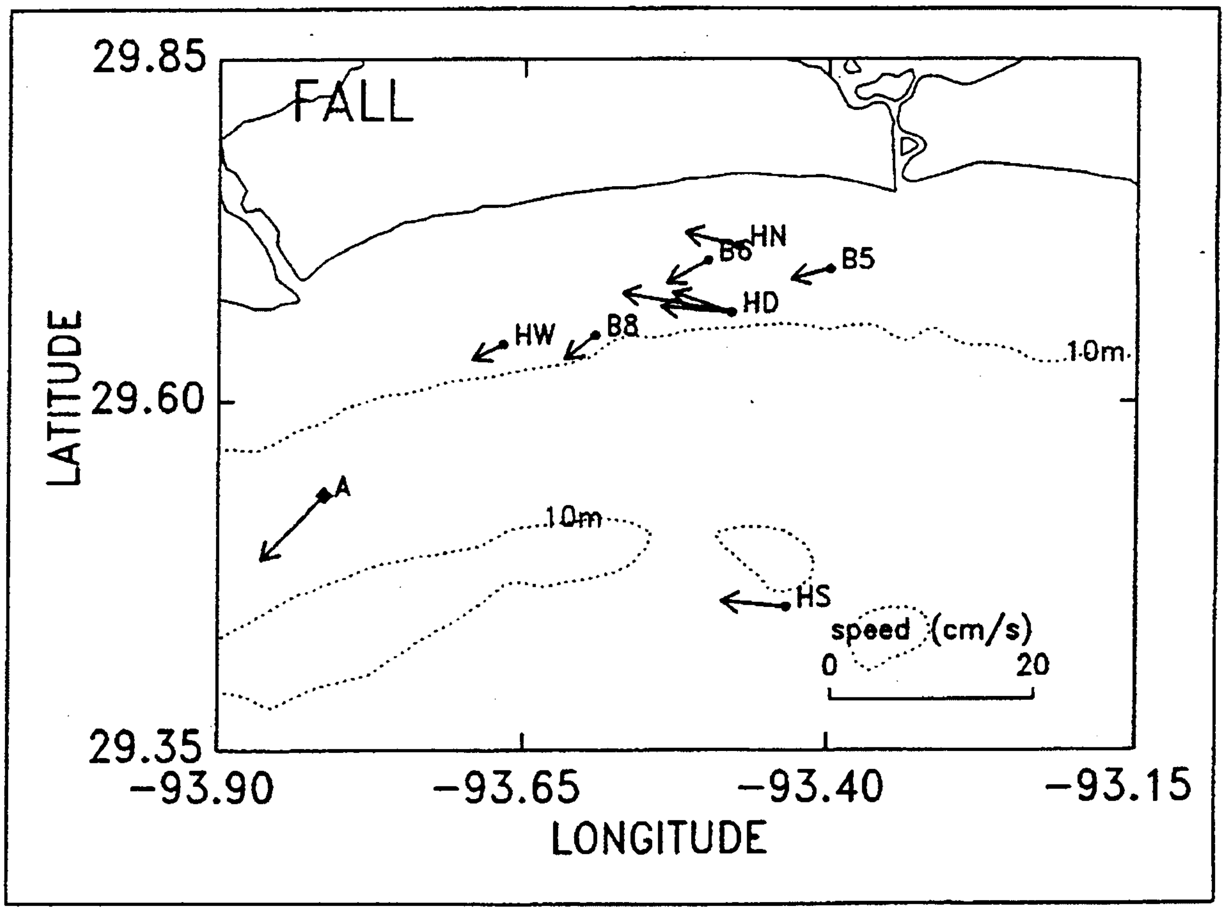
OCS Study
MMS 97-0005

Coastal Marine Institute

# Coastal Currents in the Northern Gulf of Mexico

## Dixie County, Florida, to the U.S.-Mexico Border




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

OCS Study
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# Coastal Currents in the Northern Gulf of Mexico

## Dixie County, Florida, to the U.S.-Mexico Border

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Prepared under MMS Contract
14-35-0001-30660-19928
by
Coastal Marine Institute
Louisiana State University
Baton Rouge, Louisiana 70803

Published by

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

**New Orleans**
**March 1997**

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## CITATION

Suggested citation:

Dinnel, S.P., Wm., J. Wiseman, Jr., and L.J. Rouse, Jr. 1997. Coastal currents in the northern Gulf of Mexico. OCS Study MMS 97-0005. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. 113 pp.

## ABOUT THE COVER

Cover figure shows fall mean-velocity vectors for a region of the Louisiana inner continental shelf near the Louisiana-Texas border.

## ABSTRACT

Historical observations from moored current meters were statistically analyzed to describe the inner-shelf surface currents of the northern Gulf of Mexico. Specific objectives were to describe the mean flows and the flow variability, and to describe the along-shore current maximum velocities and along-shore flow persistence. Data from 12 different programs, at 47 locations on the northern Gulf of Mexico continental shelf, from Dixie County, Florida, to the U.S.-Mexico international border, from the coastline seaward to a distance of 20 NM (36.5 km) were used in the analysis. Data were segmented into four seasons of three month durations, with December-February as winter, March-May as spring, June-August as summer, and September-November as fall. Three seasons, winter, spring and fall, exhibited predominantly westward mean flows. Spring mean flows were westward on the inner shelf west of the Mississippi Delta and eastward east of the Delta. The summer season exhibited as many occurrences of westward as eastward mean flows, with a general flow reversal to the east on the south Texas inner shelf. Maximum along-shore current magnitudes exceeded maximum cross-shore current magnitudes in all seasons. Maximum along-shore currents to the west and the along-shore variance magnitude increased to the west in all seasons. The percentage of westward alongshore flow from individual records exceeded 50% and increased in percentage to the west in all seasons except summer, when the percentage of eastward flow from individual records was similar to westward flow.

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# 1. INTRODUCTION

The Minerals Management Service (MMS) Gulf of Mexico (GOM) Outer Continental Shelf (OCS) Region acquired recently responsibility for oil spill contingency plan evaluation within the state waters in the Gulf of Mexico. MMS has extensive experience predicting the movement of contaminants (oil) across the continental shelf from OCS waters into state waters. As contaminants approach the shore, the currents responsible for advecting these contaminants are increasingly influenced by the coastal constraint (Csanady 1982); they turn and flow predominantly alongshore. The coastal currents are further accelerated by the wind and alongshore pressure gradients. Existing numerical models are unable to adequately predict these motions.

In order to make strategic management and planning decisions, statistical knowledge of the coastal currents is needed. Data sets with the desired geographical and temporal coverage do not fully exist at present. Yet, decisions must be made in the immediate future. Contingency planning will need to resort to statistics derived from analyses of the existing historical data sets. Observational studies have shown variability on time scales of days to seasons. What these studies have not shown were a consistent picture of the amplitudes and persistence of alongshore currents. To determine the maximum likely distance that contaminants could be transported in a surface or near-surface current over a designated time period, additional statistical analyses of GOM coastal currents are necessary.

The seasonal directionality of the mean currents along the northern Gulf of Mexico inner shelf is reasonably well known (Smith 1975, 1978; Hann and Randall 1981; Chuang et al. 1982; Cochrane and Kelly 1986; Schroeder et al. 1987; Wiseman and Dinnel 1988; Dinnel 1988). The intensity of these mean currents, their maximum expected values, and their persistence are less well known.

Ideally long concurrent time series, of one year or more duration, of coastal surface currents at regular positions along the GOM coast would be desirable in producing these statistics. Unfortunately less than ideal data sets are presently available. Although current meter records from the inner shelf of the northern Gulf of Mexico within 36.5 km (20 nm) of shore have been obtained, they are spotty in their spatial coverage (Figure 1). Record lengths are also variable. Only a portion of the obtained records are more than one year in duration, the rest are just a few months long. Those collected during the past decade tend to be longer and more reliable.

We provide this analysis in support of MMS oil spill response planning in state waters. We have collected, quality controlled and statistically described the available surface and near-surface current meter records for the inner shelf of the northern Gulf of Mexico. These statistics describe the record mean flows and the flow variability. They also describe measures of alongshore current maximum velocities and alongshore flow persistence.

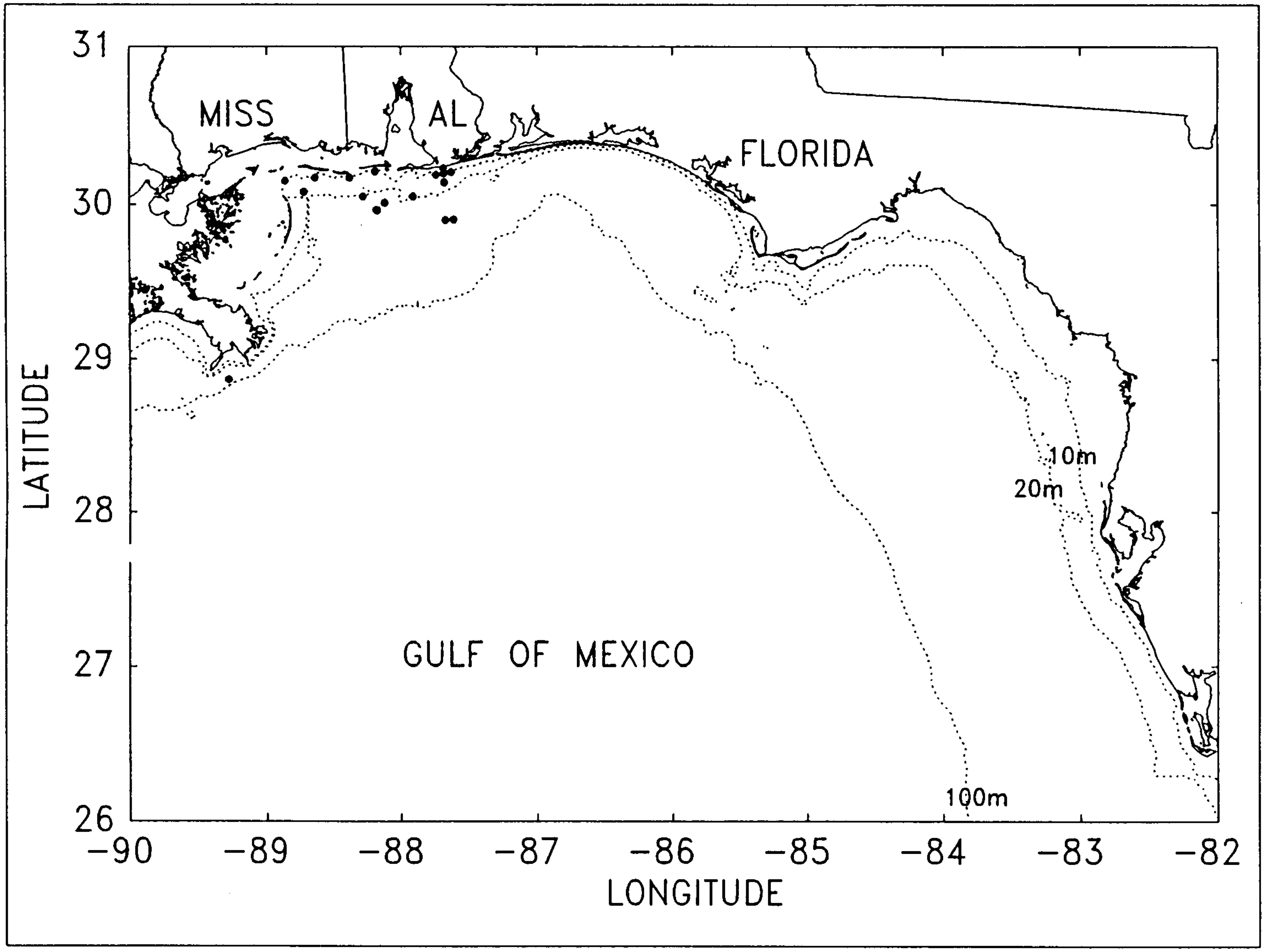


Figure 1a. Northeastern Gulf of Mexico locations of data used in analyses.

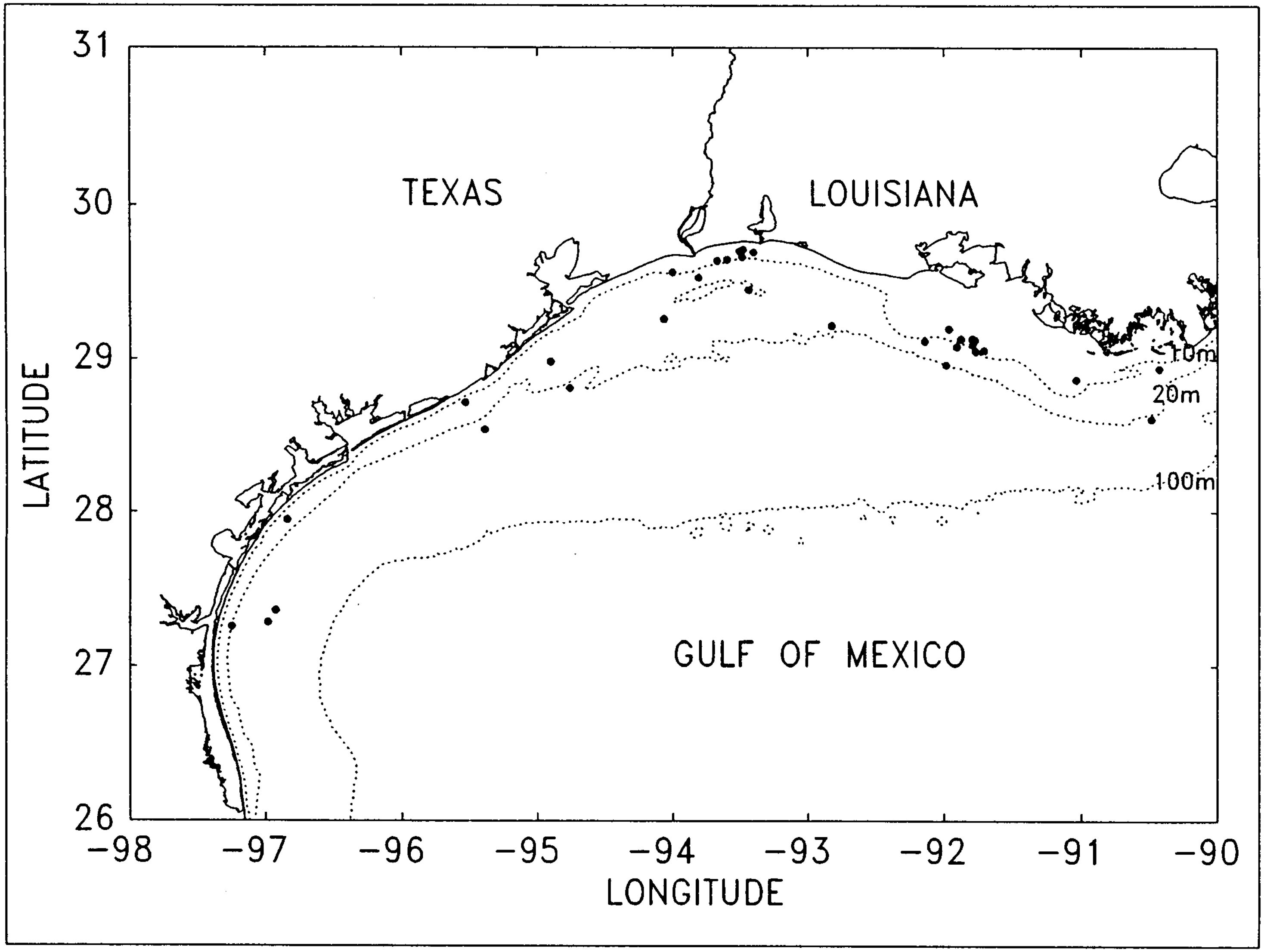


Figure 1b. Northwestern Gulf of Mexico locations of data used in analyses.

# 2. DATA

## 2.1 Data Coverage: Spatial and Temporal

Long-term, moored surface current records from the inner continental shelf of the northern Gulf of Mexico coast were identified and obtained. The geographical scope of the project was defined to extend from Dixie County, FL to the Texas-Mexico border. Current records, though, were identified and acquired only from Baldwin County, AL, east of Mobile Bay, to the south Texas coast (Figure 1). Data acquisition was limited to locations within 36.5 km (~20 NM), an arbitrary seaward boundary of the innershelf defined in consultation with MMS scientists. This boundary is within federal waters, but encompasses the seaward of the narrower band of state waters that the MMS has acquired responsibility. Water depths, at this seaward boundary, varied from ~20 m along the east Texas and western Louisiana coasts to ~30 m along the south Texas coast and east of the Mississippi Delta.

Two types of moored current meter data were acquired. The majority of the data sets were from subsurface, taut-line moorings or fixed bottom-mounted platforms. An additional data set was from moored surface buoys.

Current meter data from 12 programs and 47 different locations were used in the analyses. Current meter data used in this study were decomposed into orthogonal, horizontal velocity components. The longest continuous data records were desired for the subsequent statistical analyses in order to statistically document velocity component means, therefore only data records longer than 27 days were used. This value was arbitrary, but it was based on the number of records necessary to contain sufficient independent samples so as to determine statistically significant mean flows. The longest continuous record was over 772 days in duration. Acquired data was sampled in many years, ranging from 1977 to 1996, and so will conceivably contain a good deal of inter-annual variability.

Some of the data records were not truly near-surface records. These were used in order to insure the largest possible spatial coverage. Data was acquired from projects that investigated near bottom and mid-depth flow. All data was used from innershelf locations in less than 10 m water depth. The water column was considered to be vertically homogeneous in these shallow regions. We recognized that some frictional shear modified these records. Data from moorings in water depths greater than 10 m were not included if velocity observations were in the lower quarter of the water column as currents could be subject to considerable baroclinic vertical shear (Dinnel 1988; Wiseman and Dinnel 1988; SAIC 1989).

Geographical coverage was divided into three arbitrary regions for ease of presentation. The eastern region extends from the Mississippi River mouth eastward and includes the Mississippi and Alabama inner shelves. The central region extends from near the Mississippi River delta westward into western Louisiana, covering the shelf adjacent to the Atchafalaya River delta. The western region includes the western Louisiana shelf and extends to the Texas-Mexico border. In the figures, the western region is presented as two sections for graphical simplification (preservation of the horizontal scale), the (north)western region covers the shelf adjacent to the Louisiana-Texas border and Galveston Bay, TX, the (south)western region covers the shelf adjacent to south Texas. Three subregion figures (with expanded horizontal scales) are presented where close-packed stations make larger scale figures difficult to interpret. These are presented for the eastern, central and (north)western regions. The division of the data locations into geographical regions, *in no way*, is meant to group or categorize the inner shelf currents as similar, they are only intended to facilitate graphical presentation of the data.

For purposes of this analysis the temporal context of each record, in absolute time, was unimportant as analyses did not include rigorous contemporaneous comparisons. There was a need, though, for a relative context within the calendar year (see Section 2.1.3.4). Figure 2 depicts relative time lines for all data records. Multiple year records and programs are depicted in their entirety, single year programs are arbitrarily adjusted to an annual reference point.

## 2.2 Data Sources

### 2.2.1 Moored Current Meter Data

The following moored current meter data were acquired:

US Corps of Engineers (COE) sediment disposal study, Mississippi inner shelf (MS), 1980-1981. Eight surface meters. See Kjerfve and Sneed (1984), and Dinnel (1988) for additional information on the program, mooring deployment and data.

US Environmental Protection Agency (EPA) sewage outflow study, Gulf Shores (GS), AL, Alabama inner shelf, 1986-1987. Four surface meters and one mid-column meter.

Office of Naval Research (ONR) Louisiana Shelf (LS) study, 1983. One mid-column meter.

Minerals Management Service (MMS) Year 5 of the Gulf of Mexico Physical Oceanography program (YR5), Louisiana shelf, 1987-1988. One mid-column meter. See SAIC (1989) for additional information on the program, mooring deployment and data.

Minerals Management Service (MMS) Year 3 of the Gulf of Mexico Physical Oceanography program, Mississippi River delta study (DELTA), 1984. One near-surface meter. See Wiseman and Dinnel (1988) for additional information on the program, mooring deployment and data.

Minerals Management Service (MMS) Mississippi-Alabama Continental Shelf Ecosystem Study (MAMES), Mississippi-Alabama shelf, 1987-1989. One near-surface meter. See Kelly (1991) for additional information on the program, mooring deployment and data.

Minerals Management Service (MMS) Texas-Louisiana Shelf Circulation Program (LTX), 1992-1994. Data was provided by the LATEX Program Office, Texas A&M University. Two surface and seven near-surface meters. See Jochens and Nowlin (1994), Jochens and Nowlin (1995), and Reap et al. (1996) for additional information on the program, mooring deployment and data.

US Department of Energy (DOE) Strategic Petroleum Reserve Louisiana brine disposal analysis program (BD), 1977-1978. Four surface and four mid-column meters. Data acquired from the National Oceanographic Data Center.

The National Oceanic and Atmospheric Administration (NOAA), collected data for the US Department of Energy, Strategic Petroleum Reserve Louisiana Weeks Island (WI), LA, brine disposal analysis program, 1978-1979. Data acquired from the National Oceanographic Data Center. Five

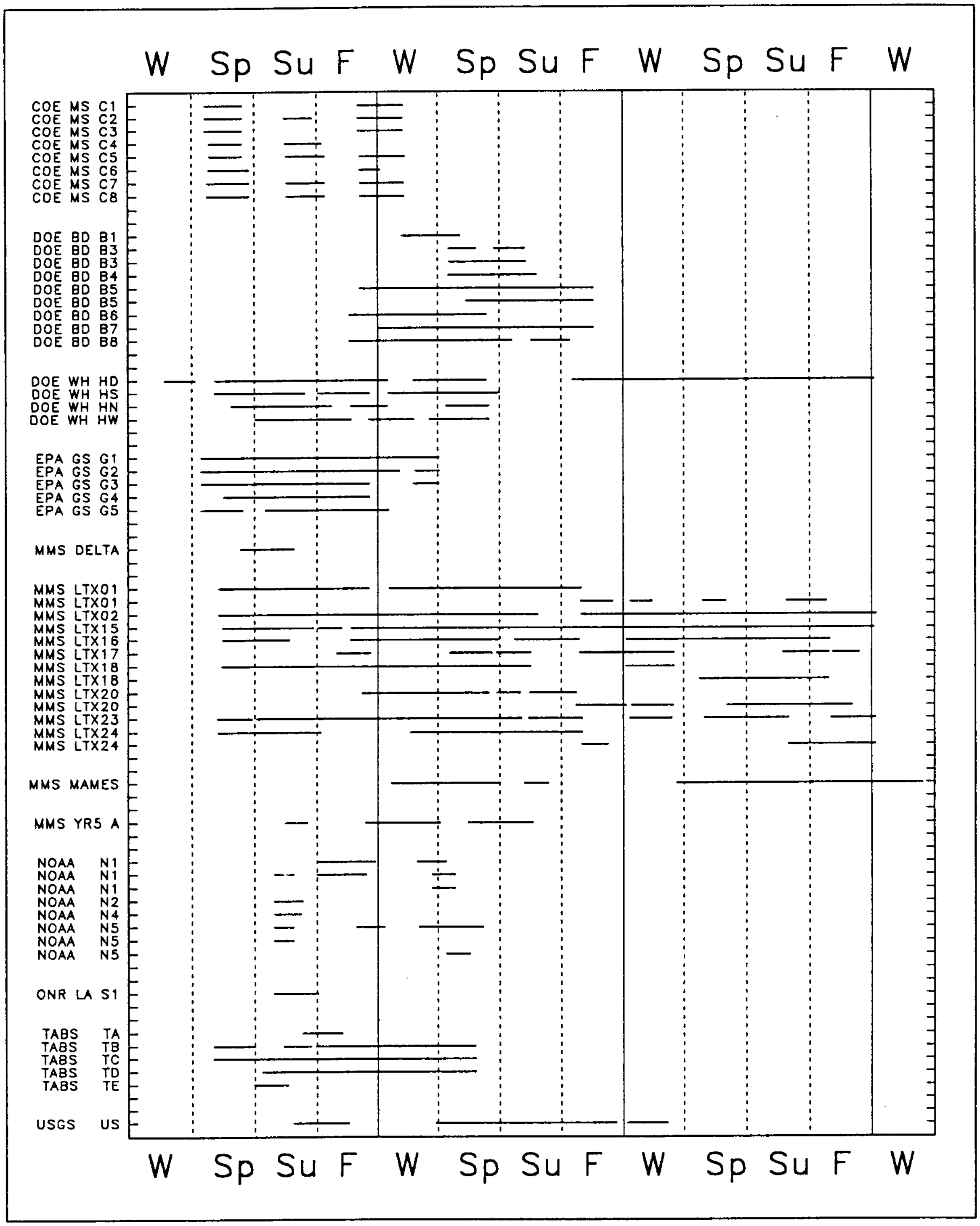


Figure 2. General time line of current meter data showing seasonal coverage. Meter locations are listed alphabetically by sponsoring agency and program. Temporal coverage by seasons are for relative years.

mid-column meters. See Frey et al. (1981) for additional information on the program, mooring deployment and data.

US Department of Energy (DOE) Strategic Petroleum Reserve West Hackberry brine diffuser monitoring program (WH), 1981-1983. Three surface and one mid-column meter. See Hann et al. (1984) for additional information on the program, mooring deployment and data.

US Geological Survey (USGS) sediment transport study, Mississippi-Alabama shelf, 1990-1992. Data was provided by the USGS. One surface meter. See Kinoshita and Noble (1995) for additional information on the program, mooring deployment and data.

### 2.2.2 Moored Buoy Current Meter Data

The following moored buoy current meter data were acquired:

Texas General Land Office (TGLO) Texas Automated Buoy System (TABS), Texas shelf, 1995-1996. Five surface meters. Data was provided by the TGLO.

### 2.2.3 Report Nomenclature

For the purposes of this analysis report the naming convention will include a data source such as the funding agency, a project/program acronym unique within this report, a mooring identification that can be either a number or letter, and in some circumstances, a geographical positional or vertical positional change identification (see section 2.3.1.2). Some mooring naming schemes were maintained from the original program, some were generated or renamed to enable their unique identification (Table 1, Figure 1) in this analysis and report. Table 1 also lists the location, temporal coverage, water depth, current meter depth, and time characteristics of the records.

## 2.3 Data Analysis

### 2.3.1 The Data

All current meter data were transformed to orthogonal velocity components. These components were normalized to standard compass orientation, positive U being eastward flow, positive V being northward flow.

#### 2.3.1.1 Temporal Sampling

It was desired that all data records have similar sample intervals or time steps. Most records were sampled with time steps of one-half or one hour. Those data records that had shorter time steps, specifically the USGS data, were filtered, using a two-hour low-pass filter, and subsampled at one-half hour intervals following procedures in Bendat and Piersol (1986). See section 2.3.1.5 for more information on the filter characteristics.

#### 2.3.1.2 Concatenation and Gap Filling

Data records were concatenated to obtain the longest continuous records from any given data location. When data gaps due to missing or obviously incorrect values were less than 24 hours in duration, gaps were filled by linear interpolation. No concatenation was performed across data gaps in excess of 24 hours in length.

Table 1.

Current meter data sources. Alphabetized by sponsoring agent (SA), program identification (PGM), then ordered by observational meter identification (M) where lower case character denotes a meter depth and/or a mooring location change, observational meter water depth ($D_O$), water depth at location ($D_W$), observational meter latitude (LAT) and longitude (LON) in degrees, observations start and end dates and times (in Central Standard Time), and the approximate total record coverage (T) in days.

| SA* | PGM+ | M | $D_O$ | $D_W$ | LAT | LON | START DATE | TIME | END DATE | TIME | T (d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COE | MS | C1 | 3.0 | 11.3 | 30.15 | 88.86 | 11/01/80 | 1100 | 1/06/81 | 1200 | 66 |
| COE | MS | C1 | 3.0 | 11.3 | 30.15 | 88.86 | 3/21/81 | 1100 | 5/13/81 | 0900 | 52 |
| COE | MS | C2 | 3.0 | 12.8 | 30.08 | 88.72 | 11/01/80 | 1400 | 1/06/81 | 1330 | 66 |
| COE | MS | C2 | 3.0 | 12.8 | 30.08 | 88.72 | 3/21/81 | 0900 | 5/13/81 | 1030 | 52 |
| COE | MS | C2 | 3.0 | 12.8 | 30.08 | 88.72 | 8/15/81 | 1400 | 8/24/81 | 1900 | 40 |
| COE | MS | C3 | 3.0 | 13.7 | 30.17 | 88.64 | 11/01/80 | 1500 | 1/06/81 | 1400 | 66 |
| COE | MS | C3 | 3.0 | 13.7 | 30.17 | 88.64 | 3/21/81 | 0700 | 5/13/81 | 1130 | 53 |
| COE | MS | C4 | 3.0 | 14.6 | 30.17 | 88.38 | 3/27/81 | 1230 | 5/13/81 | 1300 | 47 |
| COE | MS | C4 | 3.0 | 14.6 | 30.17 | 88.38 | 8/16/81 | 1830 | 9/08/81 | 1200 | 53 |
| COE | MS | C5 | 3.0 | 19.5 | 30.05 | 88.28 | 11/03/80 | 1400 | 1/09/81 | 1400 | 67 |
| COE | MS | C5 | 3.0 | 19.5 | 30.05 | 88.28 | 3/27/81 | 1800 | 5/13/81 | 1430 | 47 |
| COE | MS | C5 | 3.0 | 19.5 | 30.05 | 88.28 | 8/18/81 | 1030 | 9/12/81 | 1200 | 57 |
| COE | MS | C6 | 3.0 | 11.6 | 30.21 | 88.19 | 11/03/80 | 1730 | 12/04/80 | 0930 | 29 |
| COE | MS | C6 | 3.0 | 11.6 | 30.21 | 88.19 | 3/26/81 | 1700 | 5/23/81 | 2000 | 58 |
| COE | MS | C7 | 3.0 | 21.9 | 30.01 | 88.12 | 11/04/80 | 1930 | 1/07/81 | 2130 | 64 |
| COE | MS | C7 | 3.0 | 21.9 | 30.01 | 88.12 | 3/24/81 | 1930 | 5/23/81 | 1230 | 59 |
| COE | MS | C7 | 3.0 | 21.9 | 30.01 | 88.12 | 8/19/81 | 1430 | 9/12/81 | 0900 | 55 |
| COE | MS | C8 | 3.0 | 16.8 | 30.05 | 87.91 | 11/04/80 | 1700 | 1/08/81 | 1700 | 65 |
| COE | MS | C8 | 3.0 | 16.8 | 30.05 | 87.91 | 3/24/81 | 1730 | 5/13/81 | 1800 | 60 |
| COE | MS | C8 | 3.0 | 16.8 | 30.05 | 87.91 | 8/19/81 | 1200 | 9/12/81 | 0630 | 55 |
| DOE | BD | B1 | 4.0 | 5.0 | 29.0825 | 91.90767 | 1/07/78 | 1030 | 4/03/78 | 0400 | 85 |
| DOE | BD | B3a | 5.0 | 10.0 | 29.05167 | 91.77 | 3/18/78 | 1730 | 4/27/78 | 1500 | 39 |
| DOE | BD | B3a | 5.0 | 10.0 | 29.05167 | 91.77 | 5/25/78 | 0800 | 7/08/78 | 2000 | 44 |
| DOE | BD | B3b | 7.0 | 10.0 | 29.05167 | 91.77 | 3/18/78 | 1730 | 7/10/78 | 1030 | 113 |
| DOE | BD | B4 | 5.0 | 9.0 | 28.86667 | 91.04167 | 5/30/78 | 0700 | 7/26/78 | 1200 | 57 |
| DOE | BD | B4 | 5.0 | 9.0 | 28.86667 | 91.04167 | 3/17/78 | 1300 | 5/25/78 | 1430 | 69 |
| DOE | BD | B5a | 7.0 | 9.0 | 29.69667 | 93.39833 | 11/04/77 | 1430 | 10/18/78 | 0830 | 347 |
| DOE | BD | B5b | 3.0 | 9.0 | 29.69667 | 93.39833 | 4/12/78 | 1500 | 10/18/78 | 0600 | 188 |
| DOE | BD | B6 | 6.0 | 8.0 | 29.70333 | 93.49833 | 10/20/77 | 2000 | 5/12/78 | 1100 | 203 |
| DOE | BD | B7 | 7.0 | 9.0 | 29.565 | 94.00000 | 12/01/77 | 2030 | 10/18/78 | 1300 | 320 |
| DOE | BD | B8 | 7.0 | 9.0 | 29.64833 | 93.59167 | 10/20/77 | 1600 | 6/19/78 | 0730 | 241 |
| DOE | BD | B8 | 7.0 | 9.0 | 29.64833 | 93.59167 | 7/18/78 | 2000 | 9/13/78 | 1000 | 56 |
| DOE | WH | HD | 3.7 | 9.1 | 29.66500 | 93.47883 | 1/21/81 | 1130 | 3/ 6/81 | 1030 | 43 |
| DOE | WH | HD | 3.7 | 9.1 | 29.66500 | 93.47883 | 4/ 4/81 | 1800 | 12/15/81 | 1500 | 254 |
| DOE | WH | HD | 3.7 | 9.1 | 29.66500 | 93.47883 | 1/24/82 | 1330 | 5/12/82 | 1730 | 108 |
| DOE | WH | HD | 3.7 | 9.1 | 29.66500 | 93.47883 | 9/18/82 | 1200 | 12/ 4/83 | 1000 | 441 |
| DOE | WH | HS | 3.7 | 12.5 | 29.45200 | 93.43333 | 4/ 4/81 | 1300 | 8/13/81 | 1530 | 131 |
| DOE | WH | HS | 3.7 | 12.5 | 29.45200 | 93.43333 | 9/ 3/81 | 1300 | 11/18/81 | 0800 | 75 |
| DOE | WH | HS | 3.7 | 12.5 | 29.45200 | 93.43333 | 12/15/81 | 1600 | 5/31/82 | 0600 | 166 |
| DOE | WH | HN | 4.9 | 6.7 | 29.71400 | 93.47333 | 4/28/81 | 1300 | 9/22/81 | 1430 | 154 |
| DOE | WH | HN | 4.9 | 6.7 | 29.71400 | 93.47333 | 10/22/81 | 1130 | 12/15/81 | 1530 | 53 |
| DOE | WH | HN | 4.9 | 6.7 | 29.71400 | 93.47333 | 3/14/82 | 1300 | 5/16/82 | 1200 | 62 |
| DOE | WH | HW | 3.7 | 9.4 | 29.64167 | 93.66667 | 6/ 2/81 | 1300 | 10/22/81 | 1100 | 141 |

Table 1. Current meter data sources. (continued)

| SA | PGM | M | $D_o$ | $D_w$ | LAT | LON | START DATE | TIME | END DATE | TIME | T (d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DOE | WH | HW | 3.7 | 9.4 | 29.64167 | 93.66667 | 11/18/81 | 1500 | 1/24/82 | 0900 | 66 |
| DOE | WH | HW | 3.7 | 9.4 | 29.64167 | 93.66667 | 2/17/82 | 1100 | 5/16/82 | 0930 | 87 |
| EPA | GS | G1 | 5.2 | 10.4 | 30.23000 | 87.68500 | 3/15/86 | 1600 | 3/02/87 | 1300 | 351 |
| EPA | GS | G2 | 3.0 | 11.3 | 30.19667 | 87.68333 | 3/15/86 | 1400 | 1/02/87 | 1800 | 293 |
| EPA | GS | G2 | 3.0 | 11.3 | 30.19667 | 87.68333 | 1/26/87 | 1000 | 3/02/87 | 1100 | 35 |
| EPA | GS | G3 | 3.0 | 15.2 | 30.14000 | 87.67833 | 3/15/86 | 0930 | 11/18/86 | 1000 | 248 |
| EPA | GS | G3 | 3.0 | 15.2 | 30.14000 | 87.67833 | 1/24/87 | 1030 | 3/02/87 | 0730 | 36 |
| EPA | GS | G4 | 3.0 | 11.3 | 30.18833 | 87.74000 | 4/17/86 | 1500 | 11/18/86 | 1100 | 214 |
| EPA | GS | G5 | 3.0 | 11.3 | 30.20500 | 87.62833 | 3/15/86 | 1130 | 5/14/86 | 1000 | 59 |
| EPA | GS | G5 | 3.0 | 11.3 | 30.20500 | 87.62833 | 6/17/86 | 1030 | 12/17/86 | 0830 | 182 |
| MMS | DELTA | MD | 13.0 | 82.0 | 28.86050 | 89.27833 | 5/10/84 | 1630 | 7/27/84 | 1000 | 77 |
| MMS | LTX | 01a | 11.0 | 23.0 | 27.256 | 97.246 | 4/09/92 | 1200 | 11/16/92 | 1730 | 221 |
| MMS | LTX | 01a | 11.0 | 23.0 | 27.256 | 97.246 | 12/17/92 | 1200 | 9/29/93 | 0700 | 285 |
| MMS | LTX | 01b | 14.0 | 23.0 | 27.323 | 97.307 | 9/29/93 | 0830 | 11/14/93 | 0530 | 45 |
| MMS | LTX | 01b | 14.0 | 23.0 | 27.323 | 97.307 | 12/11/93 | 0800 | 1/11/94 | 0830 | 31 |
| MMS | LTX | 01b | 14.0 | 23.0 | 27.323 | 97.307 | 3/28/94 | 0900 | 4/30/94 | 1700 | 33 |
| MMS | LTX | 01b | 14.0 | 23.0 | 27.323 | 97.307 | 7/29/94 | 0630 | 9/24/94 | 1600 | 57 |
| MMS | LTX | 02 | 13.0 | 37.0 | 27.284 | 96.980 | 4/09/92 | 1200 | 7/26/93 | 1730 | 473 |
| MMS | LTX | 02 | 13.0 | 37.0 | 27.284 | 96.980 | 9/29/93 | 1300 | 12/06/94 | 1100 | 432 |
| MMS | LTX | 15 | 10.0 | 27.0 | 28.608 | 90.492 | 4/14/92 | 1200 | 8/25/92 | 1530 | 133 |
| MMS | LTX | 15 | 10.0 | 27.0 | 28.608 | 90.492 | 9/02/92 | 1200 | 10/06/92 | 1730 | 34 |
| MMS | LTX | 15 | 10.0 | 27.0 | 28.608 | 90.492 | 10/21/92 | 1800 | 12/03/94 | 1000 | 772 |
| MMS | LTX | 16a | 10.0 | 20.0 | 28.867 | 90.490 | 4/14/92 | 1200 | 7/21/92 | 1430 | 98 |
| MMS | LTX | 16a | 10.0 | 20.0 | 28.867 | 90.490 | 10/21/92 | 1200 | 5/29/93 | 0600 | 219 |
| MMS | LTX | 16a | 10.0 | 20.0 | 28.867 | 90.490 | 6/23/93 | 1300 | 9/26/93 | 0530 | 94 |
| MMS | LTX | 16b | 9.0 | 16.0 | 28.939 | 90.435 | 12/06/93 | 0800 | 9/29/94 | 1000 | 297 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 8/31/92 | 1830 | 10/20/92 | 0630 | 49 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 3/18/93 | 1430 | 5/19/93 | 1300 | 61 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 5/27/93 | 0640 | 7/16/93 | 1500 | 50 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 9/27/93 | 0800 | 2/13/94 | 0930 | 139 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 7/24/94 | 0700 | 9/28/94 | 0700 | 66 |
| MMS | LTX | 17 | 3.0 | 7.0 | 29.197 | 91.964 | 10/04/94 | 0400 | 11/11/94 | 1630 | 38 |
| MMS | LTX | 18a | 10.0 | 22.0 | 28.963 | 91.984 | 4/13/92 | 1800 | 7/16/93 | 1200 | 458 |
| MMS | LTX | 18b | 12.0 | 22.0 | 28.963 | 91.984 | 12/05/93 | 1230 | 2/18/94 | 1000 | 69 |
| MMS | LTX | 18b | 12.0 | 22.0 | 28.963 | 91.984 | 3/23/94 | 1400 | 9/28/94 | 1430 | 188 |
| MMS | LTX | 20a | 3.0 | 16.0 | 29.261 | 94.064 | 11/06/92 | 1730 | 5/17/93 | 1930 | 190 |
| MMS | LTX | 20a | 3.0 | 16.0 | 29.261 | 94.064 | 5/27/93 | 2000 | 6/30/93 | 1530 | 33 |
| MMS | LTX | 20a | 3.0 | 16.0 | 29.261 | 94.064 | 7/15/93 | 0730 | 9/22/93 | 0830 | 69 |
| MMS | LTX | 20b | 2.0 | 12.0 | 29.500 | 94.022 | 9/22/93 | 1200 | 12/04/93 | 0800 | 72 |
| MMS | LTX | 20b | 2.0 | 12.0 | 29.500 | 94.022 | 12/13/93 | 1030 | 2/12/94 | 0730 | 60 |
| MMS | LTX | 20b | 2.0 | 12.0 | 29.500 | 94.022 | 3/31/94 | 1100 | 11/30/94 | 0730 | 181 |
| MMS | LTX | 23a | 9.0 | 15.0 | 28.714 | 95.537 | 4/07/92 | 1800 | 5/27/92 | 0300 | 49 |
| MMS | LTX | 23a | 9.0 | 15.0 | 28.714 | 95.537 | 6/04/92 | 0600 | 7/03/93 | 0500 | 393 |
| MMS | LTX | 23b | 10.0 | 15.0 | 28.714 | 95.537 | 7/14/93 | 0830 | 9/30/93 | 1500 | 78 |
| MMS | LTX | 23b | 10.0 | 15.0 | 28.714 | 95.537 | 12/10/93 | 1100 | 2/10/94 | 0300 | 61 |
| MMS | LTX | 23b | 10.0 | 15.0 | 28.714 | 95.537 | 3/30/94 | 1400 | 7/31/94 | 0800 | 122 |
| MMS | LTX | 23b | 10.0 | 15.0 | 28.714 | 95.537 | 10/02/94 | 0930 | 12/05/94 | 0930 | 64 |
| MMS | LTX | 24a | 11.0 | 30.0 | 28.474 | 95.437 | 4/08/92 | 0000 | 9/05/92 | 1100 | 150 |
| MMS | LTX | 24b | 11.0 | 28.0 | 28.537 | 95.393 | 1/18/93 | 1200 | 9/30/93 | 1300 | 255 |
| MMS | LTX | 24c | 8.0 | 26.0 | 28.537 | 95.393 | 9/30/93 | 1900 | 11/31/93 | 0830 | 32 |
| MMS | LTX | 24c | 8.0 | 26.0 | 28.537 | 95.393 | 7/31/94 | 1030 | 12/05/94 | 0700 | 126 |

Table 1. Current meter data sources. (continued)

| SA | PGM | M | $D_o$ | $D_w$ | LAT | LON | START DATE | TIME | END DATE | TIME | T (d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MMS | MAMES | Ma | 10.0 | 31.0 | 29.900 | 87.67 | 12/21/87 | 1900 | 5/29/88 | 0200 | 159 |
| MMS | MAMES | Mb | 10.0 | 31.0 | 29.90333 | 87.61 | 7/05/88 | 1700 | 9/09/88 | 2000 | 35 |
| MMS | MAMES | Mb | 10.0 | 31.0 | 29.90333 | 87.61 | 2/18/89 | 0430 | 2/11/90 | 1730 | 358 |
| MMS | YR5 | AA | 7.0 | 14.0 | 29.11718 | 92.14430 | 7/17/87 | 0100 | 8/17/87 | 2200 | 31 |
| MMS | YR5 | AA | 7.0 | 14.0 | 29.11718 | 92.14430 | 11/13/87 | 1000 | 3/03/88 | 0500 | 110 |
| MMS | YR5 | AA | 7.0 | 14.0 | 29.11718 | 92.14430 | 4/14/88 | 0800 | 7/18/88 | 0900 | 95 |
| NOAA | WI | N1a | 6.9 | 7.6 | 29.09500 | 91.79333 | 9/ 1/78 | 1530 | 11/26/78 | 2300 | 86 |
| NOAA | WI | N1a | 6.9 | 7.6 | 29.09500 | 91.79333 | 1/29/79 | 1530 | 3/12/79 | 1300 | 41 |
| NOAA | WI | N1b | 4.9 | 7.9 | 29.09500 | 91.79333 | 6/30/78 | 2050 | 7/28/78 | 0800 | 27 |
| NOAA | WI | N1b | 4.9 | 7.9 | 29.09500 | 91.79333 | 9/ 1/78 | 1550 | 11/13/78 | 1130 | 72 |
| NOAA | WI | N1b | 4.9 | 7.9 | 29.09500 | 91.79333 | 2/20/79 | 1500 | 3/26/79 | 1500 | 34 |
| NOAA | WI | N1c | 5.9 | 7.9 | 29.09500 | 91.79333 | 2/20/79 | 1500 | 3/26/79 | 1600 | 34 |
| NOAA | WI | N2 | 4.8 | 5.8 | 29.12472 | 91.77583 | 6/30/78 | 1730 | 8/10/78 | 0100 | 41 |
| NOAA | WI | N4 | 6.7 | 7.0 | 29.05722 | 91.70944 | 6/30/78 | 2000 | 8/ 8/78 | 0900 | 38 |
| NOAA | WI | N5a | 7.9 | 8.2 | 29.13250 | 91.87695 | 6/30/78 | 1230 | 7/28/78 | 0600 | 27 |
| NOAA | WI | N5a | 7.9 | 8.2 | 29.13250 | 91.87695 | 10/30/78 | 1730 | 12/10/78 | 1100 | 40 |
| NOAA | WI | N5a | 7.9 | 8.2 | 29.13250 | 91.87695 | 2/ 1/79 | 0830 | 5/ 7/79 | 0930 | 95 |
| NOAA | WI | N5b | 5.2 | 8.2 | 29.13250 | 91.79361 | 6/30/78 | 1300 | 7/28/78 | 0600 | 27 |
| NOAA | WI | N5c | 7.3 | 8.2 | 29.13250 | 91.87695 | 3/14/79 | 0830 | 4/17/79 | 1300 | 34 |
| ONR | LS | S1 | 7.0 | 18.0 | 29.21750 | 92.82750 | 6/30 83 | 1300 | 9/02/83 | 1430 | 64 |
| TLGO | TABS | TA | 1.8 | 12.2 | 29.53202 | 93.81217 | 8/11/95 | 1800 | 10/08/95 | 1700 | 57 |
| TLGO | TABS | TB | 1.8 | 19.2 | 28.98163 | 94.89967 | 4/02/95 | 1800 | 5/31/95 | 2330 | 59 |
| TLGO | TABS | TB | 1.8 | 19.2 | 28.98163 | 94.89967 | 7/15/95 | 0000 | 8/23/95 | 0830 | 39 |
| TLGO | TABS | TB | 1.8 | 19.2 | 28.98163 | 94.89967 | 8/31/95 | 1230 | 4/24/96 | 1200 | 236 |
| TLGO | TABS | TC | 1.8 | 22.0 | 28.81095 | 94.75998 | 4/02/95 | 1200 | 4/25/96 | 1800 | 389 |
| TLGO | TABS | TD | 1.8 | 18.3 | 27.94917 | 96.84217 | 6/12/95 | 1230 | 4/25/96 | 1800 | 318 |
| TLGO | TABS | TE | 1.8 | 27.4 | 27.36050 | 96.92533 | 5/31/95 | 1800 | 7/20/95 | 1300 | 49 |
| USGS | | USa | 5.0 | 30.0 | 29.96200 | 88.17400 | 7/28/90 | 1630 | 10/18/90 | 0630 | 81 |
| USGS | | USb | 5.0 | 29.0 | 29.96283 | 88.17833 | 2/26/91 | 1430 | 11/19/91 | 1200 | 265 |
| USGS | | USc | 5.0 | 30.0 | 29.96350 | 88.18083 | 12/07/91 | 1930 | 2/04/92 | 1030 | 58 |

| *SA | Sponsoring Agent | +PGM | Program Identification |
|---|---|---|---|
| COE | Corps of Engineers | MS | Mississippi Shelf |
| DOE | Department of Energy | BD | Brine Disposal |
| DOE | Department of Energy | WH | West Hackberry, LA |
| NOAA | National Oceanic and Atmospheric Administration | WI | Weeks Island, LA |
| EPA | Environmental Protection Agency | GS | Gulf Shores, AL |
| MMS | Minerals Management Service | DELTA | Mississippi Delta |
| MMS | Minerals Management Service | YR5 | Year 5, GOM |
| MMS | Minerals Management Service | MAMES | Marine Ecosystem Study |
| MMS | Minerals Management Service | LTX | Louisiana-Texas |
| ONR | Office of Naval Research | LS | Louisiana Study |
| TGLO | Texas General Land Office | TABS | Texas Automated Buoy System |
| USGS | US Geological Survey | | |

Only records from the same location were concatenated. Those records that changed geographic location, vertical position, or apparent water depth between deployments, but retained their program mooring identification, are identified by a lower case character appended to the mooring identification, e.g. DOE BD B5a and DOE BD B5b.

#### 2.3.1.3 Data Rotation

While data were initially decomposed into east-west and north-south components, all data were subsequently rotated so that one velocity component would be alongshore. The orientation of the local coastline was determined as the angle from true east of the coastline at the point on the coastline closest to that individual mooring. In regions where the coastline was heavily convoluted or perforated an average orientation was used. After rotation each data record consisted of an alongshore velocity component, positive to the observers' right when facing the coast, and a cross-shore velocity component, always positive onshore. Positive alongshore velocity is in the general direction of east, except on the south Texas shelf where alongshore is positive towards the general direction of northeast.

It should be noted that in some cases this alignment of a velocity component with the alongshore direction may differ from the orientation of bathymetry on the inner shelf. This is especially true the more distance lies between the coast and the mooring.

#### 2.3.1.4 Seasonal Segmentation

All rotated data records were partitioned into four seasonal segments. The seasons were Winter (December-February), Spring (March-May), Summer (June-August) and Fall (September-November). These are consistent with the seasons used by Gutierrez de Velasco and Winant (1996) in an analysis of Gulf of Mexico wind variance, but not with the Florida A&M University (1988) five month winter and summer seasons. The latter study had single month transitions between seasons, we prefer a longer, three month, transition to account for interannual variability in the meteorological forcing. Our seasonal designations are also based on consideration of the average monthly Mississippi River discharge (Dinnel and Bratkovich 1993) and average monthly regional river discharge (van der Leeden et al. 1990), the average monthly wind directions and magnitudes for the entire Gulf of Mexico (Rhodes et al. 1985; Gutierrez de Velasco and Winant 1996) and the northeastern Gulf of Mexico (Schroeder and Wiseman 1985), the average number of monthly frontal occurrences of the northern Gulf of Mexico (DiMego et al. 1976) and the average type and number of frontal occurrences in the Gulf of Mexico (Henry 1979). These latter parameters are considered very important in determining the level of wind variance around the Gulf of Mexico, an important parameter driving coastal current variation. Not all the evaluated parameters had similar values throughout the northern Gulf of Mexico, nor did they consistently covary in time, but there were great similarities in parameter values within the different regions and in the timing of parameter changes, i.e. our seasonal breaks, between the different regions. Meteorological and riverine characteristics from the south Texas shelf, the west Louisiana shelf, and those of the Mississippi-Alabama shelf consistently changed at our seasonal boundaries.

#### 2.3.1.5 Low Pass Filtering

All velocity component records were low-pass filtered to create records that contained the information with greater periods (lower frequencies) passed records, allowed the analysis of the subtidal variations (frequencies less than the tidal frequencies). It also allowed the determination of the percentage of low-frequency energy (variance) in the total records. The percentage of variation not contained in the low-passed records was primarily attributed to tidal and inertial motions.

All filtering was low-pass and performed with an FFT algorithm. Each velocity component was transformed to the frequency domain, the coefficients of unwanted frequencies set to zero, and then inverse transformed. Data records were trimmed at the beginning and end by lengths equal to one-half the filter width, as determined by the frequency cutoff. A 40-hour low-pass filter was used to remove variations with periods less than 40 hours from the velocity components. Twenty hours of data were lost at the beginning and end of each low-passed record.

### 2.3.2 Statistical Analyses

#### 2.3.2.1 First Order Statistics

Along- and cross-shore velocity component means, standard errors, maxima, minima, variances, and variance principal axis orientation were determined for each current meter record (Table 2). Low-passed velocity component autocorrelation time scales, degrees of freedom, maxima, minima, variances, the percent of low-passed to total variance, and the variance principle axis orientation were determined for each current meter record (Table 3).

The record mean was computed using

$$\mathrm{MEAN} = \frac{1}{n} \sum_{i=1}^{n} (V_i),$$

where n is the number of observations in the velocity component record, V. The biased sample variance was computed using

$$s^2 = \frac{1}{n} \sum_{i=1}^{n} (V_i - \mathrm{MEAN})^2.$$

The standard error of the mean was computed using

$$\mathrm{SE} = \left( \frac{s^2}{(T/t_o)} \right)^{1/2}$$

where T is the total record length and $t_o$ is the low-passed record autocorrelation time scale. The maximum and minimum velocity component were the greatest magnitudes in the positive direction and the greatest magnitude in the negative direction, respectively. The principal axis of variation orientation, $\alpha$, was defined as the rotation angle relative to the coordinate axes, necessary to decorrelate the velocity components.

The autocorrelation time scale, $t_o$, is defined as the time lag at which the velocity record's autocorrelation function is not statistically different from zero. This scale is determined as the time lag at which the autocorrelation function falls below the standard error of the autocorrelation as defined by Newton (1988). The standard error of the sampled autocorrelation function, $p(i)$, can be approximated by

Table 2.

Seasonal statistics. Stations are listed seasonally, counterclockwise around Gulf of Mexico, and from on- to off-shore. With sponsoring agent, SA, program identification, PGM, observational meter identification, M, and where lower case character denotes a meter depth and/or a mooring location change, observational record length (days), T, where + denotes a sample time interval of 1.0 hr, all others are 0.5 hr, along- and cross-shore velocity mean ($cm \cdot s^{-1}$), MEAN, where * indicates mean values that are statistically significant at the 95% level, i.e. greater than ±2 SE, along- and cross-shore velocity standard error of the mean ($cm \cdot s^{-1}$), SE, along- and cross-shore maximum velocity ($cm \cdot s^{-1}$), MAX, along- and cross-shore minimum velocity ($cm \cdot s^{-1}$), MIN, along- and cross-shore velocity variance ($cm^2 \cdot s^{-2}$), $S^2$, and principal axis of variation, $\alpha$, in an along- and cross-shore coordinate system (a positive value is a counterclockwise rotation relative to the axes).

Seasonal statistics, winter.

