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LAGRANGIAN CURRENT MEASUREMENTS FROM THE GEORGES BANK FRONTAL STUDY, 1988-89 PART I: DRIFT BUOY TRAJECTORIES

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LAGRANGIAN CURRENT MEASUREMENTS FROM THE GEORGES BANK FRONTAL STUDY, 1988-89 PART I: DRIFT BUOY TRAJECTORIES

by

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ABSTRACT

Drinkwater, K.F., M.J. Graça and J.W. Loder. 1992. Lagrangian current measurements from the Georges Bank Frontal Study, 1988-89. Part I: Drift buoy trajectories. Can. Data Rep. Hydrogr. Ocean Sci. No. 116: iv + 105 pp.

Lagrangian current observations during the 1988-89 Georges Bank Frontal Study are presented. Drift measurements were obtained using undrogued surface buoys whose positions were acquired through satellite (ARGOS) tracking and internally-recording LORAN-C buoys with a 5-m holey-sock drogue attached, typically centered at 10 m. Three clusters of the ARGOS buoys were deployed during a cruise in late June-early July and again in August of 1988. An additional seven clusters using the combined ARGOS and LORAN-C buoys were deployed in October of 1988 and four clusters during July of 1989. Graphical presentations of the drift tracks, mean drift velocities, temperature and density structure at the time of deployment, and winds during the tracking are provided for each cluster.

RÉSUMÉ

Drinkwater, K.F., M.J. Graça and J.W. Loder. 1992. Lagrangian current measurements from the Georges Bank Frontal Study, 1988-89. Part I: Drift buoy trajectories. Can. Data Rep. Hydrogr. Ocean Sci. No. 116: iv + 105 pp.

Des observations lagrangiennes des courants effectuées pendant l'Étude frontale du banc Georges de 1988-89 sont présentées. Les mesures de la dérive ont été obtenues au moyen de bouées de surface non stationnaires dont les positions ont été acquises par poursuite par satellite (ARGOS) et de bouées LORAN-C à enregistrement interne avec drogues à courant trouées de 5 m à des intervalles types de 10 m. Trois groupes de bouées ARGOS ont été déployés lors d'une croisière à la fin de juin et au début de juillet et de nouveau en août 1988. Sept autres groupes de bouées ARGOS et LORAN-C ont été déployés en octobre 1988 alors que quatre groupes étaient déployés en juillet 1989. Des présentations graphiques des trajectoires de dérive, des vitesses moyennes de dérive, des structures de température et de densité au moment du déploiement et des vents pendant la poursuite sont fournies pour chaque groupe.

INTRODUCTION

During June to October of 1988 and in July 1989 an intensive multidisciplinary field study was conducted in the vicinity of the tidal front on the Northeast Peak of Georges Bank. The aim of this investigation, called the Georges Bank Frontal Study, was to examine the vertical and horizontal mixing processes in the vicinity of the front and determine their effects upon biological production and species distributions. Physical measurements included currents from moored instruments, a ship-mounted current profiler, and drifting buoys; temperature and salinity from moored thermistor chains and current meters, conventional CTD profiles, and a CTD mounted on an undulating towed body (BATFISH); and turbulence from a free falling microstructure profiler (EPSONDE). Biological measurements included nutrient distributions, primary production and biomass, zooplankton distributions and ichthyoplankton distributions. The latter included several cruises targeted to investigate scallop and lobster larvae. Measurements from the Georges Bank Frontal Study have been published in a series of data and technical reports (Loder et al. 1990; Irwin et al. 1990; Loder and Pettipas 1991, Oakey and Pettipas 1992) and primary publications (Brickman and Loder 1992; Loder et al. 1992; Perry et al. 1992; Tremblay and Sinclair 1992).

This report focuses upon the current measurements obtained from the drifting buoys. The principal scientific objectives of the Lagrangian current program were (1) to determine the spatial structure of the near-surface current field in the vicinity of the tidal front, (2) to investigate the occurrence and relative importance of surface convergence at the front, (3) to evaluate the relation between near-surface (Lagrangian) drift and moored (Eulerian) current measurements, including an estimate of the Stokes drift, and (4) to estimate horizontal dispersion rates. In this report we provide a graphical display of the oceanographic structure at the time of the buoy releases, the wind speed and direction during the tracking, the drift tracks of the buoys, and the detided or residual motion of the buoys. A future report will focus upon estimates of dispersion from tracking of the buoy clusters as well as calculation of the differential kinematic properties (convergence, vorticity, shear deformation, and strain deformation).

STUDY AREA

The Georges Bank Frontal Study was carried out in the northeastern section of the Bank (Fig. 1). Current meters were moored at six sites during 1988 and one (# 3) in 1989. The depth increases gently to the east but drops steeply to the north at the Bank edge. The depth of the water in the drift study area was typically 40-70 m but extended to > 200 m in Georges Basin and the Northeast Channel. The mean position of the tidal front on the Northeast Peak lies in the vicinity of the 50 to 80 m isobaths, being roughly east-west in the western sector of the study area but bending towards the southeast to the east of 67°W. Its cross-bank location changes seasonally moving into shallower waters as the summer progresses and retreating into deeper waters in the autumn. The dominant currents in the study area are semidiurnal rotary tidal currents and a generally eastward residual drift which is part of the Georges Bank gyre (e.g. Bigelow 1927, Butman et al. 1982, Horne et al. 1989).

DRIFT BUOYS

Two types of positioning systems were used in the study. The Accurate Surface Tracker (AST) is an undrogued, surface buoy positioned using the ARGOS satellite system (Dempsey 1988). It consists of a radio antenna housed in a self-flooding barrel-shaped hull with a heavy chain to provide ballast (Fig. 2). The height of the barrel is approximately 1 m. The antenna was placed to ensure reliable satellite communication but present a minimum area above the water line in order to reduce wind drag on the buoy. Buoy positions (6 to 10 observations per day) during the field program were obtained via computer link between the Bedford Institute and the ARGOS network and relayed to the ship by telephone on a daily basis. Positions between approximately 2:00 and 7:00 UT (Coordinated Universal Time) were unavailable because the satellite's orbital swath path did not overlap with the study region. ARGOS classifies the accuracy of each buoy position depending upon the number of satellite messages received, the pass duration of the satellite, the minimum angle between satellite orbit and the buoy, and the stability and consistency of the message received by the satellite. From this information, they categorize the positions to lie within either 150, 350, or 1000 m of their true values 68% of the time (designated as quality 3, 2, or 1, respectively).

The LORAN-C drifter, called the Sea Rover 3, was built by Candel Industries Ltd (Sydney, British Columbia, Canada) and has been described in detail by Woodward et al. (1991). The drifter receives LORAN-C information, stores it internally, and transmits it on VHF frequencies back to the mother ship. The buoy consists of a cylindrical hull approximately 2 m in length and a high-strength foam ring for floatation (Fig. 3). A 1-m diameter, 5-m long holey-sock drogue was generally attached to the buoy, typically centered at 10 m (Fig. 3). A 30 MHz half-wave whip antenna was attached to the top of the buoy to receive and transmit the LORAN-C data. The buoy was also equipped with a flashing light and radio beacon to facilitate recovery of the buoy. The sampling period is programmable from once a minute to once a day. During the Georges Bank study, positions were obtained every 30 minutes and the transmitted LORAN-C data were logged on a shipboard PC computer. The transmission range of the buoys was 30 to 50 km. Upon recovery of the buoy, the internal memory containing the LORAN-C position information was transferred to a PC computer, edited, and the latitudes and longitudes were calculated. The absolute accuracy of the LORAN-C positions is estimated at 250 m (Canadian Coast Guard 1988) with a repeatability of 25-50 m (Crawford 1988; Mackas et al. 1989; Woodward et al. 1991). Tests performed on land near the Bedford Institute of Oceanography confirmed these figures with the repeatability close to 25 m.

During 1989, as part of a separate study by B. Hargrave (Bedford Institute of Oceanography) to measure the downward particle fluxes in the vicinity of the tidal front, a third type of buoy was deployed to which sediment traps were attached. The conical-shaped buoy was built by Hermes Electronics Limited and tracked using the ARGOS satellite system. The hull was 2 m in length with a maximum diameter near the water line of 0.9 m (Fig. 4). A multi-sample sediment trap, known as BIOTrap was attached to the buoy by an elastic tether to uncouple the buoy motion from the trap. The trap's frame has a height of approximately 1.5 m and a diameter of 0.6 m. A funnel collector, turntable with sample bottles, batteries and electronics case were attached to the frame. The top of the trap was positioned to sample at approximately 30 m. Only the drift data obtained from the buoy appear in this report.

EXPERIMENTAL DESIGN

Drift observations were collected during June-July, August, and October, 1988, and July, 1989. The AST ARGOS buoys were used throughout the study, the LORAN-C buoys were deployed in the fall of 1988 and in 1989 and the Hermes buoy only in 1989. A total of 17 clusters of buoys were released over the two years, seven of the clusters contained AST ARGOS buoys only. Tables 1 and 2 list the release and recovery times and locations in 1988 and 1989, respectively.

A typical deployment consisted of the release of several buoys 10-20 km west of the current meter array. The starting positions were upstream of the array based upon the historical residual circulation pattern so that the cluster would typically drift through the array. The buoys were generally deployed in a line or box configuration across the tidal front although the strong tidal currents (> 1 m s^{-1}) and finite deployment times (several hours) sometimes resulted in an irregular shape of the initial cluster. Each cluster was tracked for 1 to 6 d, with the strategy of using repeated experiments to build up improved statistics on the current field in the study area. The vertical temperature and salinity structure was also measured at most release and recovery sites using a Guildline digital Conductivity-Temperature-Depth (CTD) profiler.

DATA

Drift Buoys - Data Editing and Analysis

The positions of the satellite-tracked buoys used for post cruise analysis were obtained from the "DISPOSE" files in the ARGOS archived data bank. Where positions were close in time (< 5 minutes) one was removed. If the positions were of different quality, the most accurate fix was kept. If fixes were of the same quality, the position deemed most consistent with the previous and following positions was retained. Velocities were then calculated and positions eliminated if the absolute value of the resultant velocity component (north or east) exceeded the maximum current expected, i.e. 1.5 m s^{-1}. Where possible, the velocities from the ARGOS buoys were further checked for consistency with those calculated from the LORAN-C drifters. The percentage of the ARGOS positions of quality 1, 2 and 3 were 9, 86, and 5, respectively. Of the positions eliminated during editing

(3.5% of the total), the majority were the lowest quality (53%), the remainder being of quality 2.

The LORAN-C positions are determined from time differences (TDs) in the arrival of a series of radio wave pulses sent from a master and one or more secondary stations. The measurements are made to the nearest 0.01 μs. Processing of the LORAN-C data began with the application of the Additional Secondary Factor (ASF). This is a correction to compensate for local conditions because the LORAN-C radio waves have different speeds over land and water. The ASF value was obtained from the publication of the Canadian Coast Guard (1988). Normally, the LORAN-C receiver tracks the third pulse in the group of radio waves but it is not uncommon for the receiver to lock onto the second or fourth pulse resulting in a 10 μs shift in the time difference. This produces an error in the position of 2 to 5 km but is easily detected by comparing adjacent TDs. These cycle selection errors or lane jumps occurred in 38% of the LORAN-C data in 1988 but only 4% in 1989. The difference between years is believed to be due to calmer weather and improved shielding of the antennae in 1989. All lane jumps were edited out by adding or, if necessary, subtracting 10 μs to the recorded TDs.

Velocities were calculated from the edited positions using successive fixes. Currents on the Bank were dominated by the tides with amplitudes in the velocity components of order 0.5 m s^{-1} (Fig. 5). The residual or detided velocity components for the LORAN-C buoys were calculated using a 12.5 h or 25 h running mean filter. These times represent approximately 1 and 2 M_2 tidal periods, respectively. The latter filter was used only if the buoys were tracked for 2 d or longer. The overall mean current was then determined from the average of the filtered velocities. Because of the irregular timing of the satellite-derived fixes, the positions of the ARGOS buoys at approximate multiples of the M_2 tidal period were often not available. Therefore, positions for these times were obtained using linear interpolation, but only if the times were within 1.5 h of a satellite-derived fix and there was less than a 3 h gap between fixes. Residual velocities were determined from these positions and an overall mean was calculated as the average of all of these residuals.

Drift Buoys - Data Return

Summaries of the data return for the ARGOS and LORAN-C buoys are provided in Figs. 6 and 7, respectively. A total of 4 buoy-months of ARGOS data and 5.5 buoy-months of LORAN-C data were collected during the course of the study. The poor data return from the LORAN-C buoys during deployment 9 was in part due to strong winds which reached upwards of 55 knots. The drogues on four of the drifters were lost and the antenna had disappeared from one buoy. Memory or communication problems account for the remainder of the data quality problems. In 1989 fewer problems resulted in a larger percentage of the potential data being of good quality.

Hydrographic and Wind Data

Vertical profiles of temperature and salinity were collected during the study using a CTD mounted on a Niskin bottle sampling rosette. Winds were available every three hours from a meteorological buoy located at 41.1°N, 66.6°W which was approximately 100 km south of the study site. In addition, wind speed and direction were recorded every 2-4 hours from the ship's anemometer. The wind direction conforms to the oceanographic convention, i.e. the direction towards which the wind is blowing.

Graphical Presentation

The Appendix contains additional buoy information and graphical displays of the data. For each cluster deployment there are 4 to 6 sheets. The first sheet lists the number of buoys released, their type (ARGOS or LORAN-C), the time of the first release and last recovery, and the total time of the buoy tracking is given. Comments are provided on the hydrographic structure at the time of the deployment and on the winds during the time the cluster was tracked. This first sheet also lists the depth of the drogue for each buoy, the number of fixes obtained, the total number of hours of data, and the amount of good data expressed as a percentage of the potential return, i.e. the total time the buoy was in the water. The overall mean current is also provided. On the second sheet, the upper panel shows the temperature and density (sigma-t) structure during the release of the buoys and the lower panel the wind speed and direction during the tracking of the buoys. The third sheet contains a composite plot of all of the ARGOS buoys plus the residual drift tracks from the filtered data. On the fourth sheet the individual drift tracks of each of the buoys is

provided. For those clusters containing both types of buoys, sheet 5 shows the composite and residual drift tracks of the LORAN-C buoys and sheet 6 the individual LORAN-C buoy tracks.

The buoy trajectories clearly show that the relatively high frequency sampling of the LORAN-C buoys provides good resolution of the tidal flow.

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TABLE 1: Release and recovery times (UT) and positions for Georges Bank drift buoys during 1988. The buoy type refers to ARGOS (AR) or LORAN-C (LC) drifters. The positions were determined from the ship's LORAN-C data after application of the additional secondary factor (ASF).

Dep. #	Buoy ID	Buoy Type	Release Date	Release Hr:Mn	Release Lat	Release Long	Recovery Date	Recovery Hr:Mn	Recovery Lat	Recovery Long
1	2750	AR	28 Jun	14:05	42 06.0	67 02.5	30 Jun	21:23	42 03.5	66 25.7
	2757	AR	28 Jun	14:23	42 04.0	67 01.0	2 Jul	10:37	41 55.3	66 36.4
2	2750	AR	2 Jul	12:38	42 00.4	67 00.2	5 Jul	11:07	42 02.4	66 25.3
	2757	AR	2 Jul	12:17	41 57.4	67 00.1	5 Jul	11:16	42 02.2	66 24.7
3	2750	AR	6 Jul	14:52	41 56.2	67 00.1	7 Jul	21:32	42 07.1	66 56.1
	2754	AR	6 Jul	15:13	41 59.3	67 00.2	7 Jul	20:54	42 07.2	66 49.7
	2757	AR	6 Jul	15:38	42 02.2	67 00.1	7 Jul	20:27	42 09.5	66 47.5
4	2754	AR	23 Aug	20:40	42 08.5	67 14.1	26 Aug	20:40	42 26.1	66 27.8
	2757	AR	23 Aug	23:07	41 59.8	67 13.6	26 Aug	23:38	41 59.3	66 47.7
	4440	AR	23 Aug	21:38	42 05.6	67 14.1	26 Aug	19:31	42 15.4	66 33.6
	4447	AR	23 Aug	22:20	42 02.7	67 14.1	26 Aug	18:55	42 13.7	66 39.5
5	2754	AR	27 Aug	03:25	42 05.0	66 59.6	28 Aug	20:51	41 51.5	66 33.8
	2757	AR	27 Aug	01:27	41 57.3	67 00.1	28 Aug	19:31	41 54.0	66 46.9
	4440	AR	27 Aug	02:51	42 02.1	66 59.8	28 Aug	21:43	41.47.7	66 31.5
	4447	AR	27 Aug	02:15	41 59.6	66 59.8	28 Aug	19:09	41 54.7	66 48.7
6	2754	AR	29 Aug	17:01	42 07.5	66 59.6	31 Aug	22:03	41 46.2	66 30.6
	2757	AR	29 Aug	18:30	41 59.4	66 59.5	31 Aug	20:17	41 54.3	66 52.7
	4440	AR	29 Aug	17:33	42 04.8	66 59.5	1 Sep	13:52	41 16.8	66 49.5
	4443	AR	29 Aug	18:03	42 02.0	66 59.5	31 Aug	22:58	41 46.1	66 31.9
	4447	AR	29 Aug	18:58	41 56.5	66 59.8	31 Aug	19:31	41 48.7	66 51.1
7	2755	AR	30 Sep	22:49	41 59.9	66 59.7	2 Oct	17:55	41 54.3	66 33.9
	2757	AR	30 Sep	21:38	42 04.7	66 59.9	2 Oct	21:38	41 58.5	66 54.0
	4447	AR	30 Sep	22:14	42 02.5	66 59.8	2 Oct	18:52	42 00.2	66 33.5
8	21	LC	1 Oct	20:19	42 05.3	66 59.7	2 Oct	22:07	41 57.8	66 51.4
	23	LC	1 Oct	19:12	42 00.5	66 59.9	2 Oct	23:28	41 02.1	66 58.3
	25	LC	1 Oct	19:49	42 02.9	66 59.7	2 Oct	22:48	42 00.4	66 54.0
	27	LC	1 Oct	18:45	41 58.3	66 59.8	1 Oct	22:03	41 57.9	66 55.3
9	2755	AR	3 Oct	16:27	42 00.2	67 00.1	6 Oct	19:10	41 42.5	67 23.4
	2757	AR	3 Oct	16:47	42.02.8	67 00.1	6 Oct	19:49	41 44.6	67 21.4
	4447	AR	3 Oct	16:08	41 57.8	67 00.1	6 Oct	18:16	41 41.1	67 19.0
	21	LC	3 Oct	16:28	42 00.3	67 00.1	6 Oct	17:32	41 37.5	67 16.6
	22	LC	3 Oct	16:47	42 02.8	67 00.1	6 Oct	14:00	41 56.3	67 15.1
	23	LC	3 Oct	17:05	42 05.3	67 00.0	6 Oct	14:51	42 01.4	67 13.5
	24	LC	3 Oct	18:05	42 01.7	67 05.2	6 Oct	12:58	41 51.8	67 19.0
	25	LC	3 Oct	16:07	41 57.8	67 00.1	6 Oct	16:38	41 43.2	67 12.8
	27	LC	3 Oct	18:27	42 01.6	67 02.2	6 Oct	13:38	41 55.2	67 15.1
	28	LC	3 Oct	18:46	42 01.5	66 59.2	6 Oct	12:09	41 51.3	67 12.7

Table 1. Continued.

Dep. #	Buoy ID	Buoy Type	Release Date	Release Hr:Mn	Release Lat	Release Long	Recovery Date	Recovery Hr:Mn	Recovery Lat	Recovery Long
10	2754	AR	7 Oct	01:42	42 02.3	66 58.4	10 Oct	21:06	41 35.2	67 04.2
	2755	AR	7 Oct	02:08	41 59.7	66 57.4	10 Oct	21:33	41 36.5	67 07.6
	2757	AR	7 Oct	02:41	42 03.2	66 53.9	10 Oct	20:26	41 36.5	67 05.2
	4447	AR	7 Oct	01:15	42 04.9	66 59.2	10 Oct	20:46	41 35.4	67 04.6
	21	LC	7 Oct	00:50	42 07.3	66 59.9	11 Oct	00:15	41 00.5	67 03.8
	22	LC	7 Oct	02:09	41 59.7	66 57.4	10 Oct	17:28	41 55.3	67 03.7
	23	LC	7 Oct	01:44	42 02.3	66 58.4	10 Oct	19:34	41 42.7	67 04.3
	24	LC	7 Oct	01:17	42 04.9	66 59.2	10 Oct	18:19	41 42.7	67 04.3
	25	LC	7 Oct	03:47	42 02.1	67 02.8	10 Oct	16:56	41 49.8	67 01.8
	26	LC	7 Oct	02:42	42 03.2	66 53.9	10 Oct	15:53	41 52.0	67 03.2
	27	LC	7 Oct	03:21	42 02.7	66 59.9	10 Oct	13:49	42 05.2	67 00.5
11	2754	AR	11 Oct	02:19	42 06.5	66 54.1	12 Oct	18:26	42 14.2	66 21.7
	2755	AR	11 Oct	01:56	42 03.6	66 53.3	12 Oct	17:51	42 11.8	66 24.0
	2757	AR	11 Oct	02:44	42 09.4	66 54.9	12 Oct	18:54	42 15.5	66 18.3
	4447	AR	11 Oct	01:32	42 00.6	66 53.1	12 Oct	20:59	41 58.6	66 29.9
	21	LC	11 Oct	02:45	42 09.4	66 54.9	12 Oct	16:09	42 11.5	66 23.9
	22	LC	11 Oct	03:24	42 07.4	66 59.0	12 Oct	22:35	42 11.5	66 23.9
	24	LC	11 Oct	04:12	42 07.4	66 48.8	12 Oct	16:55	42 11.5	66 23.9
	25	LC	11 Oct	02:20	42 06.5	66 54.1	12 Oct	16:10	42 11.5	66 23.9
	26	LC	11 Oct	01:57	42 03.6	66 53.3	12 Oct	23:45	42 11.5	66 23.9
12	2754	AR	13 Oct	02:11	42 04.0	66 52.1	13 Oct	21:22	41 57.4	66 31.1
	2755	AR	13 Oct	02:36	42 02.8	66 50.2	13 Oct	21:48	41 57.0	66 27.7
	2757	AR	13 Oct	01:39	42 00.4	66 53.2	13 Oct	20:48	41 54.9	66 32.4
	4447	AR	13 Oct	01:10	41 58.0	66 50.3	13 Oct	20:27	41 54.0	66 32.8
	21	LC	13 Oct	01:11	41 58.0	66 50.3	13 Oct	23:54	41 49.6	66 40.3
	22	LC	13 Oct	02:37	42 02.8	66 50.2	13 Oct	22:30	41 55.2	66 32.7
	25	LC	13 Oct	01:40	42 00.4	66 53.2	13 Oct	23:22	41 49.3	66 37.3
	26	LC	13 Oct	02:13	42 04.0	66 52.1	13 Oct	18:09	42 03.2	66 38.8
13	2754	AR	14 Oct	21:23	42 01.6	66 52.5	16 Oct	12:39	41 55.8	66 37.0
	2755	AR	14 Oct	22:58	41 59.2	66 52.1	16 Oct	13:14	41 53.5	66 39.7
	2757	AR	14 Oct	20:56	42 04.9	66 52.7	16 Oct	13:11	41 53.5	66 39.6
	22	LC	14 Oct	20:57	42 04.9	66 52.7	16 Oct	11:36	41 01.2	66 37.7
	25	LC	14 Oct	21:24	42 01.6	66 52.5	16 Oct	12:09	41 57.3	66 37.5
	26	LC	14 Oct	22:59	41 59.2	66 52.1	16 Oct	12:15	41 56.8	66 37.4

TABLE 2: Release and recovery times (UT) and positions for Georges Bank drift buoys during 1989. The buoy type refers to ARGOS (AR) or LORAN-C (LC) drifters. The positions were determined from the ship's LORAN-C data after application of the additional secondary factor (ASF).

Dep. #	Buoy ID	Buoy Type	Release Date	Release Hr:Mn	Release Lat	Release Long	Recovery Date	Recovery Hr:Mn	Recovery Lat	Recovery Long
14	2485	AR	14 Jul	19:32	41 55.8	66 52.6	19 Jul	17:01	41 47.5	66 38.3
	2754	AR	14 Jul	15:02	41 53.5	66 51.0	20 Jul	05:01	41 25.7	67 13.9
	2755	AR	14 Jul	21:47	42 00.4	66 53.5	19 Jul	22:05	41 36.0	66 30.9
	2757	AR	14 Jul	04:31	42 04.0	66 51.9	19 Jul	23:18	41 30.3	66 32.2
	21	LC	14 Jul	04:30	42 04.1	66 52.0	19 Jul	18:27	41 47.0	66 44.9
	22	LC	14 Jul	14:59	41 53.5	66 51.2	20 Jul	03:15	41 34.3	67 08.6
	23	LC	14 Jul	23:29	41 56.5	66 51.0	19 Jul	19:51	41 51.2	66 38.9
	24	LC	14 Jul	16:59	41 53.1	66 52.1	20 Jul	01:37	41 37.4	66 59.4
	25	LC	15 Jul	00:20	41 57.3	66 54.1	17 Jul	12:01	41 51.9	66 49.4
	26	LC	14 Jul	20:30	41 58.3	66 50.3	19 Jul	19:02	41 49.6	66 42.6
	27	LC	14 Jul	21:38	42 00.2	66 53.2	19 Jul	17:53	41 47.6	66 42.6
	28	LC	14 Jul	22:32	41 57.2	66 48.0	17 Jul	12:52	41 50.9	66 46.7
	39	LC	14 Jul	19:14	41 55.9	66 52.3	17 Jul	16:32	42 04.2	66 36.8
15	2485	AR	20 Jul	13:49	42 01.9	67 11.1	21 Jul	21:26	42 00.4	66 57.4
	2754	AR	20 Jul	10:16	41 59.8	67 16.2	21 Jul	19:24	42 02.0	67 07.9
	2755	AR	20 Jul	14:21	42 05.1	67 10.6	21 Jul	23:53	41 57.4	67 00.2
	2757	AR	20 Jul	10:56	41 58.1	67 16.3	22 Jul	00:56	41 60.0	67 08.7
	21	LC	20 Jul	09:30	42 01.7	67 15.9	21 Jul	19:12	42 02.8	67 08.4
	22	LC	20 Jul	14:20	42 05.0	67 10.5	21 Jul	20:48	42 00.9	66 58.1
	23	LC	20 Jul	13:28	42 00.8	67 10.5	22 Jul	01:46	42 00.4	66 59.0
	24	LC	20 Jul	10:12	41 59.9	67 16.3	21 Jul	22:47	42 01.1	67 04.9
	25	LC	20 Jul	11:36	41 56.2	67 16.5	21 Jul	19:53	42 00.0	67 05.7
	26	LC	20 Jul	10:56	41 58.0	67 16.2	21 Jul	19:42	42 00.9	67 06.5
	27	LC	20 Jul	12:17	41 58.6	67 20.8	21 Jul	22:04	42 01.4	67 00.7
	28	LC	20 Jul	10:57	41 58.0	67 16.4	21 Jul	19:08	42 03.0	67 08.6
	39	LC	20 Jul	10:22	41 59.7	67 16.3	21 Jul	23:02	42 00.7	67 04.4
16	2485	AR	24 Jul	11:12	42 13.2	67 19.5	25 Jul	18:01	42 13.0	66 41.4
	2754	AR	24 Jul	09:36	42 16.9	67 15.3	26 Jul	16:16	42 14.2	66 22.3
	2755	AR	24 Jul	12:29	42 10.0	67 15.8	26 Jul	12:56	42 09.0	66 37.4
	2757	AR	24 Jul	14:27	42 04.2	67 16.4	26 Jul	19:36	42 03.9	66 47.9
	21	LC	24 Jul	13:40	42 07.2	67 11.7	Not Recovered			
	22	LC	24 Jul	11:55	42 09.8	67 19.8	26 Jul	21:20	41 58.7	66 48.6
	23	LC	24 Jul	10:21	42 13.1	67 16.0	26 Jul	14:33	42 17.5	66 38.1
	24	LC	24 Jul	11:05	42 13.1	67 19.8	26 Jul	13:41	42 13.7	66 39.8
	25	LC	24 Jul	09:36	42 16.9	67 15.3	26 Jul	12:04	42 11.9	66 34.6
	26	LC	24 Jul	12:29	42 10.0	67 15.8	26 Jul	22:42	41 57.2	66 39.3
	28	LC	24 Jul	14:25	42 04.2	67 16.4	26 Jul	20:38	42 01.7	66 51.5
	39	LC	24 Jul	13:01	42 07.0	67 16.1	26 Jul	21:53	41 58.4	66 46.3

Table 2. Continued.

Dep. #	Buoy ID	Buoy Type	Release Date	Release Hr:Mn	Release Lat	Release Long	Recovery Date	Recovery Hr:Mn	Recovery Lat	Recovery Long
17	2485	AR	27 Jul	06:28	42 03.4	67 18.2	29 Jul	22:14	41 57.4	66 42.7
	2754	AR	27 Jul	08:36	42 16.0	67 16.6	29 Jul	18:30	42 28.4	66 46.1
	2757	AR	27 Jul	03:48	41 57.8	67 16.4	29 Jul	21:46	41 57.4	66 40.0
	22	LC	27 Jul	05:36	41 55.8	67 16.5	29 Jul	09:47	41 59.3	67 10.5
	23	LC	27 Jul	07:02	42 06.7	67 18.3	28 Jul	01:18	42 06.0	66 56.1
	24	LC	27 Jul	07:54	42 13.1	67 16.5	29 Jul	15:58	42 12.9	66 36.4
	25	LC	27 Jul	08:35	42 15.9	67 16.5	29 Jul	16:37	42 14.4	66 41.6
	26	LC	27 Jul	03:45	41 57.8	67 16.3	29 Jul	07:29	41 56.4	66 57.0
	28	LC	27 Jul	04:42	42 01.6	67 16.3	29 Jul	08:48	41 58.3	66 58.3
	39	LC	27 Jul	04:10	41 59.6	67 16.4	29 Jul	07:47	41 56.8	66 57.4

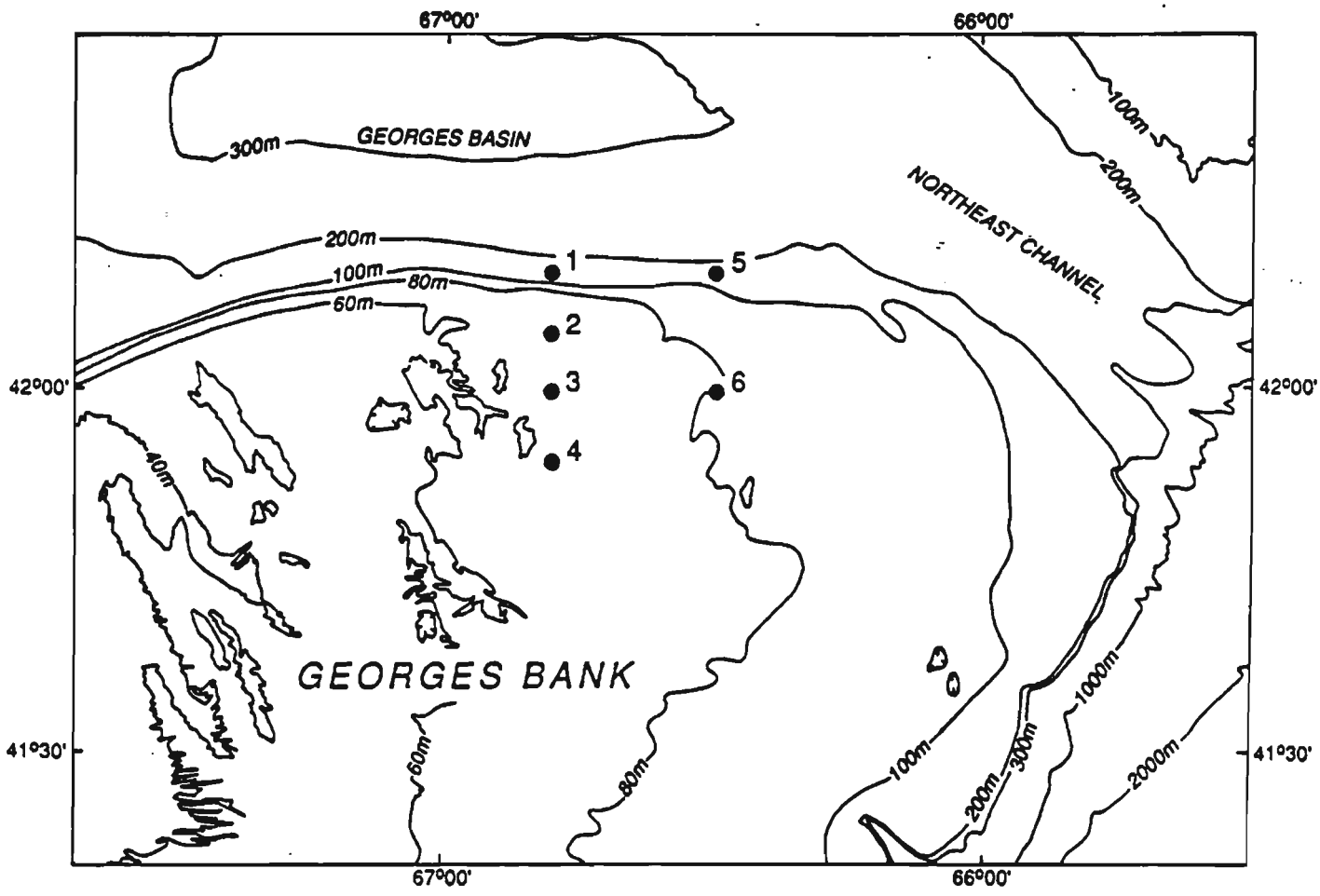


Fig. 1. The study site on the northeast peak of Georges Bank showing the location of the current meter moorings (stations 1-6) during 1988.

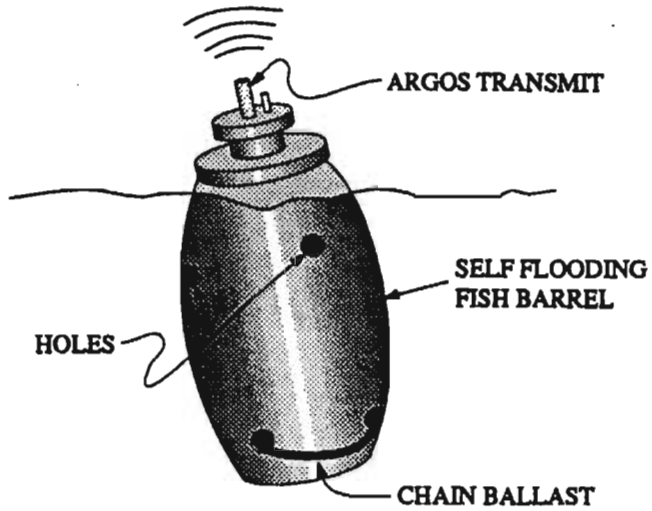


Fig. 2. The Accurate Surface Tracker (AST) ARGOS buoy.

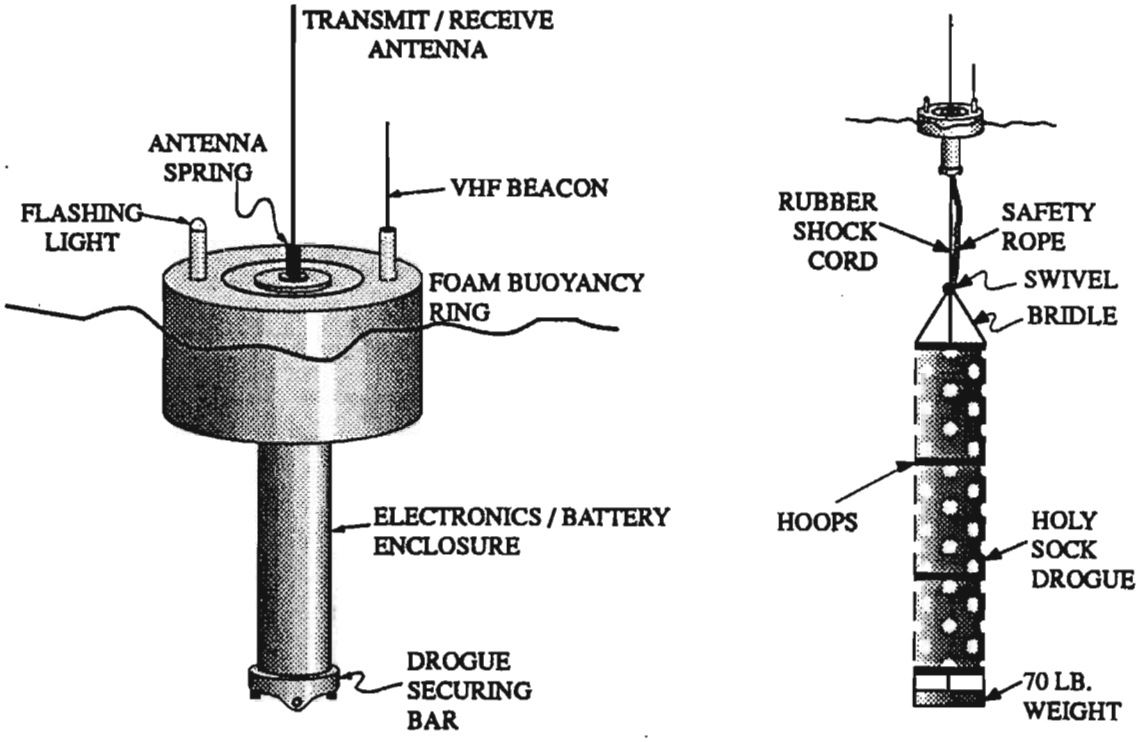


Fig. 3. Sea Rover 3 LORAN-C buoy (left) and drogue configuration (right).

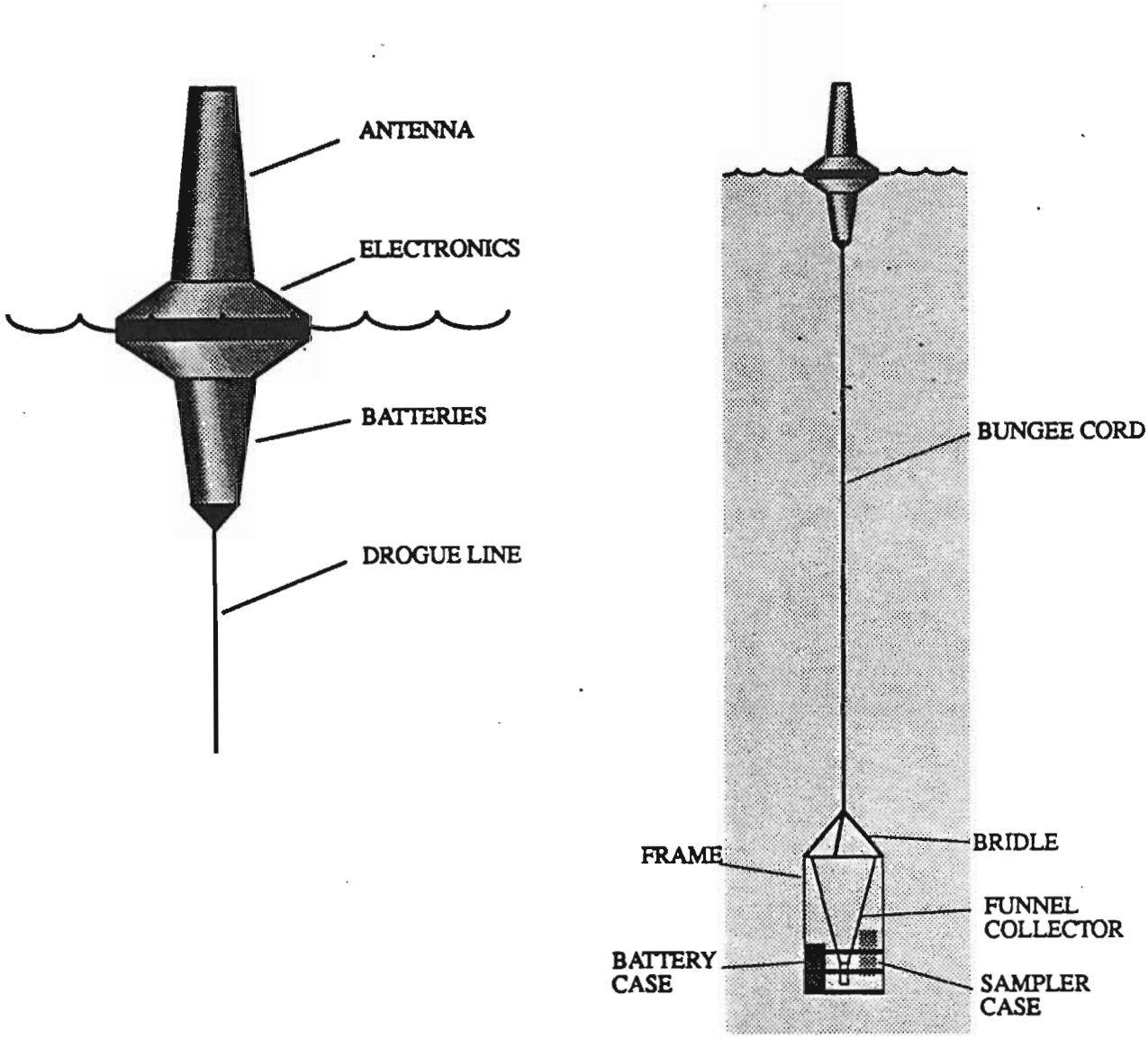


Fig. 4. HERMES ARGOS surface buoy (left) and sediment trap configuration (right).

