IS THE OCEAN JUST BLUE?

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2000

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TASK OVERVIEW

Content Area(s)/ Course: Earth Science or Life Science

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.
Describe heat transfer systems affecting the atmosphere, land, and oceans.

Project 2061 Benchmarks:
Plants 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.

Description:
This task focuses on ocean color. In this task, the student will examine how the Earth's ocean color is studied with satellites. To do this, students will perform activities in which they will understand the effects of phytoplankton and chlorophyll on ocean color. Using images provided by SeaWiFS, a satellite instrument that detects ocean color, they will be able to learn about the effects of phytoplankton on the food chain, on the carbon cycle and on global warming. 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: Three 45-minute periods.

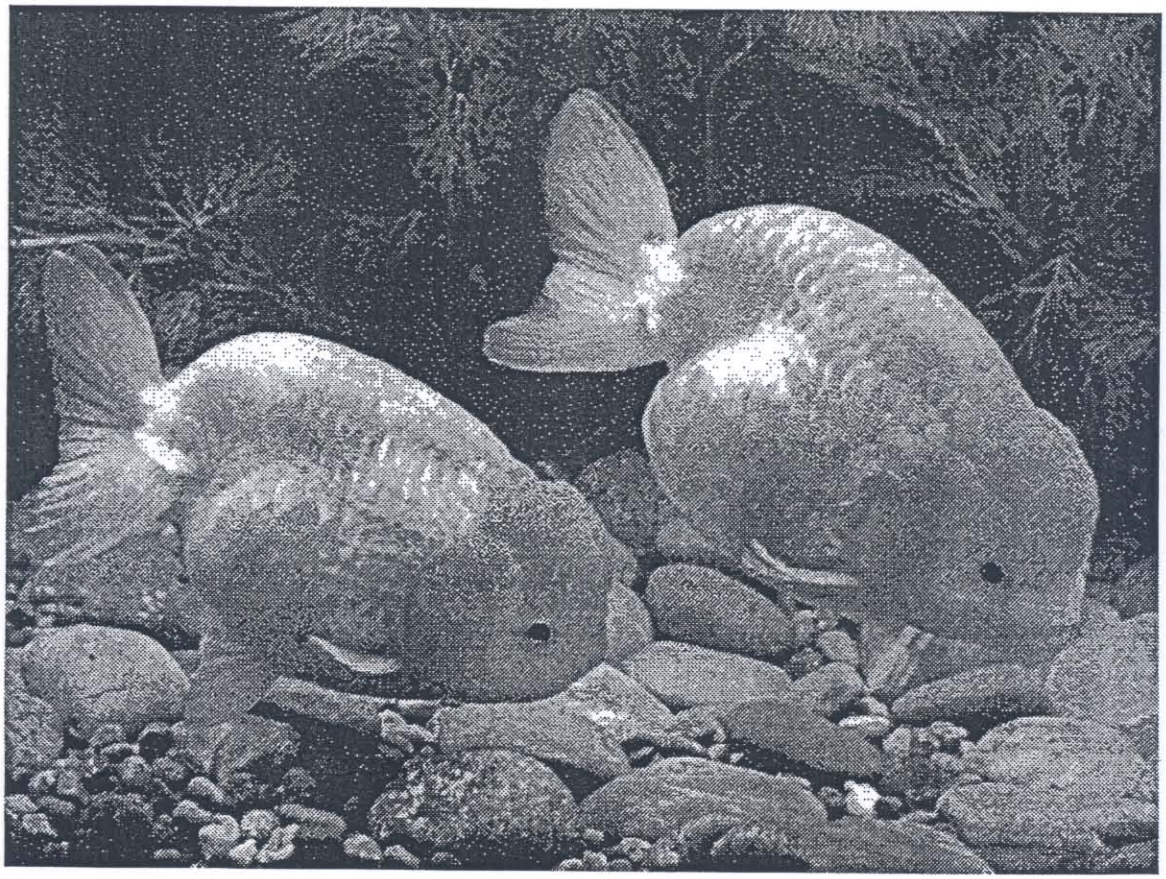
Prior Knowledge/Skills Required for Task:
Working knowledge of global warming, carbon cycle, and photosynthesis.

