World Ocean Circulation Experiment

Consideration of Mid-Depth and Abyssal Circulation Studies During WOCE: A Brief Meeting Report

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*Submitted as part of a continuing series of reports on WOCE planning activities
in the United States¹*

A meeting of oceanographers from 11 institutions was held 19–21 March 1984 at the Scripps Institution of Oceanography (SIO) to discuss plans and methods for studying the general circulation of the ocean. This planning meeting for the World Ocean Circulation Experiment (WOCE) was sponsored by the National Science Foundation (NSF) and arranged by J. L. Reid of SIO and Harry Bryden of the Woods Hole Oceanographic Institution. This report includes not only items discussed at the meeting, but also items submitted afterward by participants and other interested parties.

The purpose of the meeting was to identify needs. The conveners did not expect or attempt to arrive immediately at a consensus on which of the areas were most important, but tried to assure that all ideas were presented for consideration. Although the projects listed here are meant to be general and comprehensive, they strongly reflect the major interests of those attending and are not meant to exclude other plans or suggestions that may arise. The list presented is, of course, far beyond our present capacity to carry out in its entirety. We hope that it will stimulate even more ideas, and that some parts of it can be used to assemble an effective and coherent set of programs to be carried out as part of WOCE.

1. Summary

The altimetry provided by the TOPEX satellite will yield sea-surface elevations from whose slopes geostrophic flow at the sea surface can be calculated. To use these sea-surface slopes to calculate the subsurface geostrophic flow, it will be necessary to measure the underlying density field on various scales. Direct measurements with current meters or drifters, and the measurement of various tracer patterns are also required to describe the global circulation better and understand causal mechanisms.

The meeting brought together people interested in study-

ing the general circulation (including upper, deep, and abyssal flow) and who may wish to carry out measurements at sea. Scientists attending included those interested in hydrographic and tracer measurements, direct current measurements by moored instruments and drifters and circulation modeling. Discussions emphasized that mid-depth to abyssal circulation is the least understood and thus represents the greatest gap in our understanding of the general circulation. There was little direct discussion of the surface circulation, but surface flow is implicit in all of the studies identified.

The participants discussed ongoing or planned individual programs and the general need for measurements to allow the still broader studies of the total ocean that will be necessary to understand the general flow and its relation to climate.

There was general agreement that the study of the large-scale general circulation during WOCE should include the ocean-to-ocean and basin-to-basin exchanges that currently are least understood and may require special techniques, including direct measurements of current by fixed meters and drifters.

As a follow-up to the meeting, Reid and Bryden sent a written request for suggested hydrographic sampling to a broad representation of the community.

2. Hydrographic measurements

By hydrography was meant the measurements of temperature, salinity, oxygen, nutrients and other tracers, including Carbon-14, Helium-3, tritium, and fluorocarbons. The greatest interest was expressed in sections repeated quarterly for one or two years to monitor major currents, and in individual ocean-wide sections to examine the broadest scales of flow at all depths.

a. Repeated sections

Many coast-to-coast sections to be repeated across major passages were identified and discussed. Additional facilities may be required to carry out some repeats. The list includes sections from: Antarctica to South America, to Africa and to New Zealand or Australia; across Bering Strait, the Weddell Sea Gyre, the Florida Current, the Strait of Gibraltar and the

¹ For additional information, contact Worth D. Nowlin, Jr., WOCE Planning Office, Dept. of Oceanography, Texas A&M University, College Station, TX 77843. Tel.: 409-845-2947.

mouths of the Red Sea and Persian Gulf; from Greenland to Iceland to Scotland; from Australia to Sumatra; from Africa to Madagascar; and from Greenland to Spitsbergen and Spitsbergen to Norway.

Longer coast-to-coast repeated sections were identified along 55°N in the North Atlantic and along various parallels of latitude across the subtropical gyres in the Atlantic and Pacific oceans.