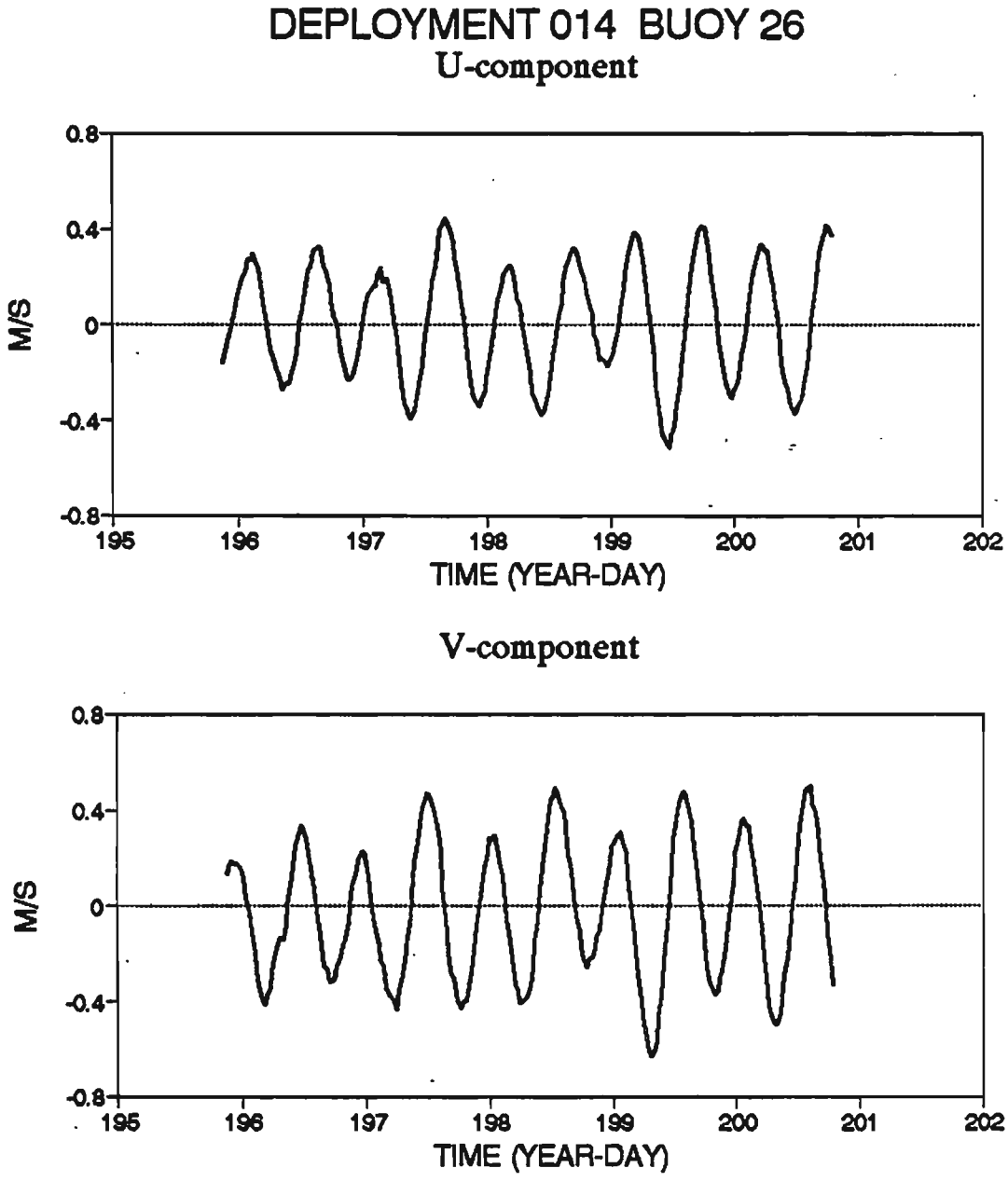


Fig. 5. The velocity components from buoy 26 during deployment 14. The U-component is positive eastward and the V-component is positive northward.

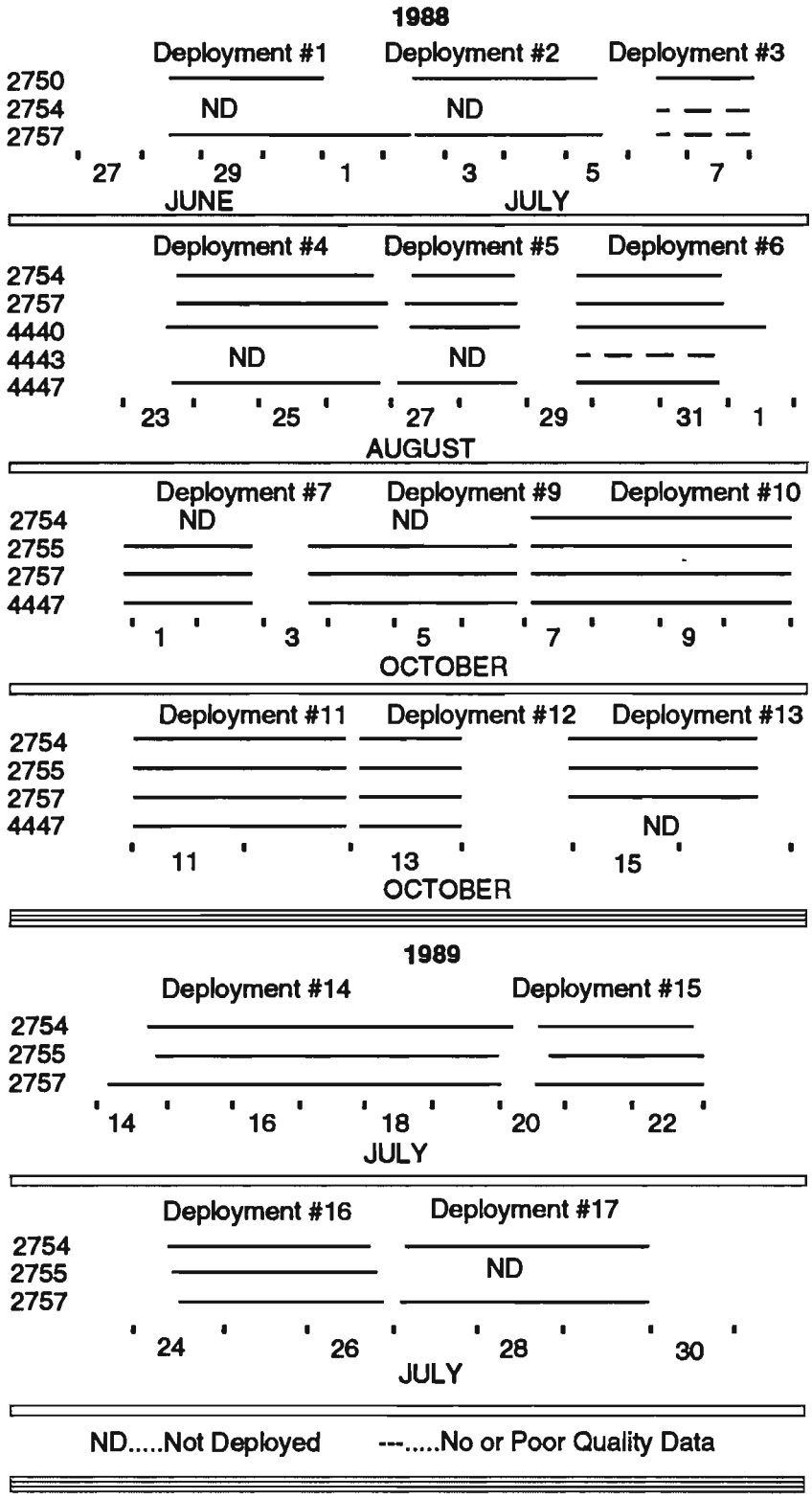


Fig. 6 Time table and data return from the ARGOS buoy deployments.

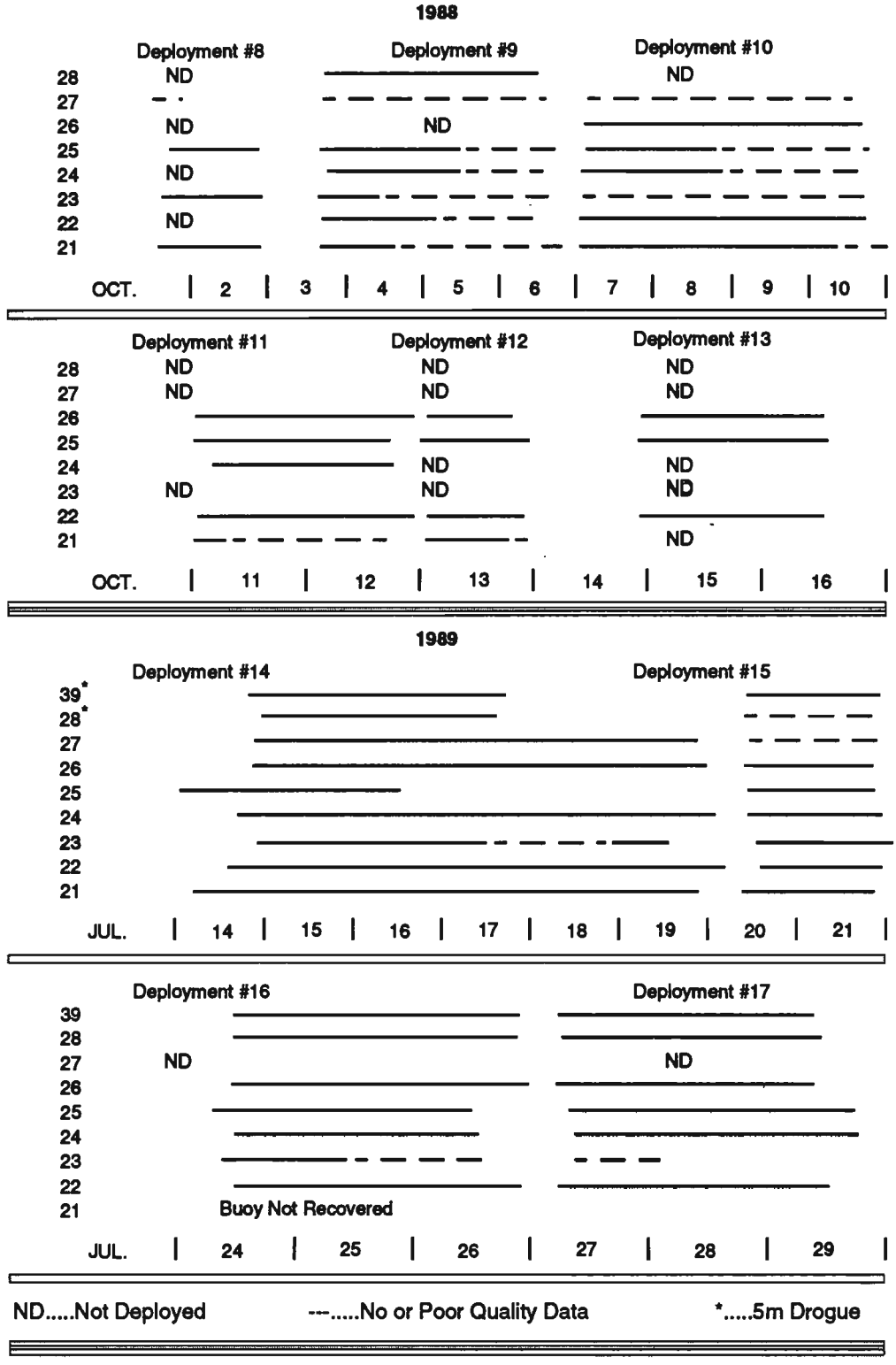


Fig. 7. Time table and data return from the LORAN-C buoy deployments.

APPENDIX

For each cluster deployment the following is provided:

1. An information sheet.

2. A figure showing the buoy release sites relative to the cross-bank temperature and density (sigma-theta) structure, when available. The ARGOS (AR) and LORAN-C (LC) buoy numbers shown above the temperature diagram were released along or near the transect line. The remaining buoys are displayed above the sigma-theta plot at the corresponding latitude. The vertical tick marks on the 0 m line indicate where CTD profiles were taken. The temperature and density plots have not been adjusted for tidal advection.

3. A figure showing the wind speed and direction as measured by the meteorological buoy and the ship's anemometer. Data from the buoy were not always available. The time of the first deployment and last recovery are marked on the time axis by vertical arrows.

4. A composite plot of the drift tracks for buoys released during the deployment. The release sites are marked by an x.

5. A plot of the residual drift tracks as determined from the filtered data. The initial start point is a mean position between the start and end locations of the first filtered average. These initial locations are marked by an x and the location at the end of each calendar day is marked by a +.

6. Plots of the individual drift tracks. The release site is marked by an x.

Note that for the trajectory plots the dotted line denotes the 60 m contour, the dash-dot line the 100 m contour and the dash-double dot line the 200 m contour.

When clusters contained both ARGOS and LORAN-C buoys, the ARGOS data are presented first.

DEPLOYMENT # 1

No. of buoys released:	ARGOS 2 LORAN-C 0
Time of first deployment:	14:05 Jun 28, 1988
Time of last recovery:	10:37 Jul 2, 1988
Total time duration:	92.5 hr

Hydrographic Structure:

No CTD data were taken during the deployment of the buoys, however, the current meter measurements and a BATFISH section taken 6 hr prior to deployment suggested that the buoys were deployed in weakly stratified water (vertical density difference of 0.2-0.5 σ_t) in the frontal zone.

Winds:

Wind speeds varied during the deployment from periods of calm to upwards of 10 m s^{-1} as measured by the ship's anemometer. Directions also varied but were primarily towards the northeast quadrant. Wind data were available from the meteorological buoy only during the first 10 hr of the tracking.

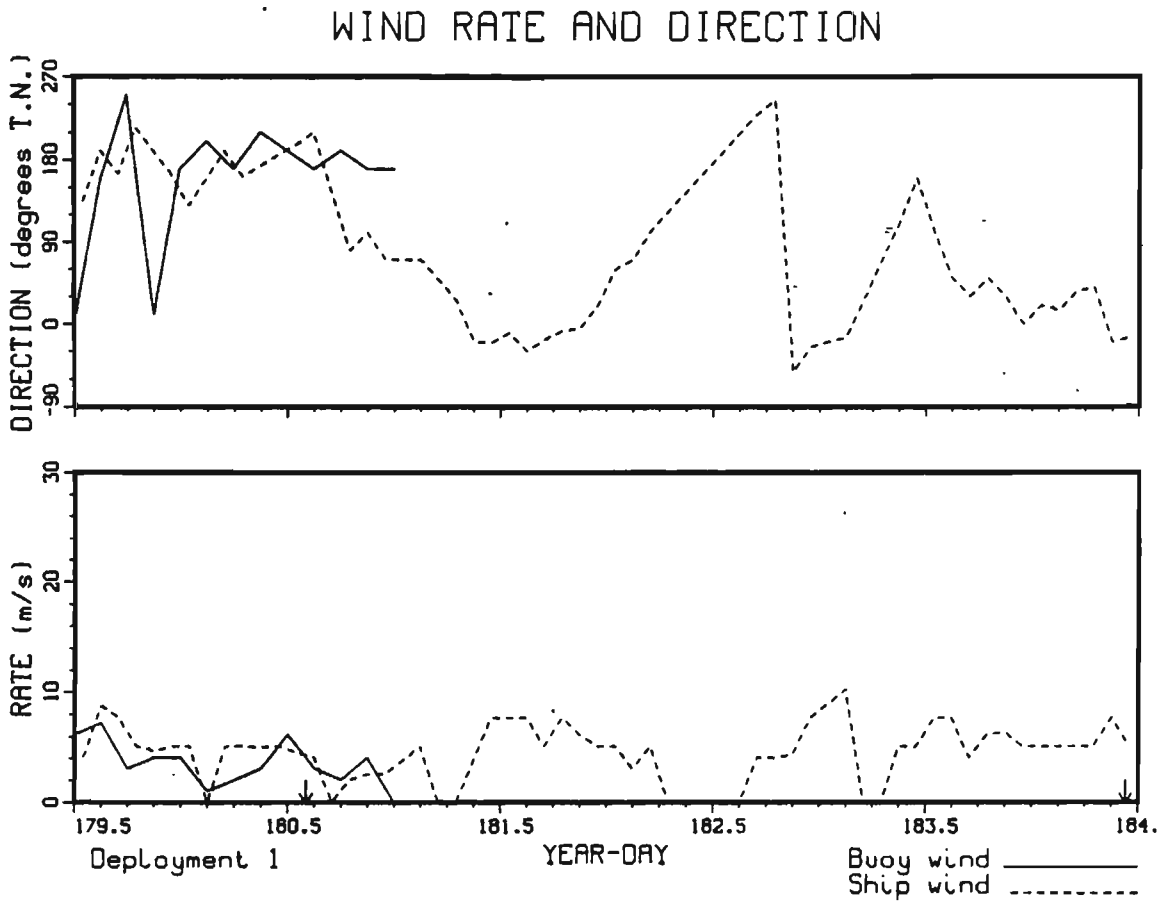
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2750	AR	-	28 Jun 14:05	30 Jun 21:23	23	56	100
2757	AR	-	28 Jun 14:23	2 Jul 10:37	37	92	100

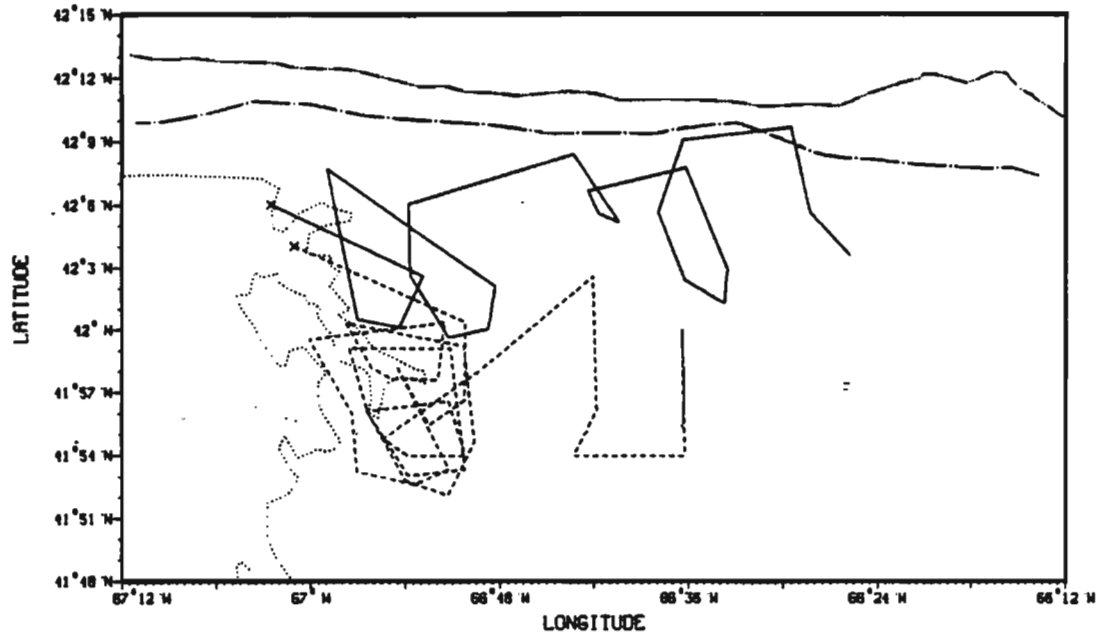
Mean Residual Currents:

Residual currents were calculated from 25 h running means.

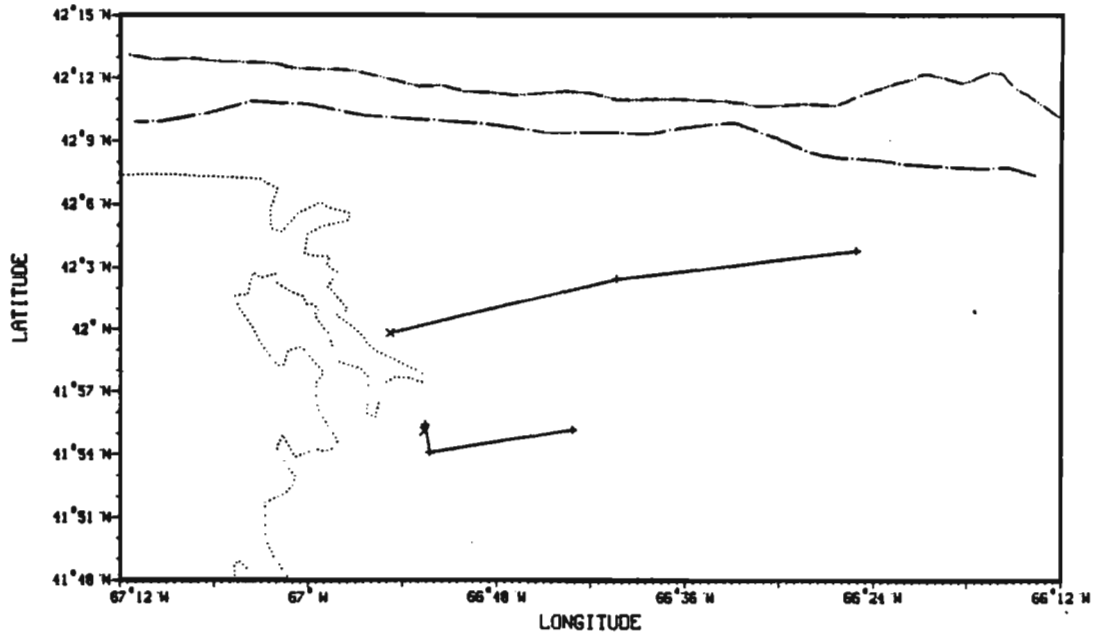
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2750	0.234	0.047	0.234	79°
2757	0.048	-0.001	0.048	91°


WIND RATE AND DIRECTION
DIRECTION (degrees T.N.)
270
180
90
0
-90
RATE (m/s)
30
20
10
0
179.5
180.5
181.5
182.5
183.5
184.5
Deployment 1
YEAR-DAY
Buoy wind
Ship wind

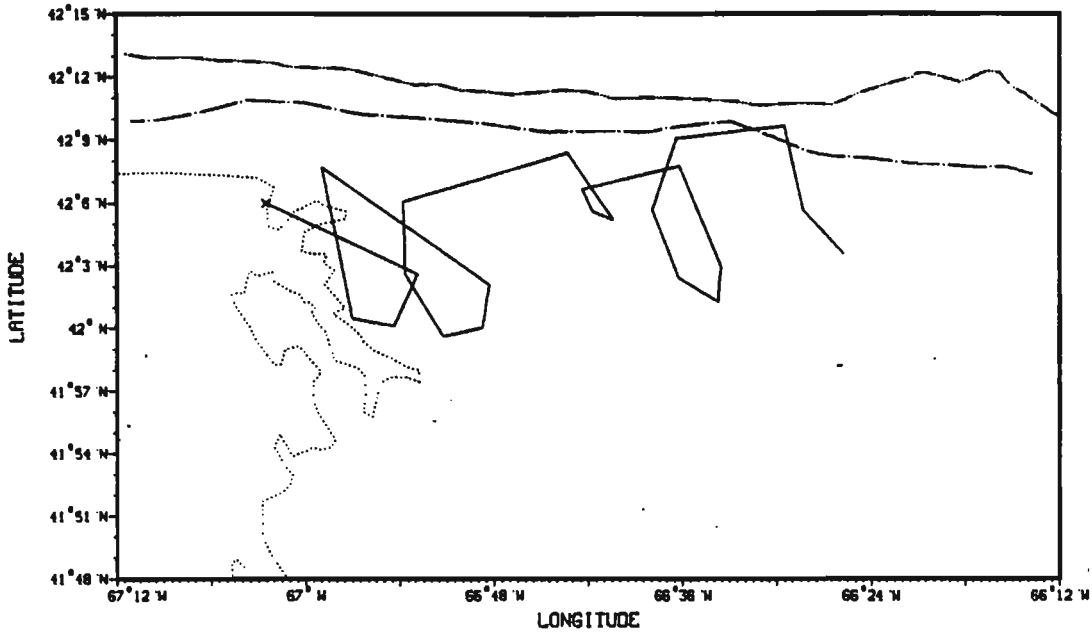
DEPLOYMENT 1 JUNE 28 - JULY 2 / 88



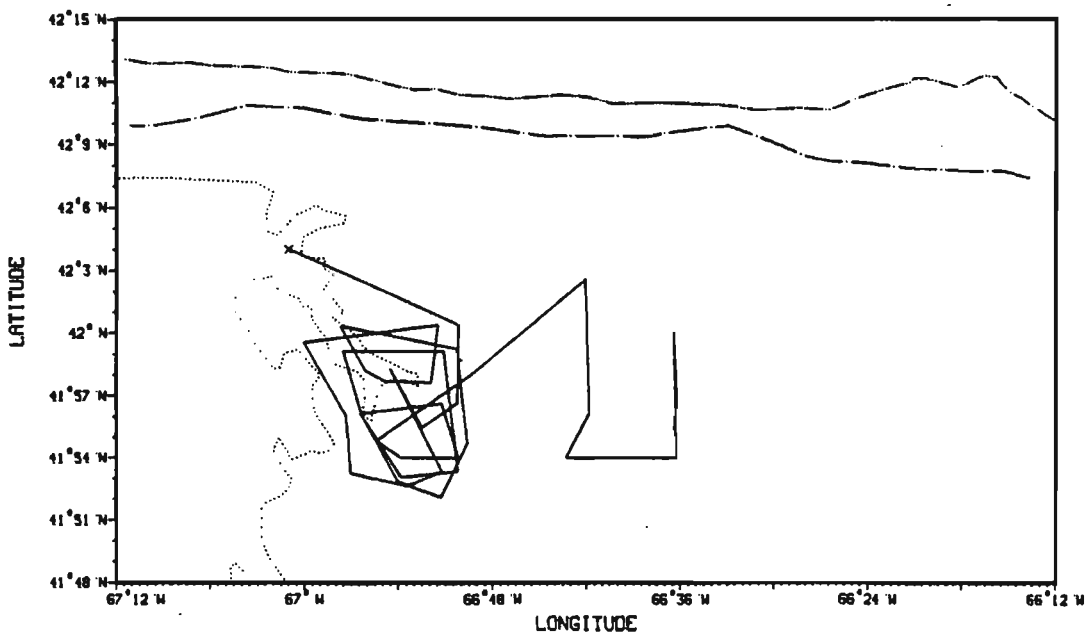
DEPLOYMENT 1 JUNE 28 - JULY 2 / 88



DEPLOYMENT 1 ARGOS BUOY 2750



DEPLOYMENT 1 ARGOS BUOY 2757



DEPLOYMENT # 2

No. of buoys released:	ARGOS 2	LORAN-C 0
Time of first deployment:	12:17 Jul 2, 1988	
Time of last recovery:	11:16 Jul 5, 1988	
Total time duration:	71.0 hr	

Hydrographic Structure:

No CTD data were taken during the deployment of the buoys, however, the current meter measurements and a satellite infrared image from 17 hr prior to deployment suggested that the buoys were deployed in the high surface temperature gradient (north-south) region of the frontal zone.

Winds:

During deployment 2 winds were weak (0-8 m s^{-1}). Directions were initially northward, veered to eastward within 16 hr of the deployment and then gradually returned to northward by the end of 4 July (day 186). Calm conditions prevailed during 5 July (day 187).

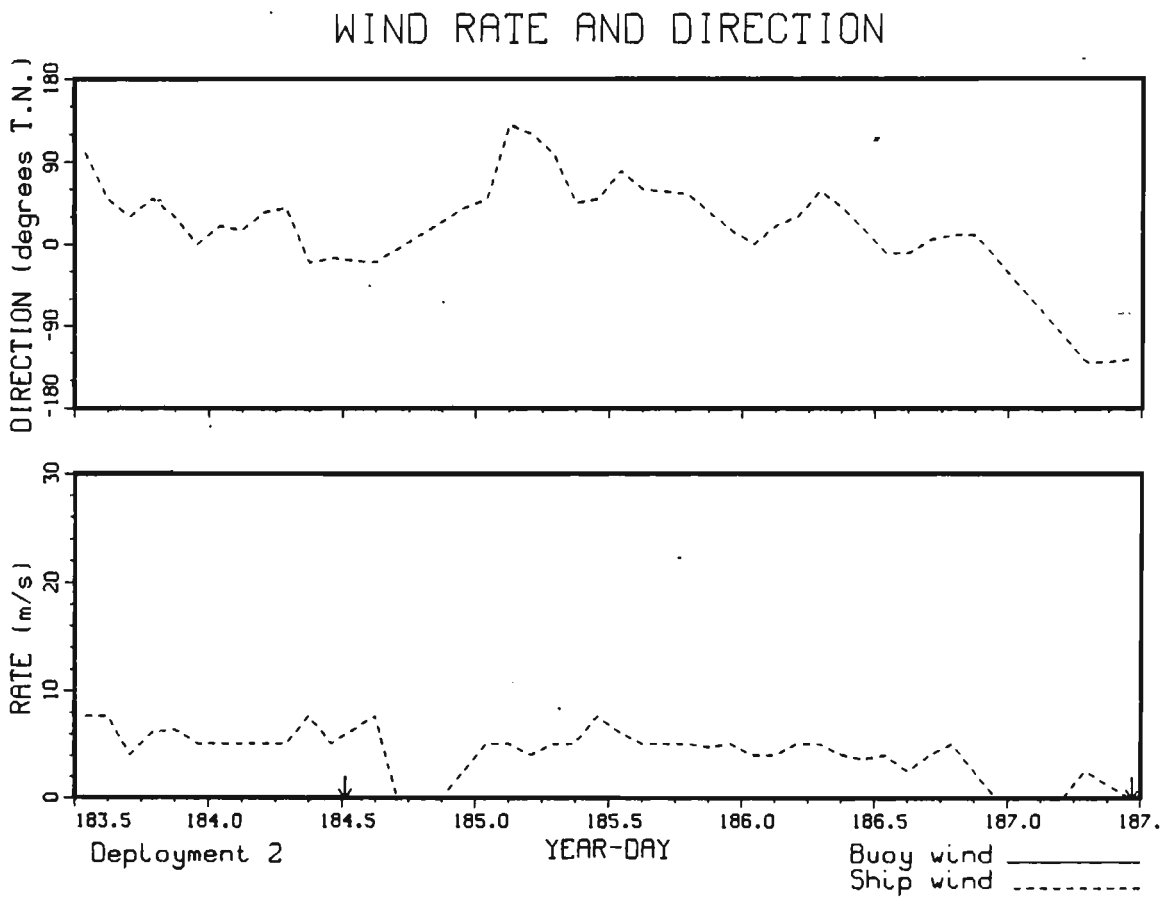
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2750	AR	-	2 Jul 12:38	5 Jul 11:07	32	71	100
2757	AR	-	2 Jul 12:17	5 Jul 11:16	33	71	100

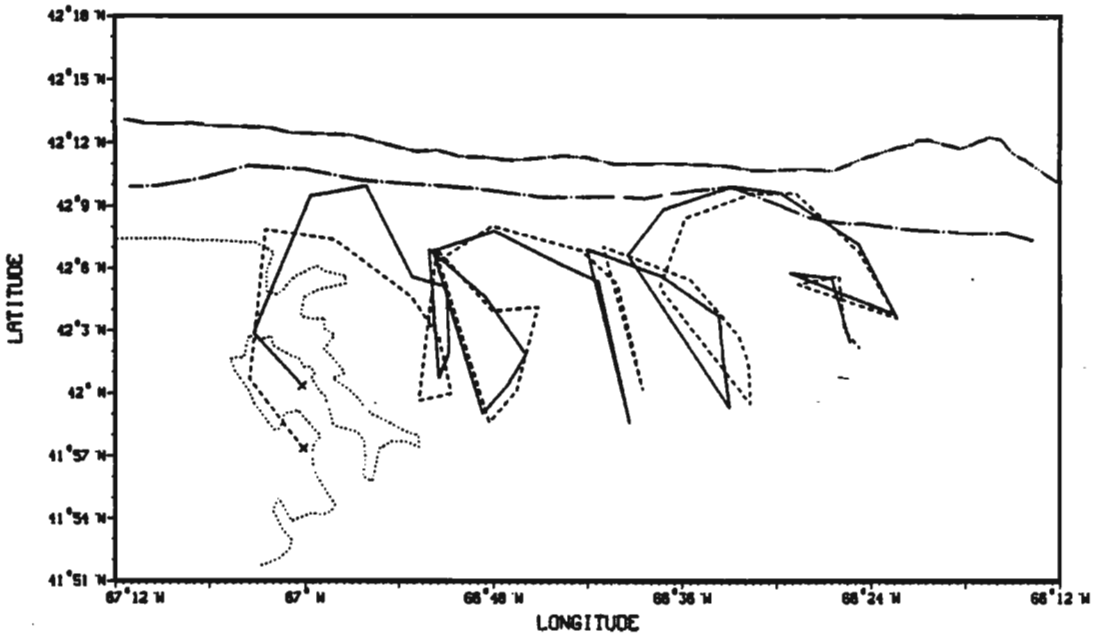
Mean Residual Currents:

Residual currents were calculated from 25 h running means.

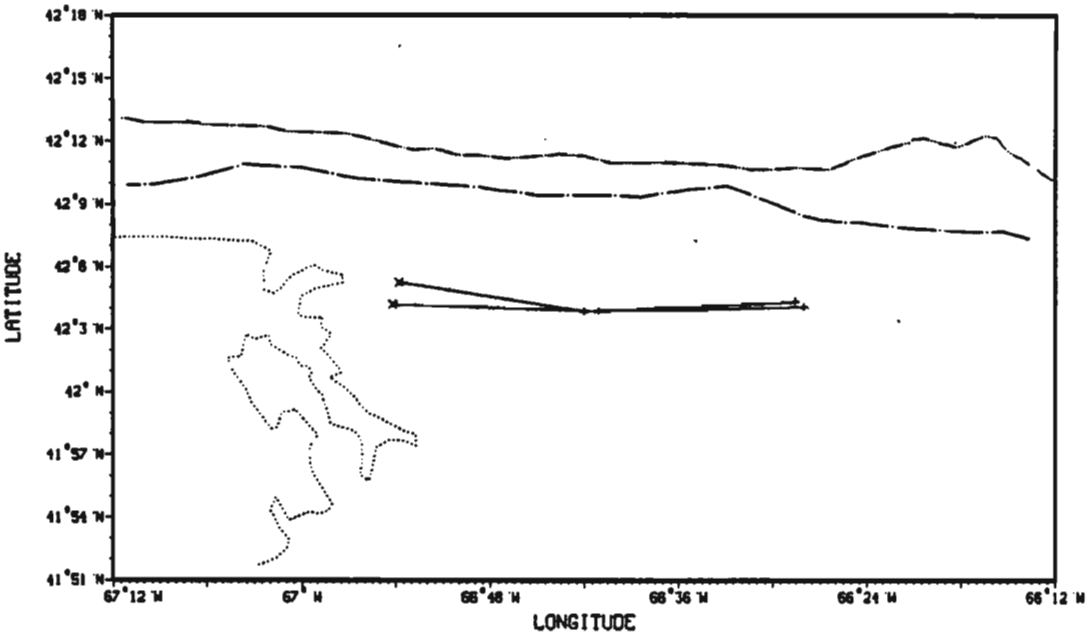
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2750	0.200	-0.011	0.200	93°
2757	0.208	-0.001	0.208	90°


WIND RATE AND DIRECTION
DIRECTION (degrees T.N.)
180
90
0
-90
-180
RATE (m/s)
30
20
10
0
183.5
184.0
184.5
185.0
185.5
186.0
186.5
187.0
187.5
Deployment 2
YEAR-DAY
Buoy wind
Ship wind

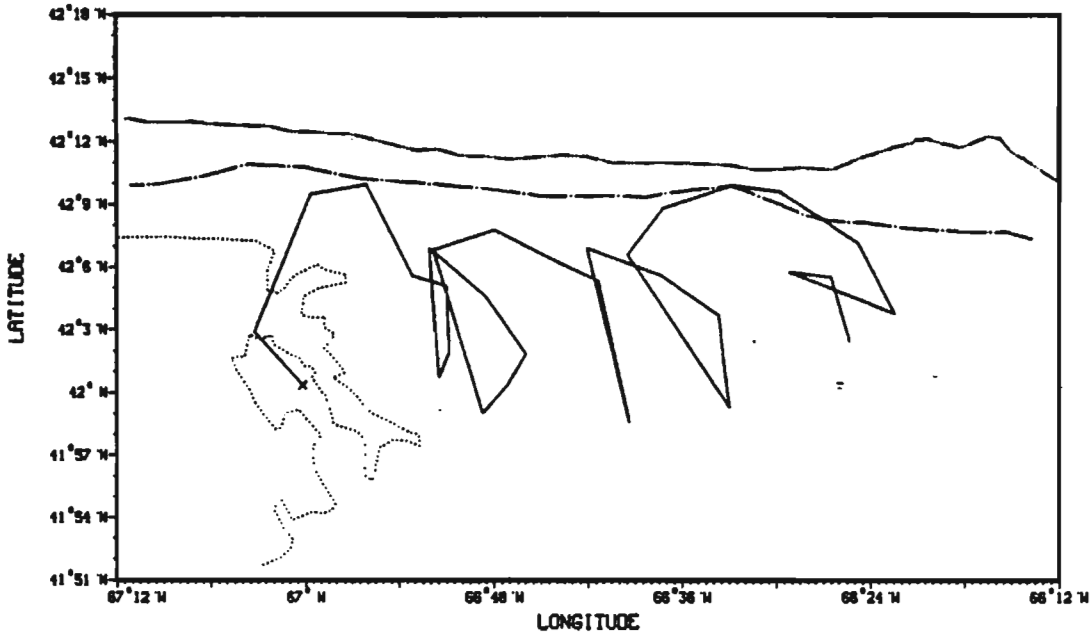
DEPLOYMENT 2 JULY 2 - 5 / 88



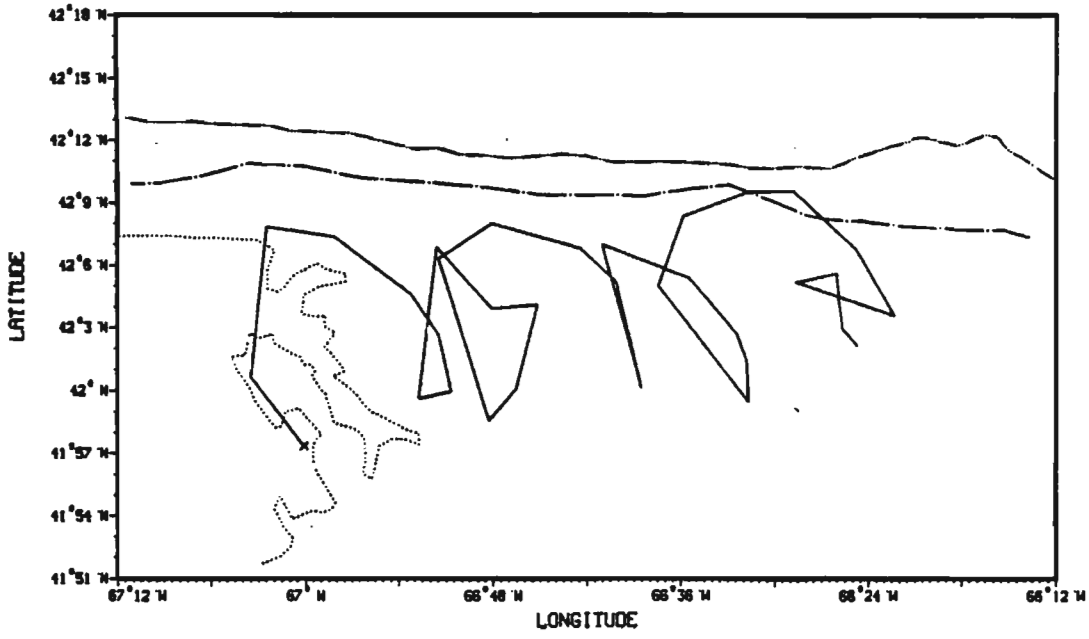
DEPLOYMENT 2 JULY 2 - 5 / 88



DEPLOYMENT 2 ARGOS BUOY 2750



DEPLOYMENT 2 ARGOS BUOY 2757



DEPLOYMENT # 3

No. of buoys released:	ARGOS 3	LORAN-C	0
Time of first deployment:	14:52 Jul 6, 1988		
Time of last recovery:	21:32 Jul 7, 1988		
Total time duration:	30.7 hr		

Hydrographic Structure:

No CTD data were taken during the deployment of the buoys, however, a satellite infrared image just prior to recovery (20:13, 7 July) suggested that the buoys 2750 and 2757 were drifting in the high surface temperature gradient (north-south) region of the frontal zone.

Winds:

Light (0-6 m s^{-1}) northward winds persisted during the tracking of deployment #3.

Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2750	AR	-	6 Jul 14:52	7 Jul 21:32	11	31	100*
2754	AR	-	6 Jul 15:13	7 Jul 20:54	2	30	0**
2757	AR	-	6 Jul 15:38	7 Jul 20:27	3	30	11**

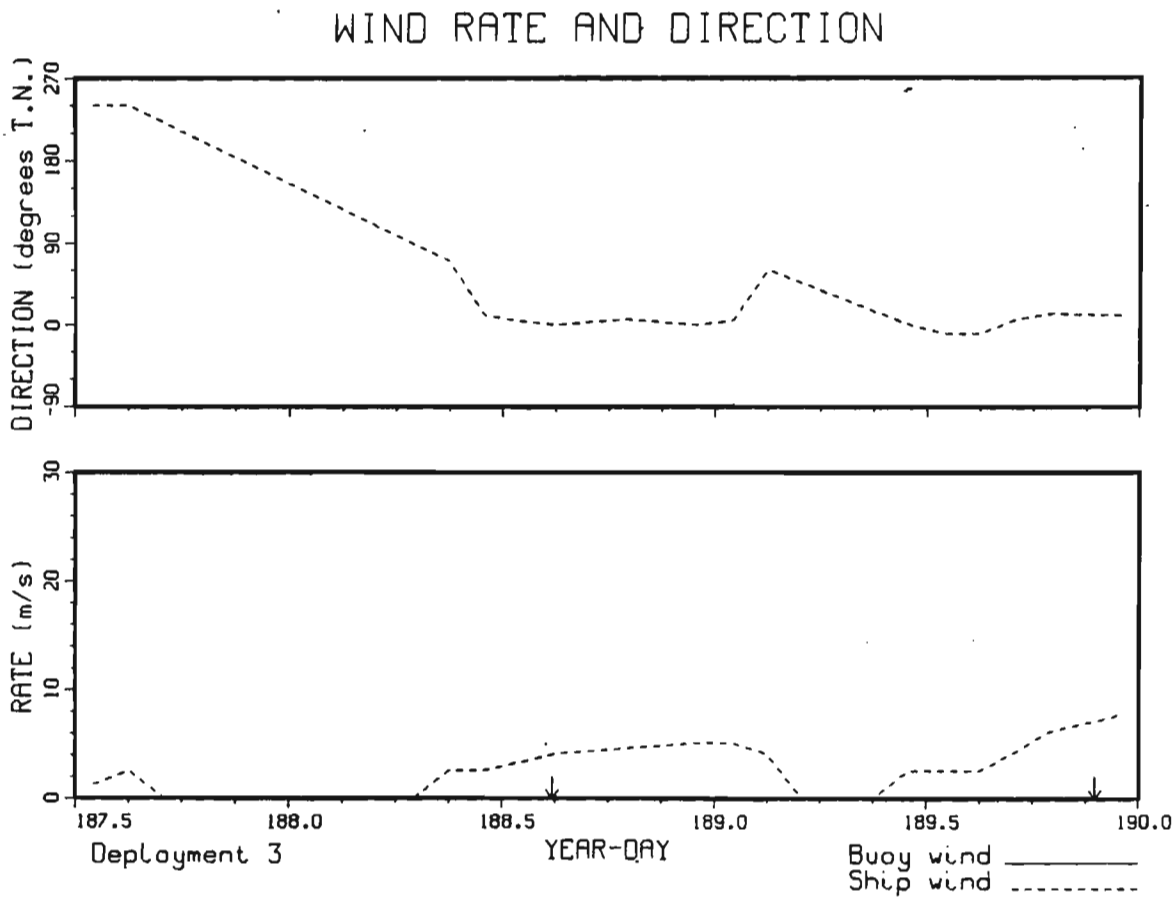
* No satellite fixes were obtained; the 2 fixes were the ship's release and recovery positions.