Materials and Resources Needed:
For each group of students:
Colored pencils or crayons
Four-8 ½ x 11 pieces of lineless drawing paper
Attached colored images provided by SeaWiFS

Date _____

Name(s) _____
_____
_____
_____

STUDENT ANSWER BOOKLET



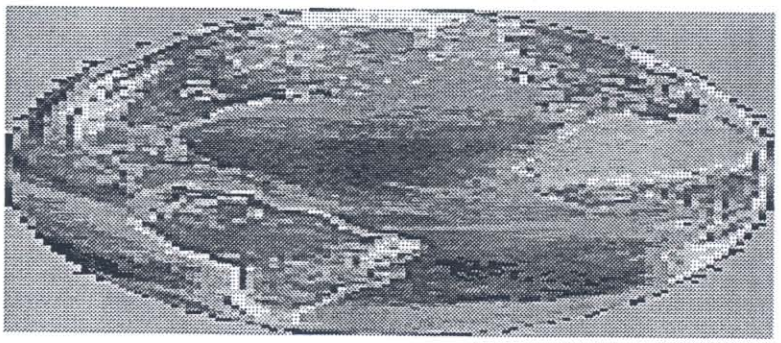
IS THE OCEAN JUST BLUE?

ENGAGEMENT

The "color" of the ocean is determined by the interactions of incident light with particles present in the water. The most significant constituents are free-floating photosynthetic organisms (phytoplankton) and inorganic particulates. Phytoplankton contains chlorophyll, which absorbs light at blue and red wavelengths and transmits in the green. Particulate matter can reflect and absorb light, which reduces the clarity of the water. Substances dissolved in the water can also affect its color. Ocean color is used for research into phytoplankton, the base of the oceanic food web.

To human eyes, the ocean appears as shades of blue, sometimes blue-green. From outer space, satellite sensors can distinguish even slight variations in color to which our eyes are not sensitive. Different shades of ocean color reveal the presence of differing concentrations of sediments, organic materials, or even phytoplankton—all of which can be measured by satellites. Satellite instruments measure the amount of reflected light of different wavelengths. These amounts allow scientists to estimate the productivity of Earth's landmasses and oceans.

Many federal agencies, such as the National Oceanic and Atmospheric Administration (NOAA) are involved with the technical and operational aspects of remote-sensing satellite systems, as well as global data bases for meteorology, oceanography, solid-earth geophysics, and solar-terrestrial sciences. From these sources, it develops and provides environmental data and information products and services. Imagine that you are an oceanographer who has just been hired by NOAA to examine ocean color data.



You will be working with other NOAA scientists to gather data pertaining to ocean color. 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. Describe the ocean color that you have seen.

_____

_____

_____

B. List at least three factors that you think affect the color of the ocean.

_____

_____

_____

_____

EXPLORATION

The SeaWiFS Project provided the following images. The images were taken between March 14, 2000 through July 18, 2000. The images show the true color of the Mid-Atlantic Ocean. The true color is the actual color of the image provided by SeaWiFS. The white color represents clouds, the brown and green represents the land and the blue represents the ocean.

Activity 2

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

B. Write down three of your observations.

_____

_____

_____

EXPLANATION

C. Compare and contrast the March 14,2000 true color image with the July 18,2000 true color image.

_____

_____

_____

_____

_____

D. Describe the differences in the land between the true color images of mid March and mid July.

_____

_____

_____

_____

_____

E. Explain why you think differences occurred during those months.

EXPLORATION

The SeaWiFS Project provided the following images. The images were derived from the previous set of true color images. The images show the false color of the Mid-Atlantic Ocean. These false color images show the estimates of plankton distribution and productivity in the world's ocean. The scale at the bottom of the images shows the concentration of chlorophyll *a*. A high concentration of chlorophyll *a* indicates a high concentration of phytoplankton. Areas of red represent the highest concentration and areas of blue represent lower concentration. The black color on the images represents either land or clouds.

Activity 3

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

B. Take a few minutes to compare the false color image to the true color image.

EXPLANATION

C. Compare and contrast the false color images with the true color images.

C. Write down three observations about the false color images.

E. Compare and contrast May 16, 2000 false color image with July 2, 2000 false color image.

F. Describe the differences in the chlorophyll concentration on May 26, 2000 false color image and July 6, 2000 false color image.

