Northeast Fisheries Science Center Reference Document 05-03

Description of the 2004 Oceanographic Conditions on the Northeast Continental Shelf

by

Maureen H. Taylor, Cristina Bascuñán,
and James P. Manning

April 2005

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Abstract

A summary of hydrographic observations for 15 surveys on the northeast continental shelf during 2004 is presented. Distributions of CTD stations, surface and bottom temperature, salinity, and anomalies are portrayed. The average surface and bottom temperatures and salinities have been calculated in five geographic regions over the northeast continental shelf: western Gulf of Maine (GOMW), eastern Gulf of Maine (GOME), Georges Bank (GB), northern Middle Atlantic Bight (MABN) and southern Middle Atlantic Bight (MABS). Time series plots from various shipboard environmental sensors are included if available.

Hydrographic data collected during 2004 were sorted into six 2-month time bins to provide the best spatial coverage used in the averaging method. A comparison of the computed areal average temperature and salinity data for 2004 with the MARMAP reference values indicate that the majority of the shelf experienced relatively cold bottom temperatures and fresher salinities in all regions during the majority of the observations made during the year.

Introduction

The Northeast Fisheries Science Center (NEFSC) conducts several different surveys off the northeast continental shelf each year. Complete coverage of the shelf (Cape Hatteras to the Gulf of Maine) occurs during the spring and fall bottom trawl surveys and during some of the Ecosystem Monitoring cruises. Station coverage on other cruises throughout the year varies.

Temperature and salinity observations from 15 NEFSC surveys conducted during 2004 are summarized and presented in this report. Cruise operation summaries are presented for all cruises. Distribution plots of surface and bottom temperature, salinity, and anomalies are contoured where sufficient data are available. Areal average temperature and salinity and the corresponding anomalies also are presented for the five different regions on the shelf and for 6 time periods throughout the year. The data are presented chronologically in atlas form. Environmental data from the SCS system (Ship-board Computing System) are presented as time series figures for each leg of a cruise. No attempt has been made here to rigorously analyze the data or discuss in detail individual observations from the cruises.

Data and Methods

Temperature and salinity measurements were obtained with a Seabird (SBE) model 19 profiling CTD (Profiler), which measures the pressure, temperature and conductivity of the water twice per second. Two different methods of deployment were used depending upon the type of work conducted at a station (See Taylor and Bascuñán, 2000). Whenever a plankton haul was done, the Profiler was placed above the bongo nets (sensors facing up), and a double oblique tow was made. Upcast data are used as the

primary data when the Profiler is deployed with bongo nets. The turbulence generated by the bongo nets during the downcast adversely affects both the temperature and conductivity data quality. If no plankton haul was done, the Profiler was deployed vertically (sensors facing down) through the water column and the downcasts are processed as the primary data. Salinity samples are taken from the bottom of a vertical profile cast, generally twice per day, in order to calibrate the conductivity data. These samples are analyzed on shore using a Guildline Autosal Salinometer maintained at the NEFSC Narragansett Laboratory.

During the deep-water systematic cruise, DEL0409, hydrographic data were collected using an Applied Microsystems CTD 12+ that was placed in a protective tube and attached to the trawl net. These data were collected as part of an instrument evaluation conducted by the Oceanography Branch with the goal of being able to deploy a CTD instrument from a non-traditional platform (i.e. on fishing trawl nets). There was very little quality control of these data, other than checking for water column stability, since it was not possible to take salinity samples. The project conclusions, cruise notes, and processed data may be downloaded from:
ftp://ftp.wh.whoi.edu/pub/hydro/cruise_rpts/2004/del0409/del0409_ctd.html

All raw Profiler data were processed using the Seabird manufactured software: DATCNV, FILTER, ALIGNCTD, BINAVG, DERIVE, and ASCIIOUT to produce 1 decibar averaged ASCII files. The data were edited, cleaned, and converted to a standard 80-column ASCII formatted cruise file and were archived in ORACLE tables and in the NEFSC anonymous FTP account (ftp://ftp.wh.whoi.edu/pub/hydro).

Station distributions and horizontal contour plots of the surface and bottom temperature, salinity, and temperature anomaly were prepared for each survey if coverage was sufficient. In addition, all the hydrographic data were combined and sorted into 2-month time bins. Areal average temperatures and salinities were then calculated for the six time periods and for the five regions of the northeast continental shelf shown in Figure 1a: western and eastern Gulf of Maine (GOMW, GOME), Georges Bank (GB), and the northern and southern Middle Atlantic Bight (MABN, MABS). Station distributions for each time period are shown in Figure 1b. Anomalies for the temperature and salinity observations were determined relative to reference values, using the method described by Holzwarth and Mountain (1990) as modified by Mountain et al. (2004). The areal averaging was also done using the method described in Holzwarth and Mountain (1990) as modified by Mountain et al. (2004). The areal averages and anomalies were plotted against the calendar mid-date of all observations within each of the six time periods. Areal averages and anomalies were also calculated by cruise and are listed in Tables 4 and 5.

Results

The NEFSC cruises included in this report are listed in Table 1. A summary of each cruise is described in Appendix A and includes information on the type of cruise, its objectives, dates, the number of hydrographic stations, type(s) of instruments used, salinity calibration value, and notes pertaining to instrument performance. No salinity correction was applied to the cruise data if the mean salinity offset was less than +/- 0.01 psu.

Table 2 lists the surface and bottom areal average temperatures and temperature anomalies that were calculated for each of the five regions. Table 3 lists the surface and bottom areal average salinity and salinity anomalies for the same five regions. For most cruises, the areal averages and anomalies could not be calculated for all regions due to limited station coverage. Combining all the hydrographic data from all NEFSC programs and ships provided a better chance of adequate spatial and temporal coverage within the regions of the northeast continental shelf. In some cases however, a simple average (not an areal weighted mean) was determined for the observations in the region; these values are indicated in tables 2 - 4 with a flag value of '1'. The standard deviations are also listed. SDV1 indicates how well the calculated anomaly represents the true regional average anomaly. SDV2 is an indicator of how closely the areal average matches the anomaly at any particular location within that region (see Holzwarth and Mountain, 1990 for further explanation of SDV1 and SDV2).

Figures 2 - 3 present the time series of surface and bottom average temperature/salinity and temperature/salinity anomaly for each region. Cruises having less than 10 observations were not included in the time series figures. We were not able to resolve small-scale, localized events because of the regional averaging method used in this report. Station positions and distributions of surface and bottom temperature, salinity, and anomalies for the different cruises are presented in figures 4 - 55. Contour distribution figures were not prepared for some of the cruises because of poor station coverage. In addition, contour levels are not always consistent for a variable within a cruise. Contour distributions have been routinely produced for the scallop survey although the station coverage for this survey does not provide sufficient spatial coverage

to allow one to produce realistic broad-scale hydrographic distributions of the MAB and Georges Bank regions. Environmental time series plots from shipboard sensors (SCS data) are included in Appendix B. Further information about this data may be obtained at http://www.wh.whoi.edu/~jmanning/foi/alongtrack.html.

Discussion

The bottom temperature anomaly time series (Figure 2) indicate that the bottom temperatures of the entire northeast continental shelf were colder (≥ 1°C) for much of the year. Similarly, the salinity anomaly pattern displayed in Figure 3 indicates that the shelf region was also fresher than the MARMAP reference annual cycle. The salinity anomaly time series suggests a pattern of increasing freshness in the Georges Bank and Gulf of Maine regions with the year ending with these regions having salinity values approximately 0.5 fresher than the reference period. The air temperatures during January 2004 were approximately 6 degrees below average in the northeast region every day for the month (Northeast Regional Climate Center, 2004), and the cold atmosphere likely contributed to the colder bottom temperatures observed on the northeast continental shelf during much of the year. The fresher surface and bottom salinities suggest an increase in cold, fresh scotian shelf water entering the eastern Gulf of Maine and being advected during the year 'downstream' into the Georges Bank and MAB regions.

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Table 1. Summary of 2004 Cruises.

Cruise	Program	Dates	Regions[1]
ALB0401	ECOMON Survey	25 – 27 January	GOM
DEL0404	Whale and Dolphin Study	2 – 9 March	MAB
DEL0405	WB Convection Study	23 – 25 March	GOM
ALB0402	Winter Bottom Trawl	4 – 28 February	MAB, GB
ALB0403	Spring Bottom Trawl	3 March – 22 April	GOM, MAB, GB
ALB0404	Marine Mammal Survey	28 April – 19 May	GSC
ALB0405	ECOMON Survey	25 may – 8 June	MAB, GB, GOM
END0495	Marine Mammal Survey	24 June – 3 August	MAB, GB
ALB0406	Scallop Survey	7 July – 5 August	MAB, GB
ALB0408	ECOMON Survey	17 July – 31 August	GB, MAB, GOM
DEL0412	Benthic Habitat	25 – 30 August	MAB
DEL0413	Hydro Acoustic Survey	9 Sept. – 11 Oct.	GB, GOM
ALB0409	Fall Bottom Trawl	11 Sept. – 27 Oct.	GOM, GB, MAB
DEL0415	Benthic Habitat	2 – 11 November	GB
ALB0410	ECOMON Survey	2 -18 November	GOM, GB, MAB

[1] Regional Abbreviations:

GSC = Great South Channel
GOM = Gulf of Maine
MAB = Mid-Atlantic Bight
GB = Georges Bank

Table 2. Areal average surface and bottom temperature and temperature anomalies presented in two month time periods using hydrographic data collected during 2004 in the five regions of the northeast continental shelf.

	SURFACE						BOTTOM					
Region	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
						January - February						
GOME	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
GOMW	8	5.15	-1.23	0.38	3.80	1	5	7.53	1.07	0.41	7.85	1
GB	14	4.72	-1.03	0.37	2.90	1	5	4.20	-2.16	0.60	7.82	1
MABN	39	3.43	-1.56	0.19	1.21	0	31	4.04	-1.70	0.23	2.17	0
MABS	63	6.45	-0.33	0.18	1.16	0	46	6.43	-0.20	0.22	1.15	0
						March - April						
GOME	31	2.63	-1.97	0.16	1.03	0	25	6.23	-0.40	0.19	1.10	0
GOMW	89	3.72	-1.10	0.13	1.00	0	86	4.54	-0.59	0.12	0.76	0
GB	52	4.25	-0.59	0.15	0.63	0	47	4.41	-0.74	0.18	0.87	0
MABN	62	4.16	-0.27	0.17	0.87	0	56	4.25	-0.79	0.20	1.42	0
MABS	86	5.88	-0.19	0.14	1.47	0	72	5.65	-0.04	0.18	1.33	0
						May - June						
GOME	22	7.31	-1.50	0.20	0.90	0	14	6.30	-0.79	0.26	1.07	0
GOMW	88	8.08	0.00	0.12	1.44	1	84	4.29	-0.86	0.10	1.11	1
GB	63	8.65	-0.71	0.15	0.96	0	54	6.46	-1.11	0.19	0.98	0
MABN	26	12.69	0.61	0.25	1.38	0	18	6.14	-1.59	0.31	1.81	0
MABS	34	18.35	2.97	0.23	1.90	0	30	7.60	-1.83	0.27	1.76	0
						July - August						
GOME	18	14.46	0.27	0.22	1.77	0	13	7.23	-1.41	0.26	1.86	0
GOMW	24	17.52	1.60	0.22	3.59	1	19	6.20	-0.84	0.22	2.86	1
GB	42	16.99	0.64	0.17	2.04	0	34	10.27	-2.03	0.20	1.72	0
MABN	39	21.19	0.75	0.21	2.05	1	28	8.89	-0.93	0.24	3.97	1
MABS	68	23.67	-0.15	0.21	1.20	0	44	10.82	-1.58	0.21	2.69	1
						September - October						
GOME	59	12.39	-0.38	0.14	1.09	0	53	7.74	-0.77	0.15	1.48	0
GOMW	81	13.12	0.24	0.13	1.09	0	74	6.42	-0.92	0.11	1.40	0
GB	77	15.00	-0.19	0.14	1.05	0	70	11.31	-1.35	0.18	2.00	0
MABN	53	18.75	0.80	0.20	1.24	0	47	12.24	-0.14	0.23	3.18	0
MABS	77	22.05	0.43	0.15	1.02	0	69	14.24	-0.18	0.19	3.66	0
						November - December						
GOME	16	8.98	-1.34	0.21	0.57	0	31	7.48	-1.00	0.24	2.47	1
GOMW	44	9.39	-0.72	0.23	1.41	1	36	6.37	-0.71	0.23	2.19	1
GB	38	10.87	-1.48	0.17	0.83	0	33	10.69	-1.09	0.20	1.17	0
MABN	22	13.21	-0.75	0.26	0.76	0	18	13.34	0.22	0.31	1.33	0
MABS	37	15.69	-0.07	0.21	0.87	0	34	15.35	0.73	0.25	1.18	0

"Region", the geographic region of the northeast continental shelf:, the calendar mid-data of all the stations within a region for a time period: "# obs", the number of observations included in each average: "Temp", the areal average temperature: "Anomaly", the areal average temperature anomaly: "SDV1", the standard deviation associated with the average temperature anomaly: "SDV2", the standard deviation of the individual anomalies from which the average anomaly was derived.

"Flag", a value of "1" indicates that a true areal average could not be calculated due to poor station coverage. The average values listed were derived from a simple average of the observations within the region.

Table 3. Areal average surface and bottom salinity and salinity anomalies presented in two month time periods using hydrographic data collected during 2004 in the five regions of the northeast continental shelf.

	SURFACE						BOTTOM					
Region	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
						January - February						
GOME	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
GOMW	8	33.45	0.22	0.25	1.37	1	5	34.30	0.33	0.23	2.36	1
GB	14	33.22	-0.09	0.23	1.04	1	5	33.21	-0.29	0.35	2.35	1
MABN	39	33.07	-0.04	0.13	0.41	0	31	33.34	-0.22	0.14	0.67	0
MABS	62	33.74	0.02	0.14	0.68	0	46	33.93	0.18	0.13	0.35	0
						March - April						
GOME	28	32.05	-0.44	0.12	0.39	0	25	33.85	-0.10	0.10	0.41	0
GOMW	88	32.51	-0.15	0.09	0.54	0	86	33.37	-0.04	0.07	0.27	0
GB	46	32.93	-0.03	0.10	0.32	0	45	33.12	-0.03	0.11	0.35	0
MABN	62	33.03	0.14	0.11	0.46	0	56	33.15	-0.19	0.12	0.50	0
MABS	86	33.06	-0.01	0.11	0.84	0	72	33.47	0.09	0.11	0.62	0
						May - June						
GOME	22	32.10	-0.24	0.15	0.21	0	14	33.64	-0.22	0.15	0.24	0
GOMW	88	32.24	-0.38	0.07	0.46	1	84	33.23	-0.04	0.06	0.26	1
GB	63	32.78	-0.12	0.09	0.31	0	54	32.96	-0.08	0.11	0.21	0
MABN	26	32.35	-0.13	0.17	0.45	0	18	32.98	-0.28	0.18	0.42	0
MABS	34	31.59	-0.48	0.17	1.19	0	30	33.21	-0.09	0.16	0.45	0
						July - August						
GOME	18	32.04	-0.43	0.16	0.24	0	13	33.95	-0.24	0.14	0.34	0
GOMW	24	31.88	-0.28	0.14	0.89	1	19	33.43	-0.21	0.12	0.52	1
GB	41	32.38	-0.36	0.10	0.57	0	34	32.79	-0.32	0.12	0.32	0
MABN	38	32.43	-0.15	0.14	0.99	1	28	32.89	-0.47	0.14	1.07	1
MABS	66	31.39	-0.63	0.17	0.67	0	44	32.56	-0.65	0.12	0.78	1
						September - October						
GOME	59	31.97	-0.62	0.10	0.34	0	53	33.99	-0.26	0.09	0.27	0
GOMW	77	32.06	-0.37	0.08	0.23	0	74	33.27	-0.31	0.07	0.56	0
GB	77	32.32	-0.45	0.08	0.38	0	70	32.65	-0.31	0.11	0.59	0
MABN	53	32.74	0.10	0.13	1.04	0	47	32.82	-0.57	0.14	0.43	0
MABS	77	32.00	-0.24	0.12	1.51	0	69	32.18	-0.99	0.11	1.38	0
						November - December						
GOME	16	31.95	-0.68	0.15	0.26	0	31	33.60	-0.57	0.14	0.89	1
GOMW	44	32.27	-0.43	0.15	0.44	1	36	33.25	-0.32	0.13	0.76	1
GB	38	32.25	-0.51	0.11	0.25	0	33	32.58	-0.47	0.12	0.39	0
MABN	22	32.54	-0.42	0.18	0.49	0	18	33.24	-0.29	0.18	0.47	0
MABS	37	32.48	-0.38	0.17	0.88	0	34	33.14	-0.17	0.15	0.71	0

"Region", the geographic region of the northeast continental shelf:, the calendar mid-data of all the stations within a region for a time period: "# obs", the number of observations included in each average: "Salt", the areal average salinity: "Anomaly", the areal average salinity anomaly: "SDV1", the standard deviation associated with the average salinity anomaly: "SDV2", the standard deviation of the individual anomalies from which the average anomaly was derived.

"Flag", a value of "1" indicates that a true areal average could not be calculated due to poor station coverage. The average values listed were derived from a simple average of the observations within the region.

Table 4. Areal average surface and bottom temperature and temperature anomalies for the 2004 NEFSC cruises in the five regions of the northeast continental shelf as shown in Figure 1.

		SURFACE						BOTTOM					
Cruise	**CD**	**#obs**	**Temp**	**Anomaly**	**SDV1**	**SDV2**	**Flag**	**#obs**	**Temp**	**Anomaly**	**SDV1**	**SDV2**	**Flag**
Gulf of Maine West													
ALB0403	104	31	2.63	-1.97	0.16	1.03	0	25	6.23	-0.40	0.19	1.10	0
ALB0405	157	22	7.31	-1.49	0.20	0.94	0	14	6.30	-0.79	0.26	1.12	0
ALB0408	241	18	14.46	0.27	0.22	1.77	0	13	7.23	-1.41	0.26	1.86	0
DEL0413	270	31	14.35	-0.47	0.18	1.84	1	28	7.97	-0.40	0.18	2.77	1
ALB0409	291	32	12.14	-0.25	0.17	0.91	0	28	7.74	-0.85	0.18	1.52	0
ALB0410	320	16	8.95	-1.35	0.22	0.57	0	29	7.39	-1.00	0.25	2.34	1
Gulf of Maine East													
ALB0401	26	8	5.15	-1.23	0.38	0.16	1	5	7.53	1.07	0.41	0.65	1
DEL0405	84	34	3.49	-0.71	0.19	0.99	1	32	5.00	-0.20	0.17	0.79	1
ALB0403	104	44	3.86	-1.10	0.16	1.02	0	43	4.35	-0.72	0.14	0.74	0
ALB0404	129	80	7.33	0.27	0.12	0.85	1	80	4.16	-0.76	0.10	0.59	1
ALB0405	158	20	9.59	-1.29	0.24	1.31	1	16	4.56	-1.19	0.23	1.84	1
ALB0408	241	26	17.73	1.56	0.22	1.99	0	20	6.16	-0.85	0.20	1.42	0
DEL0413	266	35	16.12	0.95	0.18	1.26	1	32	6.84	-0.77	0.17	2.19	1
ALB0409	295	46	11.72	-0.14	0.15	0.84	0	43	6.55	-0.92	0.14	1.33	0
ALB0410	318	40	9.38	-0.72	0.23	1.34	1	32	6.37	-0.71	0.23	2.07	1
Georges Bank													
ALB0402	57	14	4.72	-1.03	0.37	2.89	1	5	4.20	-2.16	0.60	7.82	1
ALB0403	94	52	4.25	-0.60	0.16	0.67	0	47	4.41	-0.75	0.18	0.93	0
ALB0404	131	27	6.47	-0.29	0.22	0.74	1	27	5.20	-0.30	0.22	0.82	1
ALB0405	153	35	8.66	-0.79	0.17	0.72	0	27	6.70	-1.17	0.21	1.08	0
EN395	193	5	17.54	1.55	0.73	2.63	1	nd	nd	nd	nd	nd	nd
ALB0408	238	38	17.08	0.77	0.18	2.09	0	34	10.51	-2.03	0.21	1.72	0
DEL0413	271	33	14.73	-0.60	0.17	0.49	1	32	12.68	-0.03	0.18	1.98	1
ALB0409	282	46	14.99	-0.10	0.14	1.19	0	39	11.20	-1.38	0.19	1.85	0
DEL0415	311	4	11.90	-0.62	0.50	0.35	1	4	11.87	0.05	0.48	0.91	1
ALB0410	317	34	10.81	-1.51	0.18	0.82	0	29	10.61	-1.17	0.21	1.15	0
MAB North													
ALB0402	54	39	3.43	-1.55	0.19	1.22	0	31	4.04	-1.69	0.23	2.20	0
DEL0404	66	2	4.12	-0.62	0.89	3.27	1	nd	nd	nd	nd	nd	nd
ALB0403	84	60	4.16	-0.27	0.17	0.86	0	55	4.25	-0.80	0.20	1.42	0
ALB0405	150	24	12.63	0.66	0.25	1.32	0	18	6.15	-1.59	0.32	2.16	0
EN395	195	7	18.81	-0.26	0.51	1.96	1	2	8.08	-1.88	1.01	2.43	1
ALB0408	234	23	21.09	1.34	0.26	1.88	1	22	9.28	-0.83	0.27	3.96	1
DEL0412	240	11	21.41	-0.42	0.42	1.91	1	4	7.15	-1.02	0.66	5.26	1
ALB0409	271	53	18.75	0.80	0.20	1.25	0	47	12.24	-0.14	0.23	3.18	0
ALB0410	311	22	13.21	-0.75	0.26	0.76	0	18	13.34	0.22	0.31	1.33	0
MAB South													
ALB0402	44	63	6.45	-0.33	0.18	1.16	0	46	6.43	-0.20	0.22	1.15	0
DEL0404	64	6	5.87	-2.53	0.64	1.23	1	nd	nd	nd	nd	nd	nd
ALB0403	73	81	5.89	-0.14	0.15	1.40	0	71	5.61	-0.01	0.19	1.31	0
ALB0405	148	34	18.35	2.97	0.23	1.90	0	30	7.60	-1.83	0.27	1.76	0
EN395	204	4	24.36	1.72	0.69	1.42	1	2	5.40	-2.33	1.16	1.52	1
ALB0408	232	33	23.60	-0.19	0.23	1.22	0	29	12.81	-1.45	0.26	2.90	1
DEL0412	240	32	21.73	-0.02	0.25	1.01	1	13	7.22	-1.75	0.37	2.36	1
ALB0409	262	77	22.05	0.43	0.15	1.02	0	69	14.24	-0.18	0.19	3.66	0
ALB0410	309	37	15.69	-0.07	0.21	0.87	0	34	15.35	0.73	0.25	1.18	0

(1) "CRUISE", the code name for a cruise: "CD", the calendar mid-data of all the stations within a region for a cruise: "# obs", the number of observations included in each average: "Temp", the areal average temperature: "Anomaly", the areal average temperature anomaly: "SDV1", the standard deviation associated with the average temperature anomaly: "SDV2", the standard deviation of the individual anomalies from which the average anomaly was derived.

(*) A true areal average could not be calculated due to poor station coverage. The average values listed were derived from a simple average of the observations within the region.

Table 5. Areal average surface and bottom salinity and salinity anomalies for the 2004 NEFSC cruises in the five regions of the northeast continental shelf as shown in Figure 1.

		SURFACE						BOTTOM					
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
Gulf of Maine West													
ALB0403	104	28	32.05	-0.44	0.12	0.39	0	25	33.85	-0.10	0.10	0.41	0
ALB0405	157	22	32.10	-0.24	0.15	0.21	0	14	33.64	-0.22	0.15	0.25	0
ALB0408	241	18	32.04	-0.43	0.16	0.24	0	13	33.95	-0.24	0.14	0.34	0
DEL0413	270	31	32.20	-0.30	0.12	0.34	1	28	34.25	-0.14	0.10	1.15	1
ALB0409	291	32	31.96	-0.65	0.12	0.33	0	28	33.93	-0.27	0.10	0.31	0
ALB0410	320	16	31.96	-0.66	0.16	0.25	0	29	33.67	-0.57	0.15	0.79	1
Gulf of Maine East													
ALB0401	26	8	33.45	0.22	0.25	0.13	1	5	34.30	0.33	0.23	0.24	1
DEL0405	84	34	33.08	0.24	0.13	0.53	1	32	33.62	0.06	0.09	0.24	1
ALB0403	104	43	32.40	-0.20	0.11	0.51	0	43	33.29	-0.08	0.08	0.30	0
ALB0404	129	80	32.35	-0.38	0.07	0.33	1	80	33.23	0.00	0.06	0.14	1
ALB0405	158	20	32.01	-0.17	0.15	0.46	1	16	33.15	-0.18	0.13	0.44	1
ALB0408	241	26	31.78	-0.26	0.14	0.21	0	20	33.23	-0.19	0.11	0.18	0
DEL0413	266	32	31.85	-0.34	0.12	0.28	1	32	33.52	0.00	0.10	1.02	1
ALB0409	295	45	32.18	-0.35	0.10	0.22	0	43	33.20	-0.39	0.08	0.23	0
ALB0410	318	40	32.27	-0.43	0.15	0.36	1	32	33.25	-0.32	0.13	0.66	1
Georges Bank													
ALB0402	57	14	33.22	-0.09	0.23	1.04	1	5	33.21	-0.29	0.35	2.35	1
ALB0403	94	46	32.93	-0.03	0.10	0.34	0	45	33.12	-0.03	0.11	0.38	0
ALB0404	131	27	32.74	-0.12	0.12	0.18	1	27	32.93	0.00	0.11	0.11	1
ALB0405	153	35	32.76	-0.10	0.11	0.24	0	27	32.94	-0.09	0.12	0.26	0
EN395	193	5	32.56	-0.54	0.39	1.12	1	nd	nd	nd	nd	nd	nd
ALB0408	238	37	32.43	-0.27	0.11	0.56	0	34	32.63	-0.32	0.12	0.32	0
DEL0413	271	33	32.27	-0.23	0.10	0.13	1	32	32.49	-0.24	0.10	0.18	1
ALB0409	282	46	32.31	-0.47	0.09	0.42	0	39	32.66	-0.33	0.11	0.25	0
DEL0415	311	4	31.69	-1.06	0.29	0.08	1	4	31.71	-1.03	0.28	0.08	1
ALB0410	317	34	32.30	-0.46	0.11	0.19	0	29	32.66	-0.41	0.12	0.34	0
MAB North													
ALB0402	54	39	33.07	-0.04	0.13	0.41	0	31	33.34	-0.22	0.14	0.68	0
DEL0404	66	2	33.18	-0.08	0.61	0.99	1	nd	nd	nd	nd	nd	nd
ALB0403	84	60	33.02	0.14	0.11	0.46	0	55	33.14	-0.19	0.12	0.49	0
ALB0405	150	24	32.38	-0.10	0.17	0.42	0	18	32.97	-0.28	0.19	0.48	0
EN395	195	7	32.76	-0.30	0.34	0.76	1	2	33.91	-0.56	0.53	1.07	1
ALB0408	234	23	32.12	-0.19	0.17	1.06	1	22	32.75	-0.43	0.16	0.96	1
DEL0412	240	10	32.84	-0.15	0.29	0.76	1	4	33.11	-0.66	0.40	1.79	1
ALB0409	271	53	32.74	0.10	0.13	1.05	0	47	32.82	-0.57	0.14	0.43	0
ALB0410	311	22	32.54	-0.42	0.18	0.49	0	18	33.24	-0.29	0.18	0.47	0
MAB South													
ALB0402	44	62	33.74	0.02	0.14	0.68	0	46	33.93	0.18	0.13	0.35	0
DEL0404	64	6	33.56	-0.70	0.44	0.27	1	nd	nd	nd	nd	nd	nd
ALB0403	73	81	33.07	0.01	0.11	0.84	0	71	33.46	0.09	0.11	0.62	0
ALB0405	148	34	31.59	-0.48	0.17	1.19	0	30	33.21	-0.09	0.16	0.45	0
EN395	204	4	31.91	-0.52	0.47	0.28	1	2	33.05	-0.56	0.63	0.60	1
ALB0408	232	33	31.43	-0.56	0.18	0.75	0	29	32.25	-0.57	0.16	0.77	1
DEL0412	240	30	32.72	-0.28	0.17	0.40	1	13	33.18	-0.82	0.21	0.85	1
ALB0409	262	77	32.00	-0.24	0.12	1.51	0	69	32.18	-0.99	0.11	1.38	0
ALB0410	309	37	32.48	-0.38	0.17	0.88	0	34	33.14	-0.17	0.15	0.71	0

(1) "CRUISE", the code name for a cruise: "CD", the calendar mid-data of all the stations within a region for a cruise: "# obs", the number of observations included in each average: "Salt", the areal average salinity: "Anomaly", the areal average salinity anomaly: "SDV1", the standard deviation associated with the average salinity anomaly: "SDV2", the standard deviation of the individual anomalies from which the average anomaly was derived.

(*) A true areal average could not be calculated due to poor station coverage. The average values listed were derived from a simple average of the observations within the region.

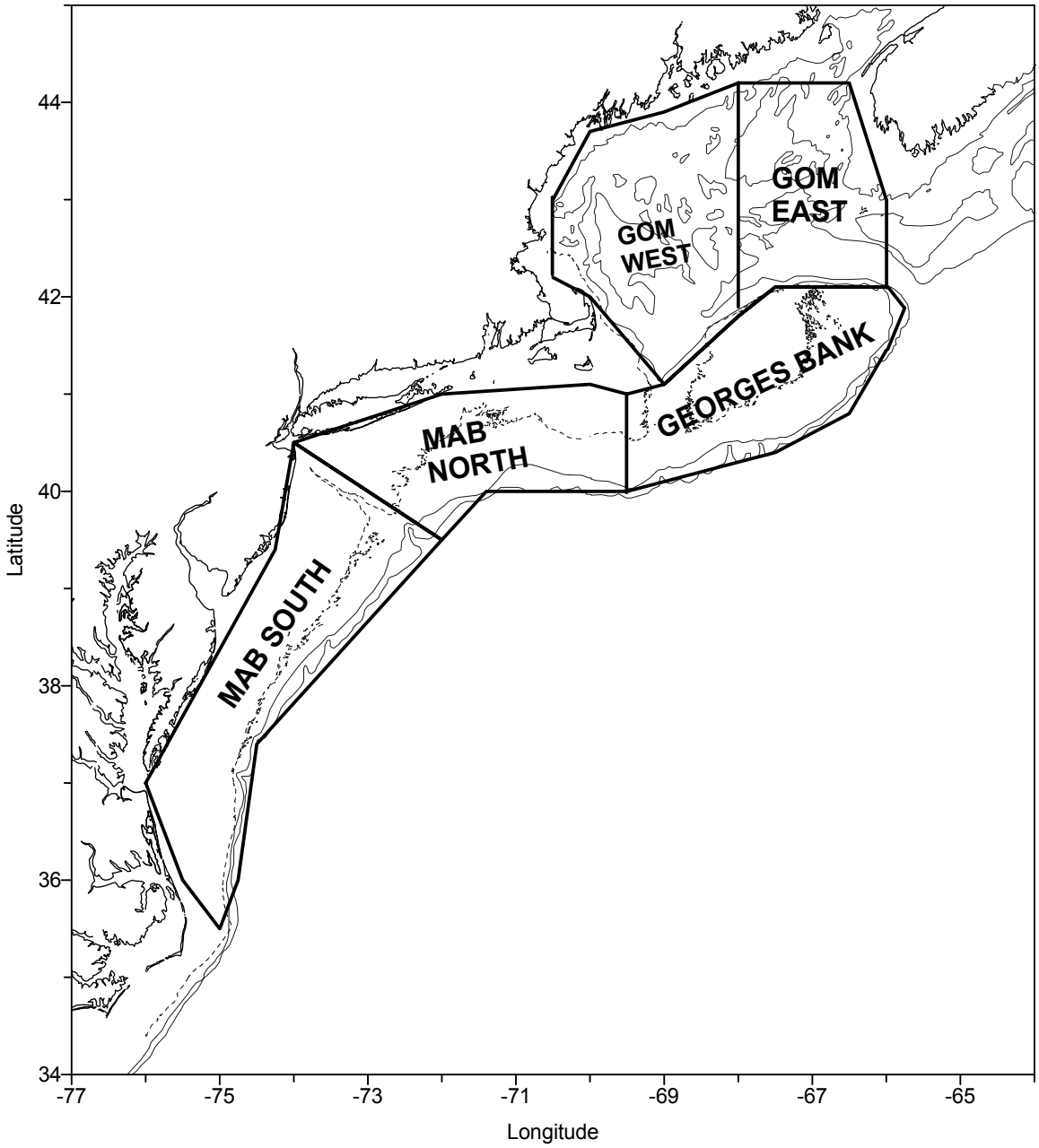


Figure 1a. The regions of the northeast continental shelf covered by the Northeast Fisheries Science Center cruises during 2004.

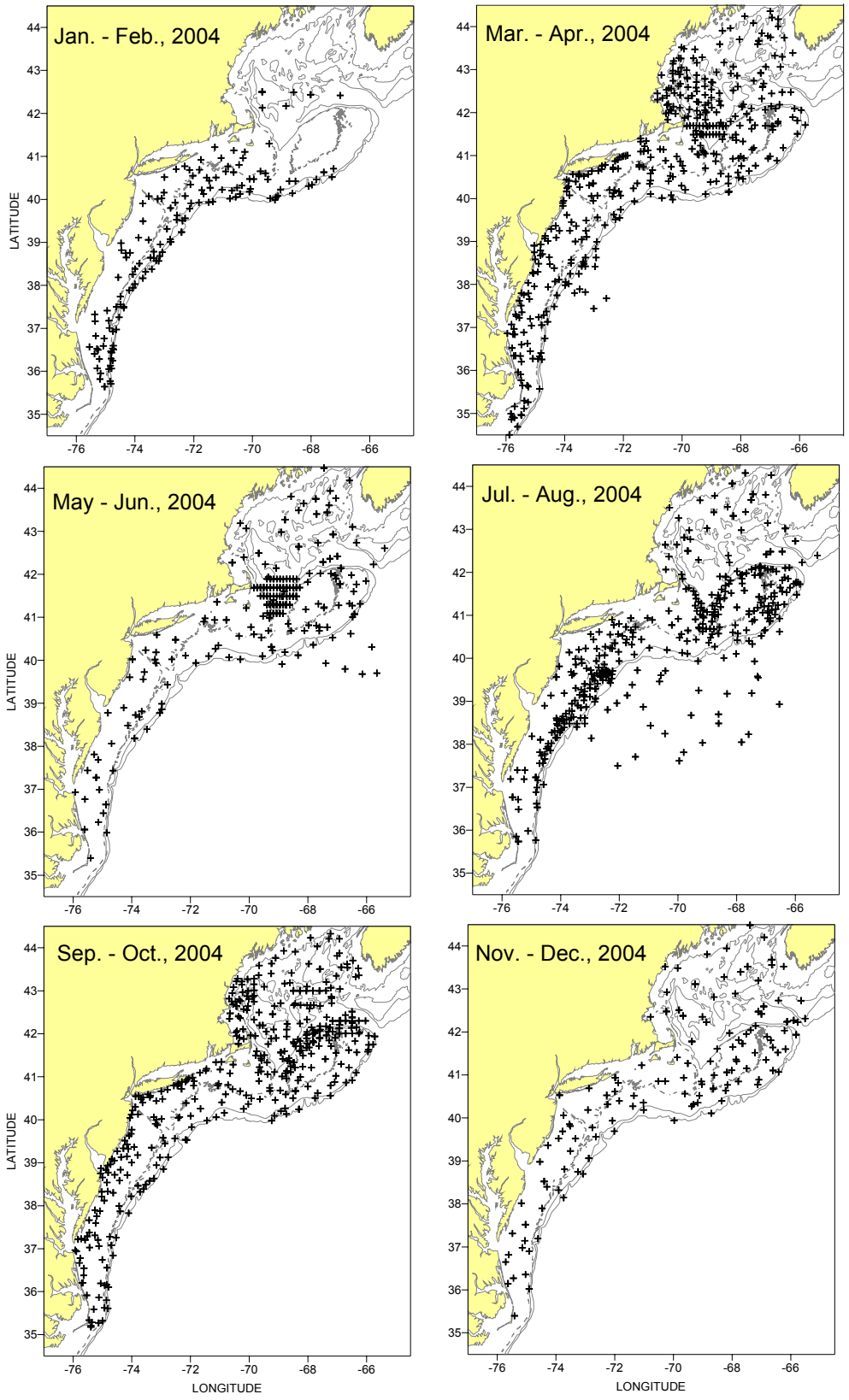


Figure 1b. Distributions of hydrographic stations occupied during 2004.

