National Aeronautics and
Space Administration
Goddard Space Flight Center

Moderate-Resolution Imaging Spectroradiometer (MODIS)

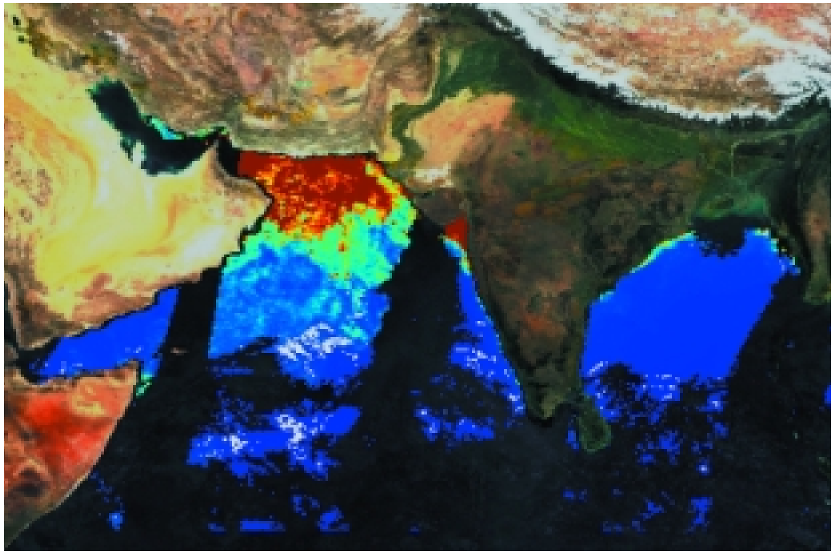

Figure 1 Chlorophyll Concentrations

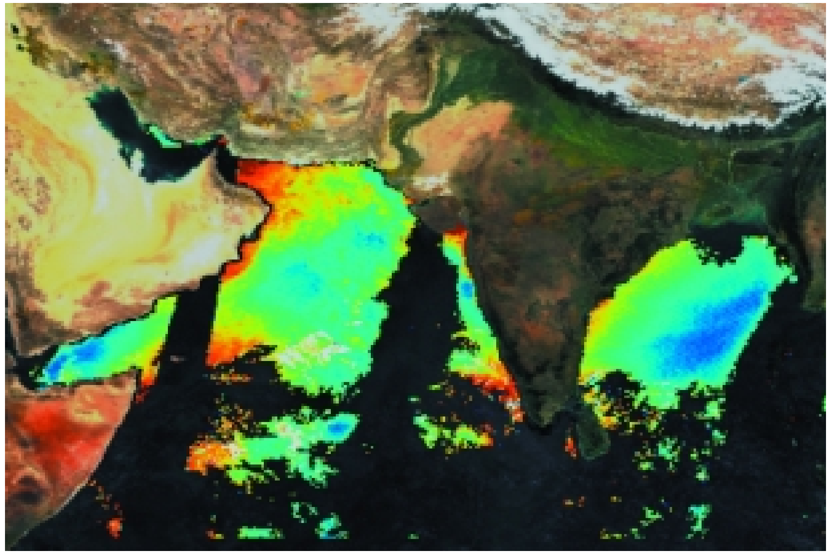

Figure 2 Chlorophyll Fluorescence

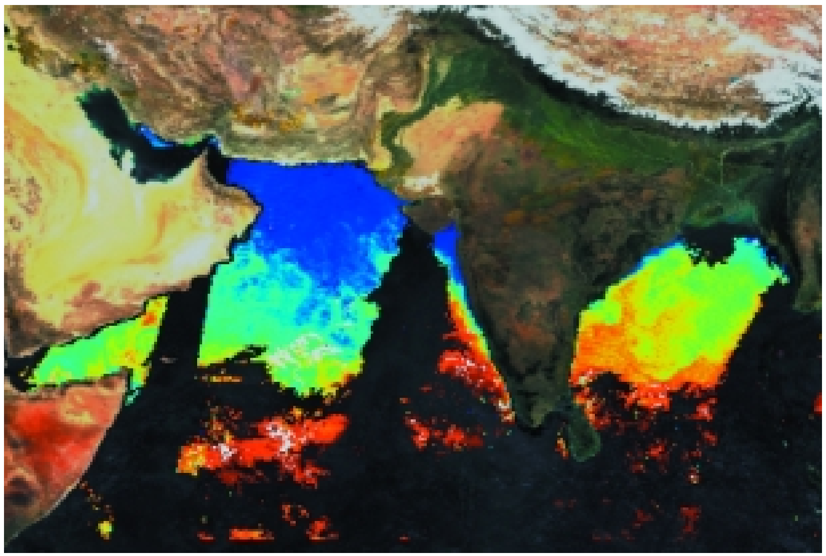

Figure 3 Photosynthetic Activity

Moderate-Resolution Imaging Spectroradiometer (MODIS)