G. Explain why you think those differences occurred.

EXPLORATION

Activity 4

Take a few minutes to make a thorough observation of the following Chesapeake Bay true color image.

A. Write down ten observations about the Chesapeake Bay true color image.

EXPLANATION

B. The shades of green indicate higher concentrations of phytoplankton. Using what you know about the food chain, make a prediction about the animal life located in the light green areas.

C. Indicate where would be the best fishing area(s).

D. Explain why you think the green colored areas of water are located near land and the blue colored areas of water are located far away from land.

EXPLORATION

Activity 5

Read about the Carbon Cycle in your student resource booklet and review the Global Carbon Cycle diagram.

EXPLANATION

A. Explain how the atmosphere and the ocean interact.

B. If a zooplankton, microscopic animal plankton, was to eat a phytoplankton, predict what will happen to the zooplankton and the carbon that remained in the phytoplankton.

C. Explain the importance of phytoplankton in the Carbon Cycle.

EXPLORATION

Activity 6

Read the information about the greenhouse effect in the student resource booklet and review the greenhouse effect diagram.

EXPLANATION

A. Explain how global warming could affect sea levels.

B. Explain why it is important to study global warming.

ELABORATION

Activity 7

Congratulations! You have just completed your first task studying the ocean. You learned that the ocean is made of a mixture of colors indicating chlorophyll concentrations. You also studied the effects of the carbon cycle on the ocean color and on global warming. Before beginning your next task for NOAA, take a few minutes to compare the false color images of the Mid Atlantic to the true color images of the Mid Atlantic. Then review the true color image of the Chesapeake Bay.

Using what you have learned from your first task, you will develop a false color image of the Chesapeake Bay using the following steps.

1. Obtain an 8 ½ x 11 piece of lineless drawing paper and the Chesapeake Bay True Color Image.
2. Using a pencil, outline the true-color image.
3. Copy the chlorophyll concentration color code key provided by the Mid Atlantic False Color Images and place it at the bottom of the outlined image.
4. Using colored pencils or crayons, carefully make a false color image of the Chesapeake Bay.

Activity 8

Once your false color image is complete, you will present it to NOAA's Office of Research and Applications describing your image and explaining why satellite usage is important to society. Before you write your description, think about the following:

The Effects of phytoplankton on the food chain
The Effects of phytoplankton on the carbon cycle
The Effects of phytoplankton on global warming
The Effects of phytoplankton on the fishing industry

Now, write a brief description of your false color image and explain the importance of satellite usage to society.

STUDENT RESOURCE BOOKLET

OCEAN COLOR

What is ocean color?

The "color" of the ocean is determined by the interactions of incident light with substances or particles present in the water. Pure ocean water is deep blue; added materials can change its color. Marine plants make the ocean greener by absorbing blue light and reflecting green light. Ocean color is also affected by suspended sediments and dissolved organic matter, particularly near the coast. Color actually provides information about the concentrations of such materials near the sea surface and provides an understanding of marine productivity and pollution.

Why is ocean color important?

The major reason scientists measure ocean color is to study phytoplankton, the microscopic ocean plants, which form the base of the oceanic food web. These plants contain the pigment chlorophyll. Plants use chlorophyll to convert sunlight into food using a process called photosynthesis. Because different types of phytoplankton have different concentrations of chlorophyll, it allows us to estimate the amount and general type of phytoplankton in that area. Ocean color is an indicator of the health and chemistry of the ocean.

What are phytoplankton and why are they important?

Phytoplankton are microscopic plants that grow in the upper regions of the ocean where sunlight is plentiful. They require sunlight, water, nutrients, and carbon dioxide to survive. These small plants are the base of the food chain for the entire planet. Small fish, and some species of whales, eat phytoplankton as food. Larger fish then eat the smaller fish. Humans catch and eat many of the larger fish.

Phytoplankton, as revealed by ocean color, show scientists where ocean currents provide nutrients for plant growth. They also show where pollutants poison the ocean and prevent plant growth. Since phytoplankton depend upon specific conditions for growth, they frequently become the first indicator of a change in their environment.

