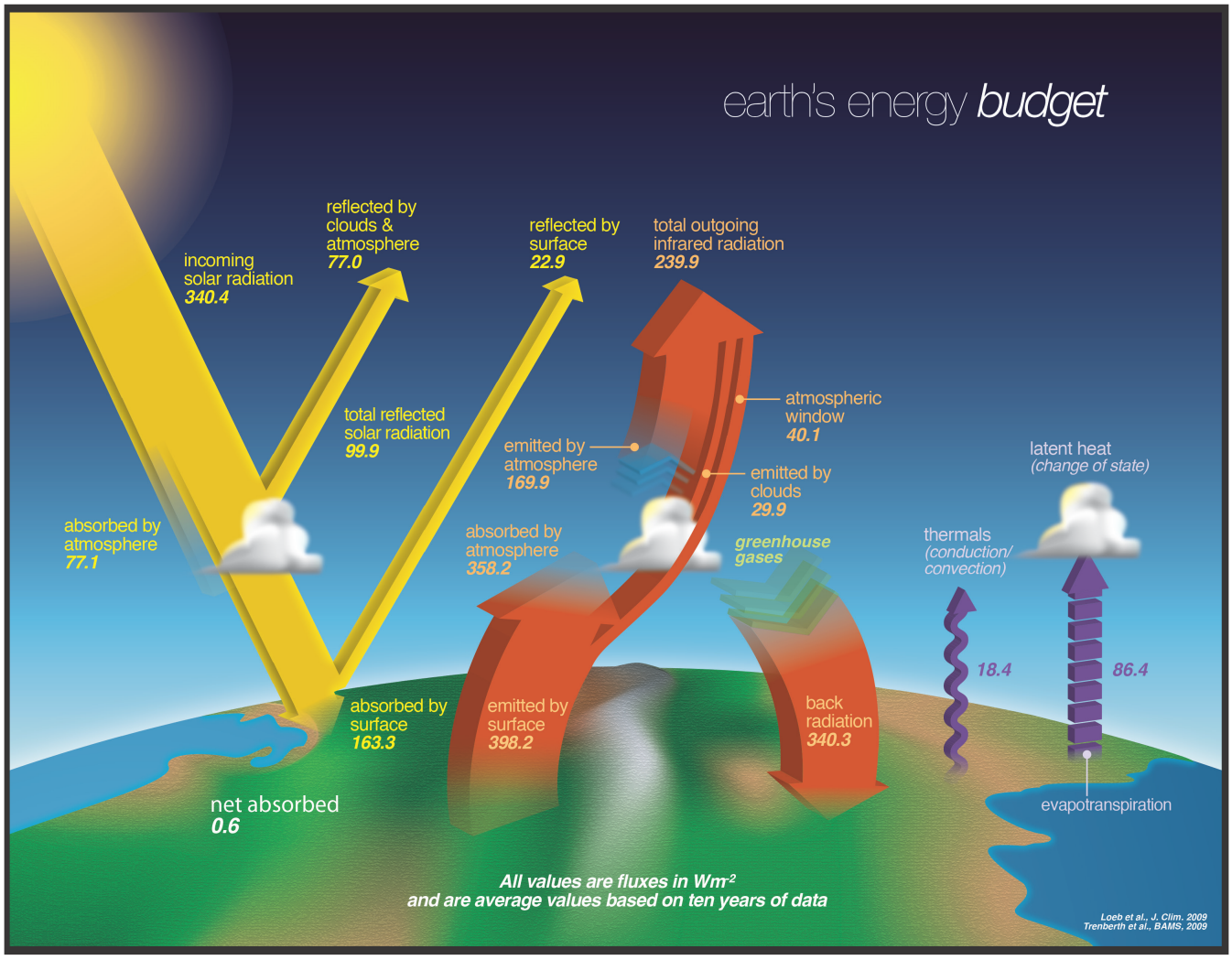
My NASA Data - GLOBE Connections

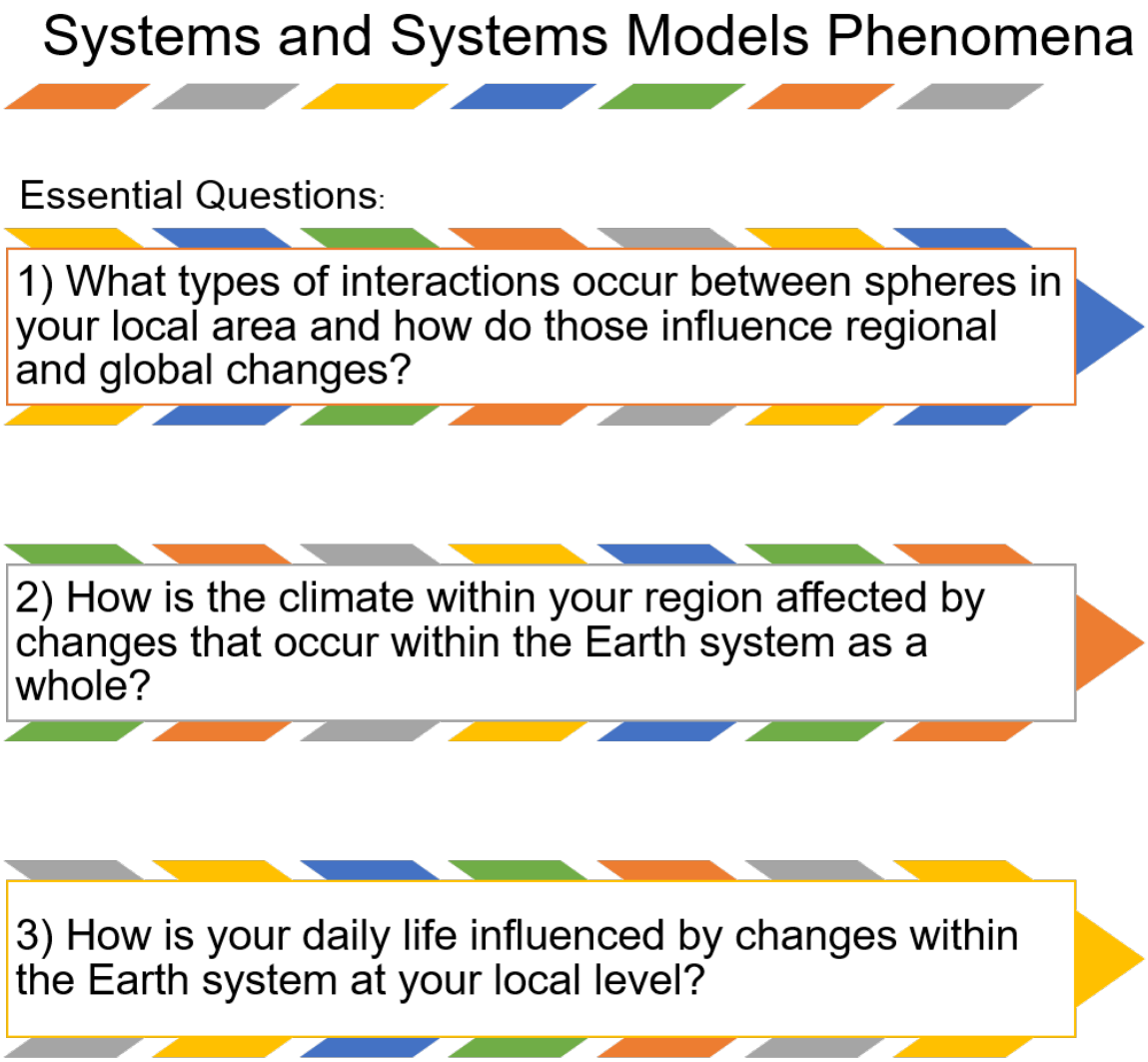
GLOBE Connections: Systems and System Models

National Aeronautics and Space Administration



www.nasa.gov

Earth as a System: The GLOBE Program provides students with the ability to explore Earth as a System by examining data sets and exploring protocols related to the Atmosphere, Biosphere, Hydrosphere, and Geosphere (soil, specifically). As they participate in a variety of learning opportunities, students gain insight into the Earth as a System from the local, regional and global perspectives. Through participation in GLOBE, students have the opportunity to contribute to the understanding of how Earth functions as a system through their own data collection and research.



