GC2: Components of the Earth System Working Together

Purpose

To develop familiarity with interactions among the major components of the Earth system at the global scale

Overview

Students review a variety of images and maps of the whole Earth in order to identify the major components of the Earth system at the global scale. The maps show solar energy, average temperature, cloud cover, precipitation, soil moisture, and vegetation, and the images are of the Earth from space. As a class, they discuss some ways that the components of the Earth system interact to form the whole Earth system. They describe the water cycle at the global scale in greater detail, identify the components through which water passes and the processes that move it, and draw an abstract diagram.

Student Outcomes

Students will be able to:

- Use images and data about the whole Earth to identify the major components of the Earth system at the global scale and stimulate their thinking about connections among those components;
- Describe the pathway of water among the components, as an example of ways they are connected;
- Translate their understanding of that pathway into an abstract diagram.

Science Concepts

Physical Sciences

Heat is transferred by conduction, convection and radiation.

Heat moves from warmer to colder objects.

Sun is a major source of energy for changes on the Earth's surface.

Energy is conserved.

Chemical reactions take place in every part of the environment.

Earth and Space Sciences

Weather changes from day to day and over the seasons.

The sun is the major source of energy at Earth's surface.

Solar insolation drives atmospheric and ocean circulation

Each element moves among different reservoirs (biosphere, lithosphere, atmosphere, hydrosphere).

Life Sciences

Organisms can only survive in environments where their needs are met.

Earth has many different environments that support different combinations of organisms.

Organisms' functions relate to their environment.

Organisms change the environment in which they live.

Humans can change natural environments.

Plants and animals have life cycles.

Ecosystems demonstrate the complementary nature of structure and function.

All organisms must be able to obtain and use resources while living in a constantly changing environment.

All populations living together and the physical factors with which they interact constitute an ecosystem.

Populations of organisms can be categorized by the function they serve in the ecosystem.

Sunlight is the major source of energy for ecosystems.

The number of animals, plants and microorganisms an ecosystem can support depends on the available resources.

Atoms and molecules cycle among the living and non-living components of the ecosystem.

Scientific Inquiry Abilities

Analyzing and images of the Earth from space

Analyzing global datasets displayed on maps

Develop explanations and predictions using evidence.

Recognize and analyze alternative explanations.

Communicate results and explanations.

Time

One class period

Level

Middle, Secondary

Materials and Tools

3 satellite images of the Earth (Figure EA-GC2-1) provided in this activity

6 maps showing the whole Earth in the month of January (Figure EA-GC2-2) provided in this activity

2-3 sheets of paper for each student, for drawing diagrams

Sample beginning student diagram (provided by GLOBE) – Sample complete student diagram (not to be distributed to students)

Preparation

Make student copies

Prerequisites

Students must:

- Be able to obtain information from a map on which different colors represent different values;
- Have learned the general path of water through the water cycle.

Crosswalks to Other GLOBE Learning Activities

An Activity Guide accompanies the GLOBE Earth System Poster *Exploring the Connections in a Typical Year* (available on the GLOBE website). The Guide describes how to help students explore patterns in the data displayed on the poster. Students find annual changes, relationships among types of data, and global patterns, and they make connections with GLOBE data.

What to Do and How to Do It

Step 1. Preparation

Make Student Copies

- 6 maps showing the whole Earth in the month of January, from the GLOBE Earth System Poster, *Exploring the Connections in a Typical Year*. The 6 maps are:
  - Solar Energy
  - Average Temperature
  - Cloud Cover
  - Precipitation
  - Soil Moisture
  - Vegetation
- 3 satellite images of the Earth (Figure EA-GC2-1) showing:
  - North and South America
  - Africa and Europe
  - Japan and Australia
- *Water at the Global Scale Work Sheet*
- Sample beginning student diagram
- Assessment rubric for this activity (You may want to share with students.)
- *Student Self-reflection Log: The Earth System at the Global Scale*

Step 2. Have the class review and discuss the satellite images of the Earth and the maps of different aspects of the Earth.

Explain to students that a new discipline of science has emerged – Earth System Science in which people are learning about ways that *parts* of the Earth *interact* to make the whole Earth system. Data gathered by instruments on satellites orbiting the Earth are fundamental to this approach. These data, together with information obtained at

the surface, can be put into the form of maps that cover the whole globe.

Distribute student copies of the images and maps, and give students some time to look them over.

Ask students to describe for the class what they see in the images and maps. Do they understand what these are showing? Go over the captions with them to clarify what they may not understand.

Tell them that they are not expected to understand absolutely everything about these images and maps. They should study them carefully and share with the class what they see, based on the captions and on their previous studies and experience.

Step 3. Ask students to identify the major parts, or components, of the Earth system that appear to be involved in each of the images and maps.

Have students look at the images and maps one by one, and name all the major components of the Earth system that they see represented.

Students may suggest such components as:

- oceans
- land
- clouds
- air
- rain
- soil
- plants
- animals
- rocks
- people
- ice (at the poles)

Then make sure that they synthesize all the components they've suggested into a small number of major components.

For the purpose of these Earth system science learning activities, GLOBE has identified four major components:

1. Air, including precipitation and clouds (atmosphere);
2. Water: bodies of water such as canals, streams, ponds, lakes, oceans, and groundwater (hydrosphere);
3. Soil (pedosphere);
4. Living things (biosphere).

It is all right if students choose a slightly different set of major components. They may include ice and snow (cryosphere), or rocks (lithosphere).

Step 4. Have students begin to identify connections among these global Earth system components, then focus on the global water cycle. Students will develop diagrams of the global water cycle.

Ask students for their ideas about some ways these major components are connected at the global scale. Discuss their ideas as a class.

Now focus on the water cycle and the pathway that water takes as it moves among the components. Distribute the *Water at the Global Scale Work Sheet-1*. Give students 20-30 minutes to complete the work sheet.

In Question 4 of the *Work Sheet*, students may need to see a copy of the sample beginning student diagram (Figure EA-GC1-1) to understand what is required.

Step 5. Have student volunteers share their water drop pathway descriptions and diagrams with the class.

Have the students identify the components and the processes involved in each major step of the pathway.

You may wish to add aspects of the water cycle that students may not have covered on their own. The example of a complete diagram is provided for this purpose. See Figure EA-GC2-3.

