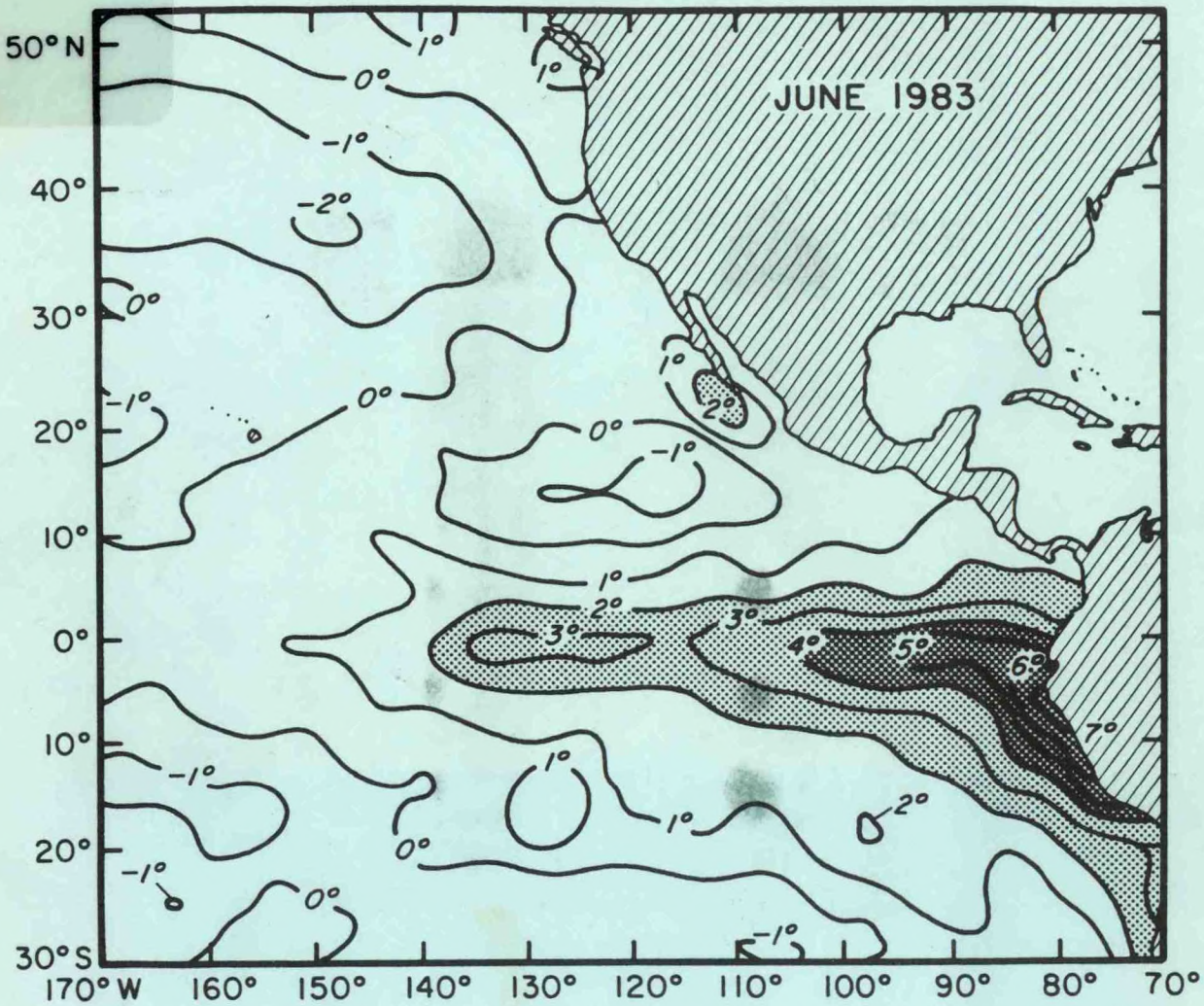
AOML ANNUAL REPORT
FISCAL YEAR 1983

EL : JUNE 1983 SURFACE TEMPERATURE ANOMALIES (°C)
IN THE TROPICAL PACIFIC OCEAN



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research
Environmental Research Laboratories
Atlantic Oceanographic and Meteorological Laboratory

AOML ANNUAL REPORT
FISCAL YEAR 1983

January 1984

Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway
Miami, Florida

UNITED STATES DEPARTMENT OF COMMERCE

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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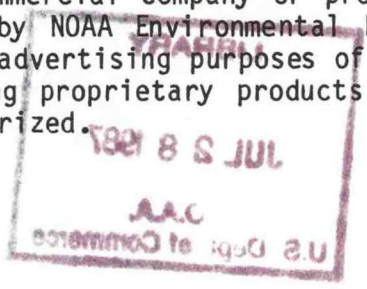

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

FY-1983 ANNUAL REPORT

PREFACE

This document presents the major accomplishments and plans of NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) for fiscal years 1983-84. This is the first "annual report" that has been published by AOML, and as an initial offering it is purposefully short and simple; future reports may be expanded or reoriented as the situation dictates. For information concerning AOML accomplishments during prior years, the reader is referred to the AOML Collected Reprints Series, which was published annually by AOML during FY-1970-79. During FY-1980-82 there was no such report - due to regulations which restricted federal publications - but AOML accomplishments during this period were, as always, widely published in the open literature (further information is available through the AOML Director's Office, upon request).

AOML is located in Miami, Florida, and is one of nine Environmental Research Laboratories (ERL) which are housed within NOAA's Office of Oceanic and Atmospheric Research (OAR). The collected plans and accomplishments of all nine Environmental Research Laboratories are jointly published in two separate volumes: the annual ERL Plans and Programs Document and the recently instituted ERL Collected Abstracts Volume. This document supplements these publications and provides a more detailed view of the AOML Program during FY-1983-84.

The document is organized into three major sections: (1) the Overview section is concerned primarily with management information - such as the AOML mission statement and organization chart, the program structure, and information on resources; (2) the Accomplishments/Plans section discusses major FY-1983 accomplishments and FY-1984 plans within the context of the ERL program structure; (3) the Appendix section includes a listing of AOML publications, with abstracts, for FY-1983. Also included is a listing of AOML staff.

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OVERVIEW

FY-1983 ANNUAL REPORT

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

OVERVIEW

The mission of NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) is to conduct a basic and applied research program in oceanography and tropical meteorology. The program seeks to understand the physical characteristics and processes of the ocean and the atmosphere, both separately and as a coupled system. Oceanographic investigations center on the fluxes of energy, momentum, and materials through the air-sea interface; the transport and composition (thermal and chemical) of water in the ocean volume; and hydrothermal processes of mineralization at seafloor spreading centers. Meteorological research is carried out to improve the description, understanding, and prediction of hurricanes. The principal focus of these investigations is to provide the knowledge that will ultimately lead: to improved prediction and forecasting of severe storms; to better utilization and management of marine resources; to a better understanding of the factors affecting both climate and environmental quality; and to improved ocean services for the nation.

Organizational Structure

The AOML organization structure (Figure 1) features five separate divisions, organized according to scientific discipline as follows: (1) Hurricane Research Division (HRD); (2) Physical Oceanography Division (PhOD); (3) Ocean Chemistry Division (OCD); (4) Sea-Air Interaction Division (SAID); and (5) Ocean Acoustics Division (OAD). Hurricane research and physical oceanography are the major disciplines represented at AOML, with HRD and PhOD representing more than 60% of the total laboratory effort; OCD represents about 20% and SAID and OAD complete the distribution. The total AOML research program during FY-1983 was approximately 129 man-years of effort with funding support of $8.6 million.

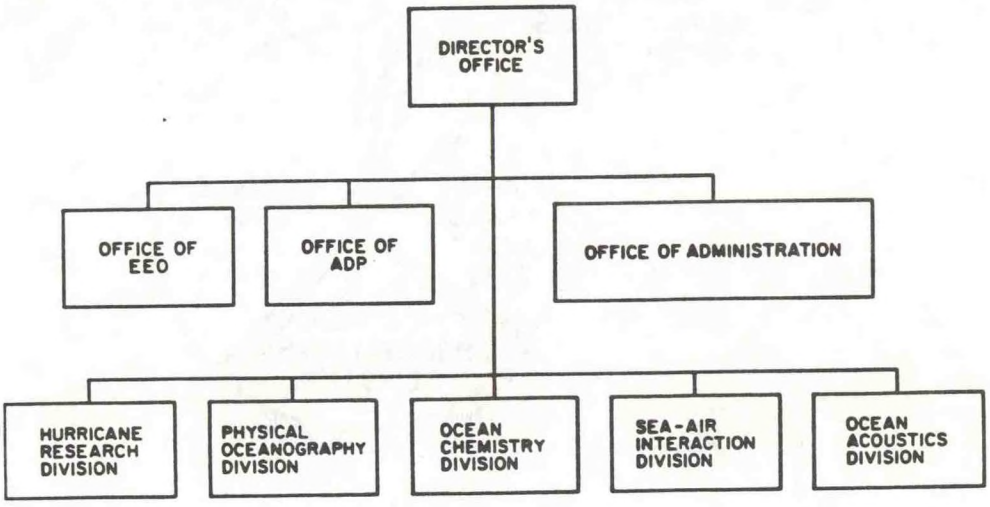

Figure 1: AOML Organizational Chart.

One item of organization significance occurred at AOML during FY-1983-84: this was the merging of two divisions - the Ocean Chemistry and Biology Division and the Marine Geology and Geophysics Division - into a single unit called simply the Ocean Chemistry Division. This change was prompted by a reduction of the Marine Geology Program during recent years and by the close working relationship that has developed between AOML's chemists and geologists, most of whom are involved in NOAA's Marine Assessment Research Program.

Program Structure

The Environmental Research Laboratories conduct a broad spectrum of environmental research. The collective activities of the ERL have been concentrated into eight major program areas. AOML actively pursues research in six of these programs which are:

1) Climate Research
2) Weather Observation and Prediction
3) Marine Assessment Research and Services
4) Marine Observation and Prediction
5) Marine Resources Research and Services
6) Air Quality Research and Development

The relative distribution of FY-1983 AOML funds by program area is shown in Figure 2. As might be expected from the AOML mission statement and organizational structure, Climate Research (39%) and Weather Observation and Prediction (26%) are the major program areas, followed by Marine Assessment Research and Services (22%). The remaining three programs are all relatively small efforts.

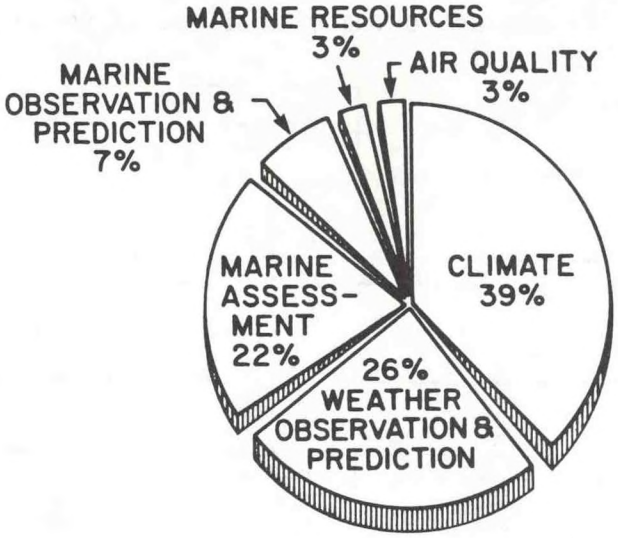

Figure 2: Program Funding Distribution (total FY-1983 funding $8.6 million).

An analysis of program funding sources provides an additional insight into the AOML program structure. The distribution of funding sources for the total AOML program is shown in Figure 3. It is significant that nearly 95% of the work that is done by AOML is funded by NOAA, either by ERL directly (86%), or by NOAA Program Offices (9%) - only 5% of the AOML effort goes for reimbursable projects with outside agencies. At the individual program level, only two programs receive any significant level of funding support from other than ERL: (1) Marine Assessment Research and Services received only 55% of its funding from ERL during FY-1983, the balance was provided by NOAA's National Ocean Service (29%) and from other agencies such as the Environmental Protection Agency, the Corps of Engineers, and the U.S. Navy (16%); and (2) Marine Observation and Prediction received approximately 70% of its funding from ERL during FY-1983, the balance was provided by NOAA's National Ocean Service and National Weather Service (17%) and by the states of South Carolina and Louisiana (13%). Of the remaining programs, Climate Research (99%) and Weather Observation and Prediction (94%) receive the large majority of their funding from ERL, and Marine Resources and Air Quality are totally funded by ERL.

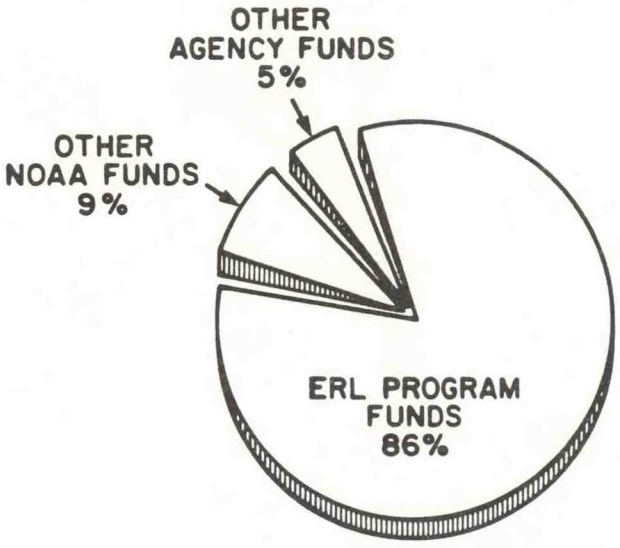

Figure 3: Funding Source Distribution (total FY-1983 funding $8.6 million).

