

How Are Earth's Spheres Interacting?

▶ ES0103

Use another sheet of paper if you need extra space to write complete answers.

- 1 Looking at the image, what are the major parts of our planet that can interact as a system?
- 2 Describe each of Earth's four spheres. List several examples of features in each sphere.
- 3 Do you think clouds should be classified as part of the atmosphere, or part of the hydrosphere? Explain why.
- 4 In each image, look for evidence of materials and energy moving among the spheres.
 - List the major features in the image and tell which sphere each one represents.
 - Describe sphere interactions you can infer from the scene.
 - Whenever possible, follow the results of an interaction through all four spheres.

A. Suez Canal

B. Tropical Island
- 4 continued
 - C. Forest fire
 - D. Oil wells burning
 - E. Wind farm
 - F. Mount Etna, a volcano on Sicily
- 5 List some Earth sphere interactions from your own daily activities.
- 6 Describe some human activities that are contributing to global-scale interactions among Earth's spheres.

How Do Interactions among Earth's Spheres Vary Regionally?

▶ ES0108

Use another sheet of paper if you need extra space to write complete answers.

- 1 For each location, tell how you think the crops get their water. What Earth system processes can be inferred at each location?
- 2 Which of the two images more closely represents how crops receive water near your home? Is the hydrosphere abundant or scarce at your location?
- 3 How does the geosphere affect the biosphere in each of these places? Describe interactions between the geosphere and the biosphere for each image.
- 4 Describe interactions between humans and the geosphere illustrated by the images.
- 5 In your region, what materials do humans take from the geosphere? What materials are returned to it?
- 6 Describe differences in interactions between the hydrosphere and the geosphere illustrated by these images.
- 7 Based on temperatures near the equator and the poles, describe how the hydrosphere and the atmosphere interact at each location.
- 8 Think about how quickly or slowly evaporation occurs at your location. (For instance, consider how long it takes a damp towel to dry out.) Describe interactions between the hydrosphere and atmosphere you can infer for your location.
- 9 What is the Leaf Area Index for your own region in the image?
- 10 Describe interactions among the biosphere, hydrosphere, and atmosphere indicated for your region by this image.

How Might a Scientist Investigate Annual Patterns of Fires?

► ES0201

Use another sheet of paper if you need extra space to write complete answers.

- 1 Brainstorm with a couple of other students: Make a list of the kinds of information you would want to gather to help you predict where wildfires might break out.

- 11 Describe how well or how poorly your fire potential ratings correlate with the national fire danger map.

Record your potential fire ratings for each variable in the table below.

	Site A	Site B	Site C	Site D	Site E
2 Relative Greenness					
3 Departure from Avg.					
4 Live Plant Moisture					
5 Temperature					
6 Relative Humidity					
7 Wind Speed					
8 TOTAL					
9 AVERAGE RATING					

- 12 Recall the hypothesis you were testing: An area's potential for fire can be predicted by rating and averaging six physical conditions: Relative Greenness, Departure from Average Greenness, Experimental Live Moisture, Observed Temperature, Observed Relative Humidity, and Observed Wind Speed. Based on the data you collected, should you accept or reject the hypothesis? Explain your answer.

- 13 Of the six conditions you rated, which do you think are the most important predictors of fire? Which do you think are least important? Describe your reasoning.

- 10 According to your ratings, which of the five sites has the highest risk of fire? Which site has the lowest risk?

- 14 How could you modify the rating system to give more weight to the most important predictors?

How Might You Investigate Scientific Phenomena?

▶ ES0205

Use another sheet of paper if you need extra space to write complete answers.

- 1 Describe some of the specific changes you observe in the animations.

Plans for Conducting a Scientific Investigation

I. Observing

- 2 Record the vegetation index values for October, November, and December.

II. Ask Questions

Mo.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UV Level	1000	2000	3000	4000	5000	6000	6000	5000	3000	2000	2000	1000
Veg. Index	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.4	0.3			

III. Form a Hypothesis

- 3 Describe the trend of vegetation levels over the course of the year.

IV. Design a research method

- 4 Describe the general relationship between vegetation index and UV level, shown in the X-Y plot of the data.

