Northeast Fisheries Science Center Reference Document 03-05

Description of the 2002 Oceanographic Conditions on the Northeast Continental Shelf

by

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

March 2003

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract

A summary of hydrographic observations for 12 surveys on the northeast continental shelf during 2002 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 2002 were sorted into six 2-month time bins to provide the best spatial coverage used in the averaging method. Review of the computed areal average temperature and salinity data indicate that during the majority of the year the northeast continental shelf experienced warmer temperatures relative to the MARMAP reference period. But temperatures were only slightly above expected values by November with the exception of the northern MAB where Gulf Stream rings were located at the shelf edge. Surface salinity observations in the eastern GOM and Georges Bank were fresher than the expected conditions during both the winter and spring although higher than expected salinity values were observed by fall. The positive salinity anomalies in the GOM and Georges Bank persisted through the end of the field season. The pattern of increasing salinity anomalies observed in the GOM regions may indicate a change in the contribution of slope water flowing into the GOM through northeast channel. Both surface and bottom salinity values were relatively saltier during most of the year in the southern MAB region. The latter observation is most likely associated with the shoreward movement of the shelf/slope front.

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 12 NEFSC surveys conducted during 2002 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, DEL0206, 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 a trial instrument evaluation that was 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 controlling of these data, other than checking for water column stability, since it was not possible to take salinity samples. The project description, cruise notes, and processed data may be downloaded from: ftp://ftp.wh.whoi.edu/pub/hydro/del0206/DEL0206_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. The areal averaging was done using the method described in Holzwarth and Mountain (1990). The areal averages and anomalies were plotted against the calendar day 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 of Appendix C.

Results

The NEFSC cruises that are 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 and 3 by an asterisk. 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- 57. 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 temperature anomaly time series (Figure 2) indicate that much of the northeast continental shelf experienced warmer surface and bottom temperature conditions during 2002 compared to the MARMAP reference values. The highest surface and bottom temperature anomalies (> 3 ^{o}C) occurred during the January – April time periods in the southern MAB (see

figure 23). The positive temperature anomalies in this region gradually subsided over the course of the year with the only exception occurring during the June ECOMON survey (ALB0206) when slightly below expected surface temperatures were observed. The cooler surface temperatures during June may have been caused by the advection of relatively cooler shelf water from the north but it is beyond the scope of this report to investigate this in any detail. By November the northeast continental shelf, with the exception of the northern MAB, was at expected or only slightly above expected temperature conditions. Two separate warm-core Gulf Stream rings were observed in COASTWATCH satellite imagery during October and early November in the northern MAB region and most likely contributed to the persistence of the relatively warmer temperature conditions and the increase in the salinity anomaly. Similarly, the Georges Bank region was most likely influenced by the passage of the above-mentioned Gulf Stream rings during the late summer and early fall.

Both regions of the Gulf of Maine and Georges Bank experienced fresher surface conditions during the first half of the year. However, the salinity anomaly time series shown in figure 3 displays a pattern beginning in early summer of relatively high surface and bottom salinity values that persisted until the end of the field season in November. It is possible that the higher salinities resulted from either a decrease in the overall contribution of Scotian Shelf water to the GOM, or the inflow of relatively warm, salty Slope water through Northeast Channel increased during the latter part of 2002.

The Northeast Regional Climate Center (NRCC, Cornell University) compiles seasonal and yearly summaries of mean air temperature and precipitation using 108 years of compiled historical data. Seasons and years are assigned a rank according to their mean air temperatures (1= coolest, 108 = warmest) and total precipitation (1 = driest, 108= wettest). The northeast

region (Maine to Virginia) ranked the highest,“108”, in average air temperature and “8” in total precipitation during the winter of 2002. The fall of 2002 ranked “62” in air temperature and “97” in total precipitation. The above average air temperatures are consistent with the warmer sea surface temperatures observed throughout much of the year on the northeast continental shelf that subsided to near expected conditions by late Fall. Further information about the NRCC and its data products may be obtained at:

http://met-www.cit.cornell.edu/climate/Climate_summary.html

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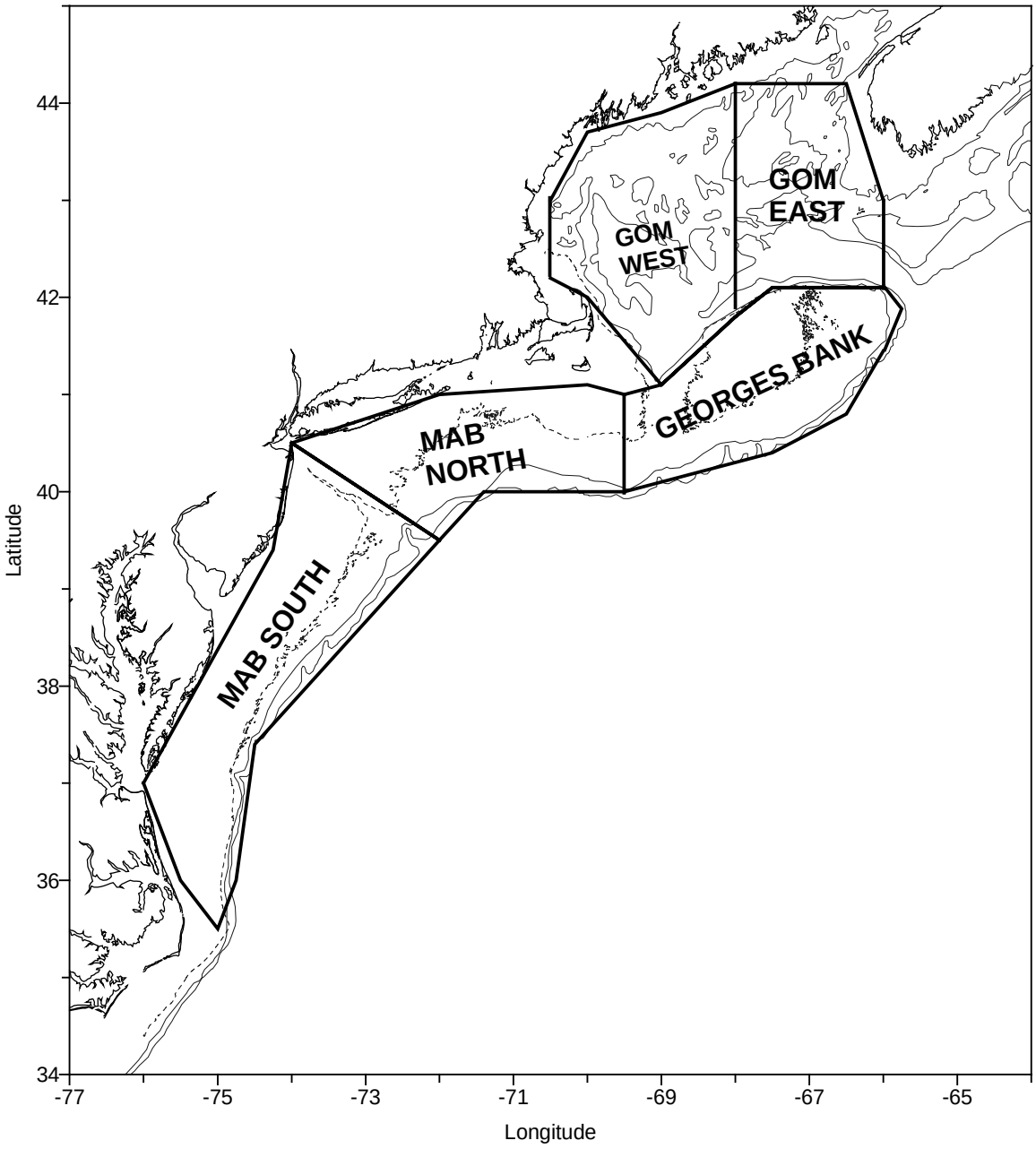


Figure 1a. The regions of the northeast continental shelf covered by the Northeast Fisheries Science Center cruises during 2002.