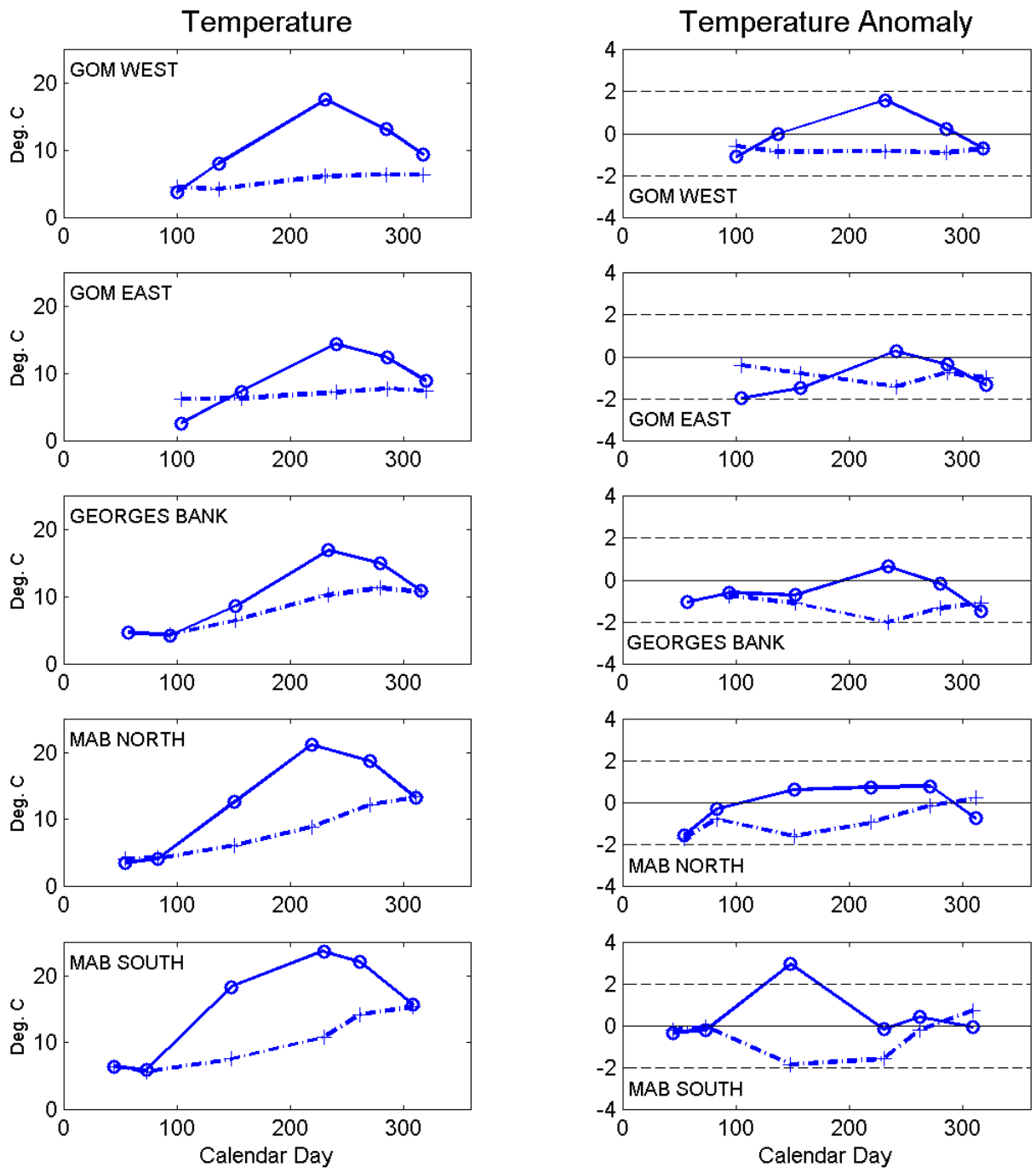


Figure 2. The 2004 areal average surface (-o) and bottom (--+) temperature and anomalies from Table 2.

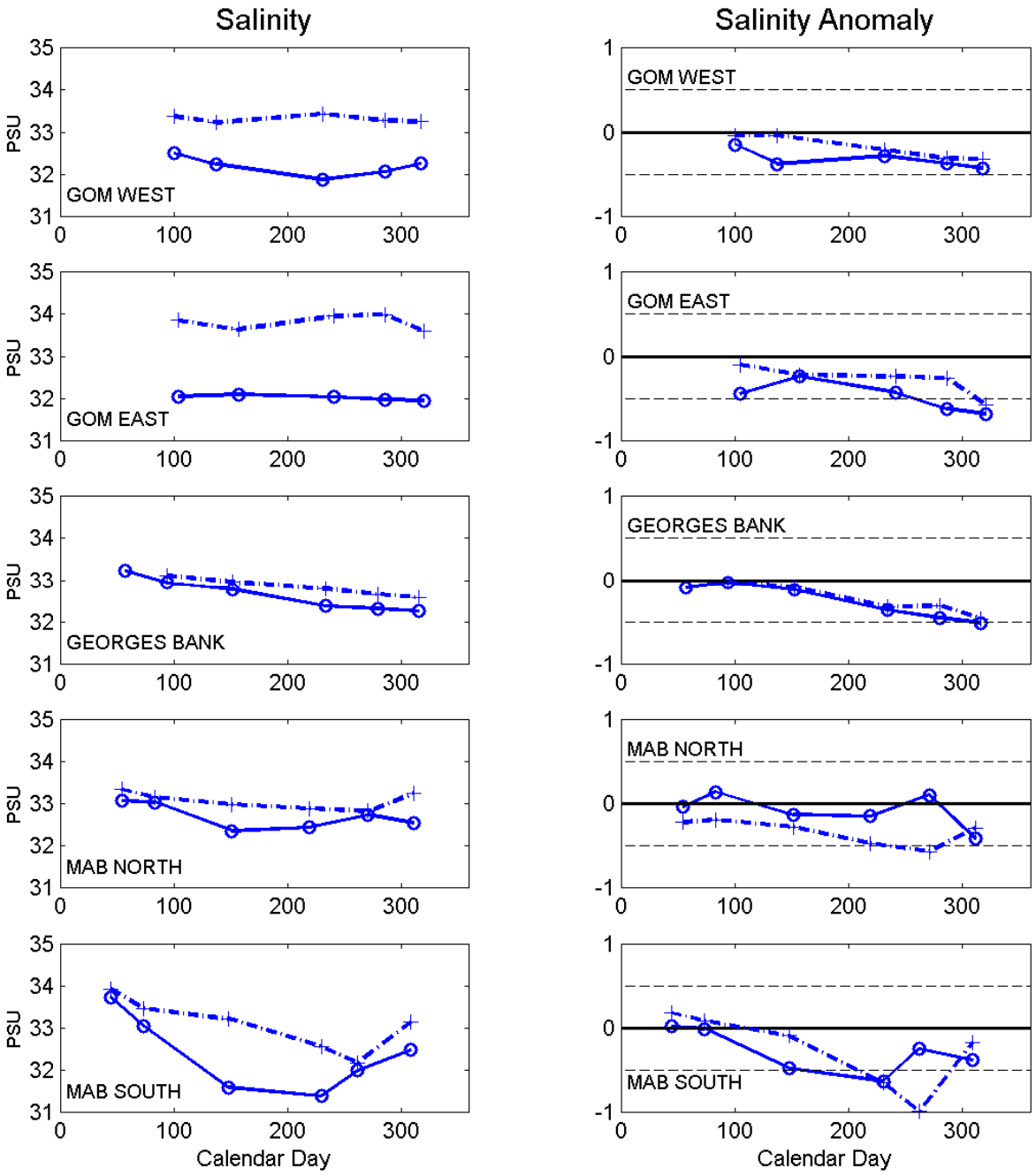


Figure 3. The 2004 areal average surface (-o) and bottom (--+) salinity and anomalies from Table 2.

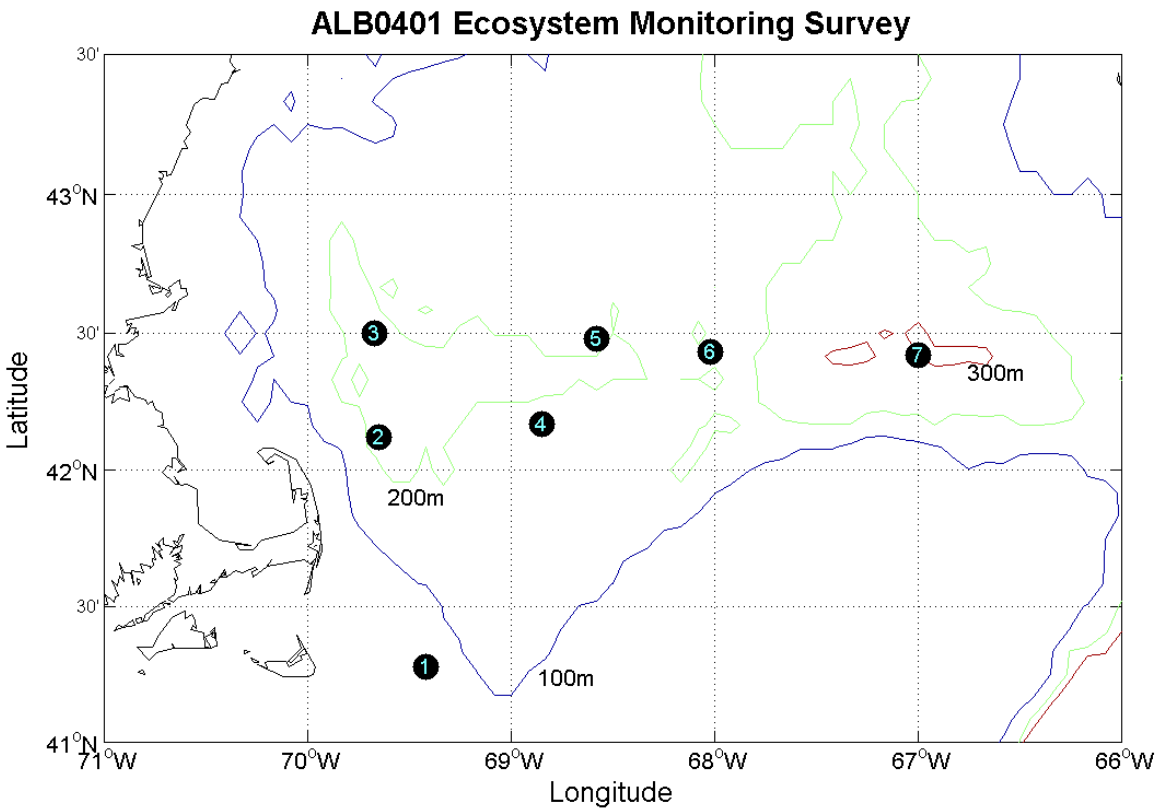


Figure 4. Hydrographic stations occupied during the ECOMON survey ALB0401.

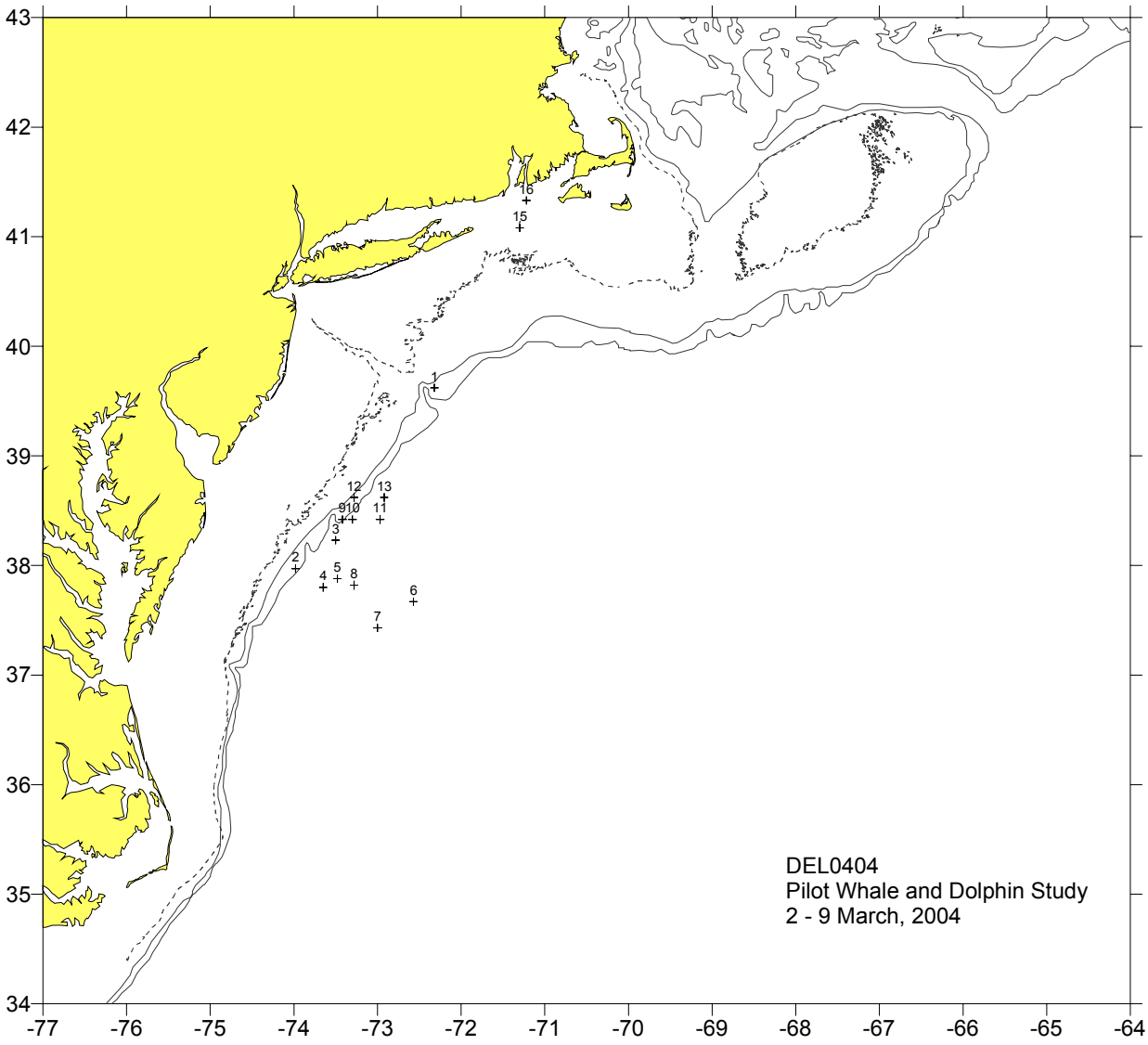


Figure 5. Hydrographic stations occupied during the Pilot Whale and Dolphin Study cruise – DEL0404.

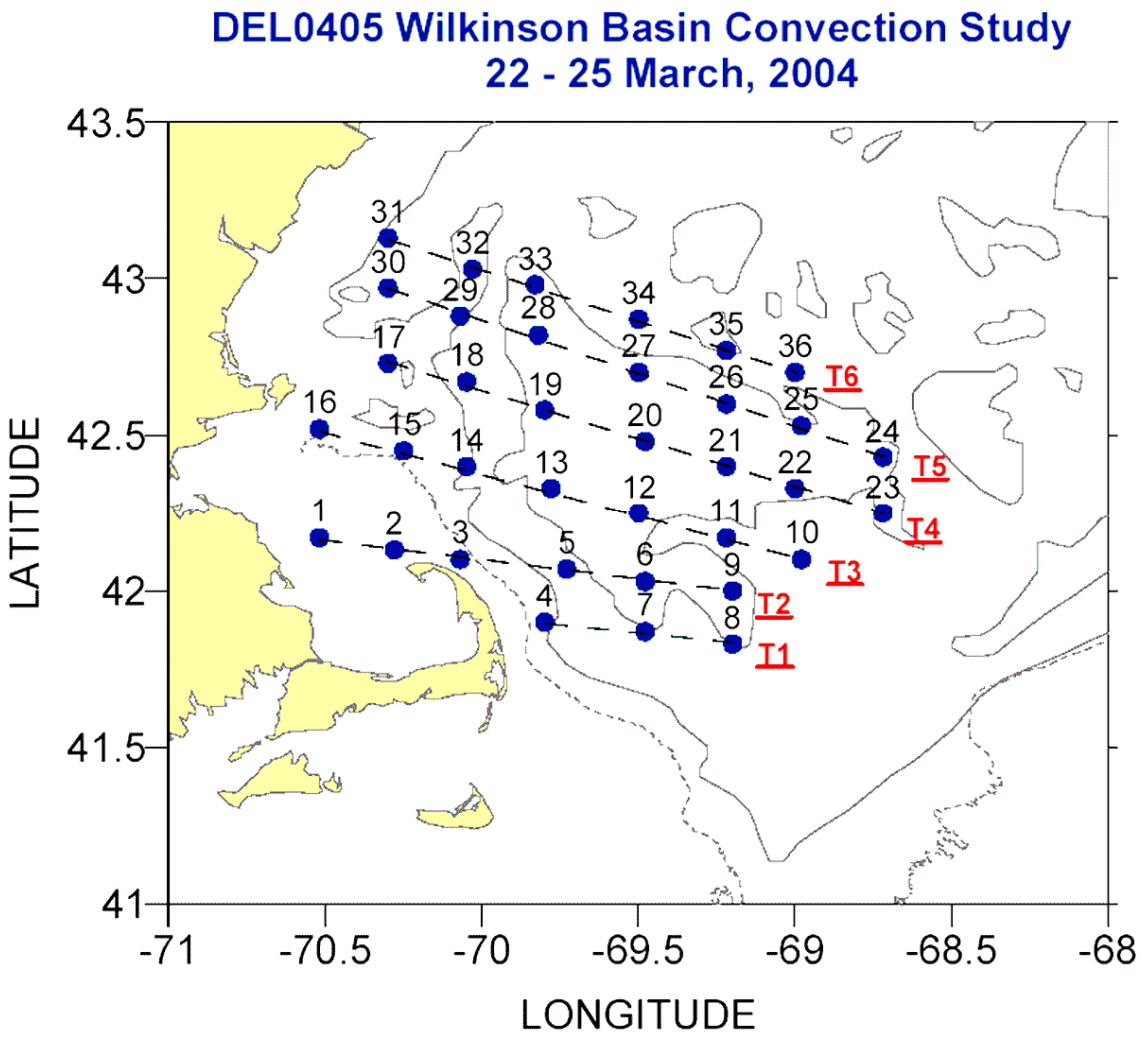


Figure 6. Hydrographic stations occupied during the Northeast Channel Hydrography cruise – DEL0405.

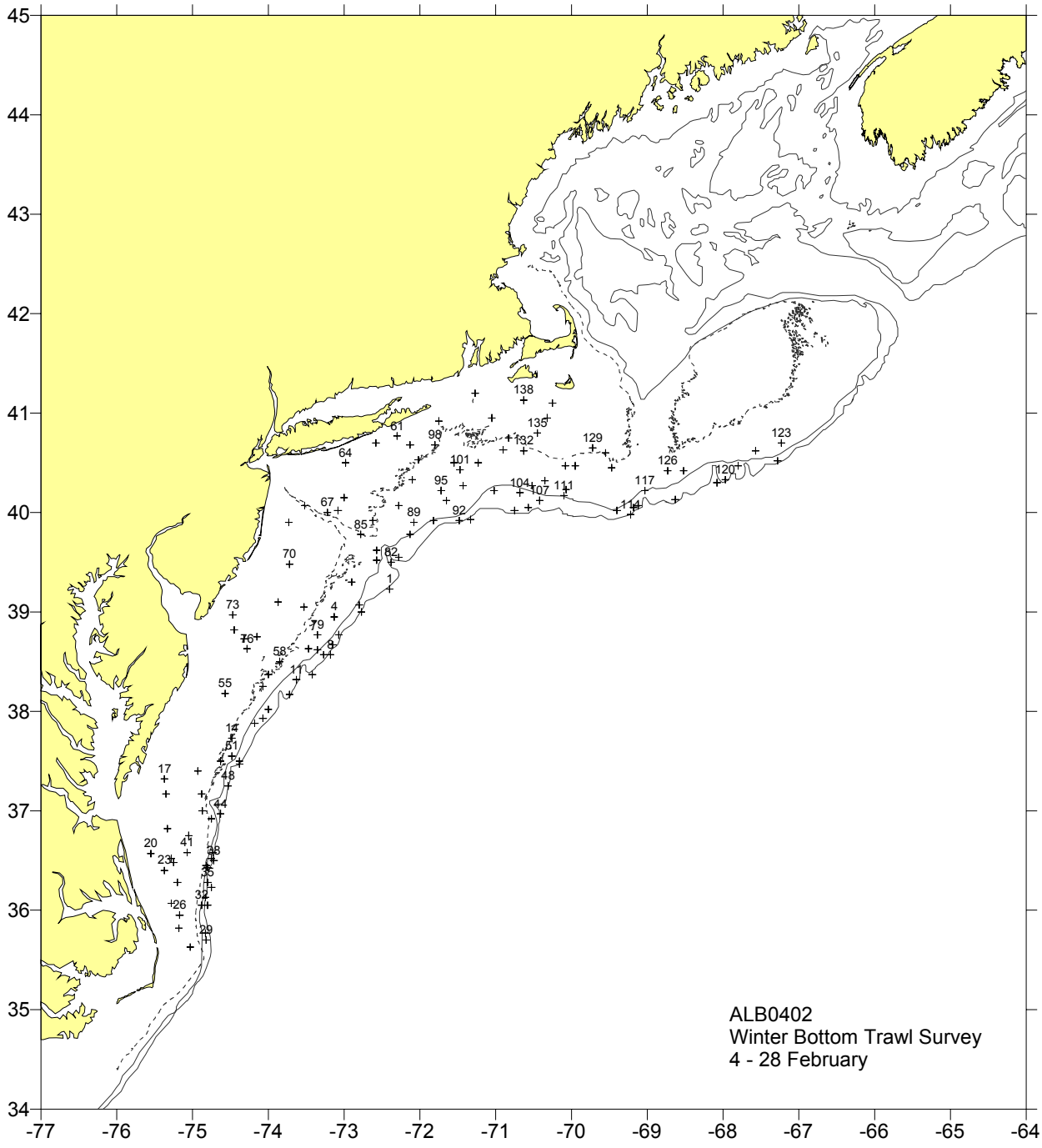


Figure 7. Hydrographic stations occupied during the Winter Bottom Trawl survey - ALB0402.

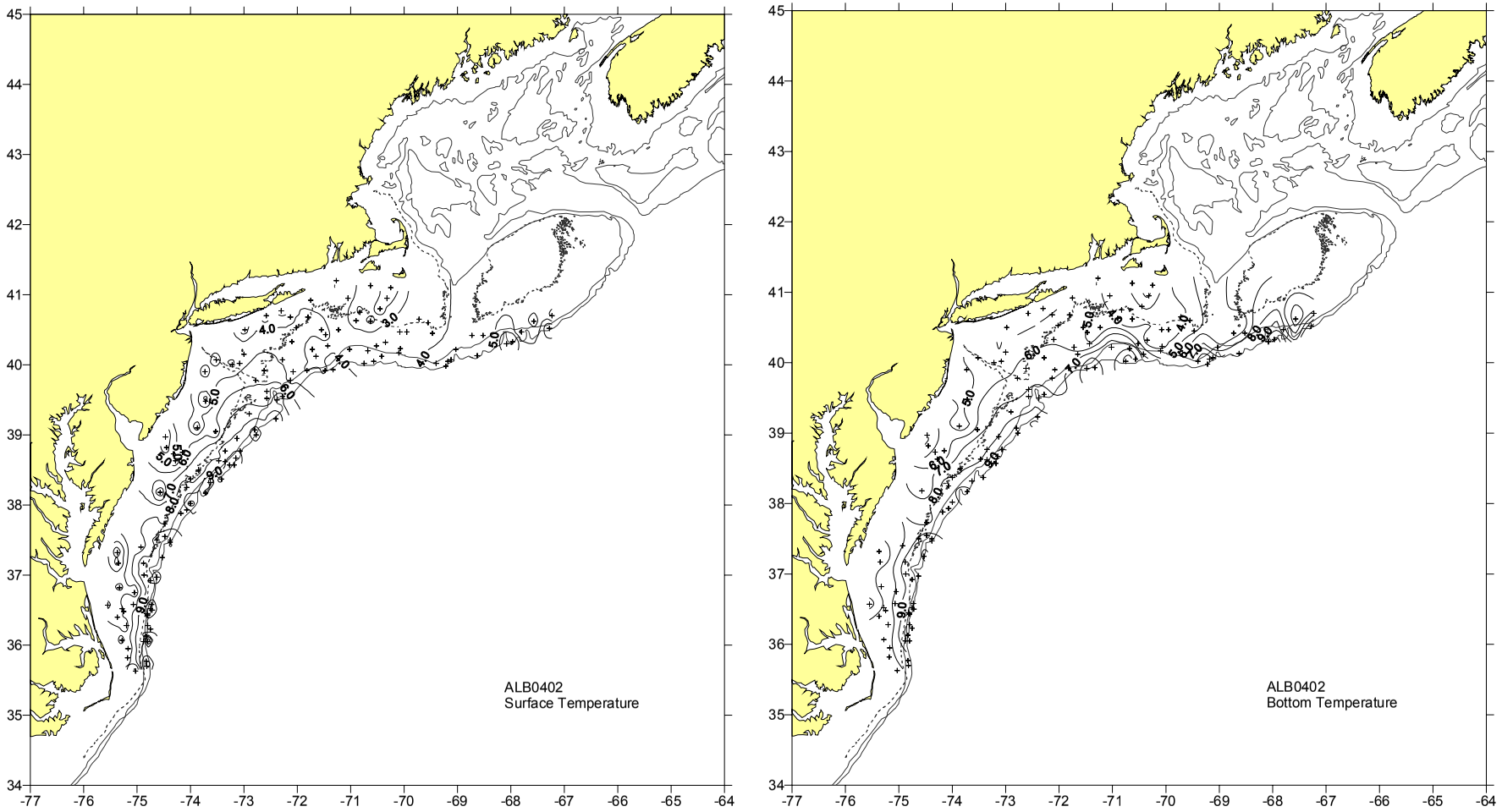


Figure 8. Surface and Bottom temperature distributions for the Winter Bottom Trawl survey – ALB0402.

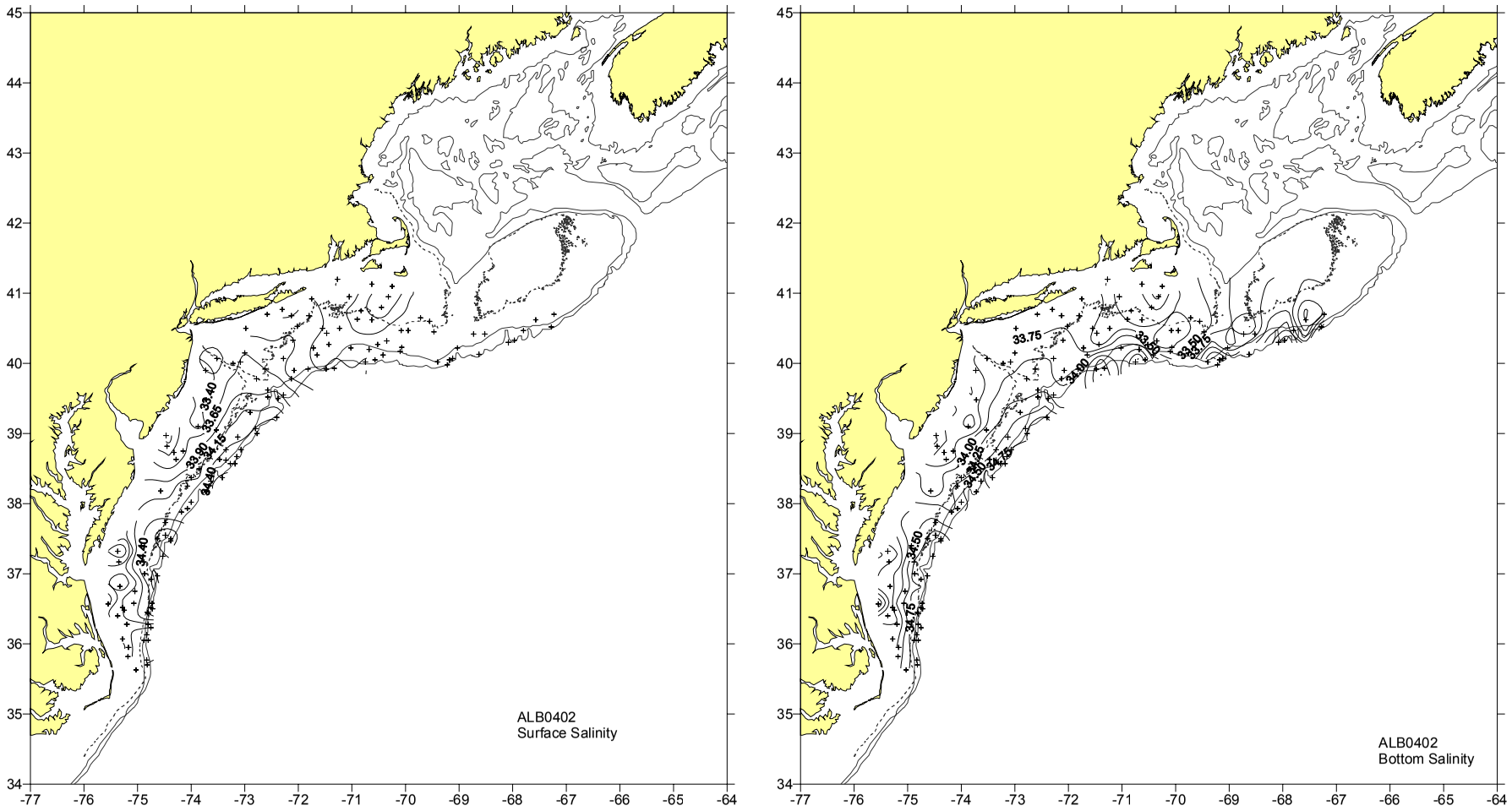


Figure 9. Surface and bottom salinity distributions for the Winter Bottom Trawl survey – ALB0402.

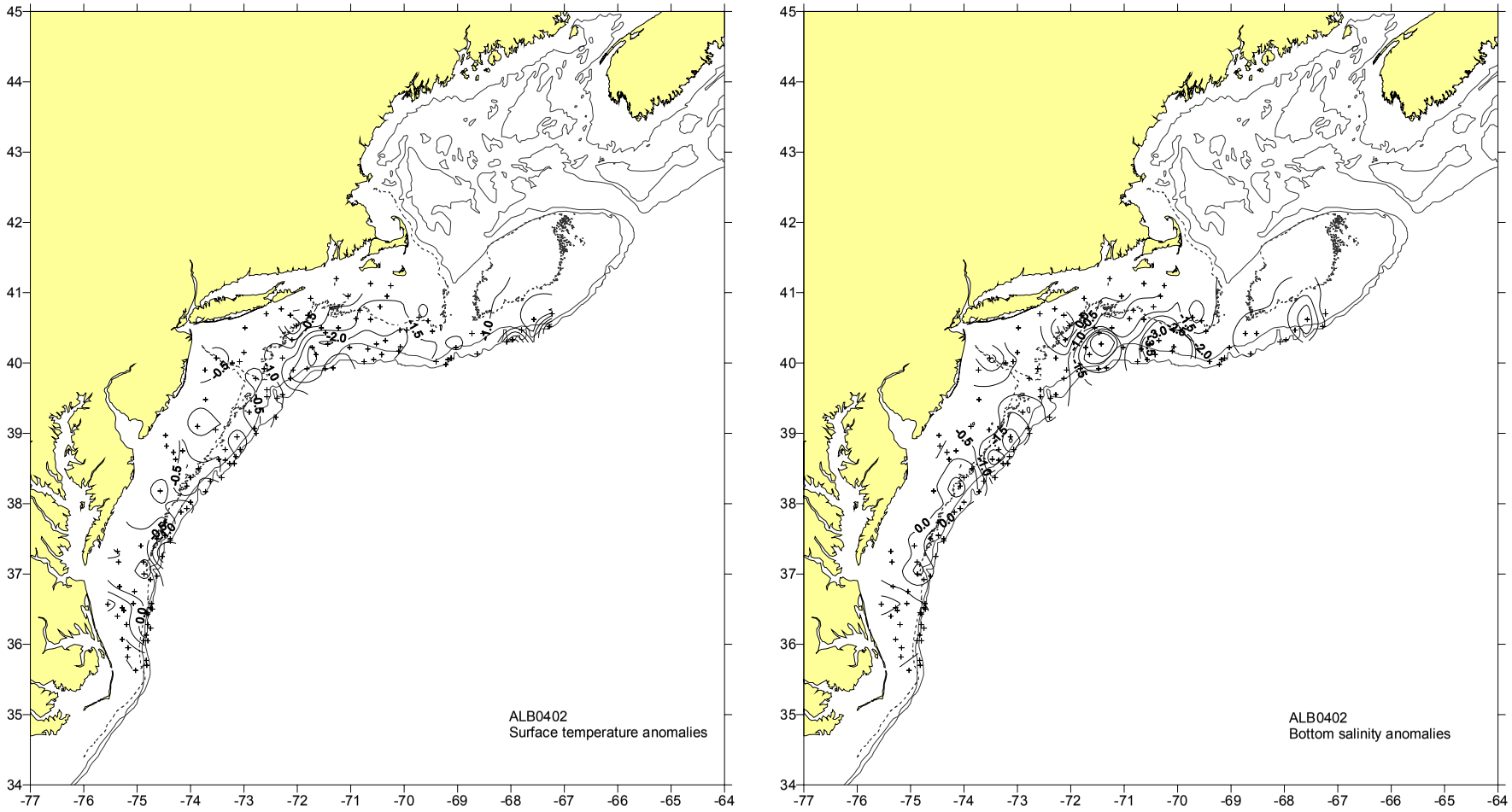


Figure 10. Surface and bottom temperature anomaly distributions for the Winter Bottom Trawl survey – ALB0402.

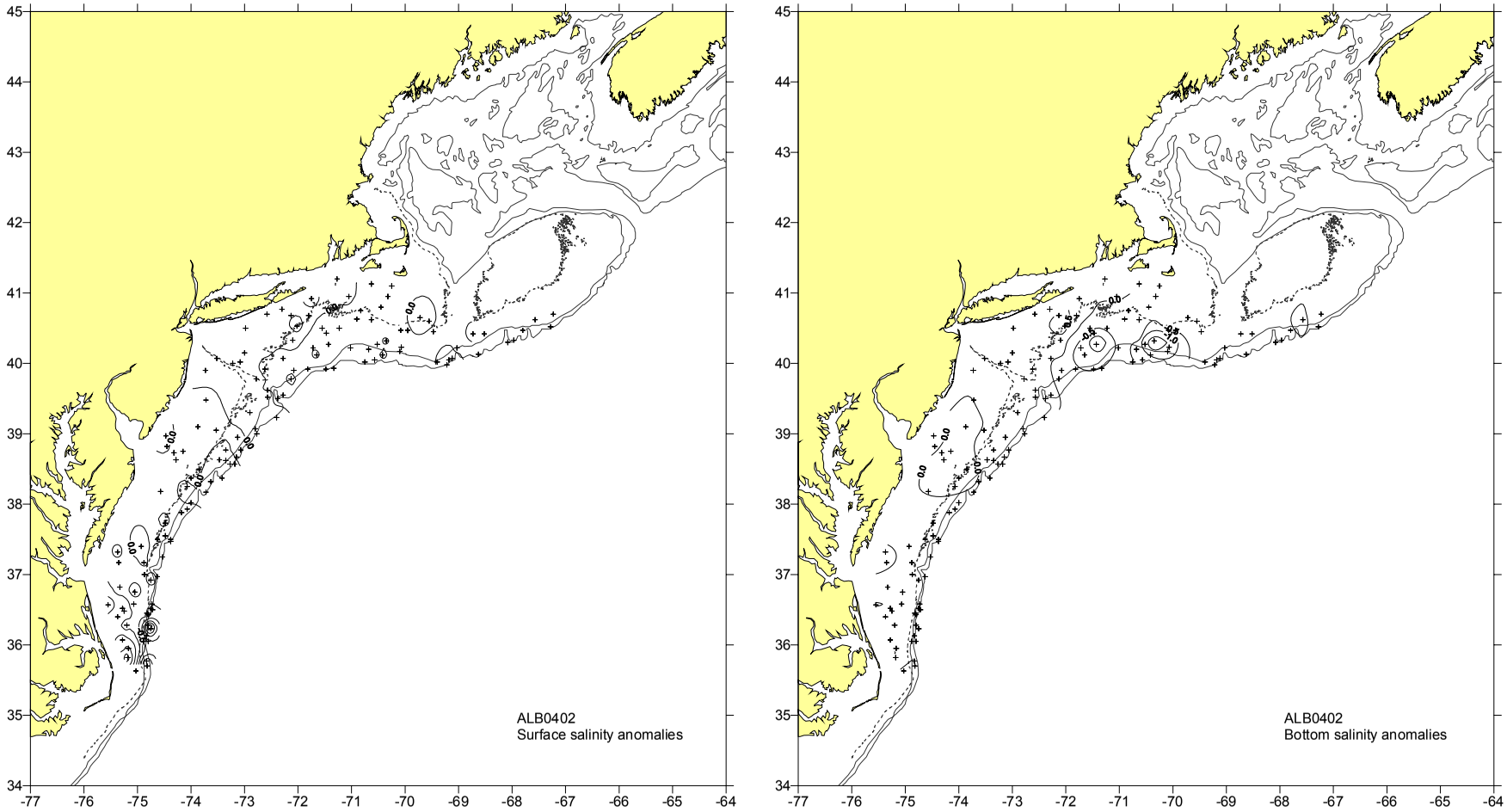


Figure 11. Surface and bottom salinity anomaly distributions for the Winter Bottom Trawl survey – ALB0402.