** Only 1 satellite fix was obtained.

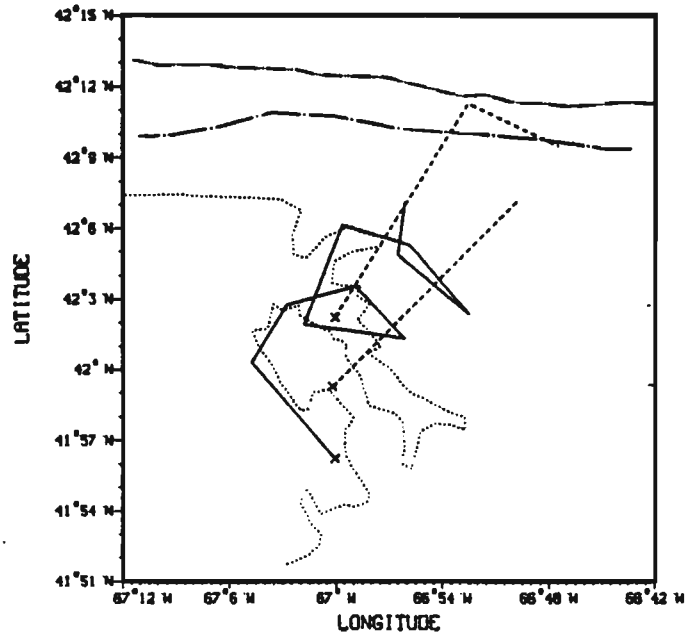
Mean Residual Currents:

The residual current was calculated from 12.5 h running means.

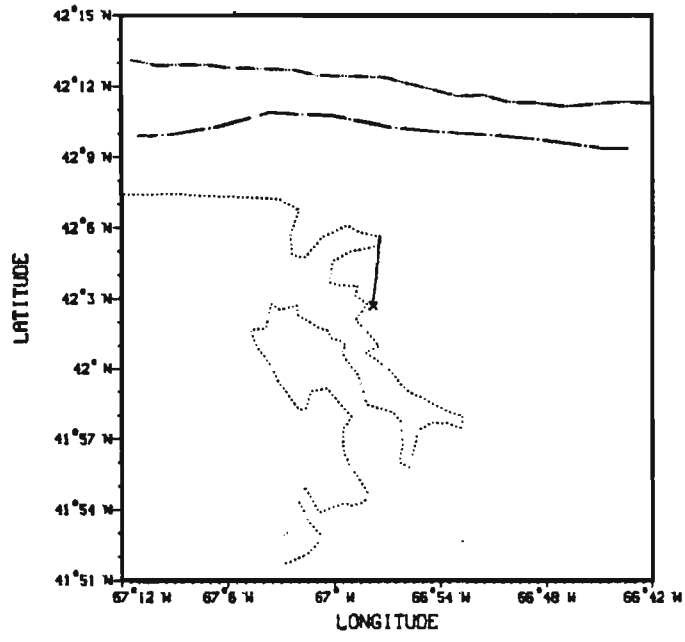
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2750	0.013	0.127	0.128	6°
2754	No Mean Calculated			
2757	No Mean Calculated			


WIND RATE AND DIRECTION
DIRECTION (degrees T.N.)
270
180
90
0
-90
RATE (m/s)
30
20
10
0
187.5
188.0
188.5
189.0
189.5
190.0
Deployment 3
YEAR-DAY
Buoy wind
Ship wind

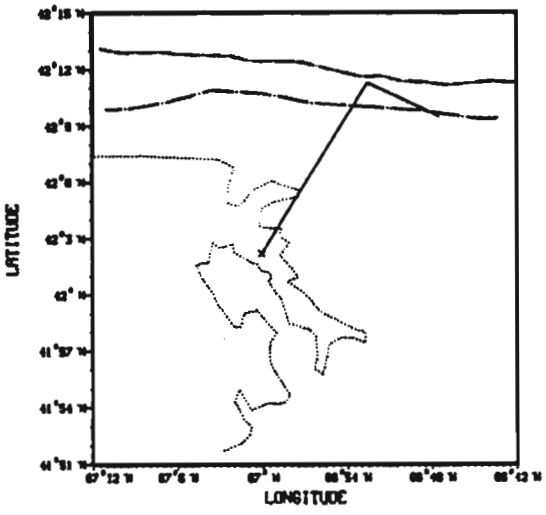
DEPLOYMENT 3 JULY 6 - 7 / 88



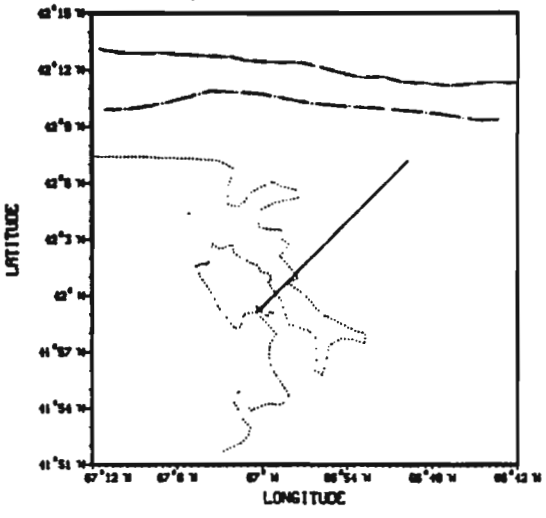
DEPLOYMENT 3 JULY 6 - 7 / 88



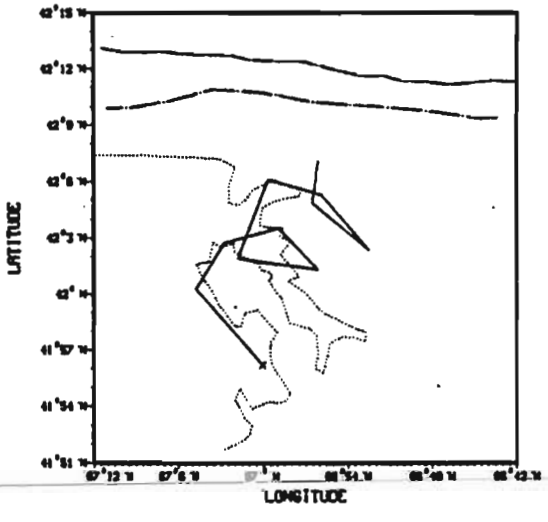
DEPLOYMENT 3 ARGOS BUOY 2757



DEPLOYMENT 3 ARGOS BUOY 2754



DEPLOYMENT 3 ARGOS BUOY 2750



DEPLOYMENT # 4

No. of buoys released:	ARGOS 4	LORAN-C 0
Time of first deployment:	20:40 Aug 23, 1988	
Time of last recovery:	23:38 Aug 26, 1988	
Total time duration:	75.0 hr	

Hydrographic Structure:

Buoy 2757 was released in relatively weakly stratified waters near the leading edge of the tidal front while buoys 4447, 4440, and 2754 were released at increasing distances to the north in highly stratified waters.

Winds:

At the time of the buoy releases light south to westward winds were blowing. Approximately 12 hr later winds increased in speed to 6-8 m s^{-1} towards the west. Later during 25 August (day 238) the ship's winds reached 12 m s^{-1} although a similar increase was not observed at the buoy site. Towards the end of 26 August (day 239) wind speeds dropped and tended towards the north to northwest.

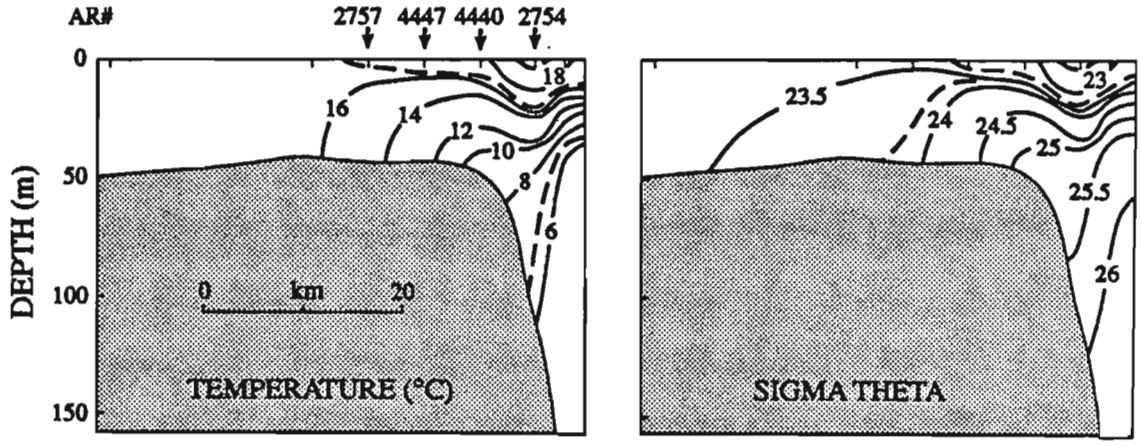
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	23 Aug 20:40	26 Aug 20:40	20	72	100
4440	AR	-	23 Aug 21:38	26 Aug 19:31	23	70	100
4447	AR	-	23 Aug 22:20	26 Aug 18:55	27	68	100
2757	AR	-	23 Aug 23:07	26 Aug 23:38	20	73	100

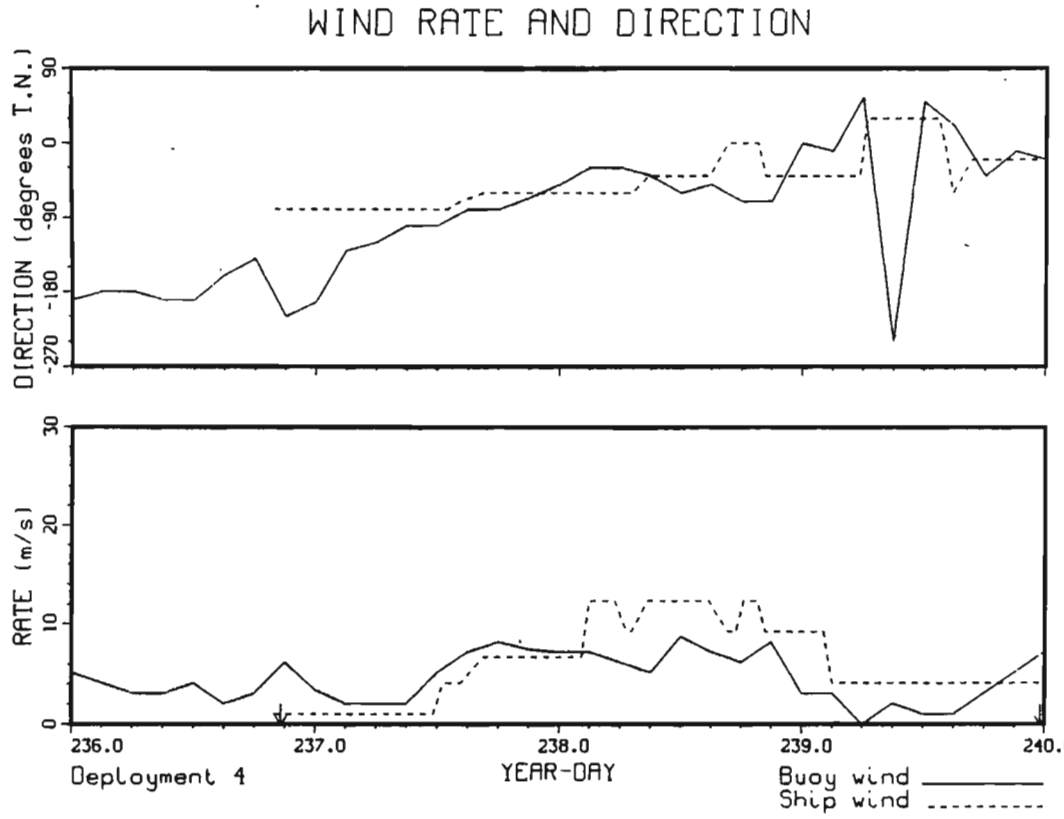
Mean Residual Currents:

Residual currents were calculated from 25 h running means.

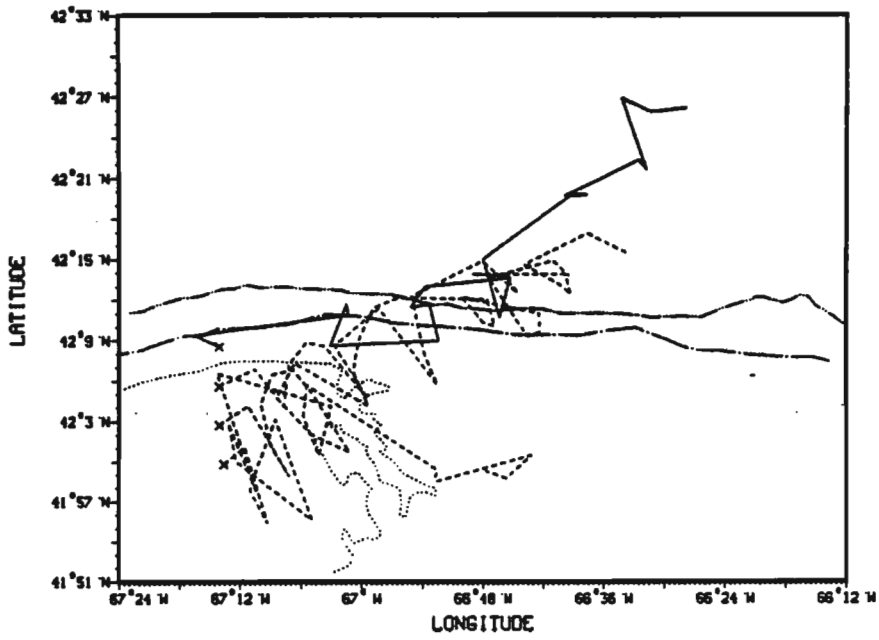
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.237	0.120	0.266	63°
2757	0.140	0.029	0.143	78°
4440	0.199	0.084	0.216	67°
4447	0.188	0.107	0.216	60°



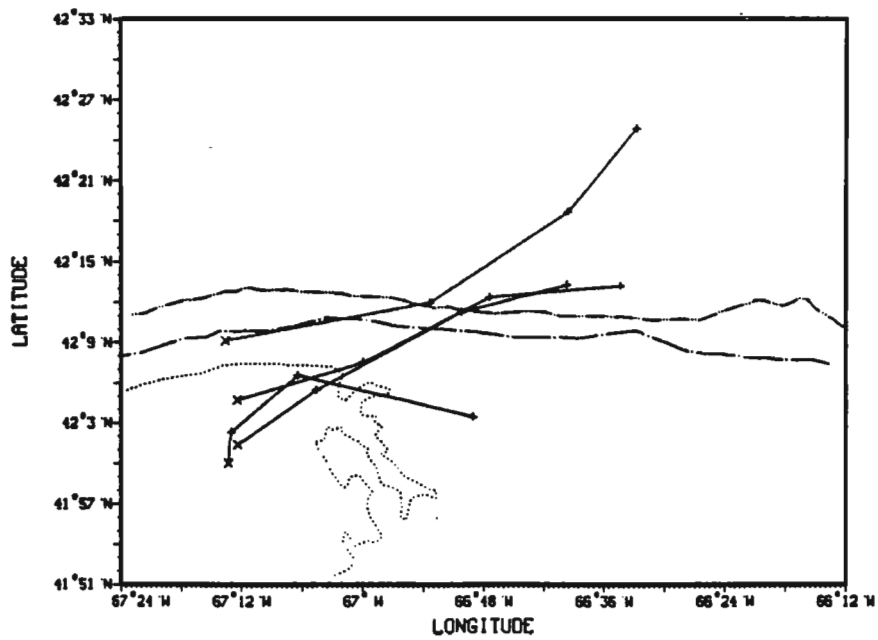
DEPLOYMENT 4 —23 AUGUST 1988 —67° 14' W



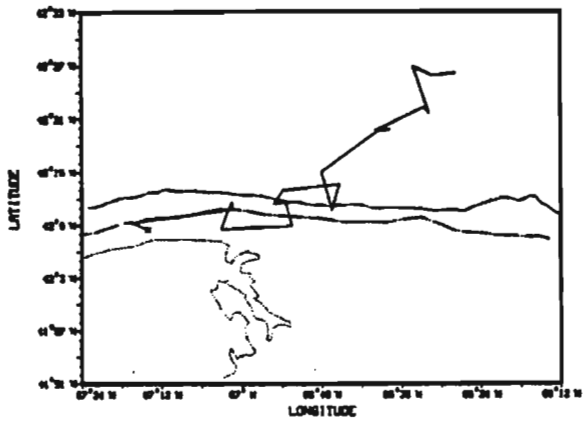
DEPLOYMENT 4 AUGUST 23 - 26 / 88



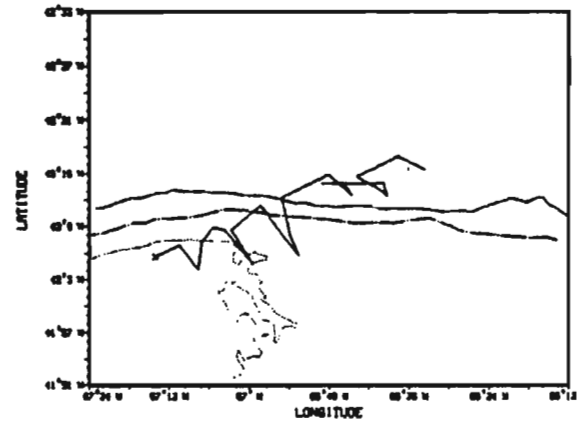
DEPLOYMENT 4 AUGUST 23 - 26 / 88



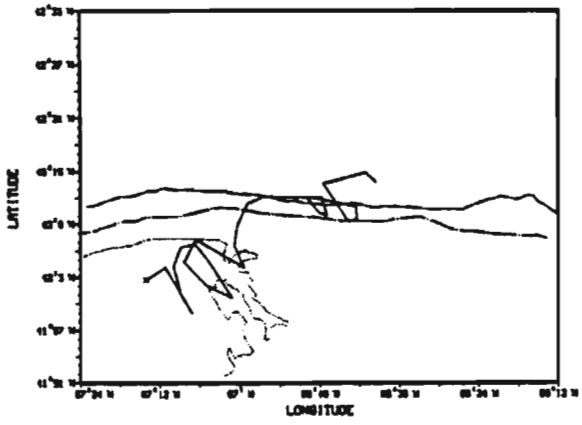
DEPLOYMENT 4 ARGOS BUOY 2754



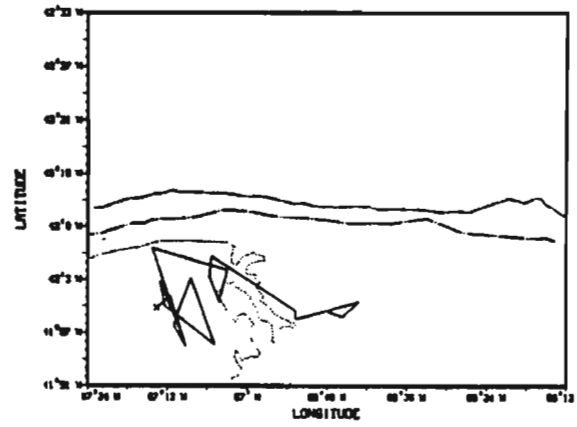
DEPLOYMENT 4 ARGOS BUOY 4440



DEPLOYMENT 4 ARGOS BUOY 4447



DEPLOYMENT 4 ARGOS BUOY 2757



DEPLOYMENT # 5

No. of buoys released: ARGOS 4 LORAN-C 0
Time of first deployment: 01:27 Aug 27, 1988
Time of last recovery: 21:43 Aug 28, 1988
Total time duration: 44.3 hr

Hydrographic Structure:

Buoy 2754 was released on the stratified side of the front, buoy 4440 near the leading edge of the front, and the remaining buoys on the well-mixed side of the front.

Winds:

During deployment 5 winds were very light and to the north.

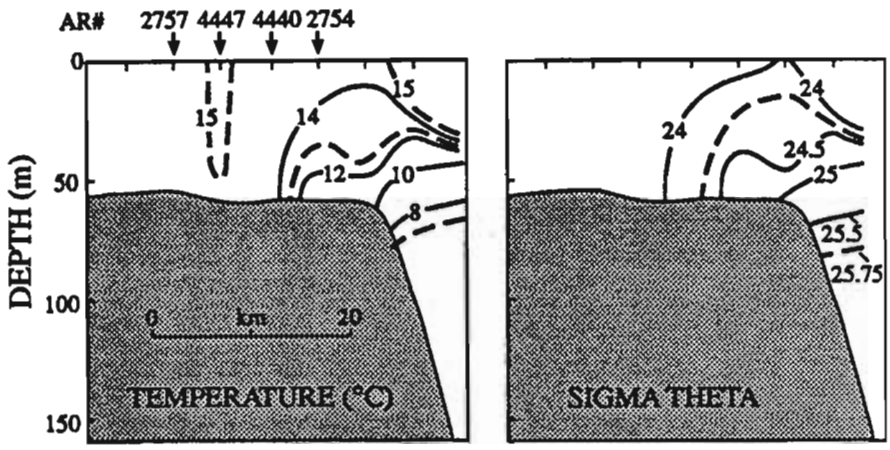
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	27 Aug 03:25	28 Aug 20:51	18	41	100
2757	AR	-	27 Aug 01:27	28 Aug 19:31	16	42	100
4440	AR	-	27 Aug 02:51	28 Aug 21:43	16	43	100
4447	AR	-	27 Aug 02:15	28 Aug 19:09	17	41	100

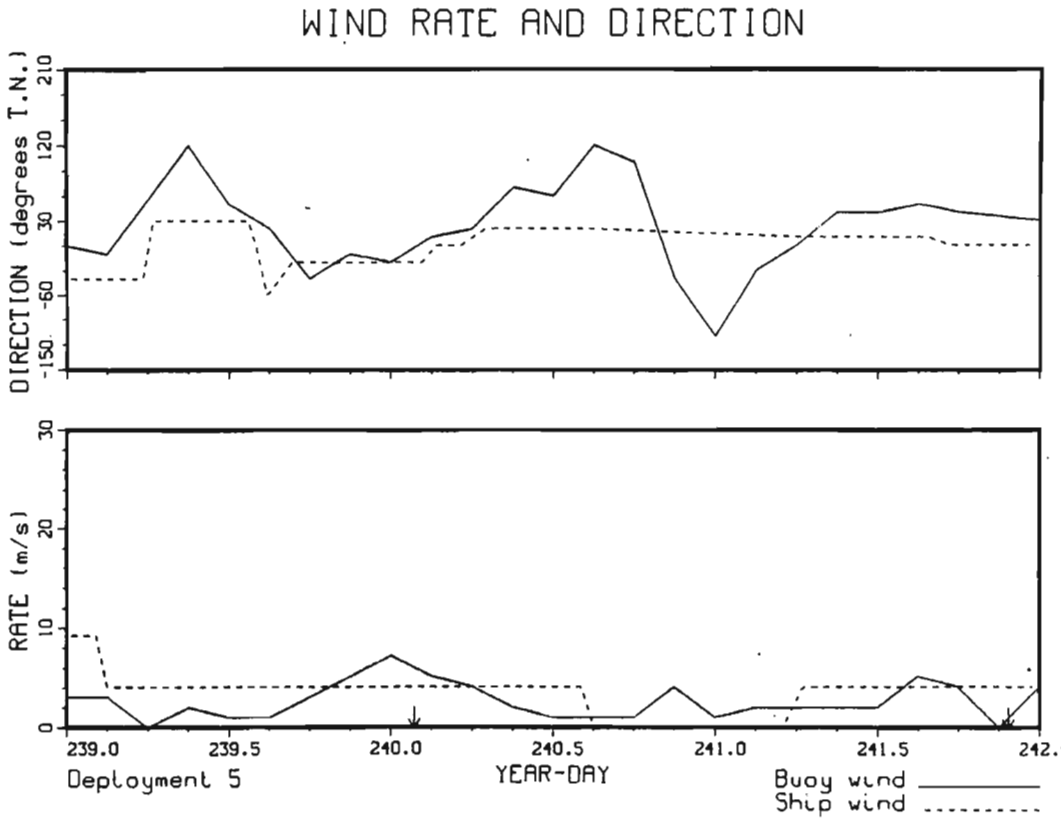
Mean Residual Currents:

Residual currents were calculated from 12.5 h running means.

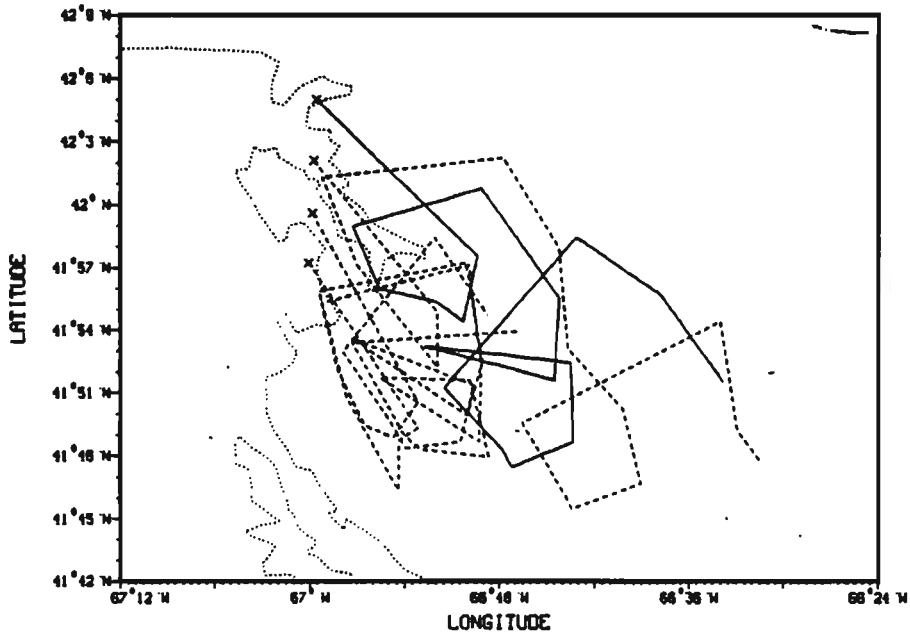
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.120	-0.117	0.168	134°
2757	0.046	-0.025	0.052	119°
4440	0.187	-0.129	0.227	125°
4447	0.028	-0.030	0.041	137°



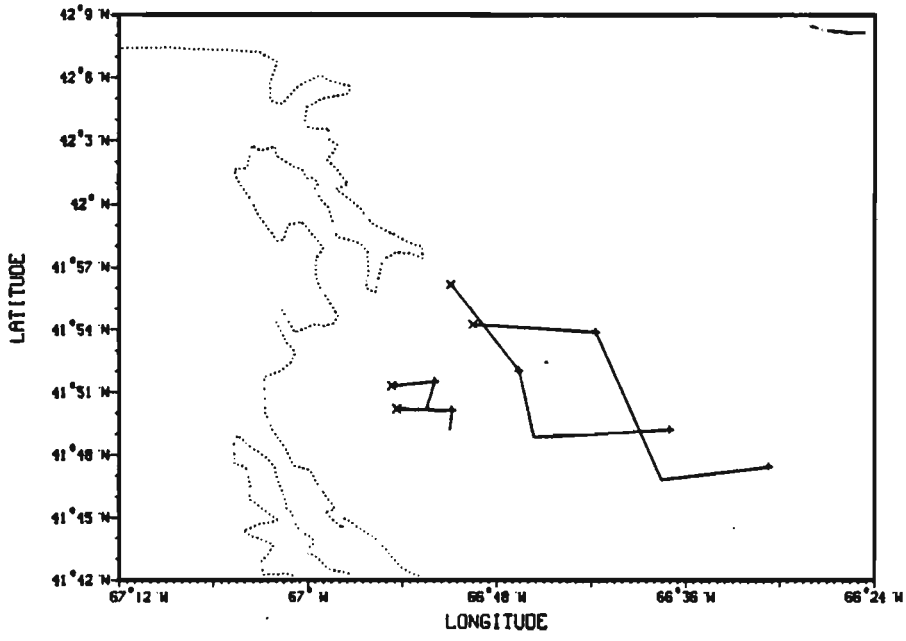
DEPLOYMENT 5—27 AUGUST 1988—67° 00' W



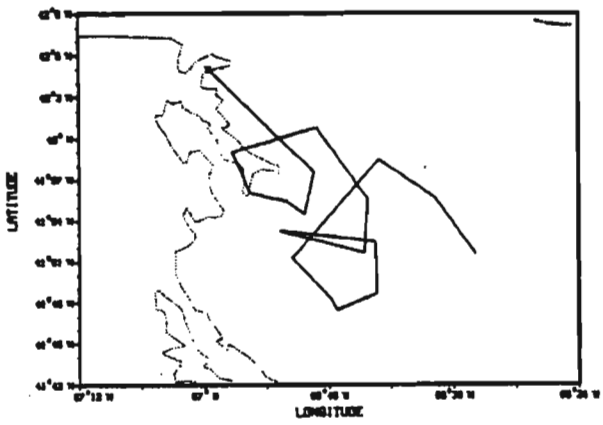
DEPLOYMENT 5 AUGUST 27 - 28 / 88



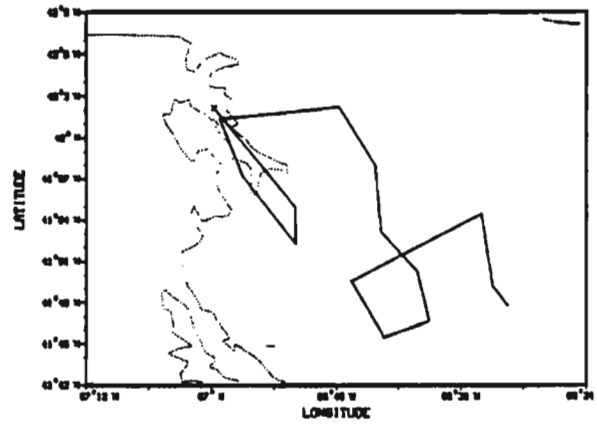
DEPLOYMENT 5 AUGUST 27 - 28 / 88



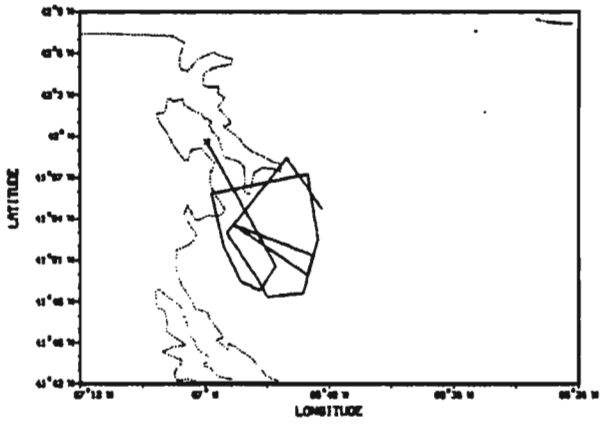
DEPLOYMENT 5 ARGOS BUOY 2754



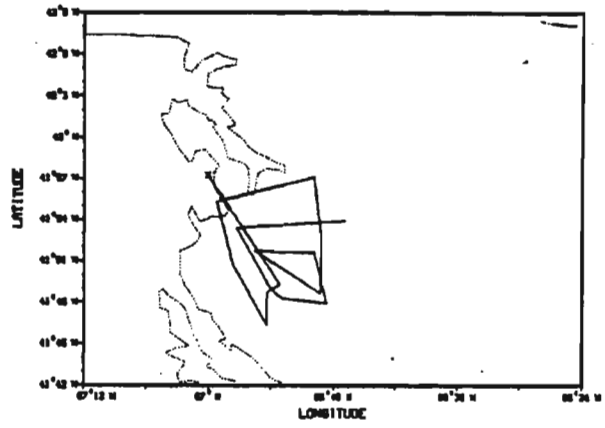
DEPLOYMENT 5 ARGOS BUOY 4440



DEPLOYMENT 5 ARGOS BUOY 4447



DEPLOYMENT 5 ARGOS BUOY 2757



DEPLOYMENT # 6

No. of buoys released:	ARGOS 5	LORAN-C	0
Time of first deployment:	17:01 Aug 29, 1988		
Time of last recovery:	13:52 Sep 1, 1988		
Total time duration:	68.9 hr		

Hydrographic Structure:

Buoy 2754 was deployed on the stratified side of the tidal front near the shelf edge. The remainder of the buoys were released in the relatively well-mixed waters with buoy 4440 closest to the tidal front.

Winds:

Northward winds of around 6 m s^{-1} were blowing during the first day of tracking. A reversal to southward winds occurred near the end of 30 August (day 243) and speeds dropped slightly to 4 m s^{-1}.

Data Recovery:

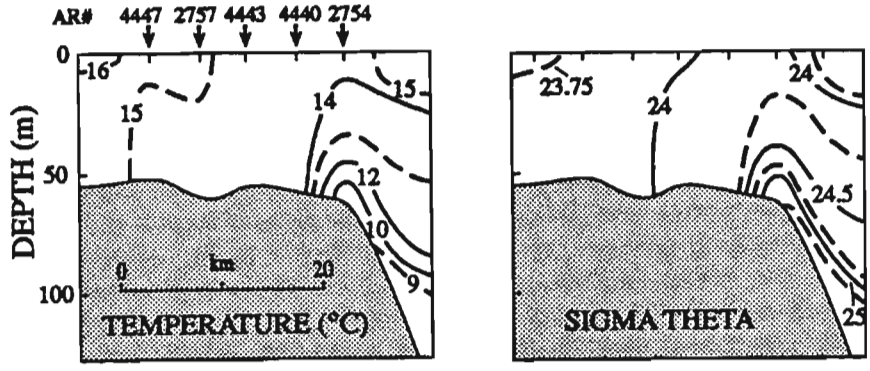
Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	29 Aug 17:01	31 Aug 22:03	19	53	100
2757	AR	-	29 Aug 18:30	31 Aug 20:17	18	50	100
4440	AR	-	29 Aug 17:33	1 Sep 13:52	24	68	100
4443	AR	-	29 Aug 18:03	31 Aug 22:58	2	53	0*
4447	AR	-	29 Aug 18:58	31 Aug 19:31	21	49	100

* No satellite fixes were obtained; the 2 fixes were the ship's release and recovery positions.

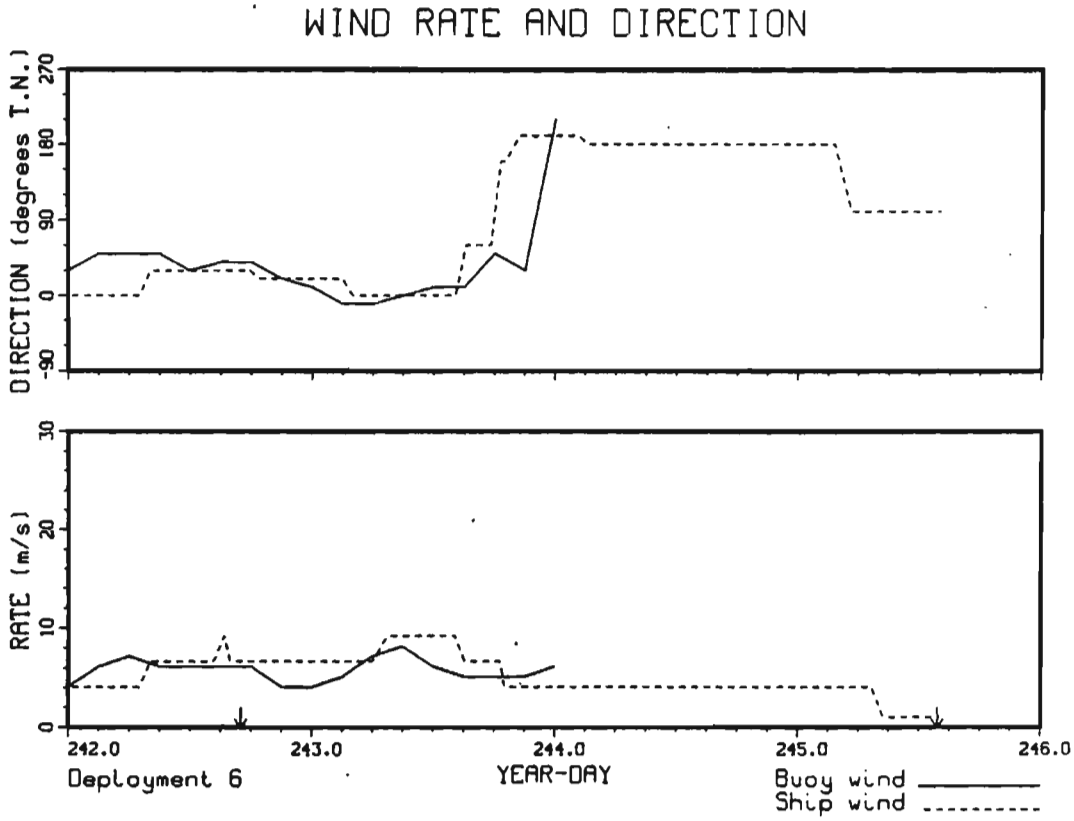
Mean Residual Currents:

Residual currents were calculated from 25 h running means.

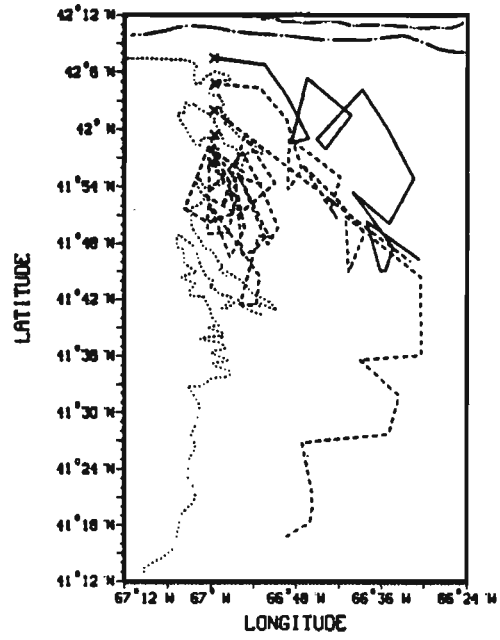
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.194	-0.172	0.259	132°
2757	0.051	-0.072	0.088	145°
4440	0.083	-0.309	0.320	165°
4447	0.041	-0.101	0.109	158°



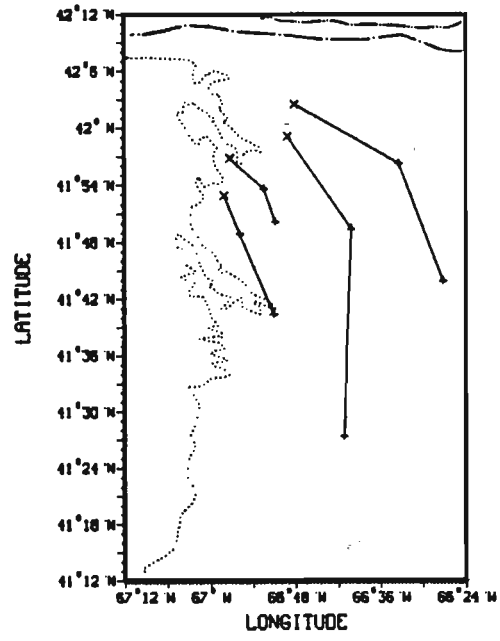
DEPLOYMENT 6—29 AUGUST 1988—67° 00' W



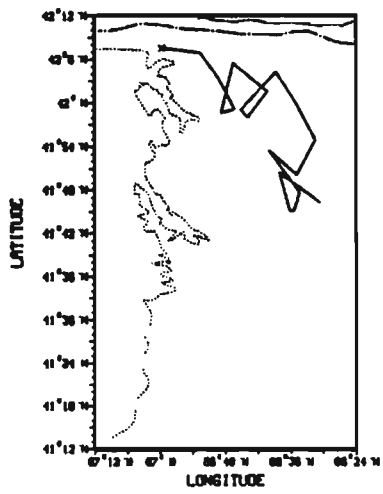
DEPLOYMENT 6 AUGUST 29 - SEPTEMBER 1/88



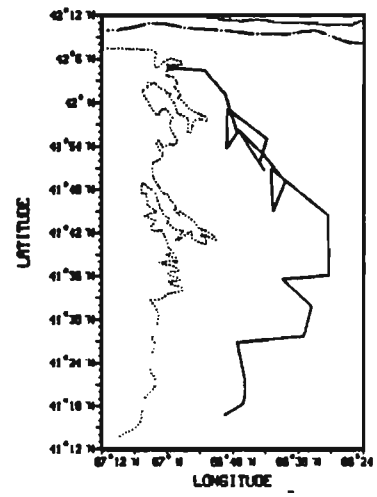
DEPLOYMENT 6 AUGUST 29 - SEPTEMBER 1/88



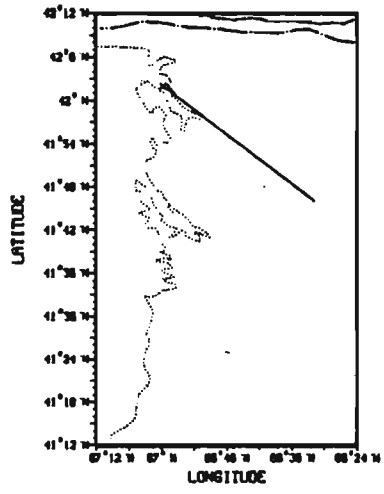
DEPLOYMENT 6 ARGOS BUOY 2754



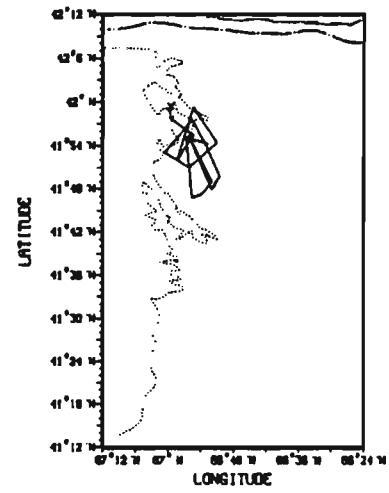
DEPLOYMENT 6 ARGOS BUOY 4440



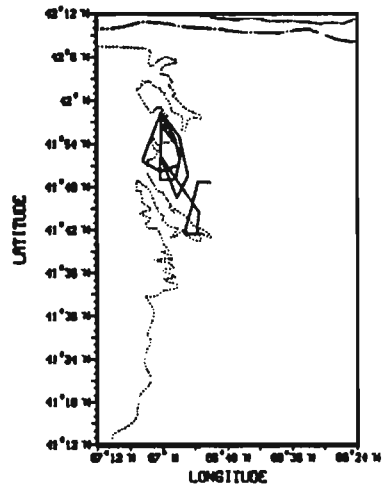
DEPLOYMENT 6 ARGOS BUOY 4443



DEPLOYMENT 6 ARGOS BUOY 2757



DEPLOYMENT 6 ARGOS BUOY 4447



DEPLOYMENT # 7

No. of buoys released: ARGOS 3 LORAN-C 0
Time of first deployment: 21:38 Sep 30, 1988
Time of last recovery: 21:38 Oct 2, 1988
Total time duration: 48.0 hr

Hydrographic Structure:

Buoys were released on the well-mixed side of the front (2757), at the surface manifestation of the front (4447) and on the stratified side of the front (2755).

