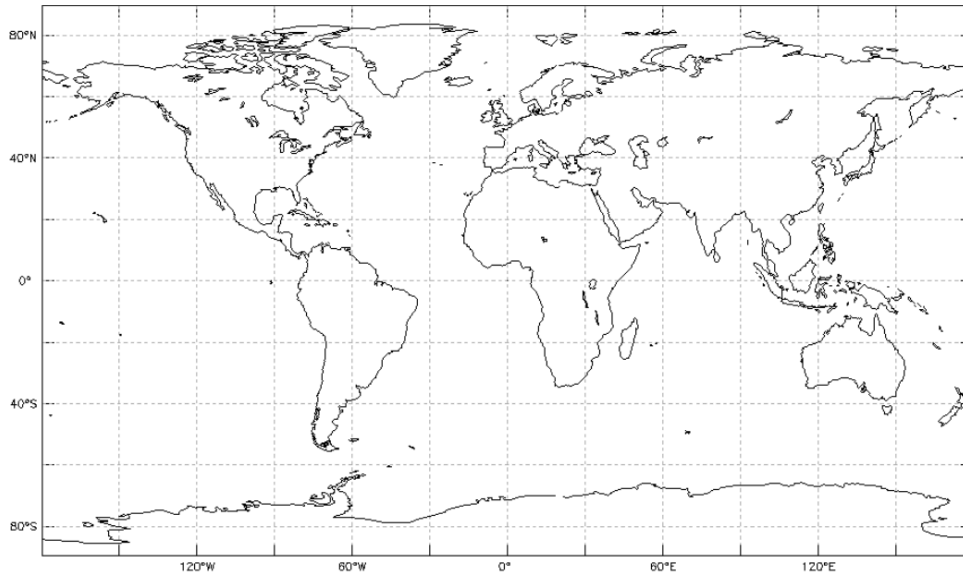
- January - red
- March - yellow
- May - green
- July - blue
- September - purple
- November - brown

Earthrise Map Inventory

Name/s:

Date:

Period:



Part 1. Directions: Review the Time Series Poster Cards of your variable. Using the blank map below, identify areas of activity and/or change with colored pencils. Note: Use a different color for each of the six different time periods. Be sure to complete the key identifying the color to the time in the space to the right.



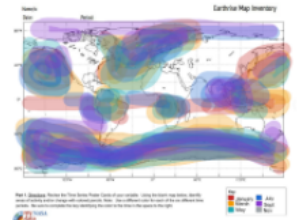
Key:	
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

- Distribute the Earthrise Map Inventory, Part 1 & 2 Student Sheet to each student, as well as coloring pencils (six different colors per student - or groups to share).
- Students should review the Earth System Satellite Images of their variable.
- Students should create a key identifying the color to the time in the space to the right.
- Using the blank map provided (and coloring pencils), students document areas of activity and/or change of their variable. Note: They should use a different color pencil for each of the six different time periods. For virtual learners, use Chrome Canvas. For example, students will identify areas of high values for each of the months, starting with January. Students use a colored pencil to shade these regions. Next, they analyze the satellite images for March and document (on the same sheet) the locations of the high concentrations using a different colored pencil. Repeat this process for each of the months. After repeated updates to the same map, geographic "hot spots" will become obvious, as well as months that experienced a shift in geographic range.



Follow the steps below to complete the composite image of your analysis. Use the images to the left as a guide.

1. Save the linked [image](#) to your computer/device.
2. Go to [Canvas Chrome](#) and select **New from Image** to upload the [image](#). This will allow you to shade in the earth data the different regions of the world.
3. Select a color that corresponds to the time in the legend. Use the colors on the key to draw on the data from each month of the variable on your poster card set.
4. Select the diameter size of your "marker". Adjust the **Opacity** of the marker to control the color transparency. Set the Diameter and Opacity of the marker tool to 30.
5. At the top of the image, be sure to identify the **Variable** you are analyzing. Now, observe the poster cards for your science variable beginning with January. Color the areas on the map where you find the highest values.
6. Once finished with the first dataset, add a new layer by clicking on the layer icon and pressing "+". Repeat Step 5 for the next month's dataset, and so on until you have completed all six layers. The layers will be added to each other as a composite image.
7. When you have finished your analysis of all months, select **Save As Image** to your computer. Then, submit to your teacher.