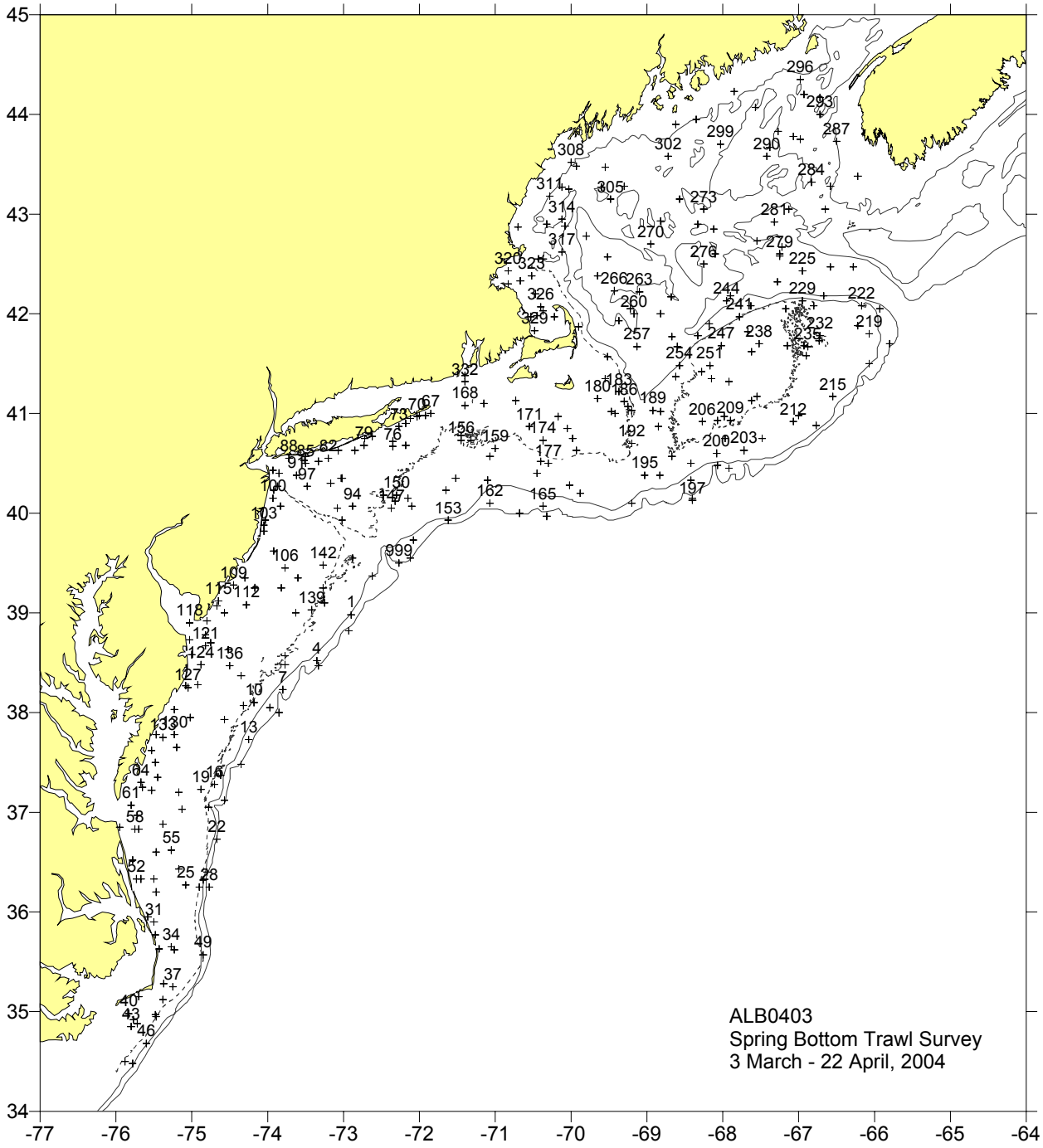


Figure 12. Hydrographic stations occupied during the Spring Bottom Trawl Survey – ALB0403.

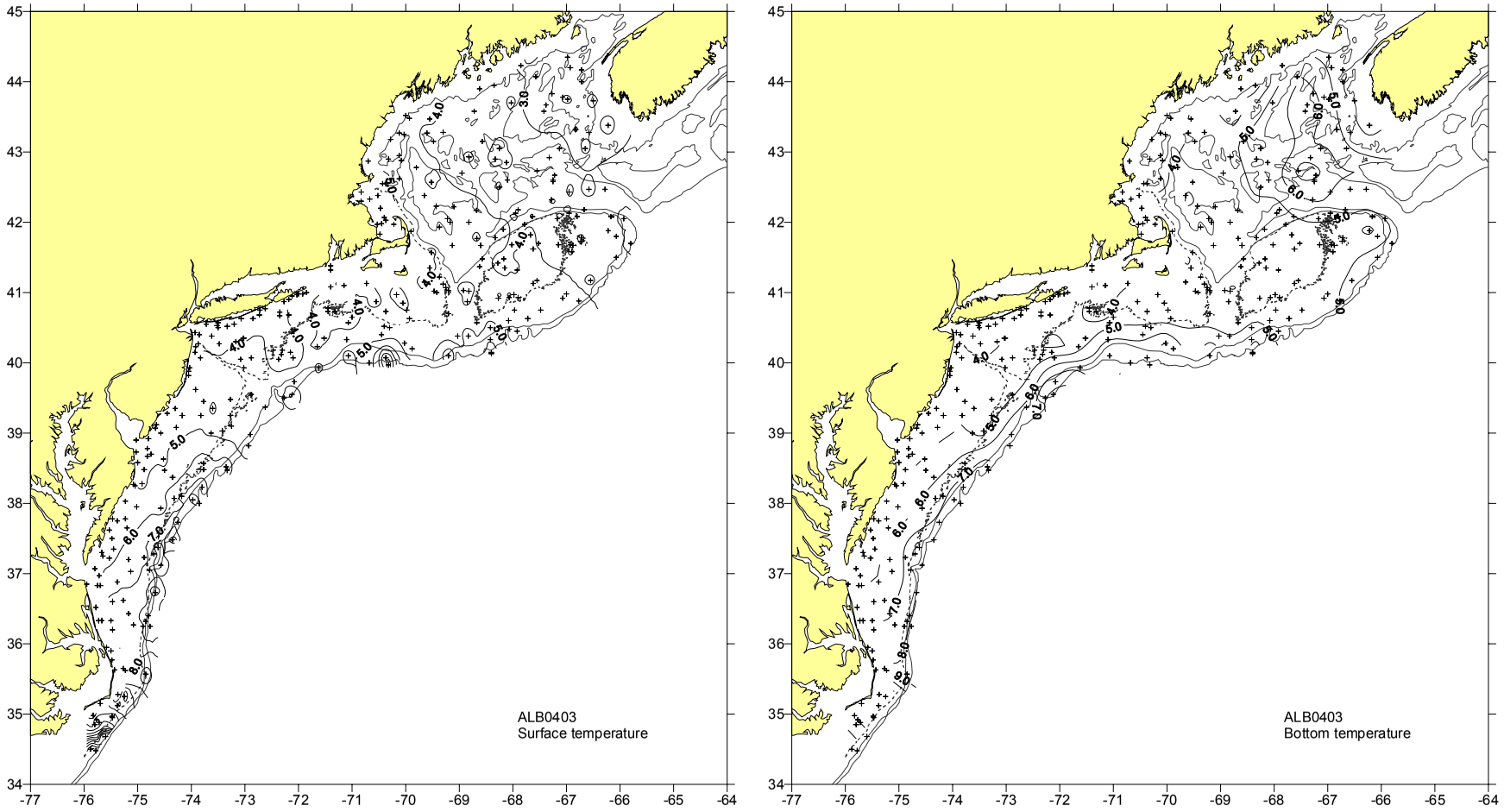


Figure 13. Surface and bottom temperature distributions for the Spring Bottom Trawl survey – ALB0403.

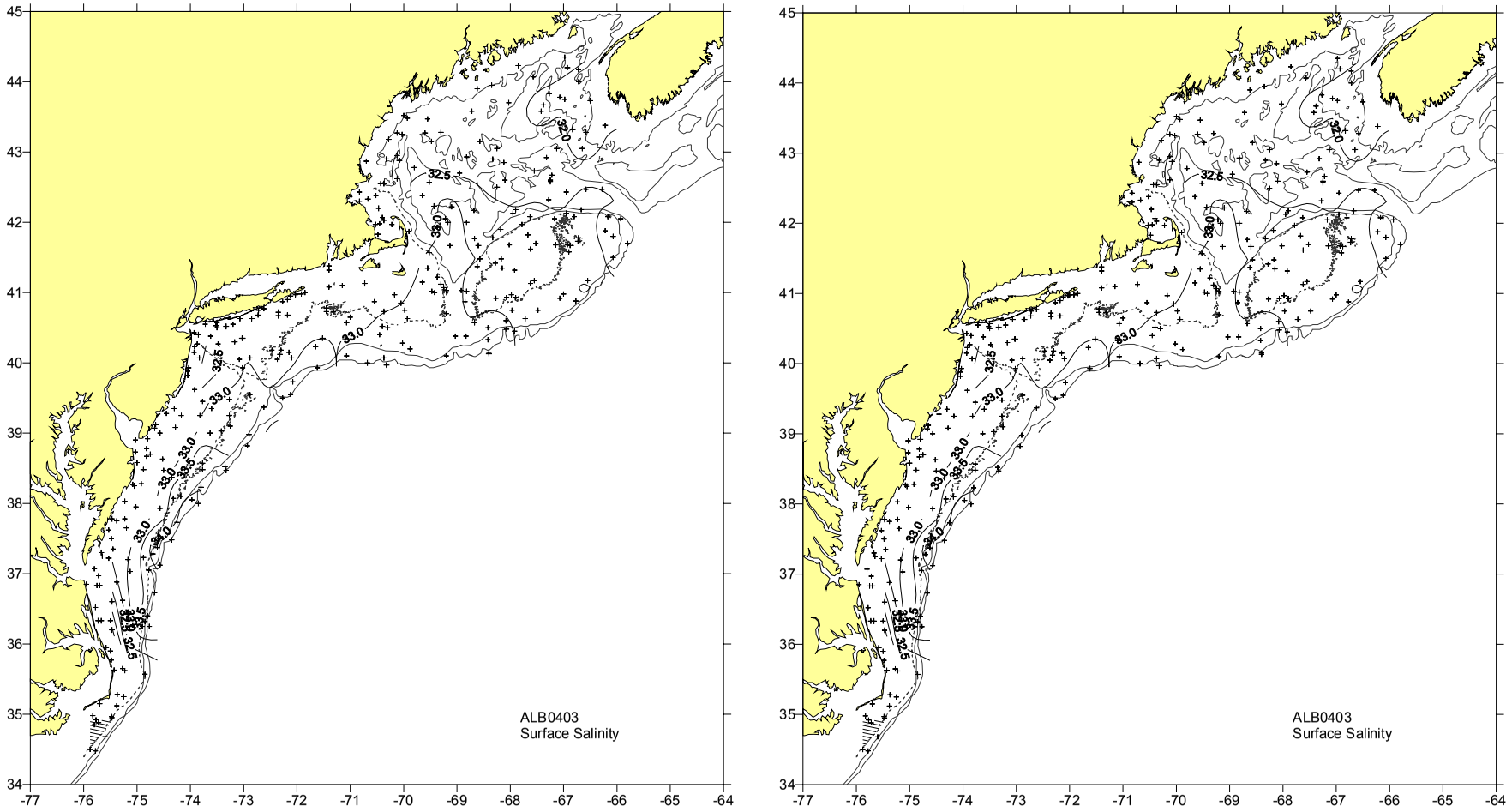


Figure 14. Surface and bottom salinity distributions for the Spring Bottom Trawl survey – ALB0403.

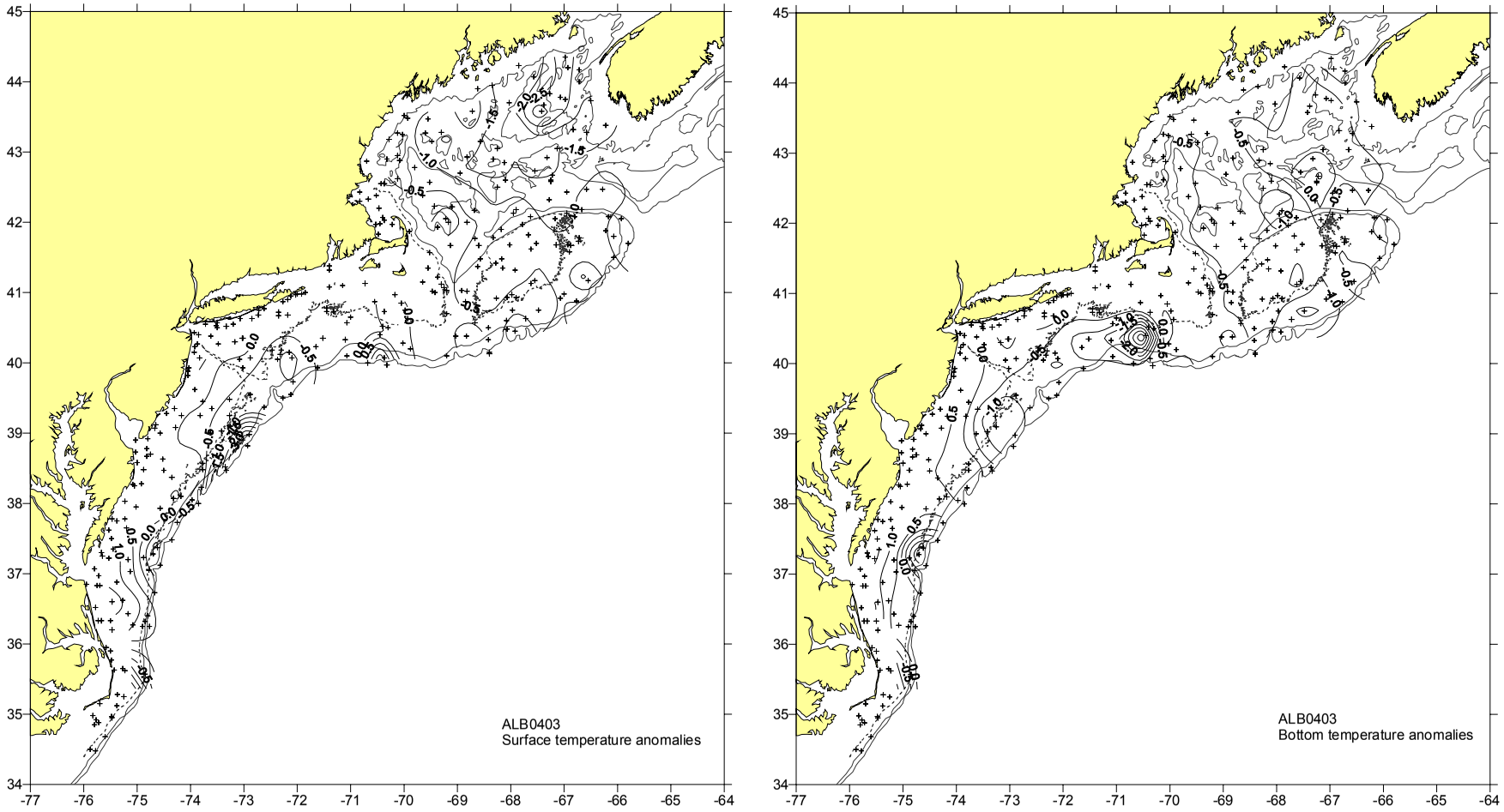


Figure 15. Surface and bottom temperature anomaly distributions for the Spring Bottom Trawl survey – ALB0403.

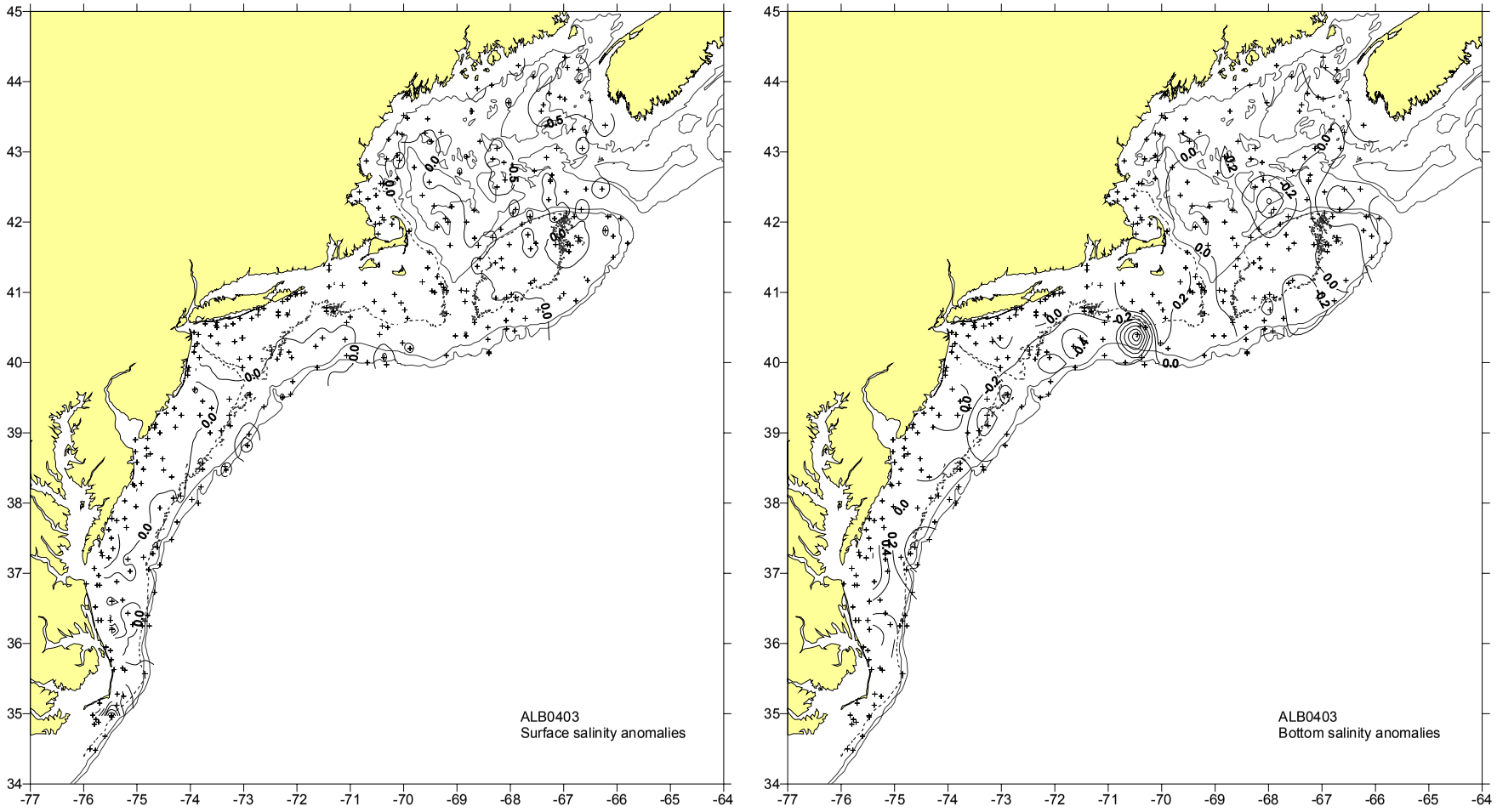


Figure 16. Surface and bottom salinity anomaly distributions for the Spring Bottom Trawl survey – ALB0403.

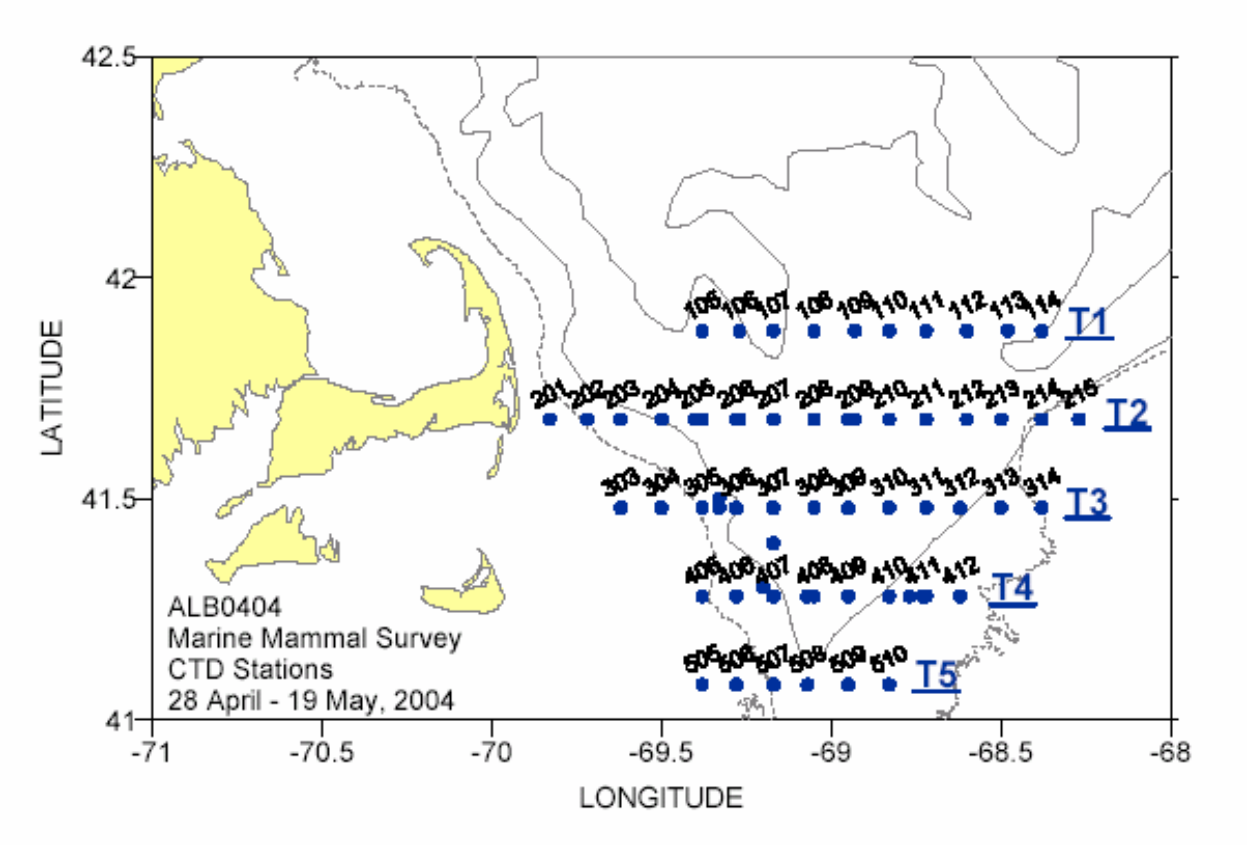


Figure 17. Hydrographic stations occupied during the Marine Mammal Survey - ALB0404.

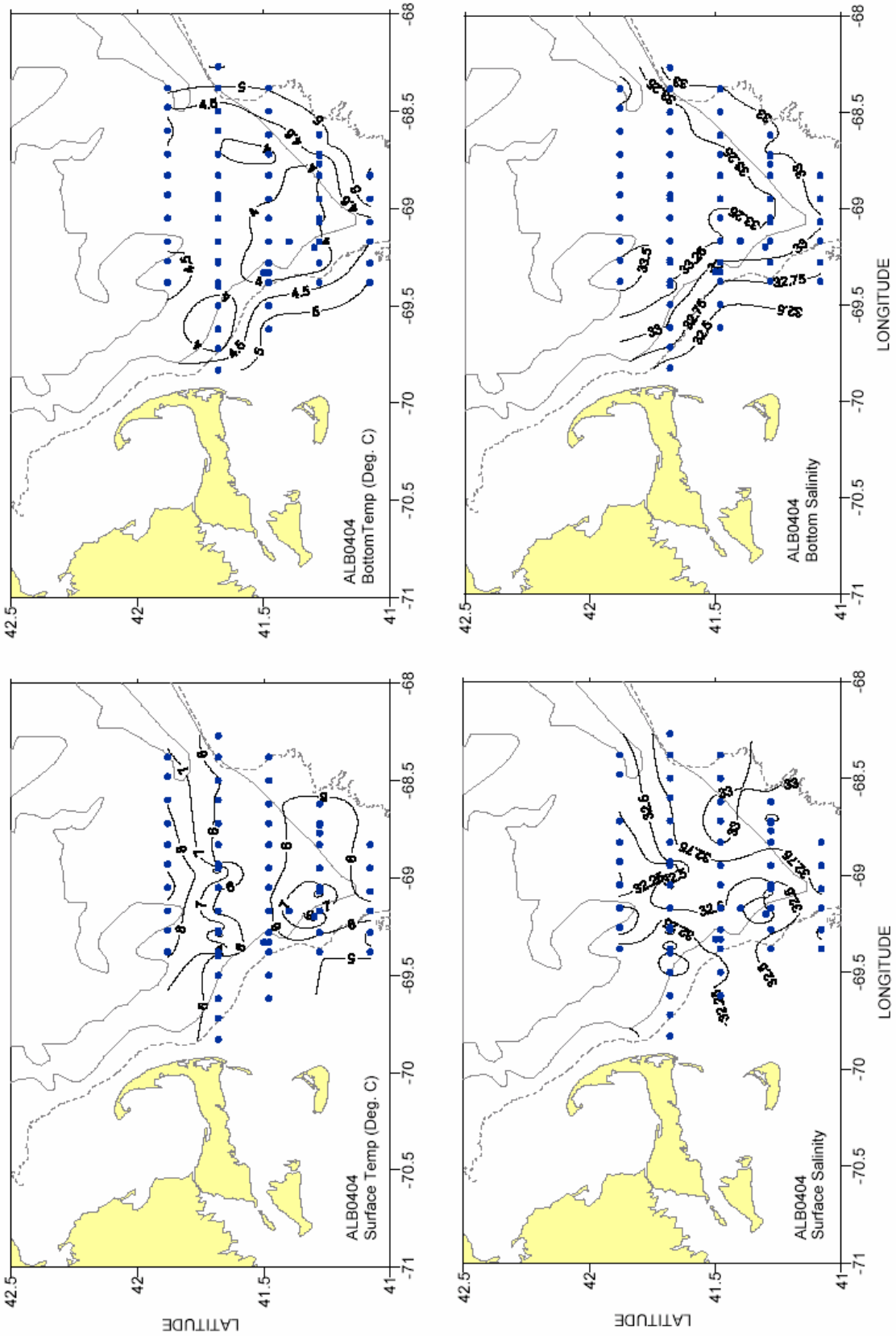


Figure 18. Surface and bottom temperature and salinity distributions for the Marine Mammal survey – ALB0404.

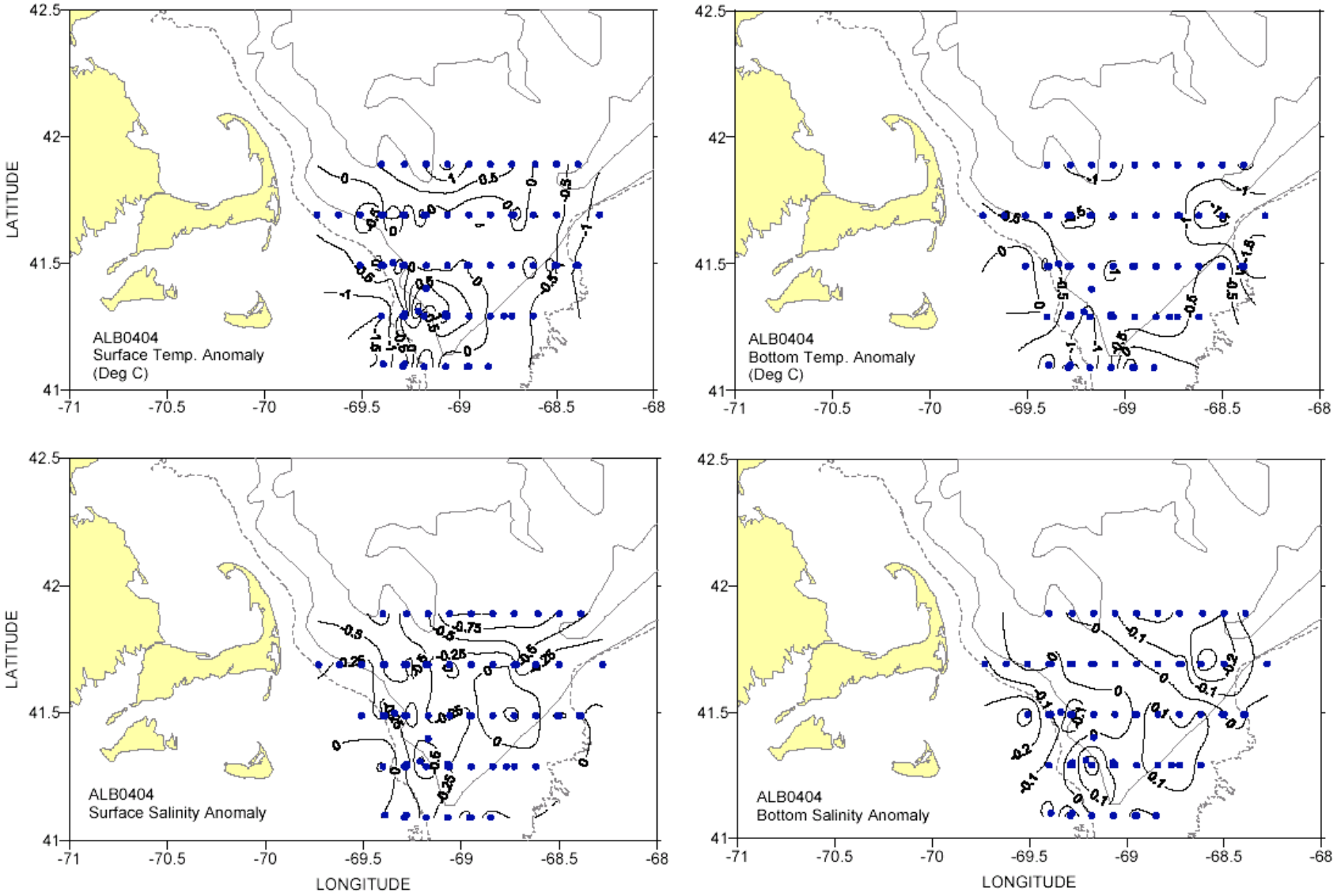


Figure 19. Surface and bottom temperature and salinity anomaly distributions for the Marine Mammal survey – ALB0404.

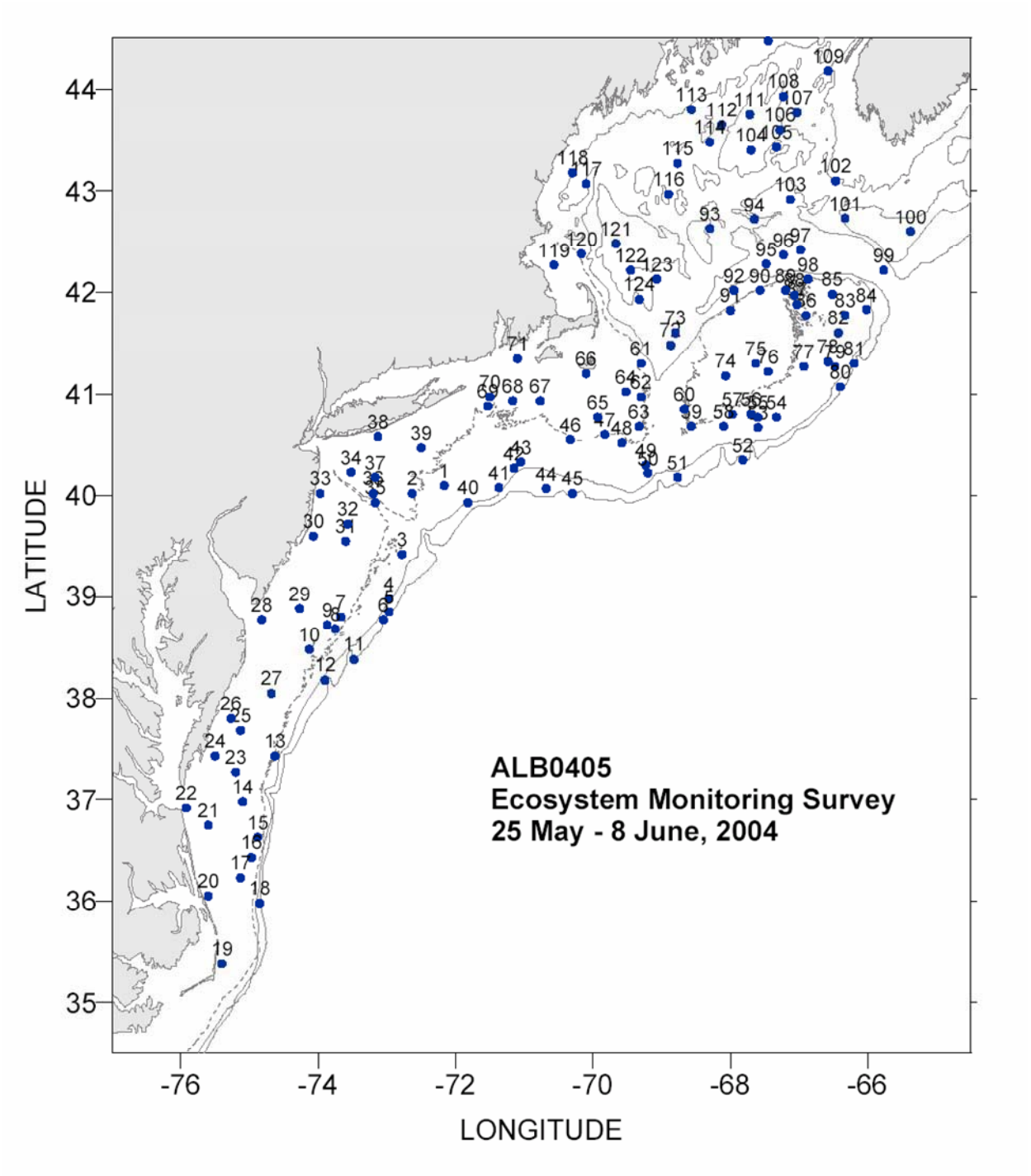


Figure 20. Hydrographic stations occupied during the ECOMON cruise - ALB0405.

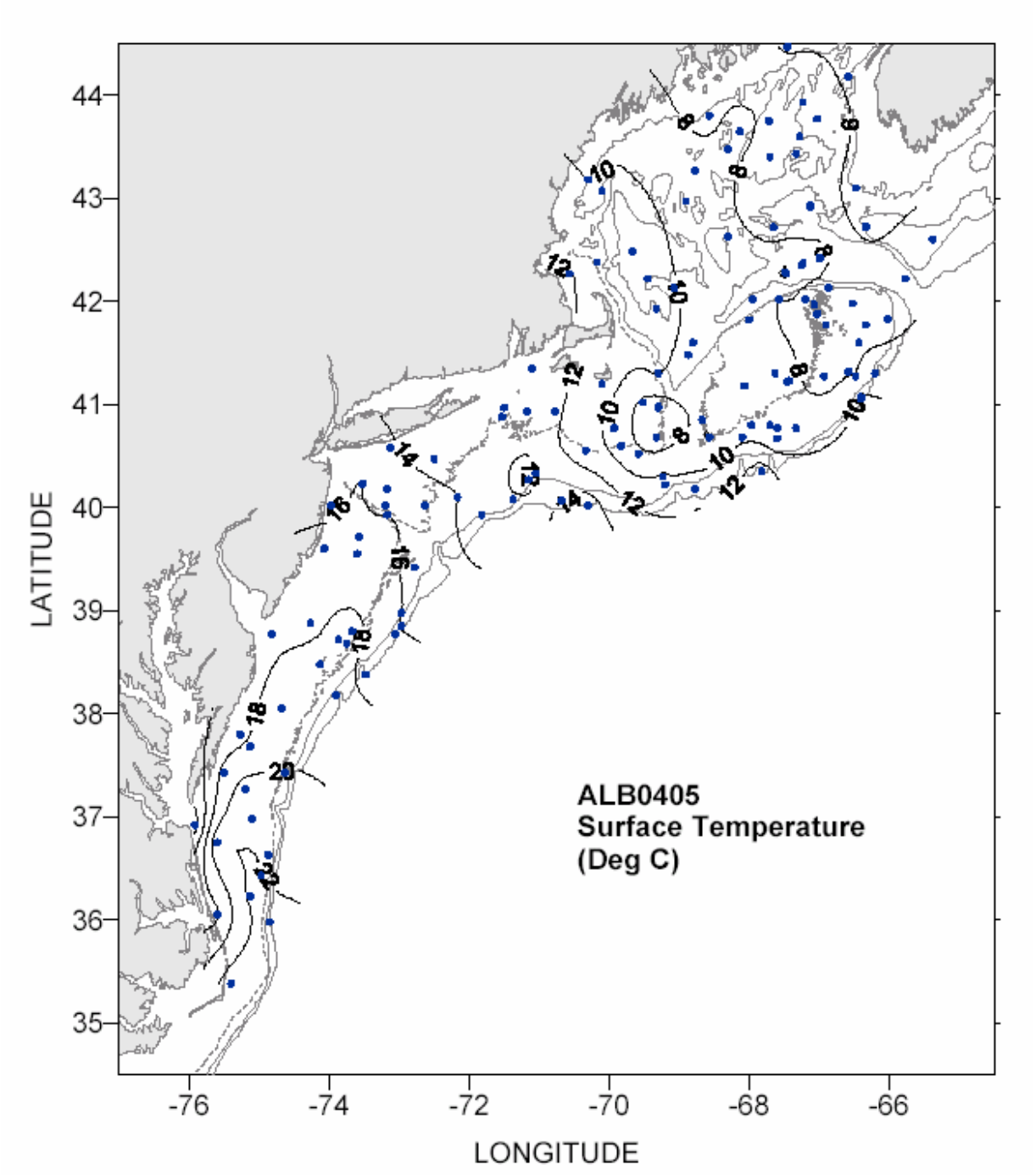


Figure 21. Surface temperature distributions for the ECOMON cruise –ALB0405.

