OCEAN SCIENCES DIRECTORATE OF THE OFFICE OF NAVAL RESEARCH

As of 2 May 1988, the Environmental Sciences Directorate at ONR became the Ocean Sciences Directorate. The list below shows the new organization of divisions and people. The main effect of the reorganization is to separate the physical parts of the old 1122 Ocean Sciences Division into a new ocean and atmospheric physics division (still code 1122), and a new biology/optics/chemistry division (code 1123). The ocean engineering division now contains an explicit remote sensing division, and the coastal sciences program is now explicitly more interdisciplinary than previously.

New Accelerated Research Initiatives to start in Fiscal Year 1989:

• Marine Bioluminescence and Upper Ocean Physics and Marine Light- Mixed Layer (ML-ML)

Program Managers: Ann Bucklin, Richard Spinrad, Alan Brandt (Physical Oceanography).

The focus of this interdisciplinary program is to understand and predict space/time variability of the bioluminescent light field in the upper ocean. A central goal is the development of mechanistic models of the interrelated biological, optical, and physical processes. This five-year Accelerated Research Program (ARI) is scheduled for FY89-94, and is a follow-on to the successful ARI, "Marine Bioluminescence and Optical Variability in the Water Column" (FY84-89), which has positioned us to make major advances in understanding. Shipboard studies, laboratory experiments, remote sensing, and numerical modeling are all required to achieve the program objectives. The field program will be conducted in the high-latitude North Atlantic, an oceanic region of strong seasonality and physical forcing.

• Ultra-Low-Frequency/Very-Low-Frequency (ULF/VLF) Acoustic Interactions.

Program Managers: Randall Jacobson (Geology/Geophysics); Marshall Orr.

The focus of this program is to understand the space-time variability of the acoustic/seismic ambient noise field in the frequency band from 0.001 to 50 Hertz; to identify the noise sources and their noise generating mechanism; and to determine the propagation modes and characteristics for the ambient noise field

• Seafloor Characterization

Program Managers: Joseph Kravitz, Office of Naval Research; Herb Epper, Naval Ocean and Research Development Activity; H. Fleming, Naval Research Laboratory.

The focus of this program is to extend our understanding of oceanographic and geologic processes that control the morphology of the seafloor. The development of the Plate Tectonics syllogism has given us a tool for understanding mega-scale geologic features (e.g.; ridge crests, trenches, seamounts, plateaus) which constrain many oceanographic processes (e.g.; ocean currents, etc.). However, we have a very poor understanding of small (kilometers to centimeters) scale seafloor features which result from these oceanographic and geologic processes.

• Topographic Interactions

Program Managers: Melbourne Briscoe; Ann Bucklin.

Recent observations indicate that dramatic ocean signatures in physical and biological properties are associated with flow over and around abrupt topography; essentially none of these phenomena are adequately predictable with existing models. This interdisciplinary ARI focuses on the flow over Fieberling Guyot. In the near-field there are numerous mixing process (e.g., internal wave reflection, boundary turbulence, lee waves) that strongly influence the benthic and water-column biological processes, in the far-field there are downstream wakes and biological patchiness. All of these phenomena are strongly influenced by additional motions such as trapped internal waves that circulate around the seamount, and Taylor columns (caused by conservation of potential vorticity) above the seamount; the effects of many of the phenomena can be sensed from space or by optical or acoustic in situ instruments. Laboratory and computer modeling is being used to help define the scientific issues and appropriate field experiments and will be essential in the synthesis of the physical and biological data sets. The goal of the seamount study is to be able to predict oceanic phenomena near strong topography. A secondary focus of the overall program is topographic stress (generalized form drag); i.e., how does one include sub-grid scale topography in numerical models of the ocean circulation in a physically and mathematically consistent manner?

Highlights of the Ocean Acoustics Program (ONR Code 1125OA, Marshall Orr, Acting Program Manager).

The acoustics program funds scientists in the academic sector to understand the physics of acoustic and elastic wavefield propagation and scatter in the ocean environment. The primary

purpose of the program is to develop an ability to predict in a quantitative manner the acoustic wavefield, which may be influenced by the entire ocean environment. The ocean environment includes the ocean volume, the ocean boundaries (air/sea, bottom), and the surrounding media (atmosphere and subbottom). Wavefield propagation and scatter in the ocean environment is controlled by spatial and temporal changes in the medium's refractive properties.

