OCS Study
MMS 94-0030

Texas-Louisiana Shelf Circulation and Transport Processes Study: Year 1, Annual Report

Volume II: Technical Report

MMS
U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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Volume II: Technical Report

Editors

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PREFACE

"In the space of one hundred and seventy-six years the Lower Mississippi has shortened itself two hundred and forty-two miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oölitic Silurian Period, just a million years ago next November, the Lower Mississippi River was upward of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing rod. And by the same token any person can see that seven hundred and forty-two years from now the Lower Mississippi will be only a mile and three-quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen.

There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

Mark Twain, 1874, *Life on the Mississippi*

The Mighty Mississippi that so inspired Twain to scientific musings discharges more fresh water into the ocean than any other river of the United States. This water mixes with waters on the continental shelf of Louisiana and Texas, where it influences the ocean circulation and the ecology of the area of the nation's most intense offshore oil and gas operations.

The Minerals Management Service (MMS) of the U.S. Department of the Interior is responsible for managing the nation's Outer Continental Shelf (OCS) Leasing Program, which includes oil and gas leases in the federal waters of the Texas-Louisiana continental shelf. To meet this responsibility, MMS seeks to understand the physical processes and the circulation of the shelf waters that may influence the stability of structures, the transport of pollutants, and the ecosystem of regions that may be impacted by oil and gas operations. Additionally, MMS seeks knowledge of the circulation on the shelf to support its Oil Spill Risk Analysis models.

In May 1988, the MMS sponsored a symposium in Galveston, Texas, on the physical oceanography of the Texas-Louisiana shelf. The attending physical oceanographers, meteorologists, and ecologists discussed the state of knowledge of the environment of the Texas-Louisiana shelf and provided recommendations to MMS on possible components of a long-term study of shelf circulation covering the region from the mouth of the Mississippi River to approximately 24°N along the Mexican coast. This symposium is summarized in Mitchell (1988). The resulting MMS-sponsored program is the Louisiana-Texas Shelf Physical Oceanography Program (LATEX).

LATEX is divided into three study units: Study Unit A, Texas-Louisiana Shelf Circulation and Transport Processes (LATEX A or LATEX Shelf), conducted by the Texas A&M University System; Study Unit B, Mississippi River Plume Hydrography (LATEX B or LATEX Plume), conducted by Louisiana State University; and Study Unit C, Gulf of Mexico Eddy Circulation (LATEX C or LATEX Eddy), conducted by Science Applications International Corporation. LATEX A is the largest of the three studies and covers the middle and outer Texas-Louisiana continental shelf from the Mississippi River to the Rio Grande.

This report focuses on the work of LATEX A from contract award in September 1991 through the end of the first field year, which extended from April 1992 through March 1993. It discusses the data that have been collected, how they were collected, processed for quality control, and archived, and what preliminary results have been obtained. The report will be updated after completion of each of the final two field years through second and third annual reports. There will be no detailed analysis or synthesis of the data in the first or second annual reports; the grand synthesis will be presented in the third and final annual report.

The substantial investment of the Minerals Management Service in the LATEX Program will produce fascinating science, rather than conjecture, about the ocean most influenced by the Mighty Mississippi of Mr. Twain.

ABSTRACT

The Louisiana-Texas Shelf Physical Oceanography Program (LATEX) is supported by the Minerals Management Service of the U. S. Department of the Interior. The Texas A&M University System is conducting Study Unit A of LATEX, the Texas-Louisiana Shelf Circulation and Transport Processes Study (LATEX A). The first field year of LATEX A was conducted from April 1992 through March 1993. Data were collected from an array of current meter moorings, bottom wave recorders, meteorological buoys, drifting buoys, and hydrographic and acoustic Doppler current profiler (ADCP) surveys deployed on the Texas-Louisiana continental shelf in the Gulf of Mexico. Historical and concurrent data from other programs in this region also were collected.

The current meter array consisted of 75 current meters measuring current speed and direction, temperature, and conductivity on 31 moorings; five directional wave gauges measuring current speed and direction, temperature, and pressure; and two inverted echo sounders measuring acoustic travel time and bottom temperature and pressure. Eight meteorological buoys were installed on the shelf to measure wind speed and direction, air and sea surface temperature, and barometric pressure. Nine drifting buoys were deployed and provided information on their locations and sea surface temperature via satellite. Four hydrographic/ADCP surveys were conducted with over 100 hydrographic sampling stations per survey and continuous ADCP measurements along the cruise track. At each hydrographic sampling station continuous profiles were made of conductivity, temperature, dissolved oxygen, downwelling irradiance, particle scattering, fluorescence, and beam attenuation. Up to 12 water samples were taken at each station and analyzed for six nutrients: nitrate, nitrite, phosphate, silicate, urea, and ammonium. At 40 or more stations, the water samples were analyzed for dissolved oxygen, salinity, phytoplankton pigments, and surface and bottom particulate matter concentrations. Secchi disk depths were taken at each daylight station. Meteorological measurements were transmitted via the Global Telecommunications System four times a day. The instrumentation as well as the calibration and sampling procedures are described in this report.

The collected data were subjected to quality control/assurance procedures as described or referenced in this report. They then were archived with the LATEX A Data Management Office and are regularly transmitted to the National Oceanographic Data Center (NODC). It should be noted that all LATEX data are still considered preliminary. Only after the field program is completed and final synthesis is well along will final data sets be submitted to the NODC. LATEX A initiated data sharing agreements with ten other programs and principals during the first field year.

Information regarding LATEX has been disseminated in various ways. To the GULF.MEX bulletin board on the electronic mail service ScienceNet of Omnet are posted cruise plans and reports, meeting announcements, weekly drifter trajectories and meteorological summaries, and the LATEX calendar. The Defense Mapping Agency, U.S. Navy Submarine Command, and the United States Coast Guard are regularly advised regarding LATEX A mooring positions and deployments. Notices of LATEX moorings have been distributed to Gulf Coast Commercial fishermen. Two meetings on the oceanography of the LATEX region have been organized. Both were well attended by representatives from LATEX A, B, and C, state and federal agencies, other concurrent research programs, and the LATEX Science Advisory Panel. Results of the panel deliberations are summarized in this report. The LATEX *Fortnightly* was published bi-weekly beginning 11 May 1992. This single sheet, two-sided newsletter is mailed to approximately 2700 addressees, giving them news and announcements regarding the

LATEX program. LATEX A scientists presented talks or papers in a variety of forms during the period covered by this report.

Assembly is underway of collateral data, consisting of information from pertinent historical reports of physical oceanographic work in the Gulf of Mexico and from other programs collecting physical oceanographic data during the LATEX field years, that might be of assistance in the interpretation/synthesis of the LATEX data. Concurrent and historical data have been compiled from seventeen sources; some of these, e.g., NODC, constitute very large data sources. Historical information compiled also includes climatologies of temperature, salinity, surface waves, tides and tidal currents. Model results have been gathered from models on general circulation, storm surges, and tides.

Texas A&M and NODC records were searched for cruises obtaining hydrographic data over the Texas-Louisiana shelf. Base maps showing station locations were prepared, and an assessment was made of cruises covering a significant portion of the shelf or constituting part of a series of repeat cruises useful in study of variability. Over 60 potentially useful cruises were identified. The preparation of standard products from these cruises is underway with the objectives of compositing the data for a meaningful average picture and of assessing interannual variability. Examples of circulation fields, based on geopotential anomaly distributions, from such cruises are presented.

Many graphical products have been produced to aid in the quality control/assurance and in initial interpretation of the LATEX data sets. For time series collected (i.e., from meteorological buoys and moored current meters) a series of standard products for the first field year were produced and are included in the microfiche appendix; these include monthly time series plots, current roses, and statistics. Representative samples are presented and discussed including examples of effects of inertial oscillations, hurricanes, atmospheric cyclones, and ring-shelf interaction. Plots are presented of trajectories for all drifters deployed during the first field year by LATEX A and results discussed. Also shown are representative plots of smoothed directional wave spectra (a case recorded during the passage of Hurricane Andrew); geopotential anomaly and surface salinity distributions from the first four LATEX hydrographic cruises; vertical sections of measured hydrographic properties; property distributions on isopycnal surfaces; and acoustic Doppler currents as measured at one level.

Preliminary results from study of the LATEX A and historical data indicate that the Cochrane and Kelly (1986) seasonal circulation schema is generally supported. An initial study of meteorological data shows that eight winter cyclones were generated over the Texas-Louisiana shelf during the winter of November 1992 through May 1993, including the March 1993 "Storm of the Century"—a class four cyclone. Indications are given of analyses in progress leading toward a timely synthesis.

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ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
ADS	Automated Delivery Service
ARGOS	Service ARGOS
ASCII	American Standard Code for Information Interchange
AXBT	air-deployed expendable bathythermograph probe
BURL1	C-MAN station at Southwest Pass, LA
C-MAN	Coastal-Marine Automated Network
CTD	conductivity-temperature-depth
DAS	data acquisition system
DMT	digital magnetic tape
DSI	Defense Systems, Inc.
EHI	Evans-Hamilton, Inc.
EPROM	Erasable/Programmable/Read-Only Memory
FTU	Formazin Turbidity Units
GDIL1	C-MAN station at Grand Isle, LA
GERG	Geochemical and Environmental Research Group
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GTS	Global Telecommunications System
HPLC	high performance liquid chromatography
ICS	ICSensors
IES	inverted echo sounder
LATEX	Louisiana-Texas Shelf Physical Oceanography Program
LATEX A	Texas-Louisiana Shelf Circulation and Transport Processes Study of LATEX (also LATEX Shelf)
LATEX B	Mississippi River Plume Hydrography Study of LATEX (also LATEX Plume)
LATEX C	Gulf of Mexico Eddy Circulation Study of LATEX (also LATEX Eddy)
LORAN C	Long Range Navigation, version C
LSU	Louisiana State University
MMA	Maine Maritime Academy
MMS	Minerals Management Service
M/V	motor vessel
NDBC	National Data Buoy Center
NESDIS	National Environmental Satellite, Data, and Information Service
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NRCC	Northwest Regional Calibration Center
NRL	Naval Research Laboratory
NWS	National Weather Service
OBS	optical backscatter sensor
OCS	outer continental shelf
PAR	photosynthetically available radiation
PBAC	particle beam attenuation coefficient
PTAT2	C-MAN station at Port Aransas, TX
QA	quality assurance
QC	quality control
RCM	recording current meter
RDI	RD Instruments, Inc.

ROV	remotely operated vehicle
R/V	research vessel
SAIC	Science Applications International Corporation
SAP	LATEX Science Advisory Panel
SAS	statistical analysis system
SBE	Sea-Bird Electronics
SEAS	Shipboard Environmental data Acquisition System
SIO	Scripps Institute of Oceanography
SOOP	Ship of Opportunity Program
SPM	suspended particulate matter
SRST2	C-MAN station at Sabine, TX
SSM	solid state memory
STP	salinity, temperature, and pressure
TAMU	Texas A&M University
TIGER	Texas Institutions Gulf Ecosystems Research
USCG	United States Coast Guard
USGS	United States Geological Survey
UTC	Universal Coordinated Time
VACM	Vector-Averaging Current Meter
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
XBT	expendable bathythermograph probe
XSV	expendable sound velocity probe

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Worth D. Nowlin, Jr.	TAMU	Program Management, Tasks A-2 and A-8
Ann E. Jochens	TAMU	Program Management, Task A-8
Norman L. Guinasso, Jr.	TAMU	Data Management, Task A-5, A-7, A-10, A-11
Robert C. Hamilton	EHI	Tasks A-1, A-4, and A-12
Denis A. Wiesenburg	TAMU	Task A-3
Douglas C. Biggs	TAMU	Task A-4
S. A. Hsu	LSU	Task A-6
Robert O. Reid	TAMU	Task A-9

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Ann E. Jochens
Worth D. Nowlin, Jr.

1 INTRODUCTION

1.1 LATEX Overview

The Minerals Management Service (MMS) of the U.S. Department of the Interior supports the Louisiana-Texas Shelf Physical Oceanography Program (LATEX). LATEX is divided into three study units. These are: Study Unit A, Texas-Louisiana Shelf Circulation and Transport Processes (LATEX A or LATEX Shelf); Study Unit B, Mississippi River Plume Hydrography (LATEX B or LATEX Plume); and Study Unit C, Gulf of Mexico Eddy Circulation (LATEX C or LATEX Eddy). LATEX A is the largest of the three studies and covers the middle and outer Texas-Louisiana continental shelf from the Mississippi River to the Rio Grande. This report focuses on the work of LATEX A from contract award in September 1991 through the end of the first field year, which was from April 1992 through March 1993.

The contract for LATEX A was awarded to the Texas A&M Research Foundation on 30 September 1991. The Texas A&M University System, a combination of Texas institutions of higher learning and Texas state agencies dedicated to training, research, and extension, conducts the LATEX A Program. In addition to support from the MMS, financial backing for LATEX A is provided by the Texas Institute of Oceanography, the Texas Engineering Experiment Station, and Texas A&M University (TAMU), all components of the System. The System is assisted in this program by subcontracts with Evans-Hamilton, Inc. (EHI), Louisiana State University (LSU), and Maine Maritime Academy (MMA).

1.2 Program Objectives

In its original Request For Proposal (RFP) the MMS outlined four objectives for the LATEX A study:

1. To identify key dynamical processes governing circulation, transport, and cross-shelf mixing on the Texas-Louisiana shelf.

2. To upgrade existing empirical evidence on the same processes, fill in gaps in the evidence, synthesize the evidence into a scheme of circulation, and quantify transports and mixing rates.

3. To develop conceptual models of small- to large-scale processes and circulation features, from coastal plumes and fronts to shelf-edge eddy exchange, and large-scale shelf circulation, all on event- to seasonal scales.

4. To provide important physical and chemical information needed for synthesis with biological data into a broader ecological characterization of the region.

MMS modified this RFP to eliminate a coastal front array for the high resolution study of the coastal boundary layer and a dense array for study of the interactions between eddies and shelf circulation at high resolution. Elimination of these arrays reduced the range of scales of phenomena that could be studied in LATEX A to those with larger scales.

These objectives, as modified implicitly, will be met through the completion of a three-year field program of observations over the Texas-Louisiana continental shelf and the accomplishment of a series of 12 tasks, which are discussed in section 1.3. The

observations will be synthesized, interpreted, and reported to provide a better understanding of the circulation and transports of properties over the shelf. This first annual report summarizes the progress that has been made on each of these tasks through 31 March 1993.

1.3 Program Tasks and Participants

Program management is provided through the Program Management Office, under the direction of Dr. Worth D. Nowlin, Jr., Program Manager, and Dr. Ann E. Jochens, Deputy Program Manager. Data management is provided through the Data Management Office, under the direction of Dr. Norman L. Guinasso, Jr., Data Manager. Each task has a Principal Investigator who is responsible to the Program Manager for successful completion of that task.

Mr. Robert C. Hamilton of EHI is the Principal Investigator of Task A-1, Current Measurement Moorings. This task consists of the deployment of 33 moorings with current meters, wave gauges, meteorological buoys, and inverted echo sounders. Initially, the plan called for maintenance cruises on 45-day intervals. Modifications to this plan are discussed in section 1.4.1. These moorings provide a shelf-wide network of current, temperature, and salinity time series with which to identify, characterize, and parameterize circulation processes. The moored array initially consisted of a boundary array along the shelf edge, cross-shelf arrays for study of along-shelf transports, a wild card array located in the southwestern portion of the study area to study the onshore migration of rings and small-scale phenomena, and two deep-water inverted echo sounders to monitor the westward passage of rings into the Texas-Louisiana shelf region.

Dr. Worth D. Nowlin, Jr., of TAMU is the Principal Investigator of Task A-2, ARGOS-Tracked Drifting Buoys. The initial plan for this task was to deploy four satellite-tracked drifting buoys in each of four seasons during field year one. Drifter tracks and sea surface temperature were monitored through Service ARGOS. Changes to this plan are discussed in section 2.3.

Dr. Denis A. Wiesenburg of TAMU is the Principal Investigator of Task A-3, Standard Grid Hydrography. The original LATEX A hydrographic sampling strategy consisted of 13 surveys of the Texas-Louisiana shelf over three years. One survey was to be conducted in each calendar season: spring, summer, fall, and winter. Each survey was to cover only one half of the shelf, with the eastern half covered in year one, the middle two quadrants in year two, and the western half in year three. The basic elements of this plan were completed for the first field year, but changes were made to the plan for years two and three (see section 1.4.2). The hydrographic/acoustic Doppler current profiler (ADCP) survey work was planned to characterize the seasonal patterns of circulation and water mass characteristics and to allow initial assessment of interannual variability.

Mr. Robert C. Hamilton of EHI was the Principal Investigator for the first three surveys conducted under Task A-4, Acoustic Doppler Current Surveys, and Dr. Douglas C. Biggs of TAMU is the Principal Investigator for the remaining Task A-4 surveys. During all hydrographic surveys, Task A-4 personnel collect ADCP measurements along the survey tracks.

Dr. S.A. Hsu of LSU is the Principal Investigator for Task A-6, Winter Northers/Cyclogenesis. This task consists of the deployment and maintenance of four

meteorological buoys during the winter season and the study of cyclogenesis resulting from cold air outbreaks.

Several tasks are the responsibility of the Data Management Office. Dr. Norman L. Guinasso, Jr., of TAMU is the Principal Investigator for these tasks. Task A-5, Collateral Data, consists of the assembly of data from concurrent programs in the LATEX region and from historical sources. Task A-7, Data Quality Control, processes all LATEX A data for quality control. Task A-10, Information Transfer, maintains the GULF.MEX electronic bulletin board on Omnet and posts LATEX A information to it. Under Task A-11, Public Notification, Cooperation, and Data Dissemination, the *LATEX Fortnightly* newsletter is published and information on LATEX A is provided to federal agencies and the public.

Dr. Worth D. Nowlin, Jr., and Dr. Ann E. Jochens are the Co-Principal Investigators of Task A-8, Analyses and Reports. Under this task, the scientific analyses and syntheses of the data are performed and the annual reports to MMS are prepared and finalized.

Professor Robert O. Reid of TAMU is the Principal Investigator for Task A-9, Field Measurements/Model Comparisons. Under this task, comparisons of observational data and model results are performed and the LATEX Science Advisory Panel is supported.

Mr. Robert C. Hamilton of EHI is the Principal Investigator of Task A-12, Government Furnished Equipment/Capital Equipment. At the conclusion of the field program, the Government Furnished Equipment will be refurbished and returned to MMS by the personnel under this task. Because this task does not commence until the end of the field program, this report will not include any further information regarding this task.

1.4 Programmatic Changes

1.4.1 Moored Measurements

In the fall of 1992, the U. S. Coast Guard (USCG) required TAMU to add surface marker buoys to all moorings having equipment within 60.96 m (200 ft) of the sea surface and not located within 30.48 m (100 ft) of a platform. Fourteen moorings (4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 45, 47, 48, and 49) were affected. It was estimated that each surface marker buoy would require replacement twice over the remaining two and a half years of the field program. No additional funding was available from the MMS to cover the substantial, new costs of deploying and maintaining surface marker buoys at each of these moorings.

To obtain the funding necessary to deploy the required surface marker buoys, programmatic changes were made to LATEX A and approved by MMS. First, the total number of general LATEX and Science Advisory Panel meetings under Program Management and Task A-9 was reduced to one per year. Second, the 45-day interval for mooring maintenance was changed to a schedule of approximately 60 days beginning with the January 1993 mooring cruise. Third, because of the distance of moorings 1 and 2 from other 60-day moorings, these moorings were placed on a 120-day rotation, rather than a 60-day rotation.

To accommodate these changes to the mooring maintenance schedule, the meteorological buoys were re-programmed to allow internal recording for over 60 days. This required that the transmission of the InterOcean S4 current meter data through the meteorological

buoys to Service ARGOS be disabled, with S4 data being collected internally only. To prevent marine biofouling during the spring and summer months, provision was made to allow maintenance, as necessary, of the S4 current meters at moorings 17 and 20 every other month when the regular current mooring cruise was not being conducted.

During the course of the program, numerous instruments were lost due to fishing pressure, hurricanes, and operational problems (see section 2.2.1). The wild card array, consisting of moorings 44, 45, 46, 47, 48, and 49, was designated, with the approval of MMS, to provide a source of spare instruments to keep the main array intact. Moorings 44, 45, 46, and 47 were removed during the first year and the instruments were used as spares. Mooring 48, however, was part of the shelf edge array and was maintained in place. Mooring 49 was the only off-shelf mooring that provided important data on eddy-slope interactions on the western side of the study area. It was maintained at its location.

All anchors in water depths less than 500 m were required to be recovered and not left on the sea floor. In the first half of the first field year, a major problem developed with the deep moorings located in water depths of 100 m or more. Failure of the acoustic releases and rope canisters required that the entire mooring with its anchor be lifted out of the water. As the moorings were being pulled, the mooring lines broke, usually above the bottom instrumentation with loss of instruments and equipment. The mooring lines had been designed to withstand being pulled with the weight of the anchors. In investigating this problem using a submersible and a remotely operated vehicle, it was learned the anchors were completely buried in the mud of the sea floor. This caused mud suction that exceeded the breaking strength of the mooring lines and resulted in breakage of the mooring lines. To alleviate this problem, permission was given by MMS to leave anchors, which were on moorings in water depths ≥ 100 m, in the mud of the sea floor, allowing a weak link to be installed just above the anchor.

The five MiniSpec directional wave gauges contained or quickly developed problems (see section 2.2.3.2). As a result, they were removed from service for a period to provide the manufacturer with the opportunity to repair the instruments. Additionally, the manufacturer did not deliver a conductivity sensor for the MiniSpecs during the first field year. In view of the other problems with the MiniSpecs and because conductivity was sampled by another instrument about 10 m above the MiniSpecs, it was decided with MMS concurrence not to add conductivity sensors to the MiniSpecs.

1.4.2 Hydrographic/ADCP Surveys

One of the recommendations made by the LATEX Science Advisory Panel at the December 1992 LATEX meeting (LATEX II) was that the hydrographic sampling strategy for LATEX A be re-evaluated and modified. Specifically, it was suggested that full shelf surveys be conducted during observed hydrographic seasons for the circulation.

The data collected in LATEX A and the climatological data from the region were evaluated. Based on this evaluation, it was concluded that the major circulation regimes on the Texas-Louisiana shelf are the wind-driven downwelling and downcoast inner-shelf flows and the wind-driven upwelling and upcoast inner-shelf flows. Thus, cruises should be made when:

1. downwelling-downcoast flow is expected to be markedly most extensive and the stratification is weak (represented by November sampling),
2. upwelling is most extensive (represented by July sampling), and

3. both regimes and a boundary between them (a coastal convergence) are most clearly marked within the region (represented by May sampling).

Further, evaluation of the hydrographic data taken on the first four cruises showed that sampling only one half the shelf at a time leaves significant unanswered questions regarding the overall shelf circulation patterns.

A new strategy for hydrographic sampling was developed, approved by the Science Advisory Panel, submitted to MMS, and approved by MMS in March 1993. Under the new strategy, the fifth half-shelf survey in year one would be combined with the first half-shelf survey in year two to make a full shelf survey conducted in late April/May 1993. Subsequently, all remaining half-shelf surveys would be replaced by four additional full shelf surveys scheduled about late July 1993, November 1993, May 1994, and late July 1994. The final cruise would be in November 1994 and would cover as much of the shelf as funding allowed. A portion of the savings from the reduction of meetings was re-programmed to enhance the hydrographic program. To enable Task A-4 to meet its budget under the new strategy, the Principal Investigator was changed from Mr. Robert C. Hamilton of EHI to Dr. Douglas C. Biggs of TAMU.

1.5 Overview of Cruise Schedule and Nomenclature

Eight mooring cruises and four hydrographic/ADCP survey cruises were conducted in the LATEX A program during the first field year. All LATEX A cruises were conducted aboard the *R/V J.W. Powell*, the R/V *Gyre*, or the *M/V Aloha*. Table 1.5.1 provides a listing of these cruises, their various designators, and their start and end dates.

The MMS identifying code is the number assigned each LATEX cruise in the LATEX Calendar that is posted to GULF.MEX. This designator is deciphered as follows

First character:	M=mooring cruise; H=hydrographic/ADCP survey
Second & third characters:	LATEX A mooring cruise number, LATEX A hydrographic/ADCP survey number
Fourth character:	C=cruise
Fifth & Sixth characters:	vessel identifier (PW = *R/V J.W. Powell*; GY = *R/V Gyre*)
Seventh & eighth characters:	year of cruise
Ninth & tenth characters:	vessel cruise number

Note for cruise 6, the MMS ID for the *R/V J.W. Powell*, although the cruise was divided into two legs, the first aboard the *M/V Aloha* (M06A) and the second aboard the *R/V J.W. Powell* (M06B).

The LATEX ID is the shorthand identifier used in this report. The Cruise ID number is the standard cruise identifier in wide use in the oceanographic community. The first two characters give the year of the cruise, the third character gives the ship identifier (P=*Powell;* G=*Gyre*), and the last two characters give the number of the ship cruise for that year.

Table 1.5.1. Cruise identifiers and dates.

Current Mooring Maintenance Cruises

Cruise	Description	MMS ID	Start Date	End Date	LATEX ID	Cruise ID
1	Initial Deployment	M01CPW9203	04/07/92	04/16/92	M01	92P03
2	I-45 Day Maintenance	M02CPW9205	05/26/92	06/04/92	M02	92P05
3	I-90 Day Maintenance	M03CPW9206	07/13/92	07/27/92	M03	92P06
4	II-45 Day Maintenance	M04CPW9208	08/28/92	09/06/92	M04	92P08
5	I-180 Day Maintenance	M05CPW9209	10/13/92	10/23/92	M05	92P09
6A	III-45 Day ROV Work	M06CPW9212	11/28/92	12/06/92	M06A	*M/V Aloha*
6B	III-45 Day Maintenance	M06CPW9212	12/08/92	12/18/92	M06B	92P12
7	Reinstallation	M07CPW9301	01/09/93	01/21/93	M07	93P01
8	I-60 Day Maintenance	M08CPW9304	03/16/93	03/24/93	M08	93P04

Hydrographic Surveys

Survey	Description	MMS ID	Start Date	End Date	LATEX ID	Cruise ID
1	Eastern Half Shelf	H01CGY9205	04/30/92	05/09/92	H01	92G05
2	Eastern Half Shelf	H02CGY9208	07/31/92	08/09/92	H02	92G08
3	Eastern Half Shelf	H03CPW9210	11/04/92	11/13/92	H03	92P10
4	Eastern Half Shelf	H04CGY9302	02/04/93	02/13/93	H04	93G02

1.6 Report Organization

This is the first annual report for LATEX A. It reports on the results of the first 12 months of field work in terms of data-gathering efforts, the measurement and analytical methodologies employed, quantity of data collected, the results of quality control exercises and determinations, the status of data archiving and data sharing with other contractors, standard computer-produced graphics, and comparisons between standard computer-produced graphics and any graphics provided from model simulations performed by a designated other contractor. There are no extensive analyses or syntheses of the information. Section 2 of the report details the data acquisition for the moored measurements, drifting buoy measurements, hydrographic and ADCP measurements, and collateral data assembly. Section 3 discusses data quality and analysis for the observations collected, including data processing efforts and data quality control methods and results. Section 4 summarizes the data archiving and information sharing through March 1993. Section 5 provides a technical discussion of the data, with samples of the data products, from the moorings, drifters, hydrographic/ADCP surveys, and cyclogenesis study. It also provides a discussion of the model/data comparison study and the Science Advisory Panel and its functions. All times are reported in Universal Coordinated Time (UTC).

2 DATA ACQUISITION

2.1 Introduction

Section 2 provides an overview of the LATEX A data acquisition activities. It includes a discussion of the data gathering efforts from the moored current meter array, meteorological buoys, drifting buoys, hydrographic/ADCP surveys, and collateral data assembly. Eight mooring maintenance cruises and four hydrographic/ADCP cruises are summarized, giving data types, data collection methods, and locations and times of data collection.

2.2 Moored Measurements

2.2.1 Mooring Maintenance Cruises

The period from contract award until early April 1992 was spent obtaining instruments and mooring equipment, calibrating instruments, and preparing for the initial deployment of the moorings. With two exceptions, all equipment was available for the initial installation of the moorings in early April 1992. The inverted echo sounders (IES) were being refurbished by Pacer Systems and were not completed in time for the April deployment. The conductivity cells for the MiniSpecs were not available from the manufacturer and were not installed.

During the first year of field operations, April 1992 through March 1993, eight mooring cruises were conducted. These included the initial installation cruise and seven maintenance cruises. The fourth cruise included use of the submersible *Johnson Sea Link* to investigate the cause of mooring loss and as an aid to mooring recovery. The sixth cruise was conducted in two parts aboard two vessels, the *R/V J.W. Powell* and the *M/V Aloha,* which provided a remotely operated vehicle (ROV) to aid in mooring recovery. The dates for these cruises are summarized in Table 1.5.1.

Maintenance work consisted of retrieval of instruments and moorings, as necessary, check-out and refurbishment of equipment, downloading of data, and redeployment of equipment. CTD casts were taken at each mooring visited to provide calibration information for temperature and conductivity sensors and for interpretation.

The field operations from April through December 1992 were conducted on a 45-, 90-, 180-, and 360-day maintenance schedule. Moorings in different water depths were maintained on different schedules as indicated in Table 2.2.1. The initial mooring configurations, including presence of temperature and conductivity sensors on each instrument, are shown in Table 2.2.1. Mooring locations are shown in Figure 2.2.1.

As a result of the programmatic changes (see section 1.4), the maintenance interval was changed in January 1993 to a 60-, 120-, 180-, and 360-day schedule, as indicated in Table 2.2.2. The mooring configurations under the rescoped work are shown in Table 2.2.2. Figure 2.2.2 shows the new locations of the moorings.

During the first year of operations, 149 instruments of various types (95 current meters, eight meteorological buoys, five wave/current meters, one wave meter, 23 releases, 15 transponders, and two IES) were used. Of these instruments, fifteen (three releases, one

Table 2.2.1. Initial mooring configurations.

Mooring No.	Water Depth (m)	Latitude (°N)	Longitude (°W)	Comments	Top	Middle	Bottom	Release	Maintenance Interval (Day)
1	21	27°15.38'	97°14.74'	Platform	174-10m T,C	NONE	Mini-19m T	NONE	45
2	37	27°17.03'	96°58.81'	Platform	174-10m T,C	NONE	174-30m T,C	397	45
3	66	27°17.38'	96°44.17'	Platform	174-10m T,C	174-30m T,C	174-61m T,C	397	90
4	201	27°07.57'	96°21.51'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
5	199	27°28.10'	96°04.40'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
6	201	27°42.51'	95°39.84'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
7	199	27°50.04'	95°04.17'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
8	201	27°49.47'	94°10.77'		174-14m T,C	Aand-100m T,C	Aand-190m T,C	397	90
9	200	27°48.50'	93°30.18'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
10	200	27°56.13'	92°44.70'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
11	200	27°50.52'	92°00.55'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	397	90
12	505	27°55.43'	90°29.68'		174-17m T,C	Aand-100m T,C	Aand-190m T,C	Benthos	180
13	200	28°03.45'	90°29.15'		174-12m T,C	Aand-100m T,C	Aand-190m T,C	Benthos	90
14	47	28°23.67'	90°29.57'	Platform	174-11m T,C	174-26m T,C	174-42m T,C	397	45
15	27	28°36.50'	90°29.49'	Platform	174-10m T,C	NONE	174-24m T,C	NONE	45
16	19	28°52.02'	90°29.45'	Platform	174-10m T,C	NONE	Mini-17m T	NONE	45
17	7	29°11.76'	91°57.89'	Platform & Met Buoy "C"=935	S4-3m T,C	NONE	Mini-5m T	NONE	45
18	22	28°57.76'	91°58.96'	Platform	174-10m T,C	NONE	174-21m T,C	NONE	45
19	51	28°27.91'	92°02.09'	Platform & Met Buoy "D"=930	S4-3m T,C	174-21m T,C	174-44m T,C	397	45
20	15	29°15.65'	94°03.82'	Platform & Met Buoy "E"=937	S4-3m T,C	NONE	Mini-13m T	NONE	45
21/51	24	28°50.24'	94°04.77'	Platform & Met Buoy "F"=934	174-10m T,C	NONE	174-21m T,C	NONE	45
22	55	28°21.29'	93°57.35'	Platform & Met Buoy "G"=931	S4-3m T,C	174-20m T,C	174-48m T,C	397	45
23	15	28°42.77'	95°32.13'	Platform	174-9m T,C	NONE	Mini-13m T	NONE	45
24	30	28°28.43'	95°26.23'	Witness Buoy "A"	174-11m T,C	NONE	174-27m T,C	NONE	45
25	45	28°09.72'	95°28.54'	Platform	174-13m T,C	174-23m T,C	174-38m T,C	397	45
42	1540	27°07.02'	92°00.00'	Deployed July 1992	NONE	NONE	IES-1540m T	Internal	360
43	3130	25°32.52'	92°00.00'	Deployed July 1992	NONE	NONE	IES-3130m T	Internal	360
44	56	27°43.53'	96°25.44'	Witness Buoy "B"	174-9m T,C	NONE	174-49m T,C	397	90
45	200	27°25.09'	96°07.59'		174-10m T,C	NONE	Aand-190m T	397	90
46	91	27°38.28'	96°14.02'	Platform	174-10m T,C	174-50m T	Aand-84m T,C	397	90
47	200	27°19.30'	96°12.77'		174-10m T,C	Aand-100m T	Aand-190m T	397	90
48	200	27°58.98'	91°17.00'		174-10m T,C	Aand-100m T	Aand-190m T	Benthos	90
49	505	27°22.15'	95°53.64'		174-10m T,C	Aand-100m T,C	Aand-495m T,C	Benthos	180
50	20	28°52.86'	95°02.20'	Platform & Met Buoy "H"=936	NONE	NONE	NONE	NONE	45
51/21	24	28°50.24'	94°04.77'	Platform & Met Buoy "F"=934	174-10m T,C	None	174-21m T,C	None	45
52	27	28°48.24'	93°01.07'	Platform & Met Buoy "I"=933	NONE	NONE	NONE	NONE	45
53	15	28°48.03'	90°57.26'	Platform & Met Buoy "J"=932	NONE	NONE	NONE	NONE	45

Met Buoy = DSI Surface Meteorological Buoy
S4 = InterOcean S4 Electromagnetic Current Meter
174 = Endeco Model 174 Current Meter

Aand = Aanderaa Model RCM 7 or 8
RCM = Aanderaa Model 4 or 5
397 = Datasonics Model 397 Acoustic Release

IES = Inverted Echo Sounder
T = Temperature Sensor
C = Conductivity Sensor

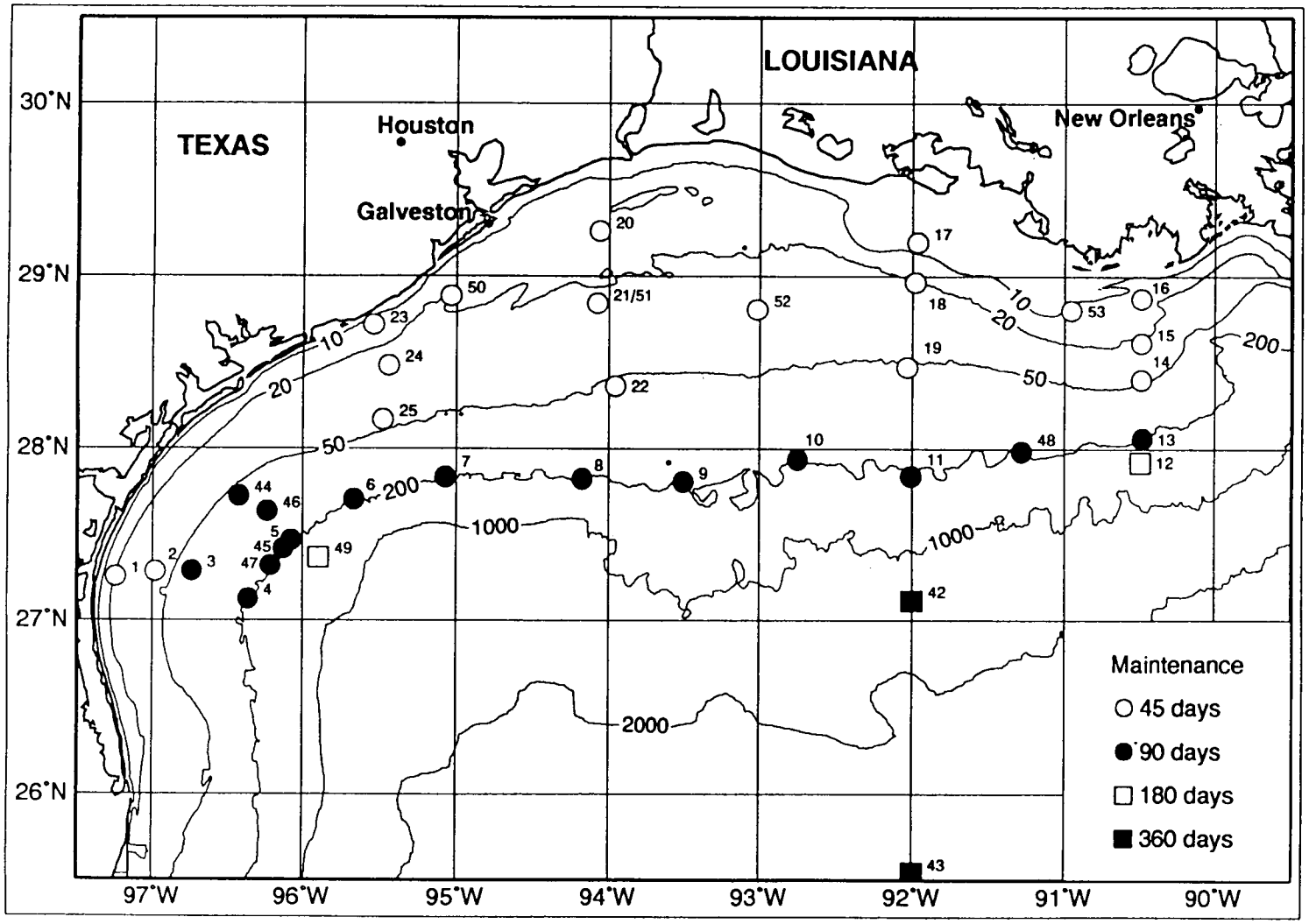

Figure 2.2.1. Initial mooring locations and maintenance intervals.

Table 2.2.2. Mooring configurations under rescoped work.

Mooring No.	Water Depth (m)	Latitude (°N)	Longitude (°W)	Comments	Top	Middle	Bottom	Release	Maintenance Interval (Day)
1	21	27°15.39'	97°14.81'	Platform	174-10m , T,C	NONE	Mini-19m, T	NONE	120
2	37	27°17.09'	96°58.81'	Platform	174-10m, T,C	NONE	174-30m, T,C	None	120
3	66	27°17.35'	96°44.18'	Platform	174-10m, T,C	174-30m, T,C	174-61m, T,C	397	120
4	201	27°07.76'	96°21.63'	Marker Buoy "L"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
5	199	27°27.82'	96°04.12'	Marker Buoy "M"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
6	201	27°42.59'	95°39.76'	Marker Buoy "N"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
7	199	27°50.12'	95°04.19'	Marker Buoy "O"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
8	200	27°49.47'	94°10.77'	Marker Buoy "P"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
9	200	27°48.92'	93°31.91'	Marker Buoy "Q"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
10	200	27°56.07'	92°44.70'	Marker Buoy "R"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	397	120
11	200	27°50.64'	92°00.45'	Marker Buoy "S"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	Benthos	120
12	505	27°55.76'	90°29.64'	Marker Buoy "T"	174-14m, T,C	Aand-100m, T,C	RCM-495m, T,C	Benthos	180
13	200	28°03.48'	90°29.18'	Marker Buoy "U"	174-14m, T,C	Aand-100m, T,C	Aand-190m, T,C	Benthos	120
14	47	28°23.74'	90°29.65'	Platform	174-14m, T,C	174-26m, T,C	174-42m, T,C	None	60
15	27	28°36.49'	90°29.53'	Platform	174-10m, T,C	NONE	174-24m, T,C	NONE	60
16	19	28°51.96'	90°29.50'	Platform	174-10m, T,C	NONE	Mini-17m, T	NONE	60
17	7	29°11.82'	91°57.89'	Platform & Met Buoy "C"=937	S4-3m, T,C	NONE	Mini-5m, T	NONE	60
18	22	28°57.74'	91°59.01'	Platform	174-10m, T,C	NONE	174-21m, T,C	NONE	60
19	51	28°27.92'	92°02.06'	Platform & Met Buoy "D"=930	S4-3m, T,C	174-21m, T,C	174-44m, T,C	397	60
20	15	29°15.67'	94°03.82'	Platform & Met Buoy "E"=931	S4-3m, T,C	NONE	Mini-13m, T	NONE	60
21/51	24	28°50.28'	94°04.79'	Platform & Met Buoy "F"=934	174-10m, T,C	NONE	174-21m, T,C	NONE	60
22	55	28°21.39'	93°57.34'	Platform & Met Buoy "G"=932	S4-3m, T,C	174-20m, T,C	174-48m, T,C	397	60
23	15	28°42.77'	95°32.13'	Platform	174-9m, T,C	NONE	Mini-13m, T	NONE	60
24	30	28°32.21'	95°23.61'	Platform	174-11m, T,C	NONE	174-27m, T,C	NONE	60
25	45	28°19.33'	95°21.57'	Platform	174-13m, T,C	174-23m, T,C	174-38m, T,C	None	60
42	1540	27°07.00'	92°00.00'	At Sea Floor	NONE	NONE	IES-1540m, T	Internal	360
43	3130	25°32.52'	92°00.00'	At Sea Floor	NONE	NONE	IES-3130m, T	Internal	360
44	56			Permanently Removed					
45	200			Permanently Removed					
46	91			Permanently Removed					
47	200	27°19.61'	96°12.89'	Marker Buoy "Y" Removed March 1993	NONE	Aand-100m, T	Aand-190m, T	397	120
48	200	27°58.98'	91°16.99'	Marker Buoy "T"	174-14m, T,C	Aand-100m, T	Aand-190m, T	Benthos	120
49	505	27°23.13'	95°53.96'	Marker Buoy "W"	174-14m, T,C	Aand-100m, T,C	Aand-495m, T,C	Benthos	180
50	20	28°52.86'	95°02.20'	Platform & Met Buoy "H"=936	NONE	NONE	NONE	NONE	60
51/21	24	28°50.28'	94°04.79'	Platform & Met Buooy "F"=934	174-10m, T,C	NONE	174-21m, T,C	NONE	60
52	27	28°48.18'	93°01.11'	Platform & Met Buoy "I"=933	NONE	NONE	NONE	NONE	60
53	15	28°48.04'	90°57.22'	Platform & Met Buoy "J"=935	NONE	NONE	NONE	NONE	60

Met Buoy = DSI Surface Meteorological Buoy
S4 = InterOcean S4 Electromagnetic Current Meter
174 = Endeco Model174 Current Meter

Aand = Aanderaa Models RCM 7 or 8
RCM = Aanderaa Models 4 or 5
397 = Datasonics Model 397 Acoustic Release

IES = Inverted Echo Sounder
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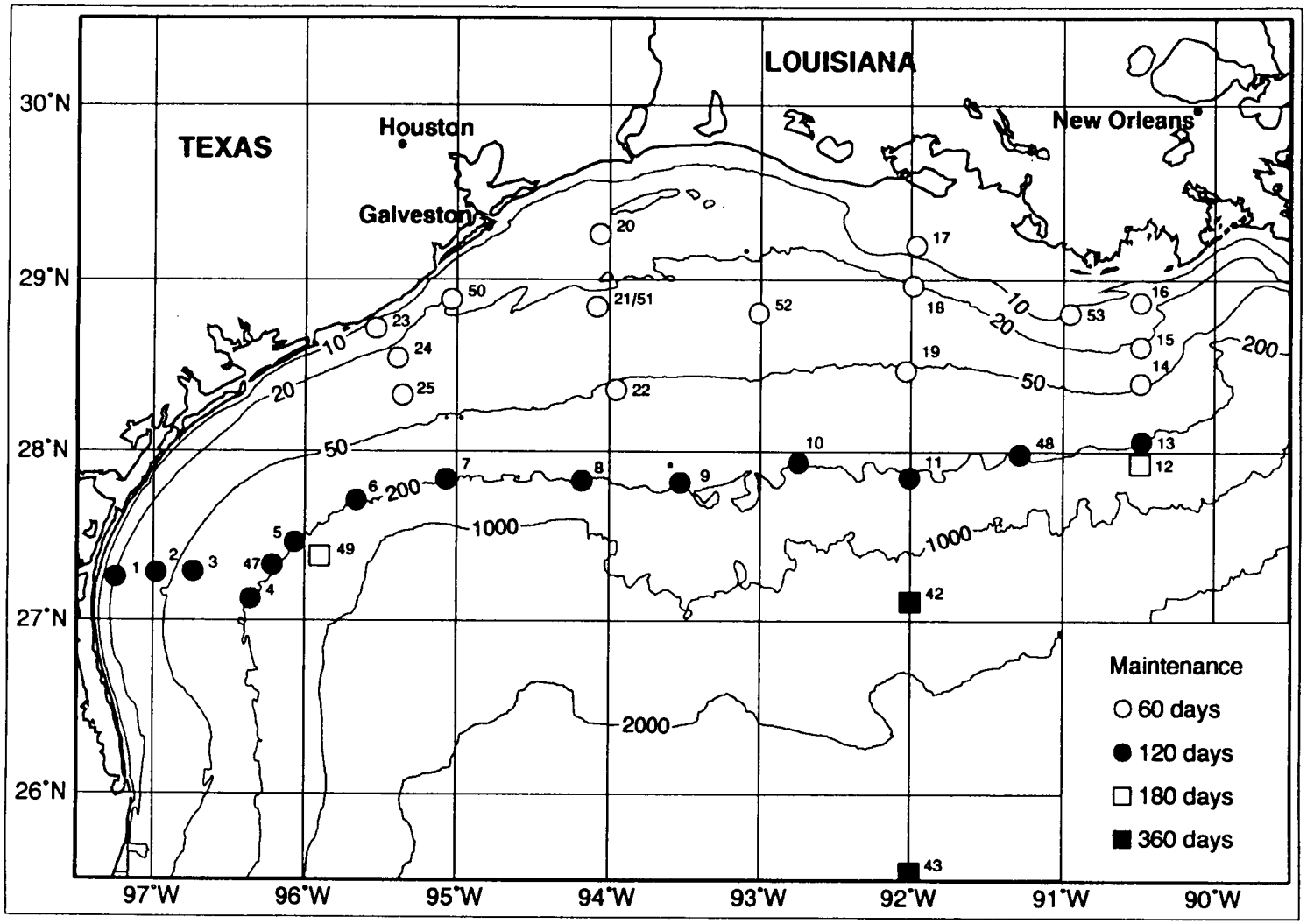


Figure 2.2.2. Mooring locations and maintenance intervals under re-programmed work.

transponder, and 11 current meters) were lost permanently due to fishing activity, Hurricane Andrew, and mooring difficulties such as mud suction on the anchors (see section 1.4.1).

The following is a summary of the major events of the eight current meter cruises made during the initial year of field operations. All cruises on the *R/V J.W. Powell* departed from and returned to Galveston, Texas. Table 2.2.3 lists the stations visited during each cruise.

2.2.1.1 Cruise M01CPW9203

The initial installation cruise (M01) was performed aboard the *R/V J.W. Powell* during the period from 7 - 16 April 1993. In an effort to protect the moorings and associated equipment, all moorings in water depths less than 100 m were placed within 30.48 m (100 ft) of an existing platform or included installation of a witness buoy adjacent to the mooring. Witness buoys were installed at moorings 24 and 46. The 124 instruments installed included 44 Endeco Model 174 current meters, 28 Aanderaa current meters, four InterOcean S4 current meters, five Coastal Leasing, Inc., MiniSpec directional wave gauges (MiniSpecs), eight Defense Systems, Inc., meteorological buoys (including the four Task A-6 buoys), 18 Datasonics ATR-397 acoustic releases, 13 Datasonics transponders, and four Benthos acoustic releases. The two IES moorings (42 and 43) were not deployed.

2.2.1.2 Cruise M02CPW9205

The first 45-day maintenance cruise (M02) occurred aboard the *R/V J.W. Powell* during 26 May - 4 June 1992. Eighteen moorings were recovered, maintained, and redeployed. During this cruise, mooring 25 was moved to a new location at 28°15.60°N 95°17.82°W because the platform near which it had been installed was being removed. A witness buoy was installed to protect it. The bottom Endeco current meter was lost during recovery of this mooring. The connecting cables between InterOcean S4 current meters (S4) and meteorological buoys at moorings 17, 19, 20, and 22 were damaged. This allowed water to penetrate the cable, short out the connections to the S4, and cause the S4 to stop operating. Modified protection for the cables was added, and the physical interface ceased to present a problem. Damaged anemometers on the meteorological buoys at moorings 20 and 22 were repaired. At mooring 19, the bottom Endeco was flooded and the internally-recorded meteorological data were not recoverable due to power loss. Attempts were made to trigger four Datasonics releases, only two being successful.

A current meter comparison experiment was conducted during this cruise, with deployments on May 27 and recoveries on June 4. Participating in this comparison were Dale Pillsbury (Oregon State University), John Robinson and coworkers (Naval Oceanographic Office), and LATEX A personnel. Eleven moorings were installed in the near vicinity of LATEX mooring 23. Twenty-five instruments were involved, including four 1200-kHz ADCPs, one 600-kHz ADCP, two expendable current meters, six acoustic current meters, one MiniSpec, two Endeco Model 174 Solid State Memory (SSM), one S4, two modified vector averaging current meters (VACM), three standard VACMs, one Aanderaa, and two Endeco Model 174 Digital Magnetic Tape (DMT) current meters modified for solid state recording. Many of these instruments were prototypes being tested; most of those failed to produce usable data. LATEX A received data from

Table 2.2.3. Mooring maintenance by cruise for first field year.

Mooring No.	M01	M02	M03	M04	M05	M06	M07	M08
1	Deploy	√	√	√	√	√	√	√
2	Deploy	√	√	√	√	√	√	√
3	Deploy		√		√	√	√	
4	Deploy		√		√	√	√	
5	Deploy		√			√	√	
6	Deploy		√			√	√	
7	Deploy		√			√	√	
8	Deploy		X		√	√	√	
9	Deploy		X	√			√	
10	Deploy		X	√			√	
11	Deploy		X	√			√	
12	Deploy				√		√	
13	Deploy		√		√		√	
14	Deploy	√	√	√	√	√	√	√
15	Deploy	√	√	√	√	√	√	√
16	Deploy	√	√	√	√	√	√	√
17	Deploy	√	√	√	√	√	√	√
18	Deploy	√	√	√	√	√	√	√
19	Deploy	√	√	√	√	√	√	√
20	Deploy	√	√	√	√	√	√	√
21	Deploy	√	√	√	√	√	√	√
22	Deploy	√	√	√	√	√	√	√
23	Deploy	√	√	√	√	√	√	√
24	Deploy	√	√	√	√	√	√	√
25	Deploy	√	√	√	√	√	√	√
42			Deploy					
43			Deploy					
44	Deploy		√		√	Remove		
45	Deploy		√		√	Remove		
46	Deploy		√		√		Remove	
47	Deploy		X		√	√	√	Remove
48	Deploy		X	√			√	
49	Deploy				√		√	
50	Deploy	√	Remove		Deploy	√	√	√
51	Deploy	√	Remove		Deploy	√	√	√
52	Deploy	√	Remove		Deploy	X	√	√
53	Deploy	√	Remove		Deploy	√	√	√

√ = Mooring Maintenance Conducted
X = Mooring visited, but left in place w/o maintenance

instruments on eight moorings, including mooring 23. Figure 2.2.3 shows in plan view the relative positions of moorings from which data were obtained.

2.2.1.3 Cruise M03CPW9206

The first 90-day maintenance cruise (M03) was conducted aboard the *R/V J.W. Powell* from 13 - 27 July 1992. Thirty-five moorings were visited. Twenty-three were recovered, maintained, and redeployed. The two IES units were installed at moorings 42 and 43. Expendable bathythermographs (XBT) were taken every 11 km (6 nautical miles) from the 200-m depth to mooring 42, and every 19 km (10 nautical miles) from mooring 42 to mooring 43. An XBT and an expendable sound velocity profiler (XSV), were taken at mooring 42. An XBT and an XSV were taken at mooring 43. The meteorological buoys at moorings 50, 51, 52, and 53 were removed from service for the duration of the hurricane season. Six 200-m moorings (8, 9, 10, 11, 47, and 48) were not maintained because other 200-m moorings tended to break on retrieval if the release failed and the anchor remained attached.

As the previous cruise had indicated problems with the Datasonics releases, two Datasonics personnel joined the cruise in an attempt to determine and correct the problems with the releases. Very little success was obtained with the Datasonics releases, and most were removed during the cruise so they could be reworked by the manufacturer. After failure of the releases, mooring recovery was attempted by pulling the mooring out. The mooring line had been designed for a load that included the anchors. During recovery, the lines or rope canisters on 8 moorings broke, with loss of the anchors. The bottom current meters at moorings 3 and 4 were not recovered in spite of attempts to drag for these instruments. The deep moorings were replaced by moorings with a lighter anchor, no release, and no rope canister. The MiniSpecs at moorings 1 and 17 failed, and were removed for return to the manufacturer. The one at mooring 1 was replaced by a Sea-Data 635-8 wave meter.

2.2.1.4 Cruise M04CPW9208

The second 45-day maintenance cruise (M04) was conducted on the *R/V J.W. Powell* from 28 August - 6 September 1992. Eighteen moorings were recovered, maintained, and redeployed. The scientists and crew of the *R/V J.W. Powell* worked in conjunction with the crew of the *R/V Edwin Link* and its submersible, *Johnson Sea Link*, to recover the 200-m moorings 9, 10, 11, and 48. Videotape from the submersible showed the anchors were completely buried in mud, making it impossible to pull the moorings out without breaking the mooring lines. It also showed that the rope canisters had failed; their rope had come loose on deployment and had tangled in the moorings. These four moorings were redeployed without rope canisters or releases and with smaller anchors.

Passage of Hurricane Andrew near the easternmost moorings resulted in loss of the Endeco at mooring 16. It was not replaced on this cruise. The MiniSpec at mooring 16 had been turned on its side by the hurricane, and was righted. Mooring 15 had been moved by Hurricane Andrew; however, it was found and recovered. One of the two MiniSpecs returned to the factory for repair after the previous cruise was installed at mooring 17. The second unit, however, did not work and was not used to replace the Sea Data 635-8.

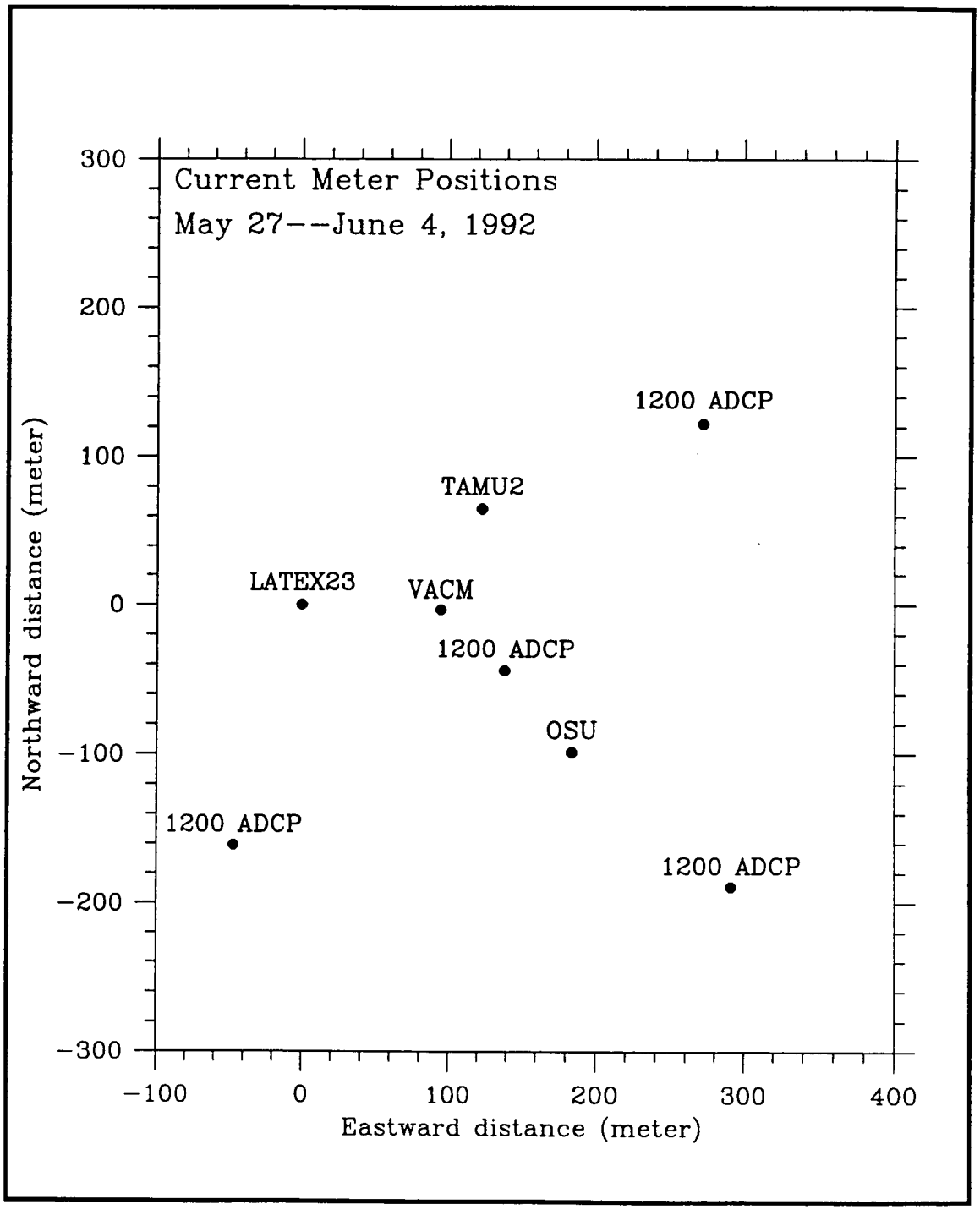


Figure 2.2.3. Plan view of the LATEX A current meter comparison experiment.

2.2.1.5 Cruise M05CPW9209

The first 180-day maintenance cruise (M05) took place on the *R/V J.W. Powell* from 13 - 23 October 1992. Twenty-eight moorings were recovered and maintained. The four meteorological buoys at moorings 50, 51, 52, and 53 were re-deployed. Mooring 16 was re-installed. Mooring 24 with two Endeco current meters was missing. A new mooring 24 was constructed and deployed immediately adjacent to the witness buoy. The middle Endeco at mooring 3 was missing. Because cables broke during attempted retrieval, portions of moorings 45 (bottom Aanderaa), and 47 (middle Endeco and bottom Aanderaa) were left in the water column. Due to the problems in recovery of the deep moorings and the potential for losing a large number of instruments, it was decided that an attempt should be made to recover a number of the moorings using an ROV during the next cruise. Therefore, maintenance of moorings 5, 6, and 7 was postponed.

2.2.1.6 Cruise M06CPW9212

The third 45-day maintenance cruise (M06) was carried out on two separate legs: the first leg, M06A, was aboard the *M/V Aloha* equipped with an ROV; the second leg, M06B, was aboard the *R/V J.W. Powell*. M06A took place from 28 November - 6 December 1992, while M06B occurred from 8-18 December 1992. Due to weather and equipment problems during M06A, the ROV visited only moorings 3, 4, 5, 6, 7, 8, 45 and 47. The moorings were not redeployed as they were to be rebuilt for deployment in January. The Aanderaa on mooring 45 had been stripped from the mooring and was not found. Although the full moorings deployed on M05 at moorings 3 and 4 were recovered, the partial moorings left from M03 were not recovered.

The second leg, M06B, maintained eighteen shallow water moorings. Moorings 24 and 44 were missing and were not redeployed due to a shortage of current meters. The three MiniSpecs at moorings 16, 17, and 20 were removed and returned to the manufacturer because they were giving suspect data. Two MiniSpecs and the Sea Data 635-8 were left installed at moorings 16, 23, and 17, respectively. The mast of the meteorological buoy at mooring 50 was missing and the buoy was not redeployed. The buoy at mooring 52 was visited but not maintained due to a medical emergency.

2.2.1.7 Cruise M07CPW9301

The reinstallation cruise (M07) occurred aboard the *R/V J.W. Powell* from 9 - 21 January 1993 and served as a 180-day cruise with all moorings except 42 and 43 being maintained. Due to the problems encountered with the 200-m moorings, it was decided that all the deep moorings would be rebuilt with new, stronger cable which would allow them to be pulled from the surface. Additionally, the USCG decreed that all the moorings not within 30.48 m (100 ft) of a platform had to be marked with lighted surface marker buoys. Thus, on M07 all 200-m and 500-m moorings were reinstalled with new mooring cable, refurbished Datasonics or Benthos releases, and surface marker buoys. Mooring 24 was reinstalled near an existing platform, and moorings 3 and 4 were installed with new mooring cable and refurbished Datasonics releases. The MiniSpecs at moorings 16 and 23 were pulled so they could be sent back to the manufacturer for refurbishment. To provide spare instruments for the main array, mooring 46 was removed permanently and moorings 44 and 45 were not reinstalled. The meteorological buoy at mooring 50 was reinstalled. The interfaces between the S4s and the meteorological buoys were disabled; the S4s continued to store their data internally. The bottom Aanderaa at mooring 48 was not recovered.

2.2.1.8 Cruise M08CPW9304

The first 60-day maintenance cruise and the last cruise during the first operational year (M08) took place from 16 - 24 March 1993 aboard the *R/V J.W. Powell*. Nineteen moorings were visited; eighteen were recovered, maintained, and redeployed. Mooring 47 was removed permanently to provide the program with spare current meters. Modified rope canisters were tested and then installed on moorings 14, 19, 22, and 25. Refurbished MiniSpecs were installed at moorings 16, 17, 20, and 23. New higher-capacity memory chips (EPROMS) were installed in the meteorological buoys to allow 87 days of internal storage. The Sea Data 635-8 was deployed at mooring 1 because the fifth MiniSpec did not work properly. The meteorological buoy at mooring 20 had broken loose and was recovered from the crew boat which had found it.

2.2.2 Instrumentation, Calibration, and Sampling Procedures

The calibration of all instruments was performed, in general, as noted in section 9.3.1 of Nowlin et al. (1991). Some variations from the procedures set out in the proposal occurred due to time constraints and the actual instruments used.

2.2.2.1 Current Velocity

Calibration of current speed and direction for the various instruments was carried out as per sections 9.3.2 and 9.3.3 of Nowlin et al. (1991). Due to time constraints caused by late delivery at the start of the program, two of the MiniSpecs were not calibrated at the U.S. Geological Survey tow tank in Bay St. Louis, Mississippi, but rather were calibrated at the tow tank of the Shell Development Company in Houston, Texas.

The Endeco SSM current meters sample net forward revolutions of the rotor once per second and the compass direction once per second. These readings are combined to determine the current vectors. These vectors are averaged over the 30-minute sampling period to provide a 30-minute, vector-averaged current velocity.

The Aanderaa RCM 7/8 current meters are vector averaging instruments that sample rotor counts over a 36-second period and combine a compass reading that is taken at the end of the 36-second period to determine a current vector. Fifty of these vectors are averaged during each 30-minute recording interval.

The Aanderaa RCM 4/5 does not vector average but rather records the total number of rotor counts over a 30-minute period to provide current speed. They provide an instantaneous compass direction at the end of the averaging period to combine with the averaged speed.

The TAMU- and LSU-modified Endeco DMT current meters do not vector average; they provide the number of rotor counts over the 5-minute recording interval, and an instantaneous compass reading at the end of each 5-minute sampling period.

The S4 current meters vector average. They sample the horizontal current components and the compass directions every 0.5 second for 10 minutes. The individual components are resolved into earth coordinates and averaged over the sampling interval to provide a 10-minute average current. The S4s were set to record a 10-minute average every 15 minutes on M01 and M02; every hour on M04 and M05; and every 30 minutes on M03, M06, M07, and M08.

The MiniSpecs sample horizontal current components every 0.5 second and average 600 samples at the beginning of every 30-minute sampling interval. The MiniSpecs do not have a compass. They obtain average east-west and north-south current velocities relative to the axis of the sensor, which is fixed to the bottom. The instruments contain no compasses, so the true geodetic orientation of the MiniSpec is measured by divers using a hand held compass at the beginning and end of each deployment.

2.2.2.2 Temperature

The calibration of the temperature sensors in the various instruments was performed as per section 9.3.4 of Nowlin et al. (1991). All current meter temperature sensors except those of the MiniSpecs obtain one instantaneous value of sea water temperature during the current velocity sampling period. The MiniSpecs obtain a five-minute-average value every 30 minutes.

2.2.2.3 Conductivity

The calibration of the conductivity sensors for the various instruments was performed as per section 9.3.5 of Nowlin et al. (1991). All current meter conductivity sensors obtain one instantaneous value of sea water conductivity during the current velocity sampling period. The MiniSpecs did not have conductivity sensors because they were not delivered by the manufacturer.

2.2.2.4 Pressure

The pressure sensors in the MiniSpec current meters initially utilized the manufacturer's calibrations because the instruments were not received in sufficient time to perform additional calibrations on them. Calibrations were performed on the sensors with a dead weight tester in early March 1993. These tests indicated that the sensors did not meet the manufacturer's stated specifications; more complete calibrations were scheduled for the summer of 1993 at the National Oceanic and Atmospheric Administration (NOAA) Northwest Regional Calibration Center (NRCC) in Bellevue, Washington. The Sea Data 635-8 wave gauge used a Paros Scientific quartz pressure sensor. Because of the reliability of the Paros sensor, it was not calibrated.

For the collection of wave information, the pressure sensors were set to record individual pressure samples over a 17.07 minute period. The MiniSpecs obtained 2048 0.5-second samples every hour for cruises M01 and M02; every 2 hours during cruises M03, M04, M05, and M06; and every three hours during cruises M07 and M08. Indications that drain on the batteries appeared to introduce noise into the pressure channel, caused the sampling on the MiniSpecs to be changed. In addition to the wave information, the MiniSpecs provided an average of 600 0.5-second pressure samples every 30-minutes as a measure of tides. The Sea-Data 635-8 was set to obtain 1024 0.5-second samples every three hours.

2.2.2.5 Sound Speed

The IES units measure acoustic travel time and bottom temperature and pressure. They were calibrated by the manufacturer, Pacer Systems, when the instruments were refurbished prior to their deployment at moorings 42 and 43. As checks of the sound speed at the site, Sippican XSV and XBT probes were taken at the time of deployment

(see section 2.2.1.3). The IES units were set to obtain measures of the acoustic travel time from the instrument to the sea surface and return. The units were set with a ping length of 6 ms, a ping interval of 10 s, a burst interval of 30 min, and a burst length of 24 pings.

2.2.2.6 Meteorology

The calibration of the buoy mounted meteorological sensors was performed as per section 9.3.8 of Nowlin et al. (1991). Additional checks on the reasonableness of the data are provided by the National Weather Service (NWS) prior to the transmission of the data over the weather network. All meteorological sensors are sampled every four seconds and then averaged over an eight minute period once per hour.

2.2.2.7 CTD

Several CTDs were utilized during the first year of the program. The original CTD was a Sea-Bird SBE25 Sealogger which was lost when the cable holding it broke after obtaining a few casts. It had been calibrated at the factory shortly before it was used. The remaining CTD casts were obtained by a LATEX Sea-Bird SBE19 or an SBE19 of the Geochemical and Environmental Research Group (GERG), each with a pump for the conductivity sensor or an EHI SBE19 without a conductivity pump. The LATEX CTD was purchased to replace the lost SBE25 and was calibrated by Sea-Bird in November 1992. The GERG CTD was calibrated by Sea-Bird in July 1991, May 1992, and January 1993. The EHI CTD was used as a backup unit and was calibrated by Sea-Bird in March 1992.

2.2.3 Summary of Data Collection

The first year of deployment was from April 1992 through March 1993. Data were recovered from the moored instrumentation during mooring maintenance cruises M02 through M08 (see Table 2.2.3). Moored instrumentation consisted of current meters collecting current speed and direction, temperature, and conductivity; meteorological buoys collecting wind speed and direction, air and sea surface temperature, and barometric pressure; and MiniSpec directional wave gauges collecting current speed and direction, temperature, and pressure. Inverted echo sounders, collecting acoustic travel time and pressure, were deployed in July 1992 and were to be recovered in July 1993. There was no data recovery from the IES units during the first field year.

2.2.3.1 Current Meter Data

Table 2.2.3 shows which moorings were visited for maintenance on each cruise. Figure 2.2.4 summarizes the recovery results for the first year. For each current meter on each mooring, Table 2.2.4 shows the data recovery and problems during the first field year. Instrument losses, discussed in section 2.2.1, contributed to some of the data losses.

2.2.3.2 MiniSpecs

Figure 2.2.5 summarizes the MiniSpecs recovery results for the first field year. Note that the instruments were returned to the manufacturer in December 1992 and January 1993 and were not redeployed until March 1993. Table 2.2.5 shows the data recovery and problems.

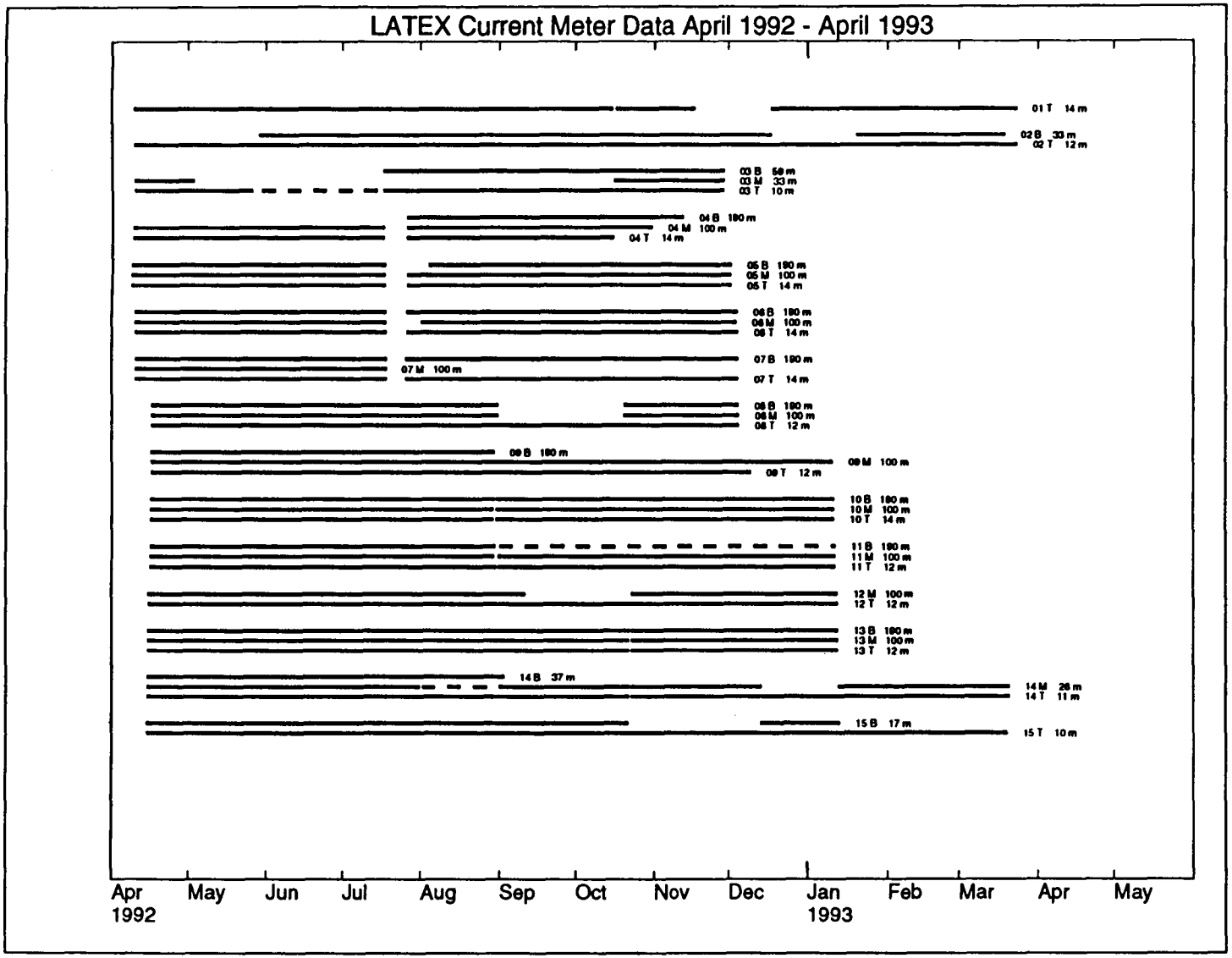


Figure 2.2.4. LATEX current meter data April 1992 - April 1993.

