ment activity. "Is this assessment real, or a just a re-labeling of current program?", asked Barron. USGCRP leaders explained that the regional workshops have come about due to the efforts of federal agencies to find resources, but funding the full assessment and the long-term process of establishing regional networks are much greater tasks. Melillo emphasizes the need for a true public-private partnership to conduct the assessment. The fundamental objectives of the assessment suggest that the sources of funding should also be diverse—both to encourage partnerships and to promote broad ownership of the conclusions.

For more information about the national assessment process and the USGCRP, see Web site http://www.usgcrp.gov.

Aquamarine Waters Recorded for First Time in Eastern Bering Sea

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During the late summer of 1997, for the first time ever recorded, most of the continental shelf of the eastern Bering Sea was covered by aquamarine waters (Figure 1), resulting from a massive bloom of coccolithophores (Figure 2). Light reflecting off the calcium carbonate plates of the flagellated coccolithophores gave the water its anomalous color, which was first observed in July. The bloom was also clearly visible from space, as shown by some of the first images from the multispectral sea-viewing wide-field-of-view sensor (SeaWiFS) scanner in September.

Light penetration into the water column, essential for primary production by diatoms and other phytoplankton, was markedly reduced. This shift potentially altered the trophic dynamics throughout the food web of one of world's most productive ecosystems.

Prior to and during the bloom, anomalous atmospheric and oceanic conditions were evident. In July, large whales were relatively abundant in the region of the middle shelf where the bloom occurred. Concomitant with the bloom of coccolithophores were die-offs of seabirds, which reportedly began in early August, and a decrease in the number of salmon returning to Bristol Bay. Field operations conducted as part of the National Science Foundation (NSF) Inner Front project and the National Oceanic and Atmospheric Administration (NOAA) Coastal Ocean Program. Also, Fisheries Oceanography Coordinated Investigations provide a wealth of data to explore 1997's anomalous conditions.

The eastern Bering Sea shelf (Figure 3) consists of three domains characterized by water properties, water column structure, and plankton dynamics. Coastal water (the depths of which are less than 50 m) is typically mixed by a combination of tidal and wind stirring. Water over the middle shelf (depth 50–100 m) usually has two well-mixed layers: the upper, resulting from the annual melt of sea ice and/or solar heating, and the lower, which remains cold and rich in nutrients essential for phytoplankton growth. Separating the domains is a structure or inner front which extends for over 1,000 km around the shelf. The dynamics of this inner front likely provide nitrogenous nutrients for the prolonged primary and secondary production, which typically occurs there.

Typical springtime phytoplankton blooms in the Bering Sea are comprised of diatoms and are associated with increased water column stratification as a result of sea-ice meltback or solar radiation. Summertime phytoplankton blooms of the magnitude observed this year are rare, in part because the nutrients for plant growth are generally thought to be limiting.

Zooplankton biomass at the Inner Front may be enhanced two different ways: increased secondary production via increased food availability for herbivorous grazers, and physical concentration of grazers due to water convergence at the front. As a result of the favorable conditions generated by this increase in prey biomass, massive flocks of seabirds return each year to feed at the front and breed in Alaskan waters.

A sequence of unusual phenomena occurred in the coupled atmosphere-ice-ocean system this year, which may have favored rapid growth of the coccolithophores. First of all, winter sea-ice conditions exhibited average areal and latitudinal extent, but meltback appeared to be unusually rapid. In the spring and summer, there were reduced numbers of energetic storms and anomalously cloud-free conditions. One consequence was that the coastal domain was stratified and the upper layer on the middle shelf was shallower than usual.

Sea surface temperatures were up to 3°C above normal in June. The decrease in storms and clouds resulted from atmospheric connections to the current El Niño occurring in the equatorial Pacific. The warm waters were not due to a direct oceanic connection to the ongoing El Niño.