The study of ocean acoustics requires an understanding of the deterministic and statistical properties (in both a spatial and temporal sense) of the propagating media. An ocean acoustician must understand the physics of acoustic and elastic wavefield propagation, fluid dynamics on a variety of spatial scales, geology and geophysics (i.e., processes which form the ocean bottom and subbottom and the heterogeneity of the bottom and subbottom elastic and anelastic properties) and marine biology (size and distribution of animals and plants that scatter sound).

Consequently, the proper characterization of the propagating and scattering media requires ocean acousticians to work on an interdisciplinary basis with physical oceanographers, geologists and geophysicists, biological oceanographers, remote sensing experts and meteorologists.

The frequency band of interest to the ocean acoustics program ranges from 10^{-3} to 10^{7} hz. The wavelength of the signals ranges from 1500 km to 1.5 mm. Spatial variability of the refractive properties of the propagating medium occurs on a similarly wide range of scales. The three dimensional and temporal changes of the acoustic wavefield propagation and scattering are of interest to the program. A quantitative understanding of these phenomena challenges existing experimental techniques, existing theory, and the largest serial super-computers.

Unlike other physical sciences which are taught on a disciplinary basis at the graduate and undergraduate level, ocean acoustics is learned by self-study or at universities which have one or two scientists whose research interests include ocean acoustics. Many ocean acousticians, who typically received primary training as physicists, learned ocean acoustics either during World War II or from people who were immediately involved in that effort. Consequently, the population of ocean acousticians within the academic sector is advancing in age and decreasing in number. The Navy is also concerned that, with the exception of the MIT-WHOI Joint Program, there are few educational centers that train young ocean acousticians and researchers; furthermore, the majority of those trained are theoretically oriented, with fewer gaining needed experience at sea and with instruments.

ONR's acoustic program, which is the only domestic source of ocean acoustic basic research funds, will be attempting to address the educational needs of the ocean acoustics discipline. This will be done by funding research at a limited number of institutions that have the critical mass of experimental, theoretical, and numerical ocean acousticians who can interact with ocean -going and theoretical physical oceanographers, geologists, geophysicists, and biological oceanographers.

In addition, the program will, when possible, respond to proposals submitted by young academic scientists attempting to enter the ocean acoustics discipline, especially if these young scientists attempt to develop collaborative and interdisciplinary ocean acoustics research with established members (mentors) of the ocean acoustics research community.

Contributed by Melbourne Briscoe and Leonard Johnson.

OCEAN SCIENCES DIRECTORATE

Director: Dr. Eric Hartwig, Code 112; *Deputy Director:* Cdr. Thomas Nelson, Code 112D

Ocean Engineering Division

Director — vacant (Dr. Steven Ramberg, acting), Code 1121; *Program Manager*, Ocean Technology: Dr. Steven Ramberg, Code 1121OT; *Program Manager*, Research Facilities: Mr. Keith Kaulum, Code 1121RF; *Program Manager*, Coastal Sciences: Dr. Alan Brandt, Code 1121CS; *Scientific Officer*: Dr. Raymond Fitzgerald; *Program Manager*, Remote Sensing: Dr. Frank Herr, Code 1121RS; *Scientific Officers*: Mr. Hans Dolezalek, Mr. Charles Luther

Ocean and Atmospheric Physics Division

Director — Dr. Alan Weinstein, Code 1122; *Program Manager*, Meso/Large Scale Physical Oceanography: Dr. David Evans, Code 1122ML; *Scientific Officers*: Dr. Thomas Kinder, Dr. Melbourne Briscoe (IPA); *Program Manager*, Small Scale Physical Oceanography: Dr. Alan Brandt (acting), Code 1122SS; *Scientific Officers*: Mr. William Cross, Dr. Norden Huang (Detail); *Program Manager*, Marine Meteorology: Dr. Robert Abbey, Code 1122MM

Biology/Optics/Chemistry Division

Director — vacant (Dr. Richard Spinrad, acting), Code 1123; *Program Manager*, Oceanic Biology: Dr. Ann Bucklin, Code 1123B; *Scientific Officers*: Dr. Bernard Zahuranec, Dr. Randall Alberte (IPA); *Program Manager*, Ocean Optics: Dr. Richard Spinrad, Code 1123OP; *Program Manager*, Oceanic Chemistry: Dr. Edward Green, Code 1123C

Geo-Acoustics/Arctic Division

Director — Dr. Leonard Johnson, Code 1125; *Program Manager*, Ocean Acoustics: Dr. Marshall Orr, Code 1125OA; *Scientific Officer*: Mr. Marvin Blizard; *Program Manager*, Geology & Geophysics: Dr. Joseph Kravitz, Code 1125GG; *Scientific Officers*: Mr. Jack Heacock, Dr. Randall Jacobson (IPA); *Program Manager*, Arctic Sciences: Dr. Thomas Curtin, Code 1125AR'; *Scientific Officers*: Mr. Robert Obrochta, Mr. Dean Horn (IPA)

FIRST DRAFT OF WOCE PLAN UNDER REVIEW

Although it represents some of the best thinking of the several dozen oceanographers involved in the U.S. planning effort over the last five years, the plan is still in draft form.