For environmental scientists, 1983 will be remembered as the year of El Niño. AOML has been a major participant in NOAA's EPOCS Project (Equatorial Pacific Ocean Climate Studies) since its inception in 1979, and was fortunate to be conducting numerous field experiments in the eastern tropical Pacific throughout the duration of the El Niño event. Thus, AOML's major accomplishment during 1983 was a documentation of the oceanographic events leading up to and encompassing the 1983 El Niño. AOML is proud of this accomplishment and is pleased that an AOML scientist, Dr. Donald V. Hansen, was a recipient of the NOAA Administrator's Award for his work in this area. AOML is similarly proud of its many other scientific achievements during FY-1983; these are discussed in the following section along with major plans for FY-1984.

FY-1983 ACCOMPLISHMENTS/FY-1984 PLANS

CLIMATE RESEARCH

Climate research at AOML is increasingly focused on investigations of the role of the oceans in determining large-scale climate and climate variability. The emphasis is on observational projects, based primarily on the NOAA research vessels, but making extensive use of data from satellites, buoys, and other instrument systems. Because of the large scale of many of the phenomena and the diversity of the observations required, much of the work must be done through cooperative arrangements with investigators in other NOAA laboratories (primarily PMEL and GFDL) and university laboratories, and with overseas investigators, particularly in western Europe and South America. During FY-1983, and continuing for FY-1984, AOML's climate research program focused primarily on the oceanographic aspects of two major research investigations: (1) EPOCS, the Equatorial Pacific Ocean Climate Studies, initiated in 1979 as a multi-year investigation of the genesis, evolution, and large-scale atmospheric consequence of interannual sea surface temperature anomalies in the tropical Pacific Ocean, concentrated its research efforts on documenting the 1982-1983 El Niño, and (2) STACS, the Subtropical Atlantic Climate Studies, initiated in 1981 with the long-term objective of understanding the role that ocean circulation in the North Atlantic Subtropical Gyre plays in the heat balance of the Earth, focused efforts on developing an economical methodology for monitoring the Florida Current (Gulf Stream) over extended periods.

Accomplishments, FY-1983

EPOCS/1982-1983 El Niño

The expectation in late FY-1982, that FY-1983 might bring exciting developments in the equatorial Pacific Ocean, was more than fully realized. By midwinter it was clear that we were in the midst of one of the greatest El Niño events of record, an "event of the century." Furthermore, because of pre-existing plans for observations in the eastern equatorial Pacific, and our ability to enhance these plans rapidly, the El Niño-Southern Oscillation event of 1982-1983 will be the best sampled such event in history. Vessel operations planned from the NOAA Ship Researcher were expanded, observations from vessels operated by other agencies and other countries were added or enhanced, and special El Nino missions were flown by aircraft of the NOAA Research Facilities Center in order to fill gaps that appeared in the planned vessel operations. A fleet of about 20 drifting buoys was maintained in the near-equatorial waters for real-time observations of sea surface temperatures and current. Arrangements were made to disseminate the buoy data through the Global Telecommunications System for synoptic use in the major meteorological centers. Close liaison was maintained with the National Weather Service Climate Analysis Center (NWS/CAC) and with scientists in South America throughout the event. At the end of FY-1983, the event seems to be coming to an end, but sampling activities will continue to document the return to normal.

STACS

During FY-1983, AOML conducted an intensive program of data collection activities aimed at developing an economical and efficient sampling strategy for monitoring the heat transport of the Florida Current. STACS investigators obtained a continuous, 1-year time series of (1) voltage/potential differences, (2) tidal height differences, and (3) subsurface pressure differences across the Straits of Florida. In addition, five current meter moorings provided a continuous record of currents at various depths.

During July 1983, an intercalibration experiment was conducted involving electromagnetic cable measurements, current meter measurements, coastal tide gage data, free-falling current probe (Pegasus) data, CODAR (coastal ocean dynamics applications radar) data, and acoustic measurements. Good correlations were found to exist between directly observed transports and transports derived from tidal and cable observations.

Coastal tide gages at Haulover, FL, and Cat Cay, Bahamas, operated by NOS, provided data from April 1982 through March 1983; bottom pressure gage data from near Jupiter, FL, for April 1982 through January 1983 and from Memory Rock, Bahamas, for June 1982 through April 1983 were processed and transcribed to computer format. All data sets were low-pass filtered. High correlations with the Pegasus transport data ($r = 0.87$ and 0.96) suggest that sea-level monitoring is a strong candidate for long-term climate research.

To supplement the time-series data, AOML conducted nine Pegasus cruises between November 1982 and August 1983 to collect additional data on current profiles. A data analysis package was developed to permit shipboard reduction of Pegasus data using the HP-85 computer. A model was also developed to remove the barotropic tidal signal from Pegasus observations.

Significant progress was made in determining the optimal configuration of an acoustic tomography system for remotely sensing the transport of the Florida Current. A new technique for studying acoustic propagation in a random ocean was developed. Two important computer programs for describing pulsed acoustic propagation in the ocean, the Pulsed Parabolic Equation Model and the Penn State Pulsed Normal Mode Program, were implemented at AOML.

Linear estimation theory was applied to STACS data in order to determine the best mix of technologies for monitoring the Florida Current. An empirical orthogonal function (EOF) analysis of STACS data identified five primary modes of variability in the Florida Current.

FGGE

Data collected from the equatorial Atlantic Ocean during the 1979 FGGE (First GARP Global Experiment) were used to generate mean monthly maps, on a $2° \times 2°$ grid, of sea-surface temperature, cloud cover, wind speed and direction, specific humidity, air temperature, sea-level pressure, latent and sensible heat fluxes, net surface shortwave and longwave radiation balances, and net oceanic heat gain. Also generated were monthly time series, on a 6° latitude by 10° longitude grid, of mixed-layer depth, heat storage in the mixed layer, and surface currents.

Plans, FY-1984

EPOCS/1982-1983 El Niño

AOML's main emphasis will be on documentation and analyses of the 1982-1983 El Niño event. AOML will conduct a national workshop on this event in November 1983 and publish a report in early 1984. Our investigations will lead to publications in the following topic areas: the physical oceanography of the 1982-1983 event in the eastern Pacific; a quantitative description of the physical changes that occurred, in terms of EOF's or dynamical modes; use of Ametek/Straza data to describe how the equatorial undercurrent passed through the Galapagos islands during October/November 1982; evaluation of shipboard navigation systems for use with the Ametek-Straza system to determine absolute currents in the eastern Pacific.

A cruise will be undertaken on the Researcher to study upwelling processes along the Equator during June/July 1984. Research will be conducted to explore the use of acoustic tomography to monitor deep ocean thermal structures.

Drifting buoy data will be analyzed to determine the surface current patterns of the 1982-1983 El Niño. Further analyses will be conducted to determine the dynamics of 30-day waves that occurred during the same period, and to consider methods of compensation for drogue loss.

Arrangements have been made to collect current measurements across the Equator at 85°W using the Ecuadorian research vessel Orion and existing Pegasus transponders. These measurements will be made on a quarterly basis throughout 1984. Regional vessels will also be used to deploy additional drifting buoys and to maintain a regular XBT sampling program.

STACS

During FY-1984, the 2-year intensive observing period in the Straits of Florida will be completed. Strategies will be developed for long-term monitoring of the Florida Current and extending STACS to studies of mid-basin heat flux components. The time and space scales of important variability in the Florida Current will be characterized and related to possible forcing functions.

The coastal tide gages at Haulover, FL, and Cat Cay, Bahamas, will continue to be operated by the National Ocean Service (NOS), with partial support from STACS. Two bottom pressure gages will be maintained in the vicinity of the Florida Current's east and west boundaries, and a third coastal tide gage and meteorological station will be installed by April 1984, all near the latitude of Jupiter, FL. Project oceanographers will participate in approximately five STACS Pegasus cruises to measure transport and two cruises to service bottom pressure gages. Data analysis will emphasize improving the correlation between coastal tide gage values and transport values by examining the role of local meteorology on the sea levels; bottom pressure gage data analysis will be directed toward correlation with Pegasus transport data and further understanding of Florida Current dynamics.

FGGE

The FGGE data from the tropical Atlantic Ocean will be analyzed and compiled to generate an atlas of climatic and heat budget variables, and a manuscript on the heat budget of the equatorial Atlantic Ocean will be prepared.

FGGE data from the western Indian Ocean will be collected and analyzed to generate monthly maps of surface oceanic and meteorological variables and heat budget terms. The mixed-layer depths and surface current fields will also be developed in order to determine the mixed-layer heat budget terms.

WEATHER OBSERVATION AND PREDICTION

AOML is NOAA's primary focus for research in tropical meteorology and hurricanes. Research teams concentrate on field programs, numerical hurricane modeling, and theoretical studies of hurricanes. The Laboratory's hurricane field program makes use of NOAA research aircraft to acquire unique data sets.

AOML interacts with the National Hurricane Center (NHC) and the National Meteorological Center (NMC) in problems of hurricane prediction and with the National Center for Atmospheric Research on scientific investigations of the inner cores of hurricanes.

Accomplishments, FY-1983

Observational Studies of Hurricanes

Microphysics

Studies of drop size distributions in hurricane clouds indicate some departure from the Marshall-Palmer drop size distributions. Better fits to the data are obtained with a gamma distribution function.

Analysis of data from hurricanes Irene (1981) and Allen (1980) indicates the presence of large quantities of ice in every region of the hurricane including the eyewall.

A detailed study of a selected maritime cumulus was completed. Complete number density size distributions of cloud particles were computed for portions of the cloud with well-defined updraft/downdraft and radar echo conditions.

These studies show that once precipitation is well developed, water is depleted faster than it can be supplied by condensation. Thus, once precipitation is well developed the clouds cannot grow or even maintain a steady state.

Convective and Mesoscale

All data processing and analysis of the hurricane rainband experiments in Huricanes Allen (1980) and Floyd (1981) were completed. These studies provide

a better understanding of the structure and dynamics of mature hurricane eyewalls as well as outer rainbands. In particular, there is a distinct difference in the organization of vertical motion between the eyewall and rainband. In the strongly convective rainband of Hurricane Floyd, boundary-layer air was thermodynamically modified by the convection so that the energy content was reduced. This energy reduction influenced the structure of the eyewall and strength of the storm. Analysis of the Hurricane Debby data revealed similar evidence of modification, although the reduction was much weaker. This difference presumably was caused by the more stratiform nature of the Debby rainfall.

A study using data obtained in Hurricane Allen (1980) revealed marked asymmetry in the three-dimensional precipitation distribution within the eyewall. During the research flight on 7 August 1980, the P-3 aircraft circled within the eyewall of Hurricane Allen three times for 20-30 minutes, enabling the tail radar to map the reflectivity structure of the eyewall in detail. Several features of the reflectivity structure were common in each time composite:

(1) In the horizontal, the strongest reflectivity was observed in a portion of the eyewall centered on the direction of storm motion.

(2) In the vertical, the strongest reflectivity occurred in the eyewall near the height of the 0°C isotherm (~ 5.5 km).

(3) The high reflectivity regions in the eyewall tended to slope upwind and outward with increasing altitude.

(4) Azimuthal cross sections of reflectivity in the eyewall showed evidence of a "bright band" in the portion of the eyewall containing the strongest reflectivities.

The study also indicates that the eyewall precipitation distribution in Hurricane Allen was primarily a result of mesoscale motions superimposed over convective-scale motions.

A summary of the airborne Doppler measurements in Hurricane Debby (1982) indicates that the NOAA airborne pulse-Doppler radar is a very good tool for determining mesoscale wind fields over large regions in a hurricane environment. The psuedo-dual Doppler analysis method provides realistic wind fields on spatial and temporal scales sufficient for kinematic analyses of the mesoscale flow patterns that were present in the northwest quadrant of Hurricane Debby.

The analyses of the airborne Doppler data were used to provide three-dimensional patterns of reflectivity, wind, and divergence in two contrasting regions of the storm while it was developing to hurricane intensity. The regions examined were the developing eyewall and a region of stratiform precipitation lying outside the developing eyewall. The three-dimensional patterns in these regions were consistent with structures anticipated from previous two-dimensional analyses of flight-level data obtained in hurricane eyewalls and rainbands, and from studies of wind data obtained in tropical cloud clusters.

The consistency of the structure observed in the developing eyewall with eyewalls seen in previous studies of mature storms indicates that eyewall structure may already be present in storms still in the process of developing to hurricane intensity.

Single sweeps of radar reflectivity gathered from the WSR-57 at Slidell, LA during the landfall of Hurricane Frederic were processed at 2-min intervals for a 12-h period that includes landfall.

A color movie was made of the radar images at 2-min intervals during landfall.

Synoptic Scale

Processing of the Omega dropwindsonde (ODW) data for Hurricane Debby (September 1982) was completed in early April and distributed to scientists at several laboratories and universities. Processing of the data from Hurricane Olivia (eastern Pacific, September 1983) will be completed by the end of February 1984. The wind, temperature, and humidity data sent during the flights were of reasonable quality for operational use. The accuracies of the processed wind, temperature, humidity, pressure, and geopotential height data appear to be very high.

Analysis of the impact of the Debby data on the operational objective analyses and the dynamical hurricane track models is being completed in a cooperative program with NMC and NHC. On the basis of just two Atlantic cases, it is not yet possible to make meaningful statements about improvements in hurricane track forecasts resulting from the ODW data. Nevertheless, some assessment of the impact of the data can be made. Both global objective analyses at NMC (the Hough and the optimum interpolation) failed to provide satisfactory analyses for the operational ODW data. Differences between the ODW winds and the analysis winds were not randomly distributed in space. Errors in the objective analysis wind fields approached magnitudes of 10 m s^{-1}, and the error vectors had patterns with a relatively large scale.

Air-Sea Interactions

Initial results were obtained in a study dealing with the differences in planetary boundary layer (PBL) wind profiles on the inflow and outflow sides of a rainband and a comparison with other hurricane PBL profiles.

The processing of Hurricane Allen SFMR (stepped-frequency microwave radiometer) data was completed, and a revised algorithm for computing surface wind and integrated rain fall rates from surface emissivities and atmospheric transmissivities was devised. Surface winds accurate to 2 m s^{-1} were calculated.