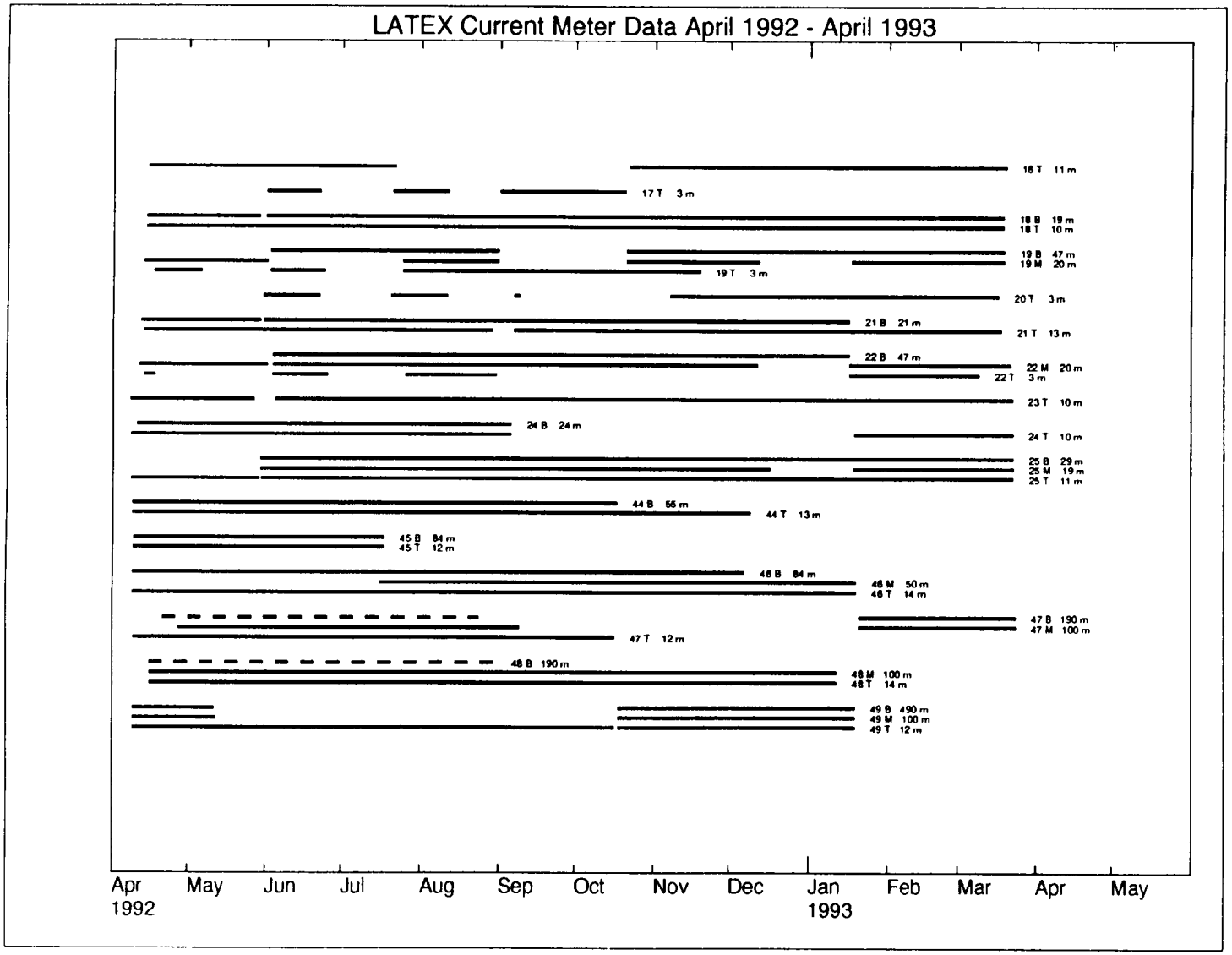


Figure 2.2.4. LATEX current meter data April 1992 - April 1993. (continued)

Table 2.2.4. LATEX Current Meter Data April 1992 - April 1993.

Mooring	Depth	S/N	Deploy Cruise	Recover Cruise	Start Data	End Data	Exceptions
01T	11m	SSM254	92P03 (M01)	92P05 (M02)	04/09/1992 18:00:00	05/28/1992 14:00:00	
01T	11m	SSM232	92P05 (M02)	92P06 (M03)	05/28/1992 18:00:00	07/16/1992 12:00:00	
01T	12m	SSM232	92P06 (M03)	92P08 (M04)	07/16/1992 16:00:00	09/04/1992 12:00:00	
01T	12m	SSM254	92P08 (M04)	92P09 (M05)	09/04/1992 18:00:00	10/15/1992 14:00:00	
01T	18m	SSM250	92P09 (M05)	92P12 (M06)	10/16/1992 18:00:00	12/17/1992 12:00:00	N
01T	14m	SSM255	92P12 (M06)	93P01 (M07)	12/17/1992 18:30:00	01/19/1993 21:00:00	
01T	14m	SSM258	93P01 (M07)	93P04 (M08)	01/20/1993 00:00:00	03/23/1993 12:30:00	
02B	27m	LSU020	92P05 (M02)	92P06 (M03)	05/29/1992 02:35:00	07/16/1992 18:20:00	
02B	33m	LSU035	92P06 (M03)	92P08 (M04)	07/16/1992 20:00:00	09/04/1992 18:00:00	N,L
02B	33m	DMT243	92P08 (M04)	92P09 (M05)	09/04/1992 18:00:00	10/15/1992 16:05:00	
02B	32m	DMT215	92P09 (M05)	92P12 (M06)	10/15/1992 16:30:00	12/17/1992 17:30:00	
02B	33m	DMT230	93P01 (M07)	93P04 (M08)	01/19/1993 19:30:00	03/18/1993 19:50:00	K
02T	13m	SSM250	92P03 (M01)	92P05 (M02)	04/09/1992 18:00:00	05/28/1992 19:00:00	
02T	10m	SSM040	92P05 (M02)	92P06 (M03)	05/29/1992 00:00:00	07/16/1992 06:30:00	
02T	10m	SSM039	92P06 (M03)	92P08 (M04)	07/16/1992 20:30:00	09/04/1992 17:30:00	
02T	12m	SSM232	92P08 (M04)	92P09 (M05)	09/04/1992 18:00:00	10/15/1992 16:00:00	
02T	13m	DMT238	92P09 (M05)	92P12 (M06)	10/15/1992 16:30:00	12/17/1992 17:25:00	
02T	12m	SSM244	92P12 (M06)	93P01 (M07)	12/17/1992 18:30:00	01/19/1993 19:00:00	
02T	12m	SSM242	93P01 (M07)	93P04 (M08)	01/20/1993 00:00:00	03/23/1993 15:30:00	
03B	59m	LSU020	92P06 (M03)	92P09 (M05)	07/17/1992 10:00:00	10/15/1992 18:45:00	
03B	59m	DMT131	92P09 (M05)	92P12 (M06)	10/16/1992 02:00:00	11/29/1992 04:00:00	F,H
03M	30m	LSU070	92P05 (M02)	92P06 (M03)	04/09/1992 20:30:00	05/03/1992 04:00:00	M,N
03M	33m	LSU075	92P09 (M05)	92P12 (M06)	10/16/1992 02:00:00	11/29/1992 04:00:00	C,D,E,I
03T	10m	SSM258	92P03 (M01)	92P06 (M03)	04/10/1992 00:00:00	07/16/1992 21:30:00	L,N
03T	10m	SSM258	92P06 (M03)	92P09 (M05)	07/17/1992 12:00:00	10/15/1992 18:00:00	
03T	10m	SSM254	92P09 (M05)	92P12 (M06)	10/16/1992 06:00:00	11/29/1992 00:00:00	
04B	190m	AA9411	92P06 (M03)	92P12 (M06)	07/26/1992 18:00:00	11/12/1992 12:00:00	
04M	100m	AA10687	92P03 (M01)	92P06 (M03)	04/09/1992 06:00:00	07/17/1992 14:00:00	
04M	100m	AA9410	92P06 (M03)	92P12 (M06)	07/26/1992 18:00:00	10/31/1992 04:01:00	
04T	12m	SSM252	92P03 (M01)	92P06 (M03)	04/09/1992 06:00:00	07/17/1992 13:00:00	
04T	14m	SSM042	92P06 (M03)	92P09 (M05)	07/26/1992 18:01:00	10/15/1992 21:01:00	
05B	190m	AA10720	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/18/1992 01:00:00	
05B	190m	AA10720	92P08 (M04)	92P12 (M06)	08/04/1992 05:59:00	12/01/1992 23:26:00	
05M	100m	AA10690	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/17/1992 22:00:00	
05M	100m	AA10687	92P06 (M03)	92P12 (M06)	07/26/1992 18:00:00	12/01/1992 18:00:00	
05T	12m	SSM257	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/17/1992 22:30:00	
05T	14m	SSM252	92P09 (M03)	92P12 (M06)	07/26/1992 18:00:00	12/02/1992 00:00:00	
06B	190m	AA9411	92P03 (M01)	92P06 (M03)	04/10/1992 06:00:00	07/18/1992 05:30:00	
06B	190m	AA10690	92P06 (M03)	92P12 (M06)	07/26/1992 12:00:00	12/04/1992 10:00:00	
06M	100m	AA10684	92P03 (M01)	92P06 (M03)	04/10/1992 06:00:00	07/18/1992 05:30:00	
06M	100m	AA10689	92P08 (M04)	92P12 (M06)	08/01/1992 05:59:00	12/03/1992 22:56:00	
06T	12m	SSM245	92P03 (M01)	92P06 (M03)	04/10/1992 06:00:00	07/18/1992 05:00:00	
06T	14m	SSM253	92P06 (M03)	92P12 (M06)	07/26/1992 12:00:00	12/04/1992 12:00:00	
07B	190m	AA9410	92P03 (M01)	92P06 (M03)	04/10/1992 12:00:00	07/18/1992 10:01:00	
07B	190m	AA10682	92P06 (M03)	92P12 (M06)	07/26/1992 06:00:00	12/04/1992 19:00:00	
07M	100m	AA10669	92P03 (M01)	92P06 (M03)	04/10/1992 12:00:00	07/18/1992 10:00:00	
07T	12m	SSM246	92P03 (M01)	92P06 (M03)	04/10/1992 12:00:00	07/18/1992 11:30:00	
07T	14m	SSM039	92P09 (M03)	92P12 (M06)	07/26/1992 06:00:00	12/04/1992 18:00:00	
08B	190m	AA10671	92P03 (M01)	92P09 (M05)	04/16/1992 12:00:00	08/31/1992 03:00:00	H
08B	190m	AA10688	92P09 (M05)	92P12 (M06)	10/19/1992 18:00:00	12/04/1992 18:00:00	
08M	100m	AA10673	92P03 (M01)	92P09 (M05)	04/16/1992 12:00:00	08/31/1992 07:00:00	H
08M	100m	AA10673	92P09 (M05)	92P12 (M06)	10/19/1992 18:00:00	12/05/1992 00:00:00	
08T	12m	SSM240	92P03 (M01)	92P09 (M05)	04/16/1992 12:00:00	10/19/1992 13:00:00	
08T	12m	SSM042	92P09 (M05)	92P12 (M06)	10/19/1992 18:00:00	12/05/1992 00:00:00	
09B	190m	AA10674	92P03 (M01)	92P08 (M04)	04/16/1992 07:44:00	08/29/1992 21:14:00	
09M	100m	AA10679	92P03 (M01)	92P08 (M04)	04/16/1992 07:30:00	08/29/1992 21:00:00	
09M	100m	AA10675	92P08 (M04)	93P01 (M07)	08/30/1992 06:00:00	01/10/1993 17:00:00	

Table 2.2.4. LATEX Current Meter Data April 1992 - April 1993. (continued)

Mooring	Depth	S/N	Deploy Cruise	Recover Cruise	Start Data	End Data	Exceptions
09T	10m	SSM233	92P03 (M01)	92P08 (M04)	04/16/1992 08:00:00	08/29/1992 21:00:00	
09T	12m	SSM241	92P08 (M04)	92P12 (M06)	08/30/1992 06:01:00	12/09/1992 12:01:00	
10B	190m	AA10672	92P03 (M01)	92P08 (M04)	04/16/1992 03:00:00	08/29/1992 23:30:00	
10B	190m	AA10674	92P08 (M04)	93P01 (M07)	08/30/1992 12:00:00	01/11/1993 04:00:00	
10M	100m	AA10675	92P03 (M01)	92P08 (M04)	04/16/1992 03:00:00	08/29/1992 14:00:00	
10M	100m	AA10679	92P08 (M04)	93P01 (M07)	08/30/1992 12:00:00	01/11/1993 04:00:00	
10T	15m	SSM241	92P03 (M01)	92P08 (M04)	04/16/1992 03:00:00	08/29/1992 12:30:00	
10T	14m	SSM257	92P08 (M04)	93P01 (M07)	08/30/1992 12:00:00	01/11/1993 04:30:00	
11B	190m	AA10683	92P03 (M01)	92P08 (M04)	04/15/1992 20:30:00	08/30/1992 06:30:00	
11B	190m	AA10678	92P08 (M05)	93P01 (M07)	09/01/1992 00:00:00	01/11/1993 14:00:00	A,B
11M	100m	AA10670	92P03 (M01)	92P08 (M04)	04/15/1992 21:30:00	08/29/1992 20:30:00	
11M	100m	AA10670	92P08 (M04)	93P01 (M07)	08/31/1992 12:00:00	01/11/1993 14:00:00	
11T	12m	SSM239	92P03 (M01)	92P08 (M04)	04/15/1992 21:00:00	08/30/1992 14:00:00	
11T	12m	SSM239	92P08 (M04)	93P01 (M07)	08/31/1992 12:00:00	01/11/1993 14:30:00	
12M	100m	AA10680	92P03 (M01)	92P09 (M05)	04/15/1992 06:00:00	09/11/1992 05:30:00	C,E,H
12M	100m	AA10684	92P09 (M05)	93P01 (M07)	10/23/1992 00:00:00	01/12/1993 12:00:00	
12T	12m	SSM247	92P03 (M01)	92P09 (M05)	04/15/1992 06:00:00	10/22/1992 17:00:00	
12T	12m	SSM245	92P09 (M05)	93P01 (M07)	10/23/1992 00:30:00	01/12/1993 12:30:00	
13B	190m	AA10676	92P03 (M01)	92P06 (M03)	04/15/1992 00:00:00	07/22/1992 17:00:00	
13B	190m	AA10669	92P06 (M03)	92P09 (M05)	07/23/1992 00:00:00	10/22/1992 01:00:00	
13B	190m	AA10671	92P09 (M05)	93P01 (M07)	10/22/1992 18:00:00	01/12/1993 17:00:00	
13M	100m	AA10682	92P03 (M01)	92P06 (M03)	04/15/1992 00:00:00	07/22/1992 16:00:00	
13M	100m	AA10684	92P08 (M04)	92P09 (M05)	07/23/1992 00:00:00	10/22/1992 00:00:00	
13M	100m	AA10669	92P09 (M05)	93P01 (M07)	10/22/1992 18:00:00	01/12/1993 17:00:00	
13T	12m	SSM042	92P03 (M01)	92P06 (M03)	04/15/1992 00:00:00	07/22/1992 16:30:00	
13T	10m	SSM245	92P06 (M03)	92P09 (M05)	07/23/1992 00:00:00	10/22/1992 00:00:00	
13T	12m	SSM256	92P09 (M05)	93P01 (M07)	10/22/1992 18:30:00	01/12/1993 17:00:00	
14B	41m	DMT025	92P03 (M01)	92P05 (M02)	04/14/1992 21:00:00	06/02/1992 03:35:00	
14B	41m	DMT222	92P05 (M02)	92P06 (M03)	06/02/1992 06:00:00	07/22/1992 11:55:00	
14B	37m	DMT131	92P06 (M03)	92P08 (M04)	07/22/1992 14:10:00	09/02/1992 17:40:00	
14B	37m	LSU040	92P08 (M04)	92P09 (M05)	09/02/1992 19:30:00	10/21/1992 20:55:00	B
14M	20m	DMT125	92P03 (M01)	92P05 (M02)	04/14/1992 21:00:00	06/02/1992 03:40:00	
14M	24m	DMT221	92P05 (M02)	92P06 (M03)	06/02/1992 06:00:00	07/22/1992 12:00:00	
14M	26m	DMT145	92P06 (M03)	92P08 (M04)	07/22/1992 14:10:00	09/02/1992 17:10:00	N
14M	26m	DMT230	92P08 (M04)	92P09 (M05)	09/02/1992 19:30:00	10/21/1992 21:00:00	
14M	23m	DMT230	92P09 (M05)	92P12 (M06)	10/22/1992 13:00:00	12/13/1992 19:05:00	
14M	26m	DMT215	93P01 (M07)	93P04 (M08)	01/13/1993 00:00:00	03/20/1993 17:30:00	
14T	10m	DMT215	92P03 (M01)	92P05 (M02)	04/14/1992 21:00:00	06/02/1992 03:30:00	
14T	10m	DMT215	92P05 (M02)	92P06 (M03)	06/02/1992 06:00:00	07/22/1992 12:00:00	
14T	11m	SSM254	92P06 (M03)	92P08 (M04)	07/22/1992 14:30:00	09/02/1992 17:00:00	
14T	11m	SSM256	92P03 (M01)	92P09 (M05)	09/03/1992 00:00:00	10/21/1992 20:00:00	
14T	11m	SSM244	92P09 (M05)	92P12 (M06)	10/22/1992 18:00:00	12/13/1992 18:00:00	
14T	11m	SSM243	92P12 (M06)	93P01 (M07)	12/14/1992 00:30:00	01/12/1993 22:00:00	
14T	11m	SSM042	93P01 (M07)	93P04 (M08)	01/13/1993 00:00:00	03/20/1993 17:00:00	D
15B	25m	DMT221	92P03 (M01)	92P05 (M02)	04/14/1992 18:00:00	06/01/1992 21:00:00	
15B	16m	DMT145	92P05 (M02)	92P06 (M03)	06/02/1992 00:00:00	07/21/1992 16:55:00	
15B	17m	DMT230	92P06 (M03)	92P08 (M04)	07/21/1992 16:50:00	09/02/1992 13:25:00	
15B	17m	LSU050	92P08 (M04)	92P09 (M05)	09/02/1992 15:00:00	10/21/1992 18:55:00	J,K
15B	17m	DMT221	92P12 (M06)	93P01 (M07)	12/13/1992 17:00:00	01/13/1993 13:20:00	
15T	11m	DMT222	92P03 (M01)	92P05 (M02)	04/14/1992 18:00:00	06/01/1992 21:00:00	
15T	10m	DMT131	92P05 (M02)	92P06 (M03)	06/02/1992 00:00:00	07/21/1992 16:55:00	
15T	10m	SSM252	92P06 (M03)	92P08 (M04)	07/21/1992 17:00:00	09/02/1992 12:00:00	N
15T	10m	SSM255	92P08 (M04)	92P09 (M05)	09/02/1992 18:00:00	10/21/1992 18:00:00	N
15T	10m	SSM240	92P09 (M05)	92P12 (M06)	10/22/1992 00:00:00	12/13/1992 12:00:00	
15T	10m	SSM247	92P12 (M06)	93P01 (M07)	12/13/1992 18:30:00	01/13/1993 13:00:00	
15T	10m	SSM243	93P01 (M07)	93P04 (M08)	01/13/1993 18:00:00	03/19/1993 23:00:00	
16T	10m	SSM041	92P03 (M01)	92P05 (M02)	04/14/1992 18:00:00	06/01/1992 23:00:00	

Table 2.2.4. LATEX Current Meter Data April 1992 - April 1993. (continued)

Mooring	Depth	S/N	Deploy Cruise	Recover Cruise	Start Data	End Data	Exceptions
16T	10m	SSM254	92P05 (M02)	92P06 (M03)	06/02/1992 00:00:00	07/21/1992 20:30:00	
16T	12m	SSM243	92P09 (M05)	92P12 (M06)	10/21/1992 18:00:00	12/13/1992 12:00:00	
16T	11m	SSM235	92P12 (M06)	93P01 (M07)	12/13/1992 18:30:00	01/13/1993 19:00:00	
16T	11m	SSM247	93P01 (M07)	93P04 (M08)	01/14/1993 00:00:00	03/19/1993 18:00:00	
17T	3m	S4-788	92P05 (M02)	92P06 (M03)	06/01/1992 01:41:00	06/22/1992 08:11:00	K
17T	3m	S4-788	92P06 (M03)	92P08 (M04)	07/20/1992 18:45:00	08/11/1992 16:15:00	K
17T	3m	S4-788	92P08 (M04)	92P09 (M05)	09/01/1992 00:33:00	10/20/1992 12:33:00	K
18B	18m	DMT131	92P03 (M01)	92P05 (M02)	04/13/1992 23:30:00	05/29/1992 08:30:00	
18B	19m	DMT230	92P05 (M02)	92P06 (M03)	06/01/1992 00:00:00	07/20/1992 22:40:00	
18B	19m	DMT146	92P06 (M03)	92P08 (M04)	07/20/1992 22:45:00	08/31/1992 18:40:00	
18B	19m	DMT221	92P08 (M04)	92P09 (M05)	08/31/1992 19:00:00	10/20/1992 17:40:00	
18B	19m	LSU070	92P09 (M05)	92P12 (M06)	10/20/1992 18:00:00	12/12/1992 18:25:00	
18B	19m	DMT145	92P12 (M06)	93P01 (M07)	12/12/1992 18:30:00	01/14/1993 19:25:00	
18B	19m	DMT221	93P01 (M07)	93P04 (M08)	01/14/1993 19:30:00	03/18/1993 20:35:00	
18T	10m	SSM039	92P03 (M01)	92P05 (M02)	04/14/1992 00:00:00	05/31/1992 21:00:00	
18T	10m	SSM256	92P05 (M02)	92P06 (M03)	06/01/1992 00:00:00	07/20/1992 22:30:00	
18T	10m	SSM255	92P06 (M03)	92P08 (M04)	07/20/1992 23:30:00	08/31/1992 18:30:00	
18T	9m	SSM244	92P08 (M04)	92P09 (M05)	09/01/1992 00:00:00	10/20/1992 17:30:00	
18T	10m	SSM235	92P09 (M05)	92P12 (M06)	10/21/1992 00:00:00	12/12/1992 18:00:00	
18T	10m	SSM241	92P12 (M06)	93P01 (M07)	12/13/1992 00:30:00	01/14/1993 19:00:00	
18T	10m	SSM235	93P01 (M07)	93P04 (M08)	01/15/1993 00:00:00	03/18/1993 20:00:00	
19B	44m	DMT243	92P05 (M02)	92P06 (M03)	06/02/1992 18:00:00	07/24/1992 19:30:00	
19B	44m	DMT221	92P06 (M03)	92P08 (M04)	07/24/1992 17:55:00	08/31/1992 12:30:00	
19B	45m	DMT145	92P09 (M05)	92P12 (M06)	10/21/1992 00:00:00	12/12/1992 13:40:00	
19B	45m	DMT208	92P12 (M06)	93P01 (M07)	12/12/1992 15:30:00	01/17/1993 13:00:00	
19B	47m	LSU040	93P01 (M07)	93P04 (M08)	01/17/1993 15:00:00	03/19/1993 06:50:00	K
19M	20m	DMT243	92P03 (M01)	92P05 (M02)	04/13/1992 04:00:00	06/01/1992 14:00:00	
19M	20m	DMT215	92P06 (M03)	92P08 (M04)	07/24/1992 17:55:00	08/31/1992 12:05:00	
19M	25m	DMT221	92P09 (M05)	92P12 (M06)	10/21/1992 00:00:00	12/12/1992 13:10:00	
19M	20m	DMT015	93P01 (M07)	93P04 (M08)	01/17/1993 15:00:00	03/19/1993 00:20:00	D,E,K
19T	3m	S4-777	92P03 (M01)	92P05 (M02)	04/17/1992 01:55:00	05/06/1992 02:55:00	
19T	3m	S4-777	92P05 (M02)	92P06 (M03)	06/02/1992 18:01:00	06/24/1992 05:46:00	
19T	3m	S4-777	92P06 (M03)	92P08 (M04)	07/24/1992 18:11:00	08/31/1992 12:41:00	
19T	3m	S4-777	92P08 (M04)	92P09 (M05)	08/31/1992 15:54:00	10/20/1992 20:54:00	
19T	3m	S4-777	92P09 (M05)	92P12 (M06)	10/21/1992 00:10:00	11/18/1992 22:10:00	
20T	3m	S4-779	92P05 (M02)	92P06 (M03)	05/30/1992 19:25:00	06/22/1992 04:40:00	
20T	3m	S4-779	92P06 (M03)	92P08 (M04)	07/20/1992 01:22:00	08/11/1992 06:07:00	
20T	3m	S4-779	92P08 (M04)	92P09 (M05)	09/06/1992 16:35:00	09/08/1992 20:35:00	H,K
20T	3m	S4-779	92P09 (M05)	92P12 (M06)	11/06/1992 23:31:00	12/11/1992 11:51:00	
20T	3m	S4-779	92P12 (M06)	93P01 (M07)	12/11/1992 14:09:00	01/16/1993 21:09:00	
20T	3m	S4-779	93P01 (M07)	93P04 (M08)	01/16/1993 22:10:00	03/16/1993 20:10:00	
21B	21m	DMT230	92P03 (M01)	92P05 (M02)	04/12/1992 02:00:00	05/29/1992 22:00:00	
21B	21m	DMT146	92P05 (M02)	92P06 (M03)	05/31/1992 00:00:00	07/19/1992 22:00:00	
21B	22m	LSU065	92P06 (M03)	92P08 (M04)	07/19/1992 22:30:00	08/29/1992 00:15:00	
21B	22m	DMT015	92P08 (M04)	92P09 (M05)	08/29/1992 00:30:00	10/23/1992 15:30:00	
21B	21m	LSU040	92P09 (M05)	92P12 (M06)	10/23/1992 15:30:00	12/11/1992 17:50:00	
21B	21m	DMT015	92P12 (M06)	93P01 (M07)	12/11/1992 18:00:00	01/16/1993 18:10:00	C,D,E,N
21T	13m	SSM256	92P03 (M01)	92P05 (M02)	04/13/1992 06:00:00	05/30/1992 22:00:00	
21T	10m	SSM255	92P03 (M01)	92P06 (M03)	05/31/1992 00:00:00	07/19/1992 22:00:00	
21T	13m	SSM257	92P06 (M03)	92P08 (M04)	07/20/1992 00:30:00	08/29/1992 00:00:00	
21T	12m	SSM246	92P08 (M04)	92P09 (M05)	09/06/1992 18:00:00	10/23/1992 15:00:00	
21T	13m	SSM247	92P09 (M05)	92P12 (M06)	10/23/1992 18:00:00	12/11/1992 17:00:00	
21T	13m	SSM253	92P12 (M06)	93P01 (M07)	12/11/1992 18:30:00	01/16/1993 18:00:00	
21T	13m	SSM039	93P01 (M07)	93P04 (M08)	01/17/1993 00:00:00	03/18/1993 00:00:00	
22B	48m	DMT208	92P05 (M02)	92P06 (M03)	06/03/1992 18:00:00	07/25/1992 12:50:00	
22B	48m	DMT208	92P06 (M03)	92P08 (M04)	07/25/1992 18:25:00	09/03/1992 14:10:00	
22B	42m	DMT145	92P08 (M04)	92P09 (M05)	09/03/1992 15:30:00	10/19/1992 21:00:00	

Table 2.2.4. LATEX Current Meter Data April 1992 - April 1993. (continued)

Mooring	Depth	S/N	Deploy Cruise	Recover Cruise	Start Data	End Data	Exceptions
22B	42m	LSU010	92P09 (M05)	92P12 (M06)	10/19/1992 22:30:00	12/11/1992 23:00:00	
22B	47m	LSU075	92P12 (M06)	93P01 (M07)	12/12/1992 01:00:00	01/16/1993 16:45:00	
22M	25m	DMT208	92P03 (M01)	92P05 (M02)	04/11/1992 07:00:00	06/01/1992 11:55:00	
22M	22m	SSM039	92P05 (M02)	92P06 (M03)	06/03/1992 18:00:00	07/25/1992 12:00:00	
22M	22m	DMT243	92P06 (M03)	92P08 (M04)	07/25/1992 18:30:00	09/03/1992 13:30:00	
22M	22m	LSU070	92P08 (M04)	92P09 (M05)	09/03/1992 15:30:00	10/19/1992 20:35:00	
22M	23m	DMT208	92P09 (M05)	92P12 (M06)	10/19/1992 22:30:00	12/11/1992 22:10:00	
22M	20m	DMT145	93P01 (M07)	93P04 (M08)	01/16/1993 15:00:00	03/21/1993 20:50:00	
22T	3m	S4-781	92P03 (M01)	92P05 (M02)	04/13/1992 05:40:00	04/17/1992 18:25:00	
22T	3m	S4-781	92P05 (M02)	92P06 (M03)	06/03/1992 14:35:00	06/25/1992 13:05:00	
22T	3m	S4-781	92P06 (M03)	92P08 (M04)	07/25/1992 18:31:00	08/30/1992 16:32:00	
22T	3m	S4-781	93P01 (M07)	93P04 (M08)	01/16/1993 15:10:00	03/09/1993 05:10:00	D,E
23T	10m	SSM232	92P03 (M01)	92P05 (M02)	04/08/1992 00:00:00	05/27/1992 09:00:00	
23T	9m	SSM041	92P03 (M01)	92P06 (M03)	06/04/1992 12:00:00	07/14/1992 17:30:00	
23T	10m	SSM041	93P06 (M03)	93P08 (M04)	07/14/1992 20:30:00	09/05/1992 13:00:00	
23T	10m	SSM040	92P08 (M04)	92P09 (M05)	09/05/1992 18:00:00	10/14/1992 12:30:00	
23T	10m	DMT222	92P09 (M05)	92P12 (M06)	10/14/1992 13:00:00	12/16/1992 14:35:00	
23T	10m	SSM254	92P12 (M06)	93P01 (M07)	12/16/1992 18:30:00	01/18/1993 18:00:00	
23T	10m	SSM246	93P01 (M07)	93P04 (M08)	01/18/1993 18:00:00	03/22/1993 16:00:00	
24B	24m	LSU075	92P03 (M01)	92P05 (M02)	04/10/1992 14:30:00	05/29/1992 19:10:00	
24B	27m	LSU060	92P05 (M02)	92P06 (M03)	05/29/1992 19:30:00	07/14/1992 22:50:00	D,E
24B	24m	DMT238	92P06 (M03)	92P08 (M04)	07/14/1992 23:00:00	09/05/1992 14:25:00	
24T	11m	SSM255	92P03 (M01)	92P05 (M02)	04/08/1992 06:00:00	05/29/1992 19:00:00	
24T	10m	SSM250	92P05 (M02)	92P06 (M03)	05/30/1992 00:00:00	07/14/1992 23:00:00	
24T	10m	SSM250	92P06 (M03)	92P08 (M04)	07/15/1992 00:38:00	09/05/1992 17:08:00	
24T	10m	SSM240	93P01 (M07)	93P04 (M08)	01/18/1993 18:00:00	03/22/1993 18:30:00	
25B	34m	LSU075	92P05 (M02)	92P06 (M03)	05/30/1992 03:00:00	07/18/1992 17:45:00	
25B	29m	LSU075	92P06 (M03)	92P08 (M04)	07/18/1992 21:00:00	09/05/1992 19:25:00	
25B	29m	DMT208	92P08 (M04)	92P09 (M05)	09/05/1992 19:30:00	10/14/1992 23:30:00	
25B	29m	DMT146	92P09 (M05)	92P12 (M06)	10/15/1992 00:00:00	12/16/1992 22:40:00	
25B	29m	DMT230	92P12 (M06)	93P01 (M07)	12/16/1992 23:00:00	01/18/1993 13:35:00	
25B	29m	DMT131	93P01 (M07)	93P04 (M08)	01/18/1993 13:30:00	03/22/1993 22:20:00	
25M	20m	LSU065	92P05 (M02)	92P06 (M03)	05/30/1992 02:30:00	07/18/1992 17:45:00	
25M	19m	DMT125	93P06 (M03)	93P08 (M04)	07/18/1992 20:40:00	09/05/1992 19:30:00	C,E
25M	19m	DMT131	92P08 (M04)	92P09 (M05)	09/05/1992 19:30:00	10/14/1992 23:15:00	
25M	19m	DMT125	92P09 (M05)	92P12 (M06)	10/14/1992 23:30:00	12/16/1992 22:40:00	G
25M	19m	DMT208	93P01 (M07)	93P04 (M08)	01/18/1993 13:30:00	03/22/1993 22:40:00	
25T	10m	SSM234	92P03 (M01)	92P05 (M02)	04/08/1992 06:00:00	05/29/1992 11:30:00	
25T	12m	SSM234	92P05 (M02)	92P06 (M03)	05/30/1992 06:00:00	07/18/1992 17:30:00	
25T	12m	SSM246	93P06 (M03)	93P08 (M04)	07/18/1992 21:00:00	09/05/1992 19:00:00	
25T	12m	SSM250	92P08 (M04)	92P09 (M05)	09/06/1992 00:00:00	10/14/1992 23:30:00	
25T	11m	SSM040	92P09 (M05)	92P12 (M06)	10/15/1992 06:00:00	12/16/1992 18:00:00	
25T	11m	SSM246	92P12 (M06)	93P01 (M07)	12/17/1992 00:30:00	01/18/1993 13:00:00	
25T	11m	SSM241	93P01 (M07)	93P04 (M08)	01/18/1993 18:00:00	03/22/1993 22:00:00	
44B	55m	LSU010	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/15/1992 12:00:00	
44B	55m	LSU060	92P06 (M03)	92P09 (M05)	07/15/1992 16:30:00	10/17/1992 13:45:00	K
44T	13m	SSM235	92P03 (M01)	92P06 (M03)	04/08/1992 18:01:00	07/15/1992 13:01:00	
44T	13m	SSM235	92P06 (M03)	92P09 (M05)	07/15/1992 18:00:00	10/17/1992 12:30:00	
44T	13m	SSM232	92P09 (M05)	92P12 (M06)	10/17/1992 18:00:00	12/09/1992 05:30:00	
45B	84m	AA10689	92P03 (M01)	92P06 (M03)	04/09/1992 06:00:00	07/17/1992 19:00:00	
45T	12m	SSM253	92P03 (M01)	92P06 (M03)	04/09/1992 00:00:00	07/17/1992 19:00:00	
46B	84m	AA10688	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/15/1992 20:00:00	
46B	84m	AA10688	92P06 (M03)	92P09 (M05)	07/16/1992 00:02:00	10/17/1992 17:30:00	
46B	84m	AA10685	92P09 (M05)	93P01 (M07)	10/18/1992 00:00:00	01/19/1993 13:30:00	
46M	50m	LSU010	92P06 (M03)	92P09 (M05)	07/15/1992 23:30:00	10/17/1992 18:40:00	
46M	50m	LSU020	92P09 (M05)	93P01 (M07)	10/17/1992 22:30:00	01/19/1993 14:20:00	
46T	10m	SSM243	92P03 (M01)	92P06 (M03)	04/08/1992 18:00:00	07/15/1992 19:30:00	

Table 2.2.4. LATEX Current Meter Data April 1992 - April 1993. (continued)

Mooring	Depth	S/N	Deploy Cruise	Recover Cruise	Start Data	End Data	Exceptions
46T	14m	SSM243	92P08 (M04)	92P09 (M05)	07/16/1992 00:00:00	10/17/1992 17:30:00	
46T	14m	SSM258	92P09 (M05)	93P01 (M07)	10/18/1992 00:30:00	01/19/1993 13:00:00	
47B	190m	AA10175	92P03 (M01)	92P12 (M06)	04/21/1992 00:00:00	08/24/1992 00:00:00	
47B	190m	AA9121	93P01 (M07)	93P04 (M08)	01/20/1993 12:00:00	03/23/1993 21:30:00	
47M	100m	AA10681	92P03 (M01)	92P12 (M06)	04/27/1992 05:59:00	09/08/1992 23:56:00	
47M	100m	AA10673	93P01 (M07)	93P04 (M08)	01/20/1993 12:00:00	03/23/1993 21:00:00	
47T	12m	SSM251	92P03 (M01)	92P09 (M05)	04/09/1992 06:01:00	10/16/1992 15:01:00	
48B	190m	AA10678	92P03 (M01)	92P08 (M04)	04/15/1992 16:00:00	08/31/1992 00:00:00	A
48M	100m	AA10677	93P03 (M01)	92P08 (M04)	04/15/1992 14:00:00	08/31/1992 00:30:00	
48M	100m	AA10672	92P08 (M04)	93P01 (M07)	08/31/1992 06:00:00	01/12/1993 00:00:00	
48T	12m	SSM244	93P03 (M01)	93P08 (M04)	04/15/1992 13:30:00	08/31/1992 00:00:00	
48T	14m	SSM233	92P08 (M04)	93P01 (M07)	08/31/1992 06:00:00	01/12/1993 00:00:00	
49B	490m	AA9121	92P03 (M01)	92P09 (M05)	04/09/1992 00:00:00	05/11/1992 12:30:00	H
49B	490m	AA9121	92P09 (M05)	93P01 (M07)	10/18/1992 06:00:00	01/19/1993 05:00:00	
49M	100m	AA10685	92P03 (M01)	92P09 (M05)	04/09/1992 00:00:00	05/12/1992 02:30:00	H
49M	100m	AA10677	92P09 (M05)	93P01 (M07)	10/18/1992 06:00:00	01/19/1993 05:00:00	
49T	12m	SSM242	92P03 (M01)	92P09 (M05)	04/09/1992 00:00:00	10/16/1992 18:30:00	
49T	12m	SSM242	92P08 (M04)	93P01 (M07)	10/18/1992 06:00:00	01/19/1993 05:00:00	

Exception Descriptions

A - No Speed Data.
B - No Direction data.
C - No Temperature data.
D - No Conductivity data.
E - No Salinity Data.
F - Dropped Samples.
G - Self checks in temp. channel.
H - Partial data.
I - Temp and Cond scrambled; No data.
J - Leaked during deployment.
K - Conductivity goes bad during deployment.
L - Meter tangled in line/wire.
M - Missing many 24 hour marks.
N - Speed goes bad during deployment.

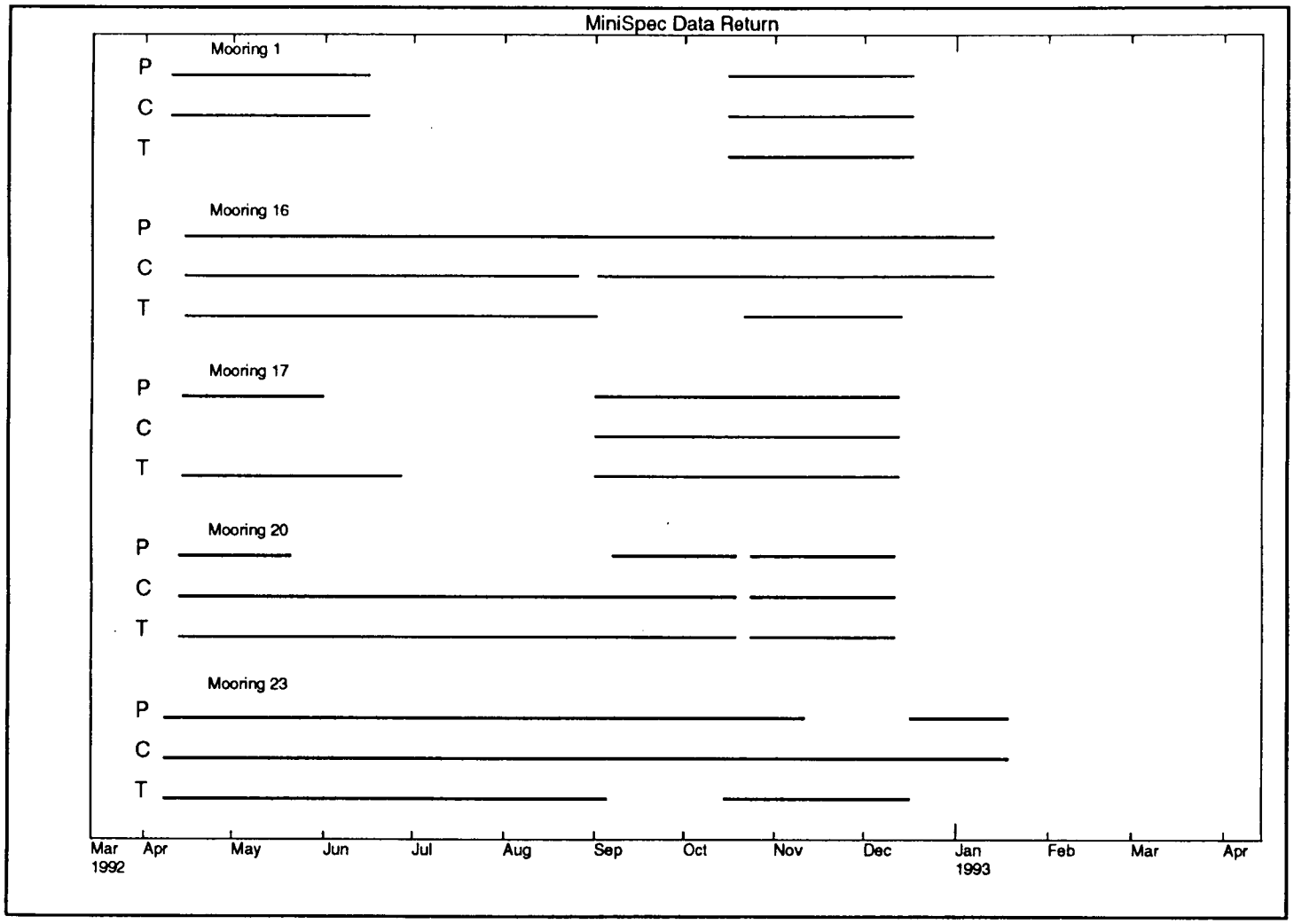


Figure 2.2.5. Data Returns for the five MiniSpecs at LATEX Moorings 1, 16, 17, 20, and 23 during the first program year of deployment. P is the pressure record, C is the current velocity record, and T is the temperature record.

Table 2.2.5. MiniSpec data files for first field year.

S/N	Mooring No.	In Water Deployment Cruise	Out of Water Recovery Cruise	Start data	End Data	Exceptions
		M01	M02			
10096	01	4/09/92 15:00	5/28/92 15:00	4/09/92 15:30	5/28/92 14:30	A, P
10092	16	4/14/92 13:30	6/01/92 18:30	4/14/92 15:00	6/01/92 18:30	B, P
10094	17	4/13/92 16:00	5/31/92 18:00	4/13/92 20:00	5/31/92 18:00	C, P
10093	20	4/12/92 21:00	5/30/92 12:40	4/12/92 21:00	5/30/92 12:00	D, P
10095	23	4/07/92 20:54	5/27/92 12:00	4/07/92 21:30	5/27/92 12:30	P
		M02 (comparison)	M02 (comparison)			
10095	23	5/27/92 20:00	6/04/92 11:40	5/27/92 21:30	6/04/92 11:30	P
		M02	M03			
10096	01	5/28/92 22:20	7/16/92 12:30	5/28/92 23:00	6/15/92 22:00	A, E, P
10092	16	6/01/92 23:20	7/21/92 12:35	6/01/92 23:30	7/21/92 12:00	B, P
10094	17	6/01/92 00:00	7/20/92 16:29	6/01/92 00:00	6/27/92 00:00	C, F, P
10093	20	5/30/92 19:20	7/19/92 13:48	5/30/92 19:00	7/19/92 13:30	G, P
10095	23	6/04/92 13:54	7/14/92 17:43	6/04/92 14:30	7/14/92 13:00	P
		M03	M04			
	01	NONE				
10092	16	7/21/92 18:52	9/01/92 15:40	7/21/92 19:00	9/01/92 15:00	B, H, P
	17	NONE				
10093	20	7/19/92 17:00	9/06/92 15:25	7/19/92 18:00	9/06/92 15:00	G, P
10095	23	7/14/92 15:19	9/05/92 07:28	7/14/92 16:00	9/05/92 07:00	P
		M04	M05			
	01	NONE				
10092	16	9/01/92 19:00	10/21/92 13:20	9/01/92 19:30	10/21/92 13:00	A, I, P
10096	17	8/31/92 21:10	10/20/92 14:15	8/31/92 21:30	10/20/92 14:00	J, P
10093	20	9/06/92 18:15	10/18/92 22:07	9/06/92 18:30	10/18/92 21:30	P
10095	23	9/05/92 15:02	10/14/92 12:45	9/05/92 15:30	10/14/92 11:30	A, I, P
		M05	M06			
10095	01	10/15/92 12:57	12/17/92 14:00	10/15/92 13:00	12/17/92 13:30	P
10096	16	10/21/92 13:25	12/13/92 13:44	10/21/92 13:30	12/13/92 13:30	K, P
10093	17	10/20/92 00:00	12/12/92 20:53	10/20/92 14:30	12/12/92 20:30	P
10092	20	10/22/92 19:00	12/11/92 14:42	10/23/92 19:00	12/11/92 14:30	P
10094	23	10/14/92 12:35	12/14/92 14:57	10/14/92 13:00	12/16/92 14:30	L, P
		M06	M07			
	01	NONE				
10093	16	12/13/92 12:00	1/13/93 16:32	12/13/92 16:00	1/13/93 16:00	A, I, P
	17	NONE				
	20	NONE				
10096	23	12/15/92 22:30	1/18/93 19:04	12/16/92 15:30	1/18/93 18:30	A, P
		M07	M08			
	01	NONE				
	16	NONE				
	17	NONE				
	20	NONE				
	23	NONE				

Table 2.2.5. MiniSpec data files for first field year. (continued)

S/N	Mooring No.	In Water Deployment Cruise	Out of Water Recovery Cruise	Start data	End Data	Exceptions
		M08	M09			
	01	NONE				
10096	16	3/19/93 20:20	5/27/93 00:08	3/19/93 20:29	5/26/93 23:29	P
10094	17	3/18/93 17:30	5/27/93 12:39	3/18/93 18:30	5/27:93 12:30	M, P
10095	20	3/17/93 17:03	5/28/93 01:05	3/17/93 17:29	5/28/93 00:29	N, P
10092	23	3/22/93 14:15	5/19/93 17:25	3/22/93 14:30	5/19/93 17:00	O, P

A - No temperature data
B - Offset between average and burst data
C - No current data
D - Pressure data stops 5/20/92
E - Electronic failure 6/19/92
F - Pressure data stops 6/27/92
G - No pressure data
H - Instrument turned on side 8/26/92 (hurricane)
I - No average mode data
J - Noisy temperature and pressure record
K - Noisy temperature record
L - Pressure failure 11/10/92
M - Pressure data stops 5/6/93
N - No burst mode data
O - Instrument turned on side 5/14/93
P - Burst data, useless

The five MiniSpec directional wave gauges delivered by Coastal Leasing, Inc., to Texas A&M University in April 1992 contained or quickly developed a number of unrelated problems, including sensor malfunctions, electronic noise, signal clipping, warm-up transients in the ICS pressure sensors, and lack of calibration for the effect of temperature on the pressure sensors (Kelly et al. 1993). During the following 16 months the manufacturer made several changes in the signal conditioning circuitry and replaced the original pressure sensor with an improved model from ICS. The changes appear to have corrected the mechanical and electrical problems.

To obtain National Institute of Standards and Technology (NIST) traceable calibration data that would include the effect of temperature on the pressure sensors, TAMU sent the MiniSpec instruments to the NRCC.

The NRCC performed a series of tests on the temperature and the improved pressure sensors as configured in the MiniSpecs. A least-squares fit of the pressure test data for each instrument to a model that is quadratic in pressure and linear in temperature yields an rms error of about 1.4 hPa (0.02 psi). With new pressure sensors and a new calibration model, the MiniSpecs now meet the manufacturer's listed accuracy of 0.1% full scale, or 3.4 hPa (0.05 psi). The test data are insufficient to quantify the long term stability of the pressure sensor. The tests of the temperature sensors confirm that the Endeco/YSI, Inc. thermistor is linear and has an accuracy better than 0.1°C over a range of 12 to 30°C.

Pressure data collected by the MiniSpecs in the field through May 1993 are contaminated because the original sensors exhibited a marked warm-up transient of about five-minutes duration. No calibration data are available for the original sensors to correct for the effect of temperature. Therefore, all of the tide mode (averaged) data collected through May 1993 should be flagged as questionable. Because of the noise and clipping problems, all of the burst pressure (wave) data collected between April 1992 and January 1993 are unusable. The burst pressure data collected during March-May 1993 can be used for

wave estimates if at least the first five minutes of each burst are eliminated and the remainder of each burst is detrended. Except for the few cases when the temperature sensors failed or were noisy, the quality of the temperature data is good.

A Sea-Data 635-8 wave meter was used to replace one of the MiniSpecs whenever one or more were pulled from the field for service or maintenance. Table 2.2.6 shows the deployment and data recovery dates. The method of zero-downcrossings was used to determine: the number of waves, average wave height, significant wave period, maximum wave height, and longest wave period. The period of the spectral band with maximum energy and the spectral significant wave height were determined from the wave spectrum. Data loss due to invalid or missing data points accounted for approximately 10% of the recovered data. These data gaps can be bridged using interpolative methods.

Table 2.2.6. SeaData 635-8 deployment data.

Mooring No.	In Water Deployment Cruise	Out of Water Recovery Cruise	Start Data	End Data
01	M03 07/27/92 22:30	M04 09/04/92 12:53	07/27/92 03:17	09/04/92 12:17
01	M04 09/04/92 15:25	M05 10/15/92 12:53	09/04/92 17:31	10/15/92 08:31
17	M06 12/12/92 21:15	M07 01/14/93 14:00	12/13/92 06:51	01/14/93 09:51

2.2.3.3 Meteorology

Internally-recorded, meteorological data collected during the first year of deployment were recovered during service cruises M02 through M08. Table 2.2.7 summarizes the recovery results for the first field year. During the first year the plan called for the recovery of 48 data sets. For this period, approximately 85% of the expected data were recovered. Figure 2.2.6 shows data recovery timelines. The reasons for unrecovered data are:

1) The instrument was accidentally turned-off before the data were downloaded;
2) Apparent collision with unknown vessel caused sensor damage and a power failure;
3) A fuse blew;
4) The buoy was vandalized causing sensor damage and a power failure;
5) A buoy was vandalized too severely for onsite repair and was removed one period; and
6) The mooring was not serviced due to a crew injury, and the data storage buffers were insufficient for a double-length deployment period, resulting in approximately 14 days of data loss.

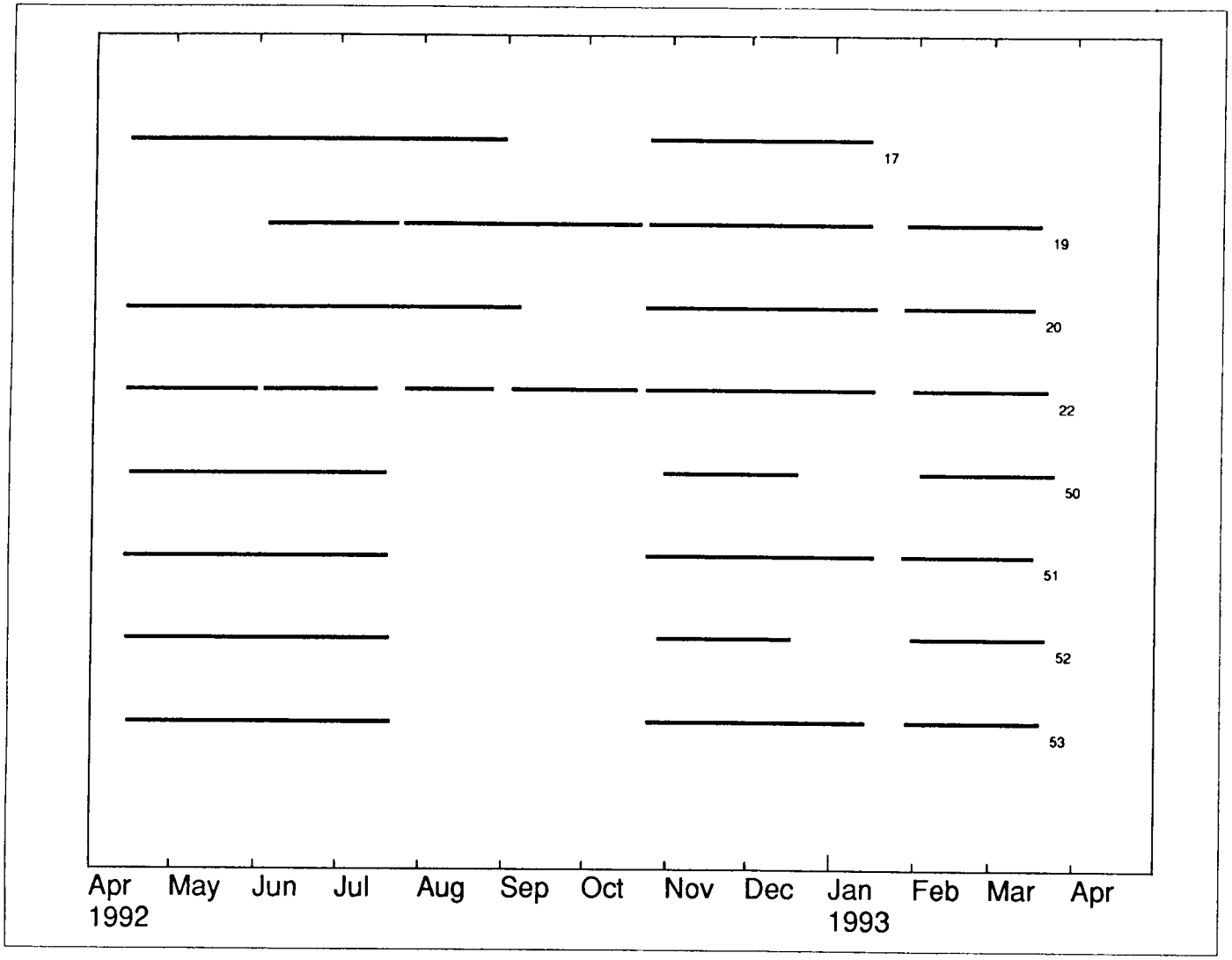


Figure 2.2.6. Data start and stop times for LATEX A meteorological buoys.

Table 2.2.7. LATEX A meteorological buoy data inventory.

Mooring	M02	M03	M04	M05	M06	M07	M08
17	√	√	√	X	√	√	X
19	X	√	√	√	√	√	√
20	√	√	√	X	√	√	√
22	√	√	√	√	√	√	√
50	√	√			√	ND	√
51	√	√			√	√	√
52	√	√			>>>	√	√
53	√	√			√	√	√

√ = data recovered
X = data not recovered
blank = mooring removed from water
>>> = not serviced, data recovered next cruise
ND = not deployed, mooring offsite for repair

The meteorological buoys employ solid-state memory to store the measured data. Unlike the older magnetic tape storage mechanisms, when the power-supply is disrupted, all of the internally-stored data are lost, even that recorded before the power failure occurred. Because meteorological buoy data also are transmitted in near-real time to the LATEX Data Office by the Service ARGOS system some of the lost data can be recovered.

Data delivered via Service ARGOS were received during all of the periods of unrecovered data. Except for cases where the sensors were destroyed or missing, these data helped to fill parts of the gaps. At the latitude of the LATEX A study, there are an average of nine satellite passes per day, each providing a data sample. The passes, however, are separated in time by variable amounts. Whenever the passes are 20 minutes or less, only the data sample with the best accuracy is used. This process provides an average of six usable samples per day. Since the meteorological buoys sample hourly, Service ARGOS-delivered data recovery accounts for somewhat less than 25% of the ordinarily available data.

2.3 Drifting Buoy Measurements

2.3.1 Deployment Times and Locations

Nine of sixteen available satellite-tracked drifters were deployed over the LATEX shelf between August 1992 and November 1992. Table 2.3.1 shows the drifter identification numbers, deployment dates and locations, and event records. Two of these drifters never transmitted data; the remainder have ceased functioning.

2.3.2 Instrumentation and Sampling Procedures

Per the contract specifications, LATEX A received from LATEX C 16 ARGOS-tracked drifters to be deployed from ships. The drifters were manufactured by Clearwater Instrumentation, Inc., of Wellesley, Massachusetts. They were made to meet the specifications of the World Ocean Circulation Experiment (WOCE), except that the total length is shorter, being only 9 m. Each drifter consists of a 33.7-cm diameter surface

Table 2.3.1. LATEX A drifters - deployment dates and disposition.

ARGOS ID	Date and Time yymmddhhmm	Deployment Locations	Event
3583	9208031150	92°00.24' W	Deployed (active 6 days)
	920809xxxx	29°04.80' N	Captured by crew boat - returned to College Station
	9211080518		Redeployed but not active when redeployed - lost
2446	9208031438	91°59.76' W	Deployed (active 11 days)
	9208131637	28°53.34' N	Captured by shrimper
	921008xxxx	90°31.08' W	Redeployed by shrimper
	9210090157	28°23.10' N	Last message - lost
3582	9208032014	91°59.82' W	Deployed (active 32 days)
	9209041506	28°26.58' N	Last message-found on beach-head returned
2447	9208040055	92°00.00' W	Deployed (active 189 days)
	9302091355	27°59.82' N	Last message - lost
6932	9211080216	91°59.94' W	Deployed (active 24 days)
	9212020244	28°26.76' N	Last message - head recovered flooded
6934	9211100546	90°30.72' W	Deployed (active 266 days)
	9211152047	28°52.86' N	Captured by persons unknown
	9304172046	86°08.52' W	Redeployed by captors
	9308030217	30°05.10' N	Last message - lost
6933	9211100719	90°30.42' W	Deployed (active 59 days)
	9301081339	28°46.38' N	Last message - lost
6931	921112xxxx	(lost)	Went into ship's screws during deployment - lost
3585	9211121447	91°59.82' W 28°14.64' N	Not working when deployed - lost

float and instrument housing attached by a 3-m tether to a 91-cm diameter hoop which supports a 6-m long canvas cylinder called a holey-sock. The housing contains a radio transmitter, a thermistor, a submergence detector, associated electronics, and a battery supply sufficient for approximately one year of operation.

Data are transmitted by satellite to Service ARGOS, which then provides the data to the customer. The ARGOS system uses two NOAA satellites in low polar orbit. Although each satellite orbits in a regular period, their periods differ. Therefore, the appearance of either satellite over the drifters is not a regular event. On some passes the satellites pass a drifter within one to two minutes of each other; on other passes they may be three to four hours apart. The number of passes is latitude dependent. Over the Gulf of Mexico eight to 12 passes occur each day. The mean number is nine.

Pre-Deployment Tasks: Tasks prior to drifter deployment include: set-up with Service ARGOS, bench tests, drifter marking, and various administrative tasks associated with disseminating the data over the Global Telecommunications System (GTS).

The location method used by Service ARGOS yields a pair of positions which are symmetrical about the satellite's ground track. Auxiliary information, such as location from Global Positioning System (GPS) equipment upon deployment, is required to resolve the correct location. Auxiliary data, such as temperature, are transmitted to the satellite as counts. Given proper coefficients, Service ARGOS converts the counts into temperature before sending the data to the customer. These coefficients were determined by Clearwater for each drifter's thermistor. Set-up consists of transmitting the current location and thermistor coefficients to Service ARGOS.

During bench testing, each drifter was activated and placed outside in an area free of overhead obstructions. GPS equipment was used to determine the geographic coordinates of the test location, and a laboratory-grade thermometer was placed nearby and read and recorded periodically. The recorded temperatures and GPS-determined locations were compared to those measured by the thermistor on the drifter hull as provided through conversion of counts by Service ARGOS, and the locations as determined by the Doppler-shift method used by Service ARGOS. One drifter failed the bench tests due to a low number of location fixes. It was returned to Clearwater and a replacement drifter was obtained.

Drifters are marked with a toll-free phone number and a statement of ownership in Spanish and English. The first eight drifters deployed were marked by hand with an indelible marker. Subsequent markings were made using water-proof self-adhesive placards.

When drifter locations are merged with the GTS they appear under identification numbers assigned by the World Meteorological Organization (WMO). These numbers were obtained through the offices of the National Data Buoy Center (NDBC). The association between each unique drifter and its WMO number is made by the Drifting Buoy Coordinator at the offices of Service ARGOS in Landover, Maryland.

Deployment: Four drifters were deployed during the hydrographic survey in August 1992 (H02); five were deployed on the survey in November 1992 (H03). The fifth drifter was deployed during survey H03 after the previously deployed drifter was destroyed accidentally by the ship's screws. This drifter and one slated for redeployment both failed to transmit sometime after mobilization. Following this cruise, detailed written deployment instructions were developed and communicated to the deployment crew and a hand-held transmitter test unit was purchased for use at sea to verify the activity of each drifter prior to deployment. During this same period, LATEX C experienced some premature drifter failures and the deployment scheduled for February 1993 (H04) was postponed until an investigation could be completed.

2.3.3 Summary of Data Collection

The mean lifetime of the seven drifters that functioned was 82 days with a range of six to 266 days. The drifters that escaped the inner-shelf survived longest. Two drifters were recovered and returned to service, two were found on beaches—un-drogued, non-functional, and with indications of collision.

Each drifter data set consists of a time series, at non-uniform intervals, of buoy identification numbers, position, date/time, sea surface temperature, and a drogue index, which provides the amount of time the buoy was submerged as an indicator of drogue condition and attachment to the buoy. Initially the drifter data were obtained directly from Service ARGOS via modem through the Telenet dial-in service. This proved to be tedious and error prone due to line noise. A change was made to use the Automated Delivery Service by which the data are sent daily to the LATEX A Data Office via electronic mail over the Internet network.

The drifter data processing has evolved to a point where most steps are automated. The processing begins by collecting the electronic mail messages into a single file and presenting this file to the drifter data processing software. This software reads the multi-line mail messages into internal arrays. Date and time strings are decoded and checked against internal calendar functions. This permits data to be ordered correctly across year boundaries or when mail messages are presented in non-sequential order to the processing program. Duplicate messages are sometimes received. These are identified and eliminated automatically. As noted above, satellite passes may be separated in time by only a few minutes. Pairs closer in time than 20 minutes are eliminated by removing the location with the poorest fix quality. Data gaps greater than three hours are filled using linear interpolation. Finally, cubic-splines are used to generate a uniform time series of locations from which east-west and north-south velocity components are produced. Velocity is calculated from first-difference formulas.

2.4 Hydrographic Measurements

2.4.1 Synopsis of Hydrographic Surveys

The period from the contract award until the end of April 1992 was spent organizing the hydrography program, planning the hydrographic surveys, and obtaining instrumentation in preparation for the standard grid hydrography cruises. During the first field year, four hydrographic cruises were conducted. Three cruises were undertaken aboard the *R/V Gyre* and one aboard the *R/V J.W. Powell*. A Sea-Bird SBE-911*plus* was used on each cruise. Over 100 CTD-Rosette stations were occupied on each cruise in the eastern two quadrants of the study area. The station positions were nearly identical on each cruise, with four lines of stations perpendicular to the coast and two lines along the 50-m and 200-m isobaths, parallel to the coast. No major problems were encountered during the first four cruises. The minor problems that occurred did not impede completion of all the planned work. On three of the cruises, more stations were completed successfully than were planned. The following is a summary of the major events for each of the four cruises conducted during the initial year of field operations.

2.4.1.1 Cruise H01CGY9205

This initial LATEX A hydrography cruise (H01) was conducted in one leg. *The R/V Gyre* departed Galveston, Texas, on 30 April 1992, and returned on 9 May 1992. Figure 2.4.1 shows the location of the stations occupied and the cruise track. Table 2.4.1 gives the station number, date, time (UTC), location, water depth, and number of bottles tripped for each of the stations.

On the first hydrographic cruise 108 CTD stations were planned; 114 were completed. The cruise was completed in nine days, one day less than scheduled. The new equipment fabricated or assembled for the cruise worked well. The GPS navigation system worked

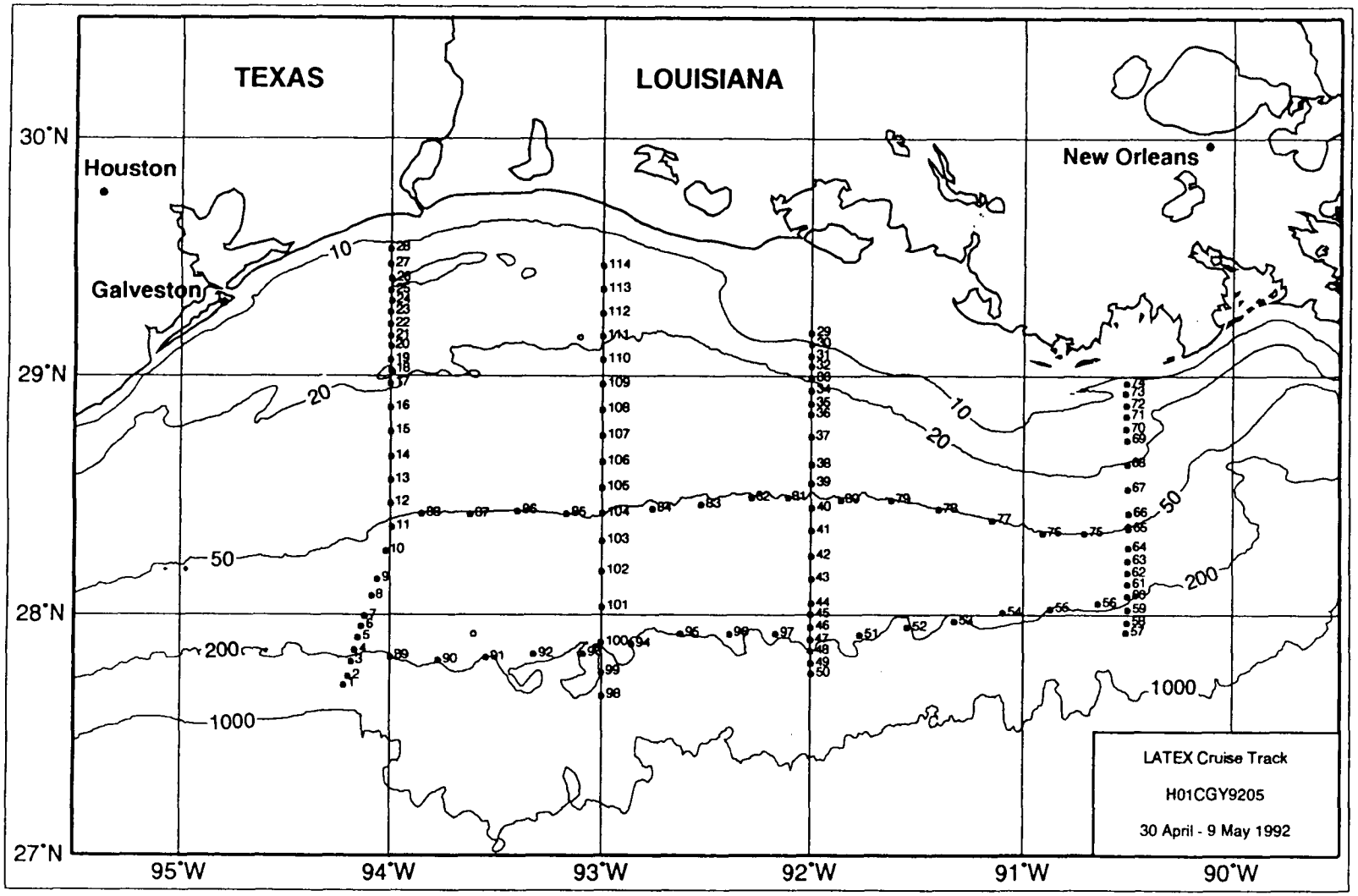


Figure 2.4.1. CTD stations and cruise track, LATEX H01CGY9205.

Table 2.4.1. Station time and position data from LATEX A cruise H01CGY9205.

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
1	01MAY92	1642	27°42.16'	94°13.52'	272	12
2	01MAY92	1832	27°44.29'	94°12.27'	432	12
3	01MAY92	2217	27°48.01'	94°11.41'	266	12
4	01MAY92	2318	27°51.00'	94°10.28'	116	6
5	02MAY92	0041	27°54.16'	94°09.31'	94	12
6	02MAY92	0202	27°57.07'	94°08.33'	82	12
7	02MAY92	0307	27°59.55'	94°07.50'	79	7
8	02MAY92	0420	28°04.67'	94°05.52'	67	8
9	02MAY92	0532	28°08.97'	94°03.79'	63	12
10	02MAY92	0714	28°16.02'	94°01.33'	56	7
11	02MAY92	0831	28°21.95'	93°59.64'	50	12
12	02MAY92	0947	28°27.93'	93°59.99'	41	7
13	02MAY92	1108	28°33.80'	93°59.94'	34	6
14	02MAY92	1228	28°39.64'	93°59.94'	28	10
15	02MAY92	1424	28°45.98'	94°00.05'	23	6
16	02MAY92	1531	28°51.91'	93°59.99'	23	7
17	02MAY92	1641	28°57.94'	94°00.14'	16	8
18	02MAY92	1822	29°01.29'	94°00.07'	18	3
19	02MAY92	1902	29°03.81'	94°00.13'	17	8
20	02MAY92	1943	29°07.36'	94°00.08'	16	3
21	02MAY92	2018	29°09.98'	94°00.07'	15	3
22	02MAY92	2049	29°13.04'	94°00.15'	13	3
23	02MAY92	2131	29°16.21'	94°00.13'	12	2
24	02MAY92	2207	29°19.00'	93°59.95'	11	2
25	02MAY92	2245	29°21.62'	94°00.12'	9	3
26	02MAY92	2320	29°24.58'	94°00.04'	9	3
27	02MAY92	2359	29°28.16'	94°00.15'	10	2
28	03MAY92	0036	29°32.06'	94°00.16'	9	2
29	03MAY92	1212	29°10.88'	92°00.00'	7	4
30	03MAY92	1304	29°07.99'	92°00.06'	11	5
31	03MAY92	1411	29°04.85'	92°00.16'	14	4
32	03MAY92	1442	29°02.31'	92°00.08'	17	4
33	03MAY92	1531	28°59.33'	92°00.07'	20	4
34	03MAY92	1609	28°56.24'	92°00.00'	22	8
35	03MAY92	1728	28°52.96'	92°00.02'	25	6
36	03MAY92	1804	28°50.27'	92°00.02'	27	10
37	03MAY92	1912	28°44.71'	92°00.10'	32	8
38	03MAY92	2022	28°37.74'	91°59.91'	38	11
39	03MAY92	2150	28°32.99'	91°59.89'	43	9
40	03MAY92	2258	28°26.78'	91°59.85'	57	7
41	03MAY92	2357	28°21.07'	91°59.86'	59	12
42	04MAY92	0105	28°14.70'	91°59.91'	67	12
43	04MAY92	0210	28°08.94'	91°59.93'	81	12
44	04MAY92	0321	28°02.71'	91°59.96'	103	12
45	04MAY92	0434	27°59.96'	92°00.04'	118	12
46	04MAY92	0541	27°56.79'	92°00.05'	98	12
47	04MAY92	0705	27°53.60'	92°00.08'	166	12
48	04MAY92	0804	27°50.69'	91°59.98'	196	12
49	04MAY92	0923	27°47.53'	91°59.99'	389	12
50	04MAY92	1033	27°44.97'	91°59.89'	491	12
51	04MAY92	1302	27°54.80'	91°45.89'	171	12
52	04MAY92	1452	27°56.69'	91°32.67'	223	12
53	04MAY92	1700	27°58.23'	91°19.55'	264	11
54	04MAY92	1841	28°00.40'	91°05.85'	128	12
55	04MAY92	2011	28°01.42'	90°52.39'	187	12
56	04MAY92	2150	28°02.72'	90°38.58'	162	12
57	05MAY92	0131	27°55.46'	90°30.48'	496	12
58	05MAY92	0242	27°58.00'	90°30.18'	435	12
59	05MAY92	0343	28°01.29'	90°30.08'	251	12
60	05MAY92	0440	28°04.66'	90°30.20'	147	12
61	05MAY92	0545	28°07.68'	90°30.17'	115	5
62	05MAY92	0800	28°10.48'	90°30.15'	92	12
63	05MAY92	0937	28°13.56'	90°30.02'	75	8
64	05MAY92	1058	28°16.84'	90°30.00'	60	9
65	05MAY92	1156	28°21.63'	90°29.96'	48	12
66	05MAY92	1332	28°25.44'	90°29.96'	44	8
67	05MAY92	1438	28°31.62'	90°30.15'	36	11
68	05MAY92	1545	28°37.94'	90°30.30'	19	12
69	05MAY92	1713	28°43.97'	90°30.37'	16	14
70	05MAY92	1802	28°46.78'	90°30.70'	16	3
71	05MAY92	1841	28°49.98'	90°30.57'	16	12
72	05MAY92	2005	28°52.71'	90°30.62'	16	4
73	05MAY92	2046	28°55.73'	90°30.86'	13	8
74	05MAY92	2131	28°58.10'	90°30.62'	13	6
75	06MAY92	0140	28°20.44'	90°42.59'	47	5
76	06MAY92	0259	28°20.41'	90°54.58'	53	10
77	06MAY92	0442	28°23.71'	91°08.91'	48	9
78	06MAY92	0626	28°26.42'	91°24.02'	49	8
79	06MAY92	0759	28°28.78'	91°37.23'	51	6
80	06MAY92	0931	28°28.79'	91°51.59'	50	8
81	06MAY92	1112	28°29.40'	92°06.60'	50	6
82	06MAY92	1228	28°29.41'	92°17.37'	50	10

Table 2.4.1. Station time and position data from LATEX A cruise H01CGY9205. (continued)

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
83	06MAY92	1406	28°27.63'	92°31.81'	50	6
84	06MAY92	1536	28°26.48'	92°45.67'	50	12
85	06MAY92	1740	28°25.35'	93°10.13'	47	12
86	06MAY92	2021	28°25.96'	93°24.00'	47	7
87	06MAY92	2200	28°25.13'	93°37.29'	48	7
88	06MAY92	2356	28°25.26'	93°51.01'	48	12
89	07MAY92	0439	27°49.26'	94°00.05'	197	12
90	07MAY92	0705	27°48.37'	93°46.28'	187	12
91	07MAY92	1151	27°49.06'	93°32.62'	198	12
92	07MAY92	1423	27°49.84'	93°19.16'	148	12
93	07MAY92	1630	27°50.08'	93°05.31'	174	12
94	07MAY92	1921	27°52.50'	92°51.39'	216	8
95	07MAY92	2104	27°55.14'	92°37.45'	191	12
96	07MAY92	2301	27°55.14'	92°23.41'	82	6
97	08MAY92	0056	27°55.14'	92°09.95'	143	10
98	08MAY92	0607	27°39.39'	92°59.92'	316	12
99	08MAY92	0737	27°45.30'	93°00.17'	203	12
100	08MAY92	0905	27°52.87'	93°00.12'	188	12
101	08MAY92	1042	28°01.82'	92°59.89'	100	12
102	08MAY92	1216	28°10.86'	92°59.98'	70	12
103	08MAY92	1313	28°18.50'	92°59.90'	52	7
104	08MAY92	1431	28°25.42'	92°59.97'	47	12
105	08MAY92	1558	28°31.89'	93°00.00'	42	6
106	08MAY92	1658	28°38.43'	92°59.94'	34	7
107	08MAY92	1755	28°44.95'	92°59.95'	28	8
108	08MAY92	1847	28°51.44'	93°00.00'	25	6
109	08MAY92	1935	28°57.81'	93°00.00'	25	7
110	08MAY92	2024	29°03.99'	92°59.96'	23	7
111	08MAY92	2126	29°10.06'	93°00.03'	18	6
112	08MAY92	2209	29°15.91'	93°00.01'	16	5
113	08MAY92	2257	29°22.01'	92°59.97'	13	3
114	08MAY92	2343	29°27.93'	92°59.97'	12	5

and allowed positioning of all stations to within 150 meters of the planned locations. The Sea-Bird SBE-911*plus* CTD system worked well. Generally good weather during the cruise assisted in keeping the data quality and spirits high.