Winds:

Relatively steady winds of 4-6 m s^{-1} towards the north to northeast were blowing during deployment 7.

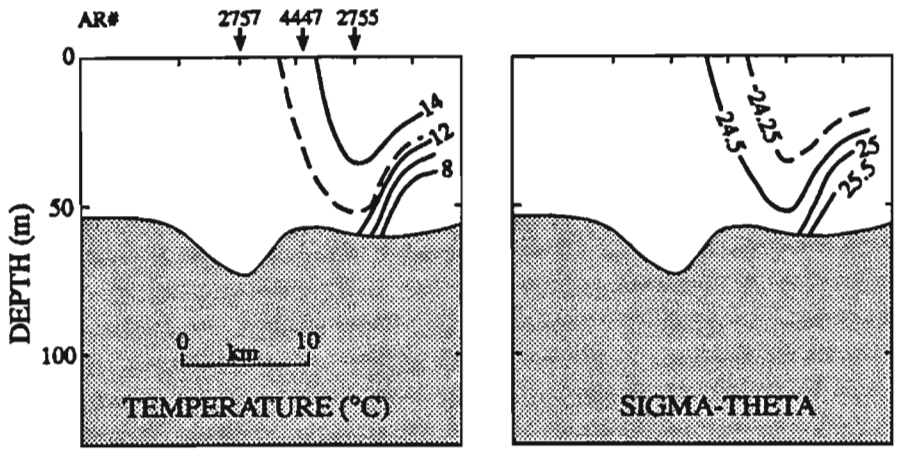
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2755	AR	-	30 Sep 22:49	2 Oct 17:55	17	43	100
2757	AR	-	30 Sep 21:38	2 Oct 21:38	22	48	100
4447	AR	-	30 Sep 22:14	2 Oct 18:52	19	45	100

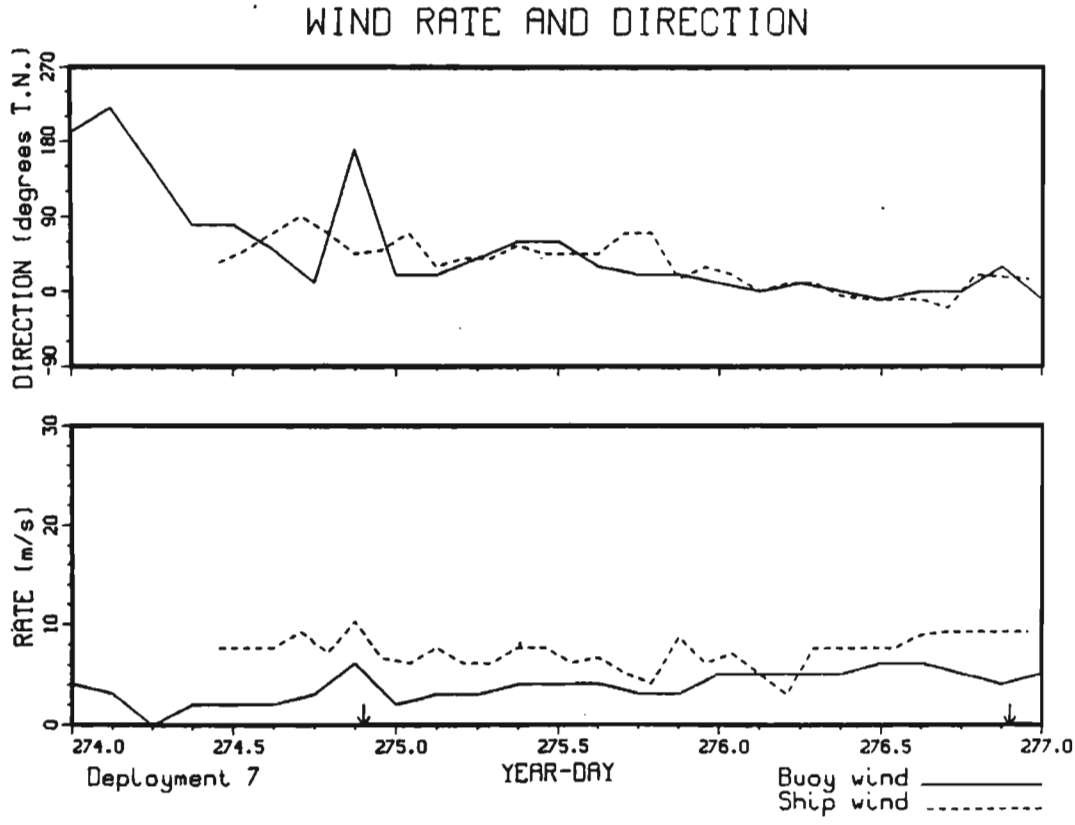
Mean Residual Currents:

Residual currents were calculated from 25 h running means.

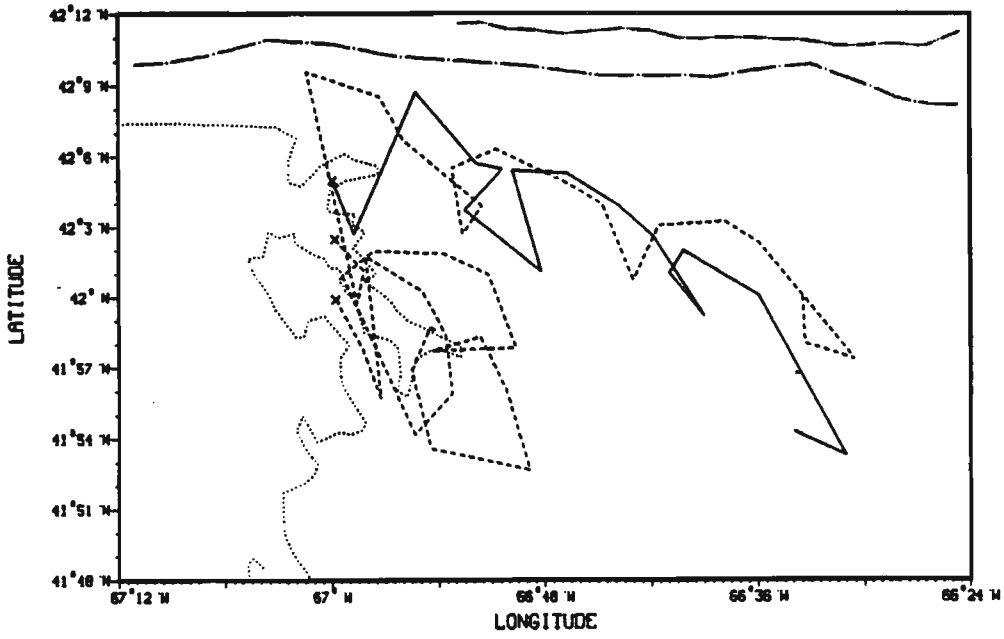
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2755	0.245	-0.115	0.271	115°
2757	0.073	-0.043	0.085	121°
4447	0.279	-0.043	0.282	99°



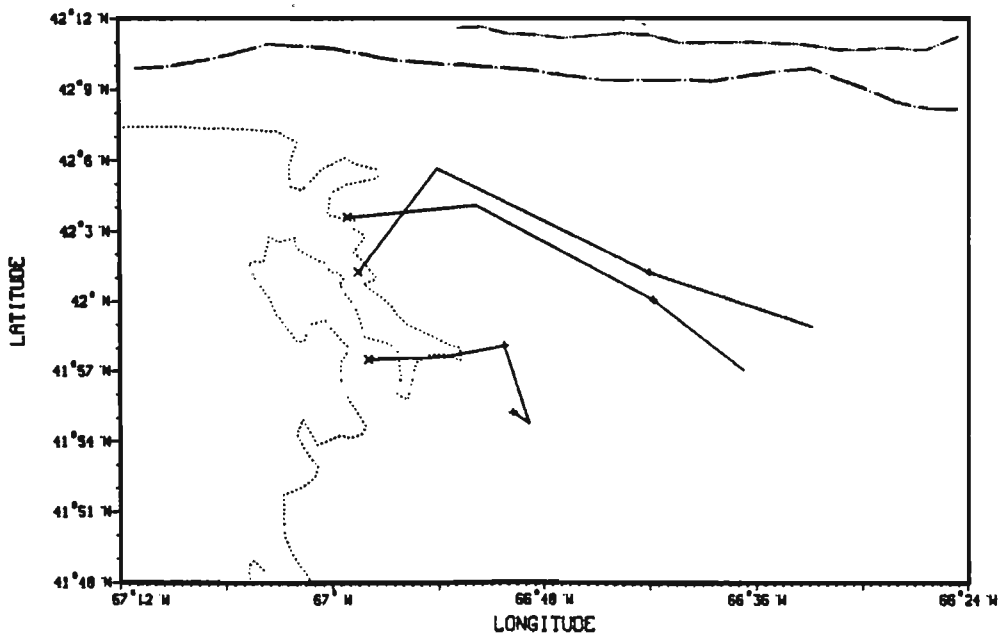
DEPLOYMENT 7— 30 SEPTEMBER 1988 — 67° 00'



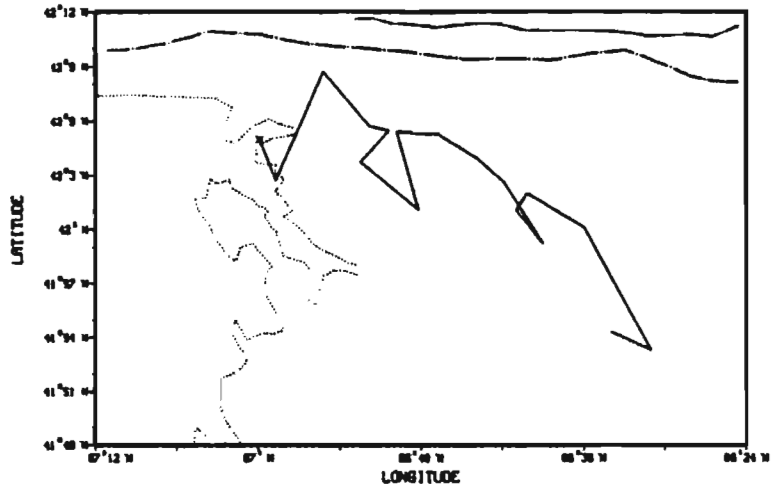
DEPLOYMENT 7 SEP. 30 - OCT. 2 / 88



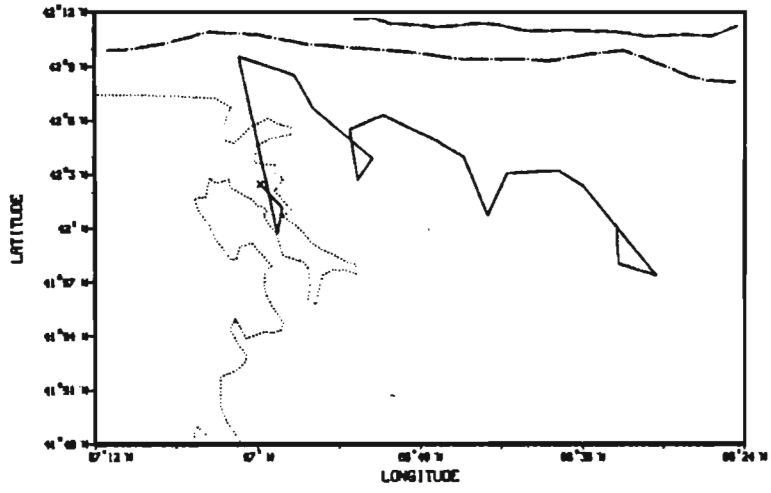
DEPLOYMENT 7 SEP. 30 - OCT. 2 / 88



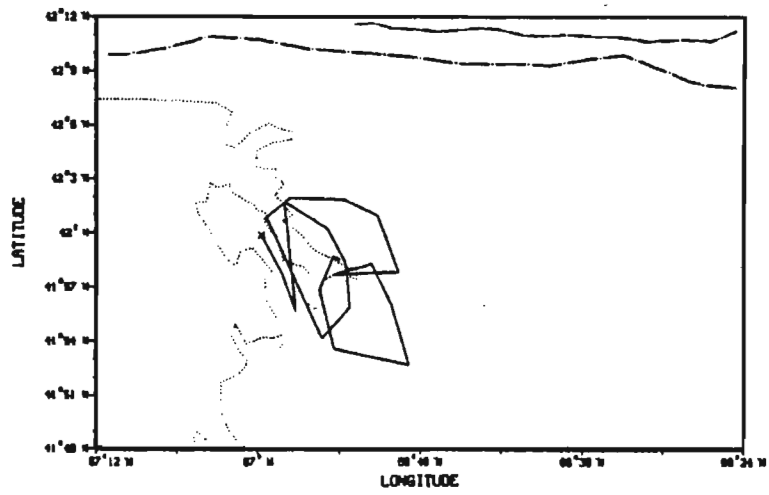
DEPLOYMENT 7 ARGOS BUOY 2755



DEPLOYMENT 7 ARGOS BUOY 4447



DEPLOYMENT 7 ARGOS BUOY 2757



DEPLOYMENT # 8

No. of buoys released:	ARGOS 0	LORAN-C 4
Time of first deployment:	18:45 Oct 1, 1988	
Time of last recovery:	23:28 Oct 2, 1988	
Total time duration:	28.7 hr	

Hydrographic Structure:

Buoy 21 was released in weakly stratified waters at or near the tidal front whereas buoys 25 and 23 were released in the nearly homogeneous waters south of the front.

Winds:

Winds were primarily towards the north at between 5-8 m/s.

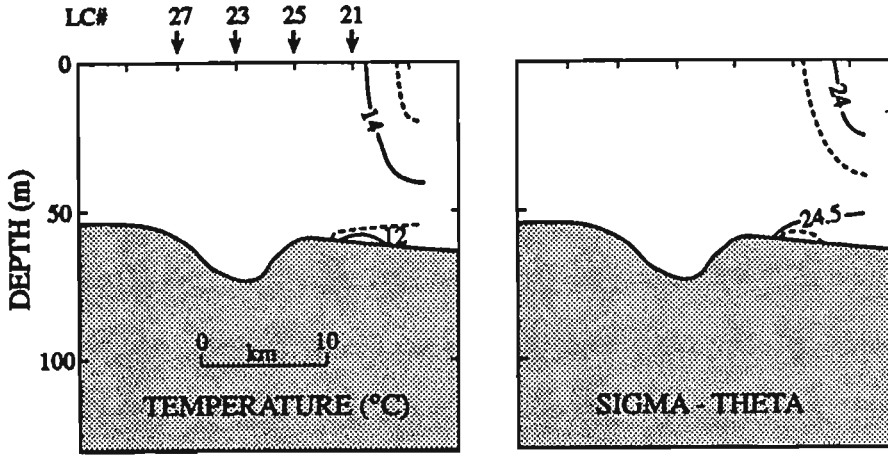
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
21	LC	10	1 Oct 20:19	2 Oct 22:07	54	26	100
23	LC	10	1 Oct 19:12	2 Oct 23:28	58	28	100
25	LC	10	1 Oct 19:49	2 Oct 22:48	56	27	100
27	LC	10	No Usable Data		0	0	0

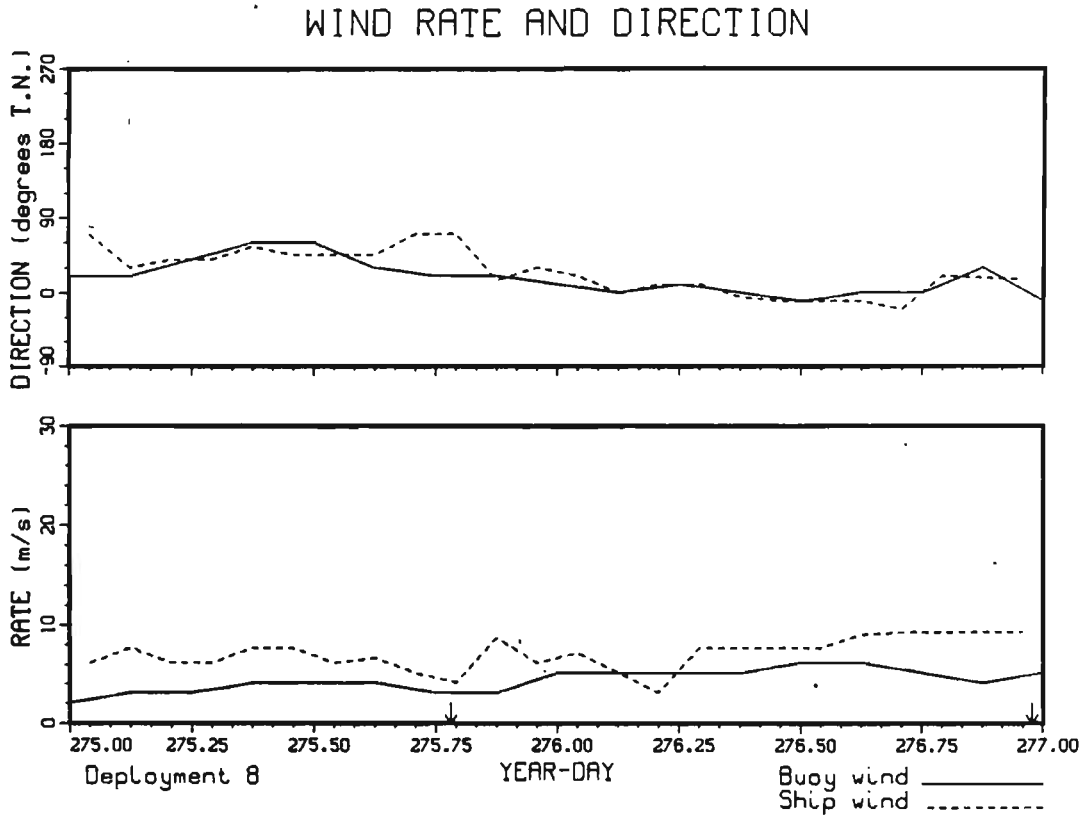
Mean Residual Currents:

Residual currents were calculated from 12.5 h running means.

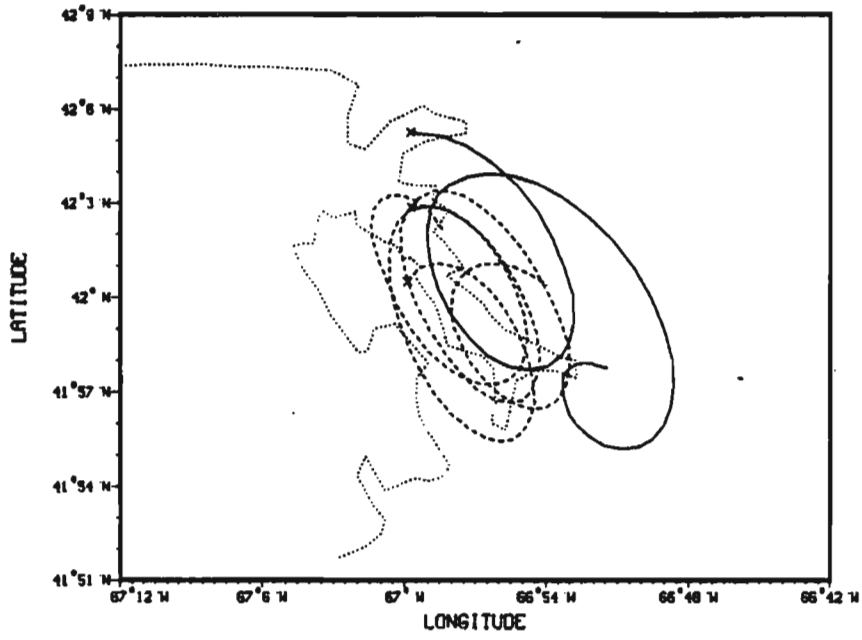
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
21	0.138	-0.123	0.305	132°
23	-0.019	0.056	0.059	341°
25	0.046	-0.027	0.053	120°



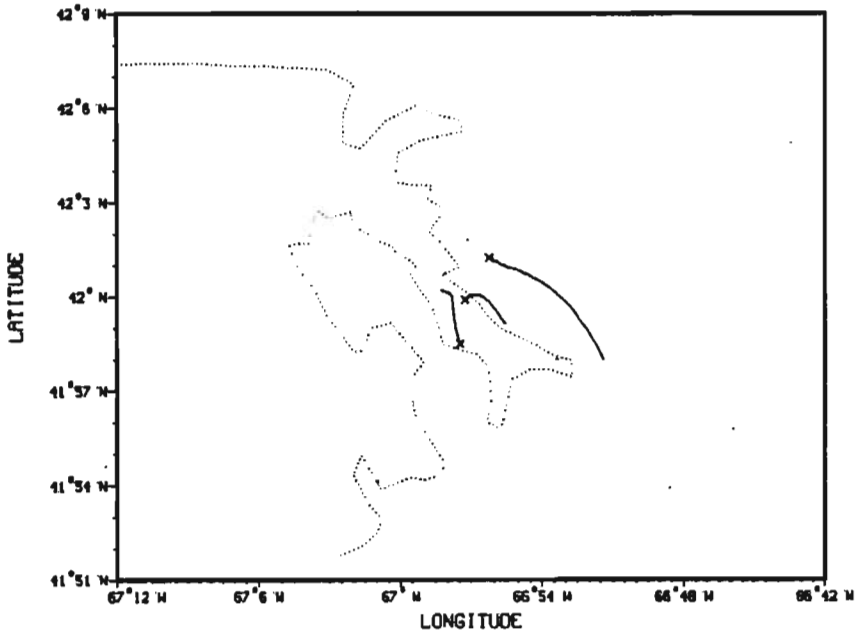
DEPLOYMENT 8 — 1 OCTOBER 1988 — 67° 00'



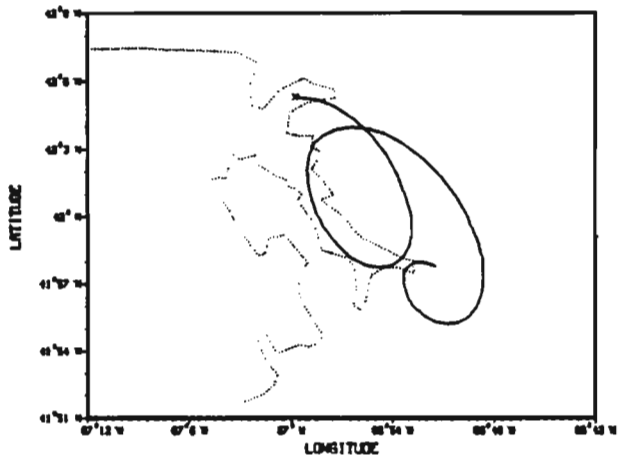
DEPLOYMENT 8 OCTOBER 1 - 2 / 88



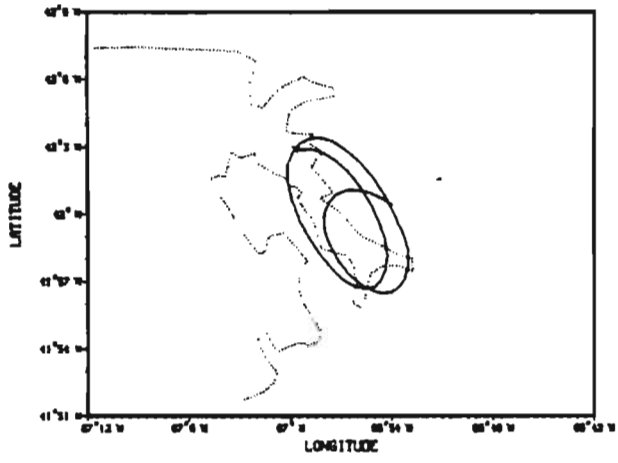
DEPLOYMENT 8 OCTOBER 1 - 2 / 88



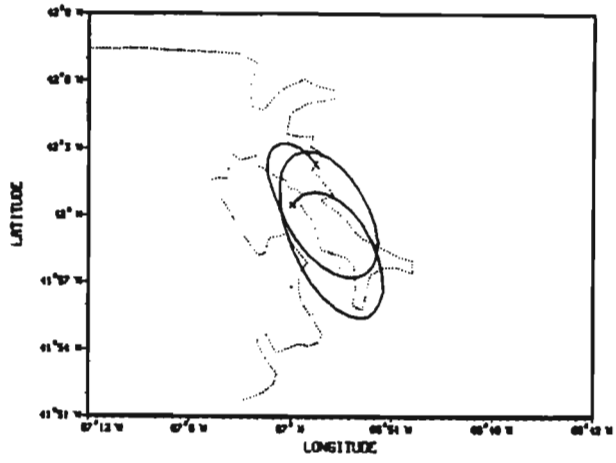
DEPLOYMENT 8 LORAN-C BUOY 21



DEPLOYMENT 8 LORAN-C BUOY 25



DEPLOYMENT 8 LORAN-C BUOY 23



DEPLOYMENT # 9

No. of buoys released: ARGOS 3 LORAN-C 6
Time of first deployment: 16:07 Oct 3, 1988
Time of last recovery: 19:49 Oct 6, 1988
Total time duration: 75.7 hr

Hydrographic Structure:

Buoys 25 and 4447 were released in the homogeneous waters to the south of the front while buoys 21 and 2755 were deployed near the leading subsurface edge of the front. Buoys 28, 27, 24, 22/2757 and 23 were released in increasingly stratified waters.

Winds:

Strong winds blew during deployment 9. Shortly after deployment the winds reversed from northward to southwestward and increased in speed from below 10 m s^{-1} to over 20 m s^{-1}. As the wind speeds began to fall on 5 October (day 279) the winds shifted to eastward.

Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2755	AR	-	3 Oct 16:27	6 Oct 19:10	24	75	100
2757	AR	-	3 Oct 16:47	6 Oct 19:49	27	75	100
4447	AR	-	3 Oct 16:08	6 Oct 18:16	29	74	100
21	LC	-	3 Oct 16:28	4 Oct 15:30	48	23	33*
22	LC	10	3 Oct 16:47	5 Oct 04:30	75	36	54
23	LC	10	3 Oct 17:05	4 Oct 11:00	37	16	27*
24	LC	10	3 Oct 18:05	5 Oct 10:30	82	39	62**
25	LC	10	3 Oct 16:07	5 Oct 11:00	87	43	60
28	LC	10	3 Oct 18:46	6 Oct 12:09	132	65	100

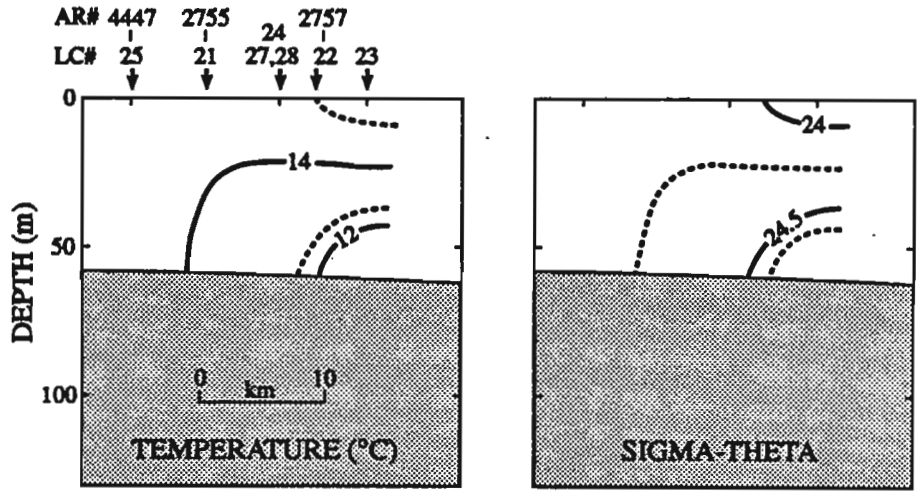
* The drogue was missing when the buoy was recovered.
** The drogue and the antenna were missing when the buoy was recovered.

Mean Residual Currents:

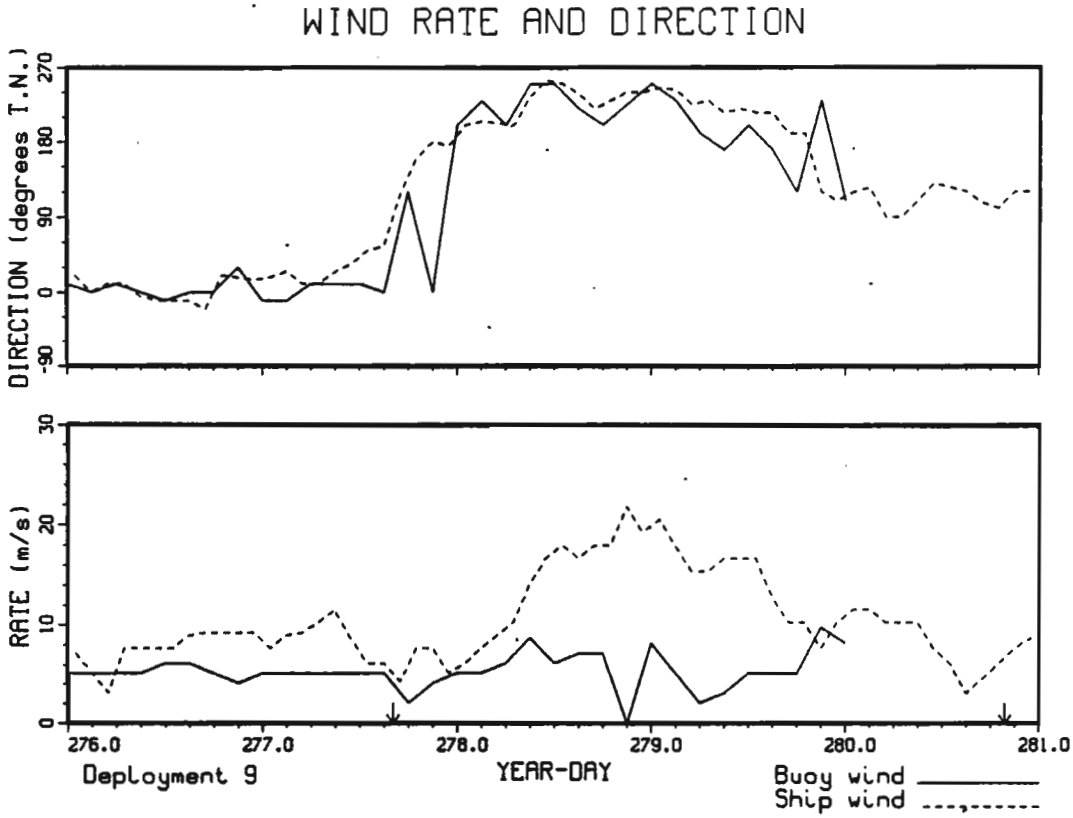
Residual currents were calculated from 25.0 h running means for the ARGOS buoys and LORAN-C buoy 28 while for the rest of the LORAN-C buoys the means were estimated from 12.5 h running means.

Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2755	-0.247	-0.143	0.285	240°
2757	-0.247	-0.151	0.289	239°
4447	-0.218	-0.149	0.264	236°
21	-0.048	-0.097	0.108	206°
22	-0.135	-0.132	0.189	226°
23	-0.154	-0.075	0.171	244°

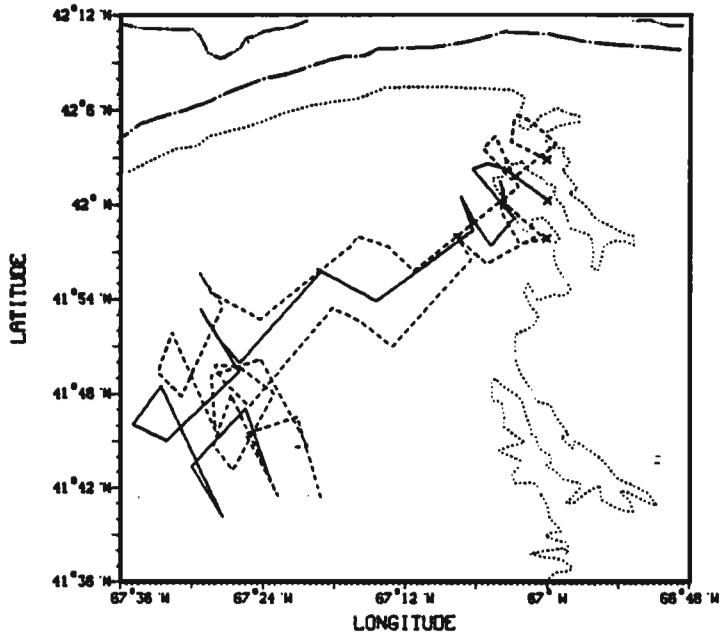
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
24	-0.171	-0.051	0.178	253°
25	-0.161	-0.078	0.179	244°
28	-0.166	-0.110	0.199	236°



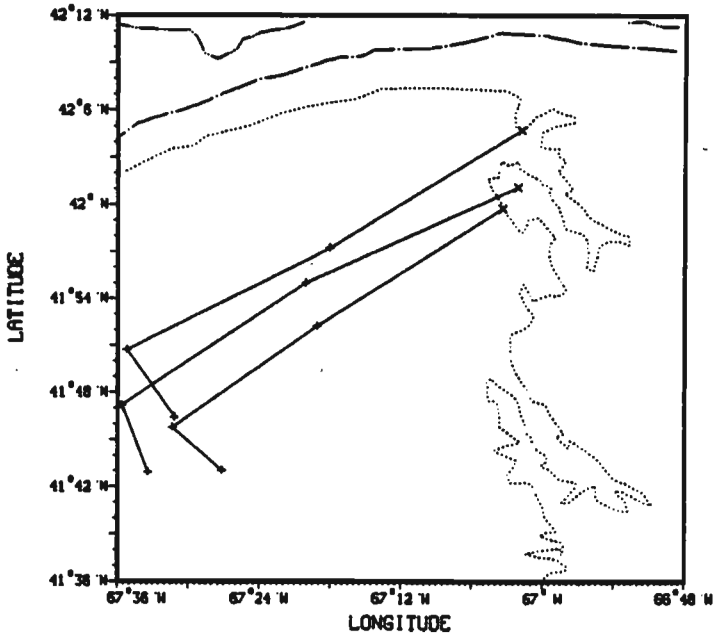
DEPLOYMENT 9—3 OCTOBER 1988—67° 00'W



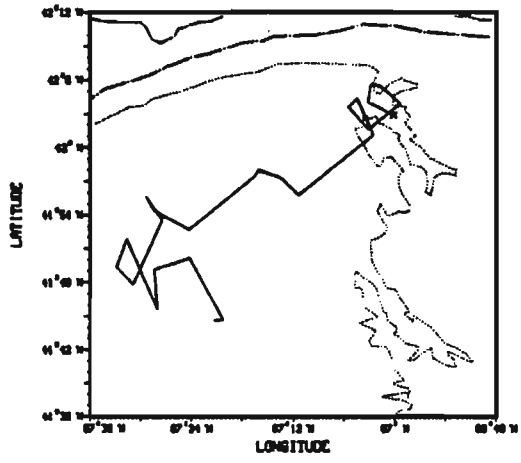
DEPLOYMENT 9 OCTOBER 3 - 6 / 88



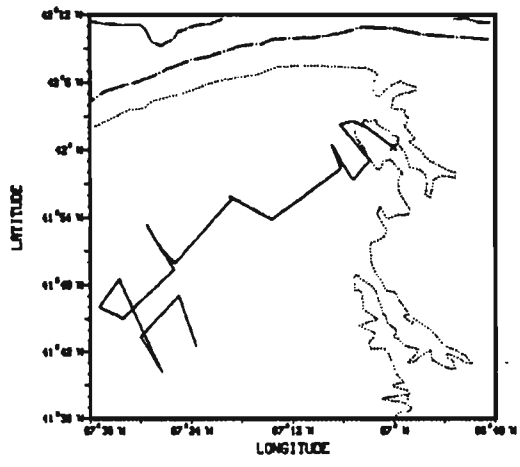
DEPLOYMENT 9 OCTOBER 3 - 6 / 88



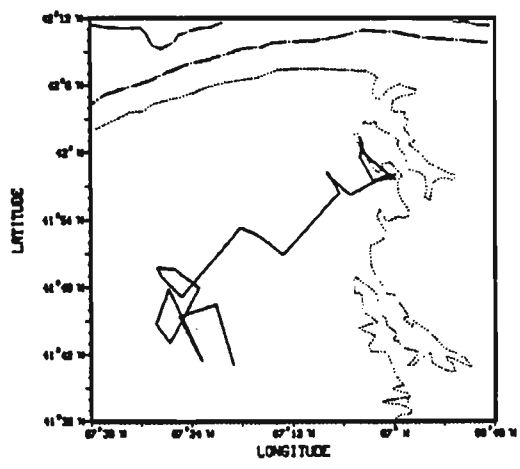
DEPLOYMENT 9 ARGOS BUOY 2757



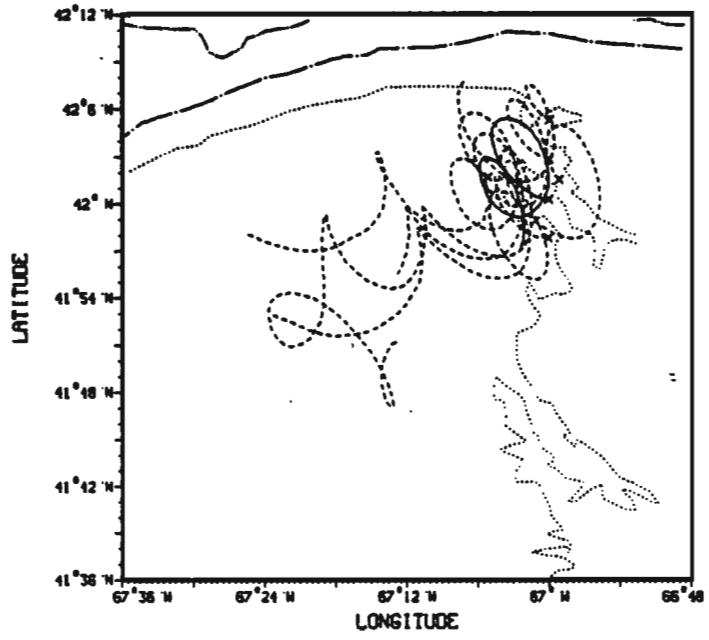
DEPLOYMENT 9 ARGOS BUOY 2755



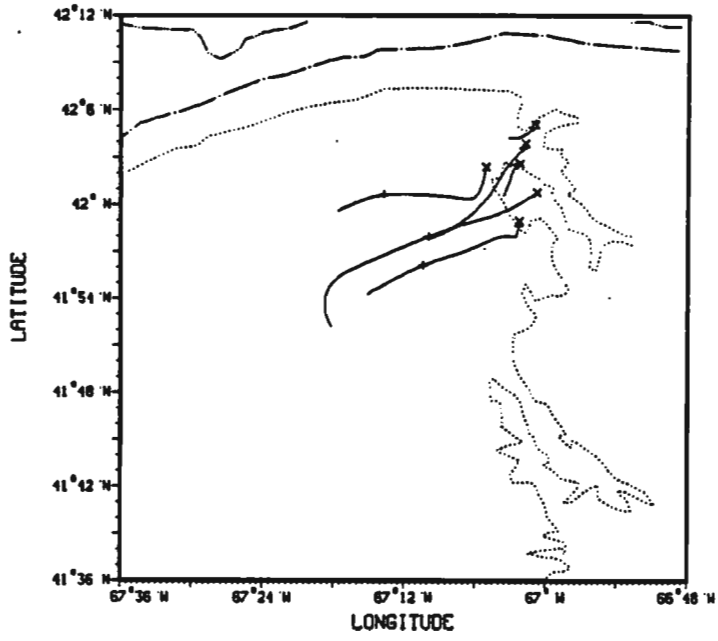
DEPLOYMENT 9 ARGOS BUOY 4447



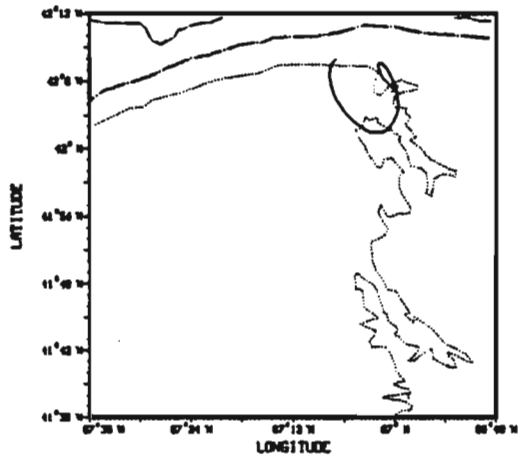
DEPLOYMENT 9 OCTOBER 3 - 6 / 88



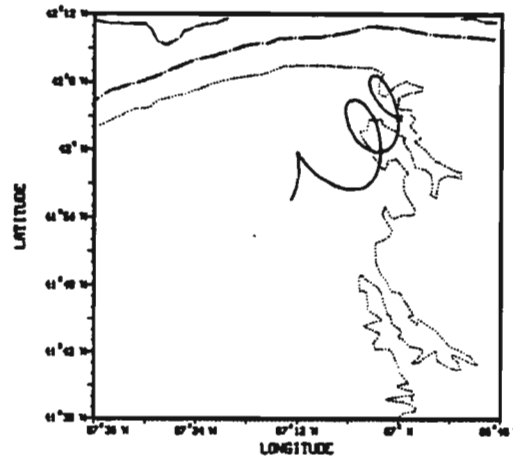
DEPLOYMENT 9 OCTOBER 3 - 6 / 88



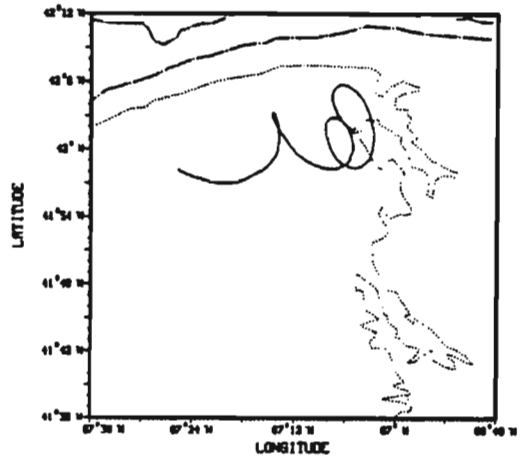
DEPLOYMENT 9 LORAN-C BUOY 23



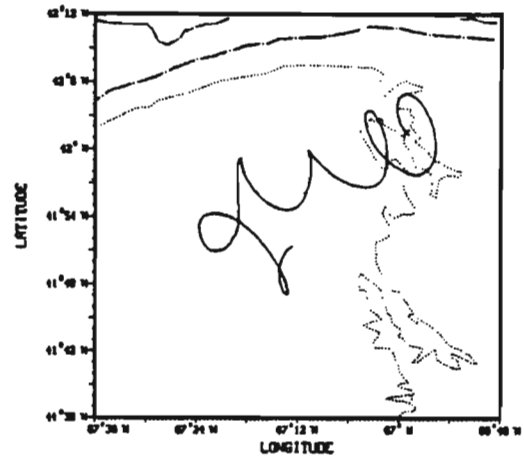
DEPLOYMENT 9 LORAN-C BUOY 22



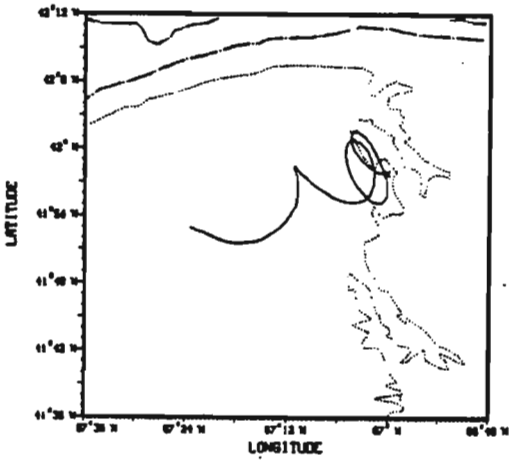
DEPLOYMENT 9 LORAN-C BUOY 24



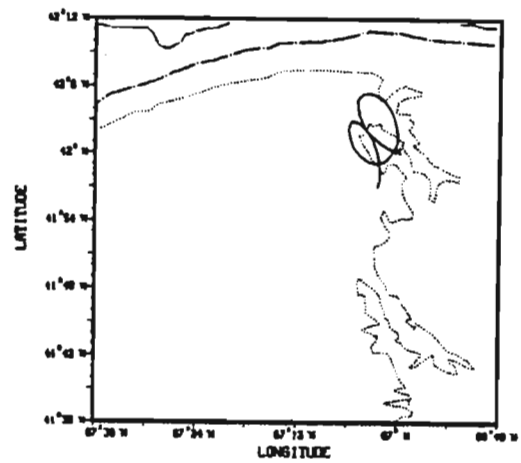
DEPLOYMENT 9 LORAN-C BUOY 28



DEPLOYMENT 9 LORAN-C BUOY 25



DEPLOYMENT 9 LORAN-C BUOY 21



DEPLOYMENT # 10

No. of buoys released: ARGOS 4 LORAN-C 7
Time of first deployment: 00:50 Oct 7, 1988
Time of last recovery: 00:15 Oct 11, 1988
Total time duration: 95.4 hr

Hydrographic Structure:

Buoys 23 and 2754 were released simultaneously near the leading edge of the tidal front. Buoys 22 and 2755 were deployed in relatively well-mixed waters whereas the remaining buoys were deployed on the stratified side of the front. Buoy 21 was placed near the bank edge in the most strongly stratified water.