GLOBE Student Research Process

Be a Scientist: The GLOBE Program encourages you to use GLOBE data to help answer questions about how the environment works. Through research projects, you can answer your own science questions by creating hypotheses, analyzing data, drawing conclusions, and sharing your results. Scientific projects that you conduct and that include the use of GLOBE data or protocols can be submitted by your teacher for publication on this GLOBE website. By sharing your findings with the rest of the world you are completing the scientific process.

Video: Real World Citizen Science

Video

Real World Citizen Science | https://www.youtube.com/watch?v=OI0PooqYP0Q | Source: The GLOBE Program

Steps in the Scientific Process: Science is something you can do. And doing science makes you a scientist! So, what do scientists do? They observe the world around them, ask questions, and use evidence (data) to answer the questions. They identify useful data that already exist or take new measurements. They also do calculations and analyze their data to draw conclusions about the questions they asked. Finally, and most importantly, they communicate their results so everyone can benefit from their work. By doing science, scientists gain a better understanding of the world around them and share that understanding with the whole world. Here are the steps that a scientist takes to conduct a research investigation. By following these steps, you can be a scientist!

Observe Nature: Looking at the world around you is an important first step in scientific research. There are many ways to explore the world and to help identify the area you want to investigate.

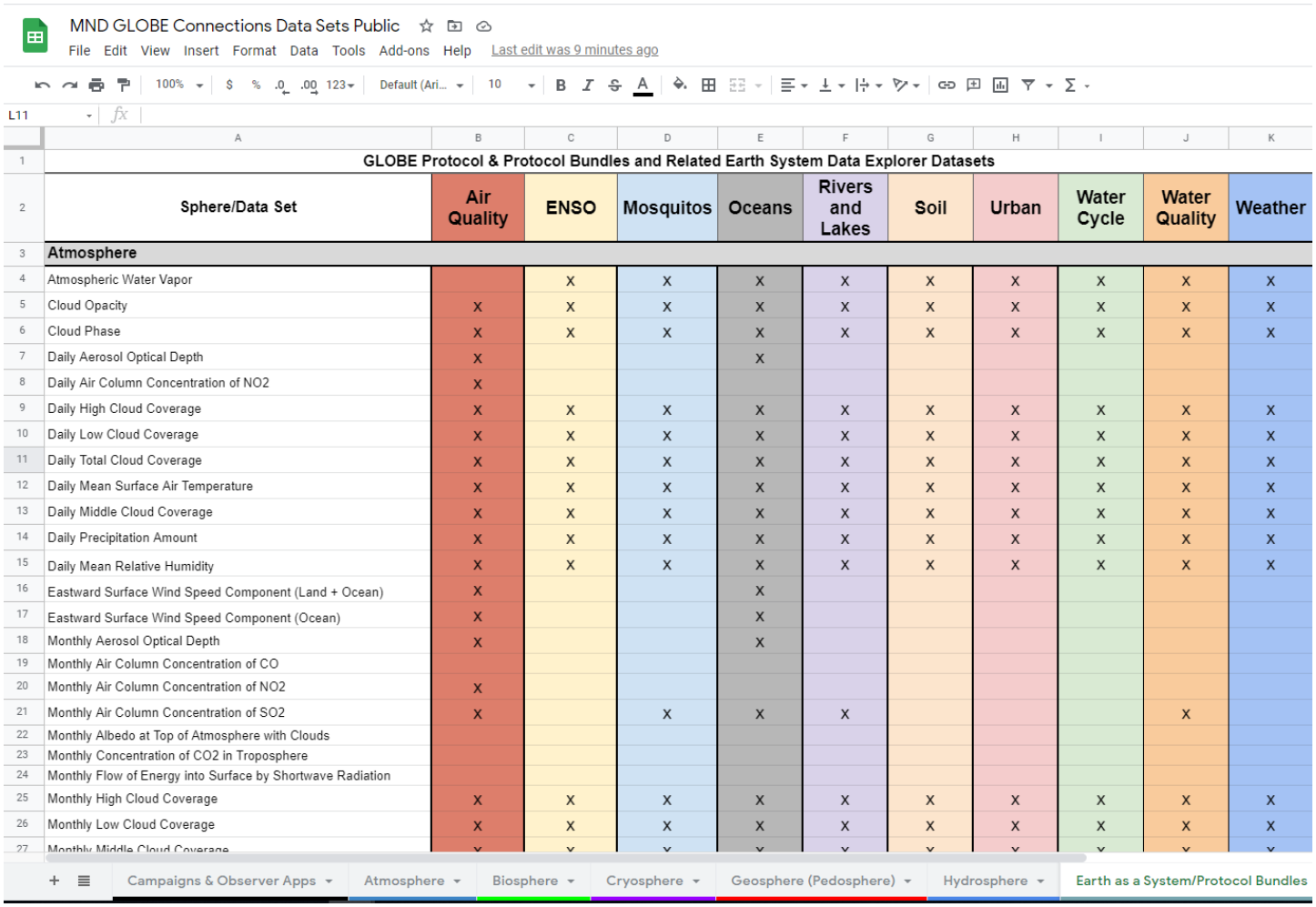
Protocol Bundles

The GLOBE Protocol Bundles focused on an Earth-as-a-system approach to phenomena are linked below. Each GLOBE Protocol Bundle page has a summary of the bundle, a list of the protocols included and additional information. **Online e-Training is available** for all protocols.

- **Air Quality**
- **ENSO**
- **Mosquito**
- **Ocean**
- **Rivers and Lakes**
- **Soil**
- **Urban**
- **Water Cycle**
- **Water Quality**
- **Weather**

Explore the MND GLOBE Connections Datasets spreadsheet to review the range of datasets available to integrate with GLOBE Protocol Bundle research by visiting the MND GLOBE

[Connections Data Sets Public link](#).