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G1 | 90.0000 | ALS | -2.10 | 1.26 | 46.52 | -43.26 | 108.74 | -20.23 |
| | | | | CRS | 2.82* | 0.65 | 53.68 | -15.02 | 33.44 | |
| EPA | GS | G2 | 32.7500 | ALS | -8.36* | 1.79 | 38.15 | -49.11 | 109.30 | -30.62 |
| | | | | CRS | 4.51* | 1.17 | 61.98 | -17.62 | 51.21 | |
| EPA | GS | G2 | 35.0417 | ALS | 0.10 | 4.18 | 82.57 | -64.06 | 319.26 | -22.96 |
| | | | | CRS | 1.29 | 1.61 | 57.98 | -25.81 | 85.72 | |
| EPA | GS | G3 | 36.8750 | ALS | 1.69 | 4.31 | 66.09 | -68.23 | 301.84 | -26.96 |
| | | | | CRS | -2.29 | 1.85 | 45.74 | -53.20 | 134.86 | |
| MMS | MAMES | Ma | 70.2083 | ALS | -0.90 | 1.32 | 27.30 | -35.01 | 86.29 | 0.47 |
| | | | | CRS | 0.45 | 0.74 | 17.41 | -21.22 | 24.69 | |
| COE | MS | C8 | 38.7083 | ALS | -3.22 | 1.72 | 42.25 | -35.81 | 124.30 | -37.99 |
| | | | | CRS | -2.13 | 1.97 | 23.65 | -37.06 | 93.30 | |
| COE | MS | C7 | 37.8958 | ALS | -4.34* | 1.53 | 33.55 | -42.05 | 114.51 | -6.30 |
| | | | | CRS | -3.70* | 1.24 | 30.30 | -32.71 | 65.51 | |
| USGS | | USc | 58.6250 | ALS | -6.20* | 2.87 | 34.56 | -57.01 | 238.48 | -0.97 |
| | | | | CRS | 1.11 | 1.16 | 33.14 | -37.54 | 93.09 | |
| COE | MS | C5 | 39.5833 | ALS | -5.29 | 2.46 | 32.76 | -52.27 | 169.06 | -29.25 |
| | | | | CRS | 3.40* | 1.52 | 34.54 | -26.44 | 88.37 | |
| COE | MS | C3 | 36.5833 | ALS | -6.22 | 3.16 | 30.86 | -45.88 | 145.88 | -19.03 |
| | | | | CRS | 0.01 | 1.20 | 28.70 | -28.47 | 52.57 | |
| COE | MS | C2 | 36.5625 | ALS | -2.44 | 1.72 | 39.51 | -43.03 | 136.36 | -44.33 |
| | | | | CRS | -2.04 | 3.30 | 22.34 | -47.46 | 132.10 | |
| COE | MS | C1 | 36.5000 | ALS | 2.63 | 1.62 | 54.92 | -49.57 | 135.39 | 2.91 |
| | | | | CRS | -5.59* | 1.42 | 31.84 | -33.91 | 75.33 | |
| MMS | LTX | 16a | 90.0000 | ALS | -2.91 | 1.46 | 48.30 | -55.12 | 183.66 | 0.75 |
| | | | | CRS | -1.14 | 1.01 | 30.39 | -35.15 | 94.49 | |
| MMS | LTX | 16b | 84.6667 | ALS | -5.59* | 1.55 | 32.84 | -51.71 | 187.97 | 10.84 |
| | | | | CRS | -0.35 | 0.88 | 44.24 | -39.15 | 70.64 | |
| MMS | LTX | 15 | 90.0000 | ALS | -7.51* | 1.74 | 33.51 | -64.91 | 200.52 | -12.07 |
| | | | | CRS | 1.99 | 1.59 | 35.30 | -33.88 | 83.00 | |

Table 2. Seasonal statistics, winter. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 15 | 90.0000 | ALS | -11.27* | 2.56 | 46.38 | -68.62 | 284.08 | -4.57 |
| | | | | CRS | -0.21 | 0.99 | 35.66 | -38.97 | 83.34 | |
| NOAA | WI | N1a | 41.8958 | ALS | -0.62 | 1.42 | 52.43 | -34.12 | 97.09 | 8.61 |
| | | | | CRS | 1.31 | 1.06 | 29.12 | -37.13 | 72.77 | |
| NOAA | WI | N5a | 27.6458 | ALS | -0.39 | 1.64 | 51.83 | -30.37 | 87.22 | 16.90 |
| | | | | CRS | 0.70 | 1.16 | 25.37 | -21.20 | 57.89 | |
| DOE | BD | B1 | 52.5625 | ALS | -3.83 | 3.11 | 125.07 | -57.32 | 508.56 | -28.63 |
| | | | | CRS | -1.42 | 2.14 | 40.62 | -85.58 | 263.25 | |
| MMS | LTX | 17 | 74.4167 | ALS | -7.33* | 2.82 | 83.79 | -114.46 | 526.45 | 13.15 |
| | | | | CRS | -2.44 | 2.70 | 88.55 | -106.05 | 413.09 | |
| MMS | LTX | 18a | 90.0000 | ALS | -8.91* | 2.11 | 41.50 | -72.97 | 279.40 | 5.40 |
| | | | | CRS | -1.51 | 1.01 | 45.69 | -41.25 | 106.85 | |
| MMS | LTX | 18b | 69.9167 | ALS | -5.80* | 2.70 | 62.08 | -61.21 | 236.68 | 5.82 |
| | | | | CRS | -1.80 | 0.96 | 27.57 | -31.00 | 74.32 | |
| MMS | YR5 | AA | 110.7917+ | ALS | -4.53* | 1.82 | 78.21 | -54.25 | 237.88 | 40.80 |
| | | | | CRS | -0.99 | 1.59 | 55.84 | -66.28 | 204.86 | |
| DOE | BD | B5a | 90.0000 | ALS | -4.55* | 1.49 | 52.19 | -48.49 | 165.75 | 26.00 |
| | | | | CRS | -2.39 | 0.91 | 28.46 | -32.80 | 66.51 | |
| DOE | WH | HS | 74.3333 | ALS | -9.35* | 1.32 | 54.71 | -70.33 | 141.51 | -4.66 |
| | | | | CRS | -0.00 | 0.90 | 36.13 | -25.82 | 59.56 | |
| DOE | WH | HD | 43.9792 | ALS | -3.21 | 1.85 | 37.92 | -33.94 | 115.25 | -13.07 |
| | | | | CRS | 1.50* | 0.71 | 18.46 | -12.42 | 22.42 | |
| DOE | WH | HD | 35.4375 | ALS | -7.95* | 2.51 | 39.16 | -83.57 | 289.41 | -7.63 |
| | | | | CRS | 1.53 | 1.09 | 24.92 | -28.34 | 51.58 | |
| DOE | WH | HD | 90.0000 | ALS | -6.58* | 2.36 | 45.70 | -65.05 | 359.27 | -12.77 |
| | | | | CRS | 3.05* | 0.94 | 31.86 | -24.98 | 78.18 | |
| DOE | BD | B6 | 90.0000 | ALS | -3.28* | 1.57 | 40.19 | -51.61 | 148.15 | 41.01 |
| | | | | CRS | -3.35* | 1.32 | 41.98 | -40.61 | 125.03 | |
| DOE | BD | B8 | 90.0000 | ALS | -6.70* | 1.35 | 35.94 | -47.54 | 122.78 | 39.10 |
| | | | | CRS | -2.98* | 1.15 | 36.92 | -27.37 | 96.78 | |
| DOE | WH | HW | 66.7708 | ALS | -7.79* | 1.50 | 30.30 | -47.63 | 122.95 | 8.42 |
| | | | | CRS | 0.69 | 0.55 | 28.57 | -17.82 | 22.27 | |
| DOE | BD | B7 | 89.1458 | ALS | -4.45* | 1.45 | 44.44 | -50.22 | 155.25 | 25.79 |
| | | | | CRS | -1.47 | 0.93 | 27.78 | -29.64 | 70.05 | |
| MMS | LTX | 20a | 90.0000 | ALS | -19.34* | 1.77 | 17.96 | -83.16 | 158.55 | 17.30 |
| | | | | CRS | 8.62* | 1.32 | 45.63 | -47.32 | 137.06 | |
| MMS | LTX | 20b | 60.8958 | ALS | -33.10* | 4.46 | 79.51 | -93.48 | 829.59 | -17.56 |
| | | | | CRS | 3.72 | 2.50 | 63.21 | -59.42 | 331.56 | |
| TLGO | TABS | TB | 91.0000 | ALS | -13.18* | 3.87 | 59.31 | -88.41 | 536.21 | 0.63 |
| | | | | CRS | -3.12* | 1.49 | 50.05 | -57.40 | 95.68 | |
| TLGO | TABS | TC | 91.0000 | ALS | -3.25* | 1.21 | 39.83 | -63.06 | 111.04 | -6.73 |
| | | | | CRS | -2.64* | 0.88 | 20.66 | -41.30 | 55.77 | |
| MMS | LTX | 23b | 90.0000 | ALS | -23.53* | 2.41 | 36.14 | -75.57 | 387.08 | -11.25 |
| | | | | CRS | 2.99* | 0.79 | 35.46 | -27.26 | 57.54 | |
| MMS | LTX | 23b | 61.6875 | ALS | -18.98* | 4.26 | 65.72 | -72.82 | 511.64 | -3.23 |
| | | | | CRS | 1.97* | 0.59 | 23.24 | -15.75 | 24.73 | |
| MMS | LTX | 24b | 41.5000 | ALS | -20.62* | 3.83 | 17.82 | -96.76 | 365.56 | -4.53 |
| | | | | CRS | 0.29 | 1.06 | 23.91 | -26.06 | 62.29 | |

Table 2. Seasonal statistics, winter. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| TLGO | TABS | TD | 91.0000 | ALS | -8.32 | 5.05 | 77.72 | -85.26 | 845.00 | 2.13 |
| | | | | CRS | -2.14* | 0.54 | 28.98 | -23.79 | 32.21 | |
| MMS | LTX | 01a | 73.5000 | ALS | -23.27* | 3.19 | 33.94 | -82.98 | 381.24 | -4.23 |
| | | | | CRS | 0.43 | 0.74 | 25.33 | -23.59 | 48.48 | |
| MMS | LTX | 01b | 31.0417 | ALS | -5.85* | 2.32 | 21.50 | -37.65 | 129.52 | 2.02 |
| | | | | CRS | 1.07* | 0.42 | 14.12 | -13.56 | 8.66 | |
| MMS | LTX | 02 | 90.0000 | ALS | -14.39* | 2.22 | 23.92 | -71.57 | 249.42 | -3.53 |
| | | | | CRS | -0.45 | 0.64 | 22.34 | -29.30 | 39.91 | |
| MMS | LTX | 02 | 90.0000 | ALS | -14.14* | 3.03 | 44.26 | -76.48 | 318.86 | 2.71 |
| | | | | CRS | -1.32* | 0.58 | 16.04 | -27.38 | 31.78 | |

Seasonal statistics, spring.

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 59.9375 | ALS | 7.52* | 2.22 | 64.04 | -38.43 | 225.15 | -35.43 |
| | | | | CRS | -0.17 | 2.03 | 48.16 | -35.63 | 169.10 | |
| EPA | GS | G1 | 77.3333 | ALS | 1.63 | 1.79 | 46.31 | -50.48 | 174.72 | -19.69 |
| | | | | CRS | 1.36 | 0.94 | 39.81 | -21.78 | 49.29 | |
| EPA | GS | G2 | 77.4167 | ALS | 4.92* | 2.10 | 62.39 | -38.13 | 208.17 | -23.04 |
| | | | | CRS | 1.67 | 1.35 | 47.93 | -23.38 | 74.62 | |
| EPA | GS | G3 | 77.6042 | ALS | 4.20 | 3.82 | 87.47 | -48.93 | 279.48 | -18.21 |
| | | | | CRS | 2.24 | 1.31 | 37.91 | -49.42 | 119.88 | |
| EPA | GS | G4 | 44.3750 | ALS | 3.23 | 3.30 | 52.59 | -36.54 | 158.51 | -20.62 |
| | | | | CRS | 0.47 | 1.35 | 23.26 | -24.48 | 46.69 | |
| MMS | MAMES | Ma | 92.0000 | ALS | 5.09* | 2.10 | 58.68 | -39.75 | 133.09 | 4.41 |
| | | | | CRS | 1.21 | 1.01 | 29.78 | -39.90 | 85.24 | |
| MMS | MAMES | Mb | 92.0000 | ALS | 1.24 | 1.65 | 36.81 | -35.64 | 116.38 | -0.46 |
| | | | | CRS | 0.40 | 1.34 | 32.41 | -26.98 | 68.08 | |
| COE | MS | C8 | 60.0208 | ALS | 2.41 | 3.11 | 58.04 | -45.38 | 203.22 | -13.83 |
| | | | | CRS | 2.05 | 1.72 | 40.56 | -48.08 | 95.86 | |
| COE | MS | C7 | 60.1250 | ALS | 2.71 | 2.59 | 38.56 | -45.55 | 148.10 | -17.01 |
| | | | | CRS | 1.55 | 1.65 | 29.79 | -43.20 | 71.85 | |
| USGS | | USb | 94.3958 | ALS | -6.22 | 3.12 | 60.38 | -67.11 | 405.93 | -4.15 |
| | | | | CRS | -0.69 | 1.73 | 51.17 | -73.86 | 251.98 | |
| COE | MS | C6 | 58.1250 | ALS | 5.11* | 1.43 | 43.07 | -24.69 | 84.99 | -35.95 |
| | | | | CRS | -0.37 | 1.27 | 37.84 | -38.61 | 63.54 | |
| COE | MS | C5 | 46.8542 | ALS | -0.82 | 2.44 | 66.20 | -38.72 | 178.29 | 26.78 |
| | | | | CRS | 2.14 | 3.22 | 56.27 | -50.54 | 259.42 | |
| COE | MS | C4 | 47.0208 | ALS | -0.45 | 2.54 | 52.61 | -46.70 | 224.07 | -39.24 |
| | | | | CRS | 3.81 | 2.16 | 64.06 | -30.35 | 188.07 | |
| COE | MS | C3 | 53.0208 | ALS | 4.56 | 3.03 | 54.86 | -51.88 | 236.42 | -14.87 |
| | | | | CRS | 2.31 | 1.44 | 40.30 | -32.64 | 110.07 | |
| COE | MS | C2 | 52.8958 | ALS | 2.39 | 2.74 | 43.25 | -34.01 | 181.51 | 30.01 |
| | | | | CRS | -0.86 | 3.49 | 43.47 | -73.65 | 306.53 | |
| COE | MS | C1 | 52.7500 | ALS | 7.00 | 4.08 | 77.30 | -34.49 | 366.44 | -19.29 |
| | | | | CRS | -0.28 | 1.64 | 39.36 | -36.59 | 115.30 | |
| MMS | LTX | 16a | 47.5000 | ALS | -4.46* | 1.51 | 31.58 | -39.96 | 111.02 | 37.13 |
| | | | | CRS | -0.92 | 1.40 | 24.16 | -36.27 | 104.04 | |

Table 2. Seasonal statistics, spring. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 16a | 92.0000 | ALS | -5.20* | 1.45 | 35.38 | -66.37 | 168.88 | 23.38 |
| | | | | CRS | -0.90 | 1.09 | 29.96 | -45.25 | 107.38 | |
| MMS | LTX | 16b | 92.0000 | ALS | -1.49 | 1.09 | 42.06 | -69.67 | 109.24 | 38.94 |
| | | | | CRS | -0.38 | 1.06 | 38.38 | -56.05 | 101.22 | |
| MMS | LTX | 15 | 47.5000 | ALS | -1.45 | 1.57 | 29.31 | -36.17 | 108.27 | -0.66 |
| | | | | CRS | -0.70 | 1.52 | 26.12 | -44.95 | 81.15 | |
| MMS | LTX | 15 | 92.0000 | ALS | -2.34 | 1.67 | 49.44 | -94.63 | 208.02 | 9.93 |
| | | | | CRS | 0.70 | 0.85 | 29.71 | -37.95 | 77.44 | |
| MMS | LTX | 15 | 92.0000 | ALS | -1.15 | 2.92 | 31.10 | -48.39 | 155.16 | -2.56 |
| | | | | CRS | 1.24 | 0.86 | 38.40 | -27.47 | 68.77 | |
| DOE | BD | B4 | 69.0417 | ALS | -4.17* | 1.10 | 22.29 | -37.30 | 74.19 | 29.33 |
| | | | | CRS | -2.96 | 0.82 | 22.87 | -27.25 | 48.82 | |
| DOE | BD | B3a | 39.9167 | ALS | -6.36 | 3.35 | 43.94 | -60.00 | 321.67 | -13.68 |
| | | | | CRS | 0.34 | 1.65 | 42.29 | -39.21 | 149.53 | |
| DOE | BD | B3b | 74.2708 | ALS | -7.68* | 2.14 | 44.45 | -56.28 | 242.55 | -15.72 |
| | | | | CRS | -0.36 | 1.92 | 36.86 | -47.97 | 124.46 | |
| NOAA | WI | N1b | 34.0000 | ALS | -1.81 | 3.29 | 69.13 | -40.47 | 321.07 | -3.75 |
| | | | | CRS | -0.19 | 1.74 | 34.99 | -49.44 | 144.78 | |
| NOAA | WI | N1c | 34.0417 | ALS | -1.63 | 2.67 | 63.26 | -33.36 | 215.07 | 0.40 |
| | | | | CRS | -0.12 | 1.44 | 30.26 | -30.97 | 99.50 | |
| NOAA | WI | N5a | 67.3958 | ALS | -5.65* | 1.47 | 41.50 | -37.07 | 89.79 | 24.60 |
| | | | | CRS | -0.86 | 0.95 | 22.73 | -30.68 | 61.87 | |
| NOAA | WI | N5c | 34.1875 | ALS | -9.01* | 3.43 | 52.44 | -44.98 | 219.18 | 23.40 |
| | | | | CRS | -0.48 | 2.13 | 46.86 | -34.89 | 132.69 | |
| DOE | BD | B1 | 33.1875 | ALS | -3.83 | 2.67 | 73.79 | -53.60 | 236.37 | -33.48 |
| | | | | CRS | 0.48 | 2.11 | 46.95 | -60.41 | 197.33 | |
| MMS | LTX | 17 | 61.9583 | ALS | -5.30 | 2.70 | 76.83 | -68.88 | 416.88 | -4.22 |
| | | | | CRS | -1.50 | 1.78 | 44.10 | -102.01 | 241.27 | |
| MMS | LTX | 18a | 48.2500 | ALS | -2.87 | 3.75 | 34.90 | -59.74 | 264.82 | 3.25 |
| | | | | CRS | -1.51 | 1.50 | 36.10 | -53.39 | 137.56 | |
| MMS | LTX | 18a | 92.0000 | ALS | 0.02 | 3.05 | 65.20 | -77.66 | 347.48 | 15.19 |
| | | | | CRS | 0.09 | 1.34 | 46.77 | -56.78 | 155.83 | |
| MMS | LTX | 18b | 69.4167 | ALS | -5.36 | 2.81 | 48.77 | -61.32 | 178.06 | 0.48 |
| | | | | CRS | -0.95 | 1.16 | 44.08 | -51.43 | 109.31 | |
| MMS | YR5 | AA | 46.6667+ | ALS | -4.45 | 4.25 | 49.64 | -65.64 | 361.61 | 33.31 |
| | | | | CRS | -2.50 | 3.14 | 39.01 | -42.84 | 225.42 | |
| DOE | BD | B5a | 92.0000 | ALS | -2.32* | 1.10 | 34.42 | -40.90 | 81.26 | 31.88 |
| | | | | CRS | -1.66 | 1.04 | 17.36 | -29.00 | 52.13 | |
| DOE | BD | B5b | 49.3750 | ALS | -3.53 | 3.18 | 63.91 | -53.39 | 314.72 | 21.03 |
| | | | | CRS | -2.98* | 1.41 | 26.29 | -31.94 | 74.91 | |
| DOE | WH | HS | 57.4583 | ALS | -10.01* | 1.95 | 22.27 | -40.63 | 116.41 | -6.51 |
| | | | | CRS | 0.92 | 1.16 | 26.37 | -29.58 | 63.94 | |
| DOE | WH | HS | 92.2708 | ALS | -12.95* | 1.63 | 31.05 | -70.38 | 167.41 | 8.63 |
| | | | | CRS | -1.52 | 1.19 | 51.70 | -43.67 | 104.72 | |
| DOE | WH | HN | 33.4583 | ALS | -5.44 | 3.02 | 20.04 | -44.12 | 197.63 | -5.31 |
| | | | | CRS | 0.74 | 1.00 | 17.90 | -19.20 | 39.13 | |
| DOE | WH | HN | 62.9792 | ALS | -10.69* | 1.82 | 26.18 | -46.74 | 164.15 | -23.96 |
| | | | | CRS | 2.63* | 1.23 | 32.10 | -29.86 | 85.05 | |

Table 2. Seasonal statistics, spring. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| DOE | WH | HD | 57.2500 | ALS | -13.32* | 3.21 | 22.74 | -52.77 | 254.44 | -12.94 |
| | | | | CRS | 2.42* | 0.92 | 22.43 | -28.14 | 41.97 | |
| DOE | WH | HD | 72.7500 | ALS | -17.40* | 3.36 | 31.47 | -61.51 | 261.53 | -15.92 |
| | | | | CRS | 2.21 | 1.48 | 27.41 | -29.90 | 73.81 | |
| DOE | WH | HD | 92.0000 | ALS | -10.75* | 3.29 | 73.15 | -84.71 | 482.39 | -10.23 |
| | | | | CRS | 3.03* | 1.02 | 46.29 | -35.61 | 91.32 | |
| DOE | BD | B6 | 92.0000 | ALS | -2.43 | 1.26 | 30.07 | -36.44 | 90.56 | 34.16 |
| | | | | CRS | -1.81 | 1.01 | 20.13 | -25.60 | 54.66 | |
| DOE | BD | B8 | 92.0000 | ALS | -2.71 | 1.38 | 27.87 | -39.61 | 86.38 | -42.58 |
| | | | | CRS | -2.66 | 1.40 | 32.45 | -33.81 | 93.30 | |
| DOE | WH | HW | 87.9583 | ALS | -14.67* | 3.15 | 34.47 | -75.59 | 310.71 | -3.14 |
| | | | | CRS | 0.97 | 0.87 | 28.14 | -36.18 | 68.29 | |
| DOE | BD | B7 | 92.0000 | ALS | -4.71* | 1.88 | 44.41 | -58.86 | 160.93 | 27.86 |
| | | | | CRS | -2.70* | 1.28 | 35.90 | -34.77 | 75.75 | |
| MMS | LTX | 20a | 75.8333 | ALS | -15.52* | 3.00 | 25.28 | -82.98 | 318.60 | -19.43 |
| | | | | CRS | 2.35 | 1.93 | 48.22 | -62.49 | 193.25 | |
| MMS | LTX | 20b | 28.5208 | ALS | 12.47 | 6.25 | 76.10 | -74.22 | 629.58 | -26.36 |
| | | | | CRS | 4.47 | 4.66 | 55.33 | -55.43 | 316.89 | |
| TLGO | TABS | TB | 59.2500 | ALS | -15.50* | 3.64 | 21.79 | -132.85 | 396.03 | 5.16 |
| | | | | CRS | 0.14 | 1.41 | 58.84 | -63.62 | 113.75 | |
| TLGO | TABS | TB | 54.4375 | ALS | -22.76* | 6.05 | 65.01 | -117.13 | 683.35 | -1.74 |
| | | | | CRS | -1.17 | 1.63 | 34.00 | -50.61 | 141.60 | |
| TLGO | TABS | TC | 53.5000 | ALS | -20.96* | 2.66 | 34.46 | -92.96 | 331.22 | -1.63 |
| | | | | CRS | 5.22* | 1.99 | 53.25 | -47.66 | 215.58 | |
| TLGO | TABS | TC | 55.7708 | ALS | -12.01* | 2.68 | 36.41 | -75.38 | 247.23 | -1.96 |
| | | | | CRS | 2.86* | 1.35 | 31.36 | -41.97 | 83.25 | |
| MMS | LTX | 23a | 49.3958 | ALS | -2.30 | 3.79 | 45.23 | -66.08 | 355.32 | -15.21 |
| | | | | CRS | -0.18 | 1.35 | 35.91 | -24.11 | 75.92 | |
| MMS | LTX | 23b | 92.0000 | ALS | -8.84* | 2.82 | 57.76 | -84.97 | 443.56 | -6.96 |
| | | | | CRS | 1.18 | 0.74 | 29.86 | -32.76 | 59.12 | |
| MMS | LTX | 23b | 62.4167 | ALS | -14.41* | 5.60 | 38.40 | -77.19 | 407.87 | -4.33 |
| | | | | CRS | 0.96 | 0.72 | 19.44 | -20.84 | 37.99 | |
| MMS | LTX | 24a | 52.6875 | ALS | -3.82 | 3.05 | 41.99 | -45.40 | 197.54 | -11.51 |
| | | | | CRS | -3.70 | 1.44 | 33.32 | -36.80 | 100.56 | |
| MMS | LTX | 24b | 92.0000 | ALS | -8.27* | 3.04 | 50.73 | -119.74 | 424.47 | 3.61 |
| | | | | CRS | -1.48 | 0.93 | 30.89 | -29.88 | 68.92 | |
| TLGO | TABS | TD | 55.7708 | ALS | -12.26* | 5.37 | 62.71 | -85.63 | 757.59 | 3.36 |
| | | | | CRS | -1.46 | 0.88 | 22.19 | -24.42 | 43.61 | |
| MMS | LTX | 01a | 52.5000 | ALS | -1.43 | 4.76 | 86.00 | -66.90 | 570.22 | -7.22 |
| | | | | CRS | 0.15 | 1.14 | 25.55 | -26.97 | 64.11 | |
| MMS | LTX | 01a | 92.0000 | ALS | -5.97 | 3.19 | 55.54 | -80.99 | 477.12 | -1.22 |
| | | | | CRS | -0.47 | 1.05 | 26.30 | -23.26 | 40.20 | |
| MMS | LTX | 01b | 33.3542 | ALS | -5.99* | 1.83 | 19.31 | -44.42 | 111.72 | 2.63 |
| | | | | CRS | -0.72 | 0.67 | 13.41 | -19.93 | 17.34 | |
| MMS | LTX | 02 | 52.5000 | ALS | -1.81 | 4.66 | 55.07 | -64.27 | 382.54 | 4.29 |
| | | | | CRS | -1.57 | 1.70 | 33.60 | -40.85 | 132.06 | |
| MMS | LTX | 02 | 92.0000 | ALS | -5.77 | 4.41 | 44.94 | -92.80 | 446.89 | 4.90 |
| | | | | CRS | -0.03 | 1.12 | 36.05 | -39.30 | 96.75 | |

Table 2. Seasonal statistics, spring. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 02 | 92.0000 | ALS | -12.65* | 2.77 | 24.49 | -69.03 | 205.54 | 4.62 |
| | | | | CRS | -1.35 | 0.95 | 21.82 | -28.09 | 62.01 | |

Seasonal statistics, summer.

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 75.5625 | ALS | 4.28 | 2.63 | 67.81 | -30.34 | 211.99 | -21.17 |
| | | | | CRS | 0.24 | 1.32 | 32.84 | -58.01 | 71.29 | |
| EPA | GS | G1 | 92.0000 | ALS | 0.09 | 1.02 | 31.81 | -32.74 | 58.68 | -11.27 |
| | | | | CRS | 1.56* | 0.49 | 19.02 | -14.77 | 16.29 | |
| EPA | GS | G2 | 92.0000 | ALS | 4.10* | 2.05 | 59.34 | -37.50 | 164.77 | -19.33 |
| | | | | CRS | 0.26 | 0.94 | 28.97 | -25.19 | 43.45 | |
| EPA | GS | G3 | 92.0000 | ALS | 8.10* | 3.97 | 82.22 | -32.72 | 335.56 | -13.23 |
| | | | | CRS | -0.27 | 1.46 | 37.81 | -36.81 | 92.05 | |
| EPA | GS | G4 | 92.0000 | ALS | 3.97 | 2.05 | 59.55 | -39.26 | 167.38 | -18.50 |
| | | | | CRS | 0.69 | 0.97 | 28.17 | -29.64 | 43.13 | |
| MMS | MAMES | Mb | 35.1042 | ALS | -0.75 | 1.92 | 29.62 | -42.93 | 96.82 | -16.41 |
| | | | | CRS | 0.10 | 1.91 | 19.11 | -31.91 | 53.48 | |
| MMS | MAMES | Mb | 92.0000 | ALS | 0.15 | 1.47 | 33.84 | -28.90 | 59.34 | 18.63 |
| | | | | CRS | 1.37 | 1.40 | 26.83 | -30.18 | 41.34 | |
| COE | MS | C8 | 55.7708 | ALS | -4.81 | 4.28 | 66.78 | -55.49 | 294.04 | -20.69 |
| | | | | CRS | 1.86 | 2.42 | 50.38 | -46.33 | 137.67 | |
| COE | MS | C7 | 55.7708 | ALS | -5.87* | 2.74 | 46.27 | -42.62 | 132.25 | -4.56 |
| | | | | CRS | 0.55 | 1.00 | 30.62 | -38.12 | 54.52 | |
| USGS | | USa | 34.3125 | ALS | 9.25 | 5.51 | 76.12 | -47.06 | 480.93 | 15.77 |
| | | | | CRS | 2.77 | 3.39 | 47.59 | -43.30 | 402.97 | |
| USGS | | USb | 92.0000 | ALS | 3.21 | 3.83 | 79.90 | -57.82 | 405.05 | -16.79 |
| | | | | CRS | 0.24 | 2.92 | 59.39 | -56.84 | 341.18 | |
| COE | MS | C5 | 57.0625 | ALS | -3.72 | 2.96 | 46.18 | -41.11 | 143.29 | -19.82 |
| | | | | CRS | 0.85 | 1.77 | 35.71 | -38.07 | 82.80 | |
| COE | MS | C4 | 53.7292 | ALS | 2.57 | 3.30 | 67.94 | -34.10 | 205.46 | -22.22 |
| | | | | CRS | -0.44 | 2.21 | 32.02 | -52.62 | 79.03 | |
| COE | MS | C2 | 40.2083 | ALS | -1.46 | 2.25 | 32.81 | -34.39 | 86.49 | 41.64 |
| | | | | CRS | 1.44 | 2.12 | 34.78 | -27.74 | 93.46 | |
| MMS | DELTA | MD | 78.5625 | ALS | -5.68 | 3.68 | 44.98 | -79.75 | 429.13 | 10.76 |
| | | | | CRS | -0.11 | 1.63 | 38.70 | -38.69 | 77.23 | |
| MMS | LTX | 16a | 50.6250 | ALS | 2.70 | 1.53 | 36.88 | -28.92 | 98.11 | 12.23 |
| | | | | CRS | 1.97 | 1.38 | 29.72 | -22.17 | 68.29 | |
| MMS | LTX | 16a | 69.4583 | ALS | 1.71 | 1.90 | 29.77 | -21.07 | 68.55 | 18.45 |
| | | | | CRS | 1.34 | 1.22 | 33.57 | -23.08 | 46.96 | |
| MMS | LTX | 16b | 92.0000 | ALS | -3.21* | 1.50 | 26.05 | -46.60 | 77.43 | 17.23 |
| | | | | CRS | -0.91 | 1.04 | 34.22 | -26.38 | 37.87 | |
| MMS | LTX | 15 | 85.6667 | ALS | 11.11* | 2.46 | 72.57 | -107.98 | 188.28 | 0.27 |
| | | | | CRS | 3.72* | 1.14 | 48.03 | -42.55 | 97.13 | |
| MMS | LTX | 15 | 92.0000 | ALS | 9.65 | 5.97 | 76.59 | -48.31 | 357.02 | 7.63 |
| | | | | CRS | 1.38 | 1.81 | 56.04 | -44.04 | 122.51 | |
| MMS | LTX | 15 | 92.0000 | ALS | 9.28* | 2.95 | 64.19 | -46.32 | 230.78 | 6.26 |
| | | | | CRS | 1.29 | 1.72 | 41.73 | -31.57 | 119.91 | |

Table 2. Seasonal statistics, summer. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| DOE | BD | B4 | 57.2292 | ALS | -1.95 | 3.04 | 28.56 | -45.48 | 138.03 | 21.13 |
| | | | | CRS | -1.18 | 1.87 | 21.00 | -33.17 | 66.36 | |
| DOE | BD | B4 | 63.1458 | ALS | -2.44 | 1.70 | 23.47 | -38.01 | 87.16 | 13.82 |
| | | | | CRS | -1.15 | 1.26 | 24.82 | -24.57 | 41.68 | |
| NOAA | WI | N4 | 38.5417 | ALS | 1.40 | 1.85 | 27.70 | -40.65 | 71.85 | 19.29 |
| | | | | CRS | -0.90 | 1.10 | 26.78 | -26.21 | 52.13 | |
| DOE | BD | B3a | 44.5208 | ALS | -2.95 | 2.35 | 25.82 | -37.61 | 120.06 | -33.01 |
| | | | | CRS | 1.54 | 1.80 | 37.31 | -27.00 | 82.64 | |
| DOE | BD | B3b | 39.4583 | ALS | -4.76 | 3.27 | 29.34 | -49.43 | 182.50 | -19.88 |
| | | | | CRS | 2.50 | 1.43 | 33.70 | -22.57 | 74.59 | |
| NOAA | WI | N2 | 41.3125 | ALS | 0.35 | 1.30 | 28.56 | -29.15 | 81.14 | -43.45 |
| | | | | CRS | 0.25 | 1.34 | 28.56 | -29.15 | 88.79 | |
| NOAA | WI | N1b | 27.4792 | ALS | 0.60 | 2.81 | 32.58 | -46.14 | 157.71 | -41.49 |
| | | | | CRS | 0.77 | 1.93 | 40.80 | -38.08 | 148.86 | |
| NOAA | WI | N5a | 27.7292 | ALS | -1.14 | 1.43 | 13.51 | -26.47 | 38.91 | -13.98 |
| | | | | CRS | -0.25 | 1.51 | 20.82 | -25.37 | 57.59 | |
| NOAA | WI | N5b | 27.7083 | ALS | -0.75 | 2.95 | 34.98 | -56.35 | 186.54 | 0.66 |
| | | | | CRS | 0.63 | 2.30 | 39.25 | -52.58 | 135.79 | |
| MMS | LTX | 17 | 50.3542 | ALS | -9.88 | 7.68 | 101.24 | -87.21 | 769.77 | -11.03 |
| | | | | CRS | -3.65 | 3.66 | 73.72 | -128.28 | 659.58 | |
| MMS | LTX | 17 | 38.7083 | ALS | -2.27 | 4.30 | 69.29 | -60.61 | 408.79 | 9.77 |
| | | | | CRS | -0.72 | 2.69 | 54.87 | -44.78 | 236.60 | |
| MMS | LTX | 18a | 92.0000 | ALS | 10.41* | 2.62 | 87.14 | -27.97 | 169.01 | 9.12 |
| | | | | CRS | 2.54 | 1.61 | 47.05 | -28.41 | 92.07 | |
| MMS | LTX | 18a | 45.5208 | ALS | 12.22* | 4.81 | 57.99 | -88.51 | 388.15 | 17.17 |
| | | | | CRS | -0.42 | 2.09 | 32.52 | -45.92 | 169.87 | |
| MMS | LTX | 18b | 92.0000 | ALS | 7.21* | 3.15 | 69.30 | -29.03 | 166.31 | 12.87 |
| | | | | CRS | 3.11* | 1.25 | 31.59 | -22.87 | 83.89 | |
| MMS | YR5 | AA | 31.8750+ | ALS | 2.73 | 3.80 | 54.93 | -46.71 | 269.08 | 22.29 |
| | | | | CRS | -0.84 | 2.29 | 23.84 | -40.04 | 83.88 | |
| MMS | YR5 | AA | 49.3750+ | ALS | -4.39 | 3.21 | 30.49 | -61.86 | 244.36 | 29.76 |
| | | | | CRS | -2.02 | 2.32 | 29.94 | -42.84 | 127.64 | |
| ONR | LS | S1 | 64.0625 | ALS | -1.30 | 1.71 | 35.63 | -50.29 | 166.07 | 25.60 |
| | | | | CRS | -2.90 | 2.72 | 33.37 | -43.57 | 177.00 | |
| DOE | BD | B5a | 92.0000 | ALS | 2.01 | 1.29 | 24.62 | -65.98 | 62.64 | 7.61 |
| | | | | CRS | 1.22* | 0.54 | 33.45 | -25.96 | 26.82 | |
| DOE | BD | B5b | 92.0000 | ALS | 1.61 | 3.41 | 52.93 | -107.59 | 311.71 | 10.10 |
| | | | | CRS | 0.35 | 1.23 | 46.49 | -26.80 | 48.91 | |
| DOE | WH | HS | 73.6667 | ALS | -0.42 | 2.90 | 46.66 | -63.27 | 232.18 | 8.28 |
| | | | | CRS | -1.97 | 2.14 | 33.81 | -57.46 | 126.94 | |
| DOE | WH | HN | 92.0000 | ALS | -3.27* | 1.89 | 29.77 | -49.87 | 135.96 | -7.74 |
| | | | | CRS | 0.54 | 0.72 | 25.77 | -36.65 | 51.00 | |
| DOE | WH | HD | 92.0000 | ALS | -2.80 | 3.13 | 46.25 | -64.73 | 291.48 | -11.09 |
| | | | | CRS | -0.03 | 0.88 | 27.96 | -31.54 | 61.28 | |
| DOE | WH | HD | 92.0000 | ALS | -2.42 | 2.34 | 43.27 | -59.03 | 230.55 | -13.43 |
| | | | | CRS | 0.62 | 0.98 | 29.71 | -33.02 | 100.19 | |
| DOE | BD | B8 | 56.6042 | ALS | -1.78 | 2.61 | 26.92 | -82.38 | 158.49 | 16.35 |
| | | | | CRS | -0.64 | 1.19 | 22.57 | -35.34 | 67.24 | |

Table 2. Seasonal statistics, summer. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| DOE | WH | HW | 90.4583 | ALS | -2.49 | 2.15 | 35.06 | -55.15 | 166.56 | 14.19 |
| | | | | CRS | 1.21 | 1.35 | 38.93 | -31.39 | 60.85 | |
| DOE | BD | B7 | 92.0000 | ALS | -0.95 | 1.88 | 32.89 | -85.68 | 134.25 | -0.22 |
| | | | | CRS | -0.11 | 1.23 | 60.81 | -30.93 | 63.91 | |
| MMS | LTX | 20a | 33.8333 | ALS | -7.27 | 5.51 | 55.36 | -79.69 | 608.61 | -24.10 |
| | | | | CRS | 4.42 | 4.22 | 58.10 | -64.55 | 459.85 | |
| MMS | LTX | 20a | 69.0625 | ALS | 5.37 | 4.97 | 72.54 | -82.42 | 778.43 | -10.37 |
| | | | | CRS | 7.96* | 3.73 | 72.53 | -52.13 | 507.41 | |
| TLGO | TABS | TB | 39.3750 | ALS | 5.35* | 2.63 | 79.68 | -119.75 | 1112.54 | 0.18 |
| | | | | CRS | 0.84 | 1.40 | 39.53 | -48.76 | 86.08 | |
| TLGO | TABS | TC | 92.0000 | ALS | 3.50 | 5.00 | 75.73 | -119.64 | 649.56 | -15.45 |
| | | | | CRS | -3.53 | 2.94 | 88.51 | -65.79 | 324.36 | |
| MMS | LTX | 23a | 88.7500 | ALS | 6.75 | 4.66 | 53.38 | -52.39 | 340.58 | -11.32 |
| | | | | CRS | -2.05 | 1.32 | 28.45 | -28.14 | 53.11 | |
| MMS | LTX | 23b | 32.2292 | ALS | 0.15 | 6.42 | 60.02 | -87.99 | 613.05 | -8.66 |
| | | | | CRS | -2.03 | 1.15 | 14.64 | -19.45 | 37.15 | |
| MMS | LTX | 23b | 48.6458 | ALS | 8.45* | 2.74 | 49.13 | -42.54 | 170.41 | -1.05 |
| | | | | CRS | 0.25 | 0.83 | 18.06 | -14.56 | 14.12 | |
| MMS | LTX | 23b | 60.3542 | ALS | 6.93 | 3.48 | 61.41 | -56.73 | 251.82 | -1.21 |
| | | | | CRS | -1.35 | 0.63 | 19.06 | -21.48 | 24.72 | |
| MMS | LTX | 24a | 92.0000 | ALS | 2.62 | 3.00 | 48.06 | -33.63 | 224.23 | -9.64 |
| | | | | CRS | 1.11 | 1.45 | 36.43 | -35.16 | 81.29 | |
| MMS | LTX | 24b | 92.0000 | ALS | 5.52 | 3.60 | 63.81 | -88.63 | 367.18 | -9.89 |
| | | | | CRS | -2.41 | 1.62 | 39.15 | -43.70 | 122.62 | |
| MMS | LTX | 24c | 31.5625 | ALS | -7.35 | 3.97 | 36.82 | -45.26 | 186.19 | -4.39 |
| | | | | CRS | 0.05 | 1.22 | 17.43 | -20.99 | 37.33 | |
| TLGO | TABS | TD | 81.4792 | ALS | 2.89 | 5.57 | 112.33 | -75.59 | 859.60 | 4.12 |
| | | | | CRS | 0.14 | 1.38 | 32.33 | -34.52 | 61.30 | |
| TLGO | TABS | TE | 49.8125 | ALS | 15.19 | 9.37 | 114.61 | -66.36 | 981.81 | 10.24 |
| | | | | CRS | 8.15* | 3.94 | 73.33 | -39.56 | 374.90 | |
| MMS | LTX | 01a | 92.0000 | ALS | 3.24 | 2.59 | 54.48 | -32.88 | 205.66 | -0.95 |
| | | | | CRS | -0.40 | 0.51 | 19.06 | -21.34 | 25.19 | |
| MMS | LTX | 01a | 92.0000 | ALS | -0.45 | 3.19 | 67.90 | -95.35 | 292.28 | 2.49 |
| | | | | CRS | 1.31 | 0.90 | 26.54 | -33.56 | 39.48 | |
| MMS | LTX | 01b | 57.5000 | ALS | -2.46 | 2.35 | 21.34 | -23.72 | 80.83 | 5.14 |
| | | | | CRS | -1.09* | 0.51 | 12.30 | -13.63 | 6.32 | |
| MMS | LTX | 02 | 52.5000 | ALS | 14.81* | 4.80 | 65.69 | -33.78 | 354.28 | -3.10 |
| | | | | CRS | 1.72 | 1.12 | 29.05 | -32.75 | 67.13 | |
| MMS | LTX | 02 | 55.5625 | ALS | 7.80 | 7.57 | 68.72 | -95.21 | 649.13 | -5.33 |
| | | | | CRS | 2.84 | 2.84 | 35.63 | -38.69 | 155.57 | |
| MMS | LTX | 02 | 92.0000 | ALS | 2.74 | 4.01 | 60.00 | -56.40 | 287.53 | 3.60 |
| | | | | CRS | 0.27 | 1.18 | 33.03 | -36.71 | 60.09 | |

Seasonal statistics, fall.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 107.3542 | ALS | -5.16* | 1.34 | 33.98 | -49.90 | 77.99 | 25.83 |
| | | | | CRS | 3.32* | 1.55 | 60.97 | -53.94 | 104.84 | |

Table 2. Seasonal statistics, fall. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $s^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G1 | 91.0000 | ALS | -2.01* | 0.84 | 30.97 | -31.04 | 48.22 | -23.64 |
| | | | | CRS | 2.00* | 0.49 | 20.16 | -12.17 | 15.60 | |
| EPA | GS | G2 | 91.0000 | ALS | -4.17* | 1.17 | 35.06 | -36.78 | 70.03 | -24.79 |
| | | | | CRS | 1.71* | 0.62 | 33.69 | -21.29 | 23.15 | |
| EPA | GS | G3 | 78.4167 | ALS | -3.36* | 1.05 | 28.93 | -29.76 | 57.97 | -30.10 |
| | | | | CRS | 0.86 | 0.76 | 30.19 | -19.45 | 32.43 | |
| EPA | GS | G4 | 78.4583 | ALS | -3.19* | 1.50 | 30.76 | -31.70 | 64.37 | -23.23 |
| | | | | CRS | 1.74* | 0.75 | 25.73 | -18.19 | 21.66 | |
| MMS | MAMES | Mb | 91.0000 | ALS | -3.03* | 1.36 | 29.65 | -33.88 | 67.04 | 10.87 |
| | | | | CRS | -1.13 | 0.77 | 26.75 | -26.78 | 30.76 | |
| COE | MS | C8 | 26.2917 | ALS | -6.35* | 3.01 | 27.08 | -47.19 | 134.46 | 41.21 |
| | | | | CRS | 2.46 | 3.32 | 41.34 | -34.04 | 165.69 | |
| COE | MS | C7 | 26.1875 | ALS | -6.48* | 3.18 | 29.17 | -52.70 | 158.83 | -25.20 |
| | | | | CRS | 1.09 | 2.02 | 34.16 | -21.86 | 87.07 | |
| USGS | | USa | 47.0000 | ALS | -1.04 | 4.48 | 69.58 | -42.71 | 335.07 | 24.23 |
| | | | | CRS | 2.26 | 2.69 | 59.16 | -40.12 | 251.18 | |
| USGS | | USb | 79.5000 | ALS | -9.66* | 2.69 | 19.59 | -45.11 | 138.64 | -22.48 |
| | | | | CRS | 2.63 | 1.34 | 31.34 | -27.35 | 74.66 | |
| COE | MS | C6 | 29.6667 | ALS | 5.25* | 1.51 | 26.27 | -22.35 | 73.38 | -23.23 |
| | | | | CRS | 1.62 | 1.02 | 32.05 | -12.05 | 36.74 | |
| COE | MS | C5 | 27.4167 | ALS | -6.73 | 3.38 | 33.25 | -43.96 | 208.72 | -33.50 |
| | | | | CRS | 4.98 | 2.36 | 35.09 | -33.09 | 124.20 | |
| COE | MS | C3 | 29.3750 | ALS | -6.13 | 3.21 | 27.16 | -39.14 | 156.17 | -24.20 |
| | | | | CRS | 1.95 | 1.25 | 39.19 | -17.92 | 61.42 | |
| COE | MS | C2 | 29.4167 | ALS | -2.92 | 1.71 | 31.31 | -33.57 | 103.38 | 40.19 |
| | | | | CRS | -2.30 | 2.03 | 22.97 | -41.46 | 128.89 | |
| COE | MS | C1 | 29.5417 | ALS | -1.44 | 2.31 | 60.57 | -44.75 | 210.29 | -18.12 |
| | | | | CRS | -0.10 | 1.14 | 58.42 | -26.31 | 58.95 | |
| MMS | LTX | 16a | 40.5000 | ALS | -4.99* | 1.83 | 27.36 | -40.51 | 114.47 | 5.78 |
| | | | | CRS | 0.83 | 0.95 | 31.69 | -22.88 | 39.49 | |
| MMS | LTX | 16a | 25.2500 | ALS | -0.42 | 3.79 | 48.04 | -31.49 | 205.26 | -3.18 |
| | | | | CRS | 0.53 | 2.50 | 40.58 | -29.15 | 137.26 | |
| MMS | LTX | 16b | 28.4375 | ALS | -5.03 | 3.06 | 20.72 | -58.82 | 177.74 | 8.61 |
| | | | | CRS | -0.74 | 1.26 | 16.42 | -26.99 | 47.92 | |
| MMS | LTX | 15 | 34.2500 | ALS | -13.91* | 4.09 | 36.22 | -64.51 | 312.89 | 2.78 |
| | | | | CRS | -2.69 | 2.37 | 30.54 | -35.98 | 90.60 | |
| MMS | LTX | 15 | 40.2500 | ALS | -1.88 | 3.17 | 42.21 | -55.58 | 192.53 | 3.38 |
| | | | | CRS | 0.44 | 1.43 | 29.11 | -26.86 | 68.23 | |
| MMS | LTX | 15 | 91.0000 | ALS | -7.36* | 2.64 | 28.32 | -54.07 | 158.20 | 1.83 |
| | | | | CRS | -0.19 | 1.20 | 36.25 | -32.32 | 50.90 | |
| MMS | LTX | 15 | 93.4375 | ALS | -15.07* | 2.44 | 19.38 | -61.16 | 197.26 | -10.37 |
| | | | | CRS | 0.54 | 1.45 | 43.18 | -28.25 | 75.77 | |
| NOAA | WI | N1a | 86.3125 | ALS | -3.51* | 0.87 | 62.97 | -29.06 | 63.65 | -28.54 |
| | | | | CRS | 0.39 | 0.77 | 33.10 | -38.98 | 57.06 | |
| NOAA | WI | N1b | 72.8333 | ALS | -6.00* | 1.76 | 27.64 | -35.29 | 85.11 | 35.80 |
| | | | | CRS | 0.58 | 1.06 | 39.93 | -29.15 | 96.00 | |
| NOAA | WI | N5a | 40.7292 | ALS | -3.65* | 1.20 | 20.43 | -31.80 | 62.30 | 40.70 |
| | | | | CRS | 0.83 | 1.27 | 25.06 | -25.23 | 59.60 | |

| Table 2. Seasonal statistics, fall. (continued) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $S^2$ | $\alpha$ |
| MMS | LTX | 17 | 49.5417+ | ALS | -9.62* | 2.46 | 37.60 | -72.10 | 277.74 | -12.87 |
| | | | | CRS | -3.80 | 2.84 | 66.55 | -67.05 | 330.56 | |
| MMS | LTX | 17 | 64.6667 | ALS | -9.76* | 2.52 | 42.16 | -69.41 | 294.18 | 12.13 |
| | | | | CRS | -1.77 | 1.83 | 56.52 | -51.95 | 216.18 | |
| MMS | LTX | 17 | 27.3125 | ALS | -4.54 | 3.07 | 39.14 | -39.17 | 232.65 | 29.90 |
| | | | | CRS | -1.28 | 2.30 | 37.68 | -37.14 | 216.79 | |
| MMS | LTX | 17 | 38.5417 | ALS | -9.34* | 3.86 | 35.06 | -66.83 | 299.30 | 21.64 |
| | | | | CRS | -1.63 | 2.78 | 47.79 | -52.79 | 275.94 | |
| MMS | LTX | 18a | 91.0000 | ALS | -7.10* | 2.67 | 30.36 | -64.92 | 232.38 | 10.53 |
| | | | | CRS | -1.07 | 1.16 | 32.78 | -34.56 | 62.79 | |
| MMS | LTX | 18b | 27.4583 | ALS | -4.55 | 3.31 | 16.82 | -36.84 | 120.18 | 9.23 |
| | | | | CRS | -0.20 | 0.85 | 17.01 | -19.87 | 23.38 | |
| DOE | BD | B5a | 26.3958 | ALS | -3.96 | 2.43 | 27.58 | -40.99 | 150.12 | 16.18 |
| | | | | CRS | -0.76 | 1.25 | 15.98 | -24.63 | 35.14 | |
| DOE | WH | HS | 75.8125 | ALS | -6.35* | 1.20 | 22.08 | -39.87 | 84.48 | 17.25 |
| | | | | CRS | 0.93 | 1.62 | 37.42 | -22.47 | 53.64 | |
| DOE | WH | HN | 53.9792 | ALS | -5.26* | 1.42 | 25.82 | -36.35 | 96.28 | -6.46 |
| | | | | CRS | 1.61* | 0.65 | 26.20 | -26.60 | 28.12 | |
| DOE | WH | HD | 91.0000 | ALS | -7.05* | 1.58 | 22.61 | -42.18 | 107.59 | -10.30 |
| | | | | CRS | 1.25* | 0.60 | 25.62 | -17.85 | 29.57 | |
| DOE | WH | HD | 73.5000 | ALS | -10.76* | 1.74 | 26.15 | -49.50 | 146.98 | -11.82 |
| | | | | CRS | 2.97* | 0.82 | 29.65 | -21.15 | 40.56 | |
| DOE | WH | HD | 94.4375 | ALS | -5.70* | 1.35 | 26.17 | -56.45 | 133.55 | -11.94 |
| | | | | CRS | 2.56* | 0.58 | 27.38 | -16.94 | 36.20 | |
| DOE | BD | B6 | 41.1667 | ALS | -4.36 | 3.05 | 28.37 | -48.93 | 185.34 | 16.73 |
| | | | | CRS | -1.81 | 1.49 | 23.42 | -39.73 | 60.80 | |
| DOE | BD | B8 | 41.3333 | ALS | -3.32 | 2.15 | 25.45 | -35.46 | 81.39 | 42.76 |
| | | | | CRS | -1.90 | 1.95 | 20.99 | -31.72 | 74.11 | |
| DOE | WH | HW | 51.4792 | ALS | -3.21* | 1.09 | 27.29 | -36.79 | 73.91 | 6.81 |
| | | | | CRS | -0.96 | 0.83 | 19.23 | -29.45 | 42.58 | |
| TLGO | TABS | TA | 57.9792 | ALS | -7.32* | 3.30 | 48.12 | -57.52 | 256.96 | 13.98 |
| | | | | CRS | -5.15 | 2.63 | 40.87 | -51.09 | 175.52 | |
| MMS | LTX | 20a | 24.2708 | ALS | -13.09* | 1.84 | 25.12 | -39.43 | 94.22 | 35.28 |
| | | | | CRS | 0.65 | 3.06 | 32.73 | -31.52 | 108.05 | |
| MMS | LTX | 20b | 72.8125 | ALS | -7.21* | 2.65 | 49.83 | -86.72 | 471.60 | -13.63 |
| | | | | CRS | 4.97* | 2.49 | 73.74 | -63.10 | 343.56 | |
| MMS | LTX | 20b | 61.0833 | ALS | -20.15* | 3.10 | 75.19 | -68.02 | 268.99 | -30.00 |
| | | | | CRS | 4.14 | 2.96 | 51.98 | -96.70 | 204.85 | |
| TLGO | TABS | TB | 92.4792 | ALS | -20.44* | 3.60 | 89.57 | -115.58 | 463.57 | -4.40 |
| | | | | CRS | -1.63 | 1.42 | 87.79 | -99.78 | 191.13 | |
| TLGO | TABS | TC | 91.0000 | ALS | 11.24* | 2.65 | 66.62 | -40.01 | 275.38 | 39.39 |
| | | | | CRS | 8.52* | 2.37 | 80.39 | -35.51 | 219.90 | |
| MMS | LTX | 23b | 91.0000 | ALS | -12.65* | 3.40 | 43.29 | -100.73 | 385.99 | -6.82 |
| | | | | CRS | 1.81 | 0.91 | 28.33 | -21.31 | 27.21 | |
| MMS | LTX | 23b | 29.6458 | ALS | -11.24* | 4.83 | 32.83 | -64.48 | 376.82 | -0.41 |
| | | | | CRS | 0.96 | 0.71 | 19.25 | -11.83 | 14.70 | |
| MMS | LTX | 23b | 64.0208 | ALS | -20.53* | 2.65 | 29.97 | -56.59 | 235.40 | -1.84 |
| | | | | CRS | 1.33* | 0.64 | 24.78 | -28.31 | 31.18 | |

Table 2. Seasonal statistics, fall. (continued)

| SA | PGM | M | T | | MEAN | SE | MAX | MIN | $s^2$ | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 24b | 29.5625 | ALS | -7.59* | 2.78 | 24.34 | -48.04 | 156.68 | -0.71 |
| | | | | CRS | -0.37 | 0.62 | 18.90 | -14.19 | 13.86 | |
| MMS | LTX | 24c | 37.3125 | ALS | -21.95* | 4.57 | 15.32 | -83.13 | 298.86 | -4.02 |
| | | | | CRS | 1.66 | 1.38 | 37.26 | -30.93 | 80.65 | |
| MMS | LTX | 24c | 95.3125 | ALS | -18.49* | 2.66 | 29.27 | -76.55 | 269.33 | -5.27 |
| | | | | CRS | 1.48 | 0.90 | 30.68 | -25.06 | 62.24 | |
| TLGO | TABS | TD | 91.0000 | ALS | -22.04* | 3.98 | 72.01 | -136.04 | 693.10 | 4.15 |
| | | | | CRS | -3.07* | 0.92 | 52.30 | -44.32 | 58.91 | |
| MMS | LTX | 01a | 76.7500 | ALS | -7.36* | 3.30 | 37.37 | -57.93 | 291.01 | 6.71 |
| | | | | CRS | -1.04 | 0.96 | 15.30 | -24.34 | 26.24 | |
| MMS | LTX | 01a | 28.0625 | ALS | -5.69* | 2.02 | 24.26 | -39.25 | 103.34 | 18.67 |
| | | | | CRS | -1.26 | 0.84 | 21.46 | -25.78 | 23.52 | |
| MMS | LTX | 01b | 45.8958 | ALS | -6.41* | 1.80 | 23.38 | -34.14 | 122.42 | 5.82 |
| | | | | CRS | 0.40 | 0.65 | 14.53 | -20.68 | 16.33 | |
| MMS | LTX | 02 | 91.0000 | ALS | -12.34* | 4.04 | 47.24 | -77.14 | 400.50 | 1.75 |
| | | | | CRS | -3.01* | 0.80 | 20.95 | -39.76 | 61.63 | |
| MMS | LTX | 02 | 62.4583 | ALS | -14.61* | 3.99 | 17.79 | -97.94 | 415.00 | -1.68 |
| | | | | CRS | 0.85 | 0.81 | 28.28 | -32.49 | 49.29 | |
| MMS | LTX | 02 | 96.4792 | ALS | -16.74* | 2.67 | 31.48 | -59.18 | 254.72 | 0.31 |
| | | | | CRS | -0.37 | 0.91 | 28.54 | -35.28 | 70.47 | |

Table 3.