Winds:

After the release of the buoys the southwestward winds increased speed reaching a maximum of near 30 m s^{-1} near the end of 8 October (day 282). The wind speed then declined and the direction gradually shifted northward.

Data Recovery:

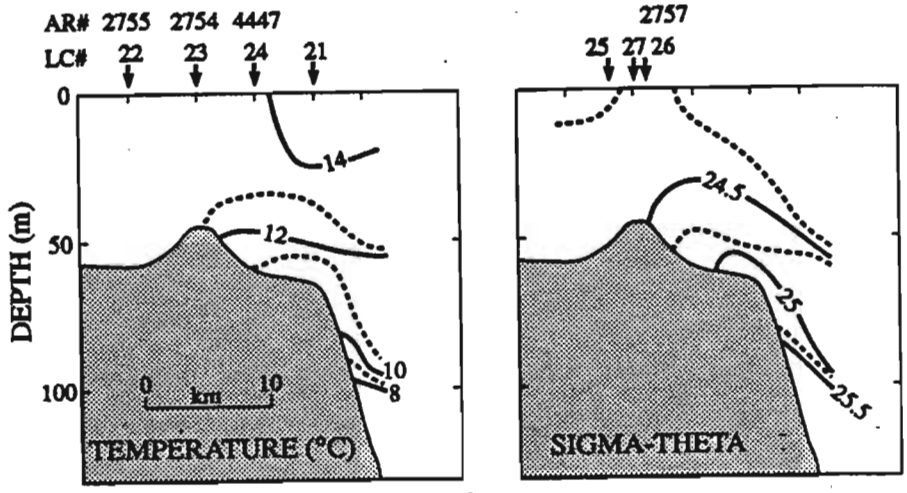
Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	7 Oct 01:42	10 Oct 21:06	35	91	100
2755	AR	-	7 Oct 02:08	10 Oct 21:33	24	91	67
2757	AR	-	7 Oct 02:41	10 Oct 20:26	35	90	100
4447	AR	-	7 Oct 01:15	10 Oct 20:46	35	92	100
21	LC	10	7 Oct 00:50	8 Oct 21:00	90	44	47
22	LC	10	7 Oct 02:09	10 Oct 17:28	176	87	100
23	LC	10	No Usable Data		0	0	0
24	LC	10	7 Oct 01:17	8 Oct 21:00	90	44	50
25	LC	10	7 Oct 03:47	10 Oct 16:56	172	85	100
26	LC	10	7 Oct 02:42	10 Oct 15:00	170	84	100
27	LC	10	No Usable Data		0	0	0

Mean Residual Currents:

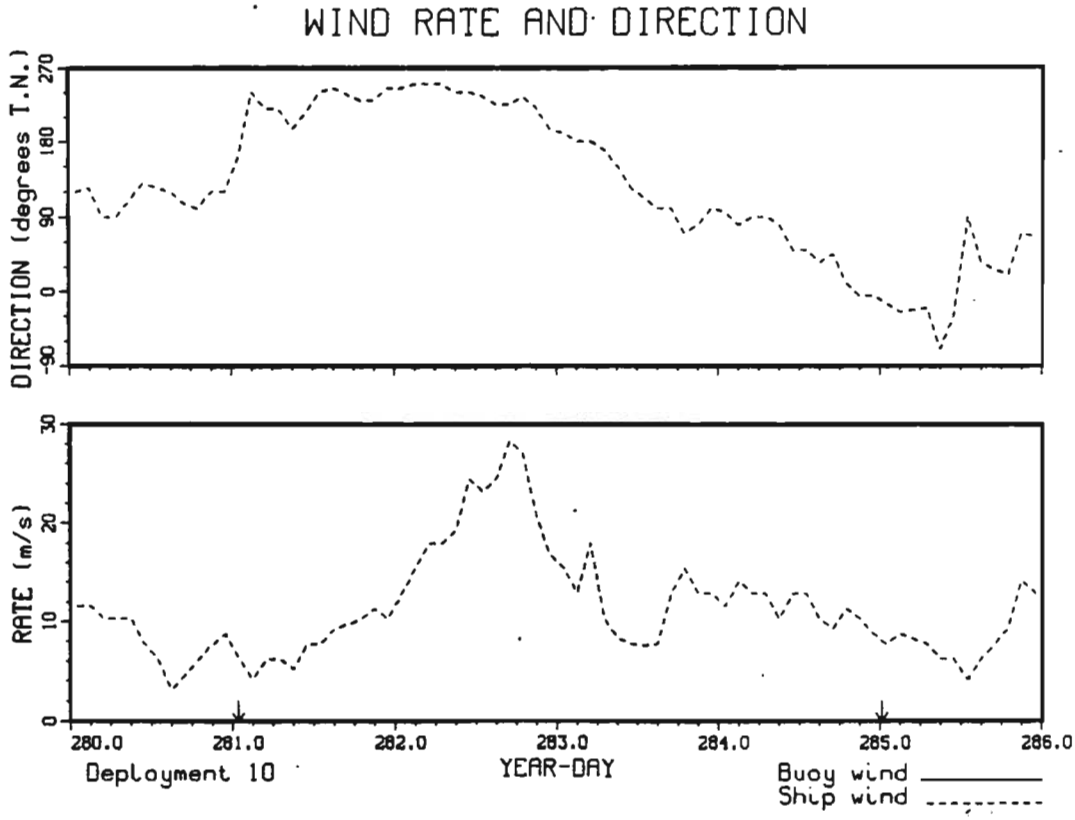
Residual currents were calculated from 25.0 h running means except for LORAN-C buoys 21 and 24 where 12.5 h running means were used.

Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754*	-0.069	-0.131	0.148	208°
2755*	-0.241	-0.158	0.288	237°
2757	-0.077	-0.137	0.157	209°
4447	-0.071	-0.138	0.155	207°
21	-0.109	-0.013	0.110	263°
22	-0.064	-0.024	0.068	249°
24	-0.138	-0.107	0.175	232°
25	-0.050	-0.044	0.067	229°
26	-0.060	-0.091	0.109	213°

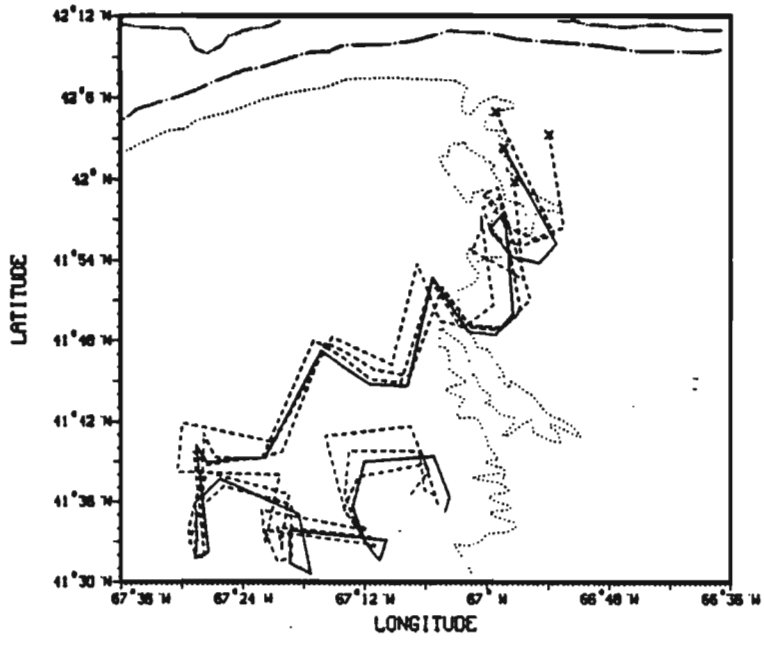
*Only representative of 7-8 October due to intermittant data



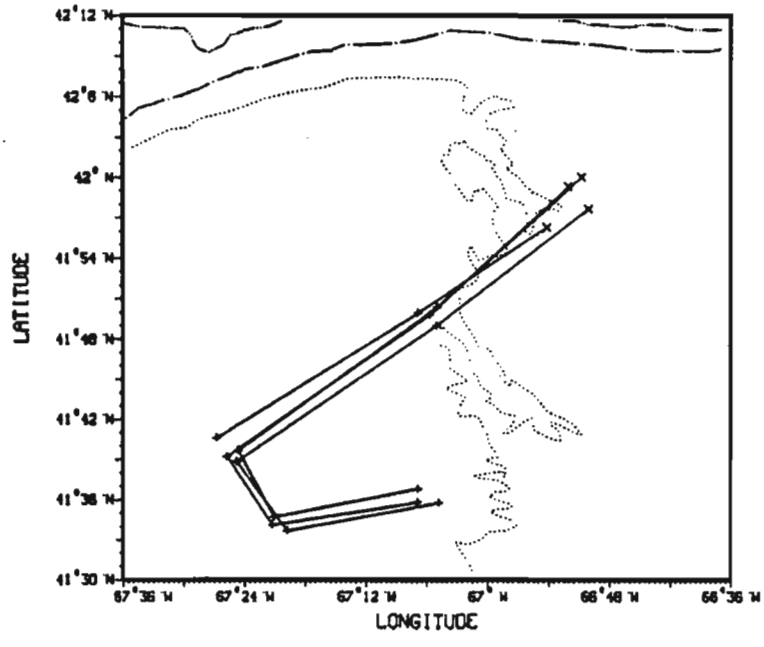
DEPLOYMENT 10— 7 OCTOBER1988 —66° 59'W



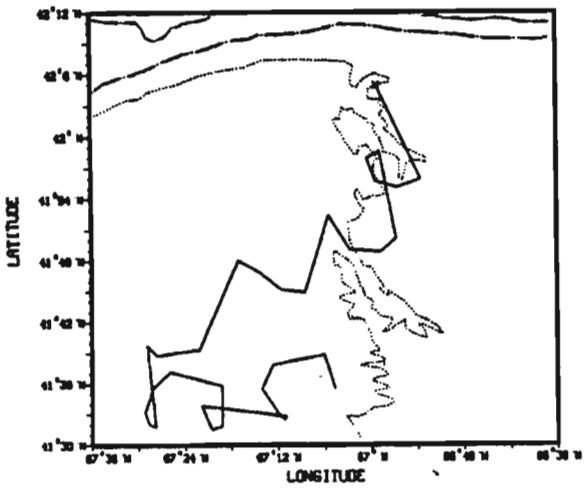
DEPLOYMENT 10 OCTOBER 7 - 10 / 88



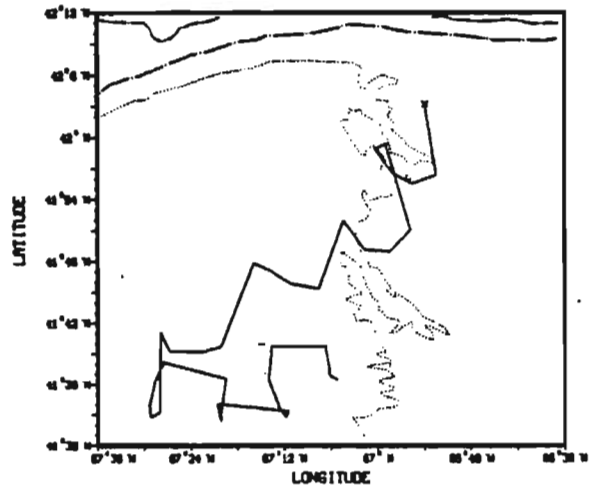
DEPLOYMENT 10 OCTOBER 7 - 10 / 88



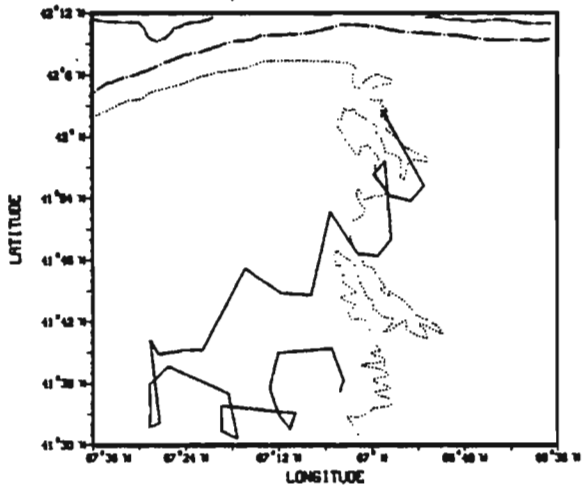
DEPLOYMENT 10 ARGOS BUOY 4447



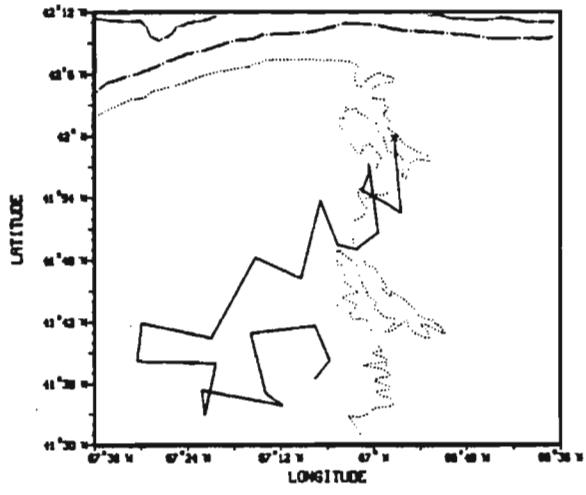
DEPLOYMENT 10 ARGOS BUOY 2757



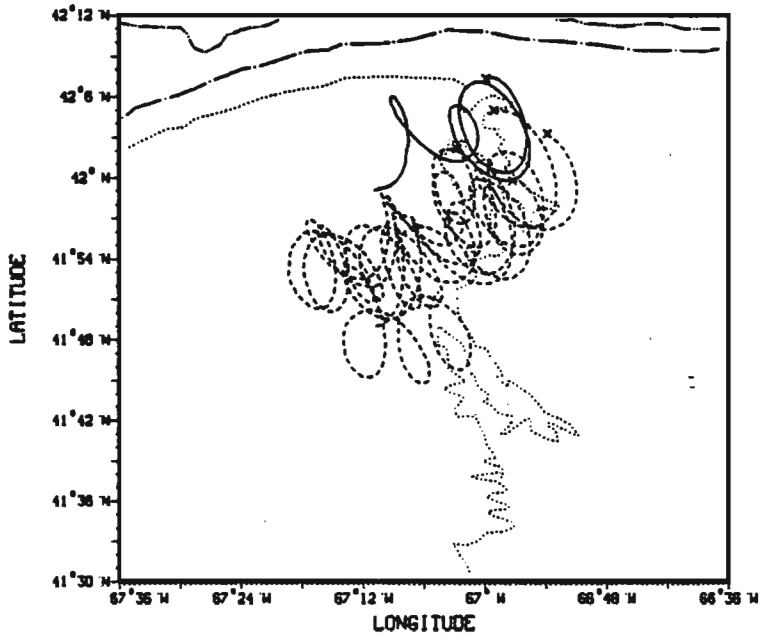
DEPLOYMENT 10 ARGOS BUOY 2754



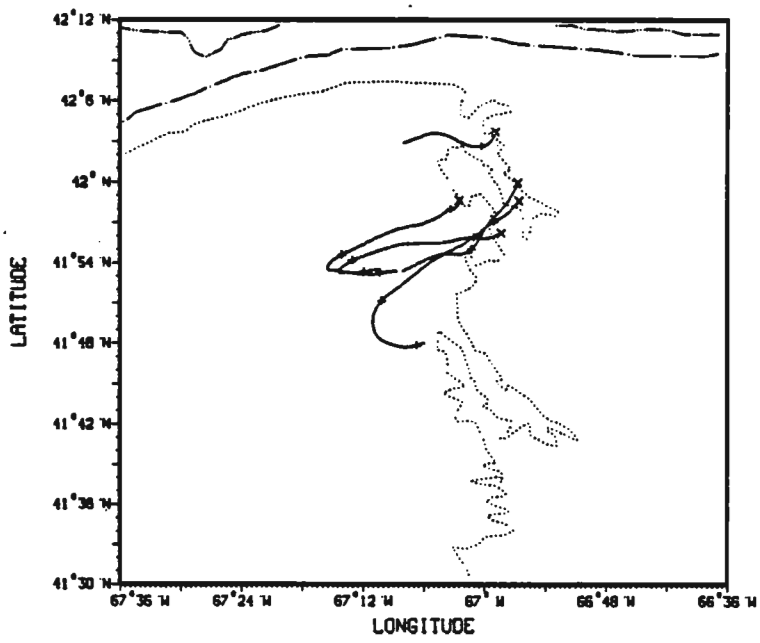
DEPLOYMENT 10 ARGOS BUOY 2755



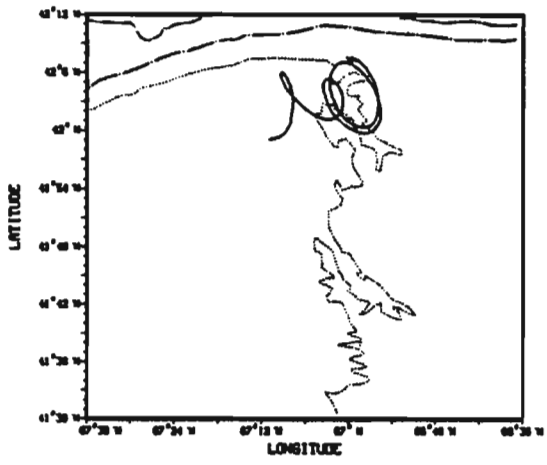
DEPLOYMENT 10 OCTOBER 7 - 10 / 88



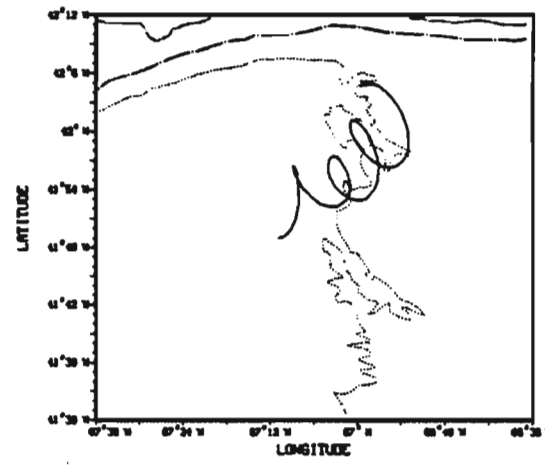
DEPLOYMENT 10 OCTOBER 7 - 10 / 88



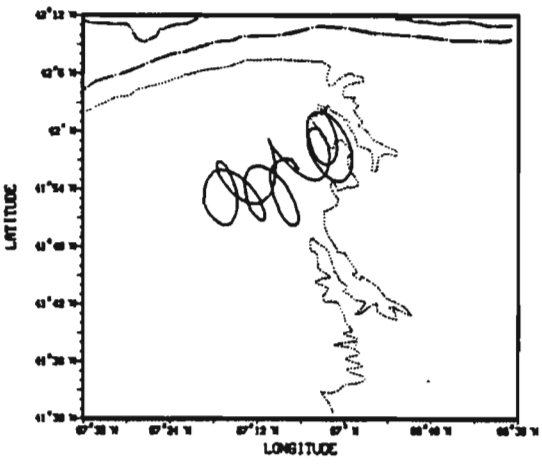
DEPLOYMENT 10 LORAN-C BUOY 21



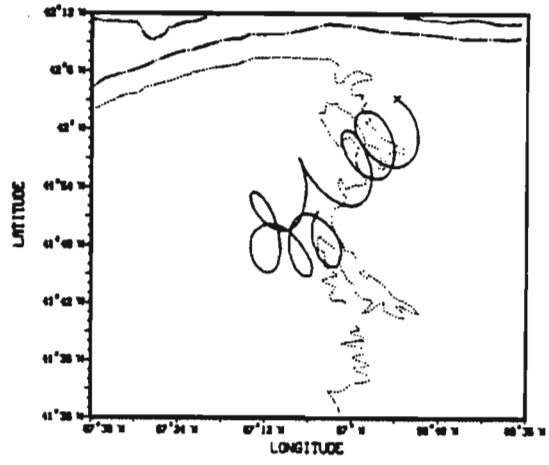
DEPLOYMENT 10 LORAN-C BUOY 24



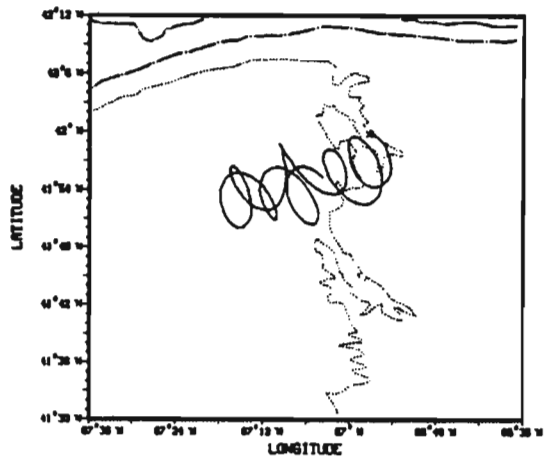
DEPLOYMENT 10 LORAN-C BUOY 25



DEPLOYMENT 10 LORAN-C BUOY 26



DEPLOYMENT 10 LORAN-C BUOY 22



DEPLOYMENT # 11

No. of buoys released:	ARGOS 4	LORAN-C 5
Time of first deployment:	01:32 Oct 11, 1988	
Time of last recovery:	23:45 Oct 12, 1988	
Total time duration:	46.2 hr	

Hydrographic Structure:

Buoys 21 and 2757 were deployed at the bank edge in highly stratified waters. The remaining buoys were released to the south. A strong tidal front was not evident from the hydrographic transect.

Winds:

Northward winds of near 10 m s^{-1} were blowing when the buoys were released. The direction veered eastward near mid-day on the 11 October (day 285), thereafter speeds increased to upwards of 14 m s^{-1}.

Data Recovery:

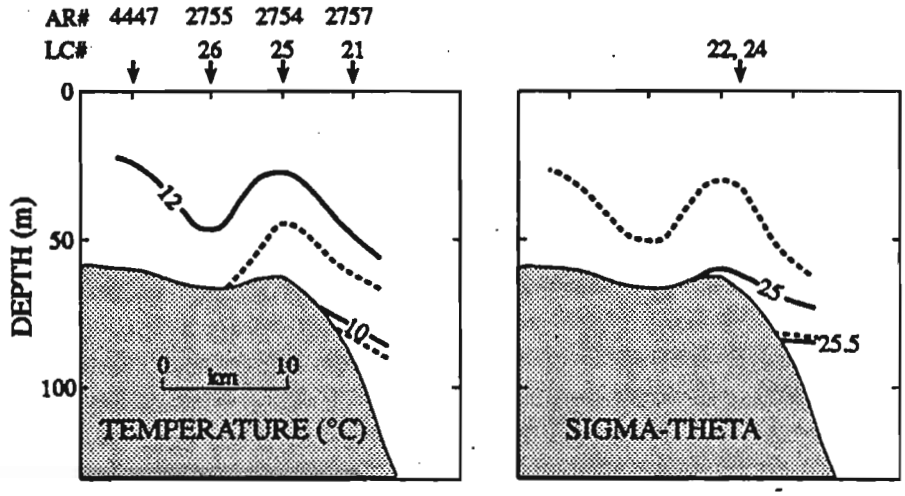
Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	11 Oct 02:19	12 Oct 18:26	16	40	100
2755	AR	-	11 Oct 01:56	12 Oct 17:51	12	40	100
2757	AR	-	11 Oct 02:44	12 Oct 18:54	17	40	100
4447	AR	-	11 Oct 01:32	12 Oct 20:59	17	43	100
21	LC	10	11 Oct 02:45	11 Oct 08:30	13	6	17*
22	LC	10	11 Oct 03:24	12 Oct 22:35	89	43	100
24	LC	10	11 Oct 04:12	12 Oct 16:14	74	36	100
25	LC	10	11 Oct 02:20	12 Oct 16:10	78	38	100
26	LC	10	11 Oct 01:57	12 Oct 23:45	94	46	100

* The antenna was missing when the buoy was recovered.

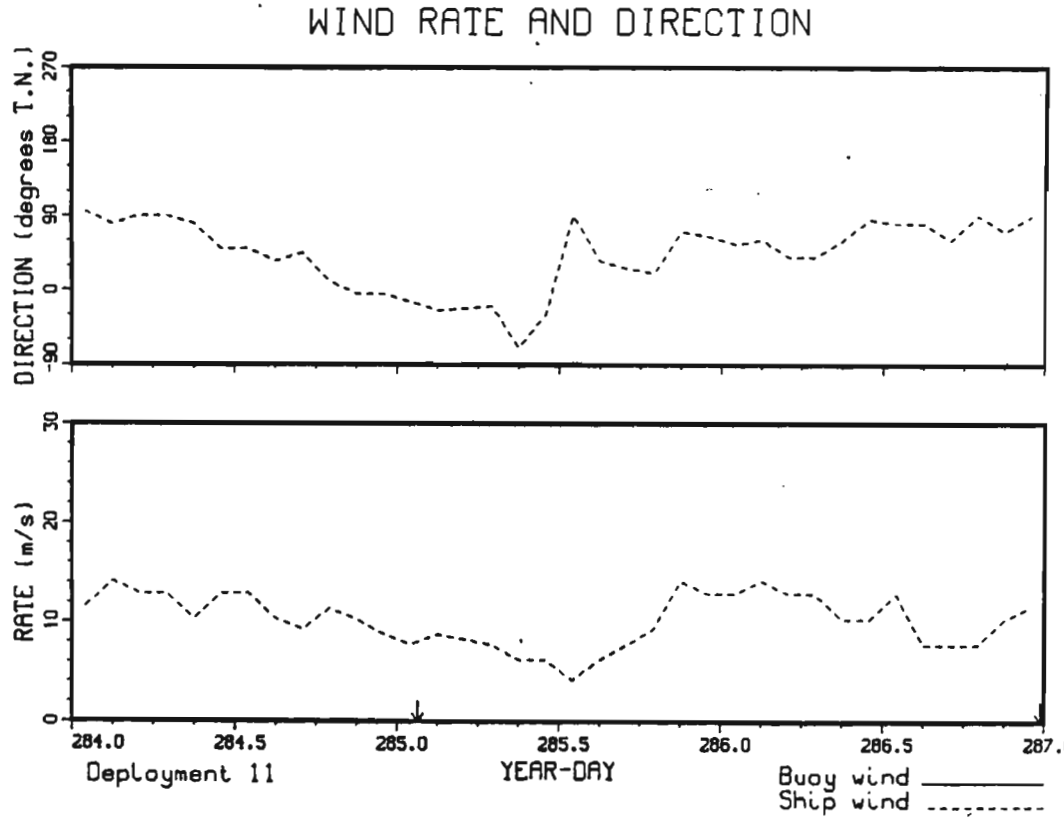
Mean Residual Currents:

Residual currents were calculated from 12.5 h running means.

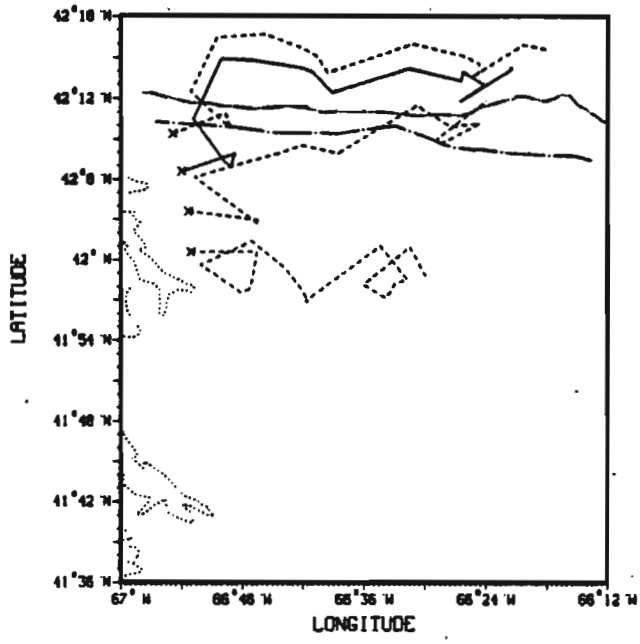
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.378	0.091	0.389	76°
2755	0.352	0.119	0.372	71°
2757	0.382	0.067	0.388	80°
4447	0.219	-0.008	0.219	92°
22	0.125	-0.225	0.257	151°
24	0.186	0.105	0.214	61°
25	0.191	0.121	0.226	58°
26	0.083	-0.122	0.148	146°



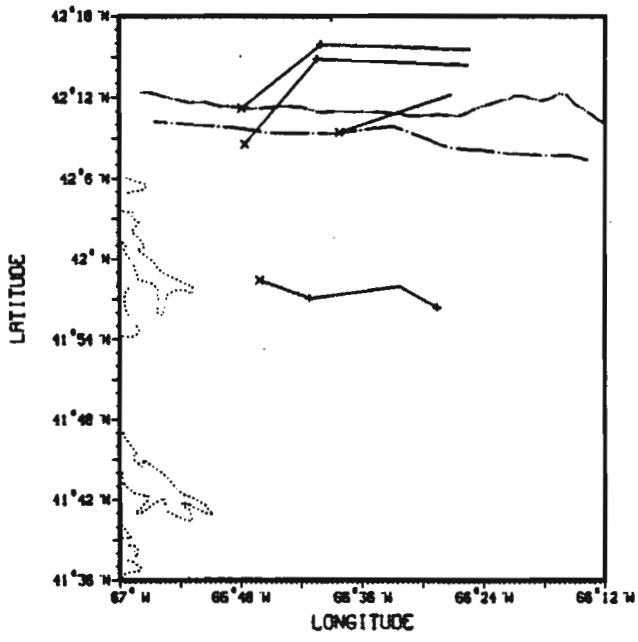
DEPLOYMENT 11—11 OCTOBER 1988—66° 54'W



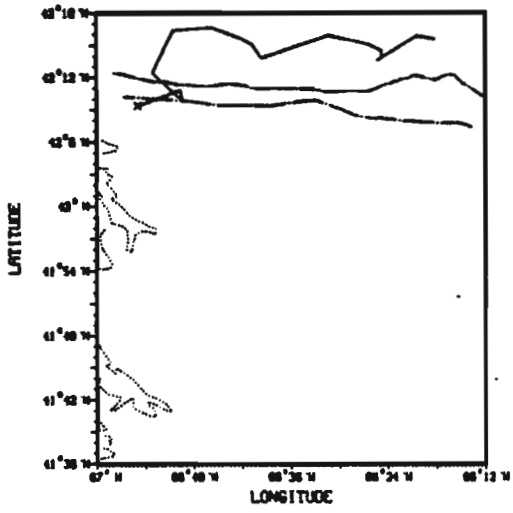
DEPLOYMENT 11 OCTOBER 11 - 12 / 88



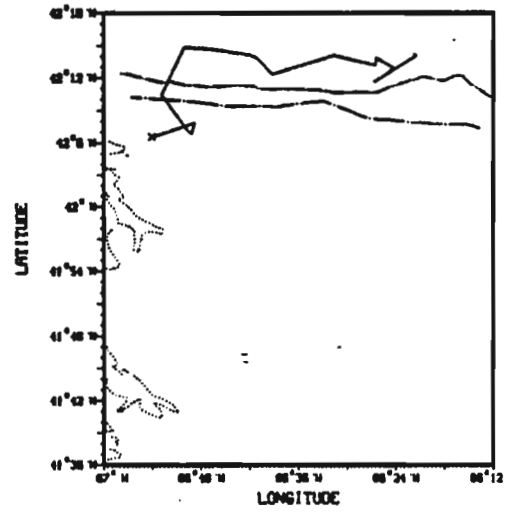
DEPLOYMENT 11 OCTOBER 11 - 12 / 88



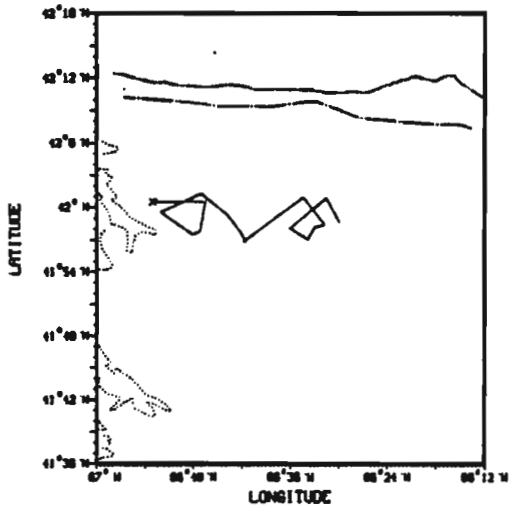
DEPLOYMENT 11 ARGOS BUOY 2757



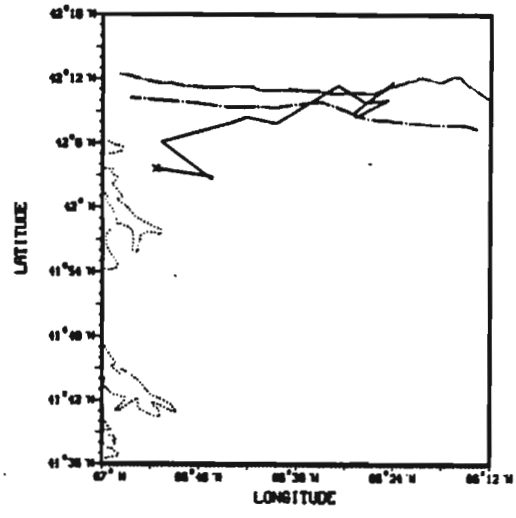
DEPLOYMENT 11 ARGOS BUOY 2754



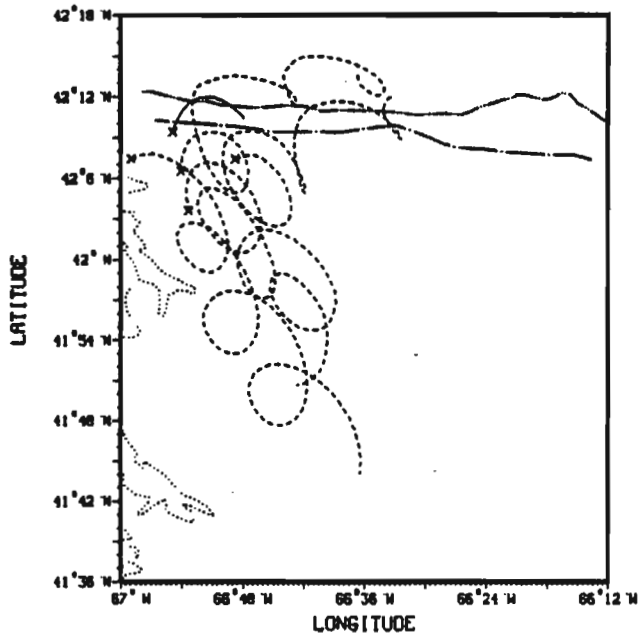
DEPLOYMENT 11 ARGOS BUOY 4447



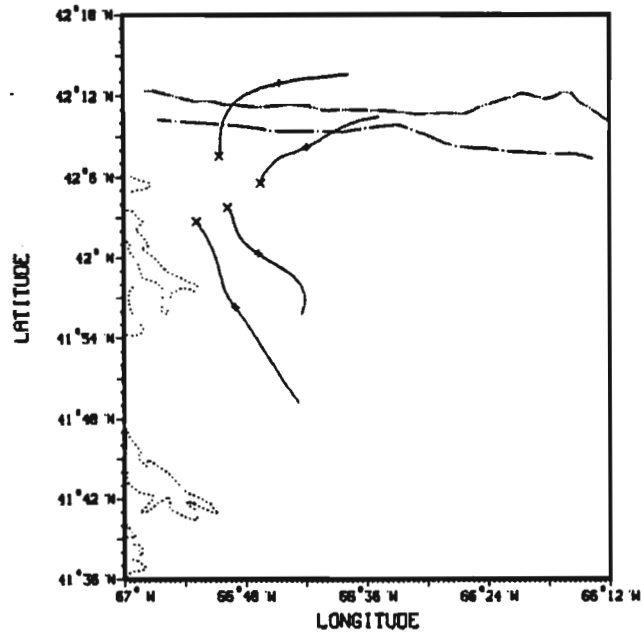
DEPLOYMENT 11 ARGOS BUOY 2755



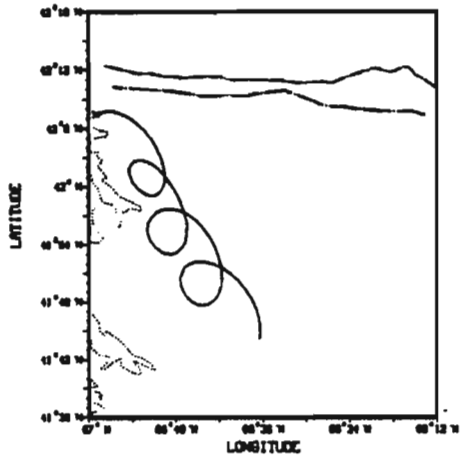
DEPLOYMENT 11 OCTOBER 11 - 12 / 88



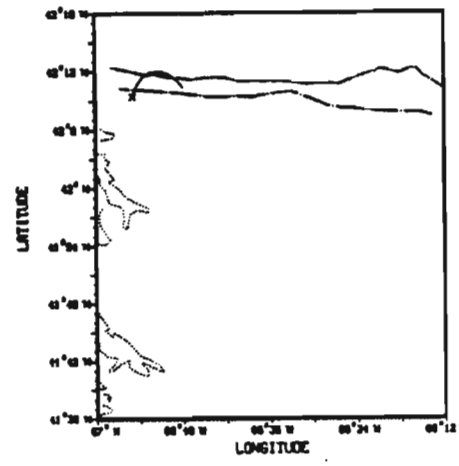
DEPLOYMENT 11 OCTOBER 11 - 12 / 88



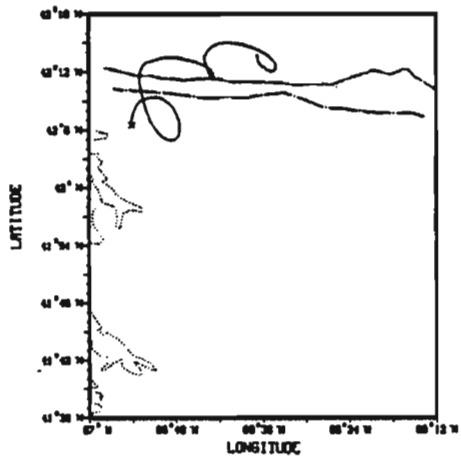
DEPLOYMENT 11 LORAN-C BUOY 22



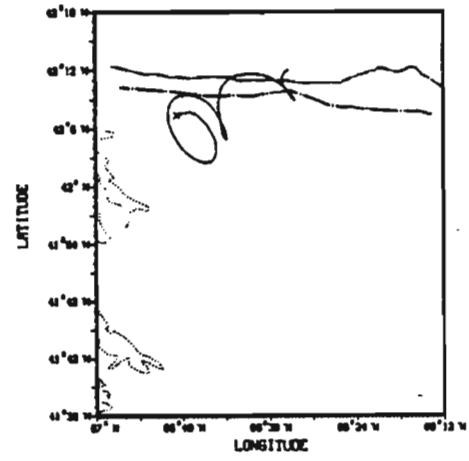
DEPLOYMENT 11 LORAN-C BUOY 21



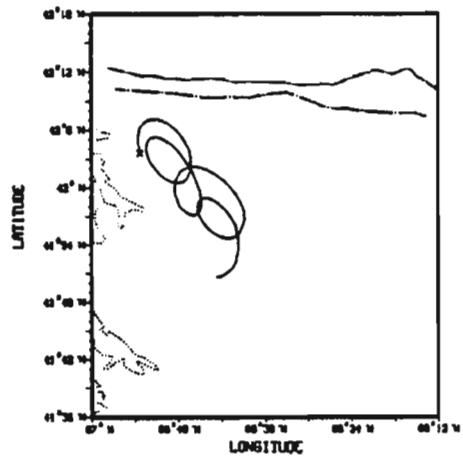
DEPLOYMENT 11 LORAN-C BUOY 25



DEPLOYMENT f1 LORAN-C BUOY 24



DEPLOYMENT 11 LORAN-C BUOY 26



DEPLOYMENT # 12

No. of buoys released:	ARGOS 4	LORAN-C 4
Time of first deployment:	01:10 Oct 13, 1988	
Time of last recovery:	23:54 Oct 13, 1988	
Total time duration:	22.7 hr	

Hydrographic Structure:

Buoys 26 and 2754 were deployed at what is thought to be the leading edge of the tidal front. The other buoys were released on the well-mixed side of the front to the south.