The 70-mm Hasselblad camera system was installed on the NOAA 43RF aircraft together with a data annotation system. The first well-documented sea state photographs in color were obtained in Hurricane Alicia for surface wind speeds of 17 m s^{-1} and 25 m s^{-1}. These will be incorporated in revisions of our sea state catalog and color-related descriptors as a function of wind speed within the next 3 to 5 years.

Seasat SMMR (scanning multi-channel microwave radiometer) data were acquired in a format that retains the original sensor resolution of the measurements at each microwave frequency. A scheme was devised to map low rainfall rates (7 mm h^{-1}) with the high-resolution (15 km) 37-GHz sensor and merge these data with data from the lower resolution (30 km), but greater dynamic range, 18-GHz sensor. The composite maps of rainfall rate computed for Hurricane Fico (1978) showed a factor-of-4 improvement in resolution over previous Seasat SMMR rainfall maps.

Hurricane Track Prediction

A new revision of the SANBAR (Sander's barotropic) model package (SAN82), which has a scan analysis capable of utilizing ODW data, produced a 25% (1982 storms) decrease in the 72-h average forecast error compared with the operational SANBAR package.

A movable grid version of SANBAR (EPSAN82) was implemented for eastern Pacific storms during the latter part of the 1982 season. EPSAN82 was run simultaneously with an eastern Pacific version of the original SANBAR (EPSNBR). For the 1982 cases, EPSAN82 performed better than EPSNBR.

In cooperation with NESDIS (National Environmental Satellite, Data and Information Service) Developmental Laboratory (Madison, WI), wind data were derived from the VISSR (visible infrared spin scan radiometer) Atmospheric Sounder (VAS) during the 1982 North Atlantic hurricane season. VAS-derived winds have already been used in analysis for September 15 and 16, 1982, 0000GMT (during Hurricane Debby) as part of the first-guess field and as bogus station data. The 72-h forecast error for the cases of 16 September was only 283 nm with the VAS data, versus 340 nm with the standard first-guess field. The other available 1982 cases are being verified. The SAN83 package (SAN82 plus some additional numerical improvements) was modified for use with the VAS data and was implemented for semi-operational runs during the 1983 season.

Statistical models for predicting tropical cyclone motion have traditionally been formulated in a coordinate system oriented with respect to zonal and meridional directions. We investigated the forecast-error-reducing potential of a grid system reoriented with respect to initial storm heading. The developmental data represent Atlantic forecast situations from 1965 through 1980 on storms initially north of 25°N. Reorientation of the coordinate system reduces the total variance in 24-h storm motion by 40%, projects most of the motion onto one (along-track) component of displacement, and makes the components nearly independent of each other. For 48- and 72-h displacements, however, these advantageous effects are substantially diminished or eliminated.

For the developmental data, grid reorientation lowers the 24-h forecast error by 13%, and reduces the speed bias by a factor of 2/3.

Hurricane Vortex Dynamics

Development and validation of the nonhydrostatic hurricane model are complete, and a series of experiments has been carried out. The model was

used to explore the detailed dynamics of the vortex core and the influence of microphysical processes upon the storm as a whole. It was particularly successful in simulation of features observed in nature from research aircraft. The microphysical parameterization may include either two water phases (rain and cloud water) or the water phases plus three ice phases (graupel, snow, and cloud ice).

The role of microphysics is especially significant. With liquid water processes alone, the simulated hurricane exhibits occasional concentric eye cycles in which an outer ring of convection supplants a pre-existing eye wall, but with ice processes added, these cycles become more frequent and more pronounced. A detailed analysis of the dynamic, thermodynamic, and microphysical budgets shows that, with ice microphysics included, cloud processes influence vortex-scale motions through stronger, longer lasting, precipitation-induced downdrafts. In addition, inclusion of ice processes leads to more realistic simulation of the structure, position, motion, and intensity of the convective rings.

Analysis of data obtained from Hurricanes Gert (1981), Floyd (1981) and Debby (1982) is largely complete and yields a consistent picture of the dynamics of asymmetric hurricanes. The west side of such a storm is characterized by divergence, outflow, low humidity, and sparse precipitation, whereas the east side has convergence, inflow, near-saturation, and heavy precipitation. The asymmetry appears to result from the interaction between the vortex and a vertically shearing environmental wind. The convection on the east side is organized into the principal rainband, a squall-line structure that tends to maintain a fixed geographical orientation relative to the storm center. The principal band must therefore propagate against the mean swirling flow. It differs from an eye wall or convective ring in that its main inflow comes from its concave (inward) side. At mean swirling flows > 35 m s^{-1}, principal bands are observed to encircle the center and to transform into convective rings.

Hurricane asymmetries are central to the track prediction problem as well as to the distribution of wind and convection in a moving vortex. It was found that a simple slab boundary layer model simulates the qualitative features of the wind field observed in Hurricane Frederic of 1979. The distribution of convection in Frederic and in Hurricane Allen of 1980, which was translating approximately twice as fast as Frederic, compared favorably with boundary layer convergence diagnosed from the model.

Hurricane Modeling

Quasi-Spectral Model

A method called QSTING (quasi-spectral time integration on nested grids) combines the flexibility of grid-point representation, as in finite difference methods, with the accuracy of harmonic spectral methods. Toward the end of 1982, a two-dimensional QSTING model with six levels of nesting was used to simulate the boundary layer flow of a moving hurricane. Analysis of the results was continued in 1983. For the most part, the results confirmed the theoretical advantage of this new method.

12-Layer Nested-Grid Model

A hurricane landfall simulation with the 12-layer resolvable heating model was completed. Comparison of the track of the landfalling storm with that of an identical experiment without land (control) showed that the landfall storm was 15 min behind and 22 km to the left of the (control) at landfall. During the 10 h before landfall, the vortex executed a trochoidal oscillation of amplitude near 14 km, about twice that of similar oscillations that appear in the control experiment. Maximum low-level winds of 70 m s^{-1} were reduced to 34 m s^{-1} at 13 h and to 27 m s^{-1} at 24 h after landfall. During the 15 h before landfall, the convective activity of the control experiment decreased slowly and rainband activity was generally weak. In contrast, during the same time, convective activity for the landfall case increased substantially. This increased convection seems to be related to small increases of moist static-energy in the low troposphere that occur in convergence along the coast ahead of the storm. These increases were advected around to the rear of the inner nested grid where the increase of convective activity begins.

Observational Studies of the South Florida Sea Breeze

Analyses of aircraft data have concentrated on comparing and contrasting the structure of the sea-breeze circulation on a day in 1980 and a day in 1981. The evolution of deep convection in the 1980 case was strongly influenced by a layer of very dry air between 850 and 700 mb. Deep convection occurred near the flight track, but rainfall did not begin until very late in the day. On the other hand, the 1981 case was characterized by profiles of temperature and moisture that were near the typical climatological values. The analyses of the two cases are aimed at understanding the role of the sea-breeze circulation in the timing of the deep convection.

A study of of peninsula-scale rainfall variations on sea-breeze days in south Florida was completed. Results show that the sea-breeze circulation accounts for approximately 35%-40% of the south Florida summer rainfall. Area-averaged rainfall and the time variations of peninsula-scale surface divergence and hourly rainfall on sea-breeze days are affected by changes in humidity, lapse rate, wind speed, and wind direction. Days with relatively high humidity and steep lapse rates typically have deep convective activity that tends to develop sooner and reach its peak earlier than normal. There are two sea-breeze regimes for low-level wind speeds $\geq$ 5 m s^{-1}. When the low-level wind blows parallel to the peninsula, the sea-breeze circulation is strong and area rainfall is greater than average. When the wind blows across the peninsula, the sea breeze is absent or weak and rainfall is below average.

Preliminary analyses of airborne Doppler radar data from two of the sea-breeze flights in 1982 were completed. These data were processed to yield maps of horizontal wind at heights from 0.5 to 12.0 km, which depict the airflow associated with a quasi-linear convective line that developed within the sea-breeze convergence zone along the southwest coast of Florida on 28 July 1982. The location and strength of convective-scale downdrafts are shown to be important factors in maintaining boundary-layer outflow. The downdrafts apparently generated new convective growth ahead (westward) of the line and accounted for the westward propagation of the system.

Plans, FY-1984

Observational Studies of Hurricanes

Microphysics

The analysis of past hurricane particle image data (Knollenberg data from $T < 0°C$) will be continued. Emphasis will be placed on describing a coherent picture of the microphysical structure of the storm clouds in relation to their location with respect to structural features of the storm.

A study of transitions in particle morphology and number density distributions through the melting layer will start; already available data will be used. Available data will also be used to initiate a study of precipitation drag, water loading, and water unloading in updrafts and downdrafts.

Convective and Mesoscale

The analysis of airborne Doppler radar data gathered in Hurricane Debby (1982) will be completed. Analysis of Doppler radar data from Hurricanes Alicia and Tico (1983) will be begin.

Analyses of the convective and mesoscale features of Hurricane Frederic as revealed by land-based radar will be completed. Analysis of the data recorded on the Galveston NWS radar during the landfall of Hurricane Alicia (1983) will begin.

Synoptic Scale

Cooperative studies with NHC and NMC will continue to examine the effect of the ODW data on the operational hurricane track models. The influence of aircraft turns on the quality of ODW wind measurements will be determined. ODW data will be gathered for additional storms during the 1984 hurricane season.

Air-Sea Interaction

A new stepped-frequency microwave radiometer (SFMR) will be installed on an OAO (formerly RFC) aircraft. This instrument will become part of the instrumentation systems used for the hurricane air-sea interaction experiment planned for 1984. The NOAA Data Buoy Center has agreed to commit two drifting buoys to this experiment. Arrangements have been made with the Air Force to deploy these drifters ahead of the projected hurricane track.

Hurricane Track Prediction

In preparation for the 1984 hurricane season, final operational packages of the Atlantic and eastern Pacific versions of the modified SANBAR system will be assembled and operationally implemented, and will probably replace the existing SANBAR package.

Archived twice-daily ATOLL (analysis of the tropical ocean layer) and 200-mb wind objective analyses for the tropical Atlantic for June through

November will be used to develop a climatology of quasi-steady and propagating disturbances for 1975 through 1983. The data for each year will be filtered to isolate particular frequency bands corresponding to 5-day waves. Complex empirical orthogonal functions (EOF's), which include phase information for propagation disturbances, will be used for the analysis.

Quantitative assessment of the combined time-space variability and the overall quality of ODW data is a prerequisite for the design of any objective analysis scheme for these data. ODW data will be compared with data from other sources (VAS, cloud vector winds and ship reports). Comparison with the Bermuda rawinsonde data will aid estimation of purely local time variability due to passage of the storm and estimation of the quality of the ODW data in that region.

Hurricane Vortex Dynamics

Emphasis will be in three areas: continued experimentation with the prototype nonhydrostatic model; dynamic analysis and interpretation of the data from Hurricanes Alicia (1983) and Tico (1983); and numerical studies of the asymmetric structure of hurricanes including the interaction of the vortex with the large-scale environment.

Investigations with the nonhydrostatic model will include detailed analysis of the dynamic and microphysical budgets of completed experiments.

The quasi-spectral, nested-grid numerical model will be used in a barotropic, primitive equation form on a beta-plane, to investigate the effect of divergence on hurricane asymmetry and motion. Weak and hurricane-strength vortices will be used to investigate the effect of advective nonlinearities.

Hurricane Modeling

Quasi-Spectral Model

A general logic for multiple mesh moving, which has already been developed, will be coded and used for basic tests.

Development of a spherical-Earth version of the quasi-spectral model (not necessarily covering the whole globe) will be started. Since the spherical model must run in two dimensions even for partial testing, the process of developing the model is likely to be slow.

12-Layer Nested Grid Model

Simulation of a 13-day hurricane will be documented, with emphasis on comparison of model and atmospheric data.

Observational Studies of the South Florida Sea Breeze

Analyses of the 1980 and 1981 case studies will be completed. Final testing of a numerical model to study the effects of differential horizontal

advection on the growth of the mixed layer will be completed. The model will be initialized with data from the 1980 and 1981 sea-breeze flights. The Doppler radar observations of the development of deep convection in the sea-breeze convergence zones will be analyzed in detail.

MARINE ASSESSMENT

A major goal of the AOML research program in marine assessment is to develop an understanding of ocean processes, their variations, and the effect of these variations on ocean resources, especially living marine resources. Present research projects include: (1) Transformation and Assimilation of Pollutants by Natural Processes (TAP) and (2) Pollutant-Particle Relationships in the Marine Environment (P-PRIME), in which natural processes are studied to develop information essential to addressing specific environmental problems. In addition, AOML conducts a vigorous program in acoustical research aimed at a variety of marine assessment applications.

Accomplishments, FY-1983

Marine assessment programs accomplished the following:

TAP

- Synthesized marine humus from several natural marine oils, and showed that marine humus does not protect plankton from radionuclide uptake; determined the molecular weight of marine humus as between 600 and 900; devised a technique using nuclear magnetic resonance (NMR) and equivalent weight data to predict the complexing capacity of fulvic and humic acids; showed that synthetic as well as natural fulvic acids can protect the photosynthetic capacity of plankton against Cu toxicity; discovered that the formation of marine humus from unsaturated lipids involves a very large carbon isotope fractionation, in fact, the largest ever observed.

- Documented biological aspects of El Niño; documented zone of enriched plankton productivity at the Mississippi outflow and correlated it with larval fish abundance; defined methodology of delineating diel variability in phytoplankton physiology; completed development of a biochemical analysis permitting investigation of in-situ growth rates in zooplankton.

- Developed and presented, at the 1983 Gordon Conference in Chemical Oceanography, a theory of metal/organic interactions in seawater as a function of ligand structure based on spectroscopic and experimental data obtained over the past three years; completed upwelling region cruise and found some evidence for very strong and/or unique complexation in such waters even though high productivity was not encountered.

P-PRIME

- Completed cruise to the Mississippi River/Delta area for program-related field work.

