NOS Oceanographic Circulation
Survey Report No. 11

Tampa Bay Oceanography Project: 1990-1991

Rockville, Maryland
July 1992

U.S. DEPARTMENT OF COMMERCE
National Oceanic And Atmospheric Administration
National Ocean Service

NOS Oceanographic Survey Report

This series of reports presents information on circulation surveys by the National Ocean Service. Normal activity includes measurements of water flow (currents), tides, temperature, salinity, and occasionally other parameters needed for understanding the physical processes. These surveys are made primarily for the Nation's navigational waterways; however, data are also obtained to describe the circulation patterns of estuaries and harbors.

These reports offer information on sampling locations, measurement techniques, processing and analysis routines, data formats, and general information on the survey area. They do not present technical interpretations of hydrodynamics of the areas.

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No. 1 Tide and Tidal Current Observations From 1965 Through 1967 in Long Island Sound, Block Island Sound, and Tributaries. Elmo E. Long, January 1978, (PB 283-849).

No. 2 Tampa Bay Circulatory Survey 1963. Demetrio A. Dinardi, August 1978, (PB 299-163).

No. 3 Puget Sound Approaches Circulatory Survey From 1973 Through 1976. Bruce B. Parker and James T. Bruce, August 1980, (PB81-113375).

No. 4 Cook Inlet Circulatory Survey: 1973-75. Richard C. Patchen, James T. Bruce, August 1980, (PB81-245-235).

No. 5 New York Harbor Circulation Survey: 1980-81. David R. Browne and Gary Dingle, February 1983, (PB83-228-635).

No. 6 Southeast Atlantic Coast Estuaries, Sapelo Sound to St. Simons Sound, Georgia Circulation Survey: 1980. William A. Watson, January 1984, (PB86-120433).

No. 7 San Francisco Bay Area Circulation Survey: 1979-80. Joseph M. Welch, Jeffrey W. Gartner, and Stephen K. Gill, November 1985, (PB87-107181).

No. 8 Chesapeake Bay Circulation Survey: 1981-83. David R. Browne and Carl W. Fisher, December 1986 (PB87-138194).

No. 9 Delaware River and Bay Circulation Survey: 1984-85. Alan S. Klavans, Peter J. Stone, and Gina A. Stoney, December 1986.

No. 10 Long Island Sound Oceanography Project: 1988-1990. Karen L. Earwaker, November 1990.

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Tampa Bay Oceanography Project: 1990-1991

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U.S. DEPARTMENT OF COMMERCE
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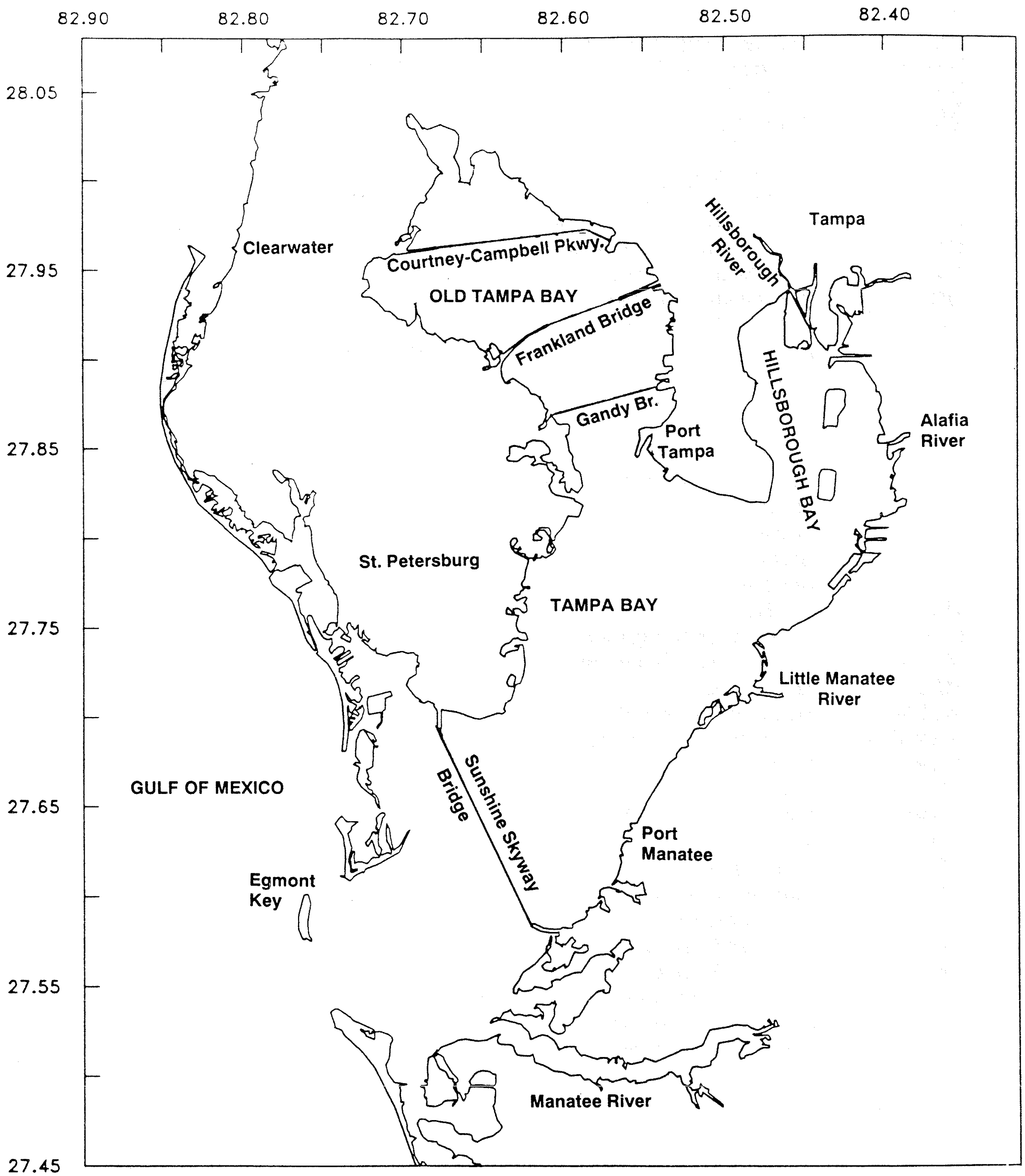
FIGURES

ACRONYMS

ADCP	Acoustic Doppler Current Profiler
ADR	Analog to Digital Recorder
ASCII	American Standard Code for Information Interchange
ATBM	Agency for Tampa Bay Management
ATDPS	Automated Tidal Data Processing System
ATON	Aids to Navigation
BMC	Boatswain's Mate Chief
CEOB	Coastal and Estuarine Oceanography Branch
CT	Conductivity-Temperature
CTD	Conductivity-Temperature-Depth
CWO	Chief Warrant Officer
DQA	Data Quality Assurance
DQC	Data Quality Control
DTNSRDC	David Taylor Naval Ship Research and Development Center
DR	Direct Reading
EOPB	Estuarine and Ocean Physics Branch (now CEOB)
EPROM	Erasable, Programmable Read-Only Memory
ETG	Electronic Tape Gage
FDNR	Florida Department of Natural Resources
FIO	Florida Institute of Oceanography
FY	Fiscal Year(October 1 to September 30)
GPS	Global Positioning System
HP	Hewlett-Packard
kHz	KiloHertz
LORAN	Long Range Navigation
MAID	Marine Analysis and Interpretation Division
MET	Meteorological
MLLW	Mean Lower Low Water
NAVSTAR	Navigation System Using Time and Ranging
NGWLMS	Next Generation Water Level Measurement System
NM	Nautical Mile
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWLON	National Water Level Observation Network
OES	Office of Ocean and Earth Sciences
OLLD	Ocean and Lake Levels Division
OMA	Office of Marine Assessment
OSDG	Ocean Systems Development Group
POD	Physical Oceanography Division
PORTS	Physical Oceanographic Real-Time System
QA	Quality Assurance
QC	Quality Control
R/V	Research Vessel
SBE	Sea-Bird Electronics, Inc.
SN	Serial Number
STAS	Science and Technology Applications Section
SWIM	Surface Water Improvement and Management
TOP	Tampa Bay Oceanography Project
USCG	United States Coast Guard
USF	University of South Florida



Base map showing locations mentioned in this report

ABSTRACT

The National Ocean Service (NOS) planned and conducted the Tampa Bay Oceanography Project (TOP) in response to mariners' observations that NOAA's tide and current predictions did not reflect actual conditions experienced at certain locations in the Bay. The results of a preliminary project to evaluate the quality of the existing predictions confirmed that improved information was required. A detailed physical oceanographic field study was conducted in Tampa Bay and the adjacent Florida shelf from May 1990 to October 1991. The physical oceanographic and meteorological properties that were measured include: currents, water levels, water temperature, salinity, conductivity, wind speed and direction, and atmospheric pressure. These measurements were used in the calibration and validation of the 3-dimensional numerical circulation model and in revising the NOAA Tide and Tidal Current Tables. Another major component of TOP was the establishment of the Nation's first fully integrated physical oceanographic real-time system (PORTS), which includes information on currents, water levels, bottom temperature, and winds at critical locations.

1.0 INTRODUCTION

NOS conducted a 15-month circulation survey of Tampa Bay as part of the Tampa Bay Oceanography Project (NOS 1990A). This project was undertaken in response to mariner's observations that the existing NOAA tidal current predictions for Tampa Bay did not reflect actual conditions at certain locations in the Bay. Tampa Bay Entrance was established as a tidal current reference station in 1950 based on observations of 1948-50. Daily tidal current predictions are given for the reference station and predictions at secondary stations in the Bay are referred to these. Dinardi (1978) described an extensive NOS circulation survey of the Bay in 1963. Data from the 1963 survey were used for revising the existing NOAA Tidal Current tables and in developing the Tidal Current charts for Tampa Bay. Since the 1963 survey, the construction of Port Manatee and its approach channels, dredge depositions, natural shoaling, and construction of the Sunshine Skyway Bridge have changed the shape of the basin and altered the circulation in the Bay. The NOAA tidal current table predictions were no longer valid at certain locations in the Bay because of these natural and manmade changes. In response to concerns expressed by the U.S. Coast Guard (USCG) and the Tampa Bay Pilots Association, NOS conducted interviews with the maritime community to assess the degree of uncertainty in using predictions based on 1963 data. As a result of these interviews and first hand observation, NOS initiated a Quality Assurance (QA) Miniproject to assess the validity of the 1963 predictions. Complete results of the QA Miniproject were published in a NOAA Technical Memorandum (Williams et al., 1989). The QA miniproject confirmed the mariner's concerns, and as a result, a major three component project was undertaken.

The major components of TOP include:

1. An intensive 15-month circulation survey of currents, water levels, water temperature, salinity, winds, and other meteorological parameters that began in June 1990. This circulation survey is described in detail in this report. Progress was reported regularly during the course of this survey (NOS, 1990 and Hess, 1992).

2. Development and application of a three-dimensional, time varying, curvilinear-grid numerical circulation model (Hess and Bosley, 1992).

3. Installation of the Nation's first fully integrated physical oceanographic real-time system (PORTS), which incorporates information on currents, water levels, bottom temperature, and winds at locations where these data are critical for safe navigation (Bethem and Frey, 1991; also Appell, 1991).

The study area for this circulation survey included all of Tampa Bay, from the mouth of the Bay at Egmont Key to the northern tip of Hillsborough Bay and Old Tampa Bay, a total surface area of 1,031 square kilometers. Stations were also located in the waters of the west Florida shelf in the Gulf of Mexico.

This circulation survey report describes the work performed, instruments used, and data retrieved during TOP. Personnel from the NOS, Coastal and Estuarine Oceanography Branch (CEOB) made 15 trips to deploy, inspect, and retrieve various instruments and equipment. In the course of the circulation survey, current data were collected at 42 locations, water level data were collected at 16 locations, meteorological data were collected at five locations, and water temperature and conductivity data were collected at three locations. In addition to the time series data, four sets of current profiles were made along five different transects and five sets of CTD (conductivity, temperature and depth) profiles were made along six different transects.

Data and information products resulting from the TOP field measurements will include (1) updated Tidal Current Tables, (2) updated Tide Tables, (3) development and validation of a circulation model of Tampa Bay, (4) production of a Tidal Circulation Atlas, and (5) reports on tidal circulation, water levels, model validation, data synthesis, PORTS, and physical oceanography of Tampa Bay.

2.0 MEASUREMENTS

TOP required the deployment of a wide range of meteorological and oceanographic instruments. Figure 1 depicts most of the oceanographic instruments used in these measurements. Specific variables that were measured include: surface and sub-surface currents, water levels, water temperature, salinity, conductivity, pressure, winds, atmospheric pressure, oxygen content, and light transmittance in water. The data gathered by these measurement systems are being analyzed and implemented in various NOS products including the tide and tidal current predictions, numerical circulation modeling, and tidal current atlas.

Logistic support for the field measurement parties was provided on a contractual basis by the Florida Institute of Oceanography (FIO) at St. Petersburg. Support was also provided by the USCG Group St. Petersburg, particularly for work on the PORTS aspect of the project. FIO provided two research vessels, the 90-foot-long R/V BELLOWS and the 102-foot-long R/V SUNCOASTER, which conducted the major portion of TOP work, including platform deployment and recovery, ADCP tows, and CTD transects. In addition, the Florida Department of Natural Resources' (FDNR) 110-foot-long R/V HERNAN CORTEZ performed one set of deployment/recovery operations, the NOAA Ship FERREL performed one set of ADCP tows and CTD transects, and the USCG Buoy Tender WHITE SUMAC provided ship support for the installation, inspection and, retrieval of the PORTS units.

Divers were utilized to deploy, locate, inspect, and retrieve the bottom-mounted instruments. Early in the project, NOAA divers from the Ocean and Lake Levels Division (OLLD) provided this service. Later, Dive-Tech Incorporated of Largo, Florida provided this service.

2.1 Current Measurements

The primary instrument used by CEOB to measure currents is the Acoustic Doppler Current Profiler (ADCP) system, manufactured by RD Instruments of San Diego, CA. This system uses the Doppler shift to measure the speed and direction of the currents through the water column (RD Instruments, 1988 and 1989). These units are deployed in an upward-looking mode on the bottom and are mounted in special platforms designed for instrument protection and leveling. The ADCP operates by transmitting a succession of acoustic pulses and segmenting the resulting backscattered water mass echoes into as many as 128 depth cells over ranges that vary with frequency of the ADCP. ADCP units operating on one of three frequencies were deployed during the TOP field program: five 1200-kHZ units (range up to 30 meters); two 600-kHZ units (range up to 60 meters); and one 300-kHZ unit (range up to 120 meters). The ADCP has a velocity range of +- 10 meters per second and long term theoretical accuracy of +- 0.5 centimeters per second according to manufacturer's specifications. NOS personnel performed calibrations on the ADCPs as a data quality control (DQC) function. Appendix D contains calibration information.

The 1200-kHZ ADCP recorded data at 1-meter increments for 10-minute intervals beginning about 0.5 meter above the transducer head. The 600-kHZ ADCP also recorded data at 1-meter increments and 10-minute intervals beginning at 1.0 meter. The 300-kHZ unit recorded data beginning about a meter above the transducer assembly and was set to record 2-meter increments. For each ADCP deployment, a pings-per-ensemble rate was set to specify the number of return signals that were

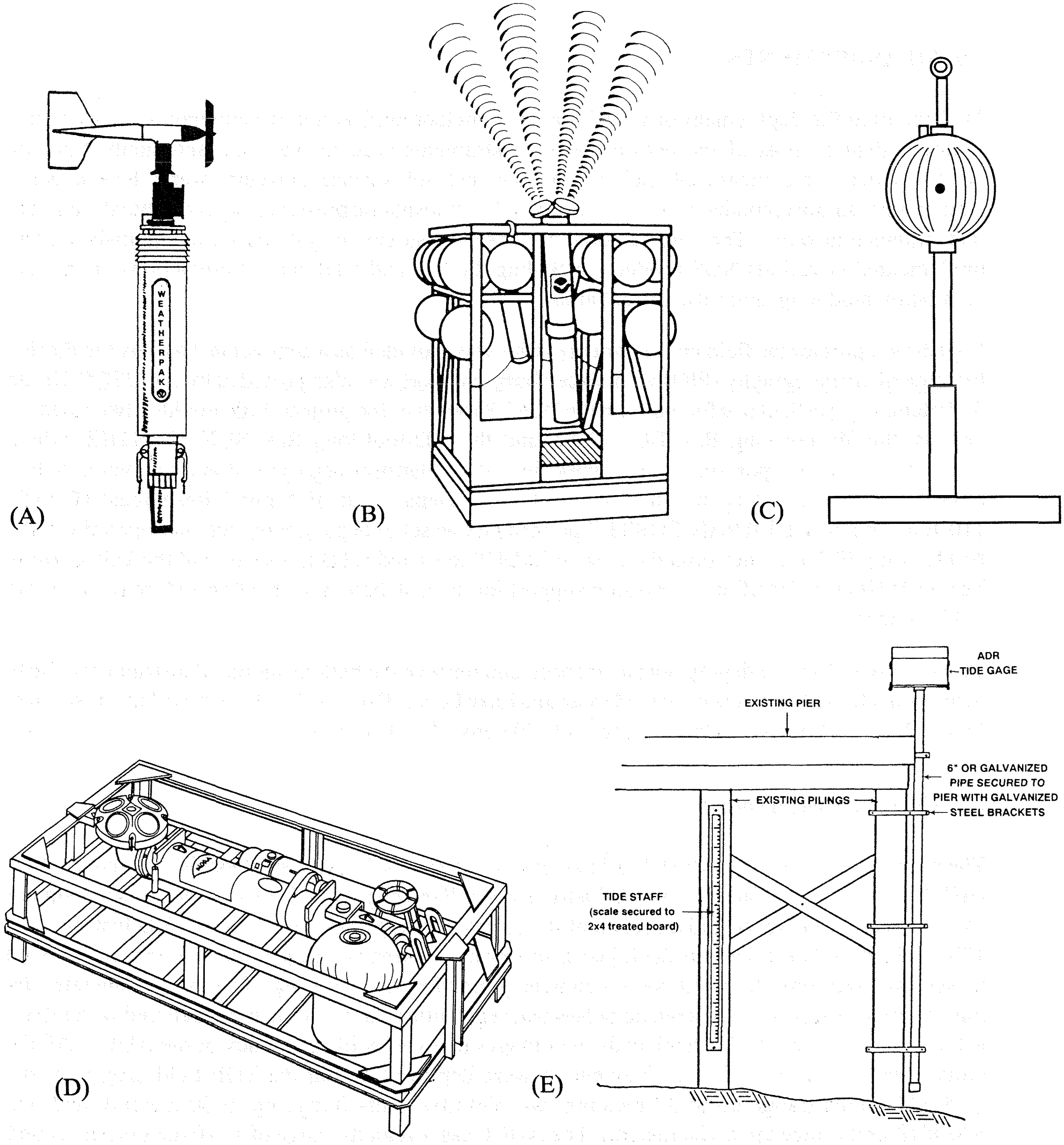


Figure 1a. Diagrams of instrument deployment platforms (not to scale)
(A) Meteorological Station
(B) ADCP Deep Water Platform
(C) S-4 Current Meter
(D) ADCP Shallow Water Platform
(E) Water Level Station

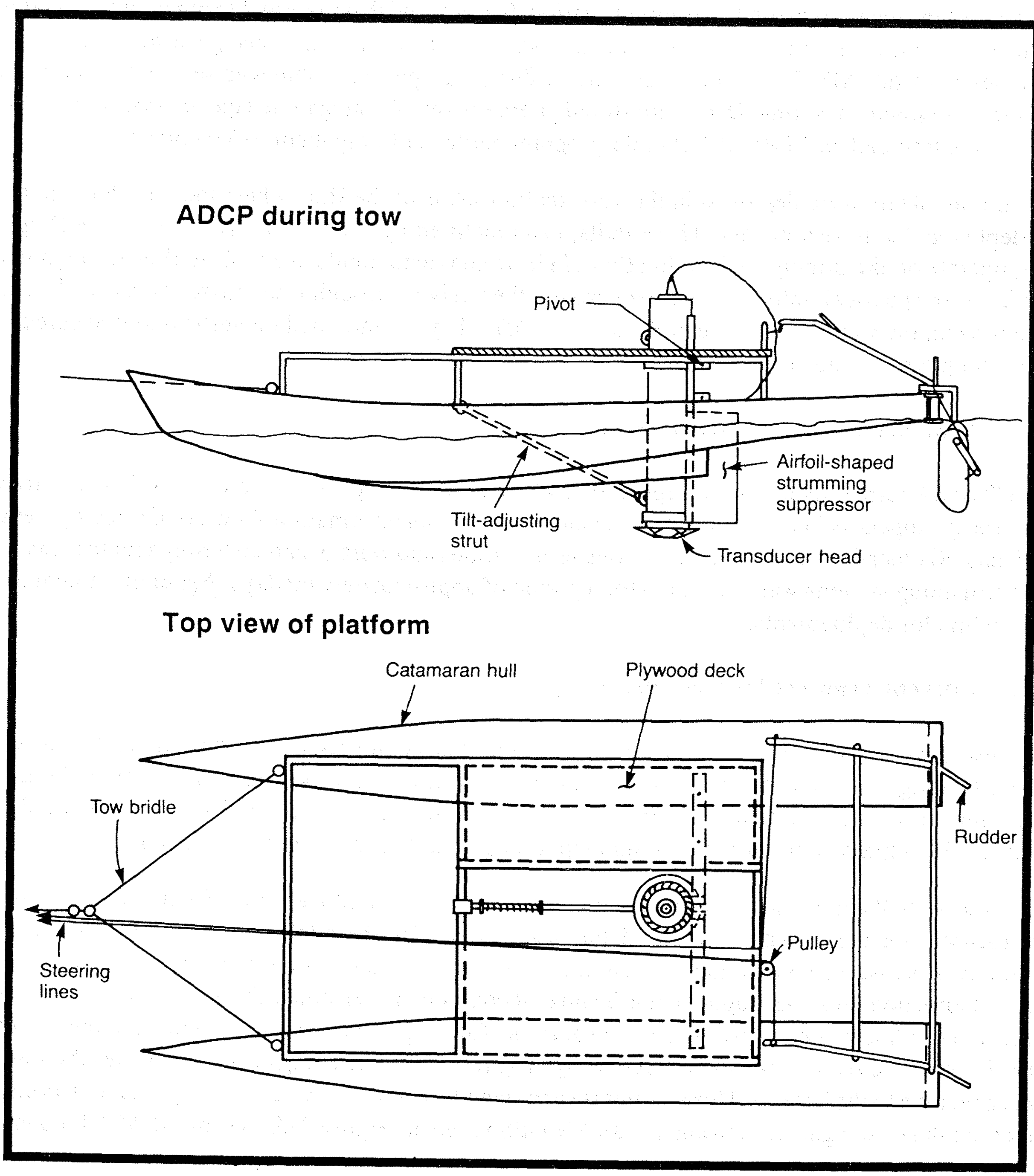


Figure 1b. Schematic (a) side view of the towed ADCP unit in the catamaran, and (b) plain view of the catamaran configuration

averaged to create a 10-minute sample. The original setting of 585 pings-per-ensemble averaged roughly 1 ping per second for the 10-minute period. It was found that a rate of 285 pings-per-ensemble resulted in significant battery power and memory savings with only a slight change in the performance parameters of the ADCP. Therefore the rate of 285 pings-per-ensemble was selected as the most efficient deployment setting. Data were stored internally on a 60-megabyte tape recorder drive. One 1200-kHZ unit had an EPROM (erasable-programmable read-only memory) recorder.

S4 current meters were deployed in the very shallow areas of the Bay, where the ADCP could not be deployed due to risk of loss. These units, manufactured by InterOcean Systems of San Diego, CA, operate on the principle of modulation of electromagnetic fields due to fluid flow through this field. These spherical units create a field around themselves through four anodes at cardinal point locations on the sphere (InterOcean Systems, 1990). They are mounted on vertical rods secured to a bottom platform and cement anchor.

