ALL DRIED UP

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2000

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TASK OVERVIEW

Content Area(s)/ Course: Earth Science/ Social Studies connection.

Grade Level: 6^{th}- 9^{th}

Indicators:
Analyze Earth (i.e., land and water) data collected from space-based instruments and relate it to weather patterns.
Research topics of current concern with regard to climate.

Project 2061 Benchmarks:
Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life.

Description:
This task focuses on drought. In this task, students will examine drought data provided by satellites. Students will respond to a series of questions related to drought impact. Finally, the students will write a report summarizing their findings. This task was designed to be used as an enrichment instructional task with embedded assessments and to be added into the lesson plan, where appropriate.

Approximate Time Required: Two 45-minute periods.

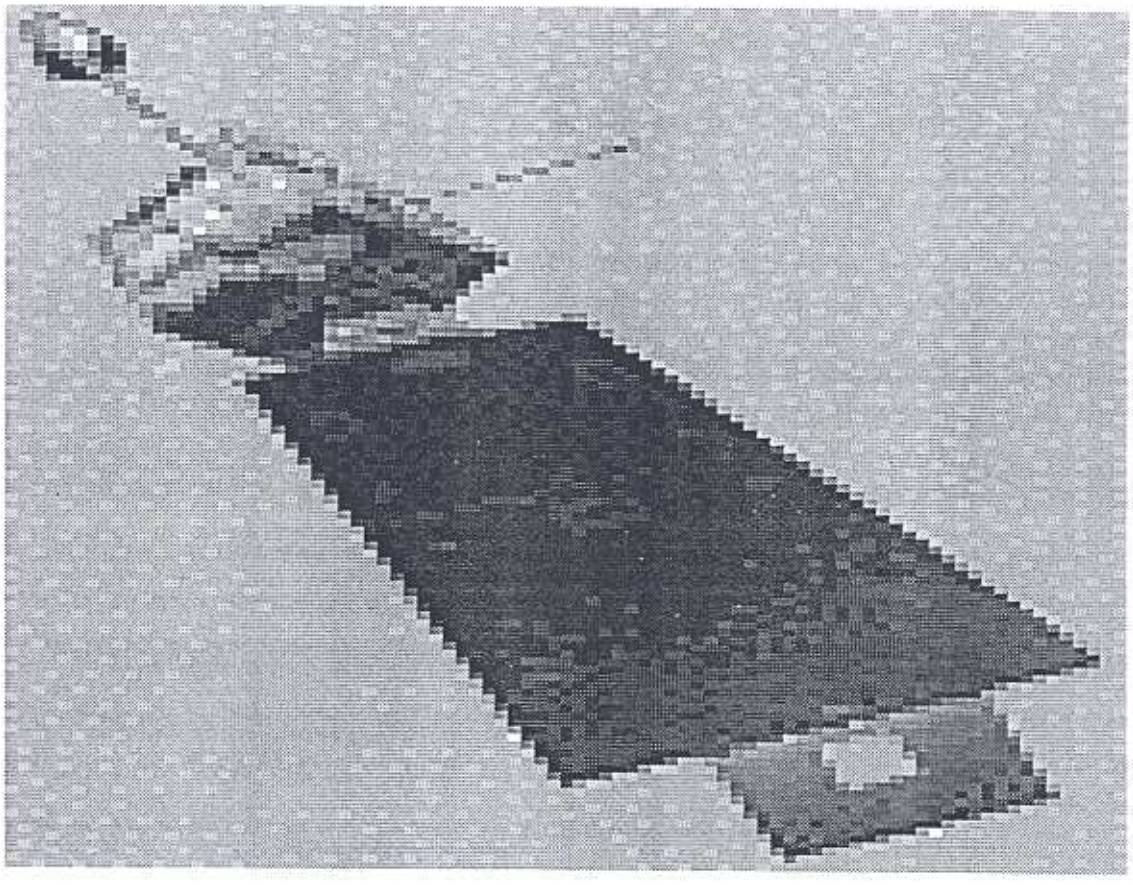
Prior Knowledge/Skills Required for Task:
Working knowledge of climate change.

Materials and Resources Needed:
Colored copies or colored transparencies of Vegetation Health Index and U.S. Drought Impact maps.

