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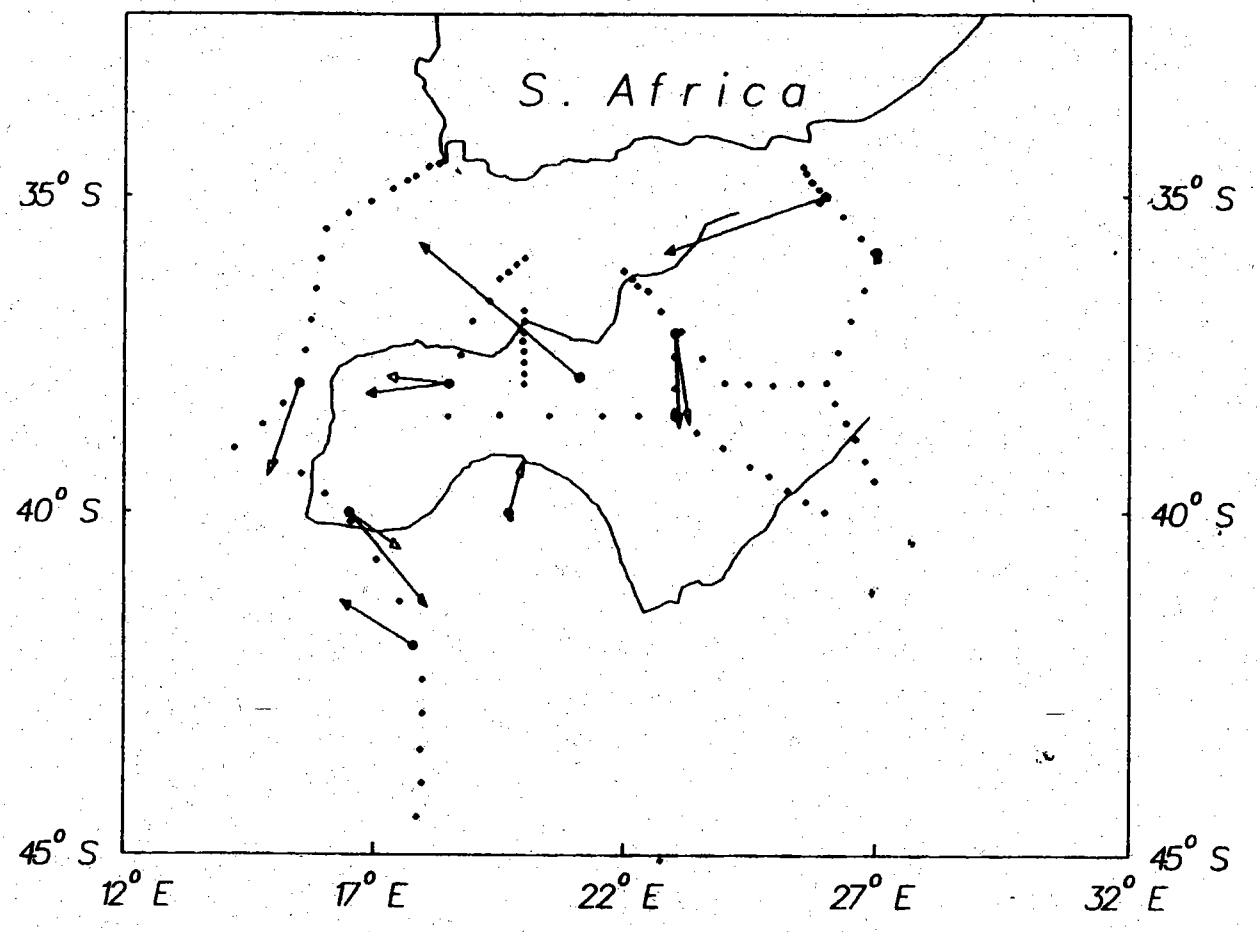
# Moored Current Meter, AVHRR, CTD, and Drifter Data From the Agulhas Current and Retroflexion Region (1985-1987) Volume XLII




by

J. Luyten, A. Spencer, S. Tarbell, K. Luetkemeyer, P. Flament, J. Toole,
M. Francis and S. Bennett

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

July 1990

**Technical Report**

WHOI-90-30

# Moored Current Meter, AVHRR, CTD, and Drifter Data From the Agulhas Current and Retroflexion Region (1985-1987) Volume XLII

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## Technical Report

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Approved for publication; distribution unlimited.

Approved for Distribution:

James R. Luyten, Chairman
Department of Physical Oceanography

## Abstract

Data are presented from an experiment designed to explore the spatial and temporal structure of the Agulhas Current and Retroflexion by direct means. Included are the current meter results from 10 moorings in the Retroflexion region, CTD stations occupied on the deployment cruise in 1985, data from satellite tracked (ARGOS) freely drifting surface buoys and numerous images of the sea surface temperature.

In addition, this report includes a floppy disk on which can be found the one-day average currents, the path of the Agulhas Current, CTD stations in "Live Atlas" format, SST frontal analyses (Chassignet and Olson, personal communication) as well as programs written in QuickBASIC which allow one to access and display these observations. The programs are stored in ASCII and can be run under the Microsoft QuickBasic (Version 4.0 or higher). Instructions for running the programs can be found in a file entitled "read.me" on the disk.

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*(fiche only)

† 'Page No.' refers to the number at the top of the printed page.

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Fiche 3 Current Meter Plots, Moorings 837–840

Fiche 4 Current Meter Plots, Moorings 841–843

Fiche 5 AVHRR Images (Sea-surface Temperatures)