Two instruments on the CTD package did cause minor problems. The Datasonics, Inc., altimeter worked only intermittently. This malfunction inhibited the ability to keep the CTD a fixed distance from the bottom. As configured for this cruise the D&A Instruments optical backscatter sensor (OBS) did not have the sensitivity required for work on the shelf; it gave data only in very turbid waters. After the cruise, the instrument was returned to the manufacturer to have its sensitivity increased. The only major problem was the loss of three General Oceanics lever-action Niskin bottles during rough weather at station 90. Three spare 10-liter Niskin bottles were used to complete the sampling.

In addition to the LATEX program work, five complementary research efforts were accommodated. Primary production measurements were made at eight stations by Dr. Sayed El-Sayed (TAMU, Department of Oceanography) and his graduate student Khaled Al-Abdulkader. Measurements of zooplankton grazing were made at 11 stations by Dr. Ed Buskey (University of Texas, Marine Science Institute) and his graduate student Susan Brown. Analyses for dissolved organic nitrogen were made at 57 stations by Diego Lopez-Veneroni, a graduate student of Dr. Luis Cifuentes (TAMU, Department of Oceanography). Estimates of coccolithophorid distributions on the shelf were made at 12 stations by Vita Pariente, a graduate student of Dr. Stefan Gartner (TAMU). Measurements of sea surface temperature and salinity were conducted by David Vogele for Dr. Doug Biggs (TAMU, Department of Oceanography).

2.4.1.2 Cruise H02CGY9211

The second LATEX A hydrography cruise (H02) was conducted in one leg with a brief stop in Sabine, Texas. The *R/V Gyre* departed Galveston, Texas, on 31 July 1992 and returned on 9 August 1992. Figure 2.4.2 shows the locations of the stations occupied and the cruise track. Table 2.4.2 gives the station number, date, time (UTC), location, water depth, and number of bottles tripped for each of the stations.

On the second hydrographic cruise more work was accomplished than had been planned. Extra time was available due to near-perfect weather. The pre-cruise plan had called for 114 CTD stations; 124 were conducted. All CTD equipment fabricated or assembled for the cruise worked well. The GPS navigation system allowed positioning of all stations within 150 meters of the planned locations. The only problem during the survey was with the ADCP operations. The ADCP did not work properly part of the time. A three hour diversion to Sabine, Texas, was required to obtain spare boards for the ADCP.

In addition to the LATEX program work, four complementary research efforts were accommodated. Primary production measurements were made at eight stations by Dr. Sayed El-Sayed (TAMU) and his graduate students Khaled Al-Abdulkader and Gaston Gonzales. Measurements of zooplankton grazing were made at 12 stations by Susan Brown, a graduate student of Dr. Ed Buskey (University of Texas, Marine Science Institute). Samples were taken at six stations to estimate coccolithophorid distributions on the shelf for Vita Pariente, a graduate student of Dr. Stefan Gartner (TAMU). Continuous measurements of sea surface temperature and salinity were made during the cruise by Dr. Lauren Sahl of Maine Maritime Academy.

2.4.1.3 Cruise H03CPW9210

The third LATEX A hydrography cruise (H03) was conducted in one leg. The *R/V J.W. Powell* departed Galveston, Texas, on 4 November 1992 and returned on 13 November 1992. Figure 2.4.3 shows the location of the stations occupied and the cruise track. Table 2.4.3 gives the station number, date, time (UTC), location, water depth, and number of bottles tripped for each of the stations.

High winds and rough seas were encountered during every day of the cruise. In spite of the weather, the sampling team worked continuously to complete the survey successfully. The survey plan for this cruise called for 114 CTD stations and all were completed. All CTD equipment fabricated or assembled for the cruise worked well. The GPS navigation system allowed positioning of all stations to within 150 meters of the planned locations. The rough weather during this cruise might have had some effect on the quality of the CTD data collected.

In addition to the LATEX program work, three complementary research efforts were accommodated. Primary production measurements were made at eight stations by students of Dr. Sayed El-Sayed (TAMU), Khaled Al-Abdulkader and Gaston Gonzales. Measurements of zooplankton grazing were made at 10 stations by Susan Brown, a graduate student of Dr. Ed Buskey (University of Texas, Marine Science Institute). Samples were taken at 12 stations to estimate coccolithophorid distributions for Vita Pariente, a graduate student of Dr. Stefan Gartner (TAMU).

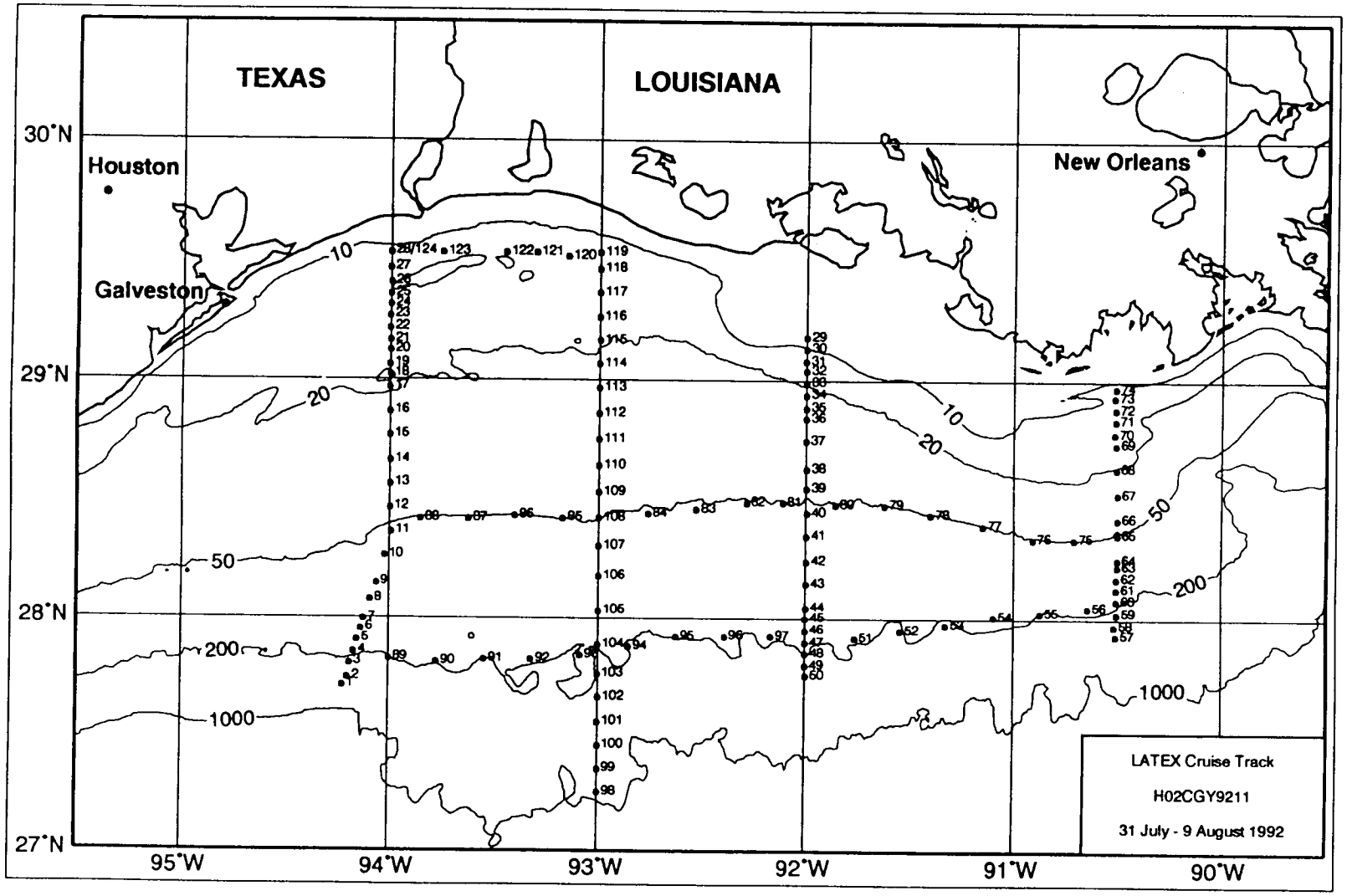


Figure 2.4.2. CTD stations and cruise track, LATEX H02CGY9211.

Table 2.4.2. Station time and position data from LATEX A cruise H02CGY9211.

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
1	01AUG92	1731	27°42.23'	94°13.42'	274	12
2	01AUG92	1912	27°44.31'	94°12.00'	430	12
3	01AUG92	2017	27°48.03'	94°11.40'	265	12
4	01AUG92	2136	27°51.03'	94°10.29'	115	10
5	01AUG92	2232	27°54.18'	94°09.30'	90	12
6	01AUG92	2332	27°57.05'	94°08.27'	81	8
7	02AUG92	0013	27°59.59'	94°07.50'	76	10
8	02AUG92	0112	28°04.65'	94°05.56'	64	9
9	02AUG92	0210	28°08.94'	94°03.83'	62	8
10	02AUG92	0319	28°15.95'	94°01.36'	54	7
11	02AUG92	0420	28°21.94'	93°59.61'	50	6
12	02AUG92	0517	28°27.93'	93°59.96'	40	6
13	02AUG92	0624	28°33.82'	93°59.85'	33	5
14	02AUG92	0721	28°39.63'	93°59.92'	28	11
15	02AUG92	0824	28°45.95'	94°00.00'	23	4
16	02AUG92	0918	28°51.89'	93°59.98'	20	7
17	02AUG92	1017	28°57.92'	94°00.15'	15	5
18	02AUG92	1105	29°01.28'	94°00.09'	16	5
19	02AUG92	1142	29°03.79'	94°00.14'	14	10
20	02AUG92	1254	29°07.36'	94°00.07'	13	5
21	02AUG92	1337	29°10.00'	94°00.06'	13	5
22	02AUG92	1419	29°13.05'	94°00.20'	11	5
23	02AUG92	1458	29°16.19'	94°00.14'	9	7
24	02AUG92	1626	29°19.00'	93°59.98'	9	5
25	02AUG92	1658	29°21.63'	94°00.06'	7	5
26	02AUG92	1739	29°24.59'	93°59.95'	8	5
27	02AUG92	1818	29°28.14'	94°00.14'	6	6
28	02AUG92	1904	29°32.07'	94°00.15'	6	6
29	03AUG92	0958	29°10.91'	91°59.97'	9	5
30	03AUG92	1048	29°07.99'	92°00.04'	10	10
31	03AUG92	1140	29°04.76'	92°00.12'	10	4
32	03AUG92	1224	29°02.29'	92°00.03'	12	6
33	03AUG92	1306	28°59.28'	91°59.98'	15	5
34	03AUG92	1339	28°56.23'	92°00.00'	17	6
35	03AUG92	1426	28°52.96'	92°00.00'	20	5
36	03AUG92	1502	28°50.32'	92°00.00'	23	12
37	03AUG92	1649	28°44.68'	92°00.10'	28	8
38	03AUG92	1752	28°37.71'	91°59.88'	34	10
39	03AUG92	1847	28°32.91'	91°59.87'	44	8
40	03AUG92	1946	28°26.76'	91°59.80'	53	9
41	03AUG92	2053	28°21.14'	91°59.87'	56	9
42	03AUG92	2152	28°14.70'	91°59.90'	63	12
43	03AUG92	2249	28°08.89'	91°59.94'	75	12
44	03AUG92	2349	28°02.64'	91°59.94'	94	12
45	04AUG92	0038	27°59.90'	92°00.01'	116	12
46	04AUG92	0118	27°56.80'	92°00.08'	100	12
47	04AUG92	0217	27°53.59'	92°00.10'	162	12
48	04AUG92	0301	27°50.69'	92°00.01'	177	12
49	04AUG92	0408	27°47.58'	92°00.09'	375	12
50	04AUG92	0504	27°44.97'	91°59.94'	490	12
51	04AUG92	0741	27°54.78'	91°45.87'	168	12
52	04AUG92	0924	27°56.72'	91°32.65'	222	12
53	04AUG92	1101	27°58.25'	91°19.57'	252	12
54	04AUG92	1246	28°00.42'	91°05.83'	127	12
55	04AUG92	1432	28°01.35'	90°52.42'	177	12
56	04AUG92	1638	28°02.71'	90°38.56'	156	12
57	04AUG92	1806	27°55.45'	90°30.35'	485	12
58	04AUG92	1906	27°58.01'	90°30.85'	427	12
59	04AUG92	2012	28°01.28'	90°30.07'	247	12
60	04AUG92	2123	28°04.64'	90°30.17'	137	12
61	04AUG92	2213	28°07.66'	90°30.19'	113	12
62	04AUG92	2307	28°10.43'	90°30.17'	90	12
63	04AUG92	2359	28°13.54'	90°29.99'	75	10
64	05AUG92	0041	28°15.33'	90°29.98'	60	8
65	05AUG92	0128	28°21.60'	90°29.98'	46	7
66	05AUG92	0211	28°25.33'	90°29.98'	41	7
67	05AUG92	0303	28°31.60'	90°29.98'	32	11
68	05AUG92	0400	28°37.92'	90°30.29'	18	5
69	05AUG92	0451	28°43.95'	90°30.39'	13	6
70	05AUG92	0532	28°46.63'	90°30.78'	13	5
71	05AUG92	0604	28°49.96'	90°30.58'	14	10
72	05AUG92	0643	28°52.76'	90°30.61'	13	5
73	05AUG92	0717	28°55.75'	90°30.85'	10	5
74	05AUG92	0747	28°58.12'	90°30.57'	10	5
75	05AUG92	1357	28°20.44'	90°42.55'	44	6
76	05AUG92	1528	28°20.41'	90°54.58'	48	6
77	05AUG92	1729	28°23.73'	91°08.89'	47	6
78	05AUG92	1923	28°26.41'	91°23.97'	47	8
79	05AUG92	2108	28°28.77'	91°37.23'	47	7
80	05AUG92	2308	28°28.81'	91°51.59'	48	7
81	06AUG92	0052	28°29.40'	92°06.59'	47	7
82	06AUG92	0200	28°29.34'	92°17.37'	48	6

Table 2.4.2. Station time and position data from LATEX A cruise H02CGY9211. (continued)

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
83	06AUG92	0330	28°27.63'	92°31.79'	49	7
84	06AUG92	0505	28°26.52'	92°45.65'	49	10
85	06AUG92	0743	28°25.37'	93°10.13'	45	10
86	06AUG92	1007	28°25.96'	93°23.99'	48	6
87	06AUG92	1146	28°25.13'	93°37.23'	46	7
88	06AUG92	1325	28°25.18'	93°51.01'	46	7
89	06AUG92	1755	27°49.26'	94°00.02'	197	12
90	06AUG92	1937	27°48.39'	93°46.23'	183	12
91	06AUG92	2108	27°49.07'	93°32.61'	183	12
92	06AUG92	2247	27°49.08'	93°19.14'	146	12
93	07AUG92	0024	27°50.12'	93°05.26'	178	12
94	07AUG92	0201	27°52.49'	92°51.30'	191	12
95	07AUG92	0344	27°55.11'	92°37.46'	190	12
96	07AUG92	0522	27°55.13'	92°23.48'	75	9
97	07AUG92	0658	27°55.17'	92°09.95'	135	12
98	07AUG92	1326	27°15.02'	92°59.99'	940	12
99	07AUG92	1507	27°20.98'	93°00.01'	750	12
100	07AUG92	1637	27°27.00'	93°00.01'	975	12
101	07AUG92	1912	27°33.01'	93°00.07'	675	12
102	07AUG92	2046	27°39.38'	92°59.94'	309	12
103	07AUG92	2101	27°45.32'	93°00.17'	197	12
104	07AUG92	2331	27°52.93'	93°00.04'	184	12
105	08AUG92	0105	28°01.81'	92°59.89'	95	12
106	08AUG92	0230	28°10.80'	92°59.94'	66	5
107	08AUG92	0342	28°18.46'	92°59.91'	50	6
108	08AUG92	0442	28°25.41'	92°59.96'	48	6
109	08AUG92	0532	28°31.84'	92°59.99'	45	6
110	08AUG92	0627	28°38.42'	92°59.93'	30	6
111	08AUG92	0729	28°44.95'	92°59.93'	28	6
112	08AUG92	0822	28°51.43'	93°00.01'	22	6
113	08AUG92	0913	28°57.81'	92°59.99'	20	6
114	08AUG92	1003	29°03.97'	92°59.96'	20	5
115	08AUG92	1117	29°10.01'	92°59.86'	18	8
116	08AUG92	1224	29°15.89'	93°00.01'	13	5
117	08AUG92	1317	29°22.00'	92°59.96'	11	6
118	08AUG92	1414	29°27.95'	92°59.97'	9	5
119	08AUG92	1505	29°31.97'	92°59.96'	8	0
120	08AUG92	1615	29°31.00'	93°09.01'	8	0
121	08AUG92	1719	29°31.98'	93°18.15'	8	0
122	08AUG92	1949	29°31.98'	93°26.90'	7	0
123	08AUG92	2144	29°32.01'	93°44.98'	8	0
124	08AUG92	2324	29°32.03'	94°00.07'	8	0

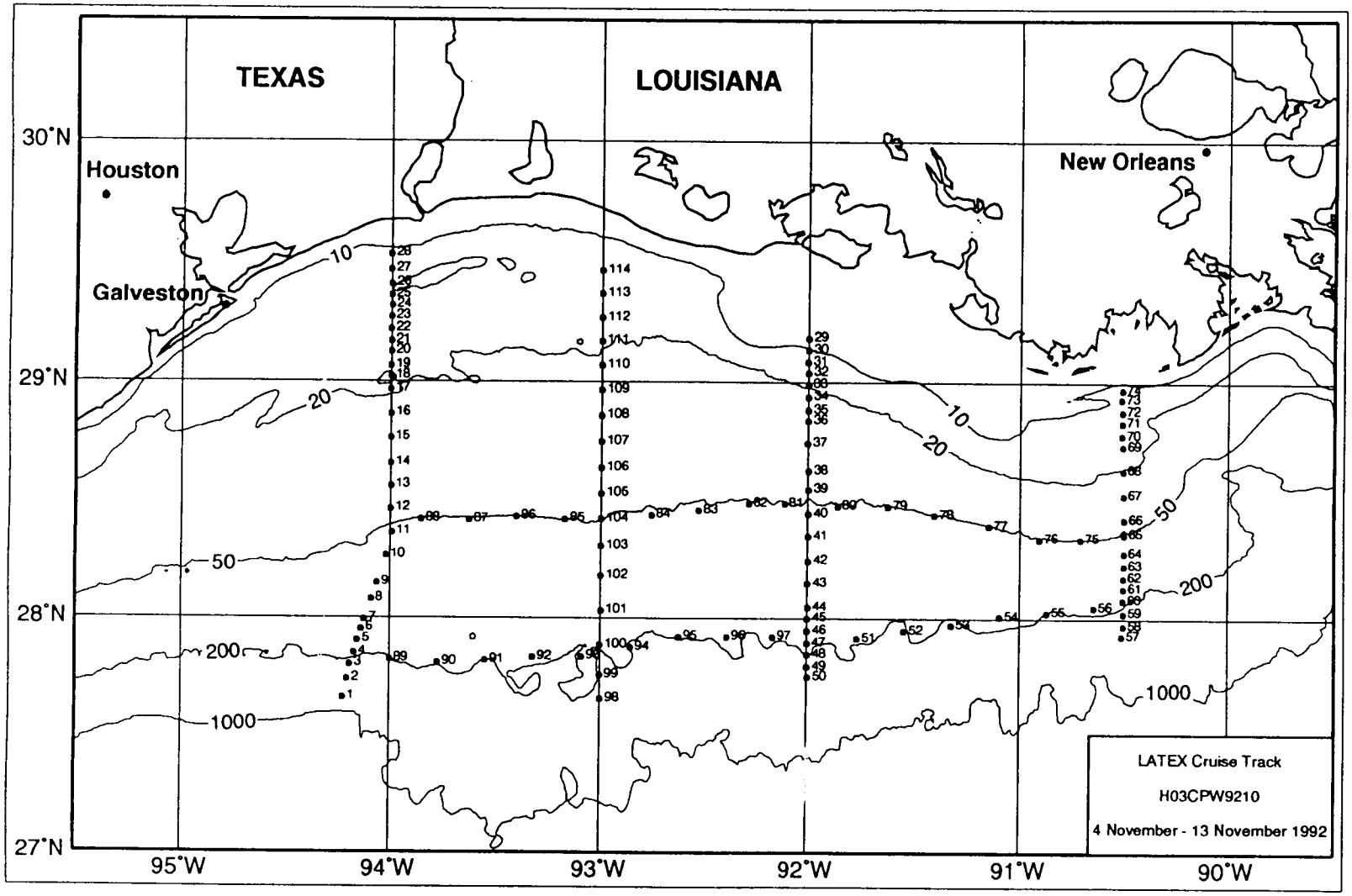


Figure 2.4.3. CTD stations and cruise track, LATEX H03CPW9210.

Table 2.4.3. Station time and position data from LATEX A Cruise H03CPW9210.

Station	Date	Time	Latitude (°N	Longitude (°W)	Depth	Niskins
1	05NOV92	1841	27°39.64'	94°13.46'	396	12
2	05NOV92	2047	27°44.29'	94°12.27'	430	12
3	05NOV92	2223	27°48.01'	94°11.44'	265	12
4	06NOV92	0043	27°50.98'	94°10.32'	120	10
5	06NOV92	0201	27°54.19'	94°09.31'	99	12
6	06NOV92	0321	27°57.08'	94°08.30'	88	8
7	06NOV92	0421	27°59.54'	94°07.50'	79	8
8	06NOV92	0548	28°04.67'	94°05.51'	71	8
9	06NOV92	0712	28°08.86'	94°03.86'	66	8
10	06NOV92	0855	28°15.96'	94°01.30'	60	7
11	06NOV92	1018	28°21.93'	93°59.64'	53	6
12	06NOV92	1150	28°27.95'	93°59.98'	45	6
13	06NOV92	1306	28°33.82'	93°59.94'	38	5
14	06NOV92	1420	28°39.51'	93°59.99'	30	11
15	06NOV92	1538	28°45.96'	94°00.09'	27	7
16	06NOV92	1659	28°51.86'	94°00.02'	27	6
17	06NOV92	1810	28°57.94'	94°00.17'	19	5
18	06NOV92	1909	29°01.25'	94°00.21'	22	5
19	06NOV92	1955	29°03.83'	94°00.15'	20	9
20	06NOV92	2053	29°07.36'	94°00.08'	19	5
21	06NOV92	2132	29°09.98'	94°00.08'	18	5
22	06NOV92	2223	29°13.02'	94°00.14'	17	4
23	06NOV92	2358	29°16.18'	94°00.11'	15	6
24	07NOV92	0042	29°18.99'	93°59.95'	13	5
25	07NOV92	0115	29°21.62'	94°00.11'	12	5
26	07NOV92	0155	29°24.56'	94°00.03'	8	4
27	07NOV92	0232	29°28.15'	94°00.15'	13	5
28	07NOV92	0317	29°32.06'	94°00.16'	12	5
29	07NOV92	1507	29°10.88'	91°59.99'	8	4
30	07NOV92	1546	29°07.97'	92°00.06'	11	8
31	07NOV92	1633	29°04.91'	92°00.15'	14	5
32	07NOV92	1707	29°02.27'	92°00.07'	17	8
33	07NOV92	1756	28°59.31'	92°00.09'	20	5
34	07NOV92	1836	28°56.25'	92°00.04'	23	6
35	07NOV92	1943	28°52.93'	92°00.01'	26	5
36	07NOV92	2021	28°50.28'	92°00.02'	27	11
37	07NOV92	2151	28°44.70'	92°00.15'	34	8
38	07NOV92	2320	28°37.72'	91°59.90'	42	5
39	08NOV92	0042	28°33.02'	91°59.88'	47	6
40	08NOV92	0206	28°26.75'	91°59.85'	57	8
41	08NOV92	0329	28°21.06'	91°59.87'	60	7
42	08NOV92	0500	28°14.69'	91°59.87'	71	8
43	08NOV92	0630	28°08.88'	91°59.99'	85	10
44	08NOV92	0802	28°02.75'	91°59.96'	108	11
45	08NOV92	0923	27°59.92'	92°00.07'	122	12
46	08NOV92	1029	27°56.74'	92°00.06'	102	10
47	08NOV92	1139	27°53.54'	92°00.11'	173	12
48	08NOV92	1411	27°50.67'	91°59.97'	201	12
49	08NOV92	1538	27°47.53'	91°59.99'	373	12
50	08NOV92	1650	27°44.96'	91°59.88'	490	12
51	08NOV92	1949	27°54.79'	91°45.89'	172	12
52	08NOV92	2226	27°56.69'	91°32.67'	228	12
53	09NOV92	0040	27°58.24'	91°19.55'	268	12
54	09NOV92	0300	28°00.40'	91°05.86'	138	12
55	09NOV92	0504	28°01.42'	90°52.40'	189	12
56	09NOV92	0730	28°02.74'	90°38.64'	168	12
57	09NOV92	0945	27°55.45'	90°30.48'	501	12
58	09NOV92	1115	27°58.05'	90°30.05'	442	12
59	09NOV92	1233	28°01.30'	90°30.07'	256	12
60	09NOV92	1351	28°04.68'	90°30.23'	151	12
61	09NOV92	1502	28°07.64'	90°30.11'	120	12
62	09NOV92	1611	28°10.43'	90°30.15'	96	12
63	09NOV92	1717	28°13.56'	90°29.99'	78	12
64	09NOV92	1836	28°16.84'	90°29.99'	64	8
65	09NOV92	1932	28°21.64'	90°29.94'	51	8
66	09NOV92	2034	28°25.42'	90°29.95'	45	7
67	09NOV92	2212	28°31.63'	90°30.14'	37	10
68	09NOV92	2358	28°37.93'	90°30.30'	22	5
69	10NOV92	0126	28°43.99'	90°30.41'	19	4
70	10NOV92	0210	28°46.79'	90°30.71'	19	4
71	10NOV92	0244	28°49.98'	90°30.60'	20	8
72	10NOV92	0330	28°52.70'	90°30.61'	18	4
73	10NOV92	0400	28°55.79'	90°30.86'	15	4
74	10NOV92	0445	28°58.09'	90°30.61'	12	4
75	10NOV92	1049	28°20.41'	90°42.60'	50	8
76	10NOV92	1219	28°20.41'	90°54.56'	52	7
77	10NOV92	1401	28°23.77'	91°08.98'	51	7
78	10NOV92	1539	28°26.51'	91°24.27'	53	7
79	10NOV92	1716	28°28.75'	91°37.21'	52	6
80	10NOV92	1850	28°28.79'	91°51.59'	54	7
81	10NOV92	2037	28°29.42'	92°06.59'	52	8
82	10NOV92	2202	28°29.41'	92°17.37'	54	6

Table 2.4.3. Station time and position data from LATEX A Cruise H03CPW9210. (continued)

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
83	10NOV92	2345	28°27.65'	92°31.81'	55	7
84	11NOV92	0132	28°26.45'	92°45.60'	54	6
85	11NOV92	0404	28°25.33'	93°10.17'	51	10
86	11NOV92	0543	28°25.95'	93°23.99'	51	6
87	11NOV92	0710	28°25.15'	93°37.37'	51	6
88	11NOV92	0844	28°25.25'	93°51.18'	52	6
89	11NOV92	1412	27°49.30'	94°00.10'	202	12
90	11NOV92	1611	27°48.51'	93°46.21'	187	12
91	11NOV92	1746	27°49.02'	93°32.65'	190	12
92	11NOV92	1938	27°49.84'	93°19.16'	155	12
93	11NOV92	2124	27°50.08'	93°05.31'	175	12
94	12NOV92	0002	27°52.50'	92°51.38'	224	12
95	12NOV92	0155	27°55.15'	92°37.44'	193	12
96	12NOV92	0326	27°55.12'	92°23.40'	81	9
97	12NOV92	0452	27°55.12'	92°09.97'	149	12
98	12NOV92	1007	27°39.35'	92°59.92'	321	12
99	12NOV92	1112	27°45.34'	93°00.17'	208	12
100	12NOV92	1225	27°52.98'	93°00.09'	191	9
101	12NOV92	1341	28°01.86'	92°59.86'	102	9
102	12NOV92	1555	28°10.82'	92°59.98'	73	8
103	12NOV92	1719	28°18.46'	92°59.89'	55	8
104	12NOV92	1900	28°25.42'	92°59.98'	50	7
105	12NOV92	2012	28°31.89'	92°59.99'	44	7
106	12NOV92	2120	28°38.43'	92°59.94'	36	6
107	12NOV92	2225	28°44.96'	92°59.95'	30	6
108	12NOV92	2327	28°51.44'	93°00.00'	27	6
109	13NOV92	0035	28°57.81'	92°59.99'	25	5
110	13NOV92	0155	29°03.95'	92°59.94'	25	5
111	13NOV92	0304	29°10.05'	93°00.03'	19	4
112	13NOV92	0412	29°15.88'	93°00.00'	18	4
113	13NOV92	0514	29°22.01'	92°59.98'	16	4
114	13NOV92	0612	29°27.92'	92°59.95'	14	4

2.4.1.4 Cruise H04CGY9302

The fourth LATEX A hydrography cruise (H04) was conducted in one leg. The *R/V Gyre* departed Galveston, Texas, on 4 February 1993 and returned on 13 February 1993. Figure 2.4.4 shows the location of the stations occupied and the cruise track. Table 2.4.4 gives the station number, date, time (UTC), location, water depth, and number of bottles tripped for each of the stations.

Due to excellent weather, five stations were added to the 114 planned CTD stations. Four stations (98, 99, 100 and 101) were added south of the southernmost planned station on survey Line 3 to extend Line 3 to about 1000 m water depth. One station, 119, was added north of Line 3. Early in the cruise one of the CTDs became inoperative and was replaced with the spare CTD unit. At Station 2 the Rosette pylon broke into two parts. This caused the loss of all the water samples at this station. The spare Rosette was installed.

In addition to the LATEX program work, four complementary research efforts were accommodated. Primary production measurements were made at seven stations by Dr. Sayed El-Sayed's graduate student Khaled Al-Abdulkader (TAMU). Measurements of zooplankton grazing were made at 10 stations by Susan Brown, a graduate student of Dr. Ed Buskey (University of Texas, Marine Science Institute). Zooplankton tows were made at 15 stations by Dr. John Rickett of the University of Arkansas and Dr. Richard Roller from Lamar University. Measurements of dissolved organic nitrogen were made at 50 stations by Zang-Ho Shon, a graduate student of Dr. Luis Cifuentes (TAMU).

2.4.2 Instrumentation, Calibration, and Sampling Procedures

The LATEX A philosophy of hydrographic data collection is to go to sea with a complete set of operational, calibrated equipment designed to provide the highest quality data set possible. In addition to this primary equipment, a complete set of calibrated, backup over-the-side equipment is carried aboard the survey vessel. This redundancy has helped to assure that a complete data set was collected on each of the first four standard grid hydrography cruises. On one cruise, the Sea-Bird CTD was replaced at the first station due to a connector failure. On another cruise, the Rosette system and eight of the bottles had to be replaced due to an accident during recovery of the system. Without a complete set of back-up equipment the hydrography data collection effort would have been either incomplete or delayed. The over-the-side equipment that is used on this program is provided at no cost by TAMU.

Conductivity/temperature/depth: The primary system for continuous measurements during LATEX standard grid hydrography cruises is a Sea-Bird Electronics, Inc. SBE-911*plus* conductivity-temperature-depth (CTD) system used with an SBE-11 deck unit. The Sea-Bird SBE-911*plus* CTD is a research grade system which offers high quality profiles of oceanic temperature, conductivity, and pressure to all ocean depths. The SBE-911*plus* uses ultra-stable, time-response matched sensors and fast, high-resolution parallel sampling for data acquisition.

The Sea-Bird SBE-911*plus* CTD uses bolt-on temperature and conductivity sensors which have an established record for reliability and long-term dependability. A Paroscientific Digiquartz pressure transducer with temperature compensated output is used for pressure measurement. A pump is used on the conductivity sensor to match its dynamic response to that of the temperature sensor. All sensors have frequency outputs

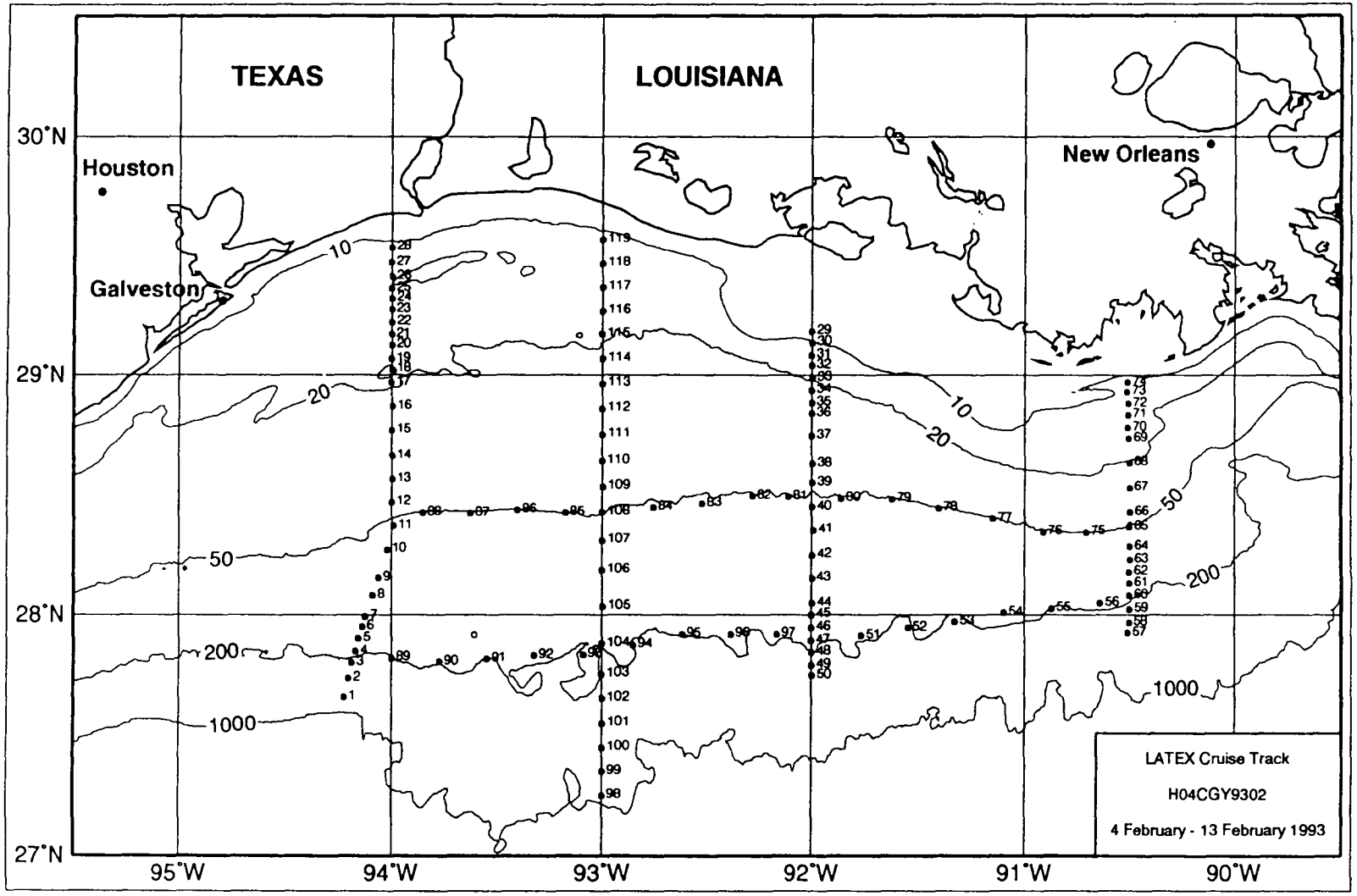


Figure 2.4.4. CTD stations and cruise track, LATEX H04CGY9302.

Table 2.4.4. Station time and position data from LATEX A cruise H04CGY9302.

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
1	06FEB93	0040	27°39.58'	94°13.48'	396	12
2	06FEB93	0250	27°44.28'	94°12.26'	455	12
3	06FEB93	0507	27°48.06'	94°11.30'	258	10
4	06FEB93	0703	27°50.96'	94°10.29'	130	10
5	06FEB93	0822	27°54.13'	94°09.32'	99	10
6	06FEB93	0941	27°56.99'	94°08.29'	86	7
7	06FEB93	1032	27°59.54'	94°07.48'	81	7
8	06FEB93	1221	28°04.63'	94°05.46'	71	8
9	06FEB93	1345	28°08.99'	94°03.70'	65	8
10	06FEB93	1535	28°16.06'	94°01.31'	58	9
11	06FEB93	1706	28°22.00'	93°59.61'	52	7
12	06FEB93	1809	28°27.96'	93°59.99'	42	7
13	06FEB93	1921	28°33.79'	93°59.95'	36	7
14	06FEB93	2031	28°39.66'	93°59.89'	30	10
15	06FEB93	2147	28°45.98'	94°00.03'	25	6
16	06FEB93	2247	28°51.96'	93°59.92'	25	6
17	06FEB93	2357	28°57.95'	94°00.13'	17	5
18	07FEB93	0033	29°01.31'	94°00.03'	20	6
19	07FEB93	0102	29°03.80'	94°00.12'	20	10
20	07FEB93	0147	29°07.30'	94°00.06'	21	4
21	07FEB93	0221	29°09.99'	94°00.09'	17	4
22	07FEB93	0255	29°13.07'	93°59.97'	14	4
23	07FEB93	0332	29°16.26'	94°00.11'	13	4
24	07FEB93	0404	29°19.06'	93°59.99'	12	4
25	07FEB93	0434	29°21.64'	94°00.14'	11	4
26	07FEB93	0507	29°24.64'	94°00.06'	10	4
27	07FEB93	0544	29°28.21'	94°00.13'	12	4
28	07FEB93	0632	29°32.07'	94°00.04'	10	4
29	07FEB93	1750	29°10.86'	91°59.99'	6	4
30	07FEB93	1833	29°08.00'	92°00.01'	10	8
31	07FEB93	1934	29°04.86'	92°00.14'	14	5
32	07FEB93	2022	29°02.29'	92°00.08'	17	7
33	07FEB93	2115	28°59.16'	91°59.86'	19	6
34	07FEB93	2159	28°56.12'	92°00.01'	22	7
35	07FEB93	2256	28°52.99'	92°00.01'	24	7
36	07FEB93	2328	28°50.27'	92°00.02'	27	10
37	08FEB93	0035	28°44.69'	92°00.04'	32	7
38	08FEB93	0133	28°37.70'	91°59.92'	40	8
39	08FEB93	0227	28°32.92'	91°59.86'	45	8
40	08FEB93	0336	28°26.75'	91°59.86'	56	8
41	08FEB93	0441	28°20.96'	91°59.59'	61	8
42	08FEB93	0843	28°14.70'	91°59.91'	70	8
43	08FEB93	0938	28°08.93'	91°59.93'	84	10
44	08FEB93	1031	28°02.71'	91°59.92'	107	9
45	08FEB93	1112	27°59.94'	92°00.04'	122	10
46	08FEB93	1157	27°56.80'	92°00.05'	101	11
47	08FEB93	1246	27°53.59'	92°00.19'	170	12
48	08FEB93	1332	27°50.66'	92°00.00'	203	12
49	08FEB93	1438	27°47.51'	91°59.99'	373	12
50	08FEB93	1523	27°44.93'	91°59.88'	479	12
51	08FEB93	1741	27°54.77'	91°45.90'	170	12
52	08FEB93	1931	27°56.70'	91°32.68'	228	12
53	08FEB93	2114	27°58.23'	91°19.49'	267	12
54	08FEB93	2304	28°00.40'	91°05.82'	138	12
55	09FEB93	0128	28°01.41'	90°52.39'	188	12
56	09FEB93	0318	28°02.72'	90°38.58'	170	12
57	09FEB93	0453	27°55.51'	90°30.49'	501	12
58	09FEB93	0615	27°58.00'	90°30.15'	440	12
59	09FEB93	0709	28°01.28'	90°30.06'	256	12
60	09FEB93	0758	28°04.63'	90°30.22'	152	12
61	09FEB93	0843	28°07.66'	90°30.20'	119	12
62	09FEB93	0943	28°10.47'	90°30.16'	96	9
63	09FEB93	1026	28°13.55'	90°29.99'	78	9
64	09FEB93	1104	28°16.84'	90°30.02'	62	9
65	09FEB93	1153	28°21.69'	90°30.17'	50	8
66	09FEB93	1246	28°25.43'	90°29.96'	45	7
67	09FEB93	1348	28°31.64'	90°30.15'	35	11
68	09FEB93	1414	28°37.95'	90°30.28'	21	6
69	09FEB93	1543	28°43.99'	90°30.37'	16	5
70	09FEB93	1616	28°46.77'	90°30.73'	18	5
71	09FEB93	1703	28°49.97'	90°30.58'	18	10
72	09FEB93	1746	28°52.73'	90°30.60'	17	5
73	09FEB93	1816	28°55.73'	90°30.86'	12	4
74	09FEB93	1842	28°58.12'	90°30.64'	11	4
75	09FEB93	2309	28°20.45'	90°42.60'	49	8
76	10FEB93	0025	28°20.41'	90°54.88'	52	9
77	10FEB93	0158	28°23.76'	91°08.90'	51	7
78	10FEB93	0334	28°26.46'	91°24.01'	51	8
79	10FEB93	0457	28°28.79'	91°37.23'	51	7
80	10FEB93	0626	28°28.89'	91°51.61'	52	7
81	10FEB93	0759	28°29.42'	92°06.66'	50	7
82	10FEB93	0916	28°29.52'	92°17.32'	52	4

Table 2.4.4. Station time and position data from LATEX A Cruise H04CGY9302. (continued)

Station	Date	Time	Latitude (°N)	Longitude (°W)	Depth	Niskins
83	10FEB93	1051	28°27.63'	92°31.82'	53	6
84	10FEB93	1221	28°26.69'	92°45.70'	52	6
85	10FEB93	1453	28°25.32'	93°10.23'	49	12
86	10FEB93	1646	28°25.95'	93°23.99'	49	6
87	10FEB93	1816	28°25.16'	93°37.30'	49	8
88	10FEB93	1951	28°25.27'	93°51.00'	50	7
89	10FEB93	2358	27°49.25'	94°00.05'	203	12
90	11FEB93	0200	27°48.37'	93°46.28'	185	12
91	11FEB93	0345	27°49.03'	93°32.56'	198	12
92	11FEB93	0529	27°49.85'	93°19.10'	150	12
93	11FEB93	0716	27°50.09'	93°05.29'	184	12
94	11FEB93	0905	27°52.53'	92°51.41'	220	12
95	11FEB93	1103	27°55.13'	92°37.42'	194	12
96	11FEB93	1251	27°55.15'	92°23.37'	85	9
97	11FEB93	1432	27°55.16'	92°09.91'	145	12
98	11FEB93	2107	27°14.97'	93°00.03'	940	12
99	11FEB93	2330	27°21.04'	93°00.03'	750	12
100	12FEB93	0108	27°27.00'	92°59.99'	975	12
101	12FEB93	0255	27°33.11'	92°59.97'	675	12
102	12FEB93	0522	27°39.38'	92°59.98'	322	12
103	12FEB93	0635	27°45.29'	93°00.13'	208	12
104	12FEB93	0818	27°52.84'	93°00.09'	193	11
105	12FEB93	0945	28°01.91'	92°59.81'	102	7
106	12FEB93	1058	28°10.89'	92°59.94'	72	8
107	12FEB93	1208	28°18.40'	92°59.95'	54	8
108	12FEB93	1312	28°25.44'	92°59.95'	50	7
109	12FEB93	1427	28°31.92'	92°59.88'	44	7
110	12FEB93	1623	28°38.37'	93°00.04'	35	6
111	12FEB93	1732	28°45.04'	92°59.91'	31	6
112	12FEB93	1848	28°51.46'	93°00.06'	25	6
113	12FEB93	1951	28°57.77'	92°59.99'	23	7
114	12FEB93	2046	29°03.98'	92°59.95'	24	6
115	12FEB93	2140	29°10.11'	93°00.05'	19	5
116	12FEB93	2238	29°15.92'	92°59.98'	17	6
117	12FEB93	2329	29°21.98'	92°59.95'	15	5
118	13FEB93	0017	29°27.99'	92°59.96'	14	5
119	13FEB93	0113	29°34.04'	93°00.02'	11	4

that are individually digitized in the underwater unit 24 times per second. The digitized data are transmitted from the underwater unit via a single conductor armored cable to the shipboard processor. This deck unit (SBE-11) decodes the incoming data and computes sensor frequencies. The binary equivalent of these frequencies is output to a controlling computer (IBM-PC compatible 386 computer with a floating point accelerator chip) using an IEEE-488 communication link. The computer logs the data on disk, and uses instrument calibration data and sensor algorithms to compute temperature, conductivity, salinity, and depth. Additionally, the data (audio tones) from the CTD are recorded on cassette tapes which can be replayed later if problems are encountered with the digital data recording. Specifications for the SBE-911*plus* CTD are given in Table 2.4.5.

2.4.2.1 Hydrographic Measurements

Oceanographic equipment used over-the-side on the LATEX A hydrography cruises included a 12 Niskin bottle Rosette system and a Sea-Bird 911*plus* CTD. In addition to providing precise measurements of temperature and salinity with depth, the CTD system is a general-purpose data acquisition and telemetry system. Data interfaces are provided by Sea-Bird which allow simple interfacing of additional sensors for measuring dissolved oxygen, fluorometry, transmissivity, and downwelling irradiance. On the LATEX hydrography cruises, these extra data channels are used to interface the CTD to a SeaTech, Inc., fluorometer; a Biospherical Instruments irradiance sensor; a SeaTech, Inc., transmissometer; a D&A Instruments optical backscatter meter; and a Datasonics, Inc., altimeter. Sea-Bird also provides data processing software which allows processing and display of data in real-time. This capability allows the LATEX CTD operator to use the data collected during the CTD downcast to make informed decisions about what depths to sample on the upcast using the attached Rosette sampling system. The hydrographic equipment for each hydrography cruise is given in Table 2.4.6. The Rosette frame was specifically designed to mount the underwater equipment so there was a free flow of water to all instruments without any obstruction to mix or perturb the water flow during the descent of the frame. The frame was fabricated in the Department of Oceanography shop facility at TAMU.

On each cruise, in addition to the listed over-the-side equipment, other equipment was used, including a six-channel AutoAnalyzer for nutrients, two Guildline AutoSals for salinity measurements, and a microWinkler system for dissolved oxygen measurements. This equipment and the technicians to operate it were supplied by the TAMU Department of Oceanography. Additionally, two filtering systems were used for suspended particulate concentration and phytoplankton pigment sample collections. The methods of use and calibration of all instruments are given below.

Dissolved oxygen - continuous measurements: Continuous profiles of dissolved oxygen are measured with a "Beckman" polarographic type *in situ* dissolved oxygen sensor connected to the Sea-Bird Electronics SBE-911*plus* CTD. This oxygen probe, manufactured by Sensor-Medics, Inc., produces an oxygen-dependent electrical current and incorporates a thermistor for determination of membrane temperature. Voltages proportional to membrane current and temperature are output by the sensor and digitized in the CTD underwater unit. These data are used along with the CTD temperature, salinity, and pressure to convert the sensor data to oxygen concentration using the algorithm of Owens and Millard (1985).

Table 2.4.5. Specifications of Sea-Bird Electronics, Inc., SBE-911*plus* conductivity, temperature, depth (CTD) underwater unit used on LATEX A-3 cruises.

Measurement Range:	
Temperature	-5°C to +35°C
Conductivity	0 to 7 S/m (0 to 70 mmho/cm)
Depth	0 to 6800 m
Accuracy:	
Temperature	0.004°C (typical, 0.01 per 6-months guaranteed)
Conductivity	0.003 S/m/month (typical, 0.001/month guaranteed)
Depth	0.05% of full scale over the ambient temperature range of 0. to 25°C (typical, 0.1% guaranteed) 0.02% with temperature compensation installed
Resolution:	
Temperature	0.0003°C
Conductivity	0.00004 S/m
Depth	0.004% of full scale
Response Time:	
Temperature	0.082 sec (0.5 m/sec drop) 0.070 sec (1.0 m/sec drop)
Conductivity (pumped)	0.084 sec (0.5 m/sec drop) 0.070 sec (1.0 m/sec drop)
Conductivity (no pump)	0.170 sec (2.0 m/sec drop)
Depth	0.001 sec
Materials:	
6000 Meter Pressure Case	7075-T6 anodized aluminum, 5 inches OD with 0.5 inches wall thickness, zinc anode protected

Weight:
24 kg in air, 15 kg in water, for a standard system with pump option. For work to depths beyond a few hundred meters, additional weight is added to minimize wire angle.

Size:
1.1 m x 0.2 m x 0.3 m, rectangular cage shape to minimize danger of rolling while stored or being serviced.

Table 2.4.6. Hydrographic equipment available on each hydrography cruise.

Instrument	Type	Quantity
CTD System + oxygen	Sea-Bird SBE-911*plus*	2
Rosette	General Oceanics 12 place	2
Rosette frame	TAMU fabrication	2
Niskin Bottles	GO Level Action, 10 liters	12
Niskin Bottles	GO Standard, 10-12 liter	12
Transmissometer	SeaTech 2000 m	2
Fluorometer	SeaTech 3000 m	1
Fluorometer	SeaTech 500 m	1
Backscatter Sensor	D&A Instruments OBS-3	2
Altimeter	Datasonics PSA-900	2
PAR Sensor	Biospherical QSP-200L	2
Secchi Disk	TAMU fabrication	2

Two prime considerations in achieving accurate, high-resolution profiles of dissolved oxygen in the ocean are the flow regime of the sensor and the time response of the oxygen probe. The oxygen sensor used on the CTD is attached to a manifold which permits active pumping of water past the sensor membrane thereby minimizing changes in response time. This pumped feature is especially important in shallow water where the lowering rate necessarily will be slow, or when the cast is stopped to take a bottle sample. The same pump stream is used to service the temperature and conductivity probes as well as the dissolved oxygen sensor, thus assuring uniformity of data. Also, the 2-second response time of the polarographic probe (which is governed by the diffusion rate of oxygen through the membrane and is essentially controlled by the membrane thickness) is sufficient to allow a continuous profile to be accurately collected even at the highest lowering rates envisioned.

In operating the dissolved oxygen sensor at sea, great care is taken to ensure that the dissolved oxygen membrane does not become fouled with oil or grease. It is well known (Gnaigner and Forstner 1983) that the Teflon membrane can be contaminated by oil or grease. Owens and Millard (1985) note that maintenance of the sensor is important for assuring sensor stability. Between casts, the oxygen sensor is flushed and kept filled with distilled water. The stability of the sensor is checked during cruises by performing dissolved oxygen titrations on water samples using the microWinkler technique (Carpenter 1965). These titration values are used in calibration of the sensor and correction of the data.

Obtaining accurate, calibrated dissolved oxygen data from an *in situ* oxygen sensor requires both precise calibration of the probe and verification of the data using concurrent bottle samples titrated for dissolved oxygen. Before and after each hydrographic cruises, the probe is calibrated. To calibrate the polarographic oxygen probe, the oxygen current bias (B_{oc}) and oxygen current slope (S_{oc}) are determined for the sensor by measuring the current output in a sodium sulfite solution (zero oxygen, yields B_{oc}) and in a seawater saturated with dissolved oxygen (yields S_{oc}). These calibration values are used with the CTD data (temperature, salinity, pressure) and oxygen sensor constants to calculate *in situ* dissolved oxygen (in $ml \cdot l^{-1}$).

The oxygen sensor constants required are the temperature correction factor for membrane permeability (tcor), pressure correction factor for membrane permeability (pcor), oxygen sensor response time (tau), and weighting fraction of oxygen sensor internal temperature (w_T). These values should be constant for each sensor and are available from the sensor technical information. However, pcor, tcor, and w_T can change due to contamination of the membrane by oil or grease. Because of this possibility, it is imperative that probe-derived dissolved oxygens be compared with bottle-titrated values throughout the cruise. At approximately half the LATEX hydrography stations in each cruise, bottle titrations are performed to determine discrete dissolved oxygen values for comparison with the continuous data from the oxygen probe. These bottle data are used in the algorithm of Owens and Millard (1985) to determine tcor, pcor, tau, and w_T and thus provide an independent calibration of the continuous profile data. Plots of profile data versus bottle data are examined after each cruise to verify that the continuous profiles are correct, or to correct them as required.

Dissolved oxygen – discrete measurements: Samples for discrete measurements of nutrients, particulate material, phytoplankton pigments, salinity, and dissolved oxygen are obtained during the cruises by collecting samples from PVC Niskin bottles mounted on the General Oceanics Rosette sampler. To assure plenty of water for measurements of all parameters, 10-liter bottles are used to collect the water samples. The Niskin bottles on the Rosette are electronically triggered from the shipboard laboratory. The bottles are closed during the raising of the CTD. The Rosette holds 12 bottles.

Water samples are drawn and processed as soon as the CTD-Rosette system is brought back on board. Sub-samples for dissolved oxygen are drawn first, followed in order by sampling for salinity, nutrients, pigments, and suspended particulate material (SPM). Analyses of dissolved oxygen, nutrients, and salinity are performed at sea. Samples for particulate material and phytoplankton pigments are processed at sea and the filters returned to the laboratory for final processing.

Samples for dissolved oxygen analysis are collected in 125-ml, calibrated, glass-stoppered bottles. When a station is sampled for dissolved oxygen, samples from all Niskin bottles (surface to bottom) are collected. Oxygen samples are collected and analyzed for dissolved oxygen by the reliable microWinkler technique (Carpenter 1965). The microWinkler method has a precision of 0.01 ml/l oxygen at STP.

Bottle salinity: Samples for salinity analysis are collected in 250-ml glass bottles that have been triple rinsed with sample water before collection. These bottles are airtight. Salinity samples are taken from at least 64 of the stations during each cruise. Salinity samples are analyzed aboard ship using a Guildline Model 8400 AutoSal Laboratory Salinometer. Salinity from the AutoSal is reported on the practical salinity scale. The accuracy of these salinity measurements is ±0.003.

Nutrients: Water samples were collected from Niskin bottles at every station during the first four LATEX A hydrography cruises. The nutrient samples were analyzed aboard the vessel immediately after sampling. A complete nutrient AutoAnalyzer is used along with two trained analysts from the Technical Support Services Group in the Department of Oceanography at TAMU. The analysts work in two 12-hour shifts and usually run the samples within a few hours of collection.

The water samples are analyzed for the nutrients phosphate, silicate, nitrate, nitrite, ammonium, and urea using a six channel Technicon AutoAnalyzer. The system is

standardized by running two to four working standards of all six nutrients prior to, and after, each set of samples is analyzed. The goal is to analyze all samples within two hours of collection. The peak height data are entered into a personal computer. The peak heights from the AutoAnalyzer are converted to nutrient concentrations in μM by linear interpolation from absorbency relative to the working standards.

Silicate is determined by the ammonium molybdate + tartaric acid + stannous chloride method; phosphate by ammonium molybdate + hydrazine method; and nitrate by sulfanilamide + NEDA method (n-1-napthyl ethylene diamine dihydropchloride), after reduction to nitrite with a cadmium reduction column (Atlas et al. 1971). Ammonium is determined by the sodium hypochlorite oxidation to nitrite method (Slawyk and MacIsaac 1972; Grasshoff 1970), and urea by the phenol hypochlorite method (Aminot and Kerovel 1982).

Meteorology: The interaction of sea and air is extremely important in the studies of various oceanographic problems. Almost all oceanographic observations must be accompanied by simultaneous meteorological and sea surface observations. The types of meteorological observations that are useful to a study such as the physical oceanography of the Texas-Louisiana shelf include: weather, cloud type and amount, visibility, wind speed and direction, dry- and wet-bulb air temperatures, barometric pressure, and mean wave (sea) and swell data.

During the first four standard grid hydrographic surveys, weather and wave observation data were collected every six hours at approximately 0000, 0600, 1200, and 1800 (UTC). The weather data are logged on the standard NOAA form entitled "Weather Report for Immediate Transmission." During surveys H01, H02, and H03 the weather information was transmitted to the GTS of the WMO by using a Shipboard Environmental Data Acquisition System (SEAS III) provided by the NWS. The weather information collected during H04 were not transmitted to WMO because no SEAS III system was available.

The SEAS III system is run by a personal computer which the operator uses interactively to enter the weather observation data recorded on the standard log sheets. Upon completion of the entry, the observation is sent to the SEAS data collection platform where it resides in a buffer until its proper transmission time. At the assigned time slot, the message is automatically transmitted and routed through the GOES satellite, Wallops Island, NESDIS, and via the GTS to the WMO.

2.4.2.2 Suspended Sediment Measurements

Particle scattering: Continuous profiles of particle scattering are measured at each hydrographic station using a D&A Instruments and Engineering temperature-compensated, optical backscatter sensor (OBS). Because of its small size, the backscatter sensor is easily attached to the CTD-Rosette package allowing particle scattering data to be collected with the same resolution as the CTD data. The Downing OBS-3 instrument measures particles using infrared radiation. The emitter-detector configuration of the OBS sensor detects infrared radiation scattered by particles in the range of angles from 140-160°. The OBS sensor is extremely linear in its response to particle loading. In the turbidity range from 0.02 to 2000 Formazin Turbidity Units (FTU), the maximum deviation of response from a straight line is less than 1.5% of the calibration range. This FTU range corresponds to a mud-sized particle range of 0.1 to 5000 mg/l. When this unit was received from the manufacturer, it did not have the required sensitivity to measure the particle loads encountered on the Texas-Louisiana shelf except at the most inshore

stations. After the first hydrography cruise, the sensor was modified to increase its minimum level of detection by a factor of 20. More usable data was obtained after this modification, but the sensor still provides useful data at about only 10% of the hydrographic stations.

Fortunately, in addition to the optical backscatter sensor, the CTD is equipped with a SeaTech, Inc., 25-cm transmissometer. This unit provides beneficial ancillary optical information in waters of lower turbidity which is found at the offshore stations. The data from the transmissometer (in % transmission) is processed along with the OBS data to determine the suspended particulate loading on the shelf. Because the optical backscatter sensor yields useful data only in very turbid waters, the transmissometer has provided a useful inventory of suspended particulate material information from most of the cruises. The transmissometer is calibrated annually by SeaTech and is returned for servicing after any cruise during which a problem develops.

Particulate matter: The D&A Instruments and Engineering OBS is provided with a factory calibration that uses an EPA-approved Formazin standard. This calibration is not useful for oceanographic work. The suspended particulate material (SPM) on the shelf should be examined in terms of milligrams of SPM per liter. To conduct a better calibration of both the OBS and the transmissometer during the cruises, water samples are collected and filtered for determination of SPM. The weight determinations of SPM from the filtered samples are used with the OBS and transmissometer data from the same depths to prepare a calibration curve (by linear regression) showing sensor voltage versus $mg \cdot l^{-1}$ of suspended particulate material. These SPM calibrations are carried out by Dr. Lauren E. Sahl at Maine Maritime Academy.

Water samples for the analysis of particulate material were collected on each of the first four standard grid hydrography cruises at about 50 stations. The SPM water samples were collected from the Niskin bottles and triggered at the surface, near the bottom, and at other depths of interest as determined by the particle backscatter and beam attenuation profiles collected in real-time.

Water samples were analyzed for SPM by filtering approximately one liter of water (measured to 1 ml) through a pre-weighed 47 mm polycarbonate Nucleopore filter with 0.4 μm pore size. The polycarbonate filters are prepared by drying them to a constant weight and weighing them three times on a Cahn Mode 29 electrobalance to +/- 0.1 μg. A ^{210}Po anti-static device is placed inside the balance to remove static electricity from the filters before weighing. The filters are stored separately in plastic petri dishes for use at sea. A series of control and blank filters are also prepared with each batch. To remove excess salt, before removing the filter from the funnel, the filter is washed four times with 5 ml aliquots of distilled water. The filter then is placed in a desiccator to dry. The dried filters are again weighed three times until the standard deviation of the weights is less than 10 μg. The suspended particulate material (in $mg \cdot l^{-1}$) is calculated by subtracting the initial average weight from the final average weight and dividing by the volume filtered. The method is similar to that described by Trefry et al. (1984), except the filters are not acid washed before use. Weighing Nucleopore filters before and after washing has shown that there is no significant weight loss from the filters from washing.

2.4.2.3 Biological Measurements

Phytoplankton pigment data: Phytoplankton pigment samples were collected at 80 or more stations during each of the first four LATEX A hydrography cruises. Water samples are collected from the Niskin bottles at depths determined by the CTD operator based on the real-time fluorescence profiles measured by the *in situ* fluorometer attached to the CTD system. Samples are collected from selected stations chosen to maximize both the areal coverage and ensure that a wide range of pigment levels are sampled. The phytoplankton pigment samples are collected in one-liter, brown, plastic bottles. As the water flows from the Niskin bottle into the plastic bottle, it passes through a mesh Nitex screen which removes zooplankton from the pigment samples.

In the shipboard laboratory, one-liter water samples are filtered in duplicate through Whatman GF/F fiberglass filters (47 mm) under low-to-moderate vacuum. The filters are frozen in liquid nitrogen immediately after collection and are returned to Texas A&M University for analysis in the GERG pigment laboratory. There the filters are removed from the liquid nitrogen and extracted in 5.4 ml 100% acetone (containing an appropriate internal standard) under subdued light. Samples are then vortexed and allowed to extract for 24 hours in the dark at -20°C. Following extraction, samples are centrifuged for five minutes to remove cellular debris. Chlorophyll and carotenoid pigments are separated using a Spectra-Physics Model SP8700 liquid chromatograph and Radial-PAK C18 (8 x 100 mm column; 5-5 m particles) at a flow rate of 6 ml per min. Prior to injection, a 1 ml aliquot of the pigment standards or algal extract is mixed with 300 µl of ion-pairing solution (15 g tetrabutylammonium acetate and 77 g ammonium acetate in one liter of distilled water; Mantoura and Llewellyn 1983). A two-step solvent program is used to separate the various pigments extracted from the natural samples. After injection (500 µl sample), mobile phase A (80:15:5; methanol:water:ion-pairing solution) is ramped to mobile phase B (methanol) over a 12 min period. Mobile phase B is then pumped for 20 min, for a total analysis time of 32 min.

Individual chlorophyll and carotenoid peaks are detected and quantified by area with a Waters Model 440 Fixed Wavelength Detector (436 nm) and a Hewlett-Packard Model 3392A integrator, respectively. Phaeophorbides and phaeophytins are detected and quantified (by area) with a Waters Model 420-AC Fluorescence Detector (EXl: 400-460 nm; EMl:>600 nm) and a Hewlett-Packard Model 3392A integrator, respectively. Peak identities of the pigment extracts are determined by comparing their retention times with pure standards and extracts prepared from "standard" plant materials (*Emiliana huxleyi*, *Phaeodactylum tricornutum*, *Pelagococcus subviridis*, spinach, etc.) of known pigment composition. On-line diode array spectroscopy (400-700 nm; Hewlett-Packard Model HP8451 Diode Array Spectrophotometer) is used to confirm the identities of the major chlorophylls, carotenoids, phaeophorbides, and phaeophytins.

Pigment standards are obtained from Sigma Chemical Co. (chlorophylls a, b, and β-carotene) or purified by preparative-scale HPLC. Concentrations of the pigment standards are determined spectrophotometrically in one-cm cuvettes using published extinction coefficients. Known pigment quantities are injected and resultant peak areas are used to calculate individual standard response factors (ng pigment per area). Pigment concentrations (ng pigment per liter) of the samples then are calculated based on these response factors and knowledge of the filtration and extraction volumes.

2.4.2.4 Marine Optics

Downwelling Irradiance: Continuous profiles of downwelling irradiance are measured at each hydrographic station using a Biospherical Instruments, Inc., Model QSP-200L irradiance-profiling sensor. The QSP-200L is a light transducer specifically designed to measure widely variant light fields in the ocean in conjunction with CTD systems. The QSP-200L has a logarithmic output which is consistent with the inherently depth-dependent exponential decay of light in the ocean. The logarithmic output allows accurate measurements over four decades of light intensity, ranging from 0.01 to 100% of full sunlight. The heart of the QSP-200L is a blue-enhanced, high-stability, silicon photovoltaic detector with dielectric and absorbing glass filter assembly. The output voltage from the irradiance sensor is digitized by the Sea-Bird CTD and transmitted to the deck along with the CTD data. The irradiance data in μ Einstein$\cdot s^{-1}m^{-2}$ are processed and displayed in real-time by the Sea-Bird CTD data acquisition software along with the other continuous profile parameters.

The QSP-200L has a spectral response designed to measure photosynthetically available radiation (PAR) between 400 and 700 nanometers with an equal quanta response. The QSP-200L is configured with a scalar 2π, "omnidirectional" irradiance optical collector. The QSP-200L downwelling irradiance sensor is entirely modular. The sensor and sensor interface electronics occupy a sealed, self-contained pressure housing. The irradiance sensor has a cylindrical shape with a length of 15 cm and a diameter of 7 cm. This unit is attached to the top of the CTD-Rosette package to ensure that the light sensor is not shaded during lowering. This modular configuration allows for ease of installation, service, and calibration. A malfunctioning sensor can quickly and easily be exchanged at sea.

The QSP-200L sensor is calibrated yearly by Biospherical Instruments using a NIST tracable, 1000-watt type FEL Standard of Spectral Irradiance. Two calibrated sensors were carried on each hydrography cruise to ensure a spare instrument was available.

Secchi disk data: On all LATEX A hydrography cruises, light penetration was measured at each station occupied during daylight hours using one of oceanography's most traditional devices, the Secchi disc. The Secchi disc is a circular plate, having a standard diameter of 30 centimeters. One side is white and the other is grey. A ring attached at the center of the disc allows a graduated line to be secured. A five to seven and one-half pound lead weight is attached to the disc so the device will sink rapidly and vertically. The line attached to the Secchi disc is marked off in one meter intervals to at least 35 meters.

The Secchi disc is designed to measure transparency and is dependent upon the available illumination which varies with the time of day, cloud formation, and amount of cloud cover. To obtain Secchi disc observations, the Secchi disc with the white side up was lowered into the water from the shaded side of the ship until the disc is just perceptible, and the depth in meters noted. The lowering is then continued until the disc is no longer visible. The disc is then slowly raised until it is again barely visible. The depth reading of this point is averaged with the reading obtained on lowering and recorded. The Secchi disc average depths are reported to the CTD operator who records them on the station CTD log sheet for transmittal to the LATEX Data Office.

2.4.3 Summary of Data Collection

On each hydrographic cruise, more data were collected than required in the contract. Table 2.4.7 summarizes data collected and scientific participation from the first four standard grid hydrography cruises. In addition, visiting researchers on each cruise collected complementary data for use in their individual research programs. Information relative to theses complementary programs is given in Table 2.4.8.

Table 2.4.7. Summary of data collected and scientific participation in the first four LATEX A standard grid hydrography surveys.

Description	H01 May 1992	H02 Aug. 1992	H03 Nov. 1992	H04 Feb. 1993
Cruise Duration (days)	9	9	9	9
Cruise Track (km)	1117	1050	1050	1080
Total Hydro Stations	114	124	114	119
CTD Stations	114	124	114	118
Nutrient Stations	114	118	114	118
Oxygen Stations	64	72	77	80
Salinity Stations	64	73	68	71
Pigment Stations	83	88	85	87
Particulate Stations	52	50	56	58
Secchi Disk Stations	51	59	45	47
Weather Obs	27	30	32	30
Nutrient Samples	936	1008	955	932
Salinity Samples	485	588	461	556
Oxygen Samples	481	590	544	636
Pigment Samples	644	689	701	900
Particulate Samples	107	93	116	122
Total Scientific Party	20	20	17	22
LATEX Scientists	14	16	14	18
Guest Investigators	6	4	3	5
Graduate Students	5	8	8	9
Complementary Studies	5	4	3	4

Table 2.4.8. Complementary programs on LATEX A hydrography surveys.

Description	H01 May 1992	H02 Aug. 1992	H03 Nov. 1992	H04 Feb. 1993
Complementary Studies	5	4	3	5
Guest Investigators	6	4	3	4
Phytoplankton Stations	83	88	85	87
Zooplankton Stations	12	11	10	10
DOM Stations	26	0	0	50
Productivity Stations	8	8	8	7

2.5 Acoustic Doppler Current Profiler Measurements (ADCP)

2.5.1 ADCP Surveys

ADCP surveys were conducted during all four hydrographic surveys in the first field year. Dates are shown in Table 1.5.1. Continuous data were obtained along the tracks of the surveys, except during periods when instrument problems occurred or the system was shut off during long periods at a fixed location. Survey tracks are shown in Figures 2.4.1 through 2.4.4. Three surveys (H01, H02, and H04) were conducted aboard the *R/V Gyre*; one survey (H03) was conducted aboard the *R/V J.W. Powell*.

An additional ADCP survey, not required by the contract, was conducted aboard the *R/V J.W. Powell* during the current mooring cruise M03 (see Table 1.5.1). Its purpose was to test the operation of the Direct-Reading model ADCP that was to be used on the *R/V J.W. Powell* during cruise H03.

2.5.2 Instrumentation, Calibration, and Sampling Procedures

Two 150-kHz narrow-band ADCPs manufactured by RD Instruments, Inc. (RDI), were used to collect current profiles during the hydrographic surveys. The unit aboard the *R/V Gyre* was vessel-mounted with a 30° concave transducer. Mounting and calibration of the ADCP aboard *R/V Gyre* has been described by Murphy et al. (1992). The unit aboard the *R/V J. W. Powell* was a Direct-Reading ADCP with a 20° convex transducer mounted in a transducer well. Its installation and calibration were similar to that of the ADCP on the *R/V Gyre*.

The Sperry gyrocompasses on both vessels were connected to the ADCPs to provide heading information. Both gyros provided a 1-to-1 output ratio; this adjustment of the ADCP heading to the gyro was automatic. The transducer offset was determined in the field by calibration runs and then by post-processing of the data. The ADCPs were controlled by personal computers that also processed and logged the data.

For surveys H01, H02, and M03 RDI's program, DAS, was used to control, record, and process the data. On surveys H03 and H04, RDI's newer program, TRANSECT, was used. DAS and TRANSECT are discussed in sections 3.5.1.1 and 3.5.1.2. The units were

operated in bottom-tracking mode. Navigation data also were recorded to provide verification and backup information for the bottom-tracking velocities. GPS (non-differential) navigation was used on all cruises.