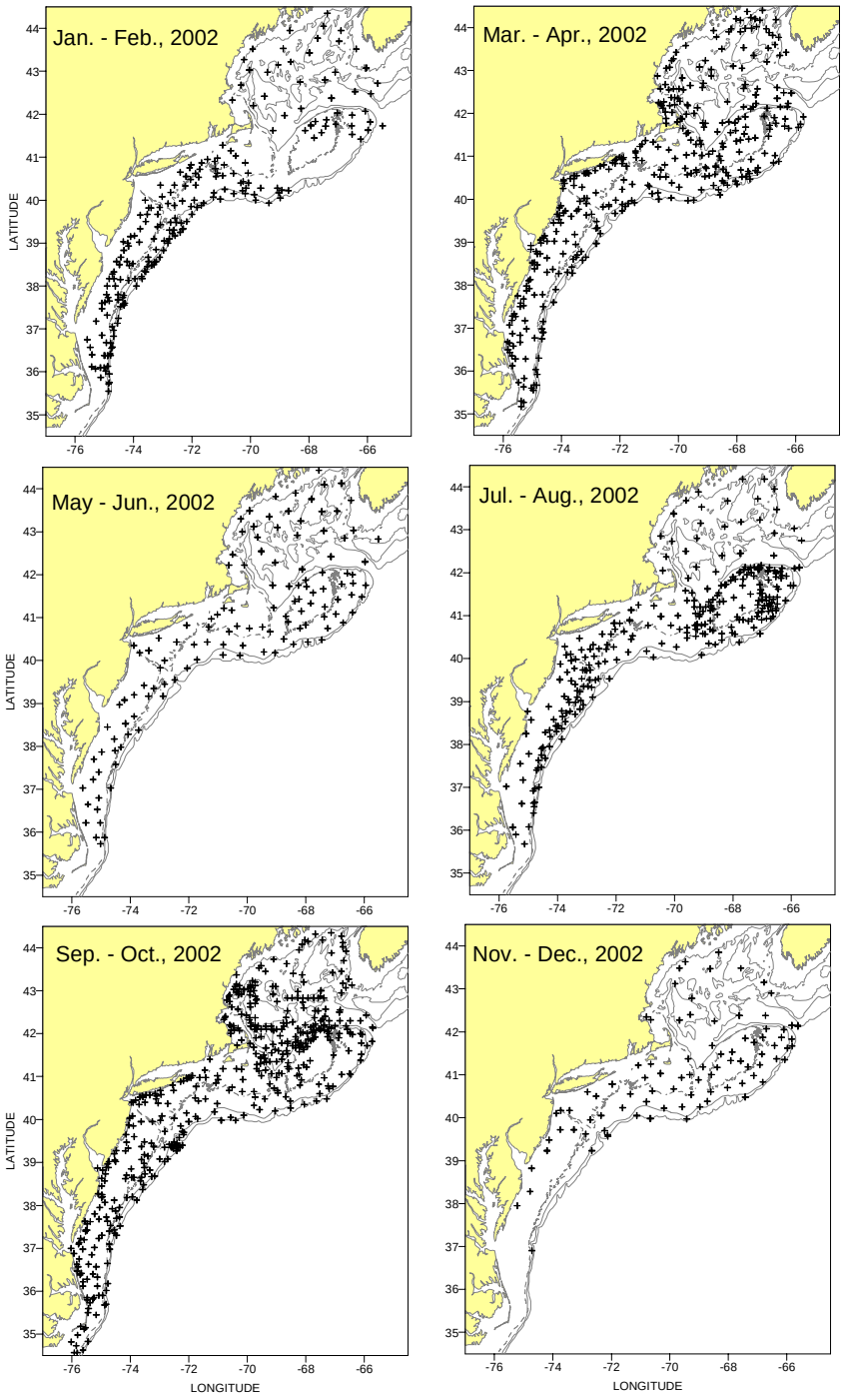


Figure 1b. Distributions of hydrographic stations occupied during 2002.

Table 1. Summary of 2002 Cruises.

Cruise	Program	Dates	Regions[1]
ALB0202	ECOMON Survey	23 – 30 January	GB, GOM
ALB0203	Winter Bottom Trawl	6 February – 2 March	GB, MAB
DEL0201	Hydro Acoustic Survey	22 February – 7 March	MAB
ALB0204	Spring Bottom Trawl	6 March – 25 April	GOM, MAB, GB
ALB0206	ECOMON Survey	23 May – 6 June	GOM, MAB, GB
NOB0201	ECOMON Survey	14 – 29 August	GOM, MAB, GB
ALB0208	Scallop Survey	17 July – 15 August	GB, MAB
ALB0209	Benthic Habitat	20 – 29 August	GB
DEL0208	Hydro Acoustic Survey	5 September – 10 Oct.	GB, GOM
ALB0210	Fall Bottom Trawl	4 September – 25 Oct.	GOM, GB, MAB
OC384	Benthic Habitat	24 Oct. – 2 November	MAB
DEL0210	ECOMON Survey	29 Oct. – 14 Nov.	GOM, GB, MAB

[1] Regional Abbreviations:

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 2002 in the five regions of the northeast continental shelf.

	SURFACE					BOTTOM				
Region	#obs	Temp	Anomaly	SDV1	SDV2	#obs	Temp	Anomaly	SDV1	SDV2 (1)
January - February										
GOMW	14	6.47	0.72	0.29	0.62	13	7.20	1.02	0.24	0.49
GOME	18	5.70	0.41	0.25	0.73	14	7.52	0.37	0.31	1.21
GB	20	6.43	1.08	0.30	.60*	15	6.79	1.27	0.23	.65*
MABN	51	6.96	2.06	0.27	1.05	37	7.15	2.31	0.31	1.03
MABS	102	9.67	3.41	0.21	2.34	78	9.65	3.23	0.27	1.75
March - April										
GOMW	46	6.37	1.39	0.20	0.86	44	6.40	1.30	0.16	0.76
GOME	35	5.46	0.71	0.19	0.74	32	7.36	0.52	0.22	0.75
GB	65	6.19	1.26	0.16	0.71	55	6.80	1.52	0.21	0.96
MABN	63	7.17	2.65	0.26	0.98	54	7.84	2.68	0.32	1.25
MABS	88	9.22	3.11	0.24	0.95	82	9.10	2.95	0.29	1.29
May - June										
GOMW	34	10.81	0.59	0.21	0.61	20	6.71	1.22	0.19	0.89
GOME	21	9.10	0.73	0.20	0.47	10	8.18	1.08	0.33	0.70
GB	32	11.20	1.94	0.26	1.34	26	8.80	1.12	0.28	0.99
MABN	23	12.49	0.96	0.35	1.22	20	8.50	0.86	0.42	1.51
MABS	41	14.62	-0.15	0.31	0.64	41	11.76	2.72	0.36	1.44
July - August										
GOMW	36	18.07	1.46	0.26	1.91	34	7.59	0.88	0.21	2.37
GOME	35	16.58	2.37	0.24	1.82	33	9.22	0.59	0.29	2.69
GB	122	19.11	3.25	0.15	2.04	117	12.28	0.72	0.17	2.22
MABN	43	23.05	3.07	0.32	1.88	40	10.74	1.13	0.37	1.54
MABS	83	24.99	1.14	0.24	1.21	80	13.11	1.72	0.28	2.15
September - October										
GOMW	111	14.90	1.41	0.14	0.79	96	8.24	1.21	0.11	1.33
GOME	53	13.74	1.14	0.19	0.72	49	9.65	1.14	0.20	1.37
GB	80	17.81	2.45	0.21	1.42	71	14.57	1.80	0.22	1.99
MABN	63	19.66	1.41	0.27	1.26	56	13.07	0.93	0.34	2.76
MABS	120	21.74	1.01	0.20	1.05	103	15.94	1.60	0.24	2.50
November - December										
GOMW	11	10.70	0.55	0.38	0.49	9	8.92	0.66	0.31	.94*
GOME	8	11.90	0.34	0.33	.66*	6	9.61	0.28	0.42	.91*
GB	30	12.78	0.09	0.23	0.65	28	12.76	0.80	0.27	1.04
MABN	22	15.77	1.16	0.38	1.39	18	14.67	1.44	0.42	1.21
MABS	18	16.07	0.34	0.43	.84*	14	15.19	0.65	0.47	.63*

(1) "Region", the geographic region of the northeast continental shelf: "#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 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 3. Areal average surface and bottom salinity and salinity anomalies presented in two month time periods using the hydrographic data collected during 2002 in the five regions of the northeast continental shelf

	SURFACE					BOTTOM				
Region	#obs	Salt	Anomaly	SDV1	SDV2	#obs	Salt	Anomaly	SDV1	SDV2 (1)
January - February										
GOMW	14	32.99	-0.06	0.14	0.26	13	33.67	0.10	0.08	0.24
GOME	18	32.35	-0.37	0.13	0.32	14	33.91	0.01	0.09	0.41
GB	20	32.80	-0.29	0.14	.43*	15	32.99	0.01	0.08	.24*
MABN	51	33.10	0.01	0.12	0.43	37	33.24	-0.13	0.12	0.34
MABS	100	34.13	0.52	0.13	0.72	78	34.23	0.51	0.10	0.53
March - April										
GOMW	46	32.51	-0.05	0.09	0.44	44	33.41	0.05	0.06	0.26
GOME	34	32.27	-0.20	0.11	0.32	32	34.02	0.05	0.07	0.32
GB	64	32.69	-0.27	0.06	0.32	54	33.12	-0.07	0.08	0.34
MABN	62	33.10	0.14	0.11	0.46	54	33.46	0.05	0.11	0.41
MABS	87	33.79	0.78	0.14	0.82	82	33.92	0.42	0.10	0.60
May - June										
GOMW	34	32.07	-0.07	0.09	0.24	20	33.50	0.18	0.08	0.28
GOME	21	32.37	-0.06	0.12	0.22	10	33.99	0.21	0.10	0.29
GB	32	32.76	-0.11	0.10	0.25	26	32.84	-0.19	0.10	0.29
MABN	22	32.51	0.11	0.16	0.38	19	33.09	-0.24	0.14	0.47
MABS	41	33.20	0.99	0.18	0.61	41	33.78	0.45	0.13	0.36
July - August										
GOMW	34	32.26	0.23	0.12	0.38	34	33.57	0.10	0.07	0.19
GOME	35	32.59	0.18	0.13	0.33	33	34.24	0.25	0.09	0.35
GB	122	32.96	0.30	0.05	0.60	117	33.07	0.09	0.06	0.34
MABN	43	32.33	-0.01	0.14	0.56	40	33.16	-0.15	0.12	0.33
MABS	82	32.26	0.51	0.16	0.68	80	33.36	0.26	0.11	0.53
September - October										
GOMW	92	32.71	0.30	0.07	0.27	95	33.84	0.22	0.04	0.32
GOME	51	32.90	0.33	0.12	0.25	49	34.45	0.22	0.07	0.27
GB	79	33.11	0.36	0.09	0.62	71	33.32	0.36	0.08	0.48
MABN	63	32.99	0.38	0.11	0.56	56	33.51	0.11	0.11	0.57
MABS	120	32.68	0.36	0.11	0.62	102	33.05	-0.16	0.09	0.56
November - December										
GOMW	11	33.09	0.33	0.17	0.13	9	33.57	0.03	0.11	.39*
GOME	7	33.01	0.33	0.17	.08*	5	34.03	0.08	0.11	.39*
GB	30	32.96	0.23	0.08	0.16	28	33.24	0.23	0.10	0.34
MABN	22	34.00	1.03	0.17	0.69	18	34.12	0.51	0.15	0.42
MABS	18	33.21	0.42	0.22	.51*	14	32.79	0.03	0.17	.47*

(1) "Region", the geographic region of the northeast continental shelf: "#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 temperature anomaly : "SDV2", the standard deviation of the individual anomalies from which the 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.