Fiche 6 CTD Station Listings

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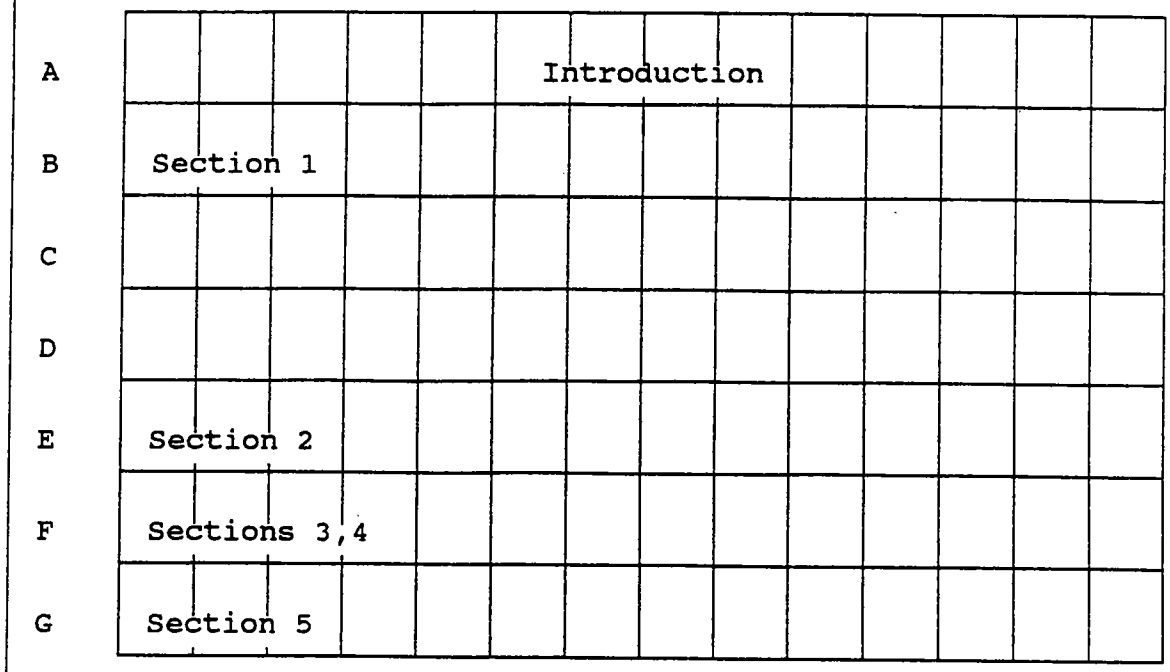
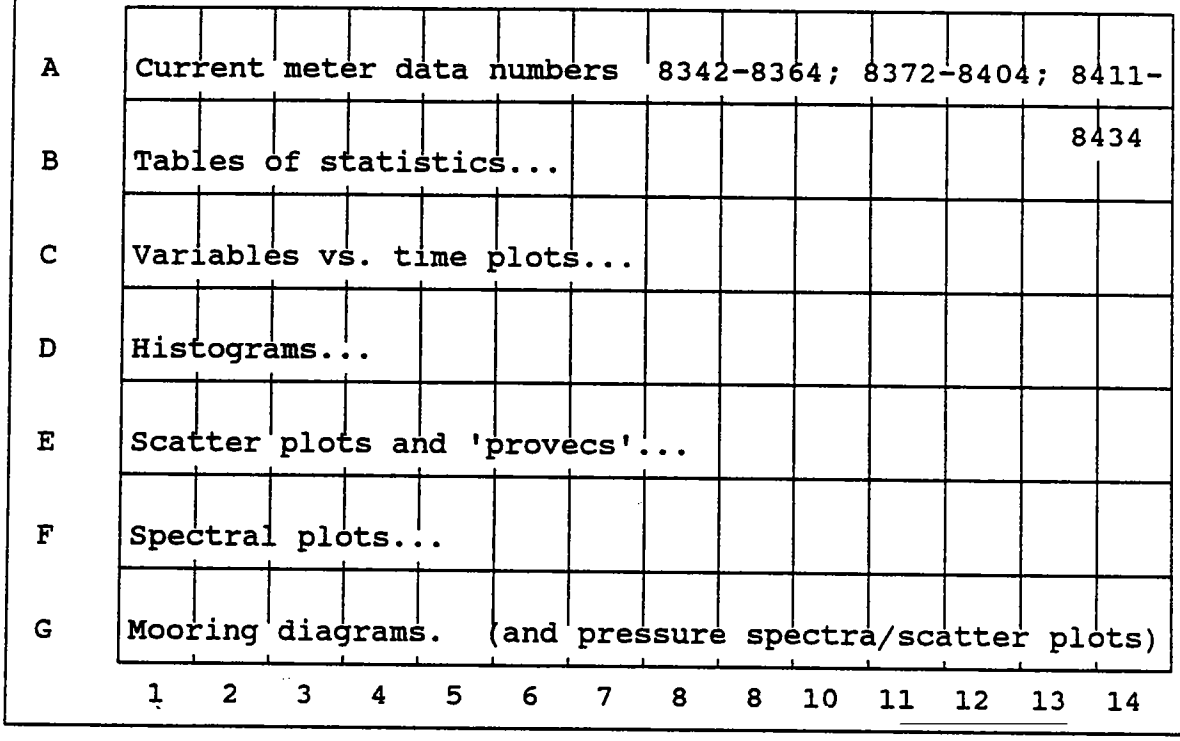



Fiche # 2, 3, 4



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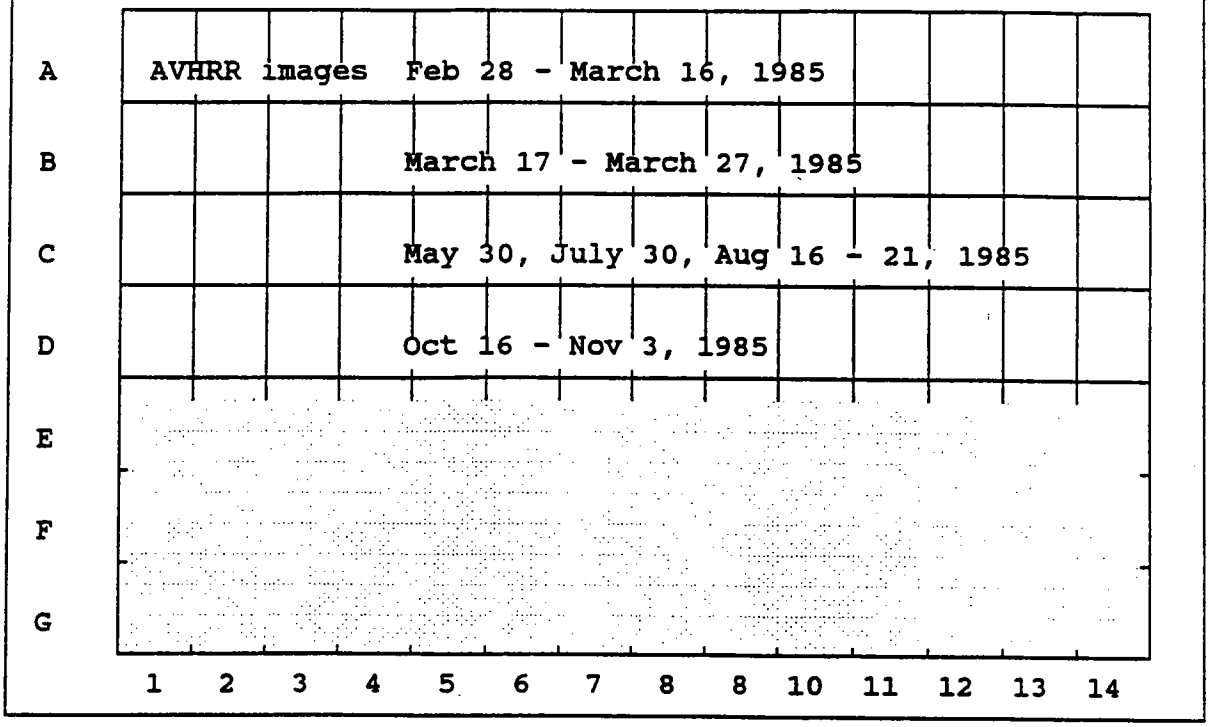
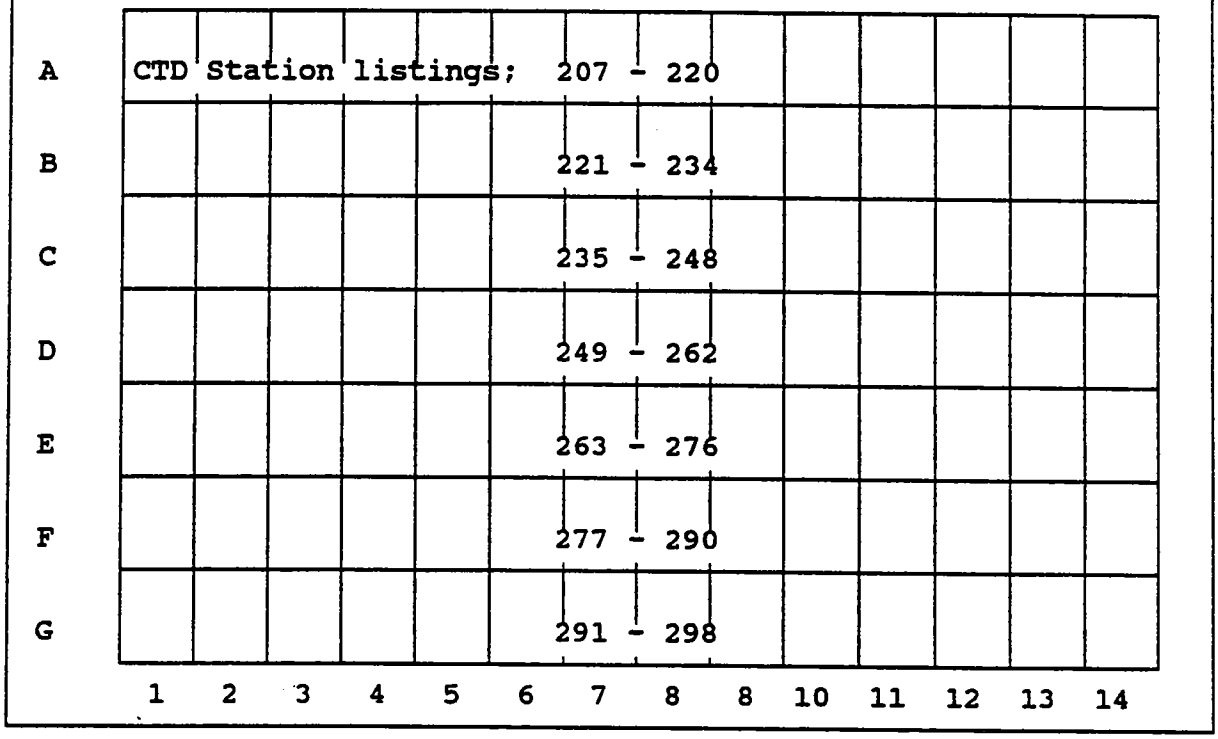