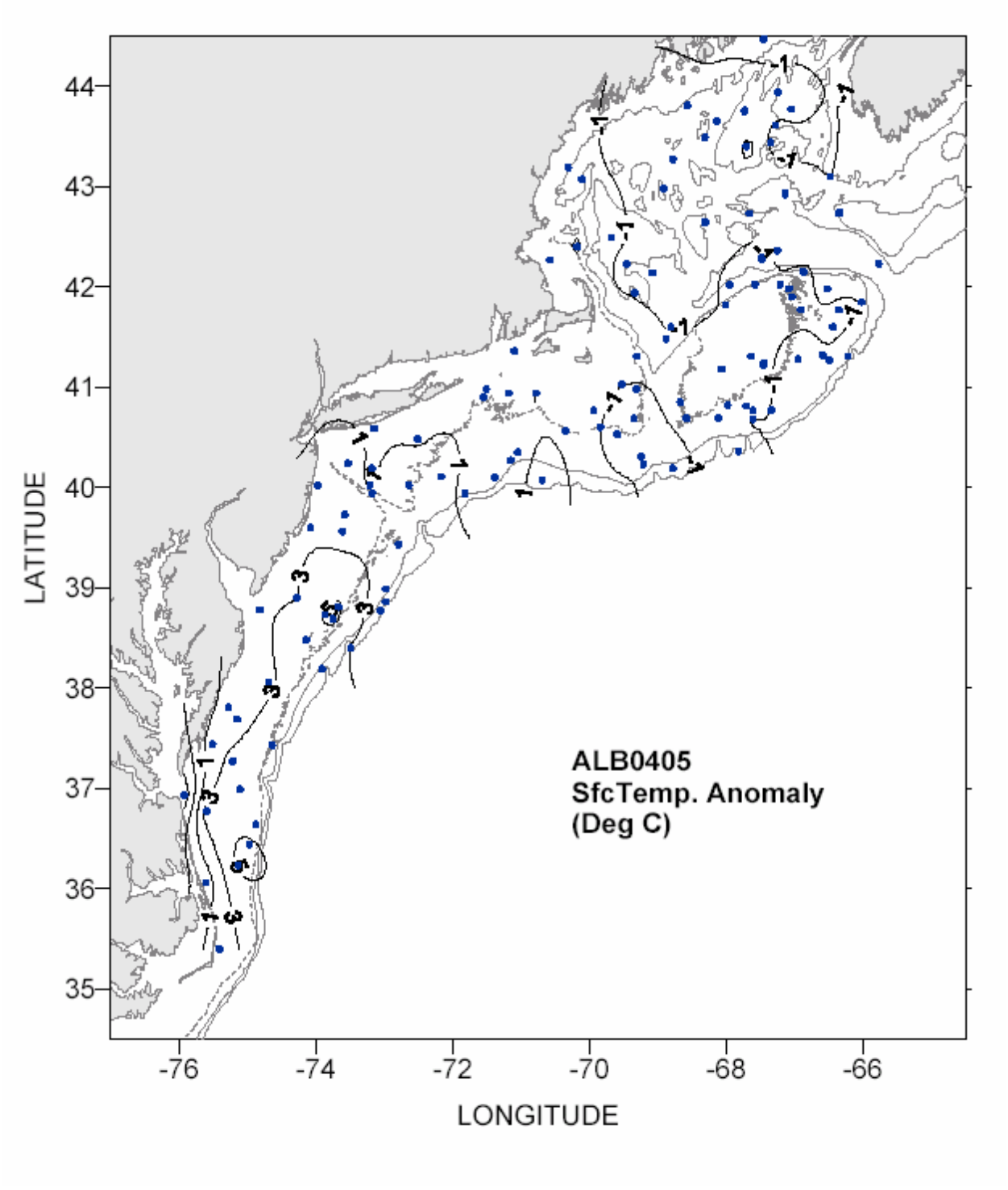


Figure 22. Surface temperature anomaly distributions for the ECOMON survey - ALB0405.

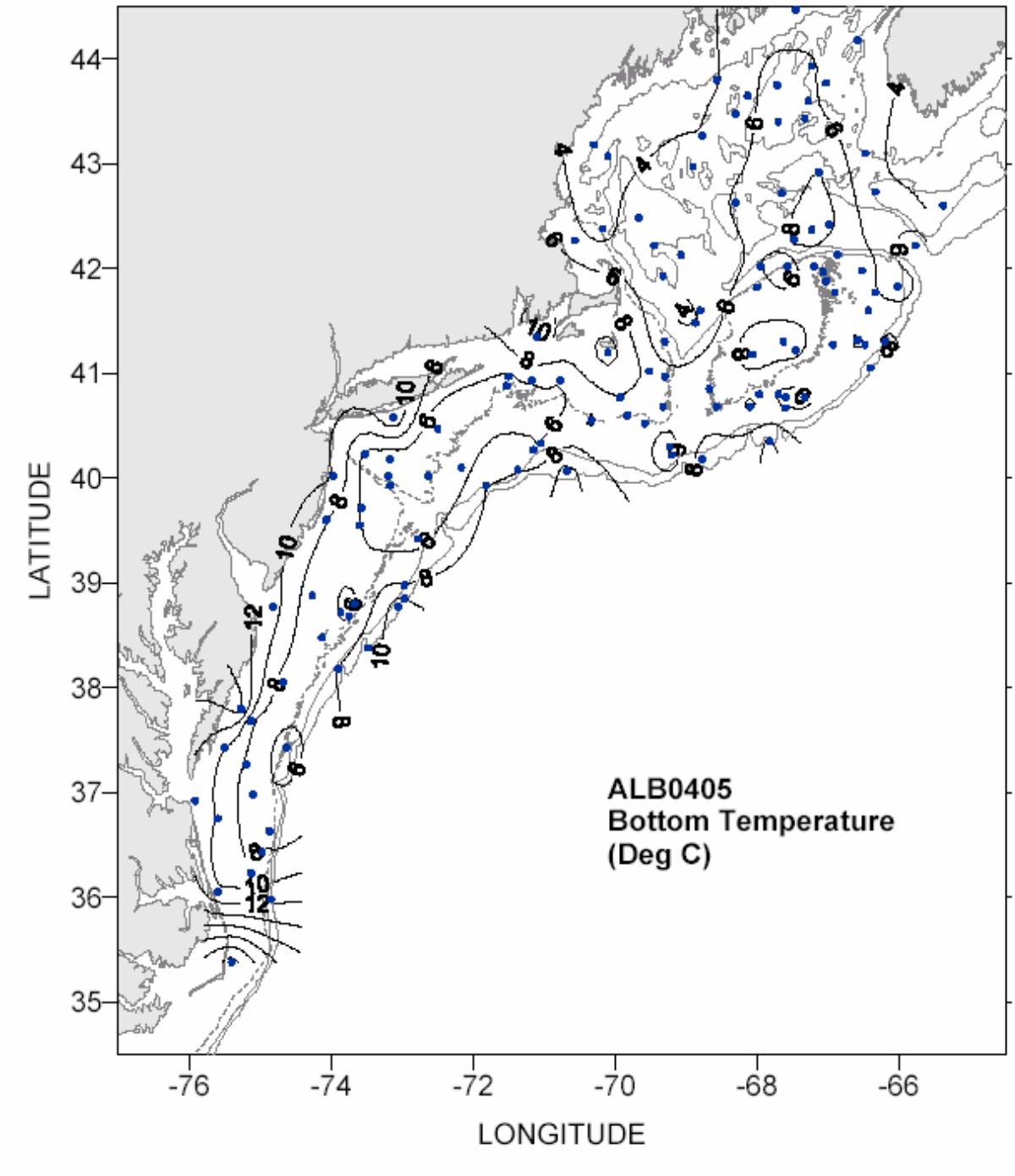


Figure 23. Bottom temperature distributions for the ECOMON cruise –ALB0405.

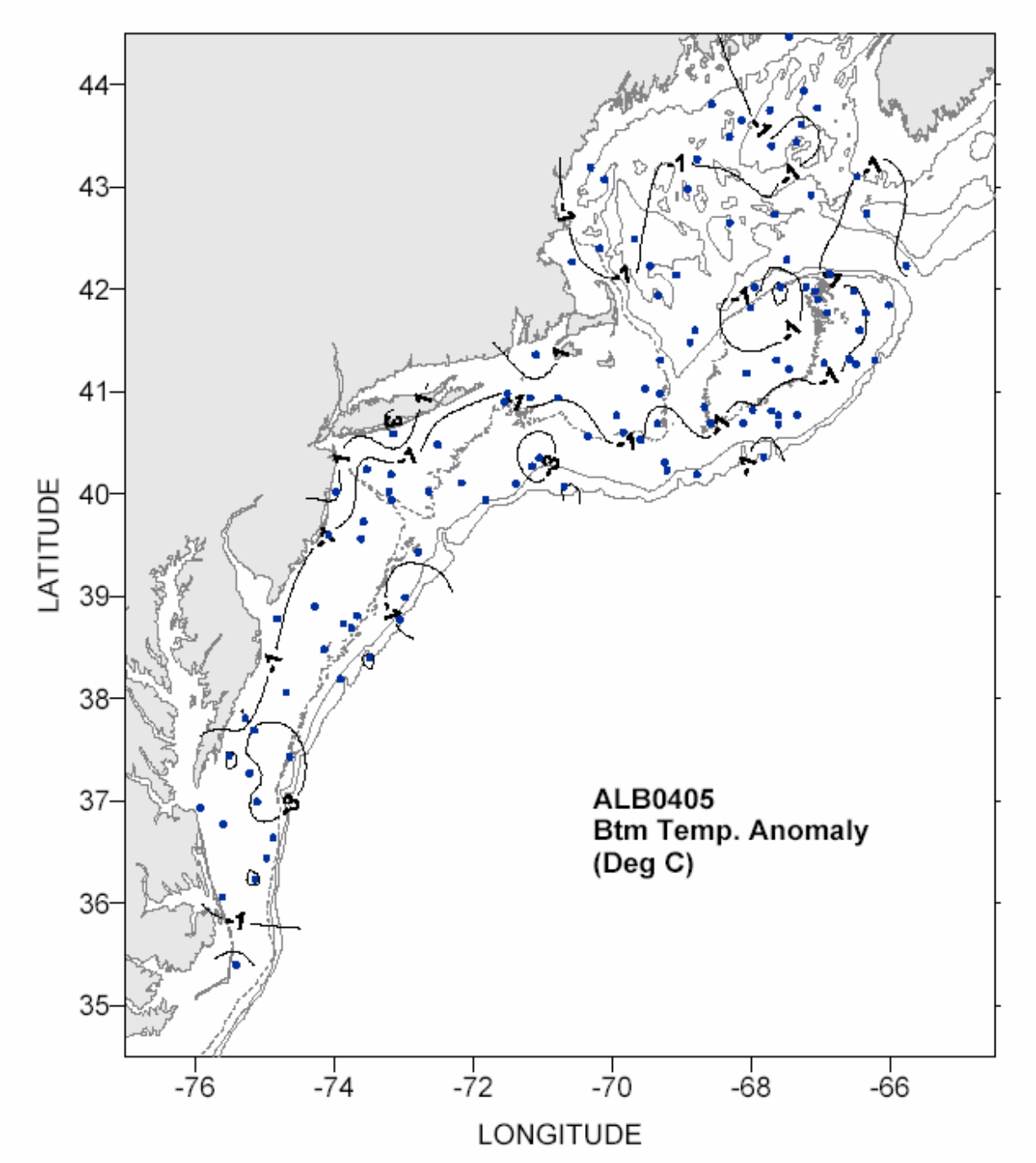


Figure 24. Bottom temperature anomaly distributions for the ECOMON cruise - ALB0405.

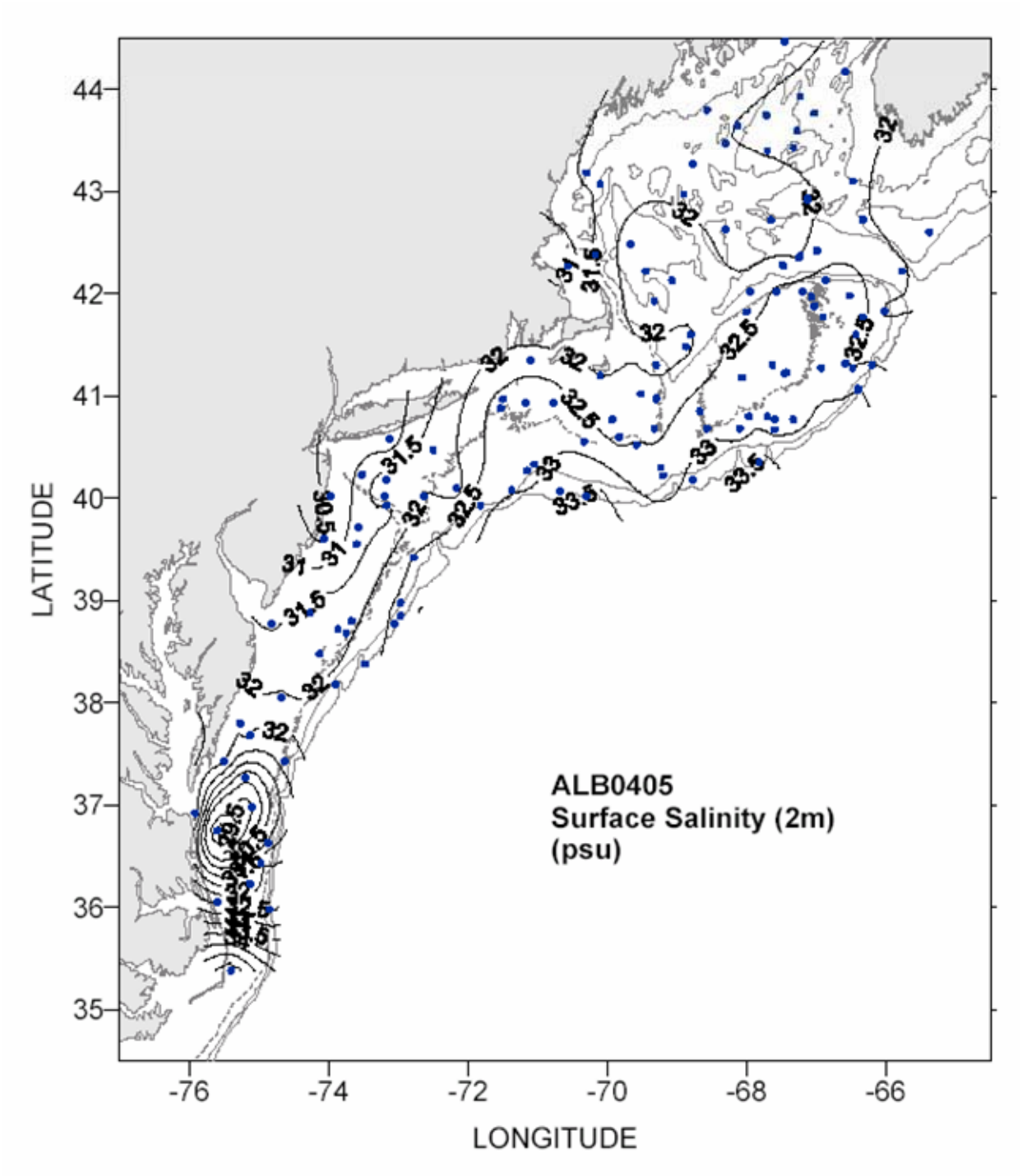


Figure 25. Surface salinity distributions for the ECOMON cruise –ALB0405.

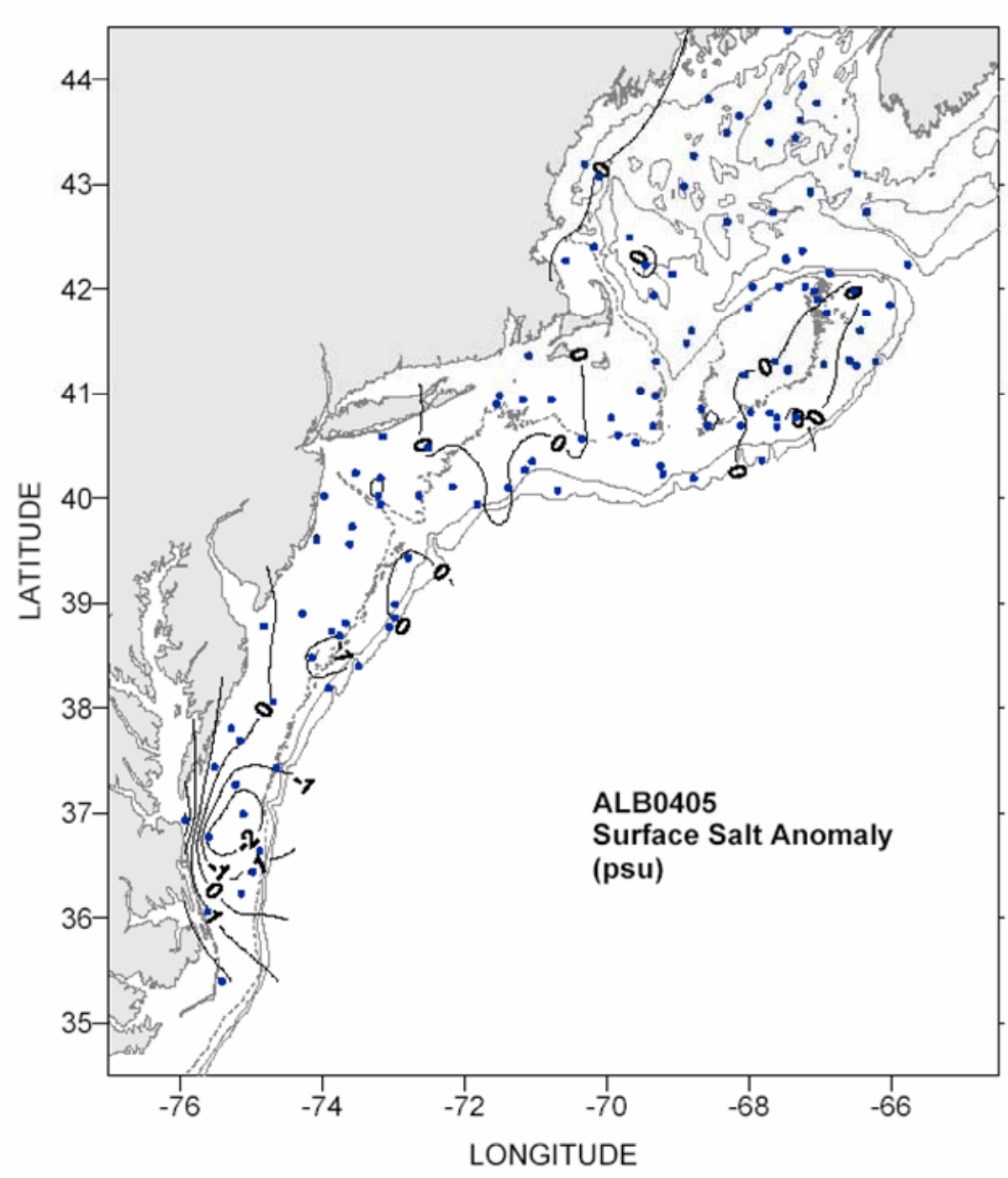


Figure 26. Surface salinity anomaly distributions for the ECOMON cruise - ALB0405.

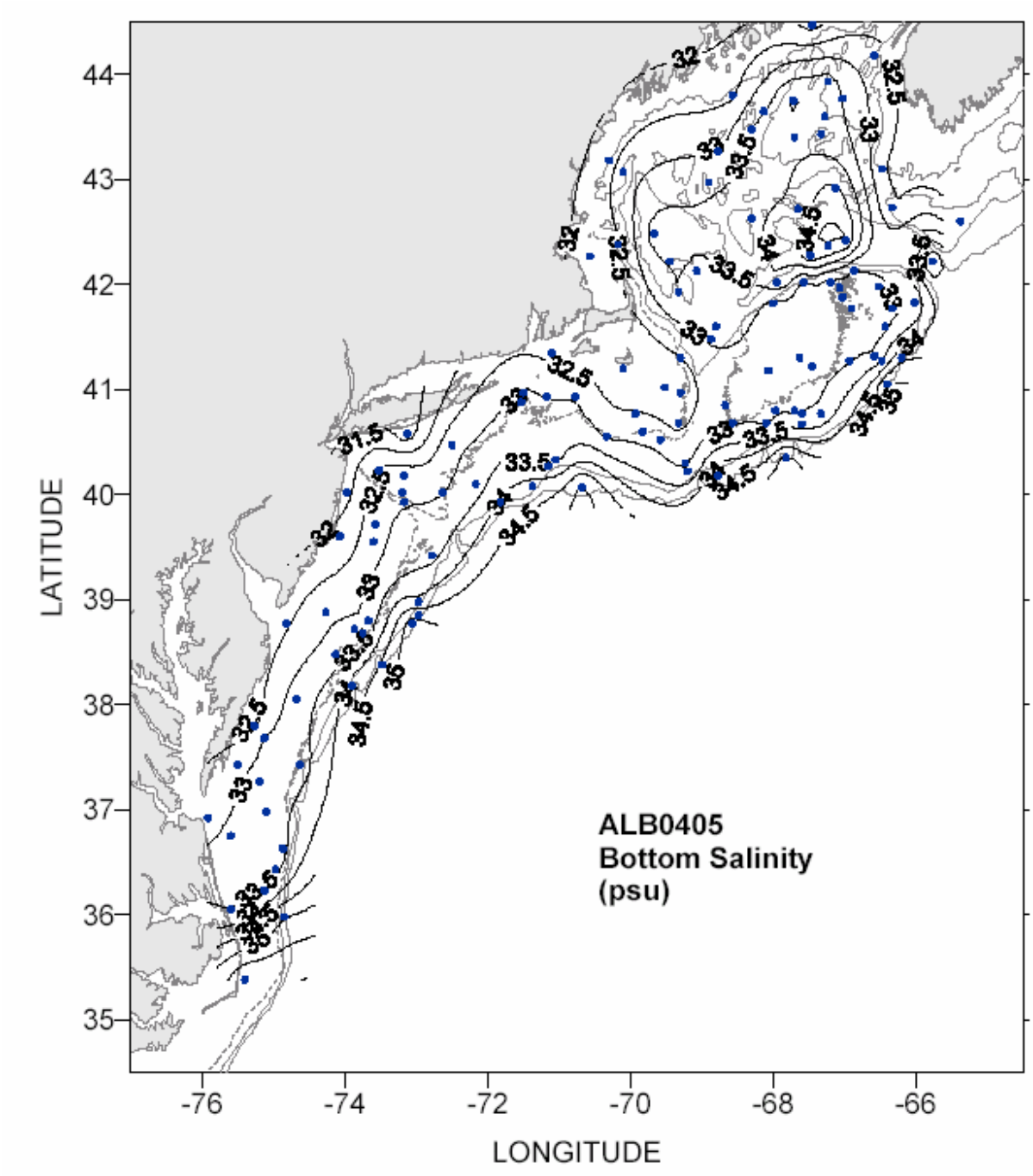


Figure 27. Bottom salinity distributions for the ECOMON cruise –ALB0405.

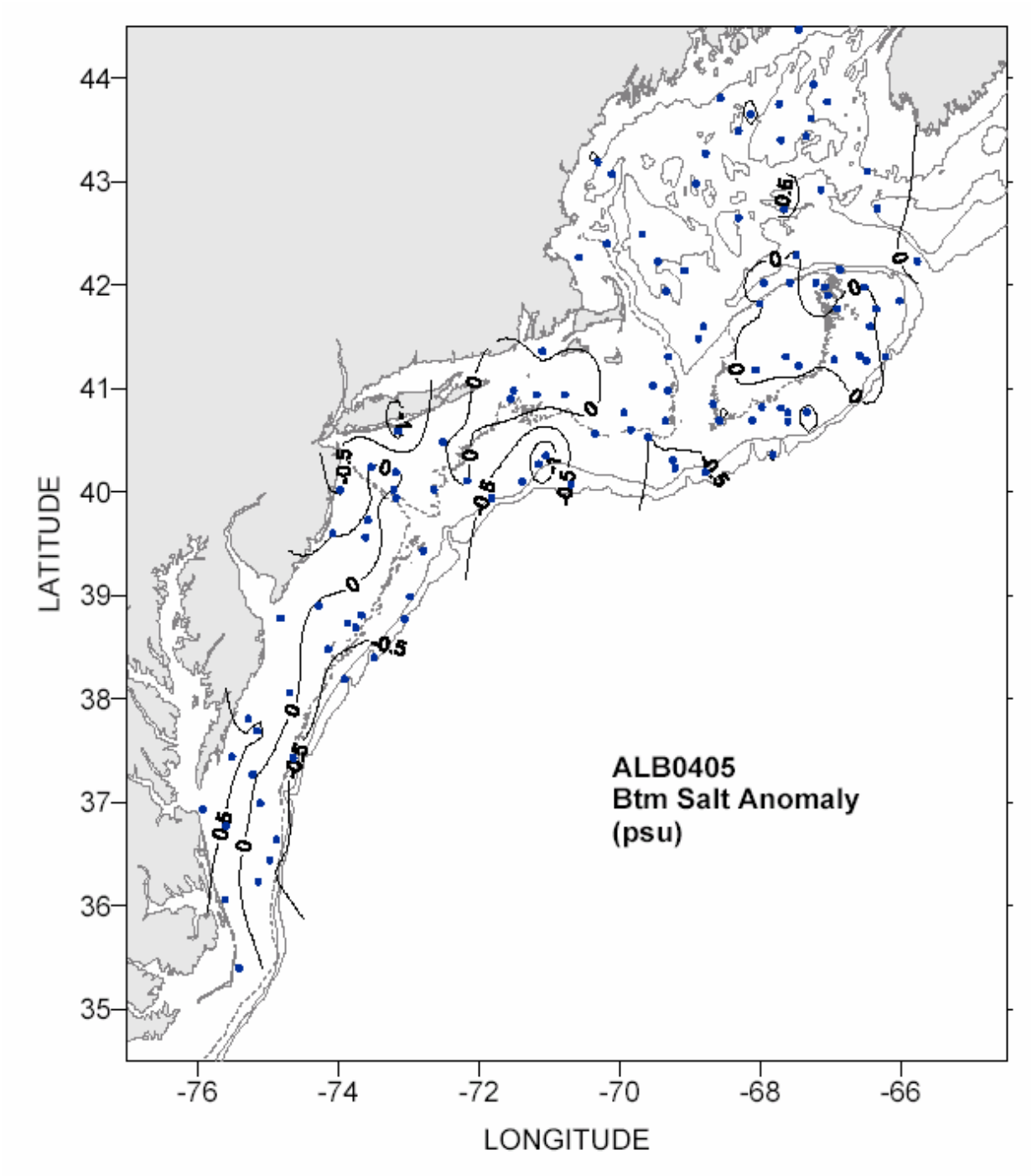


Figure 28. Bottom salinity anomaly distributions for the ECOMON cruise - ALB0405.

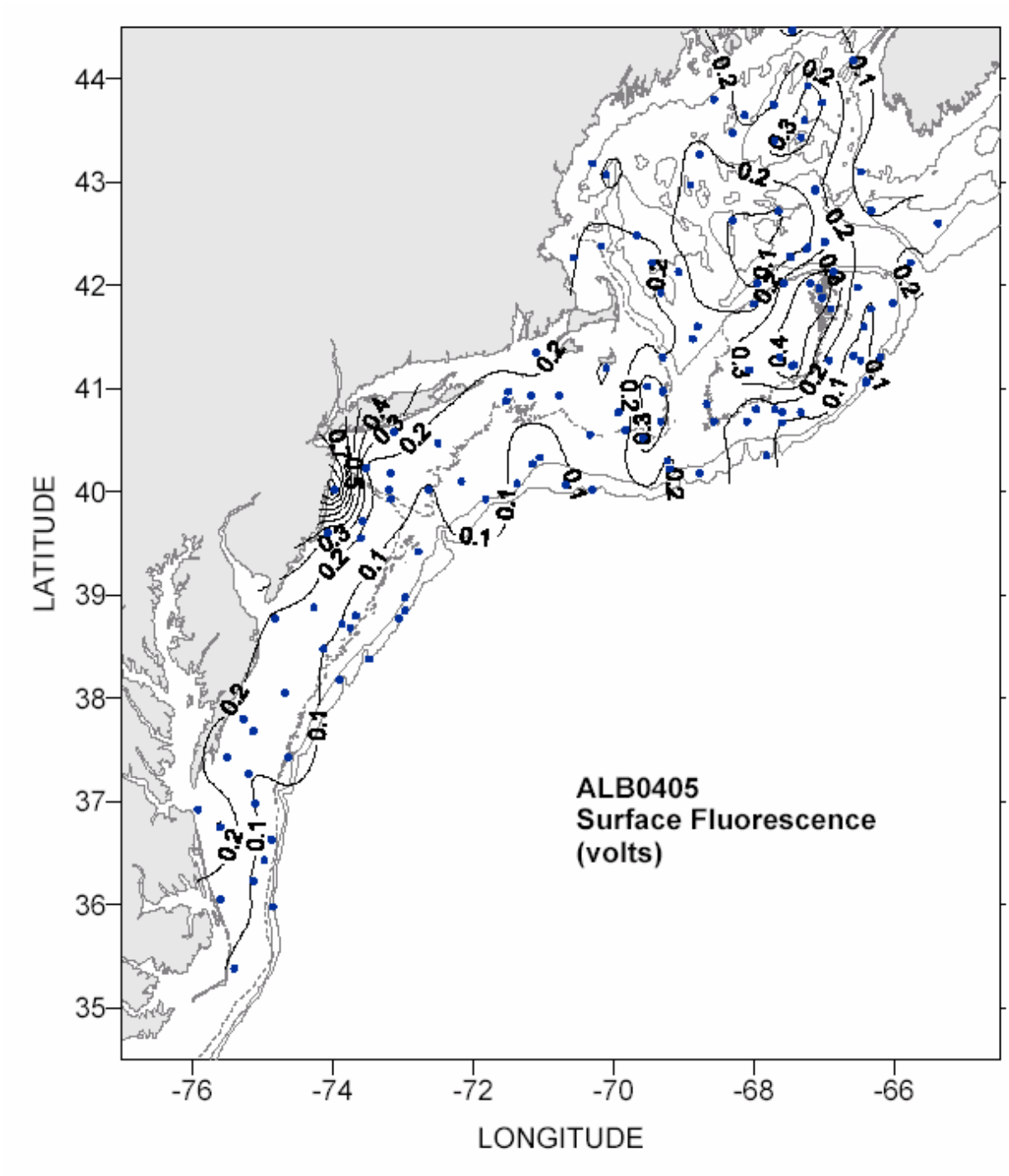


Figure 29. Surface fluorescence distributions for the ECOMON cruise - ALB0405.

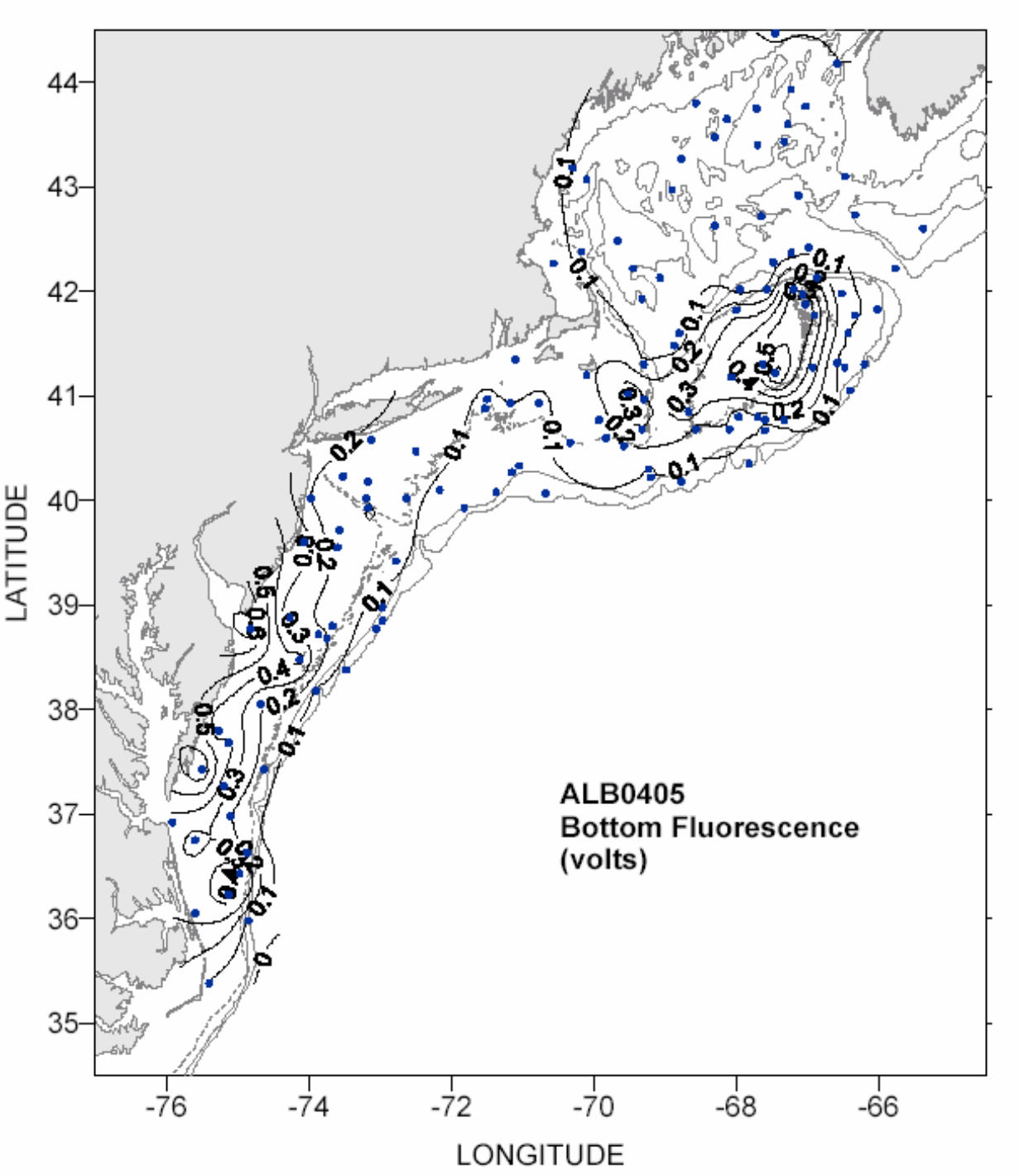


Figure 30. Bottom fluorescence distributions for the ECOMON cruise -ALB0405.

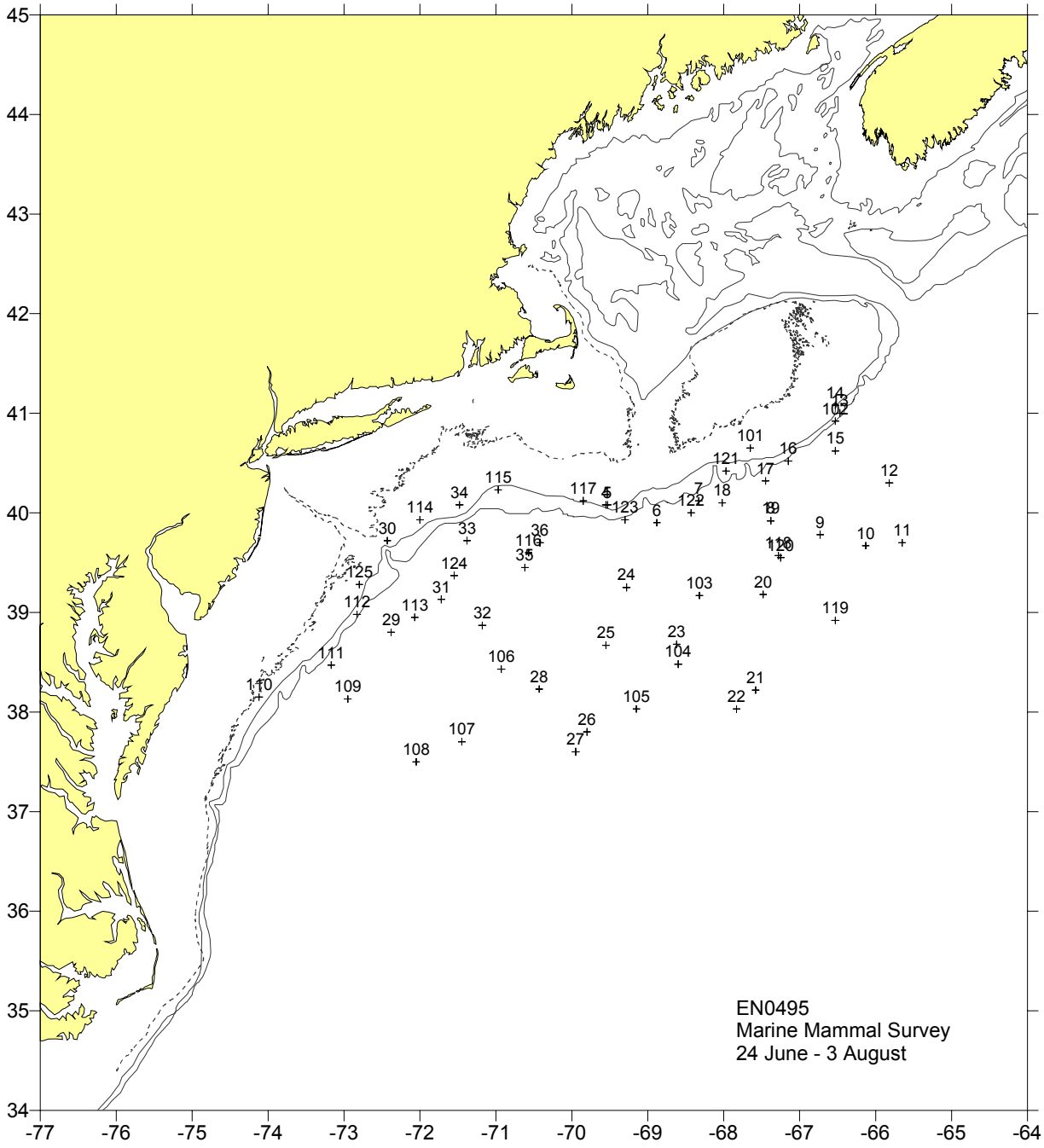


Figure 31. Hydrographic stations occupied during the Marine Mammal Survey - END0495.