MND GLOBE Connections Data Sets Public

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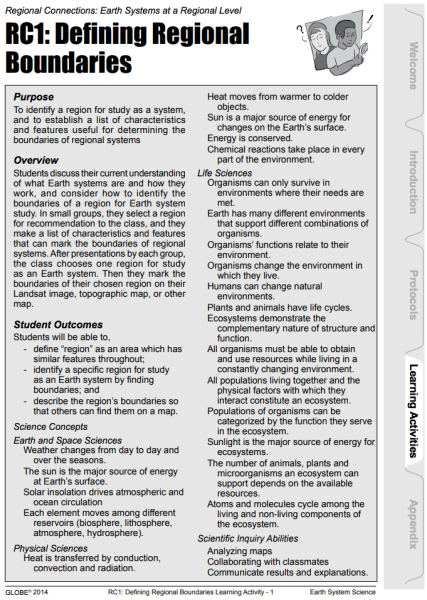
	A	B	C	D	E	F	G	H	I	J	K
1	GLOBE Protocol & Protocol Bundles and Related Earth System Data Explorer Datasets										
2	Sphere/Data Set	Air Quality	ENSO	Mosquitos	Oceans	Rivers and Lakes	Soil	Urban	Water Cycle	Water Quality	Weather
3	**Atmosphere**										
4	Atmospheric Water Vapor		x	x	x	x	x	x	x	x	x
5	Cloud Opacity	x	x	x	x	x	x	x	x	x	x
6	Cloud Phase	x	x	x	x	x	x	x	x	x	x
7	Daily Aerosol Optical Depth	x			x						
8	Daily Air Column Concentration of NO2	x									
9	Daily High Cloud Coverage	x	x	x	x	x	x	x	x	x	x
10	Daily Low Cloud Coverage	x	x	x	x	x	x	x	x	x	x
11	Daily Total Cloud Coverage	x	x	x	x	x	x	x	x	x	x
12	Daily Mean Surface Air Temperature	x	x	x	x	x	x	x	x	x	x
13	Daily Middle Cloud Coverage	x	x	x	x	x	x	x	x	x	x
14	Daily Precipitation Amount	x	x	x	x	x	x	x	x	x	x
15	Daily Mean Relative Humidity	x	x	x	x	x	x	x	x	x	x
16	Eastward Surface Wind Speed Component (Land + Ocean)	x			x						
17	Eastward Surface Wind Speed Component (Ocean)	x			x						
18	Monthly Aerosol Optical Depth	x			x						
19	Monthly Air Column Concentration of CO										
20	Monthly Air Column Concentration of NO2	x									
21	Monthly Air Column Concentration of SO2	x		x	x	x				x	
22	Monthly Albedo at Top of Atmosphere with Clouds										
23	Monthly Concentration of CO2 in Troposphere										
24	Monthly Flow of Energy into Surface by Shortwave Radiation										
25	Monthly High Cloud Coverage	x	x	x	x	x	x	x	x	x	x
26	Monthly Low Cloud Coverage	x	x	x	x	x	x	x	x	x	x
27	Monthly Middle Cloud Coverage	x	x	x	x	x	x	x	x	x	x

Campaigns & Observer Apps | Atmosphere | Biosphere | Cryosphere | Geosphere (Pedosphere) | Hydrosphere | Earth as a System/Protocol Bundles

Learning Activities

Perceiving Earth as a system begins when we first feel warmth from sunshine or get wet standing in the rain. Understanding Earth as a system requires a quantitative exploration of the connections among all parts (atmosphere, hydrosphere, lithosphere, and biosphere) of the system. The measurements of The GLOBE Program provide students with the means to begin this exploration for themselves. The processes comprising the global environment are interconnected. Many of the major environmental issues of our time have driven scientists to study how these connections operate on a global basis – to understand Earth as a system. Using GLOBE Earth System Learning Activities can guide students in the development of their own personal connections with the different components of the Earth system and how these interact with each other.

[Regional Connections-Defining Regional Boundaries](#) (RC1):



Regional Connections: Earth Systems at a Regional Level

RC1: Defining Regional Boundaries

Purpose

To identify a region for study as a system, and to establish a list of characteristics and features useful for determining the boundaries of regional systems

Overview

Students discuss their current understanding of what Earth systems are and how they work, and consider how to identify the boundaries of a region for Earth system study. In small groups, they select a region for recommendation to the class, and they make a list of characteristics and features that can mark the boundaries of regional systems. After presentations by each group, the class chooses one region for study as an Earth system. Then they mark the boundaries of their chosen region on their Landsat image, topographic map, or other map.

Student Outcomes

Students will be able to,

- define "region" as an area which has similar features throughout;
- identify a specific region for study as an Earth system by finding boundaries; and
- describe the region's boundaries so that others can find them on a map.

Science Concepts

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).

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.

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 maps
Collaborating with classmates
Communicate results and explanations.

GLOBE® 2014 RC1: Defining Regional Boundaries Learning Activity - 1 Earth System Science

Welcome Introduction Protocols Learning Activities Appendix

Overview: Students discuss their current understanding of what Earth systems are and how they work, and consider how to identify the boundaries of a region for their Earth system study. In small groups, they select a region for recommendation to the class, and they make a list of characteristics and features that can mark the boundaries of regional systems. After presentations by each group, the class chooses one region for study as an Earth system.