Fiche # 6



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CTD            <DIR>       5-24-90   9:32a
DRIFT          <DIR>       5-24-90   9:32a
MAPS           <DIR>       5-24-90   9:33a
CURRENT        <DIR>       5-24-90   9:34a
PROGRAMS       <DIR>       5-24-90   9:34a
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```
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.            <DIR>       5-24-90   9:32a
..           <DIR>       5-24-90   9:32a
AGSTNLL  DAT       552   6-14-88   1:19p
ALLCTD   DAT    235026   5-22-90   1:59p
STATIONS DIR      1288   5-22-90   1:59p
       5 File(s)    111104 bytes free
```

```
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 Directory of  A:\MAPS

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AGULHAS0 DAT       116   8-29-89  10:31a
AGULHAS1 DAT       172   8-29-89  10:31a
AGULHAS2 DAT       204   8-29-89  10:31a
AGULHAS3 DAT       408   8-29-89  10:31a
AGULHAS4 DAT       512   8-29-89  10:31a
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 Directory of  A:\PROGRAMS

.            <DIR>       5-24-90   9:34a
..           <DIR>       5-24-90   9:34a
CTDPLOT  BAS     23713   5-23-90   3:44p
AGULHAS  BAS     31346   6-01-90   1:46p
CMREAD   BAS      9196   8-31-89   3:08p
```

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 Directory of  A:\CURRENT

.            <DIR>       5-24-90   9:34a
..           <DIR>       5-24-90   9:34a
AGULCM   RAN    409600   8-13-89   4:28p
CMCONTRL DAT      3410   8-14-89   9:21a
FIFTEEN  RAN       852   8-28-89   1:50p
```

## PREFACE

This volume is the 42nd in a series of technical reports presenting moored current meter and associated data collected by the WHOI Buoy Group. Only the volumes covering data gathered since 1978 are listed here. A data directory and bibliography for the years 1963–1978 has been published as WHOI technical report 79-88. A technical memorandum, WHOI-3-88, describes the current-meter data processing system and its use.

| Volume Number | WHOI Reference Number | Author | Experiment |
|---|---|---|---|
| XVIII | 79-65 | Tarbell, S., M. Briscoe & R. Weller | 1978 JASIN |
| XXI | 79-85 | Mills, C. & P. Rhines | 1978 W.B.U.C. |
| XXIII | 80-40 | Tarbell, S. & R. Payne | 1978 POLYMODE |
| XXVIII | 81-73 | Mills, C., S. Tarbell, W. Owens & R. Payne | 1978 L.D.E. |
| XXIX | 82-16 | Levy, E. *et al.* | 1979 INDEX |
| XXX | 82-43 | Levy, E., S. Tarbell & N. Fofonoff | 1979 GSE/NSOI |
| XXXI | 83-30 | Levy, E. & S. Tarbell | 1981 WESPAC |
| XXXII | 83-46 | Levy, E. | 1979 Vema Channel |
| XXXIII | 84-6 | Spencer, A., D. Chausse & W. B. Owens | 1981 NPBC |
| XXXIV | 84-16 | Levy, E. & P. Richardson | 1983 SEQUAL I |
| XXXV | 84-36 | Tarbell, S., N. Pennington & M. Briscoe | 1982–4 LOTUS |
| XXXVI | 84-37 | Levy, E. & P. Richardson | 1983–4 SEQUAL II |
| XXXVII | 85-7 | Levy, E. & P. Richardson | 1984 SEQUAL III |
| XXXVIII | 85-39 | Tarbell, S., E. Montgomery & M. Briscoe | 1983–4 LOTUS |
| XXXIX | 86-14 | Levy, E. & S. Tarbell | 1983–4 HEBBLE |
| XL | 87-19 | Tarbell, S., P. Richardson & J. Price | 1984–6 Canary Basin |
| XLI | 87-20 | Levy, E. & S. Tarbell | 1983–5 Zonal Pacific |

## Introduction:

This report presents data gathered during the period February, 1985 through February, 1987, in the region of the Agulhas Current and Retroflexion region off southern Africa.

The principal scientific objective of this particular program has been to observe the Agulhas Retroflexion system directly. The Agulhas Current system is the western boundary current for the subtropical gyre of the South Indian Ocean. It is a vigorous narrow current, with typical speeds at the sea surface of 2 m/s or more, extending to the ocean floor. Like other western boundary currents, the Agulhas Current meanders over a wide range. In addition, direct estimates of long term mean flow and its variability provide strong constraints on models of this system.

A two-year moored current meter array spanning the Agulhas Retroflexion was deployed and recovered between 1985 and 1987. The array consisted of 10 moorings, with instruments at four depths, the uppermost instrument at a nominal depth of 200 m. The array spanned the Retroflexion from a region where the Agulhas is closely confined to the continental rise to the far western edge of the circulation. During the deployment cruise, the first detailed survey of the path of the Agulhas Current (as defined by the 15° isotherm at 200-m depth) was made, from the continental rise to the Agulhas Plateau, approximately 1800 km in length. On the recovery cruise, a detailed survey was carried out of the upper ocean density structure in the southwest "corner" of the Retroflexion, using a towed undulating CTD, a Seasoar from the Institute of Oceanographic Sciences Deacon Laboratory, Wormley, U.K.

Data were gathered using four instrumental/measuring systems. In section 1, current meter data from 10 two-year-long moorings are presented. In section 2, sea-surface temperatures obtained from satellite imagery collected at Hartebeeshoek, South Africa are presented. Thirty-three black and white images were selected and three composite color images were computed. In section 3, data from 92 CTD stations with values for salinity, potential temperature, dissolved oxygen and geostrophic velocity, are presented graphically and in tabular form. In section 4, tracks from nine surface drifters are presented graphically.

## Deployment Cruise – RV *Thomas Washington*:

The deployment of the moored current meter array was carried out on the RV *Thomas Washington*. The cruise was designated Marathon Legs 11/12 by Scripps Institution of Oceanography. The ship departed Capetown, 20 February, 1985, returning briefly to Capetown on 5 March to load additional equipment for the mooring array. The second leg departed Capetown 7 March and returned at the completion of the work on 28 March, 1985. Charts of the mooring locations and the CTD stations are shown in Figures 1 and 2 of section 1.