The first draft of a document describing the proposed U.S. contributions to the World Ocean Circulation Experiment (WOCE) was distributed in May for review and comment within the oceanographic community in the United States.

This draft Implementation Plan describes the WOCE research efforts contemplated by U.S. scientists, discusses how these activities will mesh with other projects launched by other nations, and makes a first estimate at what the programs will cost. Although it represents some of the best thinking of the several dozen oceanographers involved in the U.S. planning effort over the last five years, the plan is still in draft form. The U.S. WOCE Planning Office at Texas A&M University has mailed the plan to more than 500 scientists around the country in hopes that even better ideas will emerge from the subsequent dialogue during the summer.

WOCE is probably the most complex and ambitious program that the world oceanographic community has ever attempted. The chief goal of WOCE is to make a quantum leap in the understanding and modeling of the ocean circulation so that its influence on the climate can be measured and predicted over years and decades. During its 10-year global study of the ocean spanning the 1990s, WOCE will employ major resources that are truly planetary in scale: satellites for measuring surface winds and sea surface elevations, fleets of ships for taking water samples and launching floats and drifters across the major oceans, a worldwide network of stations for in situ sea level measurements, super computers for modeling and data management. Hundreds of scientists in dozens of countries are expected to participate.

The unique global data offered by satellites, coupled with thousands of *in situ* observations throughout the ocean, promises to offer the clearest "snapshot" of the ocean circulation ever taken. Take this unprecedented trove of data, massage it with mathematical models of great sophistication, and surely the ocean will reveal more of its secrets. In short, that is the plan and hope of WOCE.

Proposed U.S. contributions to WOCE are just as ambitious. U.S. scientists and resources are expected to play major roles in most aspects of the world experiment. Here are some of the implementation plan's key elements:

Satellite Missions. At least three satellite missions are planned for the early 1990s to obtain accurate global measurements of ocean topography, sea surface temperature, and surface winds. TOPEX/POSEIDON, a joint U.S.-French space mission scheduled for launch in 1991, will carry a U.S.-made precision altimeter for global sea level measurements for the mapping of geostrophic surface currents and their variability, as well as a French altimeter of new design. Japan's ADvanced Earth Observing Satellite (ADEOS), planned for launch in 1993, may carry a NASA scatterometer to measure worldwide surface wind velocities. Another altimeter and scatterometer are scheduled for launch in a polar orbit in 1990 aboard the European Space Agency's ERS-1. Still in the planning stage is a NASA mission to map the global gravity field and so improve our knowledge of the geoid. Combined with data still being generated by TIROS and other U.S. satellites, these missions are expected to provide an unprecedented database of crucial ocean measurements.

WOCE Hydrographic Programme. This worldwide experiment contemplates spending eight or nine years of ship time to take thousands of water samples in every ocean to measure the distributions of density, temperature, salinity and chemical tracers. The U.S. plan calls for contributions of ship time to the effort, and for U.S. funding of the international WHP project office, shipboard sampling equipment, and an accelerator mass spectrometer facility for radiocarbon analysis. U.S. scientists will participate in every phase of the program (scientific direction, shipboard sampling, shorebased chemical analysis, interpretation of results) and are expected to contribute a number of technology developments, including devising a new generation of small-volume water samplers and improving shipboard analyses of chlorofluoromethanes.

Global Surface Layer Program. Extensive studies of the ocean surface layer during WOCE will focus on investigations of surface velocity, surface layer transport, and surface layer heat flux and heat content. To support these studies, the U.S. plans a surface velocity (drifter) project, a volunteer ship project, and improved surface measurements for air-sea fluxes. The U.S. volunteer ship project will focus on the Atlantic and Pacific Oceans, where hopes are for deployment of up to 50,000 expendible instruments a year for measuring vertical profiles of temperature and, in some cases, conductivity. U.S. scientists also are developing new technology for measurements of surface meteorological parameters needed for

improved estimates of air-sea fluxes. It is hoped that such improvements can be implemented for WOCE.