A calibration transect was done on each survey. Typically, this consisted of steaming a five-mile course between two fixed reference points (oil rigs) while the ADCP logged data in bottom-track mode, and then repeating this course on the opposite heading. For H03 and H04, additional checks were made by comparing the bottom-tracking velocities against the ship's velocity as determined from GPS. The bottom-tracking mode was found to be less reliable than using GPS to determine ship's velocity. The calibration data provided a check on the accuracy of the transducer alignment by having the ship pass over the same course in opposite directions while the transducer offset in the program was adjusted to give similar water velocities.

The main purpose of the calibration transect was to provide an estimation of the transducer misalignment angle for use during the cruise. The estimated misalignment angle is an input parameter to the data acquisition software that permits the operator to view "corrected" currents while underway. However, a final estimation of the misalignment angle is made during post-processing using the complete data set, as described in section 3.5.1.4. The *R/V Gyre's* ADCP is a vessel mounted model with transducer heads that have a fixed mounting to the hull. It's misalignment angle is typically less than 2.5°; variations in this angle are due to the gyroscope. The Direct Reading ADCP used in the well aboard the *R/V J.W. Powell* has no pre-determined orientation. Once mounted in the well its orientation remains fixed during the cruise, and small variations in the misalignment angle between the ship's gyro and the ADCP heads are due to the gyro.

During H01 and H02, the ADCP configuration was changed a number of times in an attempt to obtain more information in the shallower depths and to provide real-time current information to the scientists on board in a timely manner. However, many of the configurations chosen by the operator were inappropriate and resulted in unusable data. These problems are discussed in more detail in section 3.5.2. For H03 and H04, the ADCP configuration was changed less often, with the goal of keeping the settings constant to assist with data processing and quality control. Generally, the settings in Table 2.5.1 were used.

2.5.3 Summary of Data Collection

The configuration recorded for each ADCP cruise are shown in Table 2.5.1. The dates of data collection and the quantity of ADCP data collected are indicated in Table 2.5.2.

2.6 Collateral Data

The assembly of collateral data consists of the collection of information from other programs that are collecting physical oceanographic data on the Texas-Louisiana shelf during the LATEX field years and from pertinent historical reports. These data will be used to assist in the analysis of the LATEX A data set and in the development of the final synthesis report. The collateral data assembly has followed the plan given in Nowlin et al. (1991).

In this section is a summary of progress made in assembling: a bibliography on the physical oceanography of the Gulf of Mexico; physical oceanographic data collected

Table 2.5.1. ADCP configurations.

System Parameter	H01	M03	H02	H03	H04
Averaging Interval	5 min	5 min	5 min	5 min	5 min
Depth Cell Length	2 m	4 m	2 m	4 m	4 m
Number of Depth Cells	various	various	20	100	100
Time Between Pings	1 sec	1 sec	1 sec	1.75 sec	1.75 sec
Transmit Pulse Length	various	4 m	various	4 m	4 m
Blank After Transmit	various	2 m	1 m	4 m	4 m
Navigation Type	GPS	GPS	GPS	GPS	GPS
Data Recorded	Averaged Data; Navigation	Averaged Data; Navigation	Averaged Data	Raw Data; Averaged Data; Navigation	Raw Data; Averaged Data; Navigation

Table 2.5.2. Dates and quantity of ADCP data collection.

Cruise	ADCP Start	ADCP Stop	Acquisition Program	Quantity Of Data
H01	04/30/92	05/09/92	DAS	24 mb
M03	07/13/92	07/27/92	DAS	27 mb
H02	07/31/92	08/09/92	DAS	27 mb
H03	11/04/92	11/13/92	TRANS	91 mb
H04	02/04/93	02/13/93	TRANS	84 mb

during the LATEX field years (the concurrent data) from the Texas-Louisiana shelf and adjacent waters; and historical data from the Gulf of Mexico that may be pertinent to the analysis and synthesis of the LATEX and concurrent data sets.

2.6.1 Bibliography

Based on a collection of atlases, reports, and article reprints begun by W. D. Nowlin, R. D. Parker, and W. J. Merrell, LATEX A is assembling a bibliography on the physical oceanography of the Gulf of Mexico. The 40-page LATEX Gulf of Mexico bibliography was first distributed in May 1992; a second edition was released in April 1993. Notice of its availability is posted quarterly to the GULF.MEX bulletin board and is promoted in every issue of the *LATEX Fortnightly*. More than 150 copies have been mailed to individuals and institutions. Diskette versions have been sent at the request of three libraries (Woods Hole Oceanographic Institution, the Army Corps of Engineers facility at Vicksburg, and TAMU - Galveston). The April 1993 edition will be included in the microfiche packet that will accompany the Final Report at the end of the program.

2.6.2 Concurrent Data Collection

LATEX A has established links with other programs that are collecting data on the physical oceanography of the Texas-Louisiana shelf and adjacent waters during the LATEX field years. Many of these data sets have been obtained through data sharing agreements that limit further distribution of the data. A discussion of data sharing and summary of sharing agreements is presented in section 4.3. The major data sets obtained are briefly described in Table 2.6.1.

2.6.3 Historical Data Collection

As part of the collateral data assembly, LATEX A has acquired available historical data from the Gulf of Mexico that could be useful in interpreting the LATEX data sets. The principal data sets are included in Table 2.6.1. Other historical information obtained for use in the final synthesis includes climatologies of temperature and salinity (NOAA 1974, 1985), surface currents, waves, and winds (U.S. Naval Oceanographic Office 1972), and tidal currents (Ministere des Peches et Oceans 1992; Defense Mapping Agency 1982), and reports on Gulf of Mexico models (e.g., tide and storm surge models: Bumpapong et

Table 2.6.1. Collateral data assembly.

Entity	Description of Data Obtained
LATEX B LSU	•Mississippi River Plume Hydrographic Study - Preliminary data from cruises P921, P922, and P931
LATEX C SAIC	•XBT and drifter data posted to GULF.MEX from April 1992 through March 1993
Ship-of-Opportunity Program TAMU	•Ship-of-opportunity hydrographic data from R/V Gyre cruise 93-G-03: Galveston, TX to Colon, Panama •SOOP data in the LATEX region
NOAA-NDBC	•1992 meteorological data from buoys 42019 & 42020 •1993 first and second quarter meteorological data from buoys 42019 & 42020 •CD ROM wave data through July 1992 from all NDBC/C-MAN buoys in the Gulf of Mexico that are equipped with wave measuring instruments •wave data transmitted over GTS from April 1992 through March 1993
MMS Modeling Dynalysis	•Bathymetry data set
Conrad Blucher Institute Corpus Christi	•all data 4/92 to 4/93 including 45 tide stations (all Texas Stations) and 2 TAMU-offshore meteorological stations
NOAA-NOS	•Gulf of Mexico tide data for all U.S. sea level stations for 1990
NECOP	•Agreement and password to provide access to their data base (all data). •NOAA TM GLERL-80 entitled "Nutrient Enhanced Coastal Ocean Productivity (NECOP): CTD Observations from R/V Longhorn cruise May 14-21, 1992". Authored by Dong, Bratkovich & Dinnel.
NOAA-COASTWATCH	•Over 1000 AVHRR sea surface temperature images .
NOAA- NODC	•Oceanographic Station Data (SD2), Mechanical Bathythermograph Data (MBT), Expendable Bathythermograph Data (XBT) and High Resolution CTD/STD Cast Data (F022) for the Gulf of Mexico between 9-31 degrees north and 80-100 degrees west •Current Meter Data (resultants and components) for the Gulf of Mexico •Drifting Buoy Data for the Gulf of Mexico •NODC platform & institute codes •NODC CD ROM hydrographic data.
Army Corps of Engineers	•Daily discharge of the Atchafalaya River at Simmesport, Louisiana (01-Jan-1992 to 14-Sep-1993) and the Mississippi River at Tarbert Landing, Mississippi (01-Jan-1992 to 14-Sep-1993) •All ACOE daily data for the Mississippi and Atchafalaya Rivers from 1930 to August 1993
USGS	•All USGS data for Water year 1992 (September 1991 to September 1992) for Texas Rivers and Louisiana Rivers •Preliminary set of USGS data for Water year 1993 (September 1992 to September 1993) for Texas Rivers and Louisiana Rivers
Scripps Institute of Oceanography	•Gulf of Mexico Experiment Data Report #1: August 1990 - July 1991. Meteorological, Moored Instrument & Sea Level Observations. SIO reference series #92-26. August 1992; covers the instrumentation, calibration procedures and data retrieved from the six meteorological stations, four current meter moorings and three pressure sensors which were installed on the southern perimeter of the Gulf and on the Mexican side of the Yucatan Channel.
Colorado Center for Astrodynamics Research, Univ. of Colorado	•10-day maps of dynamic height anomaly from ERS-1 and TOPEX, prepared by George Born, October 1992 through October 1993
NOAA-NWS National Meteorological Center (NMC)	•Subset of data for 1 April 1992 through 29 September 1993 of the Final Analysis Cycle from the GDAS data assimilation—NMC's High-Resolution Gridded Flux Data Set. The NMC data set is a 6-hourly, global gridded synthesis of 32 meteorological parameters derived from the world weather data with only four grid-points over the Gulf of Mexico; zonal stress, meridional stress, sensible heat flux, latent heat flux, surface temperature, zonal wind, and meridional wind only are archived. •3-hourly surface weather maps from 1 April 1992 through 31 March 1993 •Daily weather maps: weekly series from 30 March 1992 through 31 March 1993

Table 2.6.1. Collateral data assembly. (continued)

Entity	Description of Data Obtained
GULFCET	•CTD, STD, and XBT Data collected at sea aboard the Oregon II cruise between April 15 and June 8, 1992 •Technical Report 93-02-T of the Department of Marine Biology TAMU Galveston •Gulfcet cruise 02 hydrographic data, XBT, CTD and Niskin Bottle Data from 10-25 August 1992 cruise on *R/V Pelican*
JPL	•Satellite-Derived Multichannel Sea Surface Temperature and Phytoplankton Pigment Concentration Data: A CD ROM set containing monthly mean distributions for the Global Oceans, dated 30-Jan-1993

al. 1985; Reid and Whitaker 1981; Westerink et al. 1992; general models: Arango and Reid 1990; Dietrich et al. 1993; Hulburt 1986; Hurlburt and Thompson 1980; Sturges and Welch 1991; Thompson 1986; Wallcraft 1986).

Hydrographic data are more numerous and better distributed in time than other data types. For this reason, and because hydrographic data yield the most coherent description of general circulation patterns, the LATEX A study of the historical data has commenced with hydrography. A systematic evaluation and study of all previous hydrographic cruises over the Texas-Louisiana shelf was begun this past year. The intent of this work with historical data is to provide a base against which the LATEX data can be interpreted. Of particular interest is the assessment of trends and interannual variability.

The TAMU data files were searched for cruises carried out by TAMU investigators, then base maps were prepared showing station locations of all cruises taking CTD, STD, or bottle data over the LATEX region. The NODC CD ROM containing hydrographic data (including CTD and STD) was searched and analogous base maps were prepared. All base maps were examined and cruises were selected which either (1) gave reasonable coverage of all or significant portions of this shelf (e.g., *GUS III* cruises) or (2) were part of series of repeat cruises in a limited area which might be useful in assessing variability via a time series. From this selection of cruises, Table 2.6.2 was prepared showing times, regions, stations, and variables measured. Not counting LATEX and concurrent collateral cruises, there are 61 potentially useful, historical cruises listed.

The selection is being refined by assessing the data quality. Because there exists at TAMU unpublished assessments, prepared by W. D. Nowlin and R. D. Parker, of most pre-1972 cruises in the Gulf of Mexico (except data not released as of 1972), this task was relatively easy. This earlier assessment was consulted to remove bad data, stations, or cruises. This phase of the assessment for previously unreported and post-1972 cruises will be completed during the next year of this effort.

Simultaneously with this assessment, a systematic study of these cruises was begun with the preparation of "standard" products. Standard products consist of selected properties plotted on various vertical sections, horizontal levels, and isopycnal surfaces. This effort is complete for the *GUS III* cruises and for initial LATEX cruises.

Table 2.6.2. Historical data reports of interest for LATEX region.

	Ship	Cruise	Dates	Properties Measured T	S	O2	Nutrients	Measurement Types C/STD	Bottle Cast	No. Stations
1	Atlantis	Atlantis 1935	03/26-04/04,1935	X	X	X			X	27
2	Hidalgo	61 - H - 16	10/04-10/09,1961	X	X	X			X	11
3	Hidalgo	61 - H - 19	11/11-11/13,1961	X	X	X			X	11
4	Hidalgo	62 - H - 01	01/16-01/19,1962	X	X	X			X	11
5	Hidalgo	62 - H - 03	03/06-03/31,1962	X	X				X	19
6	Hidalgo	62 - H - 05	06/05-06/13,1962	X	X				X	12
7	GUSIII	GUS III - 1	01/22-02/05,1963	X	X				X	22
8	GUSIII	GUS III - 2	02/19-03/01,1963	X	X				X	41
9	GUSIII	GUS III - 3	03/26-04/07,1963	X	X				X	39
10	GUSIII	GUS III - 4	04/26-05/07,1963	X	X				X	41
11	GUSIII	GUS III - 5	05/13-05/22,1963	X	X				X	37
12	GUSIII	GUS III - 6	06/06-07/01,1963	X	X				X	41
13	GUSIII	GUS III - 7	07/10-07/17,1963	X	X				X	40
14	GUSIII	GUS III - 8	08/16-08/31,1963	X	X				X	41
15	GUSIII	GUS III - 9	09/22-10/05,1963	X	X				X	40
16	GUSIII	GUS III -10	10/20-11/04,1963	X	X				X	41
17	GUSIII	GUS III -11	11/20-12/02,1963	X	X				X	40
18	GUSIII	GUS III -12	12/10-12/22,1963	X	X				X	41
19	GUSIII	GUS III -13	01/17-01/31,1964	X	X				X	41
20	GUS III	GUS III - 14	02/07-02/24,1964	X	X				X	33
21	GUS III	GUS III - 15	02/28-03/22,1964	X	X				X	39
22	GUS III	GUS III - 16	04/14-04/26,1964	X	X				X	41
23	GUS III	GUS III - 17	05/02-05/26,1964	X	X				X	41
24	Obdorsk	Obdorsk,1964	05/26-06/06,1964	X	X				X	29
25	GUS III	GUS III - 18	06/17-06/28,1964	X	X				X	41
26	GUS III	GUS III - 19	07/09-07/19,1964	X	X				X	41
27	GUS III	GUS III - 20	08/20-09/02,1964	X	X				X	41
28	GUS III	GUS III - 21	09/17-09/29,1964	X	X				X	41
29	GUS III	GUS III - 22	10/20-10/31,1964	X	X				X	41
30	GUS III	GUS III - 23	11/10-11/27,1964	X	X				X	41
31	GUS III	GUS III - 24	12/08-12/19,1964	X	X				X	41
32	GUS III	GUS III - 25	01/07-01/16,1965	X	X				X	39
33	GUS III	GUS III - 26	02/11-03/01,1965	X	X				X	30
34	GUS III	GUS III - 27	03/13-03/25,1965	X	X				X	38
35	GUS III	GUS III - 28	04/15-04/26,1965	X	X				X	41
36	GUS III	GUS III - 29	05/19-06/02,1965	X	X				X	41
37	GUS III	GUS III - 30	06/11-06/24,1965	X	X				X	39
38	GUS III	GUS III - 32	08/11-08/24,1965	X	X				X	41
39	GUS III	GUS III - 33	09/08-09/20,1965	X	X				X	20
40	GUS III	GUS III - 34	10/28-10/31,1965	X	X				X	19
41	GUS III	GUS III - 35	12/01-12/12,1965	X	X				X	37
42	Alaminos	66 - A - 01	01/08-01/14,1966	X	X	X			X	36
43	Alaminos	66 - A - 02	01/24-01/27,1966	X	X	X			X	25
44	Alaminos	66 - A - 03	02/10-02/21,1966	X	X	X			X	16
45	Alaminos	66 - A - 12	08/27-09/01,1966	X	X	X	X		X	17
46	Geronimo	Geronimo, 1967	08/14-10/08,1967	X	X	X	X		X	29
47	Gosnold	Golsnold, 1969	11/27-12/14,1969	X	X				X	18
48	Oregon II	OregonII, 1971	08/12-08/25,1971	X	X				X	23
49	Acushnet	Achushnet, 1975	08/25-09/10,1975	X	X				X	54
50	Longhorn		01/30-02/03,1976	X	X			X		24
51	Acushnet	Achushnet, 1976	03/03-03/16,1976	X	X				X	52
52	Longhorn		05/28-06/07,1976	X	X			X		29
53	Longhorn		09/10-09/16,1976	X	X			X		27
54	Longhorn		01/08-01/21,1977	X	X			X		19
55	Longhorn		05/16-05/20,1977	X	X			X		28
56	Longhorn		09/07-09/11,1977	X	X			X		18
57	Gyre	Gyre, 1982	03/17-03/22,1982	X	X			X	X	45
58	Gyre	89 - G - 02	03/07-03/14,1989	X	X	X	X	X	X	40
59	Gyre	89 - G - 06	05/16-05/25,1989	X	X	X	X	X	X	19
60	Gyre	89 - G -1 5	11/12-11/18,1989	X	X	X	X	X	X	23
61	Gyre	90 - G - 10	07/11-07/25,1990	X	X	X	X	X	X	112
62	Longhorn	GulfCet - 01	04/15-05/01,1992	X	X	X		X	X	95-XBTs
63	Gyre	LATEX - 92A	05/01-05/08,1992	X	X	X	X	X	X	114
64	Gyre	LATEX - 92B	08/01-08/08,1992	X	X	X	X	X	X	124
65	Pelican	GulfCet - 02	08/10-08/25,1992	X	X	X		X	X	45-CTDs and 82-XBTs
66	Powell	LATEX - 92C	11/05-11/13,1992	X	X	X	X	X	X	114
67	Pelican	GulfCet - 03	11/08-11/22,1992	X	X	X		X	X	39-CTDs and 76-XBTs
68	Gyre	LATEX - 93D	02/06-02/13,1993	X	X	X	X	X	X	119
69	Powell	LATEX - 93E	04/26-05/10,1993	X	X	X	X	X	X	215
70	Powell	LATEX - 93F	07/26-08/07,1993	X	X	X	X	X	X	215

LATEX A intends to composite the existing data from all years for selected periods of the year. Individual realizations can be compared to this composition, or "average", picture, to assess year-to-year variability. For illustration and comparison, five realizations in May of different years of the surface geopotential anomaly (in dynamic centimeters) relative to 70 decibars for the Texas-Louisiana shelf are shown. Extrapolation of the reference level along the bottom for depths less than 70 m was carried out as described in section 5.4.3. Figures 2.6.1 through 2.6.5 picture these geopotential fields for May of 1963, 1964, 1965, 1992, and 1993 in order. Partial coverage of this shelf in three other years is available as well (not shown).

The three surveys by the vessel *GUS III* in May of 1963, 1964, and 1965 are remarkably similar in overall pattern of relative geostrophic flow implied from these figures. This is indicative of why Cochrane and Kelly (1986) could prepare meaningful average monthly circulation patterns from the *GUS III* data.

The patterns shown for May 1992 and May 1993 (not conducted during first field year, but included) were prepared using data from the much more complete sampling carried out on the LATEX A standard hydrography cruises. More lines are included, stations are more closely spaced along lines, samples are more closely spaced in the vertical, and (perhaps most important for study of the general patterns of shelf circulation) the sampling extends past the shelf-slope break. This latter fact allows better description of the upcoast (northward or eastward) flow along the outer shelf edge; further offshore extension of the LATEX lines would have been desirable.

The May 1993 geostrophic shear pattern is again quite similar to the three earlier patterns from *GUS III* data. The May 1992 pattern for the eastern shelf area differs from the other four realizations. In four cases a low-valued (cyclonic) feature is seen over the central mid-shelf region as an elongated tongue extending west northwestward from the shelf edge at 91° to 93°W. In May 1992 this cyclonic feature is bounded by high values to its south and is more nearly closed to the southeast.

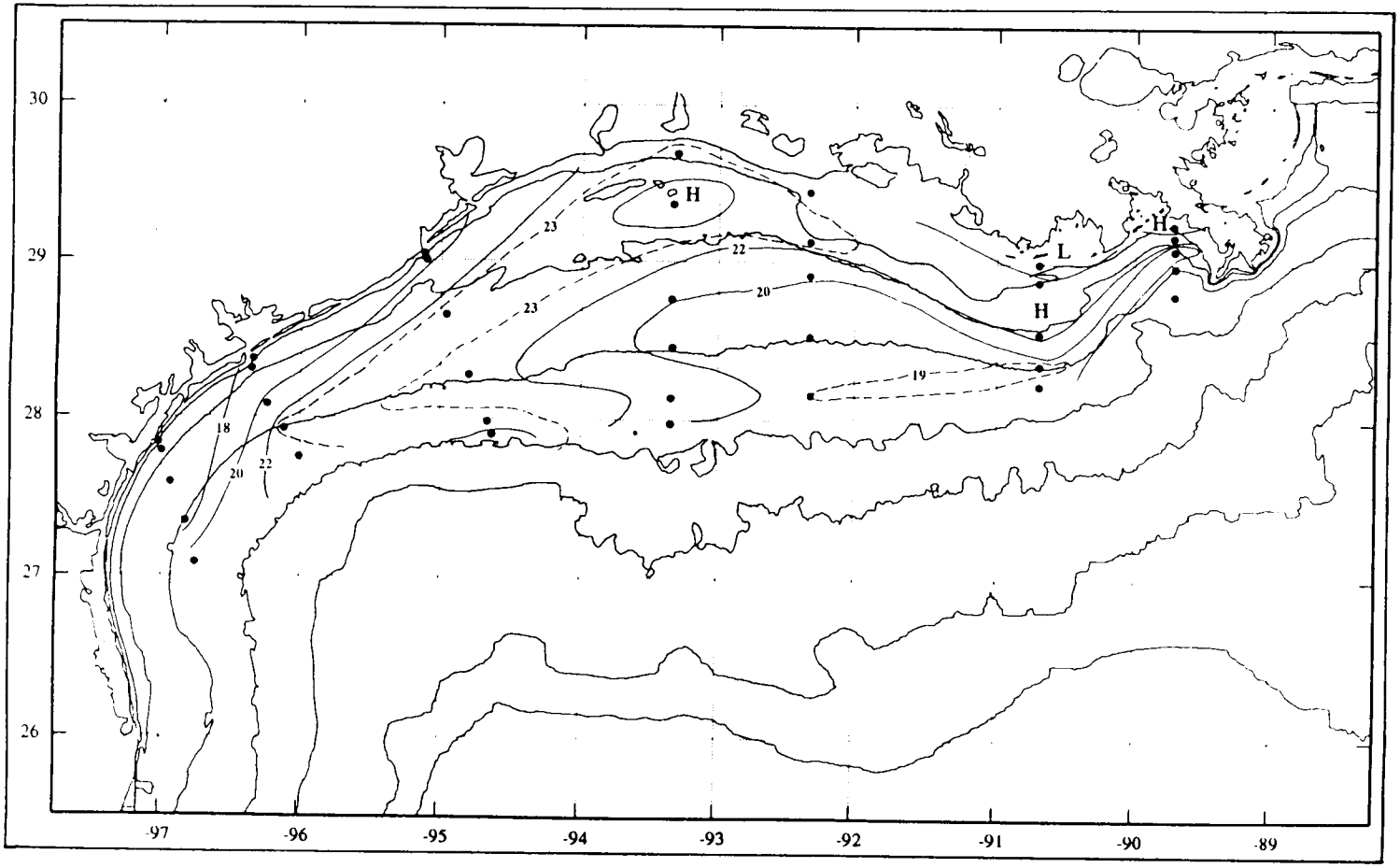


Figure 2.6.1. Geopotential anomaly (dyn cm) of sea surface relative to 70 db for *GUS III* cruise in May 1963.

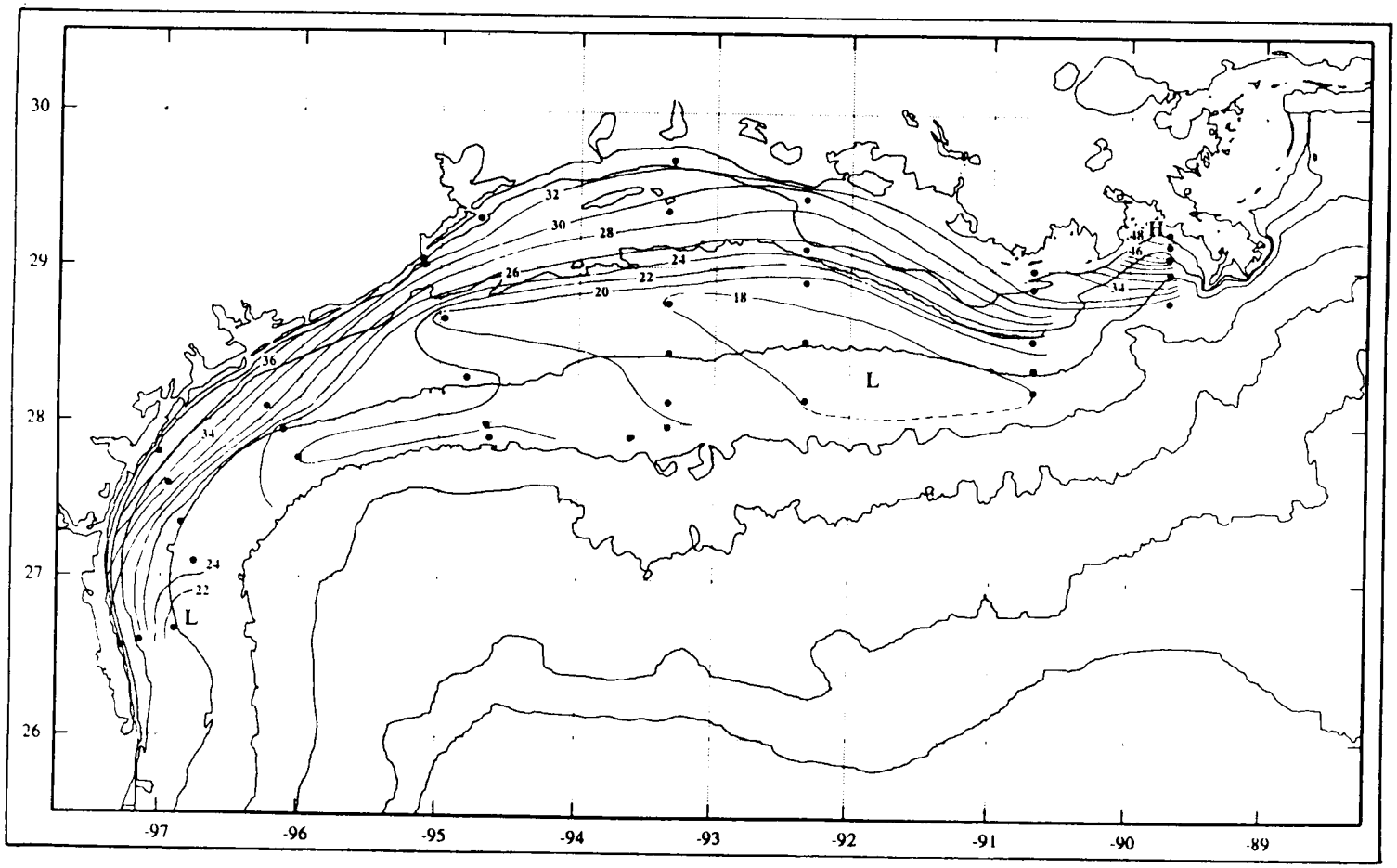


Figure 2.6.2. Geopotential anomaly (dyn cm) of sea surface relative to 70 db for *GUS III* cruise in May 1964.

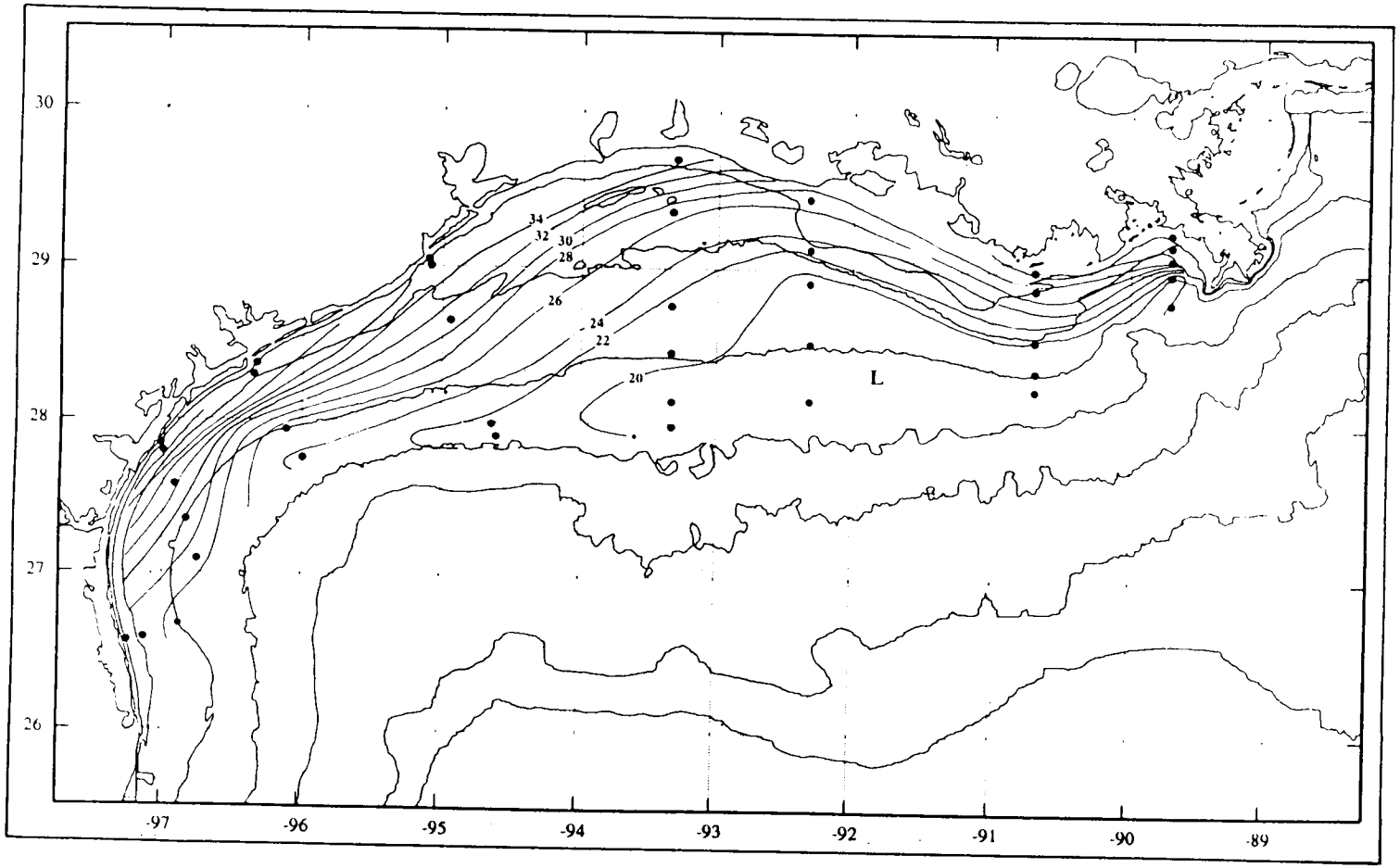


Figure 2.6.3. Geopotential anomaly (dyn cm) of sea surface relative to 70 db for *GUS III* cruise in May 1965.

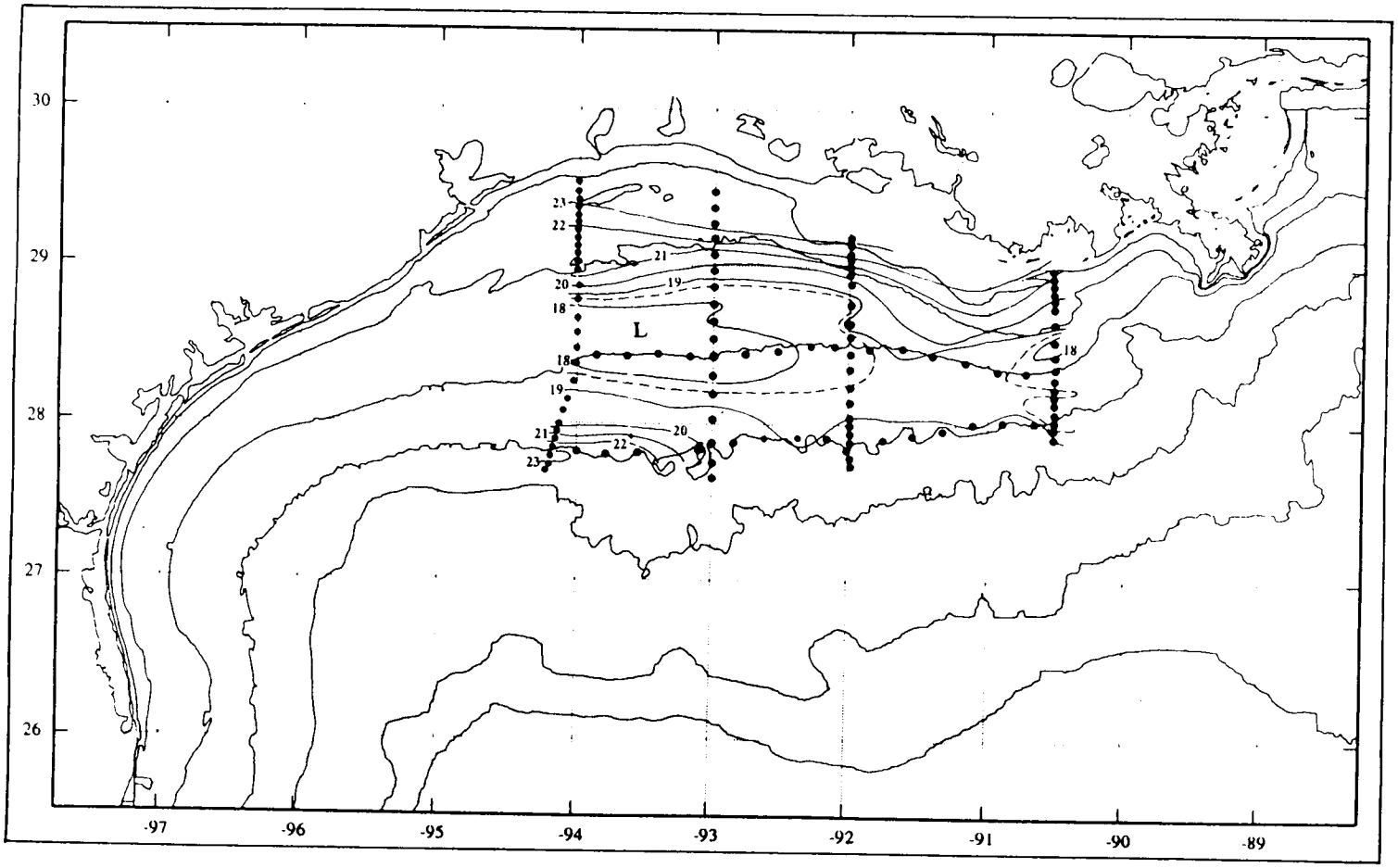


Figure 2.6.4. Geopotential anomaly (dyn cm) of 3-db surface relative to 70 db for LATEX cruise H01 in May 1992.

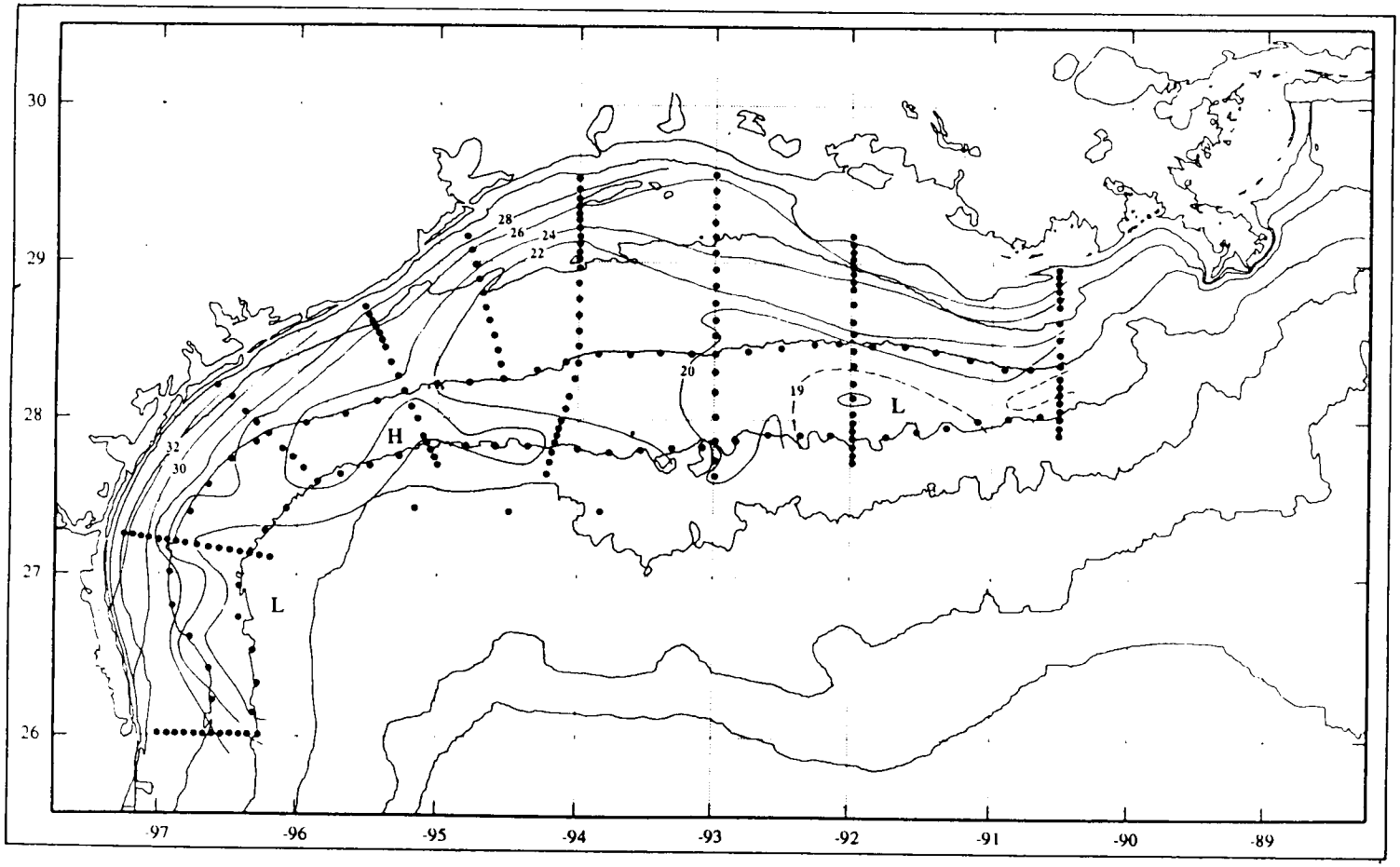


Figure 2.6.5. Geopotential anomaly (dyn cm) of 3-db surface relative to 70 db for LATEX cruise H05 in May 1993.

3 DATA QUALITY ASSURANCE AND CONTROL

3.1 Introduction

Section 3 provides a discussion of the data processing efforts and quality assurance/quality control (QA/QC) methods for each type of data and a summary of the results of the QA/QC processing. The data processing was conducted in accordance with the procedures set out in section 9 of Nowlin et al. (1991).

Data QA/QC and preliminary analyses are performed by the LATEX A Data Office. The primary responsibility for QA/QC and analysis of different types of data are handled by different individuals in the Data Office as shown in Table 3.1.1.

Table 3.1.1. Personnel performing QA/QC.

Individual	Data Type
Dr. Norman L. Guinasso, Jr.	Hydrographic data
Dr. Matthew K. Howard	Meteorological data & Drifter data
Dr. Steven F. DiMarco	Directional wave data
Mr. Linwood L. Lee III	Current meter data
Mr. Frank J. Kelly	ADCP data

In general, data sets are grouped by the name of the cruise on which the data are recovered. Data are processed into engineering units and stored in hierarchical directories on hard disks. Preliminary data products are produced, examined, and obvious errors corrected. The preliminary data products then are given to other principal investigators for examination. These investigators inform the Data Office of further corrections. After all corrections are made the data are transferred to a distribution directory where investigators can have access to the data set.

3.2 Moored Measurements

3.2.1 Current Meter Measurements

Current meter data sets require processing to determine the geophysical units from the raw data. The initial processing step converts the raw instrument data into raw geophysical units. The initial processing of the Endeco SSM-type, the InterOcean S4, and the Aanderaa current meters is done on a personal computer using software provided by the respective manufacturers. The initial processing of the TAMU- and LSU-modified Endeco DMT-type current meters uses software developed in the Data Office. Secondary and tertiary processing consists of the removal of spikes and spurious data points from the data, and editing and correcting any time base problems. Tertiary processing includes applying calibration data and generating preliminary data plots.

As a part of the QA/QC procedure, checks are made on the data for spikes, spurious data, data loss due to fouling, time base accuracy, instrument failures, and similar problems. Errors in the data which occur over a period of two hours or less are corrected by linear interpolation, while longer sections of bad data are flagged as unusable. When the data

have been cleaned of errors, calibration data are applied and preliminary clean ASCII files of the data are produced.

The degree of QA/QC required varies with instrument type and with individual instruments. The Endeco SSM, S4, and Aanderaa current meters require the least amount of QA/QC; the procedures basically are automated. The LSU-modified Endeco DMT-type current meters require extensive spike removal, range checking, time base correction, and noise removal. The TAMU-modified Endeco DMT-type meters also require significant amount of QA/QC processing.

The current meter data are converted from magnetic to true direction. For the Aanderaa and modified Endeco DMT-type current meters, conductivity is recorded, and salinity is calculated using the Practical Salinity Scale 1978 (UNESCO 1981). The Aanderaa software exhibited an incompatibility with MS-DOS version 5.0 which resulted in the corruption of several raw data files from the early cruises. The data were recovered through extensive editing. Since then, this problem has been avoided by using MS-DOS version 3.3 to extract the raw data from the Aanderaa current meters.

The LSU- and TAMU-modified Endeco DMT-type meters require the bulk of the current meter QA/QC work. The raw data sets often contain numerous inconsistencies that make any automated QA/QC efforts difficult. A few of these meters have written inconsistent 24-hour marks or dropped samples or both, and some do not have the conductivity self-check enabled. In cases where none of the time base information is available the data for the parameters involved cannot be matched in time with the data for other parameters. These problems occurred on one to five instruments per deployment during the first field year.

The QA/QC process does not yet supplement the temperature and conductivity calibration data with the CTD casts taken during the mooring service cruises. This step is being added. In addition, as more complete sets of calibration data become available, the current meter data from early in the program will be re-checked and corrected as necessary. These corrections will be included in the final data set submitted to NODC at the end of the program.

3.2.2 CLI MiniSpec Directional Wave Gauge Processing and Quality Assurance

The MiniSpec instruments provide a variety of data to determine directional wave characteristics as well as temperature, tidal variation, and local currents at five mooring locations (1, 16, 17, 20, and 23). The instrument itself is equipped with a 20 megabyte hard drive, which has been "ruggedized" by the manufacturer to resist vibration, shock, and other physical factors. The hard disk is capable of storing over 13 million points of raw data. The MiniSpec measures current using a Marsh-McBirney electromagnetic velocity sensor, and waves using an ICS strain gauge pressure sensor. The raw data set is directly downloaded from the instrument hard disk to a Bernoulli box aboard ship. It then is downloaded to floppy disks and delivered to the Data Office.

The initial processing to convert the raw data into engineering units is done on a personal computer using the manufacturer-provided "Wizard" software program. The raw data are separated into two file types corresponding to the two modes of MiniSpec operation: burst mode and average mode. Burst data files contain data obtained while the instrument operated in burst mode. The user-defined parameters for this mode are: a 0.5 Hz sampling rate and 2048 total points per burst, yielding a total burst duration of 17

minutes 4 seconds, with a one hour interval between bursts. As mentioned previously, the interval between bursts was changed to two hours for cruises M03 through M06 to reduce noise in the current record. The interval between bursts was raised again to three hours for cruises M07 and M08. The instrument records tidal data while in averaging mode. The averaging mode consists of taking a five-minute "mini" burst at a sampling rate of 0.5 Hz and recording the average. The interval between average mode points is 30 minutes. The instrument cannot average and burst sample simultaneously.

After converting to engineering units and separating files, the data are analyzed on a UNIX workstation using Visual Numerics' PV-Wave software. The data sets are scanned for data loss, time base accuracy, instrument failure, and other problems. After all data have been scanned and errors corrected or removed, the directional records (velocity) are corrected to true north based on diver provided measurements of the MiniSpec orientation relative to magnetic north. Table 2.2.5 shows the data files available from the first field year.

During the first year of deployment the MiniSpecs were plagued by a variety of problems ranging from instrument failure and malfunction to noise and warm-up transients. These problems were documented in a technical report by Kelly et al. (1993). Based on this report, a nonlinear fit now is used to convert the raw pressure data into engineering units thus improving the accuracy of the pressure records. This fit is quadratic in pressure counts and linear in temperature. Also, the installation of an improved ICS pressure sensor removed the transient warm-up effect present in earlier deployments.

Software routines to determine significant wave height and period and the directional wave spectrum have been developed using PV-Wave. See section 5.2.4 for a discussion.

3.2.3 IES Data

The first retrieval of the IES units was scheduled for July 1993; therefore, the IES units and their data are not discussed in this report.

3.2.4 Meteorological Data

The meteorological instrument packages, manufactured by Defense Systems, Inc. (DSI), measure and record: atmospheric pressure, sea and air temperature, wind speed and direction, and ancillary data such as remaining buffer space, buoy hull heading, and battery voltage. Once each hour, the instrument initiates a sampling mode in which each sensor is sampled every 4 seconds for an eight-minute period. The average value of each sensor is stored in solid-state memory for later recovery. It then is broadcast, once every 90 seconds, for reception by either of two NOAA satellites.

The data collected by satellite are delivered to the Data Office via electronic mail within 24 hours by Service ARGOS. The internally-recorded data are recovered during each mooring maintenance cruise and are delivered to the Data Office on 3.5 inch floppy disks within a few days following the cruise. Once in the Data Office, the disks are inventoried, tagged, logged, and duplicated. The duplicates are sent to the Program Office for off-site storage. The raw data are copied into central storage on a VAX cluster where they are available to Data Office personnel for preliminary processing and quality assurance. The original disks are stored in the data vault.

The data files contain hexadecimal numbers encoded in ASCII format. A FORTRAN program written by Data Office personnel converts the hexadecimal counts into geophysical units using the format description and calibration constants provided by the instrument manufacturer.

The first step in the quality assurance procedure is a simple visual scan of the data. This permits the rapid identification of those data which lack variability, contain out-of-range values, or fail other criteria for reasonableness. In most cases, lack of variability is due to sensor failure while out-of-range values are due to sporadic noise in the electronics package. The next step is to generate a time channel for each data set. This is necessary because the instrument package lacks the circuitry required to generate this information *in situ*.

There are two ways to generate the time channel. The first is to start with the instrument's reset time, which should coincide with the taking of the first sample. The time of each succeeding sample is generated by repeated additions of the sampling interval, one hour in this case. Similarly, one could start with the time that downloading operations were initiated, which should be within one hour of the last recorded sample, and repeatedly subtract the sampling interval to find the time of each previous sample. If no samples have been dropped and the electronics are sufficiently drift-free, this method should produce a fairly accurate time channel. To test this assumption the internally-recorded data, with a time channel based on the reset time plus sampling interval, was compared to the same series delivered by Service ARGOS. By aligning the two records the starting times were found frequently to be in disagreement, and in some cases, by more than two weeks. Table 3.2.1 shows the difference, in days and hours, between the start of data as given in the log books and the start of data according to Service ARGOS.

Table 3.2.1. Time difference, in days and hours, between the metbuoy reset time given by EHI and the start of internally-recorded data as determined from alignment with data delivered by Service ARGOS.

Mooring	M02	M03	M04	M05	M06	M07	M08
17	00-01[b]	00-06[b]	+	X	03-08[a]	+	X
19	X	02-04[a]	+	+	02-19[a]	00-01[b]	10-13[a]
20	+	00-03[b]	00-06[a]	X	03-21[a]	00-05[a]	10-08[a]
22	00-01[b]	07-11[a]	06-13[b]	00-01[b]	03-05[a]	+	15-17[a]
50	00-01[b]	+			16-04[a]	ND	12-21[a]
51	00-02[b]	+			00-02[a]	+	10-10[a]
52	+	00-03[a]			>>>	09-06[a]	13-09[a]
53	+	+			03-14[a]	+	14-18[a]

dd-hh = days-hours time difference
X = data not recovered
>>> = data recovered next cruise
ND = not deployed, mooring offsite for repair
+ = data starts < 1 hour after reset
[a] = data starts after reset time
[b] = data starts before reset time

Because the instrument re-broadcasts the same values for an hour, differences of up to one hour "after" are considered to be as close as can be expected. Cases for which the start times occur no more than one hour after the given reset time are marked with a "+" which is the desired situation. The "b" rotation denotes that samples were being recorded before the given reset time. These cases can only be clerical errors.

The "a" notation denotes that the first sample was recorded after the given reset time. This kind of error was the most common and had the largest observed differences. The differences are too large to be clerical errors. Errors of this kind occur when the deployment period exceeds the memory capacity. This is especially evident in the data sets recovered during M08 which were serviced approximately 60 days after the previous service cruise rather than the usual 45 days. During M08, higher-capacity memory chips (EPROMS) were installed in each meteorological buoy increasing the storage capacity to 87 days at a one hour sampling rate.

Using the second method for generating the time channel is to start with the download time and repeatedly subtract the sampling interval. Using this method, a new time series was generated and compared to the equivalent record delivered by Service ARGOS. As is shown in Table 3.2.2, this produced much better results than before, primarily because this method is not affected by memory capacity limitations. Also, the quality of the recordkeeping by shipboard personnel has greatly improved, as can be seen in the table for the later cruises.

Table. 3.2.2. Time difference, in days and hours, between the metbuoy "OFF" time given by EHI and the end of internally-recorded data as determined from alignment with data delivered by Service ARGOS.

Mooring	M02	M03	M04	M05	M06	M07	M08
17	01-00[b]	00-04[b]	00-01[b]	X	+	00-08[a]	X
19	X	02-01[a]	00-02[a]	+	00-01[b]	+	00-01[b]
20	+	+	+	X	+	00-02[a]	+
22	02-08[b]	00-04[b]	06-18[b]	00-01[b]	+	00-04[a]	+
50	+	+			00-08[a]	x	+
51	00-01[b]	00-02[a]			+	+	+
52	00-02[b]	+			>>>	+	+
53	+	+			00-01[b]	+	+

dd-hh = days-hours time difference
X = data not recovered
>>> = data recovered next cruise
ND = not deployed, mooring offsite for repair

+ = data starts < 1 hour after reset
[a] = data starts after reset time
[b] = data starts before reset time

After the time channel has been generated, each series is run through an automated quality control program developed at the Data Office to eliminate outliers and fill data gaps for up to six hours. The program uses a sliding window of seven points, three on each side of the point in question, to generate a local mean and local standard deviation. If the test point deviates from the local mean by more than 5.5 standard deviations for velocity or five standard deviations for other parameters, then the point is eliminated and replaced by linear interpolation. The sliding window size and the standard deviation factor were determined by comparing numerous raw and processed data plots using various window sizes and standard deviation factors. The selected window size and standard deviation factor best reproduced the raw data with outliers removed. The original and edited series are overlaid on a workstation display and inspected by eye to see that the proper edits had been made. In cases where several outliers occur within the averaging window, the program may fail to eliminate all outliers. In these cases, the outlier is removed manually and replaced by using linear interpolation. A typical example of raw and processed data is shown in Figure 3.2.1.

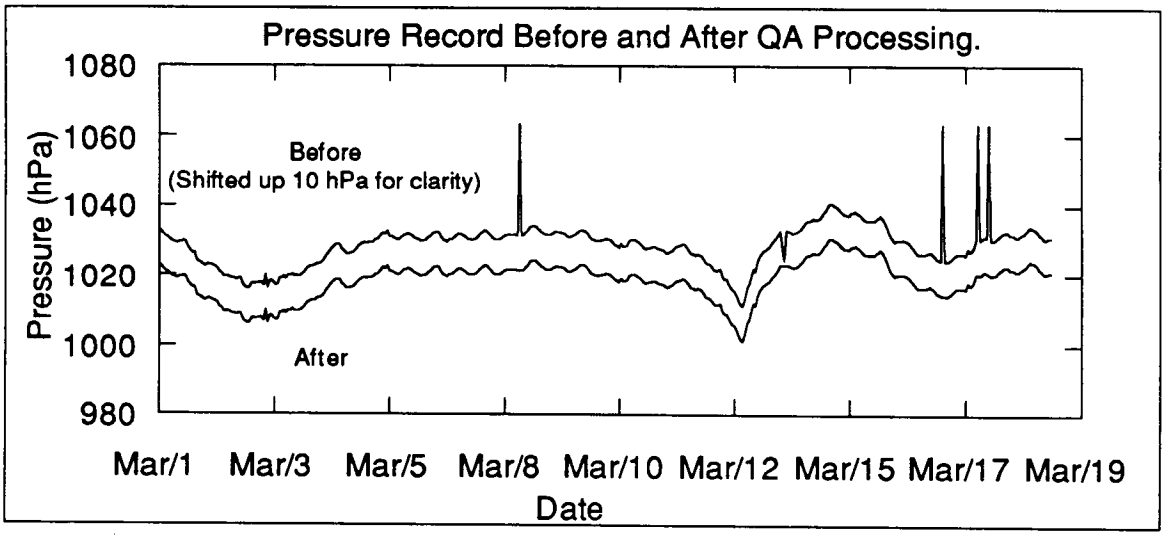


Figure 3.2.1. Sample plot of atmospheric pressure data showing the raw data and the processed data after out-of-range values and outliers have been removed. The raw data curve has been shifted 10 hPa for clarity.

3.3 Drifting Buoy Measurements

The methodology for data analysis and QA/QC for the drifting buoys is provided in Nowlin et al. (1991) and in section 2.3 of this report. A summary of times of operation is given in Table 2.3.1, and example trajectories are given in section 5.3. Drifter trajectories were posted to the GULF.MEX electronic bulletin board on a weekly basis.

3.4 Hydrographic Measurements

3.4.1 Methodologies for Processing CTD Data

After consultation about appropriate calibration coefficients between the Data Office and the Principal Investigator for Task A-3, CTD raw data are run through a series of Sea-Bird programs to produce a clean set of 50-cm, bin-averaged data. The files are stored in hierarchical directories on computers in the LATEX Data Office.

Several standard products are prepared and used for quality assurance of the primary parameters measured on the LATEX hydrography cruises. For each cruise, a composite plot of temperature versus salinity is generated. These plots often reveal any erroneous information in the data set. Individual station plots consisting of temperature, salinity, and sigma-theta profiles with accompanying temperature and salinity plots can be used to identify spurious data points in each cast.

Two computer programs were written by the Data Office to test the integrity of the CTD files and produce quick look products for quality control. The first program, DELST, reads each file, interpolates temperature and salinity to selected potential density surfaces, and produces a summary report for each station with potential temperature, potential density, pressure, depth, dynamic height, and Montgomery potential for a series of standard depths and potential densities. An auxiliary file produced for each station flags potential data problems.

The second program, LAT_SECT_CONT, produces vertical sections of all CTD variables along each track line. Data are interpolated using a distance-cubed weighting scheme that is scaled appropriately for depth and horizontal distance. Spurious information is readily apparent in the data output.

3.4.2 Methodologies for Processing Dissolved Oxygen Data

Obtaining accurate, calibrated dissolved oxygen data from an *in situ,* profiling oxygen sensor requires both precise calibration of the probe and verification of the data using concurrent bottle samples titrated for dissolved oxygen. To electronically calibrate the polarographic oxygen probe, the oxygen current bias (B_{OC}) and oxygen current slope (S_{OC}) are determined for each sensor by measuring the current output in a sodium sulfite solution (zero oxygen, yields B_{OC}) and in a seawater saturated with dissolved oxygen (yields S_{OC}). These calibration values are used with the CTD data (temperature, salinity, pressure) and oxygen sensor constants to calculate *in situ* dissolved oxygen using the program, OXFIT, provided by Sea-Bird Electronics. The electronic oxygen probe is re-calibrated before and after each cruise to determine drift during the cruise.

To further verify and correct the CTD-measured oxygen values, measurements of dissolved oxygen are made from discrete water samples. The samples are analyzed by the microWinkler method. Plots of profile data versus bottle data are examined during the cruise to verify that the continuous profiles are accurate as they are being taken. After the cruise, the oxygen bottle data are plotted on top of continuous oxygen profiles using a SAS program (OPLOT) LATEX A has written. Based on visual inspection of these plots, apparent processing or data entry problems are examined.

After completing these two initial steps, the oxygen bottle data again are plotted against the continuous measurements to examine portions of the oxygen profiles that may vary

from the actual oxygen levels due to the slow response time of the oxygen probe. The stations where these problems occur (usually shallow stations) are flagged and examined further.

3.4.3 Methodologies for Processing Salinity Data

Water column salinity is continuously measured with the Sea-Bird Electronics CTD and also measured on bottle samples using a Guildline AutoSal. The AutoSal is standardized each day using primary Standard Sea Water which is purchased from the Institute of Oceanographic Sciences, Wormley, UK. To assure that the AutoSal is calibrated to the same exact standard, a large quantity of Standard Sea Water was purchased at one time so that all of the LATEX salinity measurements would be standardized against the same batch of Standard Sea Water. The batch used by LATEX A is P119.

To ascertain the quality of the CTD salinity measurements, the temperature and conductivity sensors from the Sea-Bird CTD are calibrated before and after each cruise. The modular Sea-Bird sensors are returned to Sea-Bird Electronics where they are calibrated by NRCC. When the post-cruise calibrations are received, they are compared with the pre-cruise calibrations to determine the drift of the sensor. A drift calculation is made by Sea-Bird for each sensor, but LATEX A conducts an independent assessment of the drift.

Drift corrections are applied independently to the temperature and conductivity sensors. These require a change in the slope for conductivity and a change in the offset for temperature. These corrections are made in the Sea-Bird configuration file before the CTD data are processed.

After the CTD data are processed using the SEASOFT software package, the salinities calculated from the CTD are compared with the bottle salinities to examine both data sets for errors. First, a linear plot is made of bottle salinity versus CTD-salinity to look for systematic errors in the data. Second, at each station where bottle salinities were measured, usually more than 60 per cruise, the CTD salinity is plotted on a vertical plot with the bottle salinity for each station to look for problems in the data. This plotting is done using a SAS program (SPLOT) written specifically for this purpose.

3.4.4 Methodologies for Processing Nutrient Data

Methodologies for processing nutrient data during each cruise are discussed in section 2.4.2.1. After the cruise, the nutrient data from each station are plotted versus depth and examined in relation to the distribution of salinity and density. Any obvious problems in the data are corrected after this visual inspection of the data.

During the first year of the LATEX hydrography program, the TAMU Department of Oceanography's Technical Support Services Group participated in an international intercalibration experiment. This international group, known as QUASIMEME (Quality Assurance of Information for Marine Environmental Monitoring in Europe), provided a set of standards and a set of six sea water samples of unknown concentration to be determined. These samples were analyzed together with the LATEX samples during one of the LATEX hydrography cruises. When the results of this intercalibration experiment are received, we will have a more complete evaluation of the quality of the nutrient data produced during the LATEX hydrography cruises.

3.4.5 Methodologies for Processing Meteorological Data

The meteorological data are collected aboard ship using the weather instruments provided by the vessel. No specific quality assurance testing is made on the weather measurements collected during the LATEX cruises. The weather observer on the vessel ensures that the measurements are made properly. The captain of the vessel to ensures that the weather measuring devices on the vessel are operating and calibrated. When the weather data are transmitted to WMO via the SEAS III system, the NOAA quality assurance program removes questionable data from the data stream before it is used in weather forecasting.

3.4.6 Methodologies for Processing Particle Scattering and Particulate Matter Data

There are several stages in the quality control of the optical and suspended particulate material (SPM) data. These stages are:

1. Check transmissivity data to identify bad data;
2. Check transmissivity calibration to identify trends in the signal;
3. Check OBS data to identify spurious data points;
4. Correlate SPM data and transmissivity data. Identify SPM data points that may be spurious; and
5. Correlate SPM data and OBS data. Identify SPM data points that may be spurious.

Each of these steps was applied to data from the first four LATEX A hydrography cruises.

During data collection, profiles of transmissivity are checked to determine if the instrument operated properly at each station. This step is performed by the CTD operator on each station so that a malfunctioning sensor can be fixed or replaced. To check for sensor reliability, the up and downcast of each station is examined after each cruise. When the instrument is operating properly the up and downcast usually will fall either on top of each other or close to each other.

For the LATEX cruises the up and downcast for each station were examined to determine stations at which the offset was not normal. Abnormal offsets may be due to a malfunctioning sensor or thermal shock, which has been documented in transmissometers (Bishop 1986). In order to identify stations and depths where this occurs the up and downcast of each station is examined. Observed offsets are compared to published values to see if they are consistent with thermal shock. Stations at which thermal shock occurred are flagged. In practice, thermal shock occurs in deep water due to pronounced temperature gradients, which only occur in deep water in the LATEX study area. Offsets between the up and downcasts that cannot be attributed to normal offset or thermal shock are usually due to instrument malfunction, which requires repair to the instrument.

To evaluate drift in the transmissometer, the air calibration of the transmissometer is monitored during the cruise. This is done by cleaning the lenses of the transmissometer with Kimwipes and distilled water, completely blocking the light path and recording the voltage. The open in-air voltage is recorded at multiple stations during the cruise.

After the cruise these values are plotted against station number. The plot is examined to determine if there was a change in the calibration value during the course of the cruise.

Optical backscatterance data should be quality controlled in real time just as the transmissivity data are, by observing the up and downcasts to see if they match. Because of the generally low particle concentrations in the waters of the Texas-Louisiana continental shelf, there is very little OBS data to be obtained. Thus, these data are not quality controlled in real time.

Suspended particulate matter data are quality controlled by running a linear regression between particle beam attenuation coefficient (PBAC) and suspended particulate matter (SPM). PBAC is calculated from the transmissivity data. It has an advantage over transmissivity in that transmissivity is dependent on the beam length, PBAC is independent of beam length. In addition, PBAC increases as particle concentration increases, while transmissivity decreases as particle concentrations increases. The formula for calculating the PBAC is

$$PBAC = [-4 * LN(TRANSMISSIVITY/100)] - 0.364$$

The value 0.364 is the beam attenuation coefficient of clean water. By subtracting this value, one obtains the beam attenuation coefficient due to particles only.

In theory the relationship between PBAC and SPM is linear, so linear correlations are run between these two properties. These correlations are run for the complete data set, for the surface data only, and for the bottom data only. PBAC is a function of particle density, particle size and particle type. Since surface and bottom particles have different sources it is expected that they have different PBAC properties.

The data points and regression line for each of the three regressions are plotted separately to identify points that differ greatly from the trend. These points are flagged so that the SPM filters may be checked for obvious errors, such as tears. SPM data are also quality controlled by running a linear regression between OBS data and SPM.

3.4.7 Methodologies for Processing Phytoplankton Pigment Data

During the first year of the LATEX A hydrography program, duplicate phytoplankton pigment samples were collected and filtered for analysis by high performance liquid chromatography (HPLC). Having duplicate filters available for pigment analysis assures that, if there is a problem in the analysis or question about the data from a sample, the duplicate filter can be analyzed to provide a valid measurement for the sample. To insure that the samples analyzed in the laboratory are representative of the samples collected aboard ship, all filters are returned to College Station frozen in liquid nitrogen. The pigment filters remain in liquid nitrogen until they are removed for extraction and HPLC analysis.

Once the pigment samples have been analyzed by HPLC, the pigment identities are confirmed. This confirmation is accomplished by conducting an HPLC analysis of a combination of pigment extracts from several samples. The samples are combined and the pigments concentrated by passing the pigment extracts through a Waters Sep-pak cartridge. The concentrated pigment sample is analyzed on a Spectra Physics model 8100 HPLC following the procedure described in section 2.4.2.3. The HPLC pigment peaks from the concentrated sample are run on-line through a Hewlett-Packard diode array

spectrophotometer. Each individual pigment peak is scanned from 400 to 700 nm to provide an absorption spectrum for each peak. The absorption spectrum for every peak is compared with adsorption spectra of pigment standards run on the same system, as well as published pigment absorption spectra. These comparisons are made to verify the primary identification (based on peak retention time relative to chlorophyll a) of the pigments being analyzed from the hydrography cruise samples.

To further verify the validity of and make corrections to the phytoplankton pigment results from LATEX A hydrographic cruises, we compared the chlorophyll a measurements determined by HPLC with the *in situ* fluorometric measurements made with the CTD system. Fluorometric profile data versus chlorophyll bottle data are plotted on top of each other using a SAS program (FPLOT) written by LATEX A to plot the combined data. The data for each station are plotted separately. Based on visual inspection of these plots, the chlorophyll a values and fluorometer profile data are examined for processing or data entry problems. Chlorophyll a values that do not follow the fluorescence profile are examined to determine if there is a problem with the sampling (e.g., bottle leaked) or with the sample analysis (e.g., analytical problems).

After this comparison is completed, the chlorophyll a bottle data is then plotted on a linear plot against the CTD fluorescence measurements made at the same depth as the chlorophyll sample depth. This plot is used to examine areas of the fluorescence profiles which may vary from the actual chlorophyll levels. The stations where these problems occur (usually shallow stations) are flagged for further examination.

3.5 Acoustic Doppler Current Profiler Measurements

3.5.1 Methodologies for Data Analysis and QC

3.5.1.1 DAS Software

During cruises H01, H02, and M03, the DAS software package, developed by RDI was used to communicate with and control the ADCP and to log data. DAS receives the raw ping data from the ADCP and averages them for each bin over a selected time interval to reduce statistical variance. The standard averaging interval (called the ensemble length) for the LATEX A project is five minutes. DAS records the ensemble averages in its standard binary format to files called PINGDATA files. It does not record the individual pings used in the average. Thus, DAS does not have a replay mode in which the data can be re-averaged. After the cruises, the RDI program, LOGDAS, was used to convert the binary PINGDATA files to flat ASCII files, named CPING files. The binary PINGDATA files and the ASCII CPING files contain the same averaged data.

The GPS navigational information is made available to the DAS through the RDI program NAVSOFT. The DAS computes an average position for each ensemble and stores this position, to a thousandth of a degree, with the rest of the ensemble data. Note that at a latitude of 30°N, a thousandth of a degree corresponds to a spatial resolution of 111 m in latitude and 96 m in longitude. GPS navigation can provide position information with better resolution than recorded by DAS. To obtain a time for an ensemble, DAS uses the time of the personal computer at the end of the ensemble, i.e., when the data are stored. Thus, there is an inherent mismatch between average position computed by DAS and the time recorded by DAS; neither should be used quantitatively. DAS can only log the raw navigation data it receives in a 2048 byte user buffer that is part of each ensemble. The buffer size is too small to log navigation at a fast rate for an

entire ensemble; but the GPS position at the beginning of the ensemble can be stored here. During cruises H01 and H02, this buffer was not used. The navigation data were logged by a another program, and a precise time tie between the navigation data and individual ensembles was lost.

Another drawback of DAS is that it has a large number of parameters to set, which can lead to human error. A variety of inappropriate parameter settings were used during cruises H01 and H02, which compromised data quality. Therefore, the Data Office recommended that, beginning with cruise H03, the ADCP operators switch to RDI's newer TRANSECT software package to control the ADCP and log data.

3.5.1.2 TRANSECT Software

The TRANSECT software developed by RDI is a more user-friendly program than DAS, thus reducing the chance for human error. It can record both raw and averaged data. The raw data can be replayed, and, therefore, re-averaged using other time intervals during post-processing. Thus, some of the operator's choices for parameter settings are less critical because they can be changed and the data re-processed. TRANSECT reads ASCII navigation data from a serial port, marks it with the raw ADCP ensemble number and computer time, and saves it to a file. Of course, recording raw data greatly increases storage requirements to about 15 MB per day.

TRANSECT records the raw and averaged data to binary files. ASCII files containing averaged data are created during post processing by replaying the data. The format of the ASCII files is similar to that created by the DAS software.

3.5.1.3 First Level QC

The first three ADCP data sets, from cruises H01, H02 and H03, were sufficiently different from each other that each required a separate initial processing program. Once transformed to a common format, each averaged ensemble was checked for the following potential problems:

1) No navigation data for a given ensemble;
2) Bottom track depth too shallow for any good data;
3) No change in position from the last ensemble;
4) Computed ship speed greater than 650 cm/s;
5) The first bin of a given ensemble has the bad data indicator (19999) for one or more of the four beam readings;
6) The percent good pings for the first bin is less than 30.

Ensembles that met any of the error conditions were rejected. Those that passed were corrected as described below and reformatted. The reformatting was done because the data in the CPING files have a cumbersome, space-consuming format.

The first level of processing also performed conversions and computed average ship velocity from the GPS data. For a given ensemble, the great circle distance traveled during that ensemble was computed from the GPS fix at the beginning of that ensemble to the GPS fix at the beginning of the next ensemble. The GPS times of these two fixes were used for the time difference. The output from this step is plotted as time series and scanned for obvious errors.

3.5.1.4 Determination of Offset and Sensitivity Factors

That subset of the data having both bottom-track and navigation velocities is used to perform a calibration of the ADCP after the manner of Joyce (1989). The errors are of two types: sensitivity and alignment. As Joyce points out, sensitivity errors may arise because the orientation of the acoustic beam is not correct due to factors such as nonzero trim to the transducer and ship, small errors in the beam geometry, or overall system bias. The alignment errors are caused by mis-alignment between the reference frames of the ADCP and the ship gyro. Joyce also notes that the two types of errors arise from independent sources and produce errors approximately orthogonal. The misalignment induces an error in the velocity component perpendicular to the ship that is linearly related to ship speed, while the sensitivity error occurs in the ship-parallel component, again in linear proportion to ship speed.

SAS is used to calculate a least squares regression between the two estimates of mean ship velocity for each ensemble for which both bottom-track and GPS-navigation data are available. The mean alignment error is typically one to two degrees for the *R/V Gyre*, i.e., viewing the ship from above, the data are rotated clockwise by this angle. The mean sensitivity error is typically 1.01 to 1.04, so the data are scaled up by this value. For the *R/V J.W. Powell*, the alignment error can vary from cruise to cruise because the ADCP is re-mounted in the well for each cruise.

3.5.1.5 Second Level QC

The foregoing processing rejects ensembles with gross errors and corrects all data in an objective manner. The greatest source of remaining error is the ship's gyrocompass because it is an electro-mechanical servo system with inertia and, therefore, lag. ADCP ensembles collected while the ship is turning frequently exhibit vectors in some depth bins that are obviously inconsistent in direction and/or magnitude with vectors from surrounding ensembles at a given depth and those immediately above and below. Other factors, such as signal interference from CTD cable or significant rolling, also could result in such anomalous vectors. The *R/V Gyre's* ADCP has no pitch and roll sensors, which could be used to provide data to compensate for these modes of motion, but the Direct Reading ADCP used on the *R/V Powell* does. Ensembles with these symptoms often occurred while the ship was on station. Furthermore, the ship's track while on station is usually a set of one or more small erratic loops with very closely spaced ensembles. A plot of the vectors at a given depth for the on-station ensembles sometimes resembles a bird's nest.

An interactive program is used to view and remove ensembles with anomalous vectors and the ensembles collected while on station. This editing step is subjective. On-station ensembles, ensembles collected during other small loops, and backtracks in the cruise track are deleted. The vectors in the remaining ensembles are examined at each depth. If an ensemble had an anomalous vector at any depth, the ensemble (not just the data at that depth) was deleted. In deciding which vectors were anomalous, a three-dimensional perspective was taken. This is easy to do with an interactive program because it shows the vectors in plan view, and one can view vectors above and below a given depth; also, vertical profiles of u, v, or speed are easily viewed for any selected ensemble.

3.5.2 Cruise Specific Considerations

3.5.2.1 Cruise H01CGY9205

During this cruise the ADCP operator used a variety of different combinations of settings for the bin length and blank-beyond-transmit parameters. This made QA/QC processing difficult. The problems were worked through and some of the data were made usable.

For a 150-kHz NarrowBand™ ADCP system, RDI recommends a bin length of at least 4 m because precision becomes worse as the bin length is decreased. Therefore, the ensembles in the data set with bin lengths of 2 m, totaling some two days of records, were flagged as questionable in terms of quality; ensembles with a bin length of 1 m were rejected as unusable. RDI also recommends a blank-beyond-transmit of 4 m in order to avoid biasing the return signal with the ringing created by the out-going pulse. Unfortunately, a blank-beyond-transmit of 2 m was used throughout most of the cruise. With this value, ringing may slightly affect the data, but the degree cannot be quantified. Ensembles with blank-beyond-transmit values smaller than 2 m were rejected as unusable.