- Documented the first clear recognition of the extensive role of biopackaging of lithogenic/biogenic material at mid-shelf, and essentially pure biogenic material at outer-shelf and shelf-edge stations.

Acoustical Research

- In the Sulu Sea Internal Wave Experiment, studied seventeen soliton wave packets having wave amplitudes from 10 m to 90 m. A detailed study of the generation mechanism of the waves was completed; the tides form a hydraulic jump which upon reversal of the tides propagates northward into the sea as a single shallow-water internal wave.

- Completed a theoretical interpretation of acoustical calibration study results. A study of backscattered acoustical intensity versus concentration for three different narrow sand grain distributions was also conducted; essentially, a linear relationship was determined between backscattered acoustical intensity and concentration.

Plans, FY-1984

Marine assessment plans include the following:

TAP

- Test toxic-metal/organic-matter/plankton interaction model in cold productive waters; determine if raw fish oil, allowed to autoxidize at sea, could ameliorate the toxic effects of disposed chemical wastes.

- Investigate the mechanism supporting enhanced productivity at the Mississippi plume and its relation to sedimentation rate of suspended particles, during the Oregon II cruise scheduled for November-December 1983; measure phytoplankton productivities, abundance, and zooplankton distribution in support of the Researcher cruise scheduled for January-February 1984 by AOML's Ocean Chemistry Division in cooperation with the Southeast Fisheries Center (SEFC); continue sample analysis and data workup from previous cruises.

- Investigate trace-metal/organic-matter interactions in temperate waters in winter to test hypotheses developed regarding kinetics of formation of organic ligands important in trace-metal speciation in seawater; study metal/organic-matter interactions in anthropogenically impacted waters, specifically the New York Bight region.

P-PRIME

- Intensify efforts on P-PRIME cruise IV: (1) investigate the role of biopackaging of lithogenic particles and apparently related river plume disappearance (to be performed in conjunction with SEFC); (2) initiate simultaneous current meter/transmissometer observations to improve understanding of co-variability of currents and suspended particulate matter.

Acoustical Research

- Continue development of a model for oceanic pollution transport mechanisms. Emphasis will be placed on evaluating the ability of a stratified water column to effectively convert three-dimensional turbulent dispersion processes into two-dimensional, thin-layer turbulent dispersion processes along constant density surfaces.

MARINE OBSERVATION AND PREDICTION

AOML research in marine observation and prediction is concentrated on surface effects at the air-sea interface. These effects, especially under extreme conditions, are important to short-term forecasting of coastal and marine weather and wave conditions (sea-state heights and storm surge). Additional research is aimed at improving the observational equipment and techniques that are used to collect data on the marine environment; particular emphasis is on ocean acoustical and airborne radar techniques.

Accomplishments, FY-1983

During FY-1983, AOML participated in the Bering Sea Marginal Ice Zone Experiment (MIZEX) in collaboration with the Pacific Marine Environmental Laboratory. Radar imagery of the marginal ice zone (MIZ) and interior ice pack was obtained simultaneous to ice profile measurements with a laser altimeter and vertical photography. These data will provide unique insight about the ice-banding processes within the MIZ that lead to advance and retreat of the MIZ and penetration of the MIZ by ocean waves. From a remote-sensing viewpoint, the high-resolution, side-looking airborne radar (SLAR) imagery obtained during these flights is the first ever collected from grazing angles and will be an important test of radar backscatter theory.

Construction of computer programs to compute the ocean surface wave fields everywhere on the globe was initiated. The programs are based on mathematical groundwork laid in FY-1982. Preliminary testing of data handling and wave growth packages was completed.

The first storm surge atlas was completed in March 1983. This prototype was developed from the storm surge computer simulations in the Charlotte Harbor, FL, basin. The atlas will be used by hurricane forecasters to determine what high water values to use in forecasts and will supply information for regional planners. One SLOSH (sea-lake overland surges from hurricanes) model, Biscayne Bay, was developed, tested, and put in an operational status in 1983. SLOSH computer simulations were also completed for Charleston Harbor, SC, Sabine Lake, TX, and Lake Pontchartrain, LA.

A manuscript was prepared documenting a new interpretation of the mechanism by which sea state appearance is related to wind speed. This interpretation was based on qualitative aspects of the sea state catalog together with existing quantitative measurements. Hydrodynamic forces proportional to wave energy dissipation are hypothesized to be responsible for an approximately cubic dependence of white-water coverage on wind speed for speeds less than 14 m s^{-1}. Aerodynamic forces proportional to surface wind stress are

hypothesized to be responsible for an approximately square law dependence of white water coverage on wind speed for speeds greater than 14 m s^{-1}. New regression relations were formulated to guide subjective estimates of surface wind speed from sea state appearance. These relations should also provide guidance for algorithms relating surface wind speed to microwave radiometer and scatterometer measurements.

More than 200 slides were prepared to illustrate sea state for surface winds up to 50 m s^{-1}. These are to be used as training material in workshops for aircrews responsible for sea state wind estimates.

AOML successfully demonstrated the transverse Doppler current-profiling technique in the Bear Cut channel at Miami, FL, by measuring currents of 100 cm s^{-1} with 37-cm range resolution (in the horizontal), using a side-looking configuration to a range of 20 m in water 3 m deep. This is several times the maximum range and maximum velocity of other coherent Doppler systems, and several times the resolution in both range and velocity of single-pulse systems. Properly scaled, transverse Dopplers should permit measurement of currents within shipping channels using transducers mounted at the edge of the channel. Transverse Doppler profilers should also be useful in estuarine flow research in the upward looking mode.

Plans, FY-1984

During FY-1984, AOML will participate in hurricane research flights and in a polar cyclone flight experiment. Both experiments have the objective of experimentally observing the height and direction of ocean waves generated by relatively small but fast moving (about 30 knots) cyclones whose principal characteristic is a strongly curving wind field. Such storms represent a dilemma since they are relatively rare and it is not known if the generated wave field is significantly higher or lower than storms moving at slower velocities. If they do generate higher waves, they represent a significantly greater threat than ordinary storms.

Storm surge atlases will be completed for Corpus Christi, TX; Tampa Bay, FL; and Sabine Lake, TX. Atlas work will begin for Charleston Harbor, SC; Lake Pontchartrain, LA; and Laguna Madre, TX. Hypothetical storm surge simulations will be made for Laguna Madre, TX; Mobile Bay, AL; Pensacola, FL; and another basin not yet determined.

Photographs in the recently published sea state catalog will be digitized with the use of equipment at the Jet Propulsion Laboratory. This process will enable us to estimate percentages of white water coverage from flight-level wind-speed measurements and to verify the two different power law relations hypothesized to exist for low winds and high winds, respectively. These wind-speed measurements will complement measurements of microwave brightness temperature by an airborne radiometer system, also planned for FY-1984.

AOML plans to develop an objective analysis procedure capable of using data from an ERS-1-type satellite, as well as all conventional weather observations, to generate in near-real time the best possible estimate of the global state of the atmosphere for initializing numerical weather prediction runs. By-products of this procedure will be surface wind and wave climatolo-

gies for engineering applications, and time histories of surface wind and wave fields for general ocean circulation studies relating to climate research.

The prototype transverse Doppler current measurement system will undergo testing and evaluation. The initial data set from the Bear Cut experiment was presented to the NOS Water Levels Branch, the Port of Miami, and the Biscayne Harbor Pilots Association to suggest research possibilities for addressing problems associated with horizontal shear flow in Government Cut (Port of Miami). Deployment of an experimental, within-channel flow-monitoring system in the Miami Harbor is planned.

MARINE RESOURCES

AOML research in marine resources is investigating hydrothermal processes at seafloor-spreading centers with reference to the role of these processes in concentrating metallic mineral deposits and in controlling the heavy-metal chemistry of seawater. Research is closely coordinated with research at NOS-Office of Ocean Minerals and Energy (OME) and Office of the Chief Scientist, PMEL, and the National Marine Fisheries Service (NMFS) as part of the NOAA 5-year research plan, "Deep-Sea Metals: Polymetallic Sulfides."

Accomplishments, FY-1983

The investigation of the Trans-Atlantic Geotraverse (TAG) Hydrothermal Field revealed the first unequivocal evidence that high-temperature "black smoker" hydrothermal discharge has occurred on a slow-spreading oceanic ridge and determined both the duration and periodicity of that "black-smoker" activity.

Laboratory analysis of samples recovered from the TAG Hydrothermal Field revealed the chemical and mineralogical characteristics of the largest hydrothermal deposits discovered on a slow-spreading oceanic ridge in an open ocean basin.

Hydrothermal vent-type clams were identified on bottom photographs made by AOML in the TAG Hydrothermal Field. This is the first documented occurrence of such fauna outside the fast-spreading oceanic ridges of the Pacific.

Plans, FY-1984

Data analysis, interpretation, and documentation will be completed detailing the results of the July 1982 Researcher/Alvin-Lulu cruise to the Mid-Atlantic Ridge. Results will discuss the cooperative submersible investigations conducted at the TAG Hydrothermal Field by coinvestigators from NOAA, Woods Hole Oceanographic Institute (WHOI), and the Massachusetts Institute of Technology (MIT). An additional study, conducted jointly by NOAA and the University of Stockholm, will discuss deep crustal processes on the Mid-Atlantic Ridge.

AIR QUALITY

AOML conducts a limited program of Air Quality research. Present studies investigate natural marine sources of Acid Rain precursors.

Accomplishments, FY-1983

Acid Rain

- Identified dimethylsulfone in rain; found a major source of formic acid in atmosphere and rain in a homologous series of 1-alkenes; discovered that poisoning samples with mercury destroys 1-alkenes.

- Completed cruise to a high-productivity region. Even though bloom conditions of a phytoplankton species thought to produce dimethyl sulfide (DMS) were encountered, levels of DMS found in the water were similar to levels found in regions of low productivity; during the cruise to the Peru upwelling region we were able to document, as they were occurring, rapid changes in the hydrographic and chemical structure of the water, suggesting a relaxation of El Niño off the Peru coast.

Plans, FY-1984

Acid Rain

- Conduct a joint ship and aircraft field program in the equatorial Pacific Ocean to study tropospheric chemistry, particularly at it relates to volatile sulfur species in the atmosphere.

- Determine concentrations and fluxes of natural acid rain precursors in the equatorial Pacific Ocean.

- Develop methods for trace organic sampling from aircraft.

- Complete sample analysis and data workup from Peru cruise.

FY-1983 PUBLICATIONS

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

AO-001-83

Barnes, G. M., E. J. Zipser, D. P. JORGENSEN, and F. D. MARKS, JR. Mesoscale and convective-scale structure of a hurricane rainband. Journal of the Atmospheric Sciences 40:2125-2137 (1983).

The mesoscale thermodynamic, kinematic, and radar structure of a Hurricane Floyd rainband observed on 7 September 1981 is presented. Data are from 26 aircraft passes through the rainband from 150 to 6400 m. A composite technique which presents rainband structure as a function of distance from the storm circulation center reveals inflow from the outer edge of the band and a partial barrier to this flow below 3 km. In the direction parallel to rainband orientation, radar reveals cellular reflectivity structure on the upwind and central portions of the rainband; the frequency of cellular precipitation decreases in favor of stratiform precipitation further downwind as the band spirals gradually towards the eyewall. In the radial direction, a decrease of 12 K in θ_e is observed across the rainband in the subcloud layer. Convective scale up- and downdrafts that are associated with cellular reflectivity structure are hypothesized to be responsible for the thermodynamic modification of the cloud and subcloud layers.

AO-002-83

BEHRINGER, D. W. Simple advective beta spirals. Ocean Modelling 8-10 (1983).

No abstract.

AO-003-83

BEHRINGER, D. W., G. P. Knapp, R. J. Stanley, and H. M. Stommel. Hydrographic station data of five surveys of the beta-triangle in the eastern North Atlantic, 1978-1981. Technical Report WHOI-83-24 (1983).

This is a data report, giving temperature, salinity and dissolved oxygen data obtained during five surveys of the beta-triangle area of the eastern North Atlantic in the years 1979-1981. The report is divided into two parts. Part I consists of a listing of station data obtained on all stations occupied--on the periphery of the triangle, inside it, and some nearby stations outside it. Part II is a set of profiles of this data drawn on the three sides of the triangle, for easy reference and visual comparison. Detailed scientific study of the data is published elsewhere.

AO-004-83

BLACK, P. G. Ocean temperature changes induced by tropical cyclones. Ph.D. dissertation, The Pennsylvania State University, University Park, 278 pp. (1983).