What is the Global Carbon Cycle?

The global carbon cycle is powered by the Sun, which provides the energy for atmospheric and oceanic circulation and for plant photosynthesis. Carbon-rich fossil fuels, such as coal and oil, are a storehouse of solar energy from the past. The carbon cycle has a variety of sources and sinks. By far the most important are biological and chemical exchanges of atmospheric carbon dioxide with the land and the ocean, both of

which contain immense pools of carbon. Living organisms—including people—consume the energy stored in plants and fossil fuels, thereby releasing carbon dioxide into the environment.

It is critically important that we understand all of these sources and sinks because they seem to be currently out of balance; as a result, carbon dioxide is building up in the lower atmosphere. This gas contributes to the "greenhouse effect" because it allows sunlight to reach the Earth's surface but absorbs heat emitted by the surface. The greenhouse effect could lead to a global warming and other changes in the environment.

The two most important carbon sinks are land plants and phytoplankton, which use carbon dioxide for photosynthesis. Land plants absorb carbon dioxide directly from the atmosphere. Phytoplankton, which are eaten by marine animals, use atmospheric carbon dioxide that has entered the ocean through dissolution at the sea surface, rainfall, or runoff from the land. A small fraction of the carbon used by marine plants and animals is eventually deposited on the ocean floor in the form of solid wastes, shells and skeletons, and other organic matter. Carbon-rich ocean sediments thus represent a long-term sink in the global carbon cycle.

The two most important carbon sources are carbon dioxide released by soils and by the ocean. Microbes and higher organisms decompose organic matter to produce carbon dioxide by respiration. A large amount of carbon dioxide escapes the ocean, typically where deep waters rise to the surface. Volcanoes release a much smaller amount of carbon dioxide.

Over the course of a year, about as much carbon dioxide enters the global ocean as is returned by the ocean to the atmosphere. However, neither amount is well known. As a result, we still do not know whether the global ocean is a net sink or a net source of atmospheric carbon dioxide in any given year, or how this balance varies from one year to another.

Human activities, particularly fossil fuel burning and deforestation, are also releasing carbon dioxide into the atmosphere. Although these carbon sources are still slight compared to natural ones, they may be disturbing the natural cycle, and their rapid increase is cause for concern. The role of human activities cannot be assessed, however, without a more accurate knowledge of natural carbon sinks and sources—in particular, the annual rate of carbon dioxide uptake by marine phytoplankton. This information cannot be obtained without extended measurements of ocean color from space.

What is the greenhouse effect?

The Earth is unique to our solar system: it can sustain life. Without the Earth's atmosphere, our planet would become extremely cold and barren of life. The atmosphere consists of nitrogen (about 70 percent) and oxygen (about 20 percent). The other ten percent consists mostly of carbon dioxide, water vapor, and several "trace" gases such as neon and argon.

Like the glass roof and walls of a greenhouse, the Earth's atmosphere keeps its surface much warmer than it would be without the "greenhouse effect". How? Energy from the sun arrives as short-wavelength radiation (light), while the Earth emits long-wavelength (infrared) energy back into space. The hotter an object is, the shorter the wavelength of the radiation it emits. The short-wavelength sunlight easily penetrates the atmosphere and warms the Earth. However, the atmosphere absorbs some of the long-wavelength energy emitted from the Earth before it escapes into space. Carbon dioxide, water vapor, and other gases in the atmosphere are responsible for absorbing emitted long-wavelength energy. Thus, the Earth keeps some of the heat that would otherwise have been lost to space.