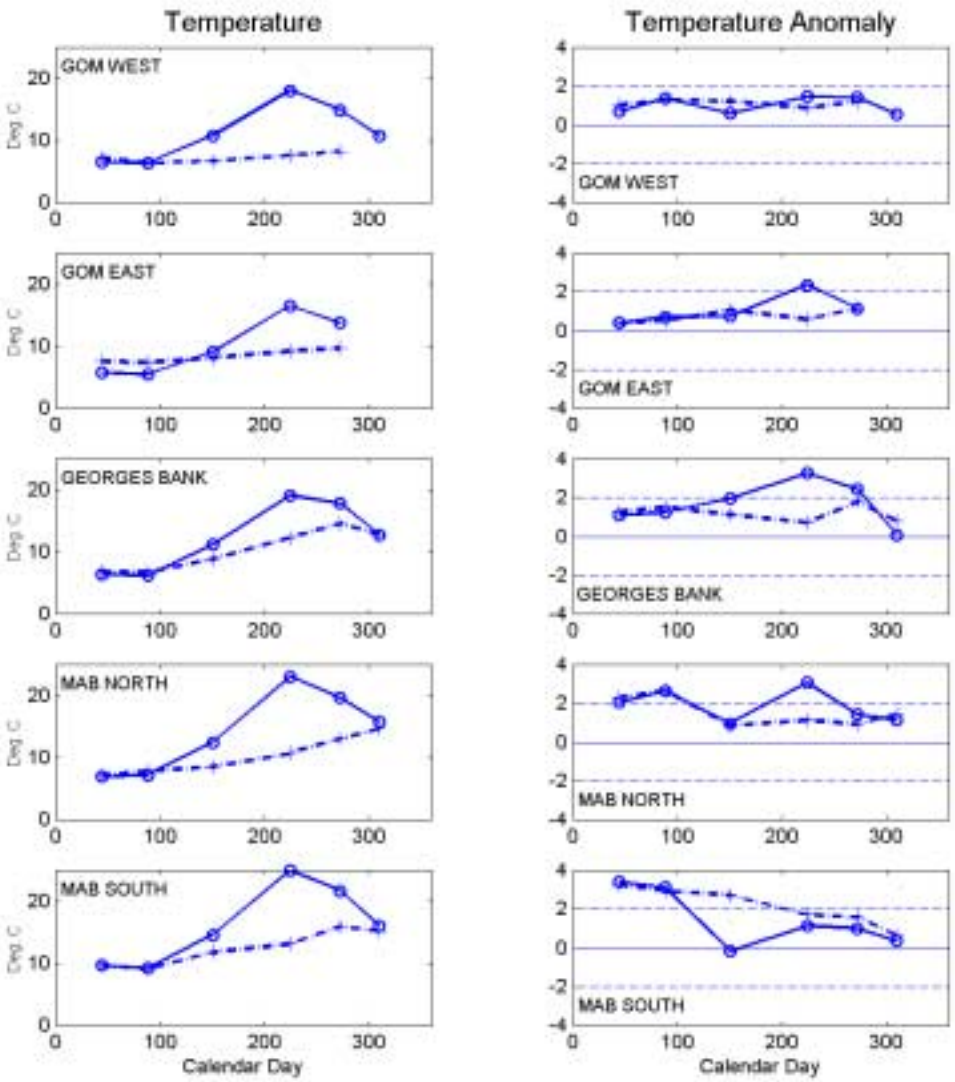


Figure 2. The 2002 areal average surface (-o) and bottom (--+) temperature and anomalies from Table 2.

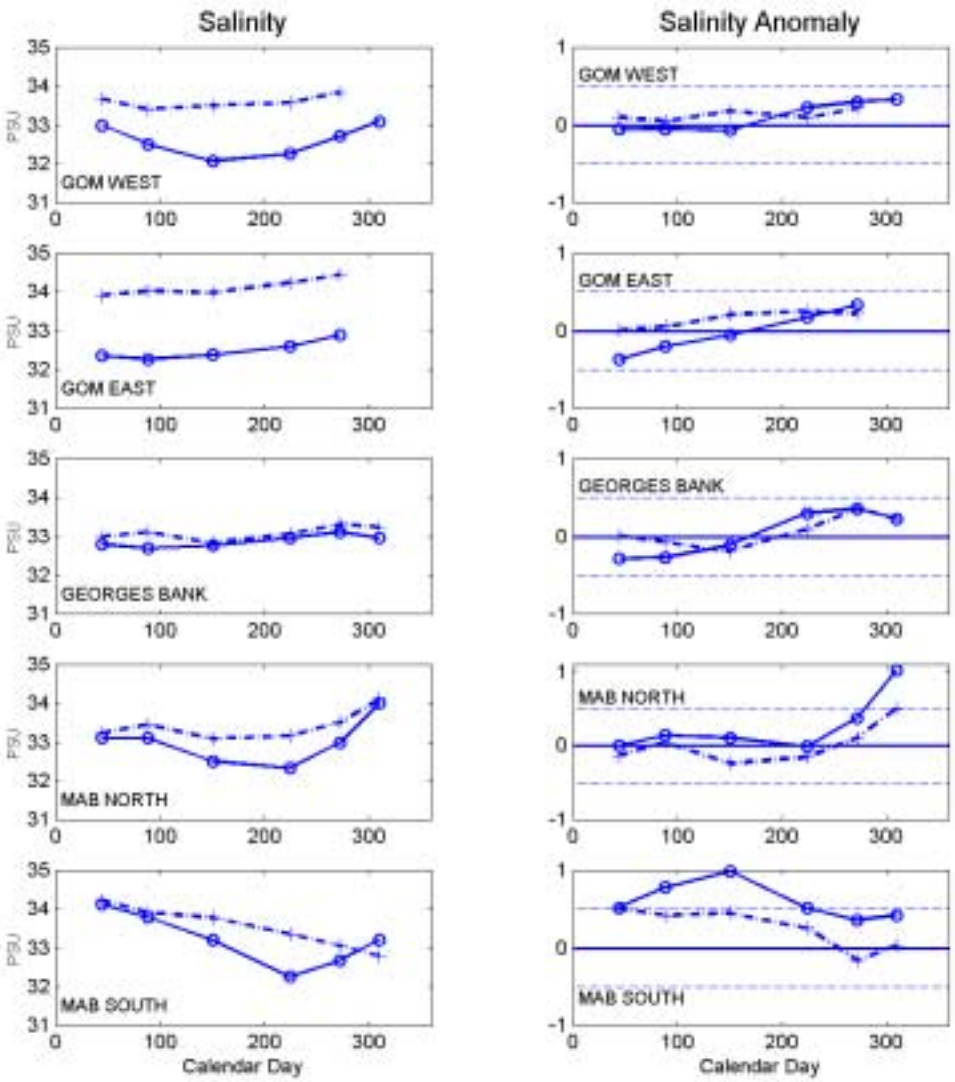


Figure 3. The 2002 areal average surface (-o) and bottom (--+) salinity and anomalies from Table 3.

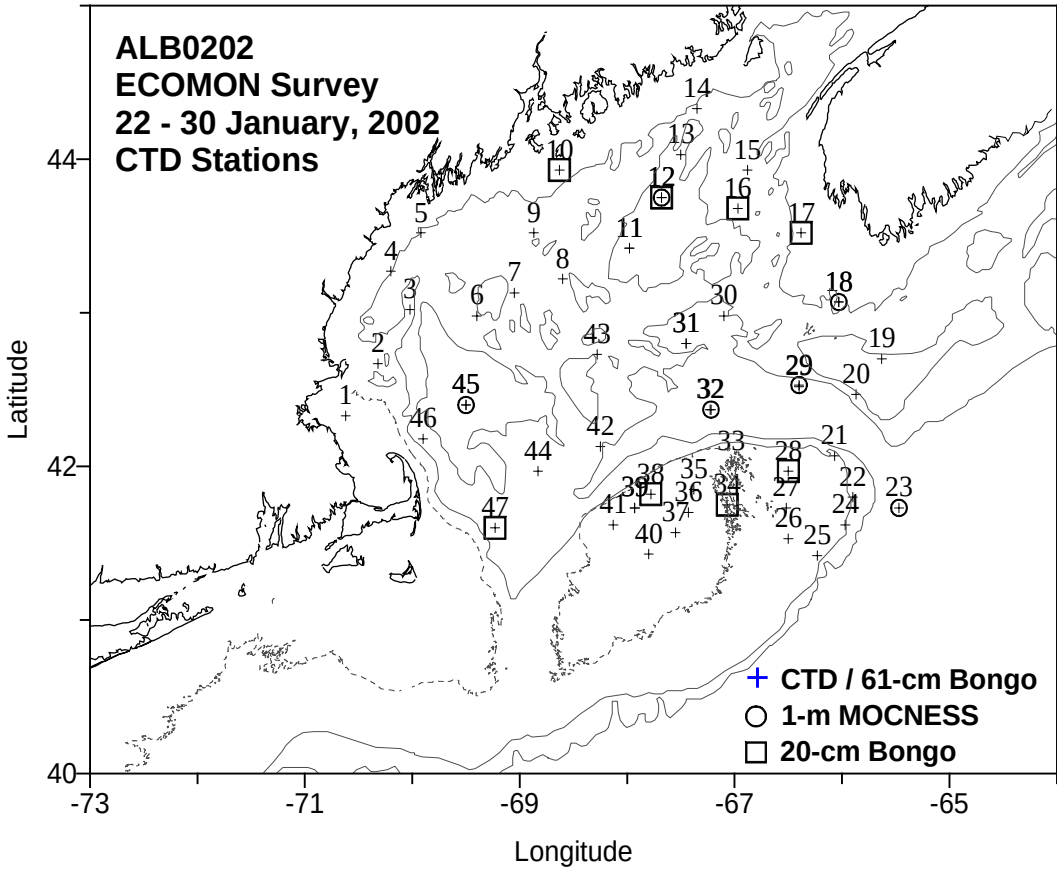


Figure 4. Hydrographic stations occupied during the ECOMON survey ALB0202.