Open-ended sections that might be repeated across particular currents included: mid-ocean meridional lines from the equator northward to the continents in the Atlantic and Pacific; several trans-equatorial lines from 15°N to 15°S in each ocean; and shorter lines across the Alaska Current, the Agulhas retroflection, and the Falkland, Brazil, and East Australia currents. A repeated western boundary study was suggested from Woods Hole to Bermuda to Hatteras.

The group identified seasonal studies of areas of formation of dense waters and of critical gas exchange in the Greenland, Labrador, Mediterranean, Weddell, and Ross Seas. These are of particular importance to the budgets of carbon dioxide and oxygen.

b. Sections to provide a background set of world ocean data

Long lines of hydrographic measurements to be occupied once for global circulation were identified in all oceans. Most were meridional, because most scientists who identified long zonal lines thought they should be repeated. Although 27 separate long meridional lines were identified, some could be eliminated as being too close to other lines. Included were trans-ocean sections from Antarctica northward across all oceans—some extending as far as Greenland, the Aleutian Islands, or India. The only zonal continent-to-continent sections identified for single coverage were along 24 and 36°N in the Atlantic Ocean and 30°S in the Indian Ocean.

c. Special studies

Studies of particular features or regions also were identified, including major fronts (subarctic, subtropical, subantarctic) in all oceans, flow over deep topographic features, a detailed examination of the Brazil Current, and a short zonal line centered on the Ryuku Islands.

3. Direct current observations

a. Moored current meters

Current meters were suggested for deployment along many of the repeated sections, especially those shorter sections where higher velocities are known or expected to occur. The largest deployment suggested was a line across the North Atlantic from Labrador to the tip of Greenland and then eastward across the various basins and ridges to Ireland. Shorter lines were identified across the deep flows near the Rio Grande Rise and the deep passage near 9°S, 170°W in the Pacific. Deployments were also suggested across the deep western boundary currents, particularly off Argentina and New Zealand.

b. Drifters

There was a great deal of interest in the use of drifters for mid-depth, large-scale studies, and for studies of major gyres, gyre-gyre exchanges or, possibly, trans-equatorial flow in one or more oceans. It was generally agreed that the latter would be one of the most difficult problems to attack; however, it is of great significance, particularly in budgetary studies. The questions of the number and type of drifters required for such studies are being addressed by several people. ●

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NSF College Science Instrumentation Program

The National Science Foundation (NSF) will begin a program to help predominantly undergraduate colleges achieve and maintain high quality science and engineering departments. Under the new program, NSF will provide funds on a matching basis for the purchase of science or engineering instruments to be used to strengthen undergraduate instruction. Funds may be used to buy the latest instructional scientific equipment, or to renovate, replace, or upgrade existing instruments. Support will also be provided for interfacing of computers with scientific instrumentation and other appropriate uses of educational technology.

Requests for NSF funds will range from \$5,000 to \$50,000. Eligible institutions are four-year colleges and universities that provide science instruction leading to the baccalaureate degree, but that do not award doctorate degrees in any of the eligible fields. The deadline for proposals is 11 January 1985. Requests for further information should be directed to the College Science Instrumentation Program, National Science Foundation, Room 414, 1800 G Street NW, Washington, DC 20550.

University of Colorado Fellowships in Environmental Sciences

The Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado offers five one-year visiting fellowships to scientists with research interests in the areas of atmospheric chemistry, atmospheric dynamics, climate dynamics, environmental chemistry and geochemistry, and environmental biochemistry and biology.

Awards may be made to senior scientists, including faculty on sabbatical leave, or to recent Ph.D. recipients. Stipends average \$25,000 a year. Those receiving these awards will pursue their own research programs and participate in institute seminars. Selection is based in part on the likelihood of interaction between the visiting fellow and the scientists in CIRES. The program is open to scientists of all countries.

For more information and an application for the 1985–86 academic year awards contact Professor Robert Sievers, Director of CIRES, Visiting Fellows Program, Campus Box 449, University of Colorado, Boulder, CO 80309.

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