Seasonal 40-hour low-passed statistics. Stations listed counterclockwise around the Gulf of Mexico, from on- to off-shore. With sponsoring agent, SA, program identification, PGM, observational meter identification, M, and where lower case character denotes a meter depth and/or a mooring location change, observational record length (days), T, where + denotes a sample time interval of 1.0 hr, all others being 0.5 hr, along- and cross-shore velocity autocorrelation time period (hr), AC, along- and cross-shore velocity degrees of freedom, DF, along- and cross-shore maximum velocity ($cm \cdot s^{-1}$), MAX, along- and cross-shore minimum velocity ($cm \cdot s^{-1}$), MIN, along- and cross-shore velocity variance ($cm^2 \cdot s^{-2}$), $S^2$, low-passed velocity variance as a percentage of the total velocity variance, %TOTAL, and principal axis of variation, $\alpha$, in along- and cross-shore coordinate system (a positive value is a counterclockwise rotation relative to the axes).

Seasonal 40-hour low-passed statistics, winter.

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G1 | 88.3333 | ALS | 31.5 | 68.57 | 21.04 | -32.35 | 78.24 | 71.95 | -21.03 |
| | | | | CRS | 27.0 | 80.00 | 27.44 | -4.09 | 19.41 | 58.04 | |
| EPA | GS | G2 | 31.0000 | ALS | 23.0 | 34.17 | 22.48 | -35.27 | 79.18 | 72.44 | -31.64 |
| | | | | CRS | 21.0 | 37.43 | 28.17 | -9.69 | 34.59 | 67.55 | |
| EPA | GS | G2 | 33.3750 | ALS | 46.0 | 18.28 | 39.80 | -35.61 | 259.25 | 81.20 | -22.83 |
| | | | | CRS | 25.5 | 32.98 | 23.89 | -13.29 | 60.50 | 70.58 | |
| EPA | GS | G3 | 35.1667 | ALS | 54.5 | 16.24 | 35.59 | -40.66 | 219.48 | 72.71 | -24.01 |
| | | | | CRS | 22.5 | 39.33 | 23.00 | -22.87 | 74.76 | 55.44 | |
| MMS | MAMES | Ma | 68.4792 | ALS | 34.0 | 49.56 | 21.84 | -21.97 | 67.33 | 78.03 | 2.71 |
| | | | | CRS | 37.5 | 44.93 | 9.09 | -8.66 | 11.29 | 45.73 | |
| COE | MS | C8 | 37.0000 | ALS | 22.0 | 42.23 | 25.37 | -21.93 | 87.15 | 70.11 | -38.53 |
| | | | | CRS | 38.5 | 24.13 | 11.16 | -27.15 | 63.29 | 67.83 | |
| COE | MS | C7 | 36.1458 | ALS | 18.5 | 49.16 | 19.03 | -28.21 | 73.40 | 64.10 | -13.98 |
| | | | | CRS | 21.5 | 42.30 | 14.17 | -24.25 | 40.11 | 61.23 | |
| USGS | | USc | 56.9167 | ALS | 48.5 | 29.01 | 20.20 | -34.87 | 161.35 | 67.66 | 2.60 |
| | | | | CRS | 20.5 | 68.63 | 14.91 | -18.80 | 30.20 | 32.44 | |
| COE | MS | C5 | 37.9167 | ALS | 34.0 | 27.94 | 20.98 | -33.88 | 129.87 | 76.82 | -26.12 |
| | | | | CRS | 25.0 | 38.00 | 21.86 | -19.85 | 47.78 | 54.07 | |
| COE | MS | C3 | 34.8958 | ALS | 60.0 | 14.63 | 14.61 | -24.12 | 74.67 | 51.19 | -4.95 |
| | | | | CRS | 24.0 | 36.58 | 15.11 | -9.80 | 15.77 | 30.00 | |
| COE | MS | C2 | 34.8958 | ALS | 19.0 | 46.18 | 8.90 | -15.01 | 30.37 | 22.27 | 29.93 |
| | | | | CRS | 72.5 | 12.10 | 11.32 | -17.05 | 42.35 | 32.06 | |
| COE | MS | C1 | 34.7917 | ALS | 17.0 | 51.53 | 16.06 | -5.15 | 19.68 | 14.54 | -23.82 |
| | | | | CRS | 23.5 | 37.28 | 3.17 | -15.42 | 17.17 | 22.79 | |
| MMS | LTX | 16a | 88.3333 | ALS | 25.0 | 86.40 | 28.58 | -43.45 | 127.45 | 69.39 | 2.48 |
| | | | | CRS | 23.5 | 91.91 | 22.50 | -19.57 | 45.33 | 47.97 | |
| MMS | LTX | 16b | 82.9167 | ALS | 26.0 | 78.15 | 23.12 | -37.18 | 127.08 | 67.61 | 11.41 |
| | | | | CRS | 22.5 | 90.31 | 18.48 | -15.20 | 26.16 | 37.03 | |
| MMS | LTX | 15 | 88.3333 | ALS | 32.5 | 66.46 | 19.75 | -44.10 | 130.89 | 65.28 | -9.74 |
| | | | | CRS | 66.0 | 32.73 | 22.68 | -16.98 | 41.45 | 49.94 | |
| MMS | LTX | 15 | 88.3333 | ALS | 50.0 | 43.20 | 27.69 | -49.64 | 188.64 | 66.40 | -1.95 |
| | | | | CRS | 25.5 | 84.71 | 16.40 | -23.65 | 32.06 | 38.47 | |
| NOAA | WI | N1 | 40.1875 | ALS | 21.0 | 47.88 | 38.25 | -26.33 | 70.31 | 72.42 | 7.68 |
| | | | | CRS | 15.5 | 64.87 | 18.93 | -8.29 | 22.03 | 30.27 | |
| NOAA | WI | N5a | 25.9583 | ALS | 20.5 | 32.37 | 37.13 | -21.67 | 71.47 | 81.94 | 14.26 |
| | | | | CRS | 15.5 | 42.81 | 16.13 | -10.67 | 24.61 | 42.51 | |
| DOE | BD | B1 | 50.8958 | ALS | 24.0 | 52.56 | 70.91 | -39.86 | 392.84 | 77.25 | -24.57 |
| | | | | CRS | 22.0 | 57.34 | 18.60 | -44.09 | 98.27 | 37.33 | |

| Table 3. Seasonal 40-hour low-passed statistics, winter. (continued) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
| MMS | LTX | 17 | 72.7500 | ALS | 27.0 | 66.15 | 53.91 | -42.05 | 269.58 | 51.21 | 16.03 |
| | | | | CRS | 31.5 | 56.70 | 23.26 | -37.68 | 75.83 | 18.36 | |
| MMS | LTX | 18a | 88.3333 | ALS | 34.5 | 62.61 | 17.67 | -45.31 | 185.80 | 66.50 | 7.36 |
| | | | | CRS | 20.5 | 105.37 | 13.55 | -14.26 | 22.62 | 21.17 | |
| MMS | LTX | 18b | 68.2083 | ALS | 51.5 | 32.58 | 38.52 | -32.62 | 182.07 | 76.93 | 8.81 |
| | | | | CRS | 21.0 | 79.90 | 13.44 | -18.68 | 23.73 | 31.93 | |
| MMS | YR5 | AA | 108.8333+ | ALS | 37.0 | 71.86 | 46.51 | -35.55 | 144.22 | 60.63 | 38.23 |
| | | | | CRS | 33.0 | 80.58 | 37.17 | -20.99 | 95.17 | 46.46 | |
| DOE | BD | B5a | 88.3333 | ALS | 29.0 | 74.48 | 35.20 | -39.23 | 136.45 | 82.32 | 26.26 |
| | | | | CRS | 27.0 | 80.00 | 15.53 | -19.29 | 46.48 | 69.88 | |
| DOE | WH | HS | 72.6458 | ALS | 22.0 | 81.09 | 38.68 | -51.17 | 103.73 | 73.30 | -3.58 |
| | | | | CRS | 24.0 | 74.33 | 11.07 | -13.77 | 15.16 | 25.45 | |
| DOE | WH | HD | 42.2708 | ALS | 31.5 | 33.51 | 28.42 | -30.28 | 93.09 | 80.77 | -12.93 |
| | | | | CRS | 24.0 | 43.98 | 9.08 | -5.25 | 7.61 | 33.94 | |
| DOE | WH | HD | 33.7708 | ALS | 18.5 | 45.97 | 31.07 | -65.30 | 241.02 | 83.28 | -4.60 |
| | | | | CRS | 19.5 | 43.62 | 11.70 | -9.10 | 12.22 | 23.69 | |
| DOE | WH | HD | 88.3333 | ALS | 33.5 | 64.48 | 33.13 | -58.55 | 309.51 | 86.15 | -11.54 |
| | | | | CRS | 24.5 | 88.16 | 20.15 | -12.71 | 37.37 | 47.80 | |
| DOE | BD | B6 | 88.3333 | ALS | 36.0 | 60.00 | 23.36 | -38.57 | 104.81 | 70.75 | 43.59 |
| | | | | CRS | 30.0 | 72.00 | 20.05 | -30.86 | 97.42 | 77.92 | |
| DOE | BD | B8 | 88.3333 | ALS | 32.0 | 67.50 | 22.41 | -38.53 | 89.91 | 73.23 | 39.57 |
| | | | | CRS | 29.5 | 73.22 | 25.21 | -18.28 | 67.57 | 69.82 | |
| DOE | WH | HW | 65.0000 | ALS | 29.5 | 54.32 | 18.31 | -38.02 | 97.29 | 79.13 | 9.24 |
| | | | | CRS | 22.0 | 72.84 | 13.81 | -4.53 | 8.12 | 36.46 | |
| DOE | BD | B7 | 87.4583 | ALS | 29.0 | 73.78 | 20.43 | -41.30 | 118.49 | 76.32 | 26.62 |
| | | | | CRS | 26.5 | 80.74 | 20.22 | -20.53 | 44.94 | 64.15 | |
| MMS | LTX | 20a | 88.3333 | ALS | 42.5 | 50.82 | 5.53 | -60.43 | 114.00 | 71.90 | 3.82 |
| | | | | CRS | 27.5 | 78.55 | 32.28 | -11.37 | 69.61 | 50.79 | |
| MMS | LTX | 20b | 59.0833 | ALS | 35.0 | 41.76 | 64.10 | -69.39 | 676.69 | 81.57 | -16.73 |
| | | | | CRS | 27.5 | 53.15 | 33.08 | -37.20 | 145.80 | 43.97 | |
| TLGO | TABS | TB | 89.3333 | ALS | 61.0 | 35.80 | 46.44 | -65.46 | 458.52 | 85.51 | -1.26 |
| | | | | CRS | 50.5 | 43.25 | 13.58 | -29.25 | 44.72 | 46.74 | |
| TLGO | TABS | TC | 89.3333 | ALS | 29.0 | 75.31 | 14.80 | -45.55 | 73.21 | 65.93 | -14.02 |
| | | | | CRS | 30.5 | 71.61 | 6.27 | -24.05 | 27.24 | 48.84 | |
| MMS | LTX | 23b | 88.3333 | ALS | 32.5 | 66.46 | 18.94 | -61.77 | 305.71 | 78.98 | -10.79 |
| | | | | CRS | 23.5 | 91.91 | 18.75 | -13.42 | 24.37 | 42.35 | |
| MMS | LTX | 23b | 60.0208 | ALS | 52.5 | 28.20 | 61.42 | -59.96 | 476.98 | 93.23 | -3.16 |
| | | | | CRS | 20.5 | 72.22 | 11.17 | -9.08 | 11.48 | 46.42 | |
| MMS | LTX | 24b | 39.7708 | ALS | 40.0 | 24.90 | 8.10 | -65.31 | 300.16 | 82.11 | -4.21 |
| | | | | CRS | 18.0 | 55.33 | 17.21 | -19.22 | 31.56 | 50.67 | |
| TLGO | TABS | TD | 89.3333 | ALS | 66.0 | 33.09 | 61.25 | -61.92 | 797.84 | 94.42 | 1.94 |
| | | | | CRS | 19.5 | 112.00 | 11.60 | -11.51 | 12.05 | 37.41 | |
| MMS | LTX | 01a | 71.8333 | ALS | 47.0 | 37.53 | 26.50 | -62.73 | 332.13 | 87.12 | -3.40 |
| | | | | CRS | 20.0 | 88.20 | 7.58 | -11.24 | 16.47 | 33.97 | |
| MMS | LTX | 01b | 29.3333 | ALS | 31.0 | 24.03 | 12.68 | -27.74 | 110.87 | 85.60 | 2.69 |
| | | | | CRS | 15.5 | 48.06 | 7.23 | -7.50 | 5.07 | 58.55 | |
| MMS | LTX | 02 | 88.3333 | ALS | 42.5 | 50.82 | 17.07 | -52.05 | 212.53 | 85.21 | -2.43 |
| | | | | CRS | 22.0 | 98.18 | 11.41 | -15.78 | 20.30 | 50.86 | |
| MMS | LTX | 02 | 88.3333 | ALS | 62.0 | 34.84 | 38.69 | -60.79 | 291.09 | 91.29 | 3.73 |
| | | | | CRS | 23.0 | 93.91 | 8.45 | -13.32 | 15.19 | 47.80 | |

Table 3. Seasonal 40-hour low-passed statistics, spring. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $s^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 58.2292 | ALS | 31.5 | 45.67 | 37.31 | -24.66 | 138.39 | 61.47 | -38.40 |
| | | | | CRS | 35.0 | 41.10 | 36.00 | -26.00 | 103.83 | 61.40 | |
| EPA | GS | G1 | 75.6667 | ALS | 34.0 | 54.59 | 31.37 | -32.54 | 135.54 | 77.58 | -21.39 |
| | | | | CRS | 33.5 | 55.40 | 31.59 | -9.67 | 34.13 | 69.24 | |
| EPA | GS | G2 | 75.6667 | ALS | 39.5 | 47.04 | 46.89 | -31.35 | 159.01 | 76.38 | -24.21 |
| | | | | CRS | 45.5 | 40.84 | 38.89 | -13.15 | 52.12 | 69.85 | |
| EPA | GS | G3 | 75.9167 | ALS | 97.0 | 19.20 | 52.99 | -37.35 | 199.36 | 71.33 | -16.55 |
| | | | | CRS | 26.5 | 70.28 | 21.50 | -22.25 | 55.71 | 46.47 | |
| EPA | GS | G4 | 42.6667 | ALS | 73.0 | 14.59 | 32.85 | -20.17 | 106.87 | 67.42 | -19.95 |
| | | | | CRS | 41.5 | 25.66 | 12.83 | -8.73 | 23.62 | 50.59 | |
| MMS | MAMES | Ma | 90.3333 | ALS | 73.5 | 30.04 | 41.87 | -17.69 | 75.79 | 56.95 | -.57 |
| | | | | CRS | 26.5 | 83.32 | 16.04 | -23.22 | 27.69 | 32.48 | |
| MMS | MAMES | Mb | 90.3333 | ALS | 51.5 | 42.87 | 26.76 | -26.51 | 69.11 | 59.38 | 4.18 |
| | | | | CRS | 58.0 | 38.07 | 14.21 | -11.78 | 27.01 | 39.67 | |
| COE | MS | C8 | 58.3333 | ALS | 68.5 | 21.03 | 33.44 | -32.72 | 156.04 | 76.78 | -9.69 |
| | | | | CRS | 44.5 | 32.37 | 23.90 | -15.23 | 46.84 | 48.86 | |
| COE | MS | C7 | 58.4583 | ALS | 65.5 | 22.03 | 23.85 | -27.30 | 116.79 | 78.86 | -16.71 |
| | | | | CRS | 54.5 | 26.48 | 16.47 | -10.84 | 30.40 | 42.31 | |
| USGS | | USb | 92.5833 | ALS | 54.5 | 41.57 | 34.23 | -45.79 | 225.13 | 55.46 | -2.76 |
| | | | | CRS | 27.0 | 83.91 | 28.35 | -30.71 | 90.98 | 36.11 | |
| COE | MS | C6 | 56.4583 | ALS | 33.5 | 41.64 | 23.42 | -12.31 | 56.08 | 65.98 | -31.33 |
| | | | | CRS | 35.5 | 39.30 | 15.55 | -16.20 | 26.87 | 42.29 | |
| COE | MS | C5 | 45.0833 | ALS | 37.5 | 29.99 | 23.92 | -24.36 | 81.68 | 45.81 | 36.22 |
| | | | | CRS | 45.0 | 24.99 | 30.99 | -18.04 | 107.74 | 41.53 | |
| COE | MS | C4 | 45.3333 | ALS | 32.5 | 34.72 | 25.31 | -28.78 | 160.15 | 71.47 | -36.98 |
| | | | | CRS | 28.0 | 40.30 | 48.42 | -15.69 | 112.08 | 59.59 | |
| COE | MS | C3 | 51.2917 | ALS | 49.5 | 25.71 | 33.53 | -18.81 | 132.25 | 55.94 | 1.39 |
| | | | | CRS | 24.0 | 53.02 | 16.78 | -8.59 | 32.85 | 29.84 | |
| COE | MS | C2 | 51.2083 | ALS | 52.5 | 24.18 | 20.88 | -15.09 | 67.35 | 37.11 | 19.86 |
| | | | | CRS | 50.5 | 25.14 | 25.53 | -43.06 | 172.00 | 56.11 | |
| COE | MS | C1 | 51.0417 | ALS | 57.5 | 22.02 | 38.02 | -14.43 | 96.94 | 26.45 | -12.23 |
| | | | | CRS | 29.5 | 42.92 | 16.35 | -23.60 | 36.89 | 31.99 | |
| MMS | LTX | 16a | 45.8333 | ALS | 23.5 | 48.51 | 11.78 | -19.27 | 28.21 | 25.41 | 28.73 |
| | | | | CRS | 21.5 | 53.02 | 7.84 | -13.73 | 21.42 | 20.59 | |
| MMS | LTX | 16a | 90.3333 | ALS | 27.5 | 80.29 | 17.93 | -38.70 | 92.44 | 54.74 | 22.21 |
| | | | | CRS | 24.5 | 90.12 | 13.02 | -23.73 | 37.46 | 34.89 | |
| MMS | LTX | 16b | 90.3333 | ALS | 24.0 | 92.00 | 22.06 | -27.54 | 52.26 | 47.84 | 29.00 |
| | | | | CRS | 24.5 | 90.12 | 26.82 | -13.47 | 32.12 | 31.73 | |
| MMS | LTX | 15 | 45.8333 | ALS | 26.0 | 43.85 | 14.04 | -19.98 | 41.74 | 38.55 | 0.71 |
| | | | | CRS | 32.5 | 35.08 | 9.39 | -16.64 | 20.76 | 25.58 | |
| MMS | LTX | 15 | 90.3333 | ALS | 29.5 | 74.85 | 37.95 | -49.41 | 125.83 | 60.49 | 12.44 |
| | | | | CRS | 20.5 | 107.71 | 13.67 | -18.53 | 18.66 | 24.10 | |
| MMS | LTX | 15 | 90.3333 | ALS | 121.5 | 18.17 | 17.69 | -31.97 | 89.40 | 57.62 | -1.44 |
| | | | | CRS | 23.5 | 93.96 | 12.24 | -12.77 | 15.99 | 23.25 | |
| DOE | BD | B4 | 67.3333 | ALS | 27.0 | 59.81 | 11.67 | -28.85 | 35.97 | 48.48 | 31.78 |
| | | | | CRS | 23.0 | 70.22 | 14.06 | -14.65 | 20.67 | 43.34 | |
| DOE | BD | B3a | 38.2083 | ALS | 33.5 | 28.60 | 28.58 | -38.74 | 173.29 | 53.87 | -1.88 |
| | | | | CRS | 17.5 | 54.74 | 9.42 | -6.16 | 12.34 | 8.25 | |
| DOE | BD | B3b | 72.6042 | ALS | 33.5 | 53.21 | 29.16 | -38.58 | 137.90 | 56.85 | -1.05 |
| | | | | CRS | 53.0 | 33.63 | 18.02 | -11.42 | 26.20 | 21.05 | |
| NOAA | WI | N1 | 32.3333 | ALS | 27.5 | 29.67 | 54.04 | -23.57 | 255.91 | 79.71 | 4.10 |
| | | | | CRS | 17.0 | 48.00 | 14.55 | -8.50 | 22.50 | 15.54 | |
| NOAA | WI | N1 | 32.3750 | ALS | 27.0 | 30.26 | 48.78 | -20.22 | 170.58 | 79.31 | 5.71 |
| | | | | CRS | 17.0 | 48.06 | 15.83 | -8.59 | 20.20 | 20.30 | |

Table 3. Seasonal 40-hour low-passed statistics, spring. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOAA | WI | N5a | 65.7083 | ALS | 39.0 | 41.47 | 25.52 | -28.33 | 57.23 | 63.74 | 19.30 |
| | | | | CRS | 23.5 | 68.83 | 13.59 | -13.00 | 17.28 | 27.93 | |
| NOAA | WI | N5c | 32.5000 | ALS | 44.0 | 18.65 | 31.48 | -26.90 | 164.35 | 74.98 | 22.26 |
| | | | | CRS | 28.0 | 29.30 | 26.31 | -19.22 | 72.09 | 54.33 | |
| DOE | BD | B1 | 31.4792 | ALS | 24.0 | 33.19 | 31.06 | -24.42 | 119.31 | 50.48 | -17.21 |
| | | | | CRS | 18.0 | 44.25 | 13.34 | -14.86 | 26.88 | 13.62 | |
| MMS | LTX | 17 | 60.2083 | ALS | 26.0 | 57.19 | 56.20 | -43.06 | 291.54 | 69.93 | -.59 |
| | | | | CRS | 19.5 | 76.26 | 15.37 | -27.14 | 41.44 | 17.18 | |
| MMS | LTX | 18a | 46.5000 | ALS | 61.5 | 18.83 | 17.99 | -38.61 | 139.39 | 52.64 | 6.83 |
| | | | | CRS | 19.0 | 60.95 | 14.01 | -18.91 | 28.30 | 20.57 | |
| MMS | LTX | 18a | 90.3333 | ALS | 59.0 | 37.42 | 58.06 | -64.61 | 257.23 | 74.03 | 17.41 |
| | | | | CRS | 25.5 | 86.59 | 20.67 | -32.49 | 63.18 | 40.54 | |
| MMS | LTX | 18b | 67.7500 | ALS | 74.0 | 22.51 | 12.57 | -37.53 | 99.02 | 55.61 | 6.08 |
| | | | | CRS | 20.5 | 81.27 | 21.06 | -29.53 | 37.16 | 34.00 | |
| MMS | YR5 | AA | 45.0000+ | ALS | 56.0 | 20.00 | 31.84 | -46.42 | 233.45 | 64.56 | 31.47 |
| | | | | CRS | 49.0 | 22.86 | 24.55 | -25.36 | 98.04 | 43.49 | |
| DOE | BD | B5a | 90.3333 | ALS | 33.0 | 66.91 | 26.57 | -25.50 | 56.57 | 69.62 | 34.87 |
| | | | | CRS | 45.5 | 48.53 | 12.07 | -15.16 | 34.08 | 65.38 | |
| DOE | BD | B5b | 47.6667 | ALS | 38.0 | 31.18 | 57.60 | -39.39 | 285.72 | 90.79 | 21.30 |
| | | | | CRS | 31.5 | 37.62 | 12.97 | -20.62 | 52.47 | 70.04 | |
| DOE | WH | HS | 55.7292 | ALS | 45.0 | 30.64 | 14.88 | -28.12 | 90.26 | 77.54 | -5.87 |
| | | | | CRS | 29.0 | 47.55 | 13.08 | -10.58 | 23.32 | 36.47 | |
| DOE | WH | HS | 90.5833 | ALS | 35.0 | 63.27 | 23.28 | -43.25 | 125.40 | 74.91 | 5.85 |
| | | | | CRS | 30.0 | 73.82 | 18.94 | -30.27 | 46.93 | 44.81 | |
| DOE | WH | HN | 31.6667 | ALS | 37.0 | 21.70 | 17.52 | -37.15 | 178.03 | 90.08 | -5.81 |
| | | | | CRS | 20.5 | 39.17 | 10.89 | -11.13 | 20.16 | 51.52 | |
| DOE | WH | HN | 61.1667 | ALS | 30.5 | 49.56 | 12.05 | -42.54 | 110.77 | 67.48 | -23.45 |
| | | | | CRS | 27.0 | 55.98 | 16.89 | -13.14 | 38.84 | 45.67 | |
| DOE | WH | HD | 55.5000 | ALS | 55.5 | 24.76 | 16.58 | -46.54 | 230.17 | 90.46 | -12.06 |
| | | | | CRS | 28.0 | 49.07 | 11.40 | -11.16 | 21.28 | 50.70 | |
| DOE | WH | HD | 70.9375 | ALS | 75.5 | 23.13 | 26.16 | -44.83 | 208.17 | 79.60 | -14.48 |
| | | | | CRS | 51.5 | 33.90 | 17.07 | -14.92 | 32.68 | 44.28 | |
| DOE | WH | HD | 90.3333 | ALS | 49.5 | 44.61 | 53.01 | -57.33 | 409.21 | 84.83 | -9.67 |
| | | | | CRS | 25.0 | 88.32 | 18.37 | -14.95 | 33.03 | 36.17 | |
| DOE | BD | B6 | 90.3333 | ALS | 39.0 | 56.62 | 14.52 | -27.00 | 65.66 | 72.50 | 36.40 |
| | | | | CRS | 41.5 | 53.20 | 15.85 | -18.84 | 40.24 | 73.62 | |
| DOE | BD | B8 | 90.3333 | ALS | 49.0 | 45.06 | 14.75 | -21.78 | 58.18 | 67.35 | -42.74 |
| | | | | CRS | 46.5 | 47.48 | 17.07 | -22.36 | 64.53 | 69.16 | |
| DOE | WH | HW | 86.2083 | ALS | 67.5 | 31.27 | 28.34 | -53.72 | 253.13 | 81.47 | -2.94 |
| | | | | CRS | 23.5 | 89.83 | 18.03 | -14.45 | 28.74 | 42.09 | |
| DOE | BD | B7 | 90.3333 | ALS | 48.5 | 45.53 | 25.57 | -44.81 | 130.67 | 81.20 | 28.99 |
| | | | | CRS | 47.5 | 46.48 | 17.69 | -17.52 | 52.77 | 69.66 | |
| MMS | LTX | 20a | 74.1667 | ALS | 51.5 | 35.34 | 14.33 | -50.24 | 222.83 | 69.94 | -22.75 |
| | | | | CRS | 35.0 | 52.00 | 31.40 | -24.19 | 102.54 | 53.06 | |
| MMS | LTX | 20b | 26.8542 | ALS | 42.5 | 16.11 | 63.68 | -45.34 | 549.58 | 87.29 | -26.64 |
| | | | | CRS | 47.0 | 14.56 | 41.60 | -29.91 | 218.38 | 68.91 | |
| TLGO | TABS | TB | 57.5417 | ALS | 47.5 | 29.94 | 11.63 | -64.86 | 262.69 | 66.33 | 3.33 |
| | | | | CRS | 25.0 | 56.88 | 23.83 | -15.67 | 42.39 | 37.27 | |
| TLGO | TABS | TB | 52.7083 | ALS | 70.0 | 18.66 | 52.87 | -70.28 | 571.42 | 83.62 | -2.99 |
| | | | | CRS | 24.5 | 53.33 | 17.33 | -27.93 | 54.27 | 38.33 | |
| TLGO | TABS | TC | 51.7708 | ALS | 27.5 | 46.69 | 23.40 | -55.64 | 174.85 | 52.79 | -13.89 |
| | | | | CRS | 23.5 | 54.64 | 35.40 | -23.35 | 125.22 | 58.09 | |
| TLGO | TABS | TC | 54.0208 | ALS | 39.0 | 34.32 | 21.06 | -55.49 | 194.29 | 78.59 | -8.12 |
| | | | | CRS | 29.5 | 45.37 | 15.14 | -20.66 | 45.00 | 54.05 | |

Table 3. Seasonal 40-hour low-passed statistics, spring. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 23a | 47.6667 | ALS | 48.0 | 24.70 | 42.69 | -43.31 | 289.93 | 81.60 | -15.93 |
| | | | | CRS | 28.5 | 41.60 | 13.30 | -14.60 | 36.17 | 47.64 | |
| MMS | LTX | 23b | 90.3333 | ALS | 39.5 | 55.90 | 47.00 | -75.37 | 380.87 | 85.87 | -7.60 |
| | | | | CRS | 20.5 | 107.71 | 19.51 | -13.76 | 22.94 | 38.80 | |
| MMS | LTX | 23b | 60.6667 | ALS | 115.0 | 13.03 | 21.34 | -58.05 | 350.03 | 85.82 | -3.07 |
| | | | | CRS | 20.5 | 73.07 | 10.70 | -10.81 | 11.24 | 29.59 | |
| MMS | LTX | 24a | 50.9792 | ALS | 59.5 | 21.25 | 23.29 | -35.93 | 143.80 | 72.80 | -12.47 |
| | | | | CRS | 26.0 | 48.63 | 17.67 | -20.68 | 53.39 | 53.09 | |
| MMS | LTX | 24b | 90.3333 | ALS | 48.0 | 46.00 | 41.69 | -90.80 | 363.87 | 85.72 | 3.01 |
| | | | | CRS | 28.0 | 78.86 | 16.81 | -16.26 | 29.61 | 42.96 | |
| TLGO | TABS | TD | 54.0208 | ALS | 51.0 | 26.25 | 54.17 | -72.02 | 700.87 | 92.51 | 3.46 |
| | | | | CRS | 23.5 | 56.96 | 7.19 | -11.73 | 16.76 | 38.43 | |
| MMS | LTX | 01a | 50.8333 | ALS | 50.0 | 25.20 | 80.15 | -58.02 | 541.05 | 94.88 | -6.88 |
| | | | | CRS | 25.5 | 49.41 | 12.35 | -12.72 | 30.13 | 47.00 | |
| MMS | LTX | 01a | 90.3333 | ALS | 47.0 | 46.98 | 42.86 | -65.25 | 433.91 | 90.94 | -1.10 |
| | | | | CRS | 60.5 | 36.50 | 11.90 | -11.61 | 13.95 | 34.70 | |
| MMS | LTX | 01b | 31.6667 | ALS | 24.0 | 33.35 | 10.90 | -30.20 | 92.26 | 82.58 | 3.63 |
| | | | | CRS | 21.0 | 38.12 | 6.05 | -7.41 | 7.79 | 44.93 | |
| MMS | LTX | 02 | 50.8333 | ALS | 71.5 | 17.62 | 41.82 | -62.34 | 330.13 | 86.30 | 4.16 |
| | | | | CRS | 27.5 | 45.82 | 18.32 | -26.02 | 73.46 | 55.63 | |
| MMS | LTX | 02 | 90.3333 | ALS | 96.0 | 23.00 | 26.34 | -82.48 | 396.94 | 88.82 | 5.12 |
| | | | | CRS | 28.5 | 77.47 | 15.41 | -26.47 | 57.21 | 59.13 | |
| MMS | LTX | 02 | 90.3333 | ALS | 82.5 | 26.76 | 15.98 | -52.72 | 166.21 | 80.87 | 5.12 |
| | | | | CRS | 32.0 | 69.00 | 11.51 | -22.27 | 31.91 | 51.46 | |

Seasonal 40-hour low-passed statistics, summer.

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 73.8958 | ALS | 59.0 | 30.74 | 44.77 | -20.59 | 161.34 | 76.11 | -22.67 |
| | | | | CRS | 44.5 | 40.75 | 18.55 | -29.06 | 40.00 | 56.11 | |
| EPA | GS | G1 | 90.3333 | ALS | 39.0 | 56.62 | 18.38 | -20.56 | 43.10 | 73.45 | -11.55 |
| | | | | CRS | 32.5 | 67.94 | 9.68 | -4.05 | 4.93 | 30.26 | |
| EPA | GS | G2 | 90.3333 | ALS | 56.5 | 39.08 | 38.84 | -20.74 | 129.08 | 78.34 | -19.56 |
| | | | | CRS | 45.0 | 49.07 | 16.61 | -17.47 | 24.78 | 57.03 | |
| EPA | GS | G3 | 90.3333 | ALS | 103.5 | 21.33 | 53.67 | -22.60 | 251.08 | 74.82 | -13.43 |
| | | | | CRS | 51.0 | 43.29 | 22.96 | -16.10 | 32.85 | 35.69 | |
| EPA | GS | G4 | 90.3333 | ALS | 55.5 | 39.78 | 39.21 | -21.89 | 132.93 | 79.42 | -18.86 |
| | | | | CRS | 48.5 | 45.53 | 13.29 | -17.60 | 24.54 | 56.90 | |
| MMS | MAMES | Mb | 33.3958 | ALS | 32.0 | 26.33 | 20.65 | -15.72 | 48.45 | 50.04 | -10.37 |
| | | | | CRS | 57.5 | 14.65 | 9.75 | -13.77 | 19.21 | 35.92 | |
| MMS | MAMES | Mb | 90.3333 | ALS | 80.5 | 27.43 | 17.35 | -11.41 | 29.38 | 49.51 | 25.78 |
| | | | | CRS | 104.0 | 21.23 | 13.81 | -15.40 | 15.09 | 36.50 | |
| COE | MS | C8 | 54.0208 | ALS | 83.5 | 16.03 | 42.10 | -40.14 | 198.86 | 67.63 | -18.69 |
| | | | | CRS | 57.0 | 23.48 | 22.50 | -13.06 | 41.35 | 30.04 | |
| COE | MS | C7 | 54.0208 | ALS | 76.0 | 17.61 | 24.62 | -29.36 | 91.52 | 69.20 | -5.88 |
| | | | | CRS | 24.5 | 54.63 | 10.26 | -5.87 | 9.08 | 16.65 | |
| USGS | | USa | 32.6042 | ALS | 52.0 | 15.84 | 28.74 | -11.81 | 104.71 | 21.77 | 6.24 |
| | | | | CRS | 23.5 | 35.04 | 15.49 | -7.97 | 23.52 | 5.84 | |
| USGS | | USb | 90.3333 | ALS | 80.0 | 27.60 | 31.33 | -27.92 | 149.06 | 36.80 | -15.64 |
| | | | | CRS | 55.0 | 40.15 | 20.54 | -18.41 | 35.24 | 10.33 | |
| COE | MS | C5 | 55.3750 | ALS | 84.0 | 16.30 | 22.15 | -27.66 | 89.83 | 62.69 | -18.59 |
| | | | | CRS | 52.0 | 26.34 | 16.76 | -12.67 | 20.02 | 24.18 | |
| COE | MS | C4 | 52.0000 | ALS | 68.5 | 18.82 | 41.25 | -22.34 | 137.32 | 66.84 | -24.78 |
| | | | | CRS | 80.0 | 16.12 | 18.32 | -16.07 | 33.80 | 42.77 | |

Table 3. Seasonal 40-hour low-passed statistics, summer. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $s^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COE | MS | C2 | 38.4792 | ALS | 56.5 | 17.08 | 6.44 | -10.73 | 11.99 | 13.86 | -5.10 |
| | | | | CRS | 46.5 | 20.75 | 15.28 | -10.06 | 31.28 | 33.47 | |
| MMS | DELTA | MD | 76.8750 | ALS | 59.5 | 31.69 | 38.40 | -57.95 | 380.54 | 88.68 | 11.13 |
| | | | | CRS | 65.0 | 29.01 | 19.91 | -17.74 | 44.01 | 56.99 | |
| MMS | LTX | 16a | 48.9583 | ALS | 29.0 | 41.90 | 17.20 | -11.59 | 22.98 | 23.42 | 18.03 |
| | | | | CRS | 34.0 | 35.74 | 10.48 | -5.15 | 8.64 | 12.65 | |
| MMS | LTX | 16a | 67.7500 | ALS | 88.0 | 18.94 | 17.48 | -12.35 | 27.62 | 40.29 | 14.84 |
| | | | | CRS | 52.5 | 31.75 | 15.12 | -6.94 | 12.52 | 26.66 | |
| MMS | LTX | 16b | 90.3333 | ALS | 64.5 | 34.23 | 9.84 | -38.36 | 43.67 | 56.40 | 12.23 |
| | | | | CRS | 63.5 | 34.77 | 9.98 | -10.68 | 9.13 | 24.11 | |
| MMS | LTX | 15 | 83.8958 | ALS | 66.0 | 31.15 | 47.14 | -7.68 | 76.45 | 40.60 | -1.80 |
| | | | | CRS | 27.5 | 74.76 | 23.98 | -17.12 | 25.65 | 26.41 | |
| MMS | LTX | 15 | 90.3333 | ALS | 220.5 | 10.01 | 59.25 | -17.52 | 237.02 | 66.39 | 9.01 |
| | | | | CRS | 59.0 | 37.42 | 20.12 | -11.27 | 27.99 | 22.85 | |
| MMS | LTX | 15 | 90.3333 | ALS | 83.0 | 26.60 | 47.05 | -30.97 | 155.60 | 67.42 | 7.81 |
| | | | | CRS | 54.5 | 40.51 | 21.19 | -21.21 | 47.06 | 39.25 | |
| DOE | BD | B4 | 55.5000 | ALS | 92.0 | 14.93 | 15.47 | -30.36 | 84.76 | 61.41 | 28.91 |
| | | | | CRS | 72.0 | 19.08 | 11.82 | -20.57 | 37.65 | 56.74 | |
| DOE | BD | B4 | 61.3542 | ALS | 50.0 | 30.31 | 15.82 | -21.74 | 44.41 | 50.95 | 25.65 |
| | | | | CRS | 57.5 | 26.36 | 8.66 | -10.13 | 14.54 | 34.88 | |
| NOAA | WI | N4 | 36.8750 | ALS | 44.0 | 21.02 | 10.78 | -13.61 | 33.98 | 47.29 | 24.27 |
| | | | | CRS | 21.5 | 43.02 | 4.32 | -12.69 | 9.25 | 17.74 | |
| DOE | BD | B3a | 42.7500 | ALS | 49.0 | 21.81 | 23.82 | -19.81 | 73.40 | 61.14 | -19.31 |
| | | | | CRS | 42.0 | 25.44 | 11.97 | -6.58 | 13.48 | 16.31 | |
| DOE | BD | B3b | 37.7500 | ALS | 55.5 | 17.06 | 22.53 | -25.40 | 124.02 | 67.96 | -8.57 |
| | | | | CRS | 26.0 | 36.42 | 10.13 | -6.98 | 12.63 | 16.93 | |
| NOAA | WI | N2 | 39.5833 | ALS | 20.5 | 48.37 | 7.18 | -10.28 | 7.94 | 9.79 | -40.66 |
| | | | | CRS | 20.0 | 49.58 | 8.31 | -13.84 | 10.42 | 11.74 | |
| NOAA | WI | N1 | 25.7500 | ALS | 33.0 | 19.98 | 21.18 | -21.86 | 92.49 | 58.65 | -4.18 |
| | | | | CRS | 16.5 | 39.97 | 10.88 | -9.27 | 16.14 | 10.84 | |
| NOAA | WI | N5a | 26.0625 | ALS | 35.0 | 19.01 | 5.89 | -14.18 | 18.72 | 48.11 | 35.90 |
| | | | | CRS | 26.5 | 25.11 | 5.80 | -10.16 | 11.98 | 20.80 | |
| NOAA | WI | N5b | 26.0417 | ALS | 31.0 | 21.45 | 19.67 | -24.45 | 104.70 | 56.13 | 12.05 |
| | | | | CRS | 26.0 | 25.58 | 7.54 | -9.00 | 13.28 | 9.78 | |
| MMS | LTX | 17 | 48.6458 | ALS | 92.5 | 13.06 | 22.84 | -62.93 | 435.93 | 56.63 | 3.33 |
| | | | | CRS | 24.5 | 49.33 | 26.06 | -20.04 | 57.25 | 8.68 | |
| MMS | LTX | 17 | 37.0000 | ALS | 42.0 | 22.12 | 49.44 | -34.03 | 266.10 | 65.09 | 11.54 |
| | | | | CRS | 28.5 | 32.60 | 12.90 | -11.15 | 26.07 | 11.02 | |
| MMS | LTX | 18a | 90.3333 | ALS | 90.0 | 24.53 | 62.85 | -19.39 | 105.76 | 62.58 | 12.76 |
| | | | | CRS | 62.5 | 35.33 | 15.59 | -11.78 | 21.93 | 23.82 | |
| MMS | LTX | 18a | 43.8542 | ALS | 65.0 | 16.81 | 42.93 | -48.51 | 303.11 | 78.09 | 19.98 |
| | | | | CRS | 28.0 | 39.02 | 22.68 | -24.75 | 80.67 | 47.49 | |
| MMS | LTX | 18b | 90.3333 | ALS | 132.0 | 16.73 | 55.97 | -17.90 | 122.88 | 73.89 | 14.38 |
| | | | | CRS | 41.0 | 53.85 | 18.75 | -16.28 | 36.32 | 43.29 | |
| MMS | YR5 | AA | 30.2083+ | ALS | 41.0 | 18.66 | 33.66 | -28.91 | 189.38 | 70.38 | 22.57 |
| | | | | CRS | 48.0 | 15.94 | 10.26 | -20.92 | 40.33 | 48.08 | |
| MMS | YR5 | AA | 47.6667+ | ALS | 50.0 | 23.70 | 18.13 | -43.38 | 155.41 | 63.60 | 27.49 |
| | | | | CRS | 50.0 | 23.70 | 14.03 | -19.43 | 46.75 | 36.63 | |
| ONR | LS | S1 | 62.3958 | ALS | 27.0 | 56.94 | 17.27 | -20.34 | 66.45 | 40.01 | -10.05 |
| | | | | CRS | 64.5 | 23.84 | 18.13 | -21.53 | 90.10 | 50.90 | |
| DOE | BD | B5a | 90.3333 | ALS | 59.0 | 37.42 | 14.85 | -44.52 | 44.58 | 71.17 | 4.23 |
| | | | | CRS | 24.0 | 92.00 | 15.39 | -12.56 | 12.56 | 46.83 | |
| DOE | BD | B5b | 90.3333 | ALS | 82.5 | 26.76 | 39.74 | -84.41 | 283.59 | 90.98 | 9.85 |
| | | | | CRS | 68.0 | 32.47 | 16.79 | -16.12 | 26.32 | 53.81 | |

Table 3. Seasonal 40-hour low-passed statistics, summer.(continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DOE | WH | HS | 72.0000 | ALS | 64.0 | 27.63 | 32.95 | -35.10 | 188.79 | 81.31 | 8.35 |
| | | | | CRS | 63.5 | 27.84 | 18.49 | -49.76 | 70.62 | 55.63 | |
| DOE | WH | HN | 90.3333 | ALS | 58.0 | 38.07 | 14.96 | -40.09 | 105.42 | 77.54 | -6.72 |
| | | | | CRS | 22.5 | 98.13 | 11.80 | -14.24 | 16.34 | 32.04 | |
| DOE | WH | HD | 90.3333 | ALS | 74.0 | 29.84 | 33.06 | -51.00 | 256.58 | 88.03 | -10.48 |
| | | | | CRS | 28.0 | 78.86 | 10.44 | -17.72 | 23.32 | 38.05 | |
| DOE | WH | HD | 90.3333 | ALS | 52.5 | 42.06 | 30.69 | -37.41 | 163.26 | 70.81 | -9.49 |
| | | | | CRS | 21.0 | 105.14 | 13.59 | -16.75 | 32.93 | 32.87 | |
| DOE | BD | B8 | 54.9375 | ALS | 58.5 | 23.22 | 16.83 | -66.57 | 120.85 | 76.25 | 15.85 |
| | | | | CRS | 28.5 | 47.67 | 10.78 | -11.24 | 27.37 | 40.70 | |
| DOE | WH | HW | 88.7500 | ALS | 60.0 | 36.18 | 19.02 | -37.77 | 126.37 | 75.87 | 14.37 |
| | | | | CRS | 65.5 | 33.15 | 20.95 | -8.83 | 23.50 | 38.62 | |
| DOE | BD | B7 | 90.3333 | ALS | 58.0 | 38.07 | 16.43 | -56.80 | 91.55 | 68.19 | 3.85 |
| | | | | CRS | 52.5 | 42.06 | 24.76 | -19.97 | 31.41 | 49.15 | |
| MMS | LTX | 20a | 32.1667 | ALS | 40.5 | 20.05 | 27.23 | -46.80 | 298.89 | 49.11 | -18.02 |
| | | | | CRS | 31.5 | 25.78 | 30.07 | -21.45 | 142.52 | 30.99 | |
| MMS | LTX | 20a | 67.3958 | ALS | 52.5 | 31.57 | 55.68 | -70.23 | 544.55 | 69.95 | -11.51 |
| | | | | CRS | 45.5 | 36.43 | 61.79 | -30.56 | 225.90 | 44.52 | |
| TLGO | TABS | TB | 37.7083 | ALS | 58.0 | 16.29 | 72.62 | -102.55 | 1069.23 | 96.11 | 0.36 |
| | | | | CRS | 21.5 | 43.95 | 10.27 | -16.96 | 31.20 | 36.25 | |
| TLGO | TABS | TC | 90.3333 | ALS | 85.0 | 25.98 | 67.35 | -91.59 | 510.22 | 78.55 | -17.45 |
| | | | | CRS | 59.0 | 37.42 | 46.56 | -44.20 | 176.34 | 54.37 | |
| MMS | LTX | 23a | 87.0208 | ALS | 136.0 | 15.66 | 44.59 | -34.37 | 294.14 | 86.36 | -11.76 |
| | | | | CRS | 69.5 | 30.65 | 8.67 | -20.15 | 23.40 | 44.06 | |
| MMS | LTX | 23b | 30.5625 | ALS | 52.0 | 14.88 | 45.10 | -72.42 | 574.30 | 93.68 | -8.81 |
| | | | | CRS | 27.5 | 28.13 | 7.38 | -15.10 | 20.85 | 56.12 | |
| MMS | LTX | 23b | 46.8958 | ALS | 51.5 | 22.67 | 32.20 | -35.50 | 153.96 | 90.35 | -.23 |
| | | | | CRS | 56.5 | 20.66 | 8.22 | -5.13 | 4.36 | 30.88 | |
| MMS | LTX | 23b | 58.5417 | ALS | 69.5 | 20.84 | 44.17 | -33.37 | 219.15 | 87.03 | -2.03 |
| | | | | CRS | 23.0 | 62.98 | 3.95 | -13.12 | 7.43 | 30.06 | |
| MMS | LTX | 24a | 90.3333 | ALS | 88.5 | 24.95 | 43.51 | -23.77 | 184.50 | 82.28 | -11.91 |
| | | | | CRS | 57.5 | 38.40 | 18.80 | -16.24 | 42.11 | 51.80 | |
| MMS | LTX | 24b | 90.3333 | ALS | 78.0 | 28.31 | 46.64 | -70.10 | 324.33 | 88.33 | -10.07 |
| | | | | CRS | 47.0 | 46.98 | 25.38 | -29.50 | 83.98 | 68.49 | |
| MMS | LTX | 24c | 29.8333 | ALS | 64.0 | 11.84 | 21.57 | -30.66 | 158.18 | 84.96 | -3.86 |
| | | | | CRS | 30.0 | 25.25 | 8.12 | -14.71 | 16.37 | 43.85 | |
| TLGO | TABS | TD | 79.7917 | ALS | 70.5 | 27.74 | 92.62 | -62.83 | 818.29 | 95.19 | 4.06 |
| | | | | CRS | 60.5 | 32.32 | 17.72 | -19.71 | 23.88 | 38.96 | |
| TLGO | TABS | TE | 48.0625 | ALS | 107.0 | 11.17 | 74.05 | -47.61 | 785.54 | 80.01 | 9.22 |
| | | | | CRS | 49.5 | 24.15 | 35.15 | -15.96 | 143.43 | 38.26 | |
| MMS | LTX | 01a | 90.3333 | ALS | 72.0 | 30.67 | 43.10 | -28.69 | 189.16 | 91.98 | -1.43 |
| | | | | CRS | 23.0 | 96.00 | 6.52 | -11.82 | 6.56 | 26.04 | |
| MMS | LTX | 01a | 90.3333 | ALS | 77.0 | 28.68 | 52.26 | -85.68 | 276.06 | 94.45 | 2.44 |
| | | | | CRS | 45.0 | 49.07 | 12.27 | -24.72 | 18.82 | 47.67 | |
| MMS | LTX | 01b | 55.8333 | ALS | 94.0 | 14.68 | 19.01 | -18.22 | 76.25 | 94.33 | 4.55 |
| | | | | CRS | 57.5 | 24.00 | 4.99 | -8.75 | 3.18 | 50.32 | |
| MMS | LTX | 02 | 50.8333 | ALS | 82.0 | 15.37 | 49.05 | -24.17 | 286.78 | 80.95 | -2.72 |
| | | | | CRS | 23.5 | 53.62 | 11.57 | -9.12 | 19.68 | 29.32 | |
| MMS | LTX | 02 | 53.8750 | ALS | 114.0 | 11.34 | 49.73 | -71.46 | 592.45 | 91.27 | -5.83 |
| | | | | CRS | 67.0 | 19.29 | 20.51 | -32.12 | 102.65 | 65.98 | |
| MMS | LTX | 02 | 90.3333 | ALS | 123.5 | 17.88 | 53.05 | -37.76 | 253.49 | 88.16 | 3.23 |
| | | | | CRS | 51.5 | 42.87 | 20.30 | -18.59 | 32.19 | 53.57 | |