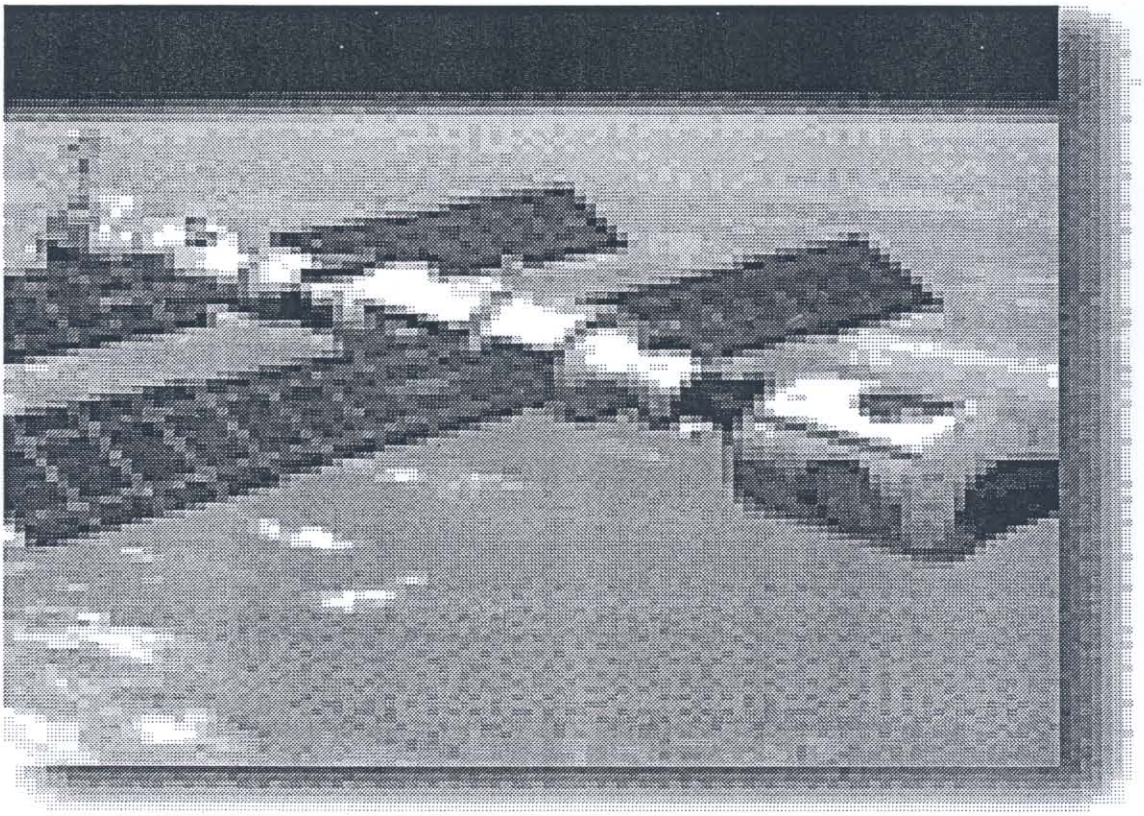
The concentration of carbon dioxide in the atmosphere has changed in the past hundred years. Before the Industrial Revolution, carbon dioxide levels stayed nearly stable for thousands of years. Since human beings developed a fossil-fuel-based global economy and lifestyle, the amount of atmospheric carbon dioxide has increased dramatically. This increase means that less long-wavelength energy emitted from the Earth can escape to space. Many scientists believe this can lead to a gradual warming of the Earth, but others believe that different factors counteract this warming effect. For example, cloud cover reflects sunlight before it ever reaches the Earth, thus reducing the amount of sunlight that reaches the Earth's surface. Studying these processes is difficult, because they are complicated. Ocean color information provides one of the many tools scientists use to try to find what changes are occurring, and how they may affect us.

Cite: NASA (Office of Mission to Planet Earth/ the Living Ocean)

GLOSSARY

Atmosphere- the envelope of gases surrounding Earth.
Biology- the science of life, including a study of the development, structure and behavior of living organisms.
Carbon dioxide- a colorless, odorless, noncombustible gas that is slightly more than 1.5 times as dense as air.
Chlorophyll- a green substance, which gives leaves their color. Chlorophyll absorbs energy from sunlight, which a plant uses to make food.
Chloroplast- a plastid that contains chlorophyll and is the site where photosynthesis and starch formation occur.
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.
Environmental Modeling Center (EMC) - National Weather Service center that conducts research on current prediction methods and develops new and improved forecast models and objective analysis methods.
False Color – an arbitrary color palette applied to a true color image so that oceanic features may be more clearly discerned. The false color images show the estimates of plankton distribution and productivity in the world's ocean.
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, as well as global databases for meteorology, oceanography, solid-earth geophysics and solar-terrestrial sciences.
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.
Oceanographer- scientist who studies ocean processes.
Photosynthesis-the process in which plants uses carbon dioxide and water in the presence of light to produce carbohydrates and oxygen.
Phytoplankton- microscopic plant plankton
Plankton- microscopic aquatic animals and plants, vast numbers of which drift in lakes and seas, normally near the surface. Plankton is the food of many fishes and whales and is thus vital to ecological balance (food chains) of the sea.
Rain- falling water drops with a diameter greater than .02 inch.
True Color- actual ocean color image
Water Vapor- water in a gaseous state.
World's Ocean- 71% of the Earth's surface.
Zooplankton- microscopic animal plankton