Detailed analyses of airborne expendable bathythermograph (AXBT) and infrared radiation thermometer data have shown that hurricanes decrease sea

surface temperature (SST) in a consistent pattern with respect to the hurricane center. The pattern of SST decreases is crescent-shaped, with largest decreases in the right rear quadrant of the storm between the radius of maximum wind (RMAX) and two times RMAX. Little or no SST decreases occur in the left front quadrant. As the value of RMAX increases, the SST decreases become greater. The magnitude of the SST decrease is nearly independent of storm speed (U) for $U > 5$ m/s, but increases nonlinearly as U decreases for $U < 3.5$ m/s. In addition, the magnitude of the SST decrease is a linear function of storm intensity for $U < 3.5$ m/s and for VMAX < 40 m/s. Otherwise, the magnitude of the SST decrease is independent of intensity. No significant SST decrease occurs at any storm speed or intensity for mixed layer depths (MLD) exceeding about 70 m. Maximum SST decreases greater than 5°C occur for storms moving slower than 2 m/s in regions of shallow MLD (30-40 m). The observations suggest that SST decreases continue at a location to the right of the storm track after the storm forcing has moved away. In the period from 0.6 to 1.4 days after storm passage, SST continues to decrease by 1-2°C. These continued decreases appear to be related to the shear-generated mixing at the base of the mixed layer associated with the clockwise rotation and acceleration of the mixed layer inertial currents induced by the storm. In addition, a residual vertical circulation appears to be sustained for some time after storm passage which continues to transport colder water upward beneath the storm track and warmer water downward beyond two times RMAX to the right of the track. The MLD decreases beneath the storm center begin with the passage of the positive wind stress curl (negative in the Southern Hemisphere) associated with the leading edge of the hurricane eyewall. The maximum MLD decrease is usually displaced to the rear of the storm center by a distance proportional to the speed of the storm. MLD increases are observed beyond RMAX to the right of the track, whereas there is very little change observed to the left of track. The maximum SST and mixed-layer temperature (MLT) decreases to the right of the storm track are located over the region where the thermocline gradient is maximum. This is a transition region between the MLD decreases along the track and the MLD increases between RMAX and two RMAX. Following the initial response, the residual SST and MLD patterns are modulated by an internal, inertia-gravity wave response. Wake patterns at larger distances and longer periods (two to five inertial periods) after the storm passage reflect scales of variation consistent with inertial wavelengths. For some intense storms, a transition region exists on the order of one to two inertial wavelengths/periods, where a 100-200 km scale of variation in the SST and MLD patterns is most pronounced. It is speculated that this may be a harmonic of the longer inertial wavelength/period excited by finite amplitude effects due to the extreme magnitude of the forcing. Wind stress curl magnitudes were found to be an order of magnitude larger for mature storms than have been assumed in numerical models of ocean response. The crescent-shaped pattern of SST decreases and MLD increases suggests that mixing mechanisms which operate on short time scales are important. A three stage sequence of events is hypothesized to explain the observed pattern and subsequent changes. It is suggested that, initially, upward surface buoyancy flux and mechanically-generated turbulence through the wind stress are important mechanisms. It is suggested that near the storm center both mechanical generation and local shear production at the base of the mixed layer are important. Finally, enhancement of the mixing process may occur after storm passage for certain limited combinations of wind stress curl, radius of maximum wind, storm translational speed, ocean baroclinic wave speed, and latitude, which results in the generation of strong inertial currents that

rotate in phase with the surface wind. Normally, however, the large mixed layer inertial currents required to produce shear-generated mixing occur too far to the rear of the storm to contribute to the crescent pattern near RMAX, but may contribute to the modulation of the pattern along the track. Cross-section analyses of temperature as a function of depth reveal consistent patterns of increases and decreases with respect to the storm center for various storm speeds. For sections normal to and through the center of slow-moving storms, and at inertial wave crests in the wake of fast-moving storms, upward isotherm displacement occurs at the center of the track from the MLD to about 150 m. At about two RMAX to the right of the storm, large subthermocline temperature increases are present to 100 m. A much smaller region of subthermocline temperature increases is evident to the left of the center. These temperature increases are associated with the MLD increases. The maximum MLT decreases are located between the regions of subthermocline temperature decreases along the track and the increases to the right of the track. The magnitude of these anomalies is a function of storm speed and initial thermocline depth, as well as subthermocline stratification. In large, slow-moving storms, SST decreases induced by a storm can cause a reduction in the sensible heat flux by up to a factor of four, and in latent heat flux by up to a factor of two. Inner core SST decreases of 2°C, or more, in 24 hours were correlated with filling rates of central pressure (PMIN) of 0.7 to 2.4 mb/hr for 6-24 hours in seven storms that were studied.

AO-005-83

BLACK, P. G. Tropical storm structure revealed by stereoscopic photographs from Skylab. Advances in Space Research 2:115-124 (1983).

A stereo pair of photographs taken by Skylab astronauts over Hurricane Ellen, September 19, 1973, resulted in the first stereo analysis over tropical storms. This pair is also the first evidence to indicate the existence of "supercell" convection in developing tropical storms. The photos are analyzed to determine the cloud top structure of the intense convection occurring in one quadrant of the storm. This type of supercell convection in tropical storms has recently been correlated with subsequent rapid deepening. The stereo analysis revealed that a circular cloud feature over the storm center was a dome which protruded 3-4 km above the undisturbed cirrus clouds. The center of the dome was capped by smaller scale convective turrets which protuded another 1-2 km above the dome. The existence of shear induced waves in the cloud tops is shown with wave amplitude ranging from 150-300 m and wave lengths ranging from 2-4 km. The existence of gravity waves at the cloud tops is also shown with wave amplitudes of 500-600 m and wavelengths of 10-12 km.

AO-006-83

BLACK, P. G., and W. L. ADAMS. Guidance for estimating surface winds based on sea state observations from aircraft and sea state catalog. FCM-G1, NOAA, Federal Coordinator for Meteorological Services and Supporting Research, Washington, D.C., 85 pp. (1983).

No abstract.

AO-007-83

BLACK, R. A., P. T. WILLIS, and J. Hallett. Case studies of ice distribution in hurricanes. Preprints, Conference on Cloud Physics, November 25-27, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 335-337 (1982).

No abstract.

AO-008-83

CHEW, F. Curvature bias in the Florida Current off Miami. Journal of Physical Oceanography 13(2):346-352 (1983).

The evidences for and the mechanism of a negative curvature bias in the Florida Current off Miami are presented. The evidences consist of a re-examination of the data tests by Schmitz (1969) and Stubbs (1971). Three different approaches are used in re-examining the first work, and all three clearly give a negative curvature bias. In revealing consistent evidence for a supergeostrophic flow, the second work supports the same bias. Thus, both works indicate a persistent tendency for fast, inertial flows to meander even when within a channel. Apparently triggered by and hence tied to the channel constriction off Miami, the curvature mechanism involves a divergence with magnitude an order larger than the geostrophic divergence, and correspondingly larger inertial torques in both the cross- and downstream directions.

AO-009-83

CLARKE, T. L. Simple flat-field eyepiece. Applied Optics, 22:1807-1811 (1983).

A simple three-element eyepiece is presented which has a zero Petzval sum and is corrected for both longitudinal and lateral color. Following a third-order analysis, results of ray tracing several examples are presented. Designs using a single glass are useful at f/4 and 40°, and multiglass designs can be used at f/3 and 40°. These latter designs also correct the coma of a paraboloidal mirror objective.

AO-010-83

CLARKE, T. L., W. L. STUBBLEFIELD, and D. J. P. Swift. Use of power spectra to estimate characteristics of sand ridges on continental shelves. Journal of Geology, 91:93-97 (1983).

Attempts to explain the origin of sand ridges on continental shelves require objective means for quantifying their wavelengths and orientations. Two-dimensional power spectral analysis is such an approach. However, mathematical peculiarities may lead to apparent discrepancies between the results of spectral analysis and wavelength estimates from bathymetric maps. This discrepancy may explain much of the reported difference between wavelength predictions based on hydrodynamic stability theory and measurements from bathymetric maps. Such a discrepancy can be significantly reduced by a modified spectral analysis technique which utilizes power spectra of bottom slopes rather than bathymetry.

AO-011-83

CLARKE, T. L., D. J. P. Swift, and R. A. Young. A numerical model of fine sediment transport on the continental shelf. Environmental Geology 4:117-129 (1982).

A numerical model of fine-grained sediment dispersion in the New York Bight of the North American continental shelf is presented. Large amounts of waste material have been dumped in this region and the dispersal patterns of this material are of great interest to environmental managers. The model assumes that fine sediment resuspension is determined by surface wave activity and that transport is determined by tidal currents. Considering surface wave activity to be a random process reduces sediment motion to a random walk which is governed by a diffusion equation. The diffusion equation is solved numerically by an implicit time difference, finite element algorithm for a number of initial conditions. Initial conditions corresponding to ocean dumping sites show patterns of dispersal controlled by the geometry of the study region and the anisotropy of the tides. Material dumped at currently used dump sites reaches sensitive coastal areas before it leaves the continental shelf. Examination of the diffusion coefficients suggests an alternative dump site for fine-grained material. This dump site is relatively near sources of dumped material but produces minimal impact on coastal areas. This site should be considered as a possible alternative to expensive direct disposal at deep ocean sites.

AO-012-83

CLARKE, T. L., B. Lesht, R. A. Young, D. J. P. Swift, and G. L. FREELAND. Sediment resuspension by surface-wave action: An examination of possible mechanisms. Marine Geology, 49:43-59 (1982).

Detailed spectral and coherence analyses of both nephelometer data and near-bottom acoustic concentration profiles support the conclusion of Lesht et al. (1980) that surface-wave activity is the most important input to the sediment resuspension processes. The sand-sized fraction is suspended primarily by bursts of turbulence which are related to peak values of the envelope of surface waves. Two mechanisms for the resuspension of fine sediment are considered. When the bed is bimodal sand and silt, pore-water motion induced by wave-pressure fluctuations may carry fine particles into the boundary layer where they are suspended. Motion of the sand matrix as bedload will also expose fine particles to the flow so that they become suspended. The combination of these two mechanisms accounts for the observed quasi-linear relation between wave orbital velocity and suspended sediment concentration for the Long Island data. The second mechanism is also consistent with observations of near-bottom fluid velocity and suspended sediment concentration in Norton Sound, Alaska.

AO-013-83

CLARKE, T. L., R. A. Young, W. F. STUBBLEFIELD, D. J. P. Swift, T. A. NELSEN, and G. L. FREELAND. Summary results of Instep Project: New York Bight marine geology. NOAA-TM-OMPA-23 (1982).

Following a brief history of the INSTEP project, the data and scientific results produced by the project are summarized. In each of the three main

study areas, seafloor inventory, suspended particulate measurements, and boundary layer measurements and modeling, the types of data taken and the methods used are briefly summarized. Sources from which copies of the data can be obtained are indicated. A complete bibliography of publications resulting from the INSTEP project is included.

AO-014-83

FRANKLIN, J. Omega dropwindsonde processing. NOAA-TM-ERL-AOML-54, 37 pp. (1983).

During the Global Atmospheric Research Program's Alpine Experiment (ALPEX) of 1982, 187 atmospheric soundings were obtained with Omega dropwindsondes. These data were post-processed at the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) Hurricane Research Division (HRD) to improve the quality of the data set. The errors common to Omega dropwindsonde data are described, and corrections of these problems through post-processing are illustrated using soundings from ALPEX and Hurricane Debby (1982). Advantages of post-processing are demonstrated by the improved accuracy of the data.

AO-015-83

FREELAND, G. L., R. A. Young, G. Drapeau, T. L. CLARKE, and B. L. BENGGIO. Sediment cap stability study, New York dredged material dumpsite, New York. District Corps of Engineers, Agreement No. NYD 80-124(C) (1983).

The project objective is to study the frequency and capability of sea-bottom currents to erode surficial sediment in a portion of the southeast quadrant of the New York dredged material dumpsite. The area under study had dredged material dumped which was determined, after the dumping occurred, to be unsuitable for unrestricted ocean disposal under the ocean dumping pollution criteria; this material was subsequently capped by clean dredged material. This study measured sea-bottom conditions on the surface of the cap from November 1980 to June 1981. It also attempts to reconstruct, through hindcasting and mathematical modelling techniques, what conditions might be expected at the site over a much longer period of time. Both actual and predictive analysis indicate a slight amount of erosion occurs during a 'normal' year. The bottom is particularly susceptable to erosion during the winter season when the water column is unstratified. Especially important for bottom sediment transport are storm conditions when the wind blows from directions of open water fetch: from east-northeast to south-southwest. Sea swell coming from these directions may also cause some transport. Severe conditions did not occur during the measurement period, nevertheless, some sediment transport, primarily to the south, did occur. Since the present surface of the cap contains high percentages of easily-transported fine sand, it is recommended that additional material be added to the cap, and that this material be clean sand as coarse as is economically available, but not finer than 0.25 mm in grain size.

AO-016-83

FRIEDMAN, H. A. Methods of analysis for forecasting in the tropics. In Guide on the Global Data Processing System. World Meteorological Organization Publication No. 305, 2nd edition, Geneva, Switzerland, V-1 - V-79 (1982).

No abstract.

AO-017-83

HALPERN, D., S. P. HAYES, A. LEETMAA, D. V. HANSEN, and S. G. H. PHILANDER. Oceanographic observations of the 1982 warming of the tropical eastern Pacific. Science 221(4616):1173-1174 (1983).

Moored current meter, sea level, hydrographic, and surface drifter measurements show the large changes that took place in the eastern tropical Pacific during the onset of the warm episode of 1982. In August the near-surface flow at 0°, 110°W reversed direction to eastward. By October the sea surface temperature in the equatorial zone increased by 5° Celsius above the long-term monthly mean value, sea level rose by 22 centimeters at the Galapagos Islands, and the thermocline was displaced downward by 50 to 70 meters along the equator and the South American coast.

AO-018-83

HARVEY, G. R. Dissolved carbohydrates in the New York Bight and the variability of marine organic matter. Marine Chemistry 12:333-339 (1983).

Concentrations of dissolved carbohydrates in the New York Bight were determined hourly, daily and weekly in June and August 1978. Results of this and many other recently published studies reveal that the concentrations of dissolved organics change dramatically over short time scales. It is proposed that a total compound class analysis of any single seawater sample will account for most of the dissolved organic carbon in that sample.

AO-019-83

HARVEY, G. R., D. A. BORAN, L. A. Chesal, and J. M. TOKAR. The structure of marine fulvic and humic acids. Marine Chemistry 12:119-132 (1983).

Fulvic and humic acids were isolated from near surface seawater samples obtained at five biologically diverse sites in the Gulf of Mexico in quantities sufficient for detailed NMR and chemical studies. A gas lift pump and a 1500-l extraction facility provided half-gram quantities of material. The proton NMR spectra of all fulvic and humic acids studied were remarkably similar and differed mainly in the absence of aromaticity in the fulvics. These observations, coupled with published spectra and chemical data, suggest a class structure and general mechanism of formation for marine humic substances. The proposed structures are crosslinked, autoxidized, polyunsaturated fatty acids.

AO-020-83

HARVEY, G. R., N. S. Fischer, P. Bjerregaard, and L. Huynh-Ngoc. Interactions of marine plankton with transuranic elements. II. Influence of dissolved organic compounds on americium and plutonium accumulation in a diatom. Marine Chemistry 13:45-56 (1983).