2.1.1 Time-Series Current Measurements

ADCP or S4 current meters were deployed at 42 locations during the 15-month TOP field program (Figure 2). Appendix B contains station positions and further information about ADCP deployments and data. Six locations were selected as long term stations and were occupied throughout the survey. The remaining stations were occupied for a period of approximately 60 days. Appendix A contains a time line for deployments.

2.1.2 Current Transect Measurements

The towed ADCP system was used for current transect measurements. During the transect a 600-kHZ direct-reading (DR) unit mounted on a catamaran in a downward-looking configuration obtained real-time current information of a vertical slice of the water current column. Data were recorded on a ZEOS 386 laptop computer via a single input/output cable connected to the ADCP unit.

In towed ADCP applications, instrument motion must be taken into account. Pitch and roll sensors compensate for the change in angle of the beam caused by the pitch and roll of the catamaran. Velocity is measured relative to the orientation of one of its beams. An internal compass rotates the current direction into true magnetic north and east components, enabling the ADCP to transmit data in earth coordinates rather than beam coordinates. The ship's speed is subtracted from the current profile data. The ADCP transmits a second signal (the bottom track ping) which measures the ship's speed relative to the bottom. This amount is subtracted from the raw water velocity data. Positioning and time data were gathered using a LORAN/GPS receiver. Figure 3 shows towed ADCP transect locations.

2.2 Conductivity, Temperature, and Depth Measurements

2.2.1 Fixed CT and CTD Measurements

CT and CTD data were collected at three fixed stations: S-1 in outer Egmont Channel, S-2 near Port Manatee Channel, and S-3 in lower Hillsborough Bay. A CT (conductivity/temperature) sensor or

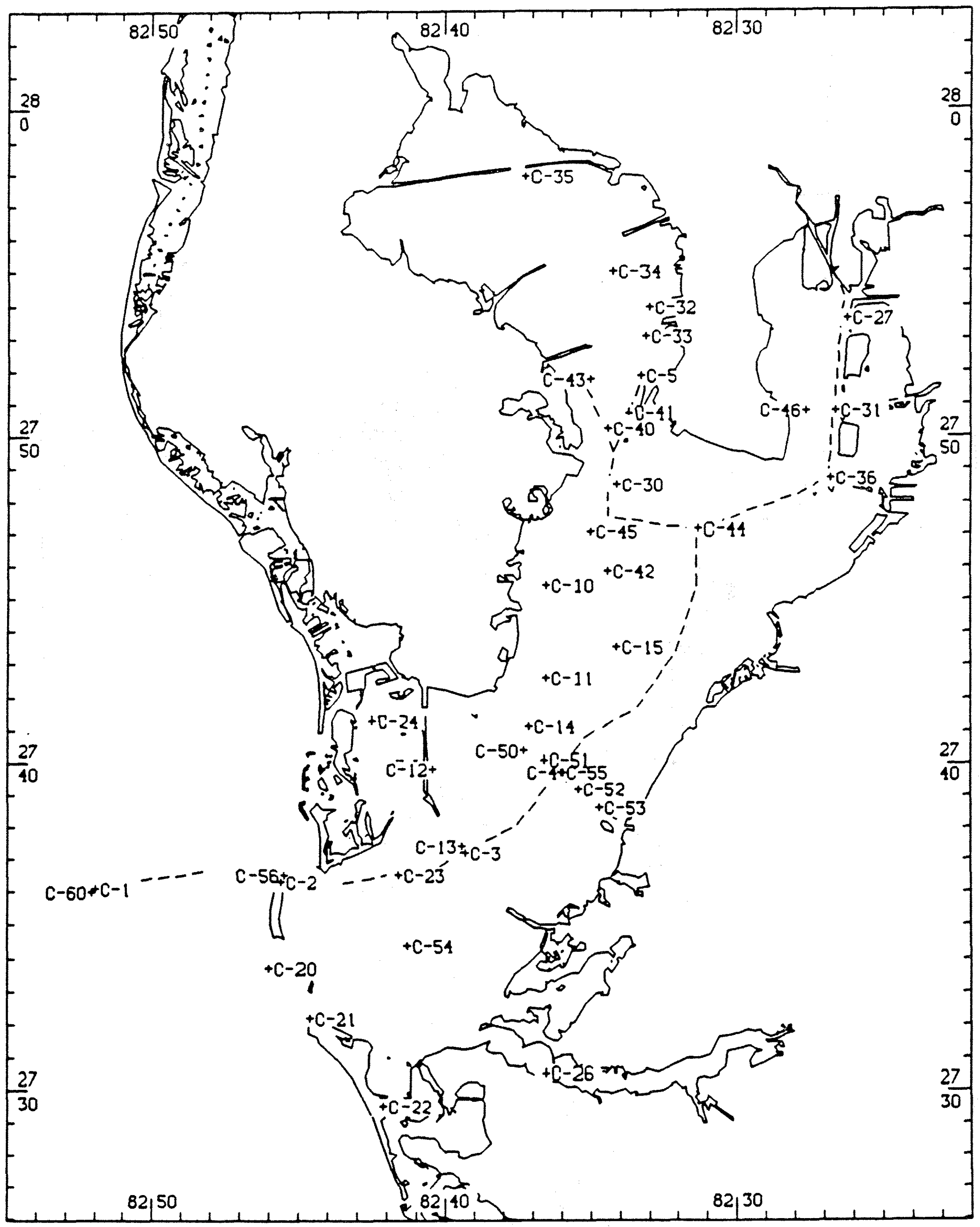


Figure 2. Location of TOP current meter station (denoted by the letter "C"). Dashed line indicates main shipping channel

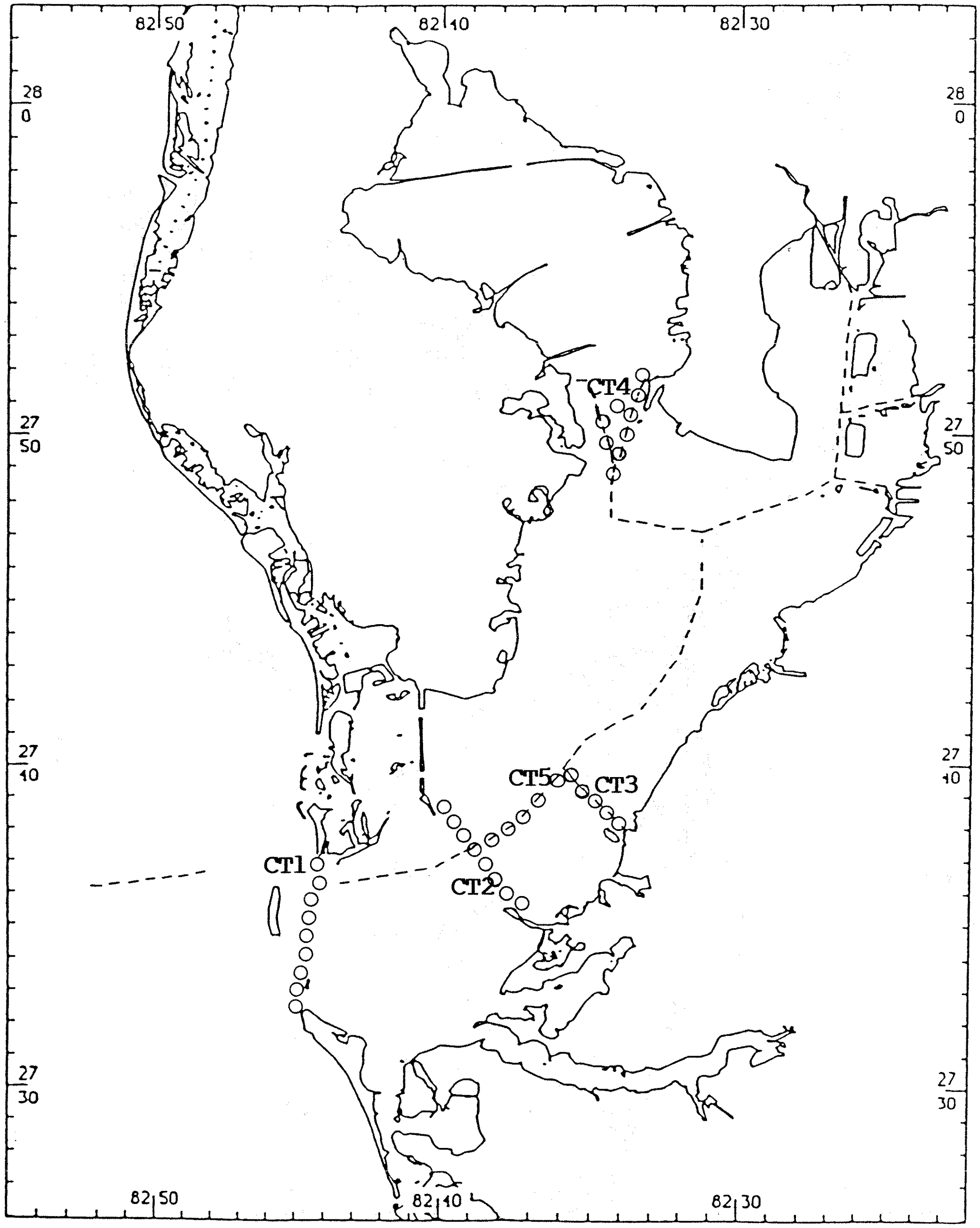


Figure 3. Towed ADCP Transect stations, denoted by a series of "ooo". Dashed line indicates main shipping channel

CT1 - Egmont Channel
CT2 - Parallel New Sunshine Skyway Bridge
CT3 - Port Manatee
CT4 - Port Tampa
CT5 - New Sunshine Skyway Bridge to Manatee Channel

a CTD (conductivity/temperature/depth) sensor was also mounted on ADCP and S4 platforms deployed for current measurements. (Figure 4 shows locations of all CT and CTD stations). The Sea-Bird SBE 19 and SBE 16 sensors were used. Data recorded internally on solid state recorders in each instrument were downloaded in the field to lap-top computers and saved on diskette. See Appendix B, Table IV, for CT and CTD data inventory.

The NOAA Northwest Regional Calibration Center provided pre-survey and post-survey laboratory calibrations for CTD and CT sensors. Appendix E includes an example of a CTD/CT calibration report. Eight CTD/CT units received mid-project calibrations.

2.2.2 CTD Profile Measurements

CTD profiles were obtained along six transects during slack water at approximately 3-month intervals. Station locations were spaced at 0.5-to 2.0-kilometer intervals (Figure 5). The profiling instrument, a Sea-Bird SBE 9 CTD system, was fitted with a Sea Tech, Inc., 25-cm transmissometer, for measuring light transmissivity, in addition to the standard sensors. Real-time data acquisition was accomplished using an RS-232 interface between the SBE 11 deck unit and an IBM-PC compatible computer. The manufacturer's SEASOFT software package was used for retrieval, processing, display, and archiving of the data.

At the start of a transect, the unit was lowered to 1 meter below the surface and allowed to acclimate for 1 minute. After software initialization, including logging of station position and name, the instrument was lowered at a constant speed of 1 m/s until it was positioned 1 meter above the bottom as determined by the ship's fathometer and the Sea-Bird pressure sensor. The unit was then raised at the same speed. See Appendix B, Table V, for further information about CTD data.

2.3 Water Level Measurements

Water level data were collected at two continuously-operating stations (E-520, E-724); five long-term stations (E-364, E-384, E-537, E-657, and E-689); one 12-month station (E-347); and eight short-term stations (E-217, E-243, E-273, E-428, E-858 in the first set of deployments, and E-641, E-667, and E-738 in the second set). Locations are shown in Figure 6. Florida Department of Natural Resources (FDNR) personnel performed routine operation and maintenance of the 14 non-continuous stations through a cooperative agreement with NOS/OLLD. Stations E-520 and E-724 were operated and maintained by a private contractor, Chapin and Associates Inc., under contract to NOS.

The two primary stations (i.e., having records at least 19 years long) at Clearwater Beach (E-724) and St. Petersburg (E-520) are part of the National Water Level Observation Network (NWLON) and collect water level data continuously to support a variety of State and Federal programs. These stations provide the necessary control for tidal datum computation at the tertiary stations (i.e., being in place for more than 30 days but less than a year) and provide information on long-term sea level variations. The gages at the two NWLON stations are contained in a small house and include a backup pressure recorder in addition to the ADR. The station at Clearwater Beach uses an electronic tape gage (ETG) instead of a tide staff. The NGWLMS station at St. Petersburg is configured with specialized data transmission equipment for use with the PORTS.

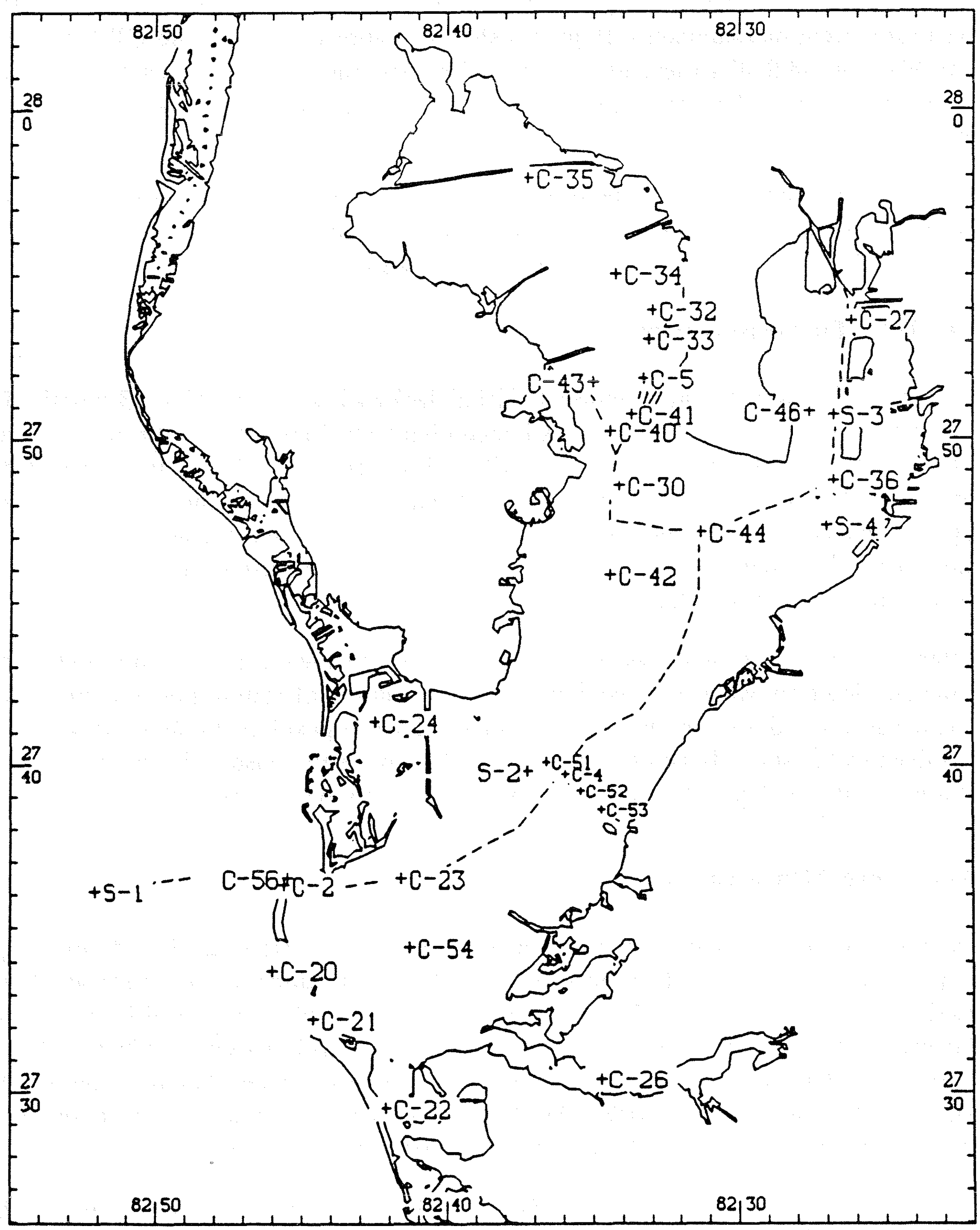


Figure 4. Location of fixed CTD stations. Moorings with a near-surface and a near-bottom CT are denoted by an "S". Bottom-mounted CTs (associated with current meter platforms) are denoted by a "C"

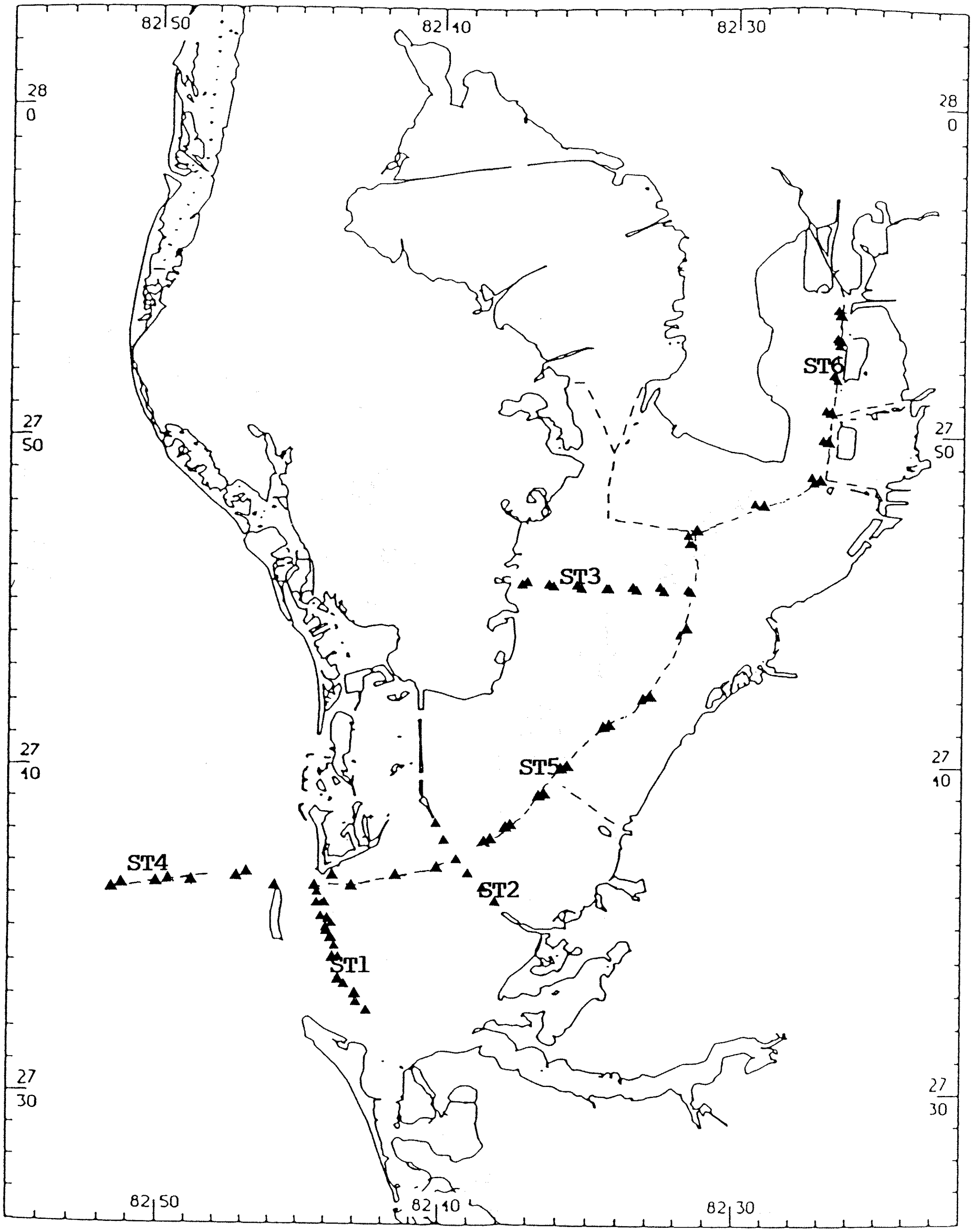


Figure 5. Locations of CTD transect stations, denoted by a series of "▲▲▲"
ST1 - Mouth of Bay
ST2 - Skyway Bridge
ST3 - Mid Bay
ST4 - Egmont Channel
ST5 - Mid Bay Channel
ST6 - Hillsborough Bay

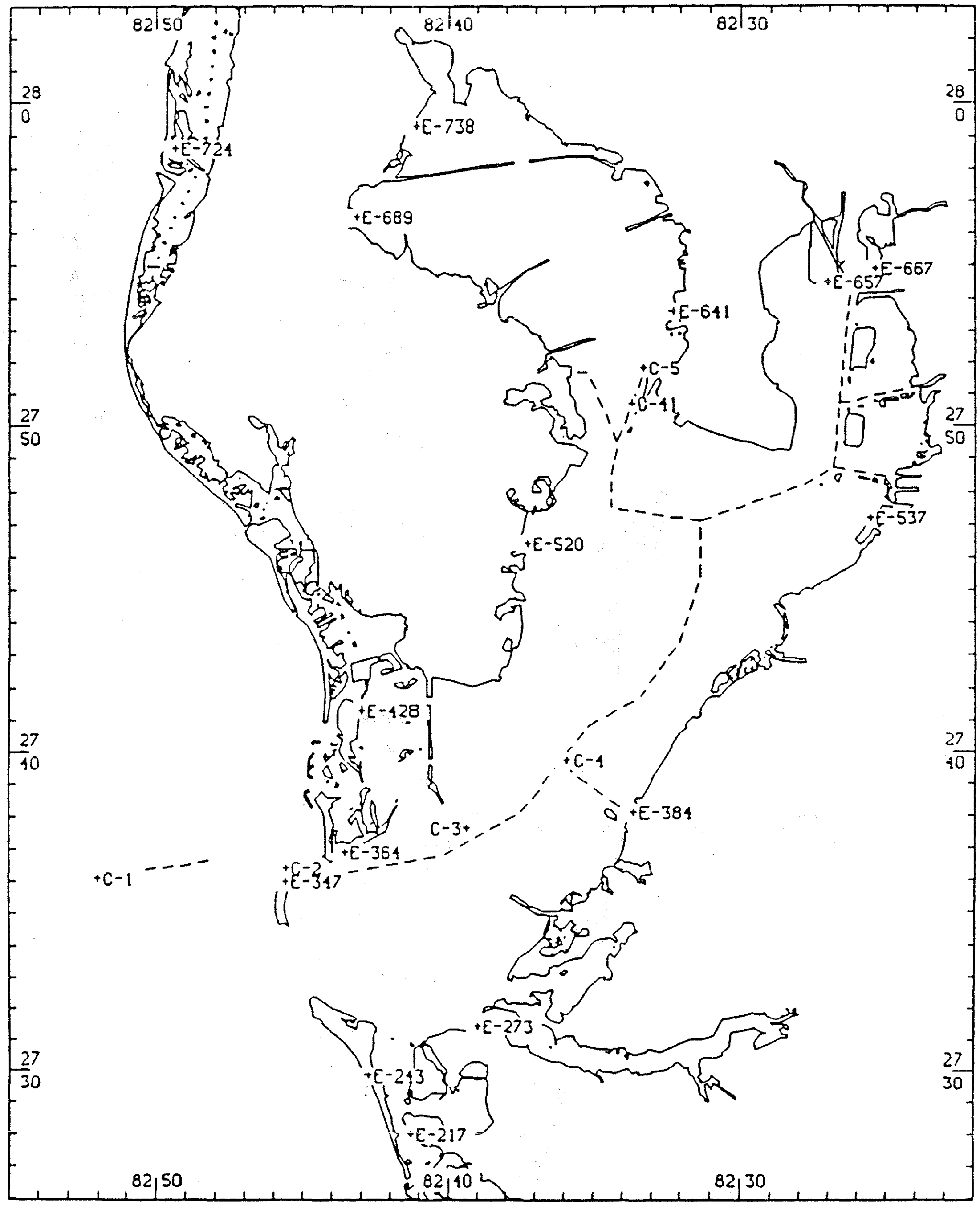


Figure 6. Location of water level stations. Shore-based measurement stations are denoted by an "E", and bottom-mounted pressure measurement stations (locations on current meter platforms) are denoted by a "C"

The Aquatrak Model 3000-NG acoustic sensor is the water level measurement sensor for NGWLMS. The St. Petersburg water level station is this type. As part of NOS's data quality program, each acoustic sensor was calibrated prior to deployment. Sensors which were installed in the field were replaced on an annual basis and returned for calibration to the Ocean Systems Development Group (OSDG) laboratory in Rockville. The sensor is a downward-looking acoustic transducer that sends a shock wave of energy down a half-inch-diameter plastic sounding tube and measures the two way travel time for the reflected signals from a calibration reference point and from the water surface. The calibration signal provides the sensor with a means of correcting each water level measurement for variations in sound speed due to changes in temperature and humidity.