V. Data Collection

- 5 Describe the trends in the levels of UV radiation over the course of the year.

VI. Hypothesis Testing

- 6 Based on the information presented here, would you accept or reject the hypothesis that the density of green vegetation is directly related to the amount of UV light that an area receives? Explain your answer.

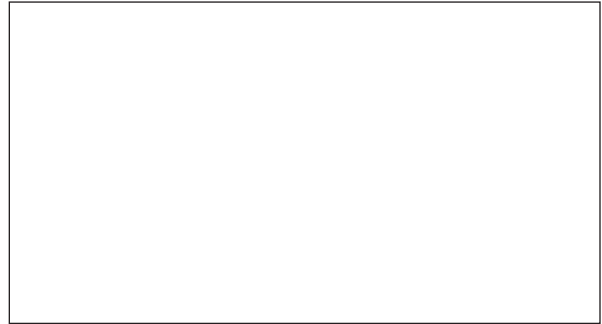
VII. Sharing your findings

How Are Landforms Represented on Flat Maps?

▶ ES0307

Use another sheet of paper if you need extra space to write complete answers.

- 1 Write a detailed description of the topography that you encounter during this flyby.
- 2 Compare the photo to the topographic map. Describe the pattern of the contour lines around features on the photo.
- 3 Which part of this land is the last to flood as the water rises?
- 4 What is the elevation of the lines marked at A, B, and C?
- 5 Describe the overall shape of the landscape.
- 6 What do closely spaced contour lines indicate about the shape of a feature? In other words, when the lines are close together, does the feature have gentle slopes or steep sides?
- 7 What is the pattern of the contour lines around a simple hill?
- 8 Make a sketch of the pattern of the contour lines moving up the valley. Draw an arrow to indicate the direction in which water flows across the lines.
- 9 What landform feature does the model show, and what do hachures on contour lines indicate?
- 10 Describe the structure inside the box on the map.
- 11 Identify the features marked at A and B. Where is the elevation highest on this map? Where is it lowest?
- 12 Which of the landforms was easiest to recognize from its topographic map?



What Time Is It?

► ES0405

Use another sheet of paper if you need extra space to write complete answers.