Table 3. Seasonal 40-hour low-passed statistics, fall. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | α |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA | GS | G5 | 105.6667 | ALS | 59.0 | 43.67 | 23.18 | -32.64 | 53.96 | 69.19 | 31.09 |
| | | | | CRS | 59.0 | 43.67 | 47.41 | -21.24 | 63.44 | 60.51 | |
| EPA | GS | G1 | 89.3333 | ALS | 32.0 | 68.25 | 13.62 | -21.53 | 34.59 | 71.73 | -23.32 |
| | | | | CRS | 33.5 | 65.19 | 10.98 | -4.45 | 8.60 | 55.13 | |
| EPA | GS | G2 | 89.3333 | ALS | 42.5 | 51.39 | 23.42 | -26.07 | 50.99 | 72.81 | -24.08 |
| | | | | CRS | 36.0 | 60.67 | 15.48 | -9.20 | 13.85 | 59.83 | |
| EPA | GS | G3 | 76.7083 | ALS | 36.0 | 52.28 | 17.49 | -22.48 | 40.92 | 70.59 | -28.95 |
| | | | | CRS | 33.5 | 56.18 | 15.39 | -15.97 | 19.24 | 59.33 | |
| EPA | GS | G4 | 76.7083 | ALS | 65.5 | 28.75 | 21.14 | -27.11 | 48.98 | 76.09 | -21.10 |
| | | | | CRS | 49.5 | 38.04 | 10.77 | -6.05 | 11.51 | 53.14 | |
| MMS | MAMES | Mb | 89.3333 | ALS | 60.0 | 36.40 | 19.36 | -25.93 | 53.43 | 79.70 | 11.96 |
| | | | | CRS | 42.0 | 52.00 | 14.11 | -12.34 | 18.27 | 59.40 | |
| COE | MS | C8 | 24.5833 | ALS | 42.5 | 14.85 | 17.07 | -24.80 | 112.86 | 83.94 | 41.37 |
| | | | | CRS | 42.0 | 15.02 | 33.67 | -20.06 | 141.53 | 85.42 | |
| COE | MS | C7 | 24.4583 | ALS | 40.0 | 15.71 | 22.17 | -29.25 | 122.06 | 76.85 | -28.35 |
| | | | | CRS | 29.5 | 21.31 | 18.83 | -13.75 | 62.09 | 71.31 | |
| USGS | | USa | 45.3333 | ALS | 67.5 | 16.71 | 24.48 | -27.64 | 112.21 | 33.49 | 17.82 |
| | | | | CRS | 32.5 | 34.71 | 14.83 | -12.11 | 36.36 | 14.48 | |
| USGS | | USb | 77.7708 | ALS | 99.5 | 19.18 | 10.70 | -35.69 | 102.50 | 73.93 | -15.32 |
| | | | | CRS | 46.0 | 41.48 | 15.51 | -14.24 | 30.31 | 40.60 | |
| COE | MS | C6 | 27.9375 | ALS | 22.0 | 32.36 | 21.39 | -9.65 | 48.70 | 66.37 | -27.04 |
| | | | | CRS | 20.0 | 35.60 | 14.85 | -8.68 | 19.07 | 51.91 | |
| COE | MS | C5 | 25.7500 | ALS | 36.0 | 18.28 | 27.52 | -33.22 | 172.73 | 82.76 | -32.73 |
| | | | | CRS | 29.5 | 22.31 | 24.30 | -18.19 | 86.65 | 69.77 | |
| COE | MS | C3 | 27.7083 | ALS | 46.5 | 15.16 | 15.28 | -25.45 | 99.25 | 63.55 | -14.59 |
| | | | | CRS | 18.0 | 39.17 | 11.25 | -8.76 | 16.74 | 27.25 | |
| COE | MS | C2 | 27.7083 | ALS | 20.0 | 35.30 | 11.09 | -14.38 | 22.87 | 22.12 | 17.39 |
| | | | | CRS | 22.5 | 31.38 | 13.94 | -22.57 | 51.80 | 40.19 | |
| COE | MS | C1 | 27.7083 | ALS | 18.0 | 39.39 | 17.41 | -19.35 | 53.12 | 25.26 | -21.43 |
| | | | | CRS | 15.5 | 45.74 | 18.21 | -17.64 | 24.09 | 40.87 | |
| MMS | LTX | 16a | 38.8333 | ALS | 28.5 | 34.11 | 13.04 | -21.87 | 79.49 | 69.44 | 11.13 |
| | | | | CRS | 22.0 | 44.18 | 14.04 | -5.98 | 14.33 | 36.29 | |
| MMS | LTX | 16a | 23.5417 | ALS | 42.5 | 14.26 | 35.88 | -14.84 | 145.56 | 70.91 | -2.57 |
| | | | | CRS | 27.5 | 22.04 | 23.73 | -23.71 | 63.02 | 45.91 | |
| MMS | LTX | 16b | 26.7708 | ALS | 36.0 | 18.96 | 14.75 | -46.58 | 135.18 | 76.05 | 10.38 |
| | | | | CRS | 22.5 | 30.33 | 10.66 | -7.83 | 14.88 | 31.05 | |
| MMS | LTX | 15 | 32.5000 | ALS | 44.0 | 18.68 | 32.80 | -50.37 | 213.99 | 68.39 | 1.56 |
| | | | | CRS | 51.0 | 16.12 | 22.42 | -15.23 | 35.96 | 39.69 | |
| MMS | LTX | 15 | 38.5833 | ALS | 50.5 | 19.13 | 22.00 | -28.71 | 115.65 | 60.07 | 9.11 |
| | | | | CRS | 29.0 | 33.31 | 18.69 | -22.48 | 28.56 | 41.86 | |
| MMS | LTX | 15 | 89.3333 | ALS | 96.0 | 22.75 | 14.23 | -36.58 | 106.28 | 67.18 | 3.89 |
| | | | | CRS | 62.0 | 35.23 | 17.48 | -12.27 | 20.66 | 40.59 | |
| MMS | LTX | 15 | 91.7708 | ALS | 67.5 | 33.22 | 11.11 | -50.02 | 154.41 | 78.28 | -6.63 |
| | | | | CRS | 62.0 | 36.17 | 19.01 | -17.00 | 35.77 | 47.21 | |
| NOAA | WI | N1 | 84.5833 | ALS | 24.5 | 84.55 | 12.81 | -24.77 | 32.93 | 51.74 | 5.22 |
| | | | | CRS | 21.5 | 96.35 | 12.72 | -7.49 | 5.59 | 9.80 | |
| NOAA | WI | N1 | 71.1667 | ALS | 63.5 | 27.53 | 14.75 | -20.31 | 49.39 | 58.03 | -6.06 |
| | | | | CRS | 20.5 | 85.27 | 7.31 | -6.97 | 5.65 | 5.89 | |
| NOAA | WI | N5a | 39.0625 | ALS | 22.5 | 43.44 | 17.64 | -16.72 | 33.63 | 53.98 | 8.73 |
| | | | | CRS | 26.5 | 36.89 | 8.55 | -3.50 | 3.95 | 6.63 | |
| MMS | LTX | 17 | 47.8750+ | ALS | 26.0 | 45.73 | 27.80 | -51.57 | 142.00 | 51.13 | 12.36 |
| | | | | CRS | 29.0 | 41.00 | 18.08 | -36.20 | 98.91 | 29.92 | |
| MMS | LTX | 17 | 62.9583 | ALS | 33.5 | 46.33 | 25.87 | -51.91 | 180.36 | 61.31 | 8.82 |
| | | | | CRS | 24.0 | 64.67 | 15.09 | -11.36 | 17.92 | 8.29 | |

Table 3. Seasonal 40-hour low-passed statistics, fall. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | α |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 17 | 25.6458 | ALS | 26.5 | 24.74 | 17.78 | -22.67 | 97.14 | 41.75 | 3.05 |
| | | | | CRS | 16.0 | 40.97 | 11.55 | -12.66 | 15.89 | 7.33 | |
| MMS | LTX | 17 | 36.8750 | ALS | 46.0 | 20.11 | 11.44 | -46.11 | 146.04 | 48.79 | -7.04 |
| | | | | CRS | 26.0 | 35.58 | 6.89 | -17.80 | 25.15 | 9.11 | |
| MMS | LTX | 18a | 89.3333 | ALS | 67.0 | 32.60 | 26.33 | -47.58 | 191.08 | 82.23 | 11.92 |
| | | | | CRS | 47.0 | 46.47 | 16.73 | -15.14 | 21.22 | 33.80 | |
| MMS | LTX | 18b | 25.7500 | ALS | 60.0 | 10.98 | 10.68 | -25.18 | 104.21 | 86.71 | 10.29 |
| | | | | CRS | 20.5 | 32.15 | 7.67 | -5.18 | 6.38 | 27.29 | |
| DOE | BD | B5a | 24.6875 | ALS | 25.0 | 25.34 | 22.70 | -30.06 | 112.98 | 75.26 | 17.84 |
| | | | | CRS | 28.0 | 22.63 | 8.07 | -10.08 | 18.07 | 51.42 | |
| DOE | WH | HS | 73.9583 | ALS | 31.0 | 58.69 | 12.25 | -26.39 | 59.74 | 70.71 | 15.15 |
| | | | | CRS | 89.0 | 20.44 | 24.20 | -13.45 | 24.01 | 44.76 | |
| DOE | WH | HN | 52.2917 | ALS | 27.0 | 47.98 | 12.84 | -27.79 | 72.89 | 75.71 | -2.37 |
| | | | | CRS | 19.5 | 66.44 | 12.90 | -7.03 | 10.32 | 36.70 | |
| DOE | WH | HD | 89.3333 | ALS | 50.5 | 43.25 | 16.39 | -32.56 | 79.94 | 74.30 | -6.92 |
| | | | | CRS | 26.5 | 82.42 | 14.44 | -8.35 | 8.85 | 29.93 | |
| DOE | WH | HD | 71.8333 | ALS | 36.5 | 48.33 | 17.45 | -43.02 | 112.23 | 76.36 | -9.95 |
| | | | | CRS | 29.0 | 60.83 | 14.99 | -8.30 | 14.34 | 35.36 | |
| DOE | WH | HD | 92.5833 | ALS | 31.0 | 73.11 | 24.21 | -39.75 | 101.70 | 76.15 | -10.27 |
| | | | | CRS | 21.0 | 107.93 | 14.84 | -9.00 | 11.44 | 31.60 | |
| DOE | BD | B6 | 39.5000 | ALS | 49.5 | 19.96 | 21.17 | -32.23 | 142.30 | 76.78 | 18.35 |
| | | | | CRS | 36.0 | 27.44 | 13.50 | -23.90 | 38.38 | 63.13 | |
| DOE | BD | B8 | 39.6667 | ALS | 56.0 | 17.71 | 12.64 | -22.70 | 55.80 | 68.56 | 44.47 |
| | | | | CRS | 49.0 | 20.24 | 13.80 | -17.60 | 54.12 | 73.03 | |
| DOE | WH | HW | 49.7917 | ALS | 20.0 | 61.78 | 12.83 | -23.80 | 41.01 | 55.49 | 8.50 |
| | | | | CRS | 20.0 | 61.78 | 9.12 | -11.54 | 15.37 | 36.10 | |
| TLGO | TABS | TA | 56.3125 | ALS | 59.0 | 23.58 | 27.51 | -41.62 | 192.79 | 75.03 | 7.76 |
| | | | | CRS | 55.0 | 25.30 | 19.42 | -36.02 | 111.23 | 63.37 | |
| MMS | LTX | 20a | 22.5208 | ALS | 21.0 | 27.74 | 18.85 | -21.74 | 64.50 | 68.46 | -30.82 |
| | | | | CRS | 50.5 | 11.53 | 10.53 | -20.96 | 49.91 | 46.19 | |
| MMS | LTX | 20b | 70.9375 | ALS | 26.0 | 67.21 | 18.92 | -55.77 | 258.03 | 54.71 | -7.59 |
| | | | | CRS | 31.5 | 55.48 | 38.98 | -21.95 | 145.06 | 42.22 | |
| MMS | LTX | 20b | 59.2917 | ALS | 52.5 | 27.92 | 16.31 | -48.80 | 175.24 | 65.15 | -27.54 |
| | | | | CRS | 62.5 | 23.46 | 29.74 | -23.86 | 90.40 | 44.13 | |
| TLGO | TABS | TB | 90.7708 | ALS | 62.0 | 35.80 | 16.54 | -78.41 | 337.34 | 72.77 | -3.75 |
| | | | | CRS | 23.5 | 94.45 | 38.32 | -24.44 | 67.70 | 35.42 | |
| TLGO | TABS | TC | 89.3333 | ALS | 55.5 | 39.35 | 50.89 | -25.63 | 219.72 | 79.79 | 36.45 |
| | | | | CRS | 56.0 | 39.00 | 48.00 | -17.76 | 133.46 | 60.69 | |
| MMS | LTX | 23b | 89.3333 | ALS | 65.5 | 33.34 | 36.21 | -69.66 | 349.98 | 90.67 | -7.06 |
| | | | | CRS | 66.0 | 33.09 | 11.42 | -13.05 | 11.94 | 43.88 | |
| MMS | LTX | 23b | 27.9375 | ALS | 44.0 | 16.17 | 20.51 | -52.29 | 343.87 | 91.26 | -.47 |
| | | | | CRS | 24.5 | 29.04 | 7.06 | -3.13 | 4.60 | 31.29 | |
| MMS | LTX | 23b | 62.3333 | ALS | 46.0 | 33.40 | 11.57 | -52.15 | 204.71 | 86.96 | -2.40 |
| | | | | CRS | 20.0 | 76.83 | 8.96 | -7.87 | 8.23 | 26.40 | |
| MMS | LTX | 24b | 27.8958 | ALS | 35.0 | 20.27 | 16.44 | -42.21 | 122.02 | 77.88 | 0.29 |
| | | | | CRS | 19.5 | 36.38 | 5.38 | -5.42 | 3.98 | 28.72 | |
| MMS | LTX | 24c | 35.5417 | ALS | 62.5 | 14.33 | 3.60 | -72.39 | 260.69 | 87.23 | -5.17 |
| | | | | CRS | 21.0 | 42.64 | 17.32 | -14.45 | 43.62 | 54.09 | |
| MMS | LTX | 24c | 93.3958 | ALS | 60.0 | 38.13 | 17.93 | -67.10 | 228.93 | 85.00 | -5.33 |
| | | | | CRS | 30.0 | 76.25 | 20.10 | -22.55 | 39.31 | 63.16 | |
| TLGO | TABS | TD | 89.3333 | ALS | 50.0 | 43.68 | 63.48 | -106.77 | 612.98 | 88.44 | 4.59 |
| | | | | CRS | 31.5 | 69.33 | 12.81 | -16.91 | 28.39 | 48.19 | |
| MMS | LTX | 01a | 75.0000 | ALS | 69.0 | 26.70 | 34.08 | -41.55 | 274.76 | 94.42 | 7.05 |
| | | | | CRS | 64.5 | 28.56 | 10.99 | -14.99 | 15.68 | 59.76 | |

Table 3. Seasonal 40-hour low-passed statistics, fall. (continued)

| SA | PGM | M | T | | AC | DF | MAX | MIN | $S^2$ | %TOTAL | $\alpha$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MMS | LTX | 01a | 26.3333 | ALS | 26.5 | 25.42 | 23.84 | -28.04 | 96.43 | 93.31 | 17.09 |
| | | | | CRS | 20.0 | 33.68 | 10.66 | -18.63 | 12.77 | 54.29 | |
| MMS | LTX | 01b | 44.1667 | ALS | 29.0 | 37.98 | 14.20 | -29.05 | 107.07 | 87.46 | 5.80 |
| | | | | CRS | 28.5 | 38.65 | 6.95 | -7.33 | 8.14 | 49.85 | |
| MMS | LTX | 02 | 89.3333 | ALS | 89.0 | 24.54 | 46.40 | -64.75 | 353.82 | 88.34 | 2.55 |
| | | | | CRS | 22.5 | 97.07 | 11.53 | -18.41 | 25.42 | 41.25 | |
| MMS | LTX | 02 | 60.7708 | ALS | 57.5 | 26.07 | 14.89 | -81.42 | 377.14 | 90.88 | -1.68 |
| | | | | CRS | 20.0 | 74.95 | 12.00 | -11.69 | 24.96 | 50.64 | |
| MMS | LTX | 02 | 94.6875 | ALS | 65.0 | 35.62 | 20.93 | -55.83 | 222.21 | 87.24 | 2.06 |
| | | | | CRS | 27.0 | 85.76 | 15.30 | -19.14 | 44.89 | 63.70 | |

$$SE = \left(\frac{1}{n}\left(1 + 2\sum_{i=1}^{q} p^2(i)\right)\right)^{1/2}$$

where $i$ is an autocorrelation time lag, and $q$ is the time lag at which the sampled autocorrelation function is essentially zero. We have taken $q$ to be the first zero crossing of the sampled autocorrelation function.

The degrees of freedom, df, i.e. the number of independent samples for each low-passed velocity record, is computed as the total record length divided by the low-passed record autocorrelation time scale.

Linear regression analysis was used following standard practices (Spiegel 1961). Hypotheses that linear regression slopes, $a_1$, were equal to zero, i.e. that there was no relationship between the dependent and the independent variable, were tested using a student-t test. A statistic, T, was computed using

$$T = \frac{a_1(N-2)^{1/2} s_x}{s_y(1-r^2)^{1/2}} .$$

Where N is the number of observations, $a_1$ is the linear regression line slope, $s_x$ is the independent variable standard deviation, $s_y$ is the dependent variable standard deviation, and r is the correlation coefficient. The computed statistic T is then compared to tabulated student-t statistics at various significance levels. If $T < t$, then one accepts the hypothesis that the regression slope is equal to zero, i.e. that there is no significant relationship between the dependent and the independent variables. If $T > t$, then one rejects the hypothesis that the regression slope equals zero, and accepts the alternative hypothesis that the regression slope does not equal zero, i.e. that there is a significant relationship with the independent variable.

#### 2.3.2.2 Alongshore Flow Persistence

Alongshore flow persistence is a general term that has been estimated in four ways. A first estimate was obtained by considering the portion of flow in either alongshore direction for each record (Appendix A). This portion of flow can also be measured in a number of ways, as the total number of hours, as a percentage of the record length, and as the number of events with an uninterrupted velocity component sign. These were determined as a summation of all velocity events with the same sign, i.e. $V > 0$, or $V < 0$. An event was defined as a period with continuous, unidirectional, velocity. Zero velocity following positive (negative) velocities was considered as continued positive (negative) flow. Only when the velocity actually changed sign, became less (greater) than zero if the flow event had positive (negative) flow, was an event considered ended.

The second measure of alongshore flow persistence is similar to the first, except that flow events were considered which exceeded or were less than velocity levels different from zero. Specifically, velocity levels at intervals of ±25 $cm \cdot s^{-1}$ were considered. The number of events, the total time, and the percentage of record length contained within these higher velocity level events were determined to estimate the proportion of record that exceeded these selected velocity levels.

The third measure of alongshore flow persistence is the distribution of event durations that exceeded a given velocity level. Only those duration categories with non-zero content are reported in Appendix A.

These duration distributions provide an estimate of the likelihood and the length of time that specific velocity level exceedence events would occur. The duration of the single longest event exceeding a given velocity level is presented as the maximum duration.

The fourth measure of alongshore flow persistence is a distance equivalent to the maximum displacement (distance in kilometers), in either the positive or negative alongshore directions, assuming spatially uniform alongshore flow. This is similar to a progressive vector displacement. It is not a true Lagrangian displacement. Our maximum displacement is only an estimate of the true displacement and serves as an indicator for planning purposes. We cannot even determine whether this is a conservative or liberal indicator of a true Lagrangian displacement.

# 3. RESULTS

Mean velocity vectors (Figures 3, 5, 7, and 9) and variance axes (Figures 4, 6, 8, and 10) are presented for the winter (Figures 3 and 4), spring (Figures 5 and 6), summer (Figures 7 and 8), and fall (Figures 9 and 10) seasons, for the various geographical regions (eastern, central and western). Note that the western region is presented as two overlapping figures, (north)western and (south)western, to ensure complete geographical coverage at the same horizontal scale. Three subregions, one each in the eastern, central and (north)western regions, are presented with expanded horizontal scales where close packed stations make interpretation difficult. The discussion of results will focus on the alongshore velocity component, although cross-shore component information is presented in the figures and tables.

In the following, eastward flow (positive alongshore velocities) and westward flow (negative alongshore velocities) will refer to flow moving to one's right (left) if facing the coast from the Gulf of Mexico. Although the coast trends roughly east-west across most of the northern Gulf of Mexico, the Texas coast curves to trend nearly north-south. References to onshore flow (positive cross-shore velocities) and off-shore flow (negative cross-shore velocities) are locally normal to the coast.

Linear relationships between various flow statistics and alongshelf distance are presented. These are not meant to be predictive relationships. In many cases larger coefficients of correlation might have been obtained using higher degree polynomials or non-linear models. As general tendencies were desired, the linear models were deemed sufficient.

Distance was measured from the Mississippi River delta, and determined as the longitudinal distance for stations east of 94°W. Here the coastal orientation turns southwest and alongshelf distance was determined as the great circle distance from 29.5°N, 94°W.

## 3.1 Seasonal Flow

### 3.1.1 Winter

Winter mean flows were predominantly alongshore to the west in all regions (Figure 3), with an increasing magnitude with alongshelf distance to the west that was statistically significant at the 99% level (Figure 11). The few exceptions to westward flow were found in the eastern region at stations COE MS C1 and MS C2 (Figure 3a) (near 30°N

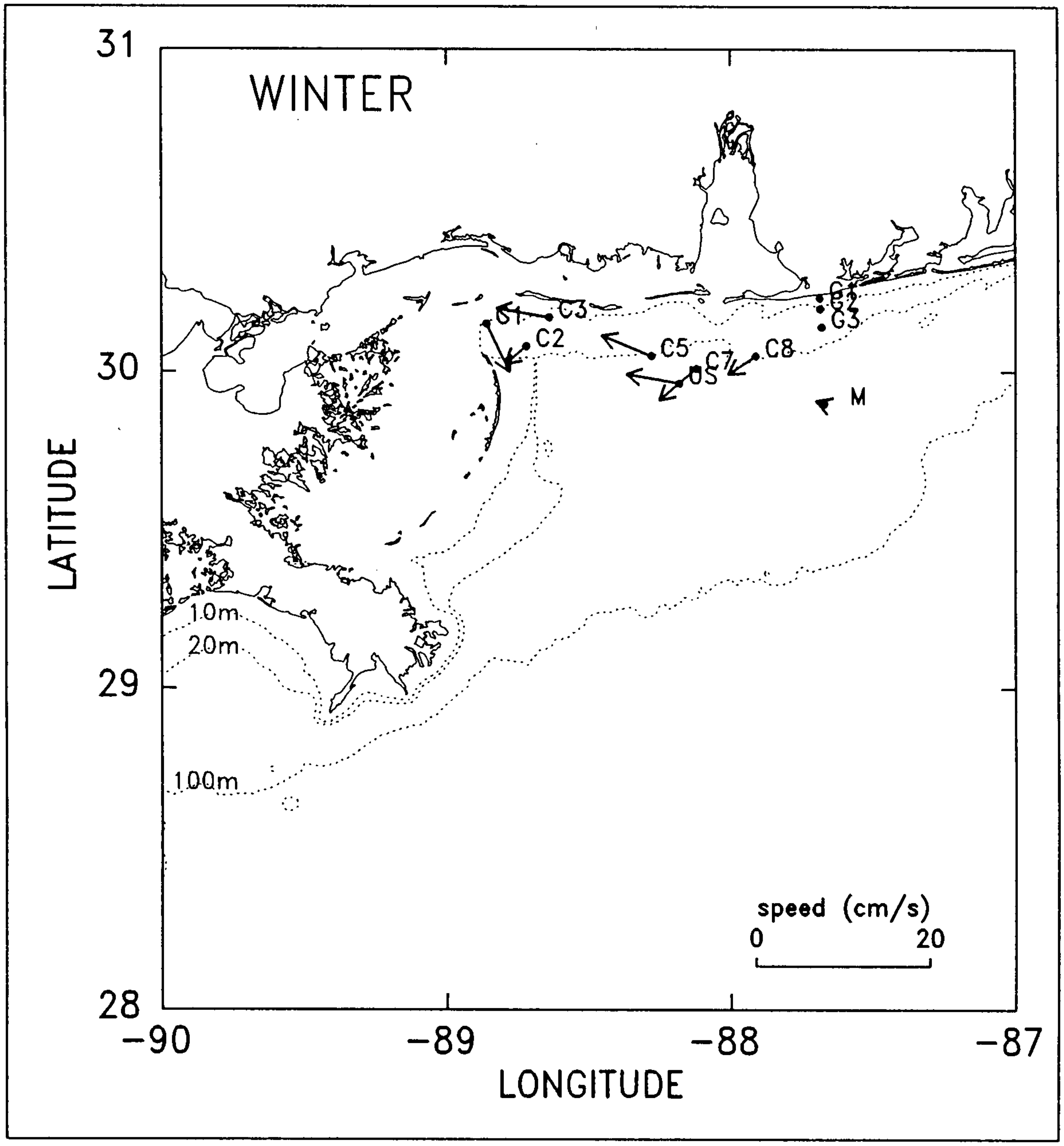


Figure 3a. Winter mean velocity vectors for eastern region. Mooring locations are plotted as dots; the mean vectors are in direction of flow.

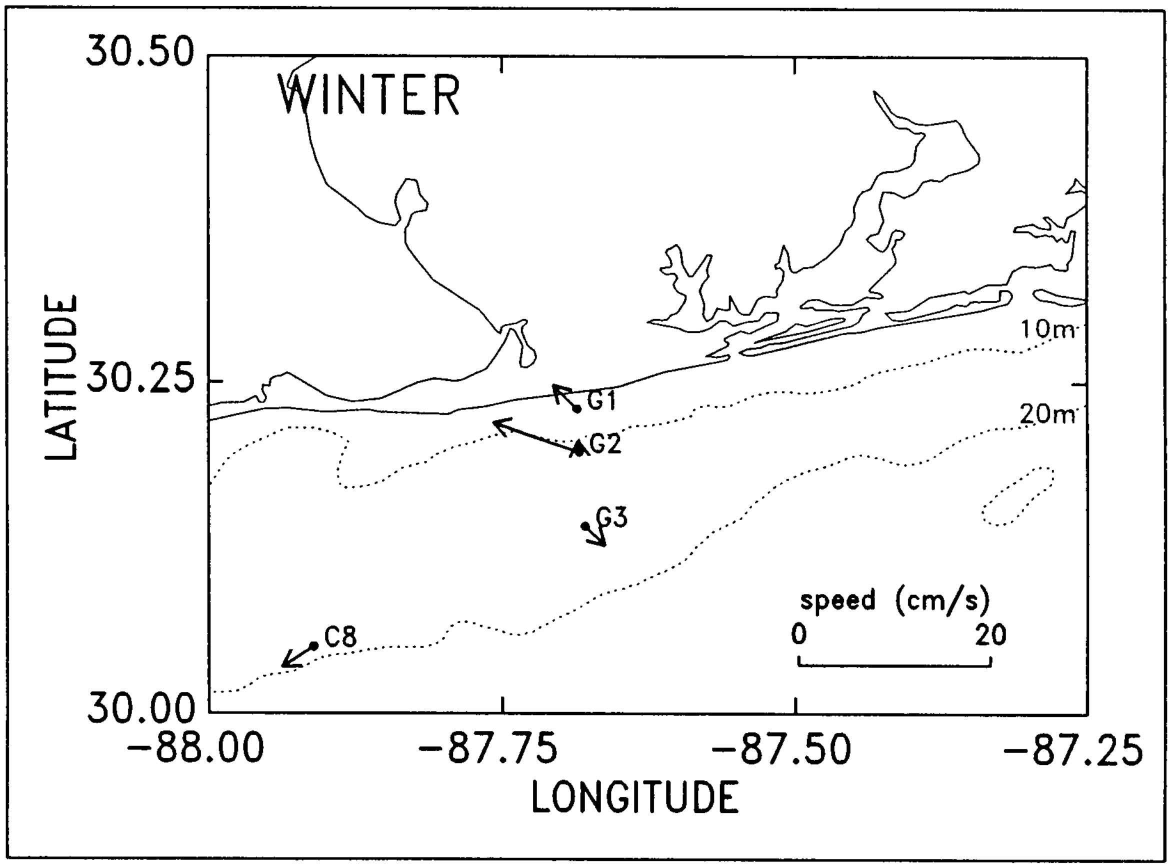


Figure 3b. Winter mean velocity vectors for eastern region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

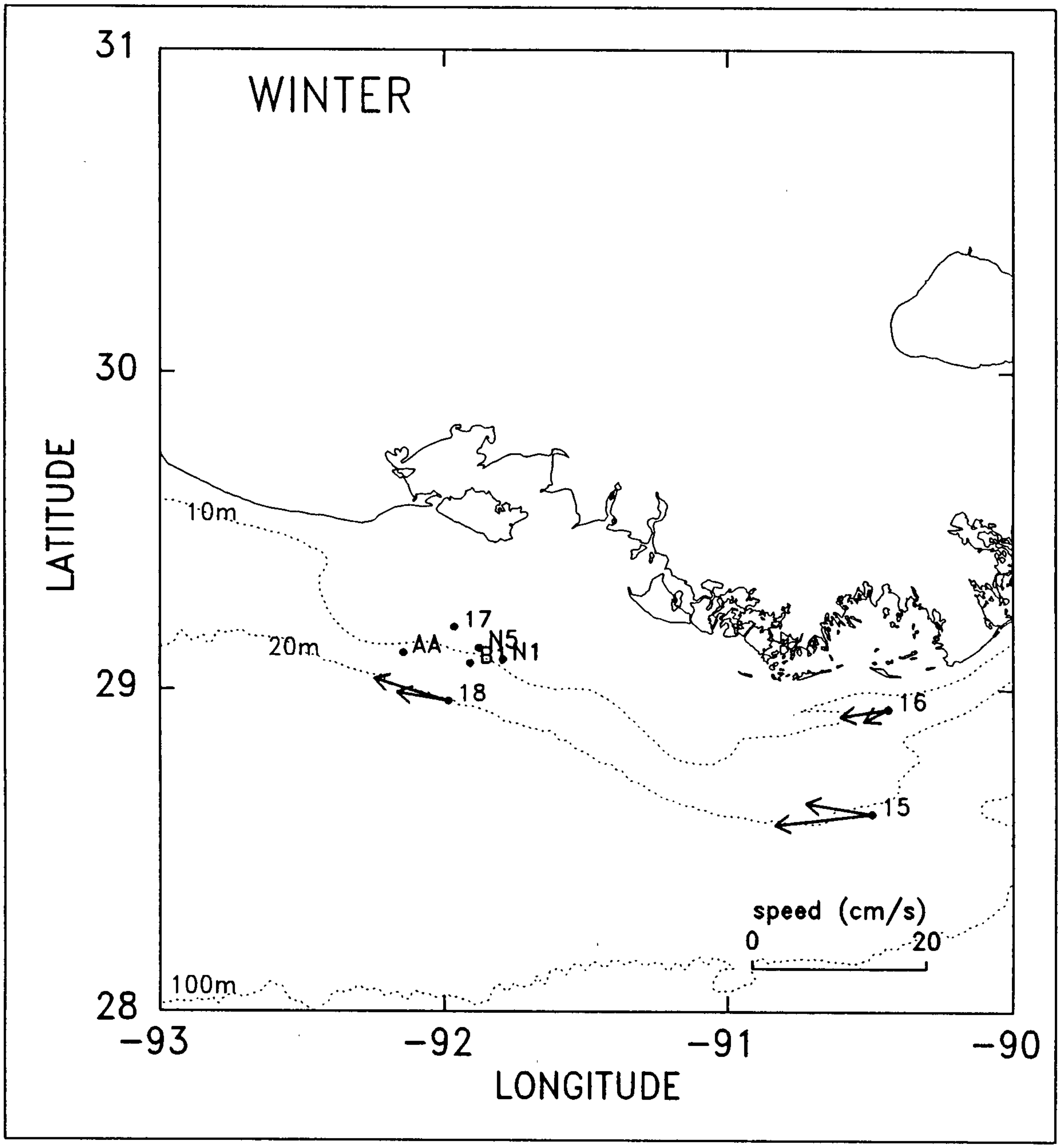


Figure 3c. Winter mean velocity vectors for central region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

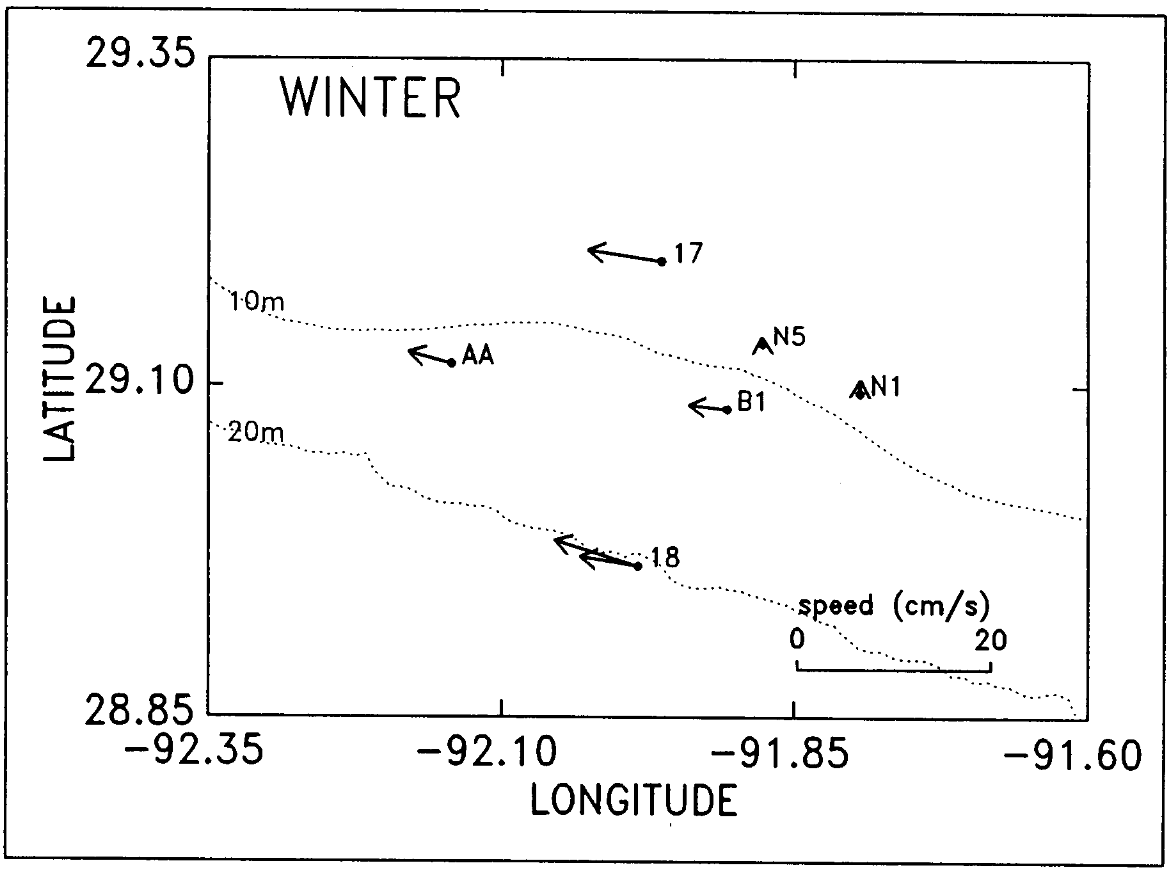


Figure 3d. Winter mean velocity vectors for central region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

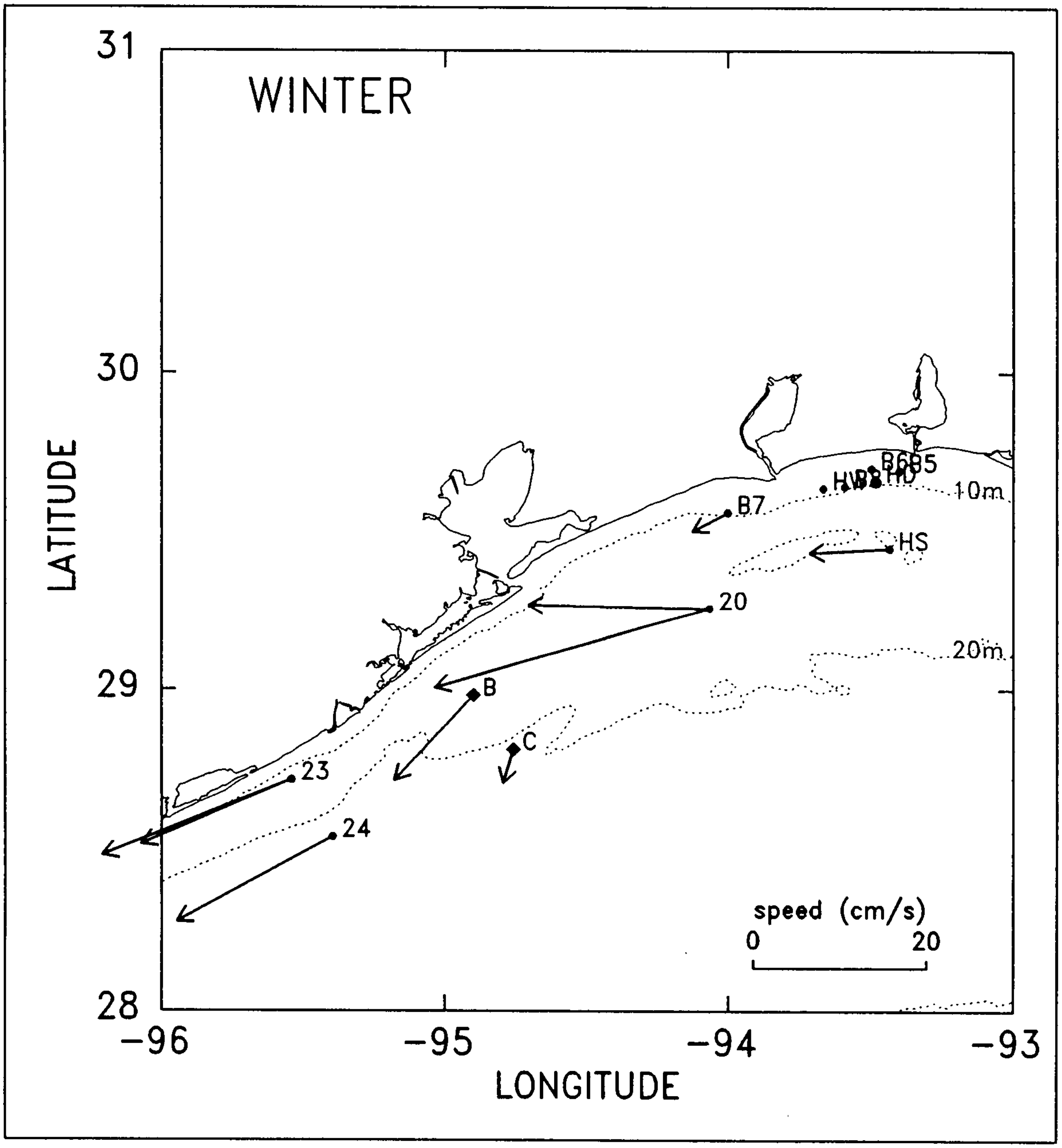


Figure 3e. Winter mean velocity vectors for (north)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

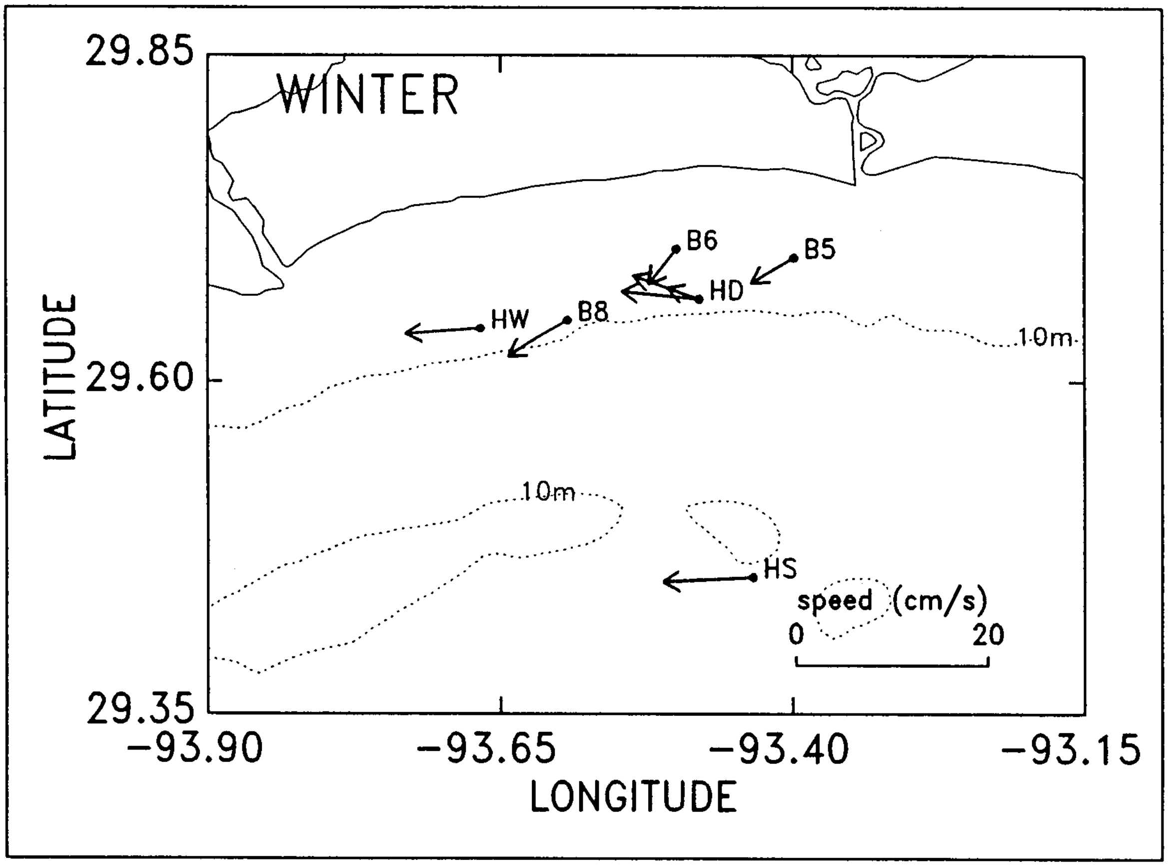


Figure 3f. Winter mean velocity vectors for (north)western region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

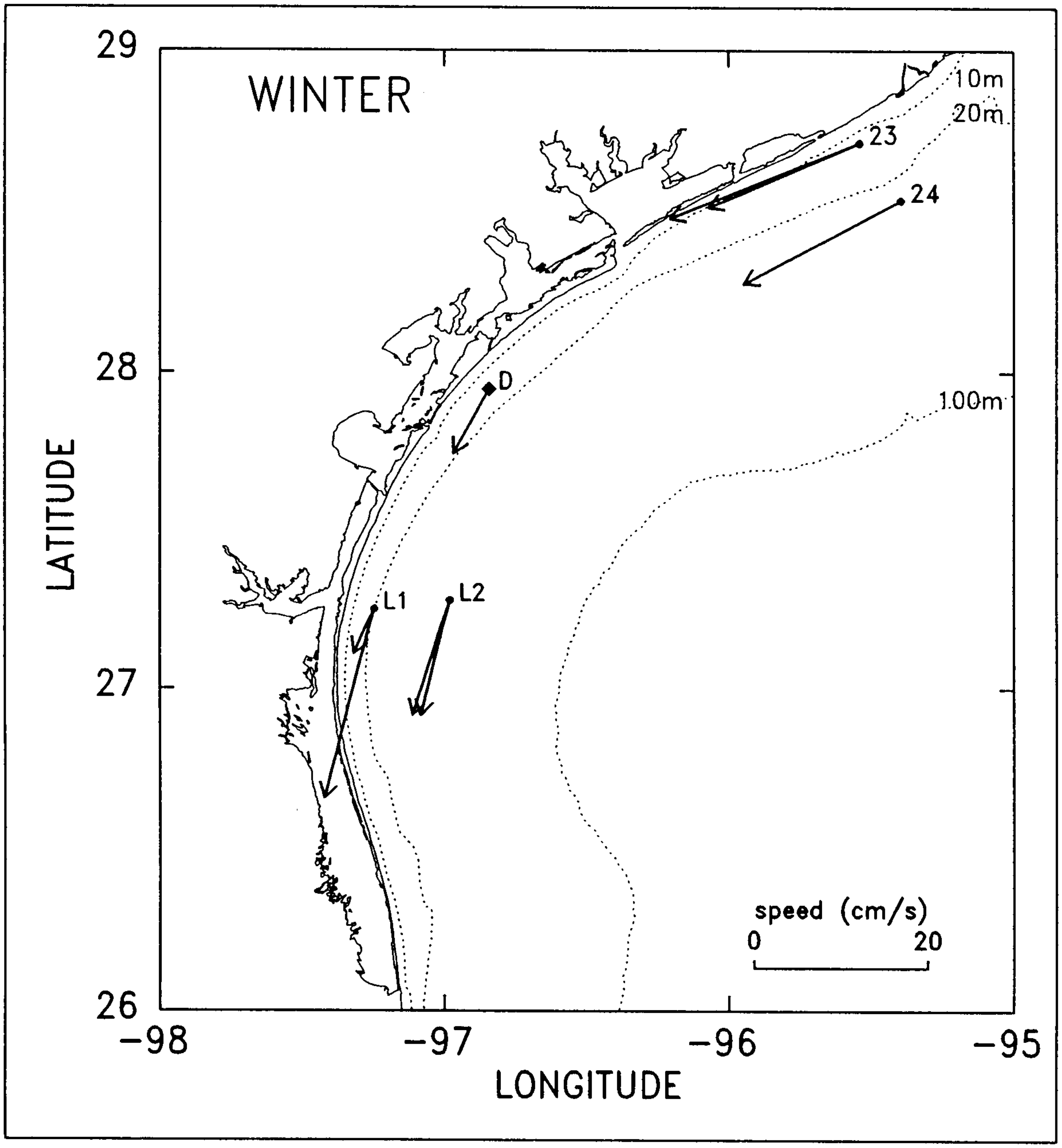


Figure 3g. Winter mean velocity vectors for (south)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

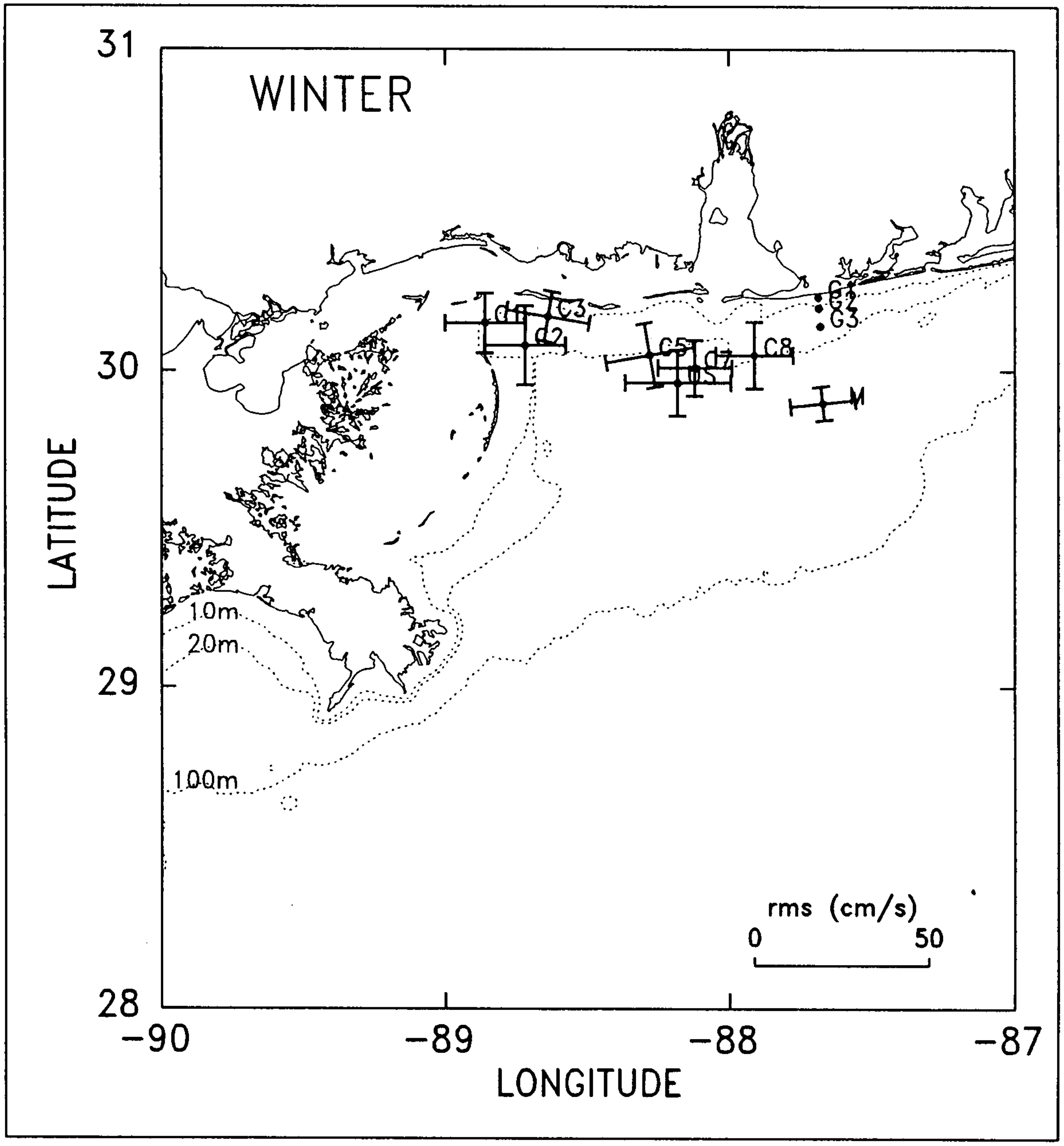


Figure 4a. Winter velocity variance axes for eastern region.
Mooring locations are plotted as dots; axes are plotted along- and cross-shore.