The principal scientific activities of the cruise were the deployment of 10 intermediate moorings, occupation of 93 full-depth CTD stations and a detailed survey of the path of the Agulhas Current, as defined by the locus of the 15°C isotherm at 200-m depth. Six ARGOS tracked surface drifters were deployed, one for Robert Chase (WHOI) and the remaining five for Don Olson (RSMAS, University of Miami). Each of these is described briefly in section 4.

**Recovery Cruise – RRS *Discovery*:**

The mooring recovery operation was carried out on RRS *Discovery*, cruise 165a. After sailing from Port Louis, Mauritius 13 March, 1987 *Discovery* steamed for the first mooring (843) to be recovered. A deep CTD station was made at each mooring location. After recovering the second mooring (842), the Seasoar was launched and was towed approximately parallel to the path of the Agulhas Current, until we approached the next group of moorings. A track chart from Read *et al.* (1987) is shown as Figure 3 (Section 1). Moorings 841, 840, and 839 were recovered. The Seasoar was deployed for a three-day run to the next mooring (837) while making a section across the Agulhas toward the coast and then back out again. Moorings 837, 838, 834, and 835 were recovered and Seasoar sections of 17–19 hours running time were made between them. After recovering the final mooring, 836, the remaining time was spent towing the Seasoar. We planned to survey the Retroflexion region, looking at the structure of the "elbow." As the weather worsened, it was found that progress could not be maintained against the westerly wind and eastward current. The Seasoar was recovered and the ship heaved to. A fire in the main engine room while hove-to terminated the scientific work. The *Discovery* returned to Capetown on 8 April 1987.

## SECTION 1

# Current and Temperature Measurements from Moored Instruments in the Agulhas Retroflexion Region

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In this section, data from current meters set on 10 moorings are presented. Current measurements were obtained from 33 of the 40 instruments set. (See Table 2 for an assessment of data quality and Figures 7–26 for velocity, temperature, and pressure plots.)

**Moorings:**

The ten moorings were designed and deployed by the WHOI Buoy Group, with four current meters on each mooring. Nine of the ten moorings had a 60-inch syntactic foam sphere as the principal buoyancy element at the top of the mooring to reduce the overall drag in the expected large near-surface current. The local topography was determined prior to launch by using the ship's Seabeam system to complete a detailed survey. The aids to navigation were generally poor, with the transit system being the most reliable. In the presence of the often strong Agulhas Current and inconsistent navigation, it was difficult to position the ship effectively to deploy the mooring "on target." This accounts for some of the variations in the "mean" depth of the current meters from their nominal depths (this is discussed briefly below under Mooring Performance).

This mooring array was the first one in which significant number of moorings (all 10) were deployed for a two-year period. This required modifications to both the current meters and acoustic releases (each discussed below). Given our uncertainty about the navigation and the survival of the acoustic releases for a two-year deployment, we included an acoustic transponder on each mooring, located at approximately 2000 m depth. All ten of the moorings were recovered in 1987 aboard the RRS *Discovery*. One of the ten (mooring 840) had parted in the first shot of the Kevlar near 2250 m depth. A microscopic analysis was performed on the end returned from sea, and it was reported that "a sharp object cut it — perhaps fishbite" (Bryce Prindle, personal communication). The moorings that were in the major part of the Agulhas Current (839, 838, 842) showed considerable wear on the shackles and other hardware close to the attachment of the syntactic foam sphere to the mooring wire.

**Mooring Performance:**

The performance of the moorings in the strong Agulhas Current was significantly poorer than had been anticipated by the mooring design program. Typically a factor of 2–3 in the ratio between the observed dip of the uppermost instrument and that calculated by the mooring design program NOYFB (Moller, 1976) for the observed current velocities was seen. A study is underway to estimate appropriate drag coefficients by fitting the performance data in a least square sense (Luyten and Tupper, in preparation).

To prepare the releases for a two-year deployment, all circuits were powered by lithium batteries. The capacity of the backup pinger batteries was increased (22 v to 45 v), and the pinger circuit current was closely scrutinized and components changed to obtain the lowest possible current drain in a quiescent state. Likewise, the receiver circuit

was tuned so that current drain was minimized and battery life extended. An extended duration test of similar lithium batteries (bottom mooring 832, off Hawaii) showed that they performed after four years in the water.

The transponder placed on each mooring at approximately 2000 m, to act as a back-up for the release transponders, proved worthwhile. On the recovery cruise, two releases failed to transpond, but fired on command after the backup transponder had indicated the mooring was in position. Double anodes were used on the outer case of the releases, to extend corrosion protection.

In September, 1988, the sphere from the parted mooring (840) was reported beached in western Australia, in the Abrolhos Island group (29°S, 114°E, near Geraldton). It was subsequently shipped back to WHOI. Mooring locations are shown in Figure 1 and in Table 1. Mooring 840 was only partially recovered (see above). Details of the moorings are shown in diagrams, located on row G of the fiche, and one is duplicated as Figure 4. The depths of the instruments were computed using program NOYFB (Moller, 1976) and are shown in Tables 2 and 3.

Table 3 gives pressure and depth information for the upper instruments. It should be noted that the depths for all instruments on mooring 835 were adjusted. A discrepancy of approximately 300 m was seen between the pressure record and the computed NOYFB depth. It was determined that a shot of wire had not been put in the mooring line. Apparent discrepancies between "calculated" (NOYFB) and "observed" (most frequent) pressures can be attributed to mean currents tilting the moorings and increasing the mean depth of the instruments.

**Current Meters:**

The moorings in the array were instrumented with burst sampling (Model 850) and vector averaging (VACM) current meters. They use a Savonius rotor to measure the current speed and are coupled in-line on the moorings. They provide a measure of the speed and direction of the currents and, with calibrated thermistors, water temperature. A crystal-controlled time reference accurate to within one second per day is synchronized with UTC (Universel Temps Coordonne) before launch and the accrued error recorded after recovery.

The only modification for the two-year deployment was the use of lithium batteries. However, with recent information available from a two-year Gulf Stream array, alkaline batteries were found to perform satisfactorily. Magnetic tape length (> 400 feet) and recording interval (30 minutes for VACMs ) were chosen so measurements could be recorded for two years. A one-hour recording rate was chosen for model 850 current meters.

The model 850 current meter, originally built by Geodyne, measures in a burst sampling mode described by Webster (1968). These early instruments were extensively modified at WHOI in the mid-1970s to take advantage of newly developed low-power integrated-circuit technology and a new sensor-bearing design. The basic burst sampling technique was not changed. At a pre-selected time interval, which can be set to any binary multiple of 7.5 minutes, the instrument turns on and begins recording a sequence of strobes (either 7, 15, or 23). These data are recorded on magnetic tape. It then turns off until the beginning of the next record. The first strobe contains temperature information, the second contains the time, and the remainder of the strobes are pairs of rotor counts and compass/vane readings. Each strobe of rotor count is accumulated over 5.19 seconds and is paired with instantaneous compass and vane samples. Valdes (1977) included a more detailed discussion of the WHOI COS/MOS 850 current meter. For the Agulhas array, the strobe rate was set to seven and the recording interval to one hour.