About these Images

The MODerate-resolution Imaging Spectroradiometer (MODIS) can monitor the location and abundance of plant life near the ocean surface on a global scale almost every day. By precisely measuring ocean color, scientists can determine where concentrations of phytoplankton are floating in the surface layers of the ocean, as well as how much of the microscopic marine plant (in milligrams per cubic meter) is present in a given bloom (see Figure 1). Like land-based plants, phytoplankton contain the pigment chlorophyll (used for photosynthesis) that gives them their greenish color. Chlorophyll preferentially absorbs red and blue wavelengths of light and reflects green light. From outer space, satellite sensors can distinguish slight variations in color to which our eyes are not sensitive—the color of the ocean reveals the presence of concentrations of sediments, organic materials, and phytoplankton. MODIS' measurements of ocean color extend the heritage of such measurements begun by the Coastal Zone Color Scanner (CZCS) satellite sensor in the early 1980s, and continued by the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) in the 1990s.

But MODIS brings improved capabilities over its heritage sensors. Because of its improved detection capabilities, MODIS can better measure the concentration of chlorophyll associated with the phytoplankton. Also, for the first time from a space-based sensor, MODIS can measure fluorescent light emitted by phytoplankton, which provides scientists with new insights into the health of a given bloom (see Figure 2). When these marine plants are under stress, they no longer photosynthesize and begin to emit absorbed sunlight as both heat and fluorescent light. What conditions would cause the phytoplankton to be under stress? (Answer: lack of sunlight and nutrients from which to feed.)

In this series of MODIS images taken over the Arabian Sea and the Bay of Bengal, we first see high concentrations of chlorophyll in red tones and lower concentrations in shades of blue. In the next image, we see levels of fluorescence (red is high values, blues are low). By comparing those two quantities, we can see the degree of photosynthetic activity that is occurring. In the third image (see Figure 3), the areas with the highest amounts of photosynthetic activity are colored blue and the lower levels are colored red.

About MODIS

The Moderate-Resolution Imaging Spectroradiometer (MODIS), provided by NASA's Goddard Space Flight Center, Greenbelt, Maryland, and built by Raytheon (formerly Hughes) Santa Barbara Remote Sensing, Santa Barbara, California, measures the atmosphere, land and ocean processes, (including surface temperature of both the land and ocean), ocean color, global vegetation, cloud characteristics, temperature and moisture profiles, and snow cover. MODIS views the entire surface (land, oceans, clouds, aerosols, etc.) of the Earth every one to two days at a "moderate resolution" of one quarter to one kilometer.

For the Classroom

Grade Level: 7-12

Have you ever thought about fluorescence? By doing a couple of simple investigations, you can investigate this fascinating subject.

In addition to phytoplankton, certain minerals and a variety of other substances fluoresce or emit visible light when illuminated by ultraviolet light. Fluorescence is a process that exchanges ultraviolet-light energy for visible-light energy, as electrons orbiting the nuclei of atoms within the substance capture photons of ultraviolet light. The electrons, gaining energy, are boosted to excited states. The electrons eventually release this captured energy as visible light as they return to lower energy states.

Take a mirror, two sugar cubes, and a roll of wintergreen Life Savers into a completely dark closet or room. Wait about 10 minutes for your eyes to adjust to the darkness. If light comes into the room under the door, seal the space with a bath towel.

Now, take the two sugar cubes and rub one against the other as if you were lighting a match on a striker. You should see a bluish white glow from the cubes as you strike them together.

Now, put the wintergreen candy between your teeth, taking care not to get the candy wet. Hold the mirror so that you can see your mouth. Look at your mouth in the mirror and bite down and crush the candy. As the candy breaks, you should see blue sparks.

Did more light come from the sugar cubes or the wintergreen Life Saver?

Is the color of the light given off from the sugar and the Life Saver similar in color to some natural phenomena?

Do you think the wintergreen in the Life Saver had an effect on the light given off during the investigation?

Answers

The wintergreen Life Saver should have given off more light.

The light given off is the same color as lightning.

Yes, the light given off by the wintergreen candy is brighter than the light from the sugar cubes.

Resources

Terra Website: http://terra.nasa.gov

NASA's Earth Observatory:
http://earthobservatory.nasa.gov

Image Credit: MODIS Oceans Science Team, Oregon State University Remote Sensing Ocean Optics, Corvallis, Oregon.