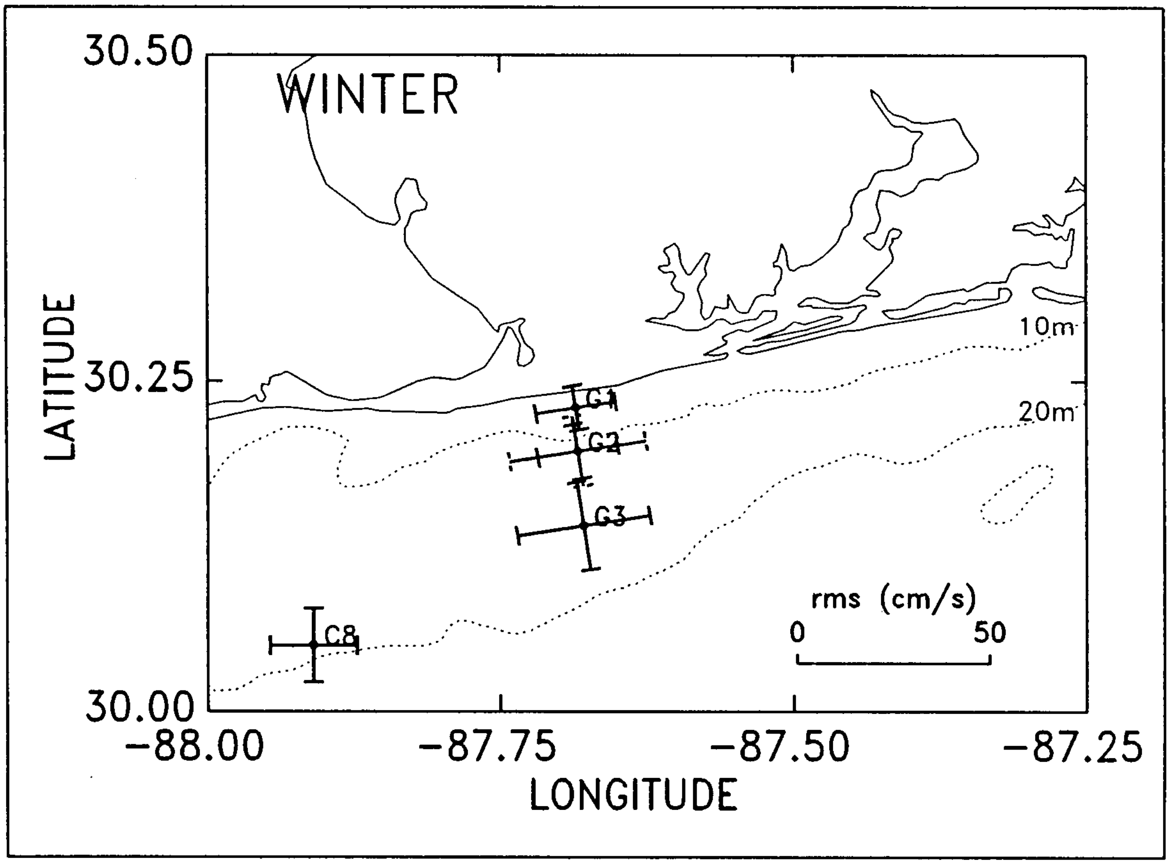


Figure 4b. Winter velocity variance axes for eastern region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

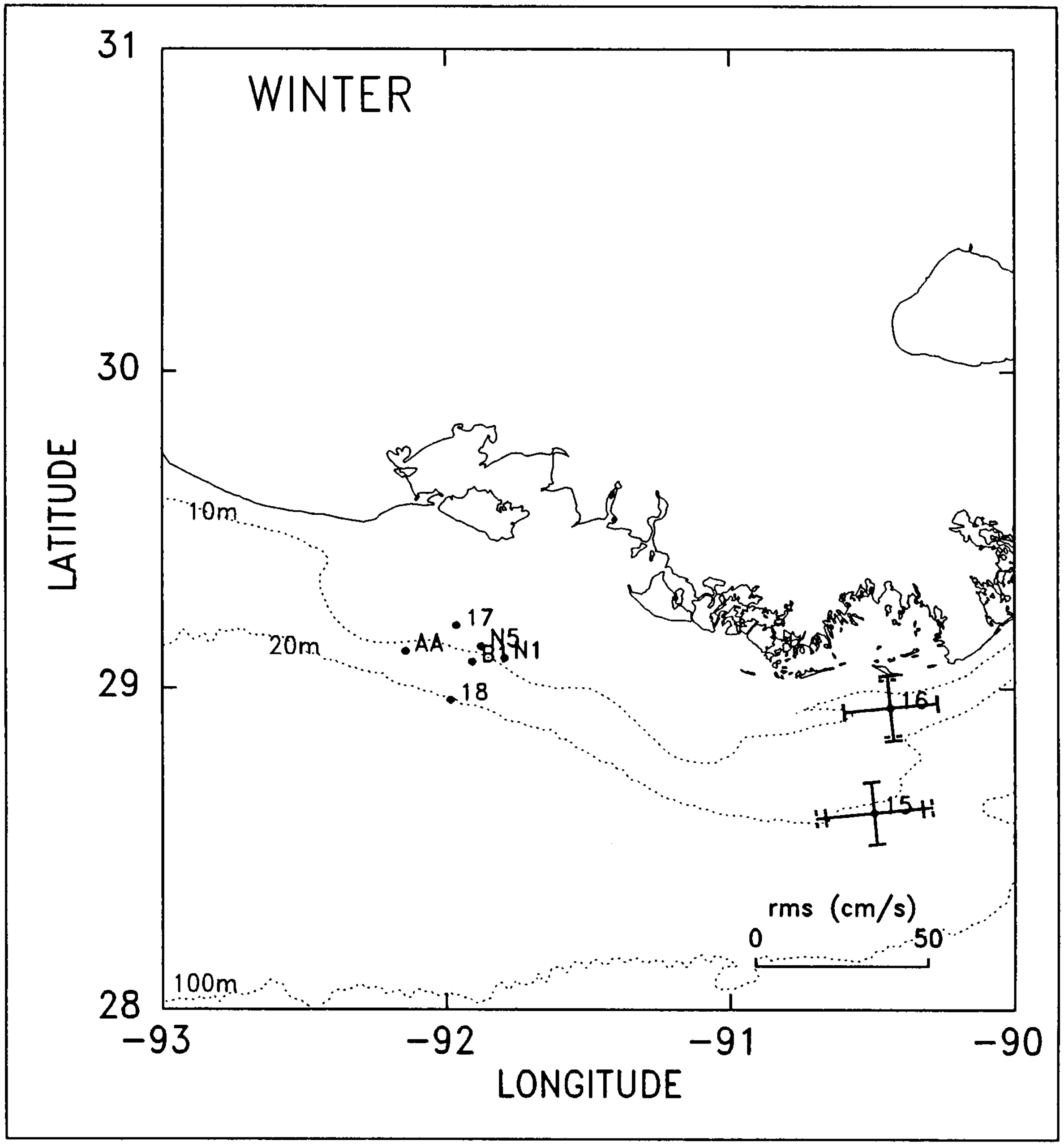


Figure 4c. Winter velocity variance axes for central region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

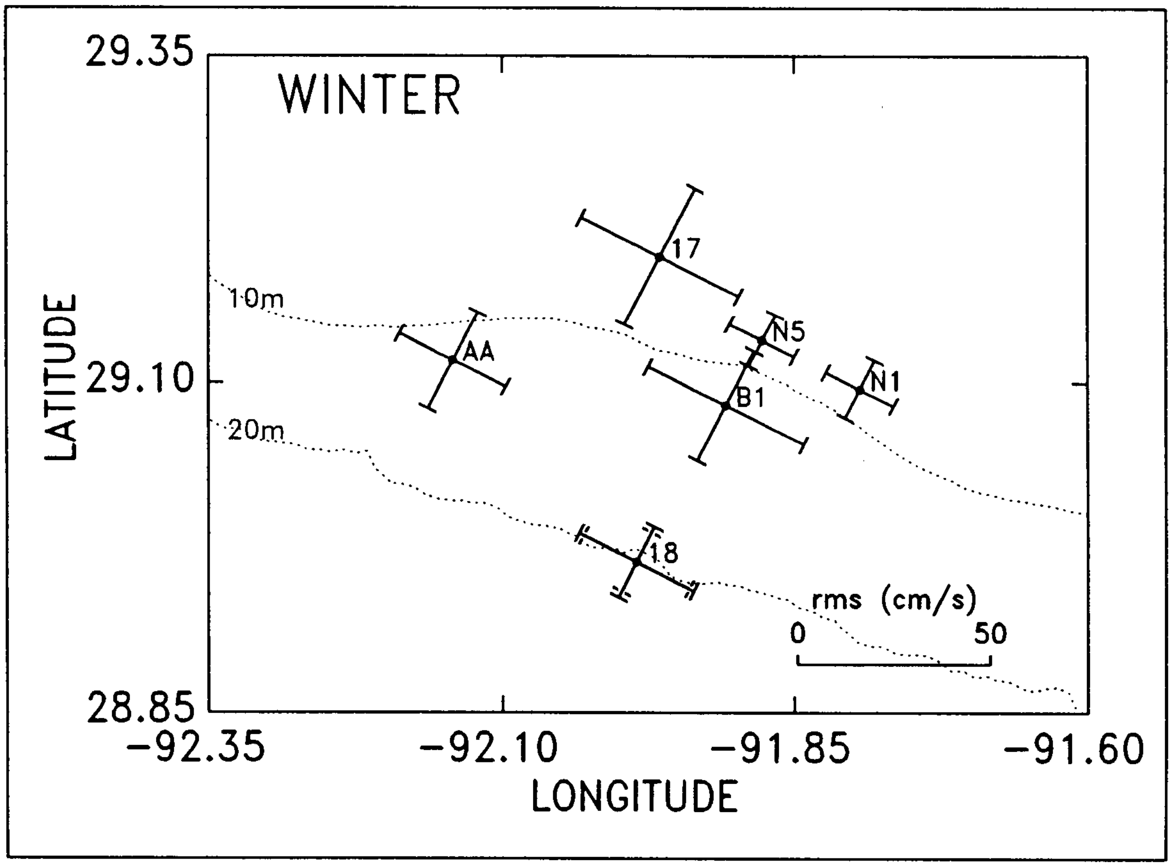


Figure 4d. Winter velocity variance axes for central region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

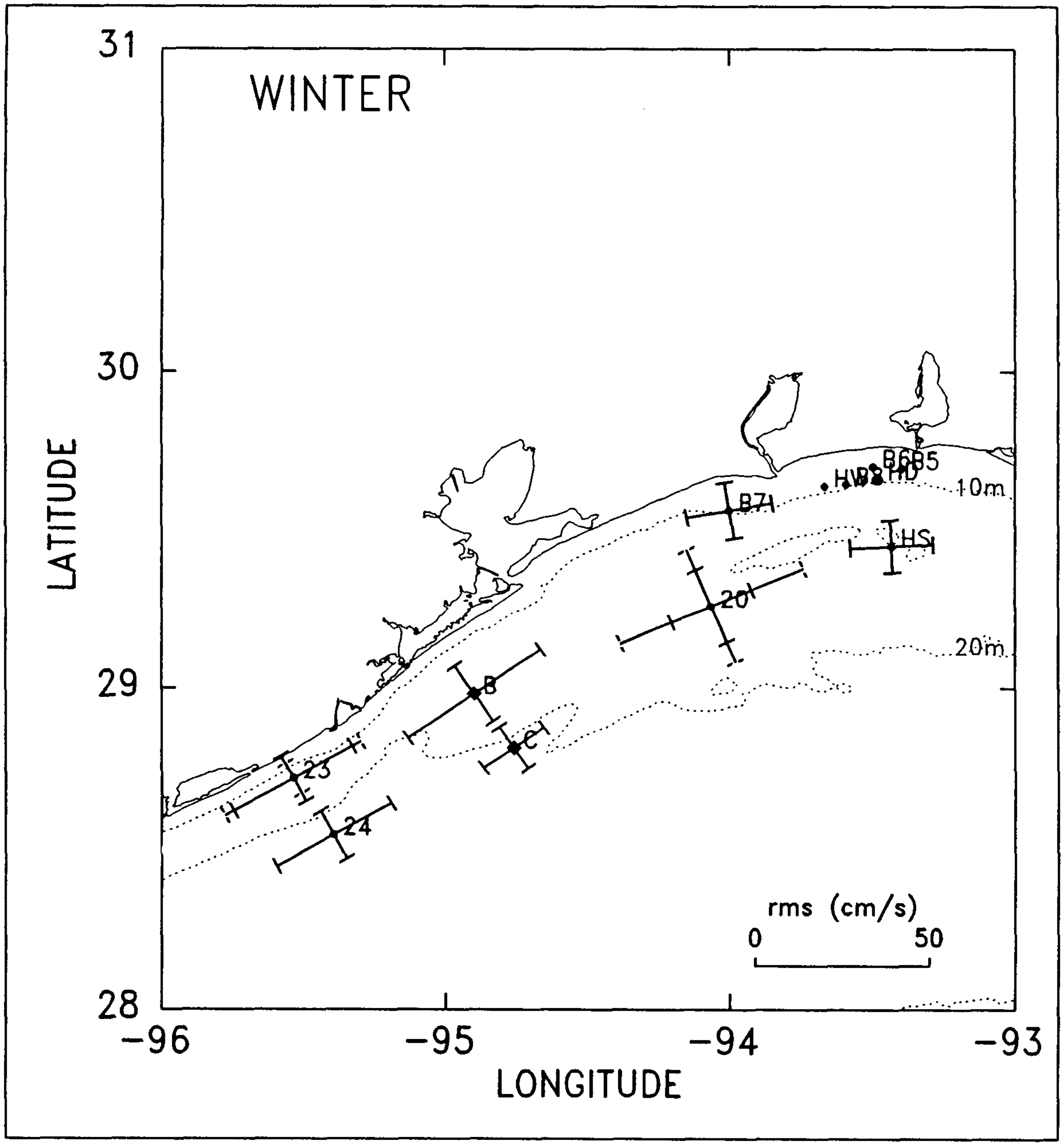


Figure 4e. Winter velocity variance axes for (north)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

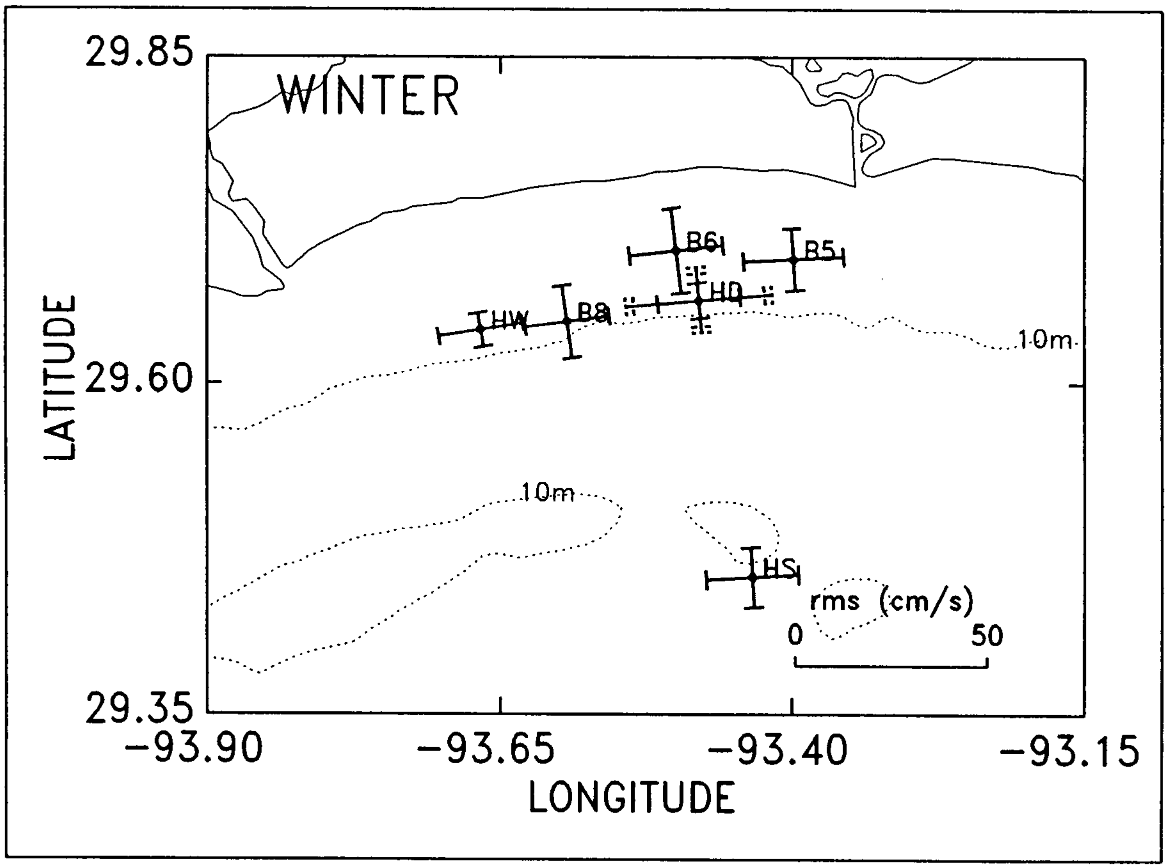


Figure 4f. Winter velocity variance axes for (north)western region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

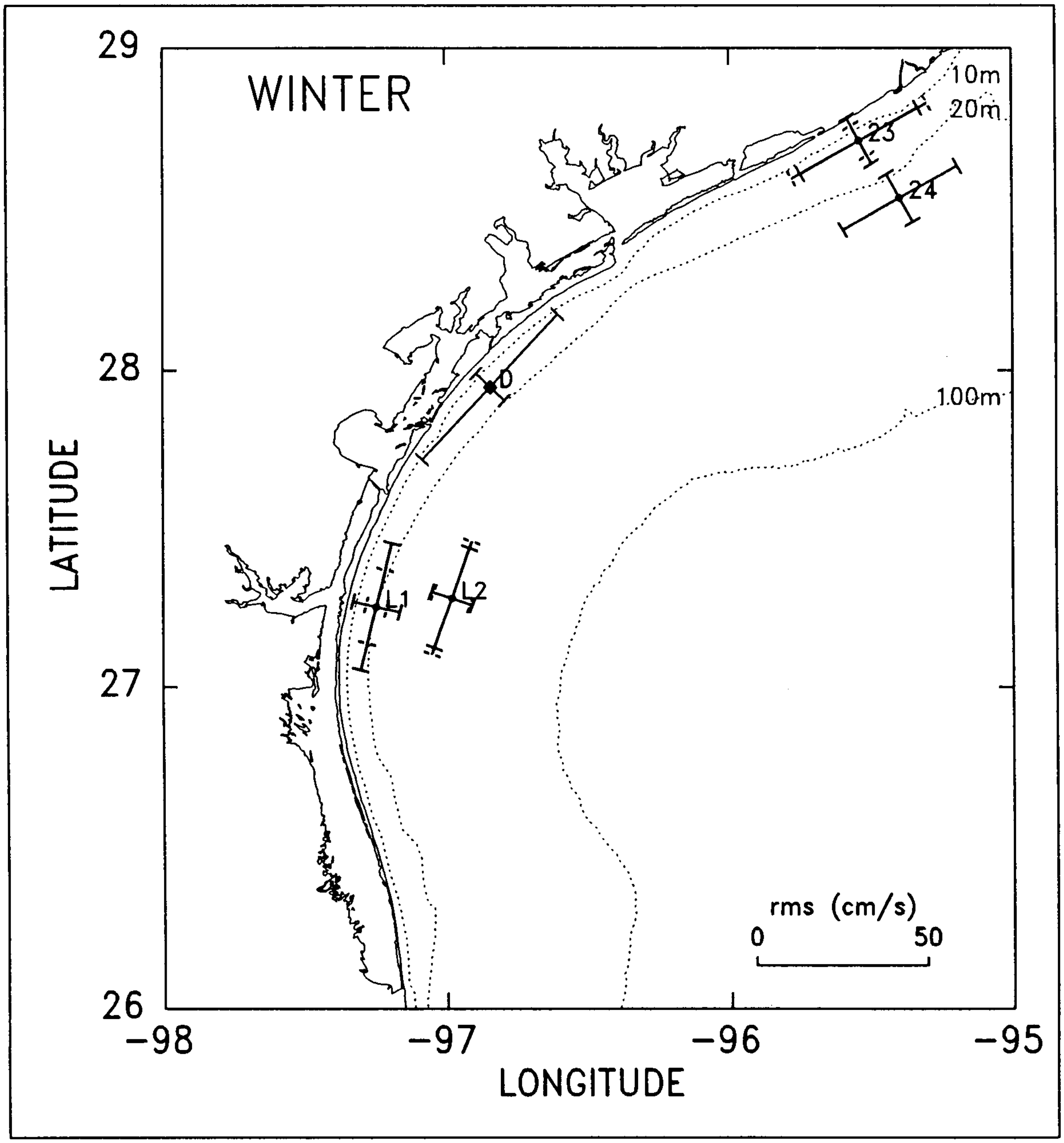


Figure 4g. Winter velocity variance axes for (south)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

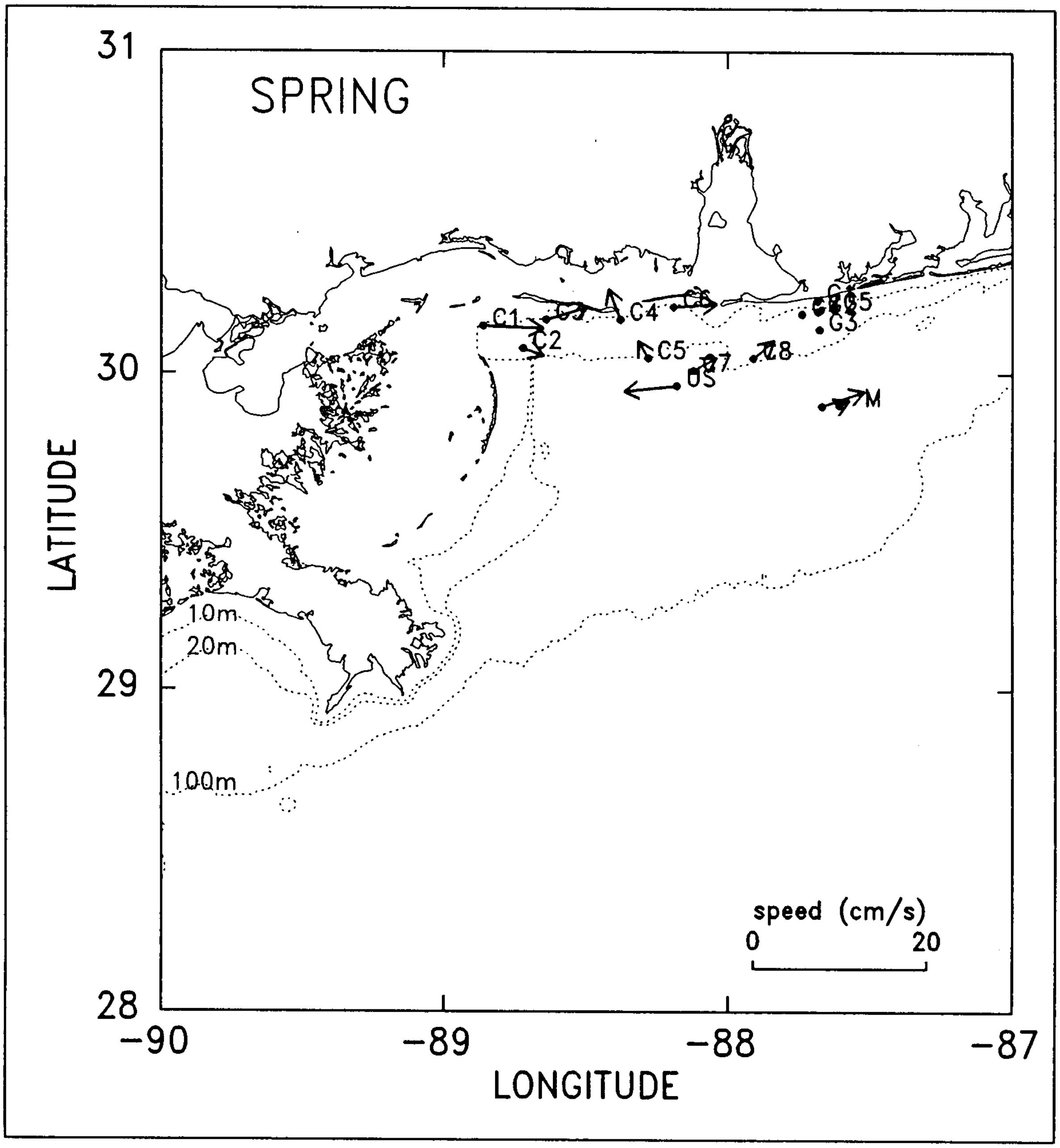


Figure 5a. Spring mean velocity vectors for eastern region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

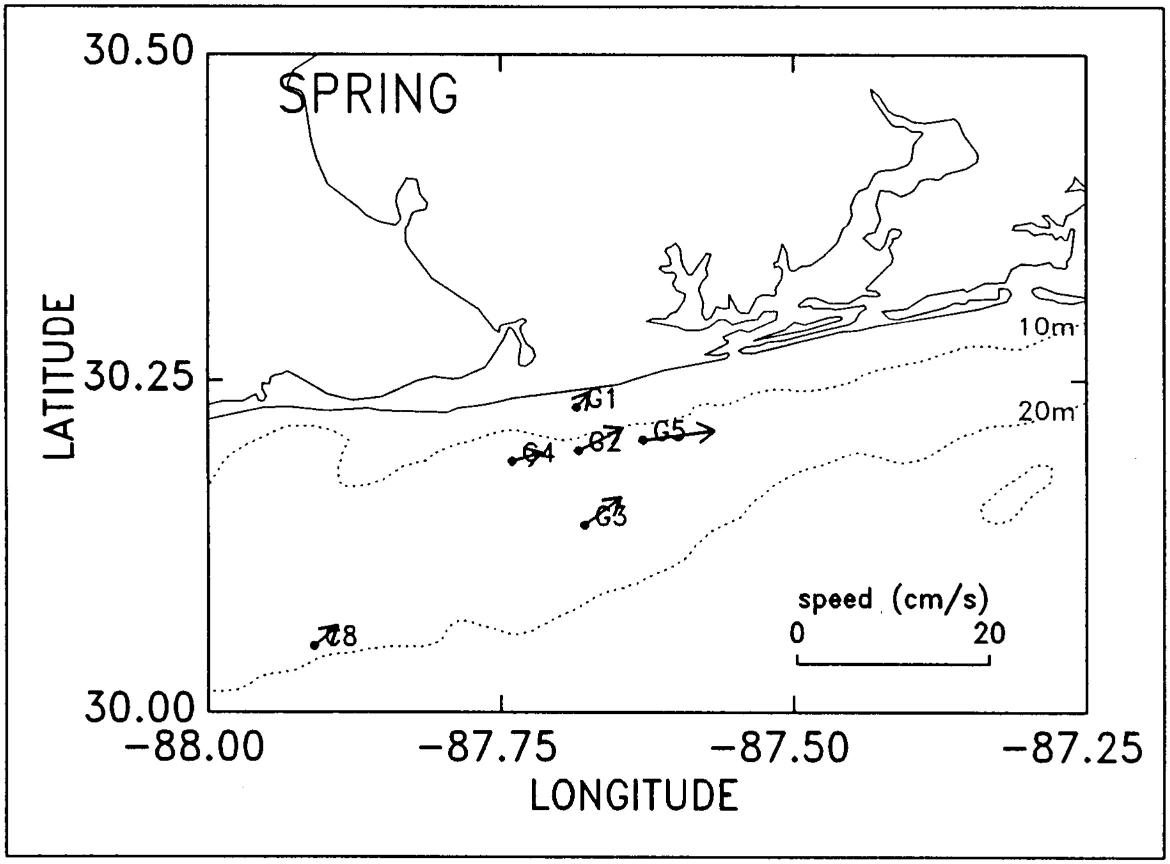


Figure 5b. Spring mean velocity vectors for eastern region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow.

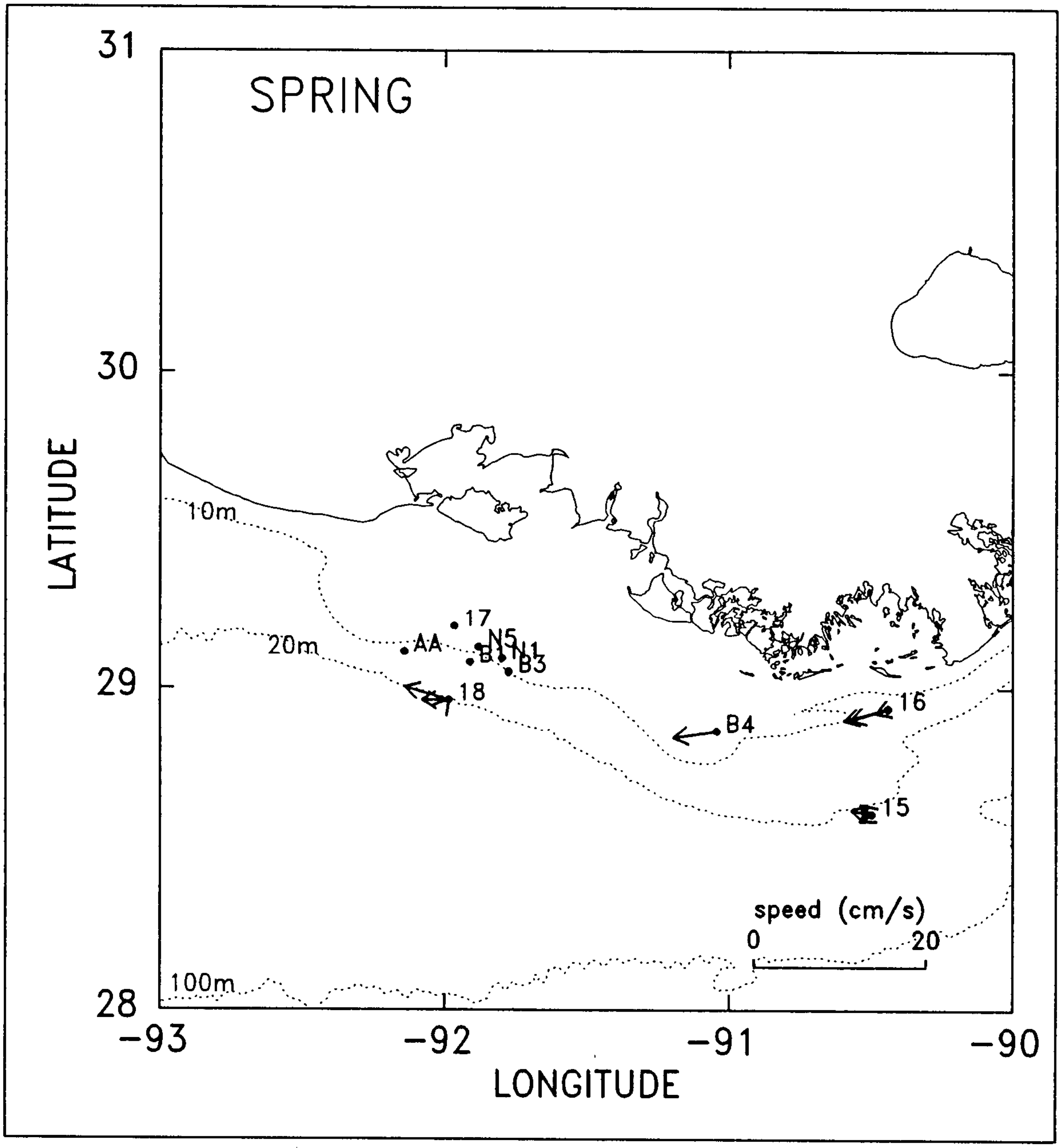


Figure 5c. Spring mean velocity vectors for central region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

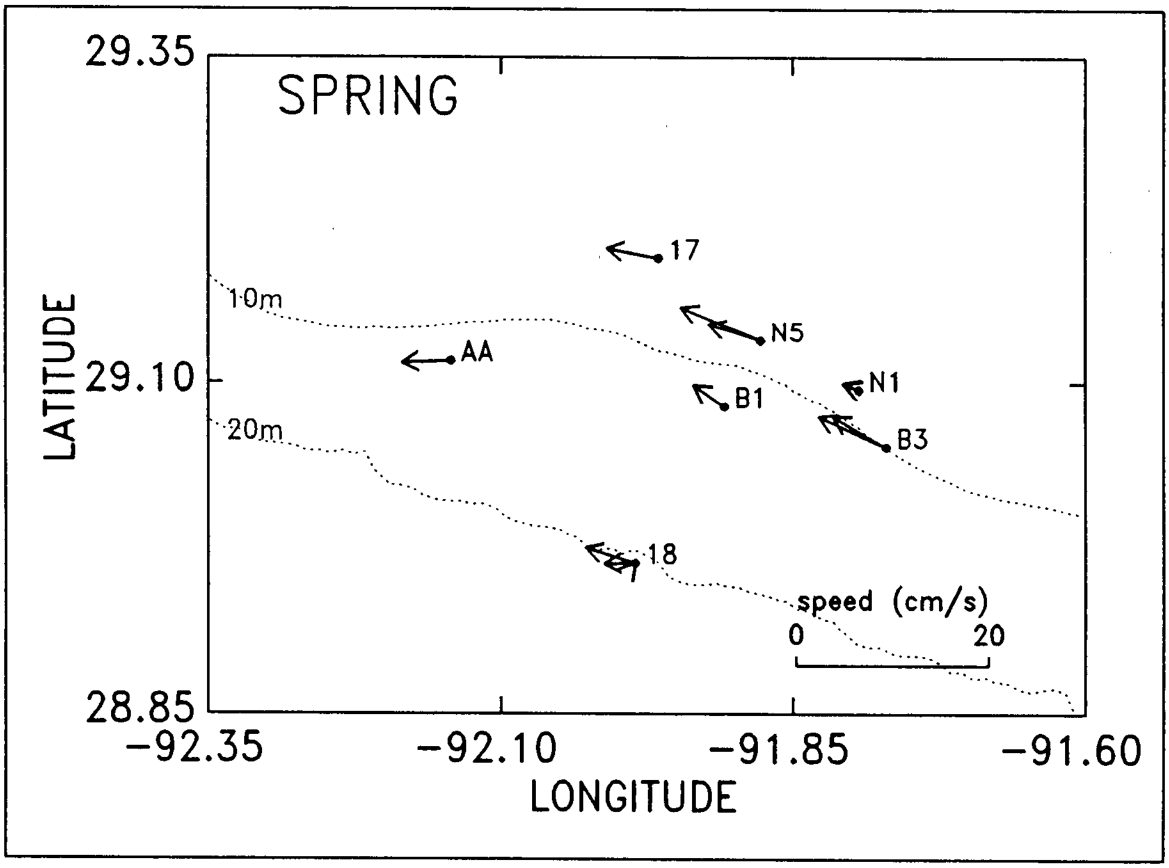


Figure 5d. Spring mean velocity vectors for central region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

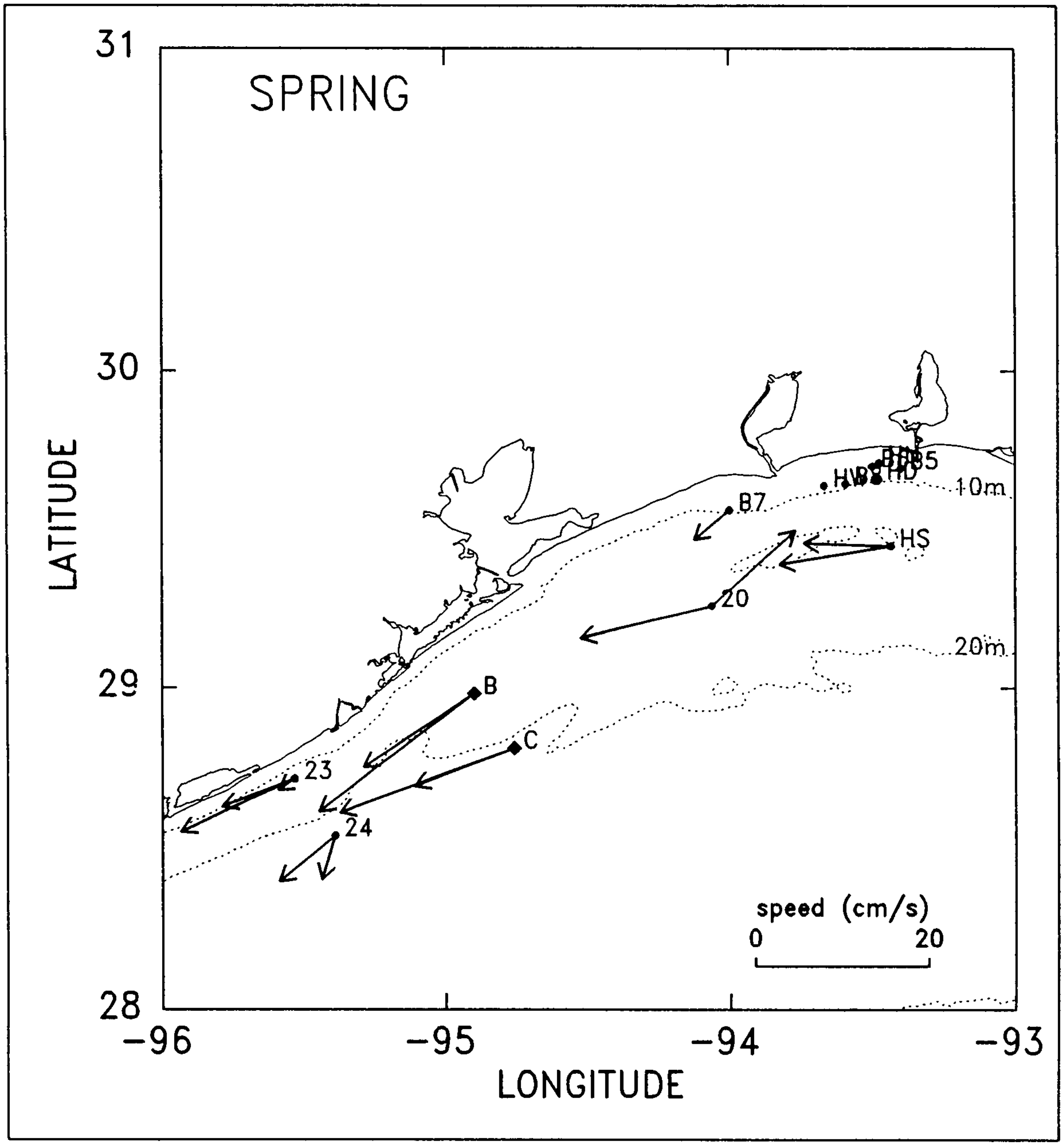


Figure 5e. Spring mean velocity vectors for (north)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

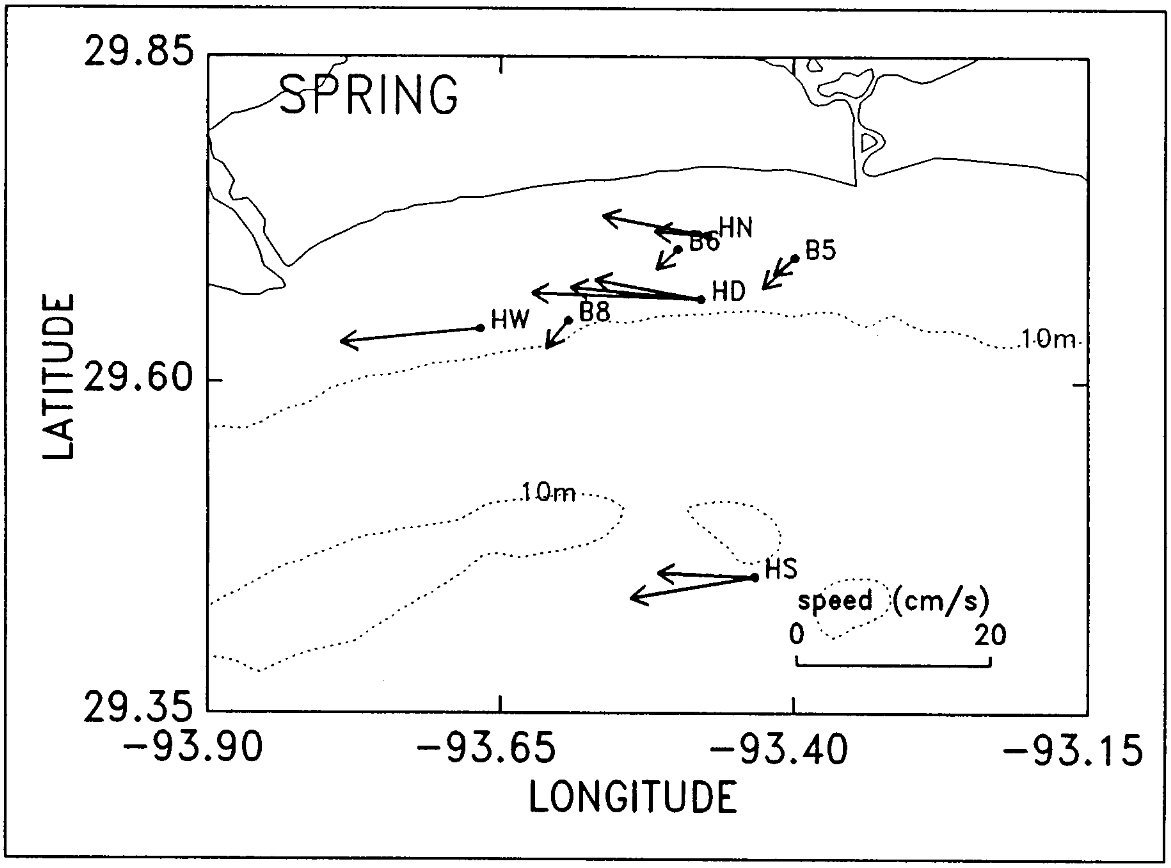


Figure 5f. Spring mean velocity vectors for (north)western region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

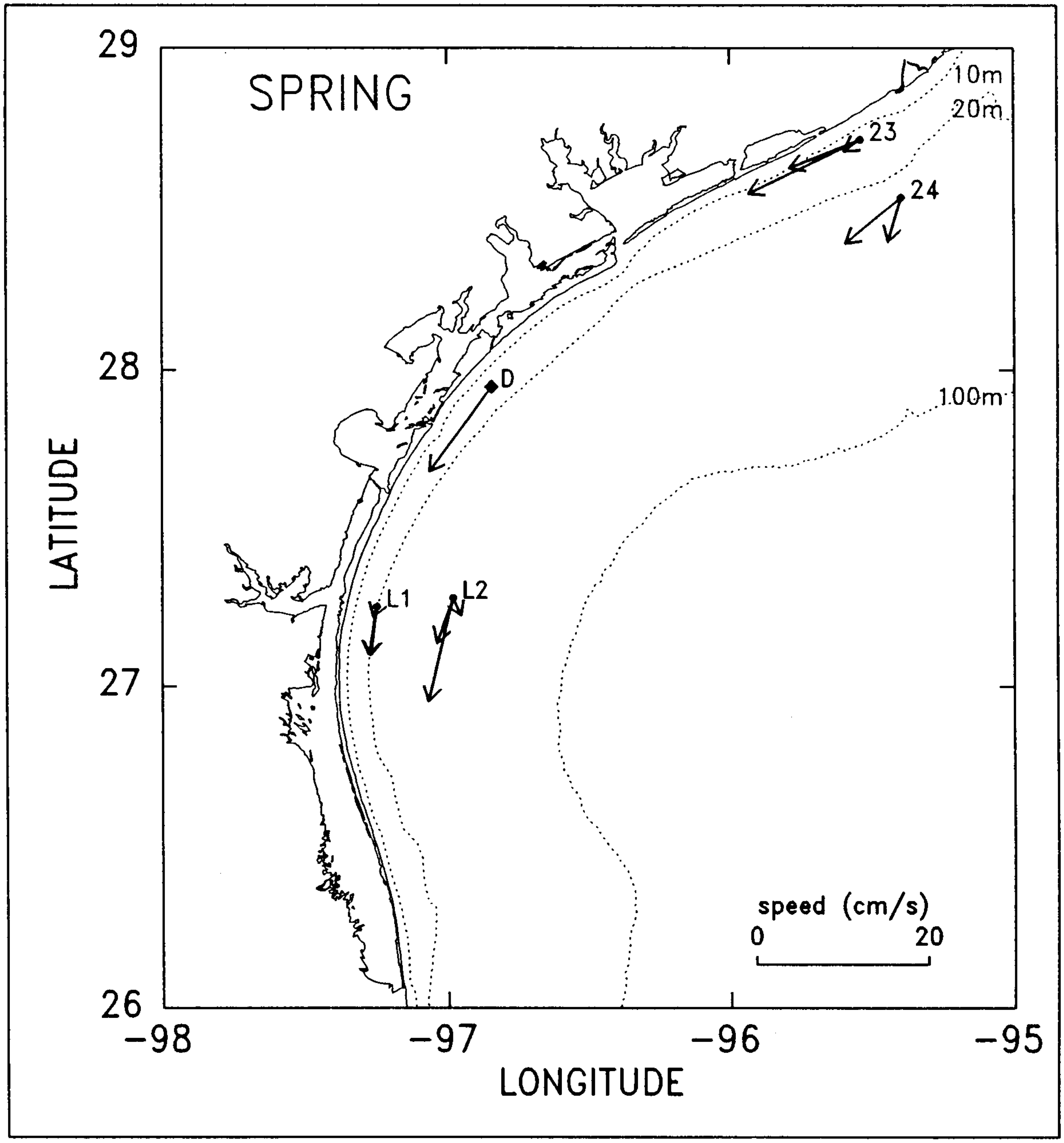


Figure 5g. Spring mean velocity vectors for (south)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

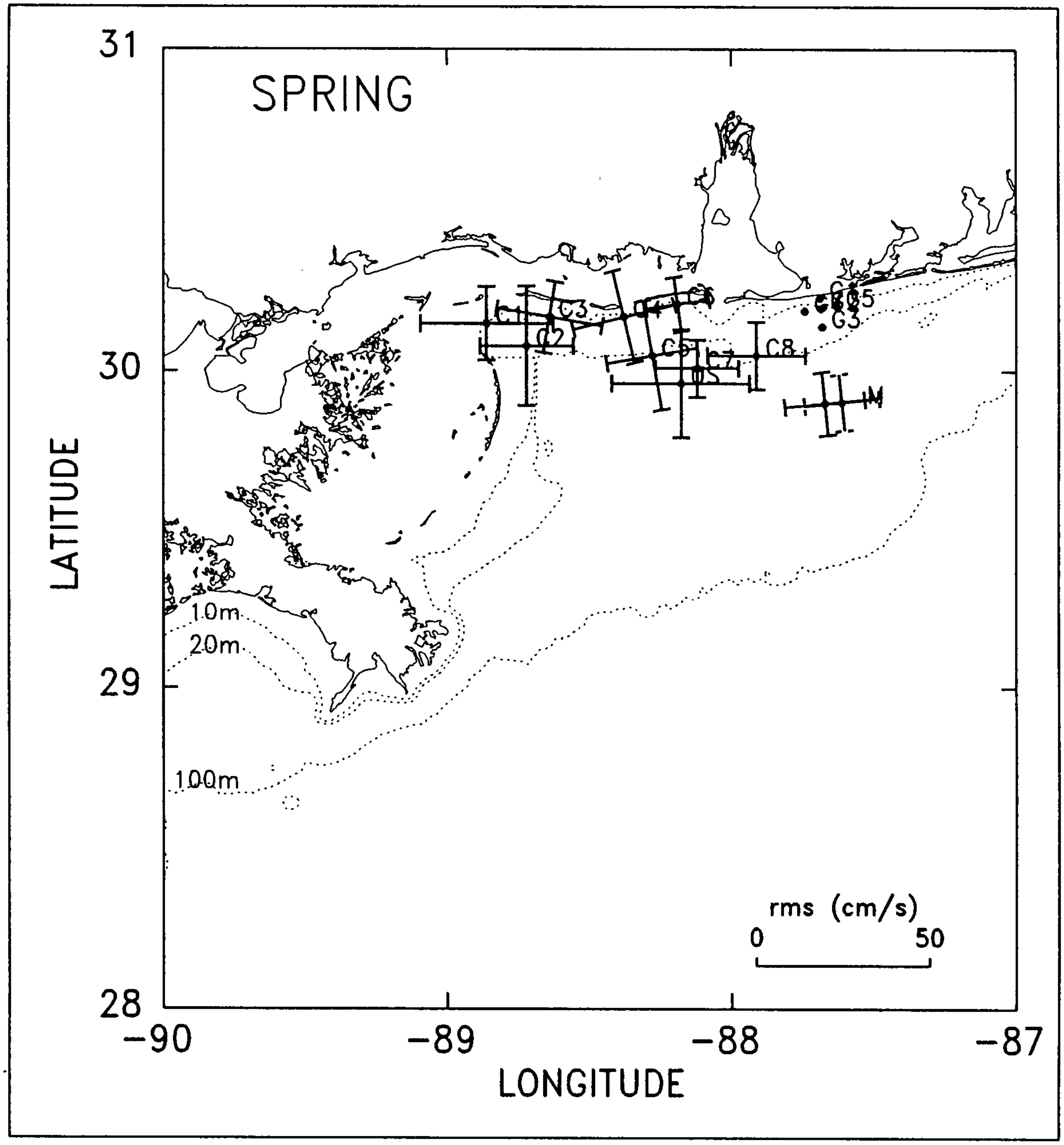


Figure 6a. Spring velocity variance axes for eastern region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

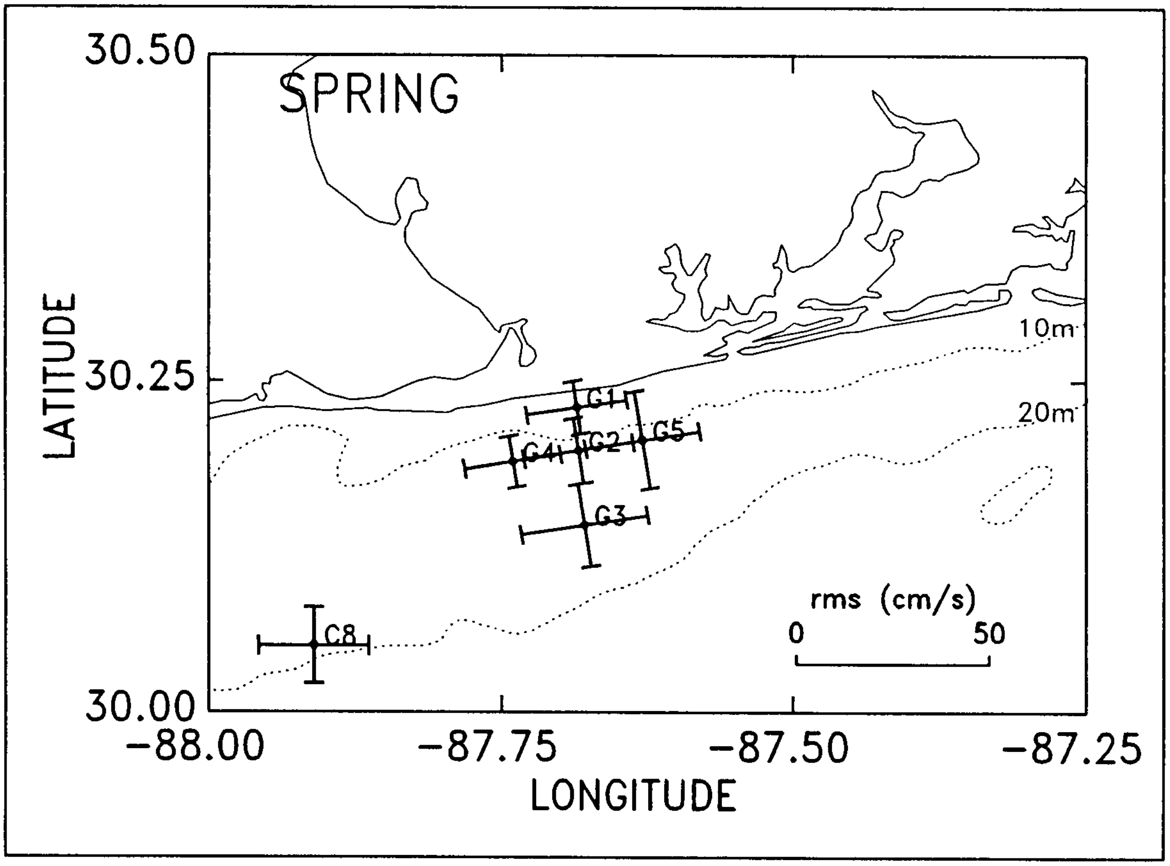


Figure 6b. Spring velocity variance axes for eastern region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore.

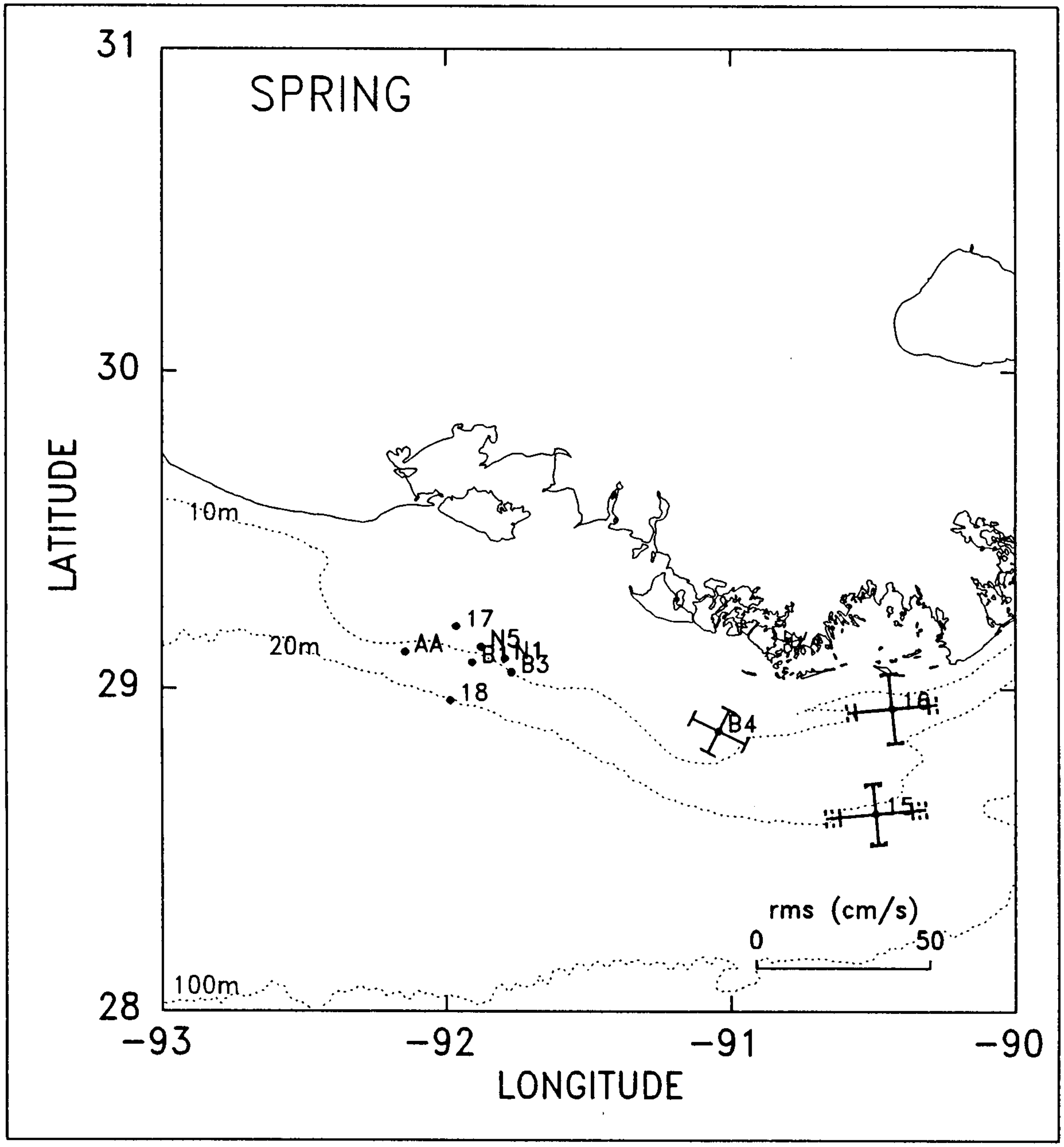


Figure 6c. Spring velocity variance axes for central region.
Mooring locations are plotted as dots; axes are
plotted along- and cross-shore. Stations with
multiple records have multiple endbar patterns.