To assess the significance of naturally occurring dissolved organic matter (DOM) on complexation of transuranic elements in seawater, a series of bioassay experiments was conducted in which the effect of DOM on the accumulation of ^{241}Am, ^{237}Pu (III-IV), and ^{237}Pu (V-VI) by the marine diatom Thalassiosira pseudonana was measured. EDTA at 0.3 μM complexed both metals substantially, resulting in reduced radio-isotope uptake by the diatom; the greatest effect was on Pu (III-IV). In contrast, there was no apparent complexation of either element by equimolar concentrations of marine fulvic (MFA) or humic acids (MHA), naturally occurring photo-oxidizable DOM (uncharacterized), or diatom exudates, as none of these materials reduced isotope uptake; on the contrary, there were indications that some of this DOM enhanced transuaranic bioaccumulation in the diatom slightly. Subsequent experiments showed this enhancement was probably due to complexation of transition metals by the DOM, leading to fewer ambient ions "competing" for binding sites on the cells; ^{241}Am uptake rates were negatively correlated ($r = -0.846$, $P < .01$) with Σ ASV-labile Cu + Zn + Cd + Pb. These experiments suggest that naturally occurring DOM may not appreciably complex Am or Pu or greatly affect their bioavailability in the sea.

AO-021-83

HAWKINS, H. F. Hurricane Allen and island obstacles. Journal of the Atmospheric Sciences 40:1360-1361 (1983).

The first significant filling of Hurricane Allen coincided with its encroachment on Haiti, Jamaica and eastern Cuba. It is suggested that the filling was due to the interruption offered to its circulation by the mountainous terrain. The accompanying secondary wind maximum may have contributed to, or have been coincidental with, the weakening observed.

AO-022-83

Hawkins, J., and P. G. BLACK. SEASAT scatterometer detection of gale-force winds near tropical cyclones. Journal of Geophysical Research 88(C3):1674-1682 (1983).

Hurricane Center advisories specifying the radius of gale force winds (GFW) in tropical cyclones are severely limited by inadequate data. Their accuracy is especially vulnerable in the data void tropical ocean regions. The SEASAT-A satellite scatterometer (SASS) sensed surface winds associated with numerous tropical cyclones. Although instrument design ruled out retrieval of winds within the inner core of the storm, surface truth studies indicate SASS can detect the threshold of gale force winds (17-18 ms^{-1}) with an accuracy comparable to the original SEASAT specifications (± 2 ms^{-1} or 10% and ± 20°). Accurate and abundant SASS observations were thus used as verification for advisories specifying the radius of gale force winds for tropical cyclones in the Pacific and Atlantic Ocean basins. Advisories were found to consistently overestimate the radius of GFW, often by a factor of two in the

central Pacific. Large asymmetries in the GFW distribution measured by SASS were often in considerable disagreement with symmetric circular and semi-circular advisory values. However, advisories that had access to low-level aircraft data closely matched SASS measured GFW values.

AO-023-83

JORGENSEN, D. P. Vertical-draft properties of mature hurricane cumulonimbus clouds. Preprints, Conference on Cloud Physics, November 15-17, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 531-534 (1982).

No abstract.

AO-024-83

JORGENSEN, D. P., K. C. BELLE, and R. W. BURPEE. Airborne Doppler estimates of the air motions associated with a developing sea-breeze-induced mesoscale precipitation line. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorology Society, Boston, Massachusetts, 670-674 (1983).

No abstract.

AO-025-83

JORGENSEN, D. P., P. H. Hildebrand, and C. L. Frush. Feasibility test of an airborne pulse-Doppler meteorological radar. Journal of Climate and Applied Meteorology 22:744-757 (1983).

A vertically scanning, airborne, pulse-Doppler radar is described. Data processing methods to yield pseudo-dual-Doppler horizontal winds are presented. Results of an intercomparison with a ground-based dual-Doppler network are presented and discussed. These results indicate that the accuracy of the Doppler estimates are not seriously degraded by the aircraft's motion in a nonturbulent environment. Reasonable wind velocities were obtained in a stratiform precipitation (pre-warm-frontal) regime despite relatively long time periods for data gathering (~ 20 min). Potential error sources are discussed, with the principal conclusion being that the uncertainty in the airborne Doppler mean velocity estimates are slightly larger than would be expected for a ground-based Doppler. However, the time period over which data are gathered is much longer than for a ground-based dual-Doppler network. Potential modifications to the antenna and data system to improve data quality are also discussed.

AO-026-83

Lass, H. U., V. Bubnov, J. M. Huthnance, E. J. Katz, J. Meincke, A. de Mesquita, F. OSTAPOFF, and B. Voituries. Seasonal changes of the zonal pressure gradient in the equatorial Atlantic during the FGGE year. Oceanologica Acta 6:3-11 (1983).

Dynamic height measurements relative to the 500 dbar surface in the Atlantic Ocean distributed between 2°N, 2°S, 44°W and 7°E and August 1978 to

March 1980 have been analyzed. In general, the pressure gradient is variable along the equator evidently due to zonally varying winds. Extremely large values of the pressure gradient have been observed in the western part of the equatorial Atlantic boreal winter 1979 and 1980. The seasonal cycle of zonal pressure gradient at the 50 dbar surface has in the central equatorial Atlantic a minimum in March to April. The pressure gradient reaches its yearly maximum value in September to October. In the central Atlantic the mean value and the yearly cycle of the equatorial zonal pressure gradient is nearly balanced by the westward directed wind stress. There is evidence of a time delay of the order of one to two months between the zonal windstress and the zonal pressure gradient in the equatorial Atlantic.

AO-027-83

LAWSON, L. M., and R. B. LONG. Multimodal properties of the surface-wave field observed with pitch-role buoys during GATE. Journal of Physical Oceanography 13:474-486 (1983).

A sophisticated analysis technique is applied to a subset of pitch-roll buoy data collected by the research vessels GILLISS and QUANDRA during the GARP Tropical Atlantic Experiment (GATE) in September 1974. The procedure enables the examination of directional properties of the wave field at a level of detail not previously achievable. Attention is focused on a wave event caused by the passage of a cyclone across the North Atlantic along 44°N latitude. By comparing properties of the observed spectra with the predictions of a simple schematic model of the storm, we conclude that swell reaching the GATE area was emitted during the first half of the storm's lifetime; swell subsequently radiated from the storm was heavily attenuated, either by sheltering of the site by the Cape Verde Islands or because of radically lower emission levels from the storm itself. This work illustrates the power, as well as the limitations, of the pitch-roll buoy when used in conjunction with a fully effective analysis technique.

AO-028-83

LEETMAA, A. Observations of near-equatorial flows in the eastern Pacific. Journal of Marine Research 40 (Supplement):357-370 (1983).

Direct measurements were made in 1980 and 1981 of the near-equatorial flow field along sections at 110°, 102.5°, 95°, and 85°W. The Equatorial Undercurrent weakens as it approaches the Galapagos. Most of the transport is lost from the warmer, upper part of the current. In June 1981, the transport at 110°W was 26 Sv (1 Sv = 10^{12} gm/sec) and at 95°W it was 13 Sv. However, further to the east at 85°W only a trace of eastward flow was present above 150 m and most of the flow was westward. To the west of the Galapagos the bulf of the eastward flow lies asymmetrically south of the equator. In the surface layers eastward flows extends southward to 3°S. This appears to be distinct from the Undercurrent. It is argued that this shallow eastward flow is driven by the curl of the wind stress. At 110°W the net transport within 3° of the equator was close to zero. The eastward transport of the Undercurrent was compensated for by westward transport in the South Equatorial Current north of the equator.

AO-029-83

LEETMAA, A. The role of local heating in producing temperature variations in the offshore waters of the eastern tropical Pacific. Journal of Physical Oceanography 13(3):467-473 (1983).

The role of local heating in producing annual and interannual sea-surface temperature variations in the eastern tropical Pacific is studied. Removed from the eastern boundary (122°W), and off the equator, local heating plays a major role in producing annual temperature fluctuations. At the same longitudes from 10°N to 10°S interannual variations in the yearly-average temperature and the anomalous net heat input into the ocean are of the same sign and magnitude. During the 1969 and 1972 ocean warmings there was increased heat input into the ocean. Closer to the eastern boundary, oceanic processes such as advection are as important as local heating. Results from a simple model incorporating local heating, offshore Ekman transports, and upwelling suggest the following scenario for the 1972-73 El Niño. During February and March 1972 enhanced local heating and reduced offshore advection were the main reasons for anomalously warm temperatures in the open ocean adjacent to Peruvian coastal waters. From April 1972 to March 1973 temperatures remained high because of offshore transport of anomalously warm inshore waters. Whether the latter were warm because of upwelling of warmer water or transport of warmer water from farther south is not clear.

AO-030-83

LEETMAA, A., D. R. Quadfasel, and D. WILSON. Development of the flow field during the onset of the Somali Current, 1979. Journal of Physical Oceanography 12:1325-1342 (1983).

During the spring and summer of 1979 a multi-ship survey studied the changes in currents along the East African coast in response to the transition from the northeast to the southwest monsoon. The Somali Current in late April and early May flowed southwestward along the coast from northern Somalia to about the equator. Surface currents were 50-100 cm s^{-1} and the transport was 3×10^6 m^3 s^{-1}. South of the equator the East African Coast Current (EACC) flowed northward. The two currents met in the vicinity of the equator and turned offshore to the southeast. Surface velocities in the EACC were about 200 cm s^{-1}, and its transport in the top 10 m was 15×10^6 m^3 s^{-1}. With the initial onset of southerly winds in early May the Somali Current reversed. By mid-May at 3°N surface speeds of 200 cm s^{-1} were observed. The flow did not continue up the coast, but turned offshore by 4°N. The second onset of the monsoon took place in mid-June. Shortly after this, surface currents > 350 cm s^{-1} were observed at the turn-off region. The transport at 3°N was 27×10^6 m^3 s^{-1} in the top 100 m. Farther to the north, northeasterly flow was observed as early as March. With the monsoon onset in June a strong anticyclonic circulation developed between 5 and 10°N. This continued to strengthen into July. The transport in the top 100 m in late June was 22×10^6 m^3 s^{-1}. Energetic, organized flows were observed below the surface layer. North of the equator between 100 and 450 m, the flow was already to the northeast in mid-April. This coastal flow was fed by westward flow along the equator at this level. Little change was seen in this portion of the water column with the monsoon onsets. Around 700 m along the coast the flow was to the southwest with a speed of 50 cm s^{-1} in late April to mid-May. Flow at 700 m along the equator was to the west. Close to the coast this turned to

the southwest. With the reversal in the surface current, the deep southwestward flow also reversed north of the equator. This deep northeastward flow increases the net transport at 3°N to about 80 x 10^6 m^3 s^{-1}. A persistent, nearshore, southwestward undercurrent was seen in the northern gyre in May-July. The current changes in the surface layer were primarily related to changes in the local winds and a northward intrusion of the EACC into the Northern Hemisphere. No direct evidence for strong remote forcing was seen. It is not clear what causes the changes in deep water.

AO-031-83

LEWIS, B. M., AND H. F. HAWKINS. Polygonal eyewalls and rainbands in hurricanes. Bulletin of the American Meteorology Society 63:1294-1300 (1982).

It was noted from analyses of radar data obtained in hurricanes that both the spiral bands and the inner boundary of the wall cloud frequently were composed of a series of straight line segments. Indeed, the eye of a strong hurricane is frequently polygonal rather than circular or elliptical. These features may have a possible kinematic explanation based on interference among differing wavenumbers and frequencies of internal gravity waves.

AO-032-83

MARKS, F. D., JR. Three-dimensional reflectivity distribution in the eyewall of Hurricane Allen. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, Massachusetts, 305-310 (1983).

No abstract.

AO-033-83

MARKS, F. D., JR., and R. A. Houze, Jr. Three-dimensional wind field in the developing inner core of Hurricane Debby. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, Massachusetts, 298-304 (1983).

No abstract.

AO-034-83

MAUL, G. A. Review. Circulation and fronts in continental shelf seas: A Royal Society Discussion. J. F. Swallow, F. R. S., R. I. Currie, A. W. Gill, and J. H. Simpson, organizers. The Royal Society, 6 Carlton House Terrace, London, SW 1Y 5AG, England, 1981, 177 pp. (1983).

No abstract.

AO-035-83

MAYER, D. A. The structure of circulation. MESA physical oceanographic studies in New York Bight, 2. Journal of Geophysical Research 87(C12):9579-9588 (1983).

The structure of velocity in New York Bight (NYB) is examined for motions in the low frequency meteorological band (periods greater than three days) and for those in the semidiurnal band during the years 1975, 1976, and 1978. An empirical modal analysis suggests that, in the lower part of the water column in the unstratified season, nearly 80% of the low frequency energy is in phase across the shelf and is organized along the major isobaths. These motions exhibit a remarkable coherence that is visually apparent across the shelf for distances up to 80 km. Near-surface motions are less organized presumably because of the surface wind stress field. Maximum coherence between the observed wind stress and currents occurs with wind angles that vary from 60°T near the New Jersey coast to 80°T at mid-shelf just northeastward of the Hudson Shelf Valley which is consistent with the analysis of sea level records by Wang (1979). Wind-coherent motions represent about 50% of the low frequency energy in the northern section of NYB off Long Island and as much as 70% in the southern section off New Jersey. The analysis suggests the existence of a wind-coherent disturbance propagating southwestward on the outer shelf at about 540 km/day. This phase speed is consistent with earlier studies (Ou et al., 1981). In the higher frequencies, the M_2 semidiurnal tidal current is in phase and rotates clockwise throughout NYB with the major axes organized approximately across the shelf.

AO-036-83

MAYER, D. A., G. C. Han, and D. V. HANSEN. Circulation in the Hudson Shelf Valley: MESA physical oceanographic studies in the New York Bight, 1. Journal of Geophysical Research 87(C12):9563-9578 (1983).

