NASA Development May Help Solve Ocean Biology Problem

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NASA and university scientists have made a breakthrough in using satellites to study the tiny, free-floating ocean plants, called phytoplankton. The plants form the base of the ocean food chain and produce half of the oxygen in the air we breathe.

The development opens the door to solving a problem that has stymied ocean biologists for more than a century, and is revolutionary to our understanding of how ocean biology and ecosystems, as well as carbon cycling, respond to climate variability and change.

Data about the growth rate of the ocean plants can be derived from space and incorporated into global estimates of their life processes. New, accurate information on phytoplankton will greatly advance understanding of marine ecosystems and how they function, including issues related to fisheries, water quality, and harmful algal blooms.

This research contributes to improved computer models that enable predictions of how climate change will alter ocean ecosystems and the Earth system. Despite their minute size, the growth and photosynthesis of phytoplankton collectively accounts for half of the carbon dioxide, a major greenhouse gas, absorbed annually from Earth's atmosphere by plants.

"While the full potential of this discovery awaits further work, what is really amazing is that a signal detectable from space has been found that tracks changes in the activity, not just abundance, of phytoplankton," said Michael Behrenfeld, a professor at Oregon State University, Corvallis, Ore., and a researcher at NASA's Goddard Space Flight Center, Greenbelt, Md.

In order to determine ocean productivity, which is the rate of photosynthesis, scientists must know plant growth rates and their abundance. Satellites can detect variations in the color of light within the ocean, and researchers use this information to tell phytoplankton amounts. The new method for recording growth rates by satellite involves advances in the way these satellite ocean data are analyzed.

"Satellite ocean color images are kind of like your television screen, where you have controls for the color setting and controls for brightness," said researcher Dr. David Siegel. "What we've done here is use both the color and brightness signals to determine plant greenness and the number of individual phytoplankton cells."

With this new information, researchers can calculate growth rates from the greenness of the individual phytoplankton cells. When cold water temperatures, bright light, or low nutrients put stress on phytoplankton, they lose pigment and appear less green. The reverse is also true, phytoplankton become greener when conditions improve and growth rates increase.

To demonstrate the new approach, the research team used ocean color data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). The data showed growth rates changed over seasons and across ocean basins in precisely the manner expected from years of laboratory studies on phytoplankton. Encouraged by these findings, researchers applied their new data to recalculate ocean production. The result was a significantly different view of ocean photosynthesis previously revealed by older models using the same satellite data.

The study appeared in the January 2005 electronic issue of the journal Global Biogeochemical Cycles. The research was an Editor's Choice in the Feb. 4 issue of Science Magazine. Coauthors include Dr. Emmanuel Boss of the University of Maine, Orono; Dr. David Siegel, University of California, Santa Barbara; and Donald Shea from Goddard.