Velocity Measurement Programs. A key aspect of WOCE will involve direct measurements of the ocean currents using arrays of moored velocity meters, floats and drifters. The U.S. plan calls for U.S. funding of at least 2,400 surface drifters and a proposed office of buoy control, which would establish standards for WOCE drifters and plan the deployment and maintenance of a global drifter array. In addition, the plan proposes U.S. deployment of as many as 2,500 subsurface floats to map velocity and estimate eddy statistics. The plan also contemplates that U.S. scientists will be involved in velocity measurements at some 20 moored meter sites around the world.

Ocean Process Studies. A special set of field studies will be focused on one particular ocean — the Atlantic. The rationale of international WOCE is that an intensive study of a single ocean basin should lead to major advances in eddy-resolving, basin-scale numerical models with realistic thermodynamics that can be extended to the global ocean. Here, U.S. scientists will have a leading role in carrying out experiments that examine subduction and three-dimensional circulation of the upper layers, deep circulation within the Brazil Basin, and mixing as studied via the dispersal of released tracers.

Sea Level Measurements. WOCE seeks to establish a network of stations around the world to record hourly sea level data. Such a system would aid in the reduction of altimetric errors from satellite missions and provide vital data for monitoring the variability of surface geostrophic currents. The U.S. plan would establish ten special sea level stations for use in the calibration of the TOPEX/POSEIDON altimeter data, further develop a network of new satellite-reporting sea level stations, and support a sea level data center in Hawaii to receive and process data from selected stations.

Ocean Circulation Modeling. Highly sophisticated numerical models are expected to become the primary tools for predicting changes in the global ocean circulation. A primary goal of WOCE is to develop models that simultaneously incorporate both eddy and thermodynamic processes. The U.S. plan calls for proposals in the general areas of model application and analysis, model development, and process and sensitivity studies. One element of the plan is a Community Modeling Effort (CME), which seeks to establish a series of baseline calculations of ocean processes for comparison with direct observations, beginning in the North Atlantic. Crucial to the modeling effort and to other aspects of WOCE are the calculations of air-sea exchanges that force the ocean circulation.

Data Management Systems. The U.S. plan is to establish a data network that would link all U.S. WOCE projects, yet protect the rights of scientists to the data they acquired as the field investigators. In keeping with the unified nature of WOCE and its products, the emphasis in data management efforts will be on providing all U.S. WOCE investigators with pertinent, quality-controlled data on a timely basis.

If the U.S. WOCE is funded at proposed levels, this will represent a new pool of monies allocated for the express purpose of studying the general circulation of the ocean. Funding for the U.S. program is expected from the National Science Foundation, the National Aeronautics and Space Administration, the Office of Naval Research, and the National Oceanic and Atmospheric Adminstration. Obviously, access to new funding avenues is one advantage that many scientists will see in participating in WOCE; more importantly, another is that the sharing of data and ideas gathered in a global study should offer some excellent opportunities for rapid progress in the advancement of knowledge.

The U.S. plan was developed within the context of the goals and objectives of international WOCE, which are presented in detail in the Scientific Plan for the WOCE, published in 1986 by the World Meteorological Organization, and the WOCE First Draft Implementation Plan, distributed in March,1988 by the WOCE International Planning Office. The scientific rationale for projects and programs proposed in the U.S. plan is contained in a series of U.S. WOCE Planning Reports published over the last three years. Planning and implementation of U.S. WOCE has been directed by a Science Steering Committee (SSC) appointed by an interagency panel of the principal Federal funding agencies for WOCE: NSF, NASA, NOAA, and ONR. The NSF chairs the panel and is the lead agency for WOCE in the United States.

Members of the SSC are D. James Baker of Joint Oceanographic Institutions Inc., Russ Davis of Scripps Institution of Oceanography, Michael Freilich of Jet Propulsion Laboratories, Arnold Gordon of Lamont-Doherty Geological Observatory, Terry Joyce of Woods Hole Oceanographic Institution, James Ledwell of Lamont, Jim McWilliams of the National Center for Atmospheric Research, Worth Nowlin (chairman) of Texas A&M University, James Price of Woods Hole, Lynne Talley of Scripps, Ray Weiss of Scripps, and Carl Wunsch of the Massachusetts Institute of Technology.

The review and comment period on the first draft U.S. implementation plan ends September 30, 1988. It then will be revised and presented in November at the WOCE International Scientific Conference in Paris. The U.S. SSC and funding agencies will consider the plan for final approval in January, and U.S. project proposals will be accepted beginning in mid-1989. A schedule of WOCE implementation activities is in the draft plan. Copies of the draft U.S. Implementation Plan are available from the U.S. Planning Office for WOCE, Department of Oceanography, Texas A&M University, College Station, TX 77843. Comments about the plan also may be addressed to the planning office or via the WOCE.WIP mailbox on SCIENCEnet.