Because of the different combinations of parameter settings, the depth to the first bin and the sequence of depths for the bins change throughout the data set. The depth to the middle of the first bin is equal to the depth of the transducers below the surface, which is 4 m for the GYRE, plus the blank-beyond-transmit, plus the bin length. The bin length then determines the sequence of bin depths. The various combinations used during the cruise and their resulting sequence of bin depths are given in Table 3.5.1. The vertical profiles of the individual ensembles were averaged and/or interpolated to a common sequence corresponding to a first bin depth of 12 m and a 4-m bin length.

Table 3.5.1. Parameter settings (in meters) and the resulting sequence of bin depths on survey H01.

Transducer Depth	Blank-Beyond-Transmit	Bin Length	Bin Depth Sequence
4	2	2	8, 10, 12, 14, ...
4	3	2	9, 11, 13, 15, ...
4	4	2	10, 12, 14, 16, ...
4	2	4	10, 14, 18, 20, ...
4	4	4	12, 16, 20, 24, ...
4	2	8	14, 22, 30, 38, ...
4	4	8	16, 24, 32, 40, ...

3.5.3.2 Cruise H02CGY9208

The Data Office carefully reviewed the ADCP data from the H02 survey, and concluded that a combination of problems render this data set unusable. First, the blank-beyond-transmit was set to 1 m throughout the survey. As a result, the ringing from the outgoing pulse saturates the automatic gain control and biases the return signal. The effect is clearly evident in the amplitude values of the vertical profiles, which indicate return signal strength. Typically, the amplitude (in units of counts) is low for the first bin (~-160), rises to values between 190-250 over the next few bins, and then slowly decreases with depth.

Second, the depth cell length (bin size) was set to 2 m, but the transmit pulse length was set to 4 m throughout the survey. The manufacturer recommends that these parameters be set to equal values. When the transmit pulse is made longer than the bin size, the data are smoothed over the range covered by the transmit pulse, reducing the spatial resolution. This smoothing reduces the amount of information collected in the profile relative to the number of measured depth cells.

Third, the number of bins was set to 20, so the maximum depth of a profile was 40 m (2-m bin size times 20 bins).

Finally, the navigation data were not recorded in the user buffer of each ensemble average. The only way to tie the navigation data to a specific ensemble is through the PC-computer clock time recorded at the end of each ensemble. However, the PC clock drifts at a substantial rate, while the GPS navigation time is accurate to nanoseconds. There is no information to indicate how often, or even if, the operator synchronized the PC clock to the navigation time. Thus, the statistical comparison of ship speed as computed from navigation data with that measured by bottom tracking (section 3.5.1.4) cannot be made with any confidence that identical time periods are being used.

3.5.3.3 Cruise H03CPW9210

This survey was conducted aboard the *R/V J.W. Powell*. A Direct Reading model ADCP, mounted in a through-ship well, and the TRANSECT program were used during this survey. This particular ADCP had beam angles of 20 degrees from the vertical, as compared to the 30 degree beam angles for the ADCP on the *R/V Gyre*. The smaller beam angle permits the ADCP to measure water velocity slightly closer to the bottom, but increases the statistical uncertainty of a ping by a factor of 1.4. The QA/QC processing was successful in making the data usable. Representative plots are shown in section 5.5.

There were several hardware problems, which the operator successfully fixed. At one point (November 9), the ADCP was pulled from the well and dismantled to replace some circuit boards. The well, the ADCP, and the mounting system were carefully marked prior to removal so that the alignment angle was not significantly altered when the ADCP was reinstalled.

The principal quality control problem was that the personal computer clock and the navigation time were not continuously synchronized. At one point the difference reached one minute and fourteen seconds. However, TRANSECT automatically logs each navigation string (includes satellite time) that it receives, together with each raw ensemble number and its associated PC time. When writing the TRANSECT software, RDI assumed the time would be used to match the raw ensembles to navigation fixes. At

the request of the Data Office, RDI modified the TRANSECT software to output the specific raw ensemble numbers used in a five minute segment average. This modification permitted the Data Office to write software that would correctly match ship speed as computed from navigation with the measured bottom-track speed.

3.5.3.4 Cruise H04CGY9302

No significant problems with the ADCP were encountered during this cruise. QA/QC processing was routine and data quality was good. Section 5.5 discusses representative plots.

4 DATA MANAGEMENT AND INFORMATION TRANSFER

4.1 Introduction

Section 4 gives an overview of data archival and sharing activities and of information transfer activities of LATEX A, including summaries of data archived at the National Oceanographic Data Center (NODC) and data provided to others. A summary of information transfer activities implemented is provided, including postings to GULF.MEX electronic bulletin board, issuance of public notices and notices to fishermen, publication of the bi-weekly newsletter, *LATEX Fortnightly,* and organization of LATEX meetings.

4.2 Data Archival

The NODC project identification code for LATEX A data is 0212. Data collected from current meter moorings, meteorological buoys, drifting buoys, and basic hydrographic data through March 1993 have been submitted to NODC. Data from the MiniSpec directional wave gauges have not yet been provided to NODC because of problems associated with their quality (see sections 2.2.3.2 and 3.2.2). Data from the ADCP collected during the hydrographic surveys have not yet been provided to NODC because of processing and data quality problems (see sections 2.5 and 3.5). The chlorophyll a data from H04 and accessory pigment data from H01 through H04 have not yet been provided to NODC because they are undergoing analysis and quality assurance processing.

Although the LATEX A data sets have received quality control and assessment, they are still preliminary. Users should expect that subsequent corrections will be made to the data sets prior to the final submission to NODC. USERS SHOULD BE AWARE THE DATA ARE PRELIMINARY AND SUBJECT TO CHANGE.

4.3 Data Sharing

There has been substantial interest in the LATEX A data set. A data sharing agreement was formulated to allow interested scientists outside of the LATEX/MMS community to use portions of the data set while protecting the interests of the LATEX A scientists in scientific use of these data. Table 4.3.1 provides a summary of data provided by LATEX A to others during the first field year.

4.4 Information Sharing

4.4.1 GULF.MEX Bulletin Board

LATEX A maintains the GULF.MEX bulletin board on ScienceNet of Omnet, a commercial electronic mail service. LATEX A posts to GULF.MEX all cruise plans and reports, meeting announcements, weekly drifter trajectories, weekly meteorological summaries, the LATEX calendar, and other selected information relative to LATEX A.

4.4.2 Public Notices

LATEX A regularly advises the Defense Mapping Agency, the U.S. Navy Submarine Command, and the United States Coast Guard regarding LATEX A mooring positions

Table 4.3.1. LATEX A data shared with others.

Name	Data Description	Date Delivered
Steve Ackleson NASA	ARGOS-delivered met data for 26 Sep - 10 Nov 1992	November 1992
Marie Neuman LSU	selected current meter data from April and May, 1992	November 1992
Dale Pillsbury OSU	MiniSpec data for current meter comparsion study	November 1992
Max Sheppard U of FL	current meter data for Moorings 24 & 25 through 10/30/92	December 1992
Peter Santschi TAMU	drifter trajectories	January 1993
John Cortinas, Jr. NSSL	met buoy data for 21-23 Nov 1992	February 1993
William Martin NSSL	met buoy data since April 1992	February 1993
Max Sheppard U of FL	current meter data from Mooring 25	February 1993
K. Al-Abdulkader TAMU	CTD, nutrient, & pigment data from selected hydrographic 1993surveys and stations	March 1993
Marie Neuman LSU	current meter and wind data	March 1993

and deployments. LATEX A obtains Coast Guard approval for the deployment of the surface marker and meteorological buoys as Private Aids to Navigation.

4.4.3 LATEX Meetings

LATEX A organized two well-attended meetings on the oceanography of the LATEX region. The first general meeting of the LATEX program (LATEX I) was held in New Orleans on 27-28 May 1992. The Science Advisory Panel (SAP) met 26-29 May. Program descriptions and early results were presented by the program managers of LATEX A, B, and C, and by principals of the MMS-sponsored modeling efforts and other collateral programs. General science presentations included the topics of modeling in the Gulf of Mexico, mass exchange between mid-shelf and offshore regions of the Gulf, atmospheric cyclogenesis, sea surface altimetry, and phytoplankton and pigment analyses. Table 4.4.1 shows the final agenda for this meeting.

4.4.5 The *LATEX Fortnightly*

The *LATEX Fortnightly* News began publication 11 May 1992 and subsequently has been published every two weeks. The newsletter consists of a single sheet, 8.5 x 11 inch format, although a few issues were published in an 8.5 x 14 inch format. The newsletter is sent to approximately 2700 addressees by bulk mail. The mailing list consists of oceanographers interested in the coastal ocean or the Gulf of Mexico; federal, Texas, and Louisiana agencies interested in marine affairs; marine laboratories; Sea Grant agents; major fishing fleet offices; oil industry operations offices; centers of vessel and low-flying aircraft traffic; and other interested persons and entities. Table 4.4.3 lists the issues published in volume 1 together with their contents; Table 4.4.4 lists the issues and contents for the first quarter of volume 2.

The newsletter has three columns on the first page. The right column always has a list of LATEX A mooring locations; the remaining two columns are devoted to articles. Interested parties have been encouraged to submit brief articles for the newsletter. The back page is divided vertically into three plates. The top third is space for the address and postage, the middle third contains a map of the Gulf of Mexico with drifter tracks and wind data summarized as wind roses for the preceding two weeks. During the period when the S4 current meters were reporting data via system ARGOS, the average current vectors for the preceding two weeks were shown as arrows at the current meter locations. The bottom third contains publication information and addresses, news on the LATEX Gulf of Mexico bibliography, and information on LATEX equipment lost and found.

Table 4.4.3. Volume 1 *LATEX FORTNIGHTLY NEWS*, 11 May 1992 to 21 December 1992.

Volume 1:	Date:	Title(s):
Iss. 1	5/11/92	Field Work Begins On Gulf Oceanography Study (story)
		Station Positions (back map)
Iss. 2	5/25/92	Met. Buoys Reporting Wind Data (story)
		Winds from 14 April - 18 May 1992 (back map)
Iss. 3	6/8/92	MMS Marine Mammal Watch (story)
		Cetaceans of the Gulf of Mexico (table)
		Winds from 22 May - 05 June 1992 (back map)
Iss. 4	6/22/92	First LATEX Hydrographic Survey Completed (story)
		Some Preliminary Results (story)
		(4) Temperature/Salinity Vertical Sections (figures)
		Winds from 04 June - 18 June 1992 (back map)
		(4) Temperature/Salinity Vertical Sections (back figures)
Iss. 5	7/6/92	Mississippi River Plume Cruise (story)
		Winds from 23 June - 07 July 1992 (back map)
		LATEX Plume Cruise Track (in back map)
Iss. 6	7/20/92	Preliminary Results from LATEX Current Meters (story)
		Four Met Buoys Removed (story)
		(4) Temperature/Salinity Plots (figures)
		Winds from 02 July - 16 July 1992 (back map)
		Current Roses for 07 April - 04 July (2nd back map)
Iss. 7	8/3/92	LATEX Shelf Hydrography Cruise Underway (story)
		Third Current Meter Service Cruise Returns (story)
		Help Sought in Locating Lost Buoy (story)
		XBT Data for Cruise 92PW06 (figure)
		Winds from 18 July - 03 August 1992 (back map)
Iss. 8	8/17/92	MMS Modeling Effort (story)
		Lost Buoy Found (story)
		Drifters Track Currents (story)
		Drifters (figure)
		Winds from 27 July - 13 August 1992 (back map)
Iss. 9	8/31/92	Hurricane Andrew (story)
		Drifter Update (story)
		Wind Speed and Pressure (figure)
		Drifters (figure)
		Hurricane Climatology for the State of Louisiana (table)
		Winds from 13 August - 28 August 1992 (back map)
Iss. 10	9/14/92	Drifter Tracks (story)
		Search for Fisherman (story)
		Drifters (figure)
		A Description of a Great Sea Storm (poem)
		Velocity Components for Drifter 2447 (back map)
		Winds from 28 Aug. - 10 Sept. 1992 (2nd back map)
Iss. 11	9/28/93	MMS Coastal Ocean Modeling Program (story)
		(2) LATEX Structure Breakdown Tables (tables)
		Winds from 11 September - 23 September (back map)
		Second MMS Whale Watch Cruise Ends (back story)
Iss. 12	10/12/92	MMS Coastal Ocean Modeling Program (story)
		Winds from 24 September - 09 October (back map)
Iss. 13	10/26/92	Current Measurements on the Texas Shelf/Via Satellite (story)
		LATEX Current Meter Servicing Cruise Returns (story)
		Mailing List Reduction (story)
		Winds from 10 October - 23 October 1992 (back map)
Iss. 14	11/9/92	LSU Scientists Complete Second Survey of the Mississippi River Plume (story)
		Third LATEX Shelf Hydrography Cruise Started (story)
		Winds from 23 October - 6 November 1992 (back map)

Table 4.4.3. Volume 1 *LATEX FORTNIGHTLY NEWS*, 11 May 1992 to 21 December 1992. (continued)

Volume 1:	Date:	Title(s):
Iss. 15	11/23/92	TAMU Scientists Complete Third Standard Grid Hydrography Cruise (story)
		Winds from 07 November - 23 November 1992 (back map)
Iss. 16	12/7/92	LATEX Mooring Records Currents During the Passage of Hurricane Andrew (story)
		Hurricane Andrew Track (figure)
		Mooring 14 - Speed/Dir./Temp./Sal. (figure)
		Winds from 23 November - 07 December 1992 (back map)
Iss. 17	12/21/92	LATEX II is a Success (story)
		MMS Releases Catalog of Environmental Studies (story)
		Winds from 08 December - 18 December 1992 (back map)

Table 4.4.4. Volume 2 *LATEX FORTNIGHTLY NEWS*, 4 January 1993 to 1 April 1993.

Volume 2:	Date:	Title(s):
Iss. 1	1/4/93	TEXFLEX and TEXFLOW: Texas A&M Programs Complement LATEX (story)
		ARGOS Drifter 5550 (figure)
		Winds from 18 December - 04 January 1993 (back map)
Iss. 2	1/18/93	Phytoplankton Pigment Distributions Across the Texas-Louisiana Shelf (story)
		92A Hydro Diagram (figure)
		Winds from 04 January - 15 January 1993 (back map)
Iss. 3	2/1/93	Fourth LATEX Shelf Hydrography Cruise Underway (story)
		Moorings Marked With Lighted Buoys (story)
		Seventh Current Meter Servicing Cruise Returns (story)
		Fourth Hydrographic Cruise Track (figure)
		Winds from 18 January - 01 February 1993 (back map)
Iss. 4	2/15/93	New MMS Program Begins Field Work on LATEX Shelf (story)
		Loc. of GOOMEX Field Study (figure)
		Winds from 01 February - 15 February 1993 (back map)
Iss. 5	3/1/93	Fourth LATEX A Hydrographic Cruise Completed (story)
		NOAA Coastal Ocean Program Releases Workshop Report (story)
		Third LATEX B Hydrographic Cruise Scheduled (story)
		Winds from 15 February - 01 March 1993 (back map)
Iss. 6	3/15/93	Spring Hydrography Cruise Expanded (story)
		CTD Stations/Cruise Track for 93E (figure)
		Winds from 01 March - 12 March 1993 (back map)
Iss. 7	3/29/93	GOSAP Program to Examine Oil Seeps in Gulf of Mexico (story)
		Navy Submarine NR-1 and NASA ER-2 to Examine Seeps (story)
		Winds from 15 March - 22 March 1993 (back map)

5 TECHNICAL DISCUSSION

5.1 Introduction

Section 5 provides a representative selection of standard computer-produced graphics. Additional graphical products will be contained in the microfiche packet that will accompany the Final Report. This section presents a brief technical discussion of these representative graphics to indicate early results of the data collection from the first field year. Included in the discussion are representations of time series from the moored measurements, drifting buoy trajectories, plots of hydrographic properties, and preliminary plots of ADCP-measured currents. The preliminary results of the first year of the cyclogenesis study are presented. The activities of the LATEX Science Advisory Panel and the relationship of the Panel to the planning of the model/data comparisons are described.

5.2 Moored Measurements

5.2.1 Representative Monthly Plots

In Figure 5.2.1 are shown monthly plots of current velocity (40-hour, low-passed, stick vectors and 3- and 40-hour, low-passed along-shelf and cross-shelf components) and of temperature and salinity (3- and 40-hour, low-passed) for the month of August 1992 from the instrument at 12 m depth on mooring 13. Similar monthly plots have been made for each moored current meter producing data for LATEX A during the first field year. The complete set will be included in the microfiche packet that will accompany the Final Report. Several such plots representative of selected phenomena that occurred during the year are presented and briefly discussed here.

Mooring 13 (Figure 5.2.1) was located at 28°03.45'N and 90°29.15'W on the outer Louisiana shelf in water depth of approximately 200 m. Mooring 14 was located approximately 20 miles north (see Figure 2.2.1 for relative locations). The eye of Hurricane Andrew passed northwest over the Louisiana shelf on 25-26 August 1992; at about 2300 UTC on 25 August it passed about 10 km east of mooring 14. During this passage, recorded current speed at 11 m on mooring 14 reached 134 $cm \cdot s^{-1}$. However, the 12-m currents at mooring 13 are even greater; see the 3-hr, low-passed current in Figure 5.2.1. At 100 m at this mooring 3-hr, low-passed currents peaked at a speed of about 70 $cm \cdot s^{-1}$, and at 190 m on the same mooring they exceeded 100 $cm \cdot s^{-1}$ (see Figure 5.2.2). For both current records shown, note how small and relatively steady were the currents until 21-22 August at which time a generally westward along-shelf component of current began to increase gradually. Then, on 25 August the current at 12 m increased dramatically toward the southwest followed about 1 day later by similarly changing currents at 190 m.

Following the passage of Andrew, very energetic inertial oscillations continued for about two weeks at meters affected by the hurricane. This is evidenced at 190 m at mooring 13 (Figure 5.2.3); the period of post-hurricane recovery lasted at least as long at mooring 14, where currents at 11 m are pictured in Figure 5.2.4.

Dramatic, energetic, near-inertial oscillations are triggered over this shelf by the passage of atmospheric fronts. Several such frontal passages occurred during July 1992. The effects are illustrated in Figures 5.2.5, 5.2.6, and 5.2.7, which show July current meter plots for 12 m at mooring 13, 15 m at mooring 10, and 12 m for mooring 25, respectively.

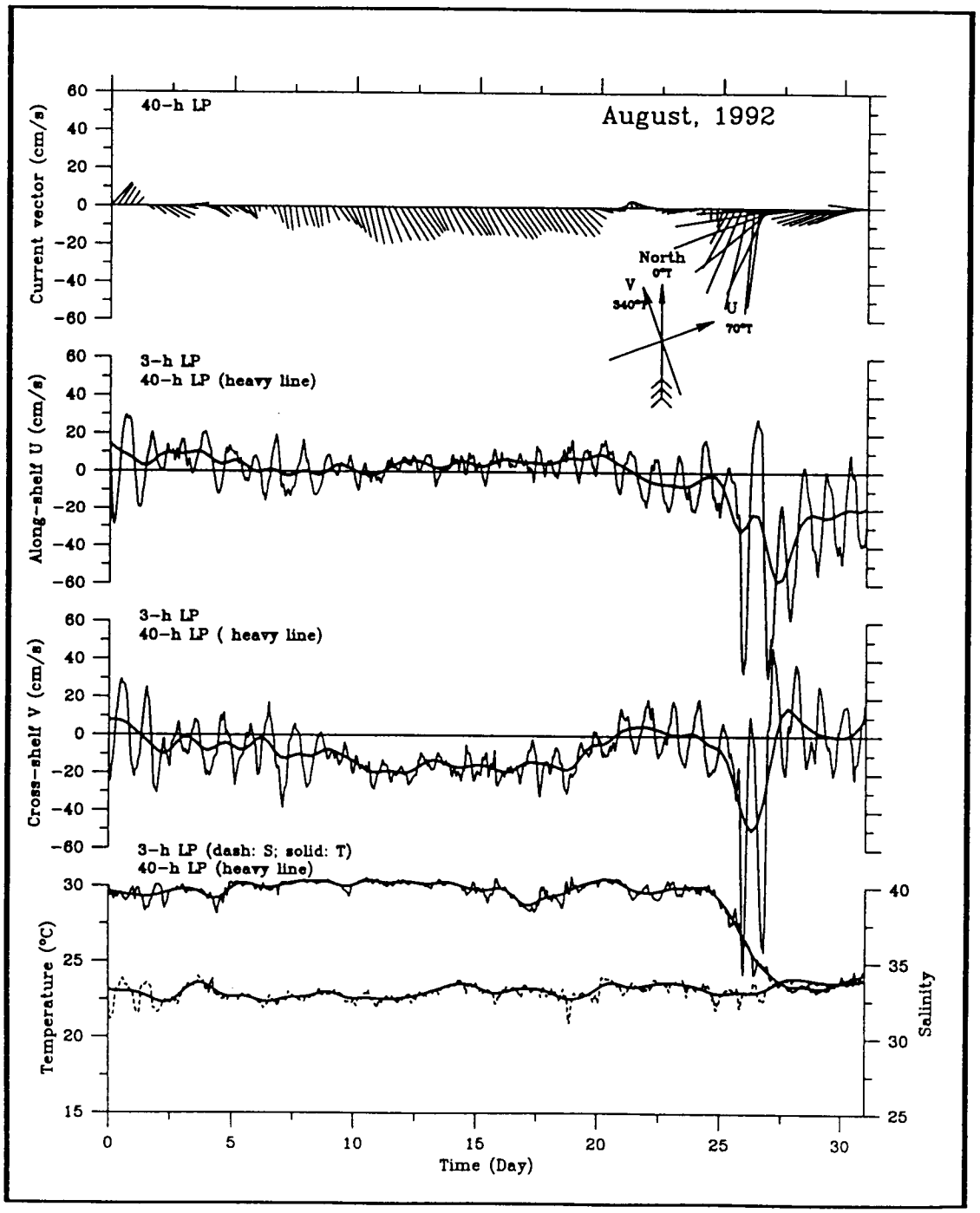


Figure 5.2.1. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 12 m for mooring 13, August 1992.

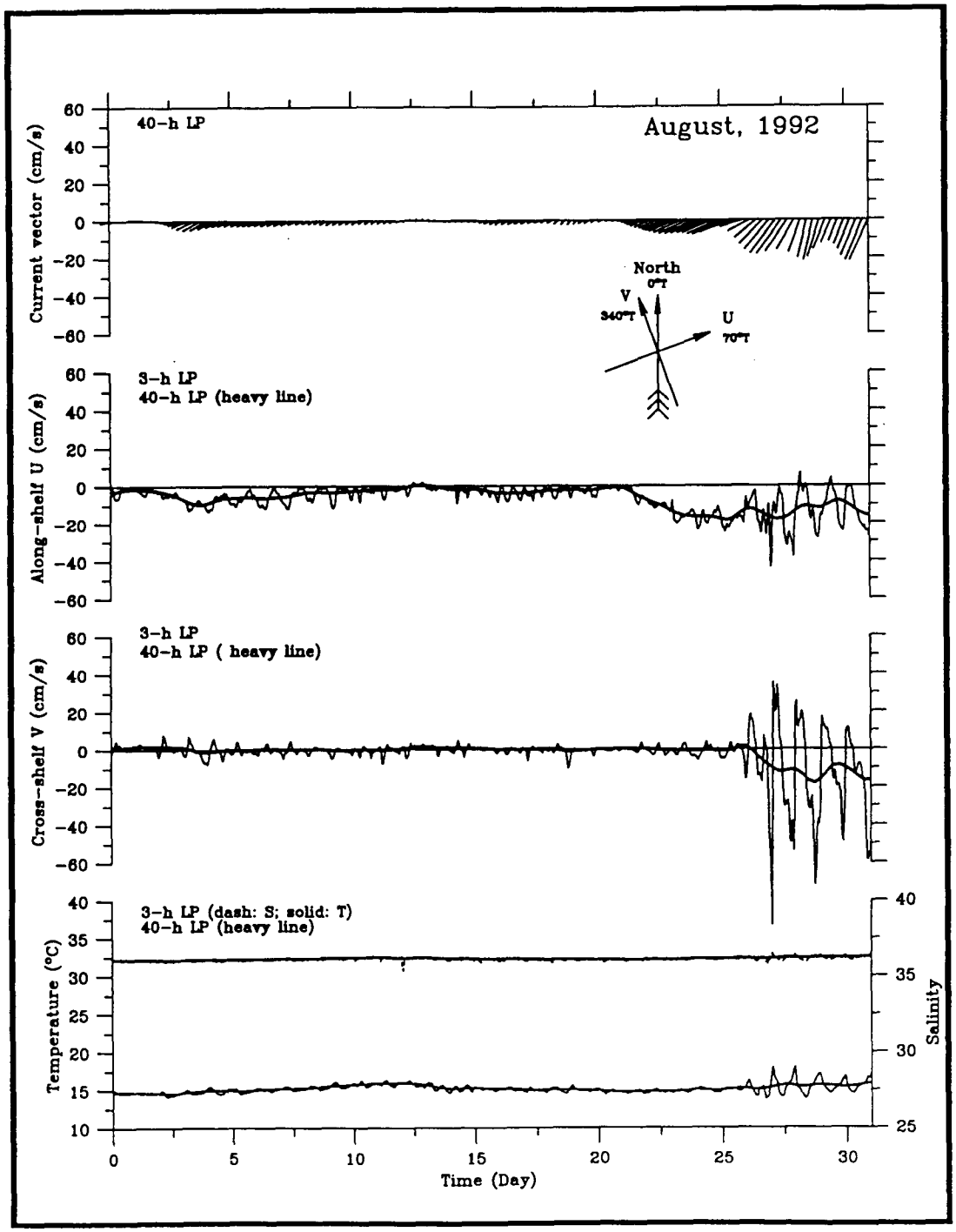


Figure 5.2.2. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 190 m for mooring 13, August 1992.

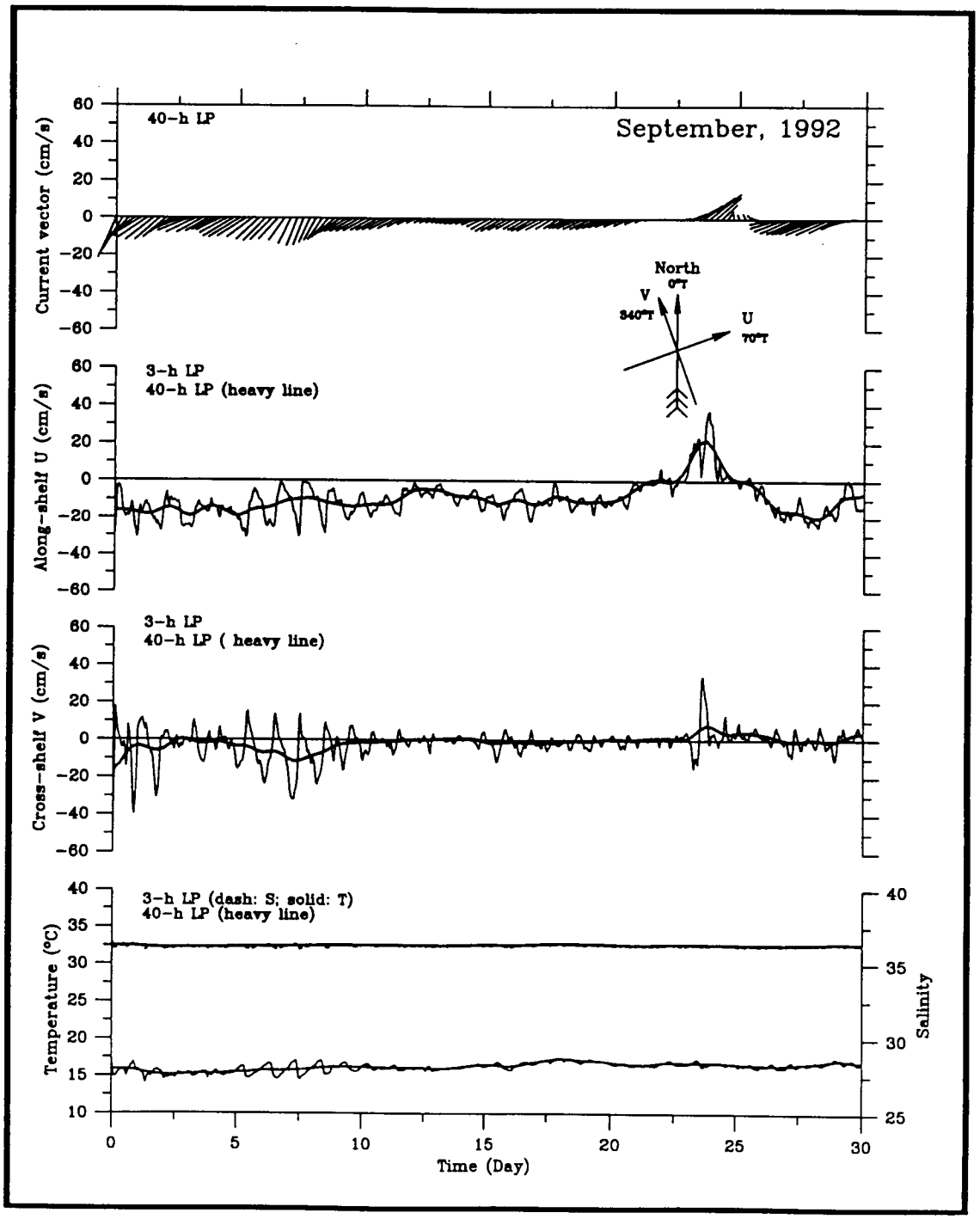


Figure 5.2.3. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 190 m for mooring 13, September 1992.

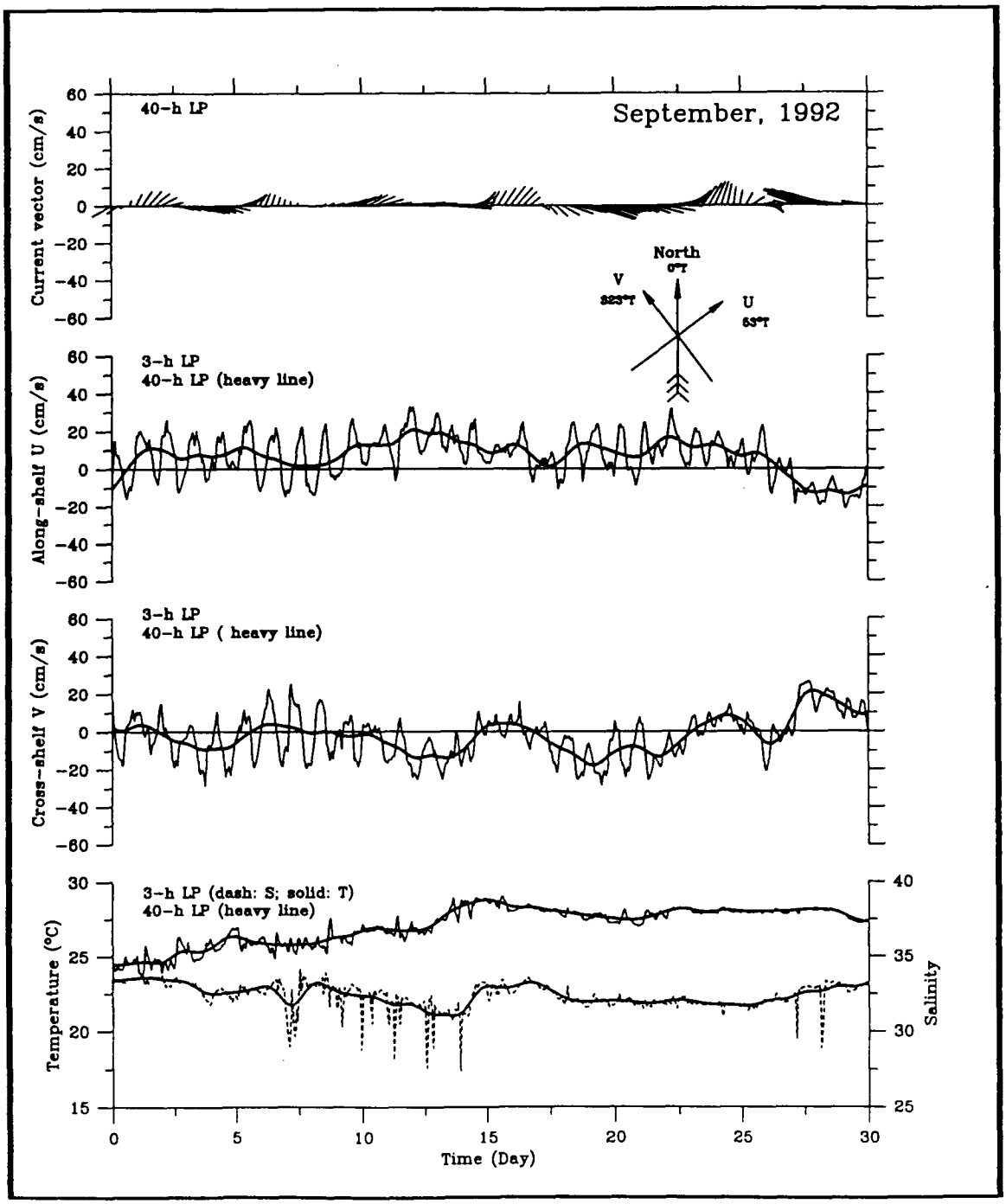


Figure 5.2.4. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 11 m for mooring 14, September 1992.

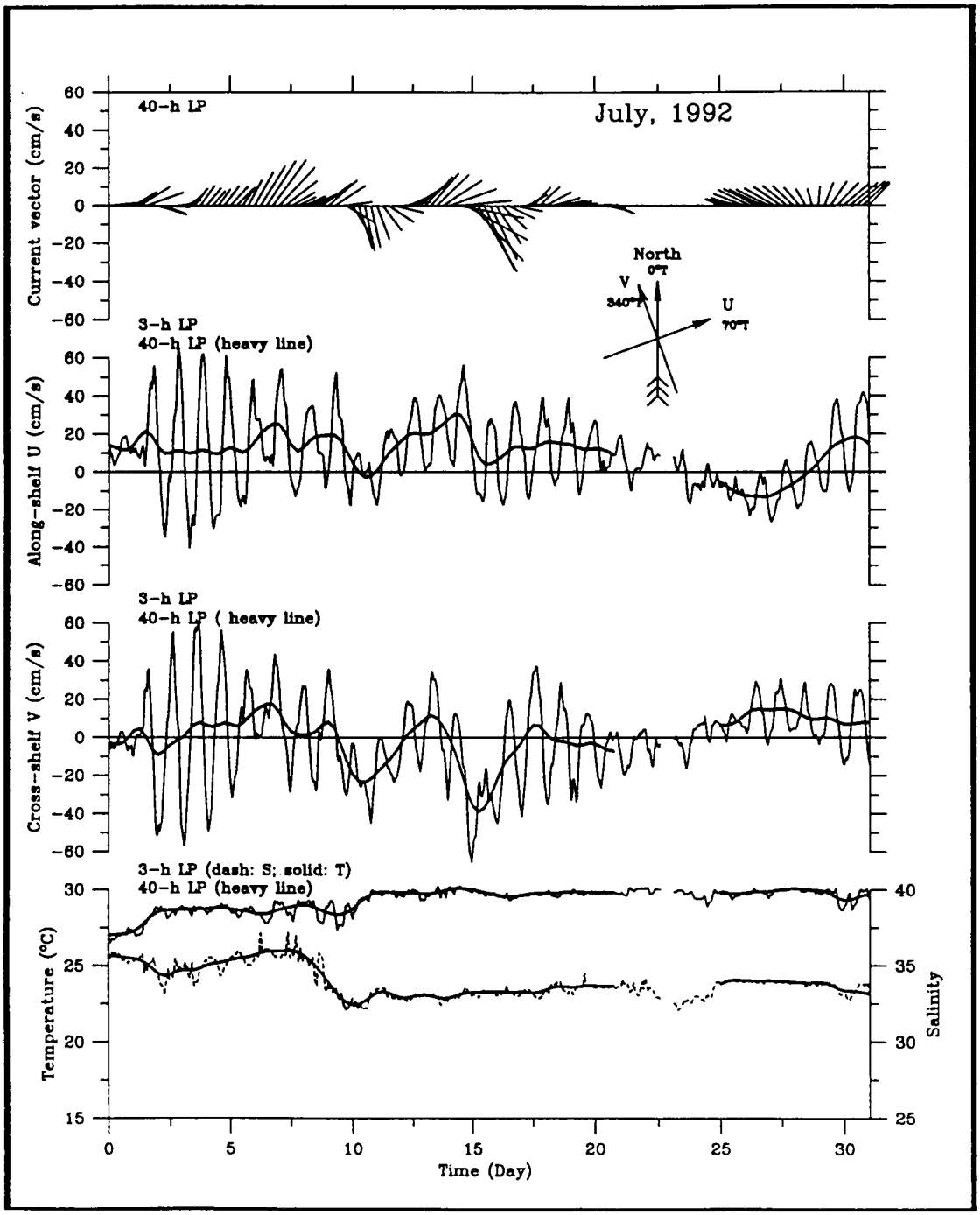


Figure 5.2.5. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 12 m for mooring 13, July 1992.

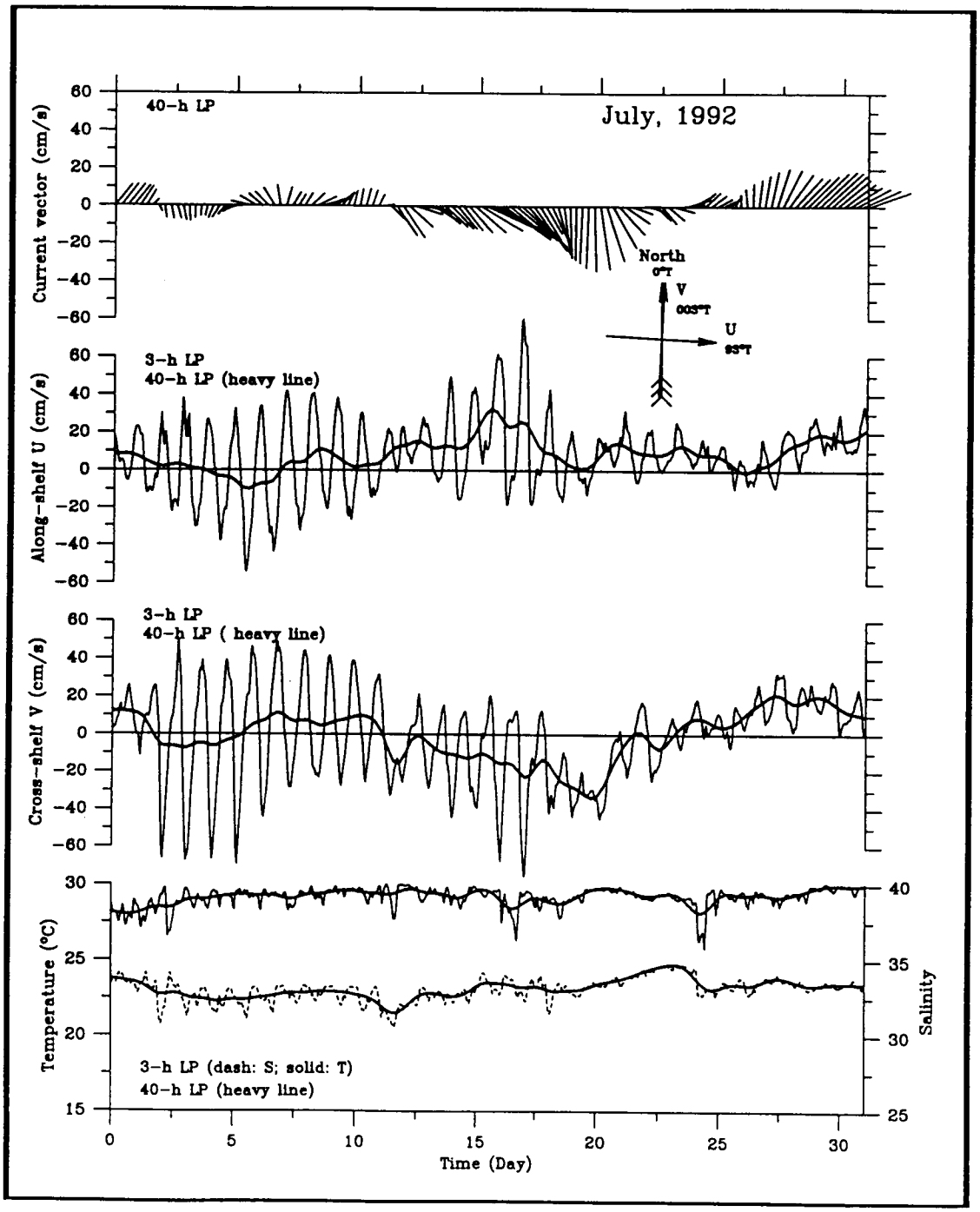


Figure 5.2.6. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 15 m for mooring 10, July 1992.

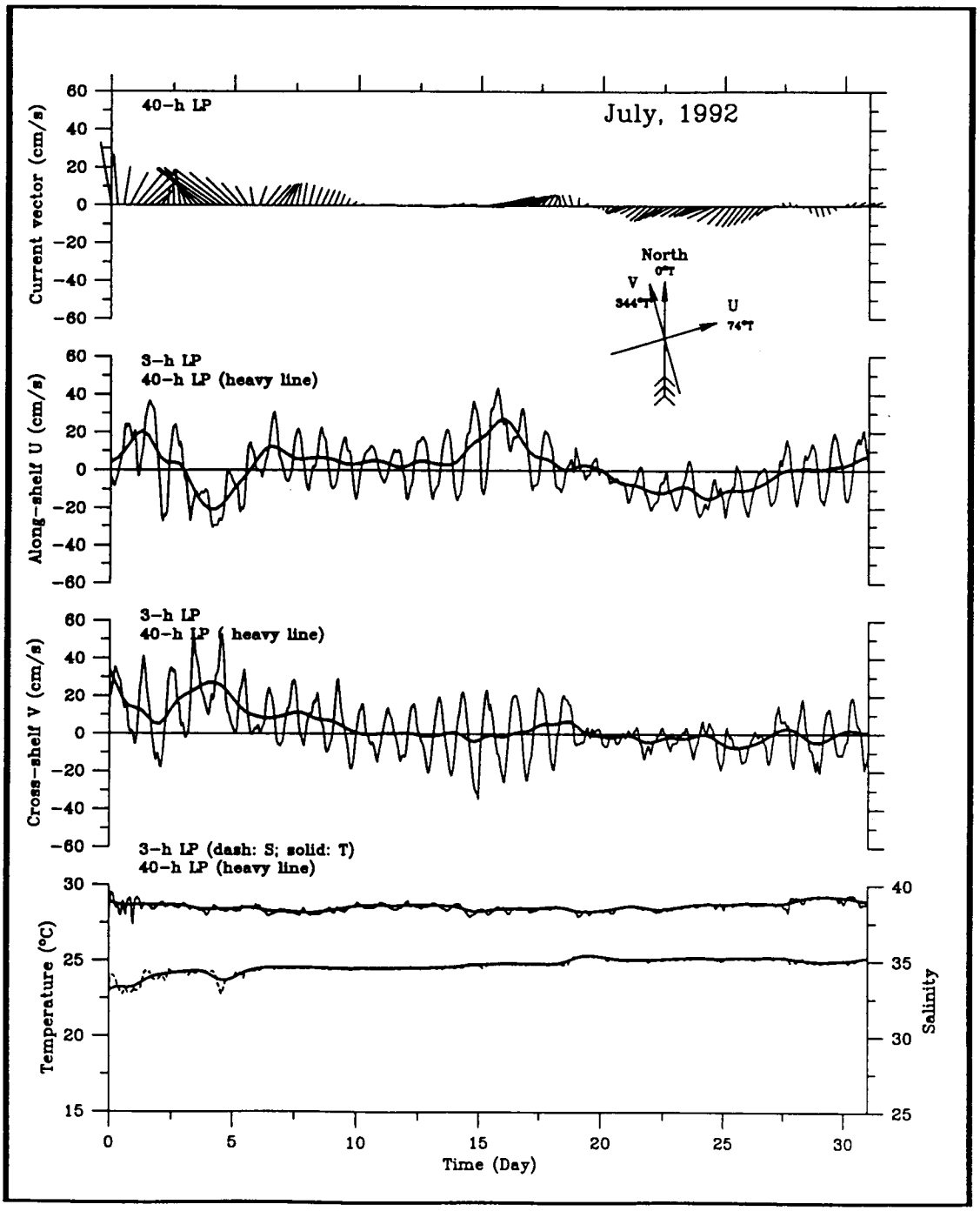


Figure 5.2.7. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 12 m for mooring 25, July 1992.

Locations are shown in Figure 2.2.1. Mooring 13 is located at the shelf break near 90°29'W; mooring 10 is located at the shelf break near 92°44'W; and mooring 25 is mid-shelf near 95°29'W. Three events are seen, the first beginning 1 or 2 July 1992. Each event seems to result in near-inertial ringing for a week or more. The oscillations appear to be coherent over large areas of the shelf, and they are more energetic at the shelf break, decreasing in energy shoreward and rapidly offshore.

Data taken during the first GULFCET hydrographic cruise (15 April - 1 May 1992) evidence an anticyclone located offshore of the southwestern LATEX region (Fargion and Davis 1993). It appeared that an anticyclonic ring was centered near 26°N, 95°W. Shortly thereafter, in May and early June, episodes of relatively strong (30-40 $cm \cdot s^{-1}$) north northwestward flow were recorded at 12 m at mooring 49. That mooring was located near 27°22'N, 95°54'W, a location corresponding to the northwest quadrant of a ring impinging on the continental shelf/slope in this region. Then, in late June 1992 north northeastward currents at this meter increased to about 60 $cm \cdot s^{-1}$ and remained essentially so for all of July and August. In Figure 5.2.8 are shown the July currents at 12 m from mooring 49. This episode of ring-shelf interaction was followed by a period of light currents which extended until mid-November 1992. Then northeast wind flow returned at mooring 49, yielding 40-hr, low-passed current speeds of nearly 80 $cm \cdot s^{-1}$ at 12 m during early January 1993. That flow was likely generated by "Unchained Eddy" moving into the region (see section 5.3 for further discussion).

On 12 March 1993 a class four cyclone was generated over the Texas shelf; this storm evolved into the Blizzard of 1993, referred to by some as the "Storm of the Century" (see section 5.6.2 for further discussion). In Figure 5.2.9 is shown a current meter record for March 1993 from 12 m at mooring 25. The pronounced affects of this cyclone are clear in the records. For the records of these cyclones examined, the generation of the near-inertial motion so prominent with many frontal passages is not seen.

The MMS wishes to determine the maximum likely distance that spilled oil over the Texas-Louisiana shelf could move in a 48-hour period. To assist in this assessment, the maximum speeds and associated directions measured at the upper instruments were determined from the first-year records of each of the LATEX A moorings. These maxima were selected from the 40-hour, low-passed current records that will be included in the microfiche packet that will accompany the Final Report. The time period during which hurricane Andrew was over the Louisiana shelf, 25-26 August 1992, was not considered in this search for maximum speeds. Table 5.2.1 gives mooring number, location, instrument depth, maximum speed, direction, and date for each site measured over the Texas-Louisiana shelf. The types of instruments used at each location are given in section 2.

For the first LATEX field year, the table shows that the maximum low-passed currents, at a nominal 10-m depth range, from about 30 to 80 $cm \cdot s^{-1}$, directions vary around the compass, and maxima occur around the calendar. This may make interpretation of these results difficult.

Moreover, these records often contain several relative spread maxima of similar values. As an example, the current meter at 12 m on mooring 4 showed a maximum low-passed current of 56 $cm \cdot s^{-1}$ toward 040° in May 1992. The other prominent near maximum was 53 $cm \cdot s^{-1}$ toward the south-southwest on 7 July 1992. These near opposite current maxima are but one example of the difficulty in estimating maximum likely water motion by considering just the record-length maximum.

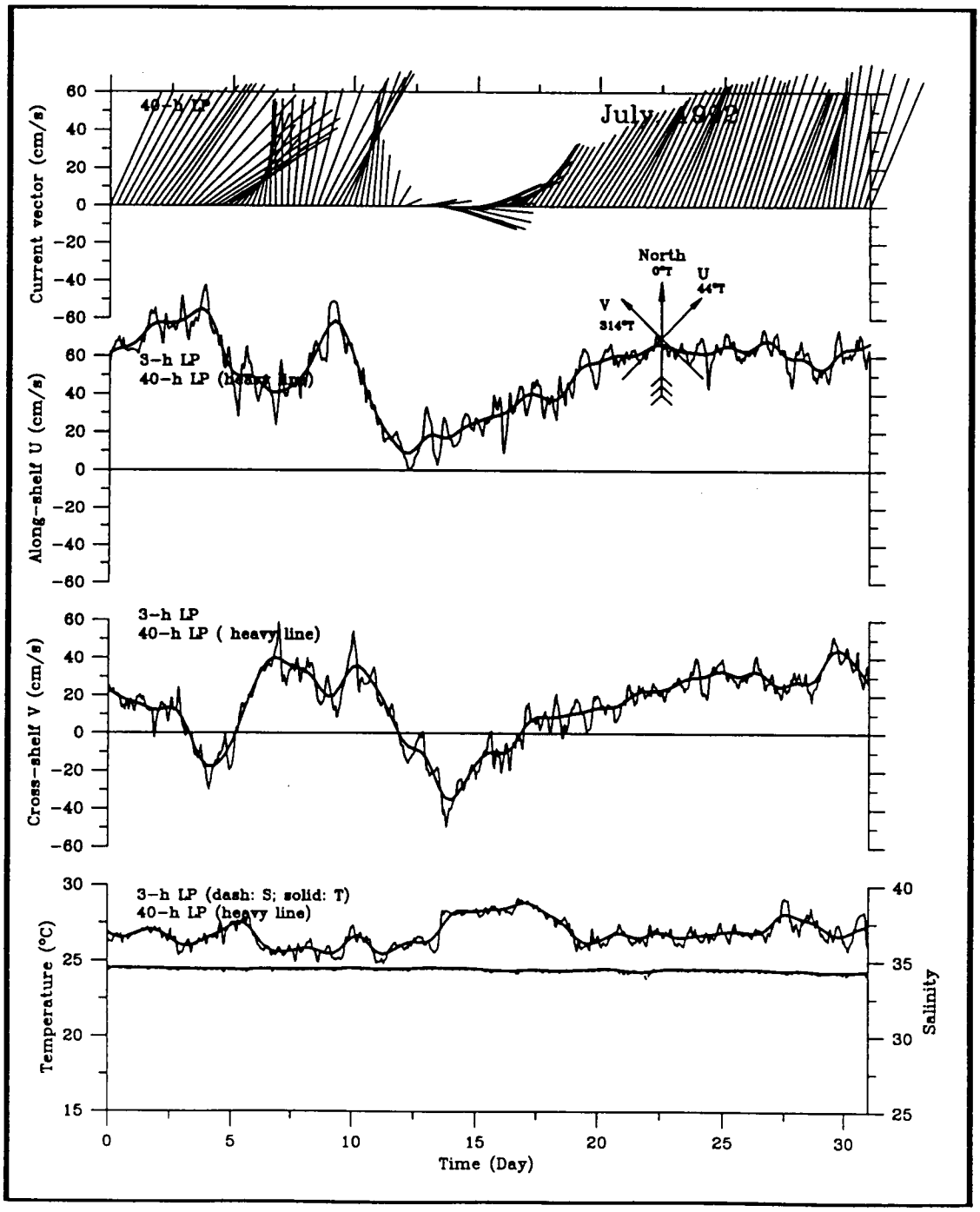


Figure 5.2.8. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 12 m for mooring 49, July 1992.

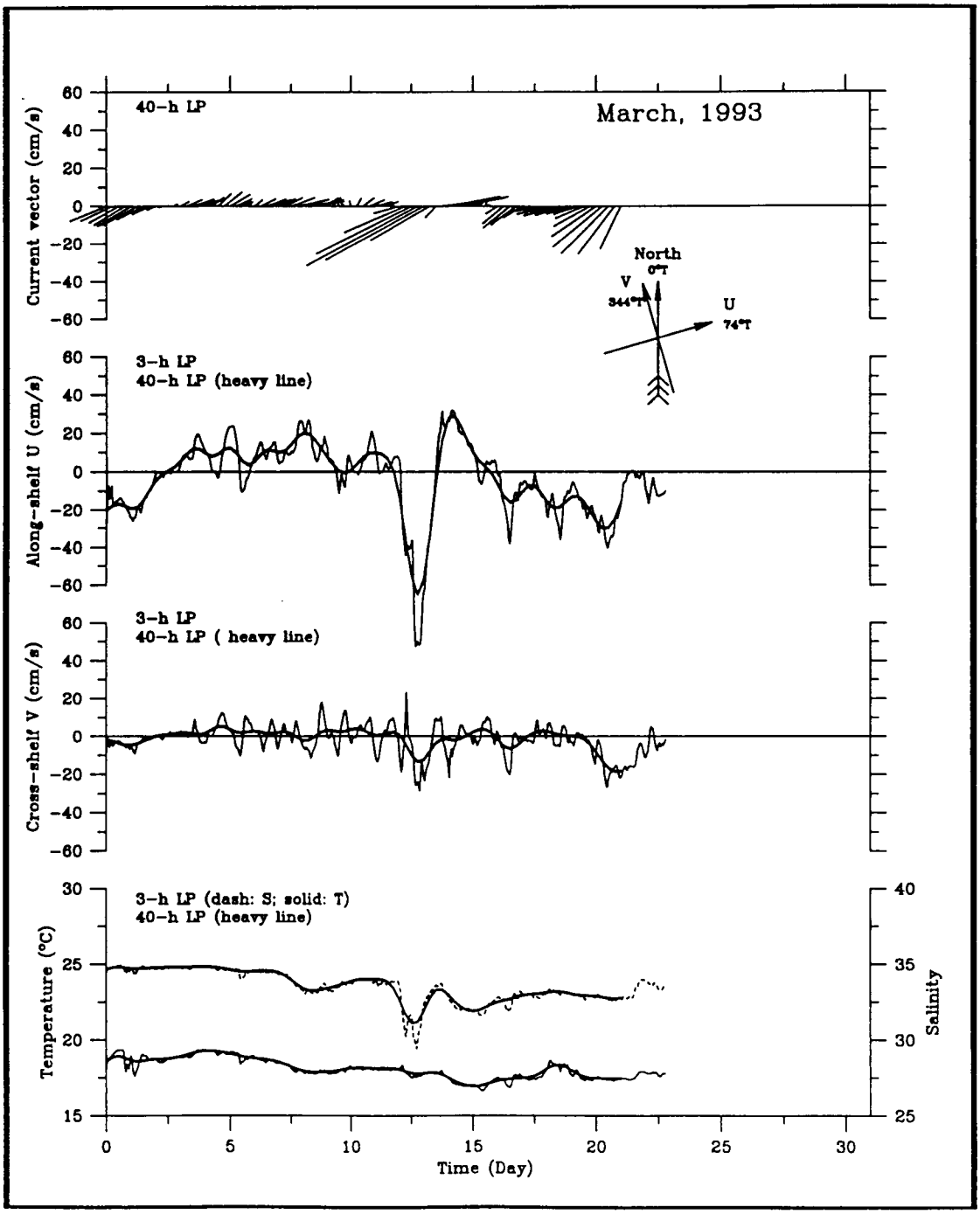


Figure 5.2.9. Monthly plot of current velocity (40-hour stick vectors, and 3-and 40-hour low passed components), and temperature and salinity (3- and 40-hour low passed) at 12 m for mooring 25, March 1993.

Table 5.2.1. Maximum speeds, and corresponding directions, observed in 40-hr, low-passed current record from each LATEX A mooring during the first field year.

Mooring	Latitude (°N)	Longitude (°W)	Depth (m)	S_{max} ($cm.s^{-1}$)	Dir_{max} (°T)	Date
1	27° 15.38'	97° 14.73'	11	75	19	29 Apr. 1992
2	27° 17.03'	96° 58.82'	10	75	205	13 Mar. 1993
3	27° 17.38'	96° 44.17'	10	52	217	30 Sep. 1992
4	27° 07.57'	96° 21.50'	12	56	40	17 May 1992
5	27° 28.10'	96° 04.40'	12	63	33	23 Aug. 1992
6	27° 42.52'	95° 39.85'	12	74	49	10 July 1992
7	27° 50.03'	95° 04.17'	12	75	90	5 Aug. 1992
8	27° 49.47'	94° 10.77'	12	53	110	18 June 1992
9	27° 48.50'	93° 30.18'	10	28	152	23 May 1992
10	27° 56.13'	92° 44.70'	15	42	114	15 July 1992
11	27° 50.52'	92° 00.55'	12	32	90	10 Nov. 1992
12	27° 55.02'	90° 29.68'	12	51	307	16 Oct. 1992
13	28° 03.45'	90° 29.15'	12	50	272	5 Nov. 1992
14	28° 23.67'	90° 29.57'	11	73	267	3 Oct. 1992
15	28° 36.50'	90° 29.50'	10	46	246	13 Mar. 1993
16	28° 52.02'	90° 29.45'	10	42	257	31 Jan. 1993
17	29° 11.77'	91° 57.90'	3	43	296	7 Oct. 1992
18	28° 57.77'	91° 58.97'	10	52	107	14 Mar. 1993
19	28° 27.92'	92° 02.08'	3	51	260	4 Oct. 1992
20	29° 15.65'	94° 03.82'	3	57	239	25 Jan. 1993
21	28° 50.23'	94° 04.77'	13	30	66	13 June 1992
22	28° 21.28'	93° 57.35'	3	50	231	15 Aug. 1992
23	28° 42.77'	95° 32.13'	10	69	247	13 Mar. 1993
24	28° 28.43'	95° 26.23'	10	41	83	23 June 1992
25	28° 09.58'	95° 28.53'	12	66	242	13 Mar. 1993
44	27° 43.53'	96° 25.43'	13	51	234	30 Sep. 1992
45	27° 25.08'	96° 07.58'	12	50	53	20 May 1992
46	27° 38.28'	96° 14.02'	10	55	56	14 June 1992
47	27° 19.30'	96° 12.77'	12	61	4	17 July 1992
48	27° 58.98'	91° 17.00'	12	50	14	23 Oct. 1992
49	27° 22.15'	95° 53.63'	12	79	43	3 Jan. 1993

5.2.2 Representative Current Roses

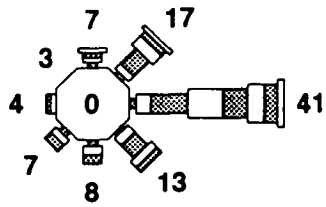
Figure 5.2.10 shows the current rose, and associated joint distribution of direction and speed from which the rose was constructed, for the initial deployment (10 April 1992 to 18 July 1992) of the current meter at 14 m on mooring 7. The microfiche packet that will accompany the Final Report will contain such figures for all deployments of LATEX A current meters recovered during the first field year, except for currents measured by the MiniSpec instruments.

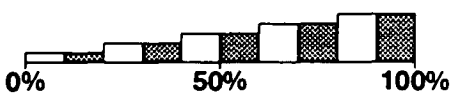
The joint speed versus direction information indicates the percentage of time the half-hourly current measurements fell within the indicated speed ranges and 45°-intervals of direction centered on the 8 principal compass directions. Speeds less than 1 $cm \cdot s^{-1}$ are categorized as calm and not assigned to compass directions, because those directions would not likely be meaningful. Also shown are the total percentage of time when the currents are within each speed range and are within each direction bin, with the corresponding average speed for each direction bin. The current roses are constructed using this information and the scale shown on each figure. White and stippled segments indicate from the rose center outward the percentage of time the currents were in speed bins 1-5 $cm \cdot s^{-1}$, 5-10 $cm \cdot s^{-1}$, ... , > 75 $cm \cdot s^{-1}$. The length of each segment corresponds to the percentage of time the current was in that speed bin; if the percentage is less than 1% for a particular speed bin, the corresponding segment is omitted. Calms are not indicated in the rose.

This rose shown for mooring 7 indicates that at the top instrument (14 m depth) the predominant flow during the deployment period was eastward 41% (of the time) with an average speed of 33.5 $cm \cdot s^{-1}$. If the directions of flow between 22.5°T and 157.5°T are included, the percentage increases to 71%. This supports a strong eastward flow along the shelf edge (200-m contour near 95°04'W) in spring and early summer, consistent with the Cochrane and Kelly (1986) circulation schema. Eastward or up-coast flow during this deployment period (early April to mid-July 1992) was also present at the upper meters of moorings 5 (200-m contour near 96°04'W; Figure 5.2.11) and 6 (200-m contour near 95°40'W; Figure 5.2.12).

Cochrane and Kelly also picture a strong eastward flow along the shelf-edge during the fall and winter period. This is confirmed by the current rose from 12 m on mooring 8 (200-m contour near 94°10'W) during the 19 October to 5 December 1992 deployment (Figure 5.2.13).

Evidence for the summer break down of downcoast (westward) flow over the inner shelf in the area including the Texas-Louisiana border, is seen in current roses from 3-m depth at mooring 20 (Figure 5.2.14-16). Mooring 20 is located at approximately 29°16'N and 94°04'W, near the Texas-Louisiana border. Figure 5.2.14 shows the speed-direction distribution for a late winter deployment (16 January - 16 March 1993); the dominant direction, with highest average speeds is to the west. Figure 5.2.15 shows the distribution for a summer deployment (20 June - 11 August 1992) which evidences a dominantly northward or northeastward flow pattern—the direction is not so well defined as in the wintertime situation. Figure 5.2.16 shows the speed-direction distribution for the 6 November - 11 December 1992 deployment, after the reestablishment of downcoast near shore flow as pictured by Cochrane and Kelly (1986).

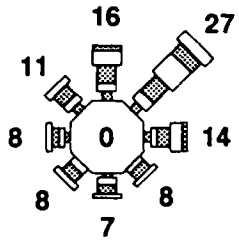


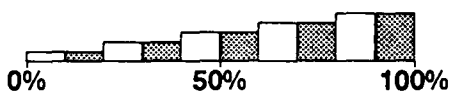


Current Meter 07 Top

Dir	Current Speed Range (cm·s⁻¹)											Avg. Speed
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	
N	0.6	1.6	1.1	1.5	1.1	0.6	0.2	0.0	0.0	0.0	6.6	18.1
NE	0.8	1.3	2.0	5.6	3.1	1.8	1.1	0.5	0.2	0.2	16.6	25.6
E	0.8	1.9	3.6	9.6	8.8	6.4	4.2	3.5	1.7	1.0	41.5	33.5
SE	0.7	1.0	2.5	4.7	2.0	1.9	0.5	0.1	0.0	0.0	13.4	22.2
S	0.5	1.6	2.3	2.3	0.9	0.2	0.1	0.0	0.0	0.0	7.9	15.5
SW	0.7	1.7	1.8	2.3	0.1	0.0	0.0	0.0	0.0	0.0	6.6	12.8
W	0.5	1.0	1.3	1.2	0.2	0.0	0.0	0.0	0.0	0.0	4.3	12.5
NW	0.8	0.8	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	2.6	10.0
Total	5.5	10.9	15.1	27.4	16.3	11.0	6.1	4.1	1.9	1.2	99.5	25.3
Calm											0.5	

Figure 5.2.10. Current rose and joint distribution; 10 April 1992 to 18 July 1992.

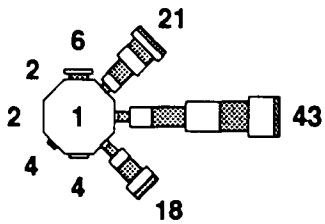


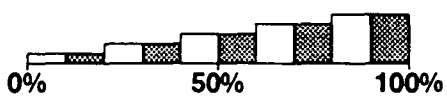


Current Meter 05 Top

Dir	Current Speed Range (cm·s⁻¹)											Avg.
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	Speed
N	0.5	2.6	2.0	4.8	3.7	1.4	0.5	0.4	0.5	0.0	16.5	23.7
NE	0.8	2.4	3.0	5.8	6.7	3.6	3.1	0.6	0.7	0.1	26.8	28.4
E	0.8	2.1	1.5	3.5	2.9	1.4	0.5	0.3	0.3	0.3	13.7	25.0
SE	0.5	0.9	1.4	2.7	1.2	0.7	0.7	0.1	0.0	0.0	8.3	22.6
S	0.2	1.2	1.7	2.6	1.0	0.5	0.1	0.0	0.0	0.0	7.4	18.9
SW	0.5	0.9	1.9	3.0	1.5	0.5	0.1	0.0	0.0	0.0	8.4	19.1
W	0.8	1.5	1.3	1.9	1.6	0.4	0.0	0.0	0.0	0.0	7.6	17.6
NW	0.5	2.2	1.9	3.6	1.9	0.6	0.2	0.1	0.1	0.0	11.0	19.2
Total	4.6	13.9	14.7	27.9	20.6	9.1	5.2	1.6	1.7	0.4	99.7	23.3
Calm											0.3	

Figure 5.2.11. Current rose and joint distribution; 8 April 1992 to 17 July 1992.

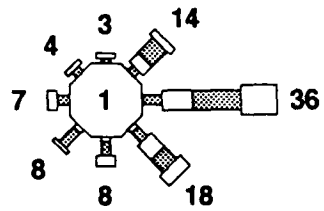


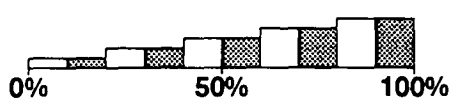


Current Meter 06 Top

Dir	Current Speed Range (cm·s⁻¹)											Avg. Speed
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	
N	0.6	0.6	0.5	1.6	1.2	0.7	0.2	0.1	0.1	0.0	5.7	23.3
NE	0.9	1.5	2.7	4.8	3.6	2.8	1.9	1.2	0.6	0.6	20.8	30.2
E	1.0	3.2	5.6	9.0	8.9	7.4	6.6	1.4	0.0	0.0	43.2	28.9
SE	1.3	3.0	3.0	4.9	2.7	1.9	0.5	0.2	0.3	0.0	17.9	21.1
S	0.5	0.9	1.1	0.8	0.5	0.1	0.1	0.1	0.0	0.0	4.1	15.4
SW	0.7	1.1	0.7	0.9	0.2	0.0	0.0	0.0	0.0	0.0	3.7	11.7
W	0.4	0.3	0.4	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.8	14.0
NW	0.2	0.4	0.4	0.7	0.2	0.1	0.1	0.0	0.0	0.0	2.0	17.0
Total	5.6	11.1	14.4	23.1	17.5	13.1	9.4	3.1	1.0	0.6	99.1	25.8
Calm											0.9	

Figure 5.2.12. Current rose and joint distribution; 10 April 1992 to 18 July 1992.

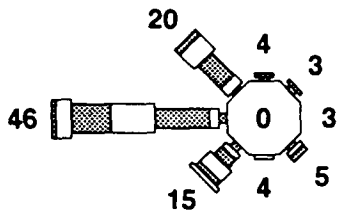


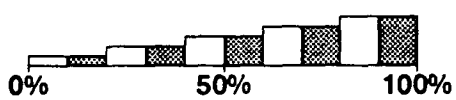


Current Meter
08 Top

Dir	Current Speed Range (cm·s^{-1})											Avg.
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	Speed
N	0.6	1.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	8.5
NE	0.9	1.9	3.2	5.7	1.8	0.0	0.0	0.0	0.0	0.0	13.6	16.8
E	0.5	5.4	7.9	12.7	9.3	0.5	0.0	0.0	0.0	0.0	36.2	19.0
SE	1.4	3.5	4.8	4.5	3.6	0.1	0.0	0.0	0.0	0.0	18.1	16.2
S	1.1	3.6	2.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0	8.2	9.3
SW	1.2	5.5	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	8.1	8.1
W	1.0	3.3	2.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	7.4	9.4
NW	0.7	1.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	8.6
Total	7.4	26.7	24.8	24.7	14.8	0.6	0.0	0.0	0.0	0.0	98.9	15.0
Calm											1.1	

Figure 5.2.13. Current rose and joint distribution; 19 October 1992 to 5 December 1992.

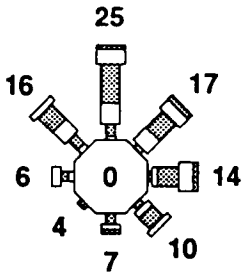


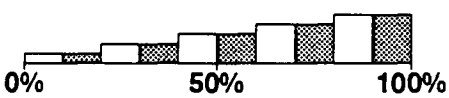


Current Meter
20 Top

Dir	Current Speed Range (cm·s⁻¹)											Avg.
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	Speed
N	0.3	1.1	0.6	1.1	0.8	0.1	0.0	0.0	0.0	0.0	4.0	16.4
NE	0.6	1.2	0.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	3.4	11.3
E	0.6	0.9	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	11.3
SE	0.4	1.2	1.2	1.8	0.1	0.0	0.0	0.0	0.0	0.0	4.7	13.3
S	0.5	0.8	1.1	0.9	0.6	0.1	0.0	0.0	0.0	0.0	4.0	15.2
SW	0.8	1.8	1.4	3.1	3.7	1.7	1.2	0.7	0.2	0.2	14.7	27.3
W	0.5	2.1	2.3	14.0	11.1	10.3	3.7	1.1	0.3	0.0	45.5	29.6
NW	0.2	1.1	2.7	8.2	5.3	1.9	0.6	0.1	0.0	0.0	20.1	23.3
Total	4.0	10.1	10.8	31.0	21.6	14.2	5.5	1.9	0.5	0.2	99.9	24.9
Calm											0.1	

Figure 5.2.14. Current rose and joint distribution; 16 January 1993 to 16 March 1993.

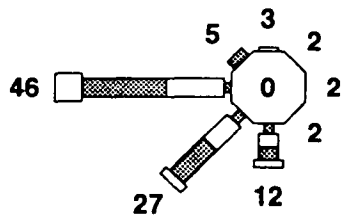


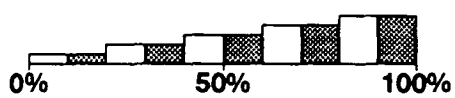


Current Meter 20 Top

Dir	Current Speed Range (cm·s⁻¹)											Avg.
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	Speed
N	1.1	3.2	5.4	10.1	3.8	1.1	0.8	0.0	0.0	0.0	25.5	19.0
NE	0.6	1.4	4.5	6.2	3.0	1.5	0.1	0.0	0.0	0.0	17.5	20.1
E	0.8	1.2	1.5	5.5	3.7	1.3	0.1	0.0	0.0	0.0	14.0	22.7
SE	0.5	1.7	1.6	4.1	1.5	0.2	0.0	0.0	0.0	0.0	9.7	16.8
S	0.7	2.8	1.4	1.0	0.7	0.0	0.0	0.0	0.0	0.0	6.7	11.9
SW	0.9	1.5	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	3.6	8.6
W	1.5	2.0	2.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	6.4	9.4
NW	1.4	3.5	4.2	5.6	1.6	0.1	0.0	0.0	0.0	0.0	16.4	14.5
Total	7.6	17.3	21.5	33.7	14.4	4.2	1.0	0.0	0.0	0.0	99.8	17.3
Calm											0.2	

Figure 5.2.15. Current rose and joint distribution; 20 July 1992 to 11 August 1992.





Current Meter
20 Top

Dir	Current Speed Range (cm·s^{-1})											Avg.
	1-5	5-10	10-15	15-25	25-35	35-45	45-55	55-65	65-75	>75	Total	Speed
N	0.1	1.0	1.1	0.1	0.4	0.0	0.0	0.0	0.0	0.0	2.7	13.0
NE	0.2	0.6	0.2	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1.7	13.7
E	0.2	0.2	0.4	0.8	0.1	0.0	0.0	0.0	0.0	0.0	1.8	15.2
SE	0.2	0.7	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	2.2	11.3
S	0.5	2.8	3.5	3.4	1.8	0.5	0.0	0.0	0.0	0.0	12.5	16.9
SW	0.5	3.0	8.5	12.1	2.3	1.0	0.0	0.0	0.0	0.0	27.4	17.4
W	0.1	1.8	14.7	22.1	6.9	0.5	0.1	0.0	0.0	0.0	46.2	18.5
NW	0.1	1.0	0.8	2.8	0.5	0.2	0.0	0.0	0.0	0.0	5.5	18.1
Total	2.1	11.2	29.9	42.1	12.4	2.2	0.1	0.0	0.0	0.0	99.9	17.5
Calm											0.1	

Figure 5.2.16. Current rose and joint distribution; 6 November 1992 to 11 December 1992.

5.2.3. Current Meter Statistics

Fortnightly statistics were prepared for measurements of eastward (u) and northward (v) velocity components, temperature, and salinity measured at all LATEX A current meters, except the MiniSpecs, during the first field year. Statistics were prepared using the 30-minute values. To establish the two-week interval bins for the statistics, the first two-week interval was taken to begin at 0000 UTC on 1 January 1992 and end at 2359 UTC on 13 January 1992. Using this as the first bin, subsequent two-week intervals continued throughout the year and into the following year. The first bin for which there were any actual measurements available began at 0000 UTC on 8 April 1992 and ended with the last measurement made before 2359 UTC on 21 April 1992.

An example for the top current meter on mooring 2 is given as Figure 5.2.17. The first column gives the days for which measurements were binned; the second gives the number of measurements available in that bin (time period). Subsequent groups of columns give for u, v, temperature, and salinity the mean, standard deviation, minimum, and maximum values for that bin. The statistics for other current meters will be included in the microfiche packet that will accompany the Final Report.