SEA-VIEWING WIDE FIELD-OF-VIEW SENSOR (SEAWIFS)



SEA-VIEWING WIDE FIELD-OF-VIEW SENSOR (SeaWiFS)

SeaWiFS was launched August 1, 1997 by a Pegasus XL launch vehicle. Data acquisition commenced on September 4, 1997. From an altitude of 705-km, SeaWiFS scans a swath 2,800-km wide, completing one polar orbit every 99 minutes. Global images are assembled every two days.

When visible light from the Sun illuminates the ocean surface, it is subject to several optical effects. Foremost among these effects are light reflection and absorption. Reflection beneath the water surface is generally inefficient, returning only a small percentage of the light intensity falling on the ocean surface. Absorption selectively removes some wavelengths of light while allowing the transmission of other wavelengths.

In the ocean, light reflects off particulate matter suspended in the water, and absorption is primarily due to the photosynthetic pigments (chlorophyll) present in phytoplankton. The net result of these optical interactions is light radiating from the ocean surface, the "water-leaving radiance". Radiometers are instruments that measure the radiance intensity at a given wavelength of light. The measured radiance may then be quantitatively related to various constituents in the water column that interact with visible light, such as chlorophyll. The concentration of chlorophyll, in turn, may be used to calculate the amount of carbon being produced by photosynthesis, which is termed primary productivity.

SeaWiFS is a spectroradiometer, which means that it measures radiance in specific bands of the visible light spectrum. It measures the violet, blue, yellow, and green hues of the ocean, as well as the intensity of red light scattered by atmospheric dust and haze, and by land surfaces.

The advantage of observing the oceans with a space-based spectroradiometer is the global coverage that a satellite provides. The disadvantage is that interfering optical effects, primarily light scattering in the atmosphere, must be accounted for to provide an accurate measurement of the water-leaving radiance.

Below is a chart of SeaWiFS sensor characteristics, which are designed to measure the ratio of green to blue light, scattered from the sea surface.

BAND	WAVELENGTH (nanometers)	COLOR	MEASUREMENT
1	402-422	Violet	Dissolved organic matter (violet absorption)
2	433-453	Blue	Chlorophyll (blue absorption)
3	480-500	Blue/green	Chlorophyll (blue/green absorption)
4	500-520	Green	Chlorophyll (green absorption)
5	545-565	Green/yellow	Chlorophyll (green reflection)
6	660-680	Red	Atmospheric aerosols
7	745-785	Red	Atmospheric aerosols
8	845-885	Red	Atmospheric aerosols

TEACHER'S GUIDE

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

Make sure that the students have colored pencils or crayons.

It may be helpful if students have access to a map that includes the Mid Atlantic Coastal States.
Note: Activity 7 asks the students to trace the bay image, but a blank image may be provided to the students if accessible.

Each group should receive the colored images provided by SeaWiFS.

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.

Related Careers

Oceanography

Atmospheric Science

Statistics

Engineering

Computer Science

Mathematics

Meteorology

Related Web Sites

http://www.noaa.gov

http://eospso.gsfc.nasa.gov/

http://seawifs.gsfc.nasa.gov/SEAWIFS.html

http://modis.gsfc.nasa.gov/MODIS/MODIS.html

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

http://earthobservatory.nasa.gov

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
Score 2 = Response includes actual dates and a color description.
Score 1 = Response includes dates or color.
Score 0 = Incorrect or no response.

