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Plankton May Influence Climate Change Says UCSB Scientist

Plankton appear to play a major role in regulating the global climate system, according to new research.

David Siegel, professor of geography at the University of California, Santa Barbara, and director of the Institute for Computational Earth System Science, made the discovery with his former Ph.D. student Dierdre Toole, who is now based at Woods Hole Oceanographic Institute.

In an article in the May 6 issue of the journal *Geophysical Research Letters*, the scientists explain their research in the Sargasso Sea, approximately 50 miles southeast of the island of Bermuda. Siegel's research group has been making observations at this location since 1992.

Phytoplankton are tiny, single-celled floating plants. They inhabit the upper layers of any natural body of water where there is enough light to support photosynthetic growth. They are the base of the ocean's food web, and their production helps to regulate the global carbon cycle. They also contribute to the global cycling of many other compounds with climate implications.

One of these compounds is a volatile organic sulfur gas called dimethyl sulfide or DMS. Scientists had previously theorized that DMS is part of a climate feedback mechanism, but until now there had been no observational evidence illustrating how

reduced sunlight actually leads to the decreased ocean production of DMS. This is the breakthrough in Toole and Siegel's research.

They describe how the cycle begins when the ocean gives off DMS to the lower atmosphere. In the air, DMS breaks down into a variety of sulfur compounds that act as cloud-condensing nuclei, leading to increased cloudiness. With more clouds, less sunlight reaches the Earth and the biological processes which produce DMS are reduced.

According to their research, it appears that phytoplankton produce organic sulfur compounds as a chemical defense from the damaging effects of ultraviolet radiation and other environmental stresses, in much the same way as our bodies use vitamins E and C to flush out molecules that cause cellular damage.

Siegel and Toole found that ultraviolet radiation explained almost 90 percent of the variability in the biological production of DMS. They showed that summertime DMS production is "enormous," and that the entire upper layer of DMS content is replaced in just a few days. This demonstrates a tight link between DMS and solar fluxes.

"The significance of this work is that it provides, for the first time, observational evidence showing that the DMS-anti-oxidant mechanism closes the DMS-climate feedback loop," said Siegel. "The implications are huge. Now we know that phytoplankton respond dramatically to UV radiation stresses, and that this response is incredibly rapid, literally just days."

He explained that the findings give new impetus for scientists to re-examine the DMS-climate feedback hypothesis. And the DMS-climate feedback may also play out under possible global warming and climate change scenarios.

As the Earth's ozone shield thins and greenhouse gases increase, higher ultraviolet radiation will reach the surface layer of the oceans. The findings indicate that phytoplankton will then produce more DMS in response to this increased ultraviolet radiation, causing increasing cloudiness and mitigating the effects of global warming. However, Siegel is careful to note that while the process may mitigate global warming it will not reverse the trend.

The project was funded by NASA. NASA's Earth Science Enterprise is dedicated to understanding the Earth as an integrated system and applying Earth System Science to improve prediction of climate, weather, and natural hazards using the unique vantage point of space.

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