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2008 Annual Report: Letter from Laurence P. Madin, Director of Research

Located at 42° North latitude, WHOI is squarely in the temperate zone, just about halfway between the equator and the North Pole. But our geographic location has never dictated where our scientists work, and 2008 saw the initiation or continuation of significant research programs at both extremes, the Arctic and the tropics. While these regions seem opposite in every way, both lie on the front lines of global climate change and its multiple effects on the world ocean.

Trekking across polar ice or diving into tropical water, WHOI scientists span the globe for their research. (Woods Hole Oceanographic Institution)

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Perhaps nowhere on earth is climate change having as dramatic and rapid an effect as in the Arctic, where ice cover, ocean water circulation, geochemistry and ecosystems are all responding to the pervasive rise in air and sea temperatures. These changing conditions will not only alter the future of that region and its human inhabitants, but will likely affect conditions far to the south. Arctic research continues to be a major focus for WHOI scientists. Supported by federal and internal sources, they participated in 18 separate expeditions into the Arctic region, at sea, on ice or land.

Camped out on the Greenland ice sheet, Sarah Das and colleagues documented the dramatically sudden drainage of meltwater lakes through crevasses that appear to carry the water all the way to bedrock beneath the ice, potentially lubricating and accelerating the movement of the ice sheet toward the sea. On the Arctic tundra Marco Coolen, Tim Eglinton and Liviu Giosan collected samples for geochemical and microbial studies.

Many other studies were conducted at sea. On three separate cruises, researchers deployed WHOI-designed and built Ice Tethered Profilers from Canadian, Russian and German icebreakers. These devices, mounted on drifting ice floes, measure properties of the water with an instrument package that travels up and down through the water column beneath the ice. Other research cruises focused on the Arctic Ocean's planktonic ecosystems or the flow of water into or out of the Arctic region.

Fifteen new Arctic projects were funded in 2008 by WHOI's Arctic Research Initiative, a program within the Ocean and Climate Change Institute that supports a wide range of investigations on the physics, chemistry and biology of the Arctic basin. The underlying goals of the Initiative are to understand the consequences of changes in the Arctic for sea ice, ocean circulation, and global climate, as well as effects on ecosystems within and beyond the Arctic. Understanding these changes in the Arctic will help us predict changes elsewhere in the world, perhaps pointing to ways to mitigate or adapt to climate change impacts.

While warming water and loss of ice are driving big changes in the Arctic, in the tropics the temperature and chemistry of surface waters bathing coral ecosystems are also starting to change. Warmer temperatures cause coral bleaching, (expulsion of their symbiotic algae), which leads to much greater coral mortality and widespread die-offs across entire reefs. An additional climate-related stress that may become significant in the next 50 years is ocean acidification – a change in the chemistry of seawater due to absorption of excess CO2 from the atmosphere – which is expected to make it increasingly difficult for corals and many other animals to build their calcium carbonate skeletons. This is a serious concern – not only for corals but also for thousands of other reef-associated species – if reefs begin to disintegrate.

WHOI scientists are studying coral ecosystems and their responses to environmental and climate change in multiple locations and on different time scales. As part of WHOI's collaboration with King Abdullah University of Science and Technology, Anne Cohen, Konrad Hughen and colleagues took coral samples in the Red Sea to analyze for effects of temperature, disease and acidification stress, using chemical and skeletal markers that reveal conditions in the ocean and within the corals themselves. Because large coral heads can be hundreds of years old, these markers also give us a picture of past environmental history and the corals' responses. This backward look can provide clues to how corals may cope with changes in the coming decades, and perhaps help us identify stresses that we can mitigate.

Though half a hemisphere apart, the Arctic and the coral reefs of the tropics are probably the two environments most strongly and immediately affected by global climate change. The changes that we are beginning to study and understand now will have implications for the climate and weather, biodiversity and economic resources of much of the rest of the planet. The physics, chemistry and biology of the ocean are central actors in climate change. Gaining a fundamental understanding of how these changes are happening is the essential foundation for any efforts of mitigation or adaptation that society might make.

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