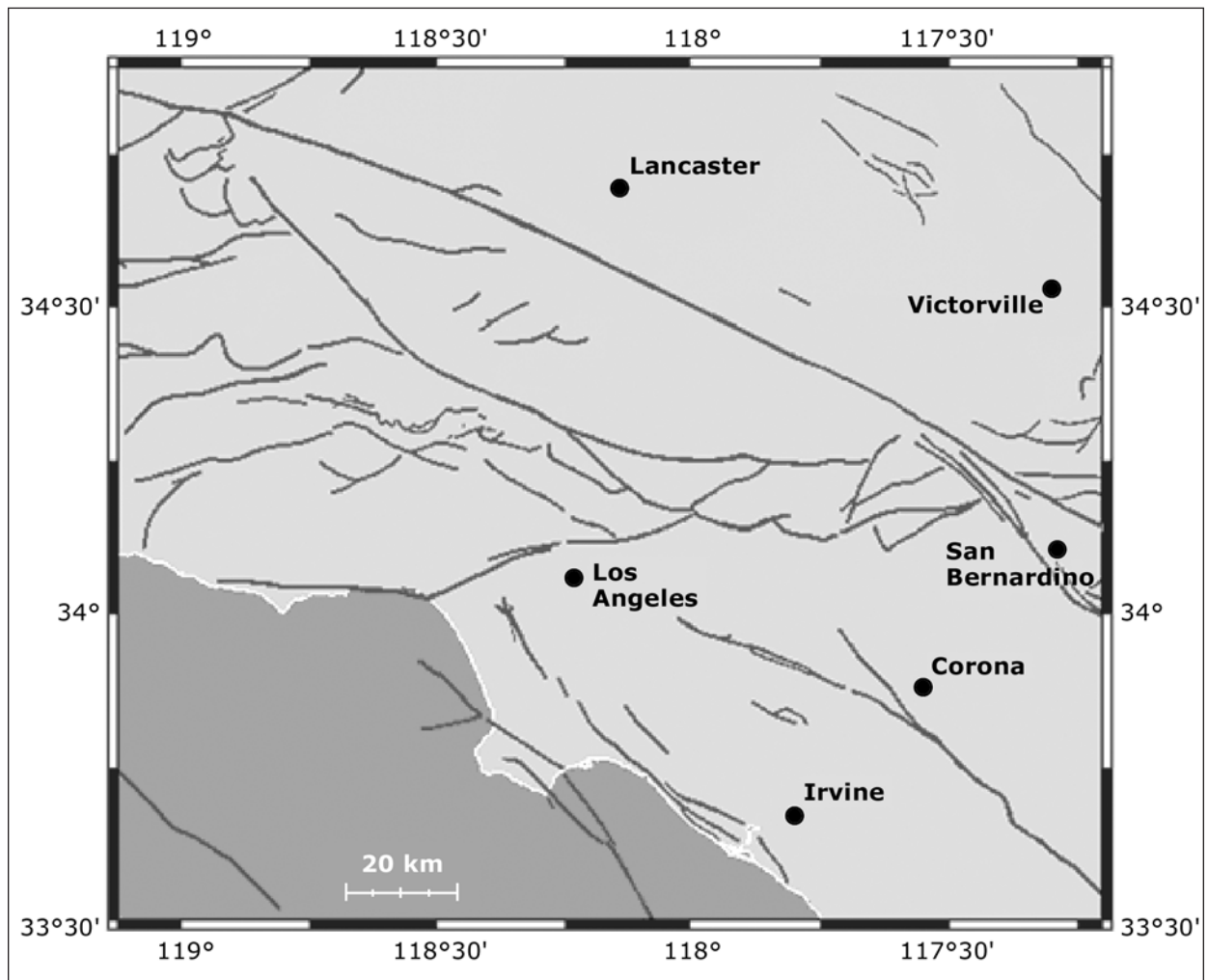
- 1 Which continents are experiencing day in the image?
- 2 Which continents are experiencing night?
- 3 In what direction does Earth rotate?
- 4 From what direction does the sun appear to rise each day?
- 5 In what direction does the sun appear to set each day?
- 6 When the east coast of the United States is experiencing sunrise, where on Earth is the sun setting?
- 7 When the west coast of Africa is experiencing sunrise, approximately what time is it in India?
- 8 Describe how you think the direction of a shadow cast by a flagpole at your location would change through the daylight hours.
- 9 Sketch a map view of a flagpole area and show the times that the flagpole's shadow would indicate when it pointed west, north, and east.
- 10 Write a simple equation to convert Universal Time to local time for the time zone where you live.
- 11 How many time zones (hours) apart are St. Louis, Missouri, U.S.A. and Kyoto, Japan?
- 12 During the hours you are normally awake, when could you call your friend in Japan to reach them when they are normally awake?
- 13 What time is it in Reno (Pacific Standard Time) when you call?
- 14 If a plane departed at 4:00 p.m. on October 24 from Tokyo, Japan (approximately 135 degrees E), and the flight takes 9 hours and 30 minutes, what time and date would the plane arrive in Los Angeles (approximately 120 degrees west)?
- 15 Use the information in the description and on the graphic to calculate the boat's longitude.

Where Was That Earthquake?

▶ ES1003

Use another sheet of paper if you need extra space to write complete answers.

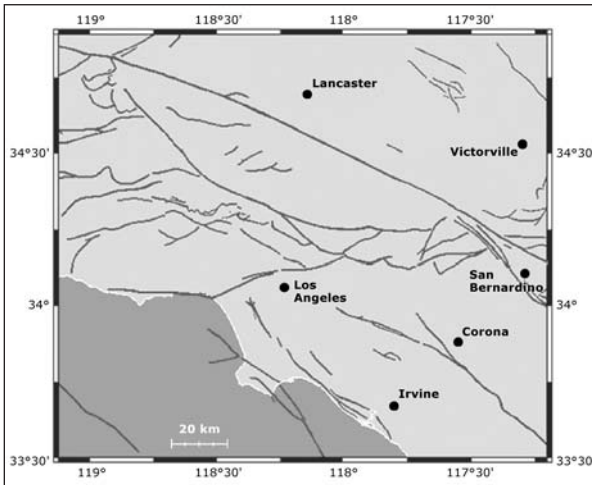
- 1 What do you notice about the time interval between the arrival of P and S waves at the three different seismograph stations? What causes these differences?
- 2 Record the distance to the epicenter from Lancaster, Victorville, and Los Angeles.
- 3 For each location, draw circles corresponding to the distances you recorded in question 2. Sketch the circles on your map and mark the epicenter location.
- 4 Describe three different examples of damage that occurred as a result of the Northridge earthquake.



