National Aeronautics and
Space Administration

**Langley Research Center**
Hampton, VA 23681-2199

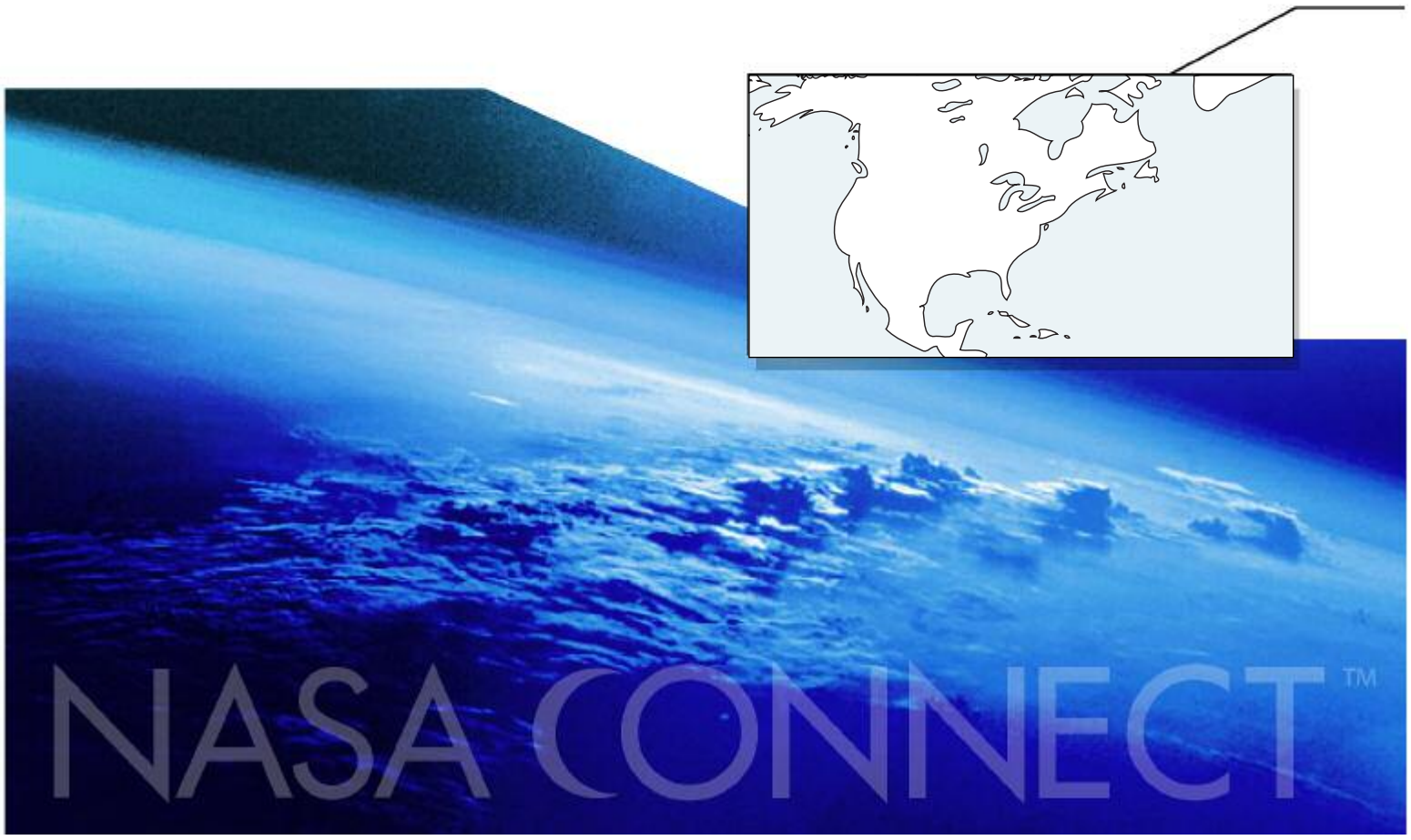
| Educational Product | |
|---|---|
| Educators | Grades 6-8 |

EG-2003-09-15-LARC

# NASA CONNECT™

# VIRTUAL EARTH

**An Educator Guide with Activities in Mathematics, Science, and Technology**



NASA CONNECT™: *Virtual Earth* is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address:
**http://spacelink.nasa.gov/products**

A PDF version of the educator guide for NASA CONNECT™ can be found at the NASA CONNECT™ web site: **http://connect.larc.nasa.gov**

NASA CONNECT™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA, and is a collaborative endeavor of NASA with the organizations below. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA.
Use of trade names does not imply endorsement by NASA.