Point out to students that if a diagram of just one aspect of the Earth system, water, is complicated, they can imagine how very complicated it is to look at all aspects of the system together. That is just what scientists do when they create a computer program to simulate the Earth system and how it changes over time. This computer program is called a model. The more that is included in a model, the better it simulates the real Earth system *but* the harder it is for scientists to determine how things change. However, even the most complex computer model is much simpler than the real Earth system!

Step 6. Collect the *Work Sheets* for assessment.

Student Assessment

Two *Work Sheets* can be used for assessment:

Water at the Global Scale

Student Self-reflection Log: The Earth System at the Global Scale

An assessment rubric for the first work sheet is provided. Students' responses to the questions on the *Self-reflection Log* cannot be quantified, yet they play a special role in student learning. Students may be willing to describe confusion they feel or other problems they're having that they would not feel free to bring up with the whole class.

Water at the Global Scale

Work Sheet-1

Name: _____Class: _____Date: _____

The images of the Earth from space and world maps that your teacher has given you are some of the ones that Earth system scientists use in their efforts to understand the Earth as a whole. The images have been made by different kinds of instruments, some on different satellites that orbit the Earth, and some on the ground. GLOBE students make some of these kinds of measurements, as you probably know!

The Earth is extremely complicated. Looking at it as parts that interact to form the whole can help you think about it more clearly.

1. Major Components.

As you study these images, what major parts, or components, of the Earth system do you find represented? List them here.

_____

_____

_____

_____

2. The Pathway of a Drop of Water.

Using the list of components of the Earth system that you made for Question 1, think about the pathways that water takes through the system. Tell the story of a drop of water, and describe what happens to it. Through which components does it travel, and how does it get there?

Describe the water drop's path as a series of steps. For example:

Step 1. It rains, and the water drop falls near my house.

Step 2. The water is absorbed by the soil.

You can add any details that you imagine. Remember to include the various forms that water takes (solid, liquid, and gas).

Turn your water drop into a world traveler, and take it across the globe. Don't leave it in your neighborhood!

_____

_____

_____

_____

_____

3. Water Connects Components.

Now go back through your steps. After each one, write the name of the system components that were involved.

For example, if you wrote, “It rains, and the water drop falls near my house,” after that, you would write, “atmosphere.”

If you wrote, “The water is absorbed by the soil,” after that, you would write, “Soil,” or “Pedosphere” (another word for soil).

4. Diagram the Water Cycle.

Get a clean sheet of paper. Write the names of the major Earth system components that you listed in Question 1, far apart from each other on the page. (It doesn’t matter in what order you write them.) Draw a circle around each name.

For each step in the water pathway during which water moved from one major Earth system component to another, draw an arrow between the two components. For example, if you described water being evaporated from the ocean, draw an arrow from the ocean to the atmosphere.

Along the shaft of each arrow, write a short phrase describing how the water moved from one component to the other. For example, on the shaft of the arrow from the ocean to the atmosphere, you would write, “Water evaporates from the ocean.”

Do this for all your water pathway steps that involve water moving from one system component to the other.

Your teacher will show you a copy of a sample diagram. It will give you an idea of how to begin.

The Earth System at the Global Scale

Work Sheet-2: Student Self-reflection Log

Name: _____Class: _____Date: _____

Your responses to the questions below are intended to help your teacher become aware of what you're thinking and what you may need help understanding. You will not be graded on these responses.

1. How useful did you feel the global maps and satellite images were in helping you identify Earth system components? Why? Please explain.

   _____
   _____
   _____
   _____
   _____

2. What, if anything, did you find confusing or difficult about looking at Earth system components at the global scale?

   _____
   _____
   _____
   _____
   _____

3. How would you describe the Earth system at the global scale?

   _____
   _____
   _____
   _____
   _____

Figure EA-GC2-1a. GOES East Satellite image of North and South America on 4 March 2015