It should be noted that these statistics are based on the LATEX A data sets corrected as of 10 January 1994. Although these data have received quality control and assessment, they are still preliminary; users should expect that subsequent corrections will be made to the data sets prior to the final submission to the NODC. THIS SAME CAVEAT APPLIES TO ALL TIME SERIES DATA REPORTED IN THIS DOCUMENT.

5.2.4 Discussion of Directional Waves and Wave Statistics

The ability to extract directional information from the spectral content of wave records is of enormous importance to both scientists and ocean engineers. The directional wave spectrum generalizes the frequency spectrum by including the azimuthal, ϕ, dependence. Longuet-Higgins et al. (1963) give an account of a method that uses the surface elevation and tilt of a floating surface buoy to determine the directional wave spectrum. This method has been adapted (Dean and Dalrymple 1984) to utilize pressure and horizontal velocity to determine the directional wave spectrum. The Longuet-Higgins method is popular because of the ease with which Fast Fourier Transform (FFT) algorithms are implemented on computers. The FFT is necessary to calculate the covariance integrals. The LATEX field program includes five directional wave gauges (MiniSpecs).

As mentioned previously the MiniSpecs experienced several problems during the first year of deployment. During extreme weather events like Hurricane Andrew, however, some useful data can be extracted from the records. Because of the warmup problem, the first 5.8 minutes of data are discarded. The remaining data are passed through a Hanning (half-cosine) filter and then bandpass filtered to preclude the amplification of noise at high frequencies when correcting for hydrodynamic attenuation. The -6 dB limits for the bandpass filter are 20 seconds and 4.5 seconds.

Date	N	U component (cm·s⁻¹)				V component (cm·s⁻¹)				Temperature (°C)				Salinity (PSU)			
		Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
8 April 1992 - 21 April	588	-4.2	11.6	-31.2	32.8	-5.5	10.0	-52.7	22.3	19.29	1.07	18.52	22.69	30.89	1.59	27.25	33.78
22 April - 4 May	672	11.1	10.6	-20.7	38.5	7.5	22.1	-44.3	47.7	22.38	0.89	19.00	23.86	30.18	1.75	27.39	33.14
5 May - 18 May	672	0.1	8.3	-25.4	21.1	4.0	13.0	-30.4	39.3	23.68	0.39	22.01	24.44	32.69	1.23	30.99	35.12
19 May - 2 June	663	-5.5	10.2	-33.7	25.0	-16.7	17.5	-63.0	21.9	24.98	0.60	22.30	25.80	31.65	1.72	28.04	34.07
3 June - 16 June	672	-1.2	12.9	-31.4	44.9	6.6	20.5	-31.2	62.4	26.30	0.91	24.42	28.01	30.66	1.51	26.02	34.02
17 June - 30 June	672	6.9	8.3	-14.4	30.0	26.6	9.9	5.7	54.3	26.72	0.59	25.58	28.09	34.20	0.16	33.33	34.37
1 July - 14 July	672	7.9	7.5	-5.2	28.0	19.3	15.1	-9.1	61.1	25.99	0.40	25.15	27.05	34.39	0.04	34.26	34.47
15 July - 28 July	645	-1.0	5.6	-17.9	12.4	0.5	11.9	-29.5	21.1	26.59	0.97	25.14	28.46	34.50	0.13	33.53	34.62
29 July - 11 August	672	2.4	6.8	-15.0	19.1	7.7	9.8	-13.6	29.1	27.18	0.80	25.35	28.31	34.48	0.39	31.51	34.66
12 August - 25 August	672	-3.0	5.7	-19.5	13.2	-11.7	7.1	-30.9	5.1	28.26	0.46	26.77	28.98	34.54	0.07	33.96	34.69
26 August - 7 September	672	3.1	5.5	-8.5	20.4	5.0	8.9	-19.6	28.5	29.01	0.18	28.67	29.47	34.26	0.25	33.33	34.63
8 September - 21 September	672	0.0	8.7	-32.8	15.4	-6.8	18.4	-68.5	31.3	29.06	0.14	28.72	29.51	33.25	1.02	29.39	34.30
22 September - 6 October	672	-10.6	12.0	-44.8	29.0	-24.7	22.0	-72.3	27.2	27.93	0.68	26.46	29.11	32.23	0.76	30.16	33.80
7 October - 20 October	1947	-0.6	8.9	-29.0	28.8	-17.8	8.6	-46.9	0.8	25.91	0.38	25.29	27.05	33.02	1.01	29.66	34.65
21 October - 3 November	4032	2.9	11.4	-34.1	36.1	-4.9	23.6	-67.6	48.0	25.38	0.25	24.80	26.08	33.24	1.08	29.54	35.17
4 November - 17 November	4032	-1.3	9.0	-27.7	24.7	-18.5	14.4	-66.2	32.7	23.42	0.98	21.86	25.78	33.38	0.29	32.60	34.05
18 November - 1 December	4032	-3.0	7.3	-33.9	23.4	-11.2	14.7	-53.1	23.7	21.42	0.75	19.61	23.04	32.80	0.63	29.93	33.98
2 December - 15 December	4032	-0.1	9.5	-35.8	29.8	-14.4	15.8	-69.6	21.2	19.28	0.99	17.26	21.27	32.95	0.64	30.99	34.30
16 December - 29 December	1086	-3.5	9.5	-32.3	21.5	-19.8	11.9	-50.7	1.1	18.87	0.97	17.10	21.70	32.60	0.74	30.70	33.54
30 December - 12 January 1993	672	-6.8	6.6	-22.4	9.1	-17.3	9.9	-38.9	2.7	20.42	1.05	17.39	22.29	33.40	0.43	31.74	33.88
13 January - 26 January	663	-4.4	8.3	-39.1	14.7	-11.7	17.0	-66.6	16.9	19.93	0.72	17.41	21.01	33.40	0.37	30.99	33.85
27 January - 9 February	672	-7.1	8.6	-36.8	11.0	-16.9	16.0	-53.9	14.2	18.64	0.85	16.82	19.96	33.04	0.64	30.49	34.08
10 February - 23 February	672	-1.0	5.5	-21.5	10.9	-0.8	10.8	-31.0	23.8	18.91	0.82	17.11	20.35	32.88	0.57	30.43	33.87
24 February - 9 March	672	-2.9	7.7	-27.5	14.1	-6.0	21.4	-47.9	38.0	17.83	0.70	16.72	19.96	31.67	0.40	29.07	32.50
10 March - 23 March	656	-4.0	12.1	-43.7	20.5	-14.8	24.2	-85.1	36.2	18.42	0.72	17.01	20.55	30.62	0.70	28.82	32.49
Total	31784	-0.8	9.9	-44.8	44.9	-9.1	19.4	-85.1	62.4	23.04	3.30	16.72	29.51	32.95	1.24	26.02	35.17

Figure 5.2.17. Example of two-week statistics showing the mean, standard deviation, minimum, and maximum for the top current meter at mooring 2.

In determining the directional characteristics of the energy spectrum using the Longuet-Higgins method, one calculates a weighted integral of the auto- and cross-covariance of the pressure and the two vector components of the horizontal velocity. The directional spectrum has the following functional form:

$$|F_W(\sigma,\phi)|^2 \approx \frac{1}{2} a_0 + \frac{2}{3} (a_1 \cos \phi + b_1 \sin \phi) + \frac{1}{6} (a_2 \cos 2\phi + b_2 \sin 2\phi) ,$$

where the a_is and b_is are directly proportional to the auto- and cross-covariance functions. $F_W(\sigma,\phi)$ is a function of both frequency σ, and azimuthal angle, ϕ, and corresponds to the first five terms of a Fourier expansion. Because the spectrum is represented by a truncated Fourier expansion the angular resolution necessarily is broad.

Figure 5.2.18 shows an example of a smoothed directional wave spectrum taken during the passage of Hurricane Andrew in August 1992 at LATEX site 16. The x-coordinate is the direction, in degrees relative to true north, in which the waves are traveling toward. The y-coordinate is the frequency (1/T, T=period) component of the wave and the z-coordinate is the spectral density (units=$m^2 \cdot deg^{-1}$ Hz). A 2-D contour is laid over the 3-D surface for clarity and shows that the dominant 13 second period waves are traveling to the west. This figure is taken four hours before the hurricane made is closest approach to this site.

Once the directional wave spectrum is calculated, other wave statistics like significant wave height and dominant wave period can be found. The significant wave height is related to the zeroth moment of the energy spectrum by:

$$H_{m_0} = 4\sqrt{m_0}$$

where H_{m_0} is the significant wave height and m_0 is the zeroth moment of the energy spectrum. The significant wave height for the directional wave spectrum in the figure is calculated to be 6.6 m. These procedures have been implemented and developed using the PV-WAVE programming language (DiMarco and Kelly 1994).

5.3 Drifting Buoy Measurements

Seven satellite-tracked drifting buoys were successfully deployed during the first year of the LATEX field program. Four drifters were released in August 1992 and three were released in November 1992 during hydrographic surveys H02 and H03, respectively. The plan called for drifters to be released at four locations: inshore and offshore of the coastal boundary frontal zone, mid-shelf, and over the outer shelf near the continental shelf break (~100 m isobath). Satellite images obtained prior to each cruise to determine the location of the coastal boundary fronts were not useful due to nearly isothermal surface waters in August and extensive cloud coverage in November. The locations of the coastal boundary front were determined by monitoring the CTD and optical data as the ship traveled south along a transect. In August, drifters were placed as planned along Line 2; a similar deployment was made in November along Line 3 (see Figures 2.4.2 and 2.4.3 for locations of these lines). At the shelf break deployment site, however, the drifter was destroyed accidentally during the November deployment and the spare drifter failed to transmit. In the discussion below, drifting buoys are identified by their ARGOS transmitter identification codes (see Table 2.3.1).

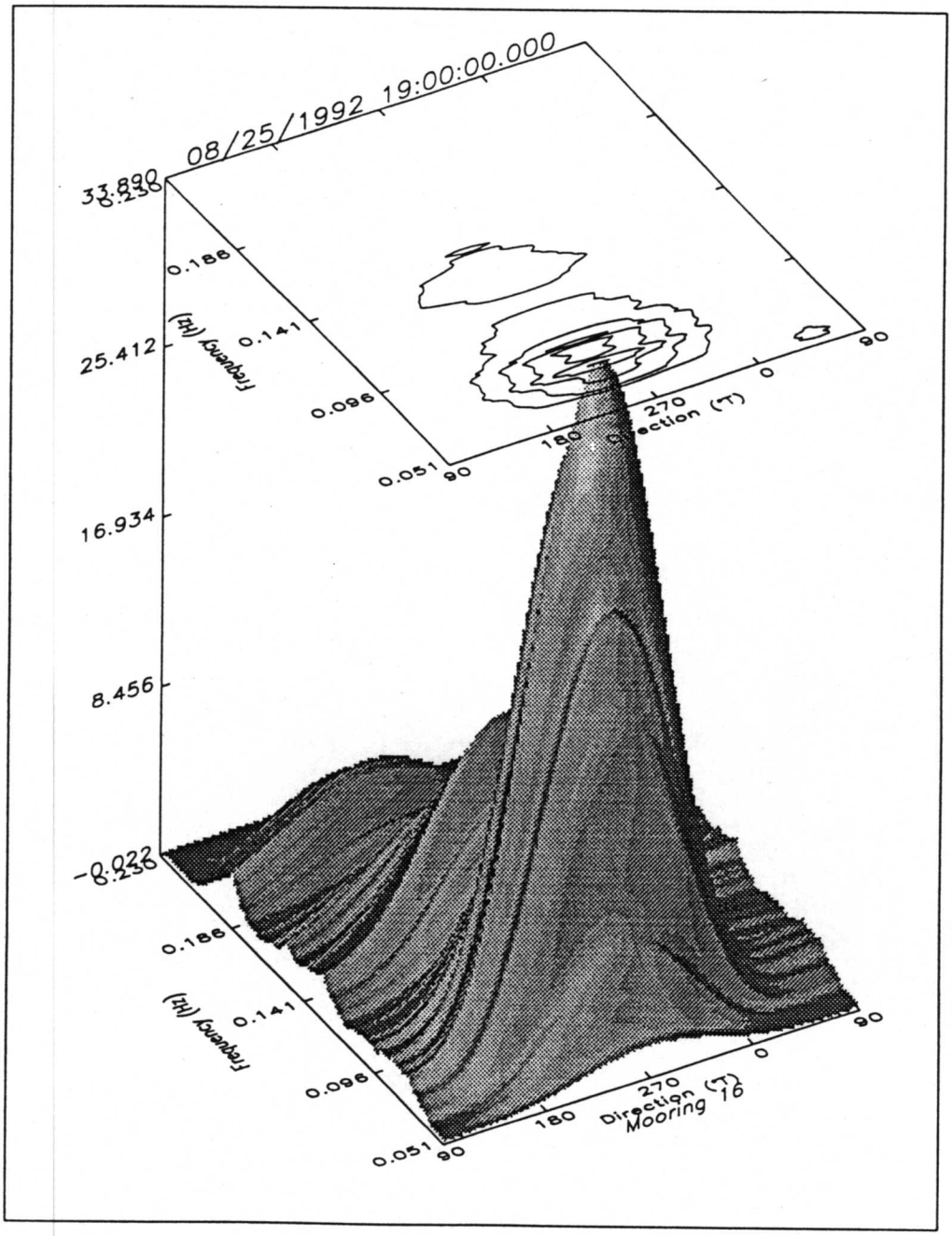


Figure 5.2.18. Example direction wave spectrum taken during the passage of Hurricane Andrew on 25 August 1992 at LATEX mooring 16. The x-coordinate is the direction, in degrees relative to true north (°T), in which the waves are traveling. The y-coordinate is the frequency (Hz) component of the wave (Frequency = 1/T where T = wave period in seconds.) The z-coordinate (vertical) is the spectral density with units of $m2\cdot(°T\cdot Hz)^{-1}$. This spectrum shows the results of a directional wave burst sample approximately four hours before the hurricane passed closest to the mooring.

The drifters released in August 1992, ordered onshore to offshore, were: 3583, 2446, 3582, and 2447. Drifter 3583 was deployed in the coastal boundary layer. It lasted six days before it was spotted and recovered by a crew boat. Speeds were low, 10 to 15 cm-s^{1}, and the trajectory could be described as eddying, hence the drifter had not traveled far from its original deployment location when it was recovered (see Figure 5.3.1). The sailor who recovered 3583 said the seas were calm and the drifter had grounded and was leaving a wake, which alerted him to the drifter's presence. It was returned to the LATEX Data Office and redeployed in November 1992, but it failed to transmit properly and was lost.

Drifter 2446 was released offshore of the coastal boundary front and moved southeast at an average speed of 25 cm·s^{-1}. Inertial oscillations with amplitudes of 50 cm·s^{-1}, are evident in this record. After 11 days the drifter was captured by a person who two months later called and identified himself as a shrimp fisherman. He was asked to redeploy the drifter close to its recovery position, which he did, but within a day following the release the signal was lost. The trajectory, velocity components, and speed for drifter 2446 are shown in Figure 5.3.2.

Drifter 3582 was deployed mid-shelf. For three weeks following its release it made several anticyclonic orbits of about 40 km in diameter at speeds of 25 cm·s^{-1}, (Figure 5.3.3). The fourth week it moved due west along the 150-m isobath at about 25 cm·s^{-1}. Inertial oscillations are also apparent in this record. Drifter 3582 stopped transmitting after 32 days. Six weeks later, on 20 November, a beachcomber found the main float and electronics housing half-buried in a berm approximately 30 mi north of Port Isabel, Texas, with obvious signs of a collision.

The trajectory, velocity components, and speed of drifter 2447 are shown in Figure 5.3.4. Within a fortnight of its release, 2447 moved off the shelf into the deeper waters of the central Gulf. For a month 2447 moved in an anticyclonic orbit, approximately 100 km in diameter, at speeds between 50 and 150 cm·s^{-1}. The associated eddy was identified in infrared images by Jeff Hawkins (NRL-Stennis) who estimated the eddy diameter to be 300 km (GULF.MEX posting). An air-deployed drifter (07837) was dropped into this ring on 13 August 1993 by LATEX C. Considerations to seed other drifters and air-deployed expendable bathythermographs (AXBTs) were discontinued when Hurricane Andrew occurred. On 1 September 1992, Dr. Forristall posted a message to GULF.MEX identifying the eddy that 2447 was tracking as "Unchained Eddy" which had detached from the Loop Current sometime in July. From September 1992 to late January 1993, 2447 continued to move in near circular orbits at speeds on the order of 50 cm·s^{-1}, as the eddy slowly translated westward. The eddy was surveyed on two SOOP cruises, 92GY13, in October 1992, under the direction of Dr. Biggs (TAMU), and in January 1993 on 93GY01 under the direction of Dr. Santschi (TAMU). Locations for 2447 were received for 189 days following its deployment. During the last four days of the record, 2447 appeared to be onboard a vessel which ultimately went to Boca Jesus Maria, Mexico.

The second group of drifters, released in November 1992, were 6934, 6933, and 6932, ordered nearshore to offshore respectively. Drifter 6934 was captured after five days by persons unknown. It was released again in late March 1993 in the eastern Gulf of Mexico. It eddied about in the same general region for about a month until it joined the southward branch of the Loop Current, ultimately exiting the Gulf through the Straits of Florida in early August 1993 (Figure 5.3.5).

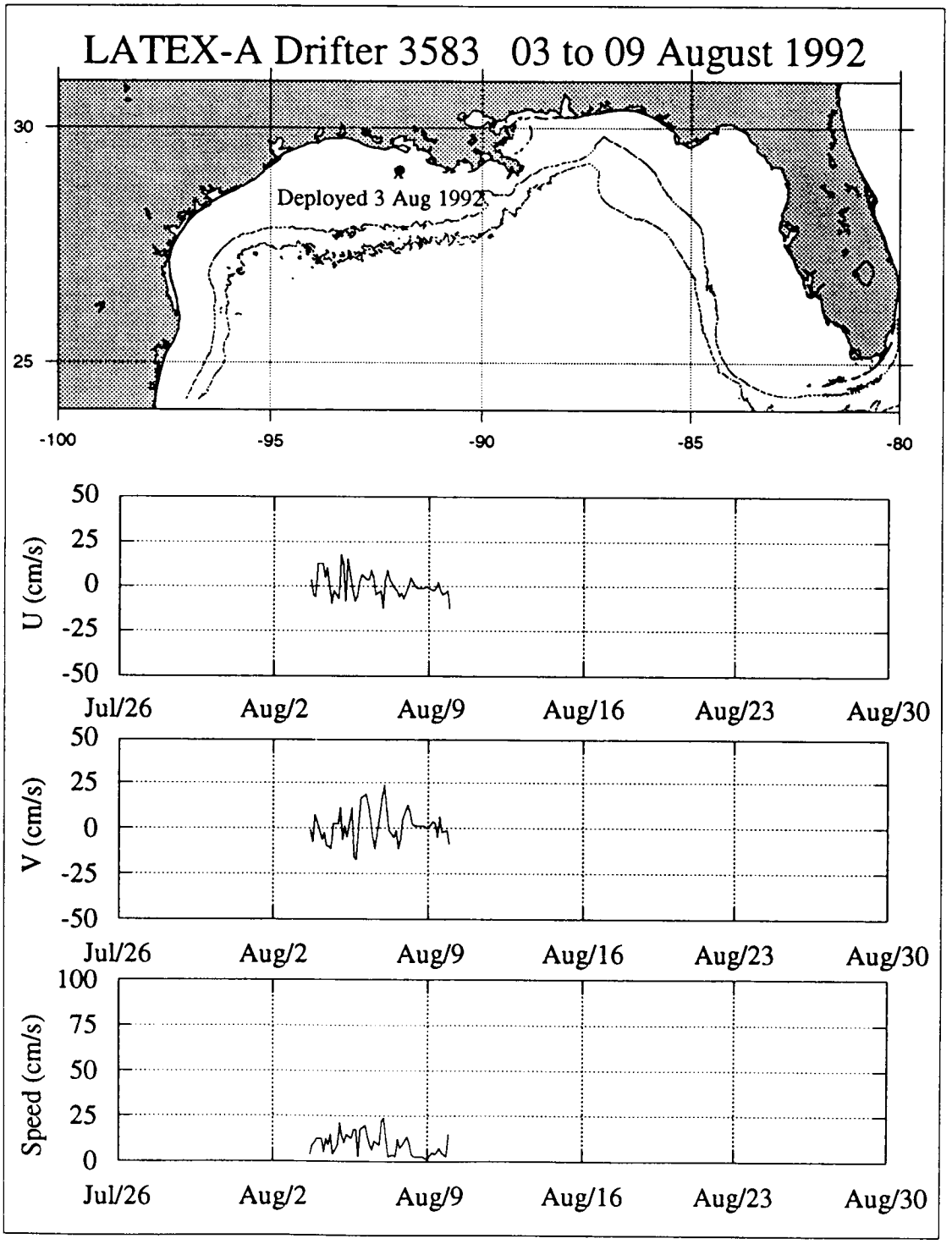


Figure 5.3.1. Trajectory of drifter 3583 August 1992 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. After 6 days the drifter was captured by a crew boat.

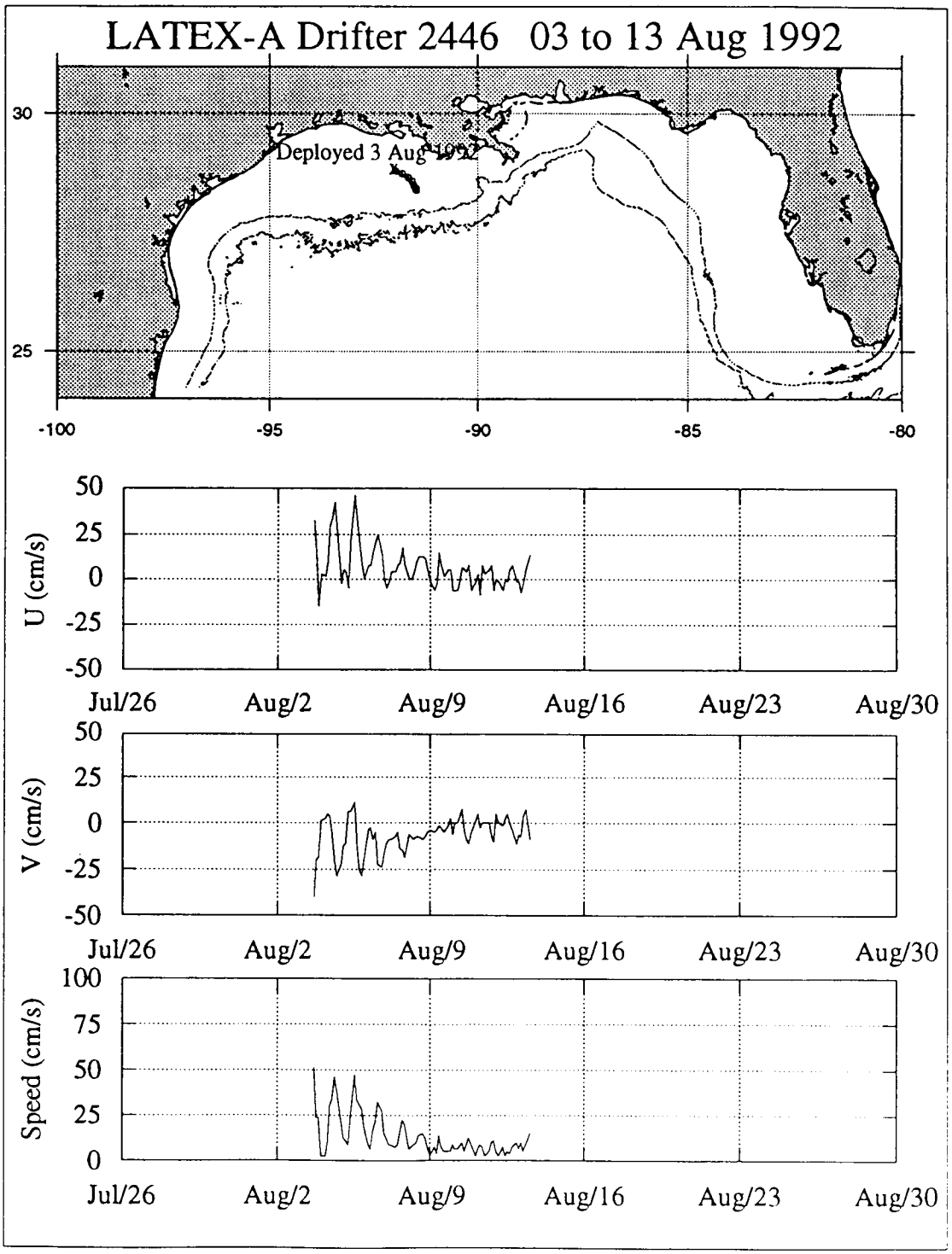


Figure 5.3.2. Trajectory of drifter 2446 August 1993 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. This drifter was captured by a shrimp fisherman after 11 days.

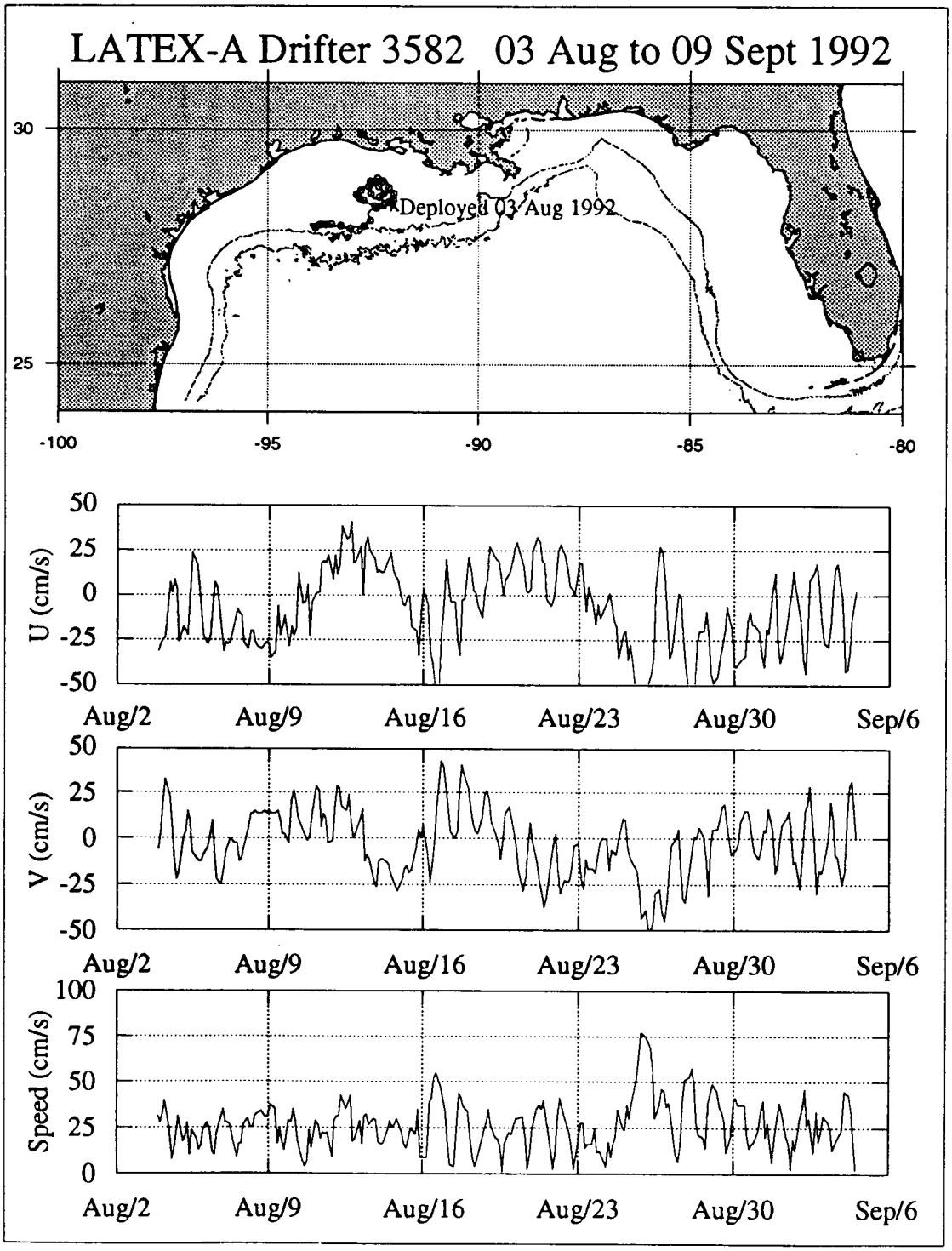


Figure 5.3.3. Trajectory of drifter 3582 August 1992 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifters's position at midnight each day. The record is 32 days long.

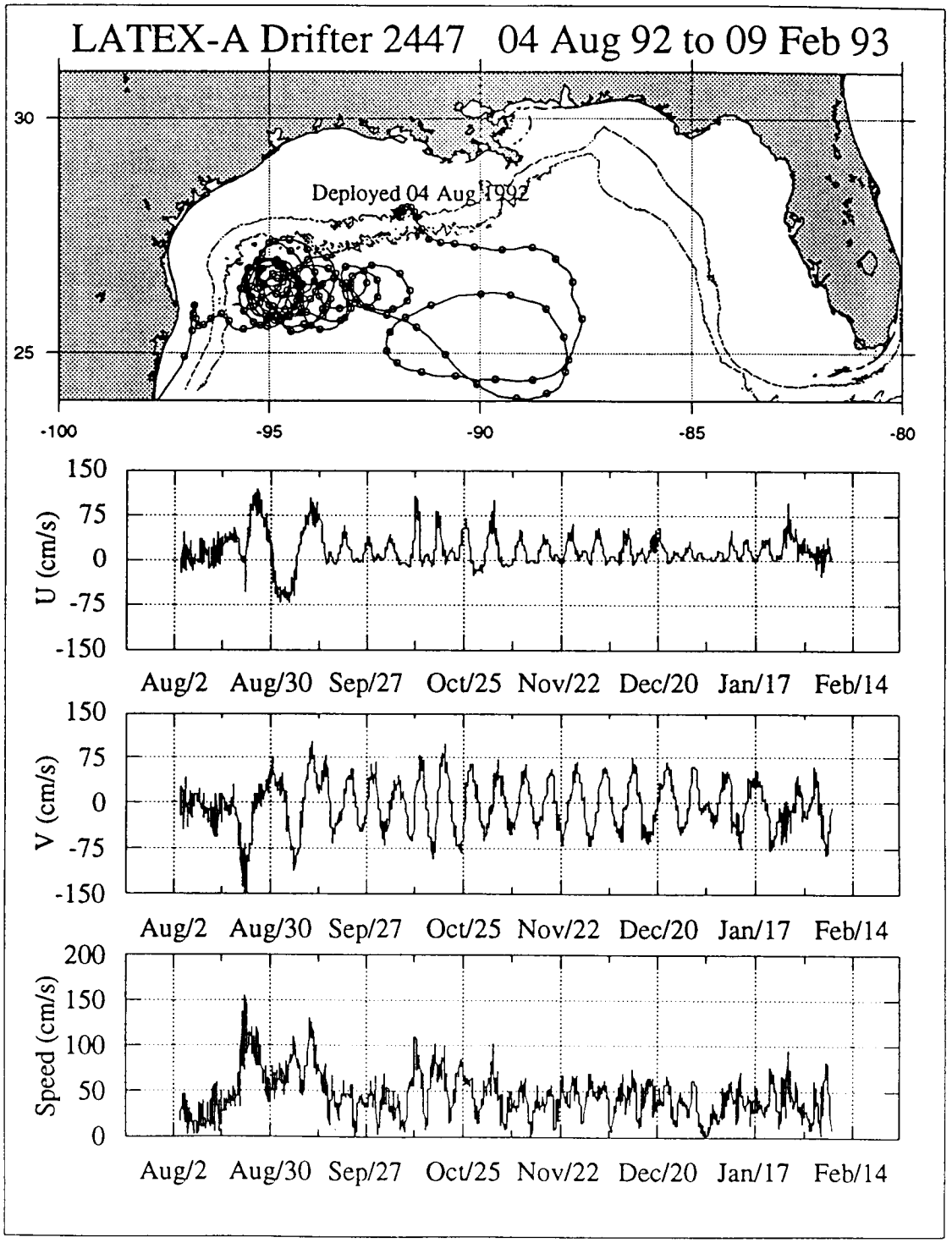


Figure 5.3.4. Trajectory of drifter 2447 August 1992 to February 1993 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. This drifter was captured after 185 days.

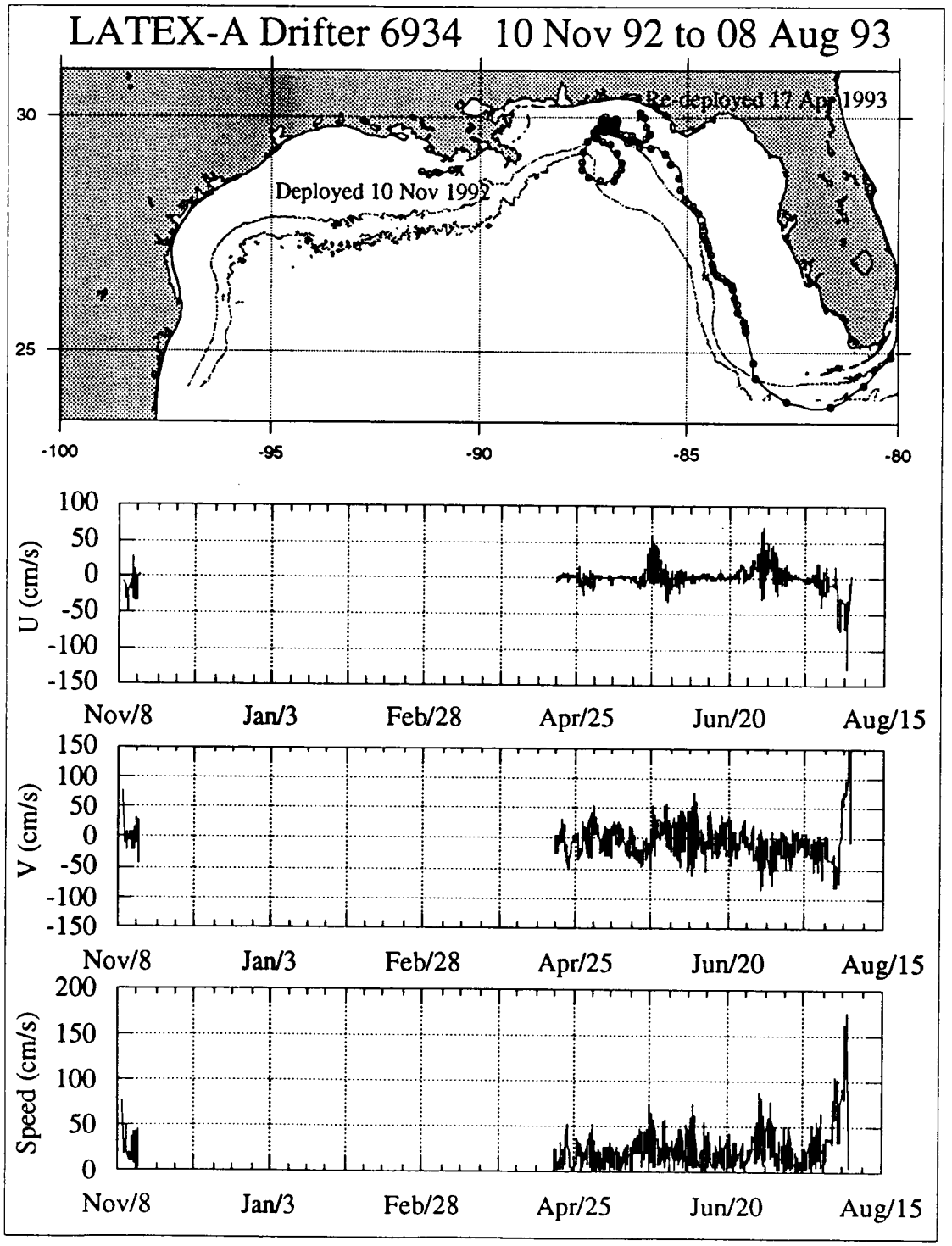


Figure 5.3.5. Trajectory of drifter 6934 November 1992 to August 1993 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. This drifter was captured after 5 days and released the following April by persons unknown. It drifted freely for 112 days.

Drifter 6933 was deployed outside the coastal boundary layer and immediately headed west, generally following the 20- to 40-m isobaths. It followed the coast southward into Mexican waters. The last location received was between Brownsville, Texas, and Boca San Rafael, Mexico. Figure 5.3.6 shows the trajectory, velocity components, and speed of drifter 6933.

Drifter 6932 was released mid-shelf. Like drifter 6933, it immediately headed west following the bathymetry. It transmitted about three weeks before its last location was received (Figure 5.3.7).

5.4 Hydrographic Measurements

In this examination of the hydrographic data, contoured property distributions on vertical sections, on uniform pressure or depth surfaces, and on uniform potential density surfaces are produced. These distributions are produced via two distinct methods: computer generation of contoured fields using either commercial or "homemade" software, and hand contouring of computer-plotted fields of values. The former is quick and thus useful for initial visualization/examination, but the latter is essential for final quality control and leads to better finished products, albeit an additional step of drafting or computer scanning is required before publication.

In the next two sections, 5.4.1 and 5.4.2, a few representative, computer-generated contoured fields in vertical and lateral sections are presented. In section 5.4.3 some representative, hand-generated distributions of geopotential anomaly are presented. A brief discussion of the particulate matter data is presented in section 5.4.4.

5.4.1 Representative Vertical Sections

Shown in Figures 5.4.1-5.4.10 are distributions of properties measured in the upper 100-m on line 4 of hydrographic survey H01. Line 4 crosses the Texas shelf near 94°W; see Figure 2.4.1 for station locations. The properties pictured are temperature, salinity, sigma-θ, dissolved oxygen, percent transmission, irradiance, fluorescence, phosphate, nitrate, and silicate.

In Figure 5.4.1 is seen a sharp thermal front at the shelf edge accompanied by a density front (Figure 5.4.2) at corresponding depths (20-80 m). Two much sharper density fronts are seen in the coastal region due almost entirely to the presence of freshwater inshore as seen in the salinity profile (Figure 5.4.3). At the coastal extent of this section the waters are nearly homogenous in the vertical; maxima in meridional gradients of salinity and sigma-θ occur between stations 26 and 24 where water depths only slightly exceed 10 m. The second distinct front associated with the coastal freshwater plume is found in depths of 15 to 20 m near stations 16 to 13. There again the upper 10 m of the water column are vertically uniform in salinity and temperature (and thus density), with strong salinity and sigma-θ fronts centered near station 15. In a band about 15 km wide to the north of this surface front, fresher water is found in the upper 10 m underlain by a strong vertical salinity gradient and associated density stratification. This results in consumption of most available oxygen, and can lead to hypoxic conditions at the bottom beneath this band (Figure 5.4.4). The effects of the stratification is seen in various other properties pictured.

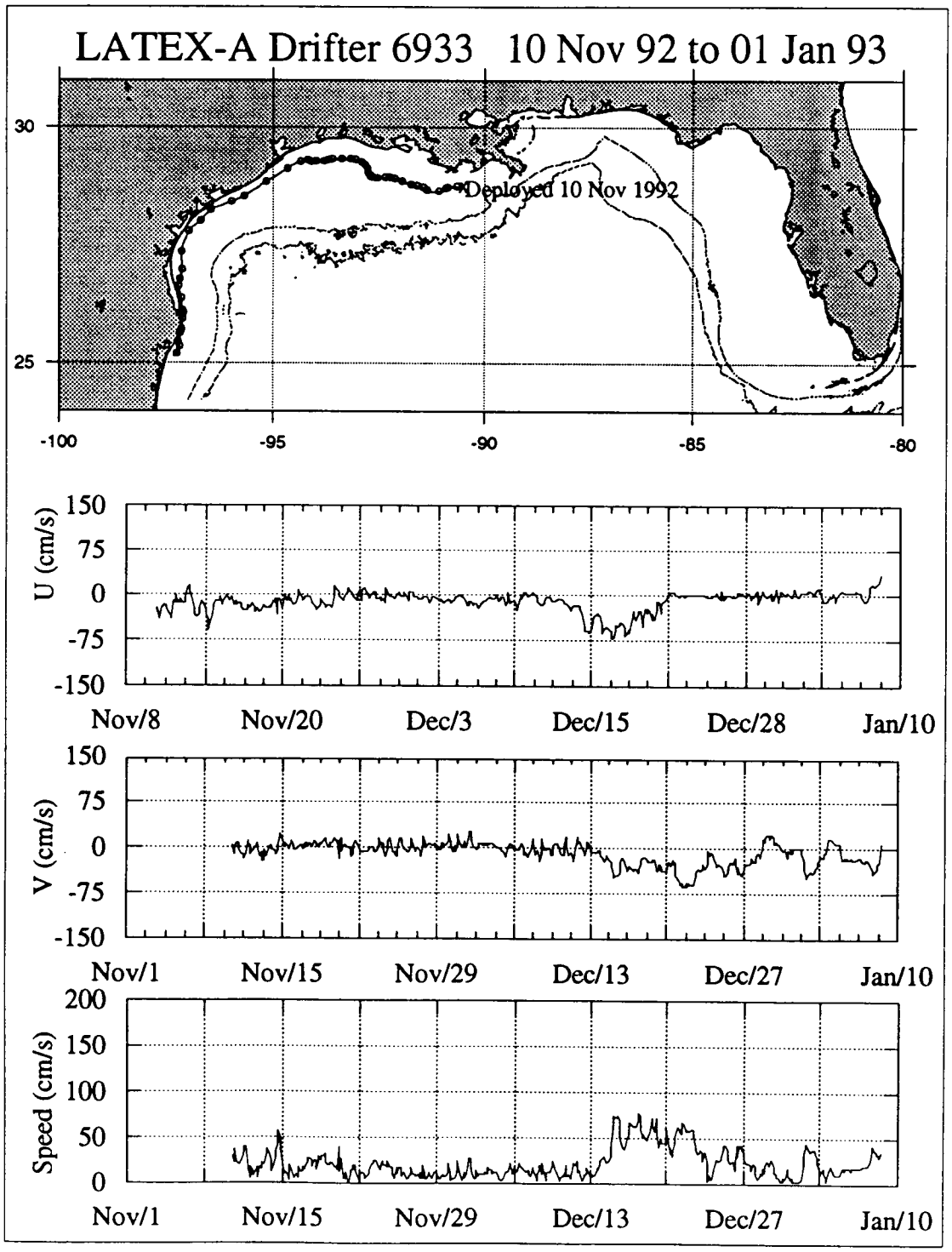


Figure 5.3.6. Trajectory of drifter 6933 November 1992 to January 1993 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. This record is 59 days long.

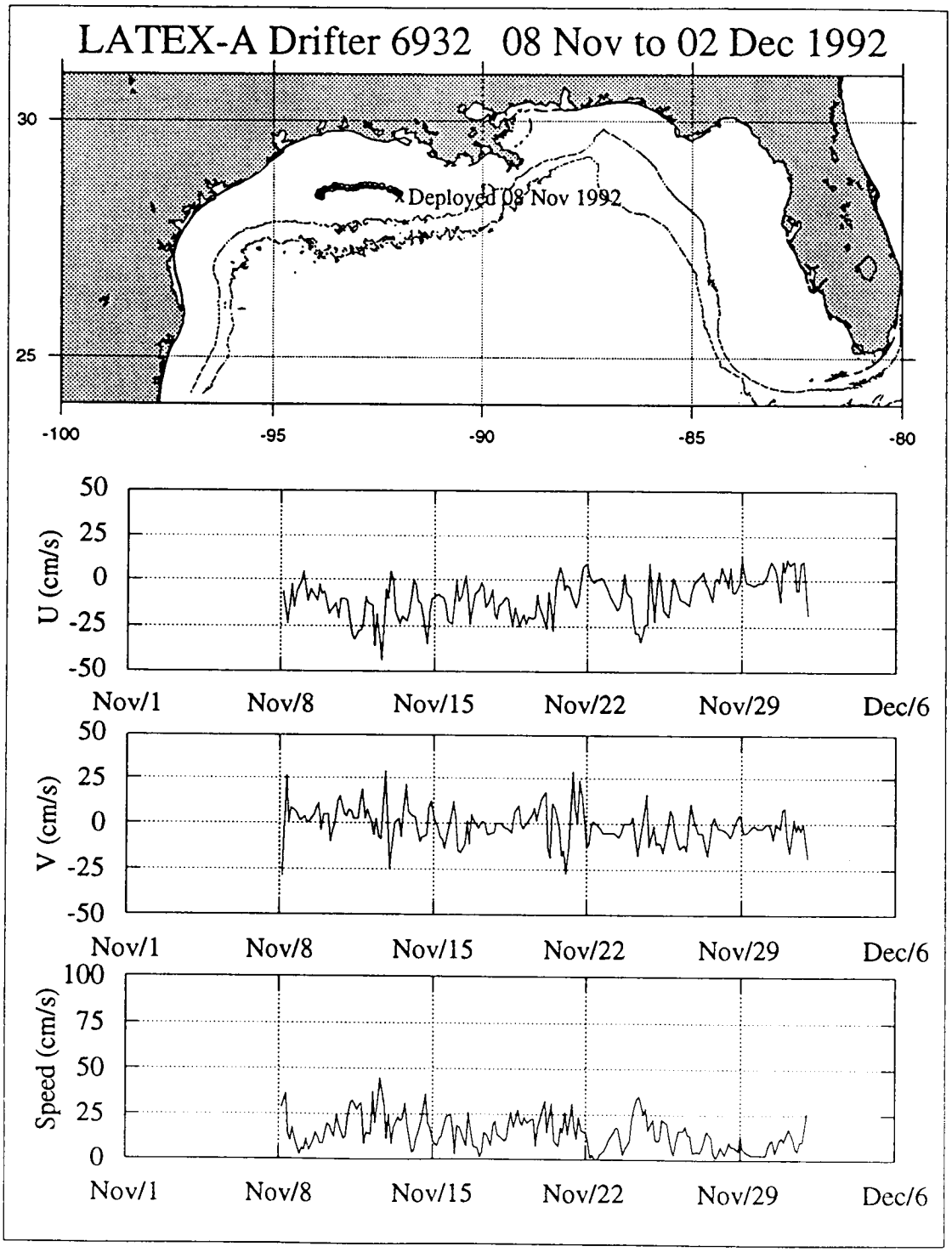


Figure 5.3.7. Trajectory of drifter 6932 November 1992 with U (East) and V (North) velocity components and speed. Circles on the trajectory trace represent the drifter's position at midnight each day. The record is 24 days long.

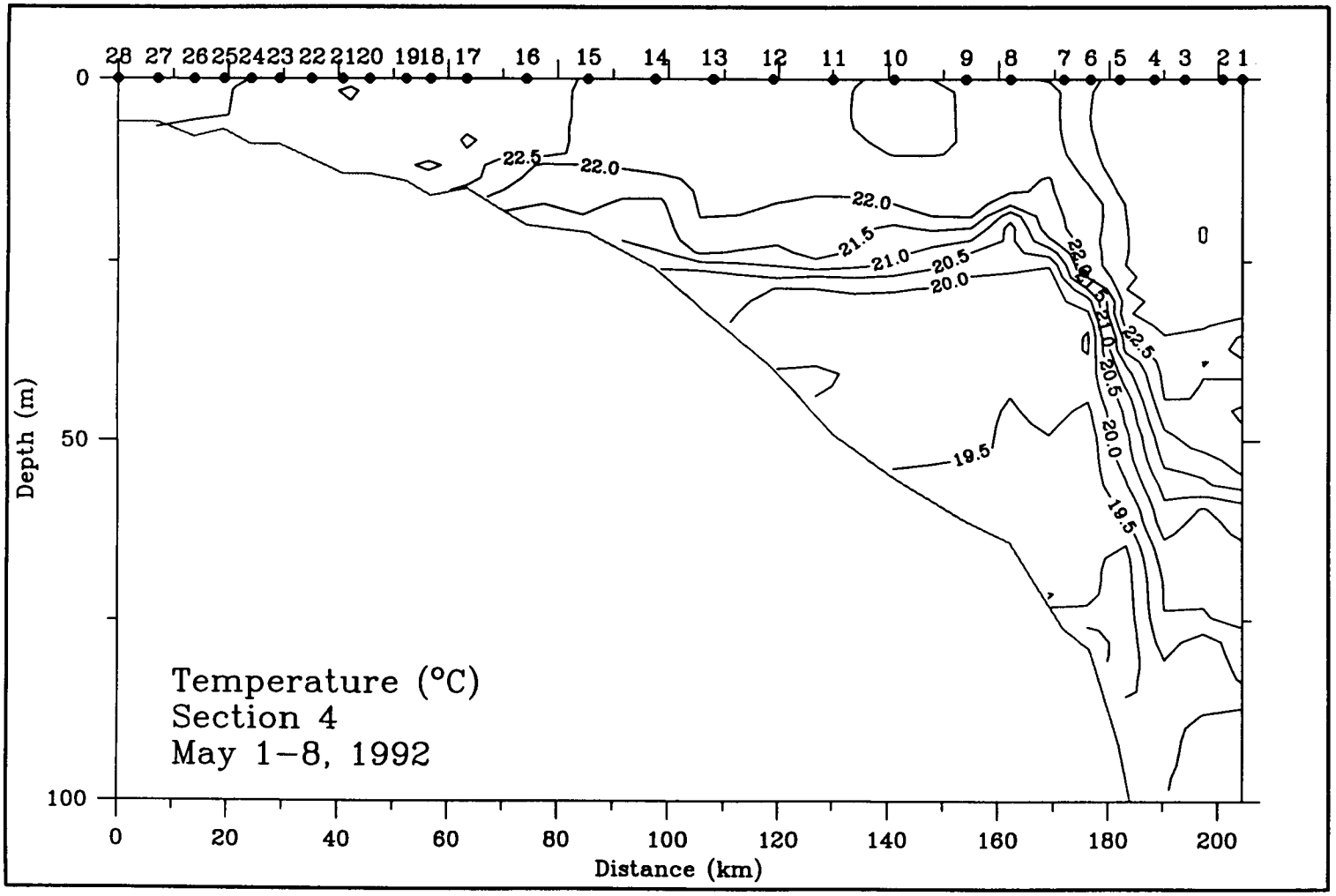


Figure 5.4.1. Temperature (°C) along cross-shelf Line 4 on LATEX A Cruise H01.

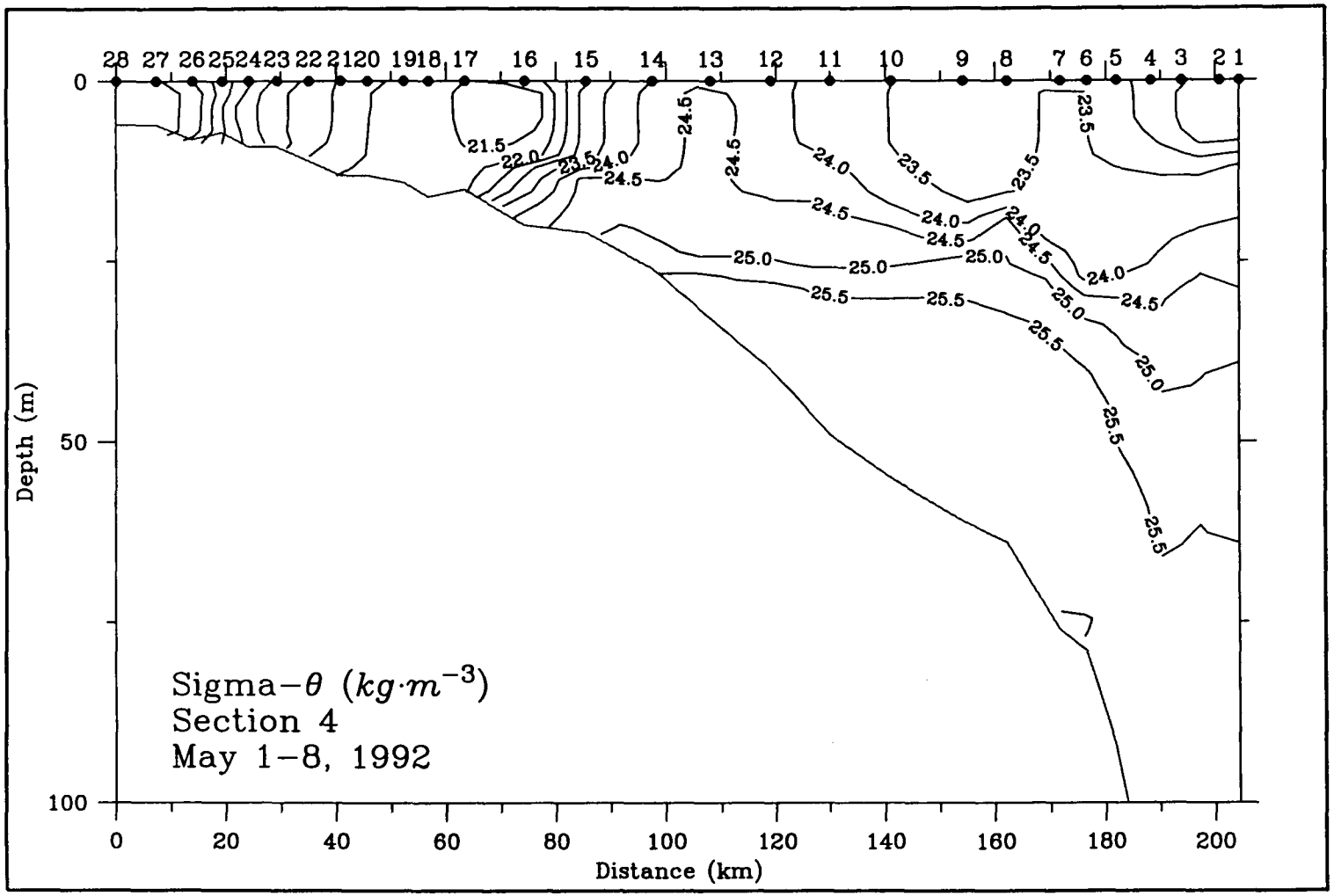


Figure 5.4.2. Sigma-θ (kg·m^{-3}) along cross-shelf Line 4 on LATEX A Cruise H01.

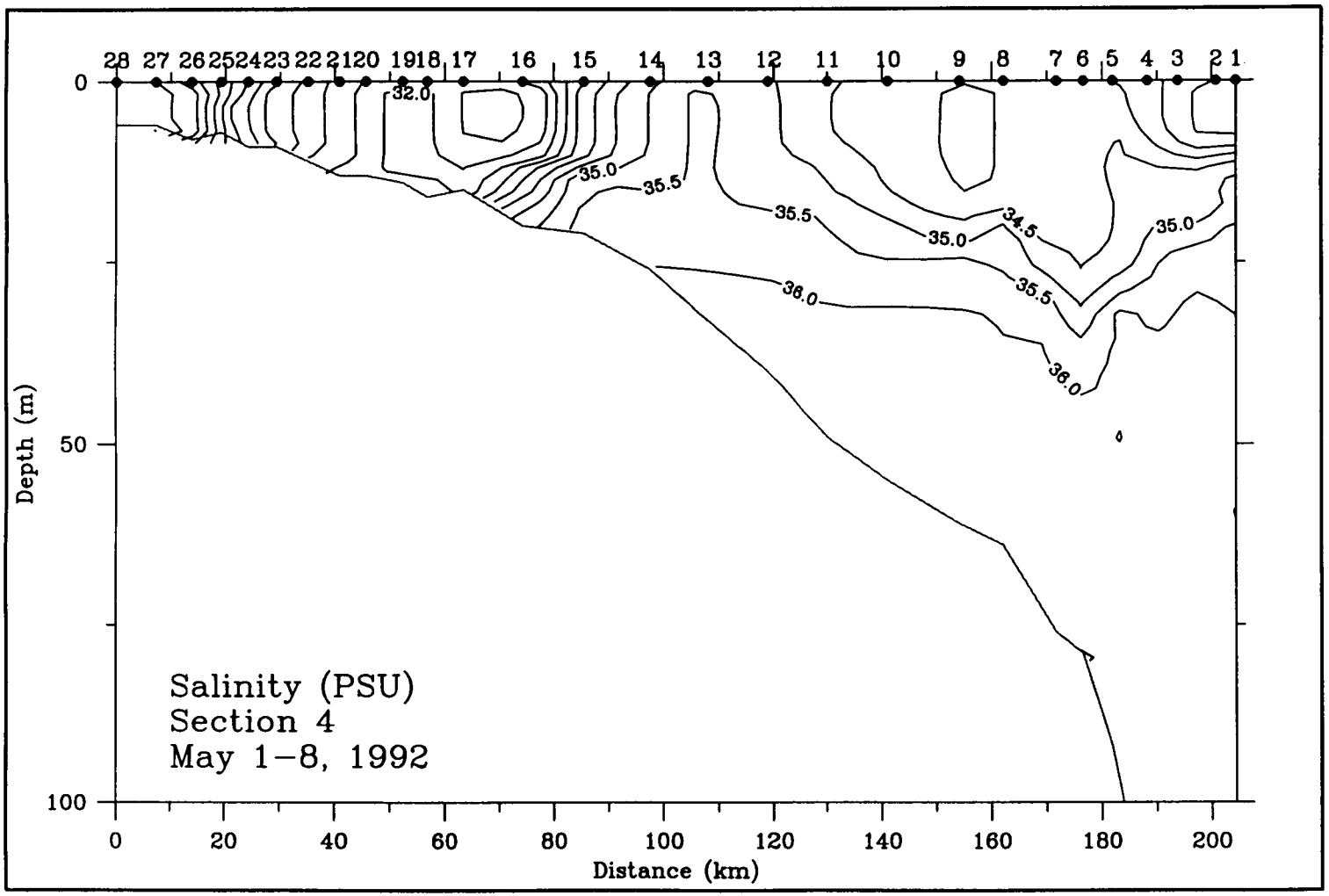


Figure 5.4.3. Salinity (PSU) along cross-shelf Line 4 on LATEX A Cruise H01.

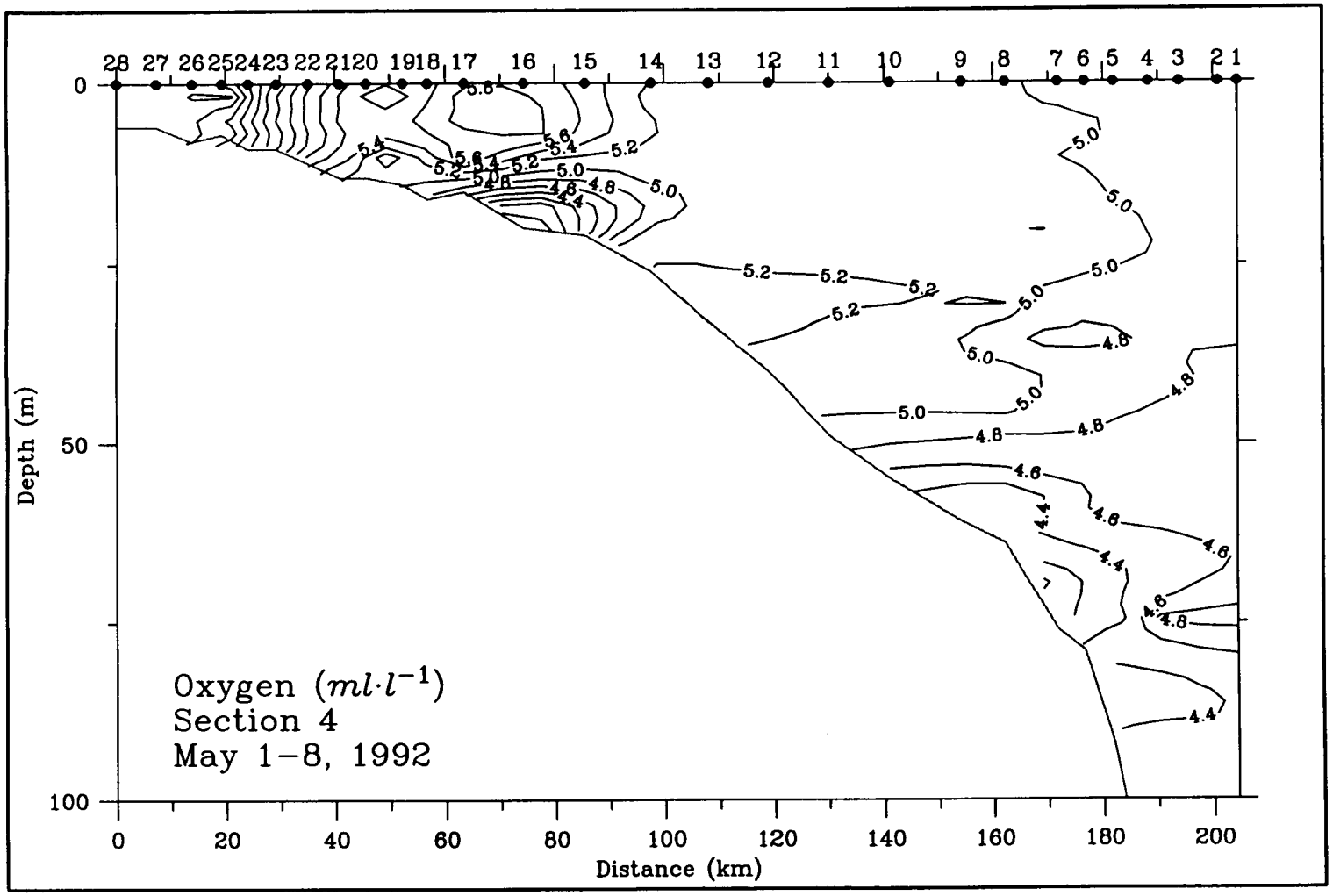


Figure 5.4.4. Oxygen ($ml \cdot l^{-1}$) along cross-shelf Line 4 on LATEX A Cruise H01.

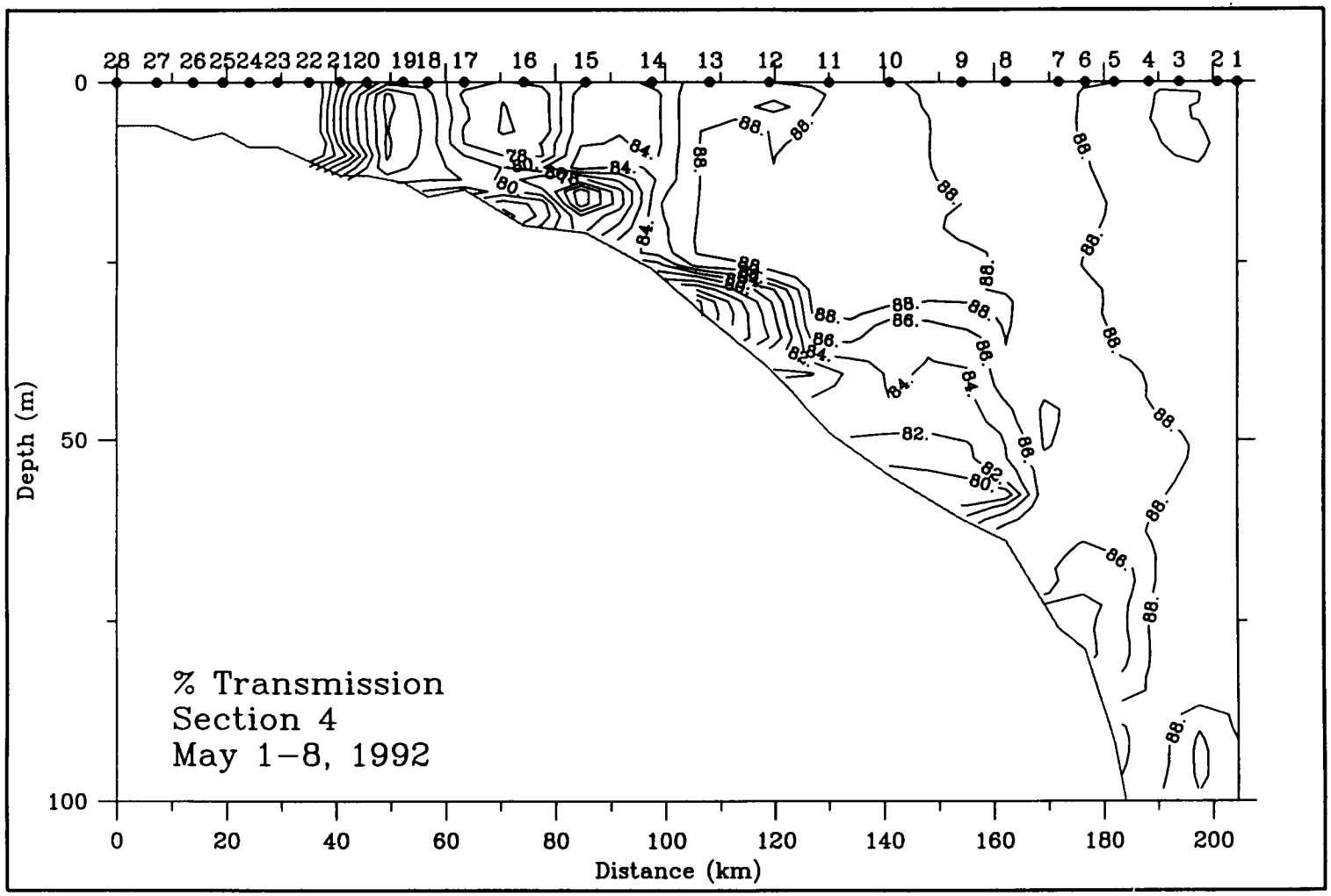


Figure 5.4.5. Transmission (% transmission) along cross-shelf Line 4 on LATEX A Cruise H01.

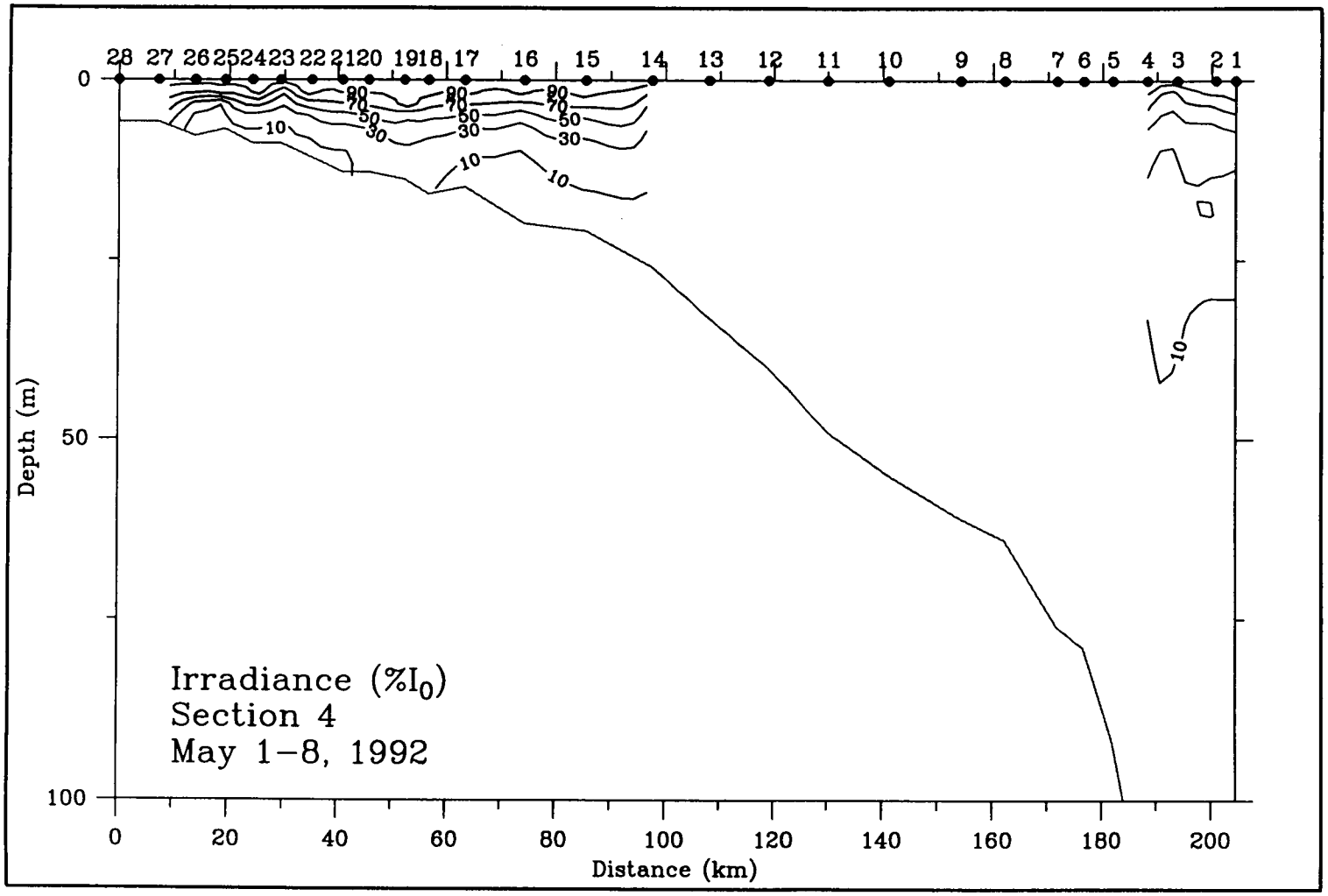


Figure 5.4.6. Irradiance (normalized as percent of surface irradiance) for daylight stations along cross-shelf Line 4 on LATEX A Cruise H01.

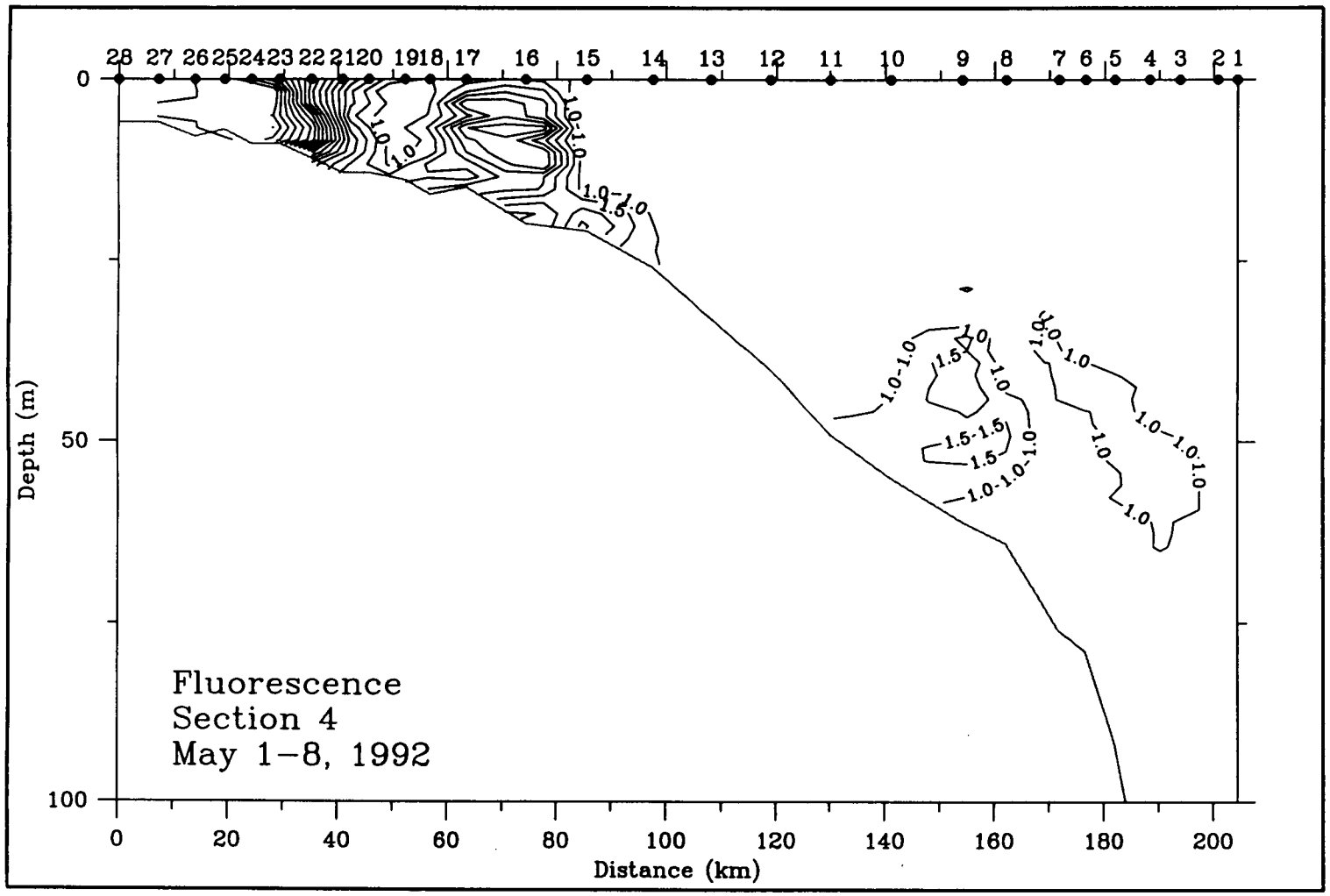


Figure 5.4.7. Fluorescence along cross-shelf Line 4 on LATEX A Cruise H01.