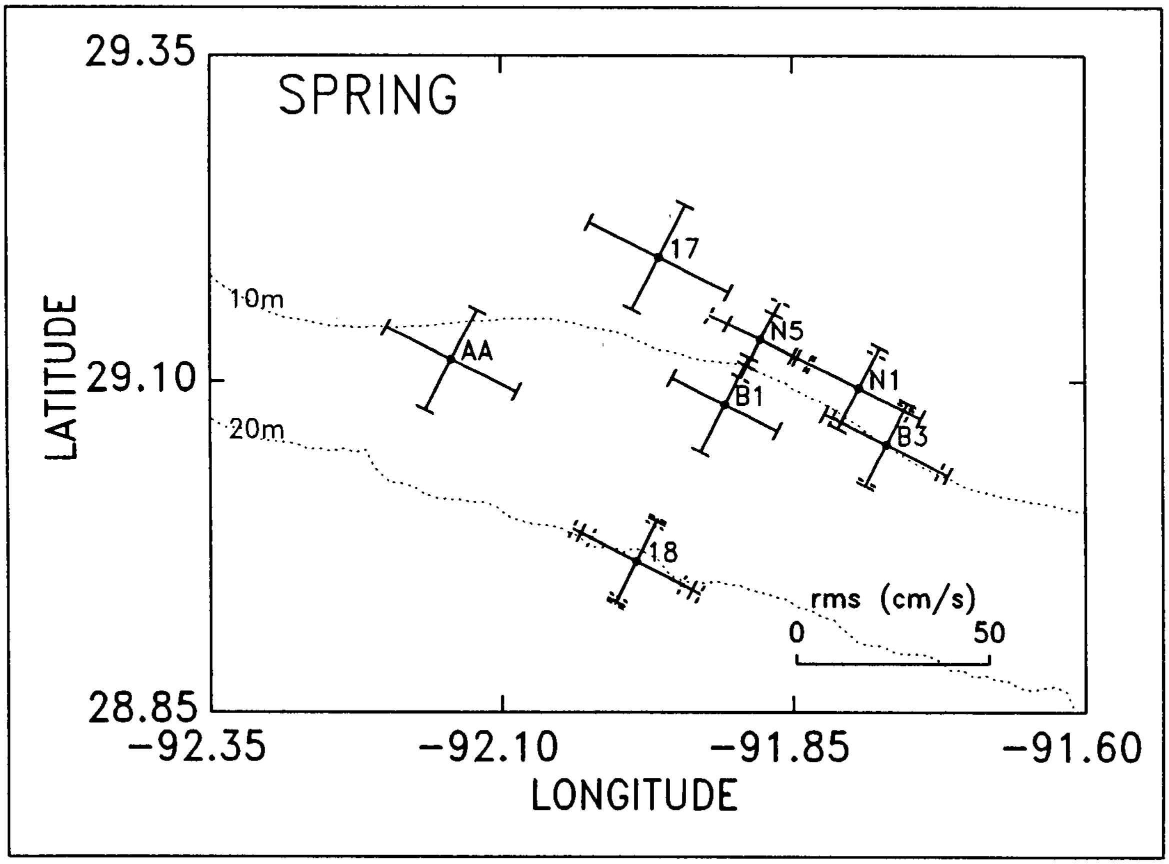


Figure 6d. Spring velocity variance axes for central region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

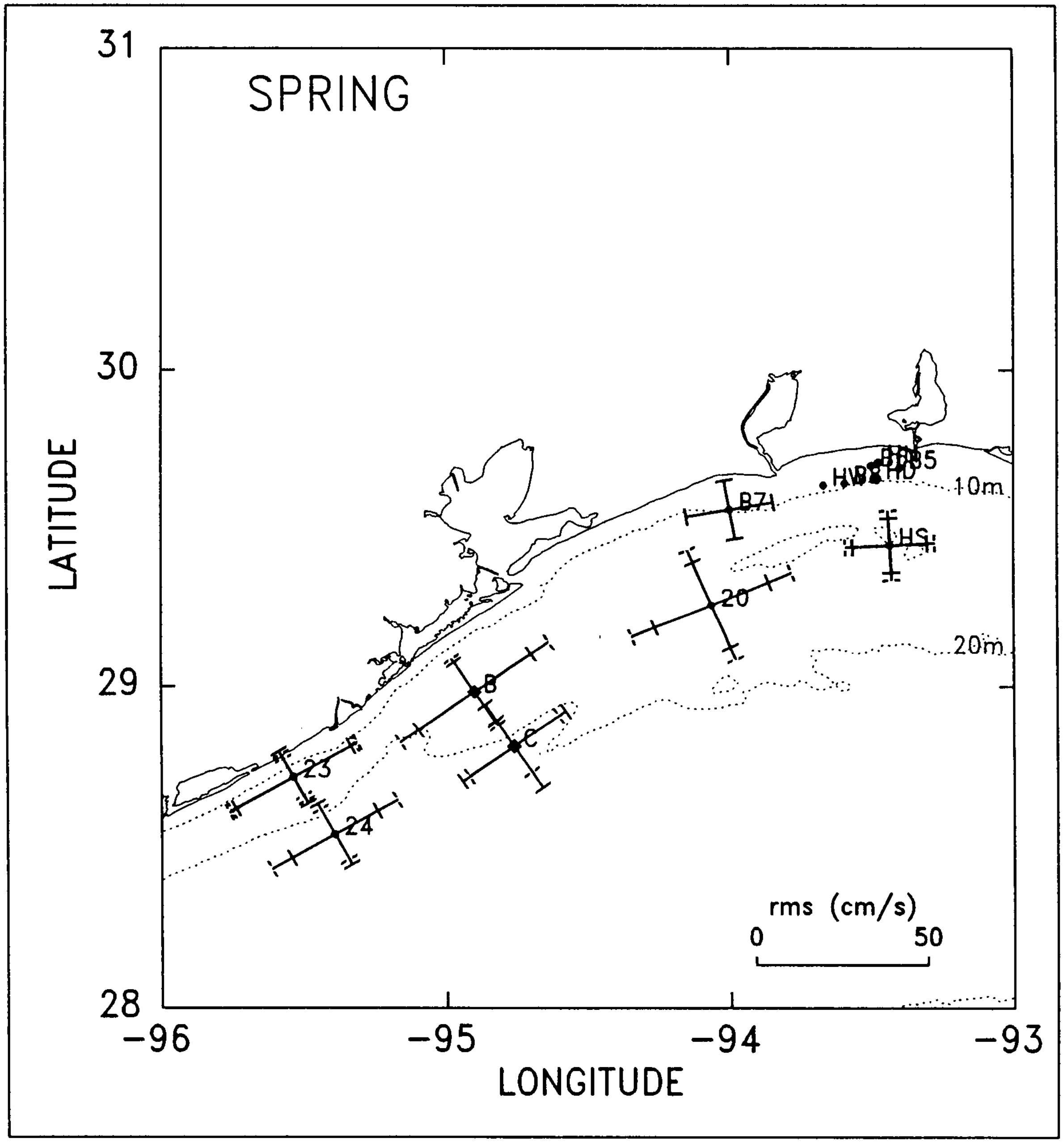


Figure 6e. Spring velocity variance axes for (north)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

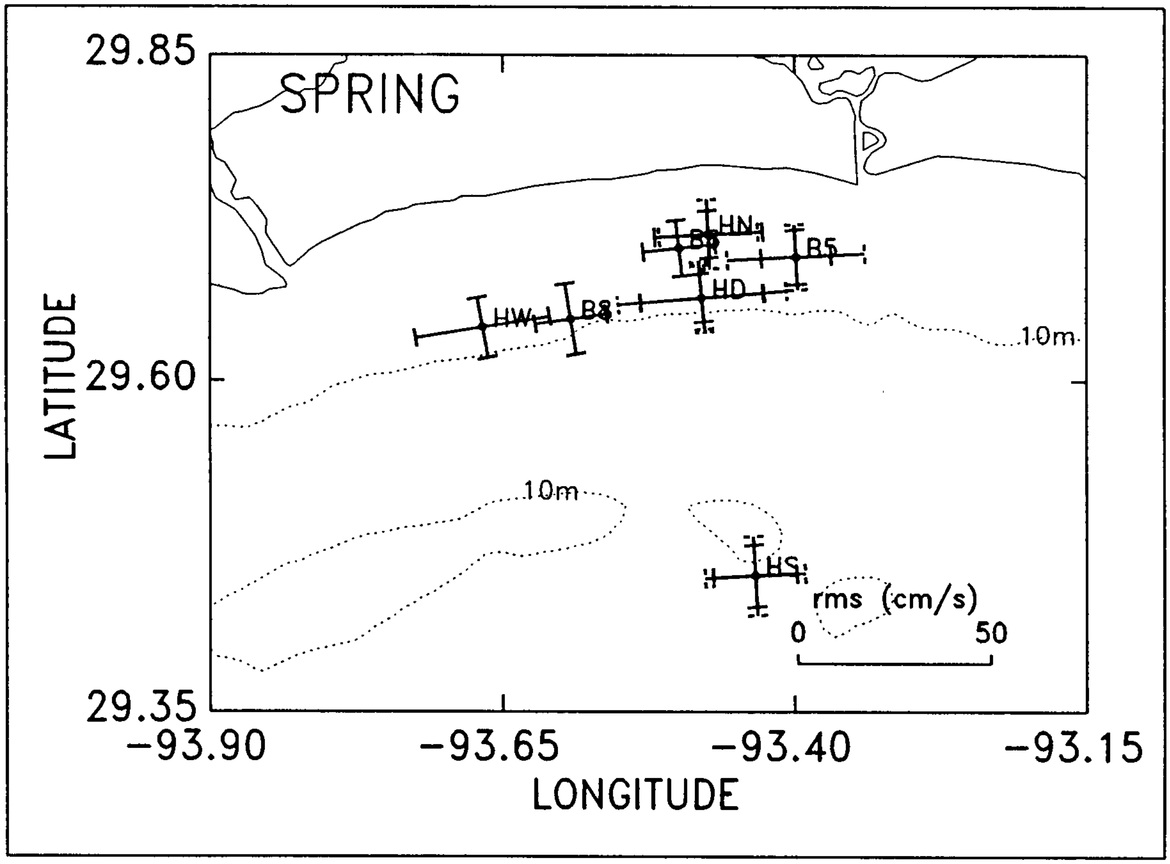


Figure 6f. Spring velocity variance axes for (north)western region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

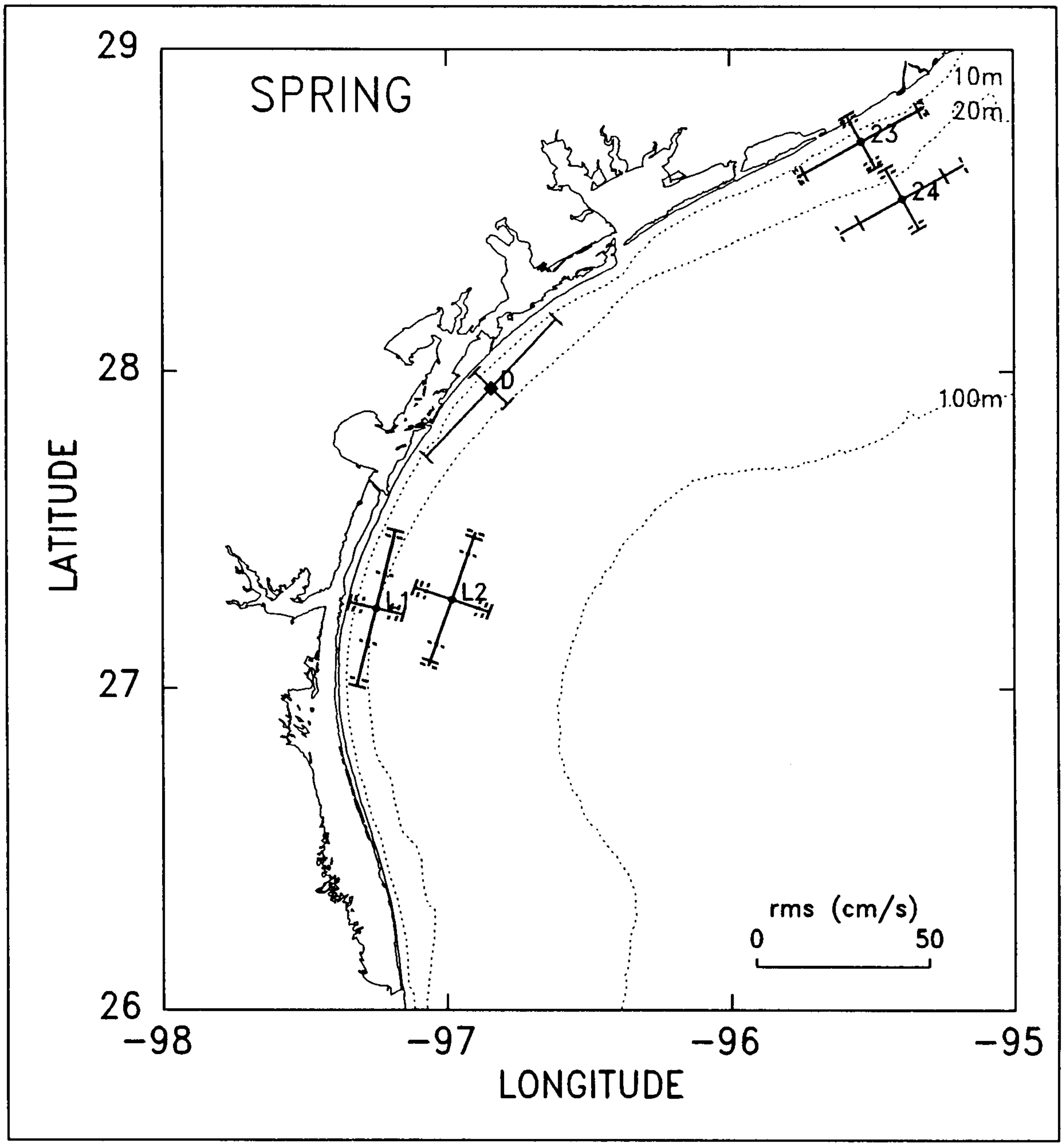


Figure 6g. Spring velocity variance axes for (south)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

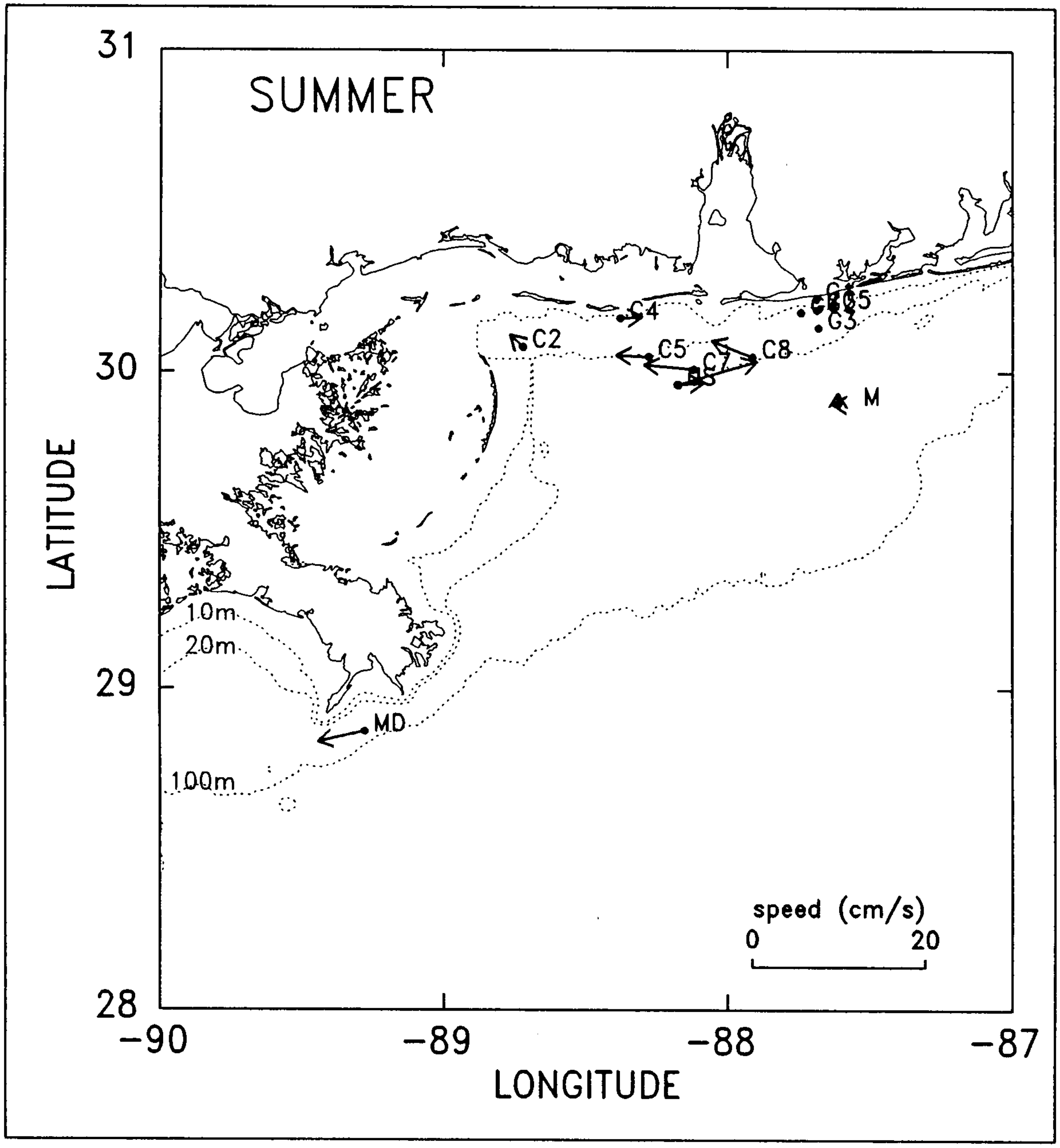


Figure 7a. Summer mean velocity vectors for eastern region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

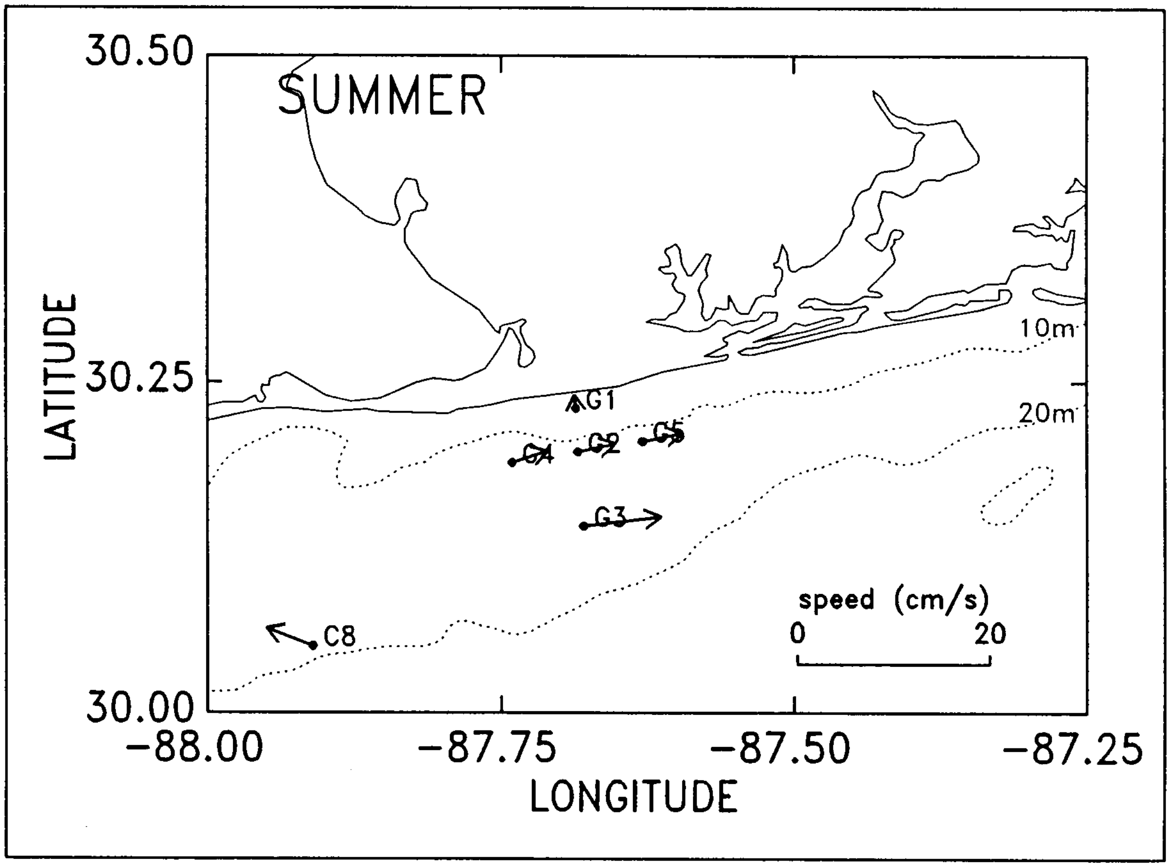


Figure 7b. Summer mean velocity vectors for eastern region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow.

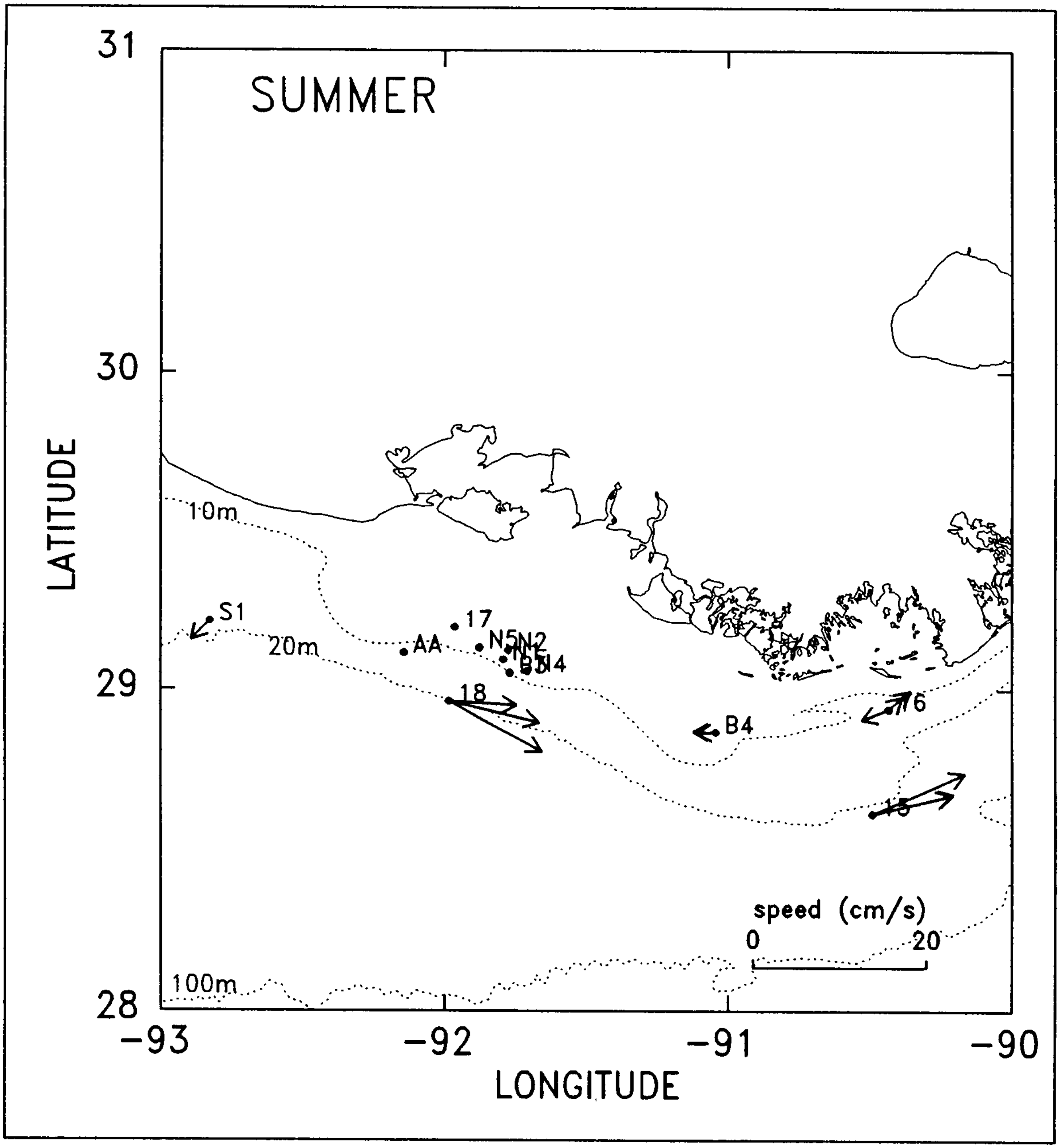


Figure 7c. Summer mean velocity vectors for central region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

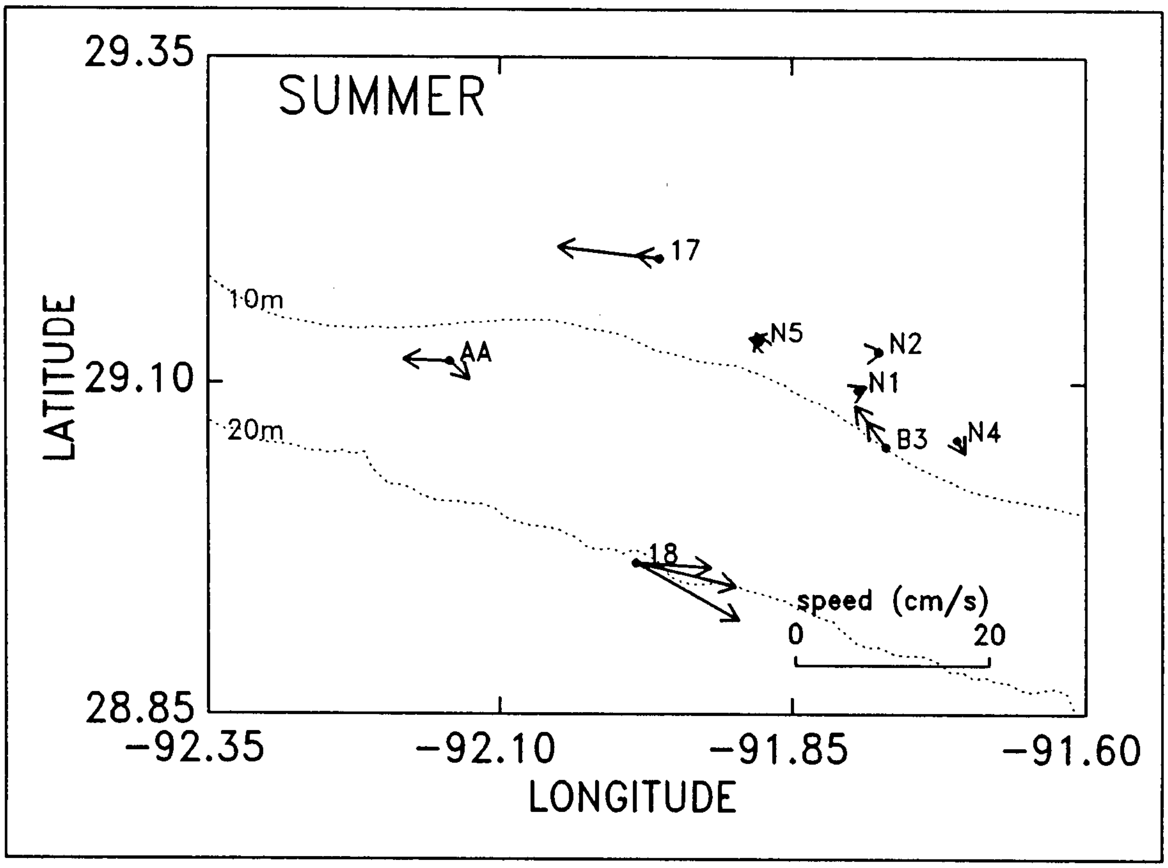


Figure 7d. Summer mean velocity vectors for central region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

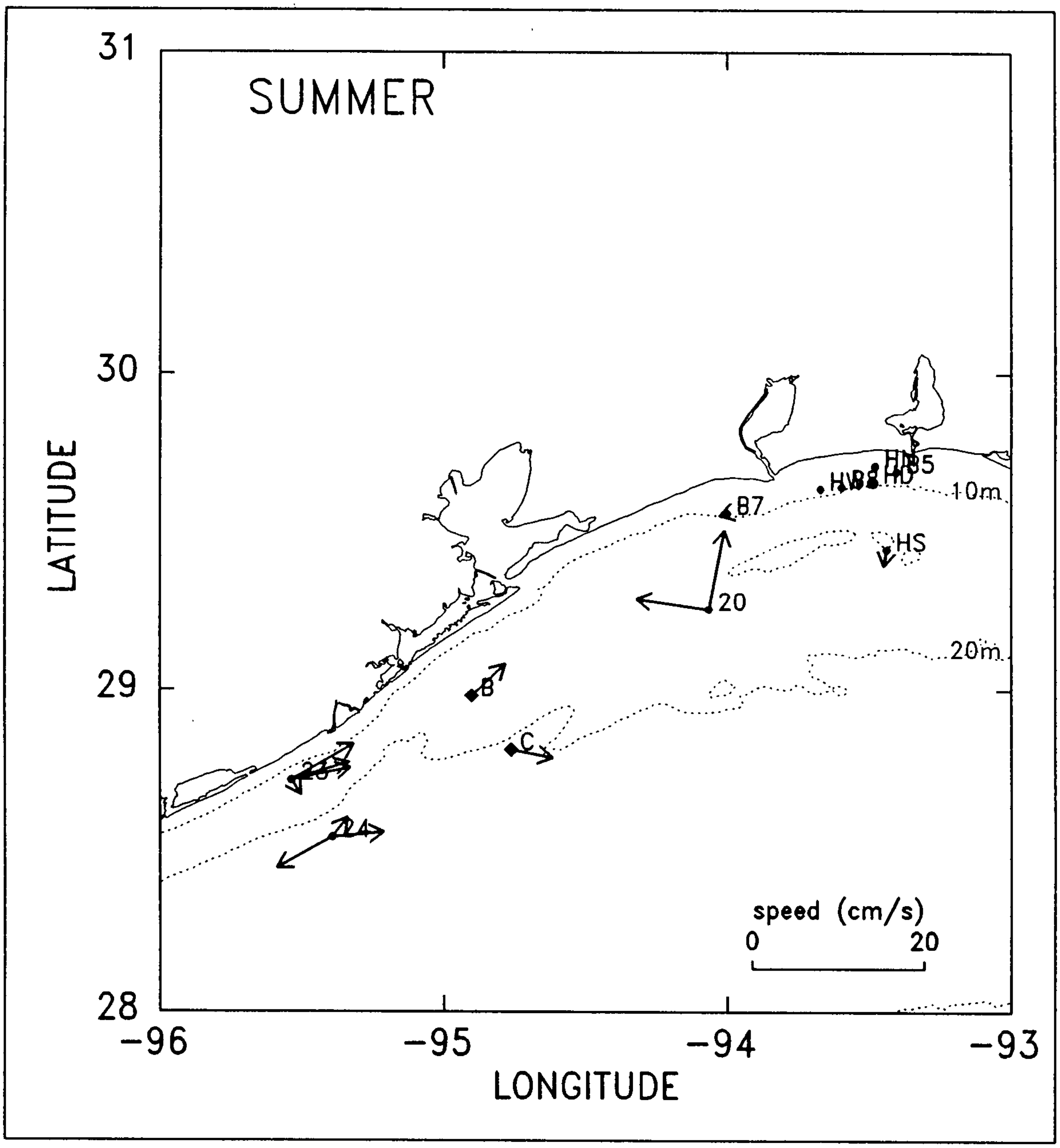


Figure 7e. Summer mean velocity vectors for (north)western
region. Mooring locations are plotted as dots;
the mean vectors are in direction of flow.
Stations with multiple records have multiple
vectors.

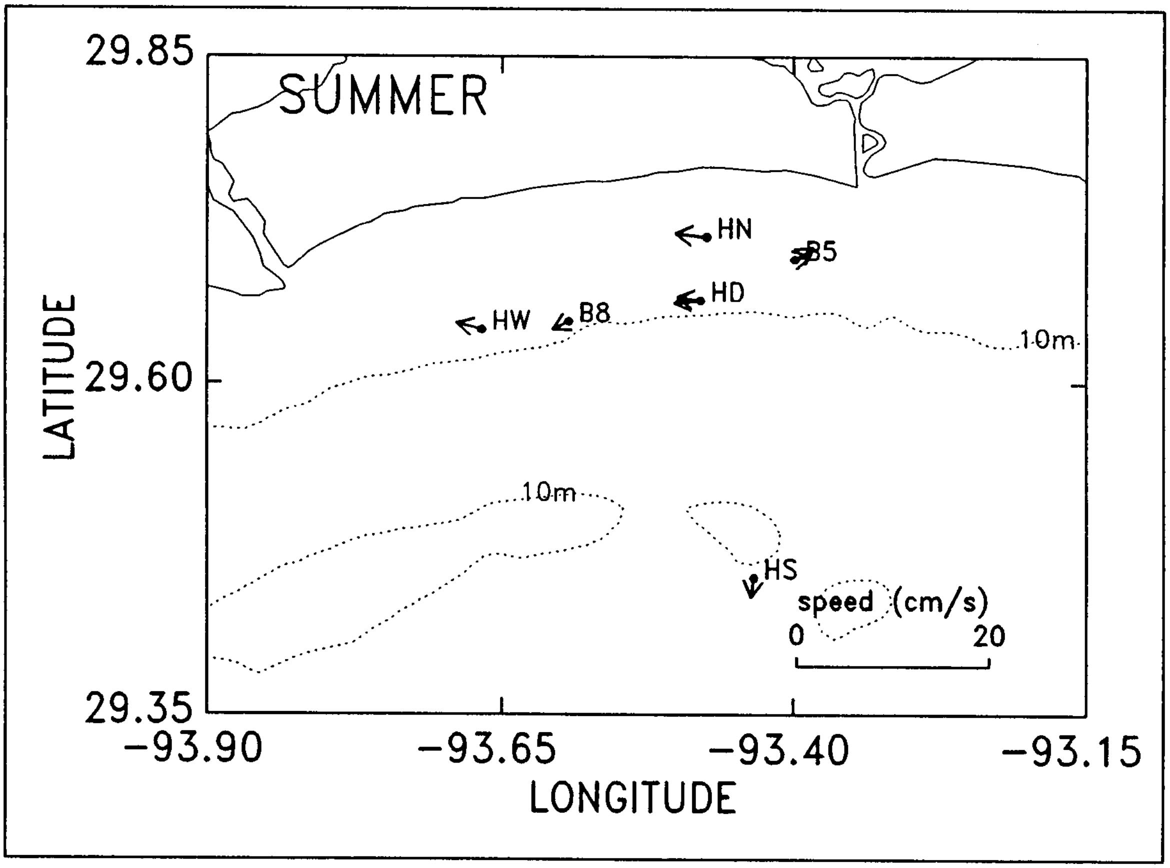


Figure 7f. Summer mean velocity vectors for (north)western region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

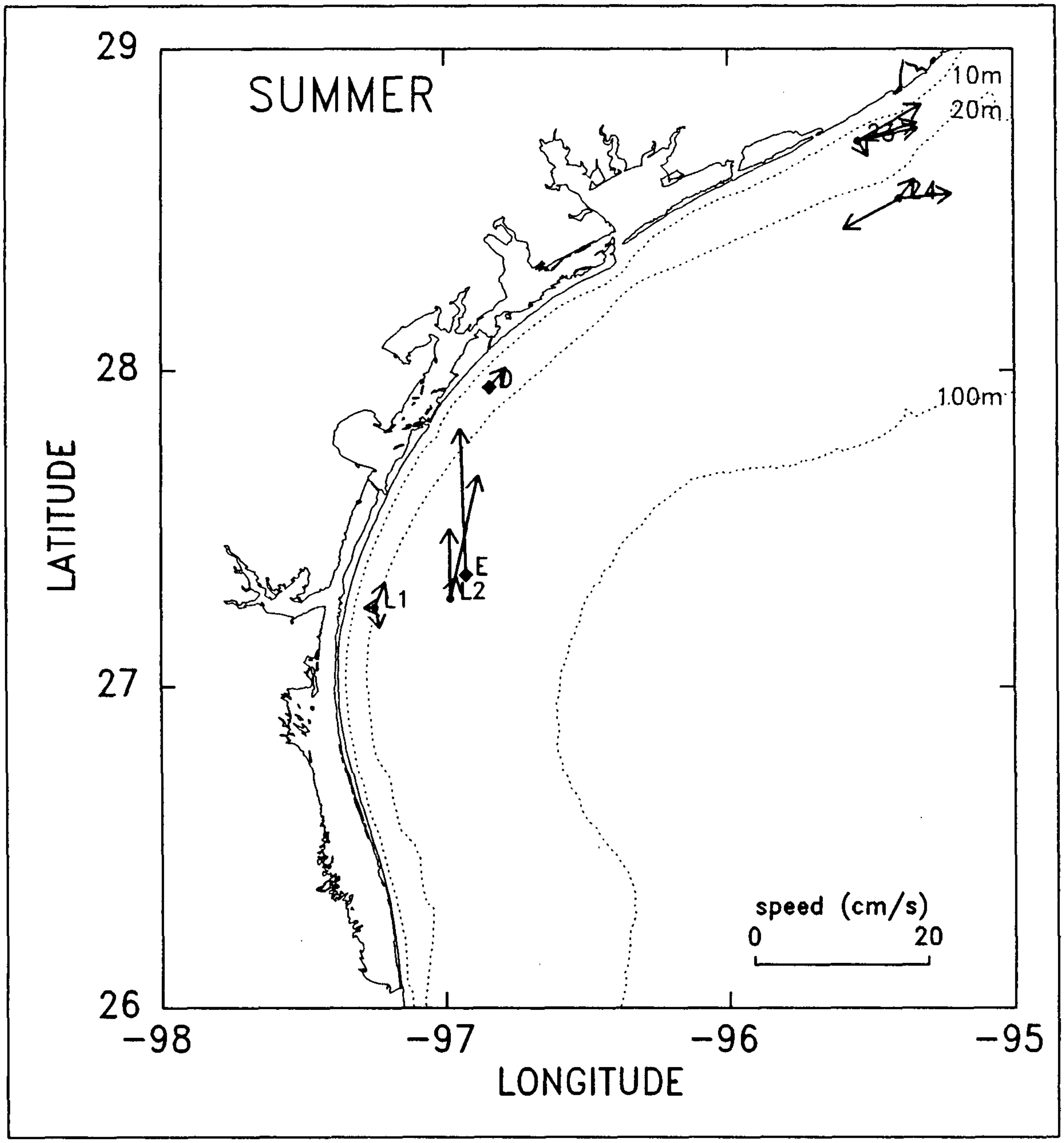


Figure 7g. Summer mean velocity vectors for (south)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

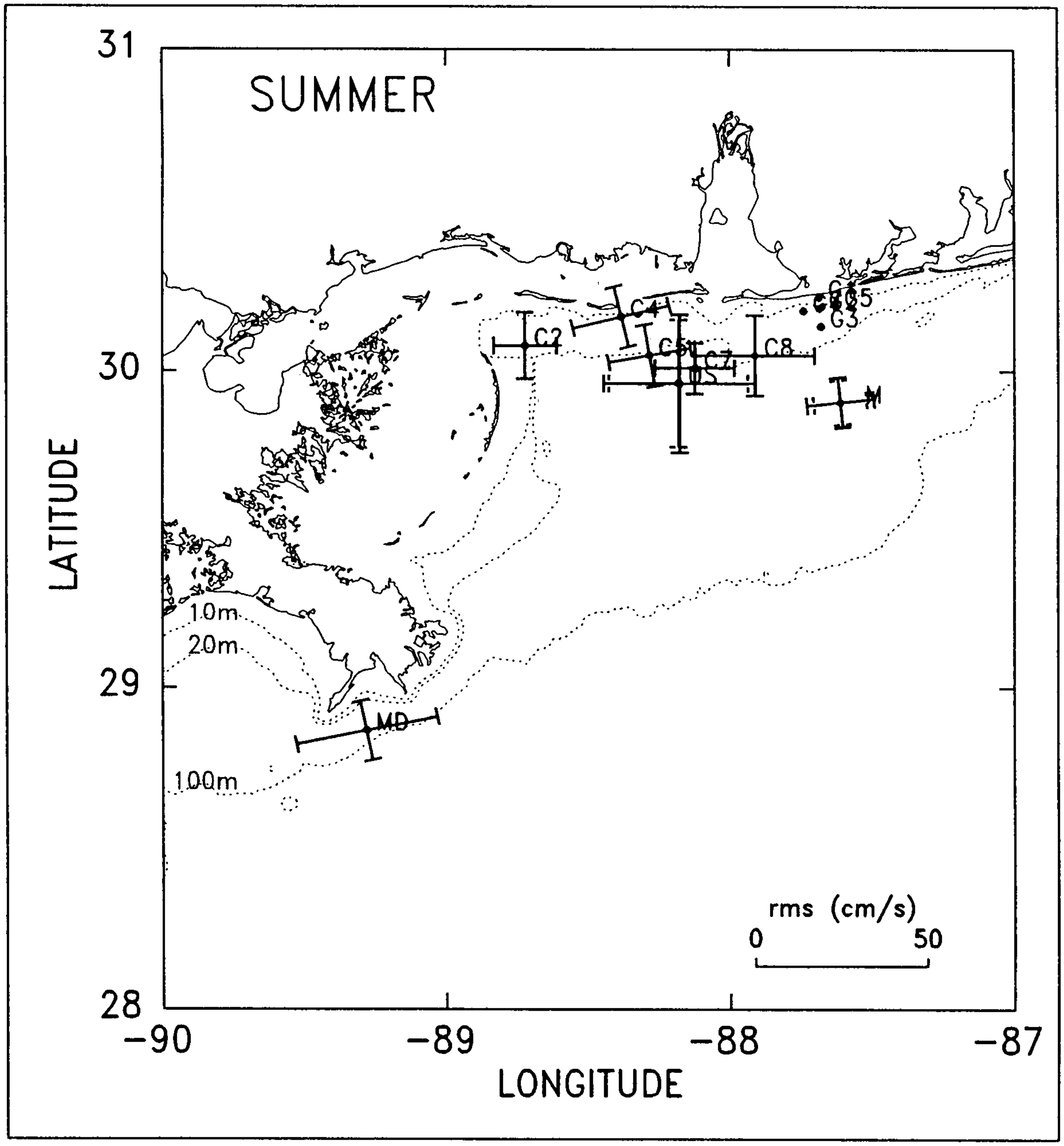


Figure 8a. Summer velocity variance axes for eastern region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

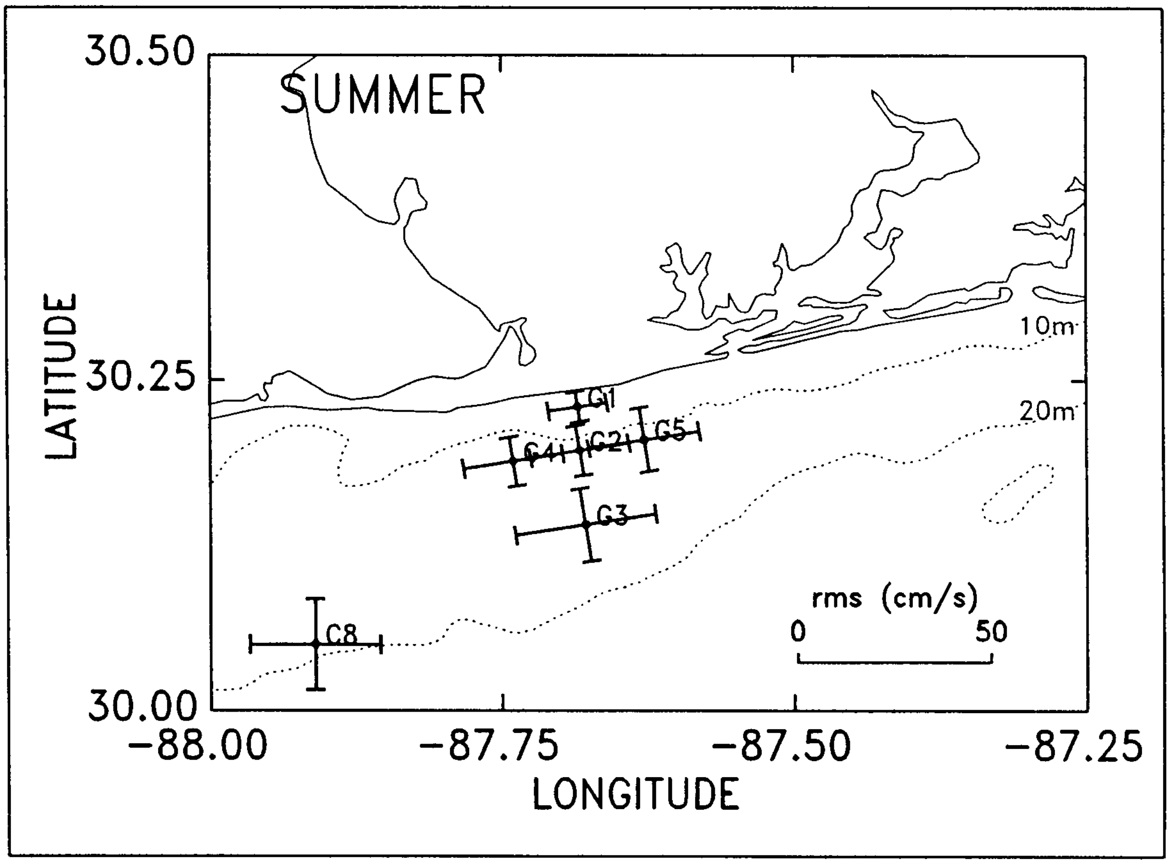


Figure 8b. Summer velocity variance axes for eastern region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore.

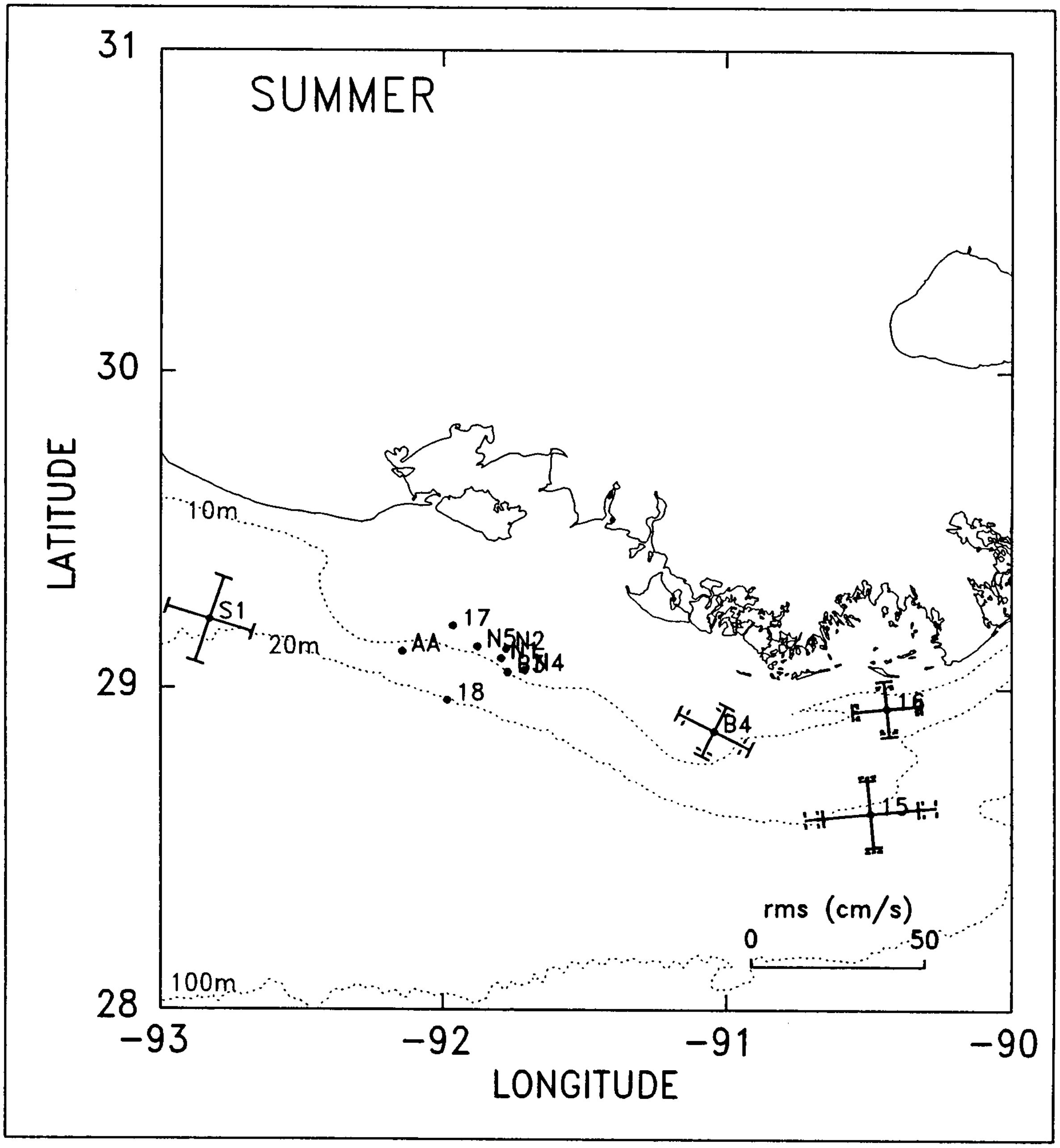


Figure 8c. Summer velocity variance axes for central region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

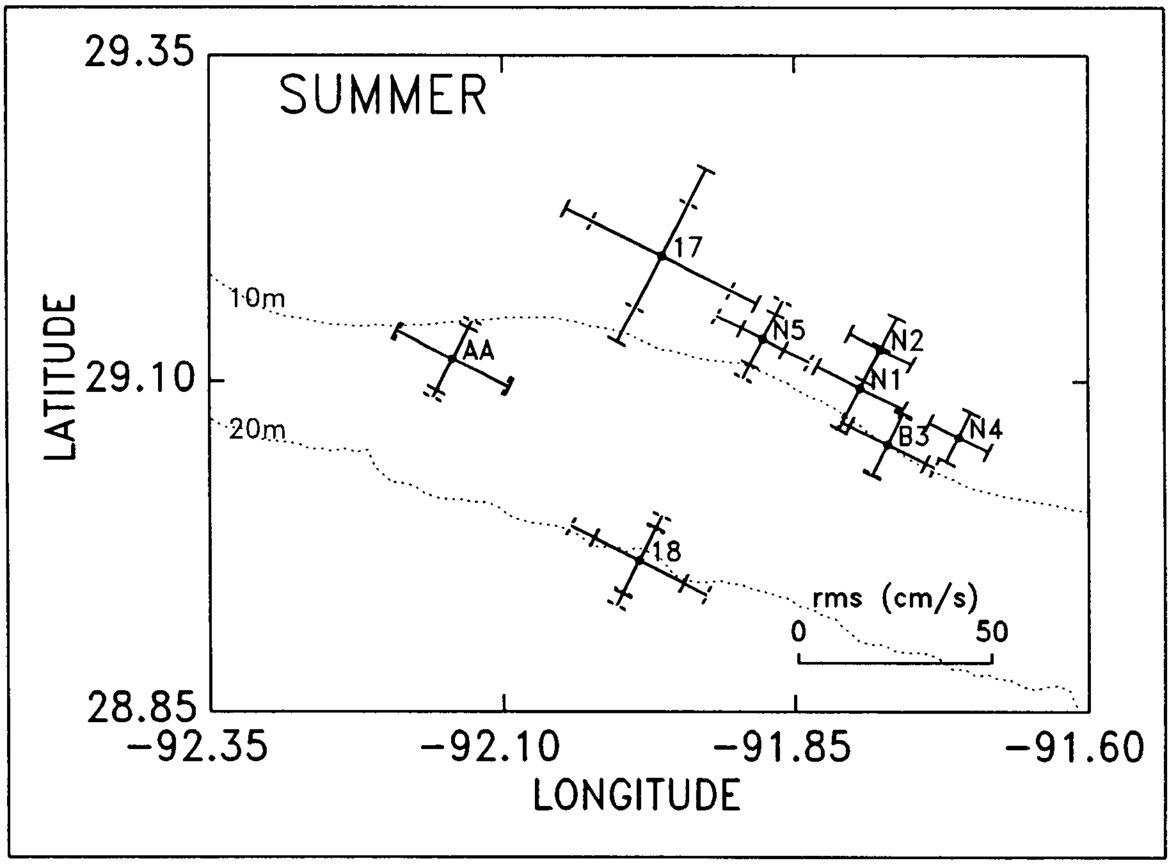


Figure 8d. Summer velocity variance axes for central region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

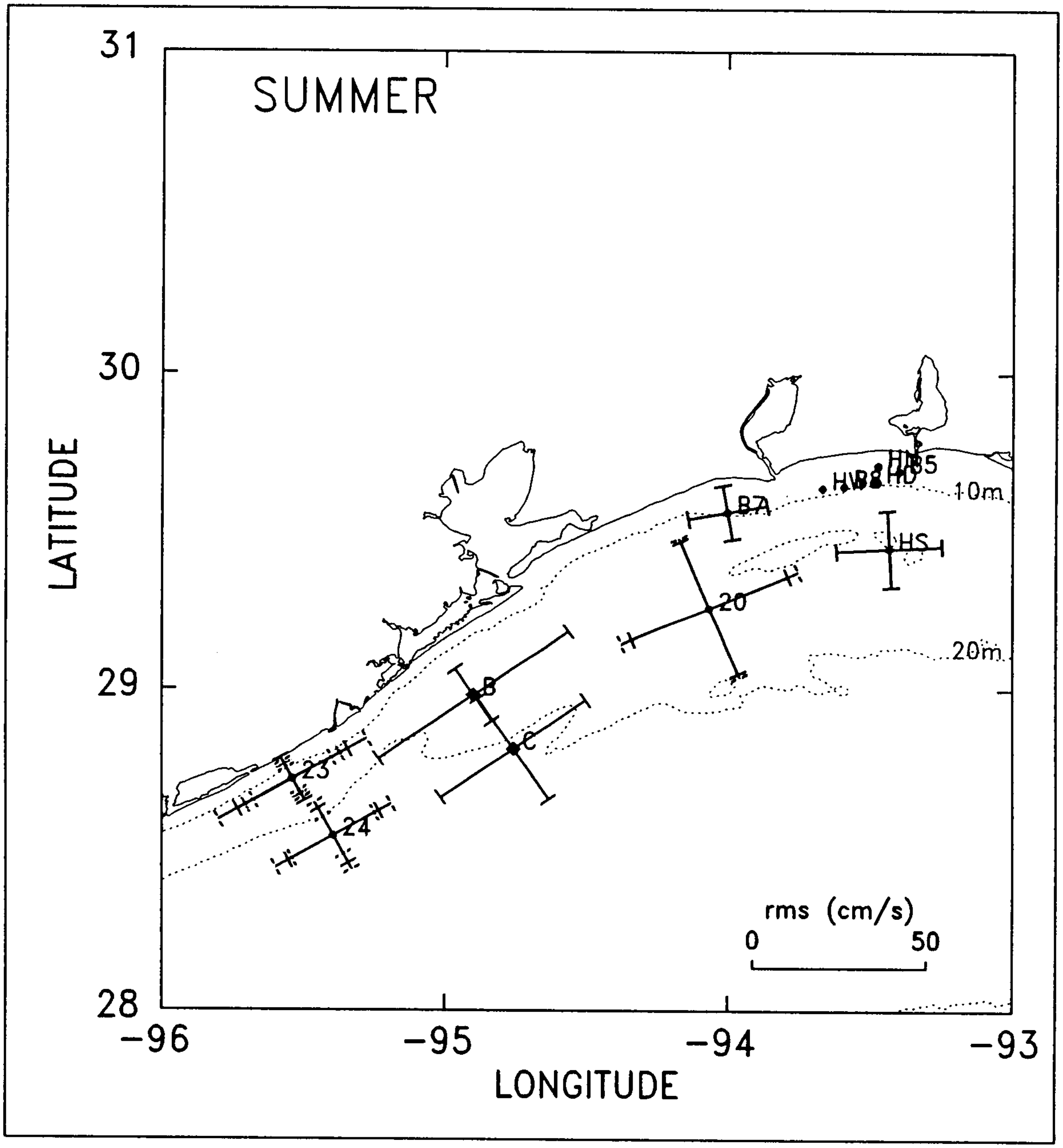


Figure 8e. Summer velocity variance axes for (north)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

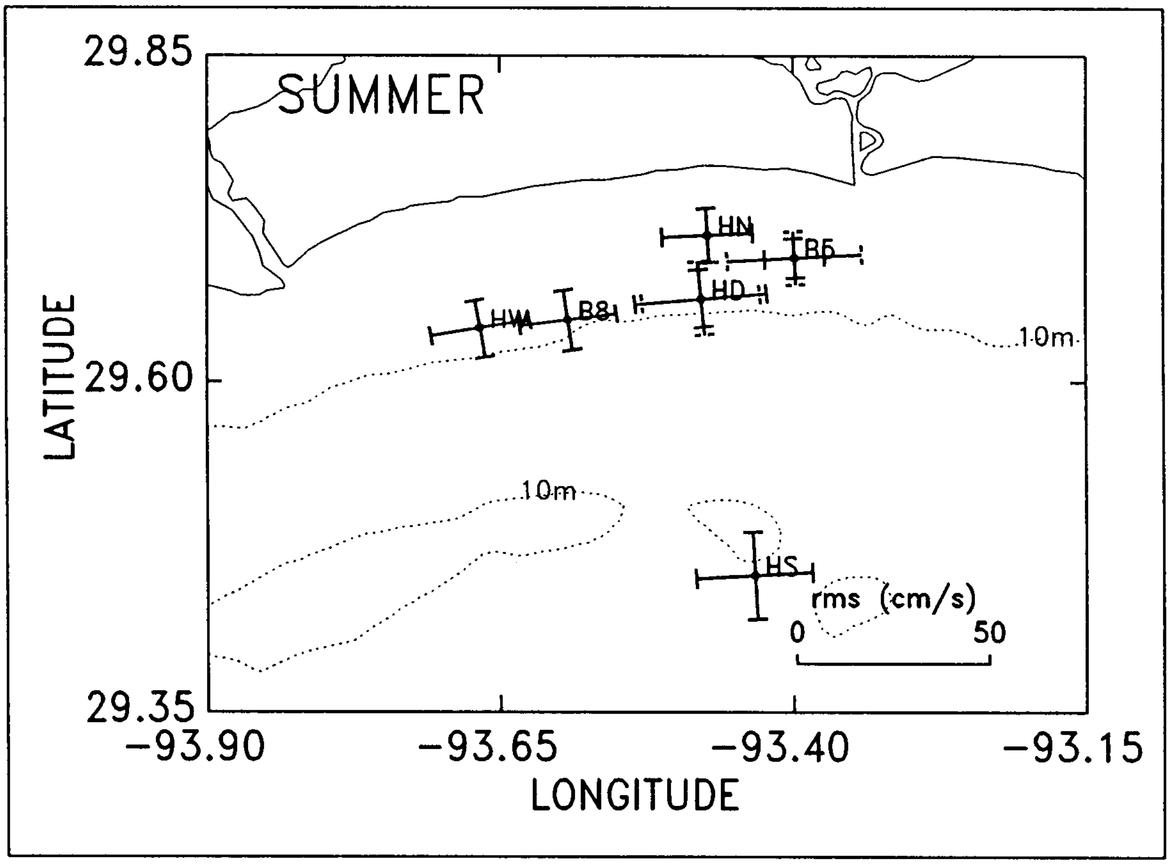


Figure 8f. Summer velocity variance axes for (north)western region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