By the early 1970's, engineers at WHOI had developed a vector-averaging current meter which is now commonly known as the VACM. Built by AMF Sea-Link Systems (now EG&G Ocean Products), the VACM continuously sums vector increments of water flow sensed by the rotor and vane. At regular intervals, set prior to deployment, it then records on a magnetic tape cassette the accumulated east-west and north-south velocities as a part of the data record. McCullough (1975) discussed calibration of the vector averaging current meter and its recording technique.

Some VACMs average temperature over the entire recording interval to an accuracy of about 0.01°C (Payne *et al.*, 1976). By 1980, a modification had been developed which permitted up to four variables in addition to current data to be recorded in a time-shared or multiplexed (MX) mode. Many of the VACMs measured temperature and pressure in the array, each averaging over one-half of the record interval. The multiplex circuit temperature measurement is accurate to about .006°C. Pressure is measured to about 0.1% or 3 decibars for a standard 3000 decibar transducer. Pressure and temperature sensors are recalibrated between deployments.

**Data Processing:**

Data from instrument cassettes or cartridges were transferred to VAX disk. Two methods were used; either transfer through an ARI interface or reading to 9-track tape on an LSI-11 computer followed by transfer from tape to VAX disc. The data were then reformatted into BUOY format (Tarbell *et al.*, 1988), the time base checked, and the data converted to scientific units. Then the data quality (Table 2) was determined, bad data points were edited out and the data series were truncated to remove launch and retrieval transients. Gaps in the data were linearly interpolated to create an evenly spaced time series. This series is known as the Best Basic Version (BBV) and is the basis for all further

processing. A low-passed version of the data was created by applying a Gaussian filter with a half-width of 24 hours, then subsampling the filtered series once a day.

WHOI Buoy Group data are identified by a mooring number, a sequential instrument position number, a letter to indicate the data version and numbers to indicate the sampling rate. Therefore, 8392B1800, identifies data from the second instrument on mooring 839. The version number is B and the sampling rate is a record every half hour (1800 seconds). 8391B1DG24 is a time series that has had a Gaussian filter applied to the first instrument on mooring 839. The filter has a half width of 24 hours (G24) and is subsampled once a day (1D).

Data quality and other information are shown in Table 2. The duration and dates are for the daily filtered series. Instrument numbers preceded by an M are model 850 current meters. Numbers preceded by a V are VACMs; if a P follows the number, a pressure sensor was used.

Instrumental problems were mostly caused by excessive vibration of the mooring line in the high currents. Data record 8391 was short due to damage to circuit board components. Data records 8371 and 8392 were unavailable due to tape-drive malfunctions. The data for record 8422 is very suspect, and the instrument exhibited a high rotor threshold.

**Data Presentation:**

Composite plots of 'sticks' (current vectors) and temperature are shown in Figures 7–26. Variables versus time plots, histograms, spectral diagrams statistics and scatterplots are presented on microfiche.

*Histograms*

The histograms of five variables are plotted as percentage of occurrences. There are 50 cells in the x-axis of East component, North component, Speed and Direction. The x-axis of temperature has 100 cells.

*Progressive Vector Plots*

Current vectors from the basic data series are placed head-to-tail to show the path a particle would have travelled in a perfectly homogeneous flow. The plot begins with an asterisk followed by annotated triangles at the first of each month.

*Scatterplots*

East and North components from the Gaussian filtered time series are plotted against each other. The line drawn is the principal axis, the major axis of the ellipse

of variance. The values describing the principal axes in the statistical table are not those for the principal axes drawn on the plot, because the table used the basic sampled data and the plot used the Gaussian filtered data. When pressure was measured, plots of temperature vs. pressure and speed vs. pressure are shown.

*Spectra*

Plots of auto-spectra for the east component of velocity, the north component of velocity, the temperature, and the pressure are shown. Further information about the program used to create these plots may be found in the WHOI program report PROSPECT (Hunt, 1982).

The data is prewhitened and recolored. Program PROSPECT allows averaging in increasingly large groups. Piece lengths are given in Table 5. The frequency-averaging sequence for these data is:

| Number of Frequencies | Number of Groups |
|---|---|
| 3 | 40 |
| 6 | 15 |
| 15 | 6 |
| 30 | 30 |
| 60 | 15 |
| 150 | 6 |
| 300 | 30 |
| 600 | 15 |
| 1500 | 6 |
| 3000 | 30 |
| 6000 | 15 |
| 15000 | 6 |

*Statistics*

The statistics for each variable from the basic time series and the daily filtered time series are presented on fiche. The equations used to derive the statistical parameters are described by Tarbell *et al.* (1988). In Table 4, the statistics from the daily series are summarized. The "< >" nomenclature is used to denote time averaging.

*Variables vs. Time*

All plots of variables versus time are from the Gaussian filtered series. The 'stick' plots, which show individual current vectors along the time scale, are plotted two ways, one with North up and the other rotated so that East is up.

*Array Plots*

A schematic of frames, with an area representing the location of the array, is set up. For a chosen depth level, vectors are plotted with their base at their instrument location. In Figure 25, the vectors represent the time-averaged velocities over the duration of the experiment (or for as long as the instruments performed). Tick intervals represent 1° of latitude and 1° of longitude. Vector scales are 10 cm/sec at upper levels and 2.5 cm/sec at lower levels. In Figure 26, the vectors are from measurements at 200 m, subsampled every tenth day from a gaussian filtered (five-day half-width) series. Tick intervals represent 2° of latitude and 2° of longitude, and the vector scale is 20 cm/sec.

**Acknowledgments:**

This research was made possible with funds provided by the Office of Naval Research, contract numbers N00014-84-C-0134, NR083-400, and N00014-85-C-0001, NR083-004. The principal investigator is James R. Luyten.

The current meter moorings were launched from R/V *Thomas Washington* (*Marathon* cruise, # 11, leg 3) and recovered by R/V *Discovery* (cruise # 165A). The observations reported here were obtained through the assistance of many individuals — notably the members of the Woods Hole Buoy Group, the Woods Hole CTD Group, Raymond Pollard and his Seasoar group from IOS Wormley. Their help is gratefully acknowledged. In addition we gratefully acknowledge the officers and crew of the R/V *Thomas Washington* from Scripps and of the RRS *Discovery* from the National Environment Research Council who often went well beyond their specific duties to assist in our program.

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Webster, F., 1968. A scheme for sampling deep-sea currents from moored buoys. WHOI Technical Report No. 68-2, 14 pp.

**Table 1: Mooring Information**

| Mooring S | Mooring # | Depth (m) | Latitude (°S) | Longitude (°E) | mv | Deployment Date & Time (1985) | Recovery Date & Time (1987) |
|---|---|---|---|---|---|---|---|
| 8 | 834 | 4831 | 38°01.8′ | 15°30.9′ | 25 | Feb 23, 0606 | Feb 15, 0228 |
| 9 | 835 | 4847 | 40°07.96′ | 16°34.6′ | 25 | Feb 25, 1253 | Feb 16, 0545 |
| 10 | 836 | 4864 | 41°59.1′ | 17°50.0′ | 26 | Feb 26, 1137 | Feb 17, 0210 |
| 7 | 837 | 5092 | 40°06.4′ | 19°44.8′ | 26 | Mar 01, 0427 | Feb 12, 1412 |
| 6 | 838 | 4705 | 38°01.5′ | 18°31.3′ | 25 | Mar 09, 0549 | Feb 13, 1529 |
| 5 | 839 | 4620 | 37°52.74′ | 21°08.54′ | 26 | Mar 10, 1003 | Feb 09, 1257 |
| 4 | 840 | 5257 | 38°34.5′ | 23°07.7′ | 26 | Mar 11, 0753 | Feb 08, 1924 |
| 3 | 841 | 5318 | 37°12.2′ | 23°02.0′ | 25 | Mar 11, 0127 | Feb 07, 1535 |
| 2 | 842 | 4649 | 35°55.5′ | 26°59.0′ | 26 | Mar 14, 2326 | Feb 06, 0141 |
| 1 | 843 | 4101 | 35°03.4′ | 26°01.8′ | 25 | Mar 15, 1844 | Feb 05, 0537 |

**Notes:**

- There are two columns of numbers under MOORING. S is the number assigned for scientific use. # is the WHOI mooring number.
- 'mv' is the magnetic variation, in °E, applied to current direction values obtained by the instrument.
- The deployment cruise was leg 3 of the Marathon XI cruise of the R/V *Thomas Washington*. The recovery was made on RRS *Discovery*, cruise #165A.