Aquamarine waters were first observed in early July. By this time, the normal summer phytoplankton community had probably been replaced by coccolithophores. Characteristic of these blooms are surface waters that have high reflectance, low chlorophyll, and particulate organic carbon concentrations. Light penetration and visibility in the aquamarine waters were markedly reduced, with Secchi depths of one-third normal being observed (2 m in bloom areas versus about 6 m in nonbloom areas).

Extinction coefficients at Nunivak Island, as determined by the photosynthetically active radiation sensor on the conductivity-temperature-depth sensor, doubled from June to August (0.07/m in June and 0.14/m in August). By September, the areal extent of the bloom was 700 x 300 km. The vertical extent

Fig. 1. Sea-viewing wide-field-of-view sensor (SeaWiFS) composite true color image showing the large areal extent of the affected waters (700 x 300 km) observed between September 18–25, 1997. Provided by the SeaWiFS Project, NASA/Goddard Space Flight Center. Original color image appears at the back of this volume.

TerraComm, 2523 Betlo Avenue, Mountain View, CA 94043 USA.

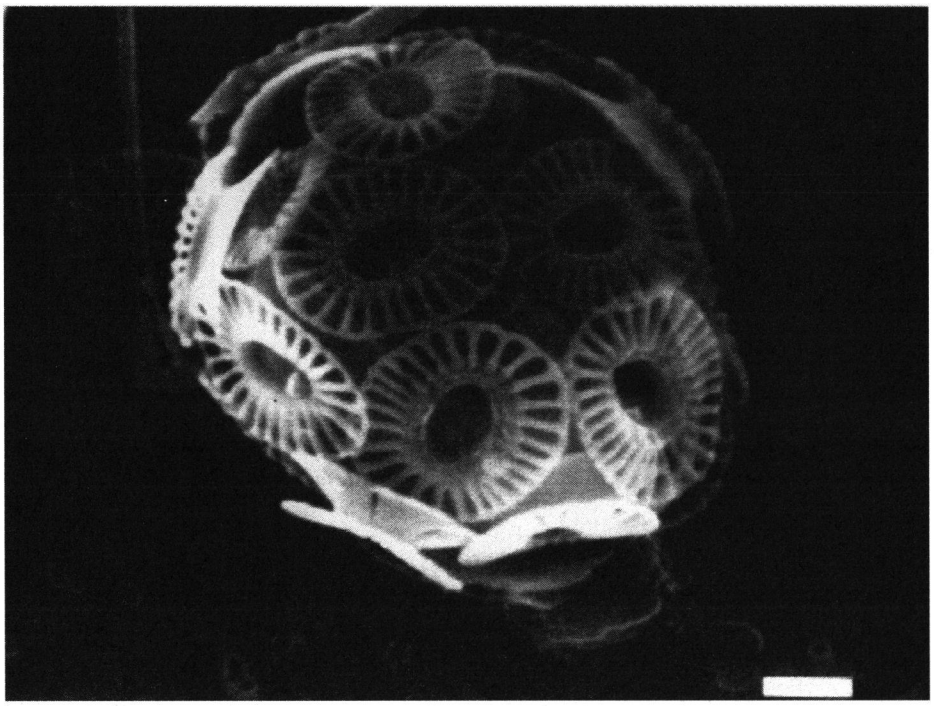

Fig. 2. A scanning electron microscope image showing coccolithophores. Photo by Patrick Holligan, from the Emiliania huxleyi Web site, http://www.soc.soton.ac.uk/SUDO/tt/eh.

of the bloom, based on underwater video observations made in September, varied from a thin layer to a layer up to 50 m deep. In some areas near shore the layer extended to the seafloor. At that time the bloom had been evident for two months which is longer than most recorded blooms.

The conditions near the inner front off Cape Newenham provide an example of the abnormal conditions. In June, nitrogenous nutrients were depleted from the bottom layer of the middle shelf, and the inner front was not well developed. Short-tailed shearwaters (*Puffinnus tenuirostris*), however, were eating their normal diet of adult euphausiids and had normal body weights. In mid-July, densities of seabirds were lower in the eastern edge of the aquamarine waters of outer Bristol Bay. In general, however, the condition and behavior of pelagic seabirds were normal during July. Large feeding flocks of short-tailed shearwaters were observed on the middle shelf.

