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NEWS

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Antarctic Icebergs: hotspots of ocean life

Global climate change is causing Antarctic ice shelves to shrink and split apart, yielding thousands of free-drifting icebergs in the nearby Weddell Sea. According to a new study in this week's journal *Science* these floating islands of ice—some over 20 kilometers (12 miles) across—are having a major impact on the ecology and chemistry of the ocean around them, serving as "hotspots" for ocean life, with thriving communities of seabirds above and a web of phytoplankton, krill, and fish below.

The icebergs hold trapped terrestrial material, and associated trace nutrients, which they release far out at sea as they melt. "The Southern Ocean lacks a major source for terrestrial material due to the absence of major rivers. The icebergs constitute a moving estuary, distributing terrestrial derived nutrients that are typically supplied by rivers in other areas of the oceans" said geochemist Timothy Shaw of the University of South Carolina.

The researchers discovered that this process produces a "halo effect" with significantly increased phytoplankton, krill, and seabirds out to a radius of more than 3 kilometers (two miles) around the icebergs. They may also play a surprising role in global climate change.

"One important consequence of the increased biological productivity is that free-floating icebergs can serve as a route for carbon dioxide drawdown and sequestration of particulate carbon as it sinks into the deep sea," said oceanographer Ken Smith of the Monterey Bay Aquarium Research Institute (MBARI), first author and principal investigator for the research.

"While the melting of Antarctic ice shelves is contributing to rising sea levels and other climate change dynamics in complex ways, this additional role of removing carbon from the atmosphere may have implications for global climate models that need to be further studied," added Smith.

To understand the icebergs' complex impacts, the multidisciplinary team of researchers carried out the most comprehensive study ever done of individual icebergs and their immediate environment, taking a wide array of measurements—physical, biological and chemical—and using satellite images provided by NASA.

At the same time, the wealth of data brought new challenges in how to manage this avalanche of information. "The whole is definitely greater than the sum of the parts, and to answer questions across the different areas from ecology to chemistry and climate, scientists need access to all the data," explained researcher John Helly of the San Diego Supercomputer Center (SDSC) at UC San Diego, who managed the data. "And we need to reliably harvest this information at sea, thousands of miles from our shore-based labs, and to preserve it as a unique snapshot of these iceberg ecosystems at this point in history."

Using SDSC-developed technologies, Helly collected the data using the *SIOExplorer-in-a-Box* digital library system (http://SIOExplorer.ucsd.edu) and then stored the information in collections at SDSC for access and analysis by scientists now and in the future.

Just getting to the icebergs was a challenge. First the scientists used satellite images to select two icebergs to study in detail. Then they sailed aboard the Antarctic research vessel *Laurence M. Gould* to reach their targets in the remote Weddell Sea, an arm of the Southern Atlantic Ocean that cuts into the Antarctic continent southeast of Cape Horn. The icebergs in the study were up to 21 km (13 miles) long and more than 40 meters (130 feet) high, with one extending nearly 300 meters (1,000 feet) into the depths.

Despite the risks of getting close to these mountains of ice—which can shed huge pieces or overturn without warning—the scientists began their shipboard sampling less than 100 meters (300 feet) from the icebergs and continued out to a distance of some nine kilometers (5.6 miles), where the icebergs' influence was no longer detectable.

"Phytoplankton around the icebergs was enriched with large diatom cells, known for their role in productive systems such as upwelling areas of the west coast of the U.S. or ice-edge communities in polar oceans. As diatoms are the preferred food for krill, we expect the changes in phytoplankton community composition to favor grazing as a key biological process involved in carbon sequestration around free-floating icebergs," said oceanographer Maria Vernet from Scripps Institution of Oceanography at UC San Diego, one of the members of the research team.

"We used a small, remotely operated vehicle (ROV) to explore the submerged sides of the icebergs and the waters between the bergs and where the ship was, standing off at a safe distance," said Bruce Robison of MBARI, an oceanographer and ROV pilot. "We flew the ROV into underwater caves and to the undersides of the icebergs, identifying and counting animals with its color video camera, collecting samples, and surveying its topography."

Based on their new understanding of the impacts of the icebergs and their growing numbers—the researchers counted close to 1,000 in satellite images of some 11,000 square kilometers (4,300 square miles) of ocean—the scientists estimate that overall the icebergs are raising the biological productivity of nearly 40 percent of the Weddell Sea's area.

In addition to Smith, Robison, Shaw, Vernet, and Helly, the study's authors include Henry Ruhl of MBARI, Ronald Kaufmann of the University of San Diego, and Benjamin Twining of the University of South Carolina. These preliminary results were gathered as part of a small exploratory study funded by the National Science Foundation's Office of Polar Programs. Many research questions remain to be answered about the role of icebergs in the pelagic ecosystem of the Southern Ocean. This research is funded to continue these studies in 2008 and 2009.

Photographs to accompany this article are available upon request.

For sample images and web links, please see
http://www.mbari.org/news/news_releases/2007/icebergs.html

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