The additional 14 stations were selected based on requirements of the numerical circulation model, variations in tidal characteristics in the estuary, and feasibility of installation.

The basic station components for the 14 short term stations consisted of a tide gage, tide staff, and a network of a minimum of five permanent bench marks. The analog-to-digital recorder (ADR) gage was secured to the top of a 6-inch-diameter stilling well and protected by a steel weatherproof cover. It is float-driven and produces a punched paper tape output using a 6-minute electronic timer. The tide staff was made of sections of vitrified steel scale screwed to a backing board that was bolted to a pier piling or stringer. The tide staffs were vertically referenced to the network of bench marks by differential leveling upon installation and removal of the gages. This procedure verified datum stability for the period of record. Figure 1 (E) depicts a typical station.

Appendix B, Table II, lists the station numbers, names, dates of occupation, and status of data.

2.4 Meteorological Measurements

WeatherPak meteorological stations manufactured by Coastal Climate Co. of Seattle, WA., provided wind speed, wind direction, atmospheric pressure, and temperature measurements. These internally-recording data collection packages each consist of an anemometer, a compass, a barometer, and a temperature sensor. Instruments were deployed at Egmont Key (M-1), Hillsborough Bay (M-4), and south of the Inter Bay peninsula (M-3), in November 1990. The station in Old Tampa Bay (M-5) was installed in March 1991. Station M-2 near Port Manatee channel was deployed in June 1990, and serves as the PORTS meteorological station. Meteorological stations are shown in Figure 7. Additional sensors for solar radiation and relative humidity were deployed at M-2. In May 1991, a solar panel and a voltage regulator were installed on all four internally recording stations. This modification eliminated the need for frequent replacement of the Weatherpak batteries. A meteorological station is shown in Figure 1 (A).

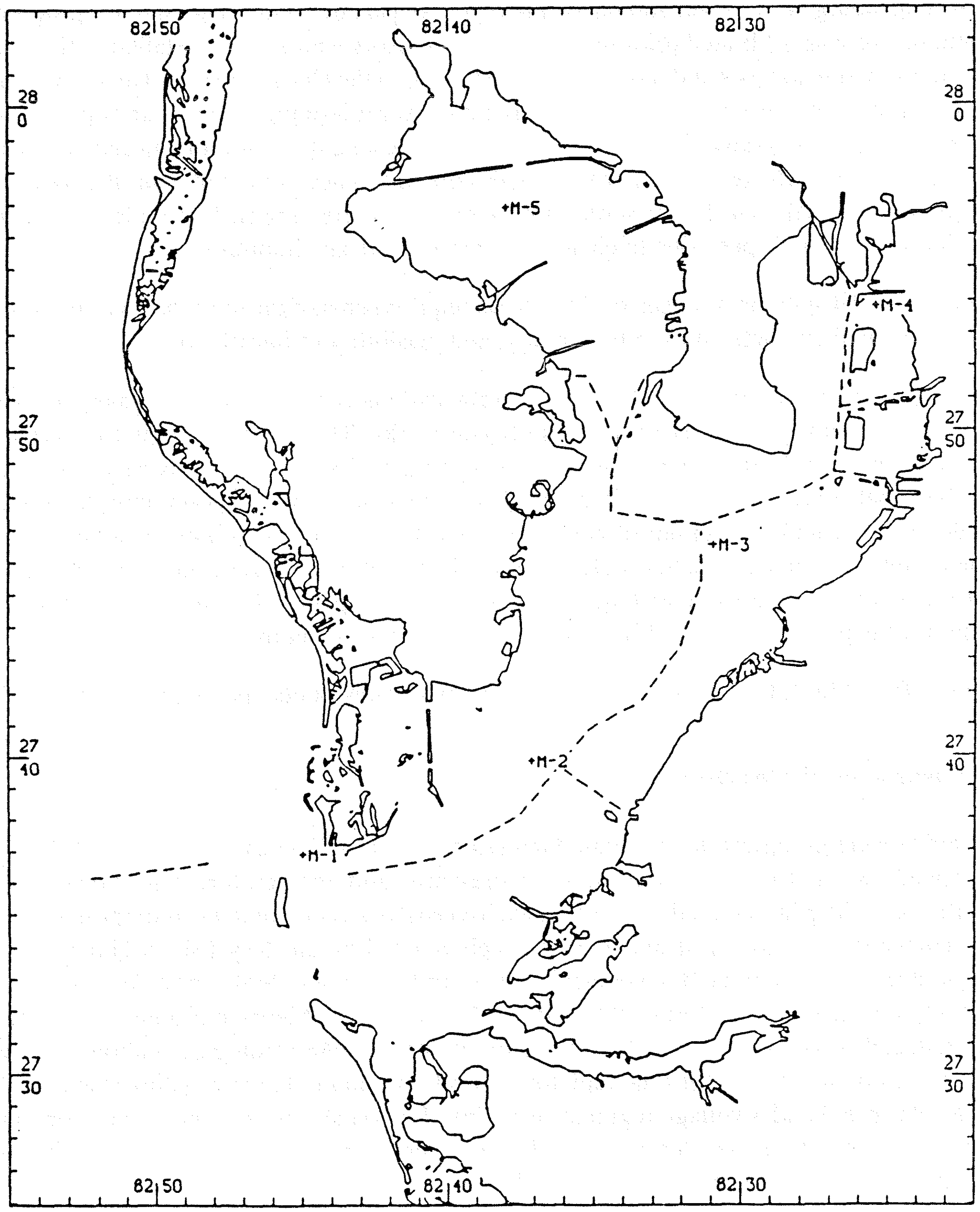


Figure 7. Location of the meteorological stations, denoted by an "M". Dashed line indicated main shipping channel

3.0 DATA QUALITY ASSURANCE

3.1 Quality Control

Data Quality Assurance (DQA) defines the set of plans, specifications, calibrations, and procedures which are used to assure that the field measurement data meet the requirements of the branch. Quality Control (QC) is the continued use of a set of established procedures to achieve and maintain the required level of data quality. DQA includes instrument acceptance tests, measurement quality control, processing quality control, and critical review of the final processed data and information products. DQA procedures were followed in instrument deployments, data processing, and in data analysis. The goal of DQA and QC is to obtain maximum usefulness of all atmospheric and oceanographic data.

3.2 Data Processing

Data processing is essential to the DQA process. Often it is only during processing that instrument errors or unreasonable data are detectable. Collected field instrument data were transferred to laptop computers, saved on diskette, and then uploaded to the Hewlett-Packard (HP) 9000/825 mainframe computer system at CEOB in Rockville, MD. A 1.2-gigabyte internal storage disk provides ample storage for all CEOB data.

Once installed on the mainframe computer, the data were backed-up, edited, and converted to engineering units. ASCII files were reviewed for QC, archived, and analyzed. Analysis included time series plots which were reviewed for noise, offset, drift, data spikes, reliability, and consistency with neighboring stations. Original data sets were then archived on 9-track tape (Rotondi, 1990).

3.3 DQA Procedures

3.3.1 ADCPs

1200-kHZ and 600-kHZ ADCPs were calibrated for speed both before and after deployment in a towing tank at the David Taylor Naval Ship Research and Development Center (DTNSRDC) in Carderock, MD. The beamwidth of the 300-kHZ ADCP is too wide for the towing tank, so calibration was performed by the RD Instruments in their lakeside towing facility in San Diego, CA. Compass calibration was performed on land by comparing instrument headings with that of a high quality magnetic compass. Field DQA procedures included frequent battery testing and replacement, verification that transducer heads were activated just prior to deployment, and diver inspection to clean transducer heads and level the platform. Manufacturer supplied software was a vital step in ADCP DQA. A computer program provided by RD Instruments performed systems checks on the power supply, transmit circuits, receive circuits, and the data recorder. All ADCP instruments passed these system tests prior to deployment.

3.3.2 S4 Current Meters

S4 current meters were calibrated for speed, both before and after deployment in the towing tank at DTNSRDC, and examined for long term drift in the laboratory at CEOB. Instrument heading was calibrated by comparison to an accurate Aanderaa magnetic compass. After data retrieval in the field, the data were plotted and studied for current components, instrument tilt and heading discrepancies, outliers, physical reasonableness, and statistical stability.

3.3.3 Water Level Gages

All ADR gages used at the water level stations were refurbished and calibrated prior to installation. New bench marks were installed at some stations to ensure a minimum of five bench marks at each station. The FDNR established a level connection between the station marks and the National Geodetic Vertical Datum (NGVD).

A special effort was made in the training of gage observers at the beginning of data collection. Observers checked water level times and heights approximately five times per week, with performance closely monitored during June and July, 1990, to ensure that observers' daily readings were being accurately recorded and that any mechanical malfunctions were reported promptly. Periodically, observers received additional training to correct deficiencies in their methods of making the daily observations. An experienced field technician visited the station two to three times a month to verify proper operation of the gages.

Processing and tabulation of station data were accomplished using NOS standard operating procedures.(NOS, 1986) These procedures include a preliminary evaluation of data quality using a visual scan and the completion of a comparative reading by a data analyst for each monthly record. Data defect information on the preliminary evaluation was forwarded to the field party for corrective action. The comparative reading uses the tide observer's staff readings and the simultaneous gage readings to establish a statistical staff-to-gage relationship or setting that is applied to the time series before tabulation. Trends, outliers, and discrepancies in staff-to-gage differences were tracked as a quality control step (e.g., to test for stilling well clogging or float hangups). The observers and field personnel made time corrections and repairs to the gages as required. The tide observer's time checks and staff checks with the gage provided effective calibration of the system. Appendix B. Table II lists the water level data series for TOP.

Uncertainties in the observed water level measurements are difficult to assess due to the nature of the environment being measured. Uncertainties in the measurements are highly dependent on location due to the dynamic effects on the measurement system of the local sea swell and wind wave regime, the speed of tidal and non-tidal currents present, and the vertical density structure of the local water column. These parameters, along with the presence of errors attributable to tide observers and gage operation, are also highly time dependent.

Timing of the data from the ADR gages is accurate to the nearest 0.10 hour, while timing of the data obtained from analog backup "bubbler" pressure gages is accurate to the nearest 0.30 hour. Data resolution of the measured elevations are 0.01 foot (0.3 cm) for the ADR data and 0.10 foot (3.1 cm) for the analog pressure data.

Generalized uncertainties (one standard deviation) in the time- series water level measurements for the ADR gages are estimated to be from 2.2 cm to 6.5 cm, depending upon the amount of data editing and gap filling and the local hydrodynamic effects. Uncertainties (one-standard deviation) are estimated to be 9.4 cm and above for the analog bubbler data used to fill gaps depending upon the sea swell and wave action present.

3.3.4 Meteorological Instruments

Anemometers and other meteorological sensors are provided by the manufacturer with detailed specifications on measurement accuracy. Meteorological data were quality controlled using similar methods to those employed for current meters. Plots were checked for outliers, noise bursts, missing data, drift, and offset. For the real-time system, daily checks were made during weekdays by calling the system on a modem hook-up from the CEOB office in Rockville, MD. For the self-recording instruments, checks for missing data were performed with each recovery.

3.3.5 Real-Time and Moored CTD/CT Sensors

The Seabird conductivity, temperature, and depth sensors were calibrated by the NOAA Northwest Regional Calibration Center in Seattle, WA. In the field, real-time CTD transect results were plotted and the profiles examined for missing data, spikes, outliers, and physical reasonableness. The derived values of salinity and density are particularly vulnerable to data collection errors. This problem in the field was minimized by allowing sensors to equilibrate at the surface and by adjusting the winch speed in lowering, stopping for a time at each desired level. All data were compared to historical data and comparisons were made between adjacent stations.

3.4 Special Considerations in Tampa Bay

3.4.1 Bio-Fouling

In the course of the Project, many circumstances arose which made data collection a constant challenge. Extensive bio-fouling hindered virtually every moored instrument deployed in the Bay. The shallow and warm waters of the basin provided a fertile breeding ground for barnacles, which attached themselves in large numbers to the submerged platforms. These marine crustaceans of the subclass Cirripedia form a hard calcareous shell which can only be removed by vigorous scraping or blasting with high pressure water. The transducer heads of the ADCP often were covered with barnacles resulting in pitting and gouging of the piezoelectric surface. Some S4 current meters were entirely covered by bio-fouling and these current meters show decreasing maximum current velocities over time, probably caused by interference from increasing barnacle growth. The Datasonics and EG&G acoustic releases were also affected by the barnacle growth, necessitating the use of divers to recover all instrumentation.

3.4.2 Lightning

The meteorological stations deployed on range markers throughout the bay were found to have numerous "re-set errors" in the data. Lightning strikes, resulting from the many electrical storms in the region, caused the internal time recorders within the meteorological station to be reset, thereby losing the correct elapsed time. This error was alleviated by installing lightning rods atop the towers.

3.4.3 Instrument Positioning

In re-occupying the long-term instrument stations, particularly ADCP stations C-4 and C-5, the data show that there were differences in the successive positions occupied (Figure 8a+b). The positioning system used in Tampa Bay was a Northstar 800 LORAN-C/GPS navigator. After May, 1991 a Global Positioning System (GPS) receiver was obtained to increase the accuracy of the Northstar. Until that point LORAN-C alone was used. LORAN is a system of transmitted time-delay radio signals sent out from different land based stations that are subject to atmospheric disturbances and refraction from coastal boundaries. The accuracy of LORAN varies from 185 to 463 meters (Digital Marine, 1989), making exact global coordinate positioning impossible. Other elements such as weather, sea state, currents, and vessel traffic contributed to changes in instrument position.

With the NAVSTAR (NAVigation System using Time And Ranging) GPS upgrade, the absolute accuracy of positioning improved to 15 to 100 meters. GPS is a state-of-the-art navigation system consisting of earth-orbiting satellites and specialized radio receiving equipment at user locations. The GPS system is currently in an intermediate stage of deployment and coverage is not continuous. The Northstar system provides continuous coverage by integrating the data from both navigation systems and automatically choosing the best fix.

3.4.4 Instrument Losses

In the course of the project, two S4 current meters (serial numbers 05451469 and 07301563), two moored CT sensors, (serial numbers 238 and 240), three moored CTD sensors, (serial numbers 501, 502, and 503) and a Datasonics acoustic locator were lost. The bottom mounted S4s were apparently struck by a deep draft ship, fishing nets, or a barge. The platforms for the S4s were also lost. Two ADCP stations were also hit during the survey; upon recovery they were found over turned but undamaged. To prevent further problems, a lighted surface buoy was deployed with each instrument, so that mariners and fishermen could avoid the deployment area. Two instruments were lost even with the marker buoys. The two S4 current meters that were lost were deployed in vulnerable locations. The risk of loss, shallowness of the water, and cost were factors that were considered in deploying the S4 rather than the ADCP. The S4 cost is about $16,000, whereas an ADCP unit can cost as much as $80,000.

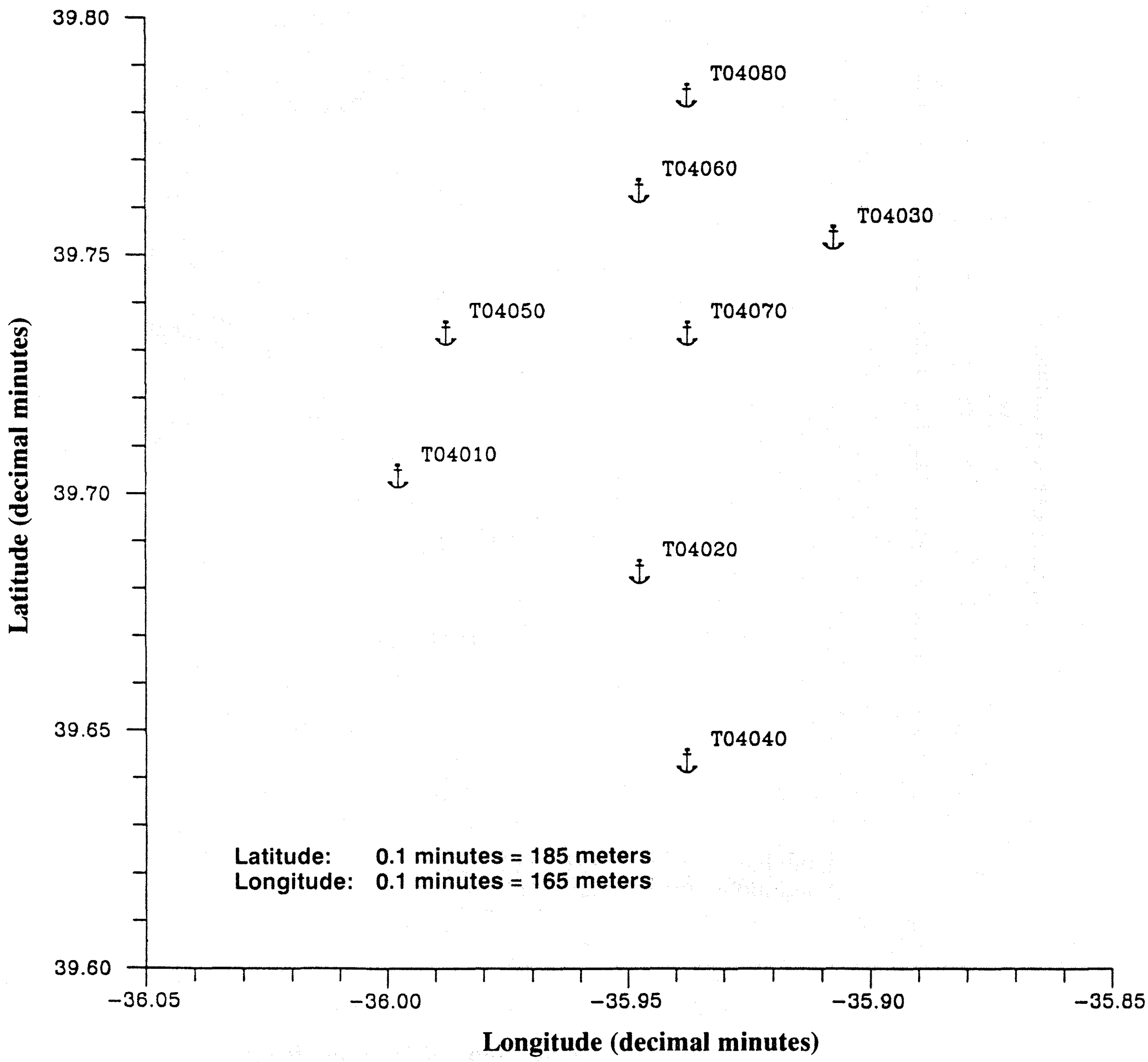


Figure 8a. Graph of position drift for station C-4. T04010 denotes file name for a particular deploymnent period

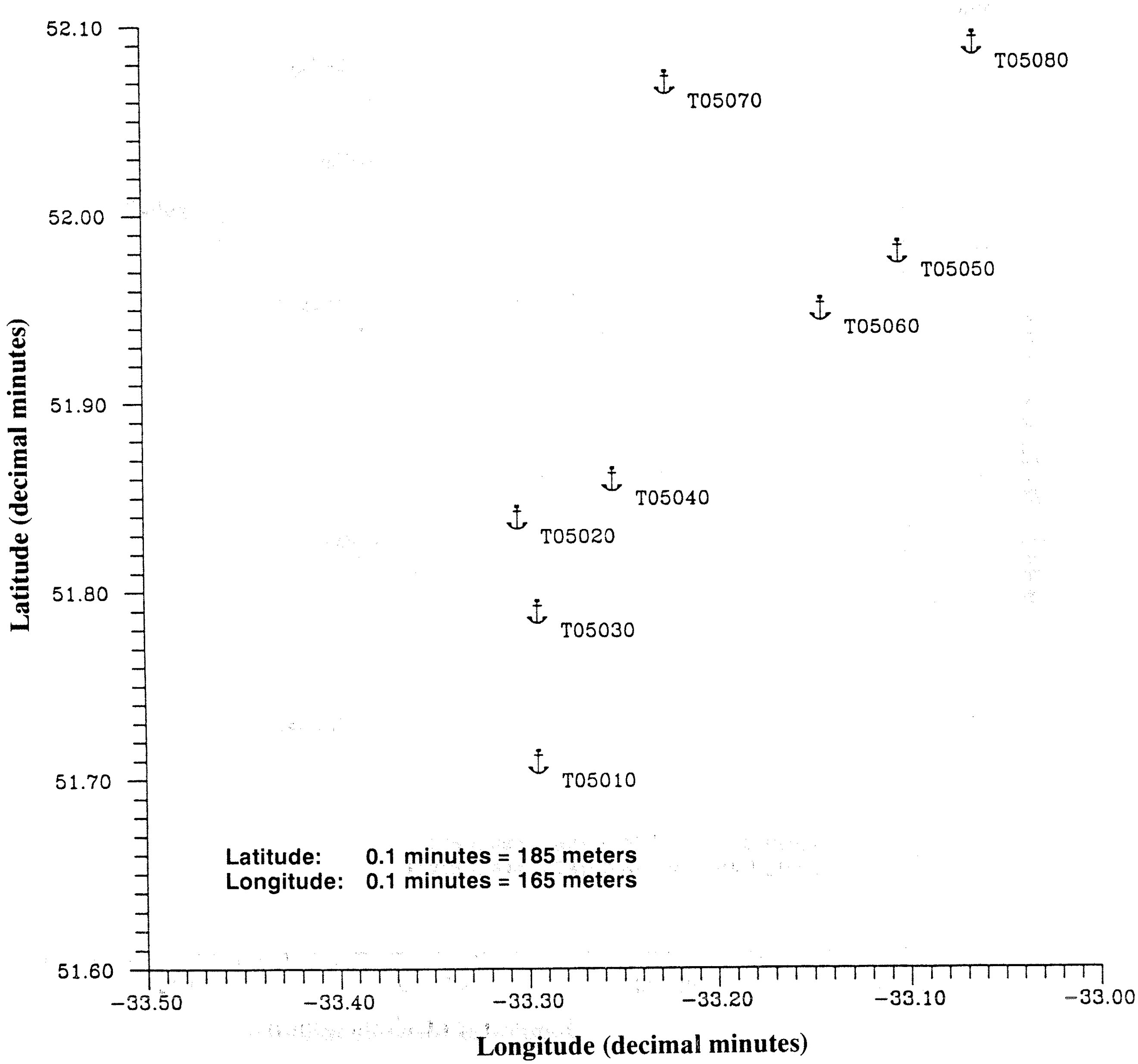


Figure 8b. Graph of position drift for station C-5

4.0 DATA AVAILABILITY AND DISSEMINATION

Current meter, CTD, CT, meteorological, and towed transect data are available from:

Chief, Information Systems Section
Coastal and Estuarine Oceanography Branch

NOAA/National Ocean Service
6010 Executive Blvd. Rm 818
Rockville, MD 20852
(301) 443-8510
fax (301) 443-8300

Water level data are available from:

Chief, Products and Services Branch
Ocean and Lake Levels Division
NOAA/National Ocean Service
6001 Executive Blvd.
Rockville, MD 20852
(301) 443-8254
fax (301) 443-1920

5.0 ACKNOWLEDGMENTS

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APPENDICES

APPENDIX A
FIELD MEASUREMENT ACTIVITIES

All major activities in the TOP measurement field program are included here.