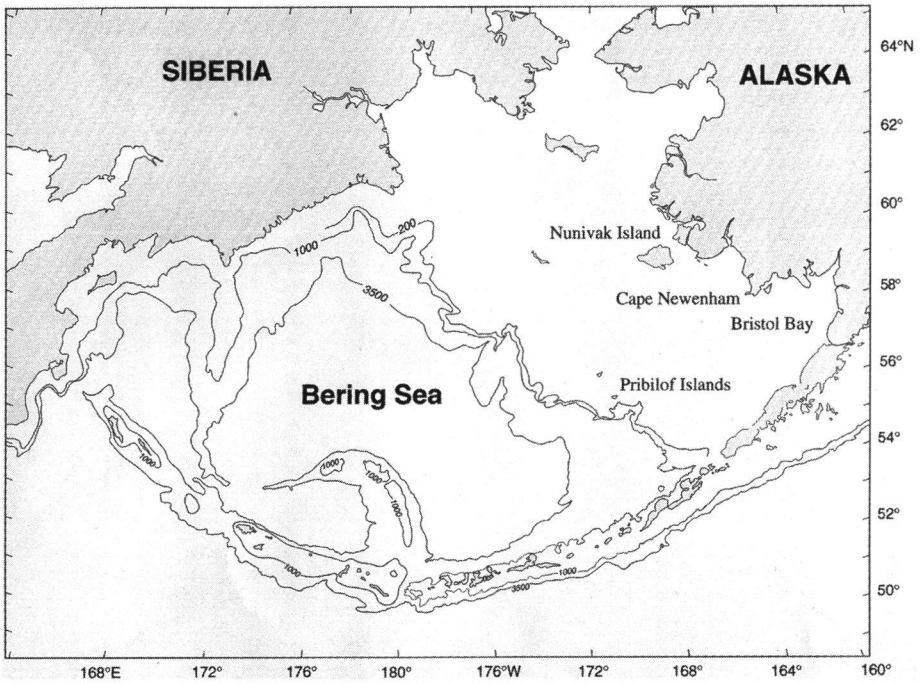

Fig. 3. Location map of the Bering Sea with the 50- and 100-m isobaths indicated.

By the first week of August, coastal die-offs of birds were reported. During the late summer and early fall, a major die-off occurred with thousands of dead birds washing ashore. In the fall, observations near the Pribilof Islands and off Nunivak Island substantiated the reports. Corpses of birds were conspicuous in areas affected by the bloom.

Both dead and living shearwaters had significantly reduced body mass compared to birds collected in June, indicating starvation. In addition to the typical diet for shearwaters of euphausiids in Bristol Bay, fish and squid were being ingested. Birds ingesting euphausiids were preying upon the smaller juvenile stages. Also, foraging shearwaters appeared to avoid areas with aquamarine water (both around the inner fronts and at the Pribilof Islands), where they may have had difficulty in detecting and capturing prey under the existing low underwater light conditions. Given the observations to date, we believe starvation was the prime cause of the shearwater die-off.

Other changes were evident in the ecosystem. The Bristol Bay salmon run was at least 15 million fish below predictions. Evidence from a test fishery at Port Moller suggests that the fish were dying on their way to Bristol Bay. Salmon were found to be more common in the diets of the northern fur seal that in previous years.