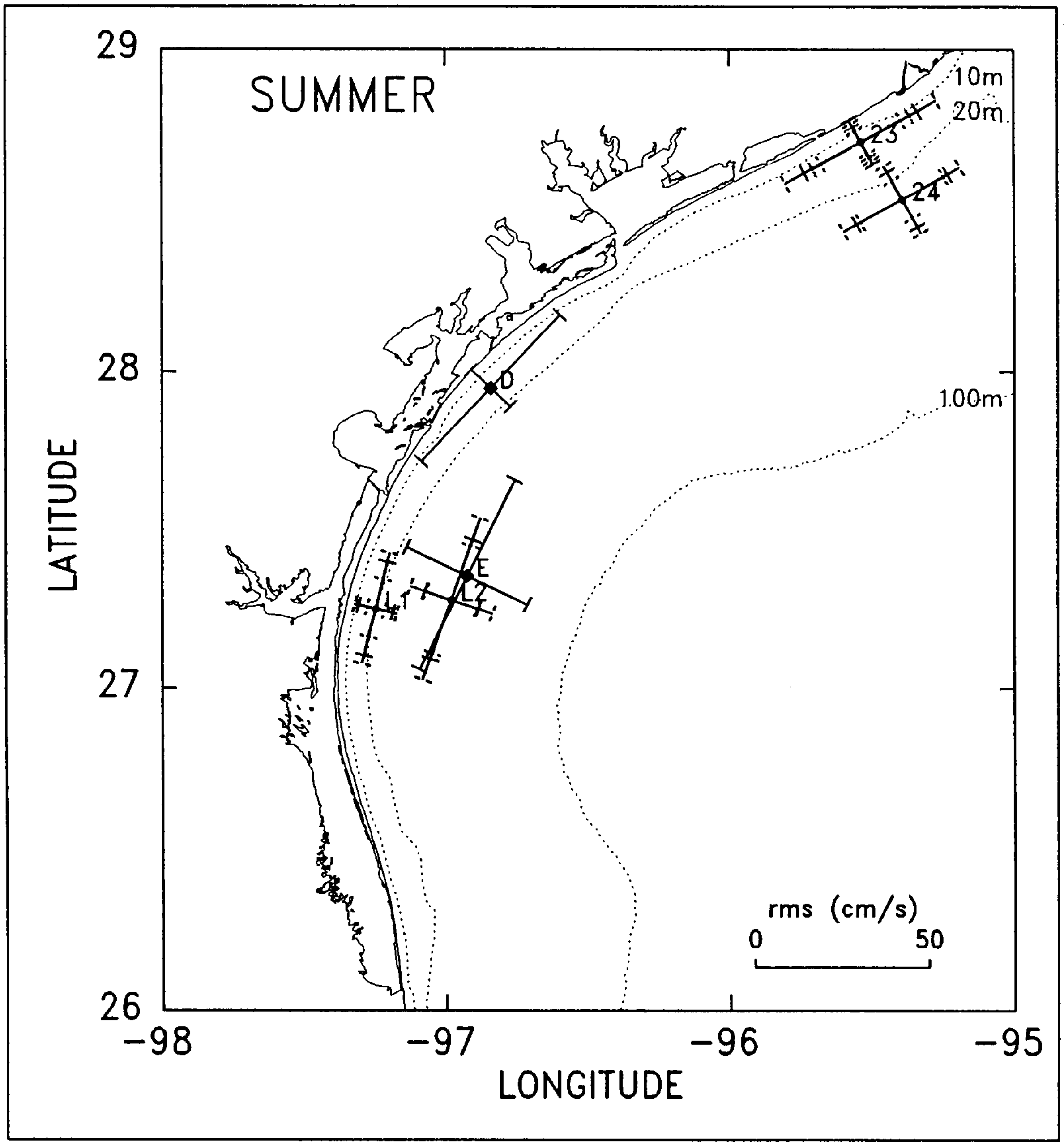


Figure 8g. Summer velocity variance axes for (south)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

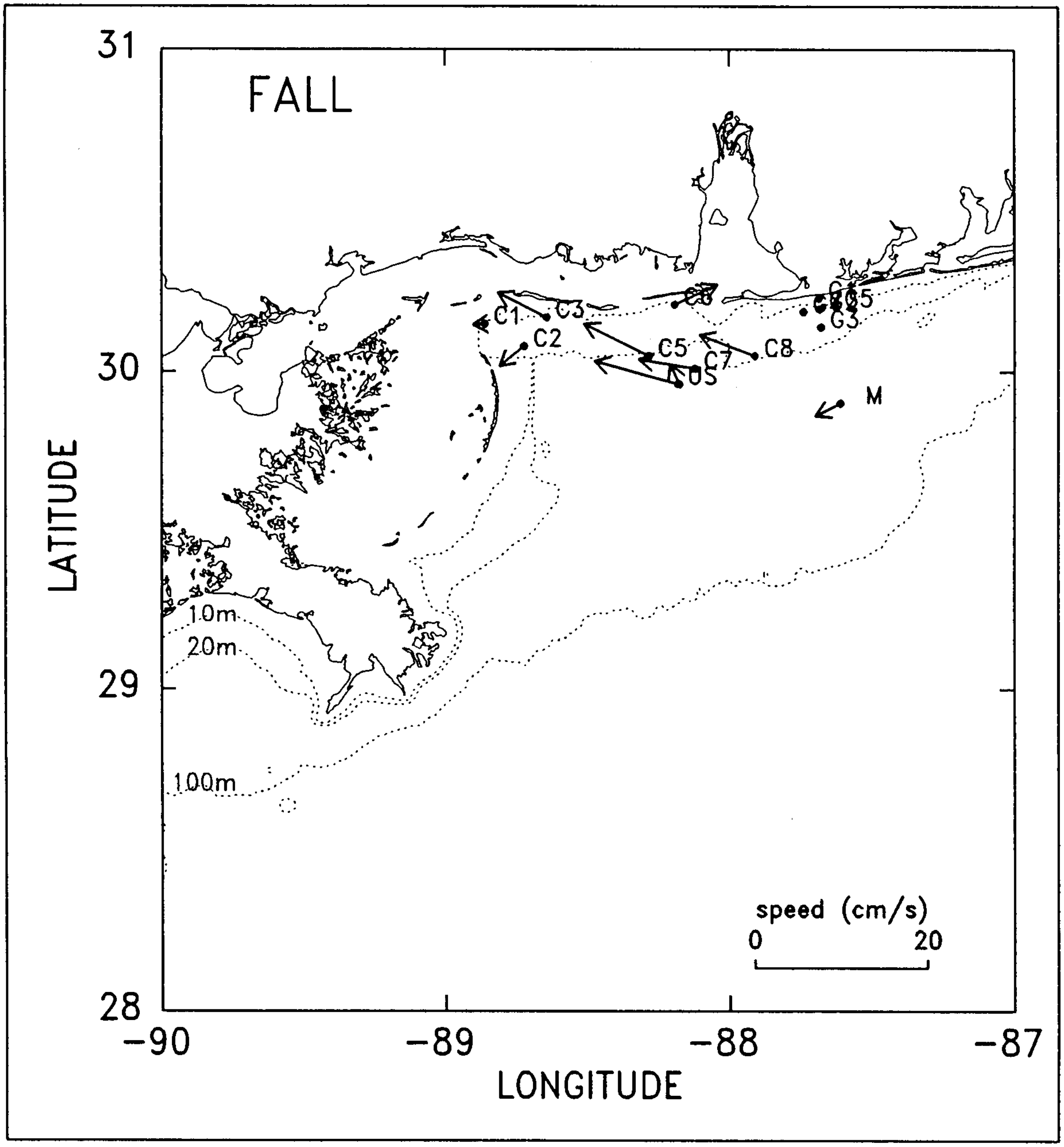


Figure 9a. Fall mean velocity vectors for eastern region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

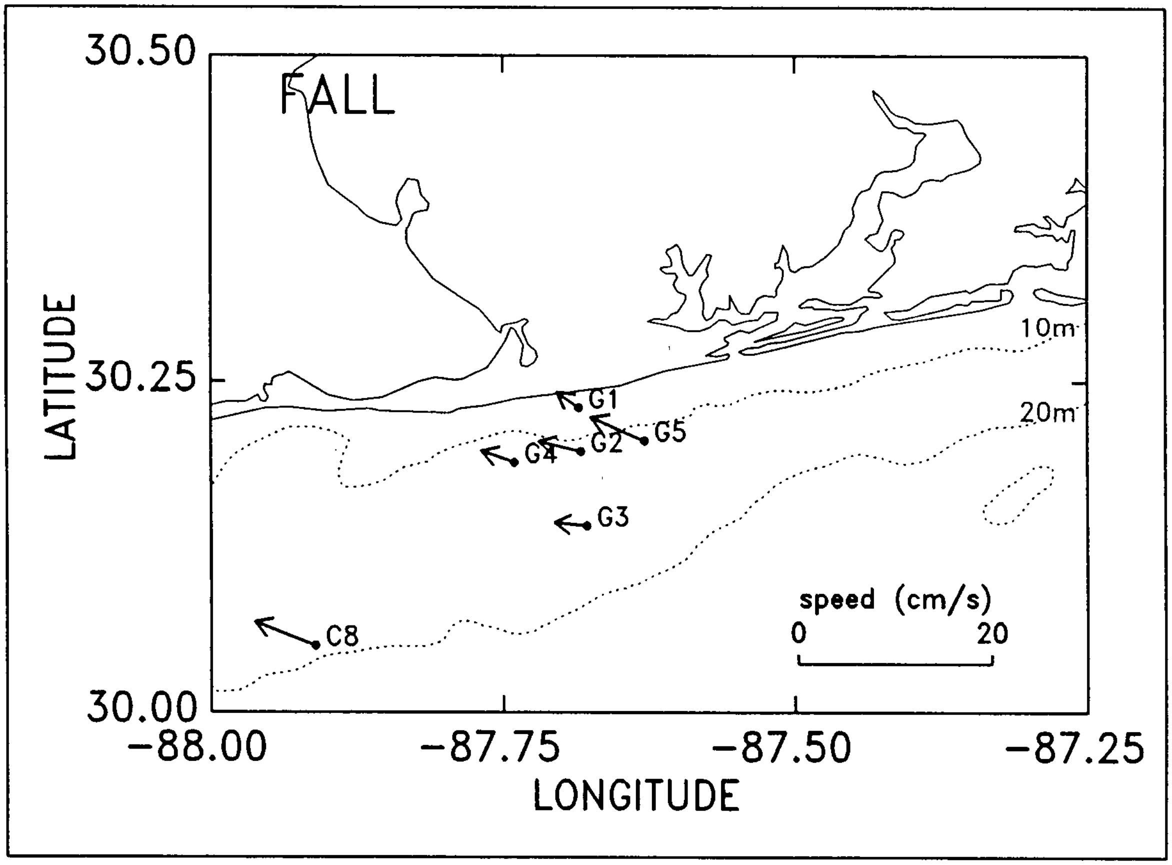


Figure 9b. Fall mean velocity vectors for eastern region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow.

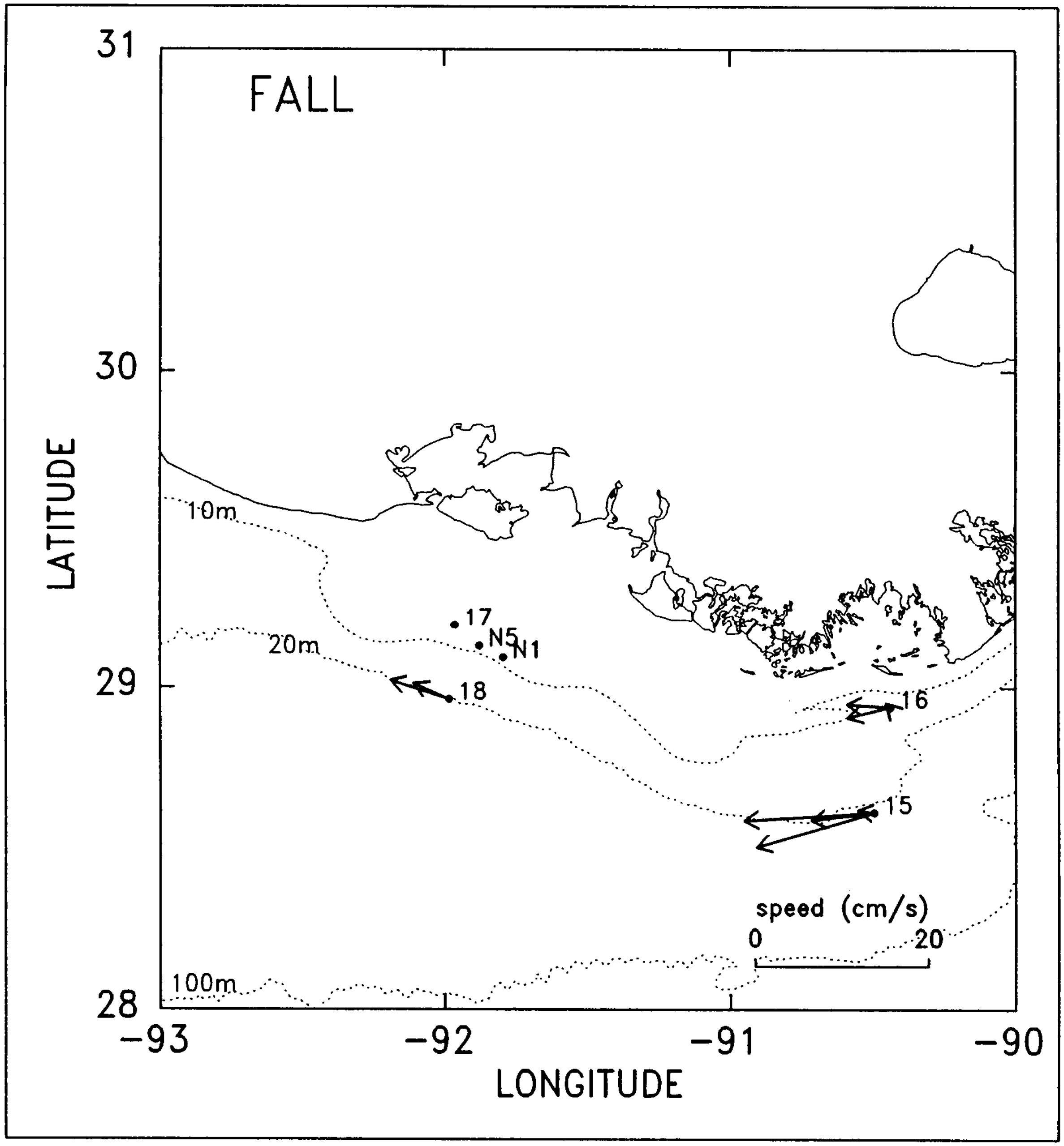


Figure 9c. Fall mean velocity vectors for central region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

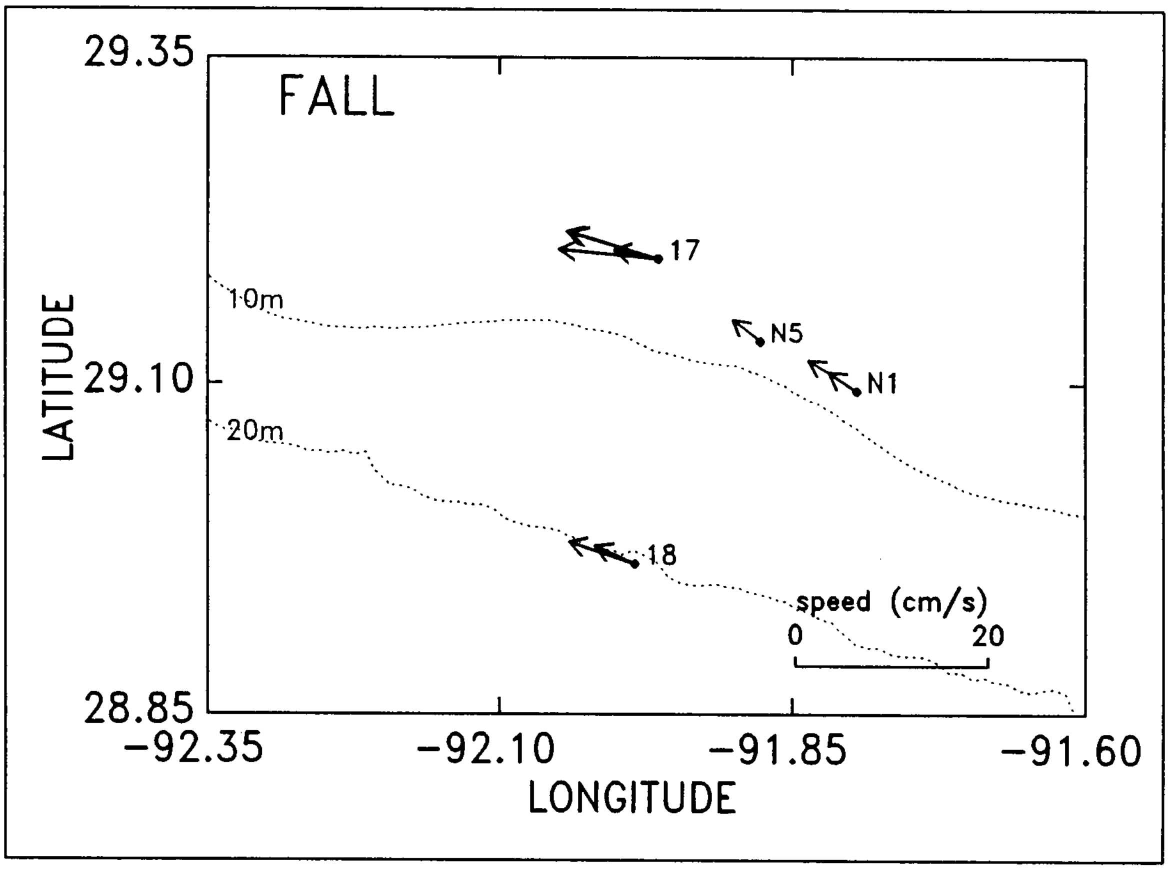


Figure 9d. Fall mean velocity vectors for central region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

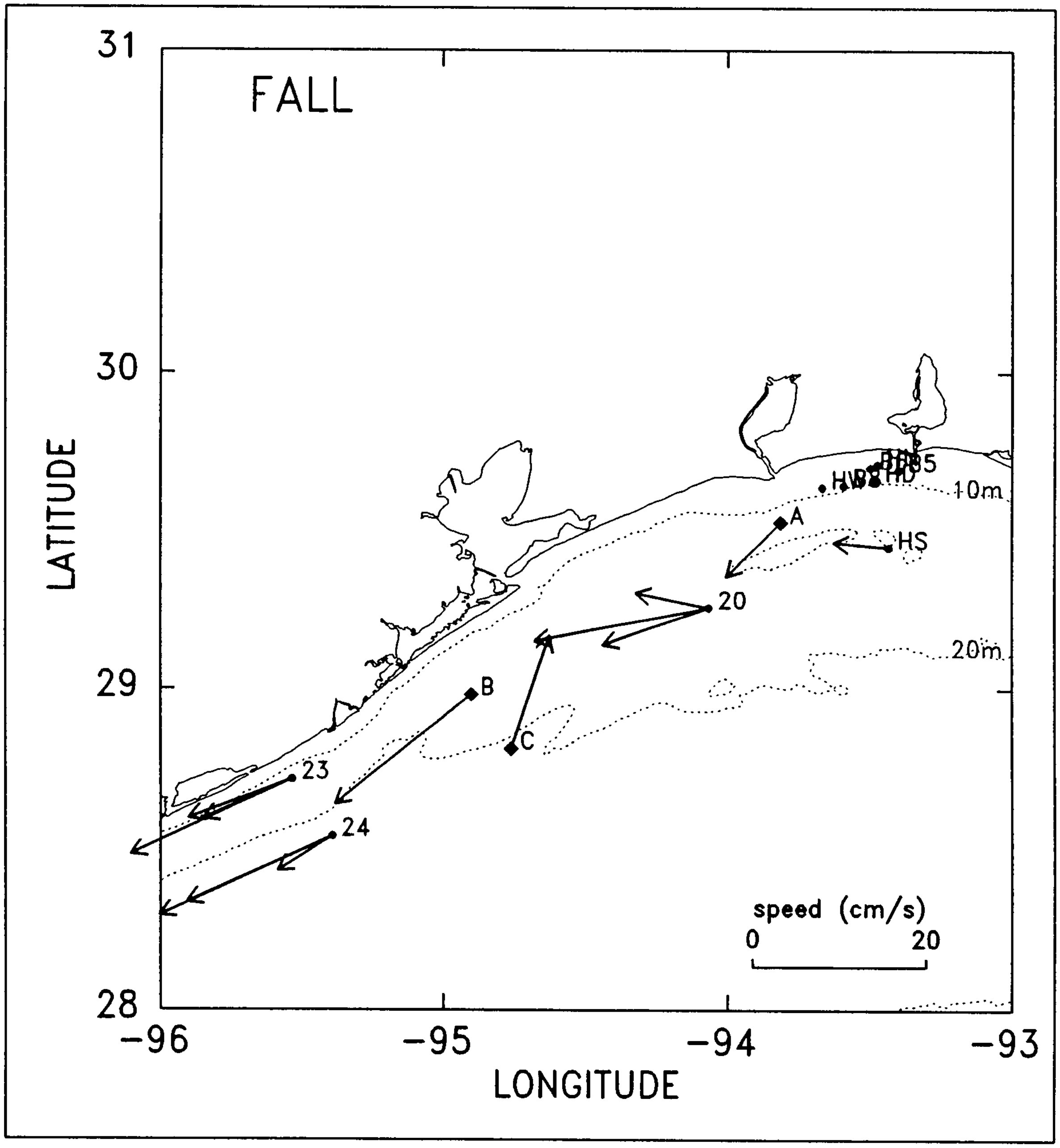


Figure 9e. Fall mean velocity vectors for (north)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

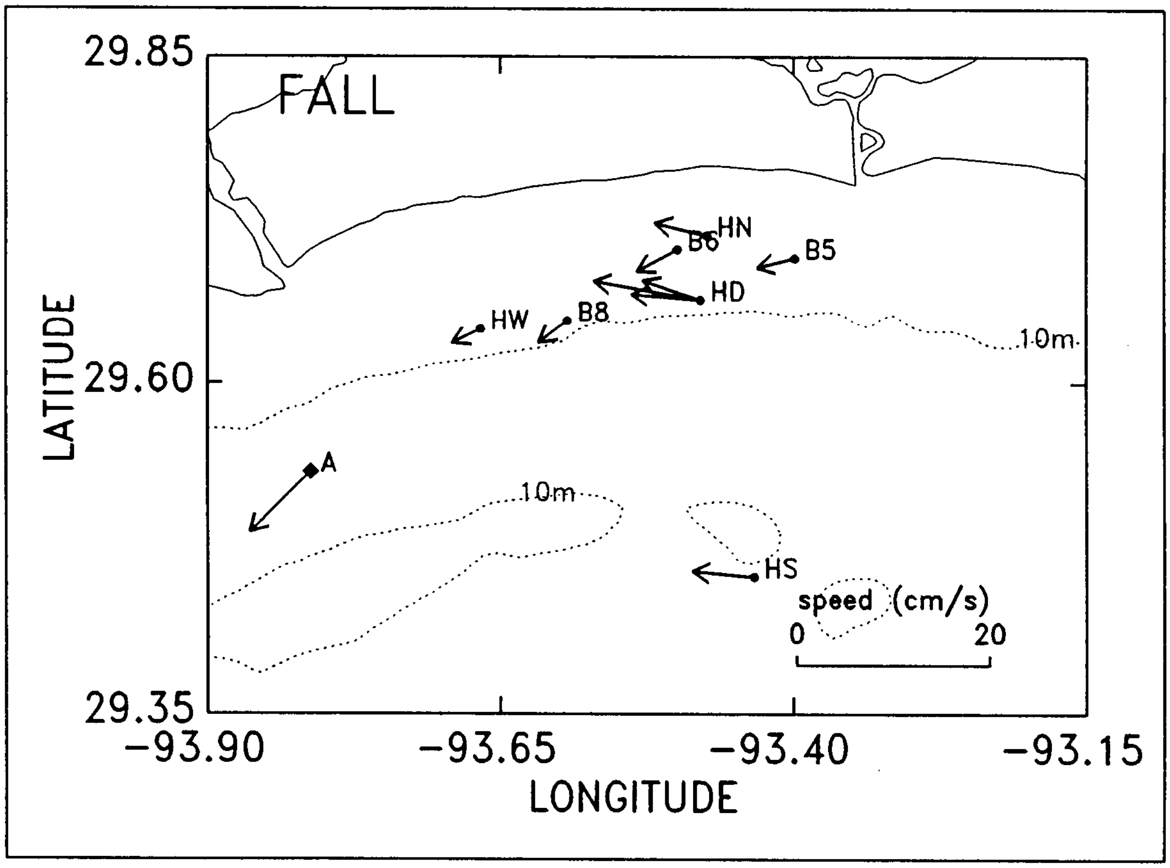


Figure 9f. Fall mean velocity vectors for (north)western region close packed stations. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

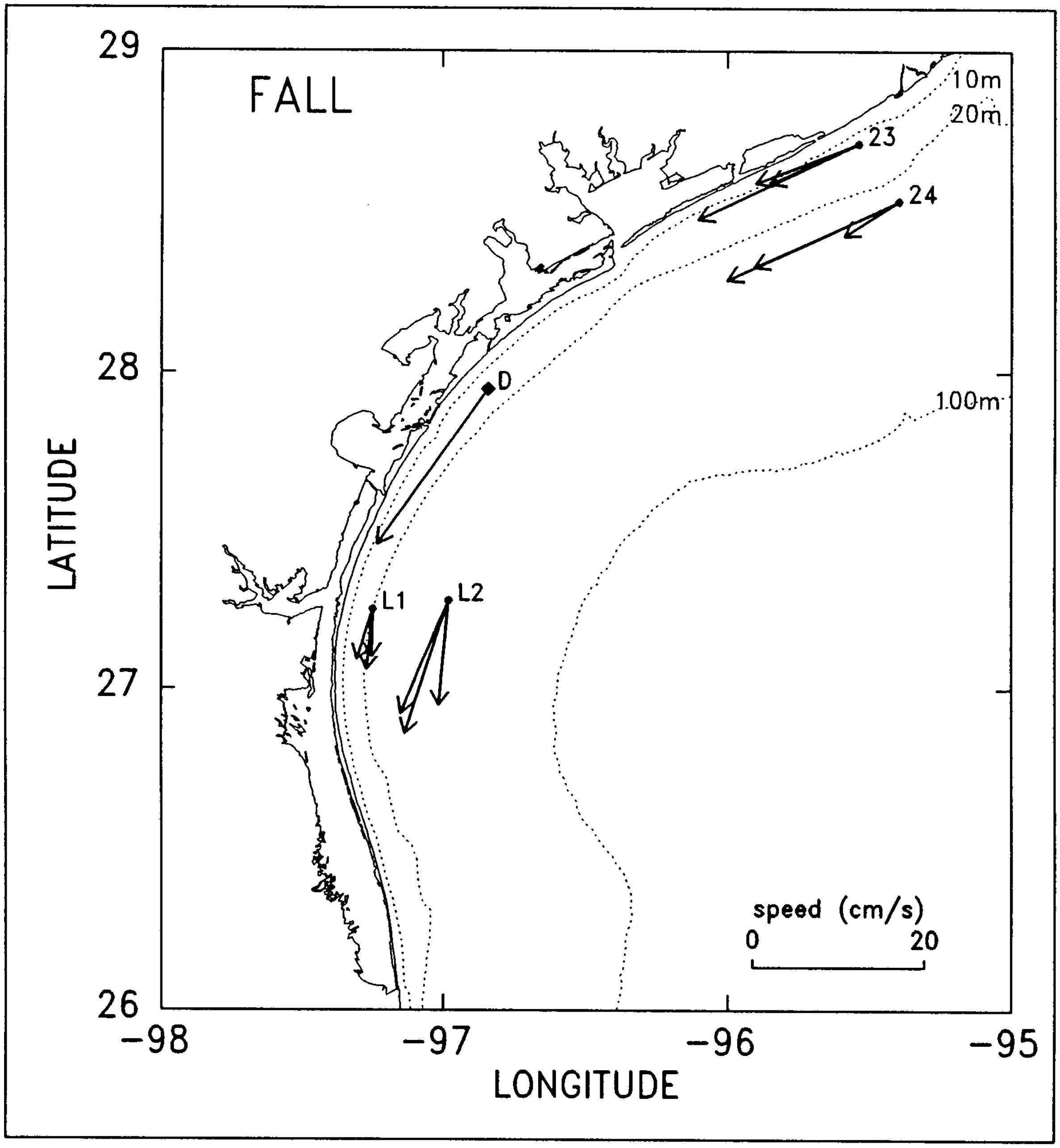


Figure 9g. Fall mean velocity vectors for (south)western region. Mooring locations are plotted as dots; the mean vectors are in direction of flow. Stations with multiple records have multiple vectors.

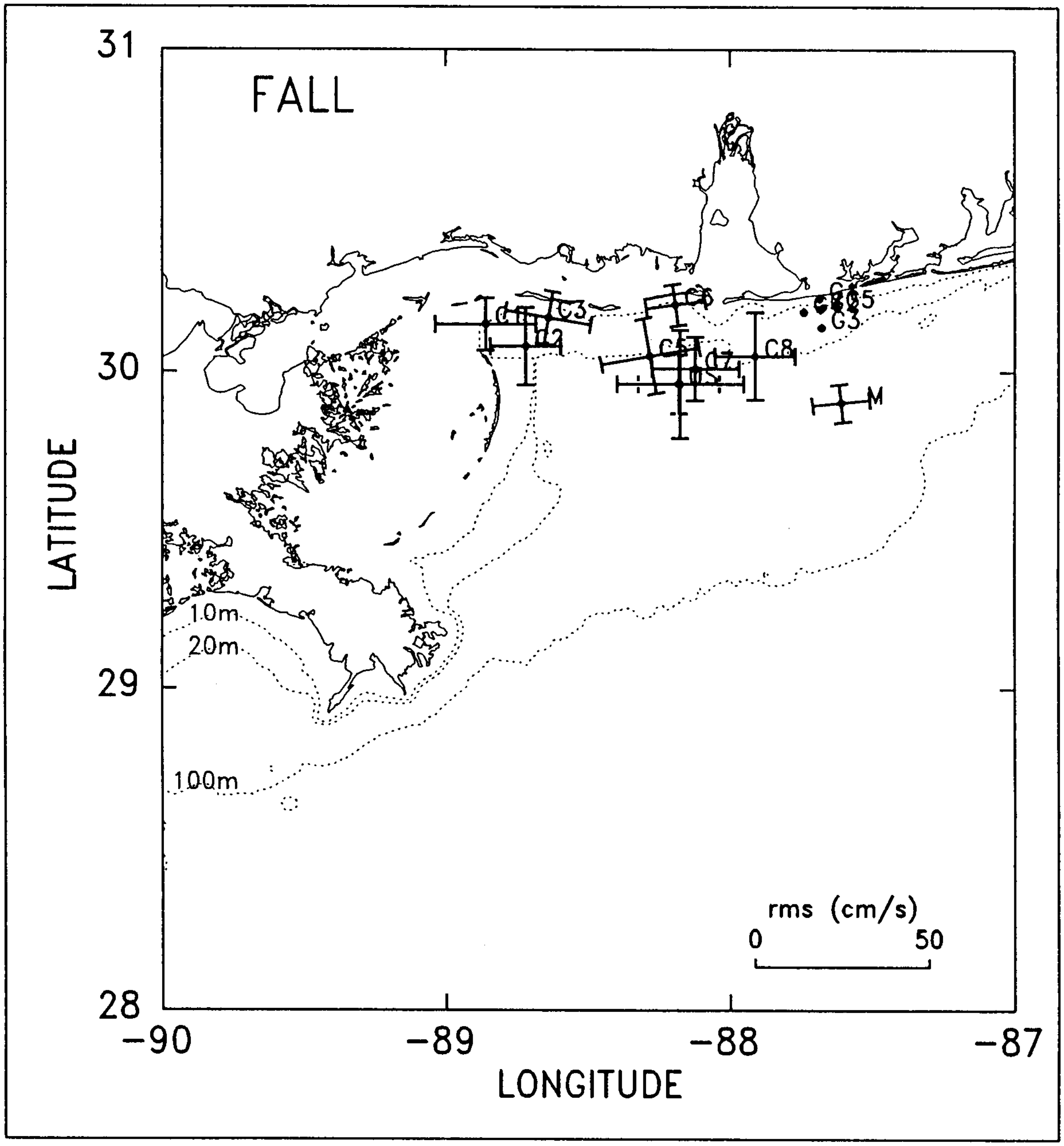


Figure 10a. Fall velocity variance axes for eastern region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

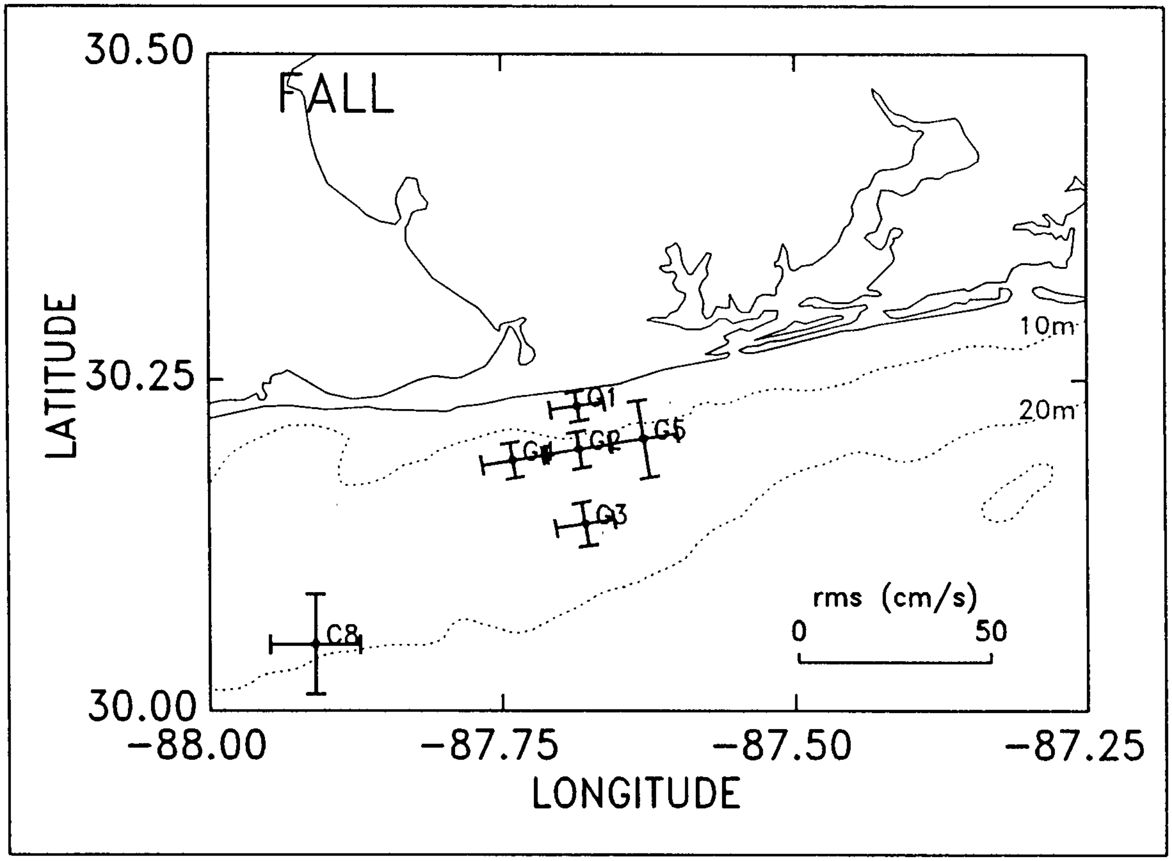


Figure 10b. Fall velocity variance axes for eastern region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore.

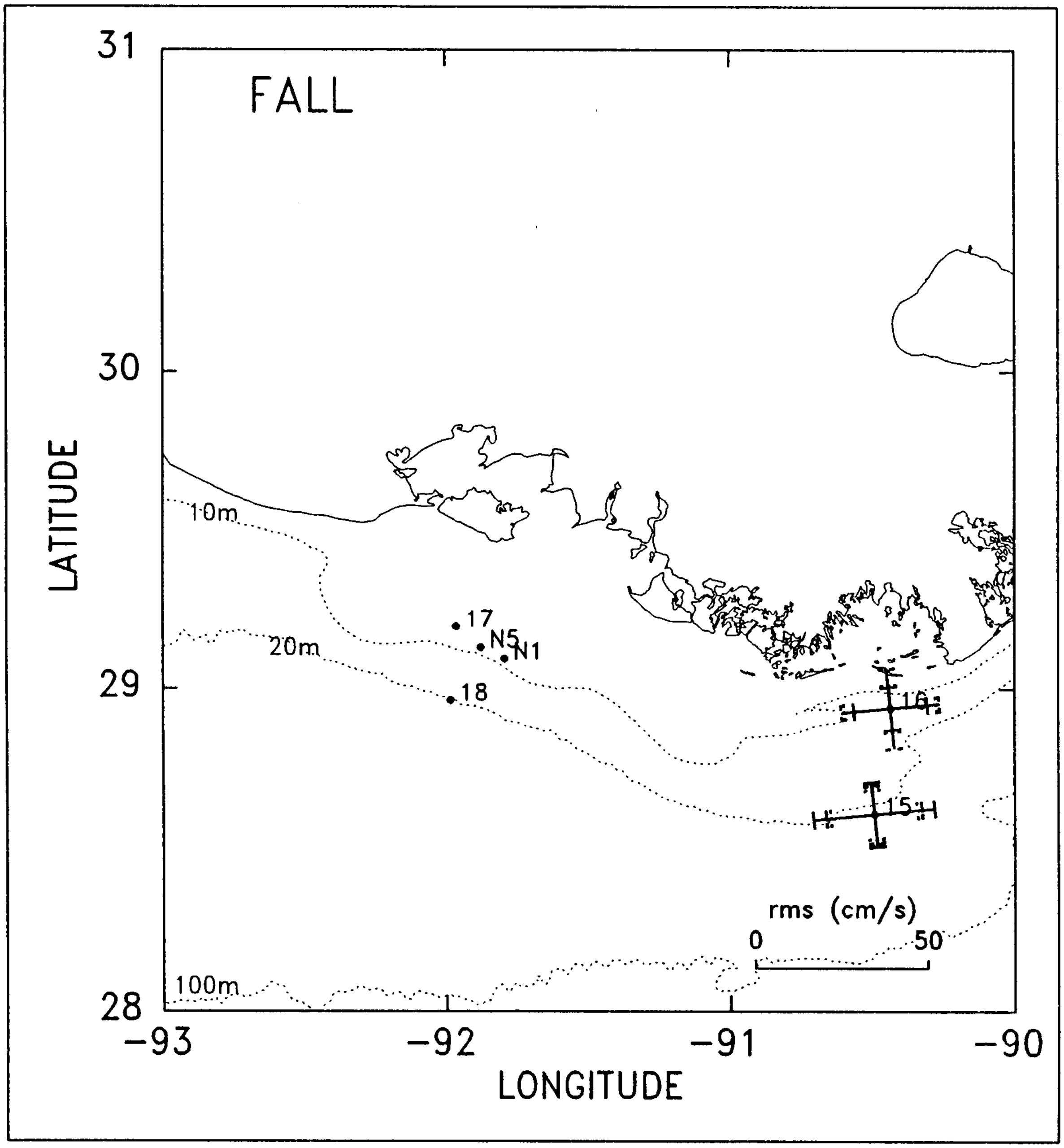


Figure 10c. Fall velocity variance axes for central region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

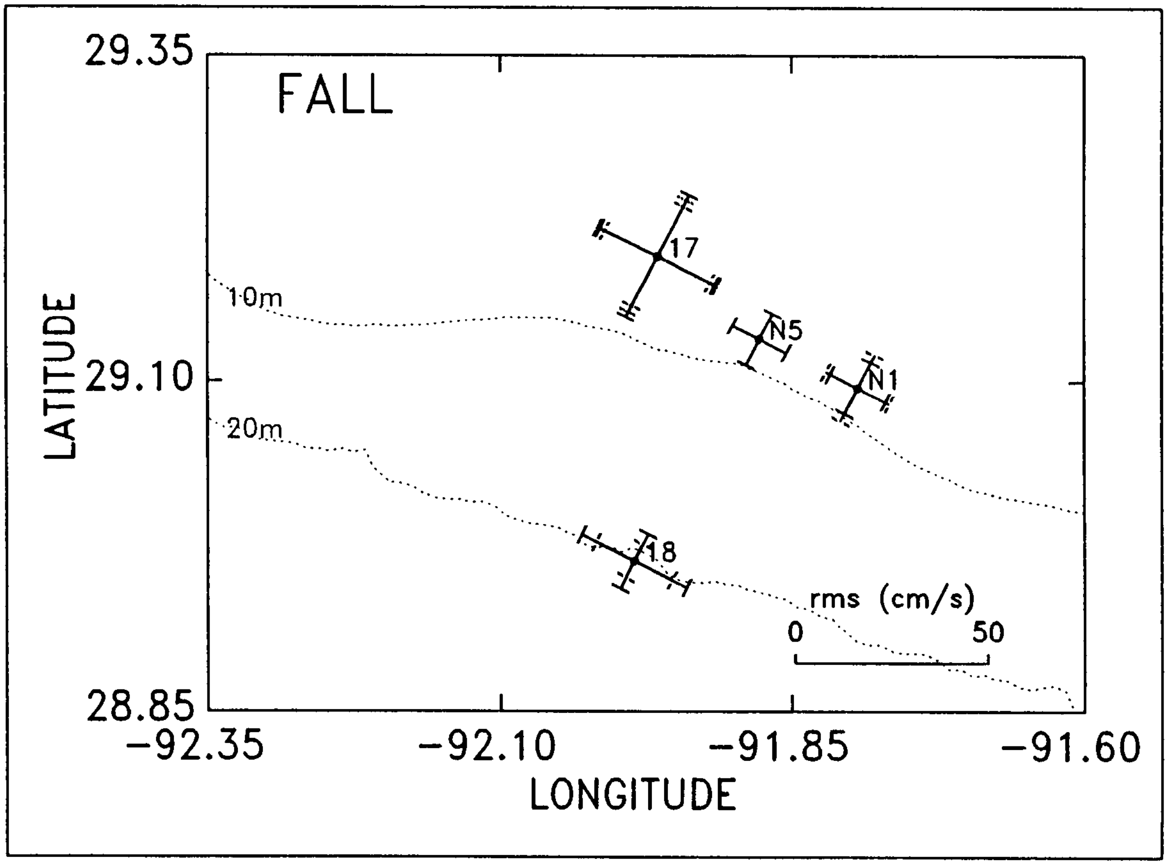


Figure 10d. Fall velocity variance axes for central region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

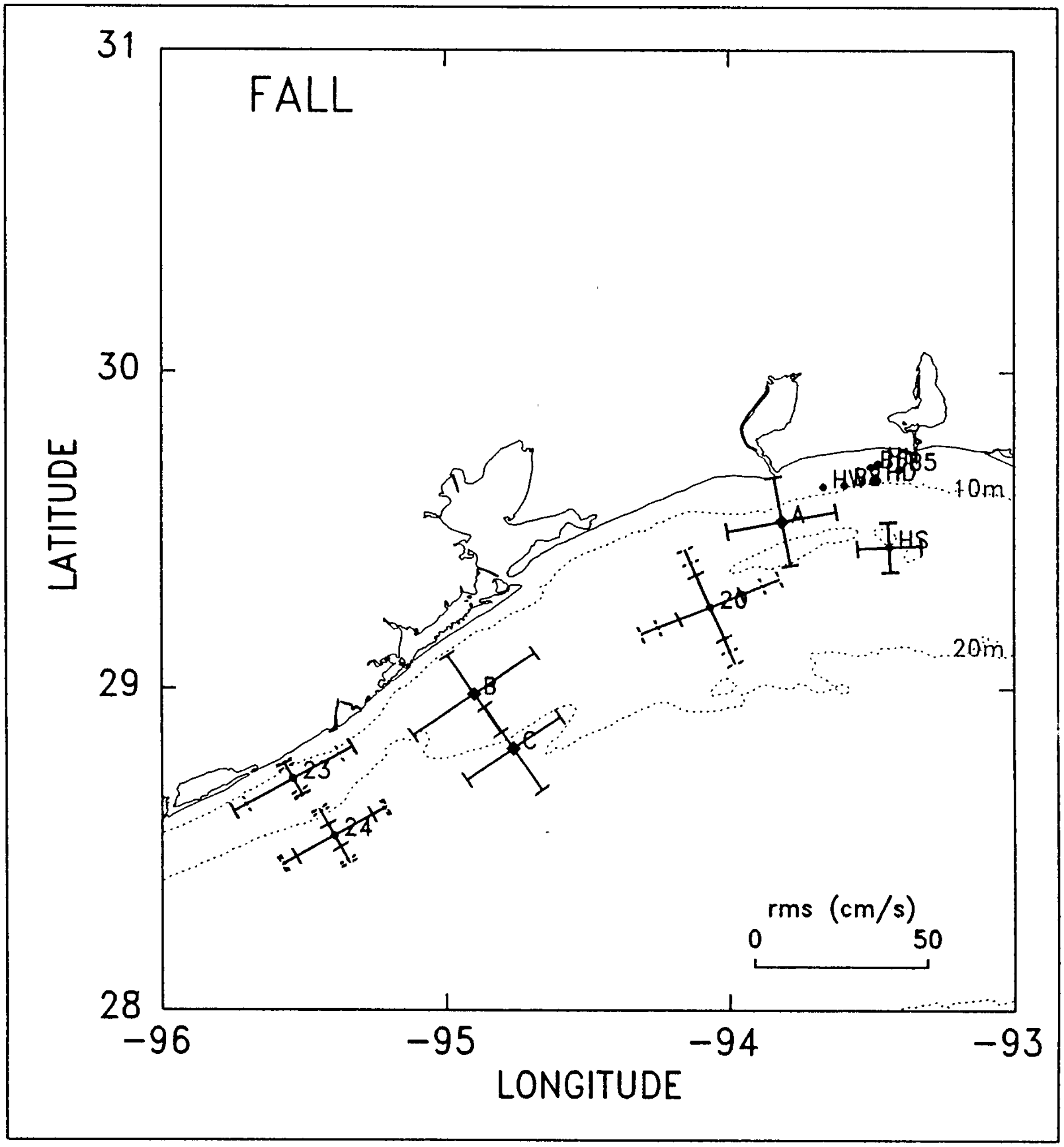


Figure 10e. Fall velocity variance axes for (north)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

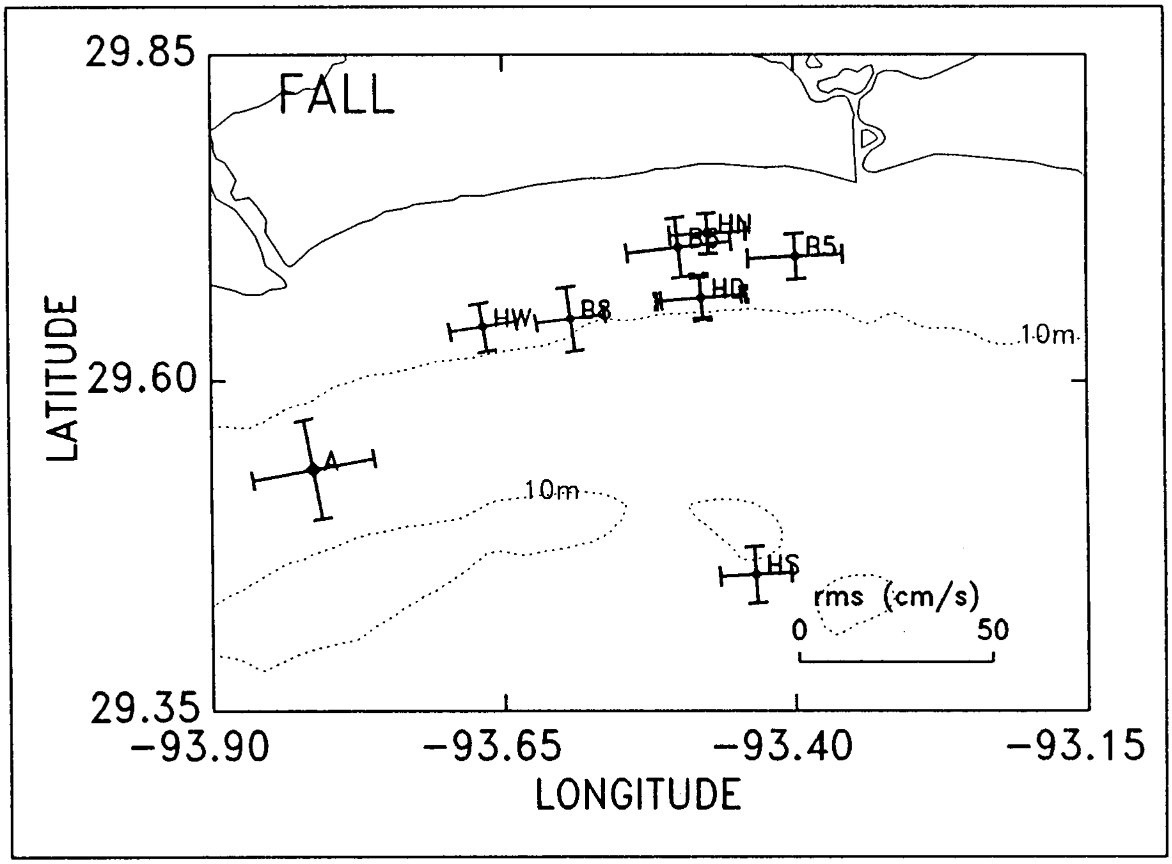


Figure 10f. Fall velocity variance axes for (north)western region close packed stations. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

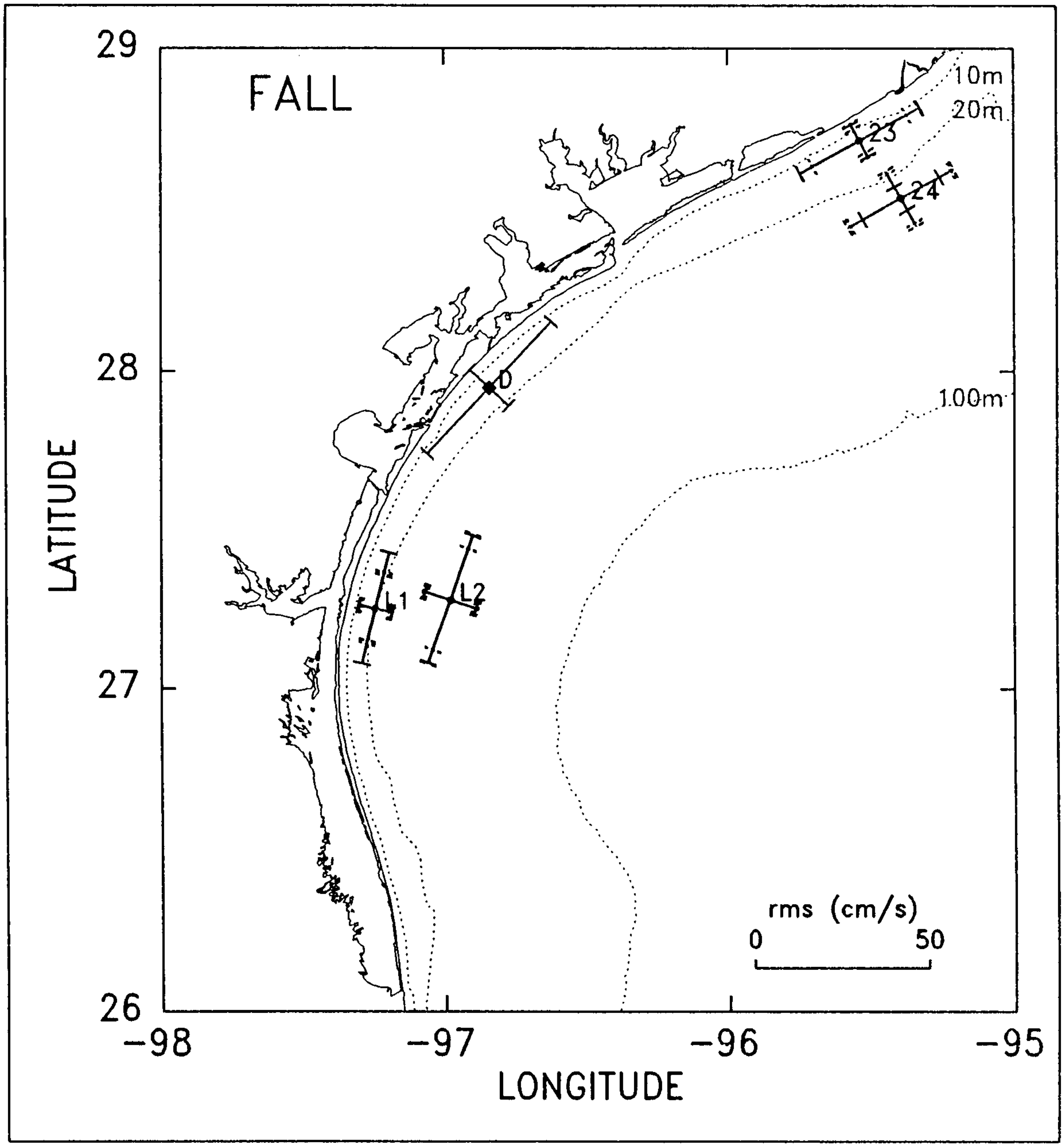


Figure 10g. Fall velocity variance axes for (south)western region. Mooring locations are plotted as dots; axes are plotted along- and cross-shore. Stations with multiple records have multiple endbar patterns.