Date _____

Name(s) _____

STUDENT ANSWER BOOKLET



All Dried Up

ENGAGEMENT

Drought is a normal, recurrent feature of climate, although many consider it a rare and random event. A drought is a period of abnormally dry weather, which persists long enough to produce a serious hydrologic imbalance, such as crop damage, water supply shortage, etc. The severity of the drought depends upon the degree of moisture deficiency, the duration and the size of the affected area.

The impacts of a drought can be economic, social or environmental. Lack of rainfall for an extended period of time can affect many farmers and major metropolitan areas. When no rain or only a very small amount of rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers decline, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought. We are told to stop washing our cars, cease watering the grass and take other water conservation steps.

The National Oceanic and Atmospheric Administration (NOAA) manages the U.S. civil operational remote-sensing satellite systems, as well as global databases for meteorology, oceanography, and solar-terrestrial sciences. From these sources, it develops and provides environmental data and information products and services. Imagine that you are a crop analyst who was just hired by NOAA to analyze drought data provided by satellites.

You will be working with other NOAA scientists to gather data pertaining to drought. Your team will consist of four members. Each individual in the group will have a specific responsibility based on the following jobs.

- **Principal Investigator**- is in charge of all operations associated with the group activity. The "PI" checks the assignment, communicates the directions of the teacher, provides assistance to other group members, and conducts group discussions about results.
- **Materials Manager**- the "MM" obtains and dispenses materials and equipment for the activity. The "MM" also sets up and operates the activity equipment in cooperation with the "PI".
- **Recorder/Reporter**- the "RR" is in charge of collecting and recording information on the group worksheet(s). Also reports results to the class.
- **Maintenance Director**- the "MD" is in charge of cleaning up the workstation and can assign other members to assist. Also is in charge of group and individual safety. Also verifies the work of the "RR".

Activity 1

A. Have you ever experienced a drought in the area that you live? _____
If yes, describe what you and your family did to conserve water. If no, describe what plan of action you would take to conserve water.