## Table 2: Data Durations, Depth, and Quality

| Data Name | Instrument Number | Depth (m) | Number of Days | Start Date | End Date | Quality Notes |
|---|---|---|---|---|---|---|
| 8341 | V-590P | 192 | 0 | — | — | Battery outgassed |
| 8342 | V-325P | 741 | 721 | 02/24/85 | 02/13/87 | Current data only |
| | | | 449 | 02/24/85 | 05/15/86 | Early failure of MX data (temp/pressure) |
| 8343 | V-375 | 1493 | 721 | 02/24/85 | 02/13/87 | |
| 8344 | M-260C | 3993 | 721 | 02/24/85 | 02/13/87 | |
| 8351 | V-181P | 408 | 719 | 02/27/85 | 02/14/87 | Depth adjusted |
| 8352 | V-134P | 958 | 553 | 02/27/85 | 02/14/87 | See text |
| 8353 | V-5115 | 1709 | 719 | 02/27/85 | 02/14/87 | |
| 8354 | M-277C | 4209 | 719 | 02/27/85 | 02/14/87 | |
| 8361 | V-177P | 145 | 638 | 02/28/85 | 11/26/86 | Battery failure |
| 8362 | V-115P | 697 | 0 | — | — | No tape pulled |
| 8363 | V-5105 | 1446 | 719 | 02/28/85 | 02/15/87 | |
| 8364 | M-207C | 3947 | 719 | 02/28/85 | 02/15/87 | |
| 8371 | V-109P | 291 | 0 | — | — | Tape problem, see text |
| 8372 | V-141P | 841 | 713 | 03/02/85 | 02/11/87 | |
| 8373 | V-436 | 1593 | 713 | 03/02/85 | 02/11/87 | |
| 8374 | M-261C | 4092 | 713 | 03/02/85 | 02/11/87 | |
| 8381 | V-183P | 195 | 705 | 03/11/85 | 02/12/87 | |
| 8382 | V-366P | 745 | 705 | 03/11/85 | 02/12/87 | |
| 8383 | V-5110 | 1497 | 705 | 03/11/85 | 02/12/87 | |
| 8384 | M-238C | 3996 | 705 | 03/11/85 | 02/12/87 | |
| 8391 | V-182P | 150 | 230 | 03/12/85 | 10/26/85 | Vibration |
| | | 150 | 393 | 03/12/85 | 04/07/86 | See text |
| 8392 | V-163P | 699 | 0 | — | — | Tape problem, see text |
| 8393 | V-5117 | 1451 | 699 | 03/12/85 | 02/07/87 | |
| 8394 | M-256C | 3951 | 176 | 03/12/85 | 09/02/85 | Velocity data only |
| | | | 699 | 03/12/85 | 02/07/87 | Temperature only |
| 8404 | M-227C | 4055 | 699 | 03/12/85 | 02/07/87 | |
| 8411 | V-204P | 194 | 613 | 03/13/85 | 11/14/86 | Battery failure |
| 8412 | V-137P | 744 | 697 | 03/13/85 | 02/06/87 | |
| 8413 | V-381 | 1496 | 697 | 03/13/85 | 02/06/87 | |
| 8414 | M-250C | 3995 | 697 | 03/13/85 | 02/06/87 | |
| 8421 | V-589P | 210 | 692 | 03/16/85 | 02/04/87 | |
| 8422 | V-164P | 760 | 685 | 03/16/85 | 01/28/87 | Tape damaged, see text High rotor threshold |
| 8423 | V-103 | 1512 | 692 | 03/16/85 | 02/04/87 | |
| 8424 | V-681 | 4011 | 692 | 03/16/85 | 02/04/87 | |
| 8431 | V-118P | 203 | 355 | 03/17/85 | 03/05/86 | Battery failure |
| 8432 | V-131P | 753 | 0 | — | — | Clock board failure |
| 8433 | V-113P | 1505 | 690 | 03/17/85 | 02/03/87 | |
| 8434 | V-685 | 3503 | 690 | 03/17/85 | 02/03/87 | |

**Table 3: Pressure Information**

| Data Name | Instrument Number | Nominal Depth (m) | NOYFB Depth (m) | Pressure Min (dbars) | Pressure Max (dbars) | Pressure Range (dbars) | Most Frequent Pressure (dbars) | Most Frequent Depth (m) |
|---|---|---|---|---|---|---|---|---|
| 8342 | V-325P | 700 | 741 | 753 | 1490 | 737 | 750 | 745 |
| 8351 | V-181P | 200 | 108 | 412 | 1105 | 693 | 420* | 418 |
| 8352 | V-134P | 700 | 658 | 966 | 1653 | 687 | 970* | 963 |
| 8361 | V-177P | 200 | 145 | 167 | 585 | 418 | 170 | 169 |
| 8372 | V-141P | 700 | 841 | 842 | 1749 | 907 | 840 | 834 |
| 8381 | V-183P | 200 | 195 | 205 | 1148 | 943 | 205 | 204 |
| 8382 | V-366P | 700 | 745 | 759 | 1699 | 940 | 770 | 765 |
| 8391 | V-182P | 200 | 150 | 209 | 982 | 773 | 209* | 208 |
| 8411 | V-204P | 200 | 194 | 205 | 723 | 518 | 210 | 209 |
| 8412 | V-137P | 700 | 744 | 760 | 1280 | 520 | 760 | 755 |
| 8421 | V-589P | 200 | 210 | 159 | 639 | 480 | 225 | 224 |
| 8422 | V-164P | 700 | 760 | 781 | 1171 | 390 | 785 | 780 |
| 8431 | V-118P | 200 | 203 | 208 | 897 | 689 | 400* | 398 |
| 8433 | V-113P | 700 | 1505 | 1524 | 2008 | 484 | 1650* | 1640 |

* See text.