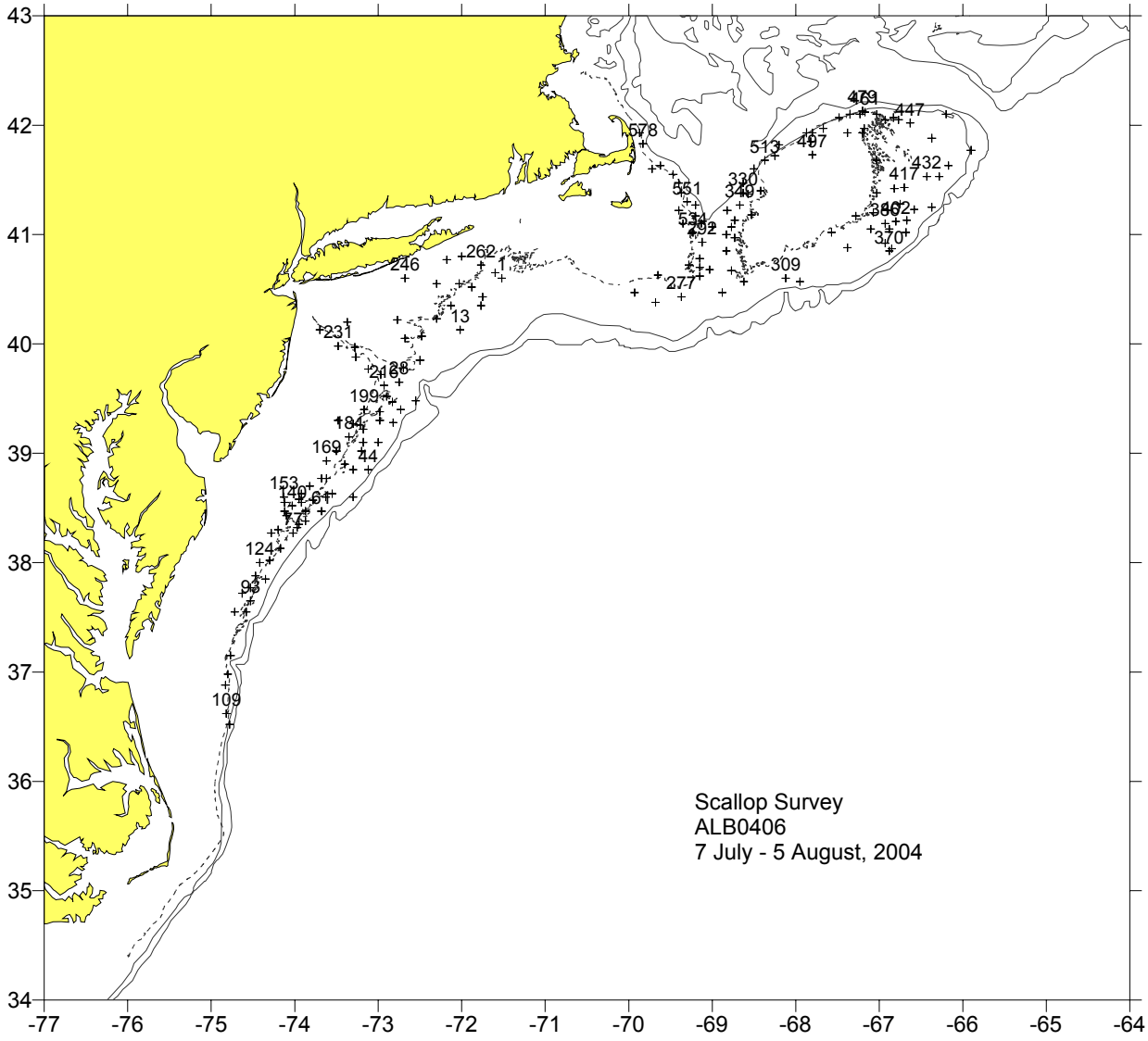


Figure 32. Hydrographic stations occupied during the Scallop Survey – ALB0406.

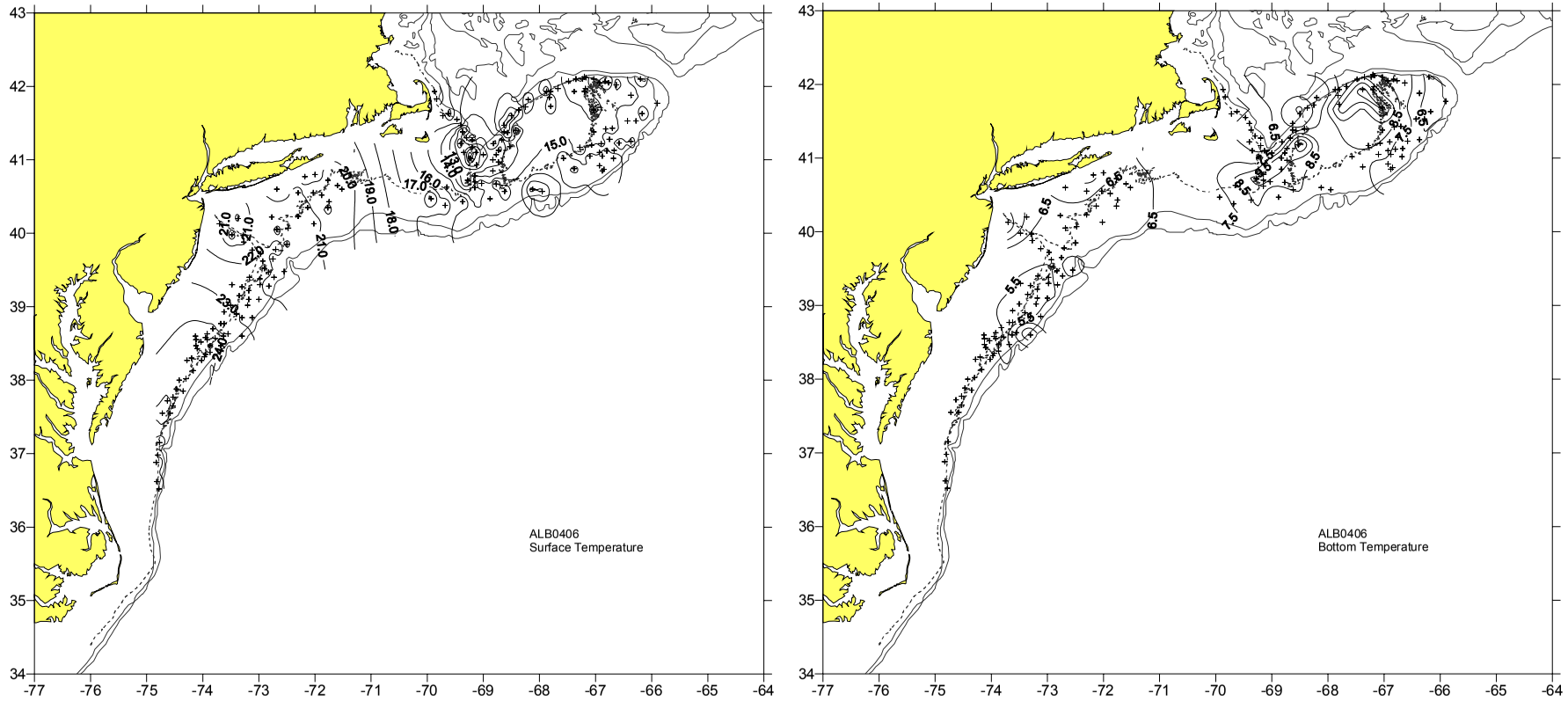


Figure 33. Surface and bottom temperature distributions for the Scallop Survey – ALB0406.

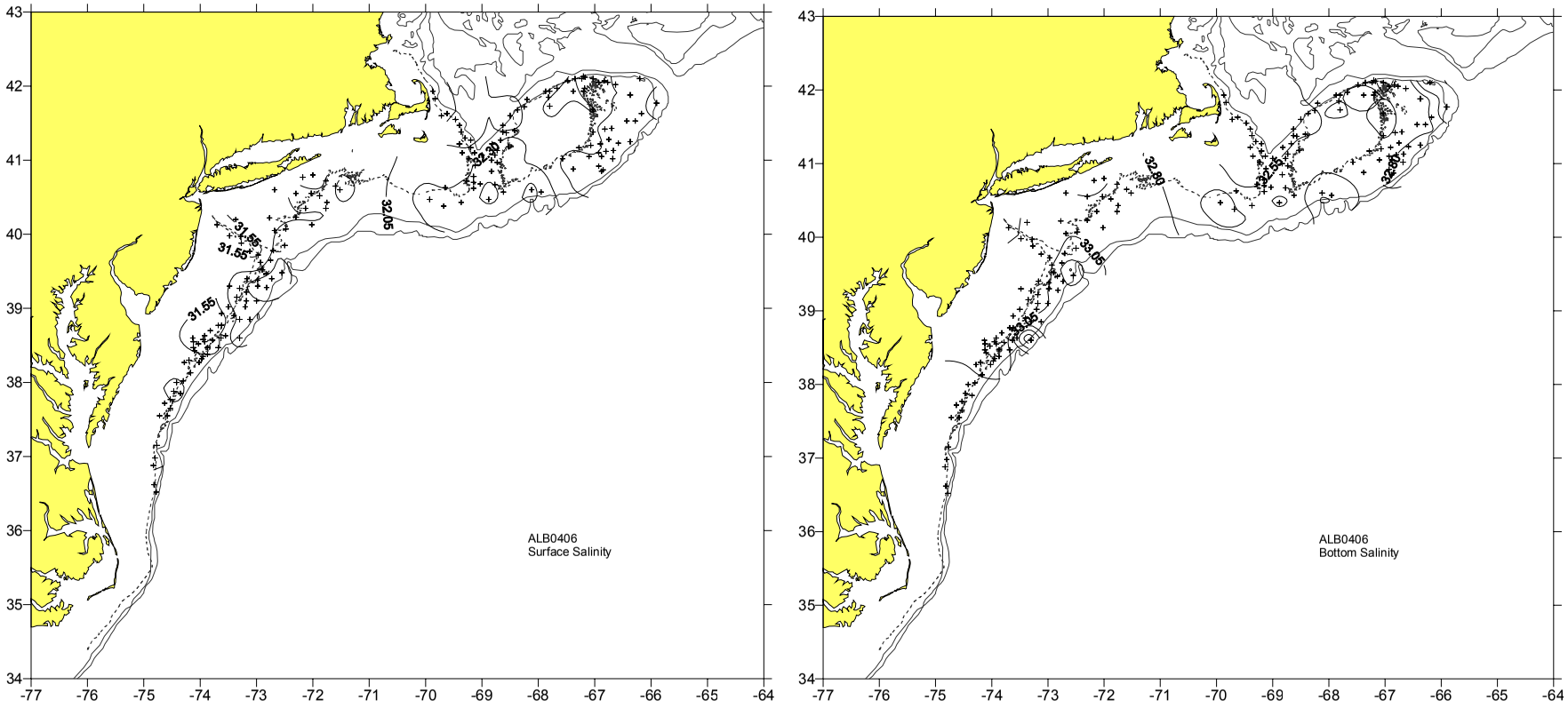


Figure 34. Surface and bottom salinity distributions for the Scallop Survey – ALB0406.

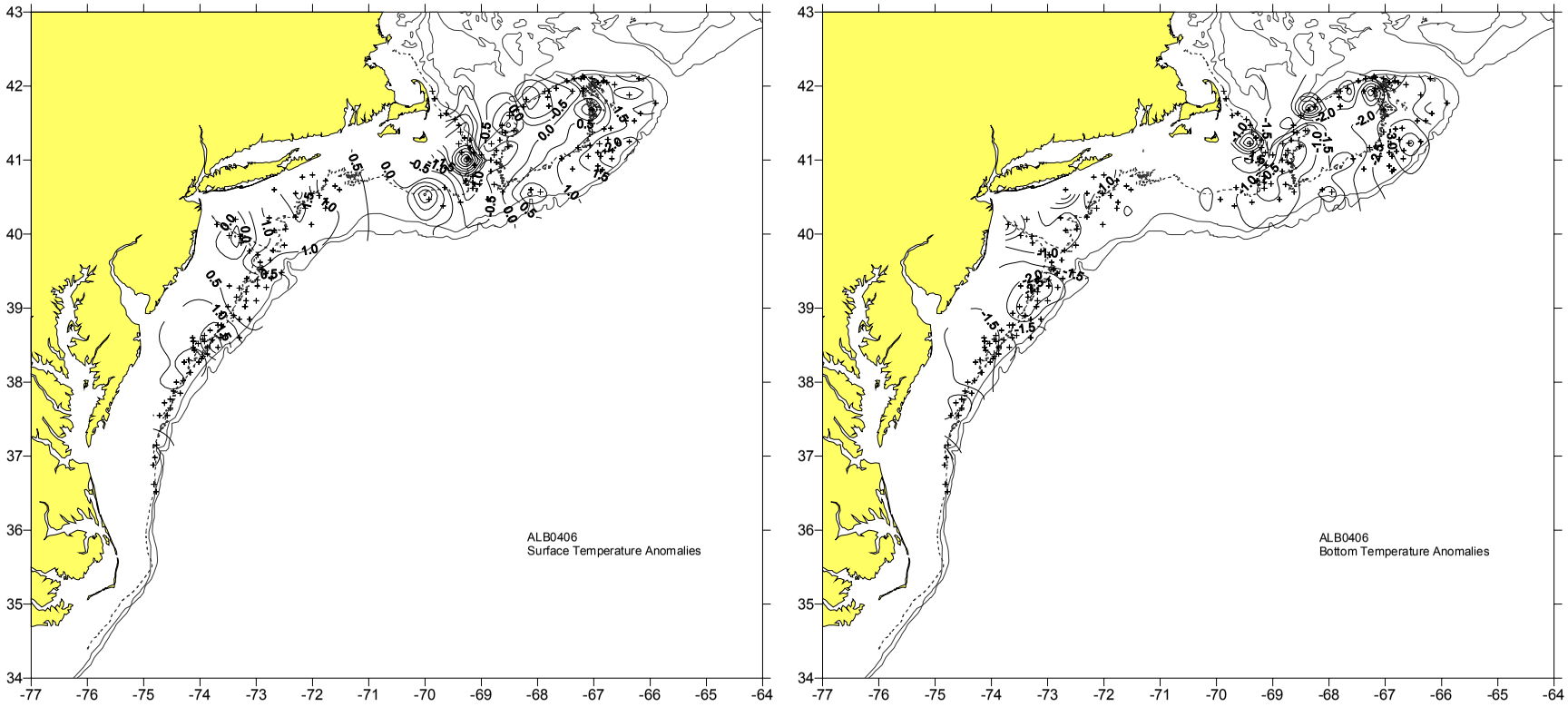


Figure 35. Surface and bottom temperature anomaly distributions for the Scallop Survey – ALB0406.

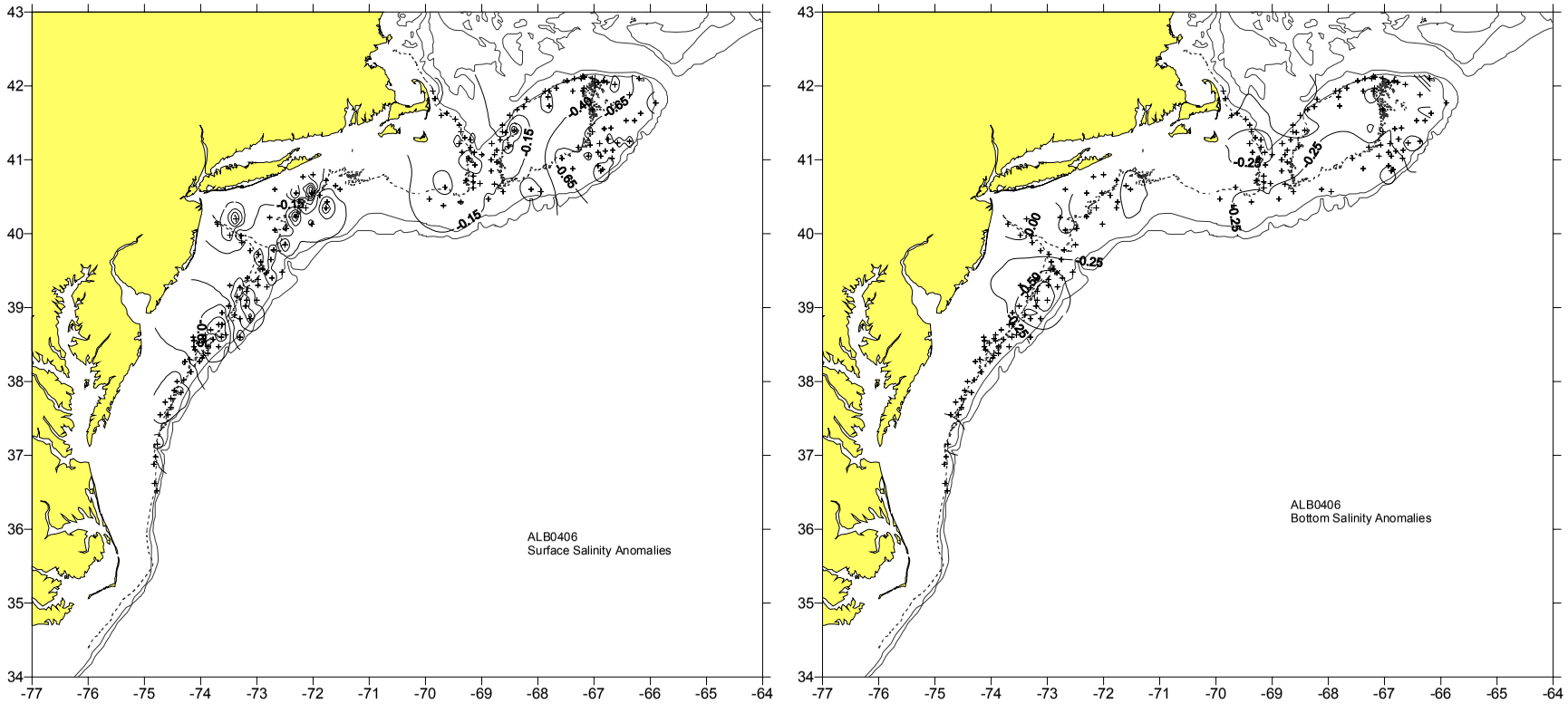


Figure 36. Surface and bottom salinity anomalies for the Scallop Survey – ALB0406.

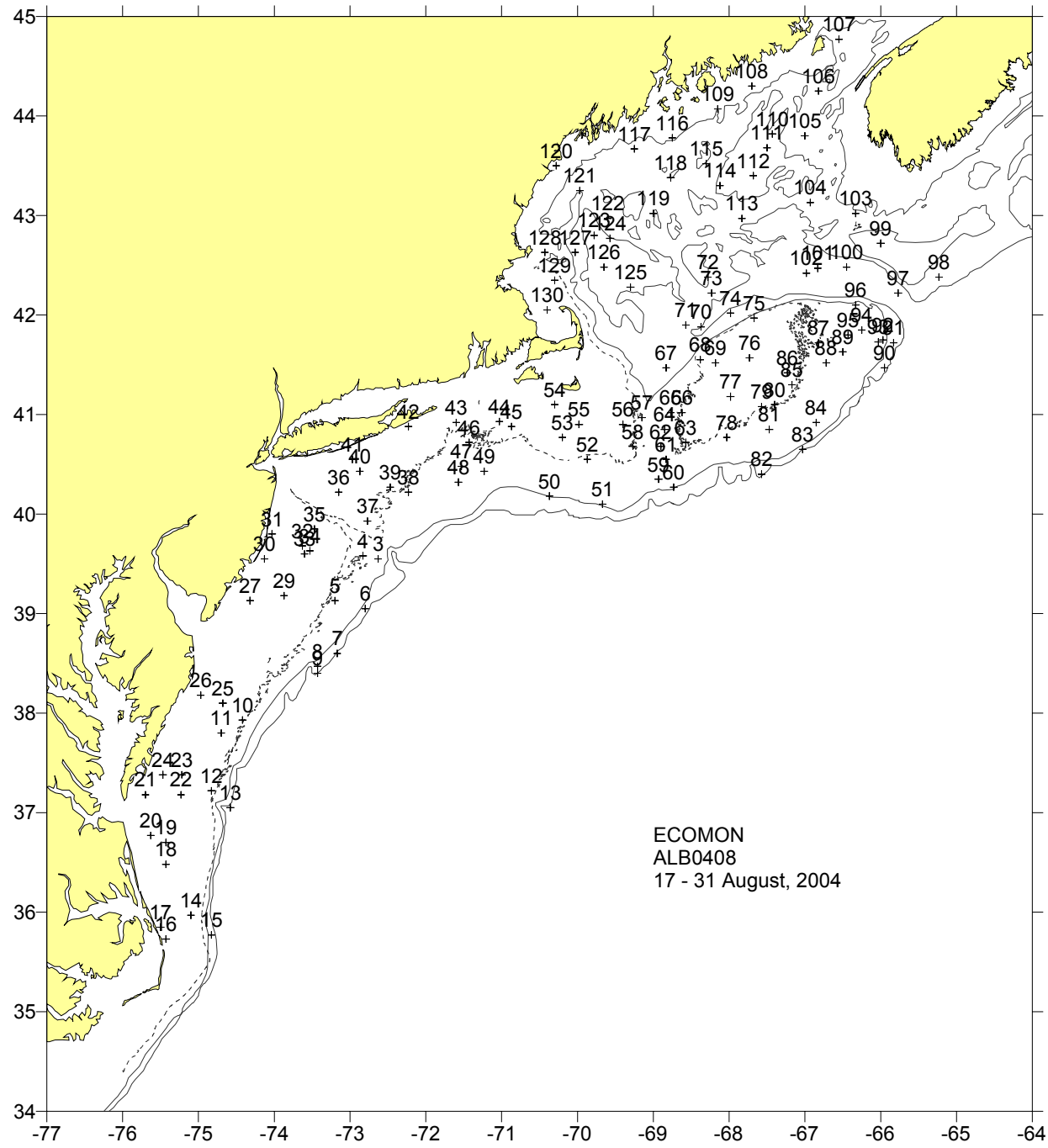


Figure 37. Hydrographic stations occupied during the ECOMON survey -ALB0408.

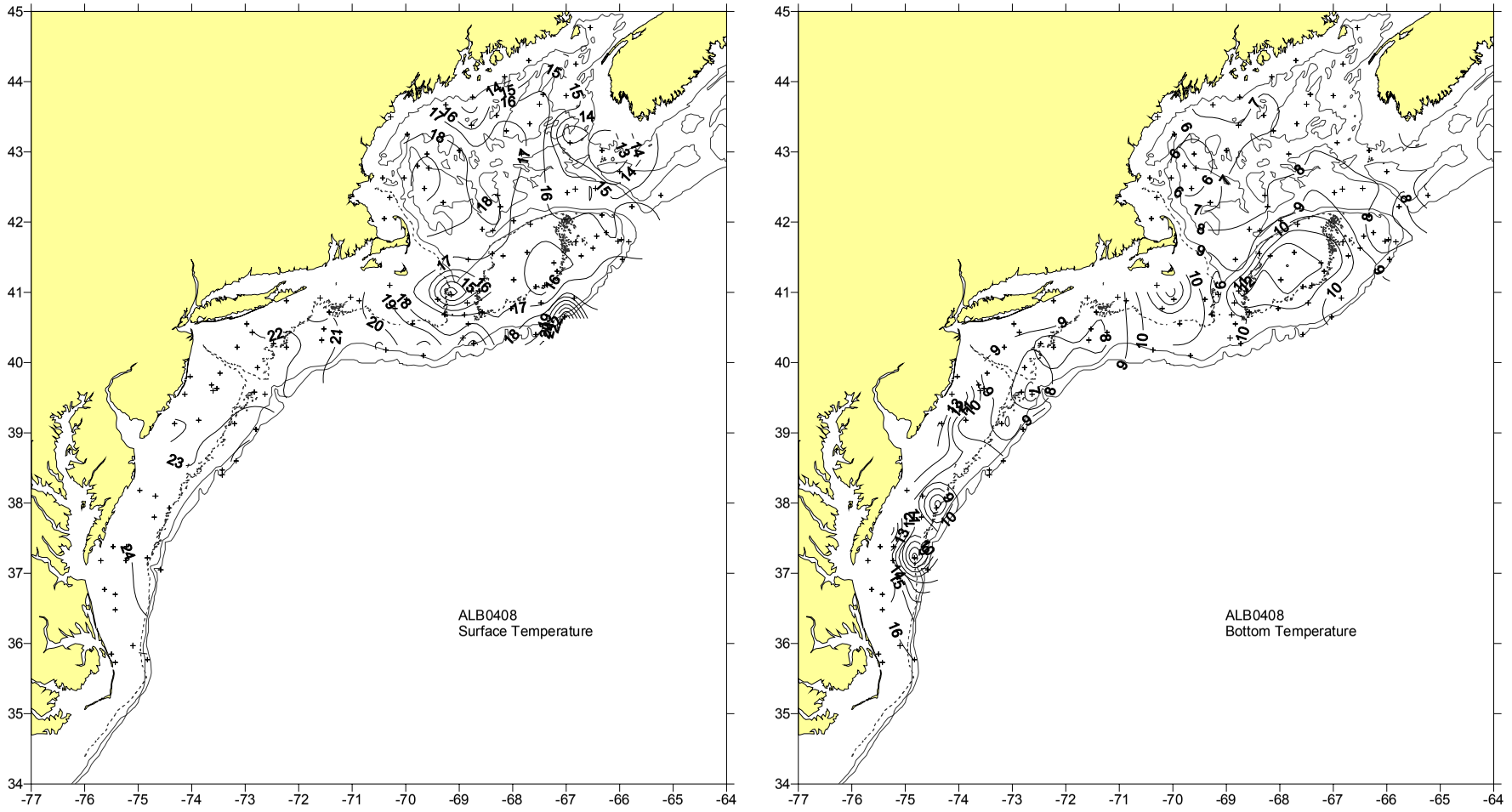


Figure 38. Surface and bottom temperature distributions during the ECOMN survey – ALB0408.

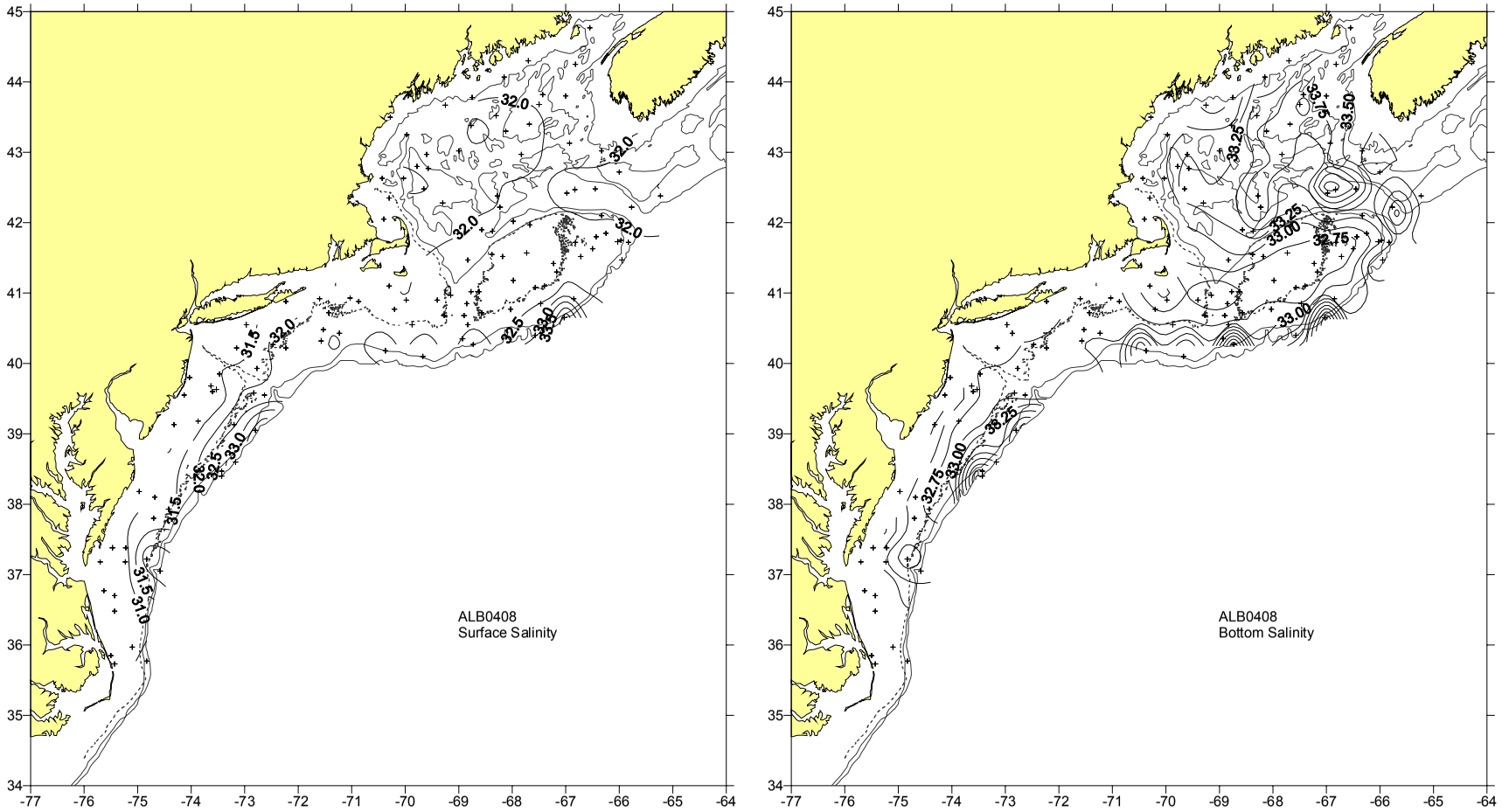


Figure 39. Surface and bottom salinity distributions during the ECOMON survey – ALB0408.

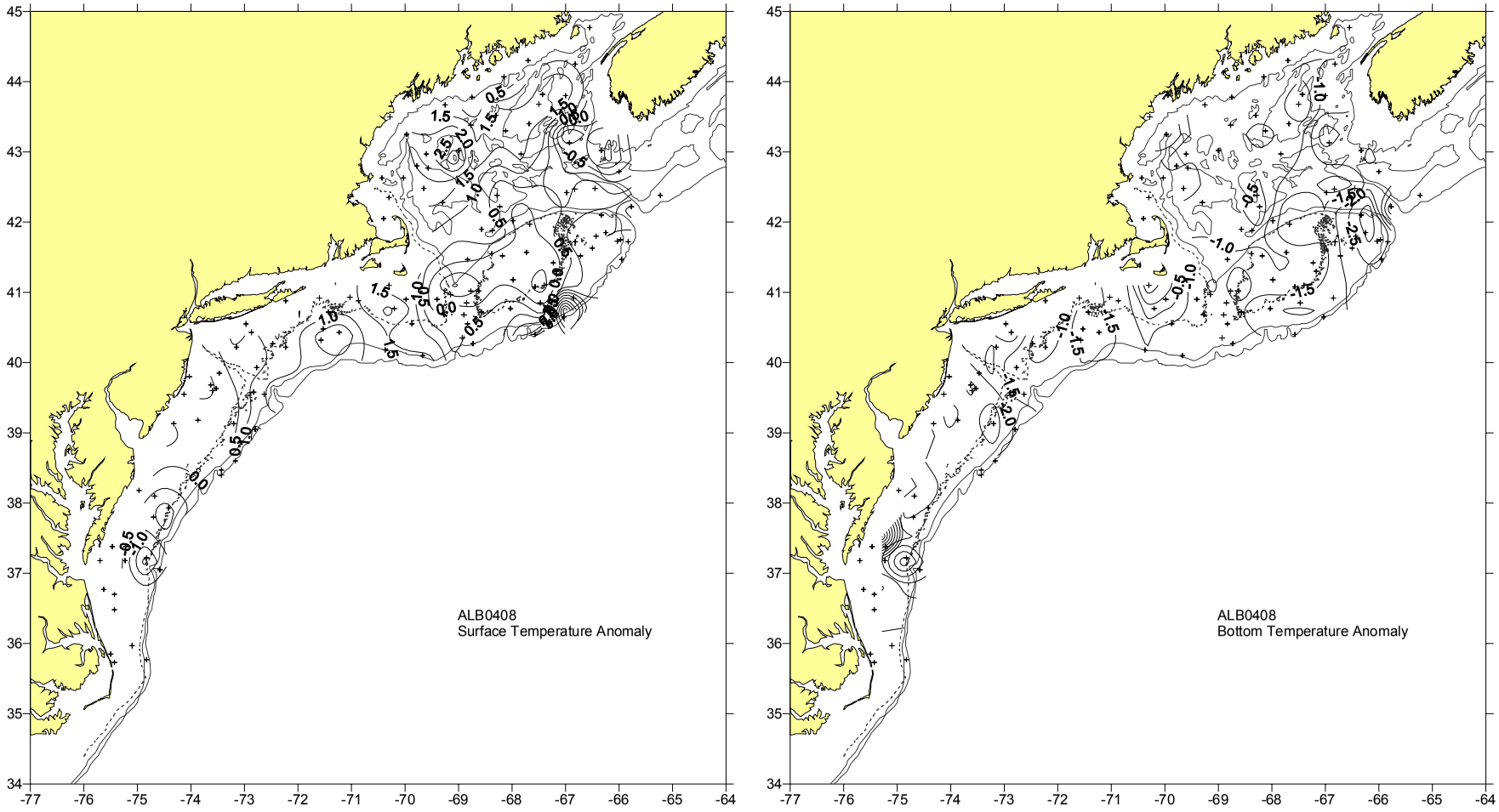


Figure 40. Surface and bottom temperature anomaly distributions during the ECOMON survey – ALB0408.

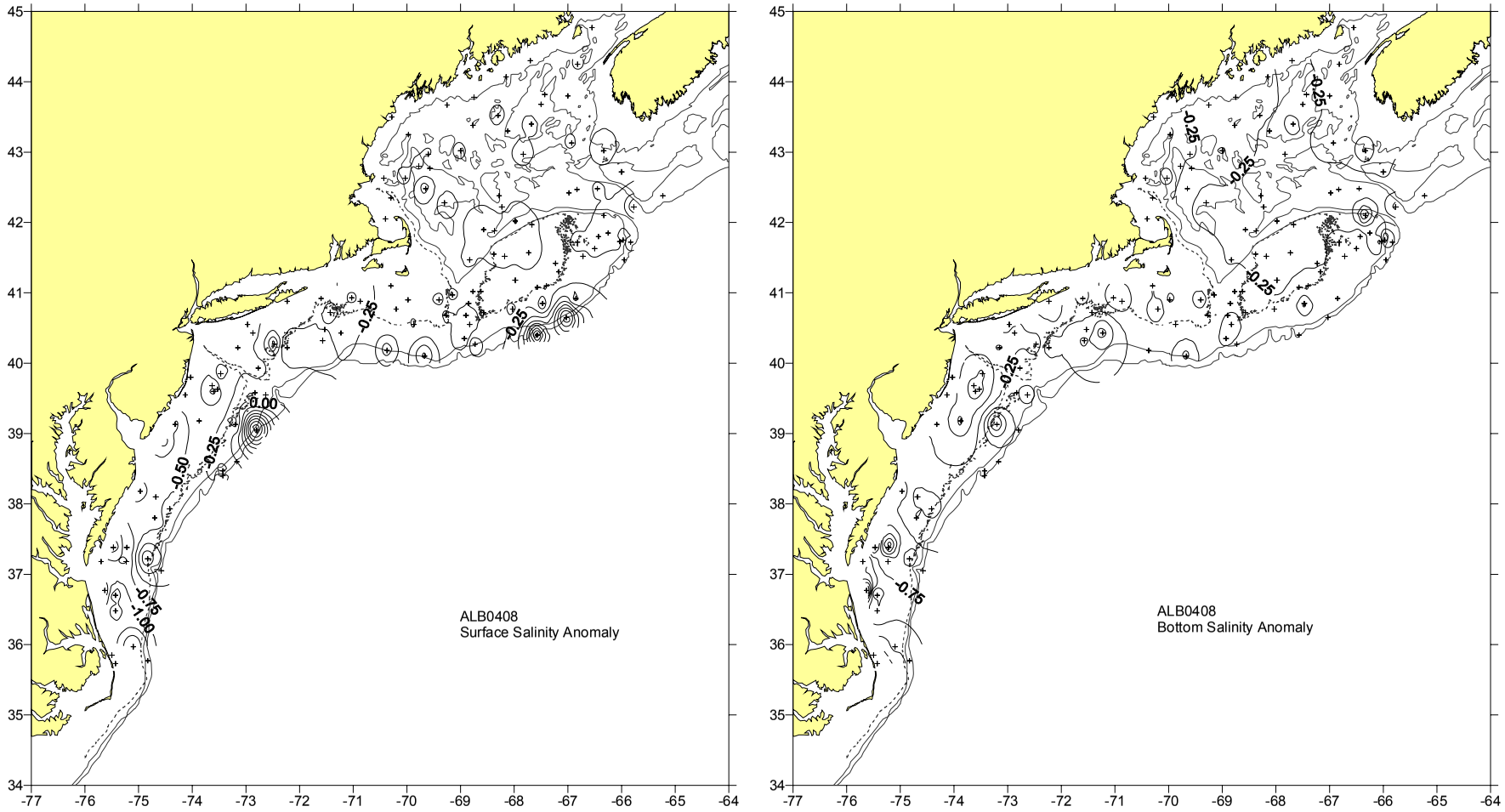


Figure 41. Surface and bottom salinity anomaly distributions during the ECOMON survey – ALB0408.