In addition, redistributions of some whale species in the southeast Bering Sea may have occurred, but there have been few large-scale synoptic surveys of cetaceans available for comparison during the past 20 years. During July, harbor porpoises (*Phocoena phocoena*) and five species of large whales—humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), minke whales (*Balaenoptera acutorostrata*), and right whales (*Eubalaena glacialis*)—were observed either in or near the coccolithophore bloom on the middle shelf. This suggests that the bloom and adjacent waters provided productive foraging for cetaceans and their prey. Comparison of this year with more nor-

mal years in the future will be needed to confirm the changes in feeding behavior.—*T. C. Vance, J. D. Schumacher, and P. J. Stabeno, NOAA-Pacific Marine Environmental Laboratory Seattle, Wash., USA; C. T. Baier, T. Wyllie-Echeverria, and C. T. Tynan, JISAO-University of Washington, Seattle, USA; R. D. Brodeur and J. M. Napp, NOAA-Alaska Fisheries Science Center, Seattle, USA; K. O. Coyle, University of Alaska, Fairbanks, USA; M. B. Decker and G. L. Hunt Jr., Ecology & Evol. Biology, University of California, Irvine, USA; D. Stockwell and T. E. Whitledge, Marine Science Inst., University of Texas, Port Aransas, USA; M. Jump and S. Zeeman, The University of New England Biddeford, Maine, USA.*

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Geoscientists Join Broad Coalition To Lobby U.S. Congress for Increased Funding

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Laurence Davis recalls reviewing a thick report about expanding a landfill in Nashua, New Hampshire, when he had worked for the state's department of environmental services. He says that although consultants had spent $400,000 on test borings, many of the drillings would have been unnecessary if the consultants simply had referred to a U.S. Geological Survey (USGS) topographical quadrant map that cost just a few dollars. The map, in this case, detailed both bedrock and surface geology, and indicated that the site the consultants were examining sat on the site of an old glacial lake bed that was not impermeable—an unsuitable location for expanding the landfill.

"Had they bought that map, they could have saved about $300,000 because they wouldn't have had to put in most of those borings," says Davis, now a professor of Earth and environmental sciences at the University of New Haven in Connecticut. When Davis recently visited congressional offices in Washington, D.C. for the first time, he related that story to elected officials to convince them of the value of scientific research and the need for increased funding for projects such as USGS mapping.

Charles Mankin, director of the Oklahoma Geological Survey at the University of Oklahoma in Norman, also told his representatives during a trip to Capitol Hill about how supporting scientific research pays off back home. He says, for example, that mapping the internal geometry of the Ogalalla Aquifer that underlies part of the state provides critical information for where best to locate corporate pig farms and waste disposal facilities so that recharge areas do not become polluted. Other geological research, he says, is helping small companies tap into existing oil reservoirs where most of the oil never was pumped out.

Davis and Mankin were among more than a dozen geoscientists—up from just four in 1997—who joined with over 225 other scientists as part of the third annual Science and Technology Congressional Visits Day in Washington, D.C. held on February 25-26. The event was sponsored by the Science-Engineering-Technology Work Group—a network that includes AGU, the American Geological Institute (AGI), and more than 40 other organizations—and the Coalition for Technology Partnerships, comprising a number of businesses, trade associations, and technical societies.

The event included a hearing on Senate bill 1305, "The National Research Investment Act of 1998," which would double federal investments in nondefense science research over ten years. The bill is cosponsored by Senator Phil Gramm (R-Tex.), Joseph Lieberman (D-Conn.), Jeff Bingaman (D-N.Mex.), and Pete Domenici (R-N.Mex.). In addition, scientists heard from White House science advisors, were briefed on the budget and lobbying etiquette, and visited hundreds of congressional offices.

The core messages of the day were that federal investment in science and technology is vital to the future of the U.S. people and economy, and that science and technology partnerships between government, universities, and industries help to diversify the nation's portfolio of investments and move university-based research into the marketplace.

In addition, the geoscientists—some of whom complained of being "invisible" within the larger science community—tacked on their specific examples of the importance of funding Earth sciences.

David Applegate, director of legislative affairs for AGI, said that geoscientists can point to many good examples of how their field serves society—in the areas of natural hazards, environmental issues, and natural resources—and why it is an important investment.