# Table 4: Velocity and Temperature Statistics

| DATA NAME | START DATE (1985) | # OF PTS. IN AVG. | DEPTH (m) | LAT. (S) | LONG. (E) | <U> | <V> | $<U>^2$ | $<V>^2$ | K.m | $<U'^2>$ (c.g.s. units) | $<V'^2>$ | K.e | $<U'V'>$ | <T> | $<T'^2>^{\frac{1}{2}}$ | $<U'T'>$ | $<V'T'>$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8342A | 02-24 | 720 | 741 | 38°01′ | 15°30′ | -5.8 | 5.3 | 33.7 | 27.9 | 30.8 | 371.3 | 339.7 | 355.5 | 30.5 | | | | |
| 8342A | 02-24 | 438 | 741 | 38°01′ | 15°30′ | | | | | | | | | | 4.652 | 1.3340 | | |
| 8343B | 02-24 | 720 | 1493 | 38°01′ | 15°30′ | -3.7 | 4.4 | 13.7 | 19.2 | 16.5 | 152.7 | 146.1 | 149.4 | -8.3 | 2.806 | 0.1441 | -0.0873 | -0.2834 |
| 8344C | 02-24 | 720 | 3993 | 38°01′ | 15°30′ | 0.0 | 1.8 | 0.0 | 3.3 | 1.6 | 177.9 | 92.2 | 135.0 | -2.8 | 1.281 | 0.1479 | -0.5038 | -0.0147 |
| 8351A | 02-27 | 718 | 409 | 40°07′ | 16°34′ | 7.3 | -6.9 | 53.2 | 47.7 | 50.5 | 912.4 | 829.4 | 870.9 | 4.0 | 9.527 | 2.5509 | -1.1129 | -8.0992 |
| 8352D | 02-27 | 718 | 986 | 40°07′ | 16°34′ | 3.2 | -3.6 | 10.4 | 12.8 | 11.6 | 290.9 | 261.2 | 276.1 | 5.1 | 4.335 | 1.4180 | -2.6463 | -2.7794 |
| 8353A | 02-27 | 718 | 1709 | 40°07′ | 16°34′ | 2.0 | -2.1 | 3.9 | 4.2 | 4.0 | 103.9 | 90.4 | 97.1 | -9.7 | 2.766 | 0.1190 | 0.0806 | -0.2476 |
| 8354B | 02-27 | 718 | 4209 | 40°07′ | 16°34′ | 0.4 | 1.0 | 0.1 | 1.0 | 0.6 | 66.6 | 58.2 | 62.4 | -2.9 | 1.128 | 0.1262 | 0.1023 | -0.4076 |
| 8361A | 02-28 | 637 | 145 | 41°59′ | 17°50′ | 9.4 | 3.8 | 87.4 | 14.1 | 50.8 | 449.5 | 365.6 | 407.5 | 37.9 | 10.486 | 1.4878 | -11.5093 | -1.3593 |
| 8363B | 02-28 | 718 | 1446 | 41°59′ | 17°50′ | 3.2 | 0.2 | 10.2 | 0.1 | 5.2 | 40.1 | 31.2 | 35.6 | -2.9 | 2.769 | 0.0639 | -0.0792 | -0.0817 |
| 8364C | 02-28 | 718 | 3947 | 41°59′ | 17°50′ | 1.9 | -1.3 | 3.6 | 1.8 | 2.7 | 29.3 | 16.5 | 23.9 | -7.2 | 1.147 | 0.1023 | -0.0331 | -0.0777 |
| 8372A | 03-02 | 712 | 841 | 40°06′ | 19°44′ | 8.2 | 5.7 | 67.2 | 32.8 | 50.0 | 354.3 | 435.1 | 394.7 | 124.8 | 4.246 | 1.1735 | 3.2169 | 1.4485 |
| 8373B | 03-02 | 712 | 1593 | 40°06′ | 19°44′ | 1.6 | 5.0 | 2.5 | 24.6 | 13.5 | 160.4 | 180.0 | 170.2 | 63.4 | 2.752 | 0.0974 | 0.1633 | 0.1142 |
| 8374C | 03-02 | 712 | 4092 | 40°06′ | 19°44′ | 0.0 | 3.0 | 0.0 | 9.1 | 4.5 | 116.3 | 66.7 | 92.5 | 21.5 | 1.170 | 0.1104 | -0.2321 | 0.0023 |
| 8381B | 03-11 | 704 | 195 | 38°01′ | 18°31′ | -14.4 | -0.2 | 206.9 | 0.0 | 103.5 | 1305.3 | 1387.9 | 1346.6 | 31.6 | 10.326 | 3.4202 | 8.9414 | 3.9019 |
| 8382A | 03-11 | 704 | 745 | 38°01′ | 18°31′ | -7.9 | 2.9 | 62.5 | 8.3 | 35.4 | 448.8 | 407.8 | 428.3 | -6.6 | 4.661 | 1.8664 | -4.7826 | 4.0800 |
| 8383A | 03-11 | 704 | 1497 | 38°01′ | 18°31′ | -4.3 | 0.2 | 18.7 | 0.1 | 9.4 | 226.4 | 176.1 | 201.2 | -1.3 | 2.769 | 0.1505 | 0.0024 | 0.2204 |
| 8384B | 03-11 | 704 | 3996 | 38°01′ | 18°31′ | 1.0 | 1.2 | 0.9 | 1.4 | 1.2 | 213.2 | 117.5 | 165.4 | 2.4 | 1.170 | 0.1203 | -0.0287 | 0.0825 |
| 8391C | 03-12 | 229 | 210 | 37°52′ | 21°08′ | -49.1 | -28.5 | 2413.0 | 812.8 | 1612.9 | 1026.3 | 846.4 | 936.4 | 87.5 | 11.813 | 2.7580 | 0.6490 | 27.0470 |
| 8391 | 03-12 | 392 | 210 | 37°52′ | 21°08′ | | | | | | | | | | 12.029 | 2.8931 | 63.0869 | 47.0286 |
| 8393A | 03-12 | 698 | 1510 | 37°52′ | 21°08′ | -6.7 | -4.7 | 44.6 | 21.9 | 33.2 | 182.4 | 64.3 | 123.4 | -5.1 | 2.908 | 0.2521 | -1.2886 | 0.0882 |
| 8394B | 03-12 | 175 | 3951 | 37°52′ | 21°08′ | 7.6 | 4.5 | 58.5 | 20.4 | 39.4 | 166.0 | 61.0 | 114.5 | 71.9 | | | | |
| 8394TC | 03-12 | 698 | 3951 | 37°52′ | 21°08′ | | | | | | | | | | 1.251 | 0.1430 | | |
| 8404C | 03-12 | 698 | 4055 | 38°34′ | 23°07′ | -2.8 | 4.8 | 7.6 | 22.8 | 15.2 | 62.1 | 107.9 | 85.0 | -29.5 | 1.422 | 0.1940 | -0.0280 | -0.5812 |
| 8411AC | 03-13 | 612 | 194 | 37°12′ | 23°02′ | -15.7 | -12.5 | 247.0 | 155.3 | 201.2 | 503.5 | 311.6 | 407.6 | 82.8 | 17.357 | 1.3442 | 8.1257 | 5.3881 |
| 8412A | 03-13 | 696 | 744 | 37°12′ | 23°02′ | -14.2 | -10.6 | 202.0 | 111.7 | 156.9 | 233.3 | 149.5 | 191.4 | 47.1 | 10.373 | 1.4504 | 6.2759 | 2.9253 |
| 8413B | 03-13 | 696 | 1496 | 37°12′ | 23°02′ | -7.1 | -8.8 | 50.0 | 77.0 | 63.5 | 70.7 | 66.5 | 69.6 | 4.3 | 3.730 | 0.3590 | 0.6320 | -0.0305 |
| 8414B | 03-13 | 696 | 3995 | 37°12′ | 23°02′ | 4.0 | 1.6 | 16.1 | 2.5 | 9.3 | 70.3 | 55.5 | 62.9 | 27.8 | 1.428 | 0.1310 | 0.0527 | 0.0129 |
| 8421A | 03-16 | 691 | 210 | 35°55′ | 26°59′ | 7.6 | -1.9 | 58.3 | 3.5 | 30.9 | 584.2 | 345.6 | 464.9 | 104.9 | 17.327 | 1.2460 | -16.8060 | 1.8410 |
| 8422QQ | 03-16 | 684 | 760 | 35°55′ | 26°59′ | 3.7 | 0.4 | 13.5 | 0.1 | 6.8 | 165.8 | 114.5 | 140.1 | 38.4 | 10.498 | 1.3178 | -8.9757 | 1.5334 |
| 8423B | 03-16 | 691 | 1512 | 35°55′ | 26°59′ | 1.8 | 0.0 | 3.3 | 0.0 | 1.6 | 38.8 | 22.6 | 30.7 | 8.1 | 3.693 | 0.3614 | -0.3036 | -0.0564 |
| 8424A | 03-16 | 691 | 4011 | 35°55′ | 26°59′ | -1.6 | -1.1 | 2.7 | 1.2 | 2.0 | 79.4 | 56.7 | 68.0 | 19.4 | 1.357 | 0.0821 | 0.2103 | 0.0435 |
| 8431B | 03-17 | 354 | 203 | 35°03′ | 26°01′ | -65.7 | -25.9 | 4319.3 | 672.9 | 2496.1 | 209.0 | 423.3 | 316.2 | 108.1 | 14.117 | 1.9493 | -2.3268 | 18.3787 |
| 8433B | 03-17 | 689 | 1505 | 35°03′ | 26°01′ | -10.8 | -2.2 | 116.2 | 4.9 | 60.6 | 36.4 | 20.6 | 28.5 | 8.6 | 3.182 | 0.2213 | -0.1440 | 0.1321 |
| 8434A | 03-17 | 689 | 3503 | 35°03′ | 26°01′ | 0.4 | 0.2 | 0.1 | 0.0 | 0.1 | 32.7 | 10.8 | 21.8 | 4.0 | 1.753 | 0.1001 | -0.0659 | 0.0212 |