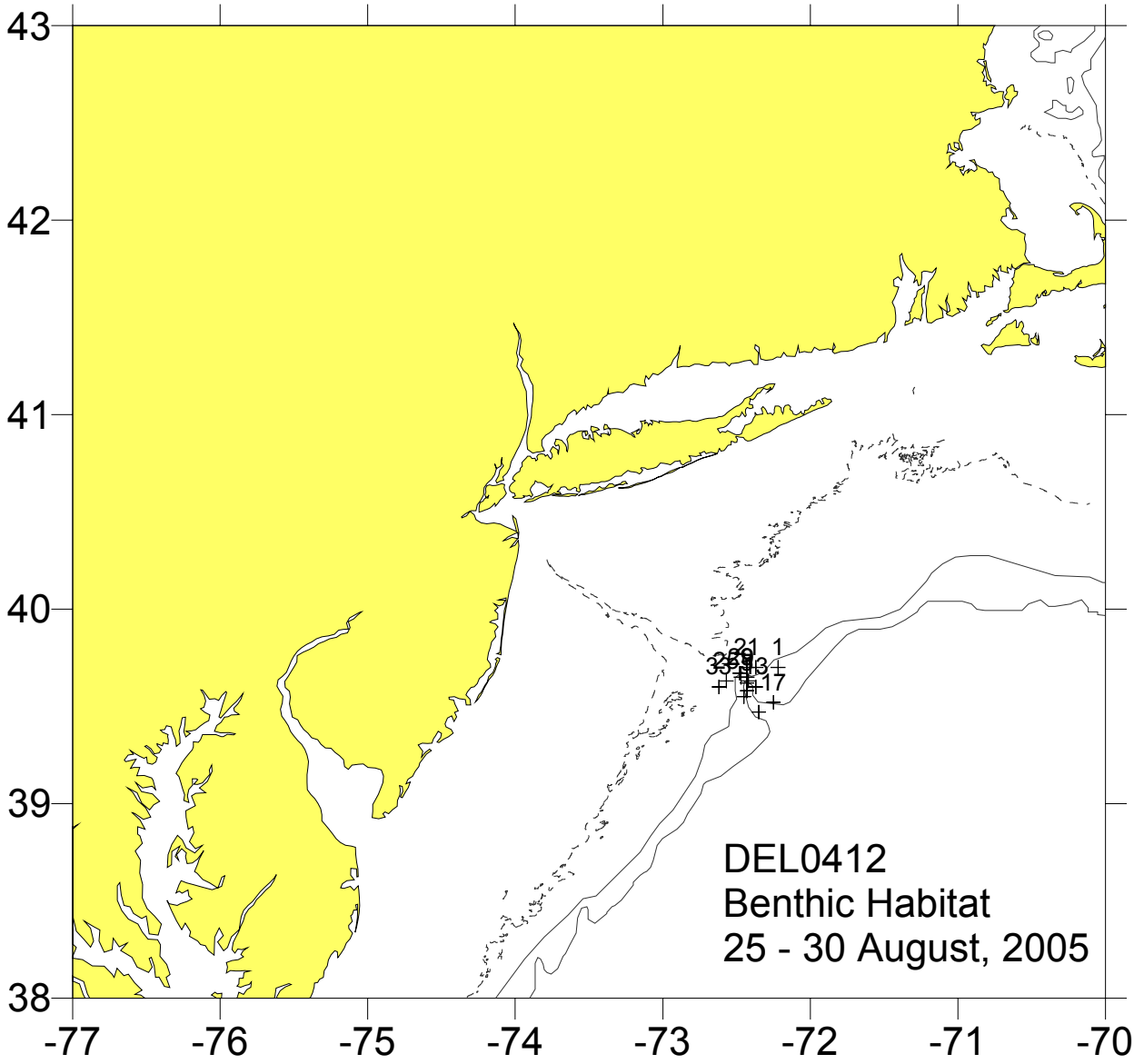


Figure 42. Hydrographic stations occupied during the Benthic Habitat cruise – DEL0412.

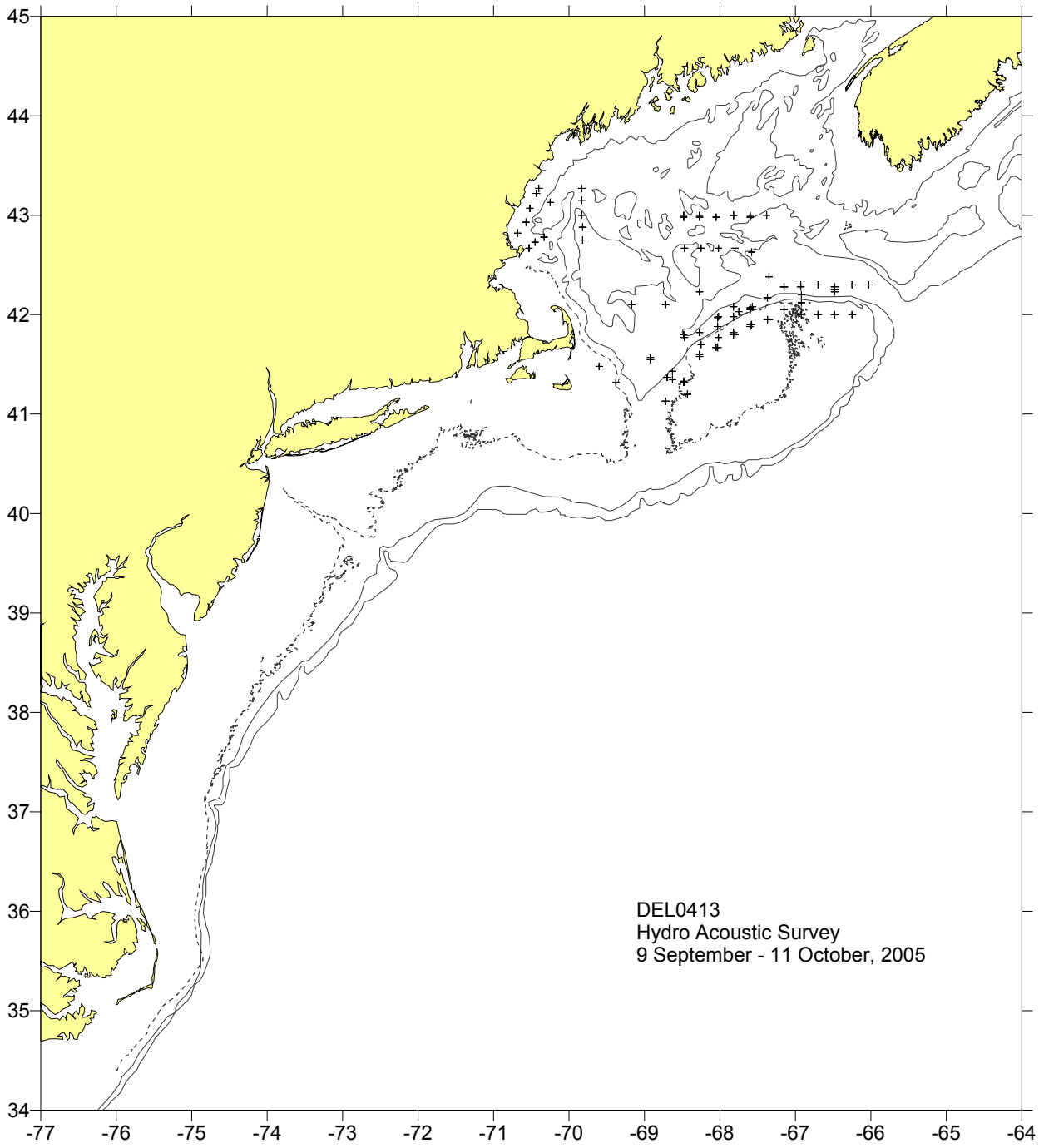


Figure 43. Hydrographic stations occupied during the Hydro Acoustic survey - DEL0413.

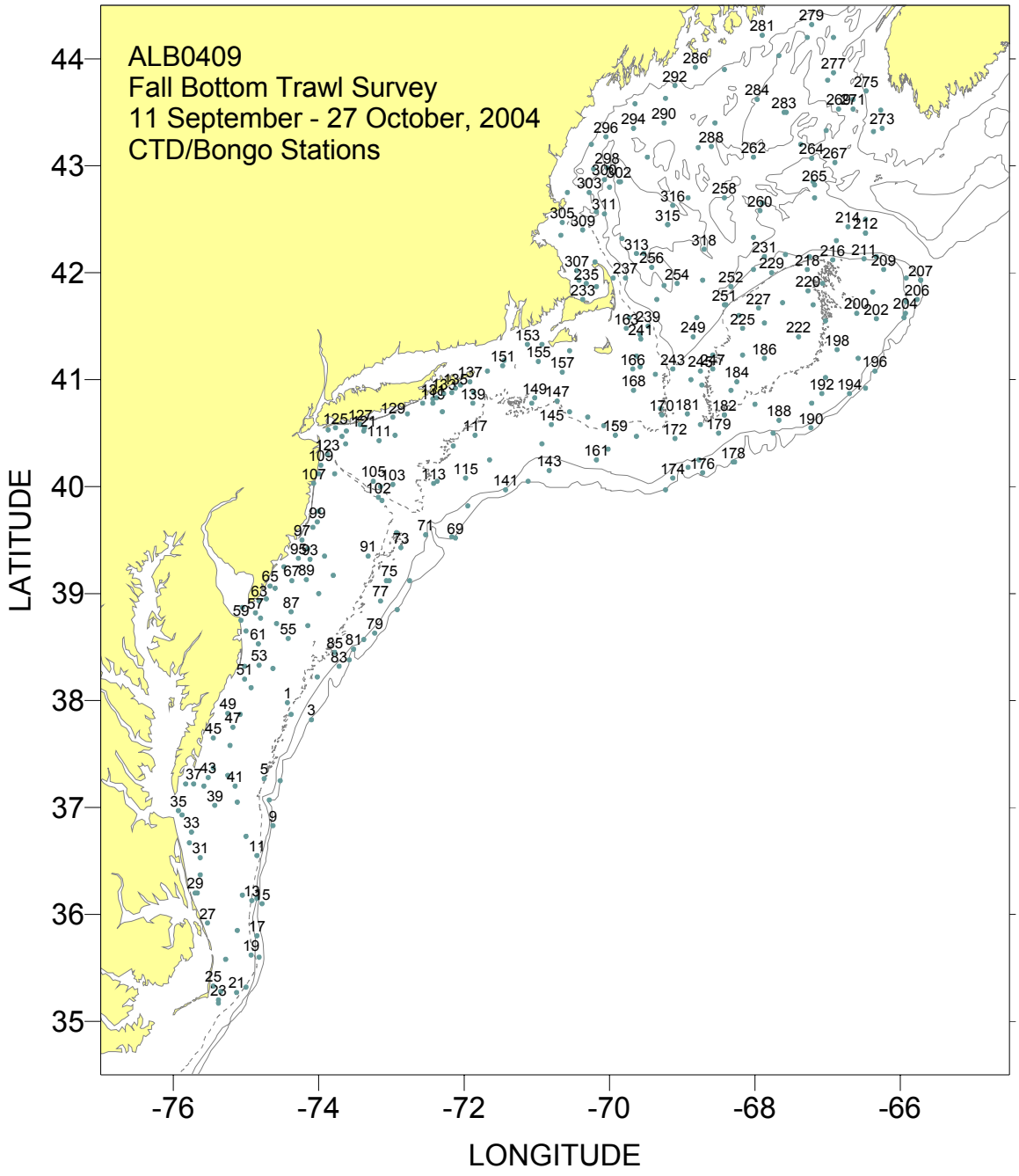


Figure 44. Hydrographic stations occupied during the Fall Bottom Trawl – ALB0409.

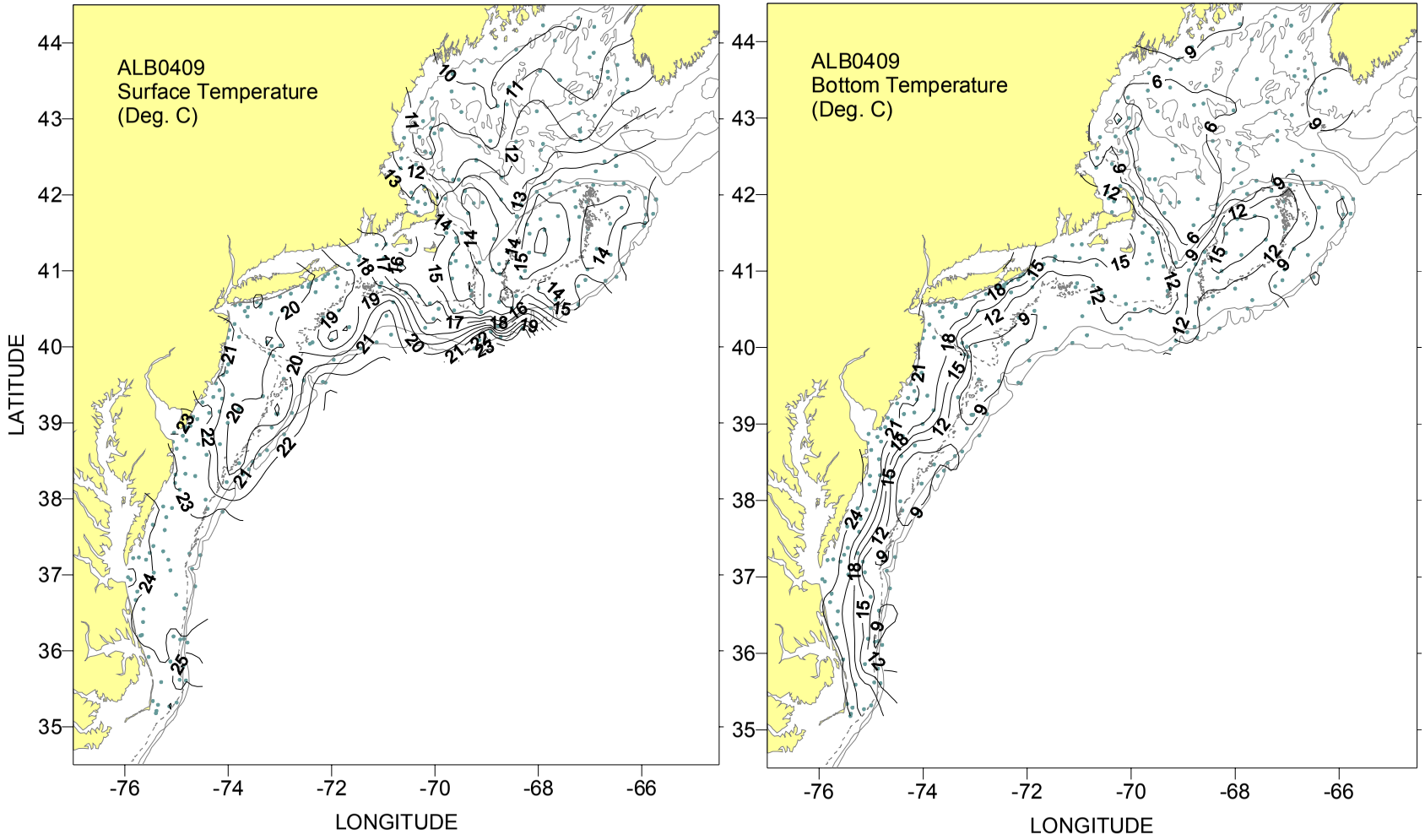


Figure 45. Surface and bottom temperature distributions during the Fall Bottom Trawl survey – ALB0409.

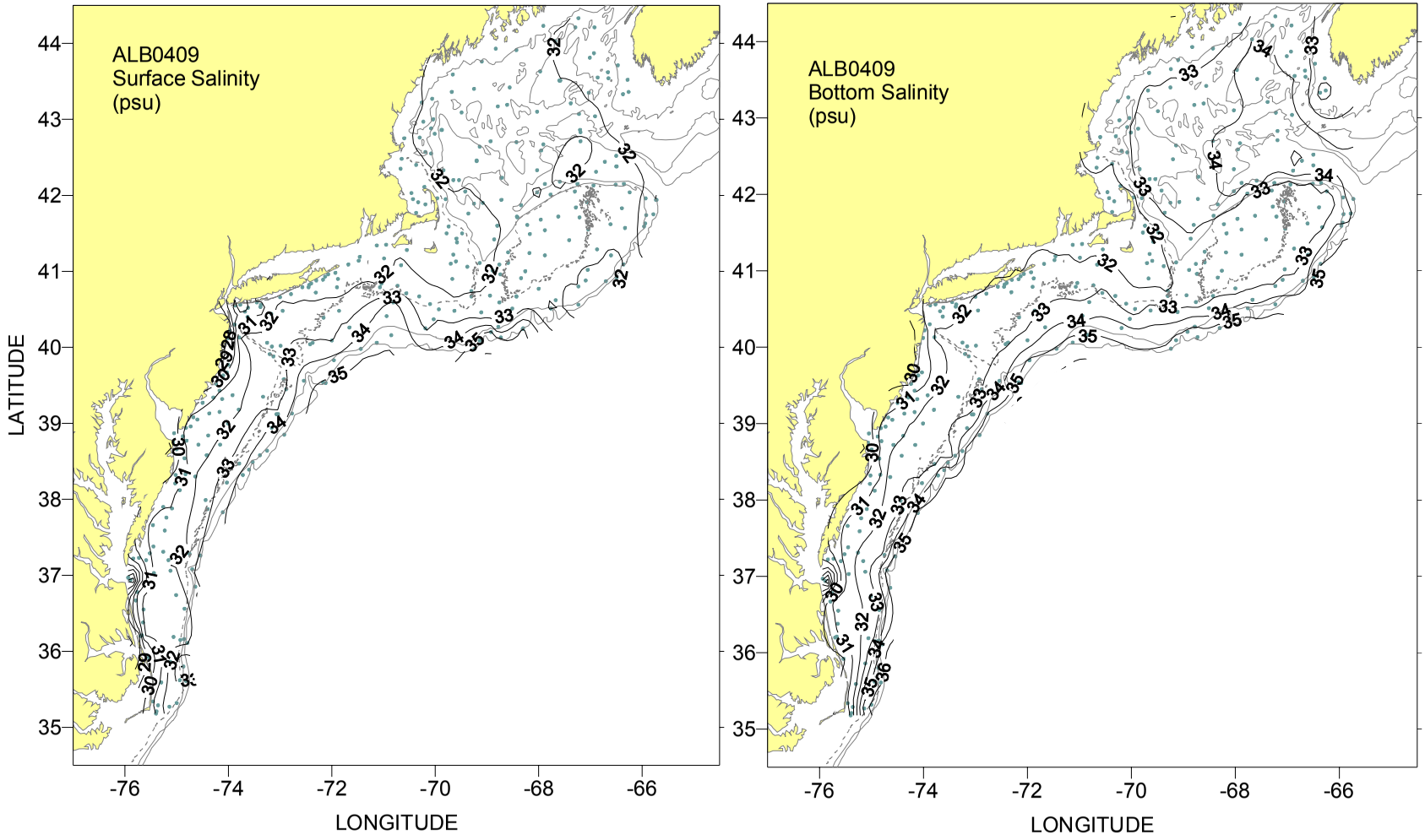


Figure 46. Surface and bottom salinity distributions during the Fall Bottom Trawl survey – ALB0409.

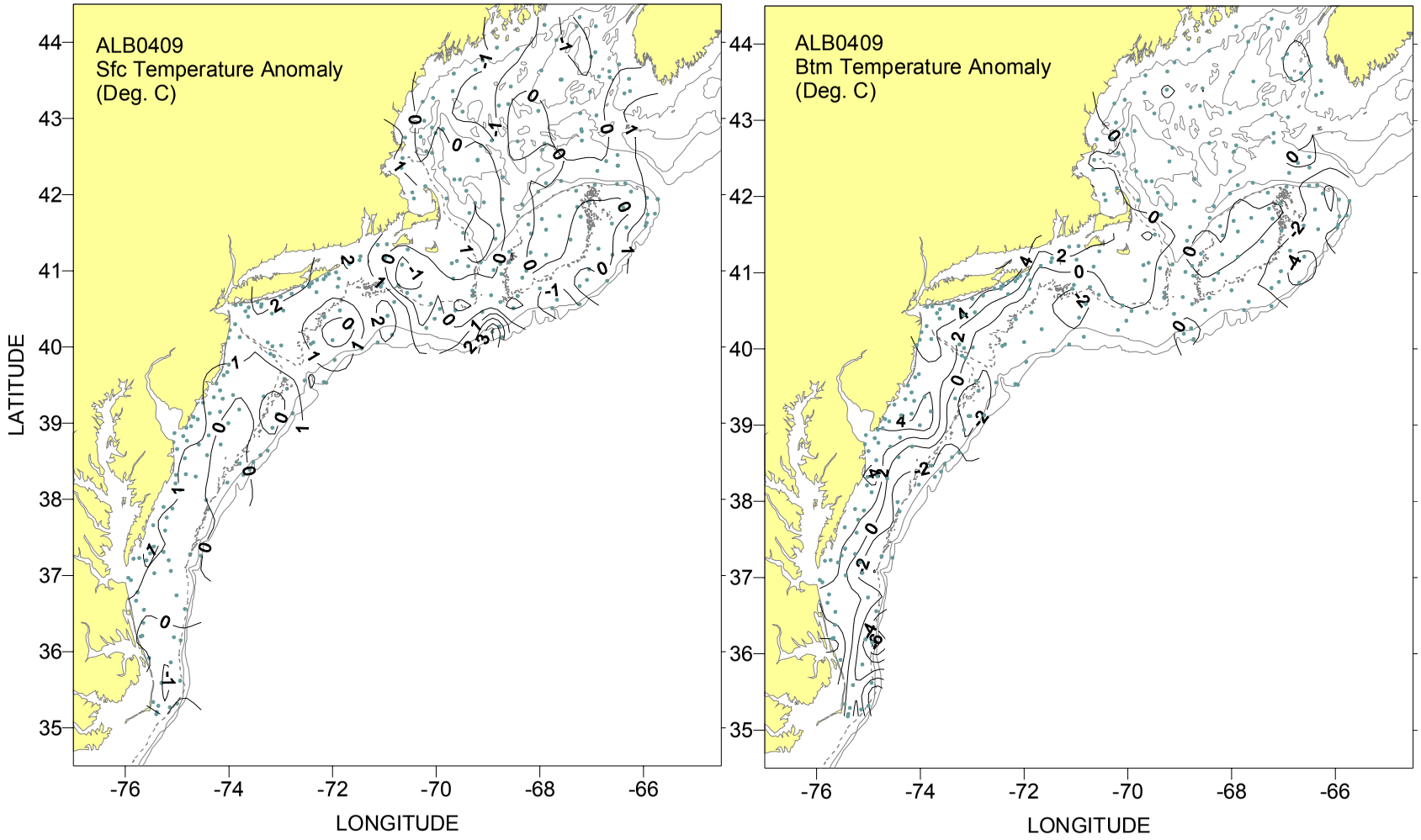


Figure 47. Surface and bottom temperature anomaly distributions during the Fall Bottom Trawl survey – ALB0409.

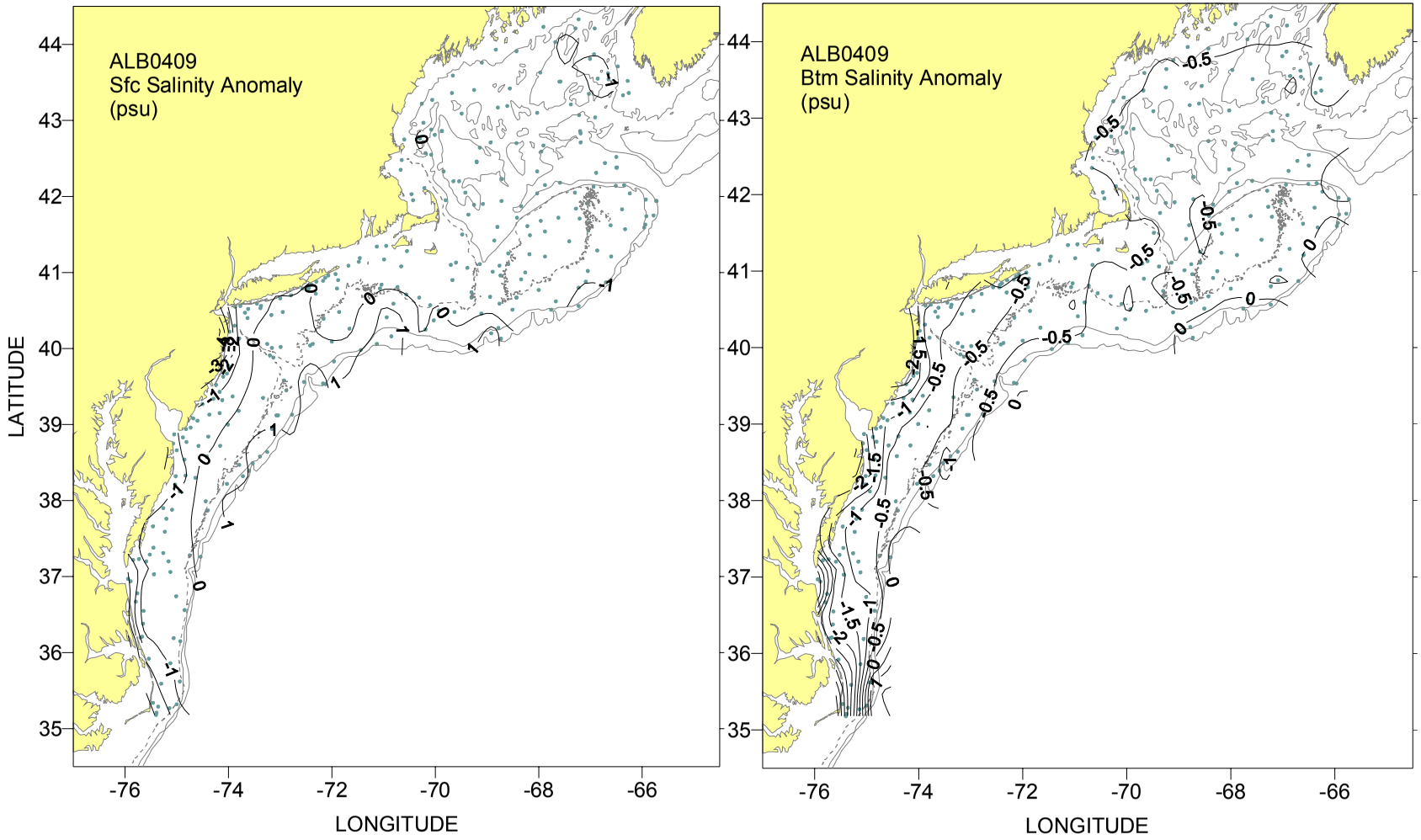


Figure 48. Surface and bottom salinity anomaly distributions during the Fall Bottom Trawl survey – ALB0409.

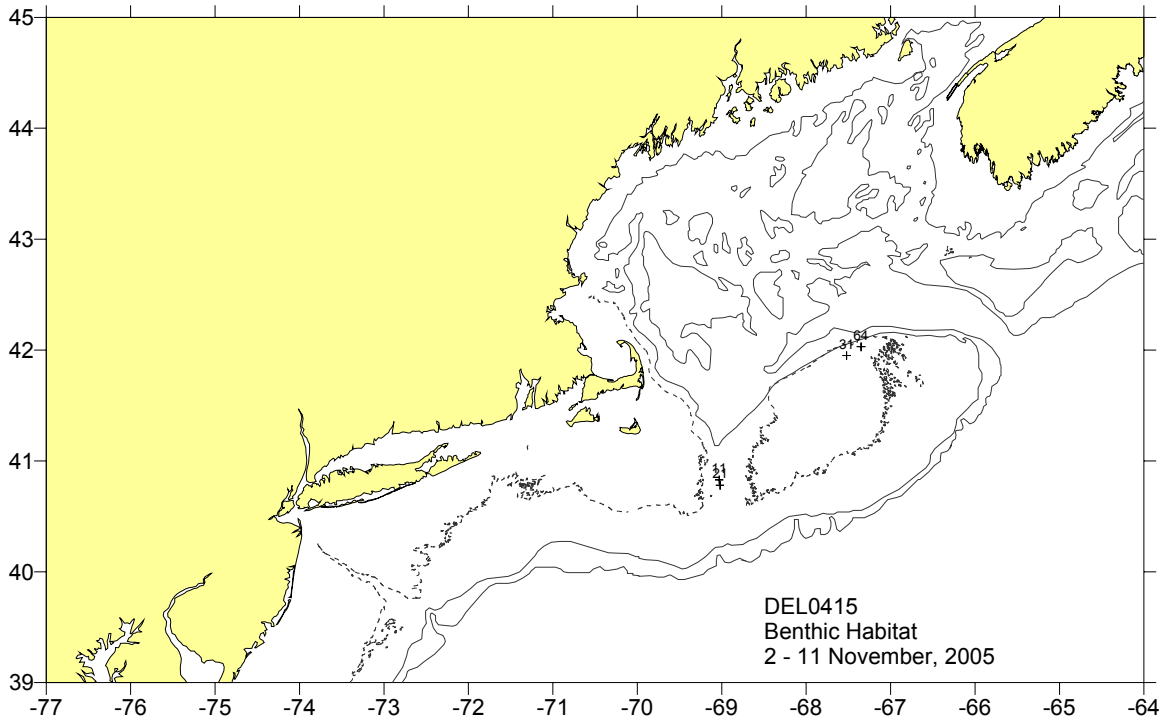


Figure 49. Hydrographic stations occupied during the Benthic Habitat cruise - DEL0415.

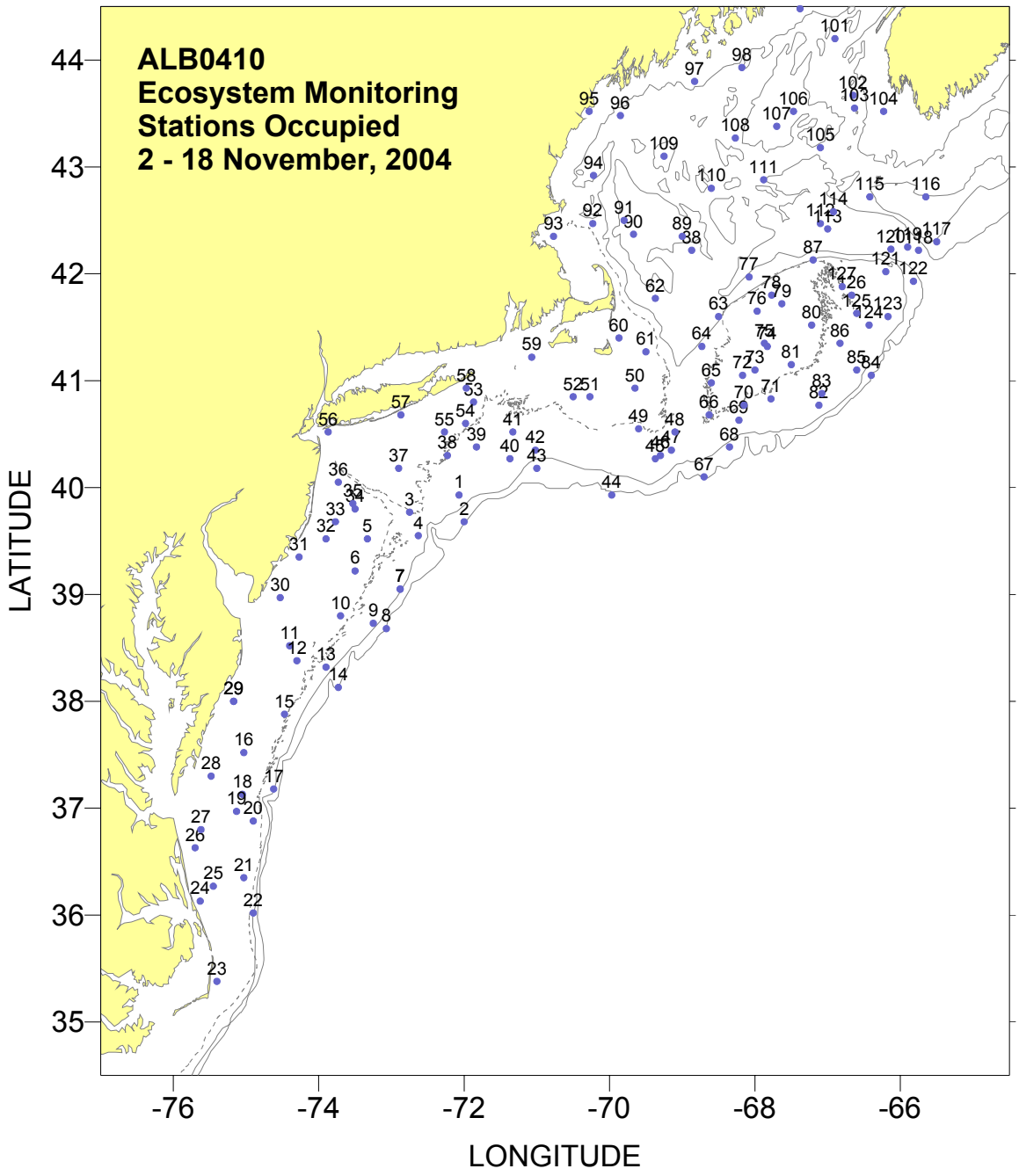


Figure 50. Hydrographic stations occupied during the ECOMON survey - ALB0410.

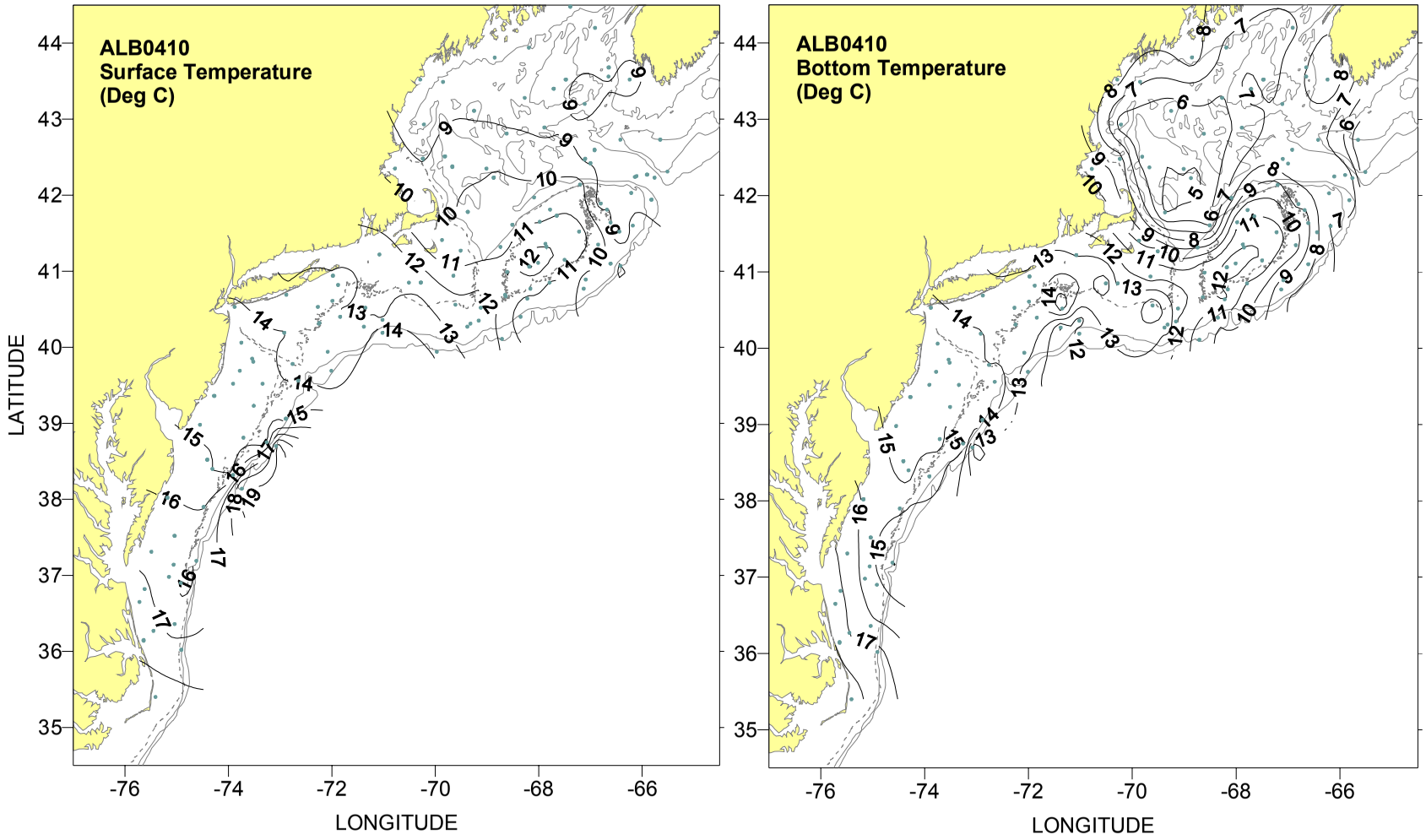


Figure 51. Surface and bottom temperature distributions during the ECOMON survey – ALB0410.