_____

_____

_____

_____

_____

B. How do you think a major drought in your community would change your lifestyle?

_____

_____

_____

_____

_____

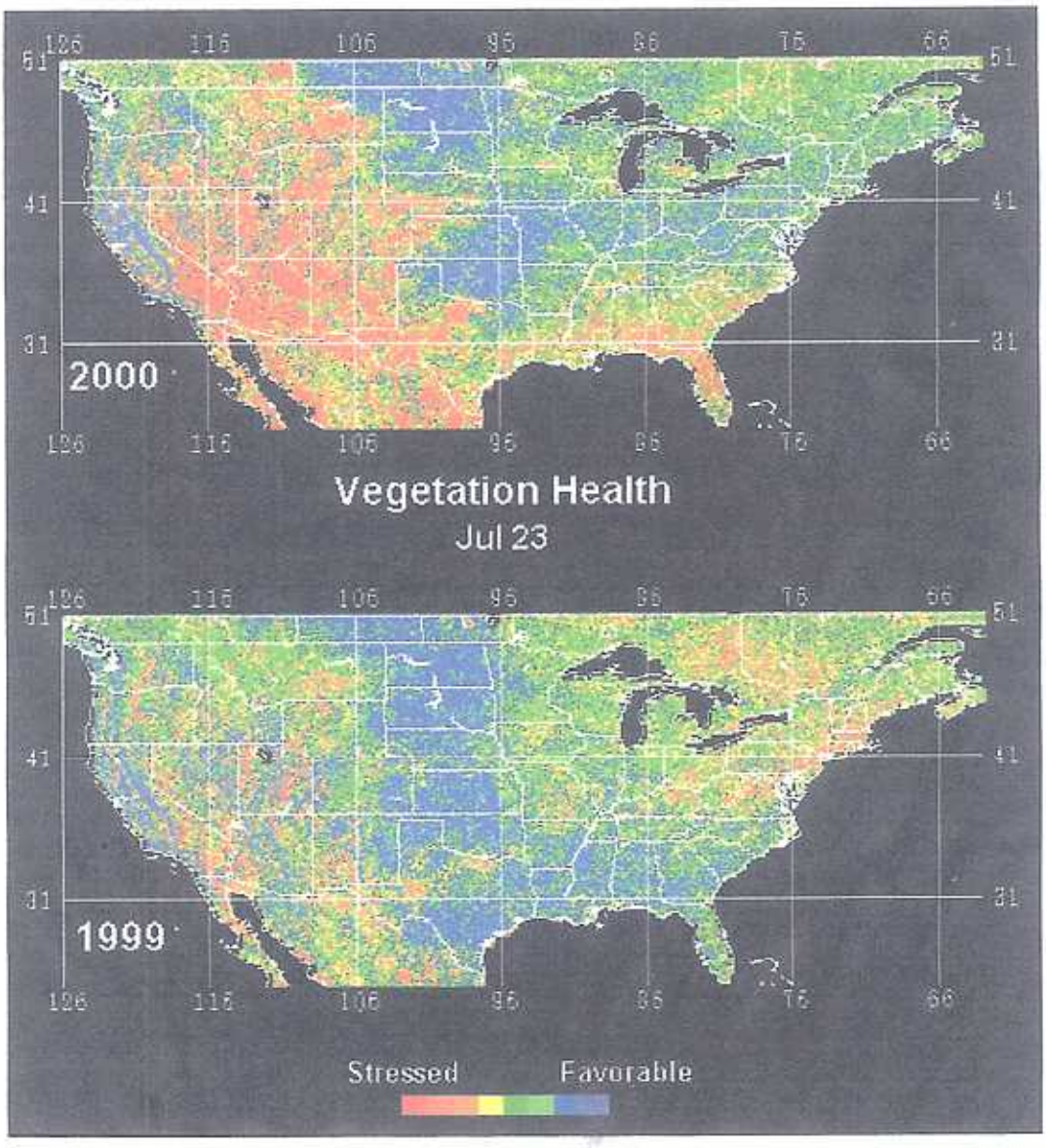
EXPLORATION

Activity 2

The vegetation images below compare vegetation conditions from two years, 1999 and 2000, as seen by the Advanced Very High Resolution Radiometer (AVHRR) on board NOAA's Polar-Orbiting Environmental Satellites (POES), NOAA-14. The AVHRR has the capability of identifying vegetation stress related to the environmental conditions. This is very useful for early drought detection, monitoring, and analysis of impact on agriculture. Vegetation stress is estimated from energy measured in the visible, near infrared and thermal intervals of the solar spectrum. The collected data were converted to a quantity that is a measure of vegetation condition.