Which Fault Moved in the Northridge Earthquake?

► ES1010

Use another sheet of paper if you need extra space to write complete answers.



- 1 Make a prediction about which fault might have moved during this earthquake. Draw a small arrow on your map pointing to the fault.
- 2 On the map, draw a line around the area that was affected by aftershocks.
- 3 In another color, draw a line around the area that experienced the strongest ground shaking.
- 4 In a third color or pattern, draw a line around the area that had the highest velocity of ground motion.
- 5 Which surface faults might be related to the fault responsible for the Northridge earthquake? Highlight these faults on your map. What evidence did you use to arrive at your conclusion?
- 6 At what depth did the Northridge earthquake occur?
- 7 At what depth range did most of the aftershocks occur?
- 8 Based on location of aftershocks compared to the Northridge epicenter, in what direction is the fault inclined?

How Does Soil Vary from Place to Place?

► ES1206

Use another sheet of paper if you need extra space to write complete answers.

1 Write three observations about the soil in this photo.

2 Identify and describe as many different layers (horizons) as you see in this soil profile.

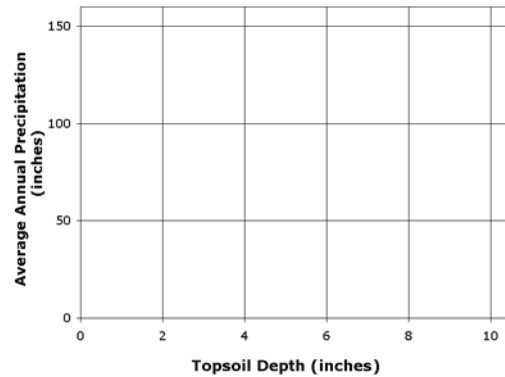
3 List several similarities and differences across these soils.

4 What relationship do you think might exist between average annual precipitation and topsoil depth?

5 Measure and record the topsoil depth in your table.

	Topsoil depth in images (inches)	Average Annual Precipitation (inches)
Arizona		7
Montana		12
Pennsylvania		48
Massachusetts		43
Georgia		47
Hawaii		150

6 Sketch the graph on your worksheet.



7 Describe any pattern that exists between topsoil depth and average annual precipitation.

8 Go to the Web site for your state soil and estimate its depth.

9 Go to the Web site for the United States precipitation map and find the average annual precipitation in your state.

10 Plot the point for your state on the graph of topsoil depth versus precipitation. How does your state's soil compare to the others?

11 Do average precipitation amounts appear to be related to the depth of topsoil in an area? If so, describe how. If you see no evidence for the relationship, suggest another factor you could plot versus topsoil depth to look for a relationship.

How Might Global Climate Change Affect Life on Earth?

► ESU501

Use another sheet of paper if you need extra space to write complete answers.

- 1 Why do you think the error bars become smaller in the more recent part of the graph?
- 2 When did concentrations of these greenhouse gases start increasing rapidly? What might have caused these increases?
- 3 Which gas affects global warming most? Which gas has the least effect?
- 4 Predict how continued increases in atmospheric carbon dioxide will affect global temperatures.
- 5 Why do scientists develop numerous models rather than rely on just one?
- 6 Based on all the models, what are the minimum and maximum temperature increases expected to occur by 2100?
- 7 Which hemisphere (north or south) appears to have experienced the most significant temperature changes? Hypothesize about why this is so.
- 8 Of the global climate change impacts considered, which one do you think poses the greatest risk to humanity? Cite evidence for your answer.
- 9 Suggest two actions that people might take to decrease human influence on global climate change.