See Google Slides for directions on how to use Canvas Chrome for virtual learners.

Part 2: Summarize Your Findings

1. Students summarize their findings on the Student Sheet, Part 2.

Name/s: _____ Earthrise Map Inventory
 Date: _____ Period: _____

Part 2. Directions: Analyze your mapped plots showing how your variable has changed over time and place.

Variable	
Observations	Qualitative: 1. 2. 3. 4. 5.
	Quantitative: 1. 2. 3. 4. 5.
Questions	1. 2. 3. 4. 5.



1. Here, they document the variable being analyzed by identifying five qualitative and five quantitative observations. (Qualitative observations use your senses to observe the results; Quantitative observations are measurable and described using numbers and data; they can be collected with instruments such as rulers, balances, thermometers, etc.)
 - Qualitative observation examples: How dark certain colors are, what the patterns look like, etc.
 - Quantitative observation examples: How many regions are shaded each month, how many places have overlapping coloring, etc.

2. Students also craft five researchable questions that come to mind in their analysis.
 - Research question examples: What is causing the patterns that I observe?, How could patterns of other variables change the patterns I see?

Part 3: Communicate Your Finding and Expand Your Research

1. Distribute Part 3 of the Earthrise Map Inventory.
2. Students team up with a student exploring a different variable.
3. Together, they complete the two tables by analyzing the two science variables as they compare their observations. They document patterns or relationships found among the two in Table A.
4. Explain to students the types of questions:
 - Descriptive Questions: describe the variables you are measuring. (*How many...?, How often...?, etc.*)
 - Comparative Questions: examine the differences between two or more groups on one or more dependent variables (*What is the difference...?, How do _____ compare?, etc.*)
 - Correlative Questions: analyze the causal relationships, associations, trends and/or interactions amongst two or more variables on one or more groups (*How does _____ change with _____?, What is the relationship of _____ to _____?, etc.*)

In Table B., students work together to create their own questions using the three different types of questions: Descriptive, Comparative, and Correlative.

Name/s: _____ Earthrise Map Inventory
 Date: _____ Period: _____

Part 3. Directions: Work with your teammate to analyze your two science variables. Compare these variables and your key findings from Part 1; document your findings in the Table A below.

Table A. Group Observations

Qualitative:
Quantitative:

Table B. Research Questions

Question Type:	Create Your Own Questions:
Descriptive Questions (examples) 1. How many _____ are in an area? 2. How frequently does _____ happen? 3. What is the temperature, height, ... of _____? 4. When does _____ happen during the year? 5. Where does _____ happen during the year?	
Comparative Questions (examples) 1. How does _____ between latitude XX and latitude XX differ? Longitude XX and longitude XX? 2. How do values at different landforms differ? 3. How do values between _____ and _____ differ at various times?	
Correlative Questions (examples) 1. What is the relationship between variable # and variable #2? 2. Does _____ go up when _____ goes down? 3. How does _____ change as _____ changes?	



Part 4: Share your Research with a Gallery Walk

1. Students share their findings through a gallery walk. This will help students view the patterns of other variables they did not study. The class should be able to have a clear view of each variable this way. Have nearly half of your students post their data sheets on the walls and disperse themselves around the room. An important factor is that the student works are spread far enough apart to reduce significant crowding.
2. The other half will walk around and visit the displayed work while carrying a clipboard with their own data. They will share their own data through the process. Students should also





discuss the questions they formulated in Parts 2 and 3.

3. Post the following questions on the board or projector for the students to answer as they conduct their Gallery Walk. Students will be expected to present their answers at the end in



an exit ticket.

- How does each of the different variables change over the year? (evaluate)
- Which variable seems to affect another variable? (apply)
- What processes connect them? How do you know? (understand)

			
Cloud Cover	Vegetation	Surface "Skin" Temperature	Precipitation

Extensions

Part 5: For Early Finishers

1. With additional time, have students explore the [Earth System Data Explorer](https://larc-mynasadata-2df7cce0.projects.earthengine.app/view/earth-sy...) (<https://larc-mynasadata-2df7cce0.projects.earthengine.app/view/earth-sy...>) to find answers to their questions identified in Parts 2 and 3.
2. Students should first review the YouTube tutorials available here, <https://mynasadata.larc.nasa.gov/basic-page/tutorials>