**Table 5: Spectral Information Table**
(number of pieces for all spectral plots = 1)

| File Name | Variables | Points Per Piece | Total Data Cycles |
|---|---|---|---|
| 8342ATP1800 | T | 21384 | 21479 |
| 8342A1800 | V | 34560 | 34611 |
| 8343B1800 | V,T | 34560 | 34622 |
| 8344C1H | V,T | 17280 | 17305 |
| 8351A1800 | V,T,P | 34496 | 34515 |
| 8352D1800 | V,T,P | 34496 | 34514 |
| 8353A1800 | V,T | 34496 | 34515 |
| 8354B1H | V,T | 17248 | 17257 |
| 8361A1800 | V,T,P | 30618 | 30644 |
| 8363B1800 | V,T | 34496 | 34514 |
| 8364C1H | V,T | 17248 | 17257 |
| 8372A1800 | V,T,P | 34200 | 34227 |
| 8373B1800 | V,T | 34200 | 34226 |
| 8374C1H | V,T | 17100 | 17113 |
| 8381B1800 | V,T,P | 33800 | 33846 |
| 8382A1800 | V,T,P | 33800 | 33843 |
| 8383A1800 | V,T | 33800 | 33843 |
| 8384B1H | V,T | 16900 | 16923 |
| 8391C1800 | V,T,P | 11016 | 11041 |
| 8393A1800 | V,T | 33534 | 33555 |
| 8394TC1H | T | 16758 | 16777 |
| 8394B1H | V | 4224 | 4225 |
| 8404C1H | V,T | 16758 | 16777 |
| 8411AC1800 | V,T,P | 29440 | 29448 |
| 8412A1800 | V,T,P | 33396 | 33459 |
| 8413B1800 | V,T | 33396 | 33458 |
| 8414B1H | V,T | 16698 | 16729 |
| 8421A1800 | V,T,P | 33212 | 33219 |
| 8422QQ1800 | V,T,P | 32832 | 32882 |
| 8423B1800 | V,T | 33212 | 33218 |
| 8424A1800 | V,T | 33212 | 33219 |
| 8431B1800 | V,T,P | 17000 | 17042 |
| 8433B1800 | V,T,P | 33048 | 33122 |
| 8434A1800 | V,T | 33048 | 33123 |

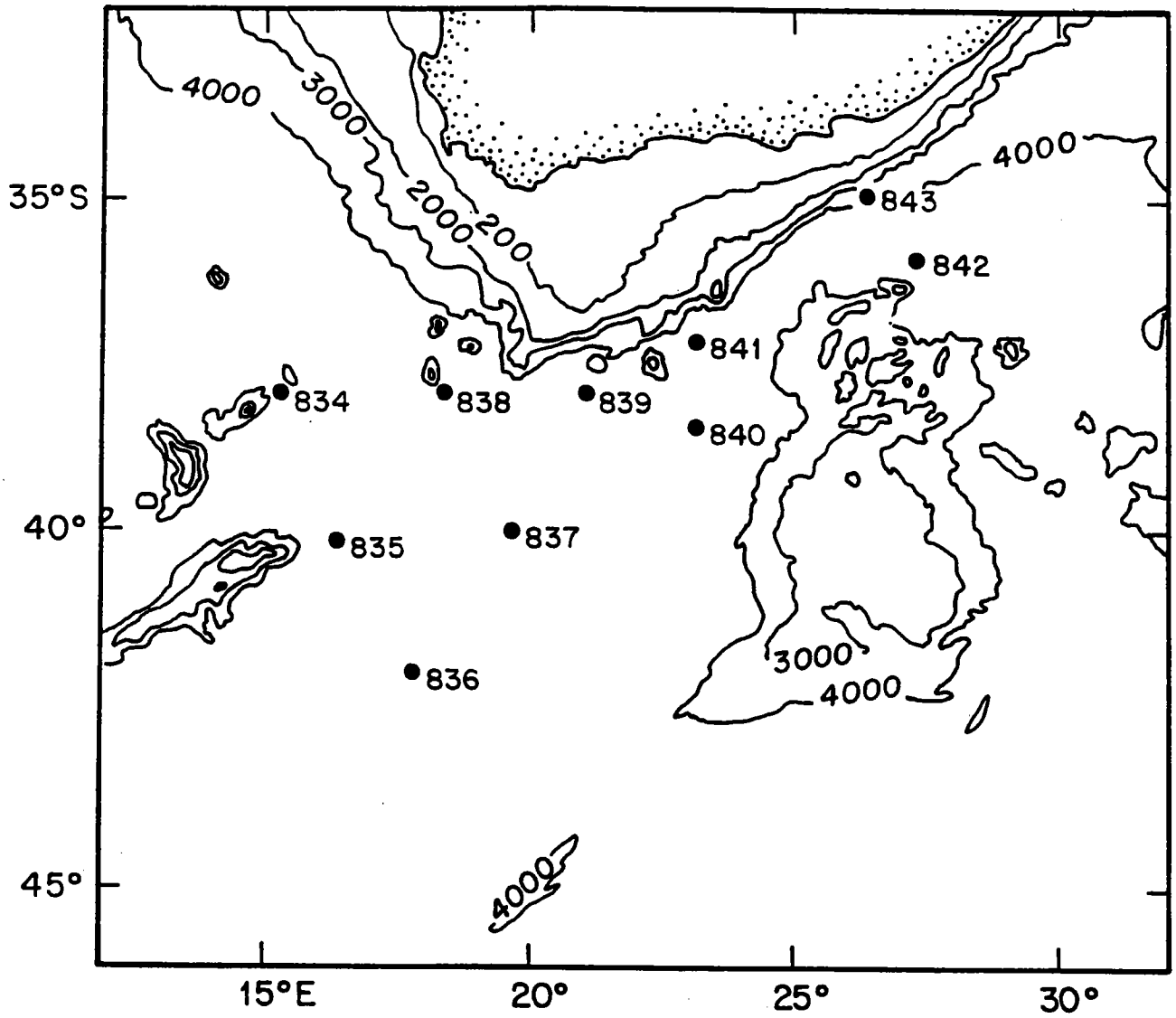


Figure 1
Mooring locations