United States Vegetation Health Index

Vegetation Health: Red - stressed, Green - fair, Blue - favorable



A. Take a few minutes to make a thorough observation of the vegetation images.

B. Write down three of your observations.

_____

_____

_____.

EXPLANATION

C. Compare and contrast the state of Maryland for the year of 1999 and 2000.

_____

_____

_____

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_____

D. Explain why you think differences occurred between those two years.

_____

_____

_____

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_____

E. Compare and contrast the state of Mississippi for the year of 1999 and 2000.

F. Explain why you think differences occurred between those two years.

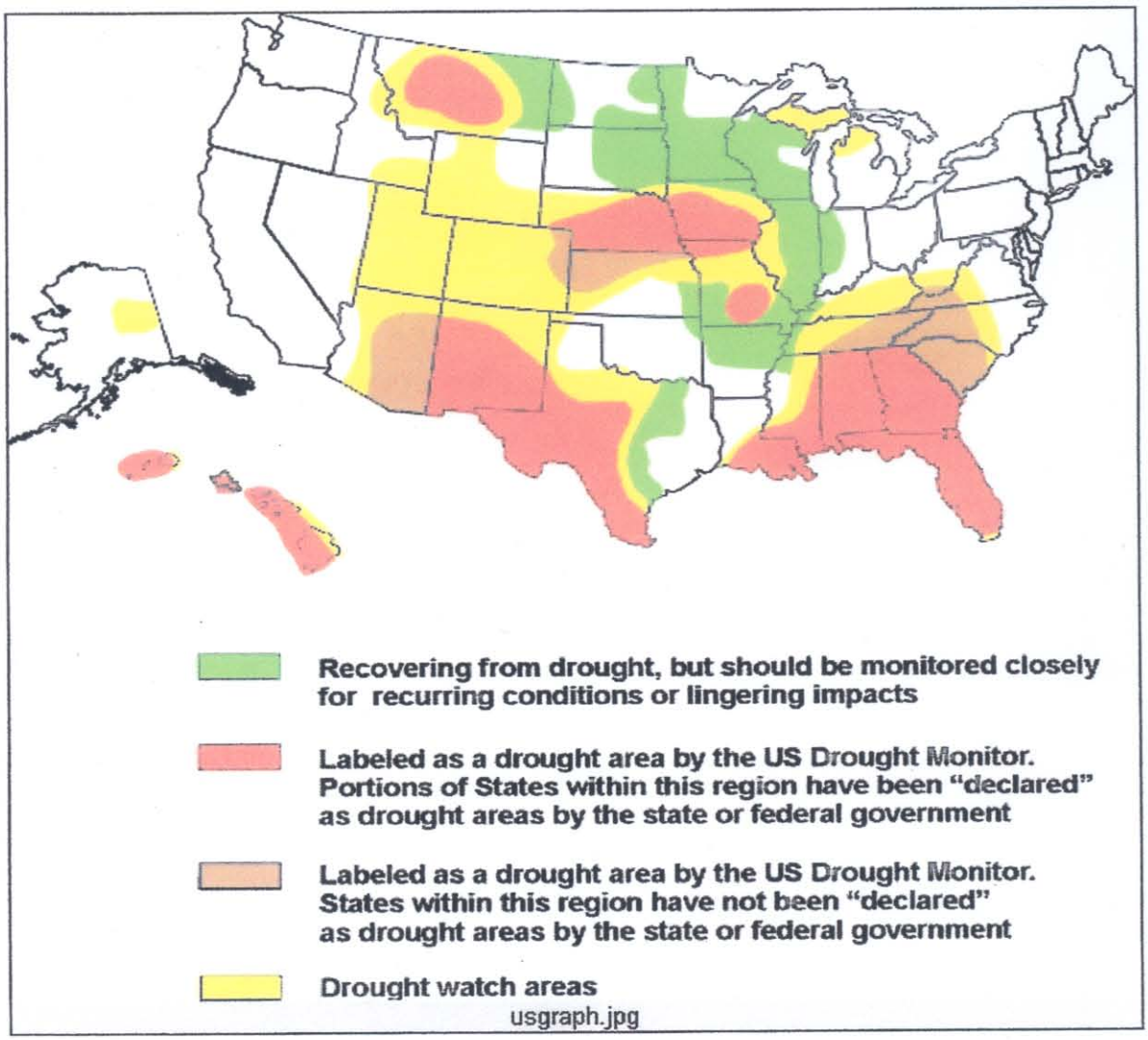
EXPLORATION

Activity 3

The US Drought Impacts report, produced by the National Drought Mitigation Center (NDMC), complements the U.S. Drought Monitor by adding long-term forecasts, outlining drought recovery areas, detailing state-by-state drought impacts, and providing information on how states are preparing for and responding to drought.

Drought Impacts in the United States

June 6 - July 5, 2000



A. Take a few minutes to make a thorough observation of the image above.

EXPLANATION

B. Make a prediction about the climate in the green shaded areas.

C. Make a prediction about the climate in the yellow shaded areas.

D. Identify a state in which you would want to live after viewing the drought impact map. Explain.

E. In your opinion, is there anything a state could do to prevent a drought from occurring. Explain.

F. Once a state has been declared a drought area, identify three steps society can take to help the situation.

ELABORATION

Activity 4

As stated earlier in this lesson, Polar-Orbiting Environmental Satellite (POES) provided the images that you studied. As a crop analyst, your job is to study the images and to provide different agencies with feedback on the impacts of drought.

After completing your data analysis, NOAA has asked you to present you findings to the Department of Agriculture. In your presentation, you will address how drought effects economic status. Please consider the following questions while writing your presentation.

How does drought affect vegetation growth?
How does vegetation growth effect prices of fruits, vegetables and grains?
How does drought affect socioeconomic status of communities?

Now, write your presentation that will be presented to the Department of Agriculture on the impacts of droughts.

STUDENT RESOURCE BOOKLET

All About Droughts

What is a drought?

A drought is a period of abnormally dry weather, which persists long enough to produce a serious hydrologic imbalance (for example crop damage, water supply shortage, etc). The severity of the drought depends upon the degree of moisture deficiency, the duration and the size of the affected area.