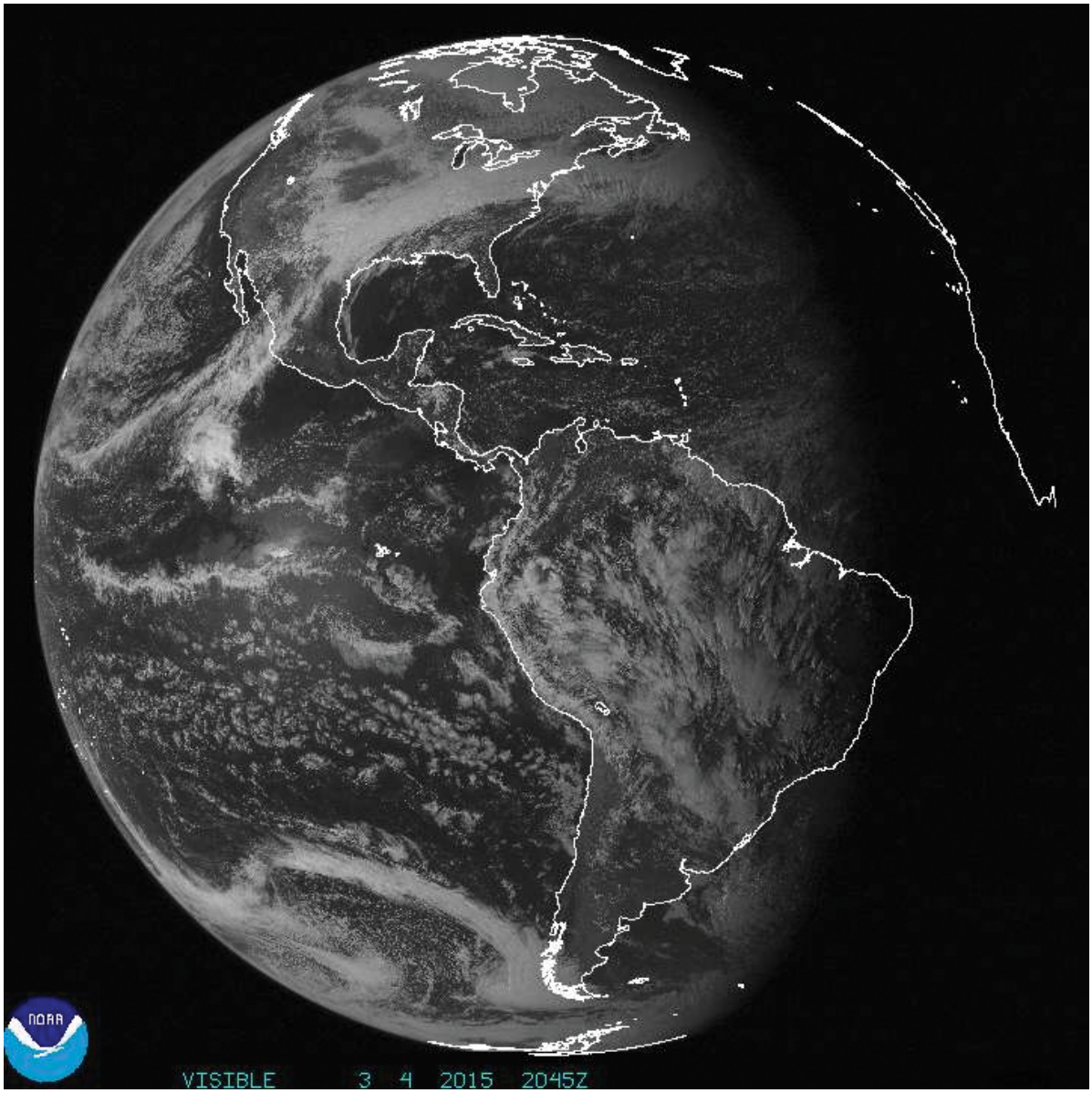


Figure EA-GC2-1b. Meteosat satellite image of Africa and Europe on 4 March 2015