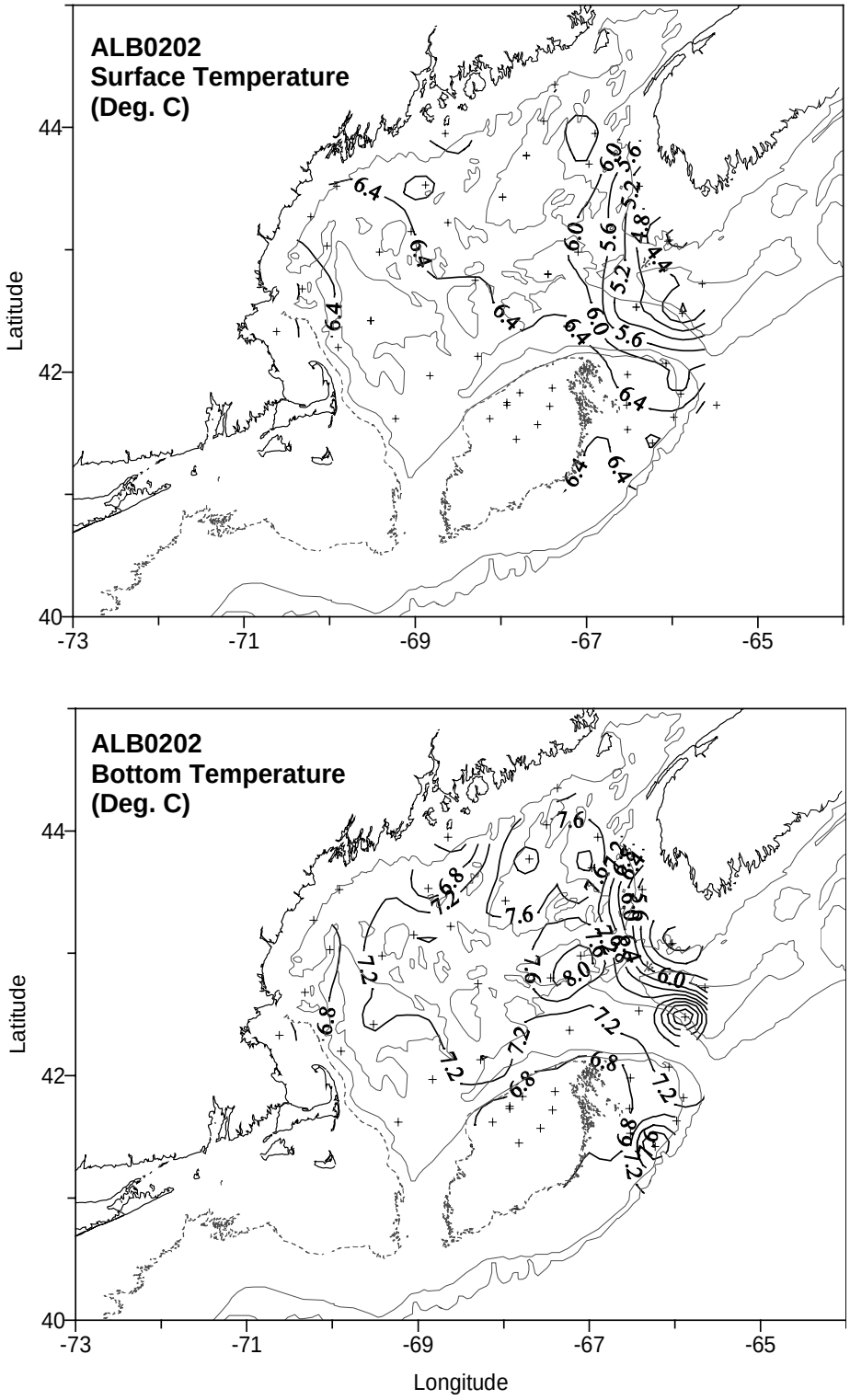


Figure 5. Surface and bottom temperature distributions for the ECOMON survey ALB0202.

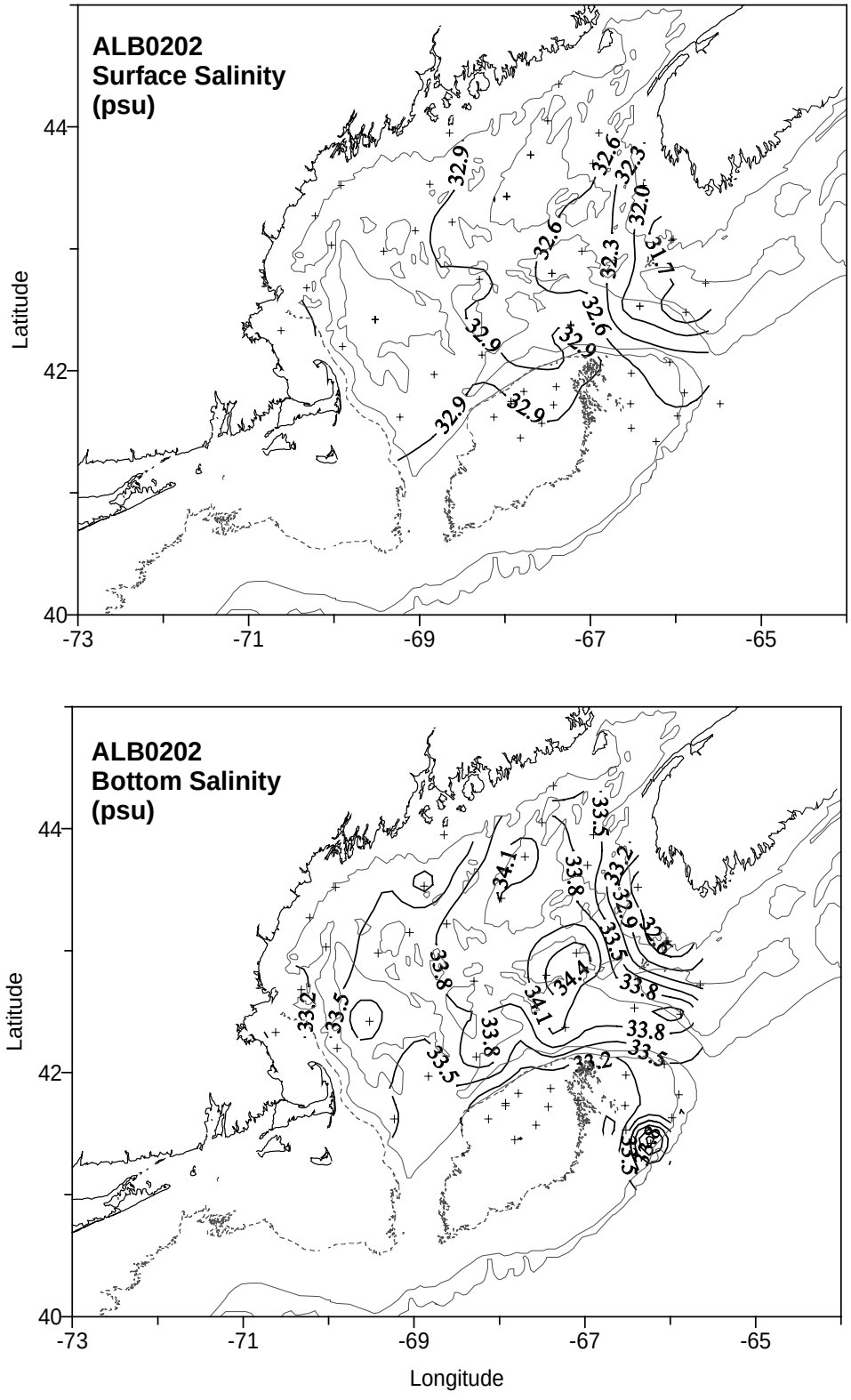


Figure 6. Surface and bottom salinity distributions for ECOMON survey ALB0202.