Winds:

Relatively steady eastward winds blew during deployment 12. Wind speeds were near 10 m s^{-1} as measured by the ship's anemometer but near 6 m s^{-1} based upon the buoy measurements.

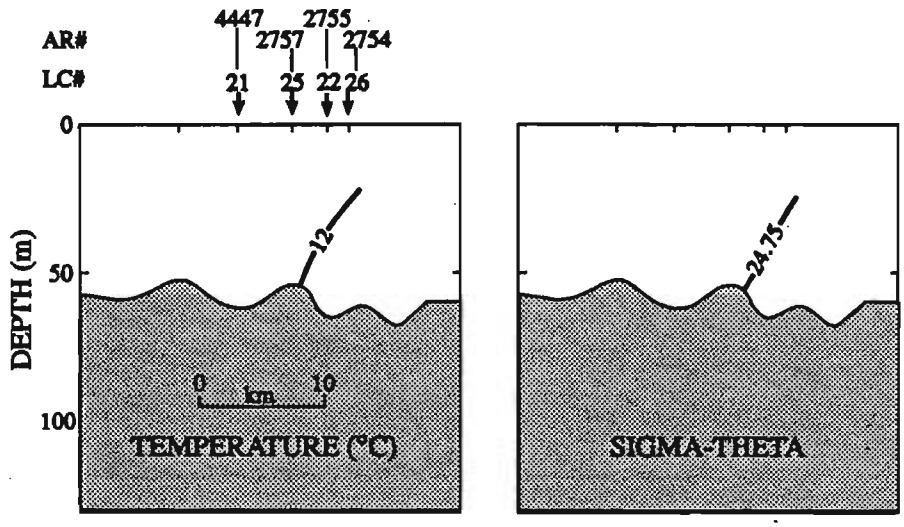
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	13 Oct 02:11	13 Oct 21:22	9	19	100
2755	AR	-	13 Oct 02:36	13 Oct 21:48	9	19	100
2757	AR	-	13 Oct 01:39	13 Oct 20:48	7	19	100
4447	AR	-	13 Oct 01:10	13 Oct 20:27	8	19	100
21	LC	10	13 Oct 01:11	13 Oct 19:00	37	18	80
22	LC	10	13 Oct 02:37	13 Oct 22:30	41	20	100
25	LC	10	13 Oct 01:40	13 Oct 23:22	45	22	100
26	LC	10	13 Oct 02:13	13 Oct 18:09	34	16	100

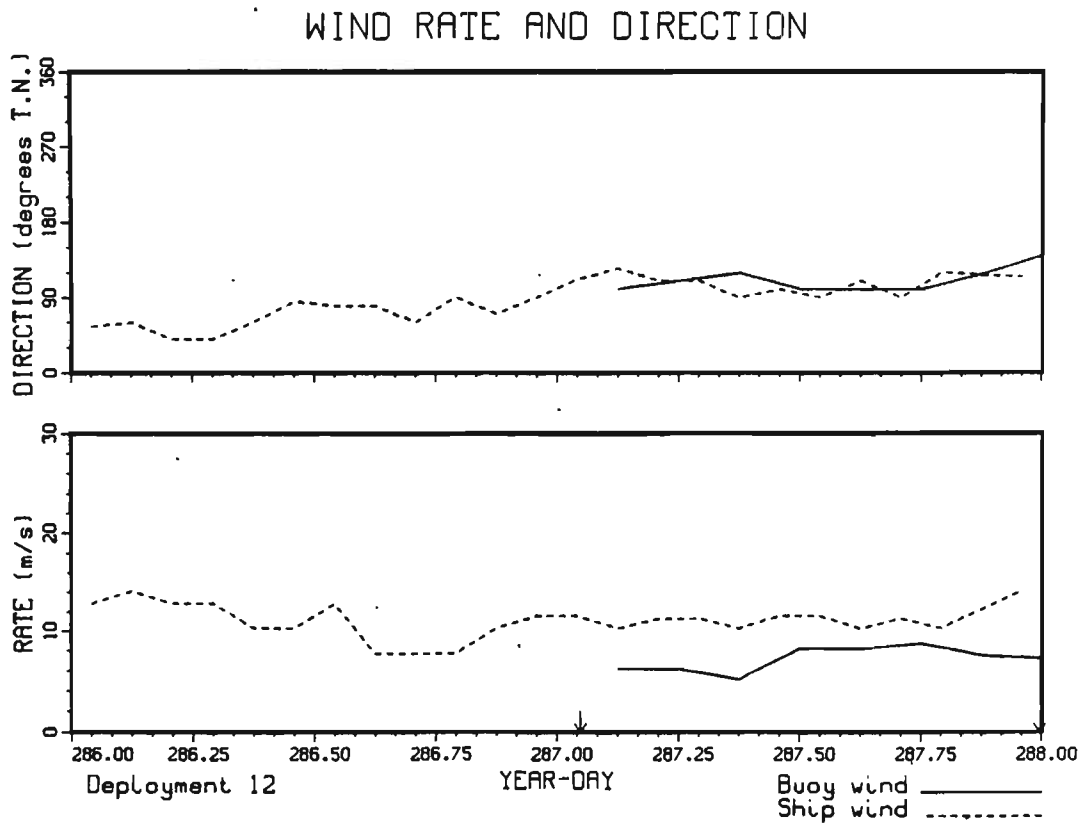
Mean Residual Currents:

Residual currents were calculated from 12.5 h running means.

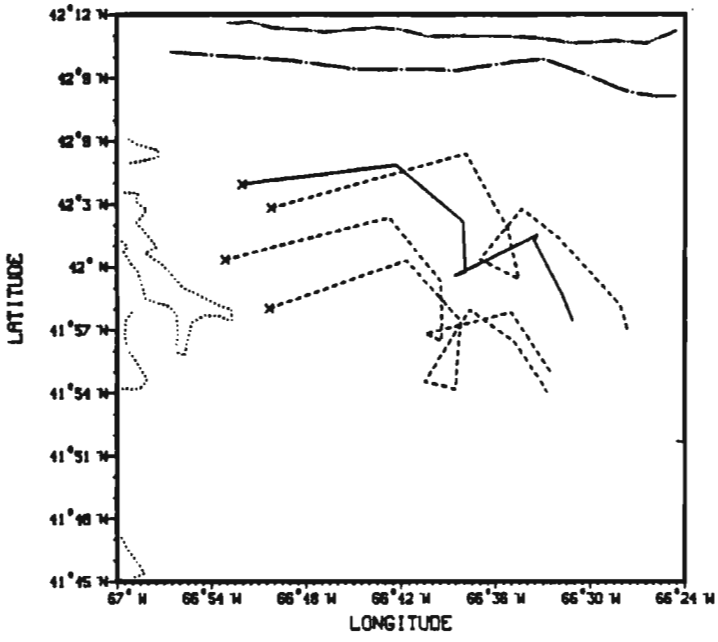
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.280	-0.222	0.357	128°
2755	0.257	-0.238	0.350	133°
2757	0.290	-0.270	0.396	133°
4447	0.264	-0.244	0.359	133°
21	0.156	-0.162	0.225	136°
22	0.245	-0.175	0.301	126°
25	0.251	-0.211	0.328	130°
26	0.291	-0.144	0.325	116°



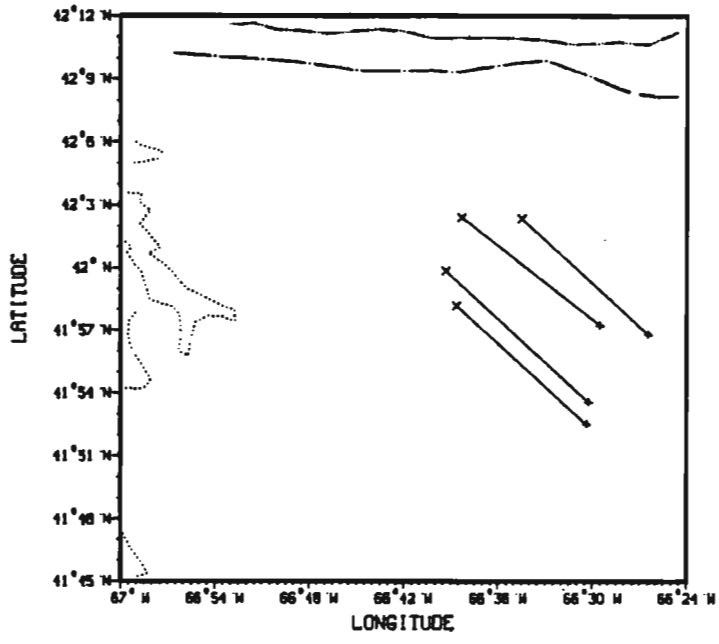
DEPLOYMENT 12— 13 OCTOBER 1988—66° 51'W



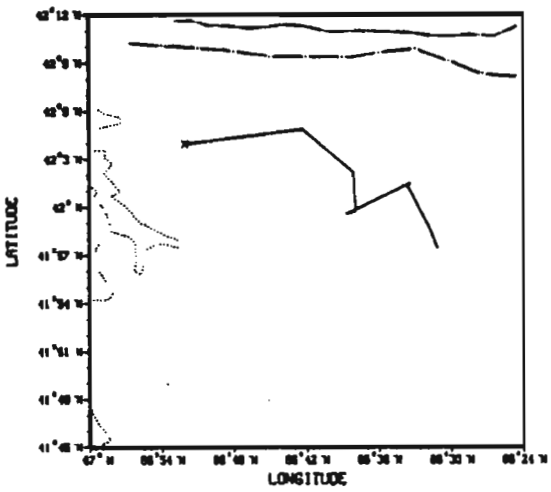
DEPLOYMENT 12 OCTOBER 13 / 88



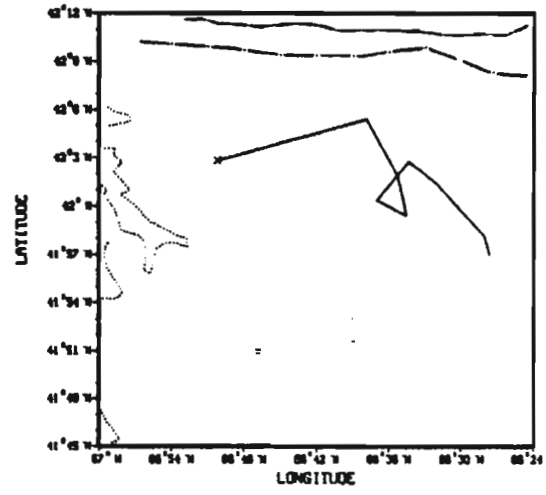
DEPLOYMENT 12 OCTOBER 13 / 88



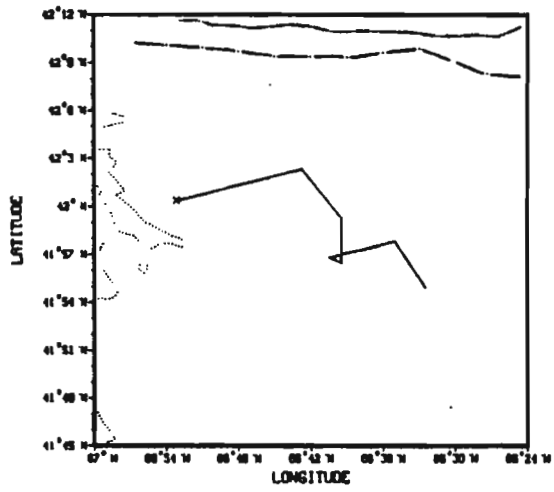
DEPLOYMENT 12 ARGOS BUOY 2754



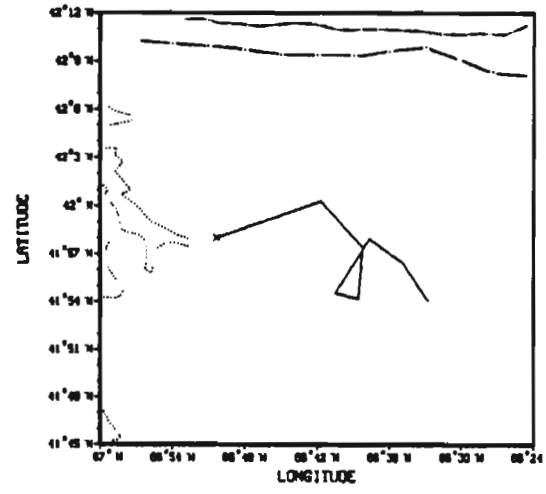
DEPLOYMENT 12 ARGOS BUOY 2755



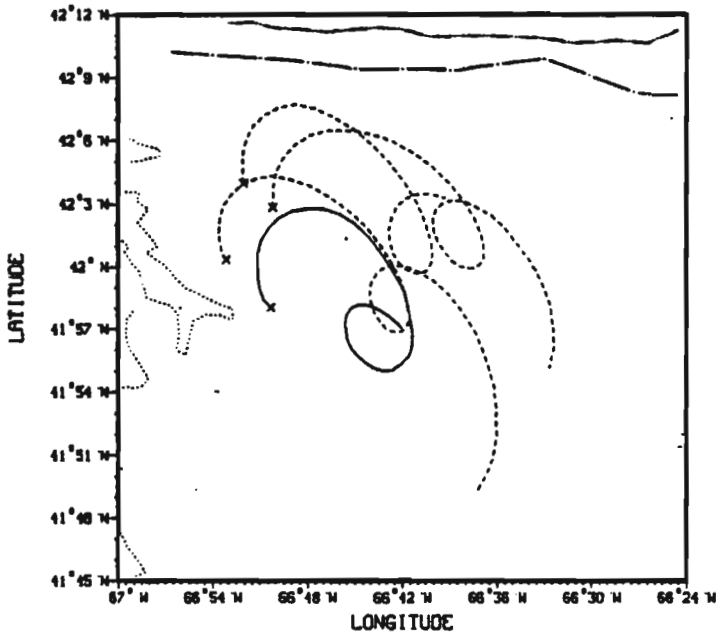
DEPLOYMENT 12 ARGOS BUOY 2757



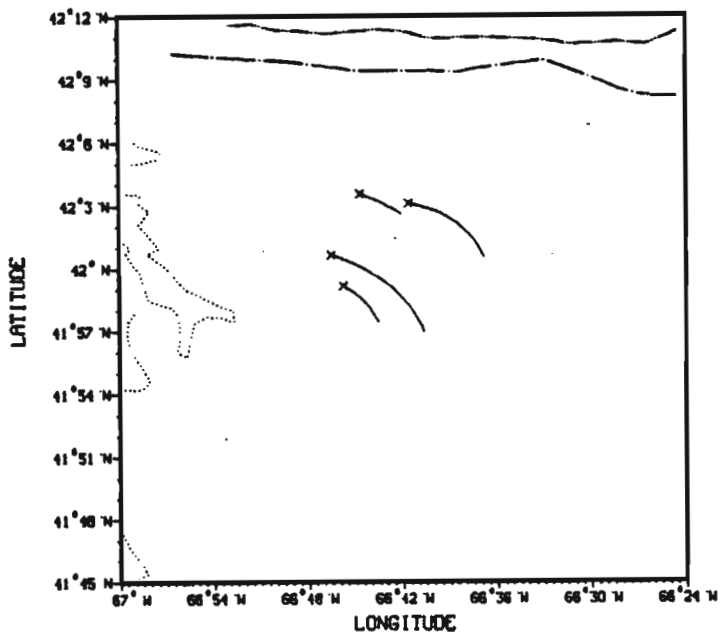
DEPLOYMENT 12 ARGOS BUOY 4447



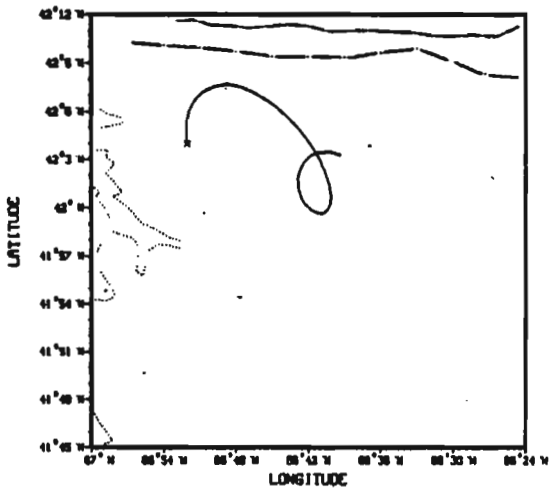
DEPLOYMENT 12 OCTOBER 13 / 88



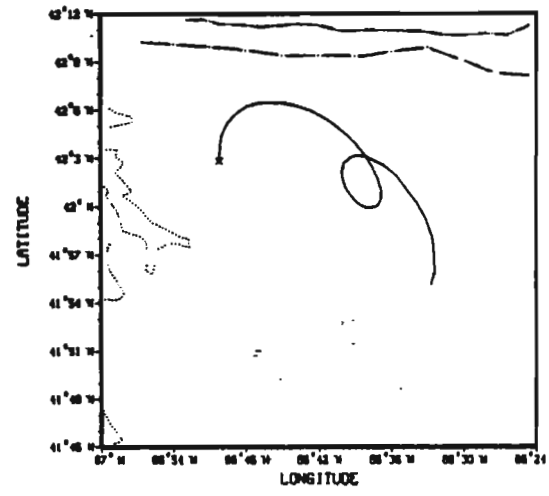
DEPLOYMENT 12 OCTOBER 13 / 88



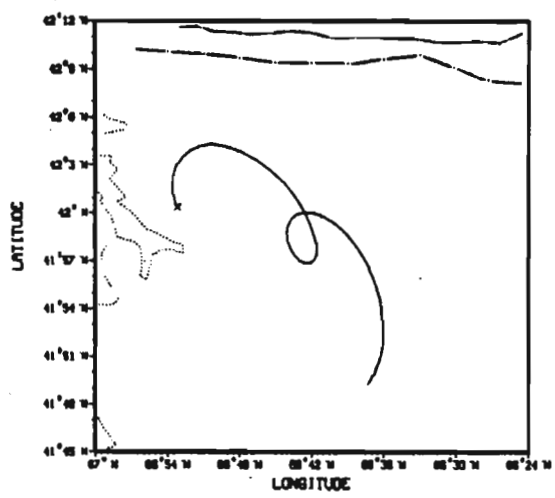
DEPLOYMENT 12 LORAN-C BUOY 26



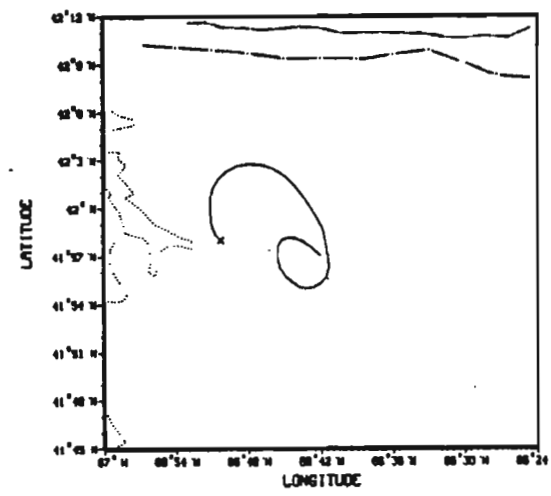
DEPLOYMENT 12 LORAN-C BUOY 22



DEPLOYMENT 12 LORAN-C BUOY 25



DEPLOYMENT 12 LORAN-C BUOY 21



DEPLOYMENT # 13

No. of buoys released:	ARGOS 3	LORAN-C 3
Time of first deployment:	20:56 Oct 14, 1988	
Time of last recovery:	13:14 Oct 16, 1988	
Total time duration:	40.3 hr	

Hydrographic Structure:

Buoys 22 and 2757 were released near the leading edge of the tidal front while the remaining buoys were deployed in the near homogeneous waters to the south.

Winds:

At the time of the release of the buoys the winds were eastward at 8-12 m s^{-1}. Wind speed gradually decreased during 15 October (day 289) to less than 5 m s^{-1} and remained low for the duration of the tracking. Wind direction shifted gradually to westward by the time the buoys were recovered.

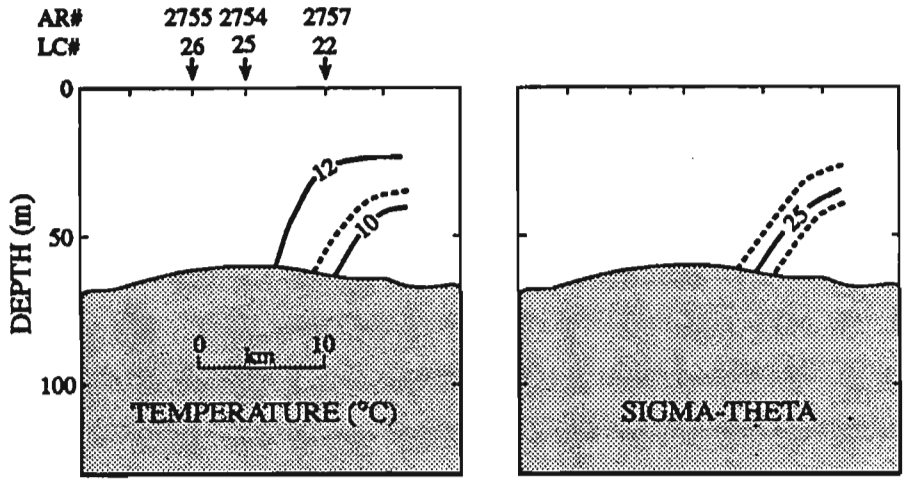
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2754	AR	-	14 Oct 21:23	16 Oct 12:39	11	39	100
2755	AR	-	14 Oct 22:58	16 Oct 13:14	14	38	100
2757	AR	-	14 Oct 20:56	16 Oct 13:11	15	40	100
22	LC	No Drogue	14 Oct 20:57	16 Oct 11:36	80	39	100
25	LC	No Drogue	14 Oct 21:24	16 Oct 12:09	80	39	100
26	LC	No Drogue	14 Oct 22:59	16 Oct 12:15	76	37	100

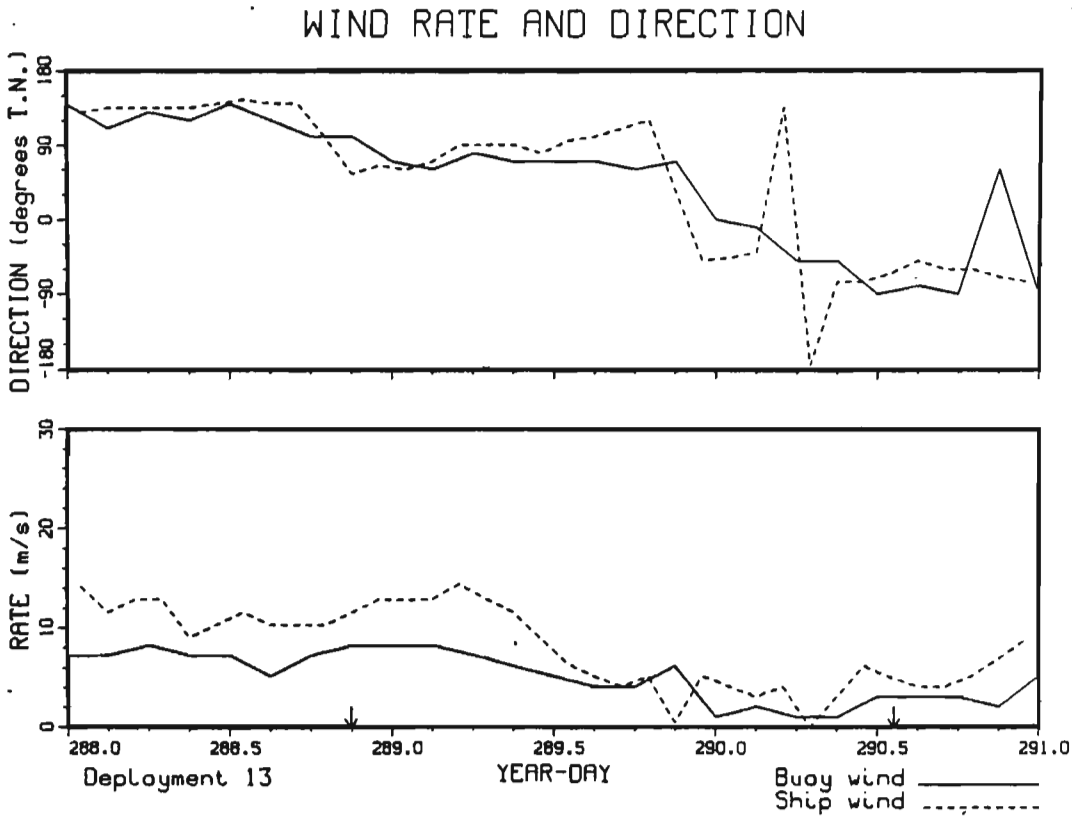
Mean Residual Currents:

Residual currents were calculated from 12.5 h running means.

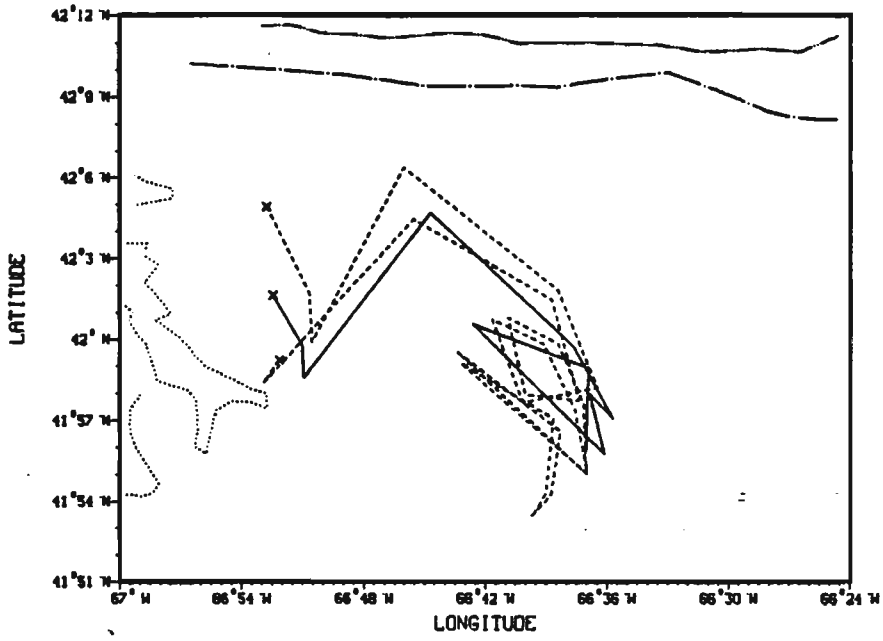
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2754	0.192	-0.047	0.198	104°
2755	0.146	-0.081	0.167	119°
2757	0.152	-0.096	0.180	122°
22	0.127	-0.048	0.136	111°
25	0.118	-0.051	0.129	113°
26	0.112	-0.072	0.133	123°



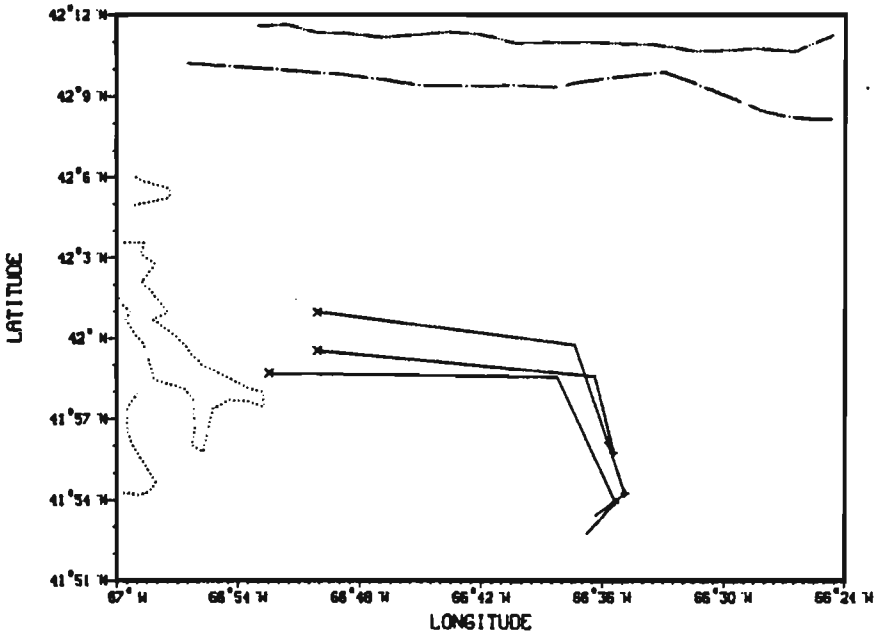
DEPLOYMENT 13—14 OCTOBER 1988—66° 52'W



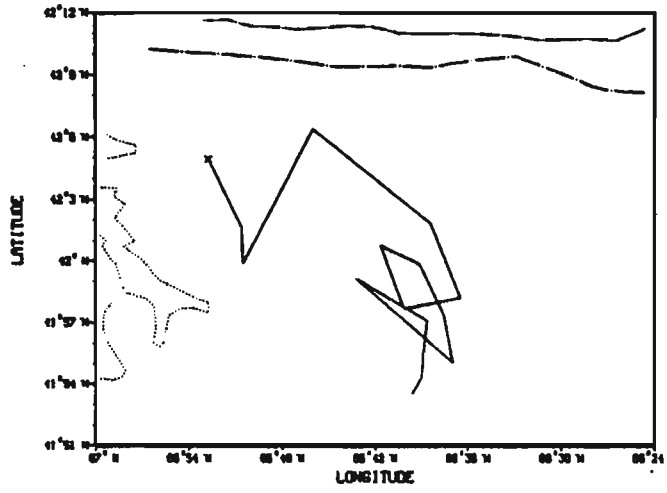
DEPLOYMENT 13 OCTOBER 14 - 16 / 88



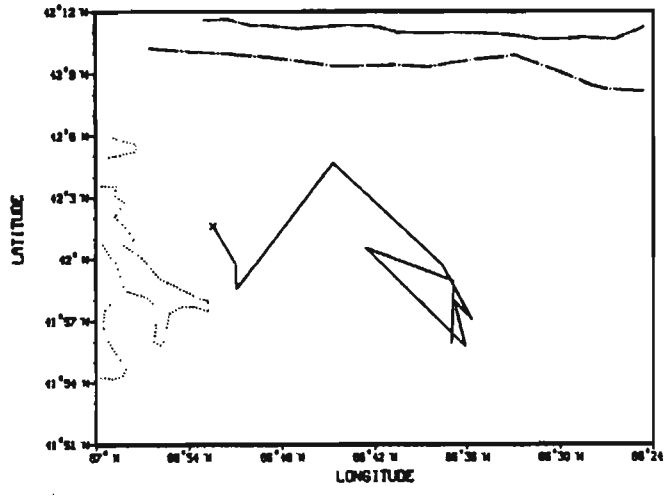
DEPLOYMENT 13 OCTOBER 14 - 16 / 88



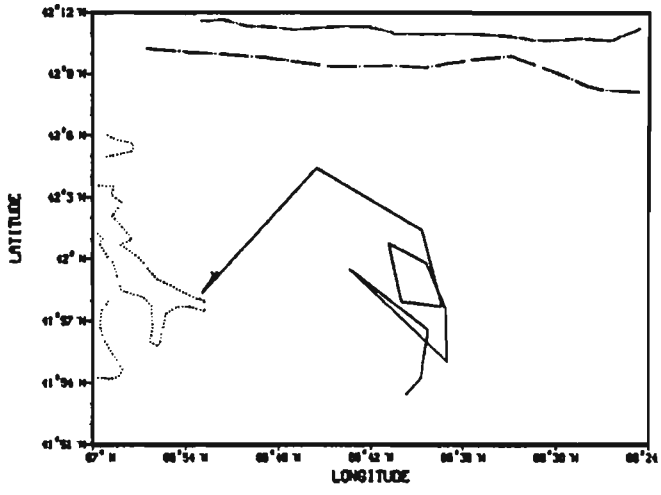
DEPLOYMENT 13 ARGOS BUOY 2757



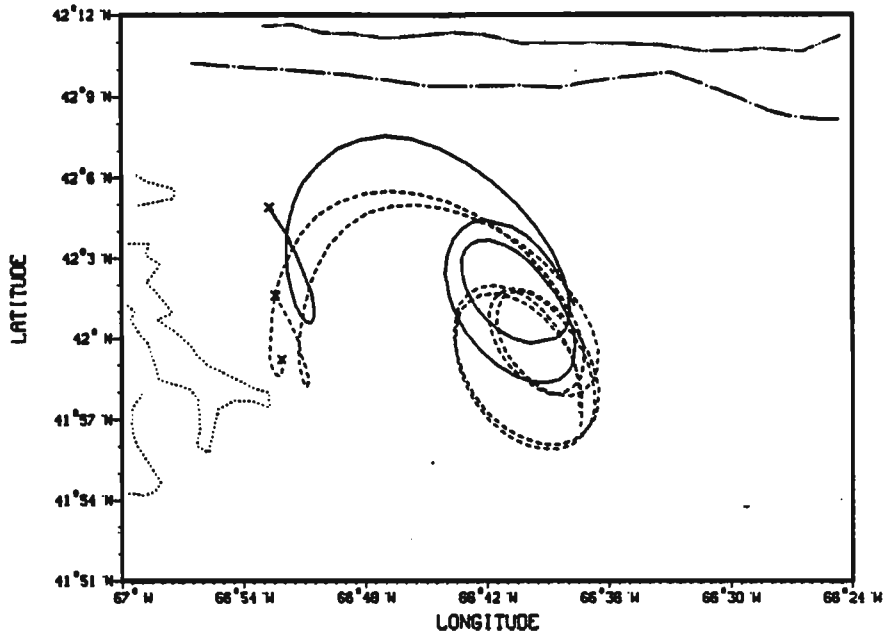
DEPLOYMENT 13 ARGOS BUOY 2754



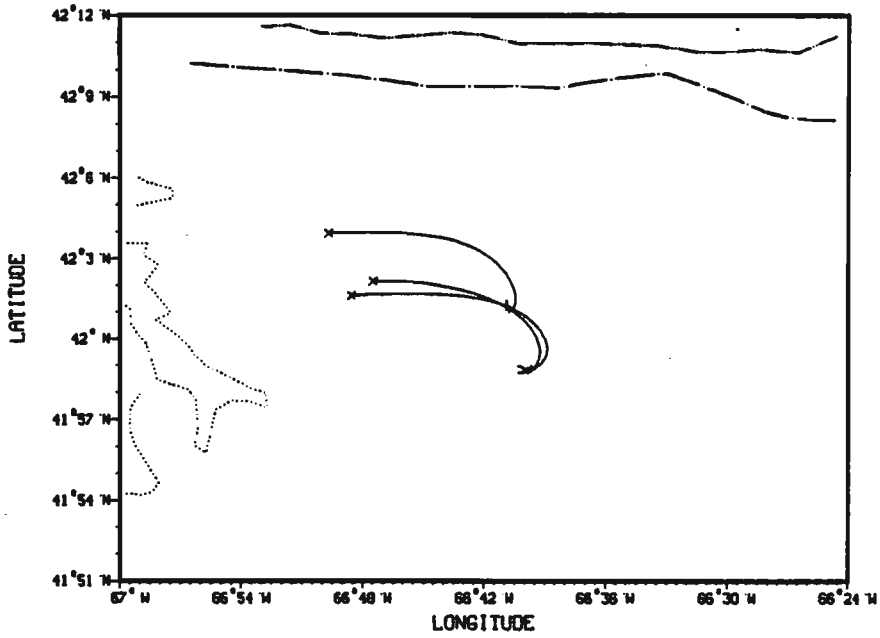
DEPLOYMENT 13 ARGOS BUOY 2755



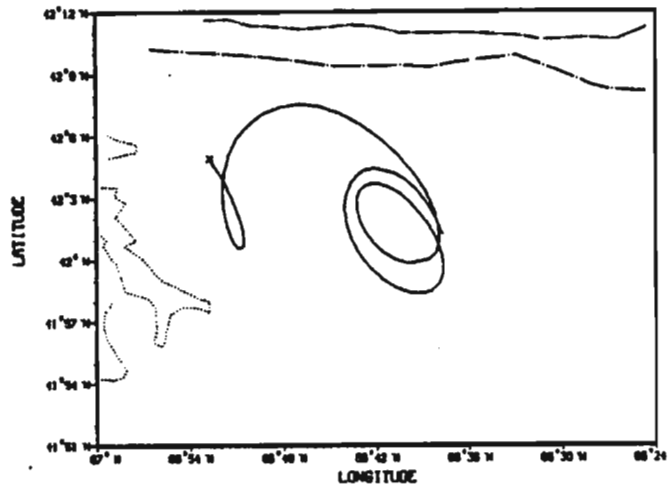
DEPLOYMENT 13 OCTOBER 14 - 16 / 88



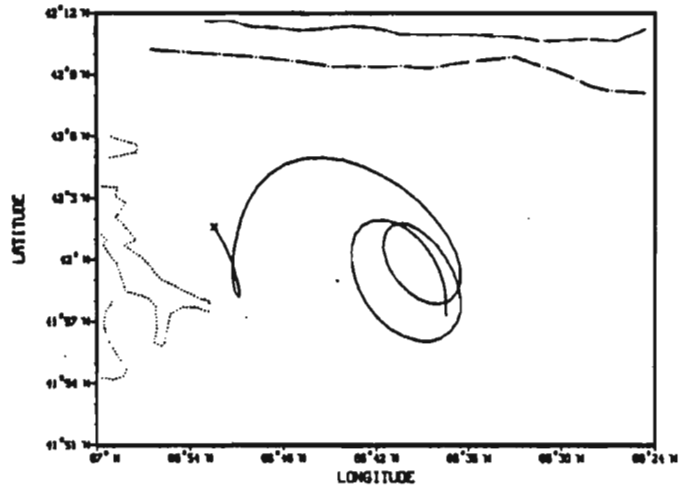
DEPLOYMENT 13 OCTOBER 14 - 16 / 88



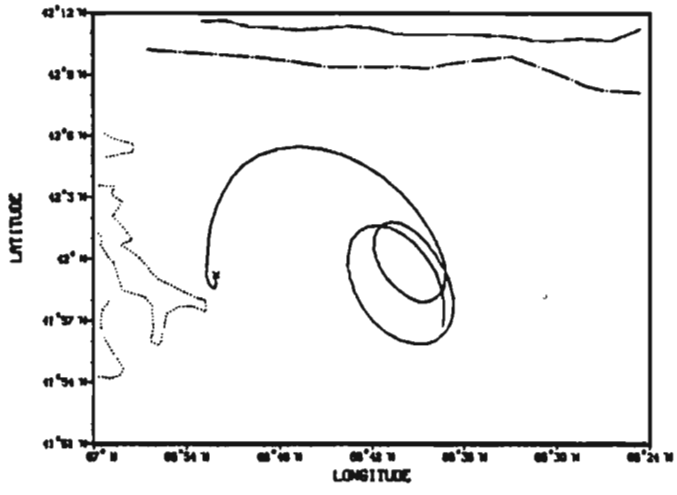
DEPLOYMENT 13 LORAN-C BUOY 22



DEPLOYMENT 13 LORAN-C BUOY 25



DEPLOYMENT 13 LORAN-C BUOY 26



DEPLOYMENT # 14

No. of buoys released:	ARGOS 4	LORAN-C	9
Time of first deployment:	04:30 July 14, 1989		
Time of last recovery:	05:01 July 20, 1989		
Total time duration:	144.5 hr		

Hydrographic Structure:

The buoys were released in stratified waters over the Bank. A tidal front was not evident from the hydrographic transect.

Winds:

Winds were generally very light during deployment 14. A short burst of wind occurred on 17 July (day 198) when speeds reached 10 m s^{-1}. Directions at this time were veering from westward to eastward.

Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2485	AR	-	14 Jul 19:32	19 Jul 17:01	47	117	100
2754	AR	-	14 Jul 15:02	20 Jul 05:01	54	134	100
2755	AR	-	14 Jul 21:47	19 Jul 22:05	21	120	100
2757	AR	-	14 Jul 04:31	19 Jul 23:18	59	139	100
21	LC	10	14 Jul 04:30	19 Jul 18:27	269	134	100
22	LC	10	14 Jul 14:59	20 Jul 03:15	267	132	100
23*	LC	10	14 Jul 23:29	19 Jul 12:00	153	75	64
24	LC	10	14 Jul 16:59	20 Jul 01:37	260	129	100
25	LC	10	15 Jul 00:20	17 Jul 12:01	122	60	100
26	LC	10	14 Jul 20:30	19 Jul 19:02	239	119	100
27	LC	10	14 Jul 21:38	19 Jul 17:53	234	118	100
28	LC	10	14 Jul 22:32	17 Jul 12:52	126	62	100
39	LC	10	14 Jul 19:14	17 Jul 16:32	141	69	100

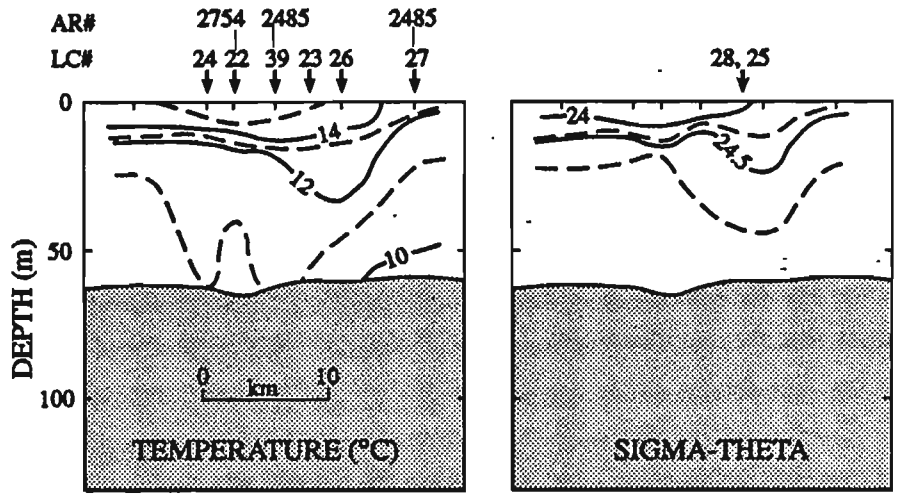
*No data were obtained between 17 Jul 11:00 and 18 Jul 20:30.