Make a table like this on a full sheet of paper, and fill it in as you explore the links.

Climate Change Impact Assessment Table			
Impact Category	Description of Expected Impacts	Most Vulnerable Locations	Ability of Humans to Adapt to Impact
Health			
Agriculture			
Water Resources			
Forests			
Species and Natural Areas			
Coastal Areas			

How Do Temperature and Salinity Affect Mixing in the Ocean?

▶ ES2202

Use another sheet of paper if you need extra space to write complete answers.

- 1 Describe some of the general patterns you observe for temperature and salinity.
- 2 Describe the location of at least three places in the world's oceans that have high temperatures but low salinity.
- 3 What do you think might cause low salinity in these areas of warm ocean water?
- 4 Determine the temperature, salinity, and density of ocean water at the following locations:
a. 0° , 50°W b. 20°N , 90°E
- 5 What is responsible for the unusually low salinity of these warm waters?
- 6 Determine the temperature, salinity, and density of water on the Mediterranean and the Atlantic sides of the Strait of Gibraltar.
- 7 Predict what would happen to water that moves from the Mediterranean Sea into the Atlantic Ocean.
- 8 Determine the temperature, salinity, and density of the water on the Caribbean and the Pacific sides of the Panama Canal.
- 9 Predict what would happen to water that moves from the Caribbean Sea into the Pacific Ocean.
- 10 Find waters near Antarctica with the combination of the lowest sea temperatures and highest salinity. Extrapolate (extend the information on the graph) to determine the approximate density of these waters
- 11 At what level in the ocean will these waters move away from Antarctica?

What Does the Ocean Floor Look Like?

▶ ES2301

Use another sheet of paper if you need extra space to write complete answers.

- 1 What evidence did you look for to predict the location of each feature?
- 2 Describe at least three observations from the animation.
- 3 Describe the sequence of how the water drains. Which features are exposed first? ...last? Why does the water drain in this way?
- 4 Imagine that you could travel across the ocean floor from Casablanca, Morocco, to Norfolk, Virginia, to Caracas, Venezuela. Narrate a brief "tour" of this path, describing the ocean floor features you would encounter. Use a map of this area to help you locate islands and distinguish them from seamounts.

When Were the Atlantic and Pacific Oceans Separated by Land?

▶ ES2307

Use another sheet of paper if you need extra space to write complete answers.

- 1 Make two observations about temperature and salinity on the Caribbean and Pacific sides of Panama.
- 2 Interpret the processes shown in the image to explain your observations from question 1.
- 3 Describe the changes in salinity in the Caribbean Sea and Pacific Ocean from six to two and a half million years ago.
- 4 Why do you think the ocean chemistry changed?
- 5 How do you think this marine species could have spread to both sides of the isthmus?

- 6 In which layers was Pulleniatina present? Complete the chart below.

		Pacific	Caribbean
Sample #	Age (mya)	Present (Yes/No)	Present (Yes/No)
1	6		
2	5.6		
3	5		
4	4.8		
5	4.3		
6	3.5		

- 7 How would you explain the presence or absence of Pulleniatina only on the Pacific Ocean side?
- 8 How many years ago was the Isthmus of Panama formed? Explain how you used the data to determine this.
- 9 Summarize the changes that have occurred in the Earth's spheres on either side of the Isthmus of Panama from six to three million years ago.

What Caused the Mass Extinction Recorded at the K-T Boundary?

▶ ESU801

Use another sheet of paper if you need extra space to write complete answers.

- 1 What biological findings have been reported at the K-T boundary?
- 2 What geological findings have been reported at the K-T boundary?
- 3 What is significant about the discovery of iridium at the K-T boundary?
- 4 What are the Deccan traps, and what theory do they help support?
- 5 How has discovery of the Chicxulub impact crater shifted the debate?
- 6 Describe how Earth's systems might interact after an asteroid impact.
- 7 Write at least one question about mass extinction that this investigation has raised for you.
- 8 How might you investigate this question?