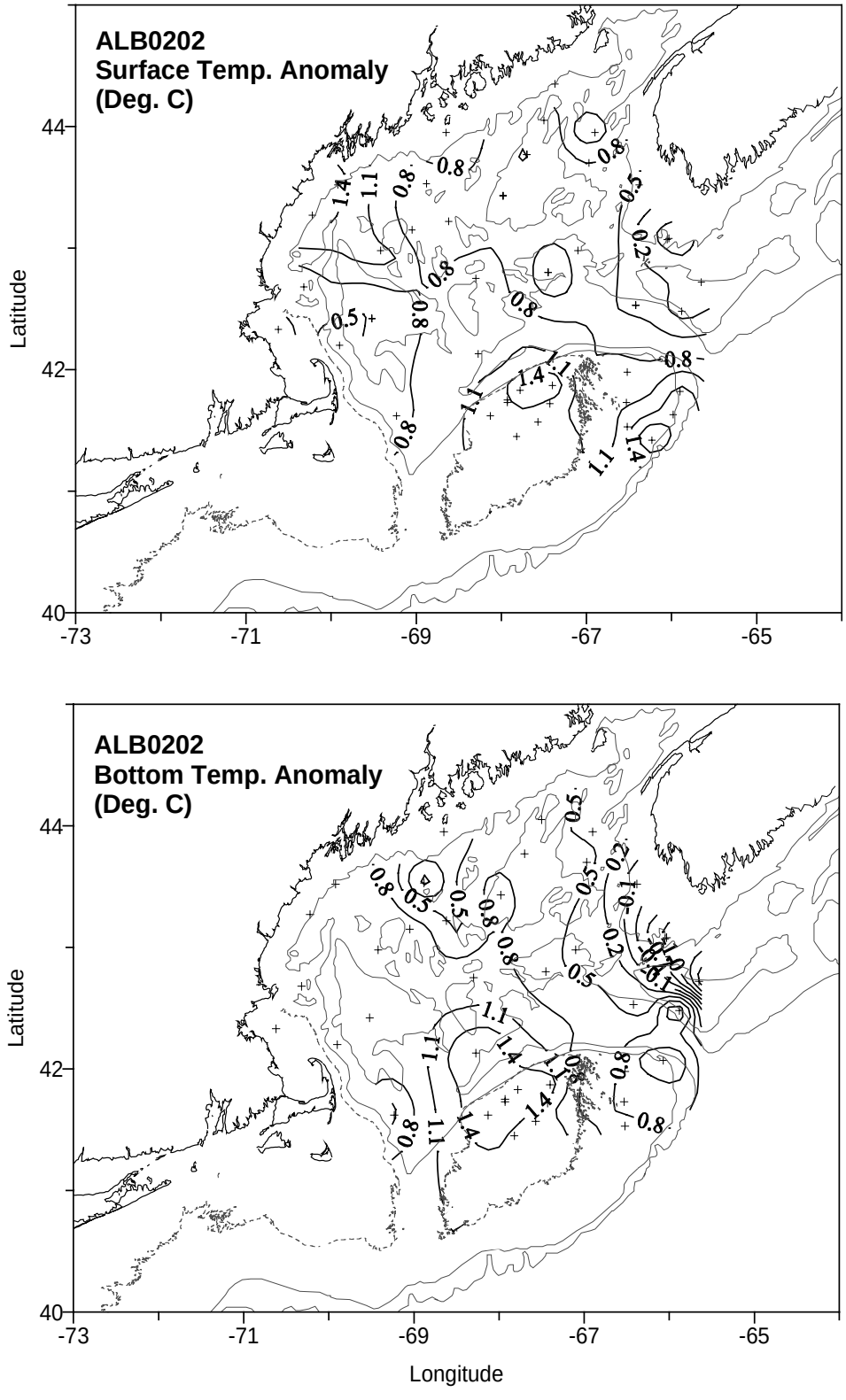


Figure 7. Surface and bottom temperature anomaly distributions for ECOMON survey ALB0202.

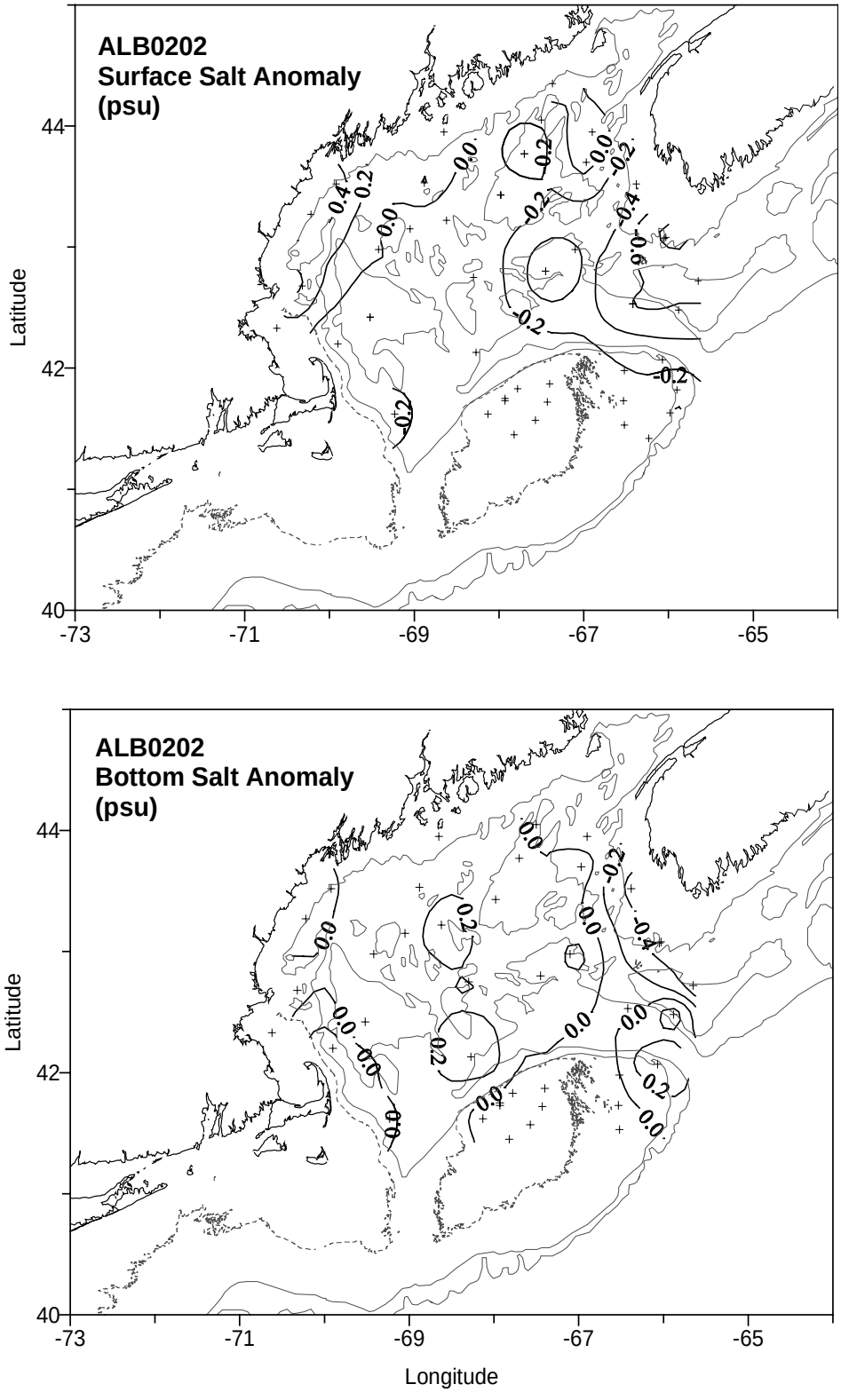


Figure 8. Surface and bottom salinity distributions for ECOMON survey ALB0202.