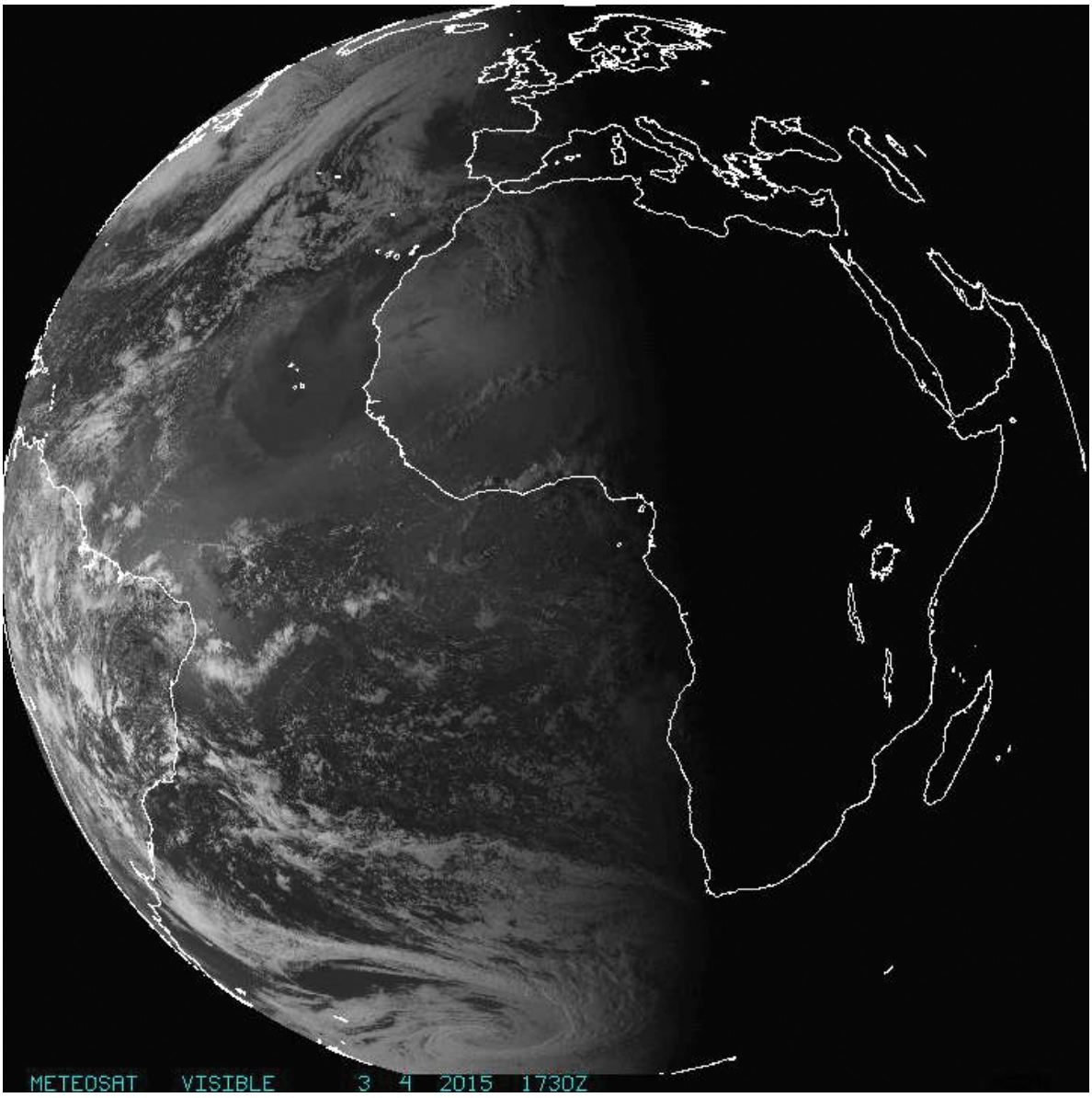
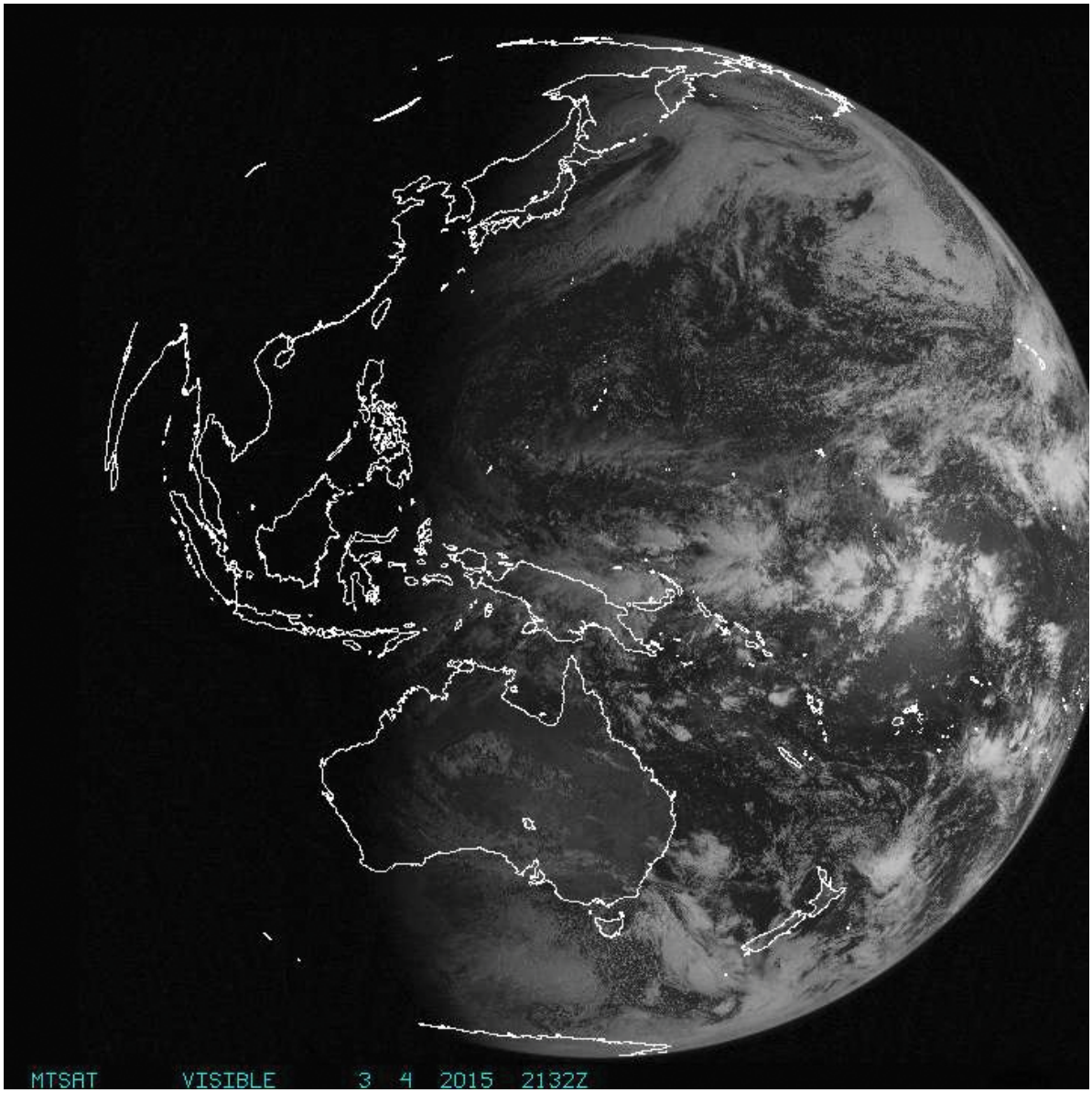
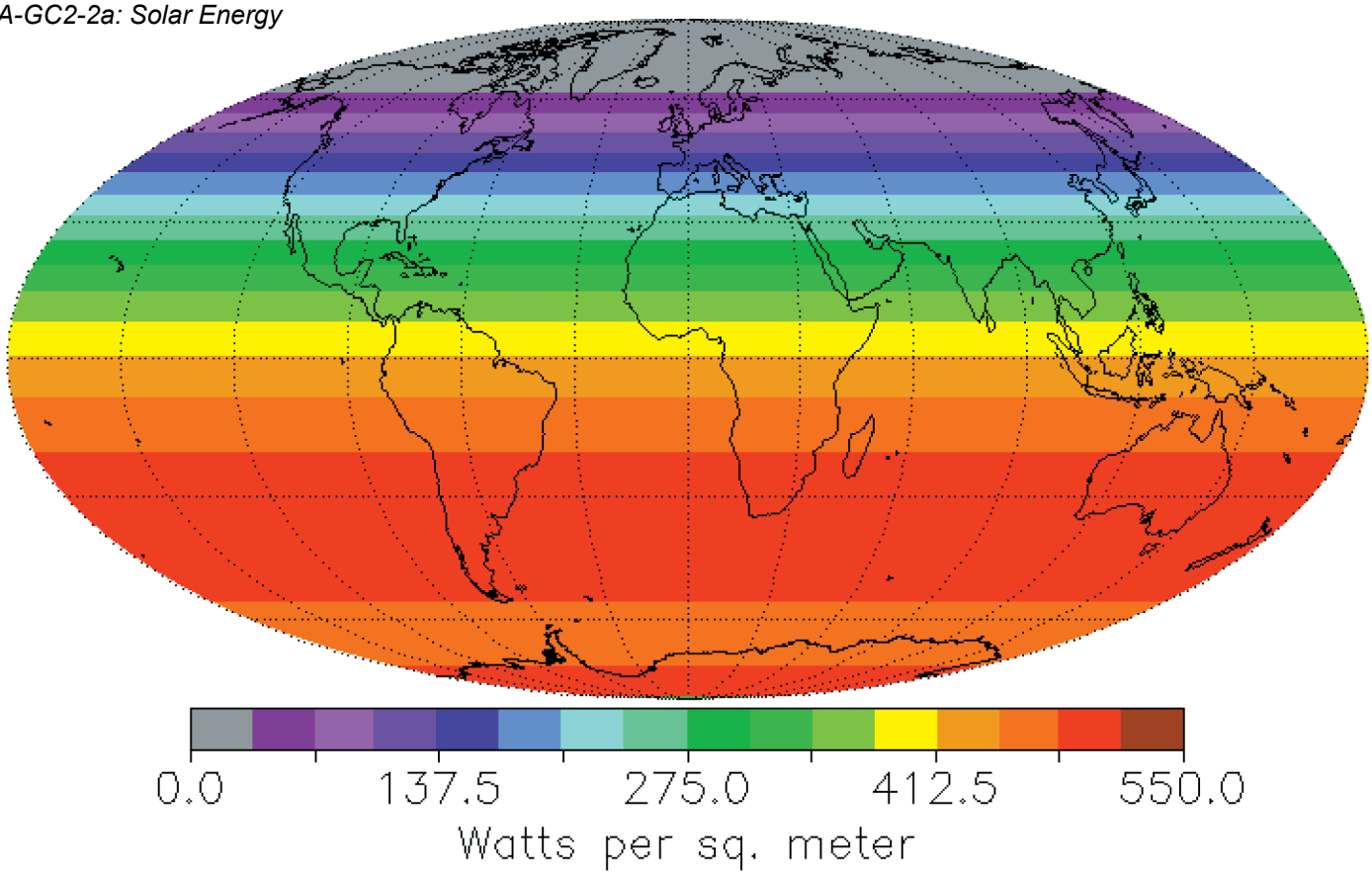