There are four different ways that drought can be defined:

> **Meteorological-** a measure of departure of precipitation from normal. Due to climatic differences what is considered a drought in one location may not be a drought in another location.
> **Agricultural-** refers to a situation when the amount of moisture in the soil no longer meets the needs of a particular crop.
> **Hydrological-** occurs when surface and subsurface water supplies are below normal.
> **Socioeconomic-** refers to the situation that occurs when physical water shortage begins to affect people.

Where do droughts usually occur?

Some areas of the United States are most likely to have droughts than other areas. In humid, or wet, regions, a drought of a few weeks is quickly reflected in a decrease in soil moisture and in declining flow in streams. People who use water from streams in these areas may face water shortages as soon as streamflow begins to decline. In arid, or dry, regions, people rely on ground water and water in reservoirs to supply their needs. They are protected from short-term droughts, but may have severe problems during long dry periods because they may have no other water source if wells or reservoirs go dry.

Does a shortage of rain mean a drought will occur?

A period of below-normal rainfall does not necessarily result in drought conditions. Some rain returns to the air as water vapor when water evaporates from water surfaces and from moist soil. Plant roots draw some of the moisture from the soil and return it to the air through a process called transpiration. The total amount of water returned to the air by these processes is called evapotranspiration. Sunlight, humidity, temperature, and wind affect the rate of evapotranspiration. When evapotranspiration rates are large, soils can lose moisture and dry conditions can develop. During cool, cloudy weather, evapotranspiration rates may be small enough to offset periods of below normal precipitation and a drought may be less severe or may not develop at all.

Why doesn't a drought go away when it rains?

Rainfall in any form will provide some drought relief. A light moderate shower will probably only provide cosmetic relief. During the growing season, most of the rain that falls will be quickly evaporated or used by plants. Its impact is short term.
A thunderstorm will provide some of the same benefits as the shower, but it also may cause loss of life and property if it is severe. Thunderstorms often produce large amounts of precipitation in a very short time, and most of the rain will run off into drainage channels and streams rather than soak into the ground. If the rain happens to fall upstream of a reservoir, much of the runoff will be captured by the reservoir and add to the available water supply.

Soaking rains are the best medicine to alleviate drought. Water that enters the soil recharges ground water, which in turn sustains vegetation and feeds streams during periods when it is not raining. A single soaking rain will provide temporary relief from drought conditions, but multiple such rains over several months may be required to break a drought and return conditions to within the normal range.

What are the impacts of drought?

Drought produces many impacts on society. This complexity exists because water is integral to our ability to produce goods and provide services. The impacts of drought can be economic, environmental, or social.

Many economic impacts occur in agriculture and related sectors, including forestry and fisheries. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect. Retailers and others who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue for local, state, and federal government. Prices for food, energy, and other products increase as supplies are reduced.

Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fire; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent.

Social impacts mainly involve public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief.

Cite: United States Geological Survey (USGS)

GLOSSARY

Carbon dioxide- a colorless, odorless, noncombustible gas that is slightly more than 1.5 times as dense as air.
Climate- the long-term effect of the sun's energy (warm in summer; cold in winter; warm in deserts; cold near Poles).
Condensation- the change of a vapor to liquid.
Continental air mass- an air mass that forms over land, making it generally dry. It may be warm or cold.
Drought- a period of abnormally dry weather which persists long enough to produce a serious hydrologic imbalance, for example crop damage and water supply shortage.
Environmental Modeling Center (EMC) - National Weather Service center located in Camp Springs, Maryland that prepares worldwide computer forecasts.
Global carbon cycle- powered by the Sun, which provides the energy for atmospheric and oceanic circulation and for plant photosynthesis.
Global warming- term used to describe a rise in mean temperatures around the world.
Greenhouse effect- the sequence of phenomena comprising the absorption of solar radiation by the earth, the conversion of this energy and its re-emission at infrared (IR) wavelengths, and the absorption of that IR radiation by atmospheric ozone, water vapor, and carbon dioxide; therefore, preventing its dissipation into space and resulting in a steady, gradual increase in atmospheric temperatures.
National Environmental, Satellite, Data, and Information Service (NESDIS)- operates the U.S. civilian Earth observing satellite systems.
National Weather Service- Federal agency that observes and forecasts weather. Formerly the U.S. Weather Bureau, it is part of the National Oceanic and Atmospheric Administration, which is part of the Department of Commerce.
Photosynthesis- the process in which plants uses carbon dioxide and water in the presence of light to produce carbohydrates and oxygen.
Rain- falling water drops with a diameter greater than .02 inch.
United States Drought Monitor- provides a summary map which identifies general drought areas.
Vegetation- crop growth such as apples, bananas and cucumbers.
Weather- day-by-day change in temperature, precipitation, winds and clouds.