Dates	Activities
May 1990	Water level gages and stilling wells installed.
June 1990	Current meters at C-4, C-5, C-10, C-11, C-12, C-13, C-14, C-15, and CT stations S-1 and S-3 are installed. Met. station M-2 (PORTS) is installed. Current meter at C-3 installed (PORTS).
July 1990	S4 current meters inspected and replaced at stations C-10, C-11, C-12, C-13.
August 1990	Removed current meters from C-10, C-11, C-12, C-13, C-14, C-15. Installed current meters at C-20, C-21, C-22, C-23, C-24. Installed current meters at C-1, C-2, and C-6. CTD transects ST1, ST2, ST3, and ST4 are performed.
September 1990	All instruments inspected. Damaged meter at C-22 is removed. Current meter at C-27 is installed.
October 1990	Long term current meters inspected. Retrieved current meters at C-20, C-21, C-23, C-24. Redeployed meter at C-27.
November 1990	Towed ADCP transects CT1, CT2, CT3, CT4, and CT5 are performed. Real time CTD transects ST1, ST2, ST3, and ST4 are traversed. Current meter stations C-1, C-2, and C-27 are inspected. CTD sensors deployed at S-1. Met. stations M-1, M-4, and M-3 are installed.
December 1990 and January 1991	ADCP current meters C-1, C-2, C-4, C-5, C-6, and C-27 are recovered and redeployed. ADCP at C-30 is deployed. CTD stations S-1 and S-2 are recovered and redeployed. S4 current meters deployed at C-26, C-32, C-33, C-34, and C-35. Downloaded Met. stations M-3, M-4, and M-1.
February 1991	S4 current meter stations inspected. ADCP current meter stations inspected.

	Met. stations M-1, M-3, and M-4 are downloaded and lightning protection is installed.
March 1991	Performed ADCP tows CT1, CT2, CT3, CT4, and CT5. Completed CTD transects ST1, ST2, ST3, ST4, ST5, and ST6. Downloaded Met. stations M-1, M-3, and M-4, installed M-5. S4 current meters recovered from C-26, C-32, C-33, C-34, and C-35 then redeployed at C-40, C-42, C-43, C-45, and C-46. Met stations M-1, M-3, and M-4 downloaded, station M-5 is installed. ADCP installed at stations C-44, C-41.
April 1991	ADCP recovered and redeployed at C-1, C-4, and C-5. All S4 current stations inspected, S4 at C-45 is lost. ADCP stations also inspected. Met. stations M-1, M-3, and M-4 are downloaded.
May 1991 and June 1991	ADCP recovered and redeployed at C-1, C-2, C4, and C-5. ADCP recovered from C-44, C-30, C-41. ADCP deployed at C-6, C-56, C-52, C-55. S4 current meters recovered from C-46, C-43, C-42, and C-40, then re-deployed at C-50, C-51, C-53, and C-54. CTD transects performed at ST1, ST6, ST4, and ST2. ADCP tows performed at CT1, CT2, CT4, and CT5. Performed ADCP tows in support of Southwest Florida Surface Water Improvement and Management district (SWIM), tows were designated SWIM1, SWIM2, and SWIM3. Downloaded Met. Stations M-1, M-3, M-4, and M-5. CT stations at S-1, S-2, and S-3 recovered and redeployed.
July 1991	ADCPs recovered and redeployed at C-55, C-5, C-2, C-1, C-52, C-4. Station C-56 was defective, unit returned to RD Instruments. S4 meters recovered and redeployed at C-50, C-51, C-53, and, C-54. Met. stations M-2(PORTS), M-1, M-5, and M-3 downloaded and reset. CT stations S-2 and S-3 are recovered and redeployed.
August 1991	Downloaded Met stations M-1, M-3, M-4, and M-5. Recovered S4 stations C-51, C-53, and C-50. Station C-54 was hit and the S4 instrument lost. Deployed S4's at C-26 and C-22. Recovered ADCP at stations C-5, C-4, C-55, C-52, and C-6.

	Deployed ADCP at stations C-1, C-60, C-2, and C-56. Performed CTD transects ST3, ST6, ST5, ST4. Performed towed ADCP transects CT5, SWIM1, SWIM2, SWIM3, and CT2. Recovered and redeployed CT's at S-2 and S-3.
September 1991 and October 1991	Last trip for TOP field work. All and instruments recovered, cleaned, packaged, and shipped to Rockville for storage. No redeployments.

APPENDIX B
TAMPA BAY OCEANOGRAPHY PROJECT
STATION SUMMARY

The following six tables contain station locations and the data collected from them.

Table	Contents
I.	Current Meter Stations
II.	Water Level Data
III.	Meteorological Data
IV.	Salinity-Temperature Data
V.	CTD Transect Data
VI.	Towed ADCP Data

TABLE I. CURRENT METER STATIONS.

Note: for instrument, R is ADCP, S is S4, P is pressure sensor, C is CT or CTD. S/N is instrument serial number. H is mean lower low water depth in meters, and Z is height of ADCP or S4 transducer above bottom in meters. Station names refer to those in the TOP Plan.

Current station	Latitude (n)	Longitude (w)	Date In	Date Out	Instrument S/n	Percent Data Recovered	H	Z
LONG-TERM STATIONS								
C-1	27 36.11	82 52.04	08/19/90	10/19/90	R 262	0	9.4	2.0
					P 32095	100		
					C 421	100		
	27 36.08	82 52.00	10/27/90	12/28/90	R 262	0	10.3	1.3
					P 32095	0		
					C 240	100		
	27 36.05	82 52.02	01/05/91	03/08/91	R 177	100	10.6	0.5
					P 33470	0		
					C 500	100		
	27 36.05	82 52.06	03/12/91	05/28/91	R 262	66	10.7	0.9
					P 32095	100		
					C 682	0		
	27 36.03	82 52.08	05/28/91	07/11/91	R 160	0		
					P 30439	0		
					C 217	100		
	27 36.01	82 52.08	07/28/91	08/22/91	R 217	100	10.5	0.8
					P 32085	100		
					C 239	100		

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-1 (cont'd)	27 36.01	82 52.08	08/22/91	09/28/91	R 229	100	10.9	0.6
					P 35210	100		
					C 415	100		
C-2	27 36.29	82 45.52	08/18/90	10/25/90	R 263	100	25.5	2.0
					P 35210	100		
					C 418	100		
	27 36.22	82 45.63	10/27/90	12/28/90	R 263	100	24.0	1.3
					P 35210	0		
					C 411	100		
	27 36.32	82 45.68	01/02/91	03/03/91	R 263	100	24.5	1.9
					P 35210	0		
					C 412	100		
	27 36.21	82 45.59	03/12/91	05/28/91	R 263	100	24.7	2.0
					P 30439	100		
					C 239	100		
	27 36.25	82 45.59	05/28/91	07/09/91	R 256	100	25.7	2.0
					P 30608	100		
					C 424	100		
	27 36.28	82 45.66	07/10/91	08/22/91	R 256	100	25.8	2.0
					P 45481	100		
					C 237	100		
	27 36.28	82 45.65	08/23/91	09/28/91	R 256	94	24.8	1.5
					P 45481	94		
					C 416	25		
C-3	27 37.25	82 39.31	08/22/90	12/31/90	R 210	100	15.3	0.6
					P 39920	100		
	27 37.25	82 39.31	01/01/91	02/19/91	R 210	100	15.3	0.6
					P 39920	100		
	27 37.12	82 39.25	02/21/91	06/11/91	R 210	100	14.6	0.6
					P 39920	100		
C-4	27 39.70	82 36.00	06/07/90	08/13/90	R 260	100	7.7	0.8
					P 34069	93		
	27 39.68	82 35.95	08/13/90	10/24/90	R 160	100	7.6	0.3
					P 38539	100		
					C 240	100		

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-4 (cont'd)	27 39.75	82 35.91	10/23/90	12/27/90	R 260	100	7.6	0.3
					P 34069	100		
					C 417	100		
	27 39.64	82 35.94	01/02/91	03/07/91	R 260	100	8.2	0.5
					P 34069	100		
					C 421	100		
	27 39.73	82 35.99	03/12/91	05/29/91	R 229	100	11.3	0.7
					P 35210	100		
					C 237	100		
	27 39.76	82 35.95	05/29/91	07/10/91	R 217	100	10.6	0.8
					C 238	100		
	27 39.73	82 35.94	07/12/91	08/14/91	R 160	0	-	-
					P 32095	0		
					C 418	100		
	27 39.78	82 35.94	08/15/91	09/25/91	R 160	100	13.3	0.8
					P 32095	100		
					C 413	100		
C-5	27 51.70	82 33.30	06/05/90	8/13/90	R 229	100	12.0	0.7
					P 33470	100		
	27 51.83	82 33.31	08/14/90	10/21/90	R 260	100	9.3	0.5
					P 34069	0		
					C 238	100		
	27 51.78	82 33.30	10/22/90	12/27/90	R 217	100	10.6	0.5
					P 30608	100		
					C 412	100		
	27 51.85	82 33.26	01/03/91	03/07/91	R 217	100	9.2	0.7
					P 30608	100		
					C 418	100		
	27 51.97	82 33.11	03/11/91	05/23/91	R 217	100	8.0	0.9
					P 30608	100		
					C 413	100		
	27 51.94	82 33.15	05/23/91	07/06/91	R 260	100	6.9	0.7
					C 406	100		
	27 52.06	82 33.23	07/06/91	08/13/91	R 260	100	6.9	0.7
					C 818	100		

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-5 (cont'd)	27 52.08	82 33.07	08/13/91	09/21/91	R 260	100	5.2	0.8
					C 818	100		
C-6	27 35.64	83 15.23	08/18/90	10/25/90	R 256	100	28.4	2.0
					P 32085	0		
					C 239	100		
	27 35.23	83 15.70	10/27/90	01/02/91	R 256	100	29.3	1.3
					P 32085	0		
					C 239	100		
	27 35.04	83 15.75	01/02/91	03/08/91	R 256	100	29.9	1.9
					P 32085	0		
					C 416	100		
	27 35.00	83 15.83	05/28/91	08/23/91	R 263	97	29.6	2.0
					C 682	100		
PERIOD 1 STATIONS								
C-10	27 45.52	82 36.63	06/07/90	07/09/90	S 05451472	0	5.9	2.1
	27 45.33	82 36.37	07/10/90	08/15/90	S 05451472	100		
C-11	27 42.48	82 36.56	06/07/90	07/09/90	S 05451469	0	5.7	2.1
	27 42.28	82 36.33	07/10/90	08/10/90	S 05451469	29		
C-12	27 39.59	82 40.24	06/06/90	07/09/90	S 05451470	100	2.7	1.8
	27 39.94	82 40.70	07/10/90	08/13/90	S 05451470	0		
C-13	27 37.64	82 39.53	06/06/90	07/08/90	S 05451471	0	6.9	2.1
	27 37.60	82 39.55	07/10/90	08/14/90	S 05451471	100		
C-14	27 41.15	82 34.22	06/07/90	08/10/90	R 160	100	6.9	0.6
C-15	27 43.52	82 32.14	06/06/90	08/10/90	R 177	100	7.0	0.5
					P 30439	0		
PERIOD 2 STATIONS								
C-20	27 33.70	82 46.04	08/15/90	10/19/90	R 177	100	9.3	0.5
					P 33470			
					C 412	100		
C-21	27 32.21	82 44.51	08/15/90	10/23/90	S 05451472	38	8.6	2.1
					C 411	100		
C-22	27 29.96	82 41.600	8/15/90	09/19/90	S 05451471	74	1.8	
					C 424	74		

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-22 (cont'd)	27 30.04	82 41.56	08/19/91	09/25/91	S 05451471 C 424	100 100		
C-23	27 36.50	82 41.64	08/14/90	10/19/90	R 217 P 26183 C 417	100 100	9.1	0.5
C-24	27 41.26 27 41.26	82 42.56 82 42.56	08/19/90 08/19/90	10/22/90 10/22/90	S 05451469 C 406	29 100	5.1	0.9
C-25	(not deployed)							
C-26	27 30.53	82 36.47	01/05/91	03/07/91	S 05451472 C 240	21 100	5.1	2.7
	27 30.04	82 34.7	08/19/91	09/25/91	S 05451472 C 419	0 100		
C-27	27 53.57	82 26.25	09/20/90	10/23/90	S 07301563	42	3.8	1.5
	27 53.83	82 26.28	10/26/90	12/27/90	R 177 P 33470 C 421	100 100	11.9	0.5
PERIOD 3 STATIONS								
C-30	27 48.31	82 34.41	03/13/91	05/20/91	R 160 P 38539 C 406	100 0 100	10.2	0.8
C-31	27 50.76	82 26.62	01/04/91	03/09/91	R 229 P 26189 C 413	100 0 100	13.8	0.9
C-32	27 53.91	82 32.98	01/03/91	03/06/91	S 05451471 C 415	100 100	5.3	2.1
C-33	27 52.99	82 33.14	01/04/91	03/06/91	S 05451470 C 238	100 100	4.0	2.1
C-34	27 55.57	82 34.22	01/03/91	03/07/91	S 07301563 C 406	100 100	4.7	2.1
C-35	27 57.98	82 37.22	01/03/91	03/13/91	S 05451469 C 422	66 100	4.3	1.8

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-36	27 48.71	82 26.84	01/04/91	03/07/91	R 160	100	12.6	0.7
					P 38539	0		
					C 237	100		
PERIOD 4 STATIONS								
C-40	27 50.22	82 34.39	03/11/91	05/21/91	S 05451470	61	7.1	2.4
					C 410	100		
C-41	27 50.70	82 33.75	03/11/91	05/21/91	R 260	100	8.0	0.5
					P 34069	100		
					C 415	100		
C-42	27 45.86	82 34.38	03/13/91	05/21/91	S 05451472	90	5.5	1.8
					C 424	100		
C-43	27 51.72	82 35.12	03/11/91	05/21/91	S 05451471	100	9.2	2.1
					C 419	100		
C-44	27 47.16	82 31.32	03/11/91	05/20/91	R 177	100	11.9	0.8
					P 33470	0		
					C 418	100		
C-46	27 50.78	82 27.57	03/11/91	05/22/91	S 07301563	100	4.3	1.8
	(Station added after inital Plan)				C 238	100		
PERIOD 5 STATIONS								
C-50	27 40.45	82 37.31	05/30/91	07/01/91	S 05451470	100	4.4	0.9
	27 40.45	82 37.310	7/02/91	08/14/91	S 05451470	100	3.8	1.8
C-51	27 40.14	82 36.55	05/30/91	07/01/91	S 05451471	100	7.9	2.4
					C 417	100		
	27 40.11	82 36.56	07/02/91	08/14/91	S 05451471	100	6.9	0.9
					C 406	25		
C-52	27 39.24	82 35.37	05/27/91	07/01/91	R 177	100	12.1	0.7
					P 34069			
					C 419	100		
	27 39.18	82 35.410	7/02/91	08/16/91	R 177	96	14.1	0.6
					P 34069			
					C 419	100		
C-53	27 38.59	82 34.72	05/30/91	07/07/91	S 07301563		4.6	1.8
					C 410	100		

Current Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered	H	Z
C-53 (cont'd)	27 38.60	82 34.67	7/08/91	08/15/91	S 05451472		4.4	1.8
					C 417	100		
C-54	27 34.36	82 41.30	05/27/91	07/07/91	S 05451472	100	5.7	2.1
					C 240	100		
	27 34.50	82 41.10	07/08/91		S 05451563			
					C240			
C-55	27 39.70	82 36.07	05/30/91	07/12/91	R 229	0	-	-
					C 413	0		
	27 39.71	82 36.03	07/13/91	08/16/91	R 229	100	13.7	0.5
					C 424	100		
C-56	27 36.46	82 45.50	05/29/91	07/09/91	R 262	0	14.4	0.8
					P 32095			
					C 420	100		
	27 36.47	82 45.55	07/10/91	07/11/91	R 262	0	-	-
					C 420	0		
	27 36.48	82 45.52	08/23/91	09/24/91	R 217	100	14.1	0.5
					P 26189			
					C 417	100		
PERIOD 6 STATIONS								
C-60	27 36.01	82 52.06	08/22/91	09/28/91	R 177	100	9.7	0.6
					P 32085			
					C 238	100		

TABLE II. WATER LEVEL DATA

Note: The St. Petersburg (E-520) and Clearwater (E-724) gages are NOS primary stations and therefore are in continual operation.

Water Level Station	**Name**	**Date In**	**Date Out**	**Missing Data**
E-217	Cortez	05/30/90	11/01/90	07/19/90 - 07/20/90
E-243	Anna Maria Outside	06/09/90	11/01/90	08/23/90 - 09/05/90 10/30/90 - 10/31/90
E-273	Desoto Point	05/30/90	11/01/90	08/20/90 - 08/25/90
E-347	Egmont Key	05/31/90	11/01/90	08/09/90 - 09/10/90 01/03/91 - 01/22/91 03/20/91 - 04/02/91
E-364	Mullet Key	05/31/90	11/01/90	10/18/90 11/09/90 - 11/10/90 12/21/90 - 01/03/90
E-384	Port Manatee	05/31/90	11/01/90	10/19/90 - 10/31/90
E-428	Tierra Verde	05/31/90	10/30/90	10/30/90 - 11/01/90
E-520	St. Petersburg	05/01/90	11/01/90	
E-537	Apollo Beach	06/08/90	11/01/90	06/04/90 - 06/08/90 02/15/91 - 02/20/91 04/01/91 - 04/30/91 08/28/91 - 09/03/91
E-641	Gandy Bridge	12/13/90	06/04/91	none
E-657	Davis Island	05/29/90	11/01/90	09/24/90 09/30/90 - 10/01/90
E-667	Mckay Bay Ent.	12/11/90	06/03/91	05/01/90 - 05/02/91
E-689	Bay Aristocrat Vill.	05/31/90	11/01/90	09/23/90 - 10/03/90 01/29/91 - 01/30/91 02/07/91 - 03/01/91 06/12/91 - 06/21/91
E-724	Clearwater Beach	05/01/90	11/01/90	
E-738	Safety Harbor	12/11/90	06/04/91	none
E-858	Venice Pier	05/30/90	11/01/90	none

TABLE III. METEOROLOGICAL STATIONS

Note: M is Coastal Climate Inc. WeatherPak 100. All WeatherPak 100's are equipped with the following sensors: anemometer, thermistor, and barometer; except M 0147, which has these additional sensors: pyranometer, thermistor, and a relative humidity sensor.

Meteor. Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered
M-1	27 35.20	82 45.50	11/07/90	12/14/90	M 1004	100
	27 36.90	82 45.00	12/14/90	01/05/91	M 1004	100
			01/05/91	02/07/91	M 1004	100
			02/07/91	03/13/91	M 1004	76
			03/13/91	04/22/91	M 1004	95
			04/22/91	05/27/91	M 1004	100
			05/27/91	07/10/91	M 1004	100
			07/10/91	08/26/91	M 1004	100
			08/26/91	09/27/91	M 1004	100
M-2	27 39.8	82 37.01	06/29/90	07/24/90	M 7016	100
			07/24/90	08/21/90	M 1004	100
			08/21/90	11/ 6/90	M 7016	100
			11/ 6/90	12/27/90	M 0147	100
			12/27/90	02/19/91	M 0147	100
			02/19/91	05/09/91	M 0147	88
M-3	27 46.30	82 31.50	-	-	M 0148	0
			-	-	M 0148	0
			-	-	M 0148	0
			02/07/91	04/22/91	M 0148	0
			04/22/91	05/24/91	M 0148	88
			05/24/91	07/03/91	M 0148	82
			07/03/91	08/24/91	M 0148	100
			08/24/91	09/29/91	M 0148	100
M-4	27 53.60	82 25.40	11/08/90	01/04/91	M 7016	100
			01/04/91	02/09/91	M 7016	2
			02/09/91	02/26/91	M 7016	10
			02/26/91	04/19/91	M 7016	100
			04/19/91	05/22/91	M 7016	0
			05/22/91	07/03/91	M 7016	100
			07/03/91	08/12/91	M 7016	100
			08/12/91	09/29/91	M 7017	0
M-5	27 56.92	82 38.00	03/14/91	04/20/91	M 7024	89
			04/20/91	05/23/91	M 7024	0
			06/06/91	07/06/91	M 7024	50
			07/06/91	08/12/91	M 7024	50
			08/12/91	09/24/91	M 7024	50

TABLE IV. SALINITY STATIONS

Note: C is SeaBird Electronics Conductivity-Temperature Sensor. All instruments measure conductivity, temperature, and salinity.

The instruments with the following serial numbers also measure pressure: 500, 501, 502, 503, 682, 683, and 817.

CT Station	**Latitude (N)**	**Longitude (W)**	**Date In**	**Date Out**	**Instrument S/N**	**Percent Data Recovered**
S-1	27 36.81	82 45.93	06/06/90	07/09/90	C 500	100
					C 501	100
	27 36.11	82 52.08	07/11/90	08/19/90	C 500	100
					C 501	100
	27 36.11	82 52.04	08/19/90	10/19/90	C 500	60
					C 501	0
	27 36.08	82 52.00	11/16/90	12/28/90	C 420	100
					C 500	0
	27 36.05	82 52.02	01/05/91	03/08/91	C 410	100
					C 500	0
	27 36.05	82 52.06	03/12/91	05/28/91	C 420	100
					C 682	0
	27 36.03	82 52.08	05/28/91	07/11/91	C 412	100
					C 418	100
	27 36.04	82 52.07	07/11/91	08/22/91	C 420	25
					C 500	100
	27 36.02	82 52.06	08/22/91	09/27/91	C 418	100
					C 817	100
S-2	27 39.80	82 37.18	02/05/91	03/07/91	C 424	100
					C 419	100
	27 39.80	82 37.18	03/12/91	05/30/91	C 416	100
					C 683	0
	27 39.80	82 37.18	05/30/91	07/08/91	C 237	100
					C 239	100
	27 39.80	82 37.18	07/08/91	08/22/91	C 421	100
					C 817	100

CT Station	Latitude (N)	Longitude (W)	Date In	Date Out	Instrument S/N	Percent Data Recovered
S-2 (cont'd)	27 39.80	82 37.18	08/23/91	09/26/91	C 406	100
					C 500	100
S-3	27 50.68	82 26.84	06/05/90	08/10/90	C 502	100
					C 503	100
	27 50.68	82 26.84	08/13/90	10/19/90	C 502	0
					C 503	0
	27 47.19	82 27.04	01/04/91	03/07/91	C 420	100
					C 239	100
	27 47.28	82 27.02	03/14/91	05/20/91	C 240	100
					C 412	100
	27 47.28	82 27.02	05/22/91	07/03/91	C 421	100
					C 500	100
	27 47.28	82 27.02	07/03/91	08/13/91	C 416	100
					C 683	100
	27 47.28	82 27.02	08/13/91	09/24/91	C 411	100
					C 683	100

TABLE V. CTD TRANSECT DATA

Station	SN	Date
CRUISE #1 - AUGUST 1990		
ST-1	208	8/17/90 8/18/90
ST-2	207	8/18/90
ST-3	208	8/18/90
ST-4	207	8/17/90 8/18/90
ST-5	207	8/17/90 8/18/90
ST-6	207	8/18/90
CRUISE #2 - NOVEMBER 1990		
ST-1	208	11/14/90
ST-2	208	11/13/90
ST-3	208	11/15/90
ST-4	208	11/12/90
ST-5	208	11/09/90
ST-6	208	11/10/90
CRUISE #3 - MARCH 1991		
ST-1	208	03/05/91
ST-2	208	02/28/91
ST-3	208	03/02/91
ST-4	208	03/01/91
ST-5	208	03/04/91
ST-6	208	02/26/91

Station	SN	Date
CRUISE #4 - JUNE 1991		
ST-1	207	06/03/91
ST-2	207	06/01/91
ST-3	207	05/25/91
ST-4	207	06/04/91
ST-5	207	05/26/91
ST-6	207	06/02/91
CRUISE #5 - AUGUST 1991		
ST-1	207	08/18/91
ST-2	208	08/26/91
ST-3	208	08/24/91
ST-4	207	08/17/91
ST-5	208	08/30/91
ST-6	208	08/24/91

TABLE VI. TOWED ADCP DATA

*The end time falls on the next day after the date given.