Figure EA-GC2-1c: MTSAT image of Asia and the Pacific 4 March 2015

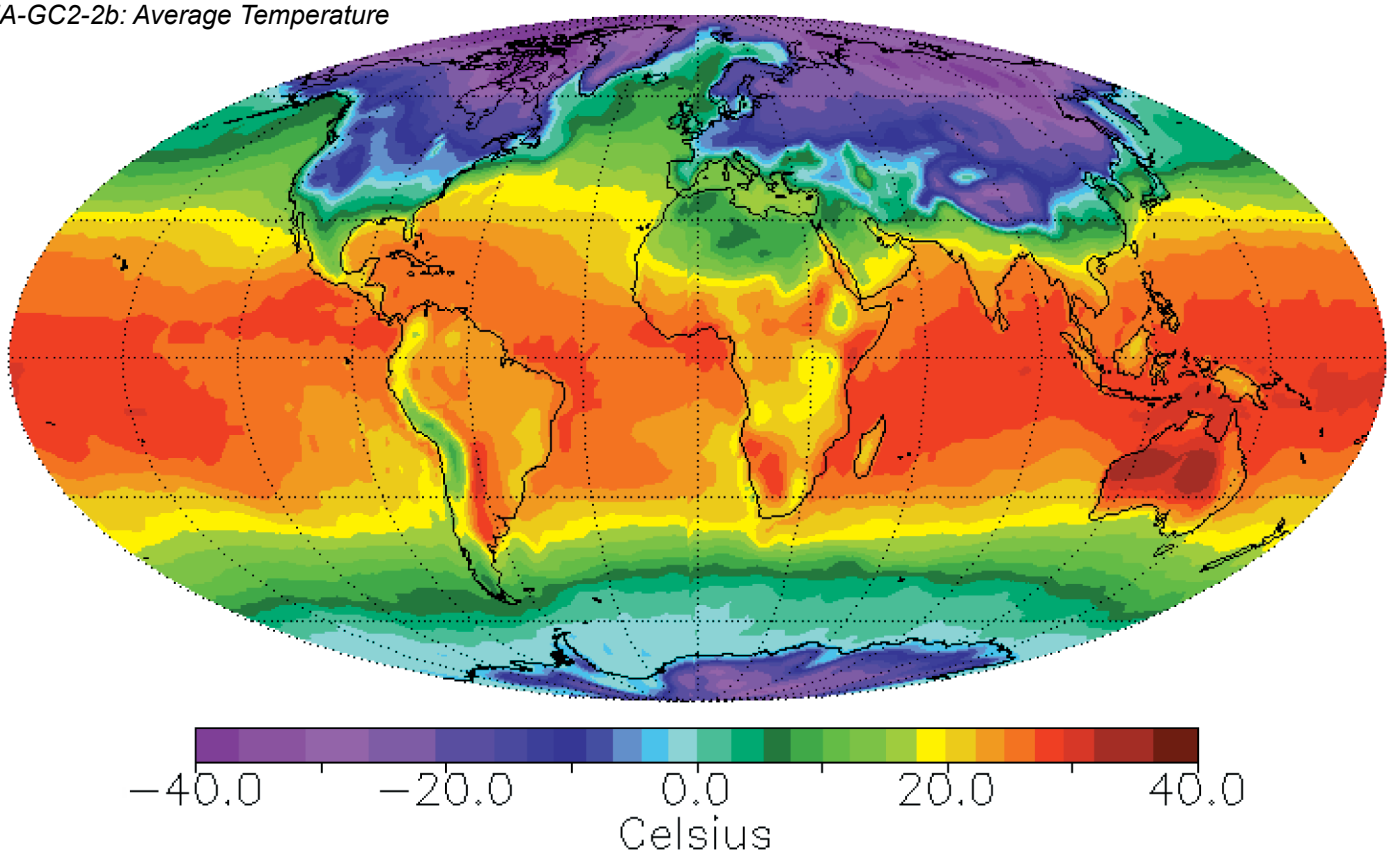


EA-GC2-2a-f: 6 maps showing the whole Earth in the month of January from the GLOBE Earth System Poster, Exploring the Connections in a Typical Year, showing a) Solar Energy, b) Average Temperature, c) Cloud Cover, d) Precipitation, e) Soil Moisture, f) Vegetation

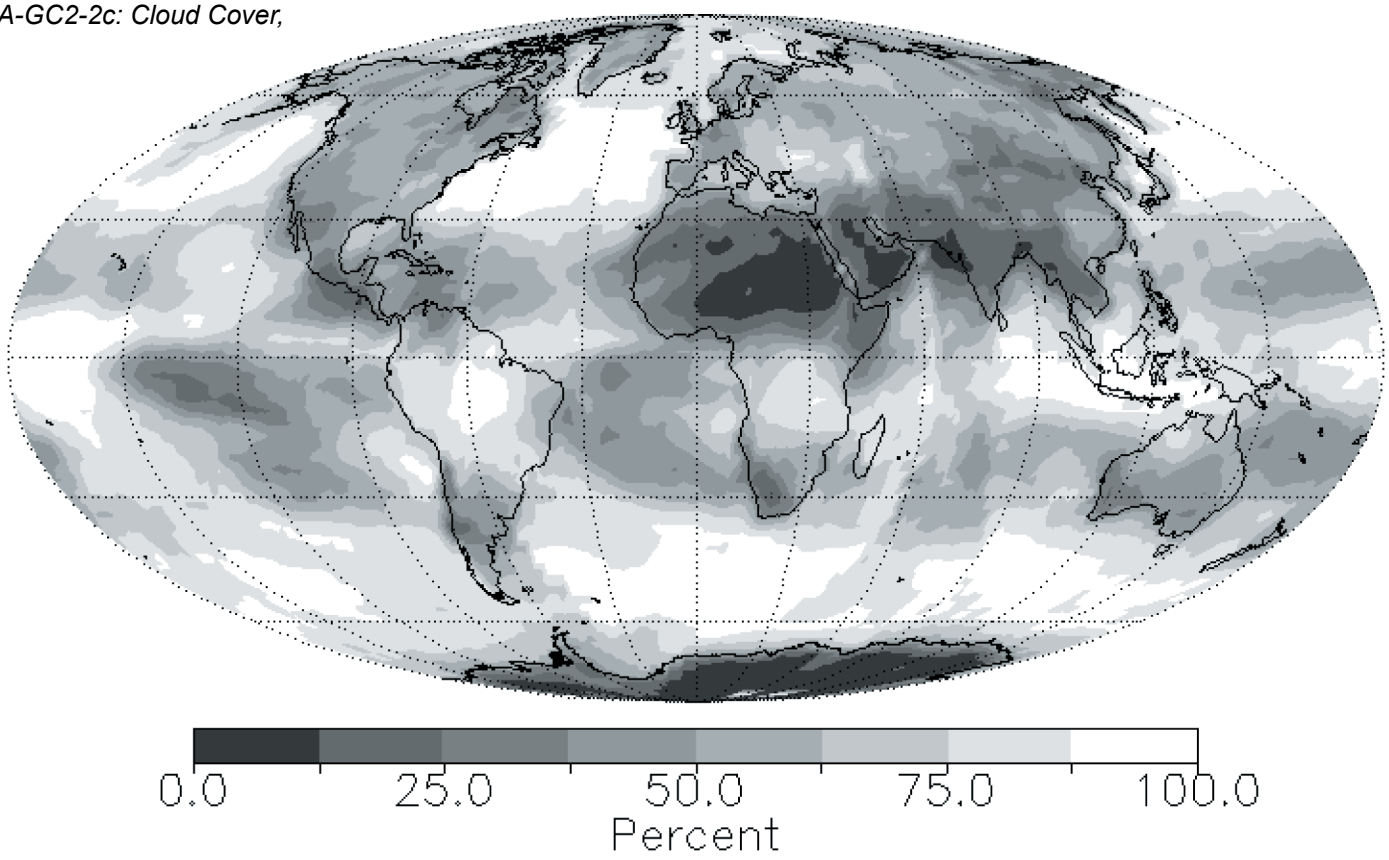
EA-GC2-2a: Solar Energy



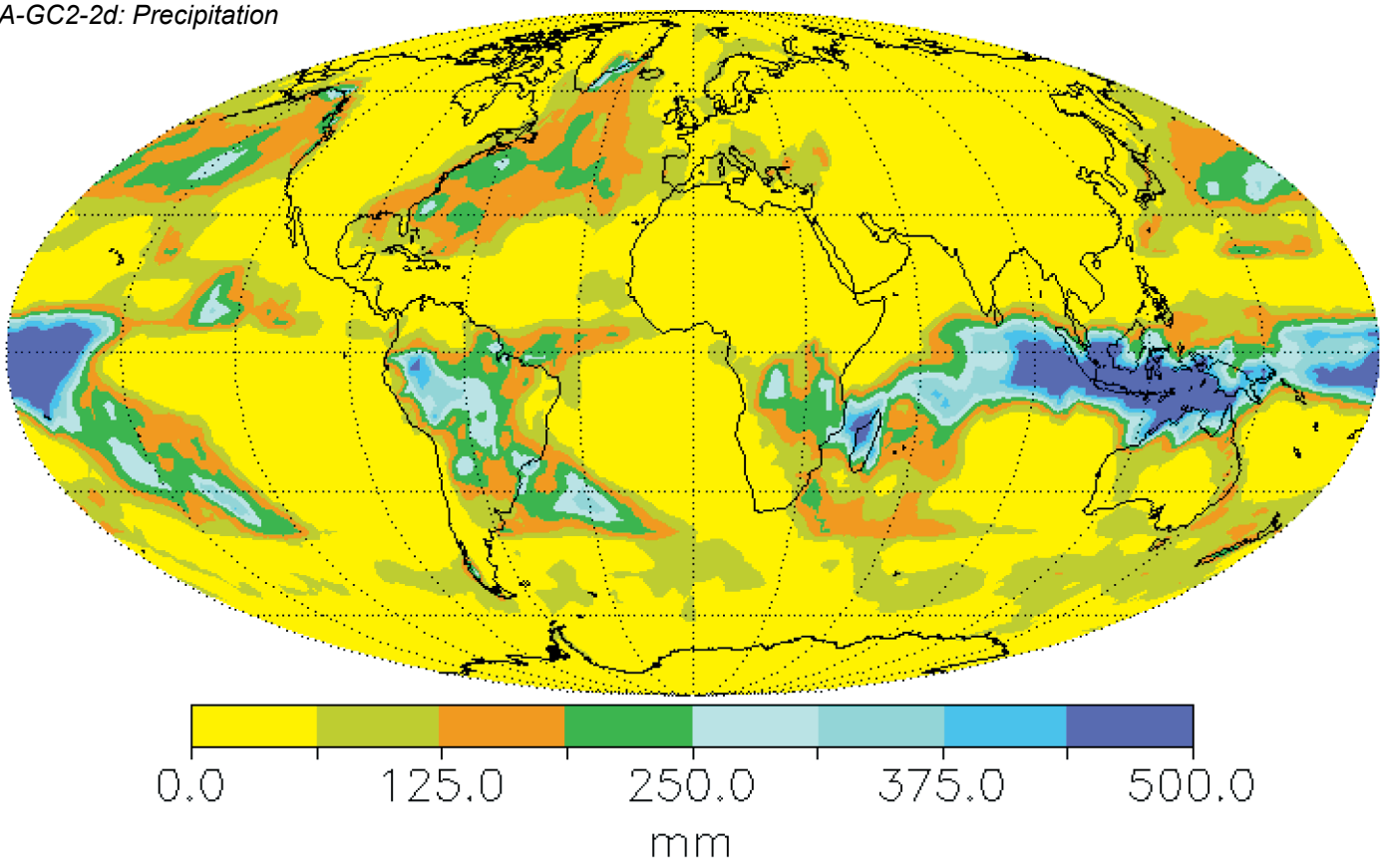
EA-GC2-2b: Average Temperature



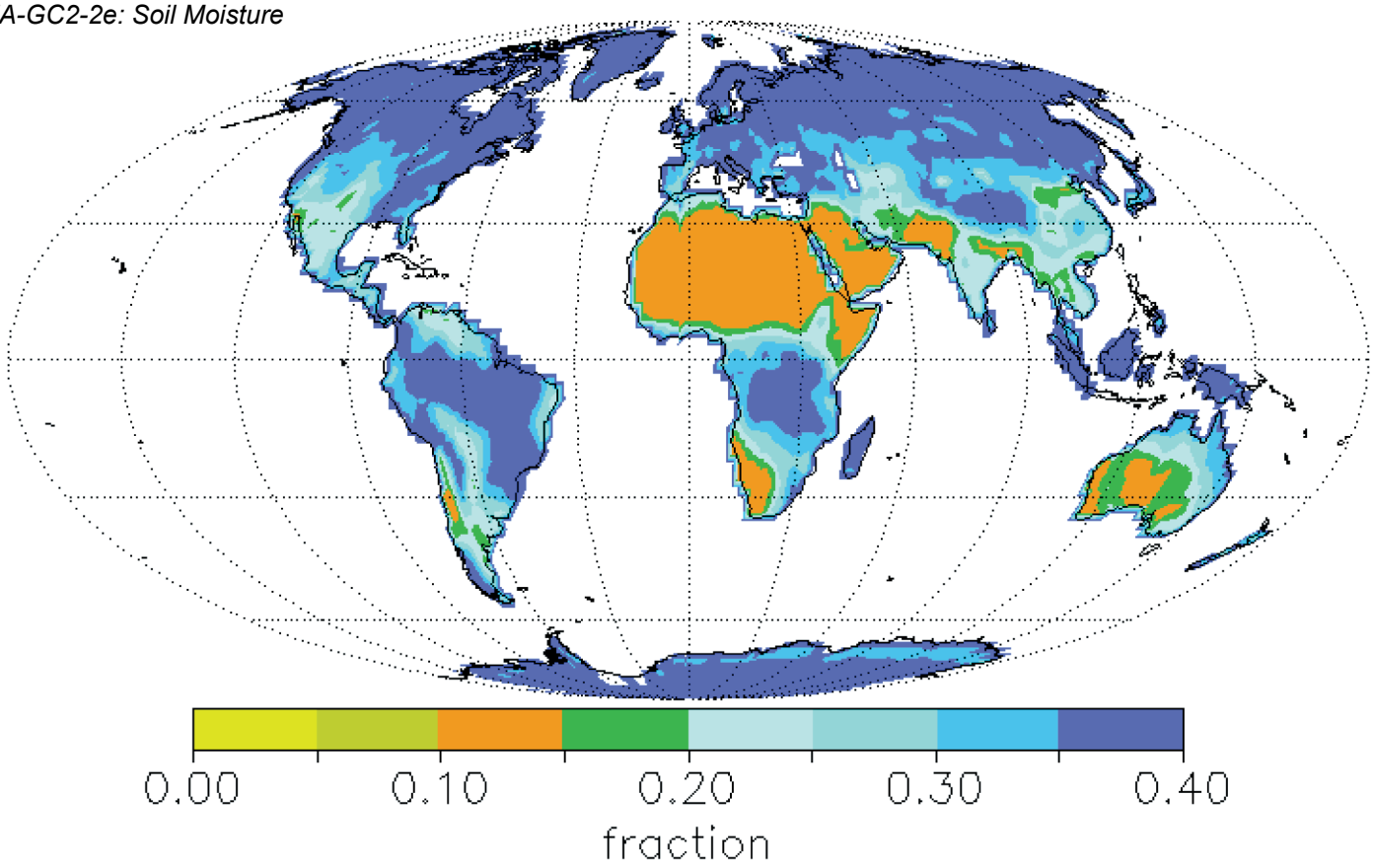
EA-GC2-2c: Cloud Cover,



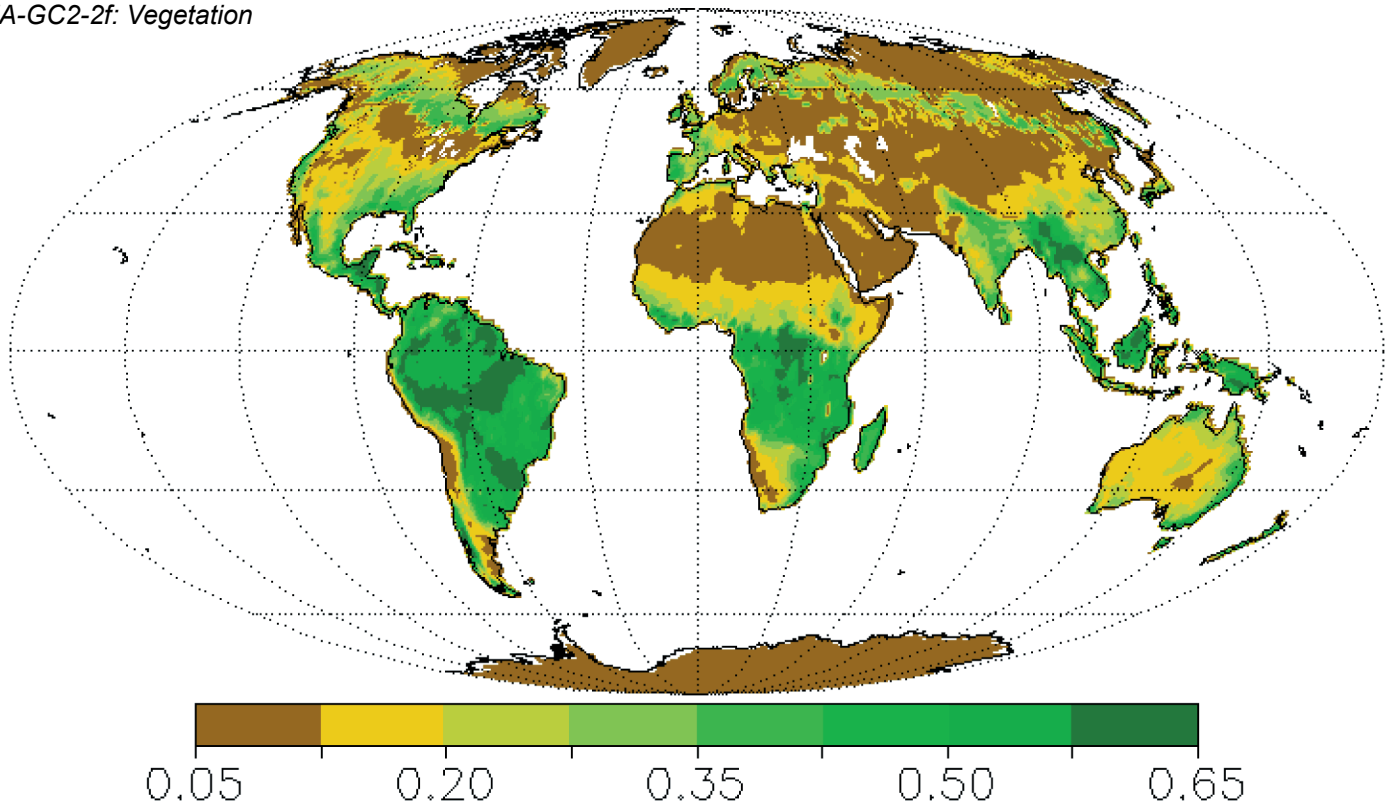
EA-GC2-2d: Precipitation



EA-GC2-2e: Soil Moisture



EA-GC2-2f: Vegetation



Assessment Rubric: *GC1: Water at the Global Scale*

Water at the Global Scale				
	4	**3**	**2**	**1**
List of System Components Represented in Global Images	Completely and accurately lists all major components and to which wind blows	Completely and accurately lists most major components	Partially lists major components	Makes little attempt to accurately or completely list components