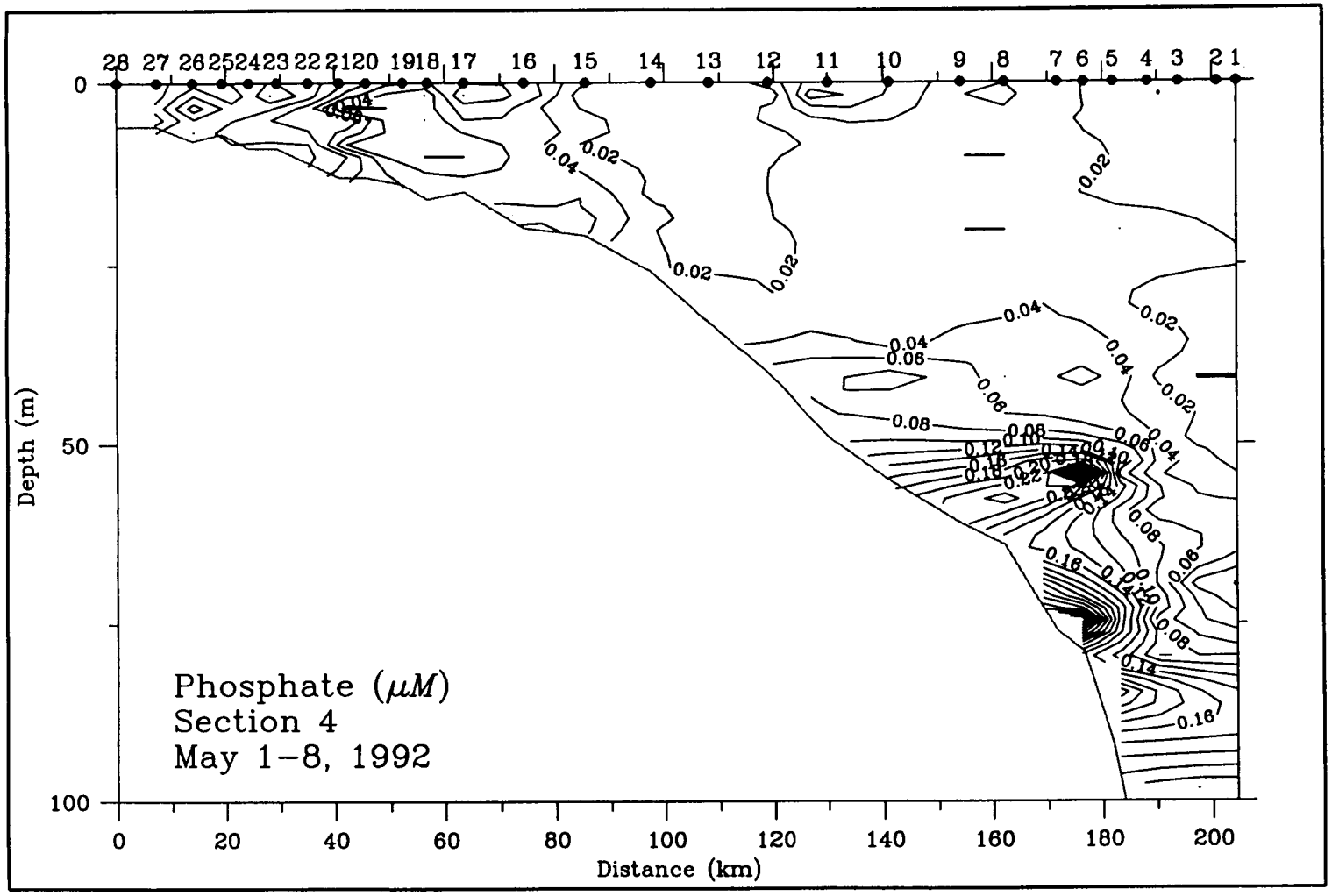


Figure 5.4.8. Phosphate (μM) along cross-shelf Line 4 on LATEX A Cruise H01.

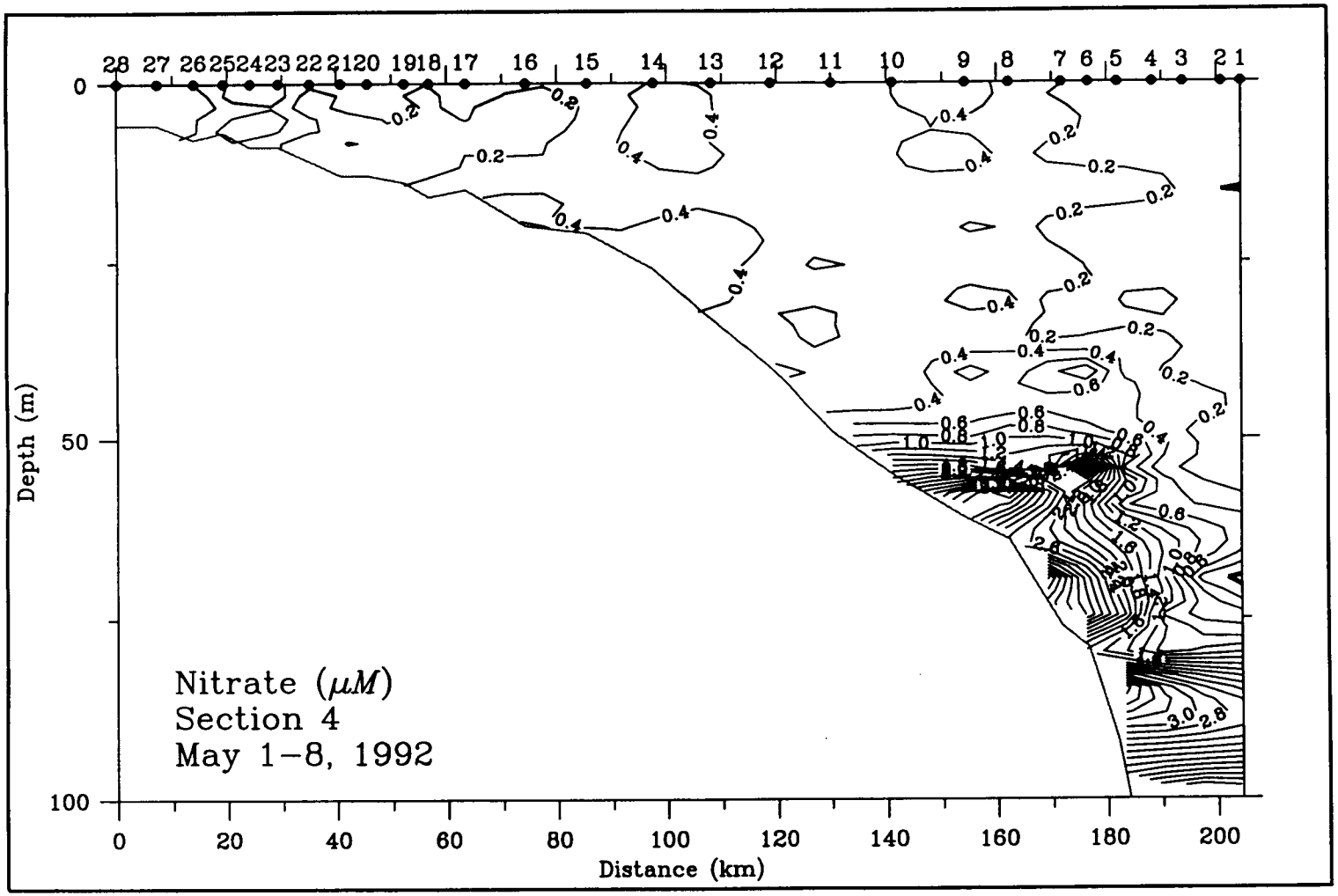


Figure 5.4.9. Nitrate (μM) along cross-shelf Line 4 on LATEX A Cruise H01.

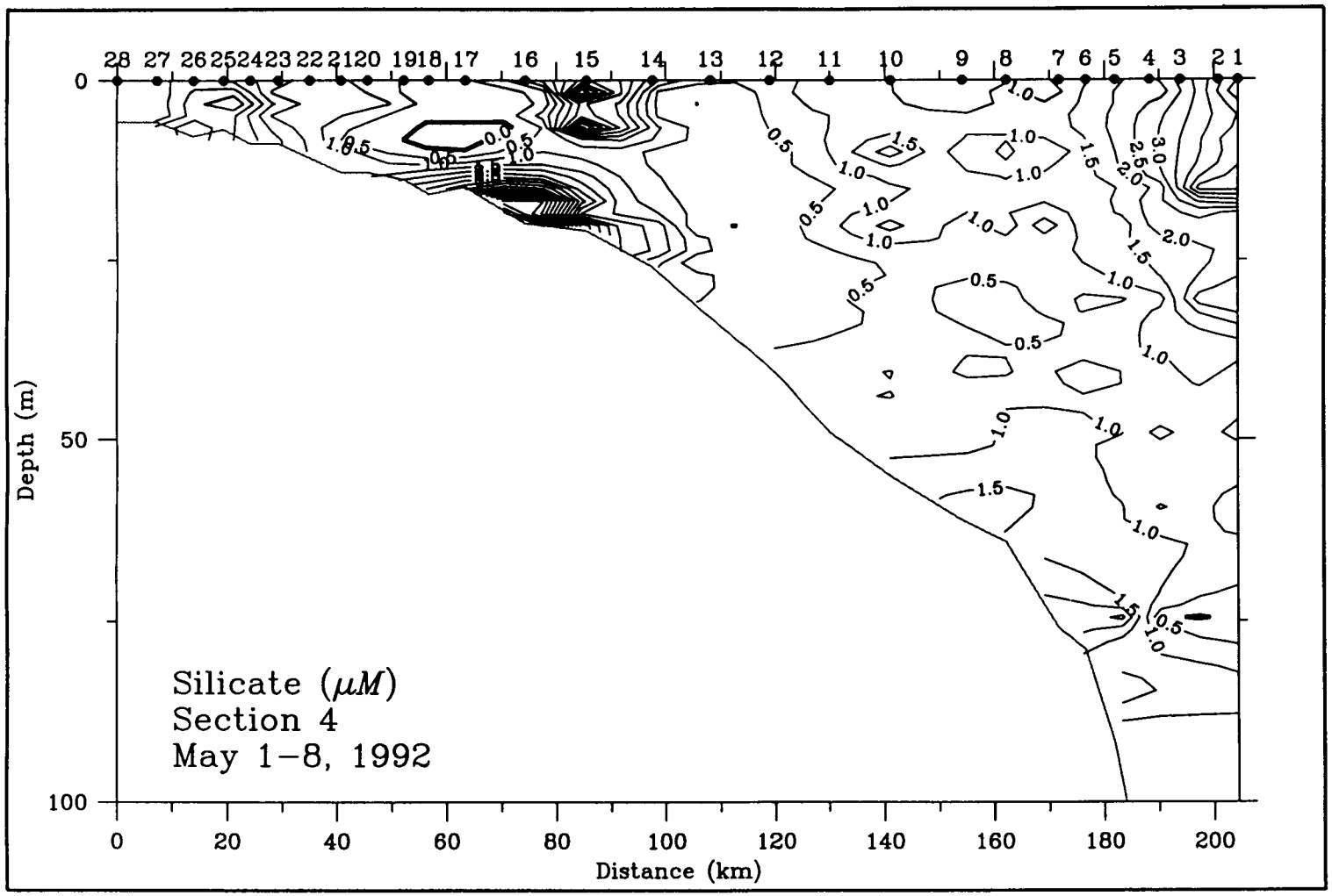


Figure 5.4.10. Silicate (μM) along cross-shelf Line 4 on LATEX A Cruise H01.

5.4.2 Representative Lateral Distributions

In Figures 5.4.11 through 5.4.14 are shown computer-generated, contoured, horizontal distributions of near-surface salinity for the first four LATEX A standard hydrographic cruises: H01, H02, H03, and H04. These distributions illustrate the extent of fresh water distribution over this shelf region. They may be compared with the corresponding patterns of geopotential anomaly presented and described in section 5.4.3.

Another type of lateral distribution used to examine circulation and sources/sinks of property extrema is isopycnal analysis—study of property distributions on surfaces of uniform potential density. In Figures 5.4.15-5.4.18 are shown computer-generated distributions of depth, temperature, salinity and and oxygen on the surface of potential density anomaly, sigma-θ, equal to 25.0 $kg \cdot m^{-3}$ for the LATEX hydrographic cruise H01 in May 1992. This density surface is found in the offshore portion of the survey region and thus may be used to infer circulation features there; it intersects the bottom at mid-shelf depths, e.g., see Figure 5.4.2. The circulation pattern inferred from the depth of this isopycnal (Figure 5.4.15) may be compared with the geopotential anomaly distribution (in dynamic cm) for this same cruise (Figure 5.4.19).

5.4.3 Representative Geopotential Anomaly Distributions

Geopotential anomaly of the sea surface has been calculated for each of the first four LATEX A hydrographic cruises. Calculations have been completed for values at three decibars (3 db $\approx$ 3 m depth) relative to a number of pressure surfaces. In view of the strong inertial oscillations encountered in ADCP and moored current meter measurements, the possibility of approximating the low-frequency currents with relative geostrophic currents has assumed a more prominent role in our investigations than was originally anticipated. The mass field on which geopotential depends is largely blind to inertial oscillations. There are, however, limitations in the use of the geostrophic current estimates.

First, departures from geostrophic flow may be considerable in the presence of friction. It is clear from measurements of vertical profiles of currents on the inner shelf, such as those of Kelly et al. (1985), that Ekman veering (turning of current direction with depth) may be very marked. However, in midshelf and outer shelf regions, friction only influences the flow significantly in much smaller portions of the water column. Accelerations constitute another kind of departure from geostrophy. These limitations are considered whenever geopotentials are employed.

A different limitation is involved in the computation of geopotential for a shelf region where the bottom depth may be less than that of the reference pressure. The geopotential can be evaluated by integration of the integral

$$-\int_{p(A)}^{p(B)} \rho^{-1}\, dp$$

along the bottom from point A to point B provided that the density (ρ) is constant along a bottom contour (more precisely, along the intersection of a pressure (p) surface with the bottom). Unless this condition is met, the integral is path-dependent so that the value of the integral would not necessarily be unique. Actually, the condition is not strictly

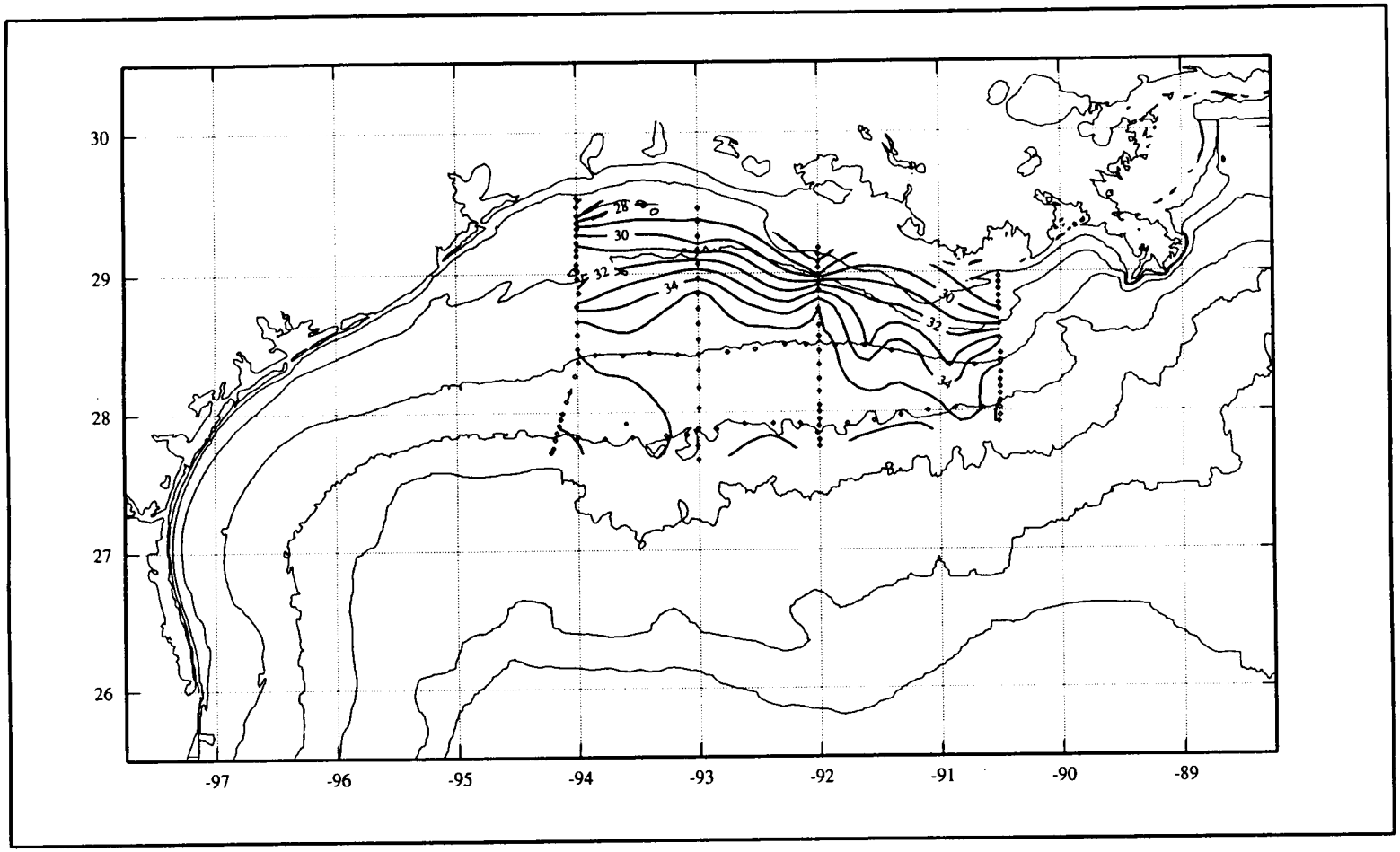


Figure 5.4.11. Salinity at Z = 3 m for the LATEX H01 cruise (1- 8 May 1992).

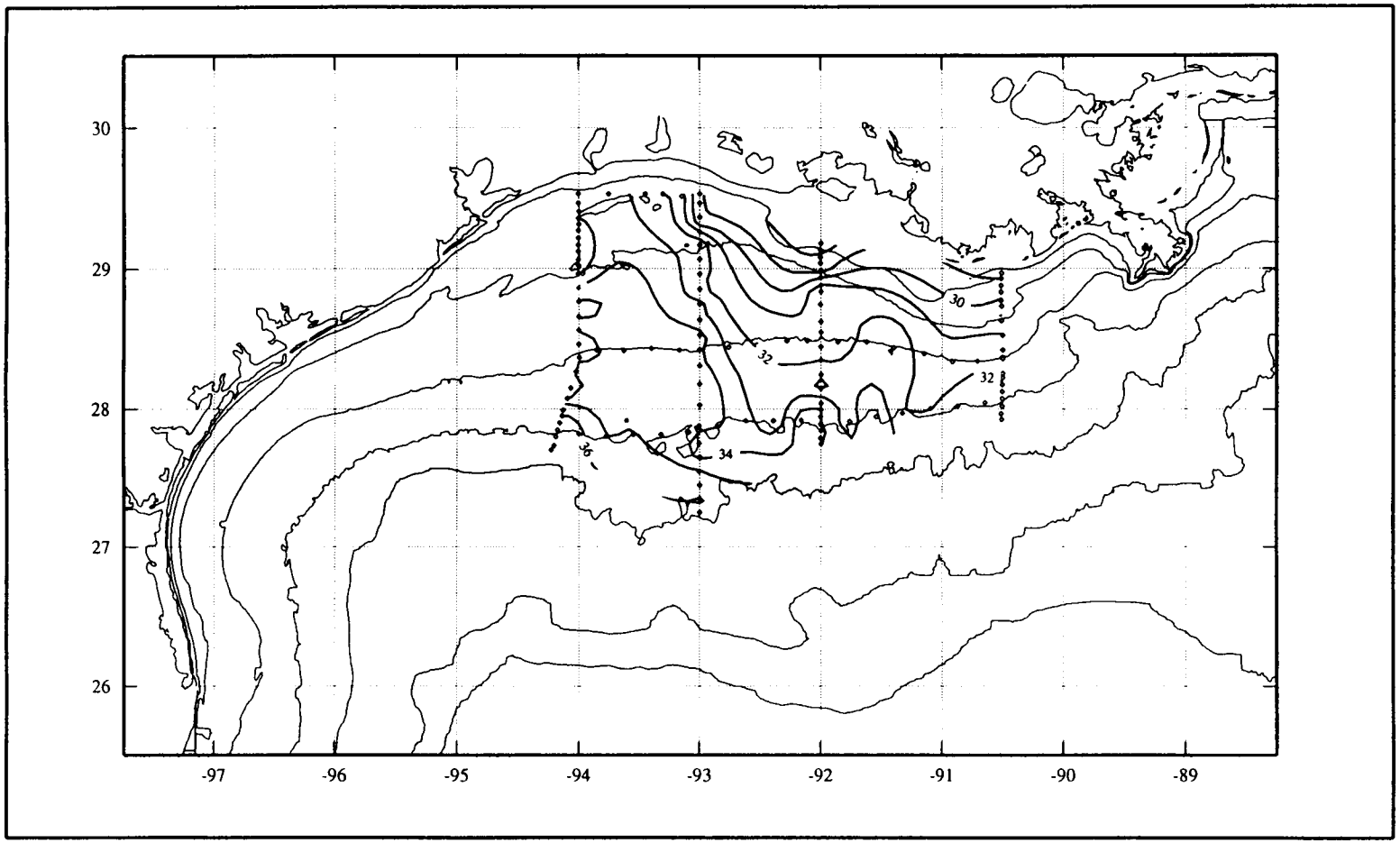


Figure 5.4.12. Salinity at Z = 3 m for the LATEX H02 cruise (1- 8 August 1992).

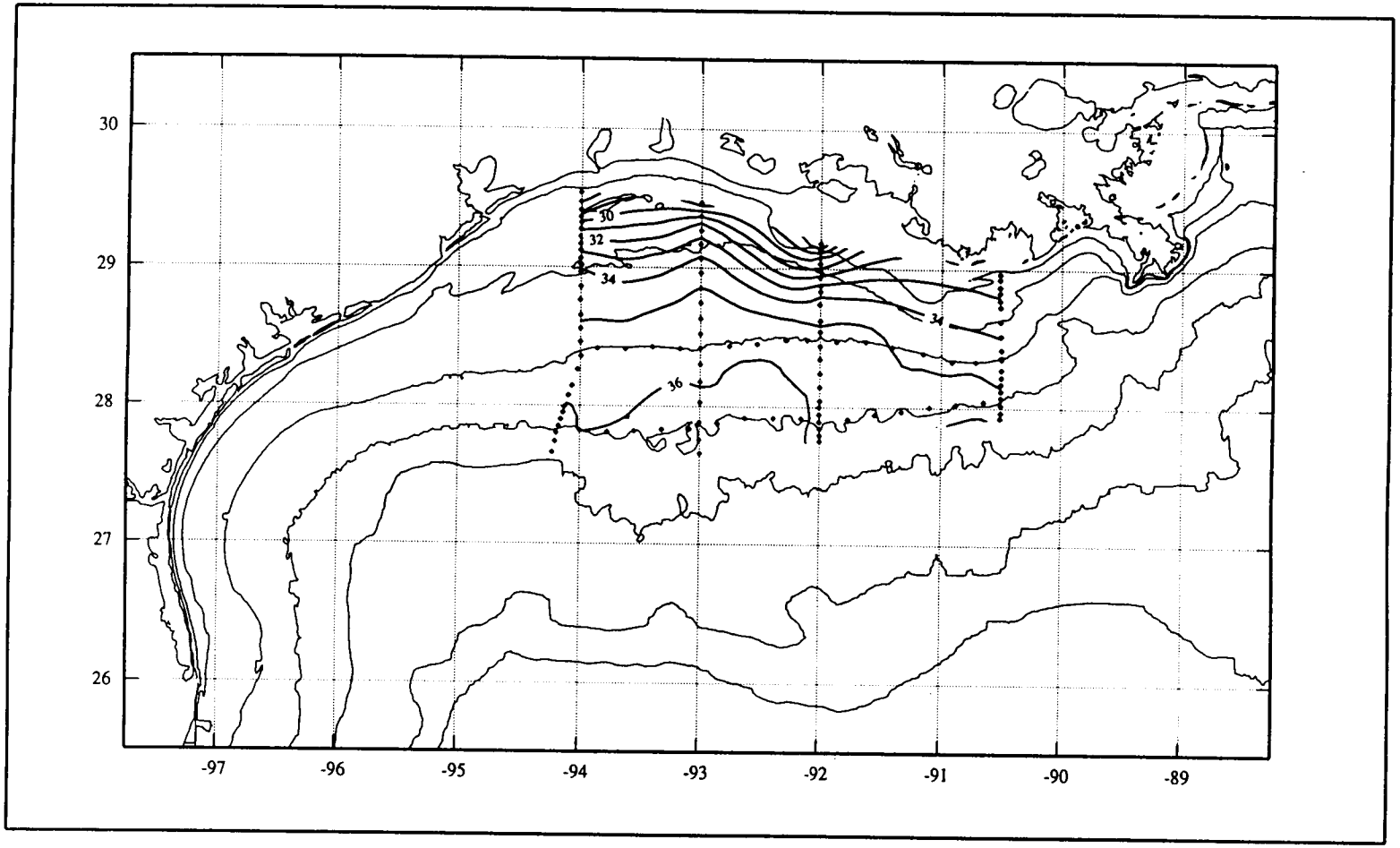


Figure 5.4.13. Salinity at Z = 4.5 m for the LATEX H03 cruise (5- 13 November 1992).

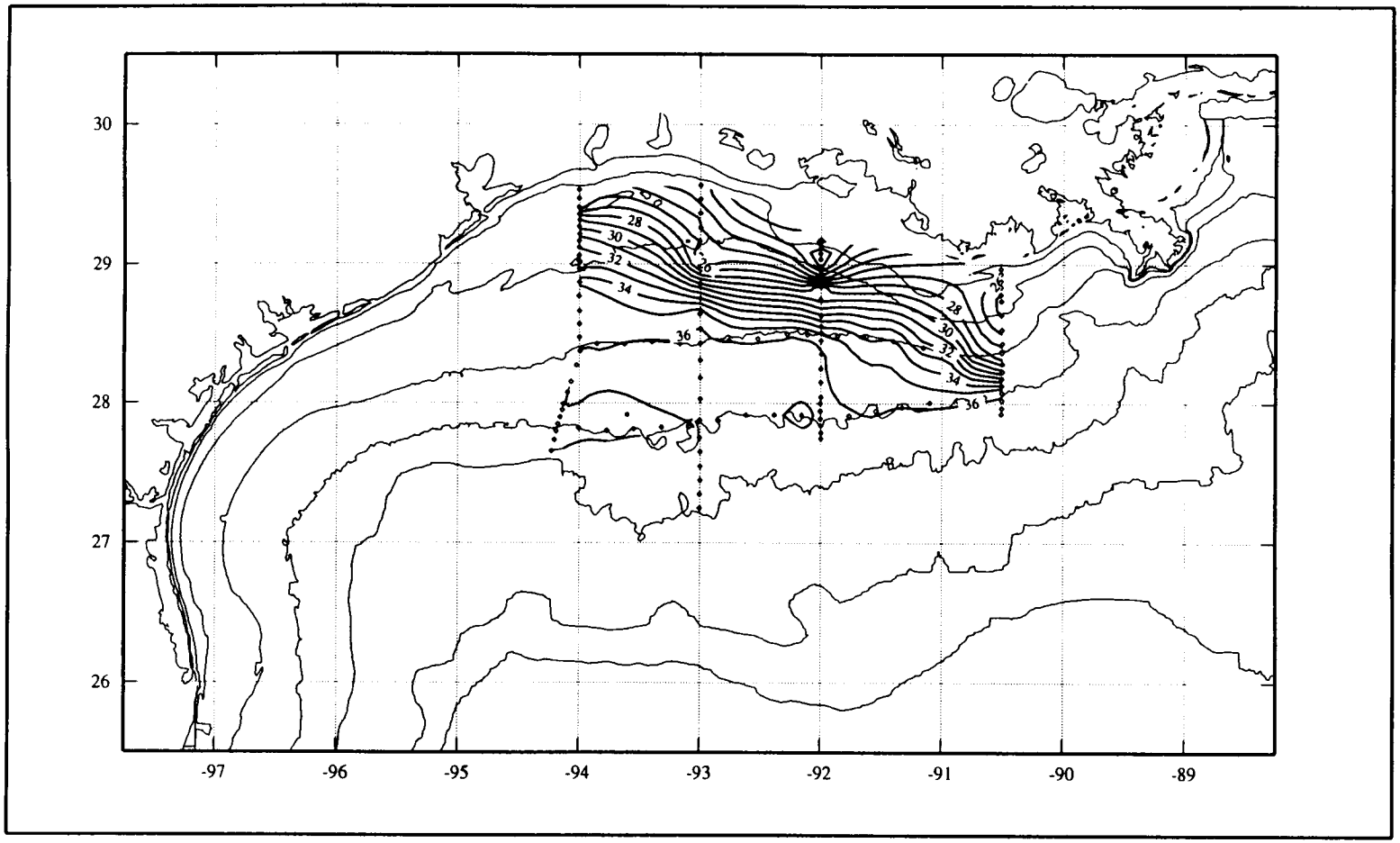


Figure 5.4.14. Salinity at Z = 3 m for the LATEX H04 cruise (6- 13 February 1993).

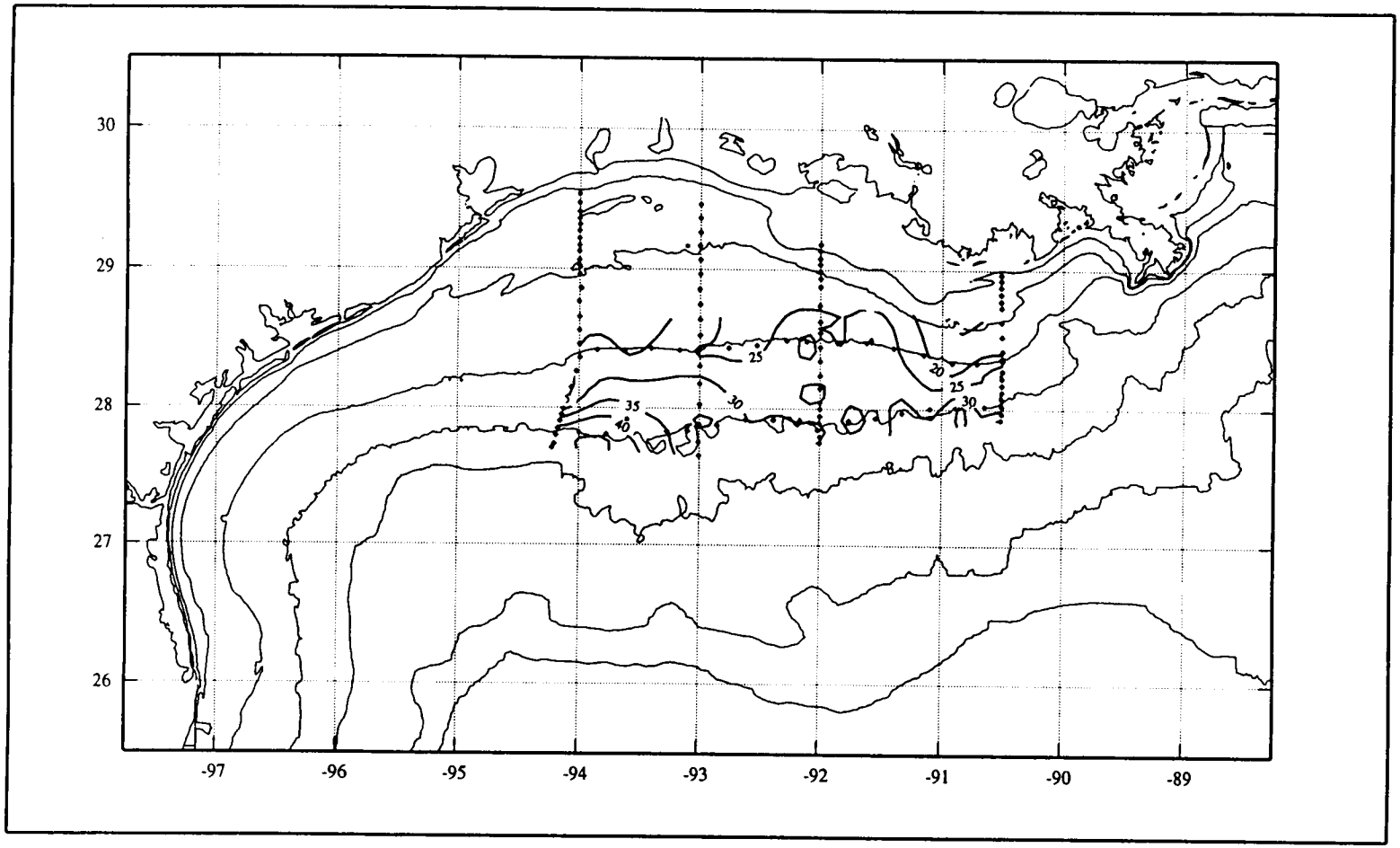


Figure 5.4.15. Depth (m) of potential density 25.0 for the LATEX H01 cruise (1- 8 May 1992).

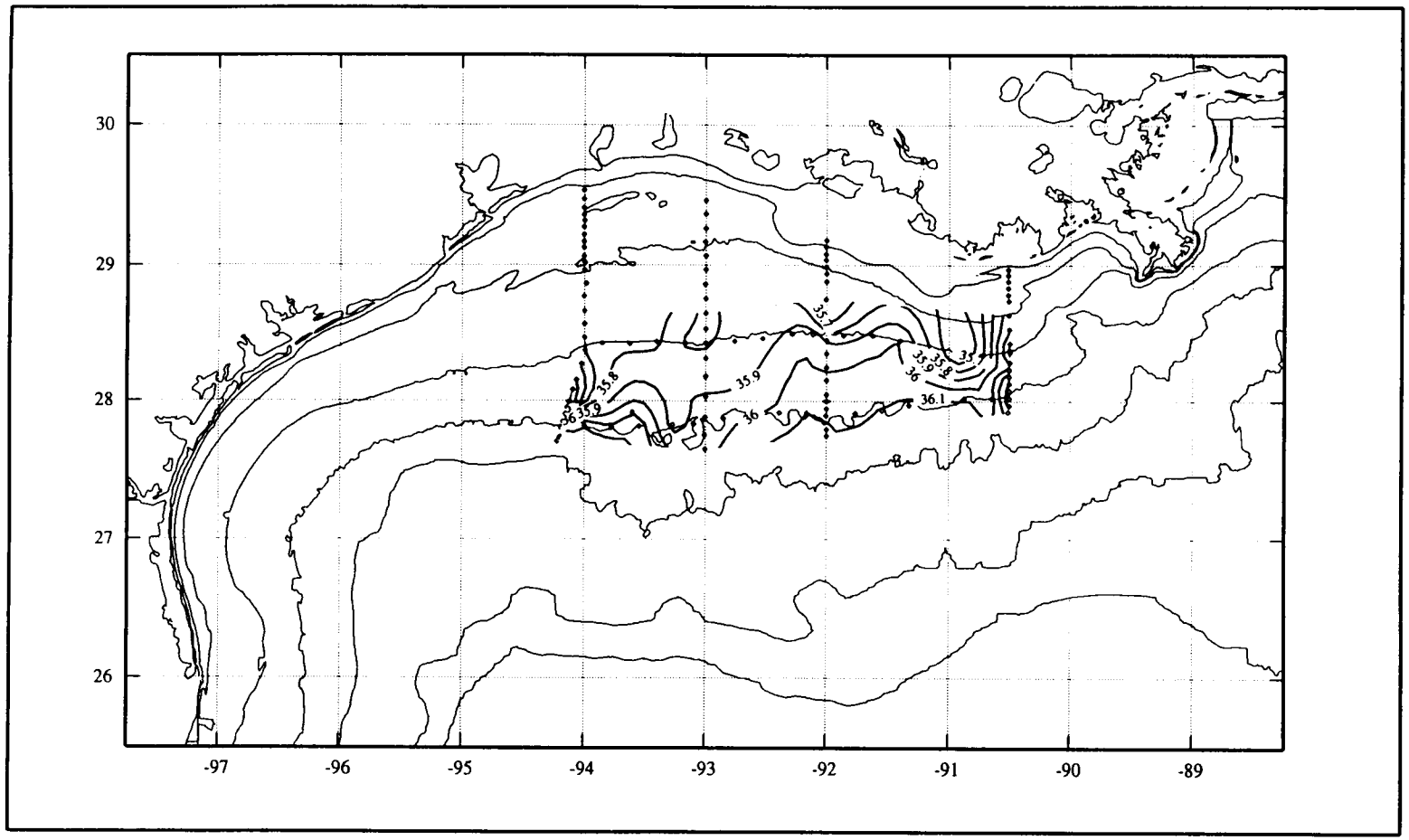


Figure 5.4.16. Salinity on surface of potential density 25.0 for the LATEX H01 cruise (1- 8 May 1992).

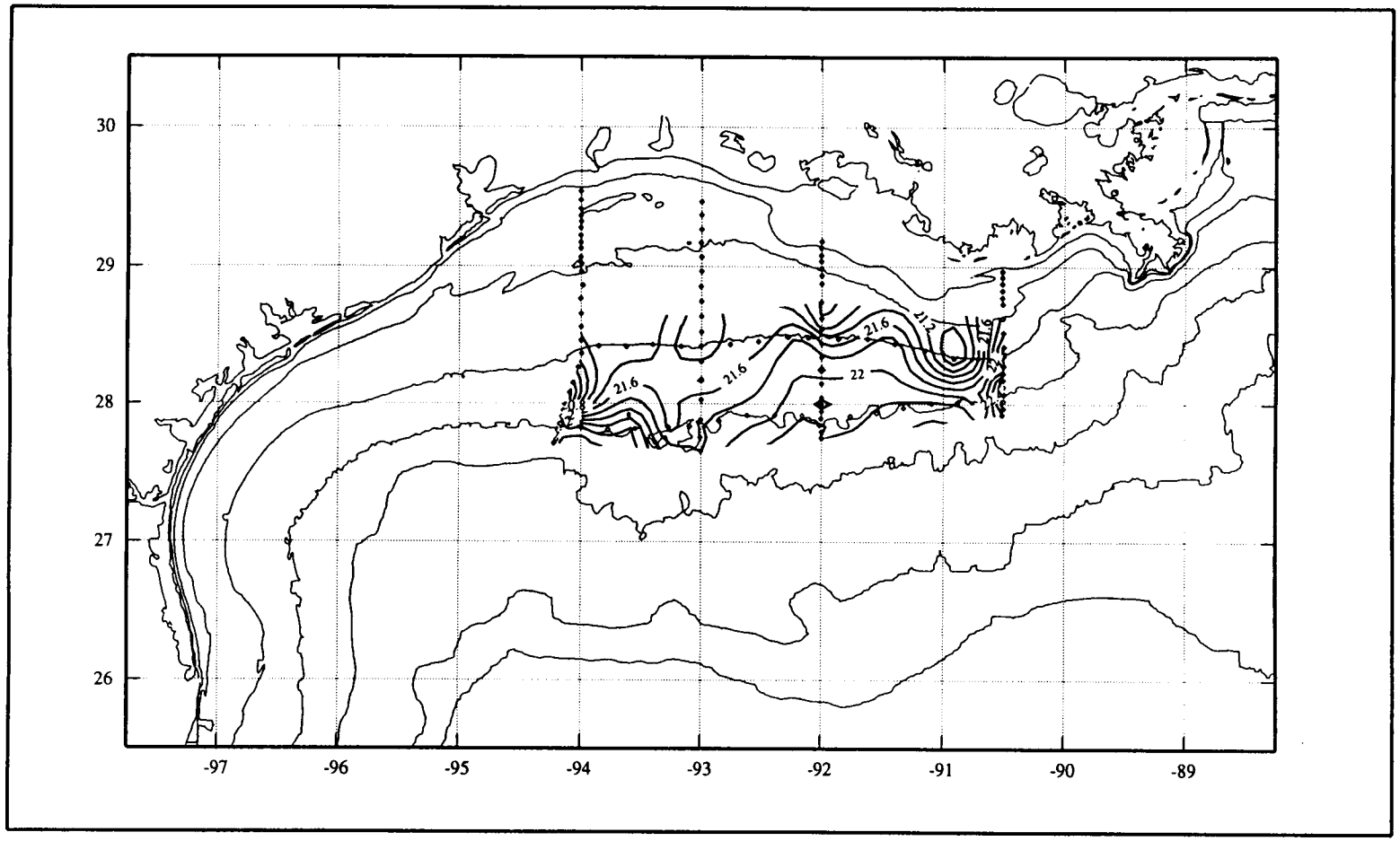


Figure 5.4.17. Potential temperature on surface of potential density 25.0 for the LATEX H01 cruise (1- 8 May 1992).

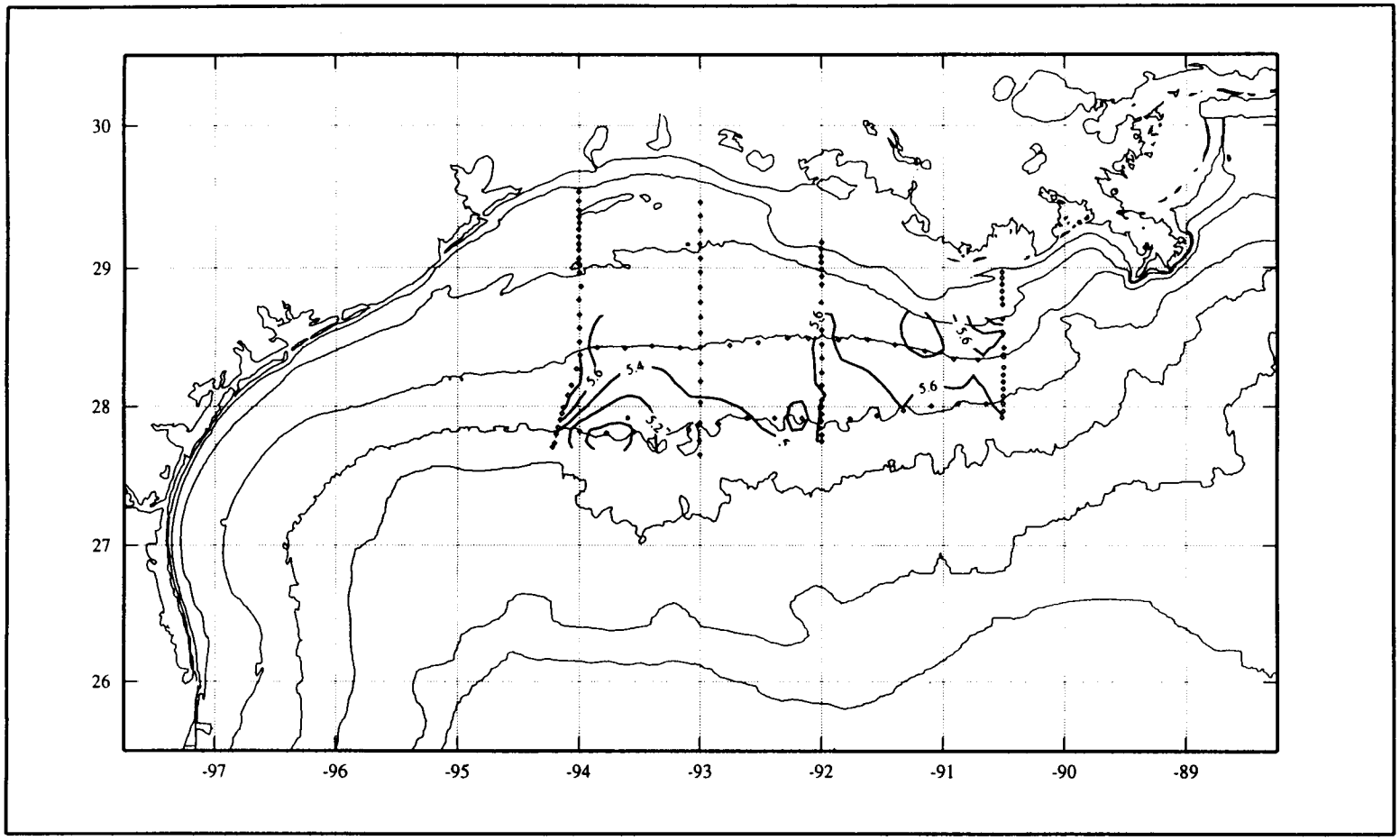


Figure 5.4.18. Dissolved oxygen on surface of potential density 25.0 for the LATEX H01 cruise (1- 8 May 1992).

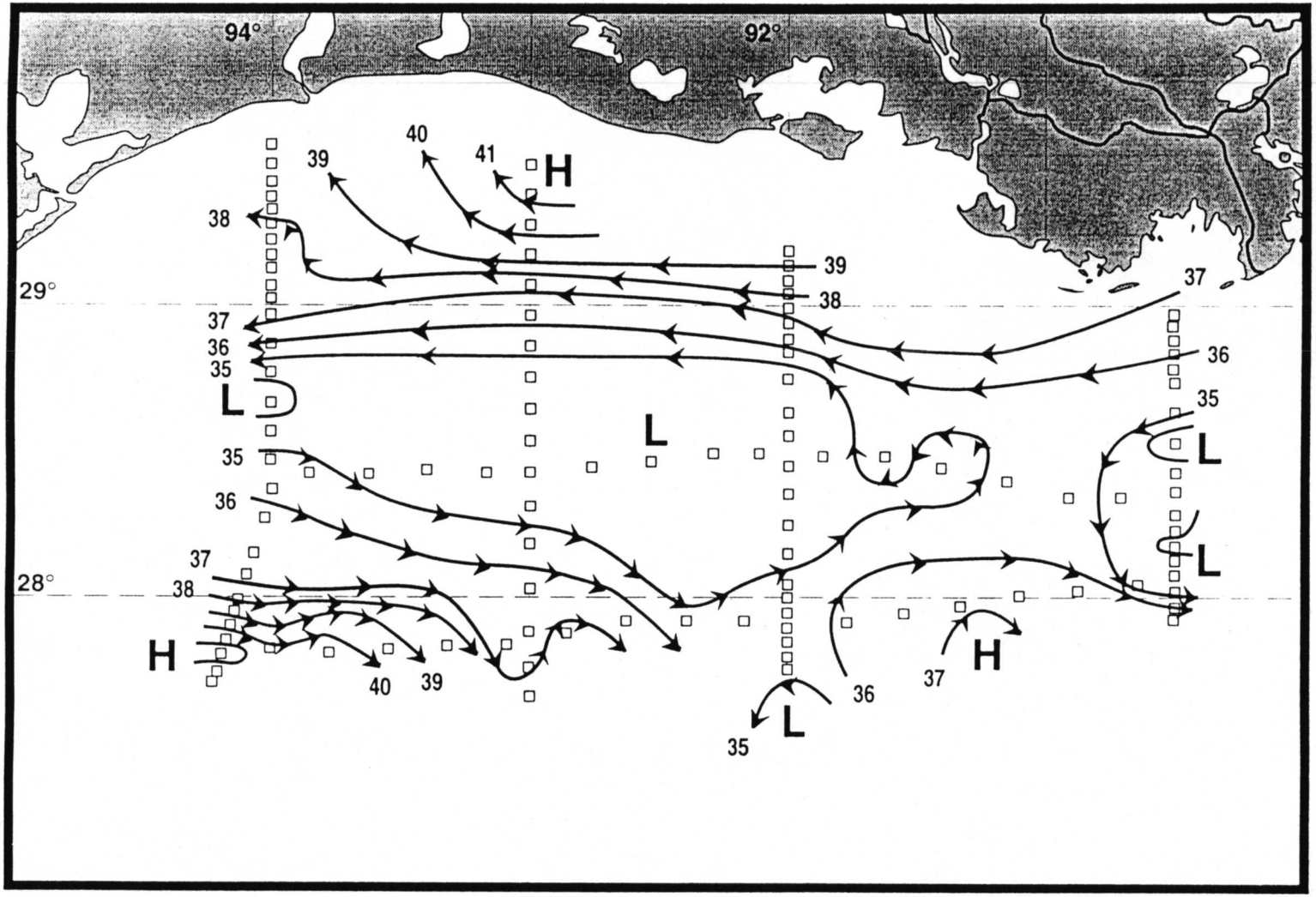


Figure 5.4.19. Geopotential anomaly at 3 decibars relative to 160 db. for LATEX A cruise of May 1992. Arrows indicate the direction of geostrophic flow.

fulfilled on the LATEX shelf. However, the departure from the condition does not appear to be large. This problem is under investigation.

The choice of a reference pressure also leads to problems. With a shallow reference surface, the presence of a strong geostrophic flow at that surface would imply that the current relative to that surface might differ greatly from the actual current. A deep reference surface, on the other hand, would necessitate more bottom integration — troublesome if the condition of constant density along bottom contours is not met fairly closely. Various reference pressures are under consideration for use.

A further difficulty which is often raised in connection with maps of geopotential (both in meteorology and oceanography) is that where data are lacking, subjectively chosen isopleth positions are entered. In the figures which follow, isopleths have been continued through regions where no data are available. It is felt that interrupted lines make the maps difficult to interpret readily. An attempt has been made to not introduce strong gradients or large curvatures. Users of these maps should realize that isopleths where few data are available must be interpreted with great caution.

Where data are available, the geopotential isopleths are drawn as objectively as possible. A few values which would necessitate very sharp curves in the isopleths have been avoided. The larger features are portrayed honestly.

Figures 5.4.19, 5.4.20, 5.4.21, and 5.4.22 show the geopotential anomaly (in dynamic cm) of the three decibar surface (about 3 m depth) relative to the 160 decibar (≈ 160 m depth) surface for the LATEX A hydrographic cruises carried out in May, August, and November 1992, and February 1993, respectively. The cruises in non-summer months (Figures 5.4.19, 5.4.21, 5.4.22) generally have a large cyclonic region (low or lows) over the midshelf region. This is the feature shown by Cochrane and Kelly (1986) in their monthly mean geopotential anomaly maps based on the *GUS III* data, except for July and August. The feature implies downcoast (westward or southward) flow for the inner shelf and upcoast (northward or eastward) flow for the outer shelf and slope regions.

In May 1992, this pattern was very prominent (Figure 5.4.19). An interesting aspect of the geopotential was a saddle point in the low which appeared near 91°W. The southward flow indicated by the low in the east provides a possible explanation for a southward tongue of low surface salinity centered near 91°W.

The November 1992 and February 1993 cruises encountered situations where the low region east of 92°W was centered over the continental slope or even farther south. Hence, the generally westward flow was present over the outer, as well as inner and middle, shelf in the east. In the west, however, the highs were found over the continental slope or outer shelf so that the indicated geostrophic flow on the outer shelf there was toward the east. The patterns found in the west were thus largely in agreement with the prevailing non-summer flow pattern proposed by Cochrane and Kelly.

The major feature of the August 1992 geopotential field is the relatively strong, largely eastward flow extending across the entire extent of the observations (Figure 5.4.20). Here again the indicated geostrophic flow provides confirmation of the flow proposed by Cochrane and Kelly. Their picture is of a prevailing eastward flow in July and the first half of August. It should be noted, however, that in the east the eastward flow is interrupted by a ribbon of westward current near 29°N.

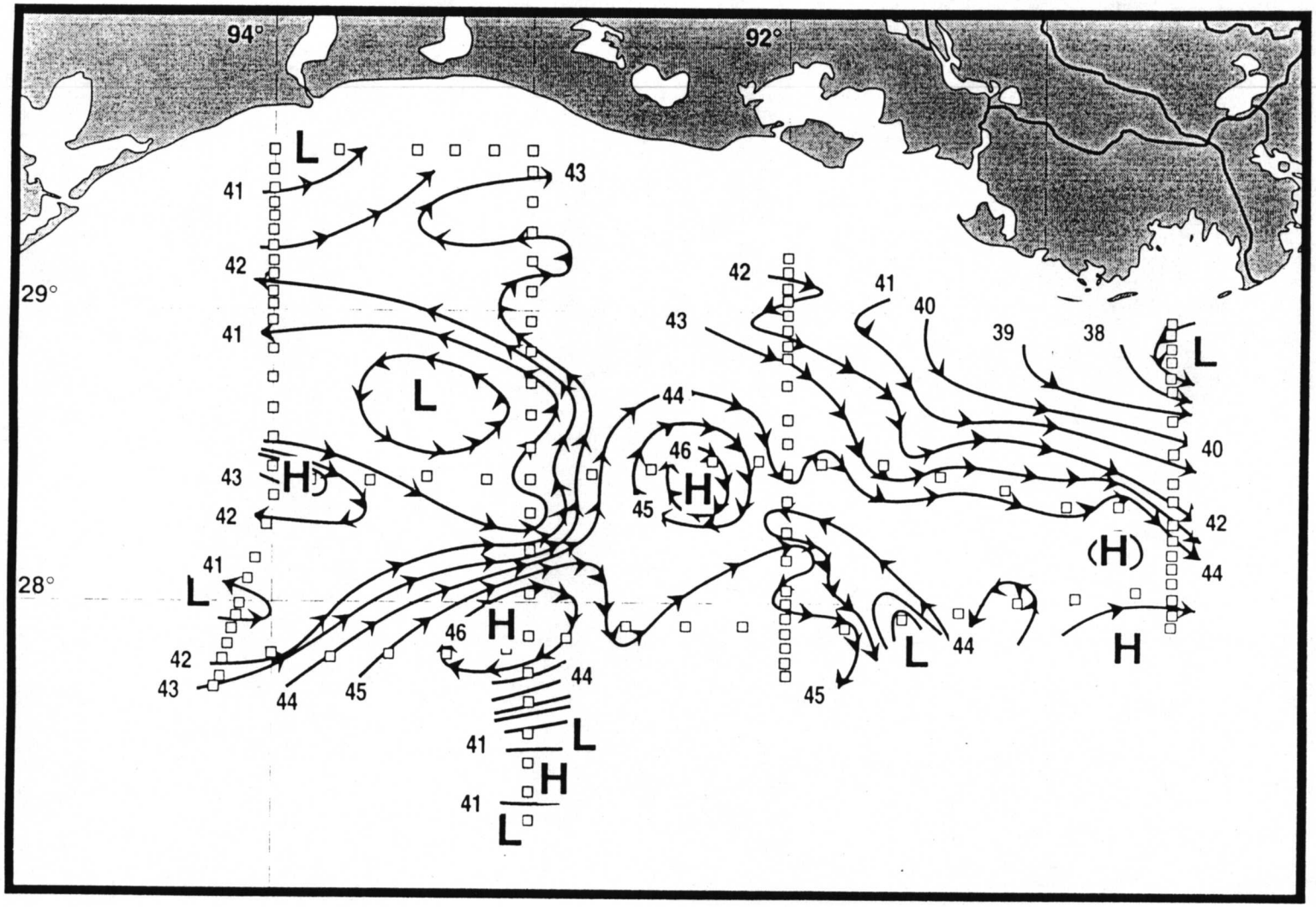


Figure 5.4.20. Geopotential anomaly at 3 decibars relative to 160 db. for LATEX A cruise of August 1992. Arrows indicate the direction of geostrophic flow.

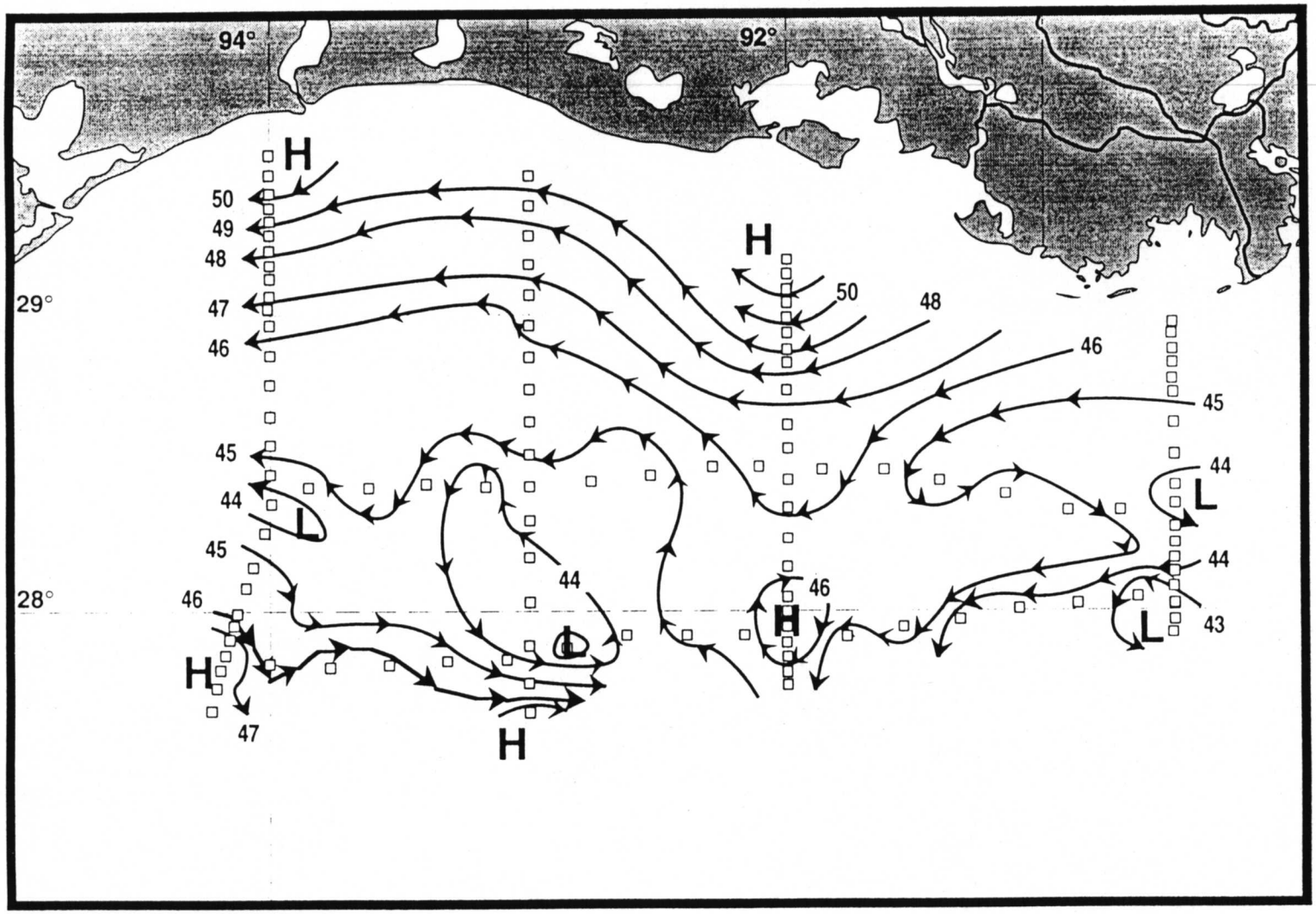


Figure 5.4.21. Geopotential anomaly at 3 decibars relative to 160 db. for LATEX A cruise of November 1992. Arrows indicate the direction of geostrophic flow.

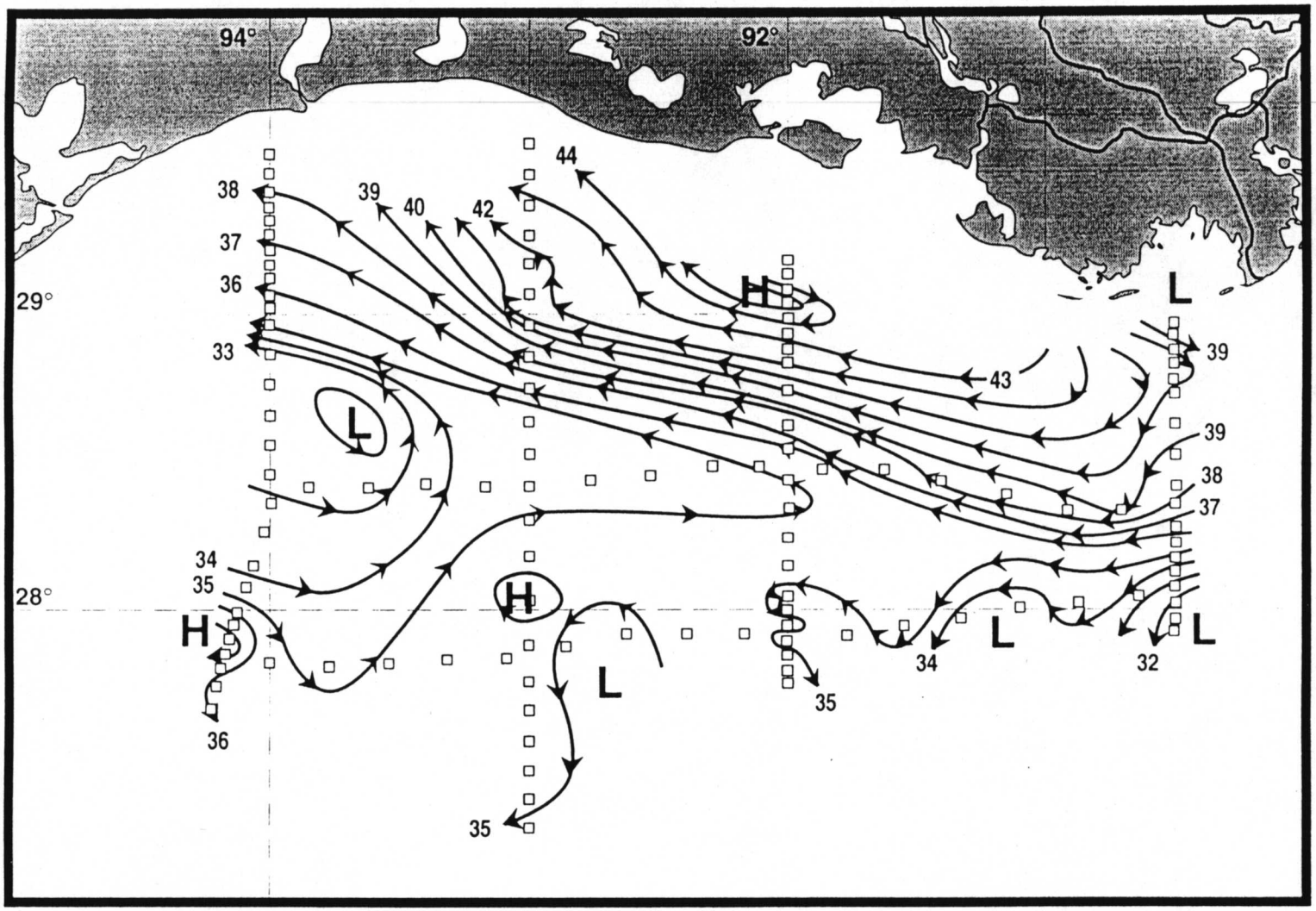


Figure 5.4.22. Geopotential anomaly at 3 decibars relative to 160 db. for LATEX A cruise of February 1993. Arrows indicate the direction of geostrophic flow.

5.4.4 Particulate Material

The data set being collected in the LATEX project is providing the information necessary to examine the temporal and spatial variability in the turbidity of shelf and slope waters. Synthesis of transmissivity data, hydrography data and current meter data will help us to understand the processes important to the transport of particles on this shelf. These transport processes have important implications for the fate of both sediment and organisms on this shelf.

Previous work on this shelf (Sahl 1984; Sahl et al. 1987) identified three important patterns in the transmissivity field over a part of the Texas Shelf. These patterns are nearshore turbid water, a bottom nepheloid layer across the shelf and mid-depth nepheloid layers at the shelf edge. LATEX A is examining these patterns over the entire Texas-Louisiana shelf. Of particular interest is that part of the shelf directly impacted by discharge from the Mississippi and Atchafalaya rivers.

The initial LATEX data show that a bottom nepheloid layer may not always be present across the Texas-Louisiana shelf. During cruise H03, a well defined bottom nepheloid layer was present at the middle and/or edge of the shelf in all of the cross shelf sections. At only some of the inner shelf stations was a well defined bottom nepheloid layer present. More commonly in the shallow waters of the inner shelf, the whole water column was turbid, with no very turbid layer at the sea floor.

Nearshore waters are often more turbid than mid and outer shelf waters, due to the resuspension of sediment by shoaling waves, and to the discharge of suspended sediment from rivers and bays. The LATEX data set shows that the most turbid coastal waters are found in the eastern study area due to the impact of the two major rivers, the Mississippi and Atchafalaya. Transmissivities on the inner shelf were lowest in the east and increased to the west. However, the turbid inner shelf water is not necessarily correlated with salinity. There are filaments of turbid water on the shelf with no corresponding filaments present in the salinity data.

5.4.5 Secchi Depth Measurements

The LATEX A Secchi depth procedure calls for the deck assistant to obtain a Secchi disk depth measurement at each daylight station, said measurement to be recorded on the CTD operator's log sheet. At each daylight station the Secchi disk is lowered until the disk is just perceptible; the depth in meters is noted. The disk is further lowered until it is no longer visible. The disk is then raised slowly until it is again barely visible; the depth reading of this point is recorded. The two recorded readings are averaged to provide one Secchi depth per daylight station. Often, difficulties with the disk going under the ship make it impossible to obtain a reading for both the lowering and raising of the Secchi disk. In that event, only the lowering depth is recorded on the log sheet.

After the Secchi depth data have been checked in by the LATEX A Data Office, the Secchi depths are entered into a Microsoft Excel spreadsheet on a Macintosh computer. The tabulated data are examined by the hydrography principal investigator for accuracy. Missing Secchi depths are verified as nighttime stations. Stations with only a lowering reading are noted. Corrections to the data set are made by LATEX A Data Office personnel for final review by the Data Manager. The data are then transferred to the Data Office's VAX computer system for further inspections and analysis. Secchi depth data are contoured to look for aberrant station data that need further review. Figure 5.4.23 is

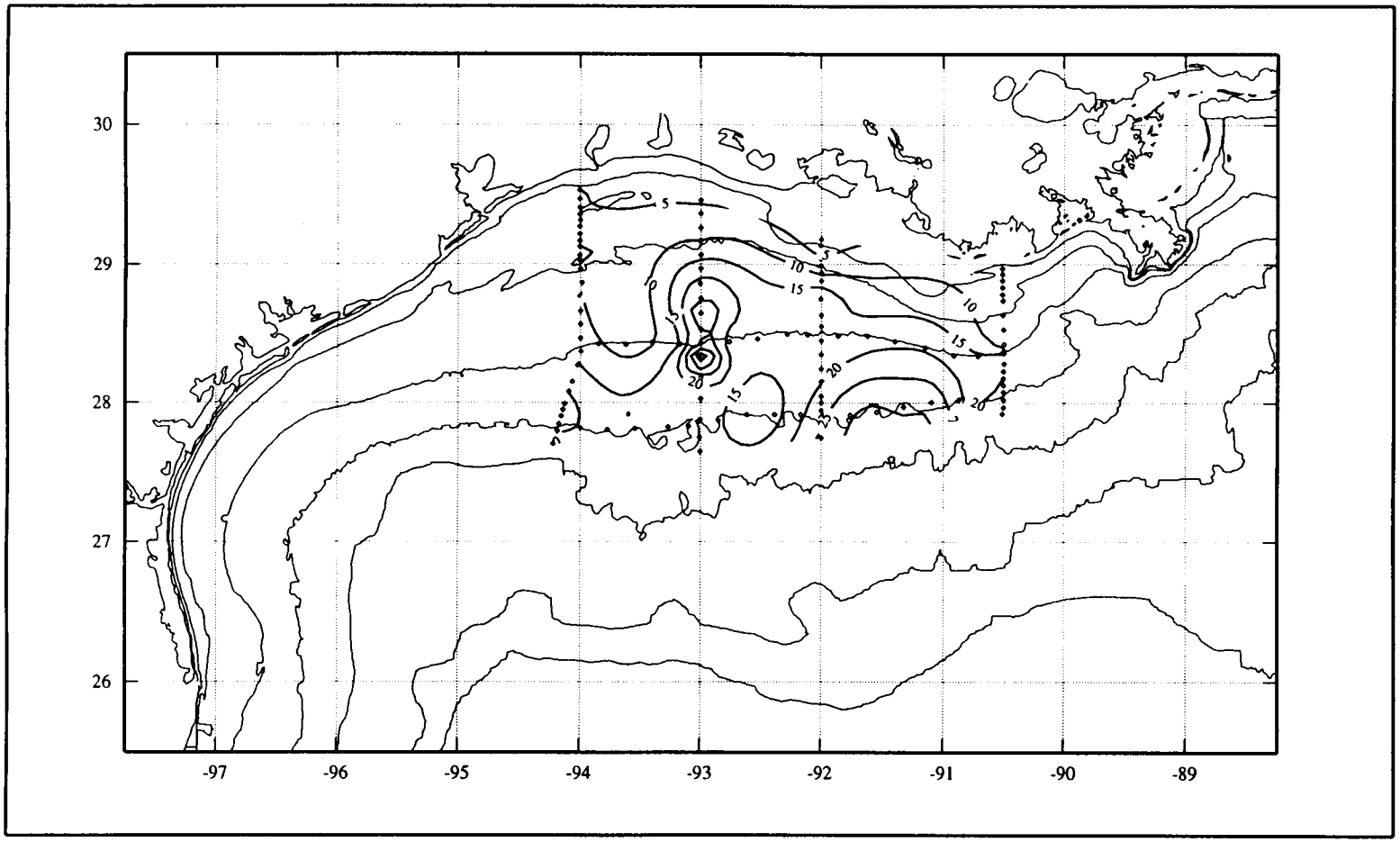


Figure 5.4.23. Secchi depth (m) for the LATEX H01 cruise (1 - 8 May 1992).

an example of one of these contour plots. Secchi depth plots for the other hydrographic surveys will be included in the microfiche packet that will accompany the Final Report.

5.5 Acoustic Doppler Current Profiler Measurements

The current velocity data collected by the ADCP during the hydrographic survey cruises are neither Eulerian nor Lagrangian, nor do they form a synoptic spatial ensemble. Because the ship's cruise track is designed for it's primary mission, the hydrographic survey, the actual velocity field is not adequately sampled in either time or space. Therefore, the velocity field measured by the ADCP is aliased by unresolved temporal and spatial variability, such as inertial oscillations (Chen et al. 1994) The sequence of ADCP ensemble averages is quite "gappy", because all of the on-station ensembles had to be eliminated, as well as some of the underway ensembles (Section 3.5.1.5). The ADCP measurements suffer also because of the close spacing of the hydrographic stations, which is five or ten kilometers on the cross-shelf transects and twenty on the along shelf ones. At a vessel speed of ten knots (5 m/s), only a few five-minute ensemble averages can be collected between stations.

Despite these limitations, the ADCP data agree qualitatively with most of the near-surface current flow features suggested by current meter measurements and geopotential anomaly distributions. Figures 5.5.1 and 5.5.2 show the velocity vectors, in stick form, from the top ADCP bin (centered at 12-m depth) for cruises H03 and H04, respectively. The lower right corner of the figures shows a velocity scale.

For H03, the ADCP velocity field for the inner shelf shows westward flow off Sabine and Calcasieu Passes and off Terrebonne Bay. Between these coastal regions there is a suggestion of clockwise circulation. Along the 200-m isobath the currents have a strong eastward component from 91.5° to 94°W. Between 90.5° and 91.5°W the currents have a general westward component, but are weaker are more variable in direction. At the southwest corner of the cruise track, the ADCP vectors indicate a strong counter-clockwise circulation cell. The current vectors along the mid-shelf transect (50 m) are quite variable and inconsistent. The major features in Figure 5.5.1 agree well with the geopotential anomaly distribution shown in Figure 5.4.21.

The ADCP velocity field for survey H04 appears variable at first glance. Interpretation becomes easier when it is compared with the geopotential anomaly field (Figure 5.4.22). The latter shows a series of small scale (~30 km) circulation cells along the 200-m isobath. The alternating north and south currents in the ADCP data along this transect correspond these cells. The ADCP data show westward currents all along the transect from Galveston to the shelf edge, but the geopotential anomaly distribution indicates eastward flow along the offshore half.

5.6 Meteorological Measurements

5.6.1 Summary of Preliminary Results of Cyclogenesis Study

The field deployment of meteorological buoys for this project began in April 1992. The data record from April 1992 through March 1993 is shown in Table 5.6.1. Because this task was designed to study winter cyclogenesis, buoys 50, 51, 52, and 53 were removed during the hurricane season to reduce risk of loss or damage. Buoys 17, 19, 20, and 22 remained on station throughout the year, although some data gaps occurred due to instrument maintenance or malfunction.