Over 900 days of current velocity data were obtained at mainly two locations in the inner and outer Hudson Shelf Valley (HSV). The large cross-axis depth gradients in the HSV, together with the strong winter cyclones and the baroclinic density distribution over the shelf, are primarily responsible for the major circulation features observed in the valley. CSTD data from 12 cruises and meteorological data from JFK International Airport and an environmental buoy were collected concurrently with the current meter data. Although the mean cross-shelf pressure gradient is generally seaward in the Middle Atlantic Bight, it is shoreward in the HSV below the level of the adjacent continental shelf (shelf horizon), thus imposing a bias toward upvalley flow. The average velocity below the surrounding shelf horizon in the HSV is upvalley or shoreward (west-northwestward ≈ 290°T) in the range of 2-5 cm/s. The circulation in the HSV is seasonal and individual events can drastically alter the mean picture. The several day average upvalley flow can sometimes approach 20 cm/s when intense winter cyclones pass over the bight and can sometimes also be directed downvalley depending upon the path of the winter cyclone. A topographically controlled barotropic flow commonly opposes the dominant (southeastward) wind direction even near the surface in the winter. In the context of circulation on the open shelf, upvalley (downvalley) flow events generated by winter cyclones are associated with reduced (enhanced) southwestward flow or flow reversals that are northeastward in the lower half of the water column at LTM, a typical mid-shelf site (Mayer et al., 1979).

Current meter data suggest that whether or not reversals occur on the open shelf depends upon the interannual variability of the winter wind regime. Upvalley flow events are not confined only to the winter (unstratified) season but are stronger in the winter and can last for several days and longer. During the summer (stratified) season the maximum horizontal KE in the upper part of the water column shifts from the meteorological forcing band, characteristic of winter, to diurnal inertial and semidiurnal frequencies. In the diurnal band there appears to be a strong relationship between the diurnal wind and currents near the surface in the HSV as well as on the open shelf (LTM). The structure of the semidiurnal motions in the inner valley where the depth gradients are larger than in the outer valley has a significant depth dependence unlike most regions on the shelf, i.e., during all times of the year the semidiurnal tidal ellipse is anticlockwise in the lower 20 m of the water column.

AO-037-83

MCLEISH, W., and D. B. ROSS. Imaging radar observations of directional properties of ocean waves. Journal of Geophysical Research 88:4407-4419 (1983).

SEASAT-A synthetic aperture radar (SAR) and side-looking airborne radar (SLAR) images of ocean waves are examined in the form of normalized directional distributions of backscatter variance at series of frequencies. This method provides a more detailed description of radar results than have contoured two-dimensional wave number spectra and reduces some of the uncertainties in relating radar measurements to the waves. The range of aspects of the radar distribution that parallel those of ocean waves is defined. Within this restriction, not only can dominant wave frequencies and directions be determined accurately, but also the shape of a directional peak at a frequency, its directional width, and the background level can be determined approximately. Some of these aspects are examined with SLAR images obtained near reference wave measurements. Through its superior directional resolution, the radar appears to have distinguished two wave trains at a single frequency only 20° different in direction. The SEASAT-A satellite SAR provided an unusual opportunity to examine directional properties of waves in the hostile environment about Hurricane Fico. A swell highly dispersed in frequency and direction at a distance from the center of 450 km had a minimum observed directional width of 11°. Wave directions, their changes with frequency, and directional widths were in accord with those expected from the hurricane winds. Thematic maps of the direction and width of the swell energy as it spread across the ocean surface show smooth changes in these properties over distance, with relatively small scatter of individual values. These patterns also are in accord with those from a simple hurricane wave emission concept, but details of the distributions show distinct departures that must represent unrecognized smaller-scale fluctuations of the process.

AO-038-83

MOLINARI, R. L. Observations of eastward currents in the tropical south Atlantic Ocean: 1978-1980. Journal of Geophysical Research 87(C12):9707-9714 (1983).

Data from four cruises to the tropical South Atlantic Ocean are used to describe the current distribution at 25°W and 27.5°/28°W. Two distinct eastward-flowing countercurrents separated by a branch of the westward-flowing South Equatorial Current (SEC) were observed during all the cruises. The South Equatorial Undercurrent, located between 3°S and 5°S, has a subsurface velocity core, with maximum speeds of about 0.4 m/s. Geostrophic volume transport of the SEUC, from the surface to 1000 m, range from 5 to 23 Sv. Surface flow above the core of the SEUC can be to the east or west. The South Equatorial Countercurrent (SECC) is located typically between 7°S and 9°S. Although weaker than the SEUC with transports ranging from 3 to 7 Sv, the SECC also has a subsurface velocity core. Maximum speeds of 0.1 m/s are observed at about 275 m. Surface flow above the core of the SECC is typically to the east. Upper layer waters of the SECC are saltier and warmer than waters within similar density layers to the north.

AO-039-83

MOLINARI, R. L. Observations of near-surface currents and temperature in the central and western tropical Atlantic Ocean. Journal of Geophysical Research 88(C7):4433-4438 (1983).

Eleven satellite-tracked drifting buoys were deployed in the central South Atlantic Ocean during two austral summer and two austral winter cruises. Between 7°S and 11°S and 23°W and 31°W during austral winter, net buoy drift was to the west. Surface geostrophic flow was to the east between 7°S and 9°S. It is proposed that strong southeast trade winds can induce directly driven surface flows to the west that are more intense than the eastward geostrophic flows associated with the South Equatorial Countercurrent (SECC). A sustained period of eastward drift within the SECC was observed during austral summer, when the trades are weaker. The trajectories indicate surface waters north of 8°S have a mean northward meridional component and those south of 8°S a southward component. The buoys which drifted north became entrained into the North Brazilian Coastal Current (NBCC) and those that drifted south into the Brazil Current. One buoy left the NBCC at about 5°N to drift northeastward in the North Equatorial Countercurrent (NECC). This trajectory and historical ship drift reports suggest that the NECC may extend only to 35°W to 40°W during boreal winter. Temperature data obtained as the buoys drifted westward and northward suggest that increases in upper layer heat content can be attributed to heat fluxes through the sea surface.

AO-040-83

MOLINARI, R. L. Sea-surface temperature and dynamic height distributions in the central tropical south Atlantic Ocean. Oceanologica Acta 6(1):23-34 (1983).

Dynamic height and temperature observations collected during four cruises to the central tropical South Atlantic Ocean are presented. The dynamic topographies of the sea-surface along sections extending from 1°N to 9°S during

two different austral summer and two different austral winter cruises are similar to topographies given earlier. They support the contention of Katz (1981) that the dynamic relief of the sea-surface in the Atlantic varies in phase with changes in the surface wind stress field. Synoptic and climatological sea-surface temperature (SST) distributions during early austral winter (June-July) are more symmetric with respect to the equator than SST distributions later in austral winter (August-September). Comparison of the observations with results from various numerical modelling efforts suggests that the early winter pattern may represent an ocean response to an increase in zonal winds, while the late winter pattern may include an additional response to an increase of meridional winds.

AO-041-83

MOLINARI, R. L. STACS: Subtropical Atlantic climate studies. EOS 64(1):2 (1983).

No abstract.

AO-042-83

MOLINARI, R. L., and D. A. MAYER. Current meter observations on the continental slope at two sites in the eastern Gulf of Mexico. Journal of Physical Oceanography 12:1480-1492 (1983).

Current-meter observations obtained at two sites on the continental slope of the eastern Gulf of Mexico, at nominal positions of 29°N, 88°W (the Mobile site) and 27.5°N, 85.5°W (the Tampa site) are presented. Data were collected at three levels at Mobile (90, 190 and 980 m) from July 1977 through August 1978 and at four levels at Tampa (150, 250, 550 and 950 m) from June 1978 through June 1979. At 90 and 190 m, the flow at Mobile was on the average to the east. Sustained periods of flow to the west were observed during the summer 1977 and spring 1978. During the periods of eastward flow, the wind was generally out of the north and during the periods of westward flow, the wind was out of the east. The flow at the top meter at Tampa was on the average to the west, in the same direction as the average wind. At both sites, the motions are perturbed by events associated with the Loop Current. These events make it difficult to define any seasonal variability in the upper layers. The flow at the bottom meters is strongly aligned with the bottom topography and lacks a strong seasonal signal. Little barotropic tidal energy was observed at either site. At both sites, maximum diurnal energy occurred near the local inertial frequency at the upper levels. These motions are probably induced by either cold-front passages or other atmospheric events. At the bottom meters, maximum diurnal-band energy occurred near the K_1-tidal constituent. These motions are strongly time-dependent and they may be related to internal tides.

AO-043-83

MOLINARI, R. L., E. Katz, E. Fahrbach, and H. U. Lass. Near surface temperature observations obtained in the equatorial Atlantic Ocean during FGGE (1979). In Hydrodynamics of the Equatorial Ocean, J. C. J. Nihoul (ed.), Elsevier Science Publishers B. V., Amsterdam, printed in the Netherlands, 65-82 (1983).

Temperature and surface wind data collected across the equatorial Atlantic Ocean during the First GARP Global Experiment (FGGE), 1979, have been compiled to study the seasonal evolution of the near-surface temperature field. The development of the large-scale, sea-surface temperature (SST) field is characterized by the appearance during boreal summer of a tongue of cold water which extends from the eastern to western basin, on and south of the equator. During 1979, the cold water first appears at 4°W and 28°W during early May and at 22°W some four weeks later. East of about 20°W, the thermocline rises and the mixed layer becomes shallower simultaneously with the lowering of SST's. West of about 30°W, the thermocline and mixed layer deepen at this time. Below average temperatures are observed through October, as the thermocline redeepens in the east and continues to deepen in the west. The 1979 SST and thermocline distributions along the equator have been compared to climatological distributions derived from historical data. The FGGE year fields are qualitatively similar to the climatological fields. Surface wind data collected during FGGE indicate that the surface cooling occurs within several days of an increase in both components of wind at 4°W and 28°W and within several weeks of the wind increase at 22°W.

AO-044-83

Mollo-Christensen, E., F. OSTAPOFF, and S. WORTHEM. Heat transport due to inertial oscillations in a weakly diffusive ocean. Tropical Ocean-Atmosphere Newsletter 18:4-5 (1983).

No abstract.

AO-045-83

NELSEN, T. A. Time and method-dependent size distributions of fine-grained sediments. Sedimentology 30:249-259 (1983).

With increased interest in fine-grained sediments it is imperative that a firm basis exist for comparative studies of these cohesive sediments. In this study the size distributions of continental slope and rise muds are shown to be dependent on both method and duration of sample pretreatment. Statistical analysis of 171 size distributions indicates that of the four most frequently used sample preparation methods (soak, stir, shake and ultrasonify) the time required to reach a "terminal" distribution beyond which no "fine-shift" was detected varied from 15 minutes to > 90 hours for a given sample solely as a function of preparation method. Data from this study also indicate that sample preparation by simple soaking alone will probably yield fine-grained sediments which, when analyzed by pipette or microsedimentation accumulation balance, undergo a continuous change in size distribution during analysis and may never reach a "terminal" distribution during the analysis time. On the other hand, stirring and ultrasonification were shown to be the most rapid and consistent methods for obtaining a sample's "terminal" distribution.

AO-046-83
NELSEN, T. A., and R. H. Bennett. Seafloor characteristics and dynamics affecting geotechnical properties at shelfbreaks. Society of Economic Paleontologists and Mineralogists 33:333-355 (1983).

No abstract.

AO-047-83
PALMER, D. R., and M. L. Blodgett. Numerical calculations using the parabolic-equation technique. NORDA Parabolic Equation Workshop, NORDA Technical Note 143 (1982).

No abstract.

AO-048-83
O'Brien, J. J., and S. B. GOLDENBERG. Atlas of tropical Pacific wind stress climatology, 1961-1970. Florida State University Press, Tallahassee, Florida, 150 pp. (1982).

No abstract.

AO-049-83
ORTNER, P. B., C. KREADER, and G. R. HARVEY. Interactive effects of metals and humus on marine phytoplankton carbon uptake. Nature 301:57-59 (1983).

Although certain trace metals are essential micronutrients required for growth, elevated concentrations of some of the same metals exert deleterious effects on marine phytoplankton populations. Laboratory studies have indicated that metal toxicity depends on metal ion concentrations rather than total dissolved metals. Although it is believed that bioavailability is largely controlled by the degree to which dissolved trace metals are organically chelated, it has not been definitively established which organic compounds chelate trace metals in natural seawater. In an effort to define ecologically significant interactions between dissolved trace metals and naturally occurring organic matter we selected marine humus (humic and fulvic acids) as being likely to interact with trace metals in seawater. These compounds, derived from plant and animal sources, are being widely studied for their role in the transport and toxicity of metal ions in terrestrial, aquatic, and marine ecosystems and are known to comprise up to half of the total dissolved organic matter in seawater. Guided by a recent hypothesis explainng the structure of marine humus and its geochemical diagenesis, a laboratory synthesis of marine fulvic acid was accomplished. The resulting material was physically, spectroscopically and chemically identical to one or more natural marine fulvic acids isolated from the Gulf of Mexico. We confirm here that isolated natural marine fulvics and marine fulvics synthesized in the laboratory affect the bioavailability of trace metals to marine phytoplankton.

AO-050-83

PARRISH, J. R., R. W. BURPEE, F. D. MARKS, JR., and R. Grebe. Rainfall patterns observed by digitized radar during the landfall of Hurricane Frederic (1979). Monthly Weather Review 110:1933-1944 (1982).