Question 2c
Score 3 = Response indicates a change in the land color, cloud coverage and ocean view.
Score 2 = Response identifies at least two of the above items.
Score 1 = Response identifies at least one of the above items.
Score 0 = Incorrect or no response.

Question 2d
Score 1 = Response indicates that the land is brown in March and green in July.
Score 0 = Incorrect or no response.

Question 2e
Score 1 = Response indicates a change in temperature.
Score 0 = Incorrect or no response.

ACTIVITY 3

Question 3a
Do not score

Question 3b
Do not score

Question 3c
Score 3 = Response indicates that the land color was green or brown on the true color image but black on the false color image.

Response indicates that the clouds were white on the true color image, but black on the false color image.
Response indicates that the ocean color is mostly blue on the true color image, but multi-color on the false color image.

Score 2 = Response identifies at least two of the above items.
Score 1 = Response identifies at least one of the above item.
Score 0 = Incorrect or no response.

Question 3d

Score 3 = Response includes dates, a color description and the chlorophyll concentration.
Score 2 = Response identifies at least two of the above items.
Score 1 = Response identifies at least one of the above items.
Score 0 = Incorrect or no response.

Question 3e

Score 2 = Response indicates higher concentration of chlorophyll on May 16, 2000 and a change in cloud coverage.
Score 1 = Response indicates a change in chlorophyll or a change in cloud coverage.
Score 0 = Incorrect or no response.

Question 3f

Score 2 = Response indicates higher concentration of chlorophyll on May 26, 2000 and includes data from the concentration key.
Score 1 = Response indicates higher concentration of chlorophyll on May 26, 2000, but does not include data from the concentration key.
Score 0 = Incorrect or no response.

Question 3g

Score 1 = Response may include tidal movement or temperature change.
Score 0 = Incorrect or no response.

ACTIVITY 4

Question 4a

Do not score

Question 4b

Score 2 = Response indicates that a higher level of zooplankton and fish live in this area because they use phytoplankton as their source of food.
Score 1= Response indicates that a higher level of zooplankton or fish live in this area because they use phytoplankton as their source of food.
Score 0 = Incorrect or no response.

Question 4c
Score 1 = Response indicates the best area for fishing would be in the light green/yellow areas.
Score 0 = Incorrect or no response.

Question 4d
Score 1 = Response indicates that the body of water closest to the land receives nutrients and fertilizers.
Score 0 = Incorrect or no response.

ACTIVITY 5

Question 5a
Score 2 = Response indicates that a difference in the heating and cooling rates of land and ocean affect air circulation. Response also indicates an exchange of carbon dioxide.
Score 1 = Response identifies at least one of the above items.
Score 0 = Incorrect or no response.

Question 5b
Score 1 = Response indicates that when the zooplankton die, they carry the carbon with them as they sink to the bottom of the ocean.
Score 0 = Incorrect or no response.

Question 5c
Score 3 = Response indicates that phytoplankton takes up atmospheric carbon dioxide.
Response indicates that the carbon taken up by the phytoplankton can eventually be deposited on the ocean floor.
Response indicates that the carbon-rich ocean sediments represent a long-term sink in the global carbon cycle.
Score 2 = Response identifies at least two of the above items
Score 1 = Response identifies at least one of the above items.
Score 0 = Incorrect or no response.

ACTIVITY 6

Question 6a
Score 2 = Response indicates that ice in polar regions will melt and sea levels will rise.
Score 1 = Response indicates that ice in the polar regions will melt or sea levels will rise.
Score 0 = Incorrect or no response

Question 6b
Score 1 = Response indicates the importance of monitoring sea levels to avoid coastal flooding or other natural disasters.
Score 0 = Incorrect or no response.

ACTIVITY 7

Score 5 = The false color image includes the following:
The land and the cloud areas are shaded black.
The yellow areas close to the land are shaded red.
The light green areas are shaded yellow to orange.
The green areas are shaded light blue to green.
The blue areas are shaded purple to blue.

Score 4 = Student has 4 of the above items shaded correctly.
Score 3 = Student has 3 of the above items shaded correctly.
Score 2 = Student has 2 of the above items shaded correctly.
Score 1 = Student has 1 of the above items shaded correctly.

ACTIVITY 8

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.