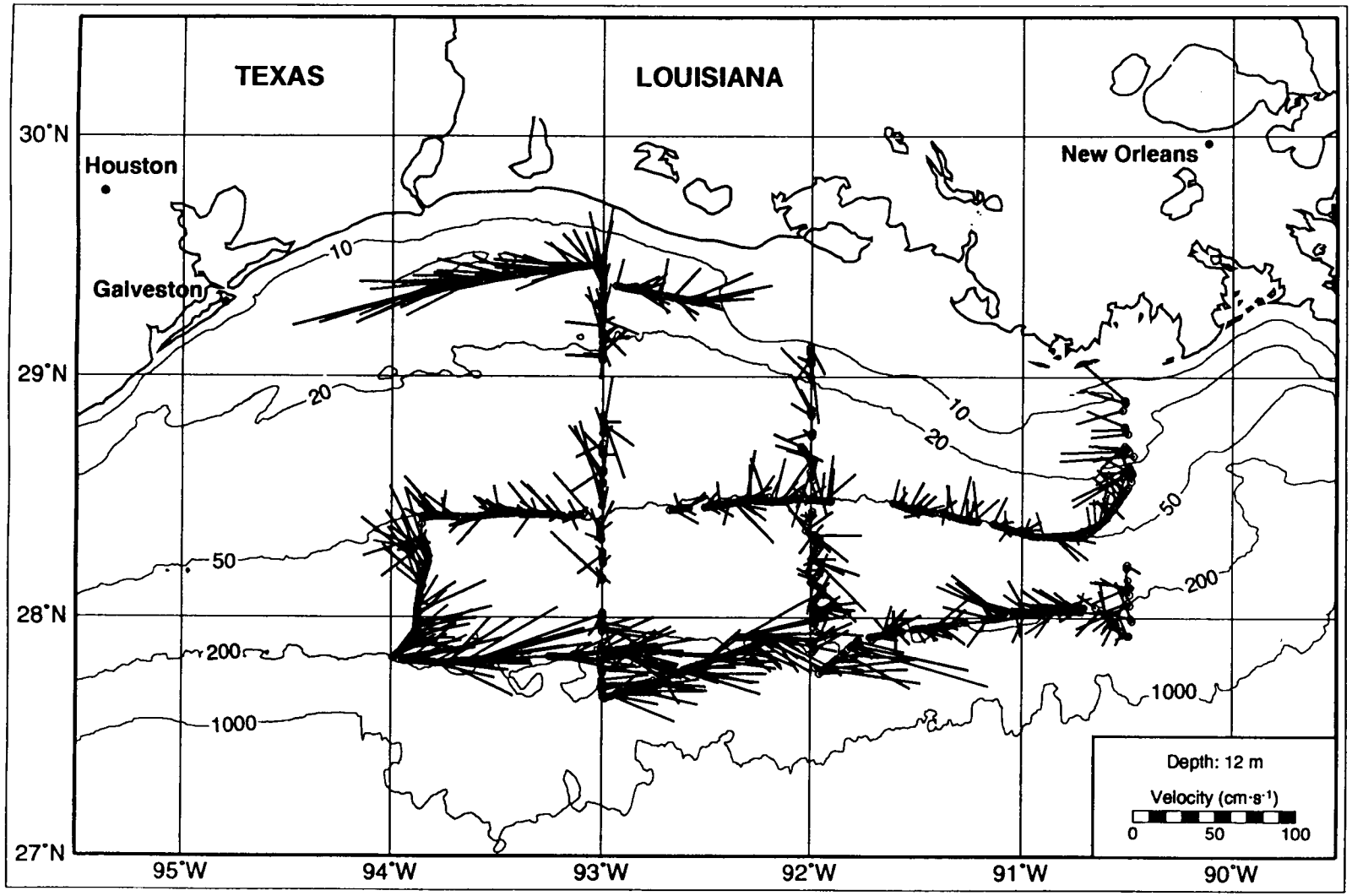


Figure 5.5.1 Stick-vector plot of currents at 12 m measured by ADCP during cruise H03.

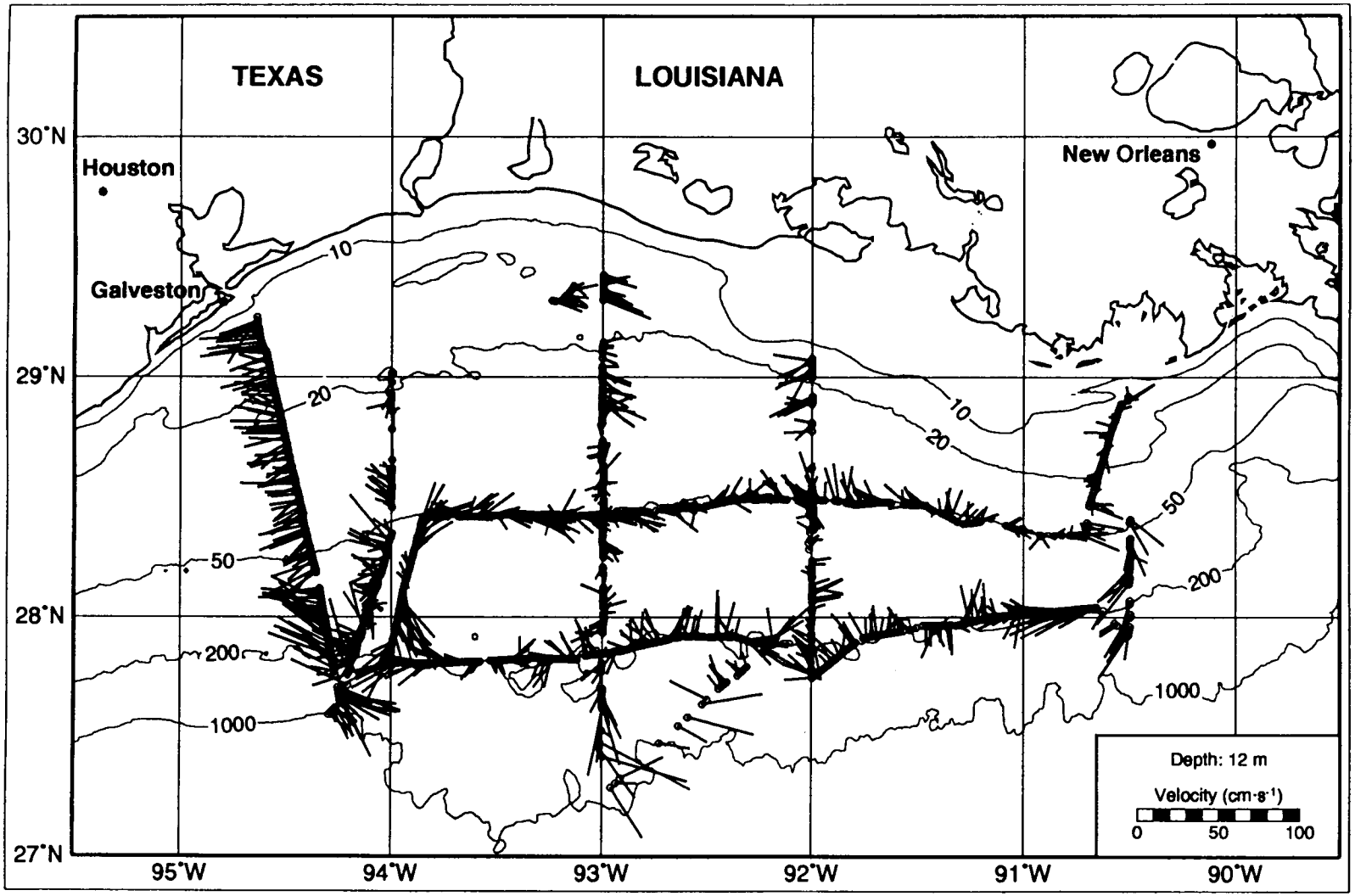


Figure 5.5.2 Stick-vector plot of currents at 12 m measured by ADCP during cruise H04.

Table 5.6.1. LATEX meteorological buoys data record 1992 - 1993 *

	1992									1993			
Buoy	A	M	J	J	A	S	O	N	D	J	F	M	A
17 = 42026	---	------	------	------	------			--------	------	---		---	------
19 = 42027			----	----	------	------	---	--------	------	---	------	------	------
20 = 42028	----	------	------	------	------	--		--------	------	---	------	------	------
51 = 42029	----	------	------	---				--------	------	---	------	------	------
22 = 42030	----	------	------	--	-----	------	--	--------	------	---	------	------	------
50 = 42031	----	------	------	-----				------	----		------	------	------
52 = 42032	----	------	------	-----				------	----		------	------	------
53 = 42033	----	------	------	-----				--------	------	---	------	----	

* Based on latest revised data shipment (26 August 1993) from the LATEX Data Office.

Temperature field analysis: In addition to the eight LATEX meteorological buoys, other meteorological stations in the northwest Gulf of Mexico provided data included in the analysis presented here (see Figure 5.6.1). They are National Data Buoy Center (NDBC) buoys 42001 (central Gulf) and 42002 (western deep Gulf); buoys 42019 and 42020 (supported by the MMS along the shelf break); and the Coastal-Marine Automated Network (C-MAN) stations of PTAT2 (Port Aransas, TX), SRST2 (Sabine, TX), GDIL1 (Grand Isle, LA), and BURL1 (Southwest Pass, LA).

As an example, variations of air and sea-surface temperatures were analyzed. Their differences for December 1992 are shown in Figure 5.6.1. The orientation or contour of the isotherms generally follows the isobaths, as expected. It is seen, however, that the most active region of convection, as indicated by maximum air minus sea surface temperature, does not occur in the deep Gulf or in the shallow shelf water but rather along the shelf break, a point important to the mesoscale air-sea interaction in the Gulf of Mexico as indicated by Lewis and Hsu (1992).

Vorticity field analysis: Because the orientation of the shoreline and the shelf break is different between the South Texas and Central Gulf coasts, the vorticity field is also expected to be different. The geostrophic vorticity over the northern LATEX region was investigated by Hsu (1992). The local vorticity over the southern LATEX region centered around Corpus Christi, TX, (Figure 5.6.2). It is presented here in Figure 5.6.3 in relation to the onshore-offshore temperature difference. Equations for the analysis are provided in Nowlin et al. (1991). On the basis of this relationship, it appears that the monthly temperature difference between the deep Gulf and the shore stations can be used to estimate the vorticity field. To demonstrate this point, the temperature difference between central Gulf buoy 42019 and C-MAN station SRST2 for the northern LATEX region is shown for 1992 in Figure 5.6.4. For comparison, the temperature difference between buoy 42020 and C-MAN station PTAT2 for the southern LATEX region for 1992 also is shown. It can be seen that the southern LATEX region has stronger vorticity potential (offshore temperature differences) than the northern region, indicating either more frequent cyclogenesis occurrence or stronger winter cyclones in the southern region.

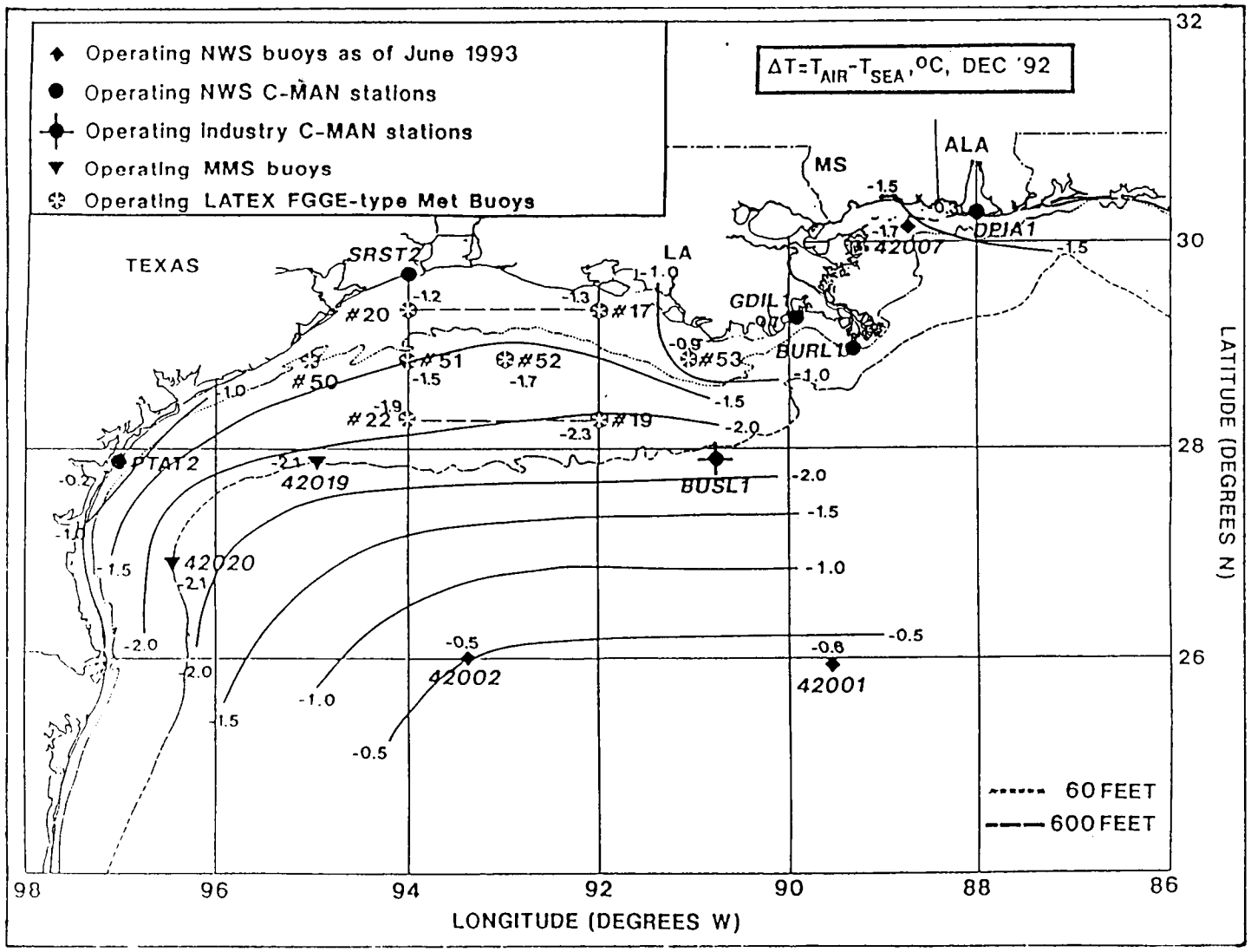


Figure 5.6.1. Stability represented by the difference in air temperature minus sea-surface temperatures in the LATEX region for December 1992.

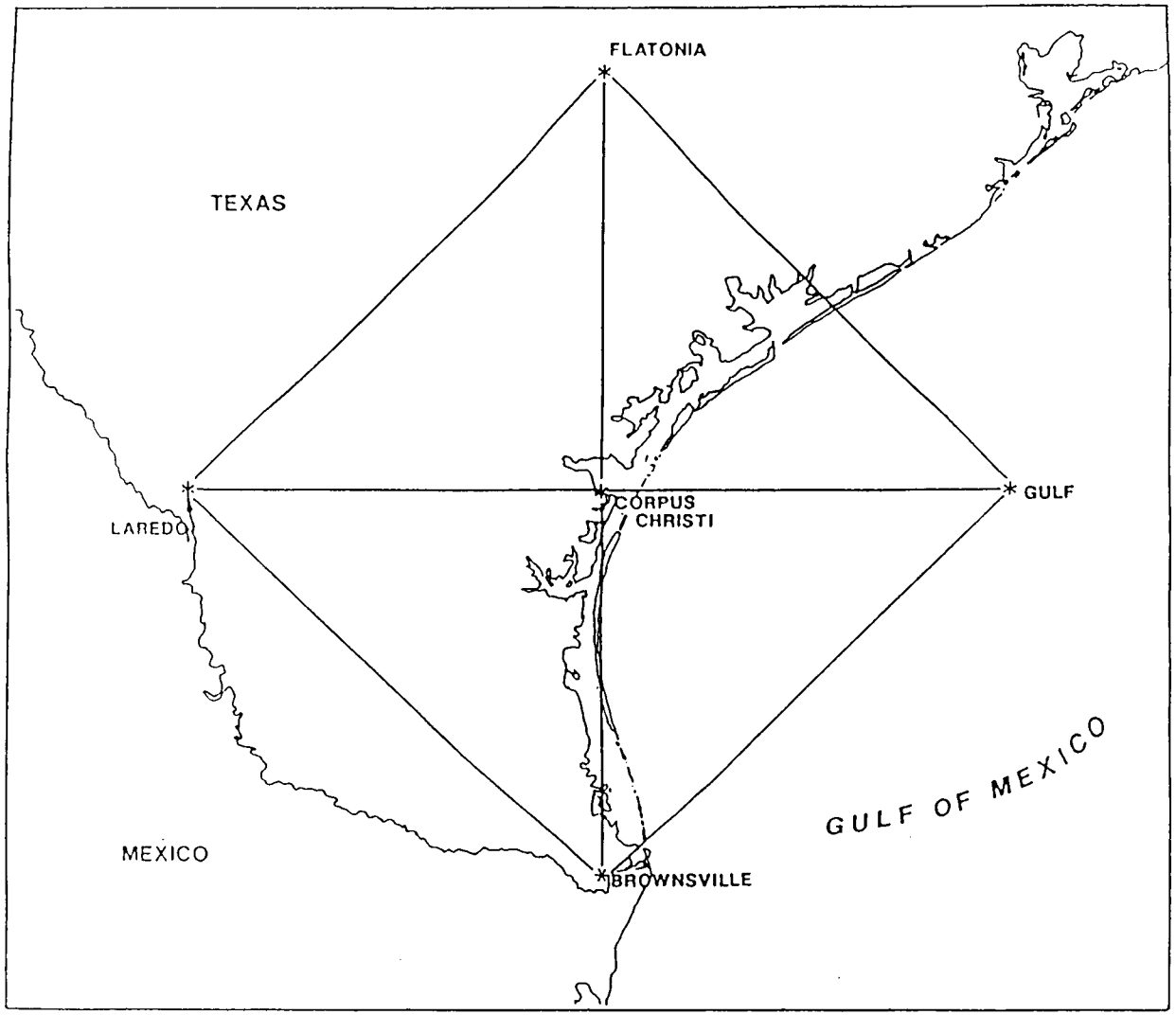


Figure 5.6.2. A five-point stencil for the computation of the Laplacian of temperature field to obtain the relative or local vorticity in the southern LATEX region.

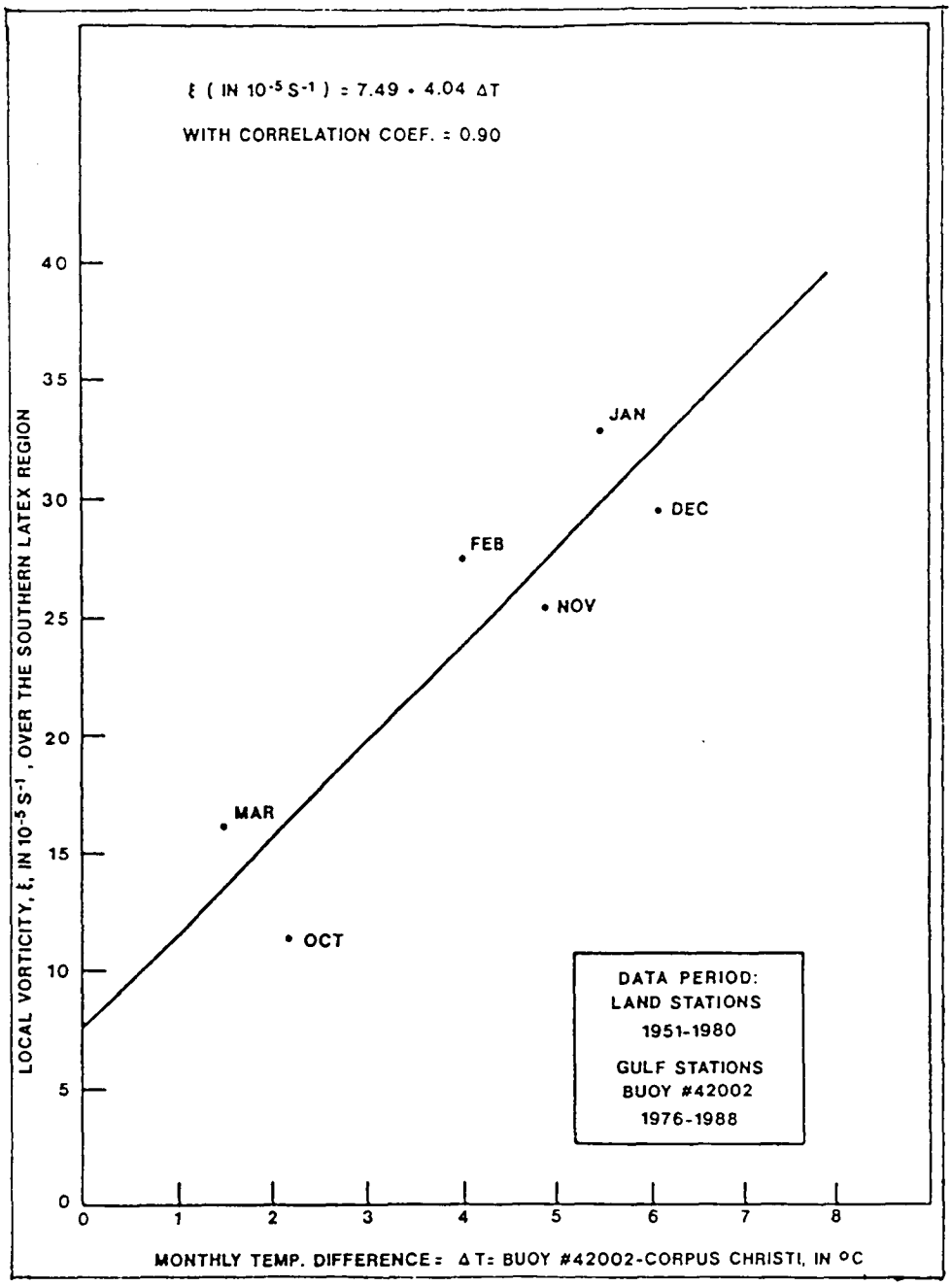


Figure 5.6.3. Linear regression between the local geostrophic vorticity over the southern LATEX region centered over Corpus Christi and the monthly temperature difference between buoy 42002 in the deep Gulf and Corpus Christi, TX.

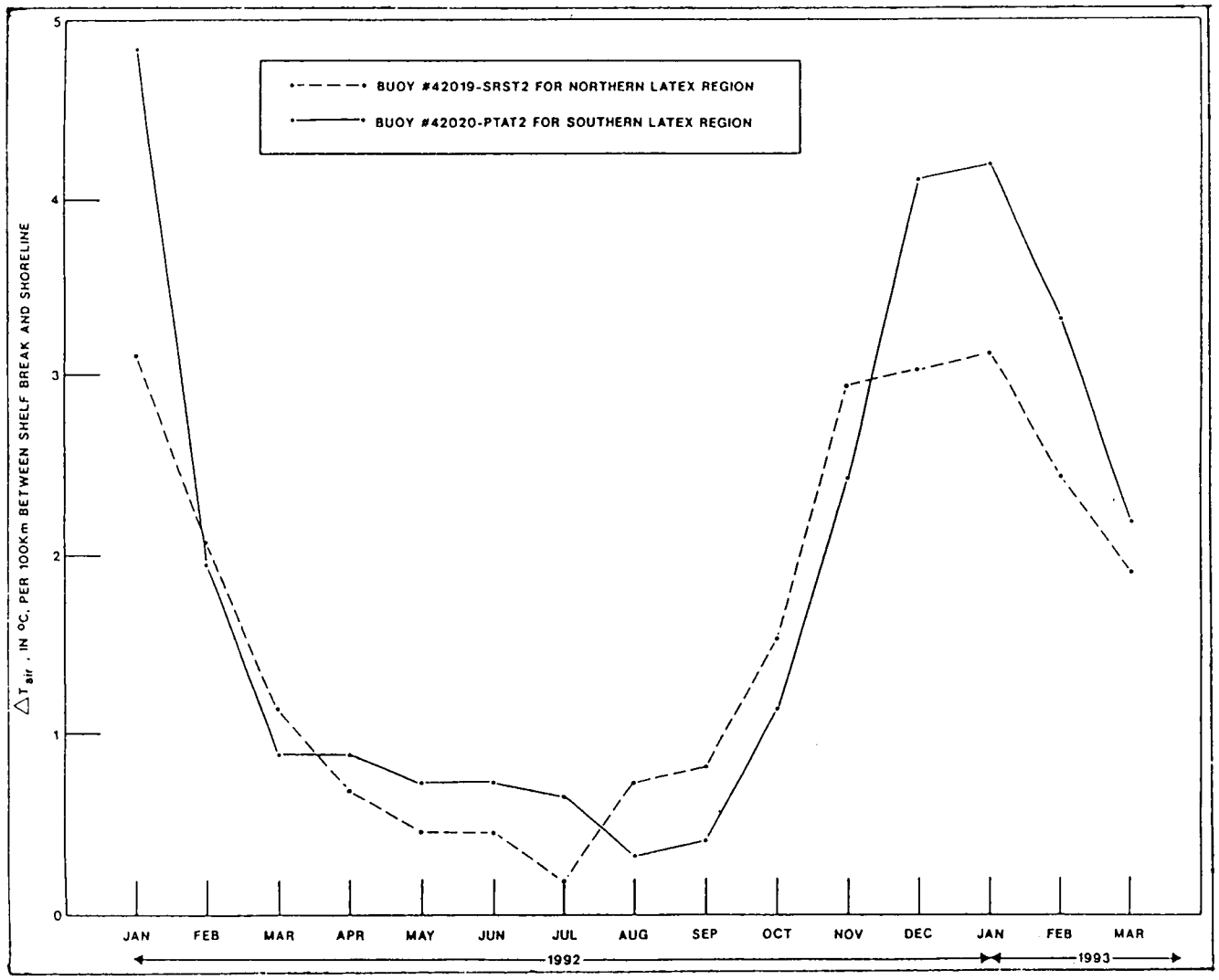


Figure 5.6.4. Monthly variations of the temperature difference between the shelf break and shore stations for both northern and southern LATEX regions.

Wind-stress curl analysis: The distribution of wind stress and wind-stress curl are essential in the understanding of wind-drift generation and current transport. Pertinent equations are given in Nowlin et al. (1991). Figures 5.6.5 and 5.6.6 give illustrations of the variation of wind stress curl computed from LATEX buoys for the months of November 1992 and January 1993, respectively. A sharp contrast in intensity and character is seen for the two months. On the basis of these monthly stress curl values in the northern LATEX region, the average Ekman pumping between November 1992 and March 1993 is estimated to be approximately 11 $cm \cdot d^{-1}$. This forcing may contribute to the production of well-mixed water columns as observed in winter.

5.6.2 Frequency of Winter Cyclogenesis from November 1992 Through May 1993

To study the intensity of winter cyclogenesis over the Gulf of Mexico, a classification scheme based on the approximate balance between the centrifugal force and the pressure gradient of the storm has been devised by Hsu (1993). This is illustrated in Figure 5.6.7. Based on this classification there were eight winter cyclogenesis cases between November 1992 and May 1993 (Table 5.6.2). In general, there are approximately 10 cyclogenesis per year (see Johnson et al. 1984). Note that among the eight cyclogenesis events that occurred, the one that developed on 12 March 1993 over the southern LATEX region was a class four cyclone and later evolved into the Blizzard of 1993, which some refer to as the Storm of the Century (see Hsu 1993). Figure 5.6.8 shows its track. During the initial cyclogenesis stage of this storm both air and sea-surface isotherms were generally oriented along the isobaths, with the gradient larger over the southwestern than over the northeastern shelf (Figures 5.6.9 and 5.6.10).

Table 5.6.2. Winter cyclogenesis over the northwestern Gulf of Mexico from November 1992 through May 1993

Year	Month	Day	Intensity*
1992	November	4	2
	November	24	3
	December	9	2
	December	15	3
1993	February	22	2
	March	12	4
	April	8	3
	May	12	1

*The intensity classification is based on Hsu (1993). The data source is "Daily Weather Maps," published weekly by NOAA.

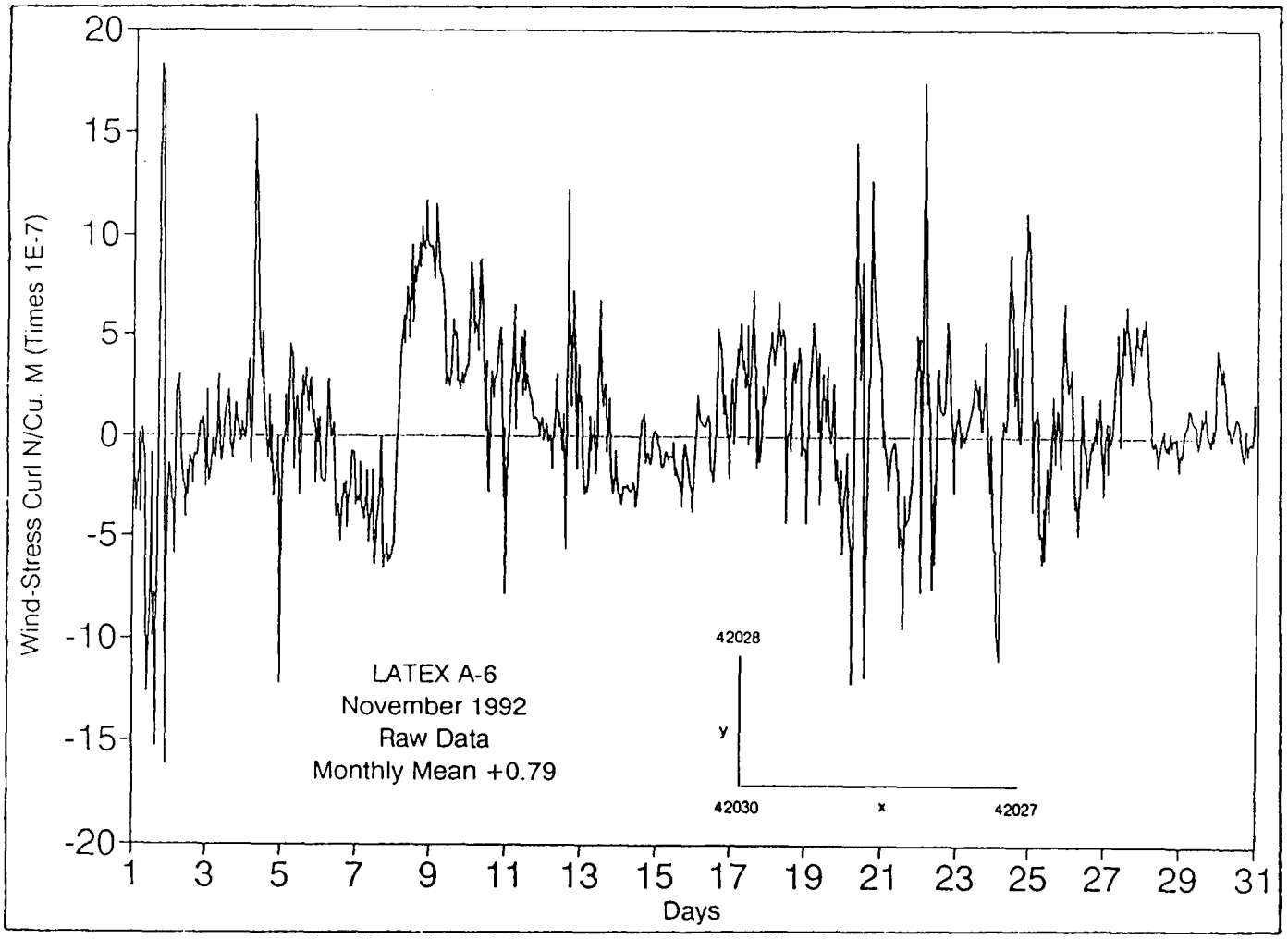


Figure 5.6.5. Variation of the wind-stress curl in November 1992 based on LATEX buoys 20, 22, and 19 located as shown in Figure 5.6.1.

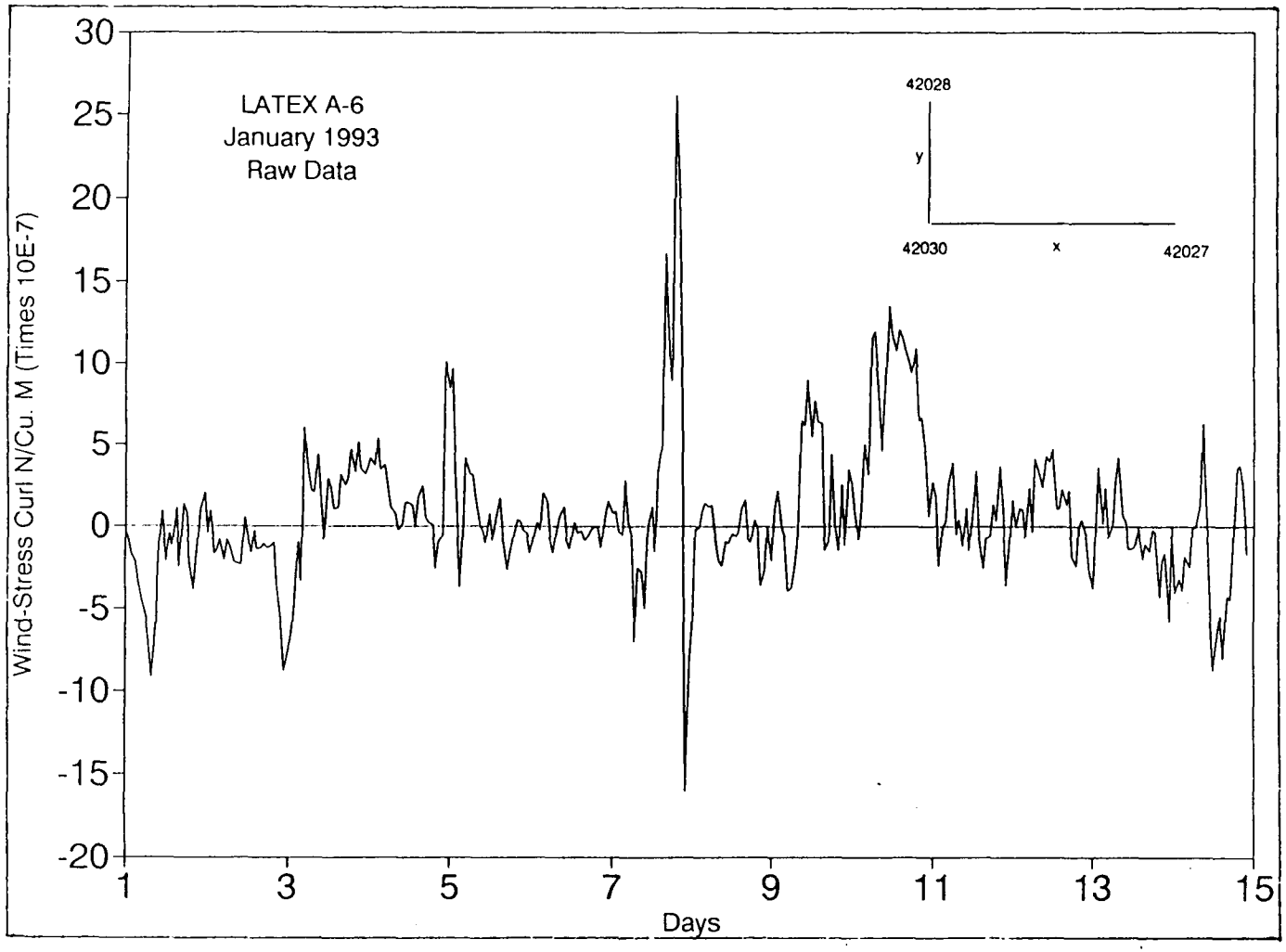


Figure 5.6.6. Variation of the wind-stress curl in January 1993 based on LATEX buoys 20, 22, and 19 located as shown in Figure 5.6.1.

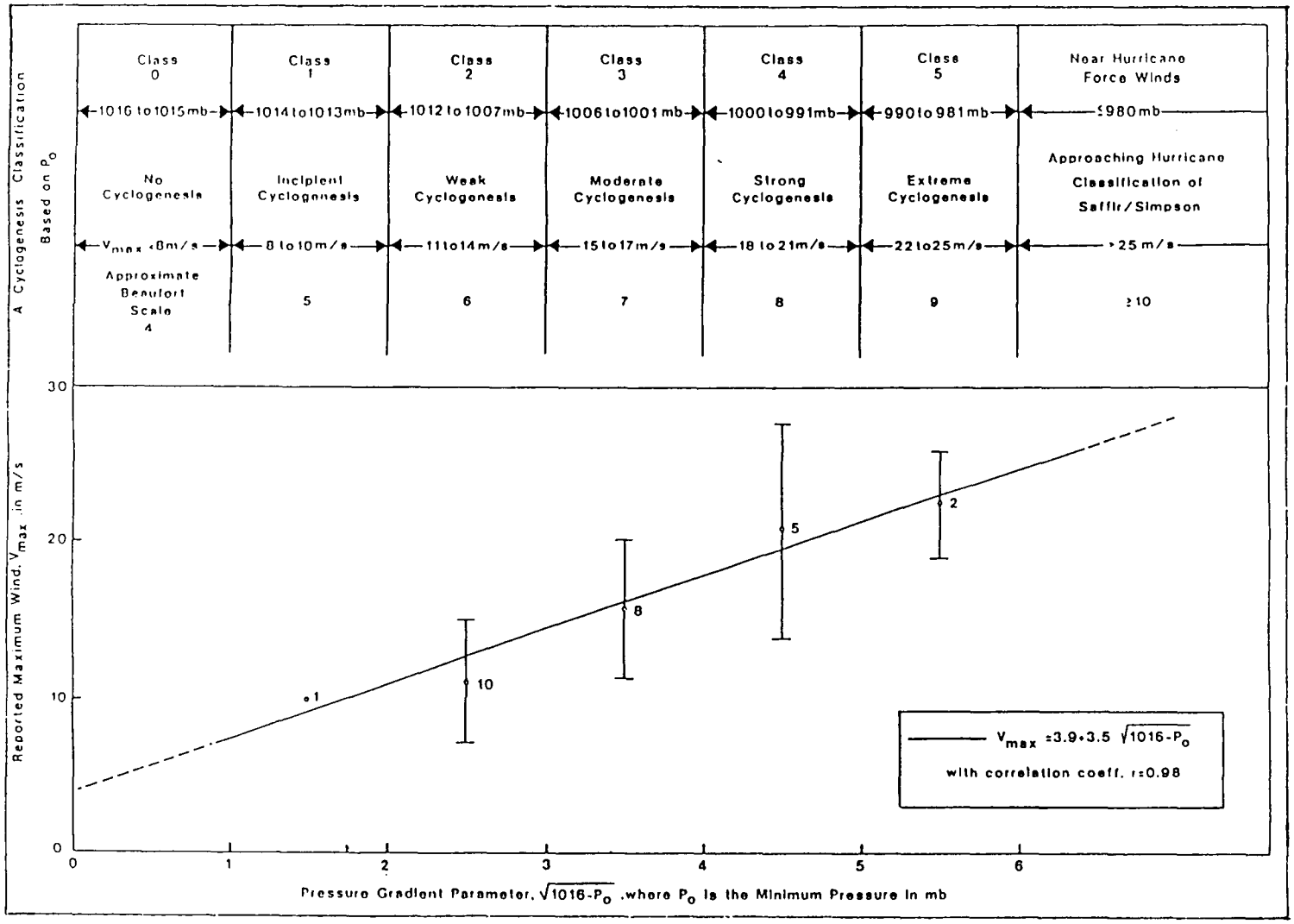


Figure 5.6.7. Winter cyclogenesis classification as devised by Hsu (1993) is based on the minimum pressure of winter storms in the Gulf of Mexico.

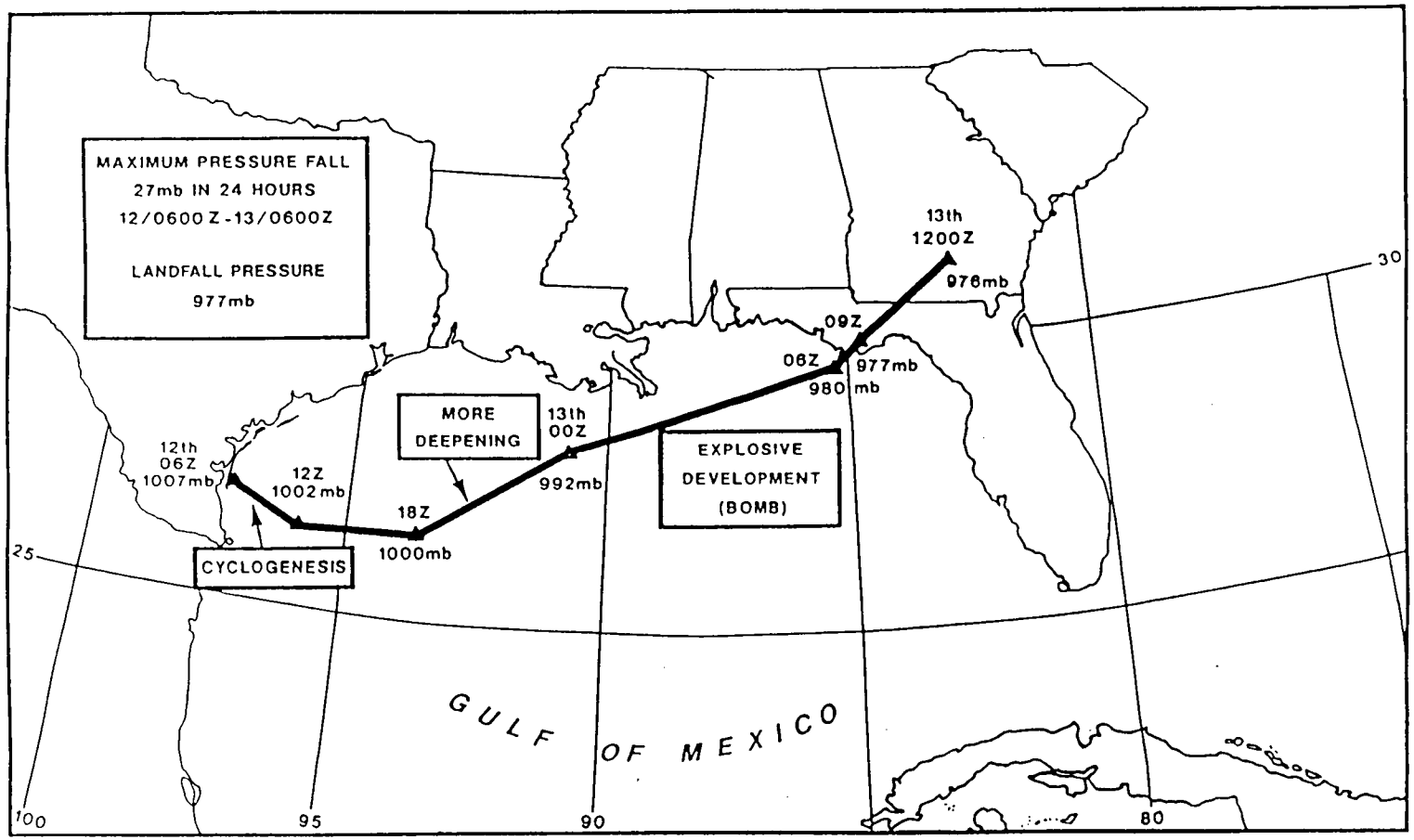


Figure 5.6.8. Storm track of the cyclone forward during 12 and 13 March 1993 over the southern LATEX region that later developed into the "Blizzard of the Century."

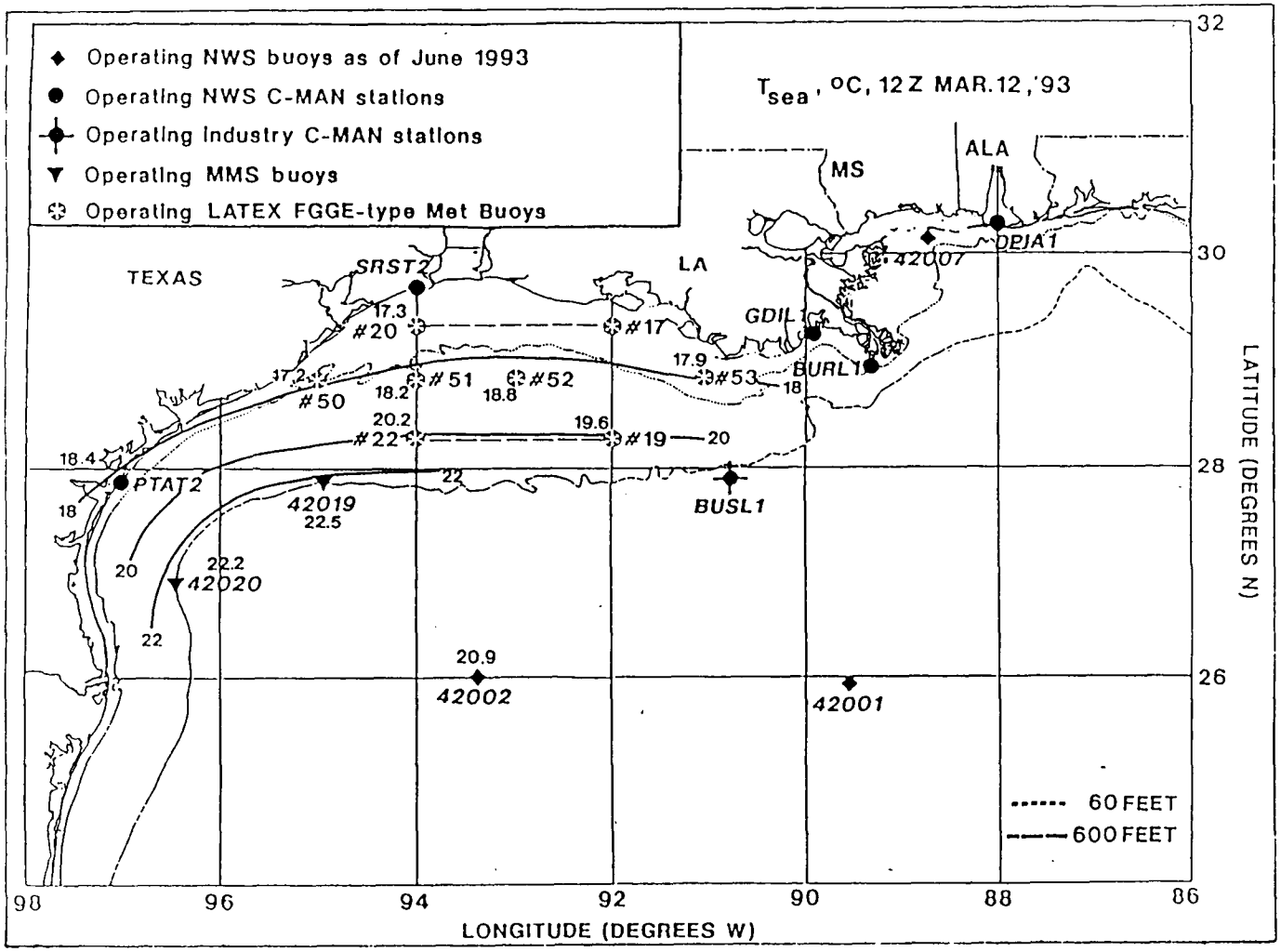


Figure 5.6.9. The distribution of the sea-surface temperature at 12 UTC on 12 March 1993 during the initial stage of the "Storm of the Century".

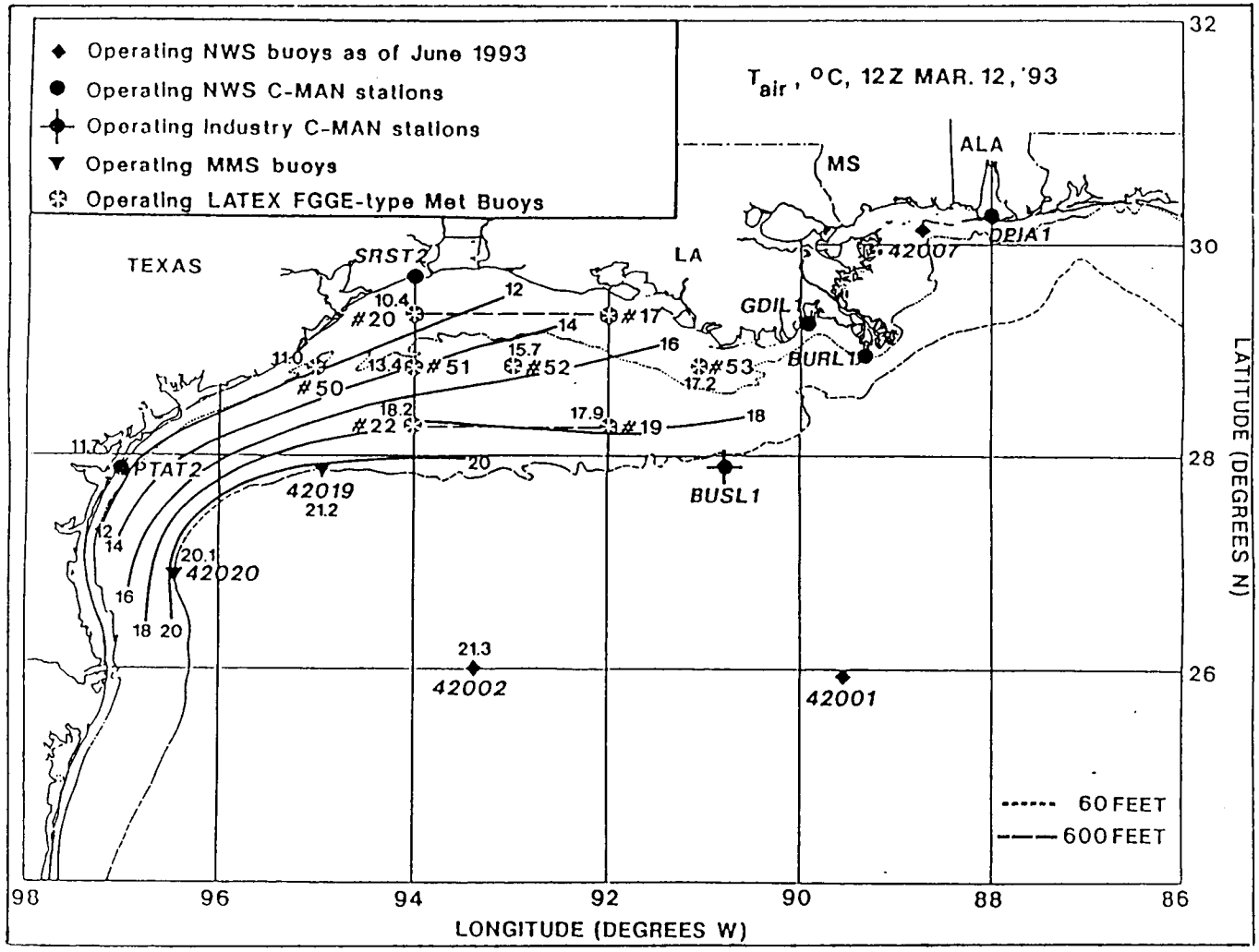


Figure 5.6.10. The distribution of the air temperature at 12 UTC on 12 March 1993 during the initial stage of the "Storm of the Century".

5.6.3 Monthly Meteorological Records

As discussed in section 2.2, LATEX A collected data from meteorological buoys at mooring locations 17, 19, 20, 22, 50, 51, 52, and 53. The relative locations are shown in Figure 2.2.1; a summary of times during which data were collected appears as Figure 2.2.6.

For each meteorological buoy for each month a figure was prepared showing time series plots of atmospheric pressure, wind speed and direction, air temperature, and sea temperature, as well as the monthly mean wind vector and the monthly means and standard deviations of atmospheric pressure, wind speed, air temperature, and sea temperature. These plots and statistics were generated from hourly data; the number of data points used is indicated on each plot. These figures will be presented in the microfiche packet that will accompany the Final Report. For months when the buoy was not deployed or no data were recovered, a figure is given without plots or statistics. Examples are shown in Figures 5.6.11 to 5.6.14.

Figures 5.6.11 and 5.6.12, from mooring locations 50 near 95°W and 53 near 91°W, respectively, illustrate the eastward progression and intensification of the class 4 cyclone generated over the Texas shelf on 12 March 1993. (See sections 5.6.2 and 5.2.1 for further discussion.) Seen are eastward increases in central low pressure and wind speed as well as delay in time of arrival.

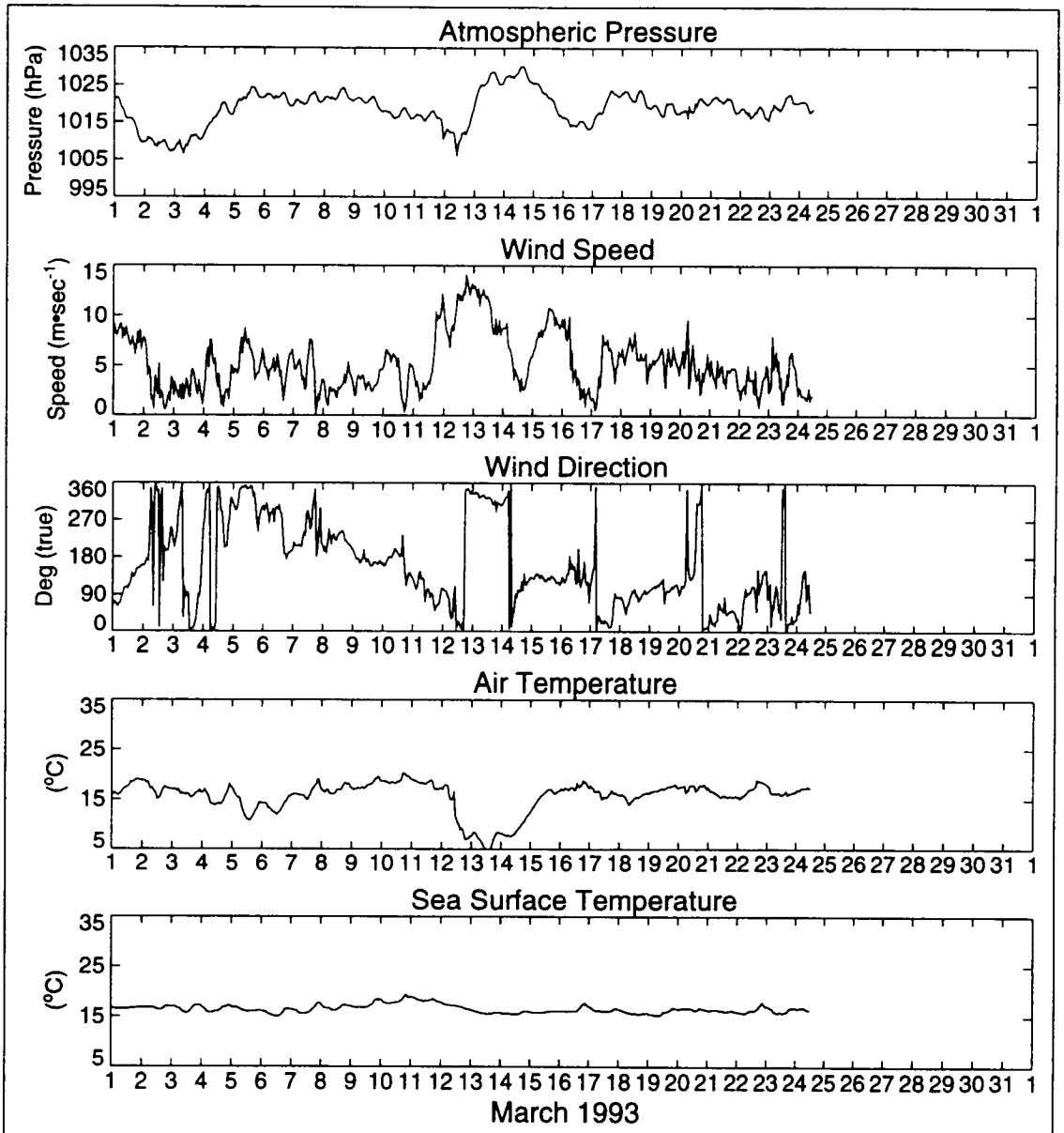
Figures 5.6.13 and 5.6.14 from moorings 17 and 19 illustrate the strength (pressure difference) and compact nature of Hurricane Andrew. Those moorings were located near 92°W at approximately 29°12'N and 28°58' N, respectively. Hurricane Andrew passed about 70 km to the northeast of mooring 17 on 26 August 1992. Note the low pressure at mooring 17 and the considerable pressure difference between records at moorings 17 and 19.

5.7 Observations/Model Comparison

A key element in the LATEX A program is to provide a setting in which relevant observational data from the components of LATEX may be compared with the results from the MMS modeling efforts directed at the Texas-Louisiana shelf and adjoining continental slope. The purpose of this observation/model comparison (Nowlin et al. 1991) is to aid in the development and validation of numerical models of shelf circulation. A long-term goal is that models and data can be used interactively via data assimilation.

During the first field year of LATEX, the MMS modeling effort was in a model development mode. Thus, no graphics from model simulations were provided to LATEX A for comparison with standard computer-produced graphics of the data.

To assist and advise in the observations model comparison effort, a team of experts in coastal physical oceanography — the LATEX Science Advisory Panel (SAP), was assembled prior to the initiation of the field program. Recommendations from the first two meetings of the SAP addressed certain aspects of the data collection strategy and identified some specific events for which model simulations should be carried out by the MMS-supported modelers.



LATEX-A Meteorological Buoy		Mean wind vector	1.4@074	
Mooring	50		mean	std. dev
Latitude	28 52.86 N	Pressure (hPa)	1018.9	4.7
Longitude	95 2.20 W	Wind Speed (m•sec^{-1})	5.2	2.8
Mast Height	3.6 m	Air Temperature (°C)	15.7	3.1
Num. of points	565	Sea Temperature (°C)	16.5	0.8

Figure 5.6.11. Time series of internally-recorded meteorological data from mooring 50 during March 1993. Data are sampled hourly.

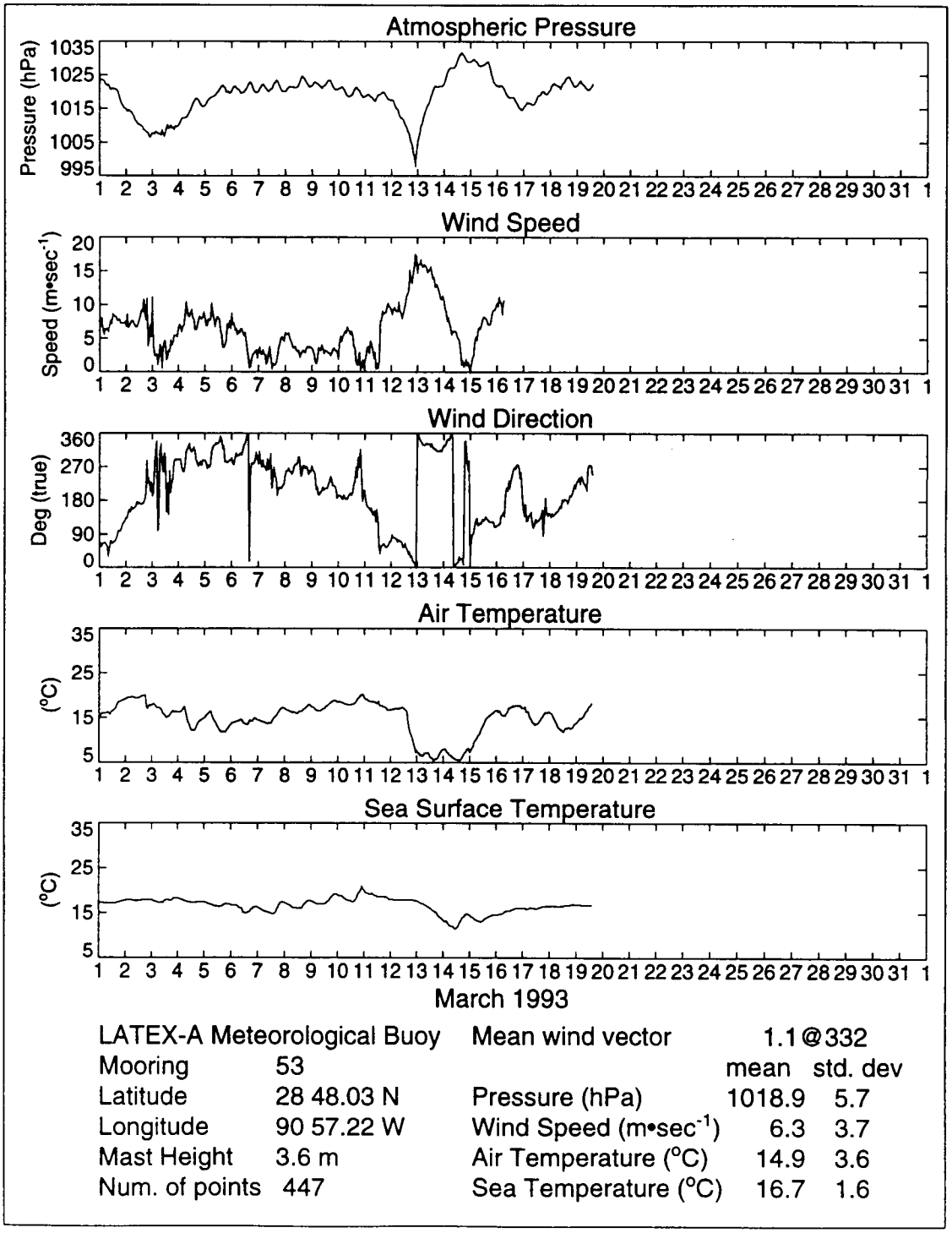
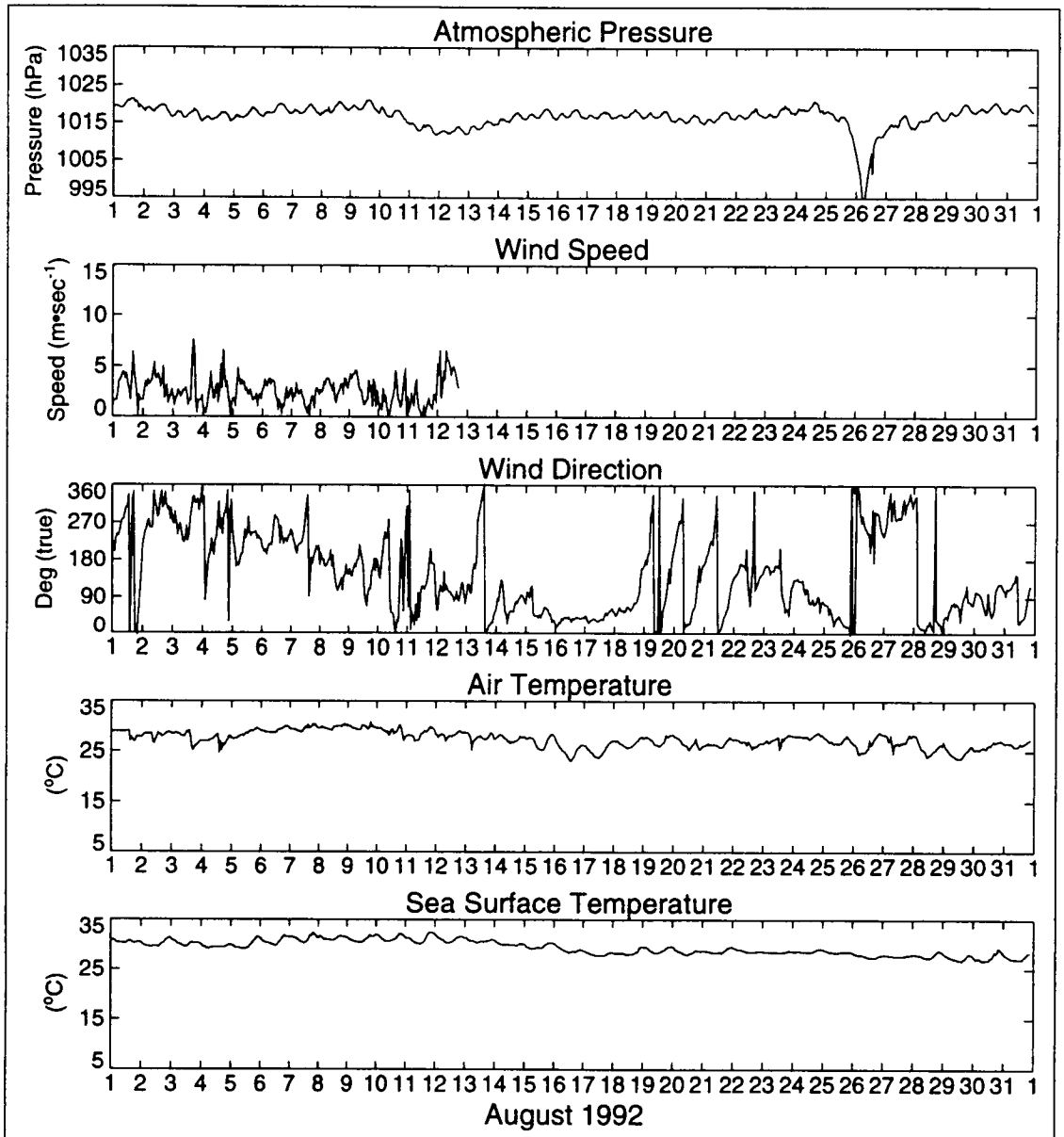
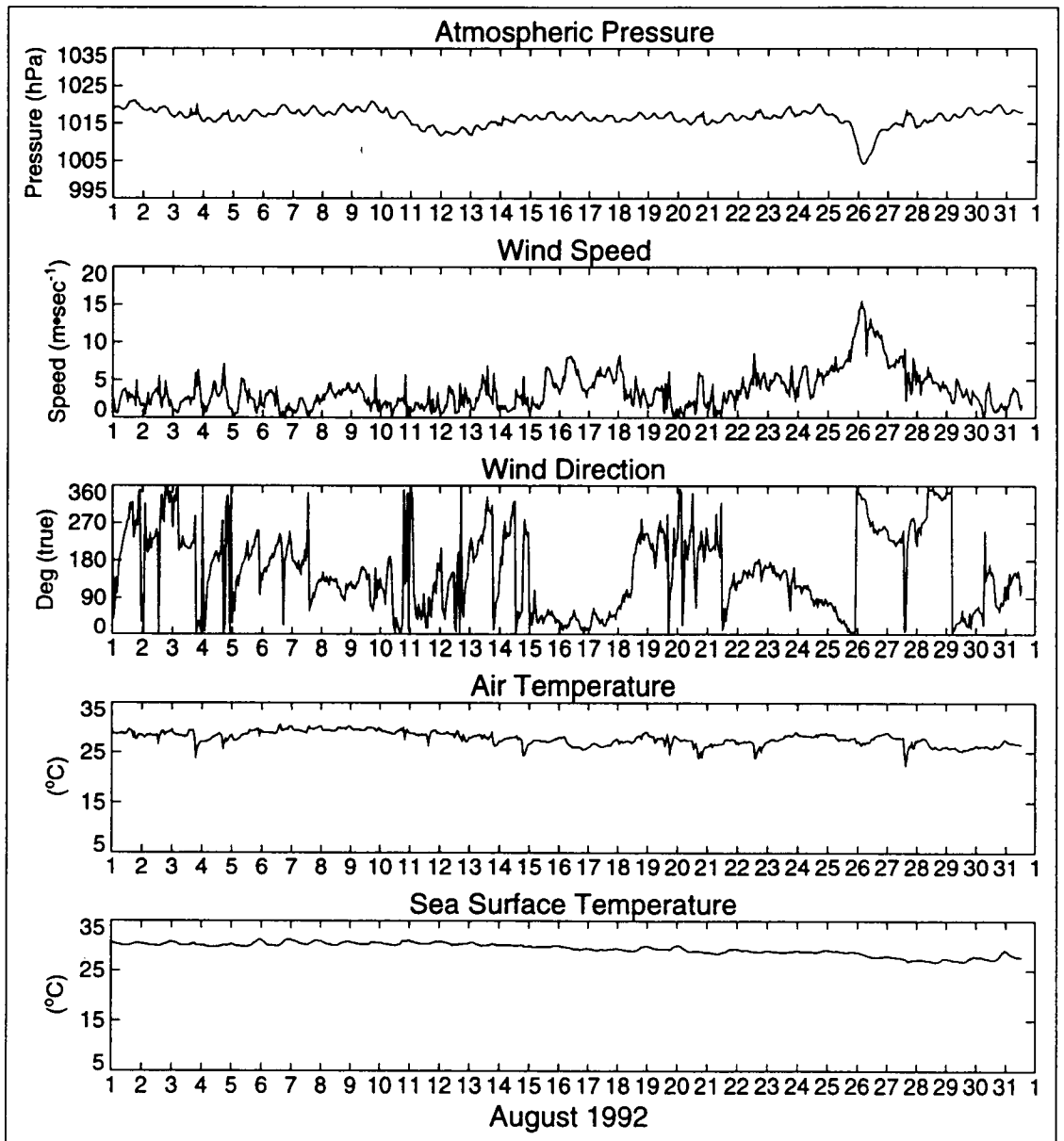


Figure 5.6.12. Time series of internally-recorded meteorological data from mooring 53 during March 1993. Data are sampled hourly.



LATEX-A Meteorological Buoy		Mean wind vector	0.8@212	
Mooring	17		mean	std. dev
Latitude	29 11.76 N	Pressure (hPa)	1016.8	3.0
Longitude	91 57.89 W	Wind Speed (m•sec^{-1})	2.6	1.4
Mast Height	3.6 m	Air Temperature (°C)	27.5	1.5
Num. of points	742	Sea Temperature (°C)	29.4	1.3

Figure 5.6.13. Time series of internally-recorded meteorological data from mooring 17 during August 1992. Data are sampled hourly.



LATEX-A Meteorological Buoy		Mean wind vector	0.4@079	
Mooring	19		mean	std. dev
Latitude	29 11.76 N	Pressure (hPa)	1016.6	2.4
Longitude	92 2.09 W	Wind Speed (m•sec^{-1})	3.6	2.5
Mast Height	3.6 m	Air Temperature (°C)	27.9	1.3
Num. of points	734	Sea Temperature (°C)	29.4	1.1

Figure 5.6.14. Time series of internally-recorded meteorological data from mooring 19 during August 1992. Data are sampled hourly.

The members of the SAP and their affiliations are listed in Table 5.7.1.

Table 5.7.1. Members of the LATEX Science Advisory Panel through 31 March 1993.

Member	Affiliation
John S. Allen	Oregon State University
John D. Cochrane	Texas A&M University
George Z. Forristall, Chairman	Shell Development Company
A. D. Kirwan	Old Dominion University
Dong-Ping Wang	SUNY - Stony Brook
Clinton D. Winant	Scripps Institution of Oceanography
William J. Wiseman, Jr.	Louisiana State University

In addition to the above contractual members, Larry Atkinson of Old Dominion University, who is a member of the MMS OCS Advisory Board's Scientific Committee, served in the role of *ex officio* SAP member. Dr. George Forristall served as SAP chairman, whose tasks included assisting with preparation of LATEX meeting agendas, presiding at SAP meetings, and formalizing the report from the SAP following its meetings.

The initial charges to the panel were:

(1) To provide scientific advice to the Program Manager of LATEX A and to the principal investigator of Task A-9 (Nowlin et al. 1991) regarding methods and evaluations of comparisons between observed data and the results of MMS-suported modeling efforts; and

(2) To provide advice to the Program Managers of all LATEX components on the conduct of the field program.

A somewhat broader interpretation of their charge by the Panel members is contained in their second report.

Two meetings of the SAP were held during the first annual report year. The first meeting was 26-29 May 1992 and the second was 1-4 December 1992, both being held in New Orleans (see section 4.4.3). The SAP sessions constituted approximately one and one half to two days at each meeting. The agendas for the SAP sessions were determined jointly by the SAP chairman, the program manager of LATEX A, and the principal investigator of Task A-9 (Nowlin et al. 1991). Each meeting included an overview of activities in the field studies and the MMS-sponsored model studies by program managers or their representatives.

In its report dated 15 June 1992, the SAP included several recommendations concerning data needs, sampling strategy, and information transfer. In particular, the SAP highlighted the need for air humidity data for quantifying latent heat exchange. It also recommended giving serious consideration to near synoptic hydrographic surveys of the whole Texas-Louisiana shelf. This recommendation was made more specific in the SAPs

second report (2 January 1993) in which shelf-wide surveys in the second year of field operations were favored over partial shelf surveys. The SAP requested sample data products at the second meeting; these were provided by all components of LATEX. The SAP also recommended maintaining the good exchange of information between modelers and observational components that occurred at the first meeting.

In its second report, the SAP identified four specific candidate events for which observational data are available and for which model simulations are needed for comparison. These are Hurricane Andrew that crossed over the easternmost mooring array in August of 1992, any one of several (recent or historical) frontal outbreak events, the 1992 spring coastal plume surveyed by LATEX B, and an eddy-shelf interaction event (Eddy Triton or Eddy Vazquez). Other LATEX II participants also recommended for simulation the translation and decay of Loop Current eddies as they transit the Gulf of Mexico.

To date, the MMS-funded modeling efforts have concentrated on medium resolution (order 20 km) experiments for the Gulf of Mexico as a whole in the attempt to reproduce realistic loop current/eddy shedding statistics, realistic eddy paths and, most important, realistic eddy size and strength upon reaching the Texas-Louisiana shelf/slope. Any realistic attempt to simulate the episodic events recommended by the SAP will require the implementation of an imbedded high resolution version of the shelf and its bathymetry.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.