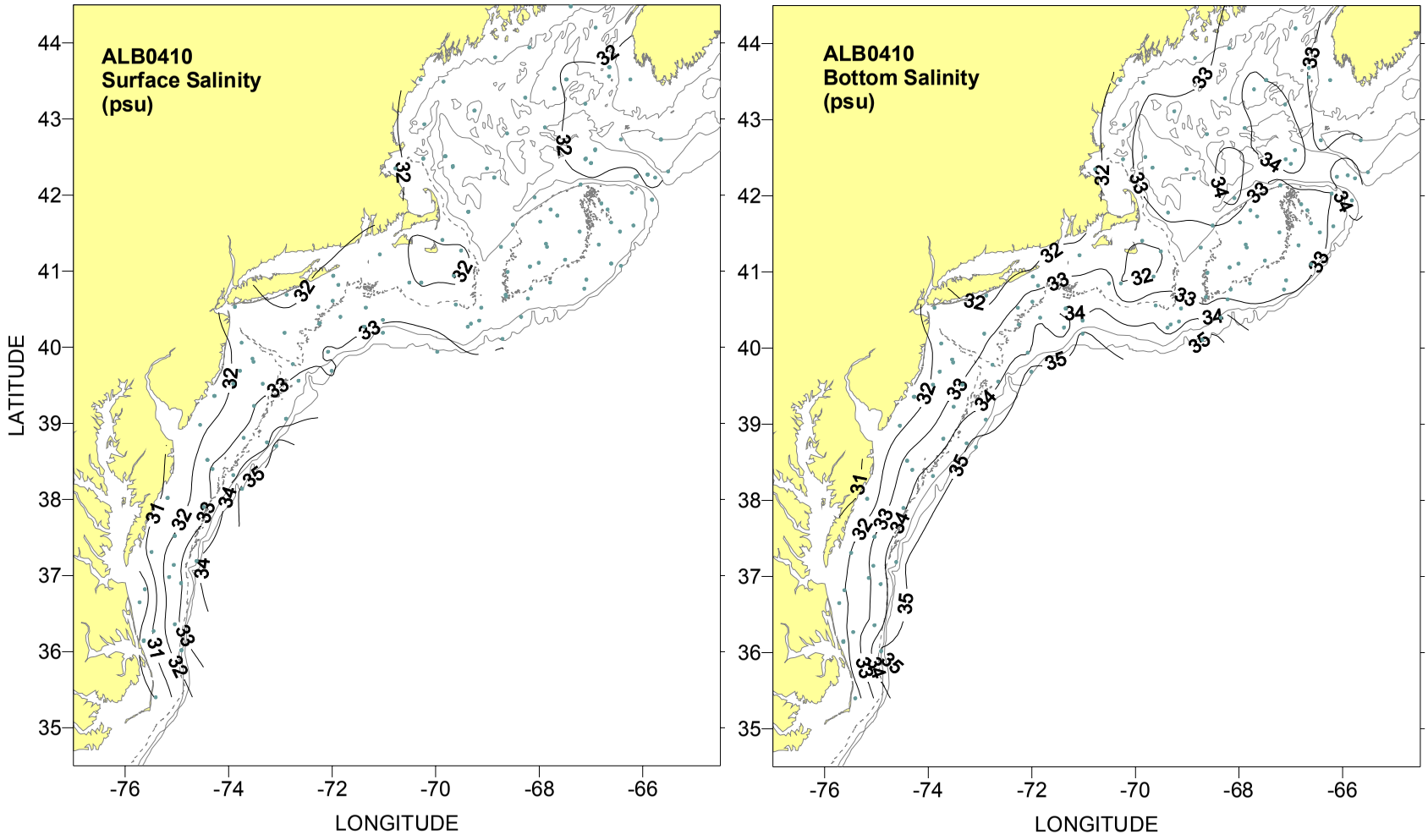


Figure 52. Surface and bottom salinity distributions during the ECOMON survey - ALB0410.

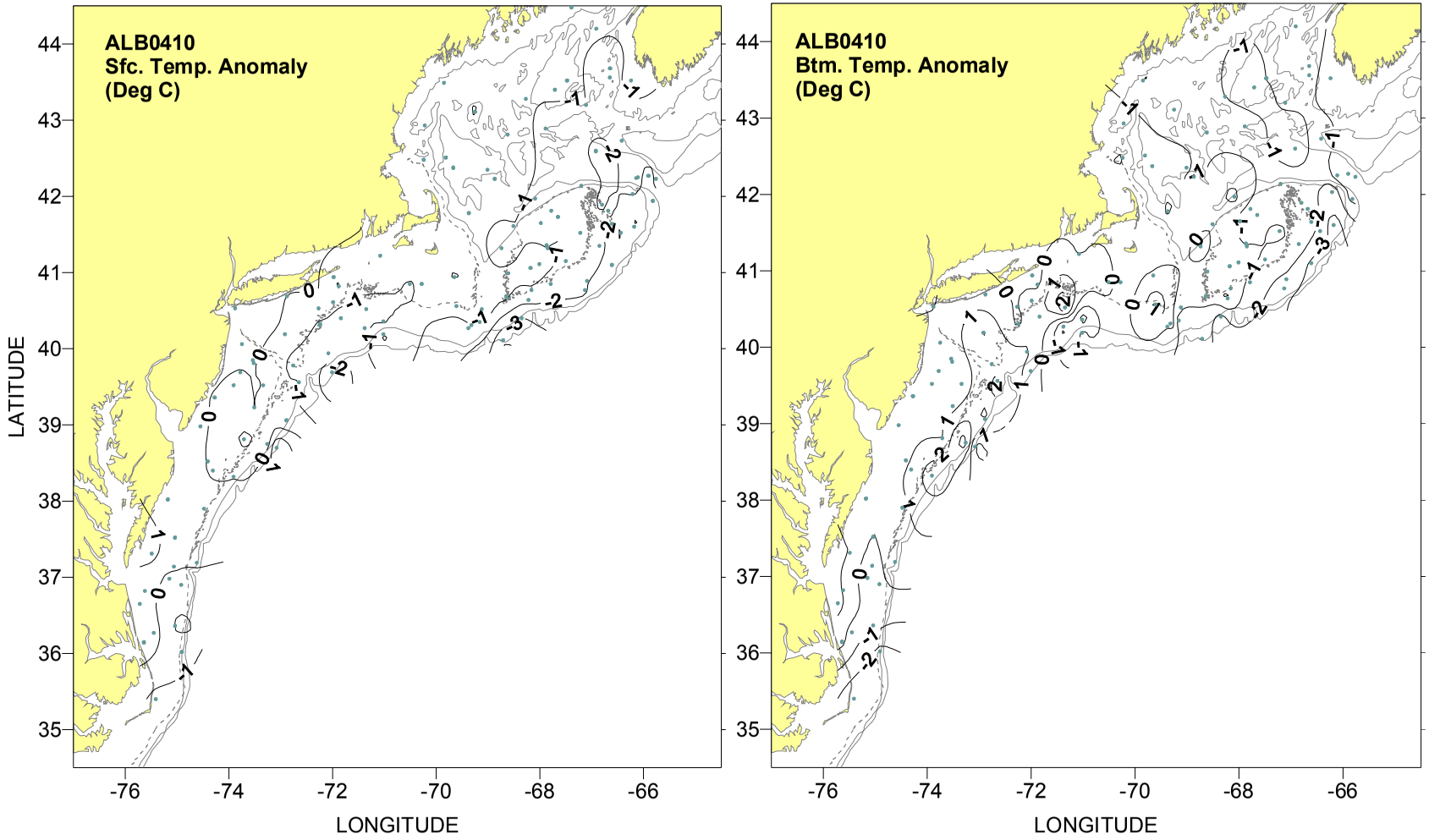


Figure 53. Surface and bottom temperature anomaly distributions during the ECOMN survey – ALB0410.

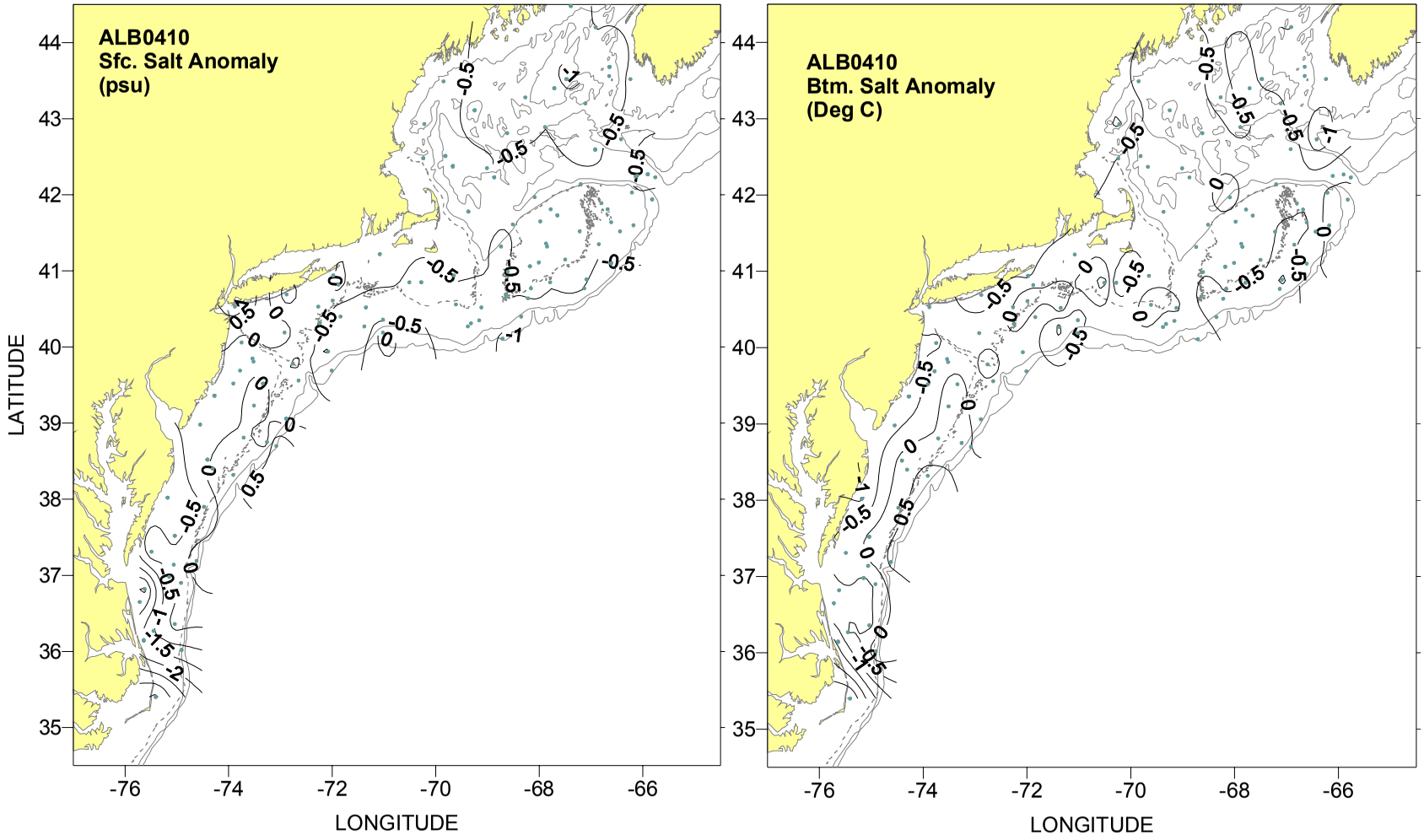


Figure 54. Surface and bottom salinity anomaly distributions during the ECOMON survey – ALB0410.

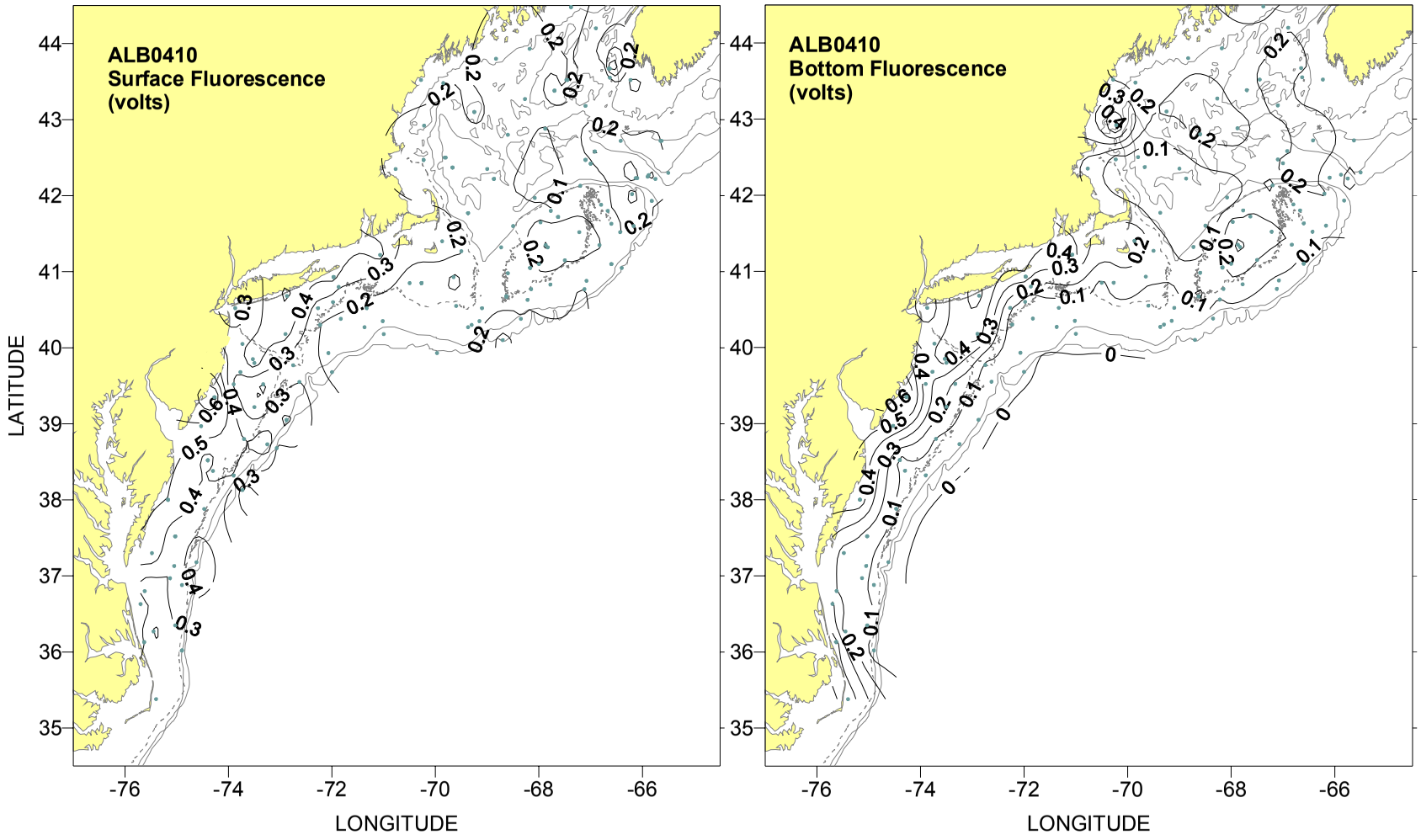


Figure 55. Surface and bottom fluorescence distributions during the ECOMON survey – ALB0410.

Appendix A. Summary of 2004 cruise operations.

Ecosystems Monitoring Survey

Cruise:	ALB0401
Vessel:	R/V Albatross IV
Dates:	25 – 27 January
Sea Days:	3
Instrument(s):	2879
Total # of stations:	7
# of vertical CTD/Profiler casts:	0
# of double oblique Profiler casts:	8
# Salinity samples:	2
Salt correction:	N\A

Cruise Objectives: To assess the impact of changing biological and physical properties of the Northeast Continental Shelf ecosystem which influence the sustainable productivity of the living marine resources.

Whale and Dolphin Survey

Cruise:	DEL0404
Vessel:	R/V Delaware II
Dates:	2 – 9 March
Sea Days:	8
Instrument(s):	2277
Total # of stations:	16
# of vertical CTD/Profiler casts:	13
# of double oblique Profiler casts:	3
# Salinity samples:	0
Salt correction:	N\A

Cruise Objectives: To (1) collect information on the relationship between cetaceans, particularly pilot whales and common dolphins, and oceanographic features using sea surface temperature and CTD data; (2) collecting data on school size; (3) collecting biopsy samples, principally from bow riding animals; and (4) collect photographs for several North Atlantic photo-identification catalogues.

Wilkinson Basin Convection Study

Cruise:	DEL0405
Vessel:	R/V Delaware II
Dates:	23 – 25 March
Sea Days:	3
Instrument(s):	4493
Total # of stations:	36
# of vertical CTD/Profiler casts:	31
# of double oblique Profiler casts:	0
# Salinity samples:	5
Salt correction:	N/A

Cruise Objectives: To (1) conduct a hydrographic survey of the western Gulf of Maine to document the winter convection of the water columns in the Wilkinson Basin region; (2) look for evidence in the density distributions of the transect lines that would suggest that the colder coastal waters could have cascaded into the deep Basin and enhanced the convective winter mixing. The third objective of the cruise was to thoroughly test and familiarize the science party and deck department with a newly acquired CTD system.

Winter Bottom Trawl Survey

Cruise:	ALB0402
Vessel:	R/V Albatross IV
Dates:	4 – 28 February
Sea Days:	19
Instrument(s):	1496, 1495, 1447, 1468
Total # of stations:	140
# of vertical CTD/Profiler casts:	83
# of double oblique Profiler casts:	28
# Salinity samples:	28
Salt correction:	1496=+0.01, 1495=N/A, 1447=N/A, 1468=N/A

Cruise Objectives: To (1) determine the winter distribution and relative abundance of fish and invertebrate species; (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, and food habits; (3) collect hydrographic and meteorological data; (4) make collections of data and samples for cooperative researchers and programs

Spring Bottom Trawl Survey

Cruise:	ALB0403
Vessel:	R/V Albatross IV
Dates:	3 March – 22 April
Sea Days:	36
Instrument(s):	1468, 1495
Total # of stations:	332
# of vertical CTD/Profiler casts:	170
# of double oblique Profiler casts:	115
# Salinity samples:	52
Salt correction:	N/A

Cruise Objectives: To (1) determine the spring distribution and relative abundance of fish and invertebrate species; (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, an food habits; (3) collect hydrographic and meteorological data; (4) make collections of data and samples for cooperative researchers and programs.

Marine Mammal Survey

Cruise:	ALB0404
Vessel:	R/V Albatross IV
Dates:	28 April – 19 May
Sea Days:	17
Instrument(s):	4501
Total # of stations:	112
# of vertical CTD/Profiler casts:	112
# of double oblique Profiler casts:	0
# Salinity samples:	0
Salt correction:	N\A

Cruise Objectives: To conduct satellite, VHF, and time-depth-recorder (TDR) tagging of northern right whales, and to conduct oceanographic sampling in association with mammal observations.

Ecosystems Monitoring Survey

Cruise:	ALB0405
Vessel:	R/V Albatross IV
Dates:	25 May – 8 June
Sea Days:	14
Instrument(s):	4501
Total # of stations:	124
# of vertical CTD/Profiler casts:	5
# of double oblique Profiler casts:	126
# Salinity samples:	26
Salt correction:	N\A

Cruise Objectives: To assess the impact of changing biological and physical properties of the Northeast Continental Shelf ecosystem which influence the sustainable productivity of the living marine resources.

Marine Mammal Survey

Cruise:	END0495
Vessel:	R/V Endeavor
Dates:	24 June – 3 August
Sea Days:	32
Instrument(s):	1496, 0853
Total # of stations:	61
# of vertical CTD/Profiler casts:	0
# of double oblique Profiler casts:	59
# Salinity samples:	0
Salt correction:	N\A

Cruise Objectives: To conduct satellite, VHF, and time-depth-recorder (TDR) tagging of northern right whales, and to conduct oceanographic sampling in association with mammal observations.

Scallop Survey

Cruise:	ALB0406
Vessel:	R/V Albatross IV
Dates:	7 July – 5 August
Sea Days:	26
Instrument(s):	2277, 1468
Total # of stations:	589
# of vertical CTD/Profiler casts:	136
# of double oblique Profiler casts:	0
# Salinity samples:	42
Salt correction:	2277=+0.018, 1468=N/A

Cruise Objectives: To (1) determine the distribution and relative abundance of the sea scallop *Placopecten magellanicus* and Iceland scallop *Chlamys islandica*; (2) collect biological samples and data relative to assessment needs; (3) monitor hydrographic and meteorological conditions; and (4) make collections for interested scientists at other institutions and laboratories.

Ecosystems Monitoring Survey

Cruise:	ALB0408
Vessel:	R/V Albatross IV
Dates:	29 17 – 31 August
Sea Days:	15
Instrument(s):	2277
Total # of stations:	168
# of vertical CTD/Profiler casts:	2
# of double oblique Profiler casts:	126
# Salinity samples:	24
Salt correction:	N\A

Cruise Objectives: To assess the impact of changing biological and physical properties of the Northeast Continental Shelf ecosystem which influence the sustainable productivity of the living marine resources.

Benthic Habitat

Cruise:	DEL0412
Vessel:	R/V Delaware II
Dates:	25 – 30 August
Sea Days:	6
Instrument(s):	1447
Total # of stations:	34
# of vertical CTD/Profiler casts:	8
# of double oblique Profiler casts:	0
# Salinity samples:	26
Salt correction:	N\A

Cruise Objectives: To monitor the recovery of the benthic habitat in the closed areas.

Hydro Acoustic Survey

Cruise:	DEL0413
Vessel:	R/V Delaware II
Dates:	9 September – 11 October
Sea Days:	21
Instrument(s):	1447, 1496, 0851, 1495
Total # of stations:	149
# of vertical CTD/Profiler casts:	100
# of double oblique Profiler casts:	0
# Salinity samples:	12
Salt correction:	N\A

Cruise Objectives: The primary goal is to provide fisheries independent abundance estimates of Atlantic herring in the Georges Bank and Gulf of Maine regions, and to calibrate the EK-500 echo-integrator and test the mid-water trawl performance.

Fall Bottom Trawl Survey

Cruise:	ALB0409
Vessel:	R/V Albatross IV
Dates:	11 September – 27 October
Sea Days:	26
Instrument(s):	0851, 0853
Total # of stations:	319
# of vertical CTD/Profiler casts:	196
# of double oblique Profiler casts:	81
# Salinity samples:	51
Salt correction:	N\A

Cruise Objectives: To (1) determine the autumn distribution and relative abundance of fish and invertebrate species; (2) collect biological samples for studies of age and growth relationships, fecundity, maturity, an food habits; (3) collect hydrographic and meteorological data; (4) make collections of data and samples for cooperative researchers and programs.

Benthic Habitat

Cruise:	DEL0415
Vessel:	R/V Delaware II
Dates:	2 – 11 November
Sea Days:	4
Instrument(s):	1468
Total # of stations:	6
# of vertical CTD/Profiler casts:	0
# of double oblique Profiler casts:	0
# Salinity samples:	6
Salt correction:	N\A

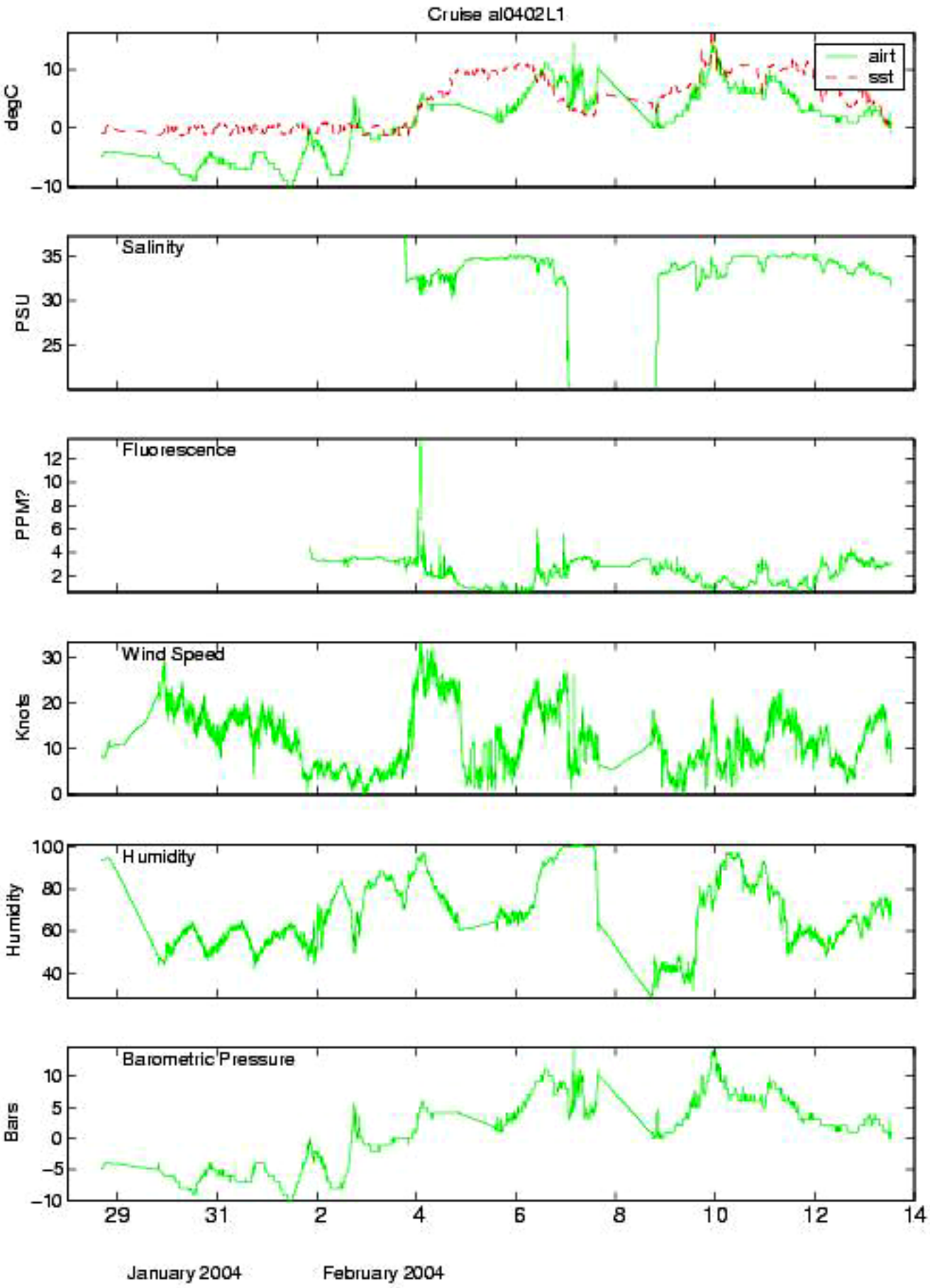
Cruise Objectives: To monitor the recovery of the benthic habitat in the closed areas.

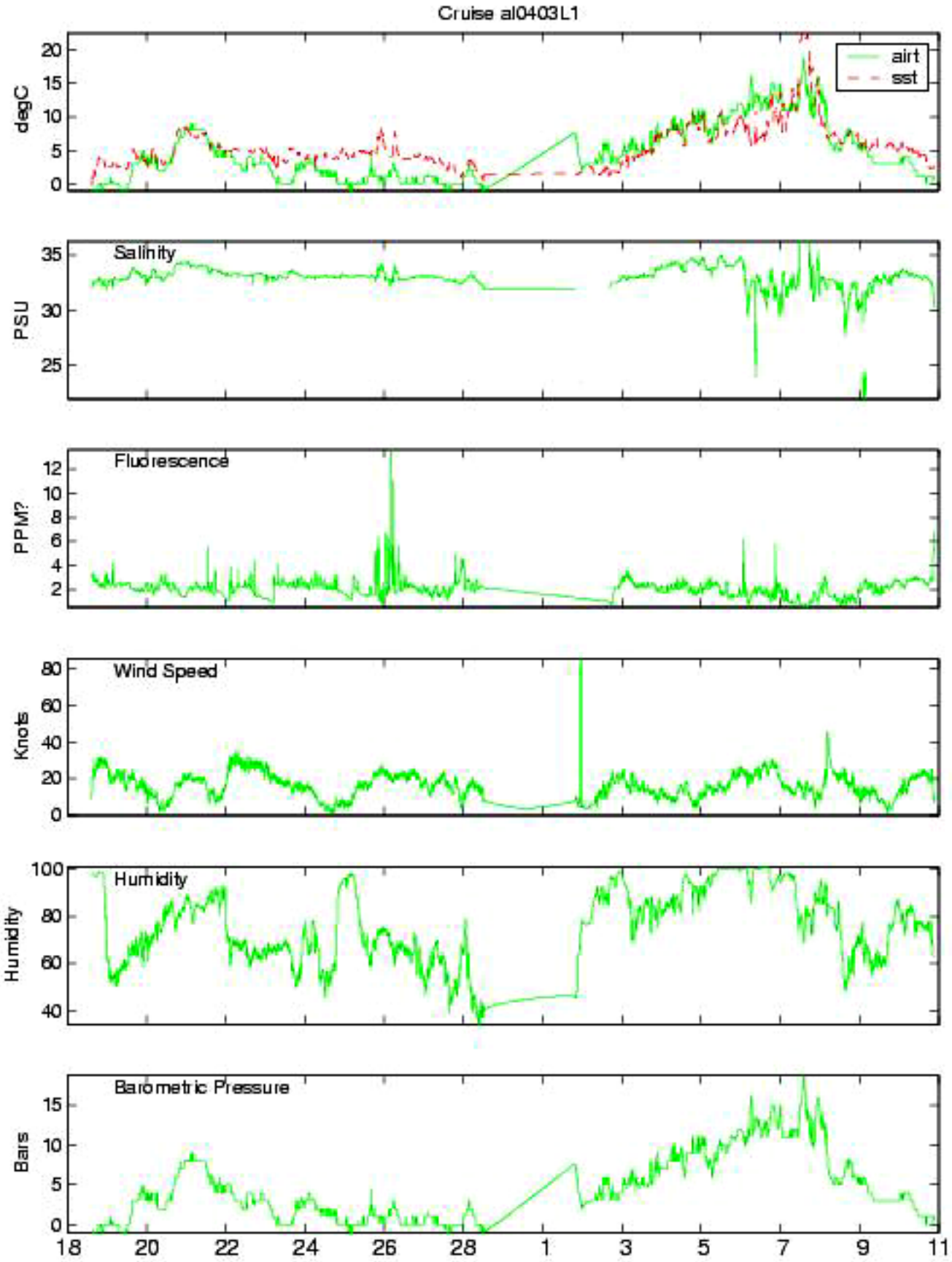
ECOMON Survey

Cruise:	ALB0410
Vessel:	R/V Albatross IV
Dates:	2 – 18 November
Sea Days:	17
Instrument(s):	2879
Total # of stations:	127
# of vertical CTD/Profiler casts:	128
# of double oblique Profiler casts:	6
# Salinity samples:	25
Salt correction:	N\A

Cruise Objectives: To assess the impact of changing biological and physical properties of the Northeast Continental Shelf ecosystem which influence the sustainable productivity of the living marine resources.

Appendix B. Time series plots of shipboard environmental sensor records.




Cruise al0403L1
degC
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Salinity
PPM?
Fluorescence
Knots
Wind Speed
Humidity
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Barometric Pressure
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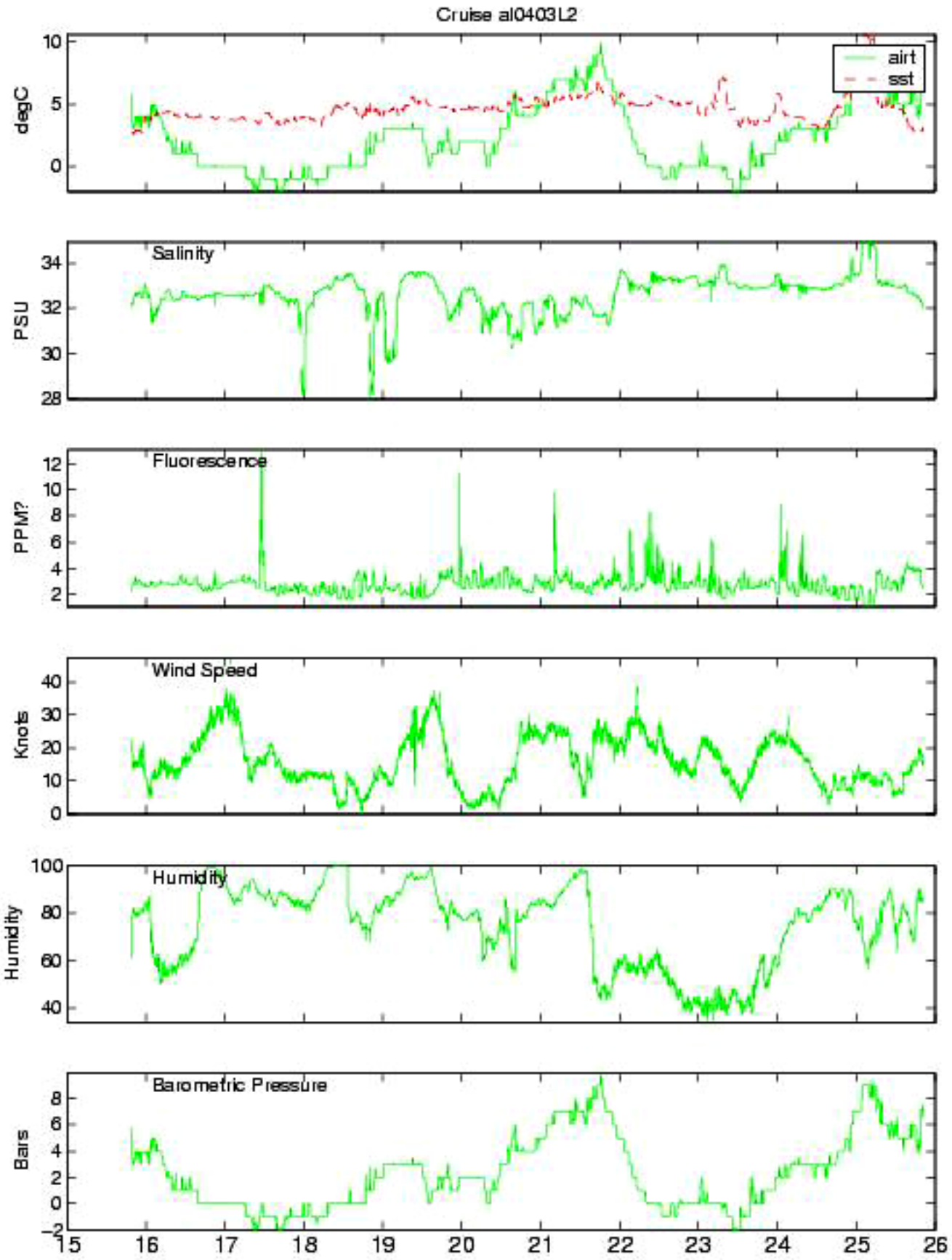
February 2004
March 2004