In September 1979, two research teams traveled to the coastal area in the path of Hurricane Frederic to record observations of the storm's rainbands with mobile radar recorders. The researchers were in position at the National Weather Service offices at Slidell, Louisiana, and Pensacola, Florida, a few hours before Frederic's outer convective bands reached the Gulf Coast. Although the recorder taken to Pensacola was damaged in transit, the recording system at Slidell collected digital data for 26 h as Frederic moved ashore at 6-7 m s^{-1}, approximately 125 km to the east of Slidell. Calculations of storm-total rainfall indicate that local rainfall maxima tended to occur in two general areas: (1) parallel to the coast near the point of landfall, with a northward extension approximately along Frederic's track, and (2) on a long band oriented from south-southeast to north-northwest ~ 50 km to the west of the storm track. The storm-total rainfall maximum along the coast was explained by a rapid increase in the intensity and area coverage of deep convection in mesoscale rainbands in the north eyewall that occurred as the north eyewall interacted with the coastline. Raingage-radar comparisons indicate that the storm-total rainfall estimated by the radars is probably within a factor of 2 of the true value. Maximum rainfall totals measured by gages and determined by radar were ~ 250 mm. Frederic's maximum accumulated rainfall was slightly below average, relative to other hurricanes that have made landfall along the Gulf Coast of the United States. During the four hours that the most intense convection in the north eyewall was near the coast, maximum hourly rainfall rates were 50-75 mm. In this four-hour period, 3% of the land area within 100 km of the center had hourly rainfall > 50 mm h^{-1}, and 39% of the same area had rain rates of 25-50 mm h^{-1}. Land areas with the greatest wind damage were highly correlated with the location or radar-observed reflectivities $\geq$ 41 db(Z). Analyses of time series of radar reflectivities and 5 min peak wind gusts at the surface indicate that the maximum surface winds near the coast occurred a few kilometers inside the radar eye.

AO-051-83

PIOTROWICZ, S. R., G. R. HARVEY, M. S. YOUNG, R. A. Courant, and D. A. BORAN. Studies of cadmium, copper and zinc interactions with marine fulvic and humic materials in seawater using anodic stripping voltammetry. In Trace Metals in Sea Water, C. S. Wong, E. Boyle, J. D. Burton, K. W. Bruland, and S. D. Goldberg (eds.), Plenum Publishing Co., New York, 699-717 (1983).

Humic and fulvic acids isolated from seawater were found to interact with Cd, Cu, and Zn in different ways at natural levels of these elements and natural pH in seawater. Fulvic acids exhibit strong interaction with Zn while Cd and Cu have little or no interaction on the time scale of the diurnal cycles of plankton or bacteria. The Zn-fulvic acid interactions in surface waters probably occur as part of a steady-state cycle of less than 40 hours duration controlled by photo-oxidation and bacterial processes. The interaction of Cd, Cu and Zn with humic acids is much more complex. It appears that the natural association of metals and dissolved humic and fulvic acids is so dynamic that once a seawater sample is taken into a closed container for

analysis, natural productive and destructive equilibria slow and finally cease. Thus, our perception of how metal-organic interactions occur in the ocean depends upon how quickly samples can be analyzed because true oceanic conditions cannot be duplicated. The use of synthetic complexers to study trace metal chemistry in seawater is discouraged.

AO-052-83

POWELL, M. D. The transition of the Hurricane Frederic boundary-layer wind field from the open Gulf of Mexico to landfall. Monthly Weather Review 110:1912-1932 (1982).

Numerous aircraft, ship, buoy and land station data were composited with respect to the center of Hurricane Frederic for two time periods: a 24 h period corresponding to the storm's position in the open Gulf of Mexico on 12 September 1979, and an 8 h period corresponding to the landfall of Frederic near 0400 GMT on 13 September. Comparison of wind analyses for the two periods indicated a rotation of maximum inflow angles from the southeast to northeast quadrants and a strong frictional decrease of wind speed over land. These and other features of the landfall analysis were compared with a model landfall study by Moss and Jones (1978). The landfall composite wind field was compared with the Fujita damage vector analysis to determine the damage time interval and mean wind speed range. Damage vector directions were found to be well correlated with the surface streamlines, with the most severe damage being associated with Frederic's northern eyewall. Ten-meter-level wind speed data over water (V_o) and at coastal stations (V_L) were used to formulate approximate relationships of the low-level (500-1500 m) aircraft wind (V_a) to the mean coastal wind and peak gust (V_{LG}) in the same position relative to the storm center. It was found that $V_o = 0.7\ V_a$, $V_L = 0.8\ V_o$, $V_{LG} = 0.8\ V_a$ and $V_L = 0.56\ V_a$. These relationships should aid forecasters in their assessments of low-level aircraft reconnaissance wind data for use in issuing warnings. The vertical shear of the horizontal wind determined from radiosonde data for two inland stations was compared with shear determined from surface and aircraft data over water. The overland shear was greater than the overwater shear, by a factor of 2, in the same relative part of the storm. The "thermal wind" shear computed in the vicinity of the center was negligible, although the 10 m level air temperature analysis over land indicated a cold core that was probably caused by adiabatic cooling.

AO-053-83

ROFFER, C., and A. LEETMAA. CTD/O_2 data collected in November 1981 and March 1982 for EPOCS. NOAA-TM-ERL-AOML-52 (1983).

Hydrographic data collected on two cruises during the Equatorial Pacific Ocean Climate Studies (EPOCS) in 1981 and 1982 are reported. The data were recorded with a Neil Brown Instrument Systems (NBIS) CTD/O_2. Descriptions of the CTD/O_2 instrument, and data acquisition, processing and calibration techniques are given. Profiles of temperature, salinity, sigma-T and oxygen are plotted for each cast. The cruise track for both cruises is shown.

AO-054-83
RONA, P. A. Evaporites at passive margins. In Dynamics of Passive Margins, R. A. Scrutton (ed.), American Geophysical Union, Geodynamics Series, Washington, D.C., 6(200):116-132 (1982).

No abstract.

AO-055-83
RONA, P. A. Exploration for hydrothermal mineral deposits at seafloor spreading centers. Marine Mining 4:7-38 (1983).

No abstract.

AO-056-83
RONA, P. A. Hydrothermal processes at seafloor spreading centers: Report on a NATO Advanced Research Institute. EOS, Transactions of the American Geophysical Union 63:770-771 (1982).

No abstract.

AO-057-83
RONA, P. A. Hydrothermal processes considered. Geotimes 27(12):22-23 (1982).

No abstract.

AO-058-83
RONA, P. A. Polymetallic sulfides at seafloor spreading centers: A global overview. Marine Technology Society Journal 16(3):81-86 (1982).

No abstract.

AO-059-83
RONA, P. A. Review, "Geology of the northwest African continental margin," edited by U. von Rad, K. Hinz, M. Sarnthein, and E. Seibold, Episodes, IUGS 1983(1):46-47 (1983).

No abstract.

AO-060-83
RONA, P. A. Review, "Minerals from the marine environment," by P. Kent. American Scientist 70:416 (1982).

No abstract.

AO-061-83
RONA, P. A. Review, "Minerals from the marine environment," by P. Kent. Marine Mining, 3 (1982).

No abstract.

AO-062-83
RONA, P. A. Review, "The oceanic lithosphere," by C. Emiliani. American Association of Petroleum Geologists Bulletin 66:2698 (1982).

No abstract.

AO-063-83
RONA, P. A. Review, "Underwater minerals," by D. R. Cronan. Journal of Sedimentary Petrology 52:1029 (1982).

No abstract.

AO-064-83
RONA, P. A., K. Bostrom, and D. J. Stanley. Iron-cemented sediment on lower continental slope off Cape Hatteras. Geo-Marine Letters 2:89-94 (1982).

The textural, mineralogical, compositional and paleontological characteristics of an iron-cemented allochthonous sediment slab recovered from a zone of slumping between water depths of 2,100 and 2,350 m on the lower continental slope off Cape Hatteras are summarized. Results support interpretation of the sediment slab as the oxidized equivalent of pyrite-cemented Pleistocene to Recent sediment, an uncommon form of lithification in deep sea sediments. We propose that exposure of such slumped sediment slabs to seawater has produced an alteration sequence from pyrite-cement to iron oxide-cement. These observations extend the range of pyrite-cemented sediment initially reported from the water depths between 4,770 and 4,950 m on the lower continental rise off Cape Hatteras.

AO-065-83
Shearme, S., D. S. Cronan, and P. A. RONA. Geochemistry of sediments from the TAG Hydrothermal Field, M.A.R. at latitude 26°N. Marine Geology 51:269-291 (1983).

Sediments from the TAG Hydrothermal Field show evidence of hydrothermal inputs in the form of Fe, Cu, Zn and Mn enrichments. The Fe, Cu and Zn are thought to have been introduced as finely divided sulphides precipitated from suspension after dispersion away from now inactive hydrothermal vents and have since been oxidized. By contrast, the manganese is believed to be in the form of primary oxide precipitate. The processes of metal enrichment have been variably active during discrete intervals in the past. Geochemical partition analysis has demonstrated that the elements determined can be distributed differently between various phases in the different types of sediments studied, and that diagenetic transfer of elements from one phase to another occurs on burial. The general lack of metal enrichments in the sediments of

the intensity sometimes found on the East Pacific Rise is thought to be largely the result of major metal pecipitation subsurface.

AO-066-83

Sunda, W. G., S. A. Huntsman, and G. R. HARVEY. Photoreduction of manganese oxides in seawater and its geochemical and biological implications. Nature 301:234-236 (1983).

Manganese is an essential micronutrient for all organisms. Its requirement by plants is particularly high because of its role in the oxidation of water in photosynthesis. According to the thermodynamic considerations, manganese should exist in oxic waters as MnO_2 which is insoluble and, therefore, not directly available for plant nutrition. In contrast to thermodynamic predictions, however, most of the manganese in near surface seawater exists as soluble reduced Mn(II). Although slow oxidation kinetics are at least partially responsible for the presence of Mn(II) in oxic waters, reduced manganese, nevertheless, should be converted to particulate manganese oxides (at rates that depend on several kinetic factors) and be lost from the water column by sinking. We report here experiments that demonstrate photoreduction of manganese oxides by dissolved organic substances (humic substances) in seawater. Such reactions appear to be important in maintaining manganese in a dissolved reduced form in photic waters, thereby enhancing its supply to phytoplankton.

AO-067-83

Swallow, J. C., R. L. MOLINARI, J. G. Bruce, O. B. Brown, and R. H. Evans. Development of near-surface flow pattern and water mass distribution in the Somali Basin, in response to the southwest monsoon of 1979. Journal of Physical Oceanography 13(8): (1983).

No abstract.

AO-068-83

Thompson, J. D., G. H. Born, and G. A. MAUL. Collinear-track altimetry in the Gulf of Mexico from SEASAT: Measurements, models, and surface truth. Journal of Geophysical Research 88(C3):1625-1636 (1983).

From September 17 to October 10, 1978, SEASAT made collinear passes over the Gulf of Mexico. Altimeter data for eight three-day repeat passes over the eastern Gulf were examined by using an arc segment fitting technique to determine the mesoscale temporal variability of the sea surface. The pattern of sea height variability was then compared with sea height data generated by a numerical model of the Gulf (Hurlburt and Thompson, 1980) from the simulation of a complex cycle of Loop Current intrusion and shedding of an anticyclonic eddy. The model data was found to match that from the SEASAT altimeter when an anticyclonic eddy separated from the Loop Current and the Loop began to repenetrate in to the eastern Gulf. Analysis of sparse ground truth data from ship of opportunity XBT's, satellite infrared imagery of the Loop Current boundary, and synthetic aperture radar (SAR) imagery, also from SEASAT, tend to confirm the circulation patterns deduced from the altimeter data and the numerical model.

AO-069-83

Vukovich, F. M., and G. A. MAUL. An observation of the surface circulation in a Gulf Stream frontal perturbation. Geophysical Research Letters 10(7):591-594 (1983).

In the period of 3-16 June 1979, a satellite-tracked, free-drifting buoy passed through a Gulf Stream frontal perturbation and was entrained into a warm filament on the shoreward side of the perturbation. Significant speed convergence was noted as the buoy passed through the perturbation and approached the counterclockwise turn into the warm filament. In the warm filament, the buoy drifted to the southwest at speeds of about 0.1 to 0.3 m/sec. Eventually, the buoy drifted out of the filament and went westward in an apparent response to wind-induced surface drift.

AO-070-83

WALTER, D. J., and J. R. PRONI. Acoustic remote sensing in the marine environment. In Manual of Remote Sensing, second edition, American Society of Photogrammetry 2:1403-1412 (1983).

No abstract.

AO-071-83

WILLIS, P. T., J. Hallet, and J. Jordan. The development of precipitation near the top of a maritime convective cloud. Preprints, Conference on Cloud Physics, November 25-27, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 211-214 (1982).

No abstract.

AO-072-83

WILLOUGHBY, H. E., H. L. Jin, S. LORD, and J. PIOTROWICZ. A nonhydrostatic, axisymmetric model of hurricane dynamics with explicit convection and ice microphysics. Preprints, 6th Conference on Numerical Weather Prediction, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, Massachusetts, 275-281 (1983).

No abstract.

AO-073-83

WORTHEM, S., F. OSTAPOFF, and E. Mollo-Christensen. Formation of layers by instability and wave-induced fluxes in the equatorial ocean. Preprints, 4th Conference on Atmospheric and Oceanic Waves and Stability, March 22-25, 1983, Boston, Massachusetts, American Meteorological Society, 43 (1983).

Data obtained with a dual sensor probe and other instruments in the equatorial Pacific show layer structures, thermostads, velocity jets and various fine scale features. The processes contributing to the formation and maintenance of these features are discussed in the light of recent analysis of thermohaline stability, wave induced flux processes and likely turbulent structure of the equatorial current system. The approximately hourly profiles

show evidence of a semidiurnal internal tidal signal with a node in the Equatorial Undercurrent core. The structure of the layering appears to be related to the tidal cycle.

AO-074-83

WORTHEM, S., E. Mollo-Christensen, and F. OSTAPOFF. Effects of rotation and shear on doubly diffusive instability. Journal of Fluid Mechanics 133:297-319 (1983).

A linear stability analysis of a doubly diffusive system, with rotation and shear, shows that overstable oscillations can occur in stratifications typical of the equatorial ocean, that internal waves encountering an equatorial current can exchange energy with the current, and that the wave-induced fluxes of salt and heat can lead to larger formation in the salinity, temperature and velocity fields.

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