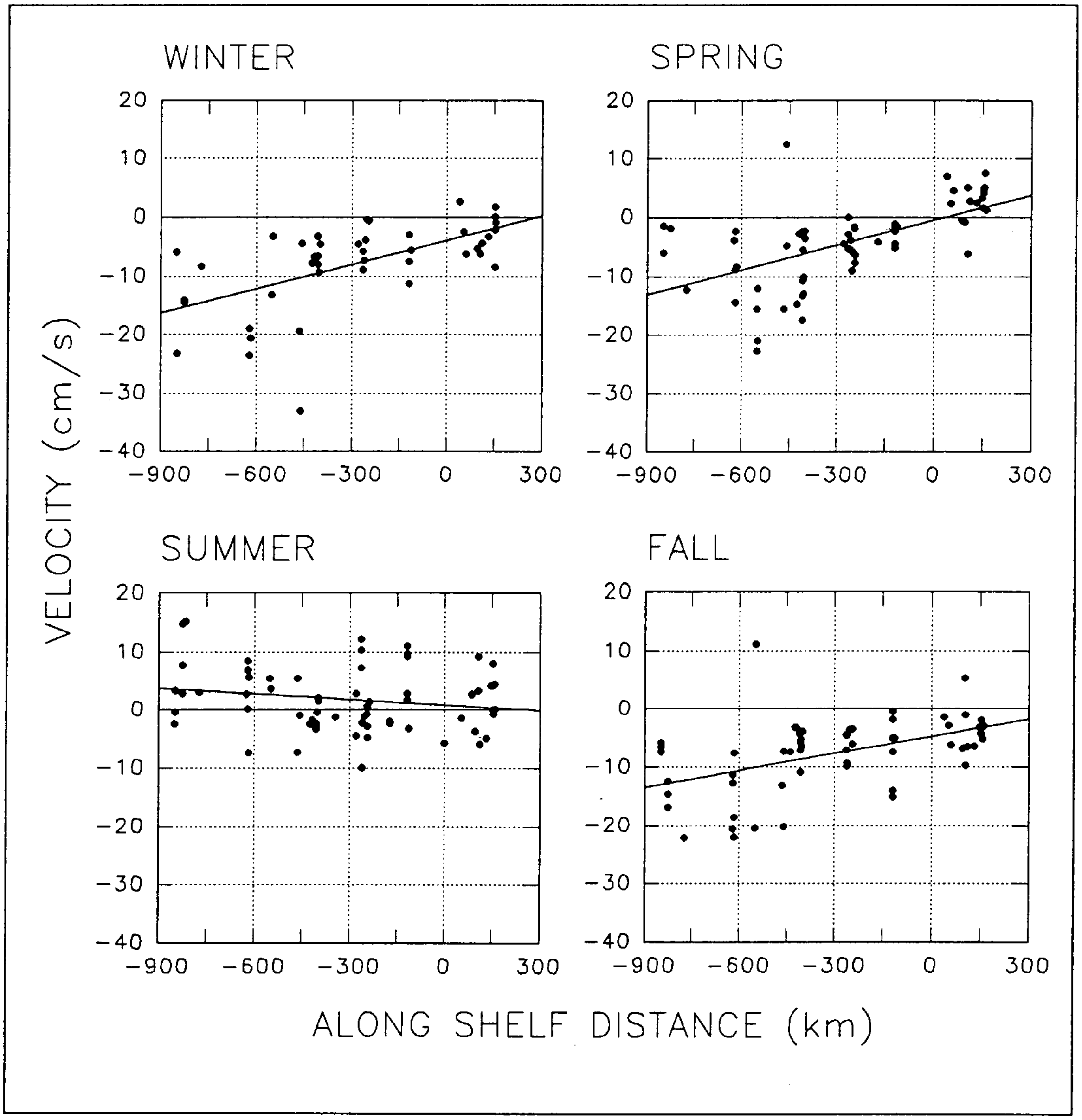


Figure 11. Seasonal alongshore mean velocity versus alongshelf distance. Positive alongshore velocity is eastward. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slopes for winter, spring, and fall were significantly different from zero at the 99% level (t=4.615, n=44; t=6.048, n=66; t=4.110, n=59, respectively), and the slope for summer was significantly different from zero at the 90% (t=-1.395, n=66).

89°W) where mean flow directions were likely influenced by the 90° bend of the innershelf bathymetry and the exchange with the backbarrier water bodies, and at the easternmost stations EPA GS G2 and G3 (Figure 3b) (near 30.2°N, 87.7°W) where large alongshore variance and short records combined to cancel out any substantial net alongshore flow. Exceptions to the general westward flow were also found at the central region stations N1 and N5 (Figure 3d) (near 29.1°N, 91.85°W).

Stations with contemporaneous nearby stations had record means that were usually consistent in direction and magnitude. Only in the eastern region at EPA GS stations (30.2°N 87.7°W) was there an apparent contradiction (Figure 3b), with the outer station, G3, exhibiting mean alongshore flow in opposition to stations closer to shore. This was probably associated with different record lengths.

Stations with multiple records were very consistent from year to year in mean direction and magnitude. The statistical significance of alongshore mean flows increased with alongshelf distance westward. Three of the 12 eastern records, 7 of 11 central records, and 19 of 21 western records had statistically significant mean westward flows (Table 2). Statistically significant alongshore mean flow magnitudes were 4-8 $cm \cdot s^{-1}$ in the eastern region, 4-11 $cm \cdot s^{-1}$ in the central region, and 4-33 $cm \cdot s^{-1}$ in the western region.

Cross-shore means flows had low magnitudes, -6 to +9 $cm \cdot s^{-1}$, with no systematic geographical trend (Figure 12). Only 5 of 12 eastern stations had statistically significant mean flows. No central region station had statistically significant mean flows, but 13 of 21 western stations did.

Record velocity maxima were determined for both positive and negative directions for each component (Table 2). Although not tested statistically, alongshore maxima were larger than cross-shore maxima, and the mean of the westward alongshore velocity maxima was larger than the mean of the eastward alongshore velocity maxima (Table 2). The westward alongshore velocity maxima increased with distance westward (statistically significant at the 99% level) (Figure 13); the eastward alongshore maximum velocity magnitudes showed no difference as a function of alongshelf distance. The cross-shore maximum velocities had the same mean magnitudes on- and off-shore. The on-shore maximum velocity magnitudes increased towards the east (significant at the 90% level), but the off-shore maxima exhibited no alongshelf trend.

All winter variance exhibited shore-parallel major axes (Figure 4), i.e. the alongshore variances were greater than the cross-shore variances, with the ratio of the alongshore to cross-shore variance increasing at the western stations. Alongshore variance was quite variable, with greater range in variation to the west. Cross-shore variances were geographically similar in magnitude, with only a few large values in the central and (north)western regions.

The percent of variance in the low-passed band was a measure of the relative importance of the tidal band variation to the subtidal variation. The alongshore variance was predominantly contained in the low-passed records, with a statistically significant increase (at the 99% level) from 60% in the east to 90% in the west (Figure 14). Low percentages, < 50%, were limited to two stations in the east, COE MS C1 and C2, where flows were highly influenced by backbarrier exchanges. Cross-shore variance was, approximately evenly split between the subtidal and the higher-frequency bands, although the scatter was large (Table 3).

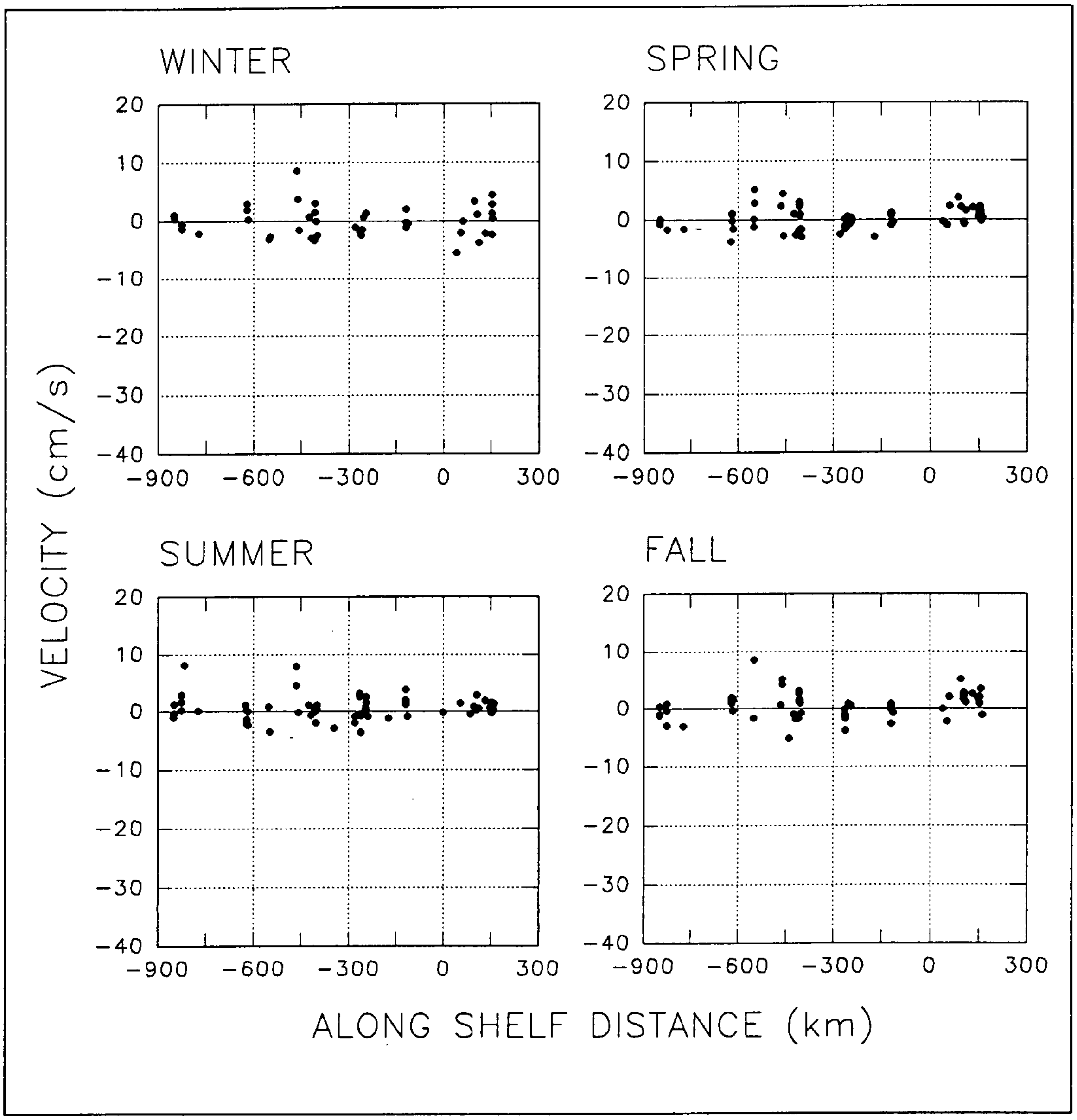


Figure 12. Seasonal cross-shore mean velocity versus alongshelf distance. Positive cross-shore velocity is onshore. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes (not shown) were tested as different from zero with a student-t test. The slopes for spring and fall were significantly different from zero at the 80% level (t=1.62, n=66; t=1.455, n=59, respectively), and the slopes for winter and summer were below the 80% significance level and considered not different from zero (t=-0.185, n=44; t=0.155, n=66, respectively).

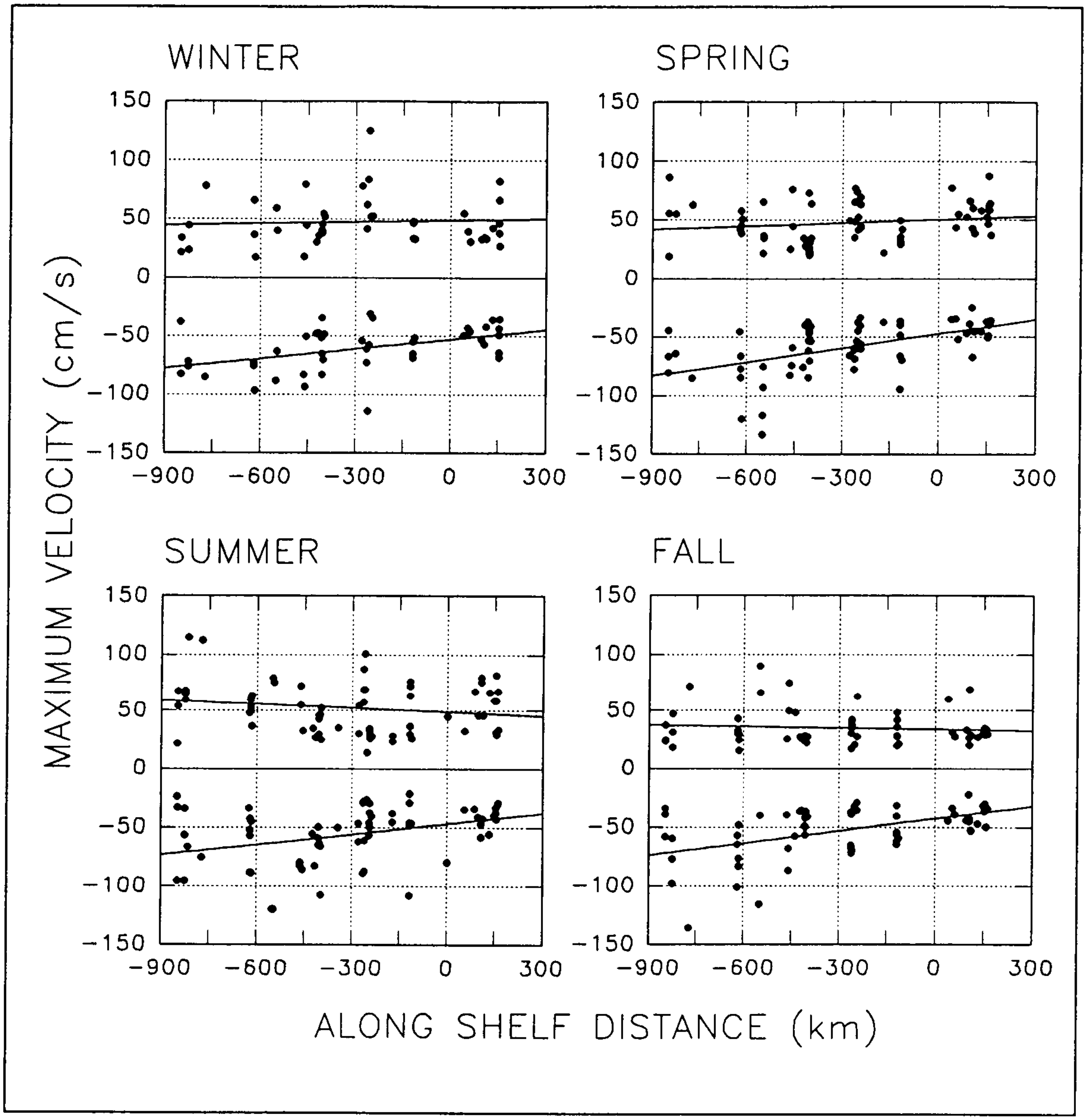


Figure 13. Seasonal alongshore maximum velocity versus alongshelf distance. Positive alongshore velocity is eastward. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slopes for westward maximum velocity were significantly different from zero at the 99% level for all seasons (t=3.248, n=44; t=5.113, n=66; t=3.180, n=66; t=4.254, n=59, respectively). The slope for spring eastward maximum velocity was significantly different from zero at the 80% level (t=1.378, n=66); no other season had a significant relationship between eastward maximum velocity and alongshelf distance.

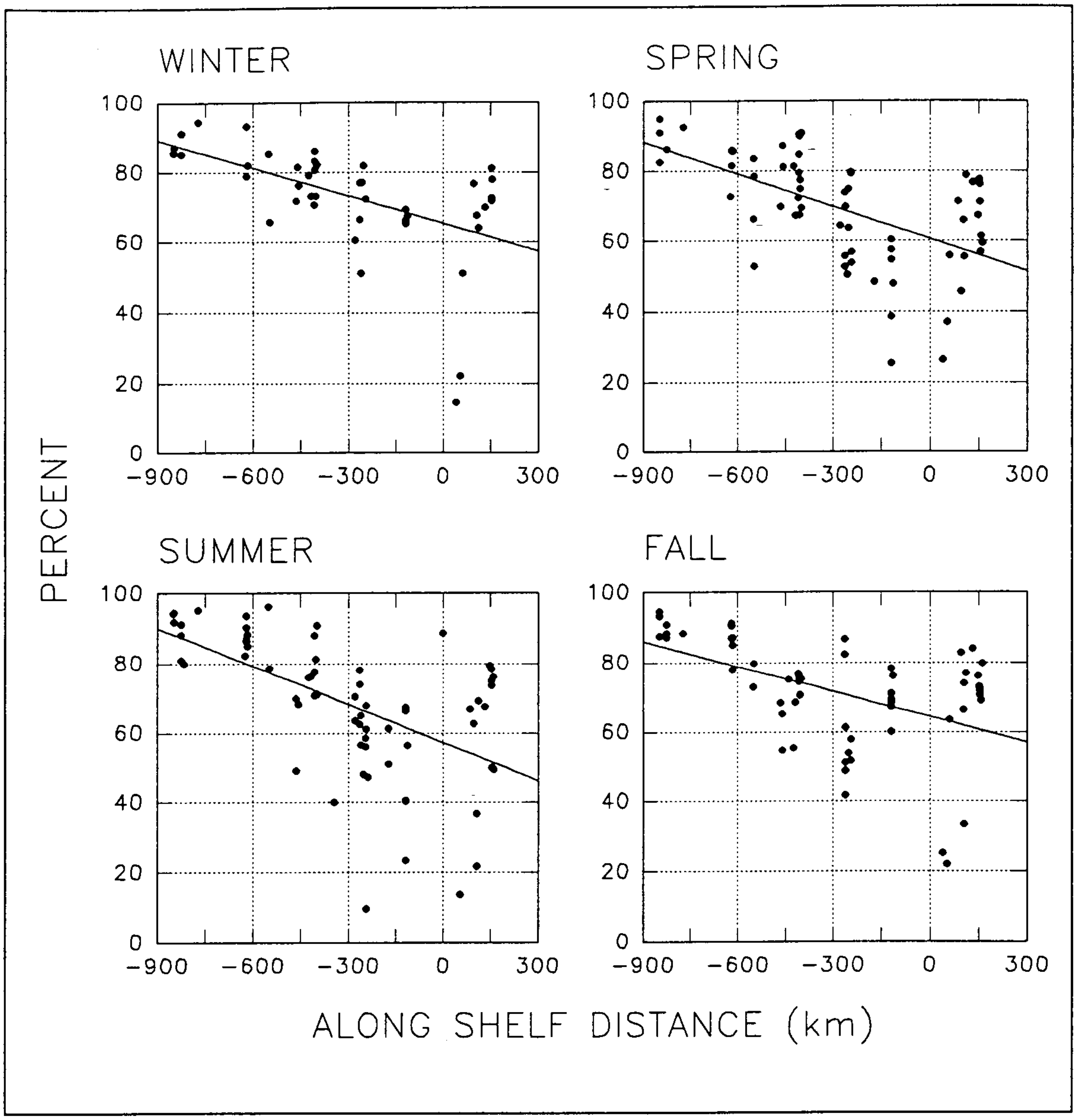


Figure 14. Percent low-pass alongshore seasonal variance versus alongshelf distance. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slopes for all seasons were significantly different from zero at the 99% level (t=-4.114, n=44; t=-5.638, n=66; t=-5.365, n=66; t=-4.032, n=59, respectively).

Along-shore winter auto-correlation time scales were between 20 and 70 hours (Table 3), with a marginally statistically significant increase (at the 90% level) towards the west. These time scales, estimates of the length of time velocity component records were correlated with themselves, were determined from the low-passed records. Cross-shore auto-correlation time scales were predominantly between 18 and 40 hours (Table 3), but with a statistically significant increase (at the 90% level) towards the east.

In general there was very good agreement in mean alongshore flow magnitudes and directions, in variance magnitudes and orientations, and the along-shore percentage of low-passed variation at stations with multiple winter records, although along-shore auto-correlation time scales varied inter-annually by a factor of 2.

### 3.1.2 Spring

Spring mean flows were predominantly eastward in the eastern region, and westward in the central and western regions (Figure 5). There was an increase in westward flow with along shelf distance to the west that was statistically significant at the 99% level (Figure 11). Exceptions to the eastward mean flow at the eastern stations were COE MS C4 (30.17°N 88.38°W), likely influenced by the local tidal pass, COE MS C5 (30.05°N 88.28°W) and USGS US. In the central region the stronger mean flows clustered near the 10 m isobath; those few records near the 20 m isobath had weaker mean flows. There was only one non-westward mean flow in the western records, MMS LTX 20 (29.5°N 94°W).

Stations with multiple spring records were fairly consistent in direction between years and poorly consistent in magnitude.

Four of 16 eastern mean flows (all to the east), 6 of 19 central mean flows (all to the west), and 20 of 31 western mean flows (all to the west) were statistically significant at the 95% level (Table 2). Statistically significant eastern station flow magnitudes were 5-8 $cm \cdot s^{-1}$, 4-9 $cm \cdot s^{-1}$ at the central stations, and 2-23 $cm \cdot s^{-1}$ at the western stations.

Cross-shore mean flows were of low magnitude, -3 to +5 $cm \cdot s^{-1}$, with no linear trend with along-shelf distance (Figure 12).

The mean of the velocity maxima were larger alongshore than cross-shore (Table 2). Larger alongshore components were westward and larger cross-shore components were offshore. There was an increase in maximum westward flow with distance to the west (significant at the 99% level), and a small increase in eastward maxima to the east (significant at the 80% level) (Figure 13). On-shore and off-shore velocity maxima increased to the east (significant at the 99% and 80% levels, respectively).

Most spring variance possessed shore-parallel major axes (Figure 6). Three exceptions were noted, two in the eastern region, COE MS C5 and C2, the former unexplained and the latter likely influenced by the 90° bend of the inner shelf bathymetry (near 30°N 89°W), the third exception was in the (north)western region, DOE BD B8, a near bottom meter with almost isotropic variance. The variance axes became less symmetric towards the west. The magnitude of alongshore variance increased towards the west, while the cross-shore variance magnitude increased towards the east.

The alongshore variance was predominantly contained in the low-passed records, with a statistically significant increase (at the 99% level) from 55% in the east to 85% in the west (Figure 14). Less than 50% of the cross-shore variance was contained in the low-passed records. A local maximum, > 60%, appeared in the (north)western region and a local minimum, > 30%, appeared in the central region, but there was no statistical relationship with alongshelf distance.

Alongshore auto-correlation time scales ranged between 24 and 120 hours (Table 3), although most were less than 75 hours. There was no statistically significant trend in auto-correlation time scale alongshelf. Cross-shore auto-correlation time scales ranged between 18 and 60 hours, and formed two clusters, one around 24 hours, the other around 48 hours. There was a statistically significant increase (at the 90% level) in cross-shore auto-correlation time scale towards the east.

There was general agreement in mean alongshore flow magnitude and direction, in variance axes magnitude and size, in along-shore percentage of variance in the low-pass band, and in along-shore auto-correlation time scales at stations with multiple spring records (Figures 5 and 6; Tables 2 and 3).

### 3.1.3 Summer

Results from the analysis of summer mean flows were inconsistent; there appeared to be no uniform alongshore flow direction for any region (Figure 5). Mean alongshore flows were distributed fairly uniformly in both directions across the regions. Although there was a slight increase to the west in eastward alongshore flow, it was not statistically significant (Figure 11). This was likely the result of interannual wind variability and unequal record lengths.

In summer there were very few statistically significant record means (Table 2). There were 3 of 15 eastern stations (2 to east), 6 of 23 central stations (5 to east), and 4 of 28 western stations (3 to east) with statistically significant (at the 95% level) alongshore mean flows. One eastern, one central and three western cross-shore means were statistically significant. All the significant cross-shore means, except one in the western region, were onshore.

The mean of the alongshore maximum velocities were approximately equal in the westward and eastward directions, but larger than the cross-shore maximum velocities, which were also approximately equal in the on- and off-shore directions. Westward alongshore maximum velocities increased in magnitude to the west (significant at the 99% level) (Figure 13).

Summer variance were typically oriented with major axes alongshore (Figure 8), and the western stations having larger ratios of major to minor axis length. Alongshore variance was highly variable, with the greatest ranges located in the western region. Cross-shore variances were of similar magnitude as in other seasons, but with more, and larger, outliers than in the other seasons.

The alongshore variance was predominantly contained in the low-passed records, with a statistically significant increase (at the 99% level) from 50% in the east to 95% in the west (Figure 14). Low percentages, < 40%, were located in the eastern region where the inner shelf bathymetry bends 90$^{\circ}$, and in the central region. The percentage of cross-shore variance in the low-passed data was usually less than 60%. Low values in the eastern region result in a statistically significant (at the 95% level) increase in percentage towards the west.

The summer season contained the largest observed alongshore auto-correlation time scales, with a number of records with time scales greater than 120 hours, and a maximum of 220 hours. The time scales clustered near 72 hours. There was a statistically significant increase (at the 80% level) towards the west. Cross-shore time scales were predominantly between 18 and 72 hours (Table 3), but with two clusters, 24 and 60 hours. There was no statistically significant trend with alongshelf distance.

In summer the alongshore flows were the most inconsistent interannually. Many stations exhibited opposing means. This was coupled with generally longer alongshore auto-correlation time scales.

### 3.1.4 Fall

Fall alongshore flows were predominantly to the west in all regions (Figure 3), with magnitude increasing with alongshelf distance to the west (statistically significant at the 99% level) (Figure 11). The two exceptions to westward flow were found at the eastern region station COE MS C6 (Figure 9a) where mean flow direction was likely influenced by the proximity to the major tidal inlet into Mobile Bay, AL, and at the western region station TABS TC (Figure 9e).

Ten of 15 eastern records, 11 of 16 central records, and 25 of 28 western records had statistically significant mean alongshore flows (Table 2). Statistically significant alongshore mean flow magnitudes were 2-9 $cm \cdot s^{-1}$ in the eastern region, 4-15 $cm \cdot s^{-1}$ in the central region, and 6-22 $cm \cdot s^{-1}$ in the western region.

Cross-shore means were similar to observations in other seasons with low magnitudes, -5 to +9 $cm \cdot s^{-1}$, and no significant geographical trend (Figure 12). Few records had statistically significant mean flows.

Alongshore velocity maxima to the west were larger than those to the east, and were similar in magnitude to observations during other seasons (Table 2). Alongshore maximum velocities increased towards the west (statistically significant at the 99% level) (Figure 13). Neither the alongshore maximum velocities towards the east, nor the cross-shore maximum velocities had a significant geographical trend.

More fall variance axes (Figure 10) had an isotropic character than in other seasons. No isotropic axes were found in the (south)western region. Along-shore variance was quite variable, with lower magnitude than in the other seasons, and an apparent increase in magnitude to the west.

The percent alongshore variance in the low-passed band was generally greater than 60%, and increased to the west (statistically significant at the 99% level) (Figure 14). Two clusters less than 60% occurred in the eastern region at stations COE MS C1 and C2, where flows were influenced by backbarrier exchanges, and in the central region near 92°W, off-shore of the Atchafalaya River delta. The percent cross-shore variance in the low-passed band was generally less than 60% with the lowest values, ~10%, occurring in the central region (Table 3).

Fall along-shore auto-correlation time scales were generally between 20 and 70 hours and fairly evenly distributed alongshelf (Table 3). A few outliers near 96 hours appeared in each region. No spatial trends were observed in either the along- or the cross-shore time scales.

There was general agreement between alongshore means and variances, in that both increased towards the west. Fall flows were notably westward, more so than in any other season.

## 3.2 Alongshore Flow Persistence

The proportions of alongshore flow as hours of record, percentage of record length, number of events and distribution of event durations are presented in Appendix A for each station record. Appendix A is a massive table and is therefore distributed on a diskette that accompanies this report. Appendix A is divided into the four seasons, within each season stations are listed in an east to west, on-shore to off-shore pattern.

### 3.2.1 Persistence

The percentage of flow to the west, the normalized amount of flow in the negative alongshore direction, changed with location and season (Figure 15). Note that the complement of westward flow would be eastward flow.

In winter, generally more then 50% of the alongshore flow was westward, with the lower values occurring in the eastern region. A linear relationship between percent westward flow and alongshelf distance, statistically significant at the 99% level, increased from 60% at the eastern stations to over 80% at the westernmost stations. There was one outlier with only 22% westward flow, COE MS C1, in the eastern region. The location of this station, inside the backbarrier waters of the Chandeleur Sound, has been shown to flow in opposition to the general inner-shelf alongshelf flow directions (Dinnel 1988).

The percentages of westward flows in spring were slightly lower but similar to winter conditions. Although percentages of westward flow were fairly stable near 65% in the (south)western region, 20% higher values were found in the (north)western region. Despite this, there was a statistically significant, at the 99% level, linear increase with alongshelf distance to the west.

The percentages of westward flow in summer were lower. Most values being less than 60%, and had a much larger range, 20-80%, than during any other season. There was a statistically significant, at the 80% level, linear increase with alongshelf distance to the east.

Shelfwide westward flow was reestablished in the fall. Flow increased to the west (statistically significant at the 95% level), although at a lower rate than in winter or spring.

Maximum displacements were defined as the largest single event displacements determined as the vector sum of the product of velocity and sample interval for all events in both the east and west alongshore directions. Maximum displacements westward increased linearly to the west with alongshelf distance. The relationship was significant at the 99% level. Magnitudes of maximum displacements in winter were less than 200 km for those stations east of 94.5°W and generally greater than 200 km for those stations west of 94.5°W. West of 94.5°, with the exception of a 61 km displacement at MMS LTX 1b, a 70 km displacement at TABS TC, and a 60 km displacement at DOE BD B7, the westward maximum displacements had magnitudes greater than 200 km. Spring maximum displacements were similar. The outlier was a 494 km westward displacement at MMS LTX 23b. Summer maximum displacements were all less than 300 km. Fall maximum westward displacements were quite variable, with many exceeding a magnitude of 300 km.

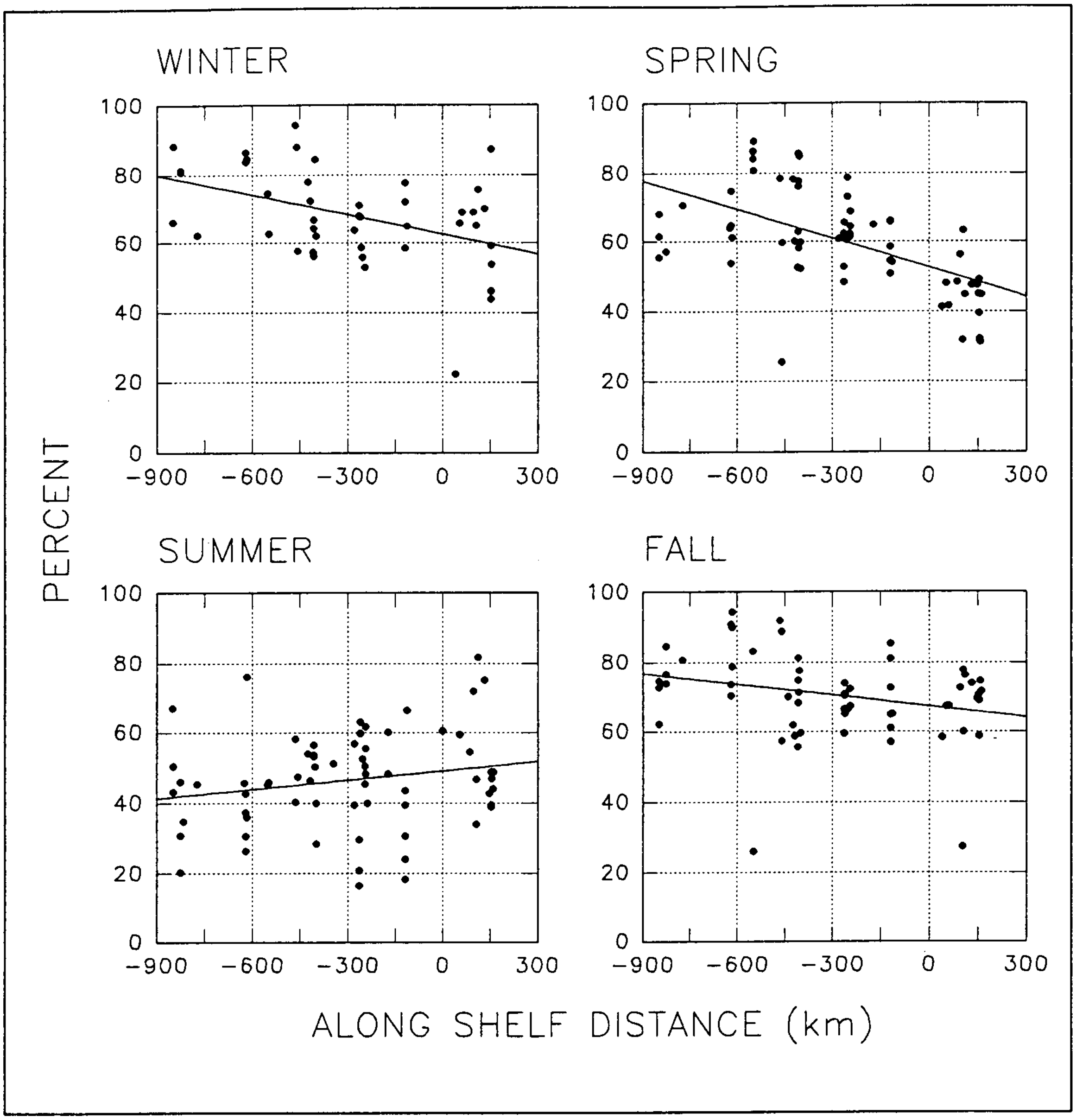


Figure 15. Percent of record with westward alongshore velocity versus alongshelf distance. Positive cross-shore velocity is onshore. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slopes for winter and spring were significantly different from zero at the 99.9% level (t=-3.123, n=44; t=-5.584, n=66), the slope for fall was significantly different from zero at the 95% level (t=-2.075, n=59), and the slope for summer was significantly different from zero at the 80% level (t=1.582, n=66).

Maximum displacements eastward were of lesser overall magnitude than those toward the west and had lower variation than maximum displacements westward in all seasons except summer when westward displacements were small (Figure 16) and eastward displacements were large (Figure 17). Magnitudes of maximum eastward displacements were generally less than 100 km in winter. There was a statistically significant (at the 95% level) linear increase in maximum eastward displacement with distance alongshelf to the west. In spring, most maximum eastward displacements were less then 100 km. The few that exceeded 100 km were in the (south)western and eastern regions. There was no statistically significant linear trend in maximum eastward displacement with distance alongshelf. Summer maximum eastward displacements had the highest variation and a statistically significant (at the 99% level) linear increase in maximum eastward displacement with distance alongshelf to the west. Most summer displacements were less than 200 km, but 20% were greater than 200 km; the longest was in the (south)western region. Fall maximum eastward displacements were again quite low; all but one were less than 100 km. There was a statistically significant (at the 95% level) linear increase in maximum eastward displacement with distance alongshelf to the west.

### 3.2.2 Persistence Example

A single station subset of Appendix A is presented as Table 4. The four seasonal records of station EPA GS G1 are presented to explain the information contained in Appendix A and to provide an example of its use. Table 4 represents alongshore flow statistics, and some stations may have only one seasonal record, while others may have multiple records in a single season. Station EPA GS G1 has one record in each of the four seasons.

The current meter depth and total water depth, 5.2 and 10.4 m for G1, and the latitude and longitude, 30.23° and -87.685° in this case, are listed for each station record in the first line of each seasonal table. The total record length for G1 in winter was 2160.0 hours (90.0 days); the record mean alongshore flow was -2.10 $cm \cdot s^{-1}$. This information is presented in the second line. The negative sign indicates flow to the west(to the viewer's left facing the coast). The maximum displacements during a single event, -50.318 km (to the west) and 35.278 km (to the east) for G1 in winter are presented in the third line. The next line, labeled 'velocity level', defines bins into which the data samples were sorted. Reading from the left, these are the number of samples with velocities greater than 125 $cm \cdot s^{-1}$ to the west, greater than 100 $cm \cdot s^{-1}$ to the west, etc.. The column labeled '<0' includes all data samples involving westward flow. The bins to the right of the label 'velocity level' are indicative of eastward flow. The next two lines indicate, respectively, that 59.26% of the record, a total of 1280 hours, involved westward flow. This is seen in the column labeled '<0'. The eighth line of this table, in the same column, indicates that there were 80 westward flow events observed, while the seventh line indicates that the longest observed westward flow event lasted 110.0 hours. Looking in the column labeled '>0', one sees that 40.74% of the record or 880.0 hours of record recorded eastward flow. The maximum continuous duration of eastward flow was 123.5 hours. There were 81 events during which flow was eastward. Most of the flow events, in either direction, were weak. The column labeled '<-25' indicates that only 1.78% of the record involved westward flows in the excess of 25 $cm \cdot s^{-1}$. This accounted for 38.5 hours of record. Thirty-two such events were recorded. The longest was 9.5 hours in duration. Looking farther down the column label '<0', one sees the westward flow events sorted by duration. Sixty-five had durations less than one day, while 6 had

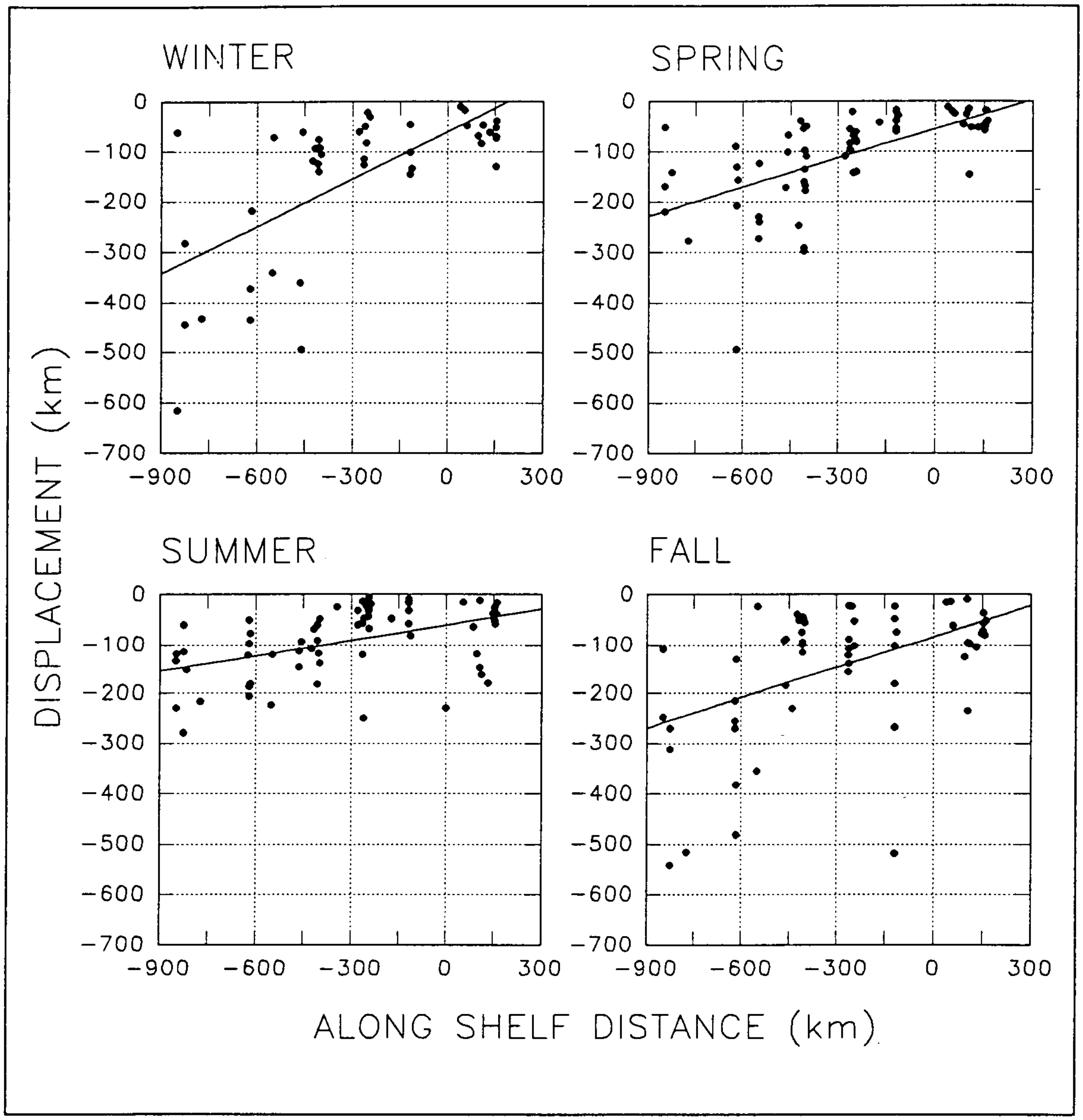


Figure 16. Seasonal maximum westward displacement versus alongshelf distance. Positive cross-shore velocity is onshore. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slopes for all seasons were significantly different from zero at the 99% level (t=5.638, n=44; t=6.134, n=66; t=4.126, n=66; t=4.225, n=59, respectively).

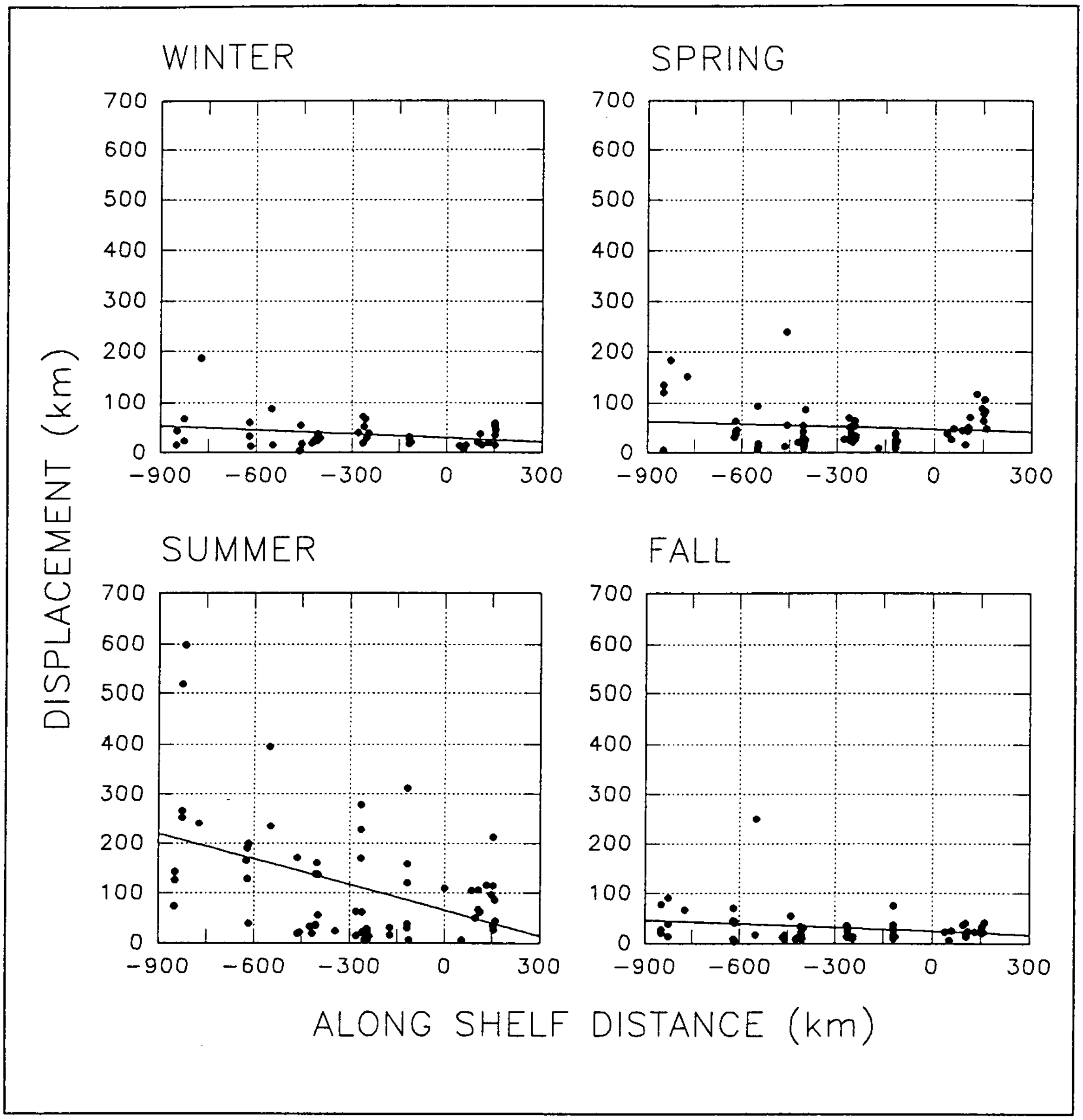


Figure 17. Seasonal maximum eastward displacement versus alongshelf distance. Positive cross-shore velocity is onshore. Zero distance is the Mississippi Delta, distance west is negative. Linear regression slopes were tested as different from zero with a student-t test. The slope for summer was significantly different from zero at the 99% level (t=-3.991, n=66), the slopes for winter and fall were significantly different from zero at the 95% level (t=-1.826, n=44; t=-1.722, n=59), and the slope for spring was below the 80% significance level and considered not different from zero (t=-0.923, n=66).

durations between 1 and 2 days, etc.. If a duration bin was empty, it was not included in the formal table. Thus, for example, the spring record at G1 included no flow events between 5 and 6 days duration. The line appropriate for this duration bin is missing from the table. The winter record from G1 included no flows in excess of 50 $cm \cdot s^{-1}$, as indicated by the zeros in all the columns labeled '<-125', '<-100', '<-75', '<-50', '>50', '>75', '>100', and '>125'. Note that the single event with maximum duration in either the eastward or westward direction is not necessarily the event associated with maximum displacement in that direction. The former is only an indication of event duration. The latter is determined by a product of duration and velocity.

Appendix A could be used to look up alongshore flow persistence at a specific location, defined by latitude and longitude, or general locations along the northern coast of the Gulf of Mexico. Consider a spill just east of the entrance to Mobile Bay, AL, in October. This is in the fall season and the closest station may be EPA GS G1 (which suggests the use of Table 4 in this example), but additional stations nearby contain supporting information. One can see from the fall persistence statistics for EPA GS G1 (Table 4 or Appendix A) that observations indicated a net alongshore flow to the west, the -2.01 $cm \cdot s^{-1}$ mean flow being statistically significant at the 95% level (Table 2). The majority of the flow had magnitudes less than ±25 $cm \cdot s^{-1}$; 0.34% of the flow exceeded 25 $cm \cdot s^{-1}$ to the west, and 0.02% exceeded 25 $cm \cdot s^{-1}$ to the east. At no time during this record did flows exceed ±50 $cm \cdot s^{-1}$. Most flow events were less than one day in duration, with the maximum event duration being less than five days, in either direction. Of the eight separate events that exceeded 25 $cm \cdot s^{-1}$ to the west, the maximum duration was only 2.5 hours. Only one event exceed 25 $cm \cdot s^{-1}$ to the east; that lasted a single time step, one half hour. Although most of the flow was westward (59%), there was nearly the same duration of flow to the east. The maximum displacements were 37 km west and 21 km east. These statistics provide duration and displacement indications of possible excursions that can occur at this location.

## 4. DISCUSSION AND INTERPRETATION

### 4.1 Seasonal Flows

Winter, spring and fall had mean alongshore flows to the west, which increased towards the west; summer flow patterns were different, there was as much flow towards the east as towards the west and no geographical trend in flow direction. Cross-shore flows were consistent throughout the year in magnitude and apparent lack of directional tendencies. Variance axes were of similar orientation and comparable in magnitude in all seasons, with the (south)western region axes being more elongated alongshore than on the other regions. There was a consistent increase towards the west in all seasons in the percentage of alongshore variance in the low-passed band.

Velocity maxima were fairly symmetric between the cross-shore directions; but the alongshore maximum velocities had seasonal asymmetry. Only the summer had balanced maximum velocities in both alongshore directions. The other seasons had higher magnitudes to the west. Although there was no substantial geographical difference in alongshore maximum velocities to the east, there was a consistent increase in maximum westward velocities to the west over all seasons. On-shore maximum velocities increased towards the east in spring and weakly in the winter, but had no trend in other seasons.

Table 4.

Seasonal alongshore flow durations for EPA GS G1. Station designation, current meter depth/total water depth (m), latitude and longitude (°), record length, record mean (cm/s), maximum westward and eastward displacments by a single event (km), the portion of the record, as a percentage (%), as total hours (hr) and as number of events, exceeding specified velocity levels, the number of events within durations of day increaments, and the duration (hr) of the single longest event.

Seasonal alongshore flow durations, winter.

STATION: EPA GS G1 (5.2/10.4m) LATITUDE: 30.23000 LONGITUDE: -87.68500
RECORD LENGTH: 2160.0 hr = 90.00 d RECORD MEAN: -2.10 cm/s

MAX DISPLACEMENT EVENT WEST: -50.318 km MAX DISPLACEMENT EVENT EAST: 35.278 km

| <-125 | <-100 | <-75 | <-50 | <-25 | <0 | VELOCITY LEVEL | >0 | >25 | >50 | >75 | >100 | >125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 1.78 | 59.26 | RECORD (%) | 40.74 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0 | 0.0 | 0.0 | 0.0 | 38.5 | 1280.0 | RECORD (hr) | 880.0 | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 9.5 | 111.0 | MAX DURATION | 123.5 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0 | 0 | 0 | 0 | 32 | 80 | ALL EVENTS | 81 | 10 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 32 | 65 | 0 TO 1 DAYS | 71 | 10 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 6 | 1 TO 2 DAYS | 8 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 7 | 2 TO 3 DAYS | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 3 TO 4 DAYS | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 4 TO 5 DAYS | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 TO 6 DAYS | 1 | 0 | 0 | 0 | 0 | 0 |

Table 4. Seasonal alongshore flow durations for EPA GS G1. (continued)

Seasonal alongshore flow durations, spring.

STATION: EPA GS G1 (5.2/10.4m) LATITUDE: 30.23000 LONGITUDE: -87.68500
RECORD LENGTH: 1856.0 hr = 77.33 d RECORD MEAN: 1.63 cm/s

MAX DISPLACEMENT EVENT WEST: -57.157 km MAX DISPLACEMENT EVENT EAST: 64.155 km

| <-125 | <-100 | <-75 | <-50 | <-25 | <0 | VELOCITY LEVEL | >0 | >25 | >50 | >75 | >100 | >125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.03 | 3.23 | 45.04 | RECORD (%) | 54.96 | 3.48 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0 | 0.0 | 0.0 | 0.5 | 60.0 | 836.0 | RECORD (hr) | 1020.0 | 64.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.5 | 13.0 | 159.0 | MAX DURATION | 103.5 | 13.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0 | 0 | 0 | 1 | 28 | 59 | ALL EVENTS | 59 | 18 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 28 | 50 | 0 TO 1 DAYS | 47 | 18 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 4 | 1 TO 2 DAYS | 7 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 3 | 2 TO 3 DAYS | 2 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 3 TO 4 DAYS | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 TO 5 DAYS | 2 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 6 TO 7 DAYS | 0 | 0 | 0 | 0 | 0 | 0 |

Table 4. Seasonal alongshore flow durations for EPA GS G1. (continued)

Seasonal alongshore flow durations, summer.

STATION: EPA GS G1 (5.2/10.4m) LATITUDE: 30.23000 LONGITUDE: -87.68500
RECORD LENGTH: 2208.0 hr = 92.00 d RECORD MEAN: 0.09 cm/s

MAX DISPLACEMENT EVENT WEST: -25.939 km MAX DISPLACEMENT EVENT EAST: 35.332 km

| <-125 | <-100 | <-75 | <-50 | <-25 | <0 | VELOCITY LEVEL | >0 | >25 | >50 | >75 | >100 | >125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 48.82 | RECORD (%) | 51.18 | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0 | 0.0 | 0.0 | 0.0 | 8.5 | 1078.0 | RECORD (hr) | 1130.0 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 80.5 | MAX DURATION | 123.5 | 4.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0 | 0 | 0 | 0 | 10 | 120 | ALL EVENTS | 120 | 5 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 10 | 110 | 0 TO 1 DAYS | 110 | 5 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 6 | 1 TO 2 DAYS | 5 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 2 | 2 TO 3 DAYS | 4 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 2 | 3 TO 4 DAYS | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 TO 6 DAYS | 1 | 0 | 0 | 0 | 0 | 0 |

Table 4. Seasonal alongshore flow durations for EPA GS G1. (continued)

Seasonal alongshore flow durations, fall.

STATION: EPA GS G1 (5.2/10.4m) LATITUDE: 30.23000 LONGITUDE: -87.68500
RECORD LENGTH: 2184.0 hr = 91.00 d RECORD MEAN: -2.01 cm/s

MAX DISPLACEMENT EVENT WEST: -36.632 km MAX DISPLACEMENT EVENT EAST: 21.205 km

| <-125 | <-100 | <-75 | <-50 | <-25 | <0 | VELOCITY LEVEL | >0 | >25 | >50 | >75 | >100 | >125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 58.81 | RECORD (%) | 41.19 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | 1284.5 | RECORD (hr) | 899.5 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 110.0 | MAX DURATION | 98.5 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0 | 0 | 0 | 0 | 8 | 78 | ALL EVENTS | 77 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 8 | 61 | 0 TO 1 DAYS | 69 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 11 | 1 TO 2 DAYS | 5 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 3 | 2 TO 3 DAYS | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 2 | 3 TO 4 DAYS | 2 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 4 TO 5 DAYS | 1 | 0 | 0 | 0 | 0 | 0 |

## 4.2 Alongshore Flow Persistence

Three seasons, winter, spring and fall, exhibit predominantly westward flows. These flows increase in magnitude and proportion of occurrence towards the west. The summer season does not exhibit a systematic flow reversal, but there are as many occurrences of eastward flow as westward flow. A general reversal to eastward flow does occur over the (south)western region.

Most velocity events, regardless of season, in either alongshore direction, are less than one day in duration. Longer durations are possible, and there is a higher number of multiple day flow events in summer than during the other seasons. Velocity events, higher than ±25 $cm \cdot s^{-1}$, are usually only a few hours in duration. These higher velocity events are more common in the western regions.

Regardless of season there appear to be larger magnitudes of maximum displacement events, in both alongshore directions, in the western regions. The maximum displacement events decrease in summer for westward displacements and increase for eastward displacements.

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**The Department of the Interior Mission**

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

**The Minerals Management Service Mission**

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

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

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