Cruise al0403L2
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Wind Speed
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Humidity
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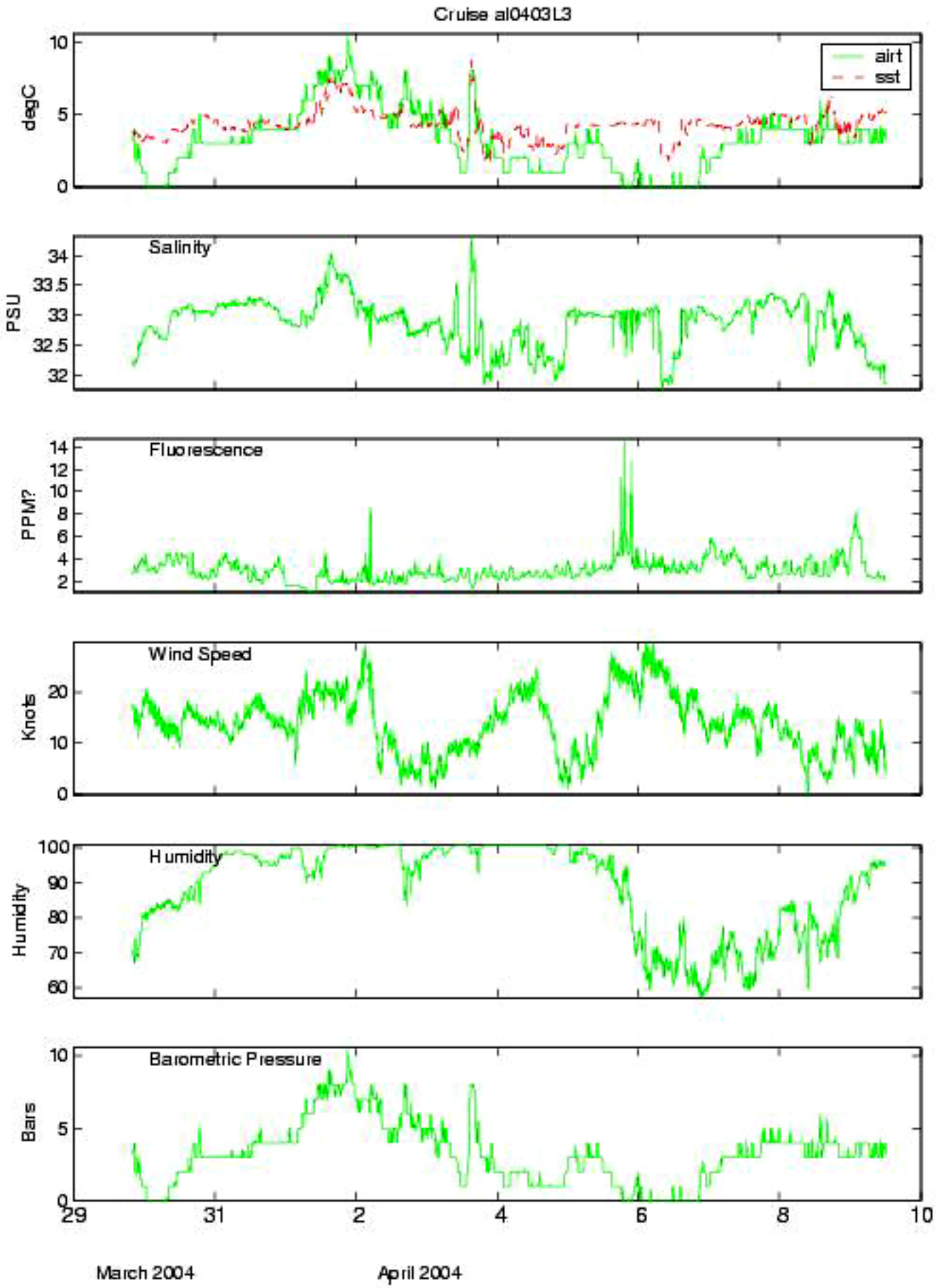
Cruise al0403L3
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PPM?
Wind Speed
Knots
Humidity
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Barometric Pressure
Bars
29
31
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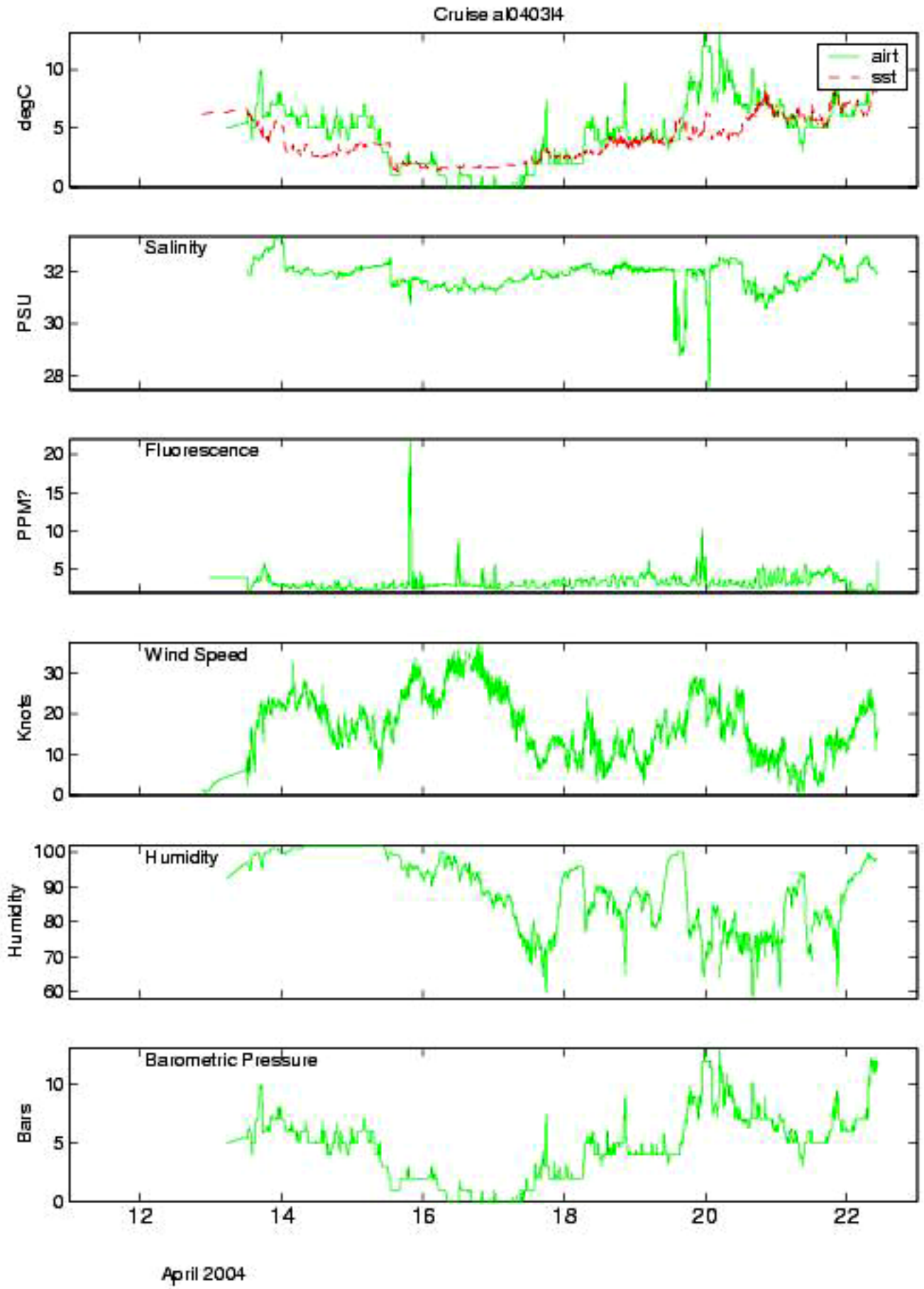
6
8
10
March 2004
April 2004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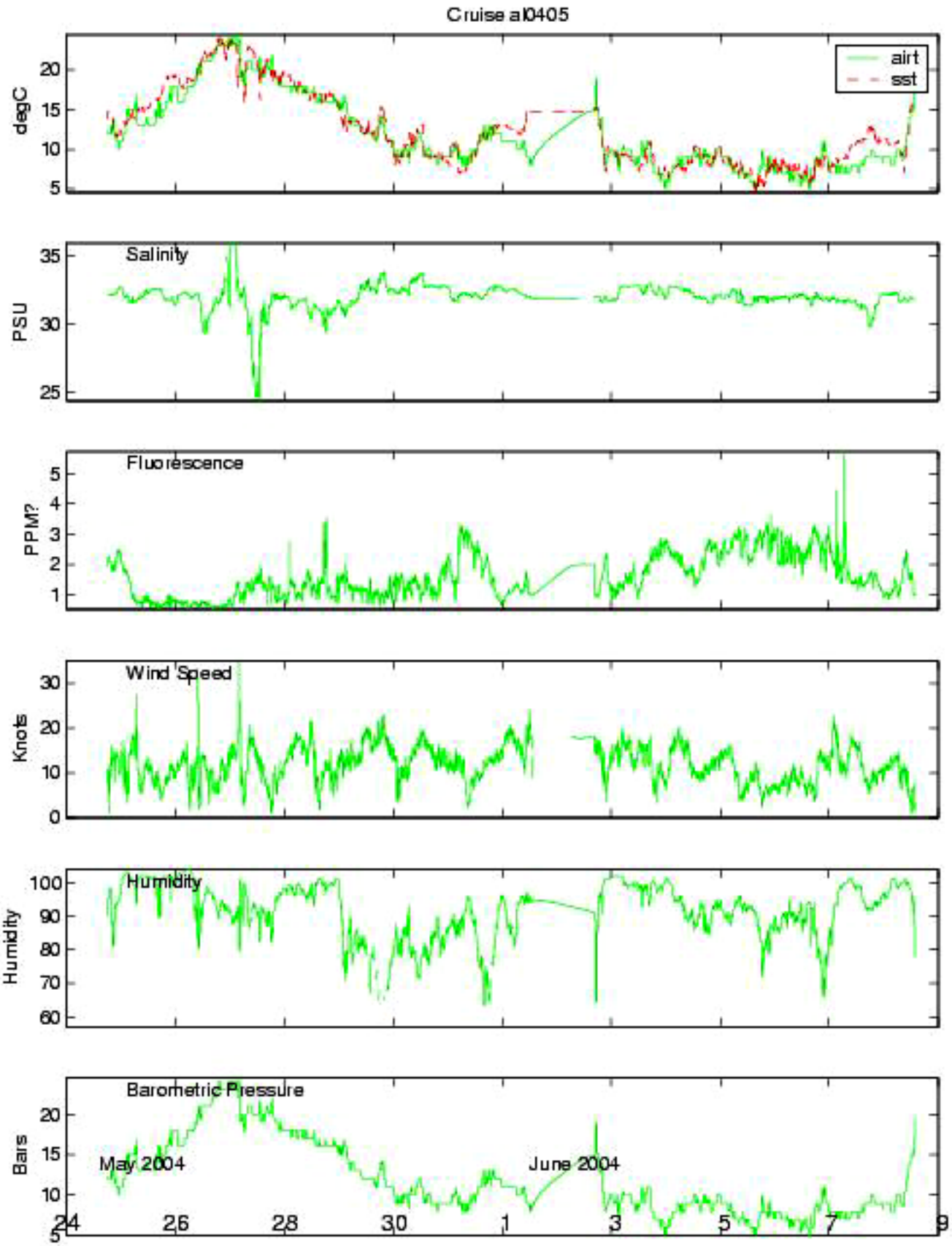
airt
sst
degC
Salinity
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
12
14
16
18
20
22
April 2004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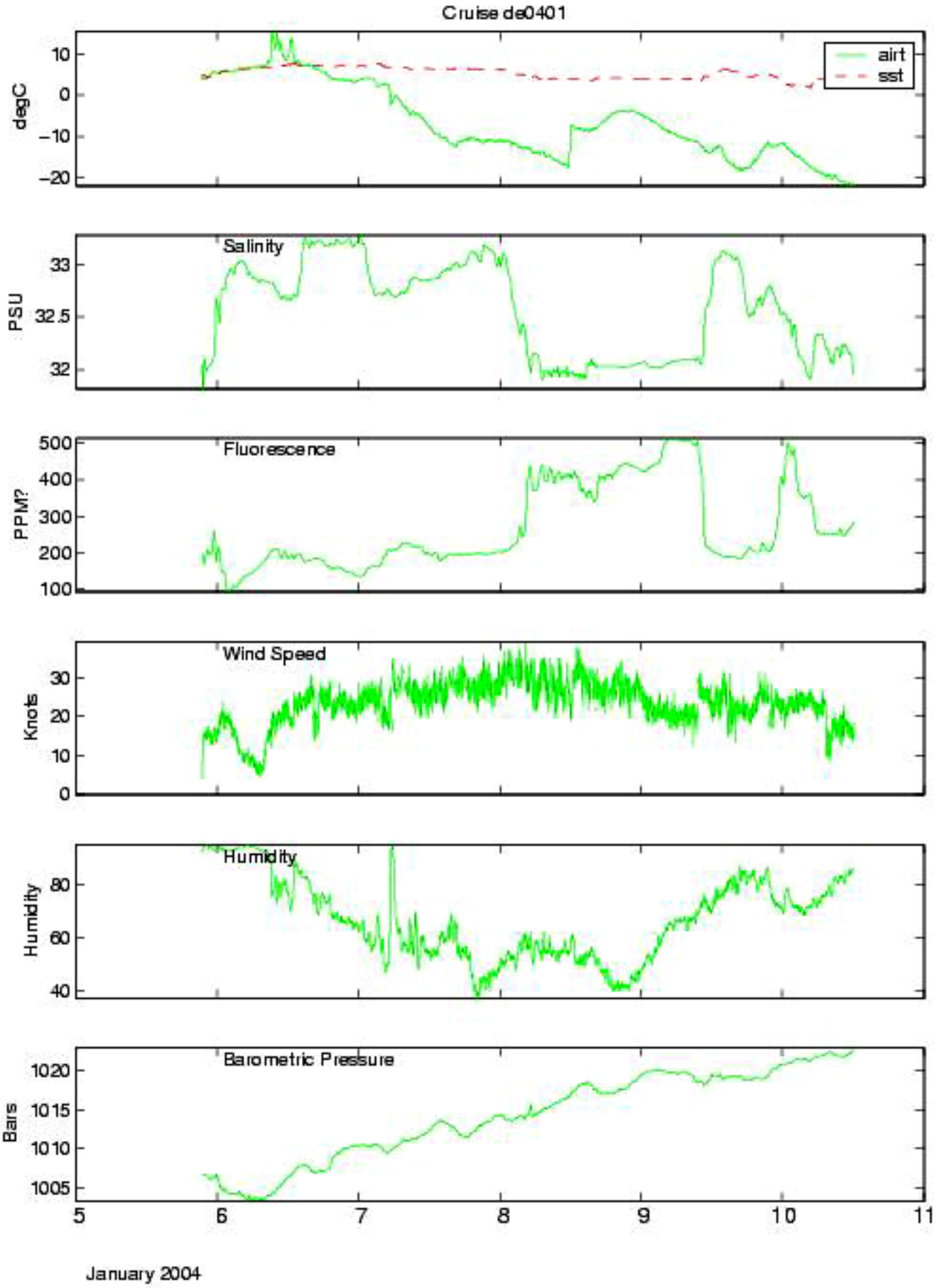
degC
Salinity
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
May 2004
June 2004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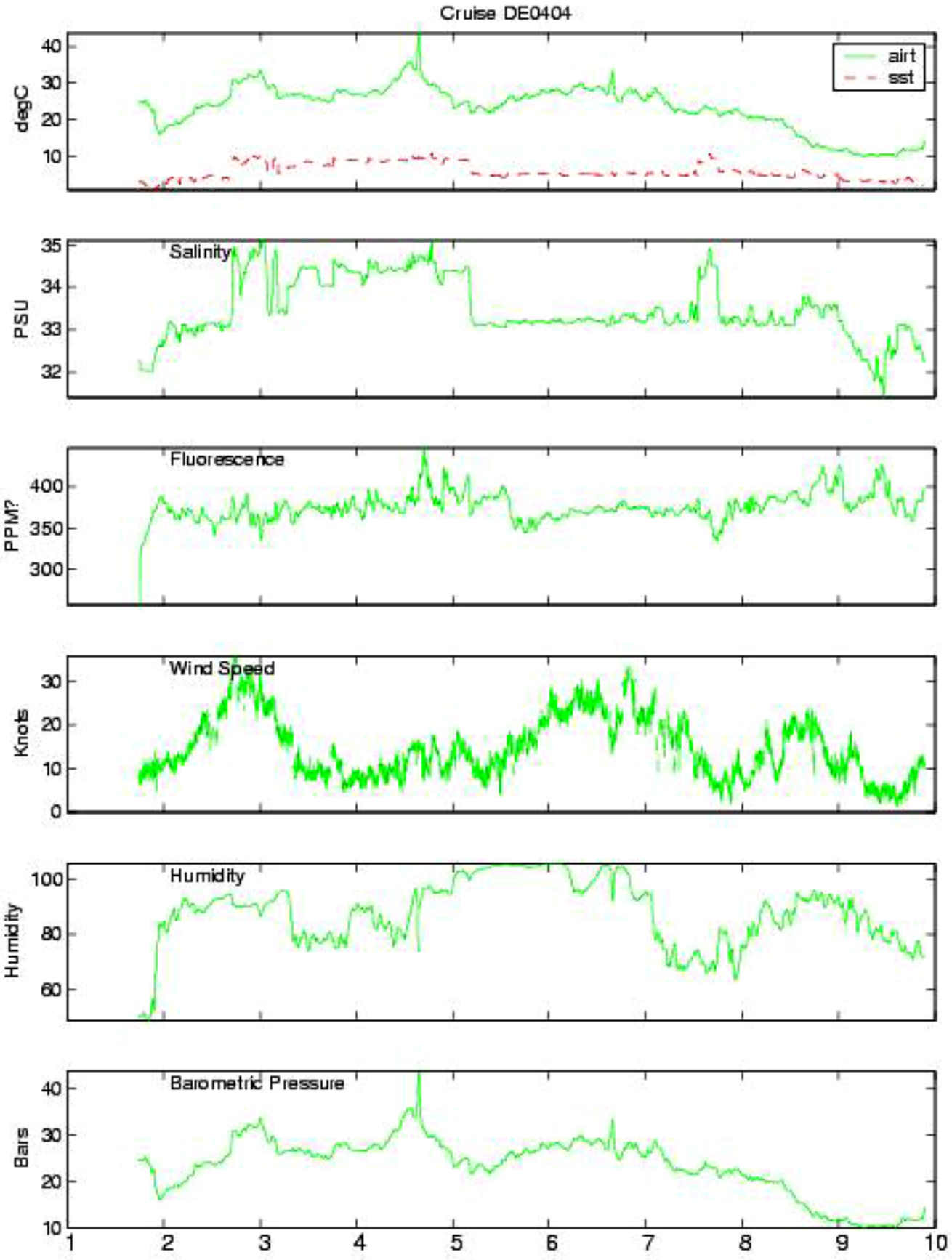
sst
degC
10
0
−10
−20
Salinity
PSU
33
32.5
32
Fluorescence
PPM?
500
400
300
200
100
Wind Speed
Knots
30
20
10
0
Humidity
Humidity
80
60
40
Barometric Pressure
Bars
1020
1015
1010
1005
5
6
7
8
9
10
11
January 2004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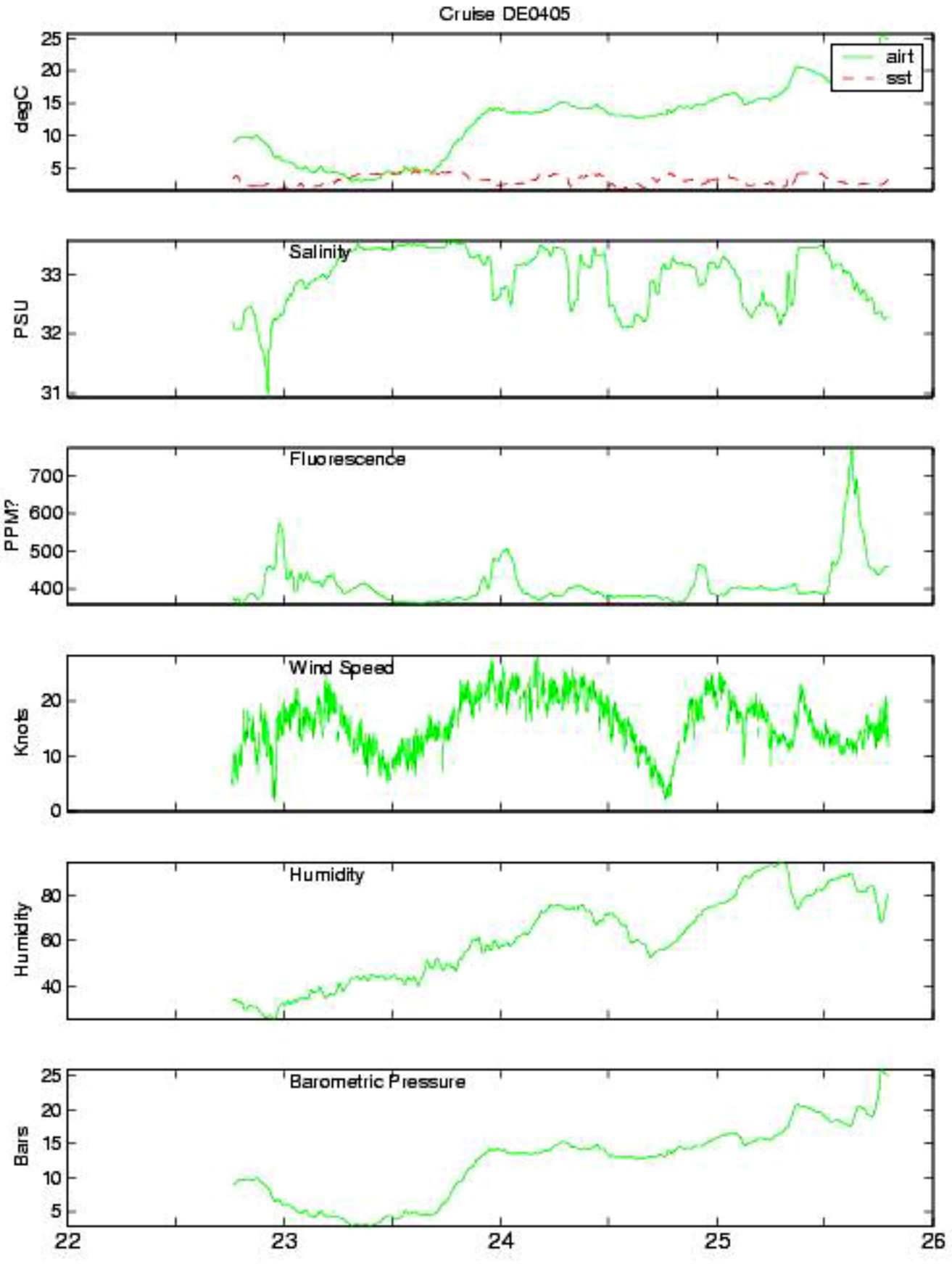
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
March 2004


Cruise DE0405
degC
airt
sst
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Fluorescence
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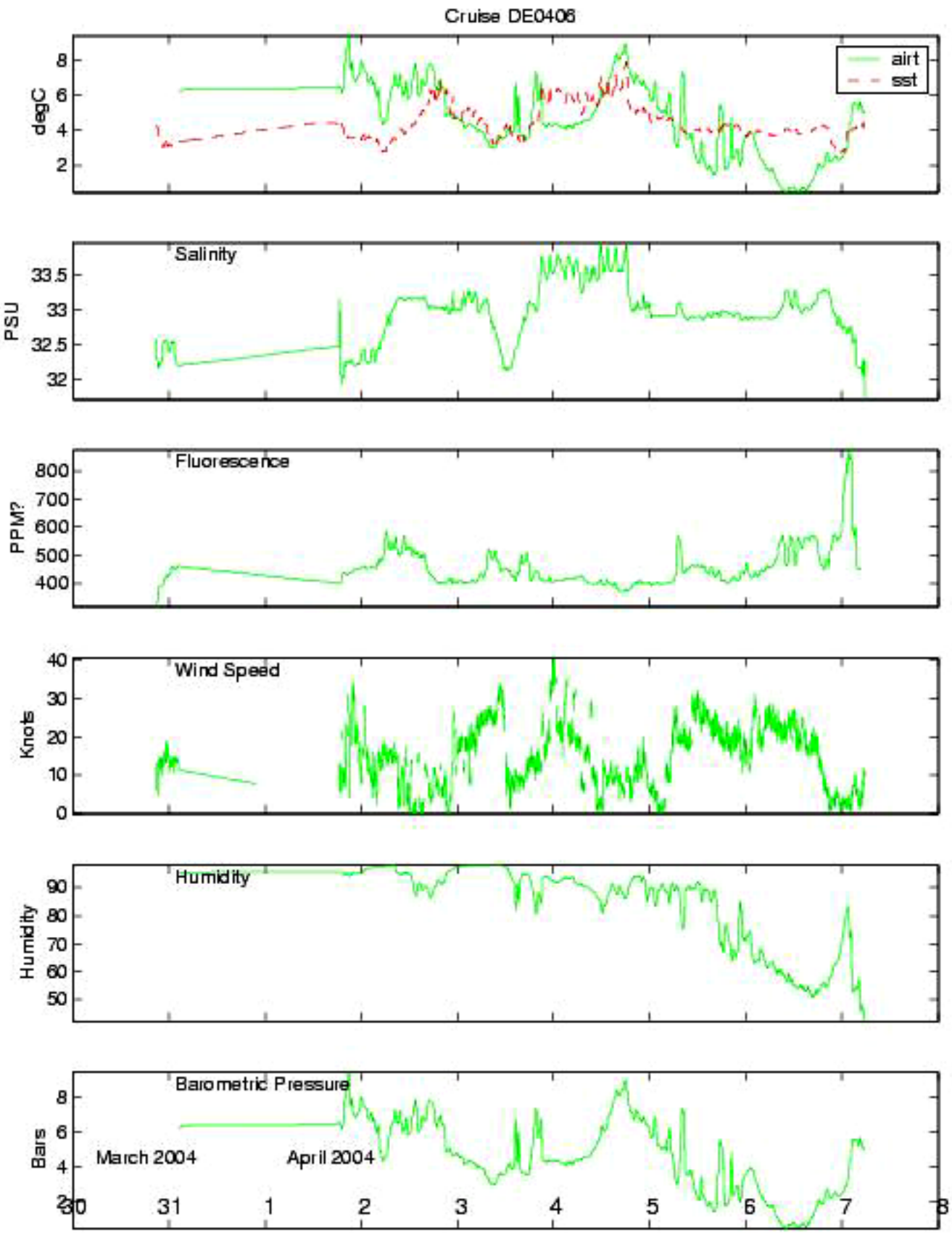
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
22
23
24
25
26
March 2004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airt
sst
degC
Salinity
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
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April 2004
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31
1
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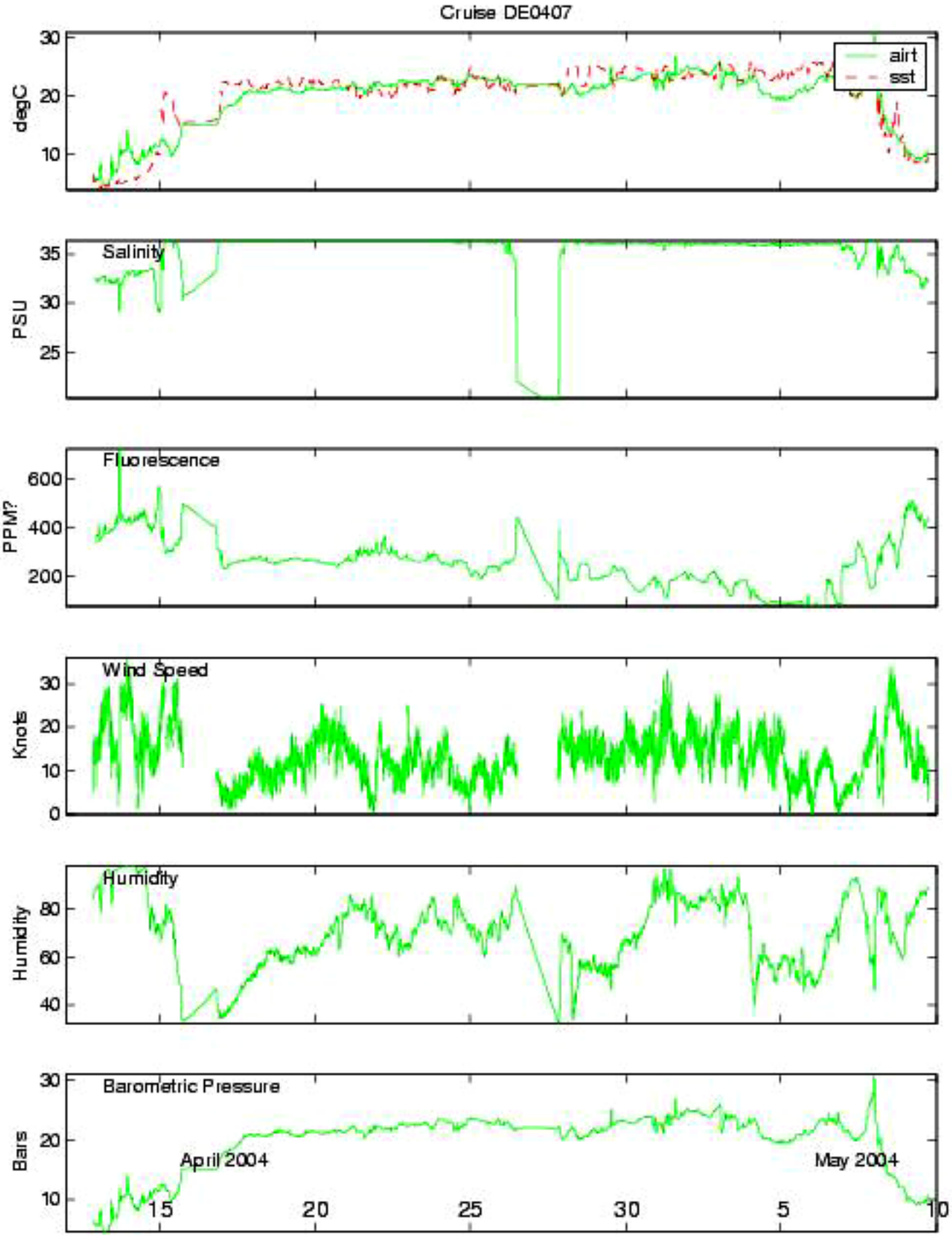
4
5
6
7
8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airt
sst
Salinity
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
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May 2004
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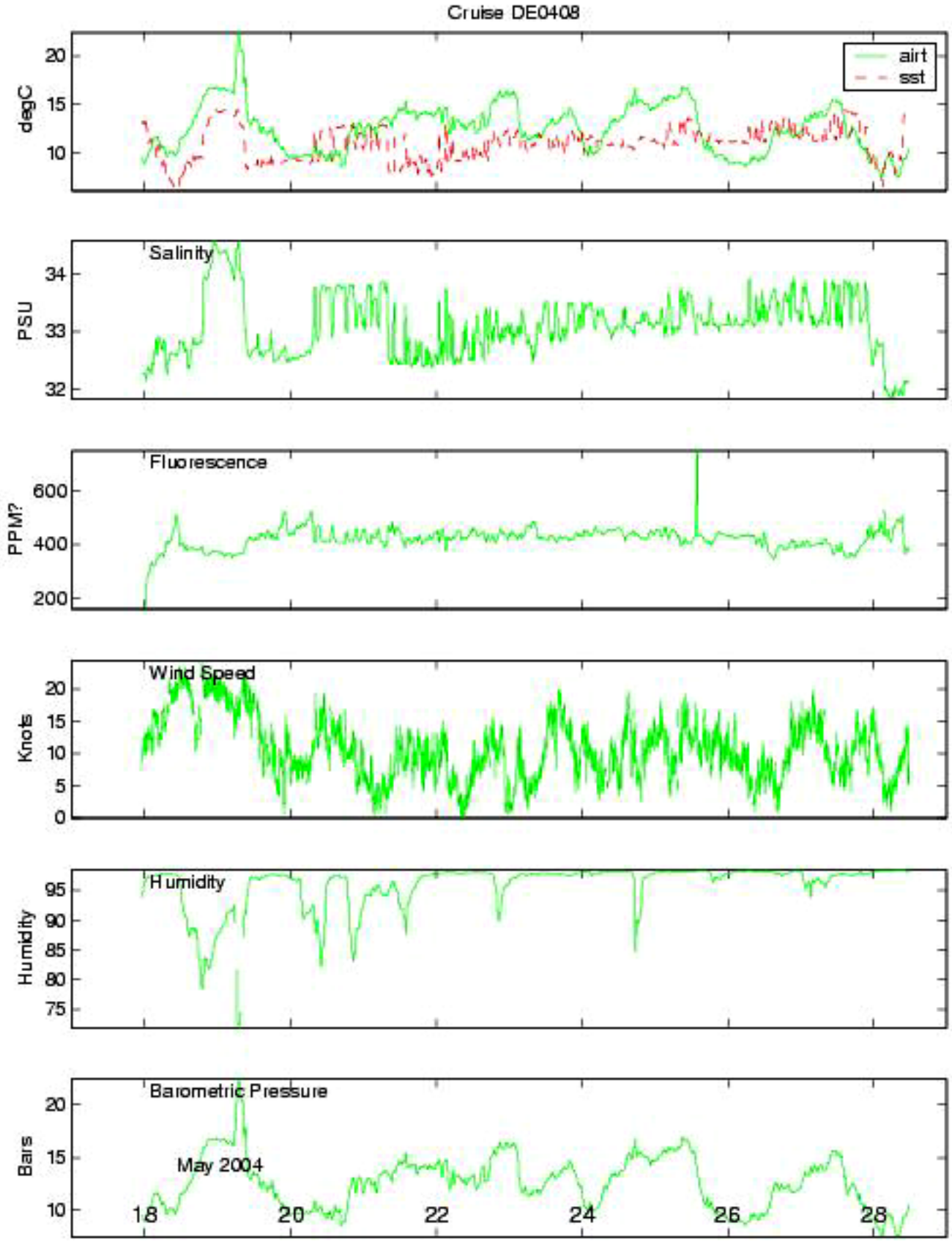
20
25
30
5
10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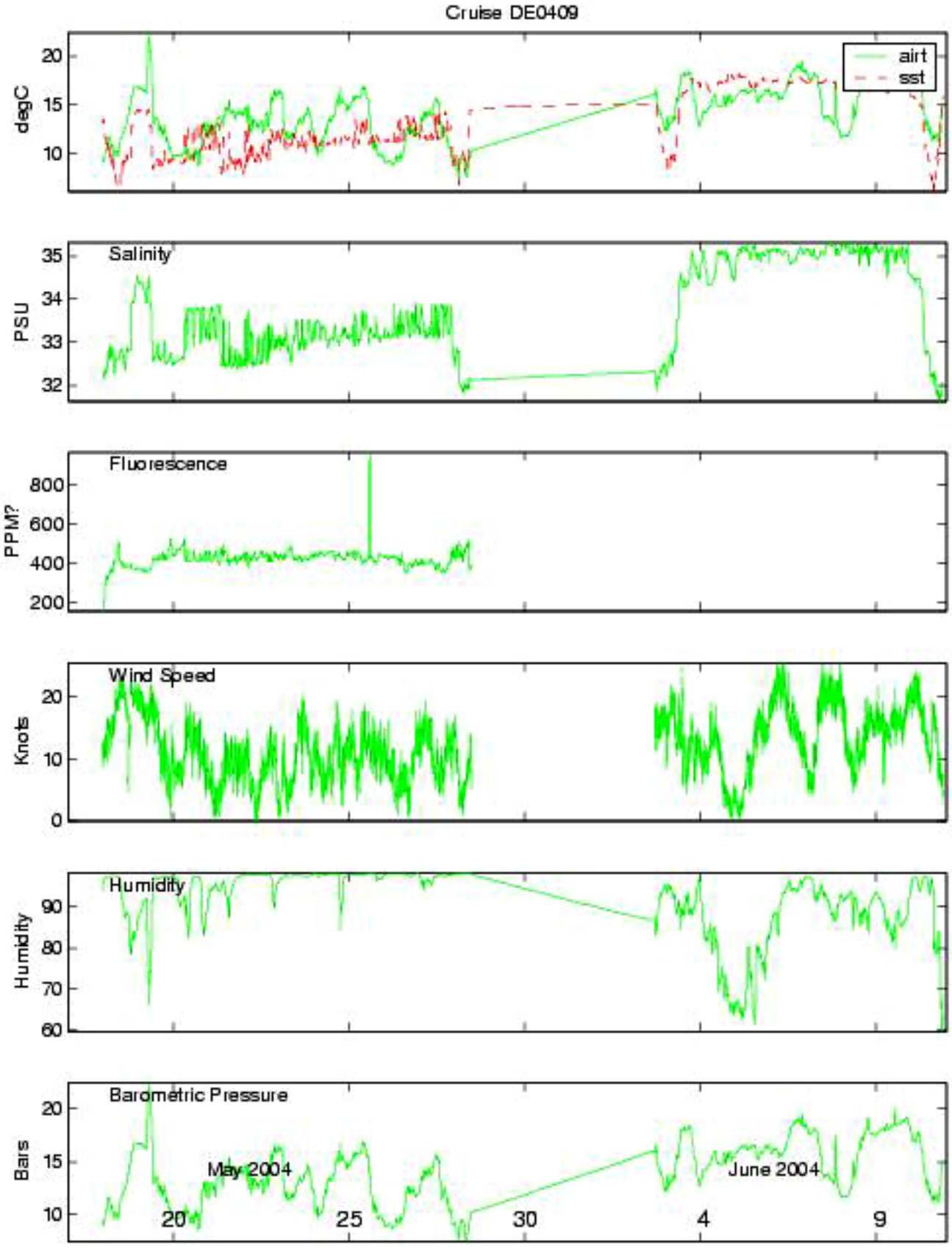
20
15
10
airt
sst
Salinity
PSU
34
33
32
Fluorescence
PPM?
600
400
200
Wind Speed
Knots
20
15
10
5
0
Humidity
Humidity
95
90
85
80
75
Barometric Pressure
Bars
20
15
10
May 2004
18
20
22
24
26
28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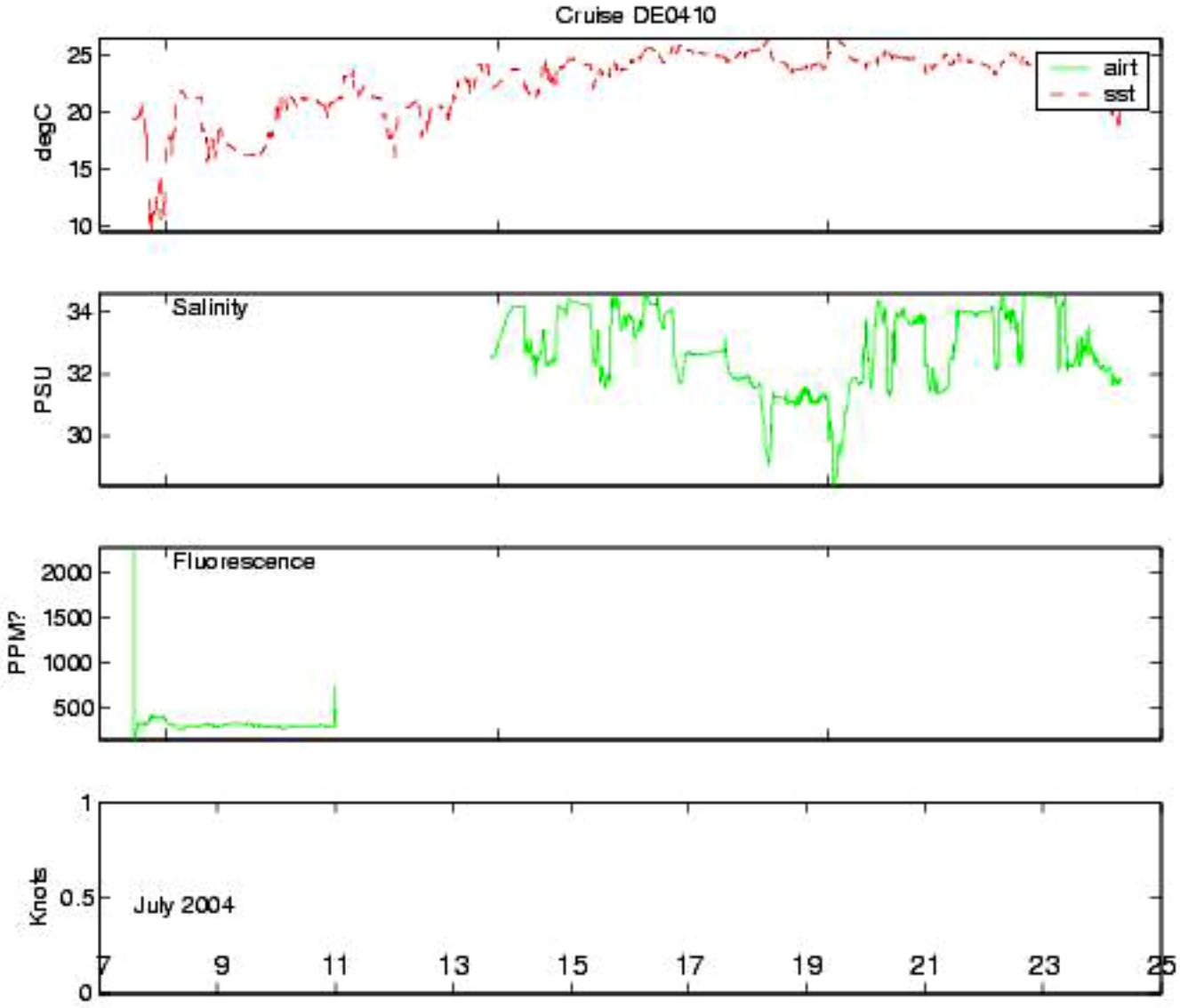
degC
20
15
10
airt
sst
Salinity
PSU
35
34
33
32
Fluorescence
PPM?
800
600
400
200
Wind Speed
Knots
20
10
0
Humidity
Humidity
90
80
70
60
Barometric Pressure
Bars
20
15
10
May 2004
June 2004
20
25
30
4
9


Cruise DE0410
degC
25
20
15
10
airt
sst
Salinity
PSU
34
32
30
Fluorescence
PPM?
2000
1500
1000
500
Knots
1
0.5
0
July 2004
7
9
11
13
15
17
19
21
23
25

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