

Antarctic icebergs help the ocean take up carbon dioxide

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A five-year research project led by marine biologist Ken Smith at MBARI shows that icebergs such as this one carry iron-rich sediment from Antarctica out into the Southern Ocean. The darker parts of the ice contain higher concentrations of sediment. Credit: Debbie Nail Meyer © 2009 MBARI

The first comprehensive study of the biological effects of Antarctic icebergs shows that they fertilize the Southern Ocean, enhancing the growth of algae that take up carbon dioxide from the atmosphere and then, through marine food chains, transfer carbon into the deep sea. This process is detailed in 19 new research papers published electronically in a special issue of the journal *Deep Sea Research Part II: Topical Studies in Oceanography*.

The research team was led by MBARI [marine biologist](#) Ken Smith and funded by the National Science Foundation. Smith, along with

researchers from more than a dozen other institutions, conducted three month-long cruises to the Weddell Sea in 2005, 2008, and 2009. By tracking individual icebergs and deploying remotely controlled aircraft and submersibles, as well as robotic drifters, the team was able to document a process that had previously been suspected, but never proven.

[Global climate change](#) is causing Antarctic ice shelves to shrink and split apart, releasing thousands of free-drifting icebergs that are carried by currents into the nearby Weddell Sea. The new research suggests that these icebergs carry iron-rich sediment from the land out into the ocean. As these icebergs melt and drift across the ocean, some of the iron dissolves in the [seawater](#), creating a trail of iron-rich [meltwater](#) that can be up to 19 kilometers (12 miles) long. The iron in this water helps fertilize the growth of [microscopic algae](#).

During their three cruises, the team studied an area they called "iceberg alley" in the inhospitable and sometimes dangerous Southern Ocean. Instead of avoiding icebergs, they directed their [research vessel](#) to approach and follow drifting icebergs the size of small towns. To follow individual icebergs, they used satellites and GPS tracking devices that were dropped on the icebergs using a radio-controlled airplane. They also used three different robotic submersibles to study life on the undersides of the icebergs.

MBARI engineers, led by Alana Sherman, developed a new robotic instrument that was programmed to sink 600 meters (about 2,000 feet) below the ocean surface while a large iceberg drifted overhead, then rise back to the sea surface after the iceberg had passed. This instrument, called a "Lagrangian sediment trap," was used to collect particles of sediment, bits of dead algae, and other debris that drifted down from the waters under and around the iceberg. This device allowed scientists to measure, for the first time, the amount of organic carbon sinking into the

deep sea beneath a large (6-kilometers wide, 35-kilometers long, and 28-meters tall), free-floating iceberg.

The researchers compared the amount of carbon sinking down to 600 meters beneath the iceberg with the amount of carbon sinking in the open ocean nearby. They found that about twice as much carbon sank into the deep sea within a 30-kilometer (18.6-mile) radius of the iceberg, compared with an open-ocean "control" area.

Extrapolating their findings to the rest of the Weddell Sea, the researchers concluded that the icebergs (both large and small) were playing an important role in controlling how much carbon from the atmosphere was taken up by algae and ultimately transported into the deep sea. "The role of icebergs in removing carbon from the atmosphere may have implications for global climate models that need to be further studied," said Smith.

In addition to the direct measurements of material sinking beneath the icebergs, the multidisciplinary research team performed a wide variety of physical, chemical, and biological studies around the icebergs. Many of these studies are detailed in the special issue of [Deep-Sea Research](#). The 19 papers in this special issue describe:

- New methods and tools for tracking icebergs from a moving ship at sea
- Water-sampling and video surveys by remotely operated vehicles
- Aerial surveys and tracking of icebergs using radio-controlled aircraft
- The fresh water, iron, and sediment released by melting icebergs

- The design and operation of the Lagrangian sediment traps, and the amounts of debris, organic carbon, and other materials collected by these traps
- Populations of marine microbes, algae, marine animals, and seabirds around the icebergs

After overcoming many challenges to study a few icebergs, Smith and Sherman are working on strategies and automated tools for measuring the effects of the many icebergs in "iceberg alley" over periods of months to years. This would provide a much better estimate of how icebergs are affecting the chemistry and biology of the [Southern Ocean](#).

Provided by Monterey Bay Aquarium Research Institute

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