Contributed by Davis Mayes, U.S. WOCE Office, 6 May 1988

WOCE is probably the most complex and ambitious program that the world oceanographic community has ever attempted.

STATUS REPORT OF NASA'S OCEANOGRAPHIC ACTIVITIES

The following is a brief status report of NASA's oceanographic activities.

TOPEX/POSEIDON: This dedicated altimeter mission, being pursued jointly with the French Centre National d'Etudes Spatiales, has been under development at the Jet Propulsion Laboratory (JPL) since its new start in FY 1987. It is proceeding on schedule for a December 1991 launch aboard an Ariane 4 rocket. The second meeting of the Science Definition Team (SDT), selected as a result of an Announcement of Opportunity (AO), was held in Paris the week of May 3, 1988.

NSCAT: Development of the NASA Scatterometer, originally to fly aboard the US Navy's NROSS satellite, was initiated in FY 1985; some flight hardware has already been delivered to the project at JPL. With NROSS now cancelled, a proposal to fly NSCAT has been submitted in response to a Japanese AO for flight aboard their Advanced Earth Observing Satellite (ADEOS). Action on this proposal is due late this July. ADEOS, planned for launch in mid-1993, offers what we feel to be a minimum overlap with TOPEX/POSEIDON of about 18 months. Should NSCAT be selected for flight on ADEOS, there will be no change in data access for the research community. The NSCAT SDT has met three times, most recently this past October.

SEA-WIFS: The Compact Wide-Field Sensor, an improved version of the Coastal Zone Color Scanner on Nimbus-7, has been proposed for flight aboard Landsat-6 in 1991. The Department of Commerce and EOSAT have signed a contract for the development of Landsat-6. NASA and EOSAT have agreed in principle to share funding for Sea-WiFS, and NASA is currently seeking support for this initiative. Under this agreement in principle, NASA has the right to data access for retrospective research use (as well as some support for real-time research cruise planning), while EOSAT has the right to sell the data for real-time operational use. Support for Sea-WiFS activities will be centered at the Goddard Space Flight Center.

ASF: The Alaska Synthetic Aperture Radar (SAR) Facility is under development at JPL for installation at the University of Alaska in Fairbanks to receive, process, archive and distribute SAR products from the European ERS-1, Japanese ERS-1, and proposed Canadian Radarsat satellites, scheduled for launch in 1990, 1992, and 1994, respectively. Formal agreements are in place with both the Europeans and Japanese regarding the ASF. SAR observations of the Arctic sea ice are the main ASF-related objective for our program.

Other activities include support on the part of the NASA Ocean Data System at JPL to develop a capability for installation at the National Snow and Ice Data Center in Boulder to process, archive and distribute sea-ice products from the Special Sensor Microwave Imager (an improved version of the Nimbus-7 microwave radiometer) now flying on a Defense Meteorological Satellite.

Finally, discussions are underway with the European Space Agency regarding access to their ERS-1 data. We in NASA are interested in the U.S. scientific community having data access for retrospective research use, while interest in NOAA exists for having similar access to quick-look products for real-time operational use. We are exploring *quid pro quo* arrangements, whereby data and products from US satellites (such as noted above) might be exchanged for those from ERS-1. This satellite is scheduled for launch in May or June of 1990.

Contributed by W. Stanley Wilson, NASA

LOGO CONTEST

It is fitting that the new society have an official logo to crown its correspondence and pepper its pages. Correspondingly, we hereby announce the Great Oceanography Society Logo Competition, the purpose of which is to choose an original artistic work that suitably represents the spirit, goals, and ambitions of the Society and its members. Contestants are encouraged to exercise their creative imaginations, keeping in mind the desirable principles of originality, expressiveness, simplicity, and good taste. Contributions can be in black-and-white or color. Line drawings, computer graphics, and abstract designs will be considered. We ask only that each contribution be limited in size to a single sheet of standard typewriter paper, be an original work signed by the artist, and be related in some way to the ocean. Contributions should be submitted before November 30, 1988 to the Secretary of the Society at the address given on the title page of the magazine. The panel of judges will be drawn from the Oceanography Society Council, augmented by qualified art critics as deemed appropriate. The judges' final decision will be announced with appropriate fanfare at the first annual meeting of The Oceanography Society.

The judges reserve the right to reject all entries and continue the competition. The winner will receive free membership in the Society for three years, an award of considerable distinction, but one which pales in comparison with the pride of recognition that will last a lifetime. *– DAB*