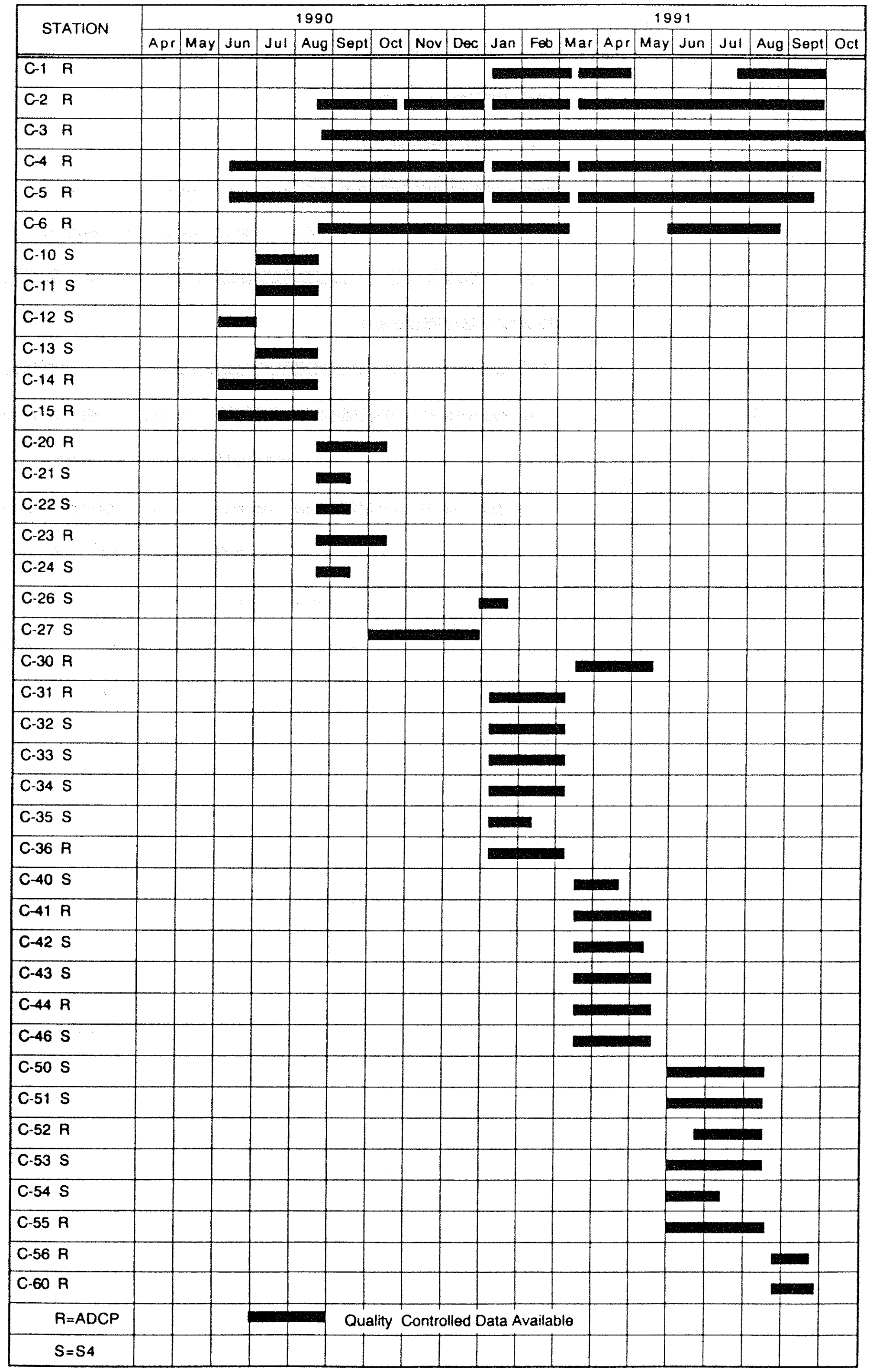
Station	Direction	Date	Time (GMT)
CRUISE #1 - AUGUST 1990			
No data collected.			
CRUISE #2 - NOVEMBER 1990			
CT-1	ebb	11/14/90	19:26-22:34
CT-1	flood	11/14/90	13:21-17:02
CT-2	ebb	11/13/90	18:35-21:40
CT-2	flood	11/13/90	12:34-16:21
CT-3	ebb	11/09/90	14:34-17:43
CT-3	flood	11/15/90	17:04-18:10
CT-4	ebb	11/10/90	14:28-18:06
CT-5	ebb	11/12/90	17:06-20:17
CT-5	flood	11/12/90	12:10-15:44
CRUISE #3 - MARCH 1991			
CT-1	ebb	03/05/91	11:26-15:01
CT-1	flood	03/05/91	06:20-09:21

The towed ADCP did not operate properly after CT-1. All other transects were cancelled for the March 1991 cruise.

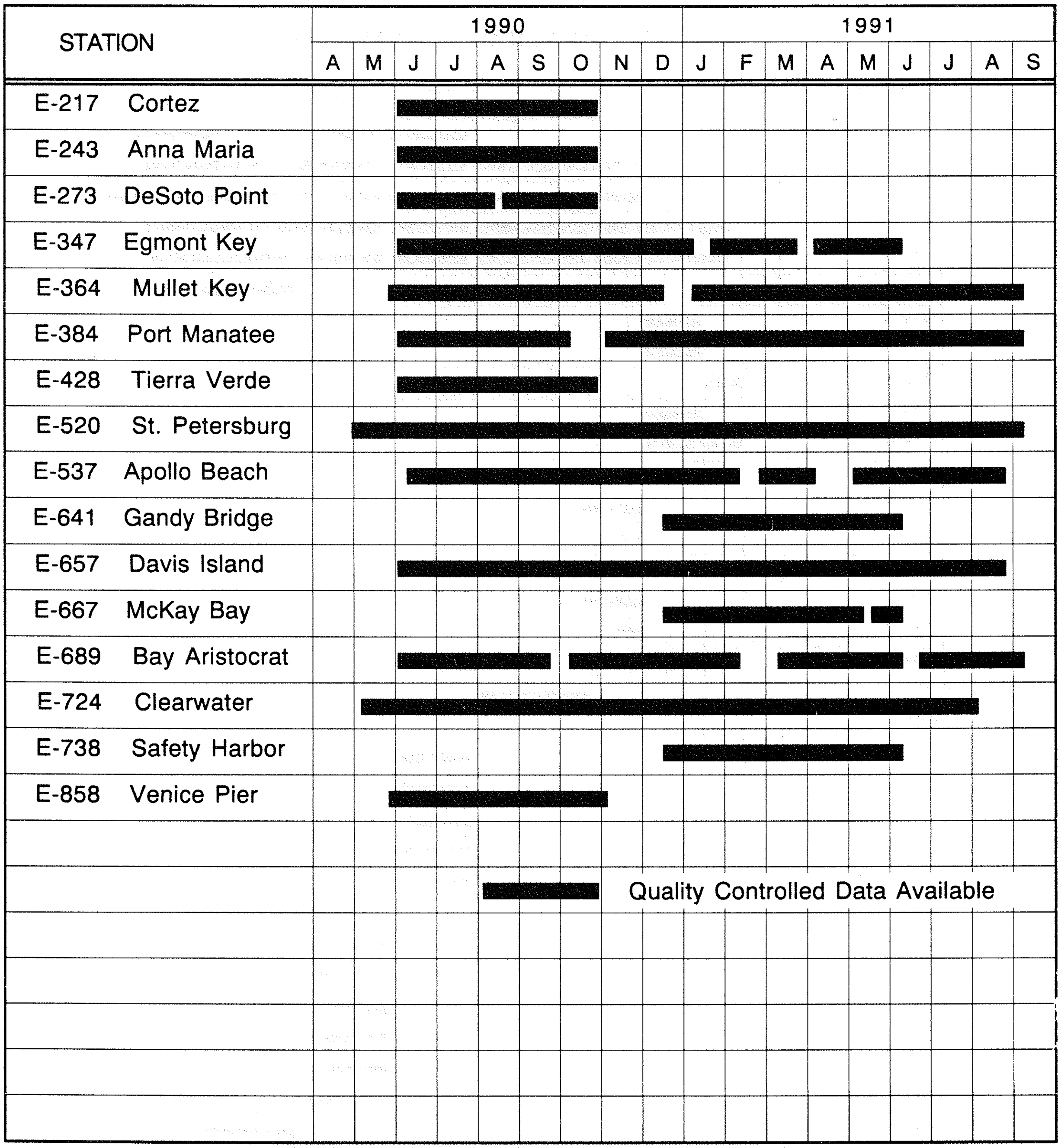
CRUISE #4 - JUNE 1991			
CT-2	flood	05/31/91	14:48-16:13
CT-3	ebb	06/03/91	23:26-02:16
CT-3	flood	06/03/91	17:32-20:54
CT-4	ebb	06/03/91	00:21-03:21
CT-5	ebb	06/01/91	21:56-00:31
CT-5	flood	06/01/91	14:36-18:30
SWIM1		06/04/91	22:37-20:43 *
SWIM2		06/06/91	13:10-13:51 *
SWIM3		06/08/91	11:51-13:58 *
Skyway PORTS	flood	06/07/91	17:12-18:30
CRUISE #5 - AUGUST 1991			
CT-2	ebb	08/17/91	13:42-15:35
CT-2	flood	08/18/91	16:25-18:15
CT-3	ebb	08/16/91	16:02-18:02

APPENDIX C
INSTRUMENT DEPLOYMENT TIME-SERIES

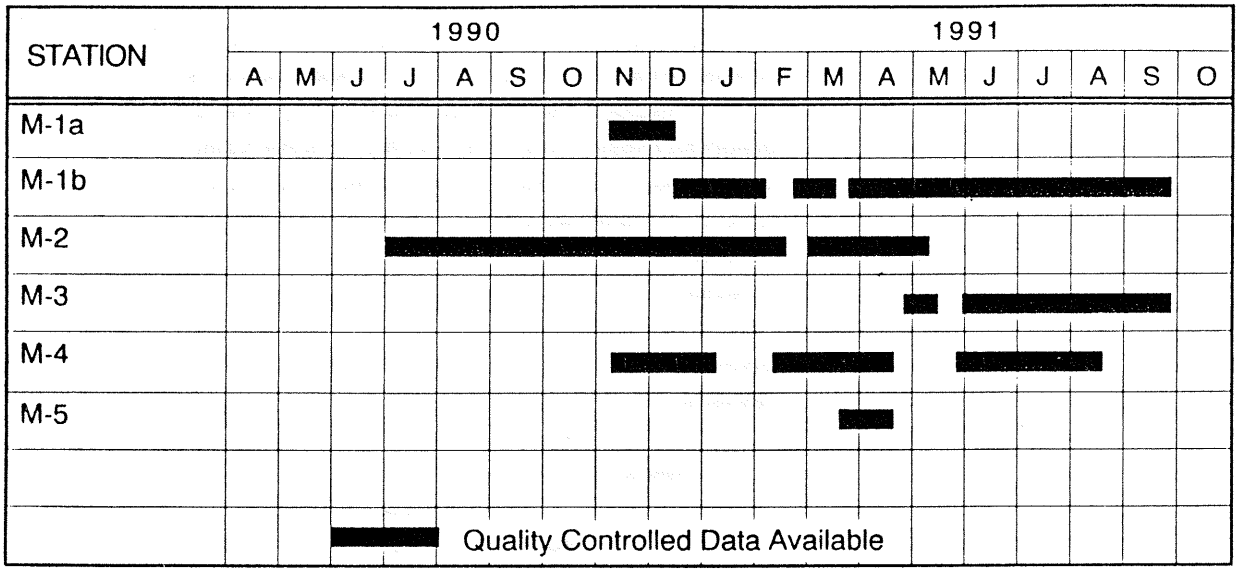
CURRENT METER DEPLOYMENTS



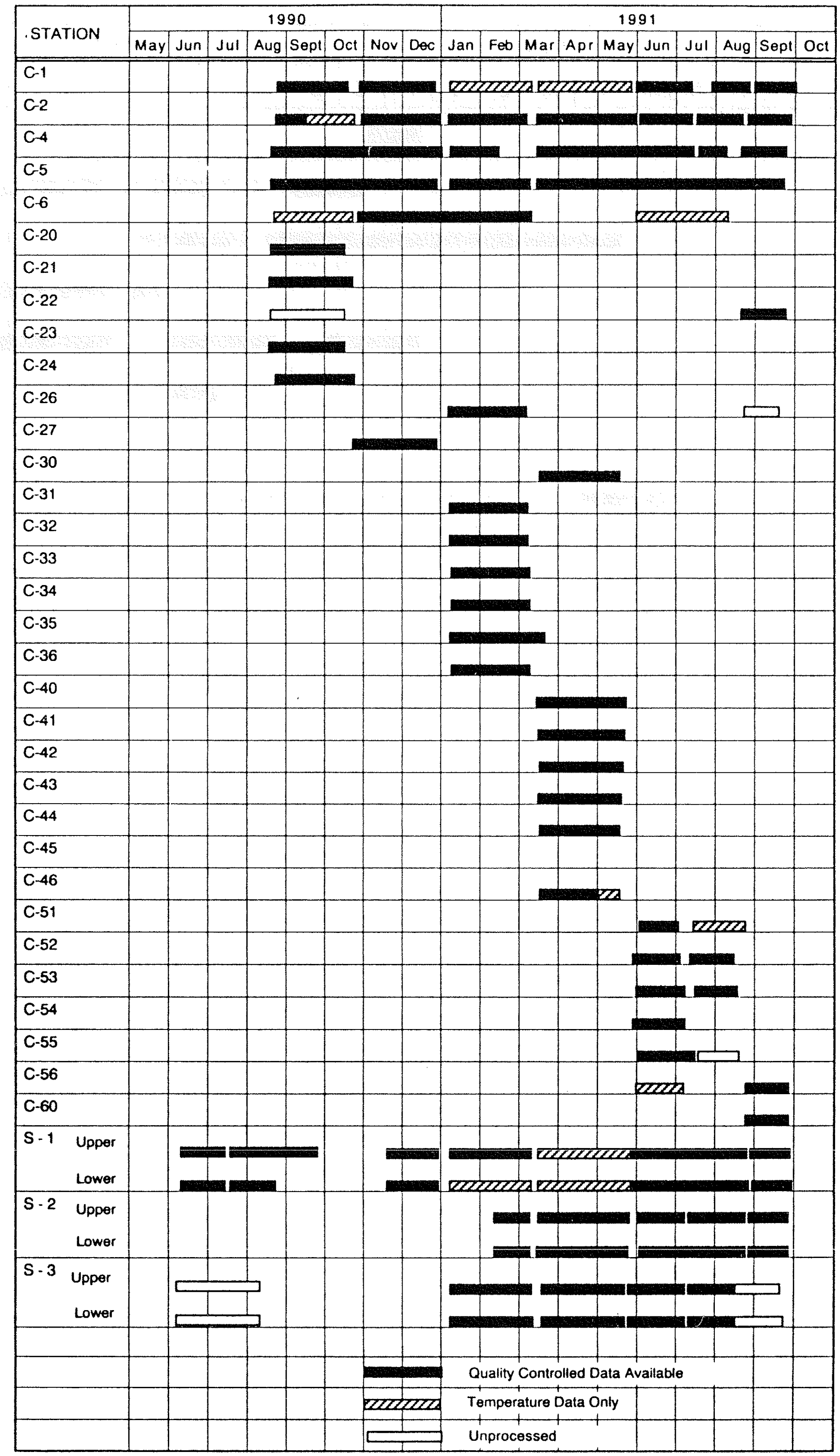
WATER LEVEL GAGE DEPLOYMENTS



METEOROLOGICAL DEPLOYMENTS



CONDUCTIVITY-TEMPERATURE DEPLOYMENTS



APPENDIX D
CURRENT METER CALIBRATION REPORT

I. Measurement Systems
   Acoustic Doppler Current Profilers (ADCP)
   S4 Electromagnetic Current Meters (S4)

II. Calibration Procedures

A. Compass

Compass calibrations were performed on all operational measurement systems prior to the survey and at the completion of the survey. Calibrations were performed at three sites: indoors or outdoors in Rockville, Maryland, or outdoors in St. Petersburg, Florida. The location is noted on each calibration data sheet used in the field.

The procedure for all calibrations was to establish magnetic north using a standard compass. A high quality magnetic compass manufactured by Aanderaa was used. The test unit was mounted in a fixture and set to magnetic north. The unit was then rotated in increments of arc on the inscribed fixture. Both clockwise and counter-clockwise rotations were performed. Data were collected at each increment of arc. Temperature or tilt angle effects on the calibration were not investigated.

ADCPs with the following serial numbers were calibrated for compass variations: 177, 217, 229, 256, 260, 262, 263, and 410.

Four S4 current meters were calibrated for direction and speed: serial numbers 1469, 1470, 1471, and 1472.

B. Current Speed

Current speed calibrations were performed at the David Taylor Naval Ship Research and Development Center (DTNSRDC) tow carriage facility in Carderock, Maryland. The carriage rides over a basin of water that is approximately 15 meters wide, 6 meters deep, and 270 meters long. Each test unit was mounted on the carriage and towed at various test speeds. Data were acquired at each speed and compared to a carriage reference speed.

Past NOS calibrations of ADCPs have indicated that they are accurate and remain stable over long periods of time. We therefore have instituted a random sample procedure for calibration rather than calibrate all units. The following ADCP's were calibrated for speed: 177, 229, 260, 262, and 263.

The S4 was also tested for zero stability prior to calibration: this is the ability of the meter to cancel out erroneous current fields and to record a consistent zero reading in the static state. The electromagnetic sensor can acquire zero offset voltages due to many factors. These offset voltages may bias the speed calibrations (i.e., indicate water flow when no flow is present).

III. Calibration Uncertainties

A. Compass

The uncertainty associated with the calibration process is estimated to be 3°. All of the ADCP compasses are within 5° in uncertainty during the post calibration process. No significant change occurred in the interval between calibrations for any of the current meters. No S4 compass produced a compass error of over 4 degrees in these calibrations.

B. Current Speed

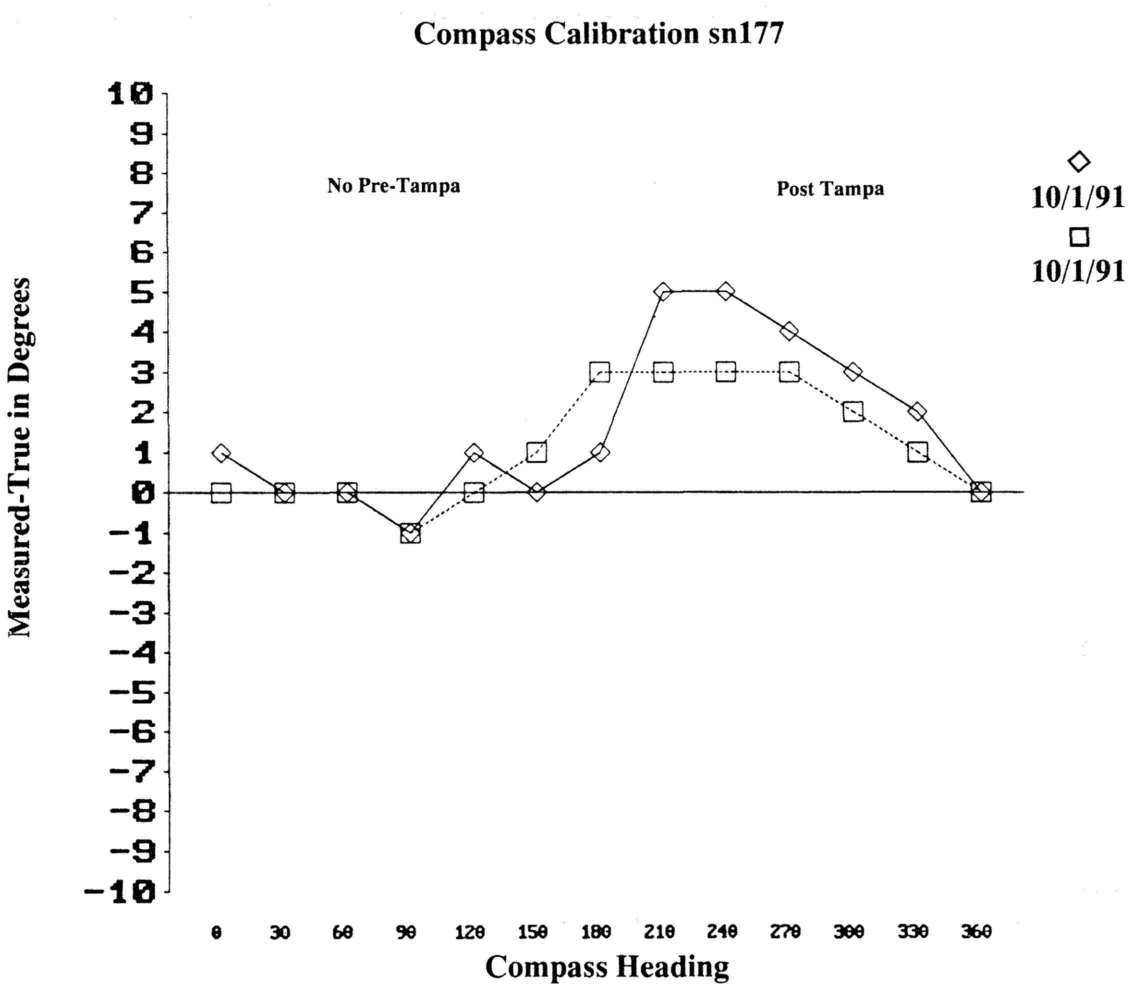
The uncertainty associated with the calibration process is estimated to be 2.5 cm/s. The exception is the 600-khz ADCP, wher a 3.5 cm/s uncertainty was established due to low echo amplitude.

ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0177- 1200 kHz TRANSDUCER

TRUE	10/1/91 CW	CCW	10/1/91 ERROR	ERROR
0	1	0	1	0
30	30	30	0	0
60	60	60	0	0
90	89	89	-1	-1
120	121	120	1	0
150	150	151	0	1
180	181	183	1	3
210	215	213	5	3
240	245	243	5	3
270	274	273	4	3
300	303	302	3	2
330	332	331	2	1
360	360	360	0	0

* Compass replaced prior to Tampa
* 10/1/91 calibrations were outdoors in St. Petersburg, FL

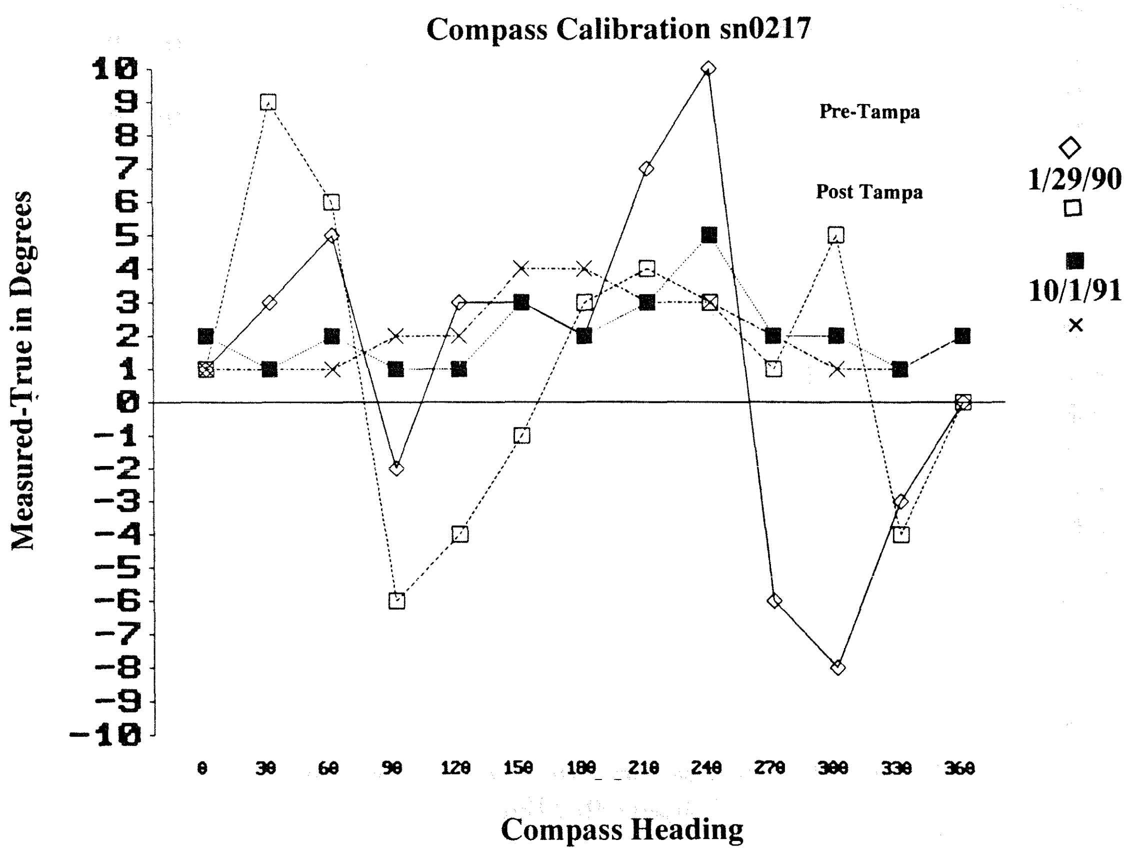


ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0217 - 1200 kHz TRANSDUCER

	1/29/90		10/1/91		1/29/90		10/1/91	
TRUE	CCW	CCW	CW	CCW	ERROR	ERROR	ERROR	ERROR
0	1	1	2	1	1	1	2	1
30	33	39	31	31	3	9	1	1
60	65	66	62	61	5	6	2	1
90	88	84	91	92	-2	-6	1	2
120	123	116	121	122	3	-4	1	2
150	153	149	153	154	3	-1	3	4
180	182	183	182	184	2	3	2	4
210	217	214	213	213	7	4	3	3
240	250	243	245	243	10	3	5	3
270	264	271	272	272	-6	1	2	2
300	292	305	302	301	-8	5	2	1
330	327	326	331	331	-3	-4	1	1
360	360	360	362	362	0	0	2	2

* 1/29/90 calibrations were indoors in Rockville, MD
* 10/1/91 calibrations were outdoors in St. Petersburg, FL

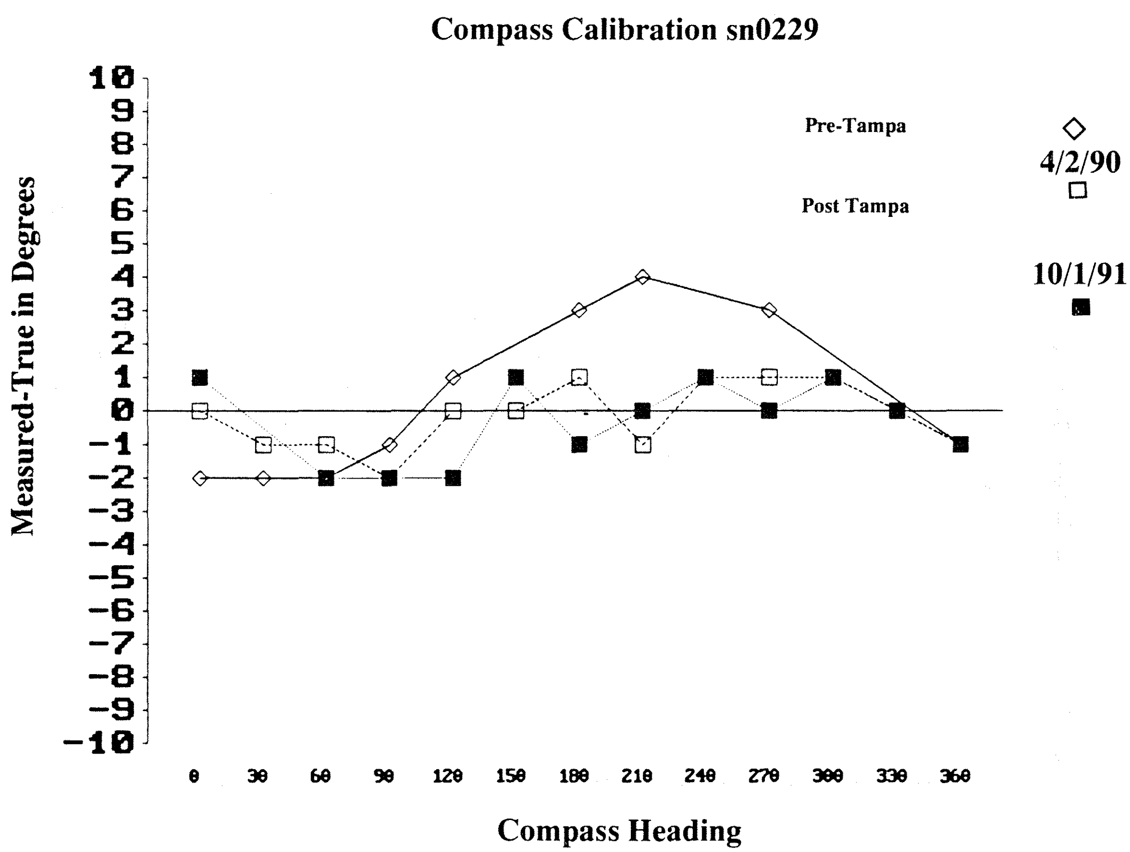


ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0229 - 1200 kHz TRANSDUCER

	4/2/90	10/1/91		4/2/90	10/1/91	
TRUE	CCW	CW	CCW	ERROR	ERROR	ERROR
0	-2	0	1	-2	0	1
30	28	29		-2	-1	
60	58	59	58	-2	-1	-2
90	89	88	88	-1	-2	-2
120	121	120	118	1	0	-2
150		150	151		0	1
180	183	181	179	3	1	-1
210	214	209	210	4	-1	0
240		241	241		1	1
270	273	271	270	3	1	0
300		301	301		1	1
330		330	330		0	0
360	359	359	359	-1	-1	-1

* 4/2/90 calibrations were indoors in Rockville, MD
* 10/1/91 calibrations were outdoors in St. Petersburg, FL

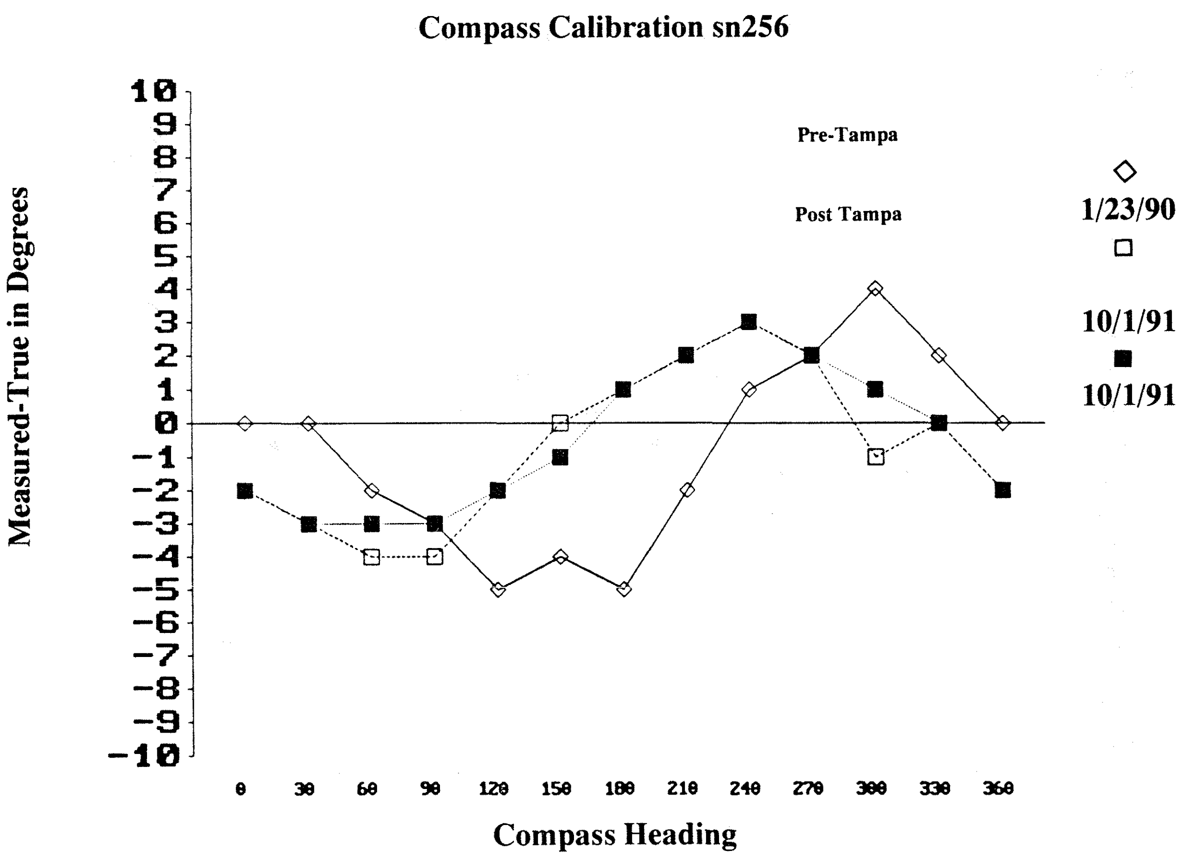


ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0256 - 300 kHz TRANSDUCER

	1/23/90	10/1/91		1/23/90	10/1/91	
TRUE	CCW	CW	CCW	ERROR	ERROR	ERROR
0	0	-2	-2	0	-2	-2
30	30	27	27	0	-3	-3
60	58	56	57	-2	-4	-3
90	87	86	87	-3	-4	-3
120	115	118	118	-5	-2	-2
150	146	150	149	-4	0	-1
180	175	181	181	-5	1	1
210	208	212	212	-2	2	2
240	241	243	243	1	3	3
270	272	272	272	2	2	2
300	304	299	301	4	-1	1
330	332	330	330	2	0	0
360	360	358	358	0	-2	-2

* 1/29/90 calibrations were indoors in Rockville, MD
* 10/1/90 calibrations were outdoors in St. Petersburg, FL

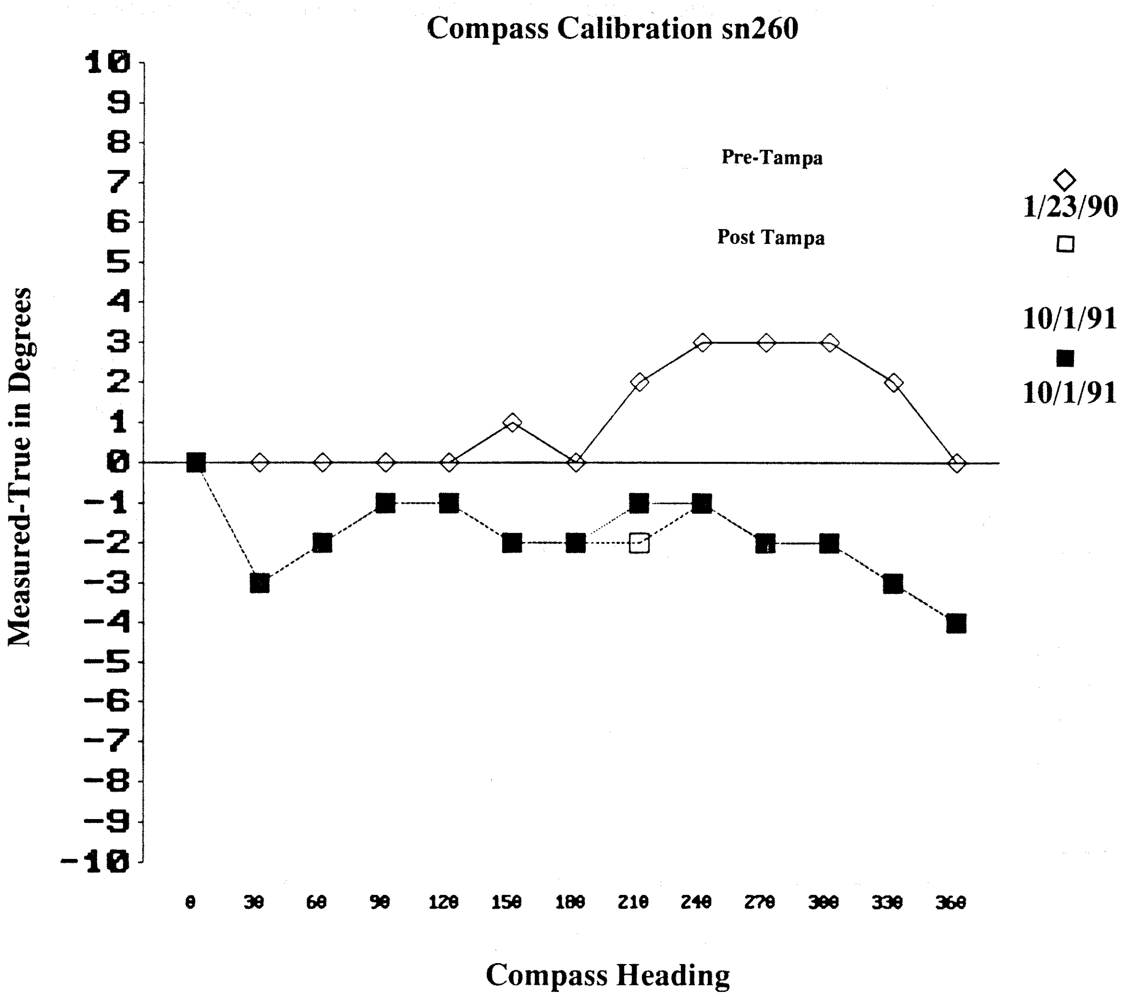


ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0260- 1200 kHz TRANSDUCER

TRUE	1/23/90 CCW	10/1/91 CW	10/1/91 CCW	1/23/90 ERROR	10/1/91 ERROR	10/1/91 ERROR
0	0	0	0	0	0	0
30	30	27	27	0	-3	-3
60	60	58	58	0	-2	-2
90	90	89	89	0	-1	-1
120	120	119	119	0	-1	-1
150	151	148	148	1	-2	-2
180	180	178	178	0	-2	-2
210	212	208	209	2	-2	-1
240	243	239	239	3	-1	-1
270	273	268	268	3	-2	-2
300	303	298	298	3	-2	-2
330	332	327	327	2	-3	-3
360	360	356	356	0	-4	-4

* 1/29/90 calibrations were indoors in Rockville, MD
* 10/1/90 calibrations were outdoors in St. Petersburg, FL

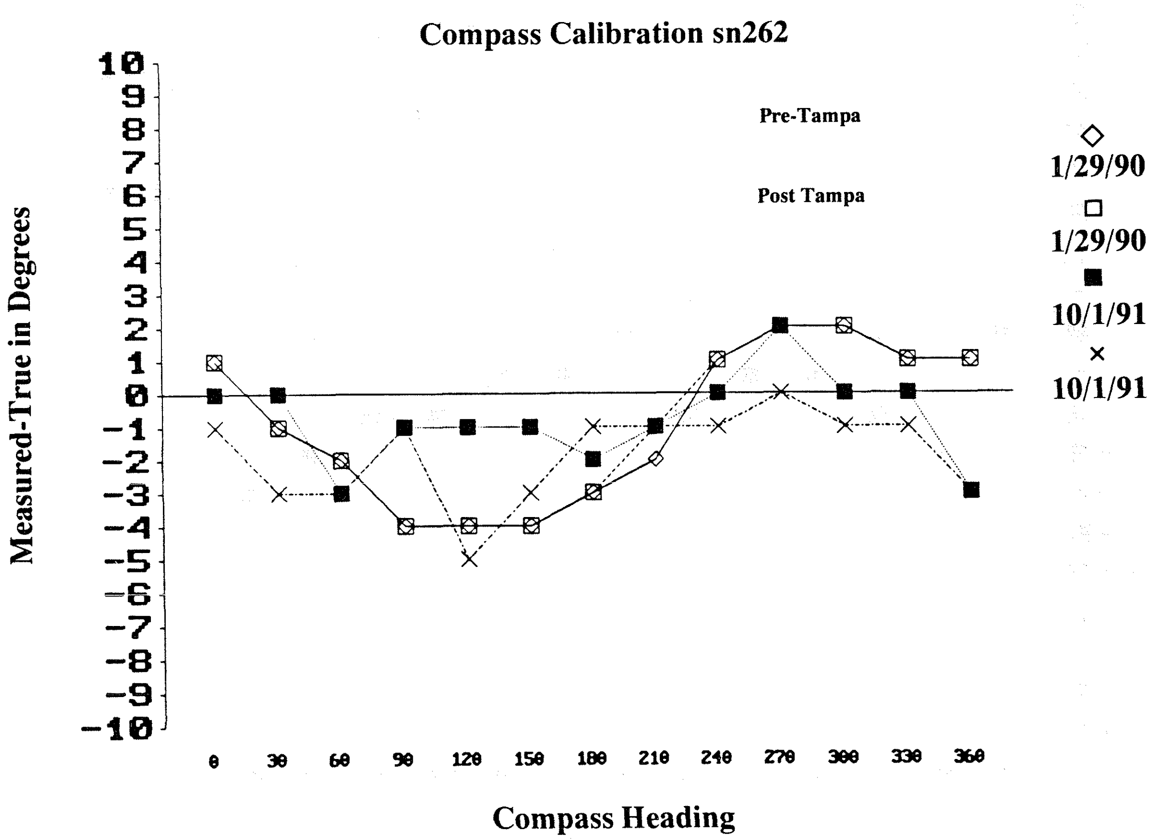


ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0262 - 600 kHz TRANSDUCER

	1/29/90		10/1/91		1/29/90		10/1/91	
TRUE	CCW	CCW	CW	CCW	ERROR	ERROR	ERROR	ERROR
0	1	1	0	-1	1	1	0	-1
30	29	29	30	27	-1	-1	0	-3
60	58	58	57	57	-2	-2	-3	-3
90	86	86	89	89	-4	-4	-1	-1
120	116	116	119	115	-4	-4	-1	-5
150	146	146	149	147	-4	-4	-1	-3
180	177	177	178	179	-3	-3	-2	-1
210	208	209	209	209	-2	-1	-1	-1
240	241	241	240	239	1	1	0	-1
270	272	272	272	270	2	2	2	0
300	302	302	300	299	2	2	0	-1
330	331	331	330	329	1	1	0	-1
360	361	361	357	357	1	1	-3	-3

* 1/29/90 calibrations were indoors in Rockville, MD
* 10/1/90 calibrations were outdoors in St. Petersburg, FL



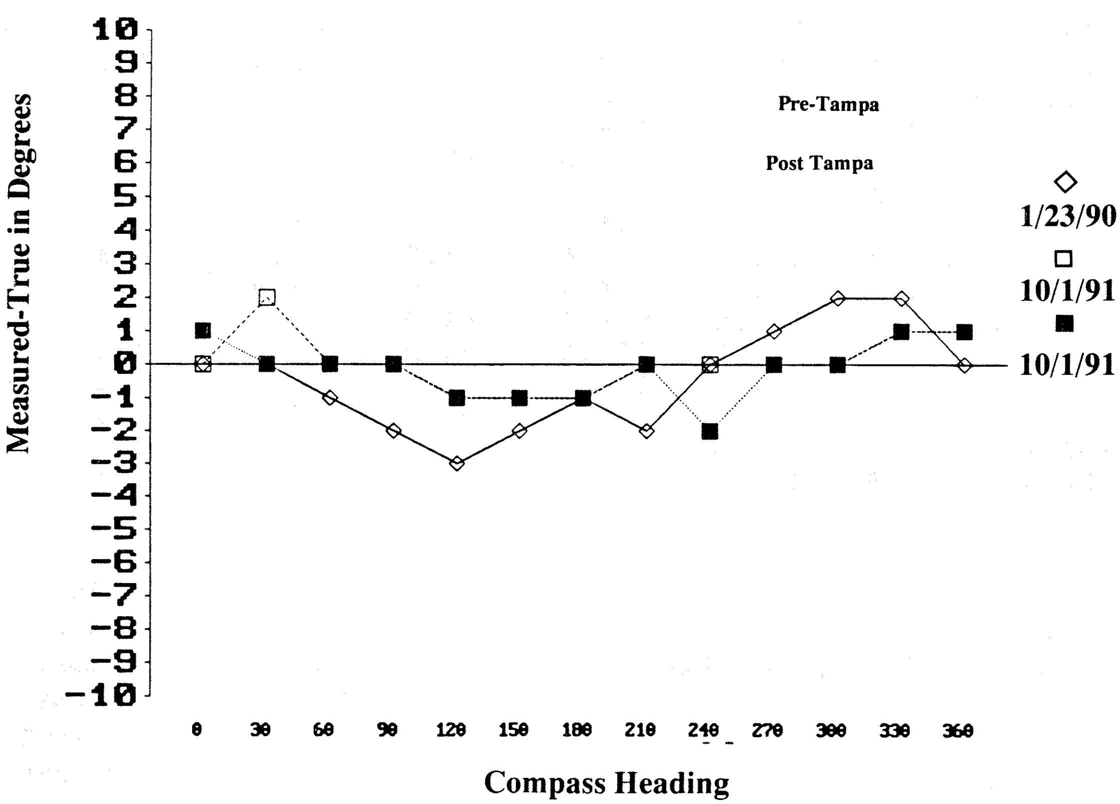
ADCP COMPASS CALIBRATION DATA SHEET

RD ADCP S/N 0263 - 600 kHz TRANSDUCER

	1/23/90	10/1/91		1/23/90	10/1/91	
TRUE	CCW	CW	CCW	ERROR	ERROR	ERROR
0	0	0	1	0	0	1
30	30	32	30	0	2	0
60	59	60	60	-1	0	0
90	88	90	90	-2	0	0
120	117	119	119	-3	-1	-1
150	148	149	149	-2	-1	-1
180	179	179	179	-1	-1	-1
210	208	210	210	-2	0	0
240	240	240	238	0	0	-2
270	271	270	270	1	0	0
300	302	300	300	2	0	0
330	332	331	331	2	1	1
360	360	361	361	0	1	1

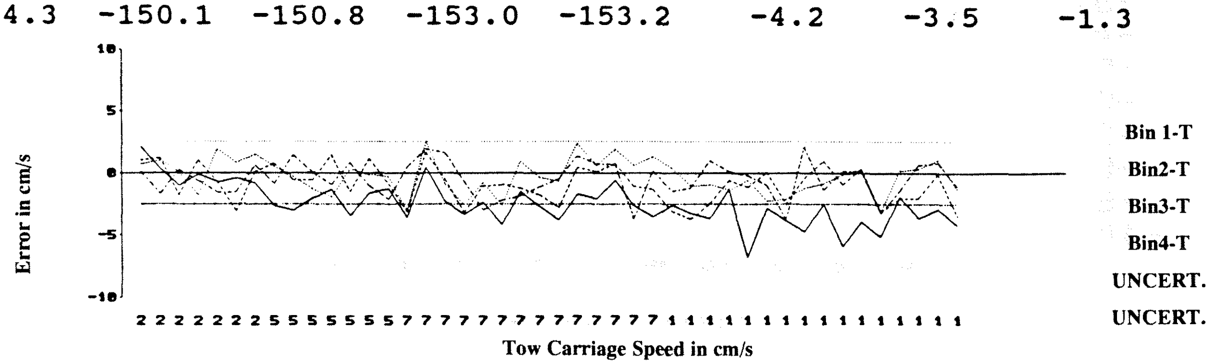
* 1/29/90 calibrations were indoors in Rockville, MD
* 10/1/90 calibrations were outdoors in St. Petersburg, FL