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES (GOES)

INTRODUCTION

One of the most important weather satellites used today is called the Geostationary Operational Environmental Satellite (GOES). These satellites are designed to provide information about the Earth's atmosphere, temperature, climate and the surface of the Earth and sea. They gather data and other information and send them to ground terminals for use by The National Weather Service. NOAA then turns the gathered data into images. The GOES satellites circle the earth in a "geostationary" or "geosynchronous" orbit over the equator. This means that the satellites observe the Earth from the same place at all times and their orbit is "in sync" or the same as the Earth.

INSTRUMENTS

Each satellite carries two major instruments. The first instrument is the Imager that operates in both the visible and the infrared spectrum. It sends back pictures, which provide information on clouds, water vapor in the atmosphere, smoke, wind, fire and temperature. The other instrument is known as the Sounder and it operates only in the infrared spectrum. The Sounder sends back information and data on the atmosphere, land and sea surface. It also transmits data on ozone, clouds and water vapor in different layers of the atmosphere. These two instruments are used to assist weather forecasters in the prediction of severe storms and other types of weather.

The National Oceanic and Atmospheric Administration (NOAA) operate the GOES satellites. Within NOAA, the National Environmental Satellite, Data, and Information Service operates and manages the system. The National Aeronautics and Space Administration (NASA) is responsible for launching the spacecraft.

LOCATION

NOAA operates two GOES satellites. One satellite is located over the equator at 75 degrees west, while the other satellite is located over the equator at 135 degrees west. Working as a team, these two satellites can view most of the Western Hemisphere and much of the Pacific and Atlantic Oceans. They can take pictures during both the day and the night that show almost all of this area, or they can focus on much smaller areas in order to observe severe weather activity quickly in local areas.

POLAR-ORBITING ENVIRONMENTAL SATELLITES (POES)

INTRODUCTION

Polar orbiting satellites circle the Earth in a sun-synchronous orbit: the orbital plane of a polar orbiting satellite remains stationary with respect to the sun. As the satellite moves through its orbit, the Earth rotates below it. The result is that the satellite scans a different

strip of the Earth during each orbit. From a fixed point on Earth, a polar orbiting satellite will always cross the equator at approximately the same local time relative to the sun. Each orbit has a period of approximately 102 minutes. Therefore, in one day, the satellite makes roughly 14 orbits (1440 minutes per day/ 102 minutes per orbit).

POES have provided continuous observations of the land ice, oceans, and atmosphere from the tropics to the polar regions. These global observations have led to dramatic improvements in weather prediction and to significantly enhanced understanding of how the Earth works.

INSTRUMENTATION

AVHRR/3 – Advanced Very High Resolution Radiometer
Application: Surface & Cloud Imaging, Sea Surface Temperature, Vegetation Index, Aerosols, Radiation Budget, Snow/Ice Cover

HIRS/3 – High Resolution Infrared Sounder
Application: Temperature Profiles, Ozone, Cloud Detection, and Radiation Budget

AMSU-A - Advanced Microwave Sounding Unit A
Application: Temperature Profiles

AMSU – B – Advanced Microwave Sounding Unit B
Application: Water Vapor Profiles

SBUV/2 – Solar Backscatter Ultra Violet spectral radiometer
Application: Total and Profile Ozone Products

SEM/2 – Space Environment Monitor
Application: Solar Environment Monitoring and Solar Terrestrial Phenomena

SAR – Search and Rescue
Application: The Search and Rescue system is designed to detect and locate emergency beacons.

DCS – Data Collection System
Application: The Data Collection system measures environmental factors such as atmospheric temperature and pressure, velocity and direction of the ocean and wind currents. Data is collected from buoys, free-floating balloons, and remote weather stations.