Student Outcomes:

- Define "region" as an area that has similar features throughout
- Identify a specific region for study as an Earth system by finding boundaries
- Describe the region's boundaries so that others can find them on a map

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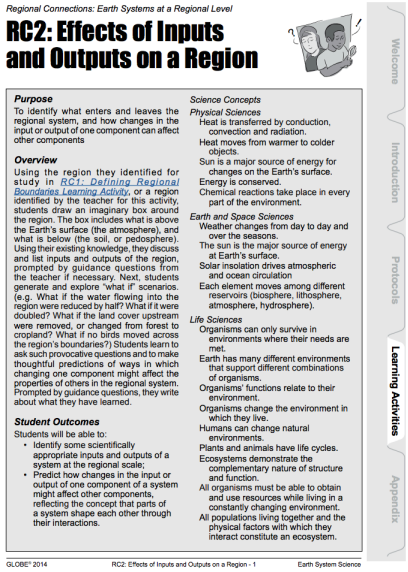
Regional Connections-Effects of Inputs and Outputs on a Region (RC2):

Overview: Using the region they identified for study in RC1: Defining Regional



Regional Connections: Earth Systems at a Regional Level

RC2: Effects of Inputs and Outputs on a Region

Purpose

To identify what enters and leaves the regional system, and how changes in the input or output of one component can affect other components

Overview

Using the region they identified for study in *RC1: Defining Regional Boundaries Learning Activity*, or a region identified by the teacher for this activity, students draw an imaginary box around the region. The box includes what is above the Earth's surface (the atmosphere), and what is below (the soil, or pedosphere). Using their existing knowledge, they discuss and list inputs and outputs of the region, prompted by guidance questions from the teacher if necessary. Next, students generate and explore "what if" scenarios. (e.g. What if the water flowing into the region were reduced by half? What if it were doubled? What if the land cover upstream were removed, or changed from forest to cropland? What if no birds moved across the region's boundaries?) Students learn to ask such provocative questions and to make thoughtful predictions of ways in which changing one component might affect the properties of others in the regional system. Prompted by guidance questions, they write about what they have learned.

Student Outcomes

Students will be able to:

- Identify some scientifically appropriate inputs and outputs of a system at the regional scale;
- Predict how changes in the input or output of one component of a system might affect other components, reflecting the concept that parts of a system shape each other through their interactions.

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.

GLOBE® 2014 RC2: Effects of Inputs and Outputs on a Region - 1 Earth System Science

Welcome Introduction Protocols Learning Activities Appendix

Boundaries Learning Activity, or a region identified by the teacher for this activity, students draw an imaginary box around the region. The box includes what is above the Earth's surface (the atmosphere), and what is below (the soil, or pedosphere). Using their existing knowledge, they discuss and list the inputs and outputs of the region, prompted by guidance questions from the teacher if necessary. Next, students generate and explore "what if" scenarios.

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Student Outcomes:

- Identify some scientifically appropriate inputs and outputs of a system at the regional scale;
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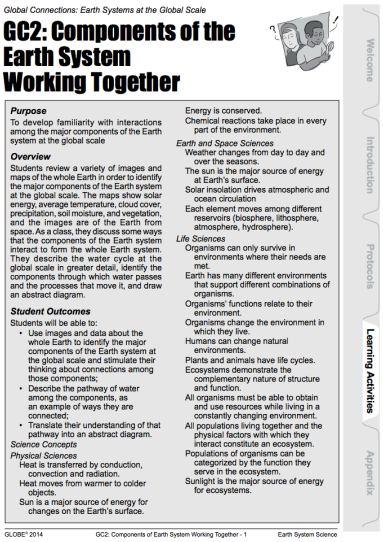
Global Connections (GC2) -Components of the Earth System Working Together:


Global Connections: Earth Systems at the Global Scale

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
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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.

