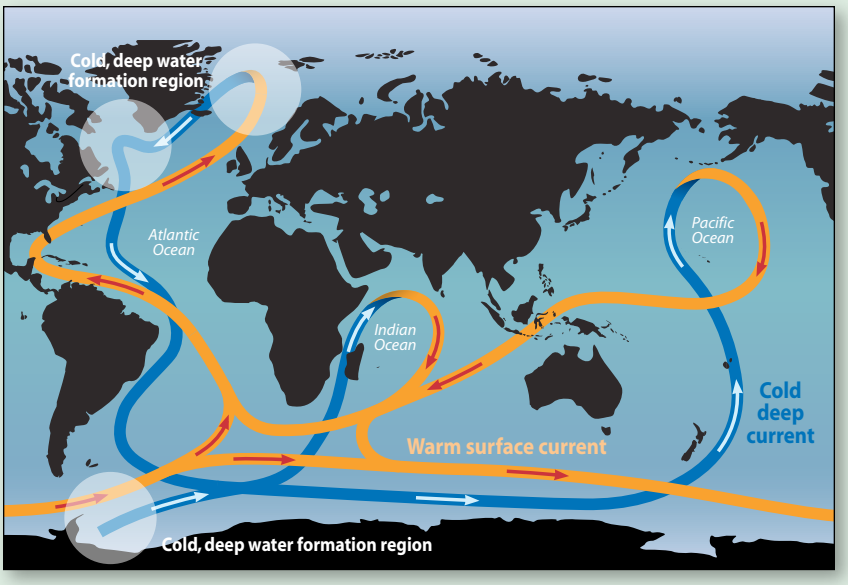
WOODS HOLE OCEANOGRAPHIC INSTITUTION

Ocean and Climate Change Institute

All human endeavor depends on our climate. And our climate depends on the shifts and rhythms of our ever-circulating oceans

From polar to tropical oceans, changes in the oceans could lead to changes in our climate.



The global ocean circulation system, often called the Ocean Conveyor, transports heat worldwide. White circles represent regions where cold, dense waters sink to the abyss to propel the Conveyor. Disruptions to the Conveyor have caused significant climate changes in the past and may again in the future.

The Oceans' Role in Climate Change

The oceans cover 71% of Earth's surface and contain 1,100 times more heat than the atmosphere. Slowly circulating, they comprise a crucial component of a planetary heating and ventilation system that redistributes huge amounts of heat and water around the Earth and regulates its climate.

The Ocean and Climate Change Institute explores:

- the internal processes that underlie the oceans' circulation and the forces that can cause circulation and climate changes
- ocean-atmosphere interactions that transfer water and water vapor around the globe and affect precipitation patterns
- the oceans' ability to absorb and sequester the greenhouse gas carbon dioxide from the atmosphere—and its crucial role in climate change in the past and future.
- the North Atlantic and Arctic Oceans' strategic and delicately balanced roles in causing abrupt climate change

The WHOI Ocean and Climate Change Institute

The Challenges

Unlike the weather we experience every day, Earth's climate changes relatively slowly, varying from year to year and over millennia. Studying the past can reveal clues to possible future climate. But modern climate records, using accurate thermometers, wind gauges, and other essential measuring devices, did not exist more than 150 years ago. While we can see strong trends, including global warming, in the modern record, it is too short to decipher other important changes that occur over decades or longer. Extending our modern record into the distant past requires careful analysis of imperfect, sometimes ambiguous "proxies" of important environmental variables, such as temperature, precipitation, snow and ice cover.

Another challenge is that Earth's climate varies regionally. Cold winters in Labrador, accompanied by warm winters in Scandinavia, is just one example. This regional variability complicates the analysis of climate change. It means that we need data from many regions to see patterns of change that can clarify seemingly contradictory findings.

The inherent complexity of Earth's changing climate—occurring over short and long timeframes and affecting various regions of the globe differently—presents a formidable challenge to any scientific endeavor, be it an observational program, research analysis, or a modeling effort.

Large Diameter Gravity Core (5 meters long) being launched from USCG Icebreaker *Healy* in the Bering Sea, July 2002. Used to collect sediments from the seafloor that reveal the ancient history of Earth's oceans and climate.

We must advance understanding of ocean-atmosphere connections that affect climate change.

The Strategy

While El Niño is now widely recognized as an important climate phenomenon in which the ocean plays a fundamental role, we must advance our understanding of other ocean-atmosphere connections that affect climate change. Scientists have made progress in deciphering patterns of climate change variability, and we can now target specific geographic regions for fieldwork and analysis that will sort out seemingly contradictory results in past climate reconstructions.

- Aggressive deployment of new instrumentation will make it possible to routinely measure some key climate variables in the ocean.
- Better models of the ocean will be critical in reconstructing the modern ocean circulation record, giving us a still-short but broad array of important climate-related variables.
- These improved models can then be used to test past climates, as a tool for improving the prediction of future ones.
- Internal funding of innovative research will lead to new opportunities to study the oceans and Earth's changing climate.
- Securing funds from non-federal sources can significantly improve our ability to sustain key oceanic climate time series in the presence of a risk-adverse, time-dependent federal funding arena.

The Approach

The Ocean and Climate Change Institute is working to make substantial contributions to advance knowledge by focusing on a few key research areas. Taking advantage of WHOI's strong engineering and technical expertise, we have launched innovative research and sustained measurement programs in strategic ocean locations. Capitalizing on our strong educational culture, the Institute aims to be a magnet for highly qualified graduate and postgraduate researchers and a catalyst for mentoring the next generation of climate scientists.

Bernhard Peucker-Ehrenbrink uses a petrol-powered rock saw to cut into an iridium-rich layer deposited immediately after the Marinoan "Snowball Earth" glaciation 635 million years ago, which is exposed in the Hoanib valley in northwest Namibia.

Scientists and engineers from WHOI and Scripps built the remote-controlled Spray glider, a new generation of robotic vehicles that can roam over hundreds of kilometers of remote seas over weeks and months, gathering data on the oceans and transmitting it to shore via cellphone.

The stratification of sediment cores and the small plants and animals they contain is being used by scientists Lloyd Keigwin (standing), Jeff Donnelly, and graduate student Mea Cook to study ocean climate variability during the past 2000 years.

WHOI researchers install a new WHOI-developed Ice-Tethered Profiler (ITP) in the Arctic Ocean. Drifting on an ice flow, the ITP measures water properties in ice-covered oceans and sends daily reports via satellite to scientists on shore.

Research at the Ocean and Climate Change Institute

The Ocean and Climate Change Institute fosters research that will have a significant and lasting impact on our understanding of Earth's climate by:

- supporting interdisciplinary approaches to climate research
- supporting the application of innovative technology to ocean/climate observations
- supporting graduate and postdoctoral fellowships in climate research
- utilizing Institute funds derived from private sources to leverage federal funding and other support
- Effectively communicating the results and importance of our science to a non-scientific constituency

WHOI geochemist Scott Doney explores how the buildup of heat-trapping greenhouse gases in Earth's atmosphere could warm the planet and acifidy the oceans, making it harder for corals and marine organisms (like small snails called pteropods, inset above right) to make their shells.

John Kemp, a WHOI engineer, is lowered by basket from an icebreaker to hook a tangled chain of yellow floats—the bottom end of a mooring—in the Arctic Ocean (the top end surfaced somewhere under a jumble of sea ice.) WHOI scientists are deploying innovative new instruments in climatically sensitive regions to help decipher current and potential climate changes.

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