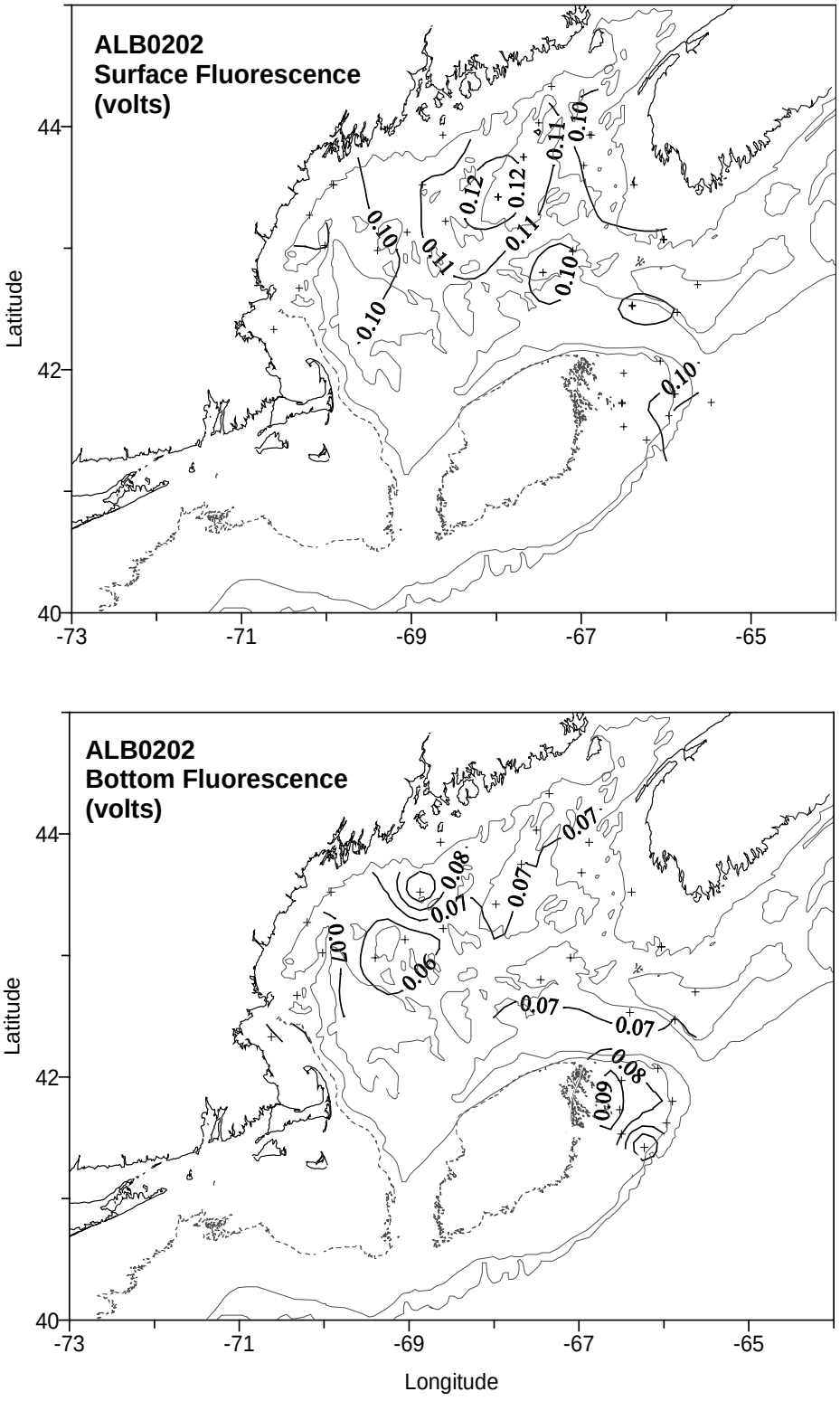


Figure 9. Surface and bottom fluorescence distributions for ECOMON survey ALB0202.

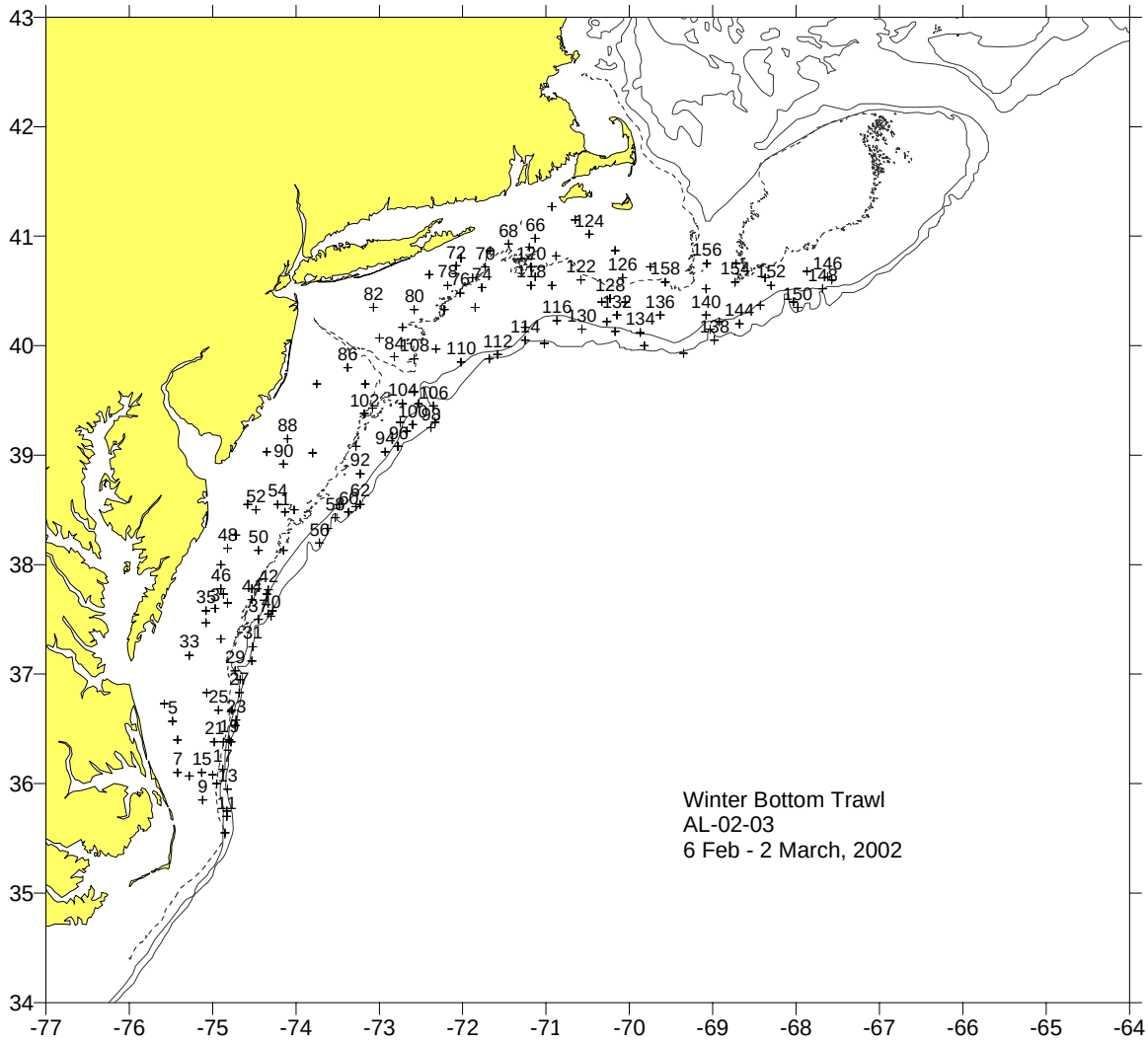


Figure 10. Hydrographic stations occupied during the Winter Bottom Trawl survey ALB0203.

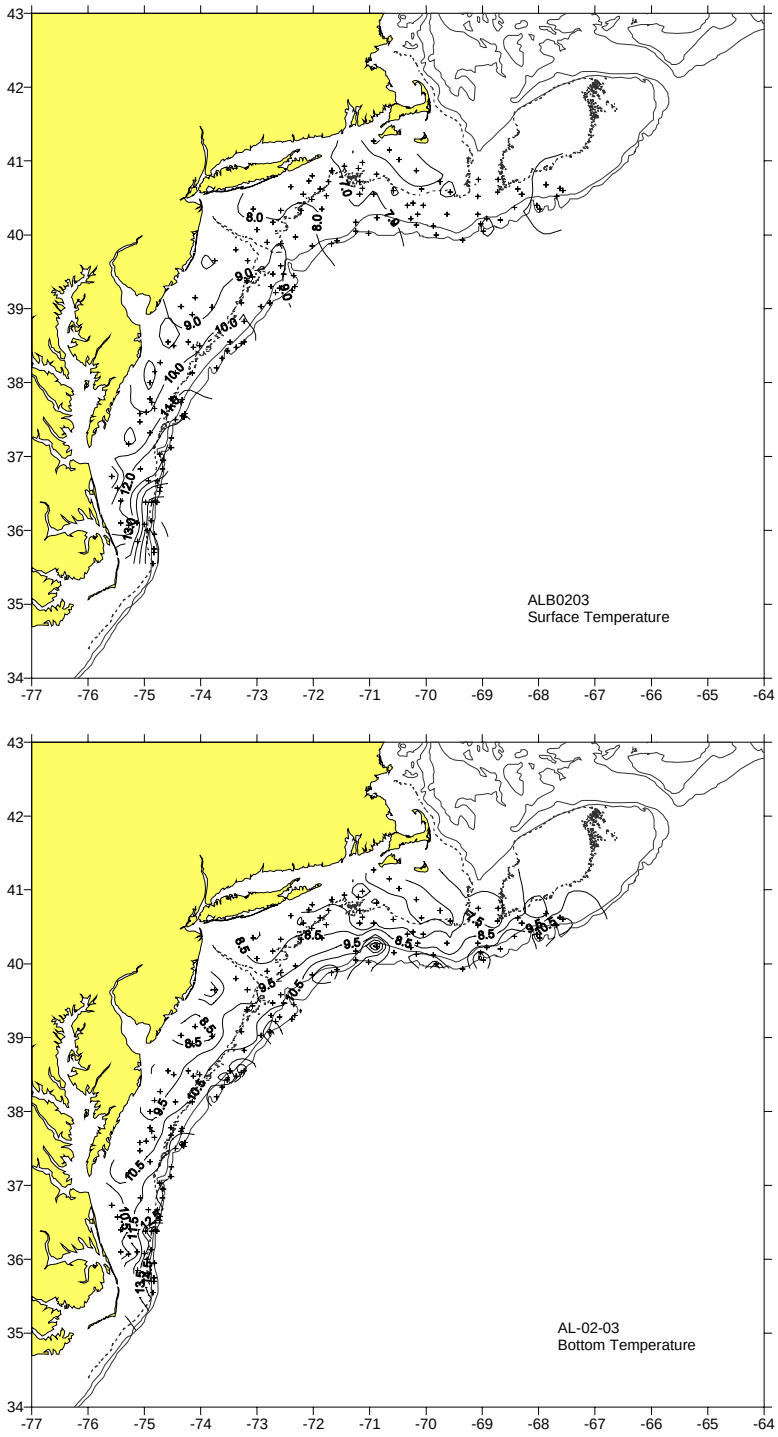


Figure 11. Surface and bottom temperature distributions during the Winter Bottom Trawl survey ALB0203.

