New report recommends research priorities for Antarctic and Southern Ocean science

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An initiative to better understand how melting ice sheets will contribute to sea-level rise, efforts to decode the genomes of organisms to understand evolutionary adaptations, and a next-generation cosmic microwave background experiment to address fundamental questions about the origin of the universe are the top research goals for Antarctic and Southern Ocean science recommended in a new report from the National Academies of Sciences, Engineering, and Medicine.

The report, which offers a strategic vision to guide the U.S. Antarctic Program at the National Science Foundation over the next 10 years, also recommends that NSF continue to support a core program of investigator-driven research across a broad range of disciplines and strengthen logistic and infrastructure support for the priority research areas.

"The discoveries emerging from the Antarctic and the Southern Ocean advance our understanding of how our planet works and how our universe formed," said Robin Bell, professor of geology and geophysics at the Lamont-Doherty Earth Observatory of Columbia University in New York and co-chair of the committee that conducted the study. "Continued Antarctic and Southern Ocean research will produce new insights that will be critical as society adapts to the global consequences of change in these remote regions."

Informed by extensive input from the scientific community, the committee selected the three large-scale research goals based on the

criteria of compelling science, potential for societal impact, time sensitivity, readiness and feasibility, and key areas for U.S. and NSF leadership. Additional criteria included partnership opportunities, impacts on NSF program balance, and the potential to help bridge disciplinary divides.

The report proposes a major new effort called the Changing Antarctic Ice Sheets Initiative to investigate how much and how fast melting ice sheets will contribute to sea-level rise. The initiative's components include a multidisciplinary campaign to study the complex interactions among ice, ocean, atmosphere, and climate in key zones of the West Antarctic Ice Sheet, and a new generation of ice core and marine sediment core studies to better understand past episodes of rapid ice sheet collapse.

A second strategic research priority is to understand from a genetic standpoint how life adapts to the extreme Antarctic environment. For more than 30 million years, isolated Antarctic ecosystems have evolved to adapt to freezing conditions and dramatic environmental changes, and now must adapt to contemporary pressures such as climate change, ocean acidification, invasive species, and commercial fishing. Sequencing the genomes and transcriptomes of critical populations, ranging from microbes to marine mammals, would reveal the magnitude of their genetic diversity and capacity to adapt to change.

In addition to being a vast natural laboratory, Antarctica has a dry, stable atmosphere that offers an ideal setting for astrophysical observations. The report recommends a next-generation experimental program to observe cosmic microwave background radiation, the "fossil light" from the early universe. This would include an installation of a new set of telescopes at the South Pole, as part of a larger global array, which will allow highly sensitive measurements that could detect signatures of gravitational waves. Such observations might provide evidence that could

confirm the theory of cosmic inflation and the quantum nature of gravity, as well as address other enduring questions about the nature of the universe.

"Although remote, the changes occurring in the Southern Ocean and Antarctica can directly influence the United States," said committee co-chair Robert Weller, senior scientist at Woods Hole Oceanographic Institution in Massachusetts. "But these are challenging areas to do research, so there is a pressing need to prioritize the allocation of resources in order to assure reliable, safe support for critical observations and research campaigns."

The report recommends the following as key needs for supporting and implementing the priority research goals and other areas of Antarctic and Southern Ocean science:

- Expanded access to remote field sites, including a deep field camp and logistics hub, over-snow traverse capabilities, and improved all-weather access to research stations and field locations by air;
- Design and acquisition of a new heavy icebreaker ship and an ice-capable polar research vessel;
- Support for sustained observations through strategic augmentation and coordination of existing observational networks;
- Improved communications and information technology for data transmission; and
- Efforts to facilitate more open and coordinated data collection, sharing, and integration.

The report notes that the priority research initiatives all require some degree of collaboration among NSF divisions, with other U.S. agencies, and with other nations. In addition, NSF can play an important role in

developing Antarctic-themed educational resources for K-12, undergraduate and graduate programs, and informal education institutions.

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