Welcome Introduction Protocols Learning Activities Appendix

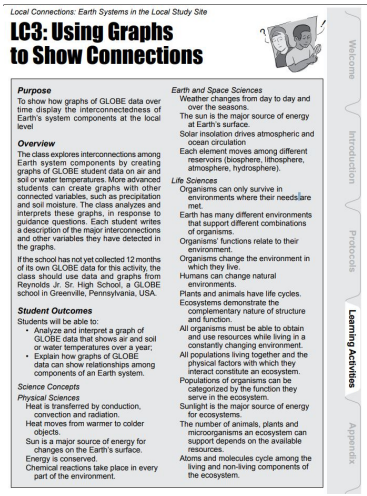
GLOBE® 2014 GC2: Components of Earth System Working Together - 1 Earth System Science

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 a 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:

- 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

A Local Connection-LC3: Using Graphs to Show Connections:



Local Connections: Earth Systems in the Local Study Site

LC3: Using Graphs to Show Connections

Purpose

To show how graphs of GLOBE data over time display the interconnectedness of Earth's system components at the local level

Overview

The class explores interconnections among Earth system components by creating graphs of GLOBE student data on air and soil or water temperatures. More advanced students can create graphs with other connected variables, such as precipitation and soil moisture. The class analyzes and interprets these graphs, in response to guidance questions. Each student writes a description of the major interconnections and other variables they have detected in the graphs.

If the school has not yet collected 12 months of its own GLOBE data for this activity, the class should use data and graphs from Reynolds Jr. Sr. High School, a GLOBE school in Greenville, Pennsylvania, USA.

Student Outcomes

Students will be able to:

- Analyze and interpret a graph of GLOBE data that shows air and soil or water temperatures over a year;
- Explain how graphs of GLOBE data can show relationships among components of an Earth system.

Science Concepts

Physical Sciences

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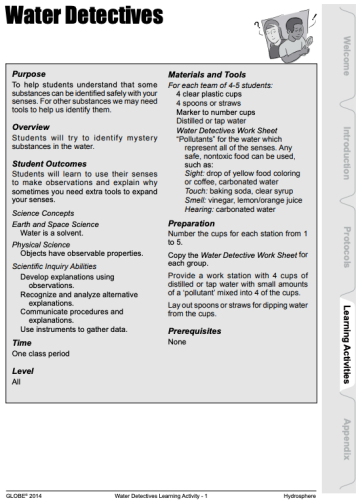
Student Outcomes:

- Analyze and interpret a graph of GLOBE data that shows air and soil or water temperatures over a year;
- Explain how graphs of GLOBE data can show relationships among components of an Earth system.



Water Detectives

Purpose

To help students understand that some substances can be identified safely with your senses. For other substances we may need tools to help us identify them.

Overview

Students will try to identify mystery substances in the water.

Student Outcomes

Students will learn to use their senses to make observations and explain why sometimes you need extra tools to expand your senses.

Science Concepts

Earth and Space Science

Water is a solvent.

Physical Science

Objects have observable properties.

Scientific Inquiry Abilities

Develop explanations using observations.
Recognize and analyze alternative explanations.
Communicate procedures and explanations.
Use instruments to gather data.

Time

One class period

Level

All

Materials and Tools

For each team of 4-5 students:
4 clear plastic cups
4 spoons or straws
Marker to number cups
Distilled or tap water
Water Detectives Work Sheet
"Pollutants" for the water which represent all of the senses. Any safe, nontoxic food can be used, such as:
Sight: drop of yellow food coloring or coffee, carbonated water
Touch: baking soda, clear syrup
Smell: vinegar, lemon/orange juice
Hearing: carbonated water

Preparation

Number the cups for each station from 1 to 5.

Copy the *Water Detective Work Sheet* for each group.

Provide a work station with 4 cups of distilled or tap water with small amounts of a 'pollutant' mixed into 4 of the cups.

Lay out spoons or straws for dipping water from the cups.

Prerequisites

None

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GLOBE® 2014 Water Detectives Learning Activity - 1 Hydrosphere

[Water Detectives]:

Overview: Students will try to identify mystery substances in the water.

Student Outcomes:

- Students will learn to use their senses and explain why sometimes you need extra tools to expand your senses.
- Water is a solvent.
- Objects have observable properties.