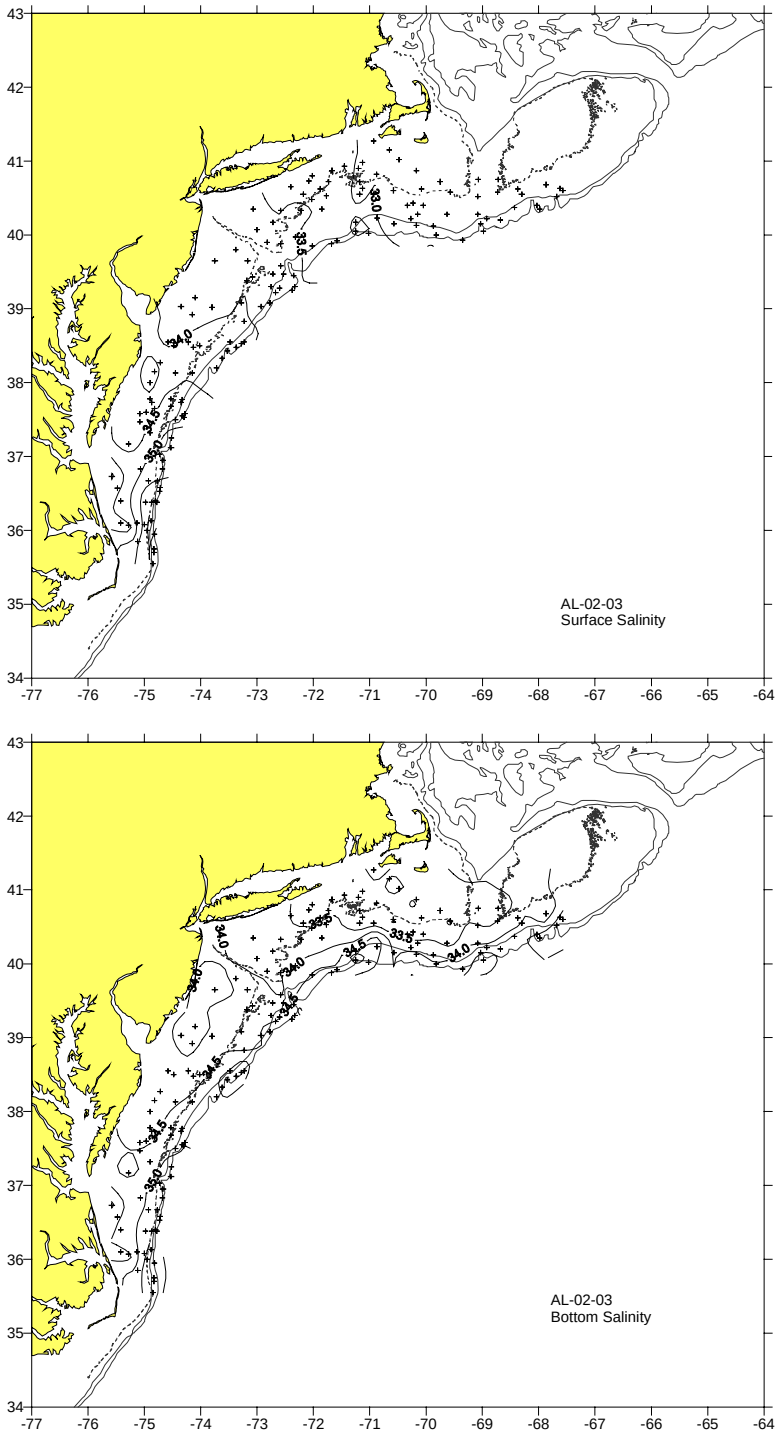


Figure 12. Surface and bottom salinity distributions during the Winter Bottom Trawl survey ALB0203.

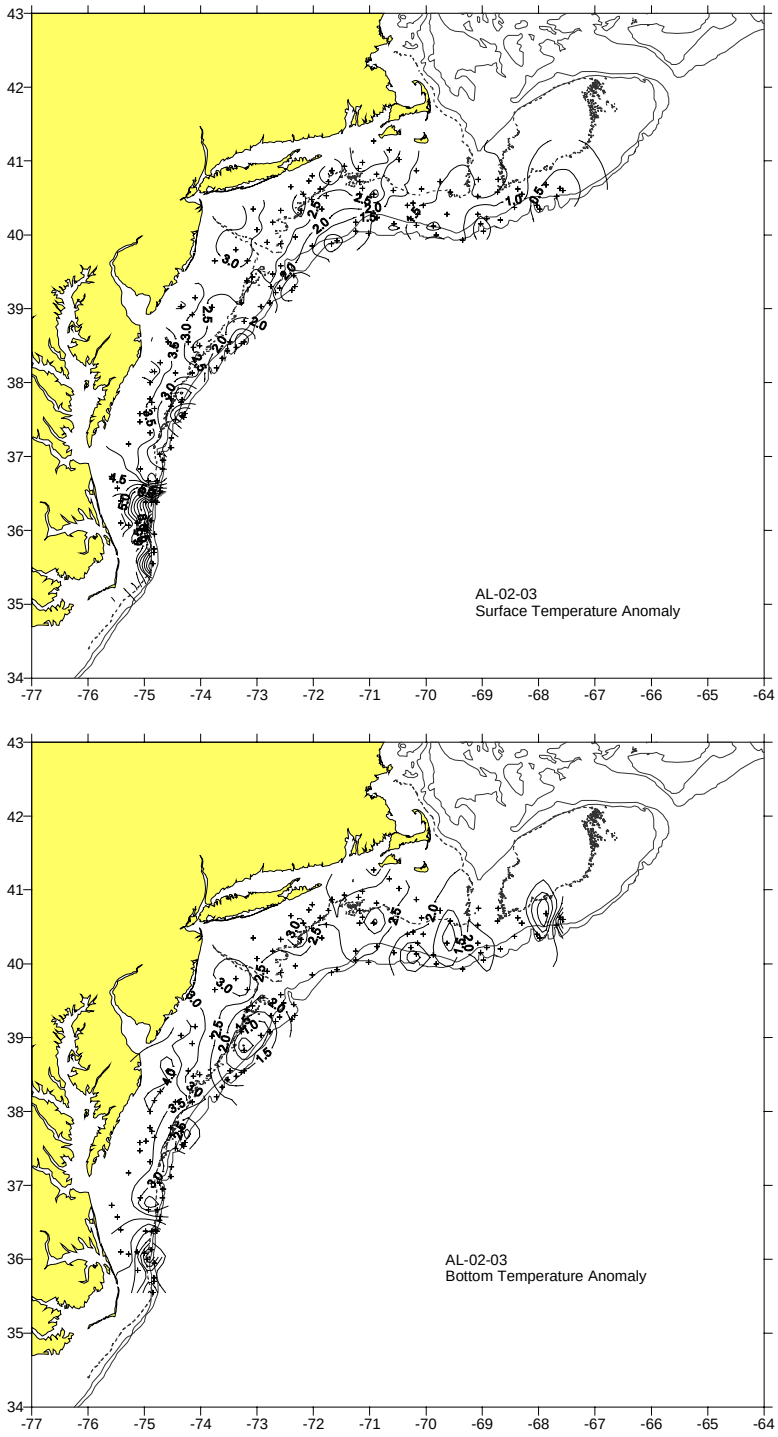


Figure 13. Surface and bottom temperature anomaly distributions during the Winter Bottom Trawl survey ALB0203.