AIAA FOUNDATION
www.aiaa.org

CHRISTOPHER NEWPORT UNIVERSITY
www.cnu.edu

NCTM
www.nctm.org

Council of the Great City Schools
www.cgcs.org

www.getmagic.net

ITEA
International Technology Education Association
www.iteawww.org

NSTA
www.nsta.org

AECC
Aerospace Education Coordinating Committee
www.nasa.gov

NEC
NEC Foundation of America
www.nec.com

knowitall.org
http://knowitall.org

NASA CONNECT™

# VIRTUAL EARTH

**An Educator Guide with Activities in Mathematics, Science, and Technology**



AIAA FOUNDATION Registered users of NASA CONNECT™ may request an American Institute of Aeronautics and Astronautics (AIAA) classroom mentor. For more information or to request a mentor, e-mail **nasaconnect@aiaa.org**.

CC Captioning provided by NEC Foundation of America


**Acknowledgments:** Special thanks to Anne Arundel County Public Schools, Summer 2003 Educators in Residence, Chris Giersch, and The National Council of Teachers of Mathematics (NCTM).

# program overview

## SUMMARY AND OBJECTIVES

In NASA CONNECT™: *Virtual Earth*, students will be introduced to Earth system science. They will learn what a system is and how to apply the concept of systems to learn more about how the Earth functions. Students will understand the only way to really comprehend the workings of our planet is to look at the Earth as a whole system. They will also focus on Earth science applications of national priority to expand and accelerate the use of knowledge, science, and technologies resulting from the Earth Science Enterprise mission of improving predictions in weather, climate, and natural hazards. By conducting inquiry-based and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

## STUDENT INVOLVEMENT

**Inquiry-Based Questions**

Host, Jennifer Pulley, and NASA scientists and engineers will pose inquiry-based questions throughout the program. These questions allow the students to investigate, discover, and critically think about the concepts being presented. When viewing a videotape or DVD version of NASA CONNECT™, educators should pause the program at designated segments so students can answer and discuss the inquiry-based questions. During the program, Jennifer Pulley and NASA scientists and engineers will indicate the appropriate time to pause the tape or DVD. For more information on inquiry-based learning, visit the NASA CONNECT™ web site, ***http://connect.larc.nasa.gov***.

**Hands-On Activity**

The hands-on activity is teacher created and is aligned with the National Council of Teachers of Mathematics (NCTM) Standards, the National Science (NSTA) Standards, and the International Technology Education Association (ITEA) Standards. Students will model a familiar Earth system by using standard system symbols.

**Web Activity**

The web activities, Earthquake Hunters and Waterworld, are created by SPACESTARS and are aligned with the National Council of Teachers of Mathematics (NCTM) Standards, the National Science (NSTA) Standards, and the International Technology Education Association (ITEA) Standards. In Earthquake Hunters, students will step into the shoes of the scientists studying information from a NASA satellite and take a look at the tectonic activity on Earth. Can you forecast where the next earthquakes will happen? In Waterworld, students will use satellite technology imagery from NASA and Geographic Information Systems (GIS) to allow them to explore the impact the cryosphere has on the Earth. What would happen to humans if the polar ice caps of Antarctica completely melted? To access Earthquake Hunters and Waterworld, go to the NASA CONNECT™ web site ***http://connect.larc.nasa.gov.***

## RESOURCES

Teacher and student resources support, enhance, and extend the NASA CONNECT™ program. Books, periodicals, pamphlets, and web sites provide teachers and students with background information and extensions. In addition to the resources listed in this educator guide, the NASA CONNECT™ web site ***http://connect.larc.nasa.gov*** offers online resources for teachers, students, and parents.

# hands-on activity

## BACKGROUND

Scientists have established a new field of science called Earth System Science. The Earth is a system of individual parts that work together as a complex whole. Earth System Science is an integration of many scientific disciplines including geology, biology, chemistry, physics, oceanography, meteorology, computer science, and all other sciences that study life and the Earth.