Mean Residual Currents:

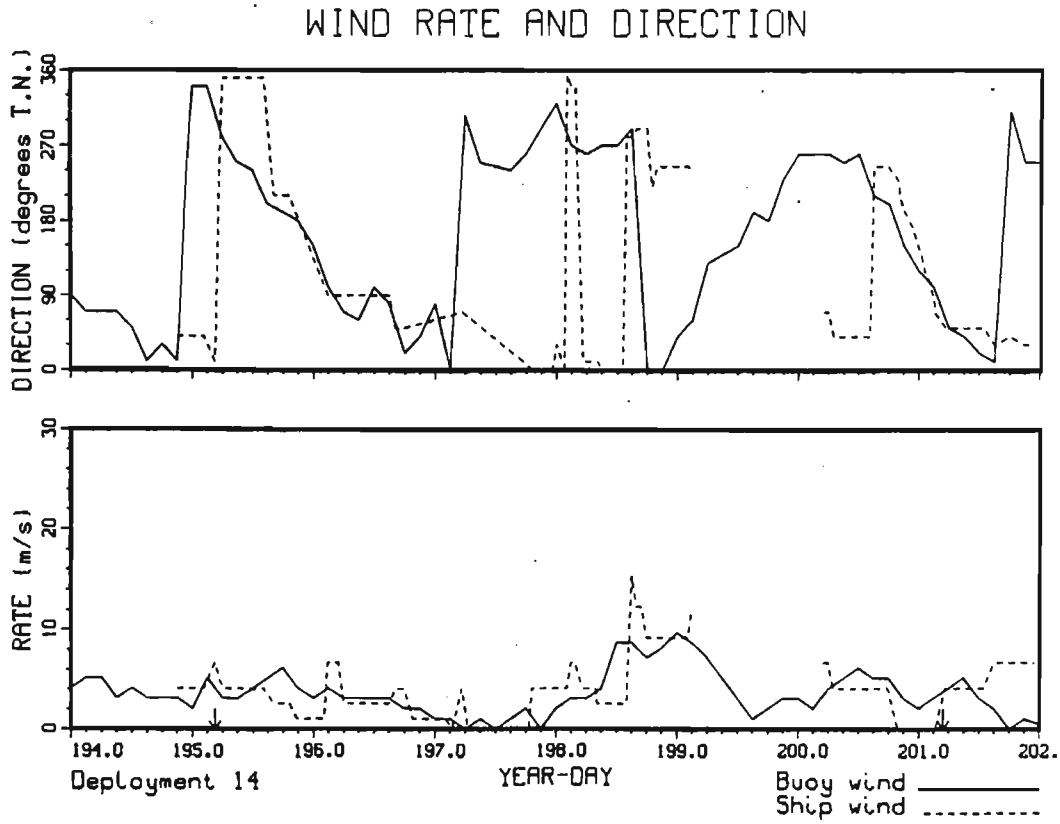
Residual currents were calculated from 25.0 h running means.

Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2485	0.072	-0.061	0.094	130°
2754	-0.056	-0.096	0.111	210°
2755	0.132	-0.095	0.163	126°
2757	0.062	-0.109	0.125	150°
21	0.007	-0.086	0.086	175°
22	-0.043	-0.072	0.084	211°
23	0.009	-0.046	0.047	169°
24	-0.005	-0.063	0.063	185°
25	0.064	-0.036	0.073	119°

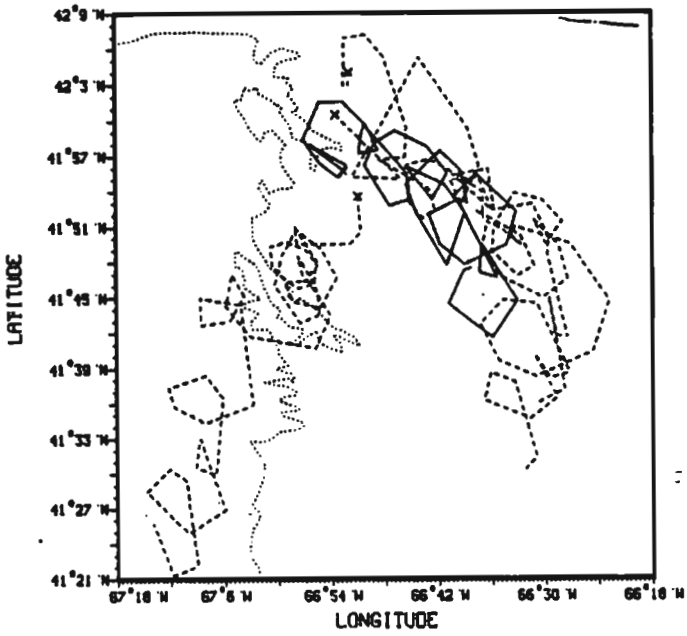
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
26	0.010	-0.050	0.051	169°
27	0.019	-0.070	0.073	165°
28	0.031	-0.056	0.064	151°
39	0.181	0.029	0.183	81°



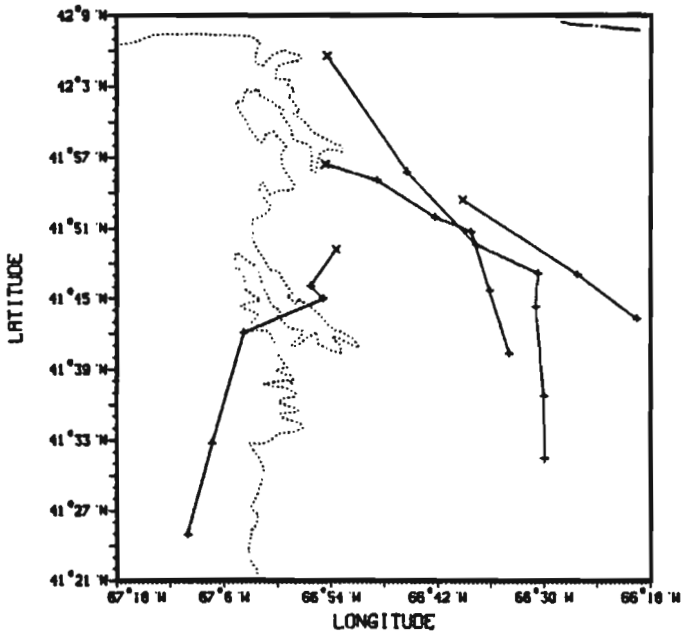
DEPLOYMENT 14—14 JULY 1989—66° 51' W



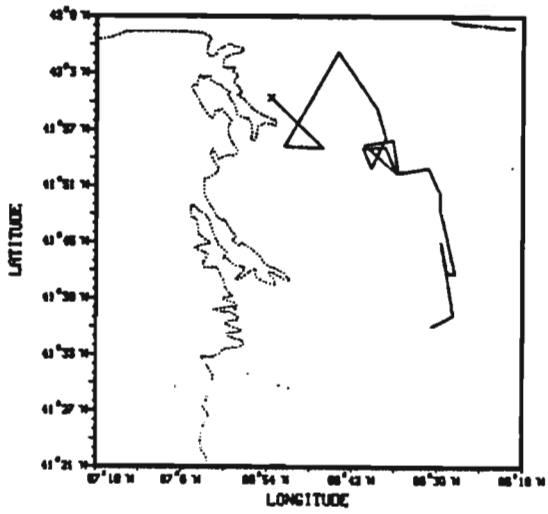
DEPLOYMENT 14 JULY 14 - 20 / 89



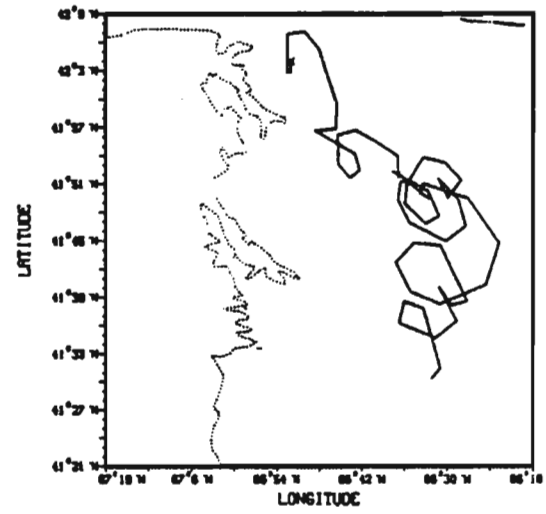
DEPLOYMENT 14 JULY 14 - 20 / 89



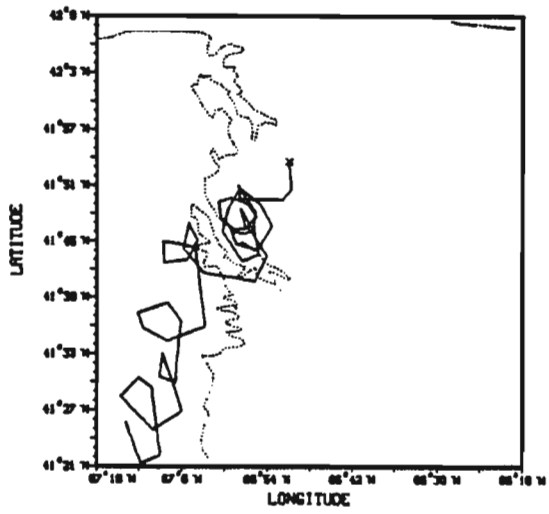
DEPLOYMENT 14 ARGOS BUOY 2755



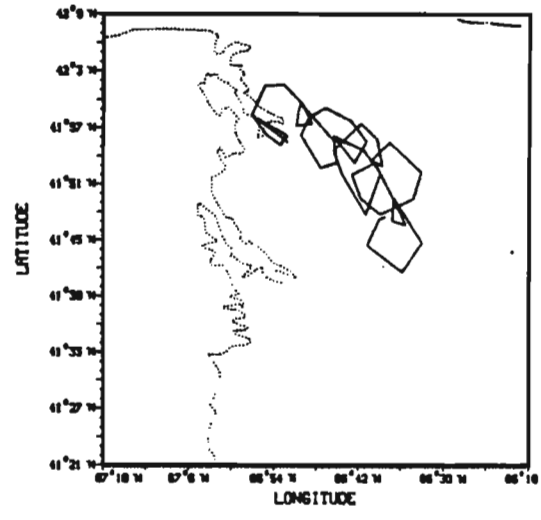
DEPLOYMENT 14 ARGOS BUOY 2757



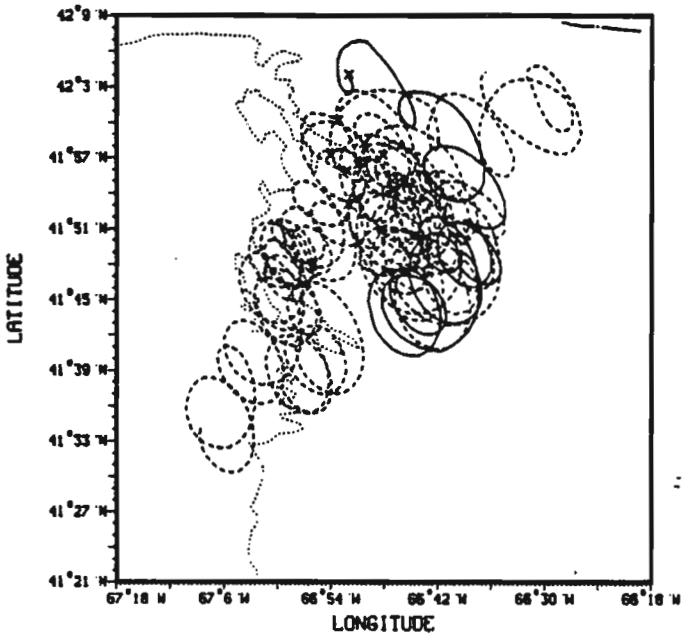
DEPLOYMENT 14 ARGOS BUOY 2754



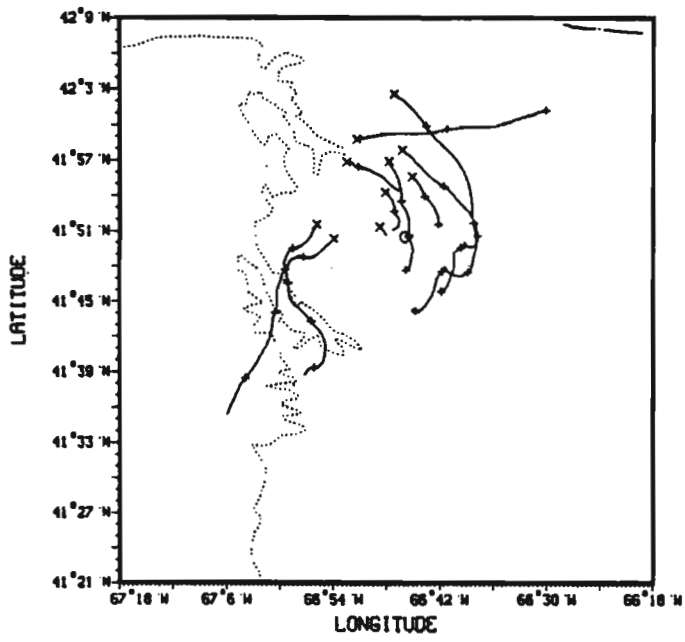
DEPLOYMENT 14 ARGOS BUOY 2485



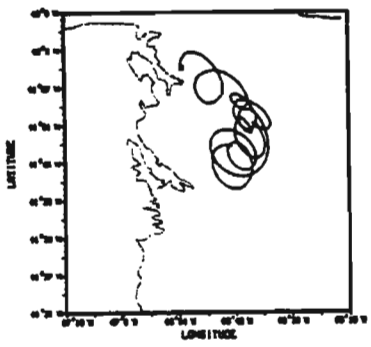
DEPLOYMENT 14 JULY 14 - 20 / 89



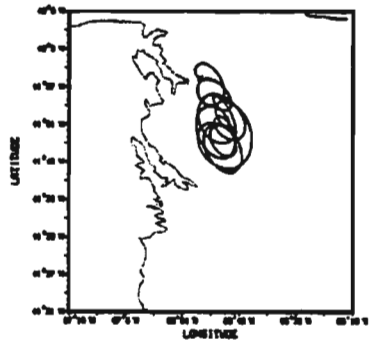
DEPLOYMENT 14 JULY 14 - 20 / 89



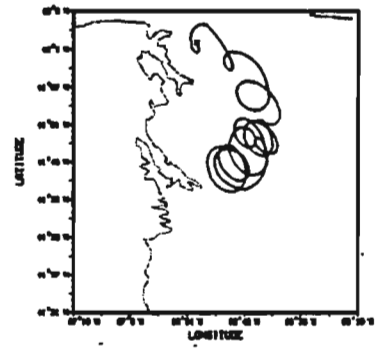
DEPLOYMENT 14 LORAN-C BUOY 27



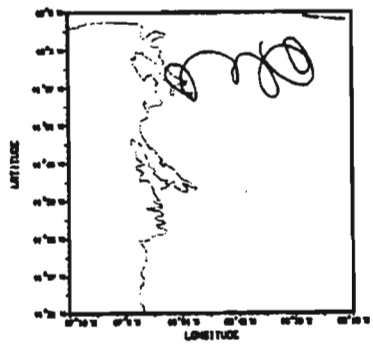
DEPLOYMENT 14 LORAN-C BUOY 26



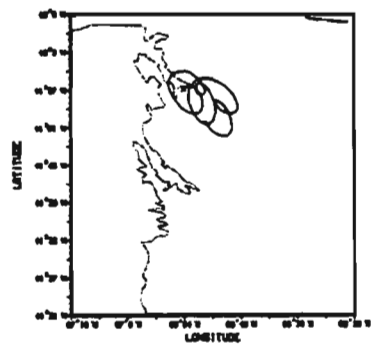
DEPLOYMENT 14 LORAN-C BUOY 21



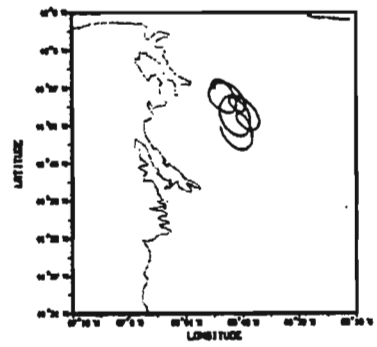
DEPLOYMENT 14 LORAN-C BUOY 39



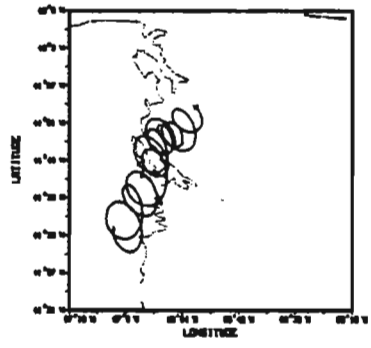
DEPLOYMENT 14 LORAN-C BUOY 25



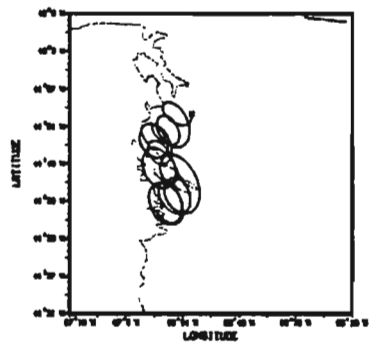
DEPLOYMENT 14 LORAN-C BUOY 28



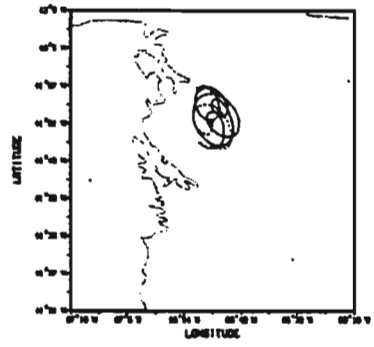
DEPLOYMENT 14 LORAN-C BUOY 22



DEPLOYMENT 14 LORAN-C BUOY 24



DEPLOYMENT 14 LORAN-C BUOY 23



DEPLOYMENT # 15

No. of buoys released: ARGOS 4 LORAN-C 9
Time of first deployment: 09:30 July 20, 1989
Time of last recovery: 01:46 July 22, 1989
Total time duration: 40.3 hr

Hydrographic Structure:

Most of the buoys were released near the leading edge of the tidal front. Buoys 22 and 2755 were deployed in the waters with the highest stratification while buoy 25 was deployed in the most homogeneous waters.

Winds:

Generally light winds prevailed during deployment 15. Directions were initially northeastward but shifted to westward shortly after the buoys were deployed.

Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2485	AR	-	20 Jul 13:49	21 Jul 21:26	14	32	100
2754	AR	-	20 Jul 10:16	21 Jul 19:24	14	33	100
2755	AR	-	20 Jul 14:21	21 Jul 23:53	4	34	100
2757	AR	-	20 Jul 10:56	22 Jul 00:56	17	38	100
21	LC	10	20 Jul 09:30	21 Jul 19:12	69	34	100
22	LC	10	20 Jul 14:20	21 Jul 20:48	63	30	100
23	LC	10	20 Jul 13:28	22 Jul 01:46	75	36	100
24	LC	10	20 Jul 10:12	21 Jul 22:47	75	37	100
25	LC	10	20 Jul 11:36	21 Jul 19:53	66	32	100
26*	LC	10	20 Jul 10:56	21 Jul 19:42	68	33	100
27*	LC	10	20 Jul 12:17	21 Jul 22:04	17	8	25
28*	LC	5	20 Jul 10:57	21 Jul 19:08	36	15	53
39	LC	5	20 Jul 10:22	21 Jul 23:02	76	37	100

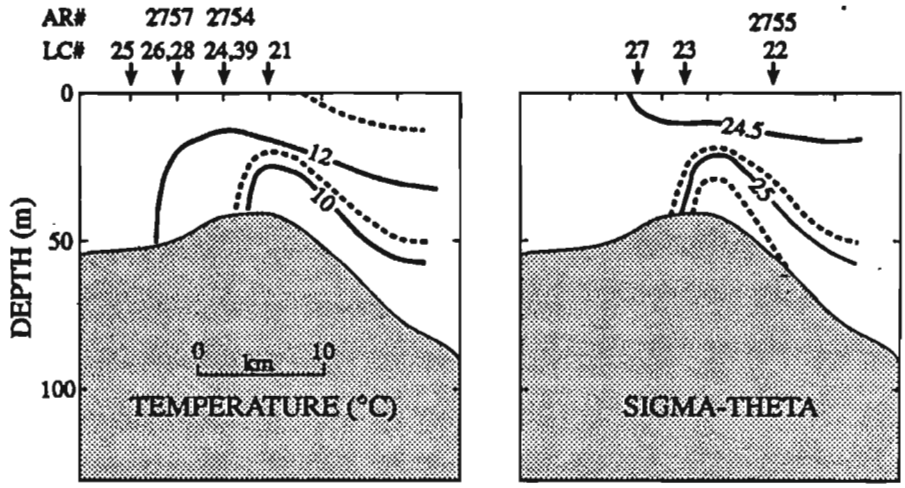
*Data recovered was intermittent

Mean Residual Currents:

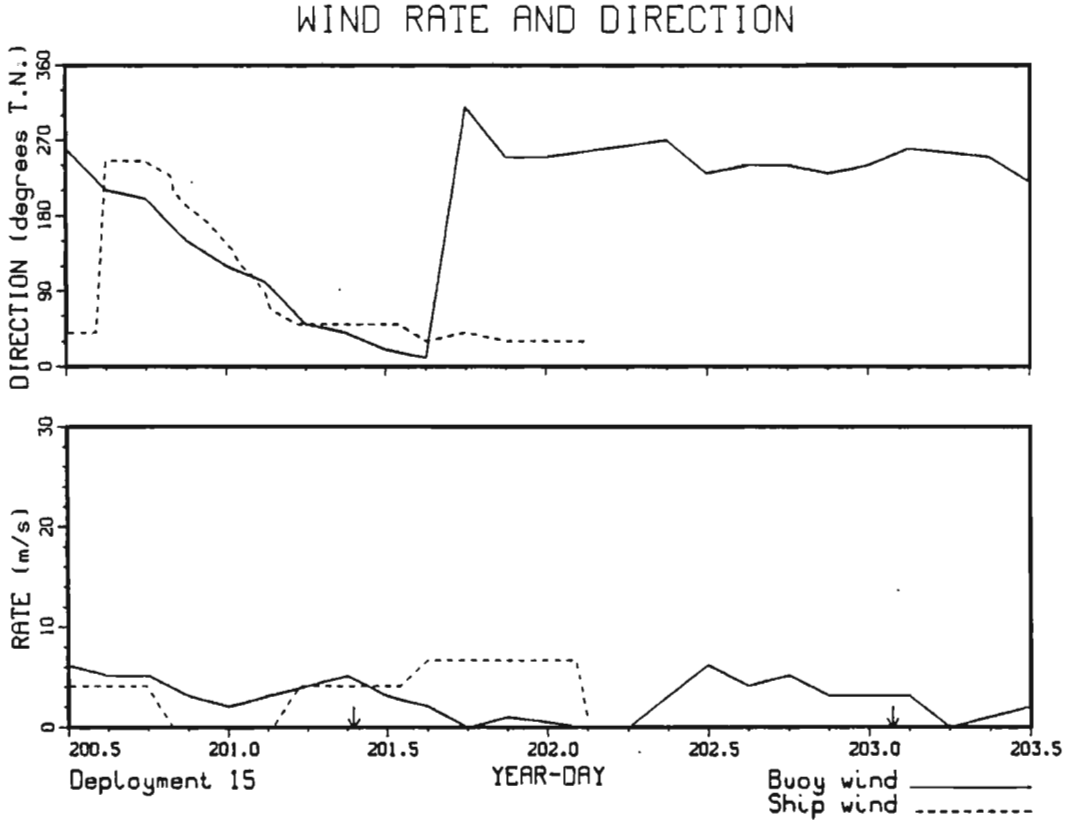
Residual currents were calculated from 25.0 h running means.

Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2485	0.105	-0.070	0.126	124°
2754	0.061	-0.145	0.157	157°
2755		No mean calculated		
2757	0.036	0.030	0.047	50°
21	0.080	-0.127	0.150	148°
22	0.033	-0.103	0.108	162°
23	0.071	0.008	0.071	84°
24	0.059	0.019	0.062	72°
25	0.108	-0.114	0.157	137°

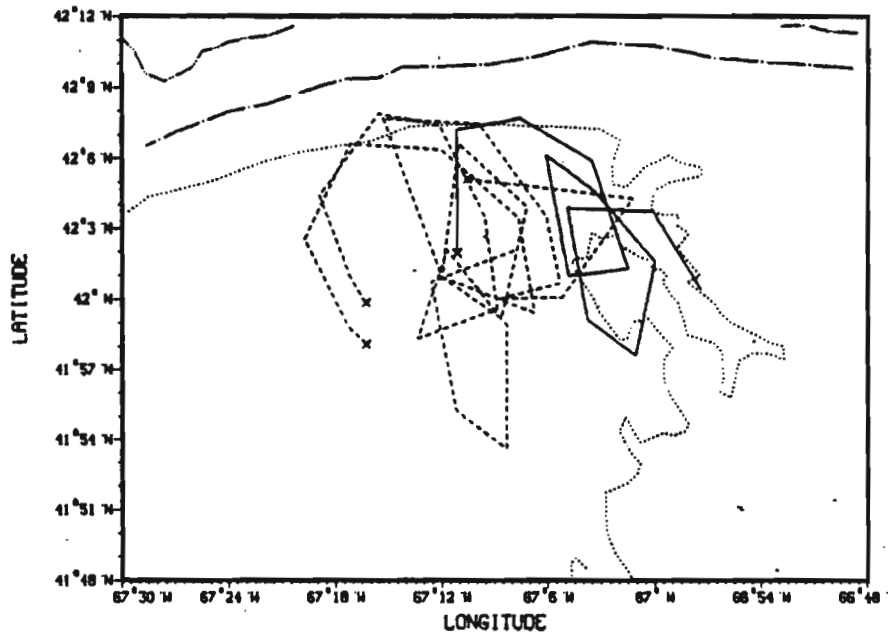
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
26	0.092	-0.111	0.144	140°
27		No mean calculated		
28		No mean calculated		
39	0.061	0.026	0.066	67°



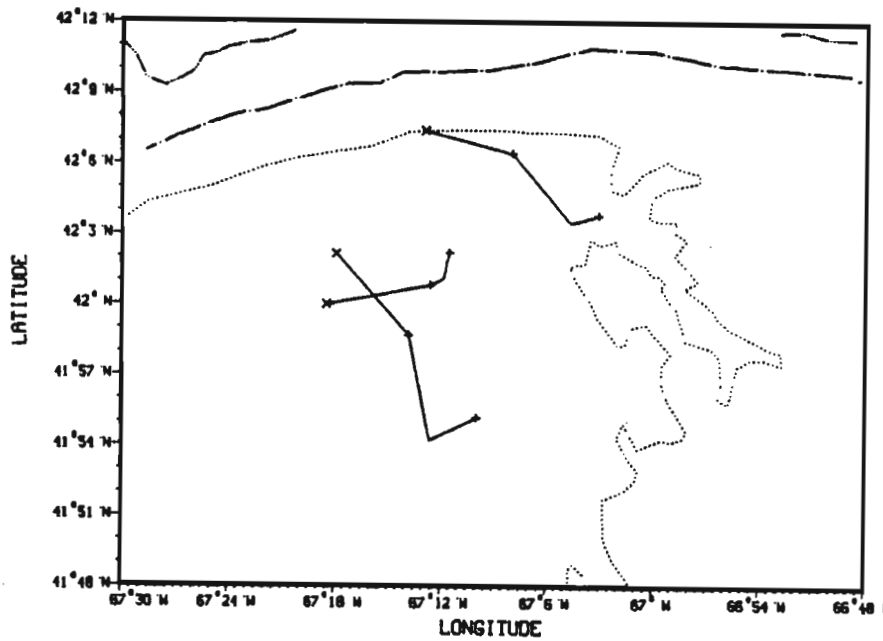
DEPLOYMENT 15— 20 JULY 1989— 67° 16'W



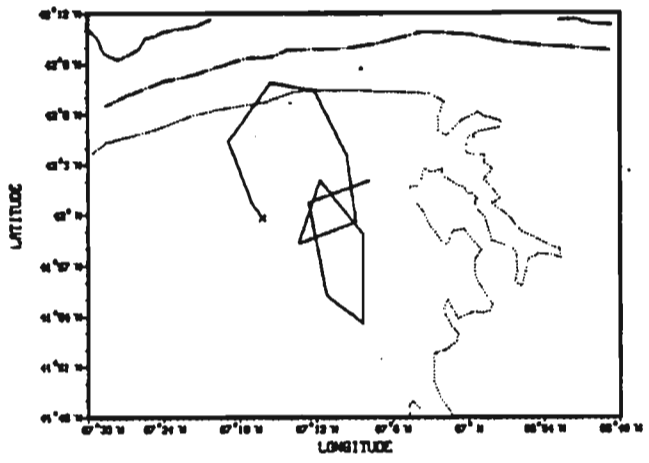
DEPLOYMENT 15 JULY 20 - 22 / 89



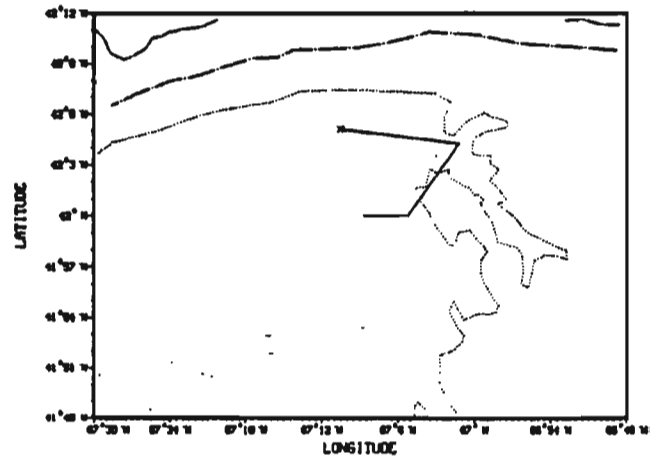
DEPLOYMENT 15 JULY 20 - 22 / 89



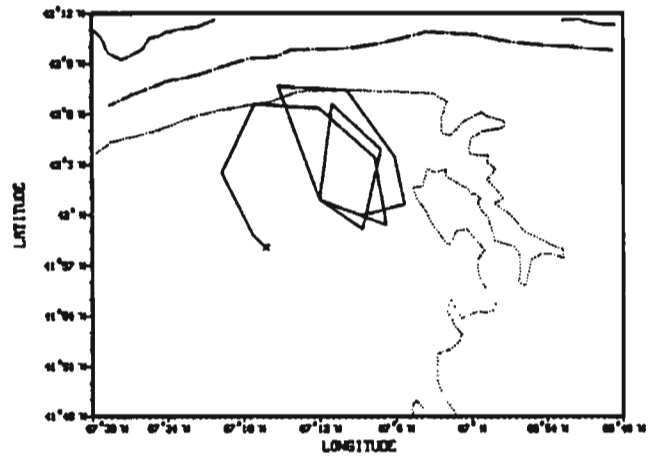
DEPLOYMENT 15 ARGOS BUOY 2754



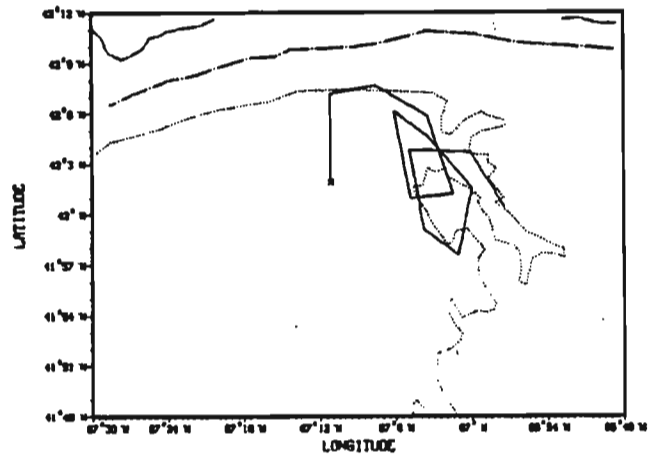
DEPLOYMENT 15 ARGOS BUOY 2755



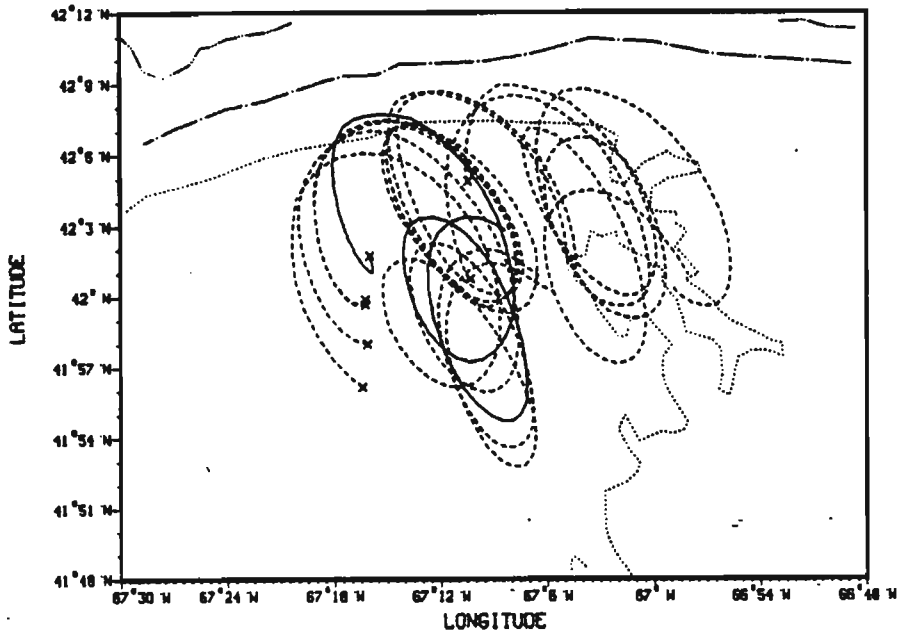
DEPLOYMENT 15 ARGOS BUOY 2757



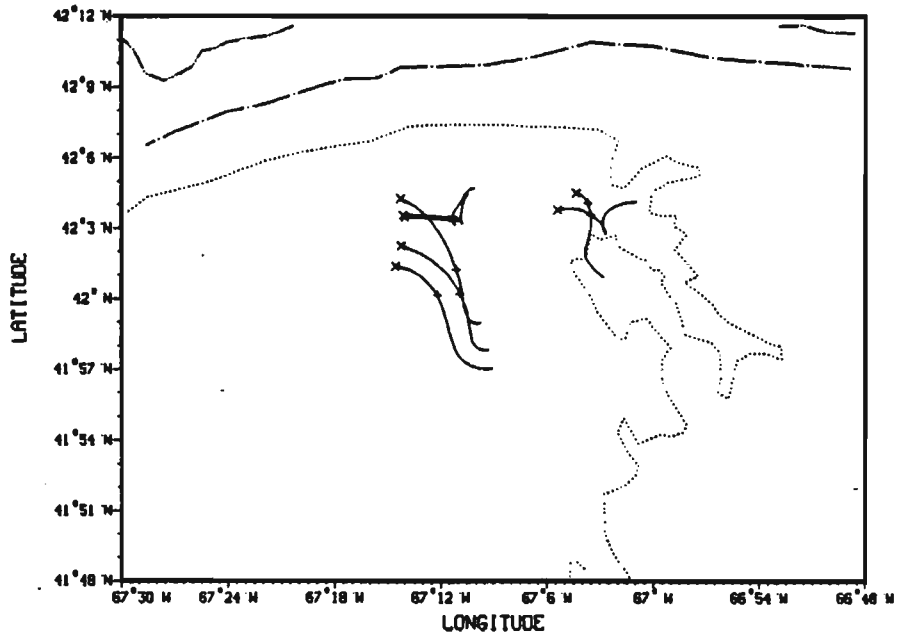
DEPLOYMENT 15 ARGOS BUOY 2485



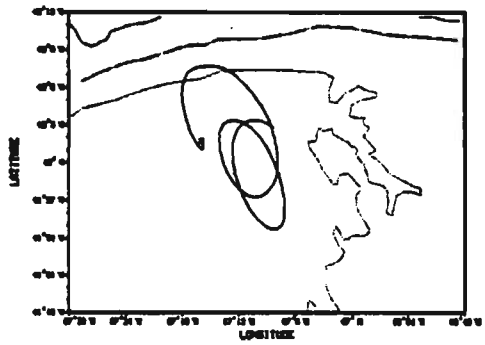
DEPLOYMENT 15 JULY 20 - 22 / 89



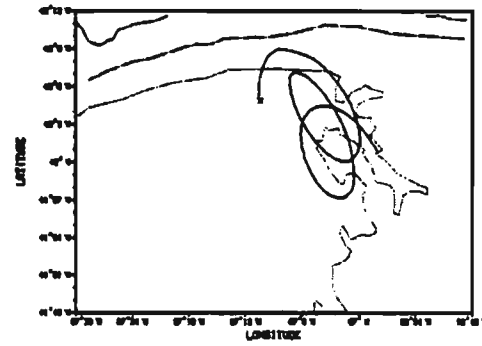
DEPLOYMENT 15 JULY 20 - 22 / 89



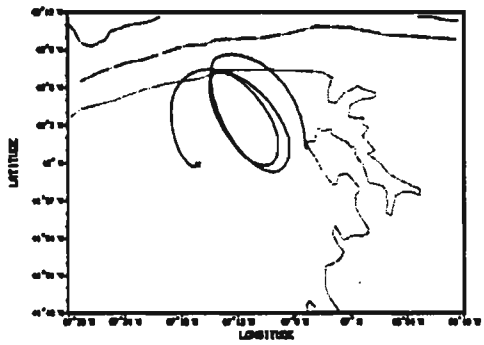
DEPLOYMENT 15 LORAN-C BUOY 21



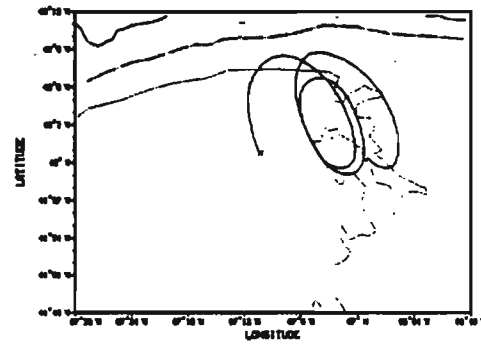
DEPLOYMENT 15 LORAN-C BUOY 22



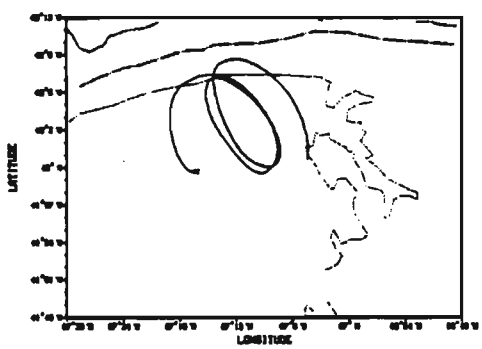
DEPLOYMENT 15 LORAN-C BUOY 24



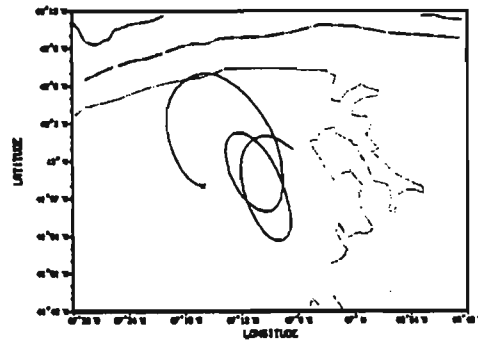
DEPLOYMENT 15 LORAN-C BUOY 23



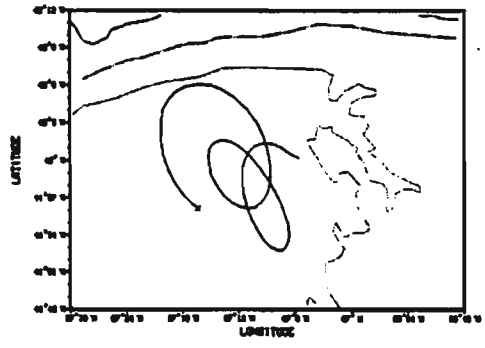
DEPLOYMENT 15 LORAN-C BUOY 39



DEPLOYMENT 15 LORAN-C BUOY 26



DEPLOYMENT 15 LORAN-C BUOY 25



DEPLOYMENT # 16

No. of buoys released: ARGOS 4 LORAN-C 8
Time of first deployment: 09:36 July 24, 1989
Time of last recovery: 22:42 July 26, 1989
Total time duration: 37.1 hr

Hydrographic Structure:

Most of the buoys were released at the edge or off the Bank in stratified waters. Buoys 28 and 2757 were deployed on the Bank but still in highly stratified water.

Winds:

Light winds (<5 m s^{-1}) from variable directions were blowing during the release of the buoys. By the end of 24 July (day 205) the wind direction changed to northeast to northward where it remained for the duration of the tracking. Wind speeds increased during the latter half of the tracking to 4-8 m s^{-1}.