Both Democrats and Republicans reported favorable news about bipartisan support for increased funding for research and development. Jack Gibbons, who is stepping down this month as the President's science advisor, reviewed the Clinton Administration's fiscal year 1999 budget, which proposes $78.2 billion for research and development spread across a number of federal agencies—a 2.6% increase over fiscal year 1998.

"We, I think, all rejoice in the rise of bipartisanship in the approach to science," Gibbons said. He added that while science supporters are optimistic about budget increases, there will be lines of resistance in Congress and elsewhere. "We have broken through a very important line," he said. "Now, can we keep up the momentum, and move on down to the actual achievement of these activities?"

Neal Lane, director of the National Science Foundation and nominee to succeed Gibbons, said, "I sense the [science] community is starting to hum a little bit of a different tune: 'What a Difference a Day Makes,' or 'What a Difference a Year or Two Makes.' It wasn't too long ago that many of us, myself included, were talking about the proposed cuts and the fact that this [decrease] would be a very risky experiment."

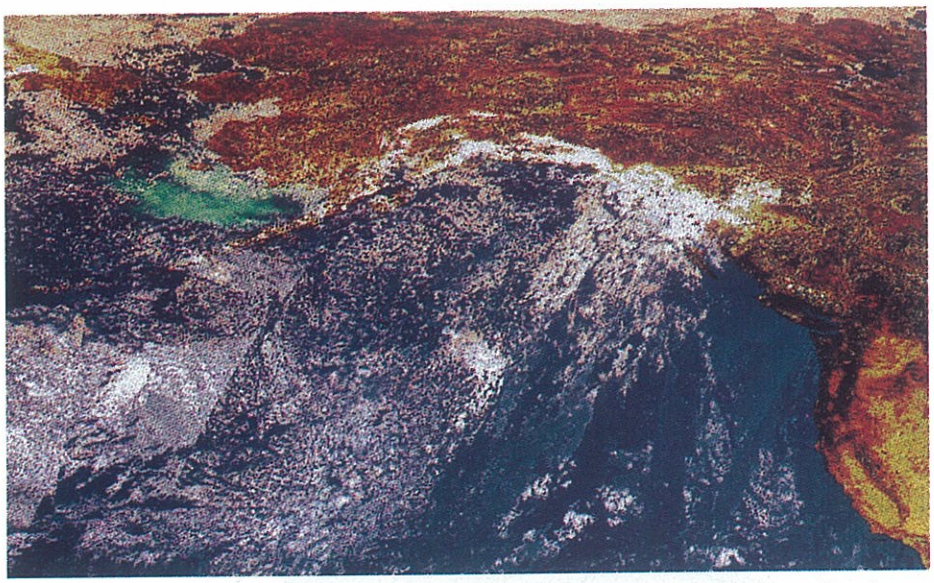
Lane said that not only does the current U.S. economic outlook bode well for increasing funding for science and technology, but that economic growth is linked to advances in science and technology. "The economy's steady growth is driven by advances that run a gamut of science and technology," he said.

Senator Gramm, in an interview with *Eos*, echoed the bipartisan push for increased science and technology funding. "We're entering an era where people realize that we have neglected science for 25 years, and that what has appeared to be a natural monopoly on science could become threatened, and so I think we have an opportunity to see this bill [S1305] pass. Now, when we get to actually funding it, I don't know how the bipartisan consensus will hold up," he said.

"I think there is a growing consensus that when research expenditures in nondefense areas have declined from 5.7% of the budget in 1965 to 1.9% of the budget today, that there is a problem," Gramm said.

Gramm, who said that some agencies currently not in the bill could be included later, added that passage of the bill "depends on how hard the scientific community works on it." He said, "The scientific community is starting to understand that if they want support for research, they've got to become more active politically."

For further information and details about next year's congressional visits, contact David Applegate at AGI; +1-202-785-0017; E-mail: applegate@agiweb.org.—*Randy Showstack*



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