Compass Calibration sn263



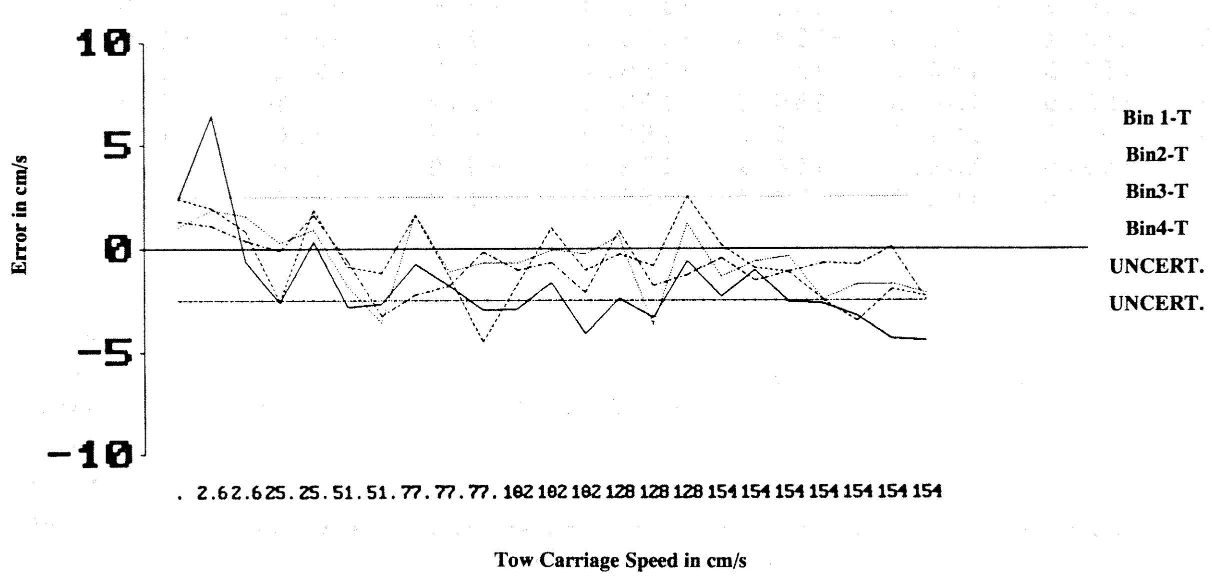
DTRC SPEED CALIBRATION FOR ADCP SN 0177 ON 10/30/91

TRUE	BN1	BN2	BN3	BN4	BN1-T	BN2-T	BN3-T	BN4-T
2.6	-4.7	-3.6	3.3	-2.6	2.1	1.0	.7	.1
2.6	2.9	3.8	3.6	.9	.4	1.2	1.0	-1.7
2.6	1.6	.8	2.6	2.8	-1.0	-1.8	.0	.2
2.6	-2.4	3.6	.8	1.9	-.1	1.0	-1.8	-.6
25.7	25.0	25.0	27.6	24.2	-.8	-.8	1.9	-1.6
25.7	25.3	22.7	26.5	24.2	-.4	-3.1	.8	-1.5
25.7	24.9	25.8	27.2	26.3	-.8	.1	1.5	.6
51.4	-48.8	-52.2	-52.0	-50.6	-2.7	.8	.5	-.9
51.4	-48.4	-50.9	-51.1	-52.9	-3.0	-.6	-.3	1.4
51.4	-49.4	-50.8	-50.2	-51.5	-2.0	-.6	-1.3	.0
51.4	50.1	52.9	49.5	50.5	-1.3	1.4	-2.0	-.9
51.4	48.0	49.9	51.7	52.2	-3.4	-1.5	.3	.8
51.4	49.8	52.6	51.2	50.4	-1.6	1.1	-.2	-1.1
51.4	50.2	50.5	51.1	49.3	-1.3	-.9	-.3	-2.1
77.2	-73.6	-74.0	-74.1	-77.6	-3.6	-3.1	-3.0	.5
77.2	-77.6	-78.8	-79.7	-79.1	.4	1.7	2.5	1.9
77.2	-74.8	-76.6	-76.2	-78.7	-2.3	-.6	-1.0	1.6
77.2	-73.8	-74.0	-74.6	-76.5	-3.3	-3.2	-2.6	-.6
77.2	-74.8	-76.1	-76.4	-74.2	-2.3	-1.0	-.8	-3.0
77.2	-73.0	-76.2	-74.5	-75.0	-4.2	-1.0	-2.6	-2.2
77.2	-75.6	-75.9	-78.1	-75.3	-1.5	-1.3	.9	-1.8
77.2	74.4	75.4	76.8	76.1	-2.7	-1.8	-.4	-1.1
77.2	73.3	74.4	76.5	76.7	-3.8	-2.8	-.7	-.5
77.2	75.5	77.5	79.5	78.5	-1.7	.4	2.4	1.3
77.2	75.1	77.2	77.8	77.9	-2.1	.1	.6	.7
77.2	76.6	77.9	79.1	77.9	-.6	.8	1.9	.7
77.2	74.5	76.1	77.8	73.5	-2.7	-1.1	.6	-3.7
77.2	73.6	75.8	78.4	77.3	-3.5	-1.4	1.3	.1
102.9	-100.3	-99.8	-103.3	-101.4	-2.6	-3.1	.4	-1.5
102.9	-99.6	-99.1	-101.8	-101.7	-3.3	-3.8	-1.1	-1.2
102.9	-99.2	-100.4	-101.9	-103.8	-3.7	-2.4	-1.0	.9
102.9	-101.6	-102.2	-101.5	-102.9	-1.3	-.6	-1.4	.1
128.6	-121.8	-127.4	-128.0	-128.4	-6.8	-1.2	-.6	-.2
128.6	-125.7	-128.6	-126.4	-127.6	-2.9	.0	-2.2	-1.0
128.6	-124.7	-126.1	-126.5	-124.8	-3.9	-2.5	-2.1	-3.8
154.3	149.6	153.9	153.1	156.4	-4.7	-.4	-1.2	2.1
154.3	151.8	155.3	153.5	153.0	-2.5	1.0	-.8	-1.3
154.3	148.4	153.4	154.2	154.4	-5.9	-.9	-.1	.1
154.3	150.3	154.7	154.5	154.5	-4.0	.4	.2	.2
154.3	-149.2	-151.2	-151.2	-151.1	-5.1	-3.1	-3.1	-3.2
154.3	-152.4	-152.3	-154.5	-152.9	-1.9	-2.1	.2	-1.4
154.3	-150.7	-152.4	-154.7	-155.0	-3.7	-2.0	.3	.6
154.3	-151.4	-154.2	-155.3	-155.1	-2.9	-.1	1.0	.8
154.3	-150.1	-150.8	-153.0	-153.2	-4.2	-3.5	-1.3	-1.1



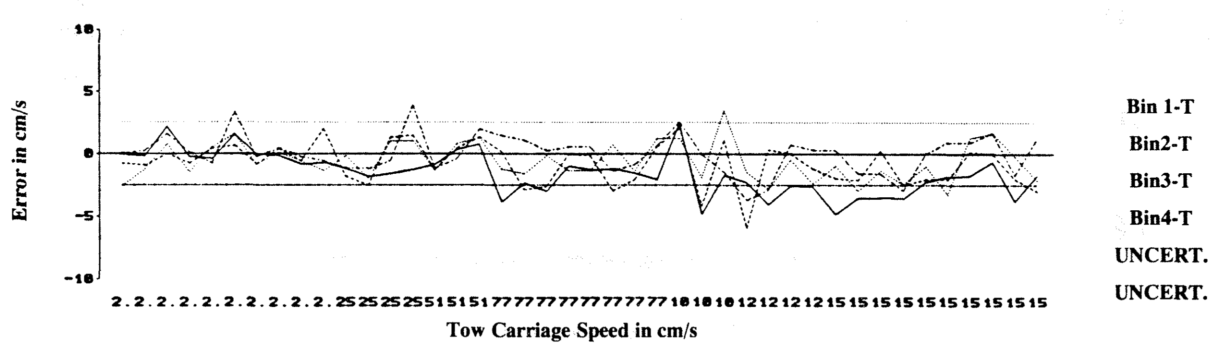
DTRC SPEED CALIBRATION FOR ADCP SN 0229 ON 10/30/91

TRUE	BN1	BN2	BN3	BN4	BN1-T	BN2-T	BN3-T	BN4-T
2.6	-4.9	-5.0	-3.6	-3.9	2.4	2.4	1.1	1.3
2.6	-9.0	-4.5	-4.4	-3.7	6.4	1.9	1.9	1.1
2.6	1.9	-3.4	-4.1	-2.9	-.6	.8	1.5	.4
25.7	-23.1	-23.2	-26.0	-25.6	-2.6	-2.5	.3	-.1
25.7	-26.1	-27.6	-26.6	-27.3	.3	1.9	.9	1.6
51.4	-48.6	-50.6	-49.7	-50.8	-2.8	-.9	-1.8	-.6
51.4	-48.8	-50.2	-47.9	-48.2	-2.6	-1.2	-3.6	-3.2
77.2	-76.4	-78.8	-78.8	-74.9	-.7	1.6	1.7	-2.2
77.2	-75.4	-75.8	-76.1	-75.4	-1.8	-1.3	-1.1	-1.8
77.2	-74.2	-72.6	-76.5	-77.0	-3.0	-4.5	-.7	-.2
102.9	-100.0	-101.1	-102.2	-101.9	-2.9	-1.8	-.7	-1.0
102.9	-101.3	-103.9	-102.8	-102.2	-1.6	1.0	-.1	-.6
102.9	-98.8	-101.9	-102.6	-100.8	-4.1	-1.0	-.3	-2.1
128.6	126.2	128.4	129.2	129.5	-2.4	-.2	.6	.9
128.6	125.3	127.8	124.9	126.8	-3.3	-.8	-3.7	-1.8
128.6	128.0	131.1	129.8	127.4	-.6	2.5	1.2	-1.2
154.3	152.0	154.5	153.0	153.9	-2.3	.2	-1.3	-.4
154.3	153.3	153.4	153.7	152.8	-1.0	-.9	-.6	-1.5
154.3	-151.8	-153.2	-154.0	-153.2	-2.6	-1.1	-.3	-1.1
154.3	-151.7	-151.9	-151.9	-153.6	-2.6	-2.5	-2.4	-.7
154.3	-151.1	-150.8	-152.6	-153.6	-3.2	-3.5	-1.7	-.8
154.3	-150.0	-152.4	-152.6	-154.4	-4.3	-2.0	-1.7	.1
154.3	-149.9	-152.0	-152.2	-151.9	-4.4	-2.3	-2.1	-2.5



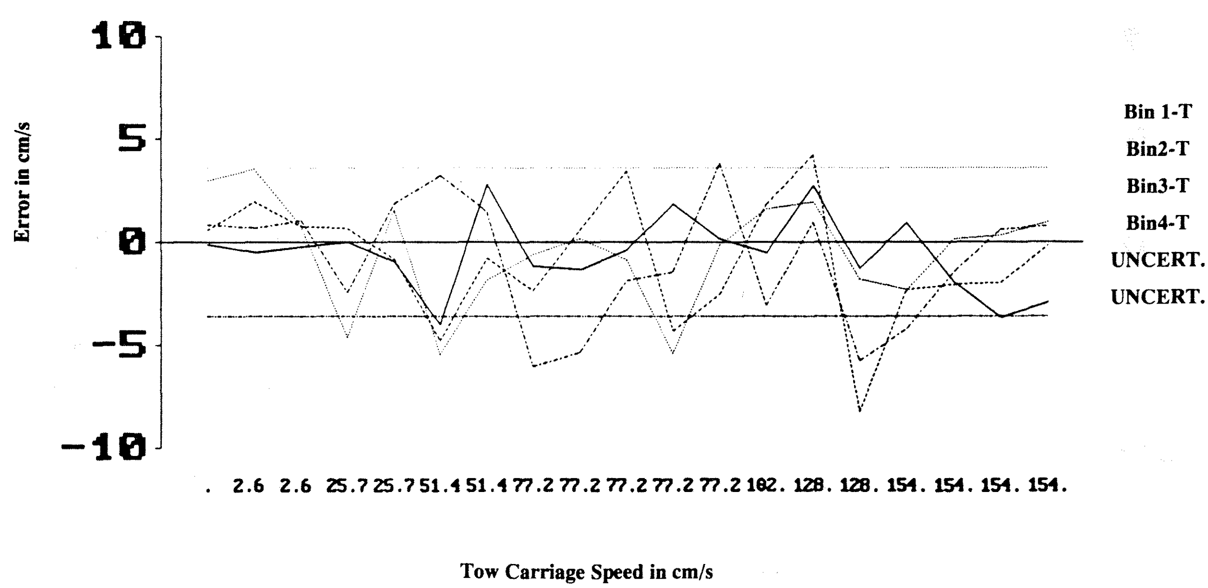
DTRC SPEED CALIBRATION FOR ADCP SN 0260 ON 10/30/91

TRUE	BN1	BN2	BN3	BN4	BN1-T	BN2-T	BN3-T	BN4-T
2.6	-2.5	-1.8	0	-2.6	-.1	-.8	-2.6	.0
2.6	-2.3	-1.6	1.3	-2.8	-.2	-.9	-1.3	.2
2.6	-4.8	-2.6	-3.4	-4.2	2.2	-.0	.8	1.6
2.6	-2.3	1.8	1.1	-2.6	-.3	-.8	-1.5	.1
2.6	-2.2	-3.0	-3.1	1.8	-.4	.4	.5	-.8
2.6	-4.1	-3.2	-4.2	-5.9	1.5	.7	1.6	3.3
2.6	2.5	-1.7	1.7	2.3	-.1	-.8	-.9	-.2
2.6	-2.4	3.0	2.6	-3.0	-.2	.4	.0	.5
2.6	-1.7	2.0	-2.0	-2.3	-.9	-.6	-.6	-.3
2.6	-1.9	-4.6	1.2	-2.0	-.7	2.0	-1.4	-.6
25.7	-24.5	-23.9	-25.6	-24.6	-1.2	-1.9	-.1	-1.2
25.7	-23.9	-23.2	-23.7	-24.5	-1.9	-2.5	-2.0	-1.2
25.7	-24.2	-27.1	-26.7	-25.2	-1.6	1.3	1.0	-.5
25.7	-24.4	-27.2	-26.8	-29.6	-1.3	1.5	1.0	3.9
51.4	-50.6	-50.2	-50.1	-50.3	-.9	-1.3	-1.3	-1.2
51.4	-51.8	-51.9	-52.3	-51.1	.4	.4	.8	-.4
51.4	-52.2	-52.8	-52.7	-53.4	.8	1.3	1.3	2.0
77.2	-73.3	-77.3	-75.9	-78.6	-3.9	.2	-1.3	1.4
77.2	-74.8	-74.3	-75.5	-78.2	-2.3	-2.9	-1.6	1.1
77.2	-74.1	-74.6	-77.0	-77.4	-3.0	-2.6	-.2	.2
77.2	-76.2	-77.1	-75.8	-77.7	-1.0	-.1	-1.3	.5
77.2	-75.8	-77.0	-75.8	-77.6	-1.3	-.2	-1.4	.5
77.2	-75.9	-74.2	-77.9	-75.8	-1.2	-3.0	.7	-1.4
77.2	-75.6	-75.1	-75.8	-76.3	-1.6	-2.0	-1.3	-.8
77.2	-75.1	-77.7	-78.4	-77.8	-2.1	.6	1.2	.7
102.9	105.4	105.0	104.1	105.5	2.5	2.1	1.2	2.6
102.9	98.0	98.7	100.9	102.8	-4.8	-4.2	-1.9	-.1
102.9	101.2	104.0	106.4	101.4	-1.7	1.1	3.5	-1.5
128.6	126.3	122.7	127.2	124.9	-2.3	-5.9	-1.4	-3.7
128.6	124.6	128.9	125.7	125.8	-4.0	.3	-2.9	-2.8
128.6	126.0	128.6	128.1	129.3	-2.6	-.0	-.5	.7
128.6	125.9	127.4	126.2	128.9	-2.7	-1.2	-2.4	.3
154.3	-149.5	-152.3	-153.4	-154.6	-4.8	-2.0	-.9	.3
154.3	-150.8	-152.2	-151.3	-152.8	-3.5	-2.2	-3.0	-1.6
154.3	-150.8	-154.6	-153.0	-152.7	-3.5	.2	-1.3	-1.6
154.3	-150.7	-151.8	-151.9	-151.4	-3.6	-2.5	-2.5	-2.9
154.3	-152.1	-152.3	-153.3	-154.3	-2.2	-2.0	-1.0	-.0
154.3	-152.5	-152.2	-151.0	-155.2	-1.9	-2.1	-3.3	.9
154.3	152.6	154.5	155.6	155.2	-1.7	.1	1.3	.9
154.3	153.7	154.3	156.0	156.0	-.7	-.0	1.7	1.7
154.3	150.5	152.3	154.1	152.6	-3.8	-2.0	-.2	-1.7
154.3	152.6	151.3	152.2	155.6	-1.7	-3.0	-2.2	1.3



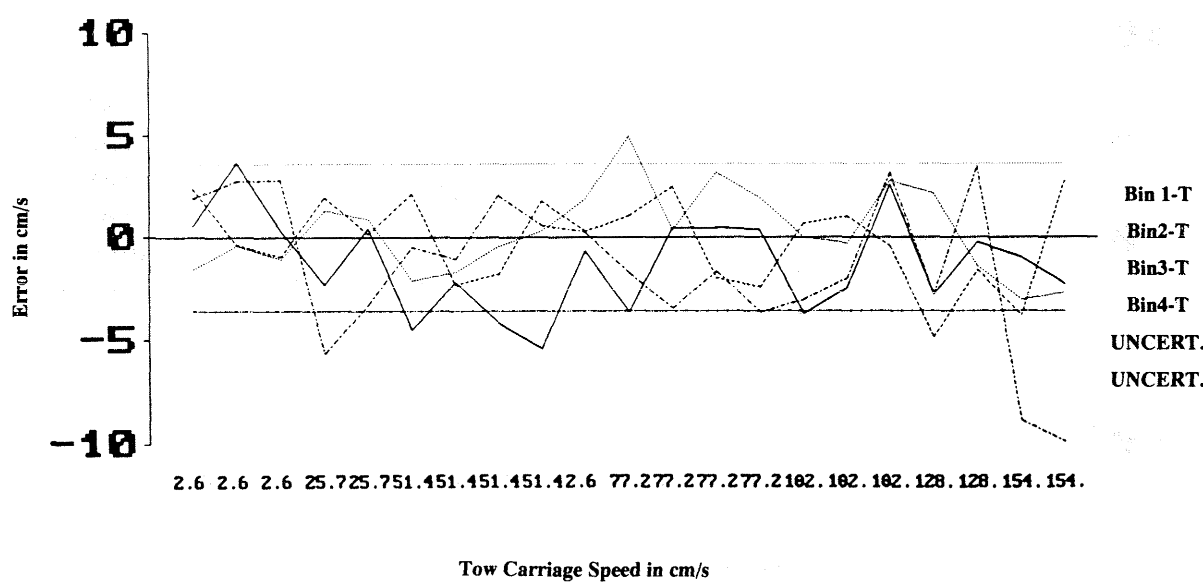
DTRC SPEED CALIBRATION FOR ADCP SN 0262 ON 10/30/91

TRUE	BN1	BN2	BN3	BN4	BN1-T	BN2-T	BN3-T	BN4-T
2.6	-2.4	-3.2	-5.6	3.4	-.1	.6	3.0	.8
2.6	-2.1	4.5	-6.1	3.2	-.5	2.0	3.6	.7
2.6	2.3	-3.3	-3.4	-3.6	-.2	.7	.8	1.1
25.7	-25.7	-26.4	-21.1	-23.3	.0	.7	-4.6	-2.4
25.7	-24.8	-24.9	-27.3	-27.6	-1.0	-.8	1.6	1.9
51.4	-47.4	-46.7	-46.0	-54.7	-4.0	-4.8	-5.4	3.3
51.4	-54.2	-50.7	-49.6	-52.9	2.8	-.8	-1.8	1.5
77.2	-76.0	-74.8	-76.6	-71.1	-1.2	-2.4	-.6	-6.0
77.2	-75.8	-77.7	-77.3	-71.8	-1.3	.6	.2	-5.3
77.2	-76.8	-80.6	-76.3	-75.3	-.4	3.4	-.9	-1.9
77.2	79.0	72.9	71.7	75.7	1.8	-4.3	-5.4	-1.4
77.2	77.3	74.6	77.0	81.0	.2	-2.5	-.1	3.8
102.9	102.3	104.7	104.5	99.8	-.5	1.8	1.6	-3.1
128.6	-131.3	-132.8	-130.6	-129.6	2.7	4.2	2.0	1.0
128.6	-127.3	-120.3	-126.8	-122.9	-1.3	-8.3	-1.8	-5.7
154.3	155.2	152.0	152.0	150.1	.9	-2.3	-2.3	-4.2
154.3	-152.4	-152.3	-154.5	-152.9	-1.9	-2.1	.2	-1.4
154.3	-150.7	-152.4	-154.7	-155.0	-3.7	-2.0	.3	.6
154.3	-151.4	-154.2	-155.3	-155.1	-2.9	-.1	1.0	.8



DTRC SPEED CALIBRATION FOR ADCP SN 0263 ON 10/30/91

TRUE	BN1	BN2	BN3	BN4	BN1-T	BN2-T	BN3-T	BN4-T
2.6	-3.1	-5.0	1.0	-4.5	.6	2.4	-1.5	1.9
2.6	6.2	-2.2	2.2	-5.3	3.7	-.4	-.4	2.8
2.6	2.9	1.6	1.5	-5.4	.3	-.9	-1.1	2.8
25.7	-23.4	-27.7	-27.0	-20.1	-2.3	2.0	1.3	-5.7
25.7	-26.2	-25.9	-26.6	-22.4	.4	.2	.9	-3.3
51.4	-46.9	-53.6	-49.3	-50.9	-4.5	2.2	-2.1	-.5
51.4	-49.2	-49.1	-49.7	-50.3	-2.2	-2.3	-1.7	-1.1
51.4	-47.3	-49.6	-51.0	-53.5	-4.2	-1.8	-.4	2.1
51.4	-46.0	-53.2	-51.8	-52.0	-5.4	1.8	.3	.6
2.6	-1.9	-2.8	4.5	-2.8	-.7	.3	1.9	.2
77.2	73.5	78.2	82.1	75.4	-3.7	1.1	5.0	-1.8
77.2	77.6	79.7	77.5	73.7	.4	2.5	.3	-3.5
77.2	77.6	75.1	80.3	75.5	.5	-2.0	3.2	-1.7
77.2	77.5	74.7	79.1	73.5	.3	-2.5	1.9	-3.7
102.9	-99.2	-103.6	-102.9	-99.8	-3.7	.7	.0	-3.0
102.9	-100.4	-103.9	-102.6	-100.9	-2.5	1.0	-.3	-2.0
102.9	-105.5	-102.4	-105.6	-106.1	2.6	-.5	2.8	3.2
128.6	125.8	123.7	130.7	125.8	-2.8	-4.9	2.1	-2.8
128.6	128.4	127.0	127.2	132.1	-.2	-1.6	-1.4	3.5
154.3	-153.3	-150.5	-151.3	-145.4	-1.0	-3.8	-3.1	-8.9
154.3	-152.0	-157.1	-151.6	-144.4	-2.3	2.7	-2.7	-9.9



S4 PRE-DEPLOYMENT SPEED CALIBRATION ERROR (CM/S)