Data Recovery:

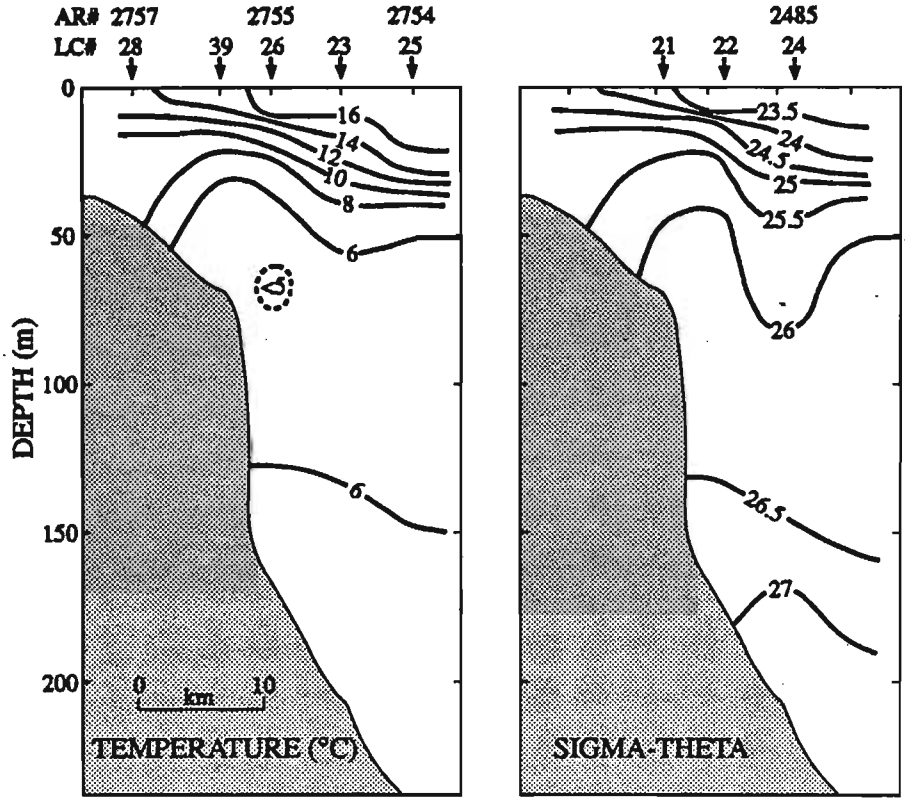
Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2485	AR	-	24 Jul 11:12	25 Jul 18:01	27	55	100
2754	AR	-	24 Jul 09:36	26 Jul 16:16	27	55	100
2755	AR	-	24 Jul 12:29	26 Jul 11:37	18	47	98
2757	AR	-	24 Jul 14:27	26 Jul 19:36	25	53	100
21	LC	10	Buoy Not Recovered				0
22	LC	10	24 Jul 11:55	26 Jul 21:20	117	57	100
23	LC	10	24 Jul 10:21	25 Jul 10:00	49	24	47
24	LC	10	24 Jul 11:05	26 Jul 13:41	103	51	100
25	LC	10	No Usable Data Recovered				0
26	LC	10	24 Jul 12:29	26 Jul 22:42	119	58	100
28	LC	10	24 Jul 14:25	26 Jul 20:38	111	54	100
39	LC	10	24 Jul 13:01	26 Jul 21:53	114	57	100

Mean Residual Currents:

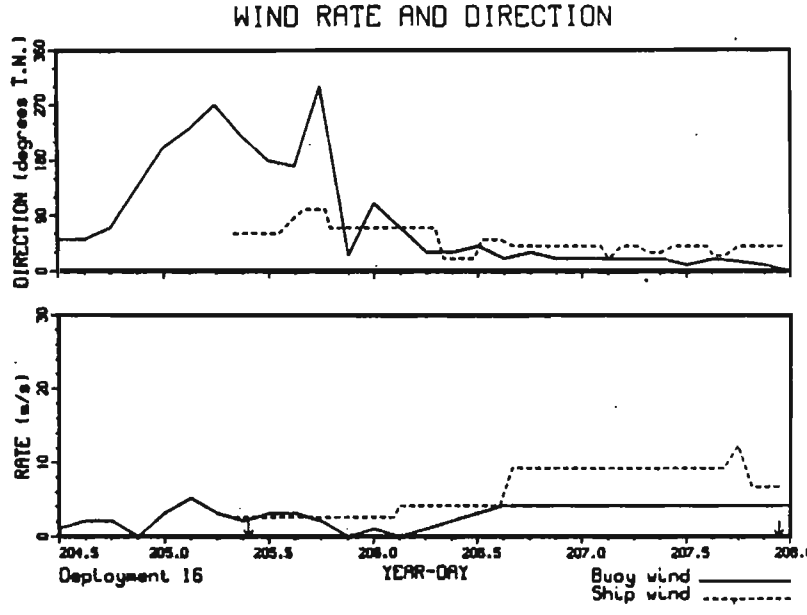
Residual currents were calculated from 25.0 h running means except for ARGOS buoy 2755 and LORAN-C buoy 23 which were determined using 12.5 h running means.

Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2485	0.257	0.015	0.257	87°
2754	0.335	-0.037	0.337	96°
2755	0.422	-0.056	0.426	98°
2757	0.189	-0.006	0.189	92°
22	0.235	-0.138	0.273	120°
23	0.187	0.034	0.190	80°
24	0.280	-0.000	0.280	90°

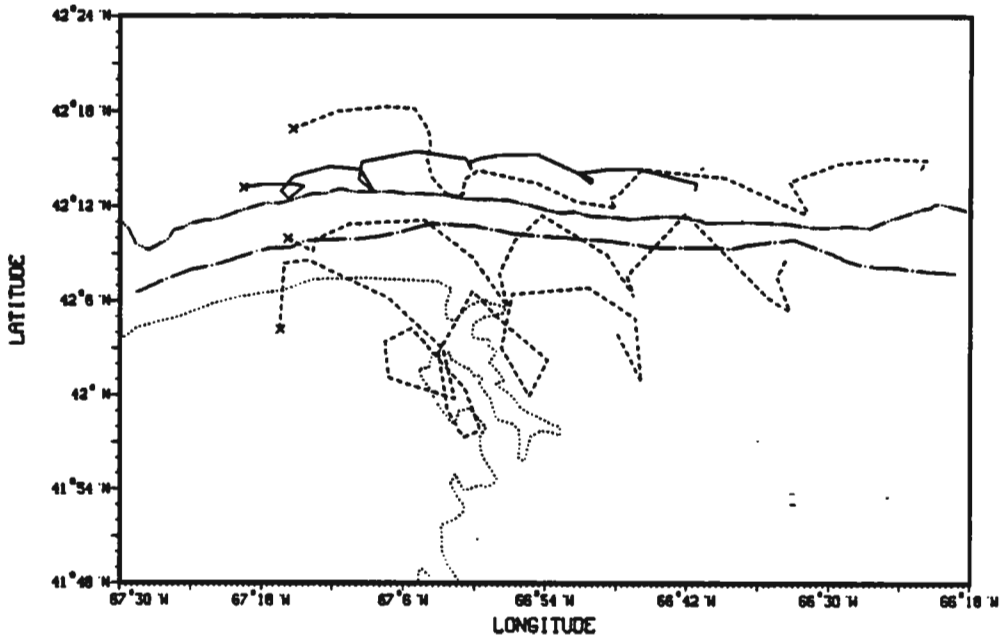
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
26	0.278	-0.147	0.314	118°
28	0.195	-0.036	0.198	100°
39	0.216	-0.144	0.260	124°



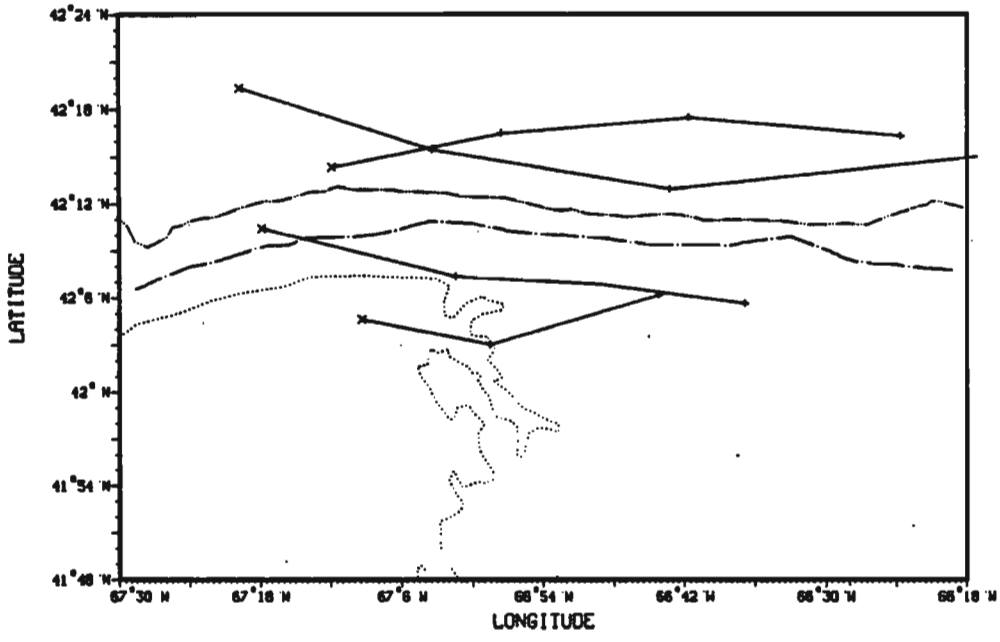
DEPLOYMENT 16— 24 JULY 1989— 67° 16'W



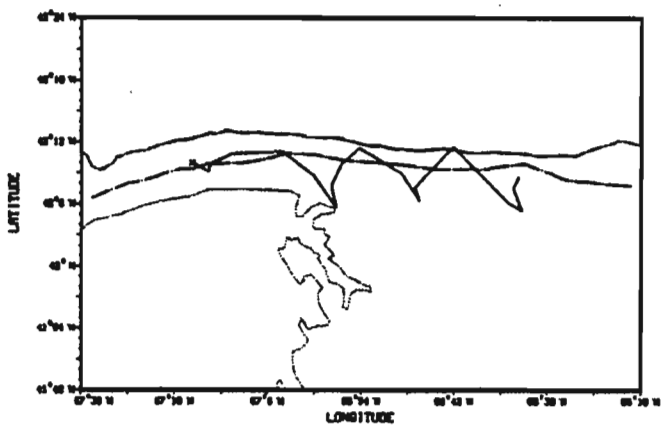
DEPLOYMENT 16 JULY 24 - 26 / 89



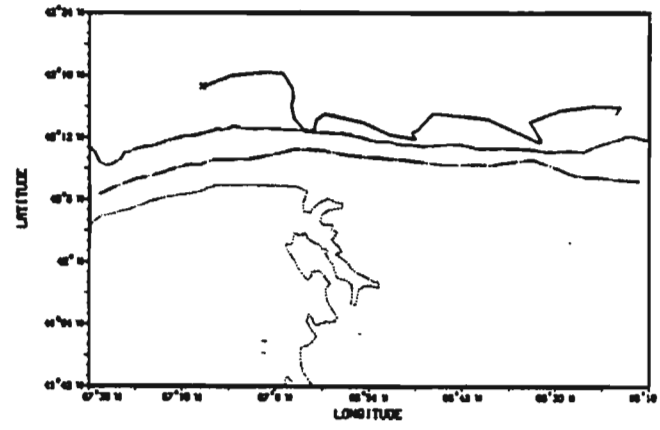
DEPLOYMENT 16 JULY 24 - 26 / 89



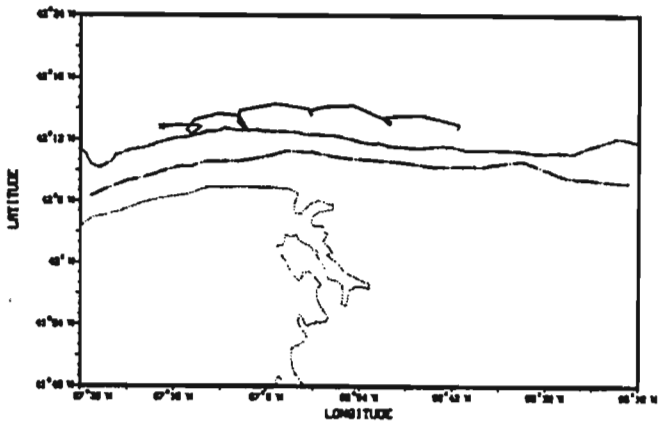
DEPLOYMENT 16 ARGOS BUOY 2755



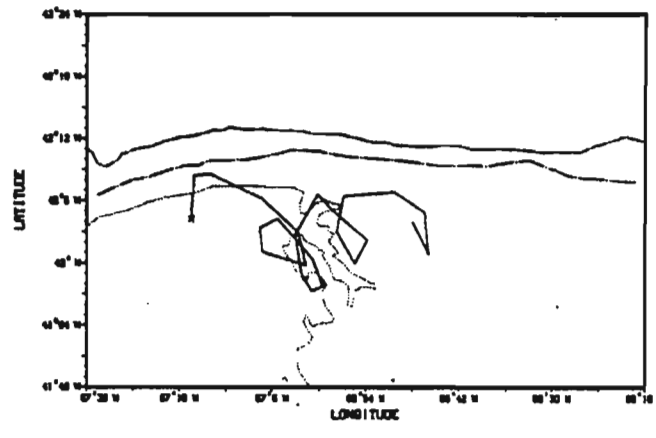
DEPLOYMENT 16 ARGOS BUOY 2754



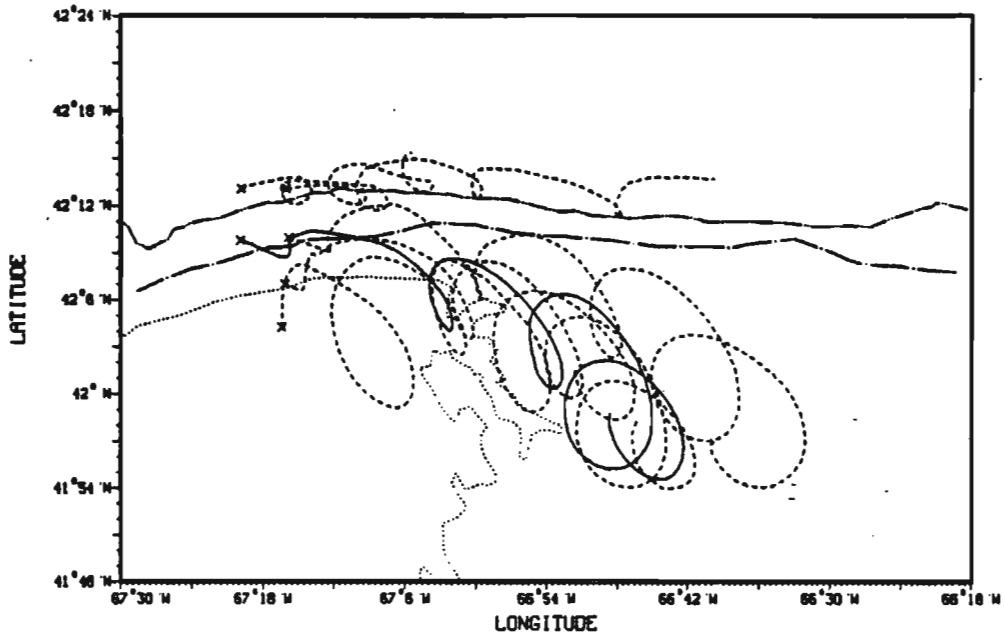
DEPLOYMENT 16 ARGOS BUOY 2485



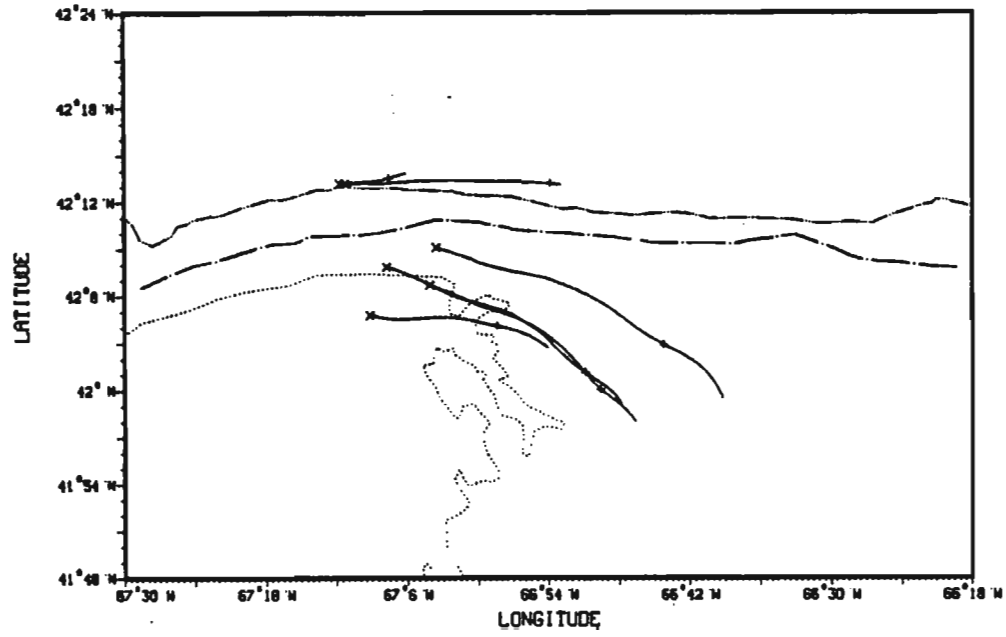
DEPLOYMENT 16 ARGOS BUOY 2757



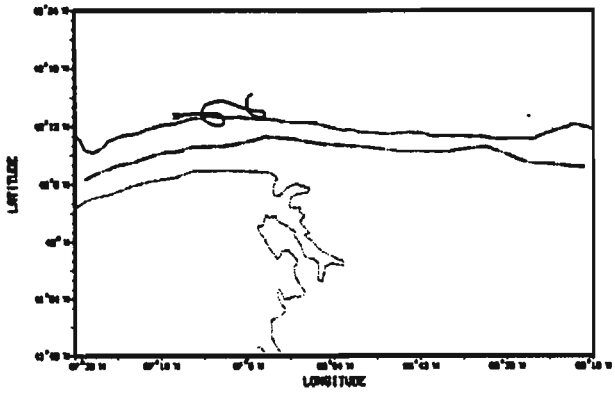
DEPLOYMENT 16 JULY 24 - 26 / 89



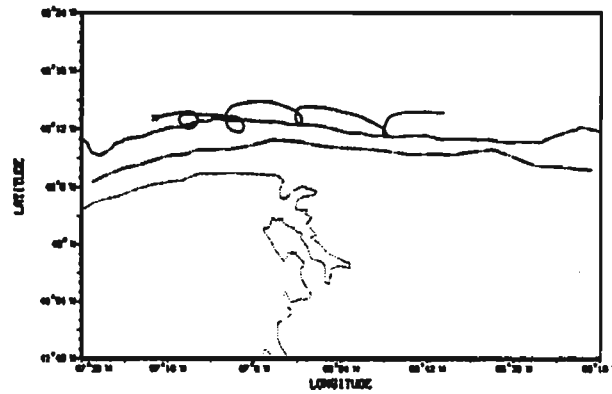
DEPLOYMENT 16 JULY 24 - 26 / 89



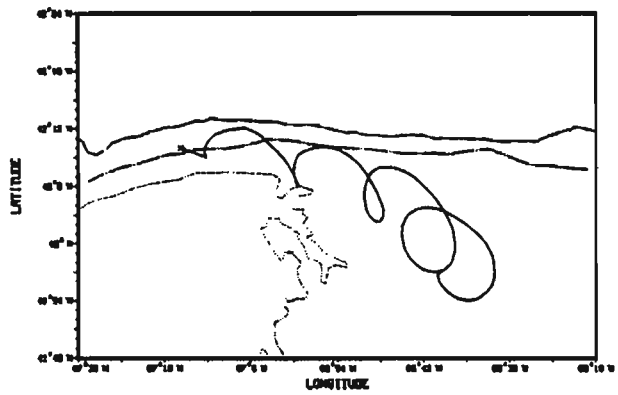
DEPLOYMENT 16 LORAN-C BUOY 23



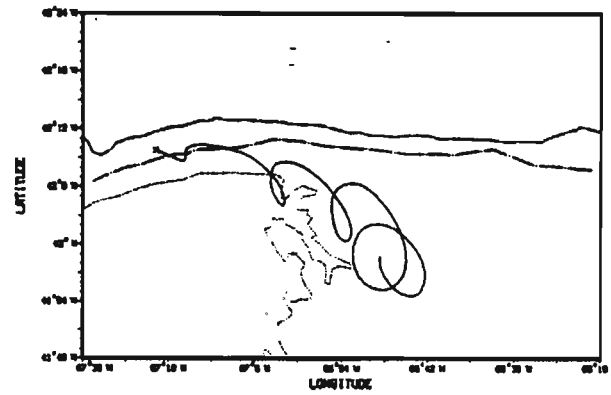
DEPLOYMENT 16 LORAN-C BUOY 24



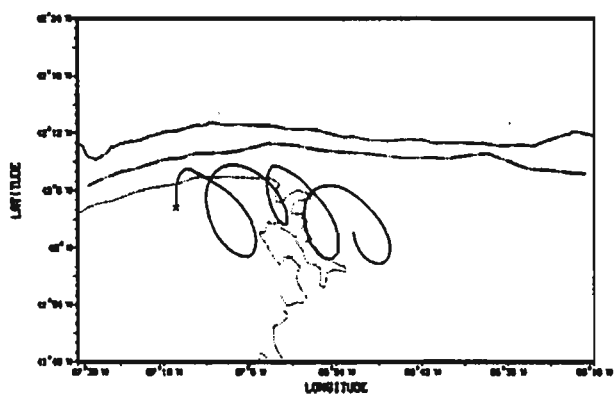
DEPLOYMENT 16 LORAN-C BUOY 26



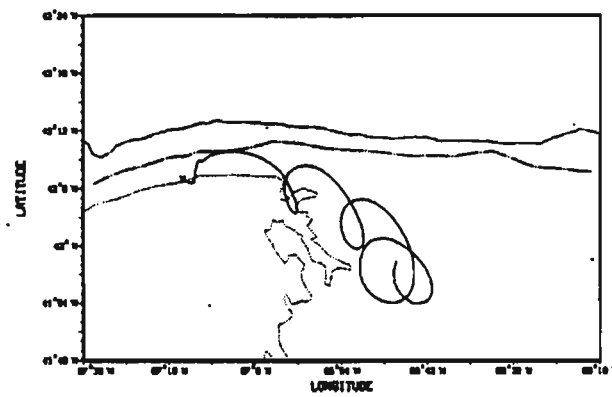
DEPLOYMENT 16 LORAN-C BUOY 22



DEPLOYMENT 16 LORAN-C BUOY 28



DEPLOYMENT 16 LORAN-C BUOY 39



DEPLOYMENT # 17

No. of buoys released:	ARGOS 3	LORAN-C 7
Time of first deployment:	03:45 July 27, 1989	
Time of last recovery:	22:14 July 29, 1989	
Total time duration:	66.5 hr	

Hydrographic Structure:

Two ARGOS buoys and 5 LORAN-C buoys were deployed on the Bank while one ARGOS and 2 LORAN-C buoys were deployed well off the Bank in highly stratified water. Buoy 39 was released near the leading edge of the tidal front while 22 was released in the well-mixed region of the Bank.

Winds:

North to northeastward winds of 4-10 m s^{-1} blew during the first two days. On 29 July (day 210) the winds veered southeastward.

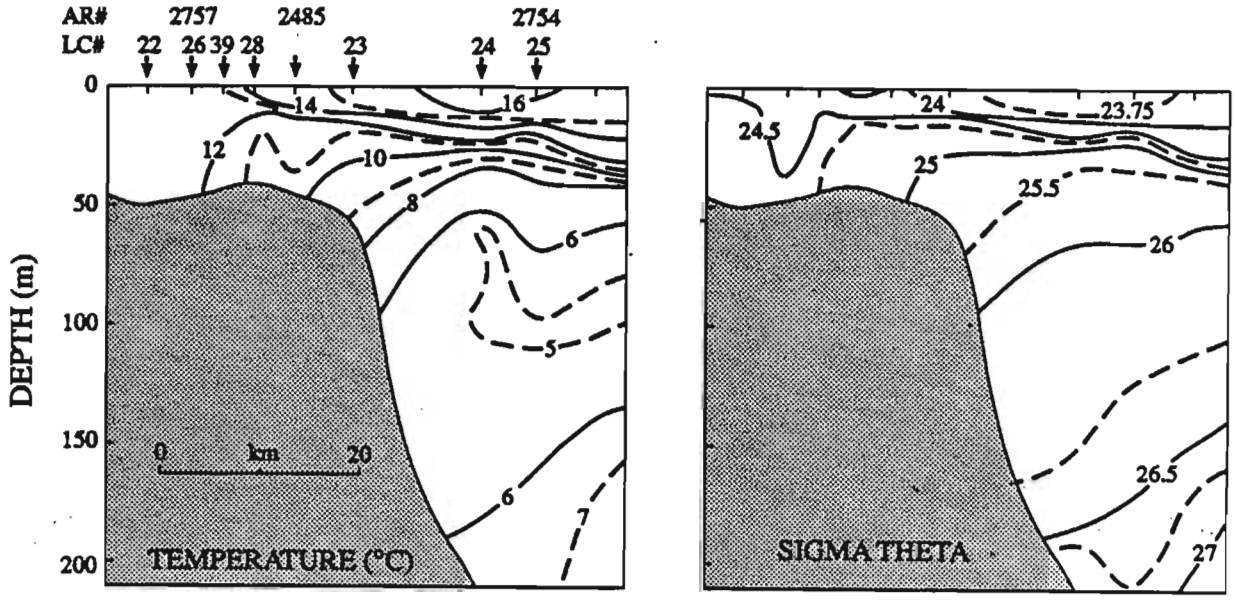
Data Recovery:

Buoy ID	Buoy Type	Drogue Depth(m)	Start Date Hr:Mn	End Date Hr:Mn	# Fixes	# hr Data	% Potential Data Return
2485	AR	-	27 Jul 06:28	29 Jul 22:14	28	66	100
2754	AR	-	27 Jul 08:36	29 Jul 18:30	24	58	100
2757	AR	-	27 Jul 03:48	29 Jul 21:46	25	66	100
22	LC	10	27 Jul 05:36	29 Jul 09:47	106	52	100
23	LC	10	No Usable Data Recovered				0
24	LC	10	27 Jul 07:54	29 Jul 15:58	114	56	100
25	LC	10	27 Jul 08:35	29 Jul 16:37	114	56	100
26	LC	10	27 Jul 03:45	29 Jul 07:29	105	52	100
28	LC	10	27 Jul 04:42	29 Jul 08:48	106	52	100
39	LC	10	27 Jul 04:10	29 Jul 07:47	105	52	100

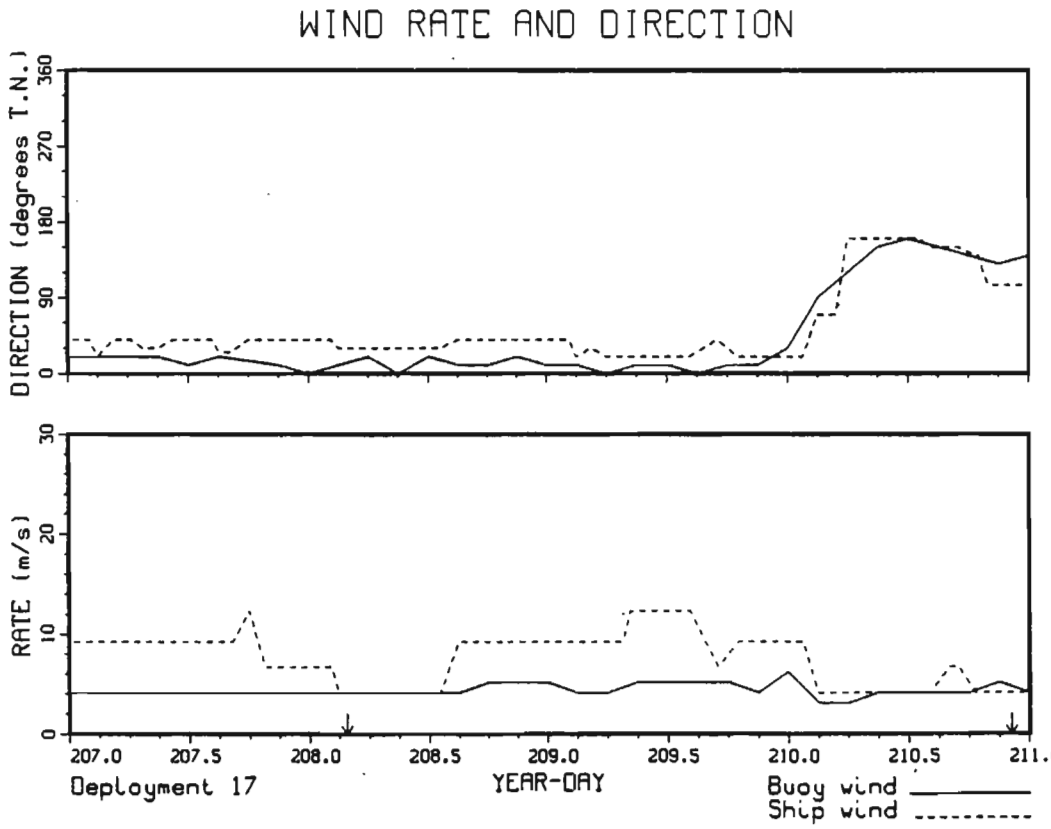
Mean Residual Currents:

Residual currents were calculated from 25.0 h running means.

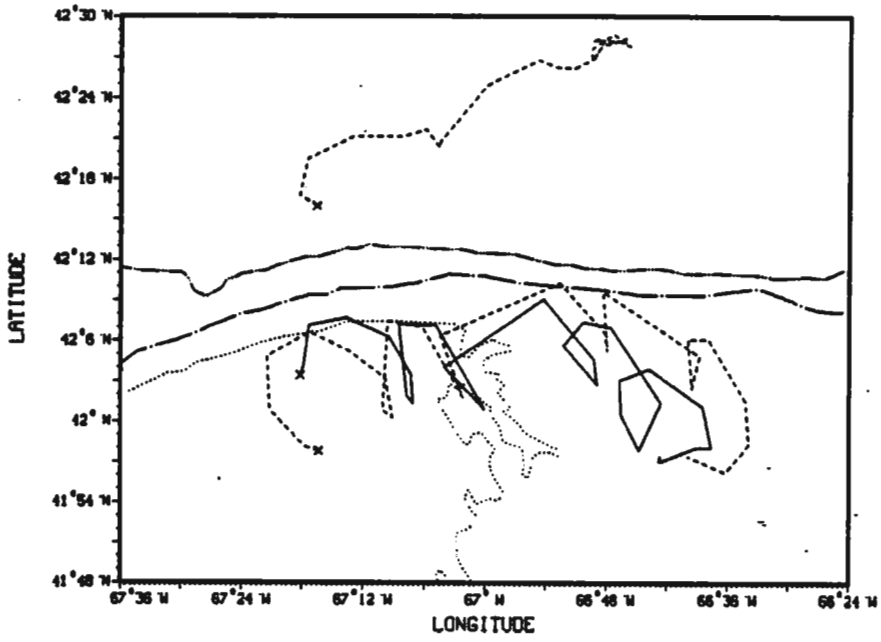
Buoy ID	U-comp. (m/s)	V-comp. (m/s)	Rate (m/s)	Dir.
2485	0.233	-0.031	0.235	98°
2754	0.191	0.090	0.211	65°
2757	0.265	-0.005	0.265	91°
22	0.093	0.010	0.094	84°
24	0.320	-0.032	0.322	96°
25	0.263	-0.048	0.267	100°
26	0.171	0.001	0.171	90°
28	0.133	-0.025	0.135	101°
39	0.136	0.020	0.137	82°



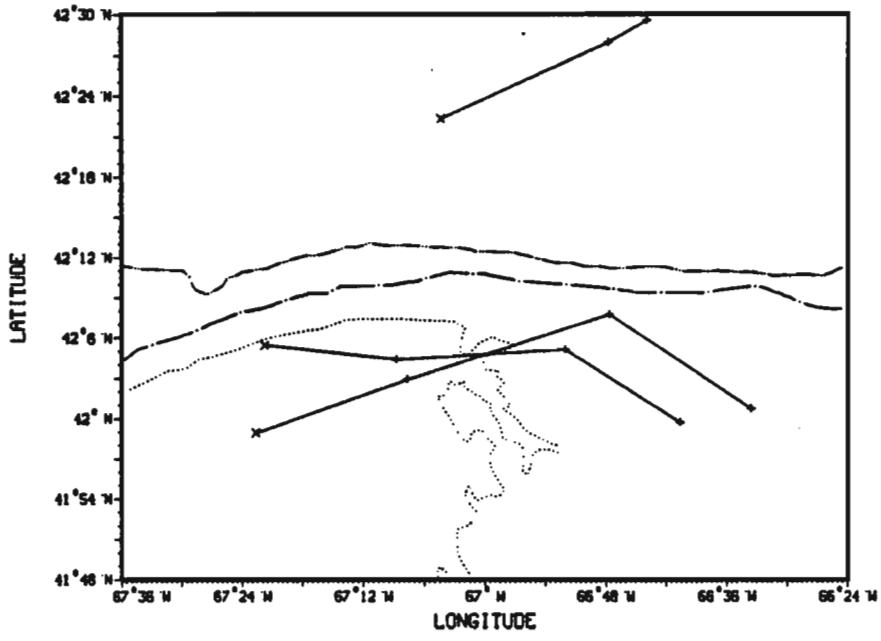
DEPLOYMENT 17—27 JULY 1989— 67° 16' W



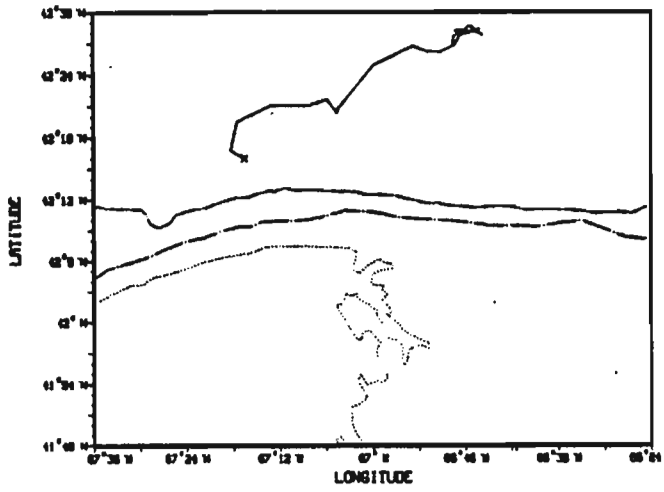
DEPLOYMENT 17 JULY 27 - 29 / 89



DEPLOYMENT 17 JULY 27 - 29 / 89



DEPLOYMENT 17 ARGOS BUOY 2754



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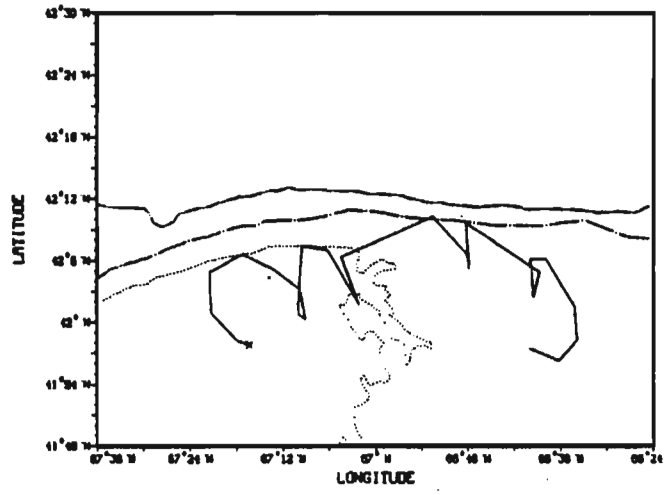
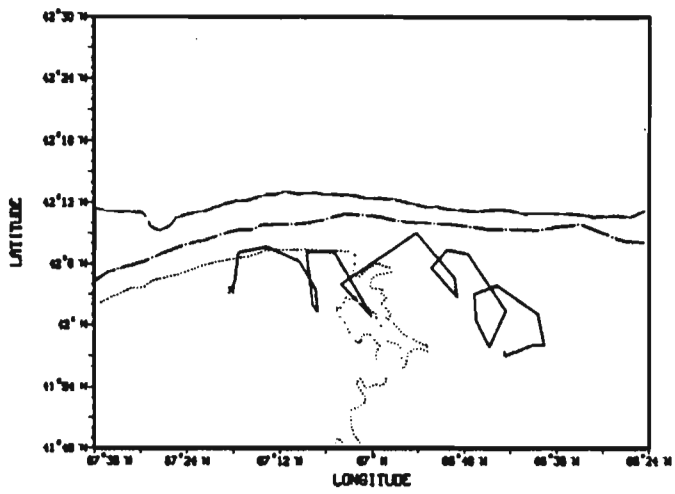
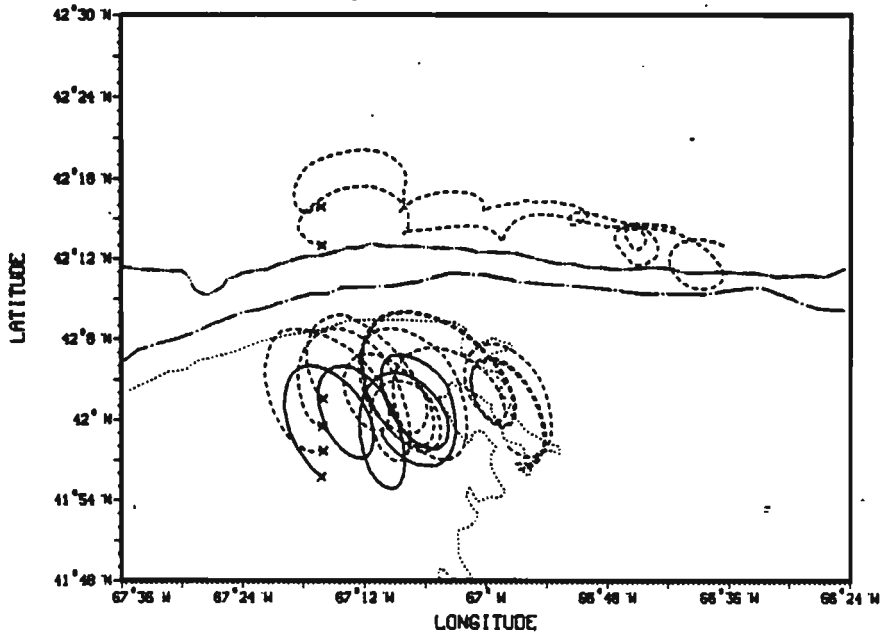


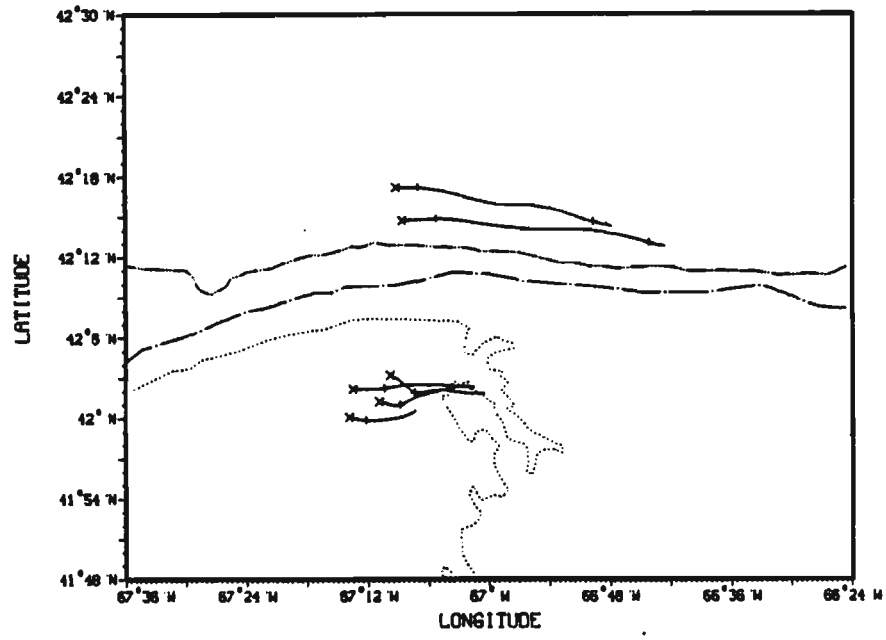
DEPLOYMENT 17 ARGOS BUOY 2485



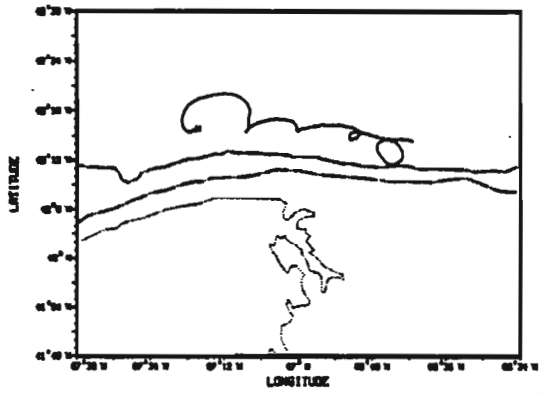
DEPLOYMENT 17 JULY 27 - 29 / 89



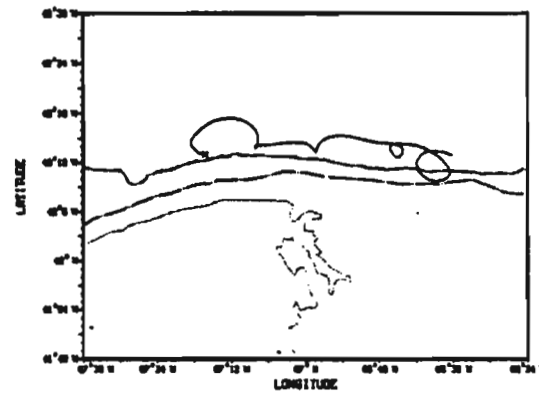
DEPLOYMENT 17 JULY 27 - 29 / 89



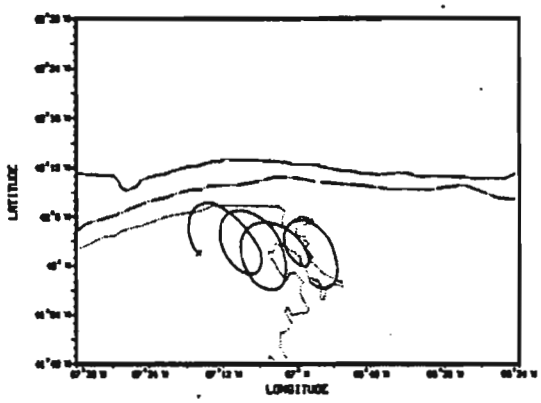
DEPLOYMENT 17 LORAN-C BUOY 25



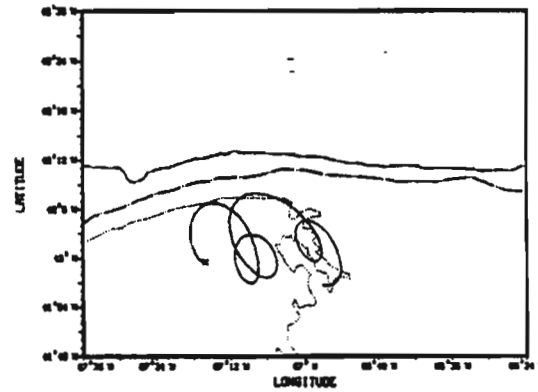
DEPLOYMENT 17 LORAN-C BUOY 24



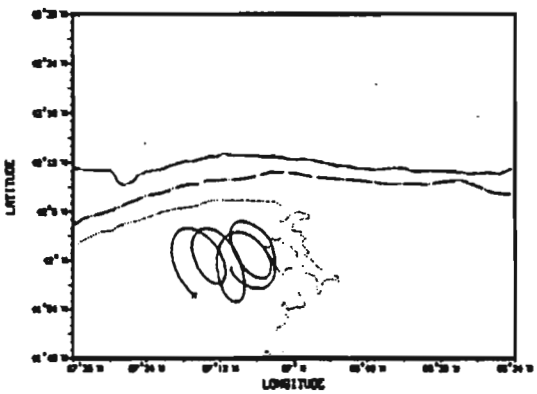
DEPLOYMENT 17 LORAN-C BUOY 28



DEPLOYMENT 17 LORAN-C BUOY 39



DEPLOYMENT 17 LORAN-C BUOY 22



DEPLOYMENT 17 LORAN-C BUOY 26