Description of Water Pathway Through Components at Global Scale	Fully describes pathway of water through components, accurately and with elaborate detail	Adequately and accurately describes pathway of water through components	Partially describes pathway of water through components	Describes very little of pathway of water through components
List of System Components Associated with Steps along Water Pathway	Accurately lists all components associated with each step along pathway	Accurately lists most components associated with each step along pathway	Partially lists components associated with each step along pathway	Lists few components associated with pathway
Diagram of Water at the Global Scale	Completely and clearly represents interconnections that water makes among components at the global scale, and demonstrates all expected science knowledge	Completely and clearly represents most interconnections that water makes among components, and demonstrates most expected science knowledge	Somewhat clearly represents a few interconnections that water makes among components, and demonstrates some expected science knowledge	Inadequately develops interconnections among components of site,and demonstrates little expected science knowledge

Figure EA-GC2-3: Sample Beginning Student Diagram for Journey of a Water Drop

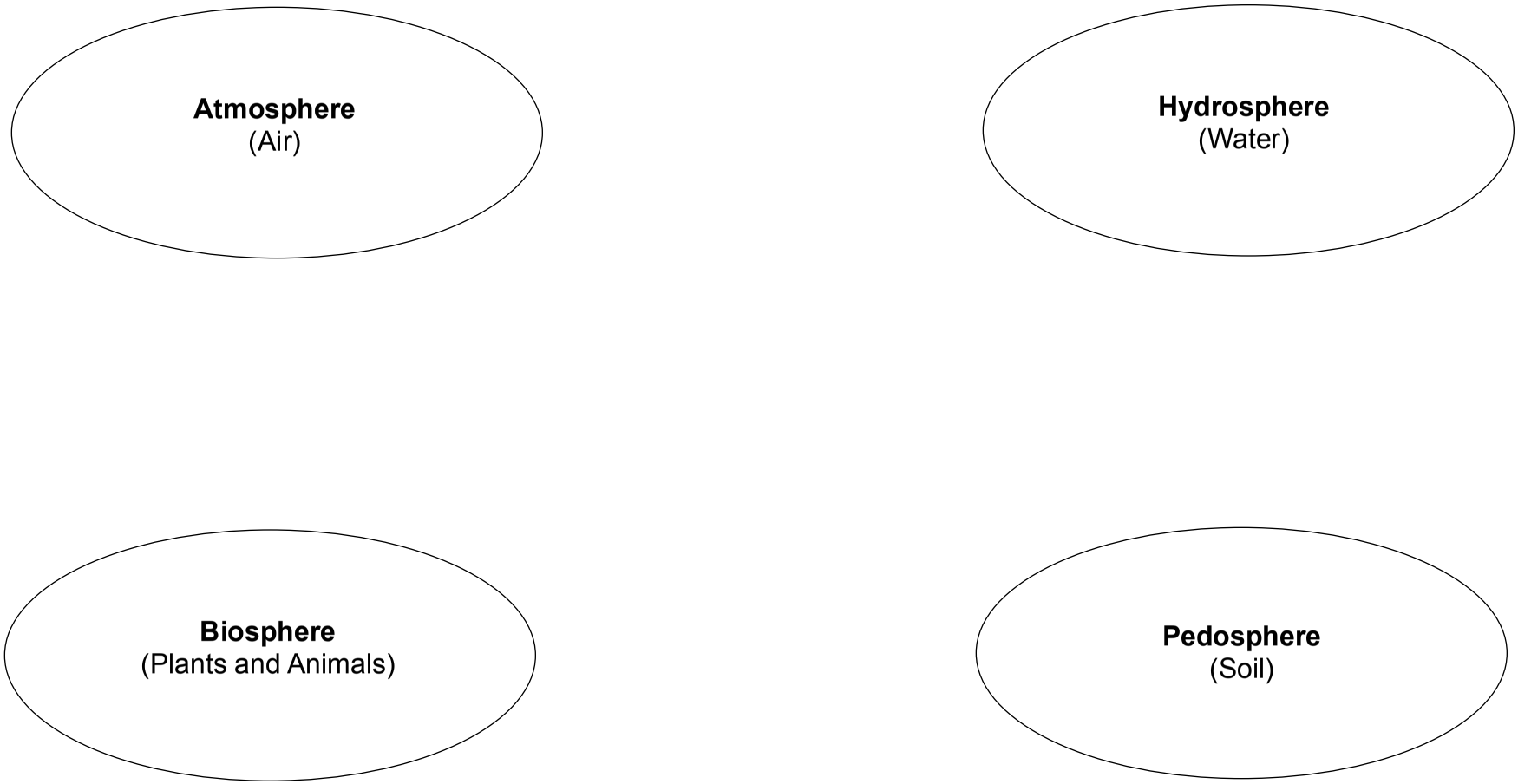


Figure EA-GC2-4: Sample Completed Student Diagram for Journey of a Water Drop