LOCATION

The orbits of the polar orbiting satellites are nearly from pole to pole, with an inclination of 98 degrees. Each day as the Earth rotates around the sun the orbit also rotates in the other direction. This keeps the angle between the sun and the orbit (nearly) constant. Because the angle between the orbit and the sun is constant the orbit always crosses the equator at the same time of day.

TEACHER'S GUIDE

TEACHERS GUIDE

Prepare a plan for grouping the students in groups of four.

Each group should receive the colored images provided by POES or colored transparencies may be used for the entire class.

The student resource booklet may be separated from the student response booklet to decrease copying. It is recommended that each student receive a student response booklet to complete his or her answers. It is also recommended to make one class set of the student resource booklet to use throughout the day.

Please instruct students on how to use the resource booklet.

Note: The colored images may be found on the last two web sites listed below.

Related Careers

Crop Analyst

Hydrologist

Atmospheric Science

Statistics

Engineering

Physical Scientist

Computer Science

Mathematics

Meteorology

Related Web Sites

http://www.noaa.gov

http://orbit-net.nesdis.noaa.gov/ora/

http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci/usa.html

http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci/usa/html

http://enso.unl.edu/ndmc/impacts/us/usimpact.htm

SCORING GUIDE

SCORING GUIDE

ACTIVITY 1

Question 1a
Do not score

Question 1b
Do not score

ACTIVITY 2

Question 2a
Do not score

Question 2b
Do not score

Question 2c
Score 2 = Response indicates that for the year of 1999 the vegetation health for the state of Maryland was stressed and for the year of 2000 the vegetation health was favorable.
Score 1 = Response identifies one of the above items.
Score 0 = Incorrect or no response.

Question 2d
Score 2 = Response indicates that during the year of 1999 there was a lack of rain and during the year of 2000 there was a sufficient amount of rain.
Score 1 = Response identifies one of the above items.
Score 0 = Incorrect or no response.

Question 2e
Score 2 = Response indicates that for the year of 1999 the vegetation health for the state of Mississippi was favorable and for the year of 2000 the vegetation health was stressed.
Score 1 = Response identifies one of the above items.
Score 0 = Incorrect or no response.

Question 2f
Score 2 = Response indicates that during the year of 1999 there was a sufficient amount of rain and during the year of 2000 there was a lack of rain.
Score 1 = Response identifies one of the above items.
Score 0 = Incorrect or no response.

ACTIVITY 3

Question 3a
Do not score

Question 3b
Do not score

Question 3c
Do not score

Question 3d
Score 2 = Response indicates a state with an explanation.
Score 1 = Response indicates a state without an explanation.
Score 0 = Incorrect or no response.

Question 3e
Score 1 = Response with an explanation.
Score 0 = Incorrect or no response.

Question 3f
Score 3 = Response indicates three steps.
Score 2 = Response indicates two steps.
Score 1 = Response indicates one step.
Score 0 = Incorrect or no response.

ACTIVITY 4

Score 4 = This presentation has been exceptionally well drafted. It has a clearly stated title and several paragraphs that develop the overall idea. It is directed to the appropriate audience. The focus statements have all been thoroughly addressed, and supported. Errors in grammar, spelling, and punctuation, if present, do not deter from the impact of the presentation. Scientific terminology is used correctly. The writing is neat and legible. The organizational pattern is well established. Additional resources may have been referenced. The writing is focused, and consistently on topic.

Score 3 = This presentation is similar to a 4 above. Minor errors in grammar, spelling, and punctuation, if present, have little impact on the paper. Scientific terminology is used correctly. Additional resources are unlikely to have been referenced. Only minor deviations from the organizational pattern occur. Some of the focus statements may need additional support. The paper is legible.

Score 2 = Several key elements of the prompt are not addressed. One or more of the focus statements may have been completely ignored. Errors may occur in the use of scientific terminology. The prompt is inadequately focused on the topic, and an organizational pattern, if established, is inconsistently followed. Gross errors in grammar, spelling, and punctuation may significantly impact the paper. The paper is legible.

Score 1 = Few important points of the prompt are addressed. The organizational pattern, if established, is virtually ignored. Scientific terminology is not used, or is used incorrectly. Gross errors in grammar, spelling, or punctuation may severely impact the paper. The article may not be in the correct format. The paper may be illegible.

Score 0 = The writing is off task, completely illegible, or scientifically inaccurate.