NASA scientists use modern technologies to measure key features of our planet, such as concentrations of gases in the atmosphere and the temperature of the ocean in many locations. Satellites orbiting our planet provide enormous amounts of data that scientists use to try to understand how our planet works and what kinds of changes are happening.

Earth science, long perceived as a minor field compared to biology or the physical sciences, is emerging as an important field of study because of the new ability of humans to change the balance of the Earth system. And with Earth System Science, students will have greater opportunities to learn through inquiry, exploration, and discovery, aided by the expanded use of the Internet and visualization technology. It is fair to say that the quality of life depends on the knowledge of the Earth scientists and on the awareness that citizens have about the Earth system. Understanding the land, air, water, and life of our planet gives us the knowledge to best manage the world around us.

### *To understand and protect our home planet…*

We have come to understand that the only way to really comprehend our climate and to protect the scarce resources of our little blue planet is to look at the Earth as a single, whole system. This holistic approach allows us to see how the oceans affect climate on land, for example, and how natural and man-made environmental hazards in one part of the world affect other parts of the world.

From the unique vantage point of space, we can see, and more importantly, predict, how dust storms in the Sahara will affect crops in the American Midwest; we can predict how mosquito-borne diseases will spread; and we can tell farmers which parts of their fields need fertilizer and which parts do not.

NASA's job is to develop the technologies of the future to meet its mission and then to turn that technology loose so that government and America's entrepreneurs can create products for the greater good to serve the important objective of environmental protection.

*~ Sean O'Keefe, NASA Administrator*

## INSTRUCTIONAL OBEJECTIVES

The student will

- model a familiar Earth system by using standard system symbols.

## NATIONAL STANDARDS

**NCTM Mathematics Standards**

Representation

- Use representation to model and interpret physical, social, and mathematical phenomena

**NSTA Science Standards**

Unifying Concepts and Processes

- Systems, order, and organization

Science as Inquiry

- Abilities necessary to do scientific inquiry

Earth and Space Science

- Structure of the Earth system

**ITEA Standards for Technological Literacy**

Standard 12: Students will develop abilities to use and maintain technological products and systems.

## NASA RELEVANCE

Scientists and engineers use system diagrams frequently to design and plan future NASA missions.

## PREPARING FOR THE ACTIVITY

**Student Materials**

- Technical Passage: The Global Water Cycle
- journals or notebooks

**Teacher Materials**

- Video: NASA CONNECT™: *Virtual Earth*
- picture of the water cycle
- Sample Activity-Specific Scoring Tool

**Time for Activity**

- 60 minutes (watching the video and discussing the inquiry-based questions)
- 45 minutes (the activity)

## THE ACTIVITY

**Brief Description**

In this lesson, the teacher will guide students' thinking about Earth as a group of separate systems. Students apply their knowledge of a system diagram to model an Earth system.

## Lesson Description

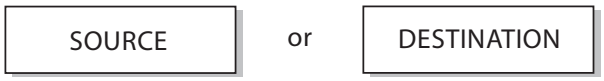
**ENGAGE**

Have students view the program, NASA CONNECT™: Virtual Earth. Working in groups, students answer and discuss all inquiry-based questions that are presented in the program.

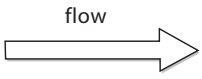
**EXPLORE**

Model how to create a system diagram by using one of the systems identified by the students. The following symbols are one way to represent the components of a flowchart or system diagram. Students are strongly encouraged to develop their own representations.

1. A box symbolizes a source of matter or energy or a destination into which matter or energy flows.



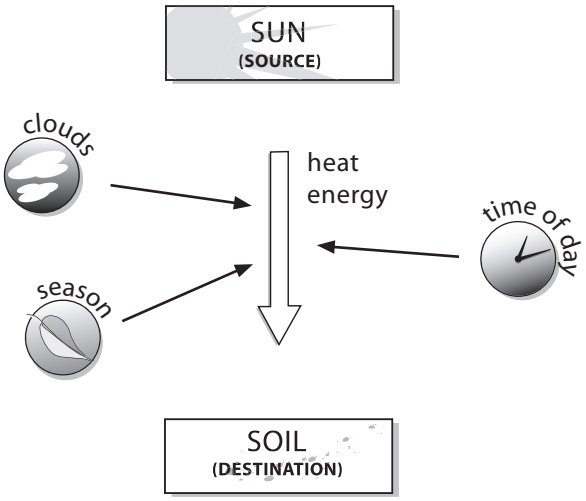

2. An arrow symbolizes the connection and direction (called a flow) between a source and a destination.




3. A circle symbolizes a condition or factor that will affect the system.


Model example: *Soil being warmed by the Sun*

Possible Solution:




*Technology Insertion Point*:

If you and your students have access to Personal Digital Assistants (PDAs), incorporate a free software utility called PiCoMap™. PiCoMap™ is a concept-mapping program that enables you to express the connections you see between ideas. A Concept Map is a set of nodes linked by directional edges. You and your students may then share these Concept Maps with peers through the power of infrared beaming, beam them directly to an infrared-capable printer, or view them on the computer's desktop. To learn more about PiCoMap™ and to download a free copy of PiCoMap™ and the user's manual, visit ***http://www.goknow.com/Products/PiCoMap.html***.

*Journal Write (Students):*
Create a diagram of your system. Students are encouraged to use their own system symbols. Explain the representation or system symbols that you select. Describe the following:

1. A "name" for the system
2. A list of some sources and destinations
3. The flow (arrows) between the sources and destinations and the direction of the flow
4. The conditions that affect the system

*Technology Insertion Point:*
PDA using PiCoMap™

**EXPLAIN**

*Journal Write (Students):* Write a short paragraph summarizing your system. One or two groups share their diagrams and explanations with the class. Encourage students to contribute other ideas by clarifying or adding to each groups' presentations.

**EXTEND**

Working in groups, read the technical passage, "The Global Water Cycle", which describes an Earth system. To help students visualize the water cycle, show them a picture of the cycle. See the United States Geological Society (USGS) picture of the water cycle at ***http://ga.water.usgs.gov/edu/watercyclegraphic.html***

*Technology Insertion Point:*
If you have access to a computer or computer lab, the following web site has a great water cycle animation: ***http://watercycle.gsfc.nasa.gov***

*Journal Write (Students):*
Students work with their group members to create a systems diagram of the global water cycle as described in the reading passage. Explain the representation or symbols that you select.

1. Create a name for the system.
2. Label the sources and destinations.
3. Label the flow by putting arrows between the sources, destinations, and the direction of the flow.
4. Label the approximate percentages of the flows.

*Technology Insertion Point:*
PDA using PiCoMap™

**EVALUATE**

As a class, create a scoring tool to evaluate the completeness of the system diagram. Students can use the Activity-Specific Scoring Tool as a guide. Here are some suggested criteria:

- appropriate use of system symbols
- identification of system components
- appropriate use of flows to connect the components

Groups exchange system diagrams and evaluate data by using the Activity-Specific Scoring Tool.

# Student Handout

## *The Global Water Cycle*

One way a system can behave is to cycle. A cycle is a sequence of events that continuously reoccurs. Matter is transferred from one part of the cycle to another and returned. In a perfect cycle, no matter or energy would be lost. In nature, some matter and energy is lost or added from the system, but this change is usually very small. There are many cycles in the universe. The Sun, each of the planets, and the Moon all have chemical cycles. There are also cycles of chemical substances in living things. Some biological materials cycle between living and nonliving things.

The physical and life processes of Earth involve cycles on many scales of time and space. There are smaller cycles within larger global cycles. Some cycles require only a few minutes; others may take millions of years.

One example of a cycle on a global scale is the water cycle. This cycle may be thought of as a system. In the water cycle system, we can follow the transport of water from one part of the Earth to another. Water evaporates into the atmosphere from the Earth's surface. Most of the water (about 86%) comes from the oceans. Additional water (about 14%) evaporates from the land. As water evaporates from the Earth's surface, it enters the atmosphere and collects on small particles in the air as droplets or ice, a process called condensation, and forms clouds. When enough water or ice collects in a cloud, it rains.

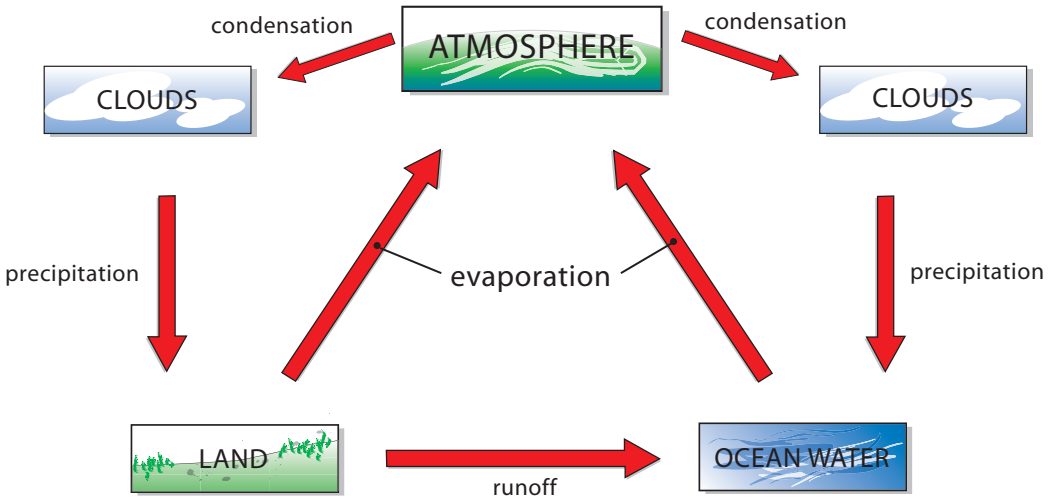
Water returns to the Earth's surface from the atmosphere as precipitation. The amounts of precipitation falling back on the land and oceans are slightly different — 22% back to the land and 78% to the oceans. About 8% of the water precipitated on land is returned to the oceans by runoff from rivers.

Cycles and systems usually remain in balance. The water cycle and life cycles of plants and animals are examples of cycles that stay in balance. Sometimes, however, major changes, such as ice ages, occur during these cycles. Natural changes in time and disruptions to cycles and systems are part of the way in which the Earth's cycles and systems function.

# Teacher Handout

## Possible Solution:

System Model – Water Cycle




- Water evaporates into the atmosphere from Earth:
  86% of the evaporated water comes from the oceans.
  14% of the evaporated water comes from the land.

- Water returns to Earth's surface by precipitation:
  78% falls back into the oceans.
  22% falls back on the land.
  8% of the precipitation falling on the land returns to the oceans as runoff from rivers.

# Teacher Handout

## Sample: Activity-Specific Scoring-Tool

2: A complete explanation is given that includes all the following scoring cues:

- System symbols are used correctly.
- All system components are correctly identified.
- Components are connected by using flows.

1: A partial explanation is given, but the response lacks one or two of the scoring elements above and/or is inaccurate.

- Most system symbols are used correctly.
- Most system components are correctly identified.
- Most components are connected by using flows.

0: All other responses

# RESOURCES

## BOOKS, PAMPHLETS, AND PERIODICALS

Sussman, Art, Ph.D.: Dr. Art's Guide to Planet Earth, WestEd and Chelsea Green Publications, 2000.

## WEB SITES

**Earth System Science**

http://www.earth.nasa.gov/science/index.html

**Teaching Earth Science**

http://earth.nasa.gov/education/

**Practical Benefits Enabled by the Earth Science Enterprise**

http://www.earth.nasa.gov/eseapps/

**Dr. Art's Guide to Planet Earth**

http://www.planetguide.net

**Education programs developed at the American Geological Institute**

http://www.agiweb.org/education

**Education activities for teachers and students sponsored by USGS (United States Geological Society)**

http://www.usgs.gov/education/index.html

**SPACE STARS, a laboratory for GIS/Remote Sensing Education**

http://digitalquest.com/spacestars/

**The Earth Observing System (EOS): A Series of EOS Science posters**

http://eospso.gsfc.nasa.gov/eos_homepage/for_educators/eos_posters/index.php

**Earth System Science Education Alliance**

http://www.cet.edu/essea/

**NASA Classroom of the Future: Exploring the Environment**

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

**Figure This!**

Offers Mathematics Challenges that middle school students can do at home with their families to emphasize the importance of a high-quality mathematics education for all.

http://www.figurethis.org

**Engineer Girl**

Part of the National Academy of Engineering's Celebration of the Women in Engineering project. The project brings national attention to the opportunity that engineering represents to people of all ages, but particularly to women and girls.

http://www.engineergirl.org

**NCTM – National Council of Teachers of Mathematics**

http://www.nctm.org