	S4 Aligned West			Rotated 90 Degrees		
SERIAL NUMBER	CARRIAGE SPEED	S4 SPEED	S4 ERROR	CARRIAGE SPEED	S4 SPEED	S4 SPEED
1469	2.28	2.46	.19	2.75	2.83	.09
	12.93	12.30	-.63	13.14	12.65	-.49
	25.70	25.83	.14	25.73	25.26	-.47
	38.53	37.61	-.92	38.33	37.19	-1.14
	51.40	50.48	-.92	51.46	49.98	-1.48
	76.98	74.08	-2.90	76.72	73.39	-3.33
	103.36	98.56	-4.80	103.18	98.01	-5.17
	153.30	147.60	-5.70	154.42	146.96	-7.46
1470	2.73	6.06	3.34	2.83	4.45	1.62
	12.82	12.37	-.45	12.96	12.80	-.16
	25.72	24.89	-.83	25.92	25.58	-.34
	38.57	36.07	-2.50	38.79	36.70	-2.09
	51.48	48.28	-3.20	51.55	48.92	-2.63
	77.22	71.27	-5.95	77.14	72.67	-4.47
	103.04	95.87	-7.17	103.28	96.45	-6.83
	154.40	142.80	-11.60	153.98	144.79	-9.19
1471	2.65	2.86	.21	2.72	2.95	.23
	12.85	12.54	-.31	12.96	12.01	-.95
	25.75	25.87	.12	25.89	25.62	-.27
	39.10	37.90	-1.20	38.68	37.23	-1.45
	51.40	49.21	-2.19	51.31	49.73	-1.58
	77.60	73.29	-4.31	77.64	72.47	-5.17
	102.94	98.89	-4.05	103.00	97.94	-5.06
	154.62	145.91	-8.71	154.46	145.58	-8.88
1472	12.79	12.41	-.38	12.90	13.41	.51
	25.82	25.48	-.34	25.49	25.32	-.17
	51.52	49.08	-2.44	51.54	49.04	-2.50
	77.47	72.30	-5.17	77.29	72.55	-4.74
	103.45	95.44	-8.01	103.14	97.77	-5.37
				154.41	144.59	-9.82

S4 PRE-DEPLOYMENT COMPASS CALIBRATION (DEGREES)

SN 1469

REFERENCE COMPASS	S4 CW	S4 CW-ERROR	S4 CCW	S4 CCW-ERROR
360	361	1	361	1
45	47	2	46	1
90	91	1	90	0
135	135	0	135	0
180	179	-1	178	-2
225	222	-3	223	-2
270	268	-2	269	-1
315	315	0	315	0
0	0	0	0	0

SN 1470

REFERENCE COMPASS	S4 CW	S4 CW-ERROR	S4 CCW	S4 CCW-ERROR
360	359	-1	359	-1
45	49	4	45	0
90	91	1	89	-1
135	137	2	135	0
180	180	0	179	-1
225	226	1	222	-3
270	271	1	271	1
315	316	1	315	0
0	1	1	2	1

SN 1469

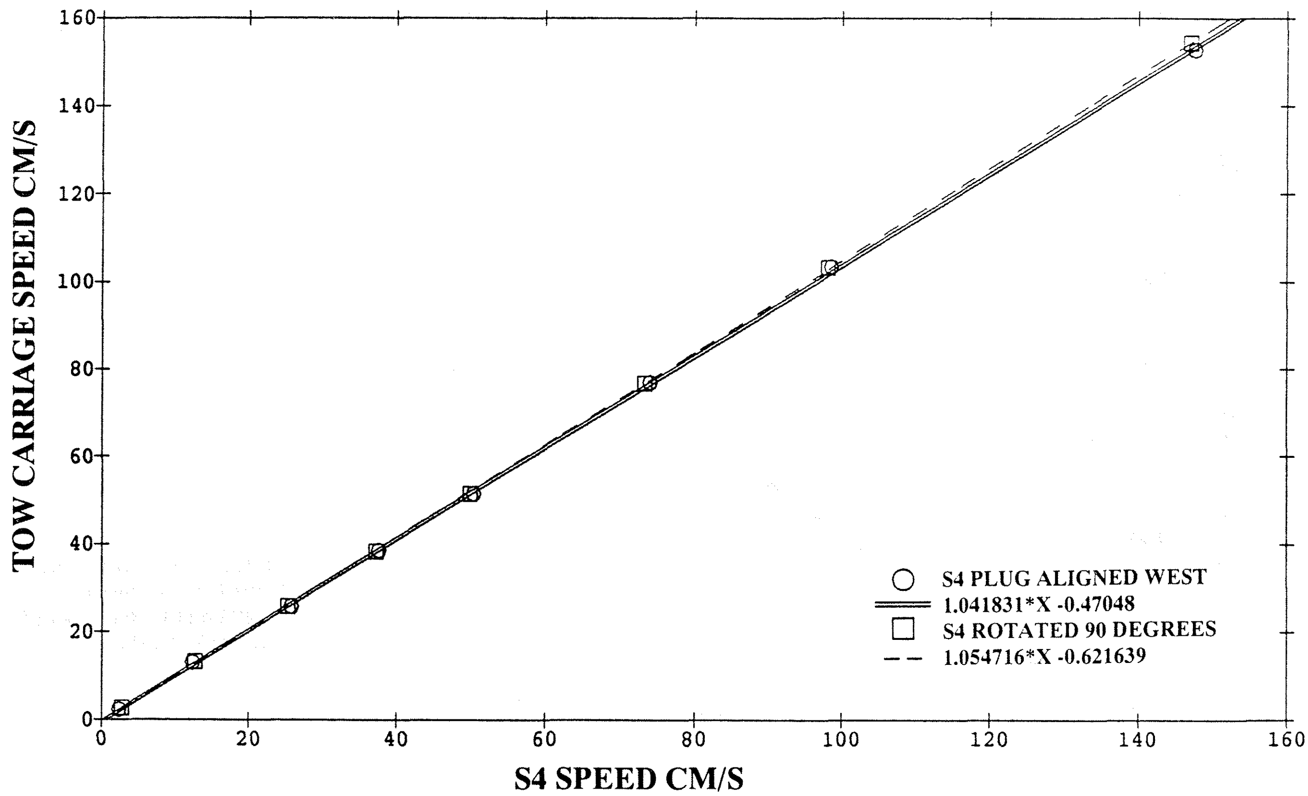
REFERENCE COMPASS	S4 CW	S4 CW-ERROR
360	358	-2
45	43	-2
90	89	-1
135	136	1
180	180	0
225	226	1
270	269	-1
315	312	-3
0	0	0

SN 1469

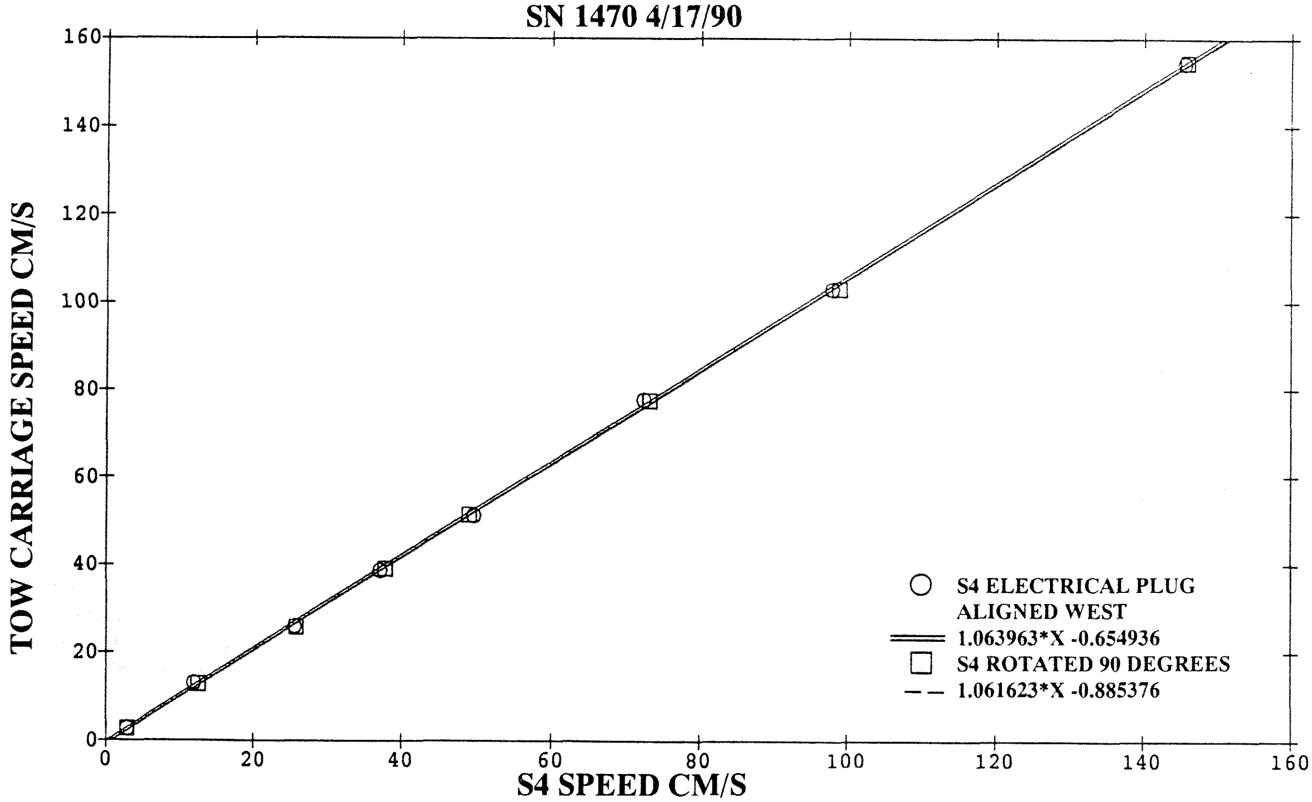
REFERENCE COMPASS	S4 CW	S4 CW-ERROR	S4 CCW	S4 CCW-ERROR
360	358	-2	358	-2
45	43	-2	45	0
90	90	0	90	0
135	135	0	135	0
180	180	0	180	0
225	224	-1	223	-2
270	270	0	270	0
315	313	-2	313	-2
0	-2	-2	-2	-2

DTRC S4 PRE-DEPLOYMENT SPEED CALIBRATION
EAST & WEST SPEED AVERAGED

SN 1469 4/17/90

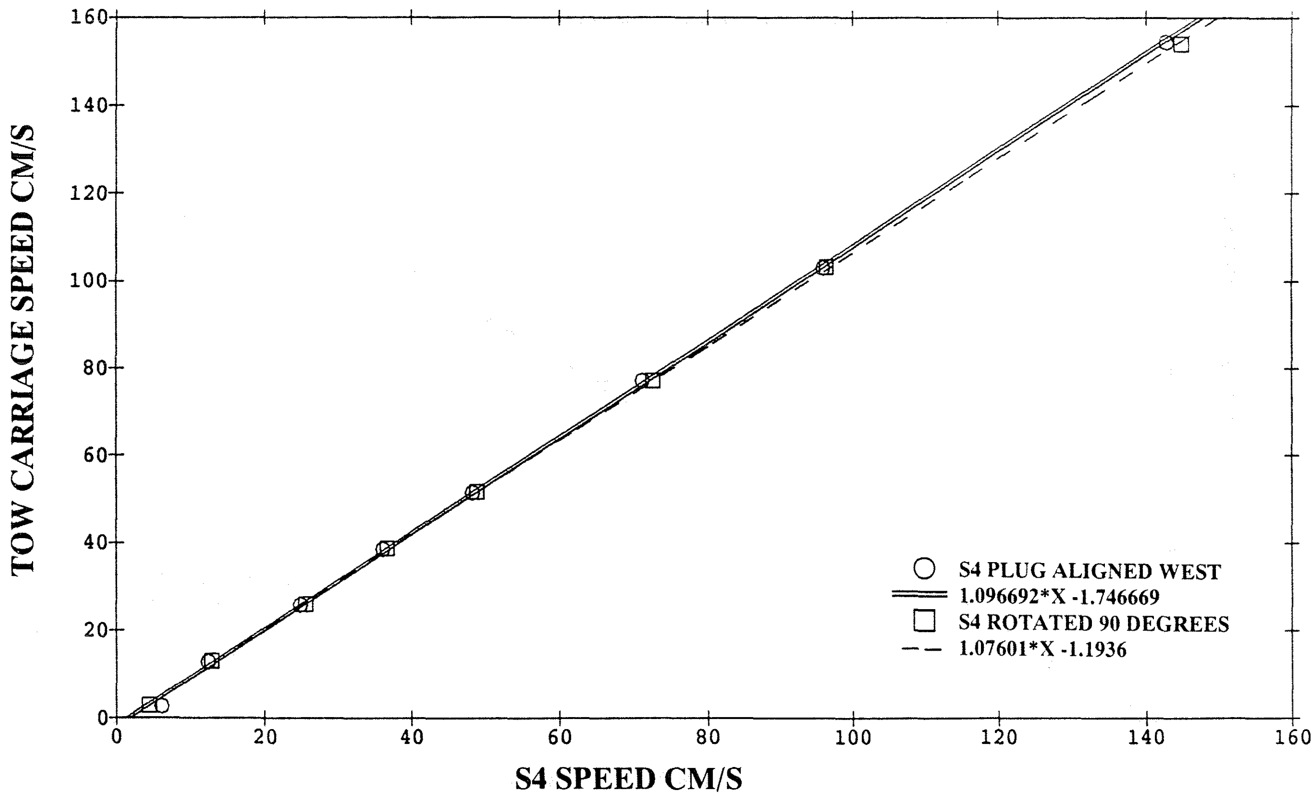


SN 1470 4/17/90

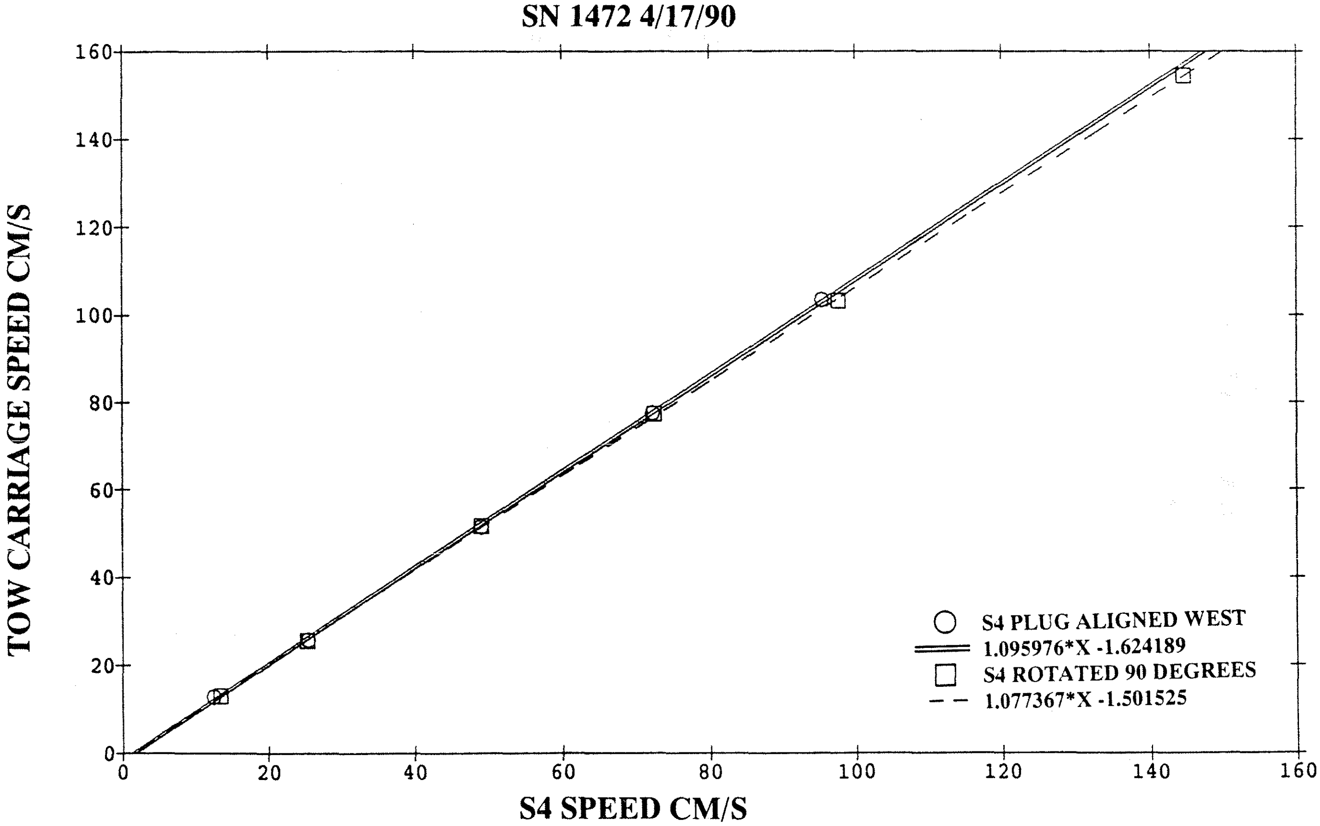


DTRC S4 PRE-DEPLOYMENT SPEED CALIBRATION
EAST & WEST SPEED AVERAGED

SN 1471 4/17/90



SN 1472 4/17/90



APPENDIX E
CT/CTD CALIBRATION REPORT

SBE 163487-500 24 May 1990

Pressure calibration: PAINE 211-75-710-04 100 psia S/N 136421

Straight Line Fit:

Pressure(psia) = M * N + B (N = Binary output)

M = -0.01296 B,= 49.13

Quadratic Fit:

Pressure(psia) = A0 + A1 * N + A2 * N * N (N = binary output)

A0 = 49.08437 A1 = -1.294702e-02 A2 = 7.721039e-09

Pressure (psi)	Output (N)	Straight Line Fit error, psi	Straight Line Fit error, %FS	Quadratic Fit error, psi	Quadratic Fit error, %FS
14.64	2664.00	-0.024	-0.02	0.009	0.01
20.01	2253.00	-0.074	-0.07	-0.059	-0.06
40.02	707.00	-0.058	-0.06	-0.090	-0.09
60.04	-840.00	-0.027	-0.03	-0.071	-0.07
80.05	-2386.00	-0.011	-0.01	-0.028	-0.03
100.06	-3927.00	-0.058	-0.06	-0.013	-0.01
80.05	-2394.00	0.093	0.09	0.076	0.08
60.04	-851.00	0.115	0.12	0.072	0.07
40.02	696.00	0.085	0.09	0.052	0.05
20.01	2245.00	0.030	0.03	0.044	0.04
14.64	2663.00	-0.014	-0.01	0.020	0.02

Output binary values are averages of 101 samples taken at 2 Hz.

SEASOFT Versions 3.3M and higher will prompt for A0, A1, and A2

SEASOFT Versions 3.3L and lower will prompt for M and B

CT/CTD CALIBRATION REPORT

CONDUCTIVITY CALIBRATION DATA PSS 1978: C(35,15,0) = 4.2914 Siemens/meter
CALIBRATION DATE: 05-18-90

SENSOR SERIAL NUMBER = 500

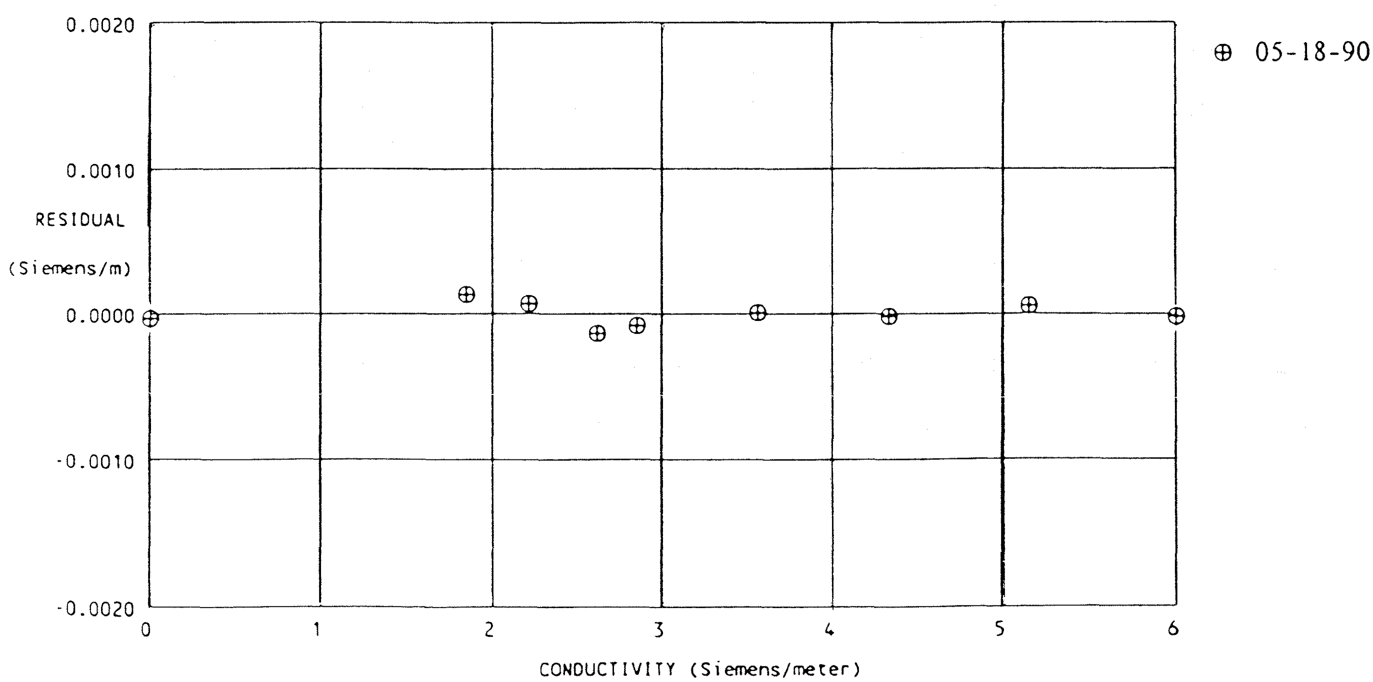
a = 2.23958482e-04 b = 4.58323619e-01
c = -3.82352556e+00 d = 3.10268467e-04
m = 3.3

BATH TEMP (°C)	BATH SAL (°/oo)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
27.0782	15.2610	2.61312	8.05349	2.61299	-0.00013
18.9183	15.2592	2.20858	7.49288	2.20865	0.00007
11.1413	15.2589	1.84213	6.94534	1.84226	0.00013
31.0313	35.3350	5.99581	11.72573	5.99579	-0.00002
23.0209	35.3603	5.14755	10.92408	5.14761	0.00006
15.0114	35.3609	4.33205	10.09190	4.33203	-0.00002
6.9473	35.3601	3.55601	9.22914	3.55602	0.00001
-0.9836	35.3593	2.84562	8.35997	2.84554	-0.00008
0.0000	0.0000	0.00000	2.88542	-0.00003	-0.00003

Conductivity = $(af^m + bf^2 + c + dt) / [10(1 - 9.57(10^{-8})p)]$ Siemens/meter, where p = pressure in dbars

Residual = instrument conductivity - bath conductivity

NOTE: Multiply Siemens/meter by 10 to obtain mmho/cm



CT/CTD CALIBRATION REPORT

TEMPERATURE CALIBRATION DATA
CALIBRATION DATE: 05-18-90

SENSOR SERIAL NUMBER = 500

$a = 3.67423889e-03$ $b = 5.78069970e-04$
$c = 1.17545208e-05$ $d = 1.93718555e-06$
$f_o = 2284.03$

BATH TEMP (°C)	INSTRUMENT FREQ (Hz)	INST TEMP (°C)	RESIDUAL (°C)
27.0782	4164.70	27.0771	-0.00113
18.9183	3534.84	18.9179	-0.00036
11.1413	2999.52	11.1394	-0.00189
3.0085	2504.48	3.0112	0.00266
31.0313	4496.14	31.0311	-0.00017
23.0209	3842.82	23.0236	0.00270
15.0114	3258.22	15.0110	-0.00039
6.9473	2736.22	6.9471	-0.00022
-0.9836	2284.03	-0.9848	-0.00119

Temperature = $1/\{a + b[\ln(f_o/f)] + c[\ln^2(f_o/f)] + d[\ln^3(f_o/f)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature