SUGGESTED REFERENCES

- *Envisat*
  http://envisat.esa.int/
- *MERIS*
  http://envisat.esa.int/object/index.cfm?fobjectid=1665
- *The Environmental Protection Agency Homepage*
  http://www.epa.gov/climatechange/
- *Global Climate Change at NASA*
  http://climate.nasa.gov/

NATIONAL SCIENCE EDUCATION STANDARDS

Grades 9 - 12
Science & Technology
Abilities of technological design
Understandings about science & technology

Grades 9 - 12
Science in Personal & Social Perspectives
Natural resources
Environmental quality
Natural and human-induced hazards
Science and technology in local, national, and global challenge

Grades 9 - 12
Life Science
Biological evolution
The interdependence of organisms
Matter, Energy and Organization in Living Systems

**Source: National Science Education Standards, 1996, National Academy Press*

CREDITS

EDUCATOR ADVISORY PANEL

Patricia Heydet-Kirsch, Ed.D.
John A. Murnan III, M.S.
Debra A. Murnan, B.A.

PRODUCTION CREDITS

WRITER/PRODUCER:	Jon Glassman
ASSOCIATE PRODUCER:	Judi Sitkin
EDITOR:	Stuart Scoon
NARRATOR:	J.J. Wilson

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1000 Clint Moore Road, Suite 108, Boca Raton, FL 33487
tel: 1.800.232.2133 email: info@ssrvideo.com
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ENVIRONMENT - *Science for a Healthy Planet*

ABET
Accreditation Board for Engineering and Technology
www.abet.org

NMOE
National Museum of Education
www.nmoe.org

CILC
Center for Interactive Learning and Collaboration
www.cilc.org

JETS
Junior Engineering Technical Society
www.jets.org

SYNOPSIS

The Earth's climate has a long history of drastic fluctuation. From ice ages to long periods of warmth, there are natural occurrences such as volcanic eruptions and changes in the Sun's intensity that affect the climate. More recently, there is wide speculation that activities associated with the Industrial revolution have altered the atmosphere and have negatively affected the climate.

This edition demonstrates how scientists measure, study, and research the health of our planet from the atmosphere to the depths of the ocean.

CURRICULUM UNITS

- CHEMICAL ENGINEERING
- CHEMISTRY
- EARTH SCIENCE
- ECOLOGY
- ENVIRONMENTAL SCIENCE

RUNNING TIME

12 minutes

BACKGROUND

Scientists have a variety of tools at their disposal for keeping a close watch on the health of the Earth. Satellites, such as the ENVISAT use several onboard instruments, measure things such as atmospheric chemistry, ocean temperature and changes, hydrology, ozone depletion wind patterns, and snow and ice. Analyzing detailed images from space regarding ice sheet characteristics, distribution and dynamics helped researchers identify a problem on the eastern side of the Antarctic Peninsula; A huge chunk of the Larsen B Ice Shelf had shattered and separated.

Envisat is equipped with the powerful spectrometer SCIAMACHY, which collects data to help us understand the chemistry and physics of the troposphere, stratosphere, and mesosphere. Scientists have identified gases in the earth's atmosphere that caused the depletion of the ozone layer. These gases include chlorofluorocarbons and hydrochlorofluorocarbons are produced by humans and are not naturally found in the atmosphere. We use CFC's and HCFC's as coolants in refrigerators and air conditioners. Starting in 1989, the Montreal Protocol established limits on CFC's and related compounds that should result the recovery of the ozone layer in coming years.

Some tree species act as indicators of changes in the environment. Scientists measure the levels of carbohydrates and amino acids in the leaves of plants in environments to understand their reactions to local conditions. By comparing data from satellites, weather changes and plant species, scientists can begin to predict how human activity can affect plant life.

Well known for their diet of dead animal and plant matter, threadworms help scientists identify the presence of toxins in the environment. They absorb toxins through their food, and are optimal because they live in pore water on the ground all over the world. Threadworms have many genes that are the same as humans. By studying the effect of environmental toxins on threadworms, scientists can gain insight into how the chemicals may affect humans. To see the effect of toxins on the threadworms, scientists implant the organisms with a genetically altered fluorescent "switch." When scientists expose the threadworms to a toxin, the switch will cause them to fluoresce neon green which is easy to see in the microscope.

Satellites are also used to keep a close eye on ocean patterns, including oil spills. This can help in predicting the spread and density when assessing the damages caused by oil spills. These satellites are also helpful in calculating concentrations of phytoplankton and seaweed by looking at changes in the color of ocean water. When the concentration of one kind of phytoplankton, called algae, gets too high, the color of the ocean water changes from blue-green to orange-red. This phenomenon is known as an algae bloom. The most common reason for an algae bloom is overly abundant nitrogen and phosphorus nutrients in water. This is a particular problem in coastal regions where governments are prone to release sewage into the oceans.

CRITICAL THINKING EXERCISES

1. Research the ice levels of the Chukchi and Beaufort Seas. With declining ice levels, what are the consequences for the ecosystem? How will the loss of ice levels affect sea ice algae and polar bears? (see http://www.espo.nasa.gov/icescape/)
2. Outline how satellite technology has helped scientists to monitor changes in the atmosphere and the oceans.
3. Oil spills are disastrous to marine animals, and affect shoreline ecosystems as well. How are scientists using satellite technology to design plans to react most efficiently to oil spills?
4. What technologies assist scientists as they track the presence of harmful algae blooms (HABs) in an effort to reduce serious health effects on humans, marine organisms, and regional economies?

CAREER POSSIBILITIES

- BIOLOGIST
- CHEMIST
- EARTH SCIENTIST
- ECOLOGIST
- ENGINEER
- ENVIRONMENTALIST
- METEOROLOGIST

ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 4. The Physical Setting
Section B: The Earth, Grades 9-12

- Greenhouse gases in the atmosphere, such as carbon dioxide and water vapor, are transparent to much of the incoming sunlight but not to the infrared light from the warmed surface of the earth. When greenhouse gases increase, more thermal energy is trapped in the atmosphere, and the temperature of the earth increases the light energy radiated into space until it again equals the light energy absorbed from the sun.
- Climatic conditions result from latitude, altitude, and from the position of mountain ranges, oceans, and lakes. Dynamic processes such as cloud formation, ocean currents, and atmospheric circulation patterns influence climates as well.

Benchmark 4. The Physical Setting
Section C: Processes that shape the Earth, Grades 9-12

- Plants on land and under water alter the earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.

Benchmark 5. The Living Environment
Section D: Interdependence of Life, Grades 9-12

- Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

**Benchmarks can be found at www.project2061.org/tools/benchol/bolintro.htm*

VOCABULARY

Chlorofluorocarbons . . . . Any of several volatile, inert, saturated compounds of carbon, fluorine, chlorine, and hydrogen: used as refrigerants, foam-blowing agents, solvents, and formerly as aerosol propellants until scientists became concerned about depletion of the ozone layer.

Envisat . . . . . Earth observation satellite aimed to improve environmental studies regarding atmospheric chemistry, ozone depletion, biological oceanography, ocean temperature and color, hydrology, agriculture, natural hazards, digital elevation modeling, monitoring of maritime traffic, atmospheric dispersion modeling, cartography and the study of snow and ice.

Hydrochlorofluorocarbons . . Compounds of hydrogen, chlorine, fluorine, and carbon atoms. HCFCs and their cousins, hydrofluorocarbons (HFCs), were created in the 1980s as substitutes for chlorofluorocarbons (CFCs) for use in refrigeration and a wide variety of manufacturing processes. Because all three of these classes of compounds either destroy the stratospheric ozone layer essential to life on Earth, and/or contribute to an unnatural warming of the planet's climate, international agreements have been organized to eliminate their production.

Mesosphere . . . . . The region of the Earth's atmosphere lying above the stratosphere and below the thermosphere, from a height of about 50 kilometers (31 mi) to about 80 kilometers (50 mi) above the Earth's surface.

Phytoplankton . . . . . Plankton consisting of free-floating algae, protists, and cyanobacteria. Phytoplankton form the beginning of the food chain for aquatic animals and offset large amounts of carbon, which would otherwise be released as carbon dioxide.

Stratosphere . . . . . The region of the Earth's atmosphere from the tropopause to about 50 kilometers (31 mi) above the Earth's surface. The stratosphere is characterized by the presence of ozone gas (in the ozone layer) and temperatures which rise slightly with altitude, due to the absorption of ultraviolet radiation.

Topography . . . . . The three-dimensional arrangement of physical attributes, such as shape, height, and depth of a land surface. Physical features that make up the topography of an area include mountains, valleys, plains, and bodies of water.

Troposphere . . . . . The lowest and densest region of the Earth's atmosphere, extending from the Earth's surface to the tropopause. It is characterized by temperatures that decrease with increasing altitude. At the top of this region, temperatures are close to -55°C (-67°F). The weather, major wind systems, and cloud formations mostly occur here.

Ultraviolet . . . . . Relating to electromagnetic radiation having frequencies higher than those of visible light but lower than those of x-rays.