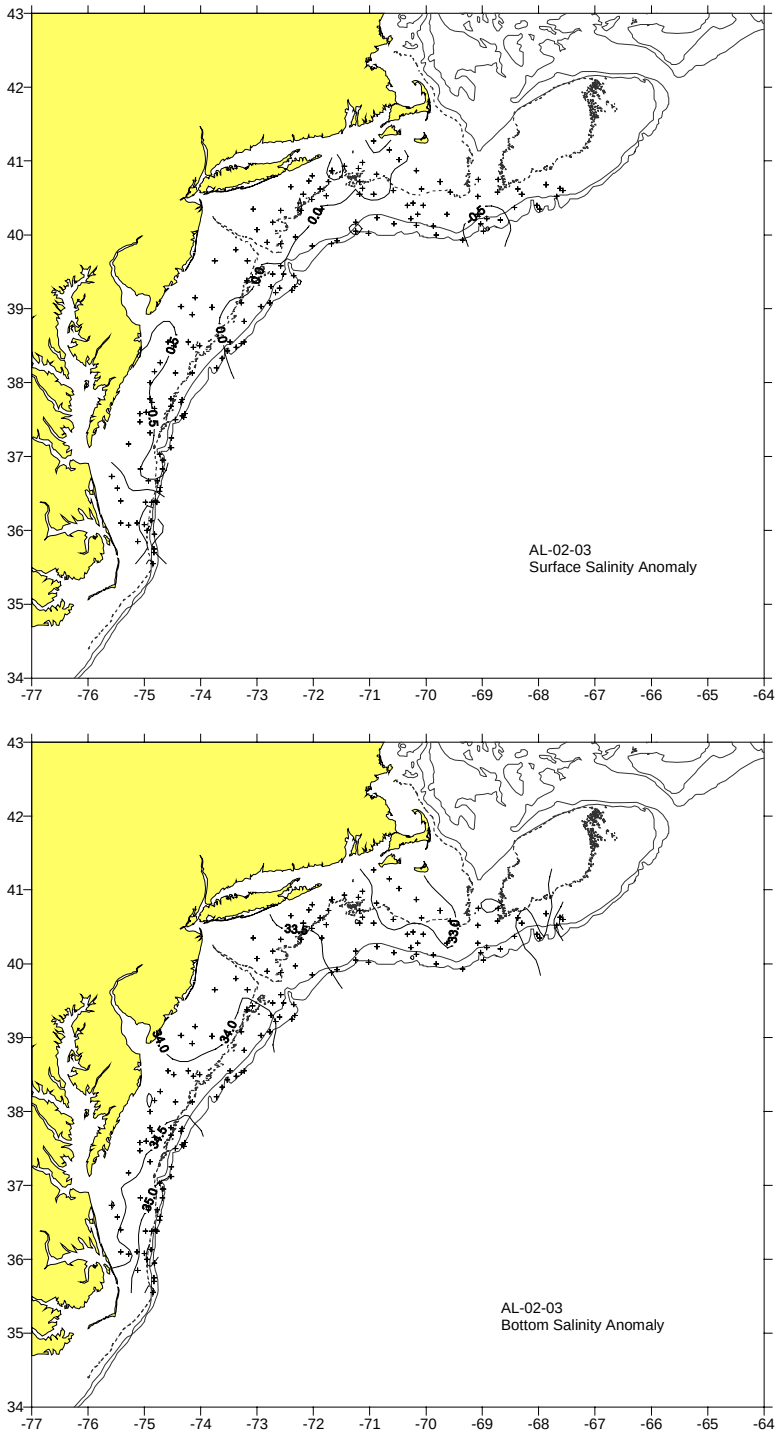


Figure 14. Surface and bottom salinity anomaly distributions during the Winter Bottom Trawl survey ALB0203.

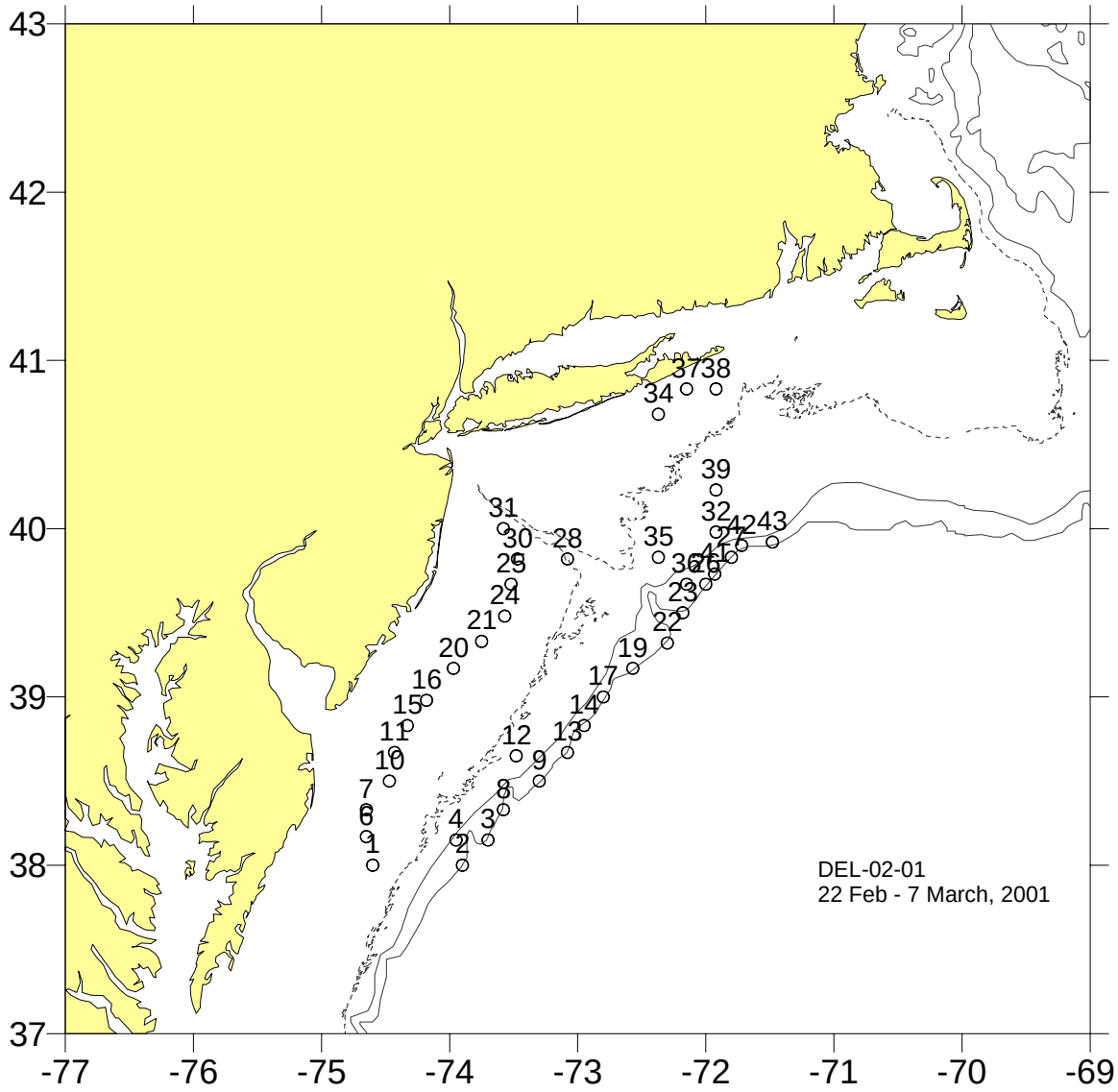


Figure 15. Hydrographic stations occupied during HydroAcoustic survey DEL0201.

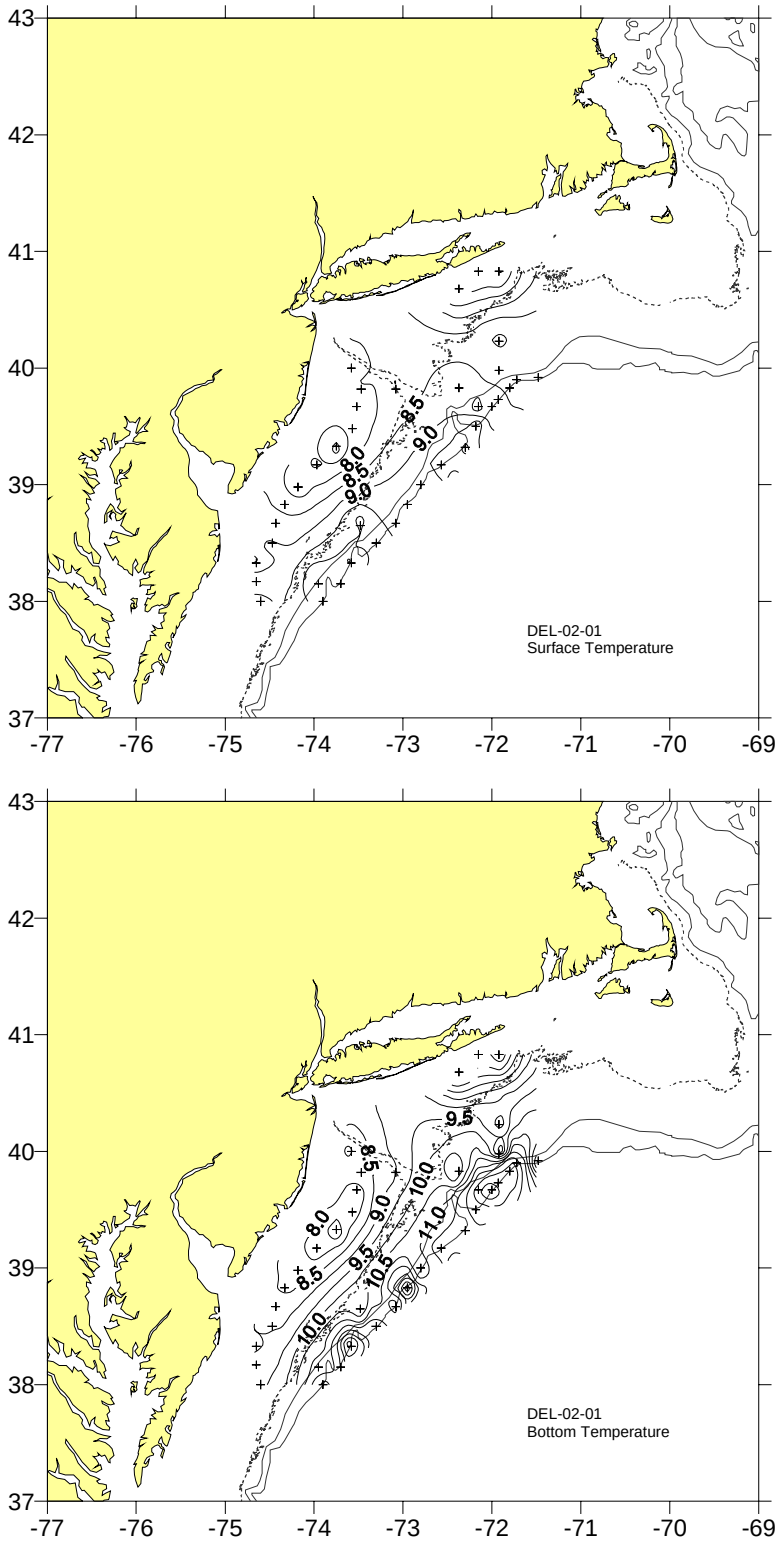


Figure 16. Surface and bottom temperature distributions for HydroAcoustic survey DEL0201.

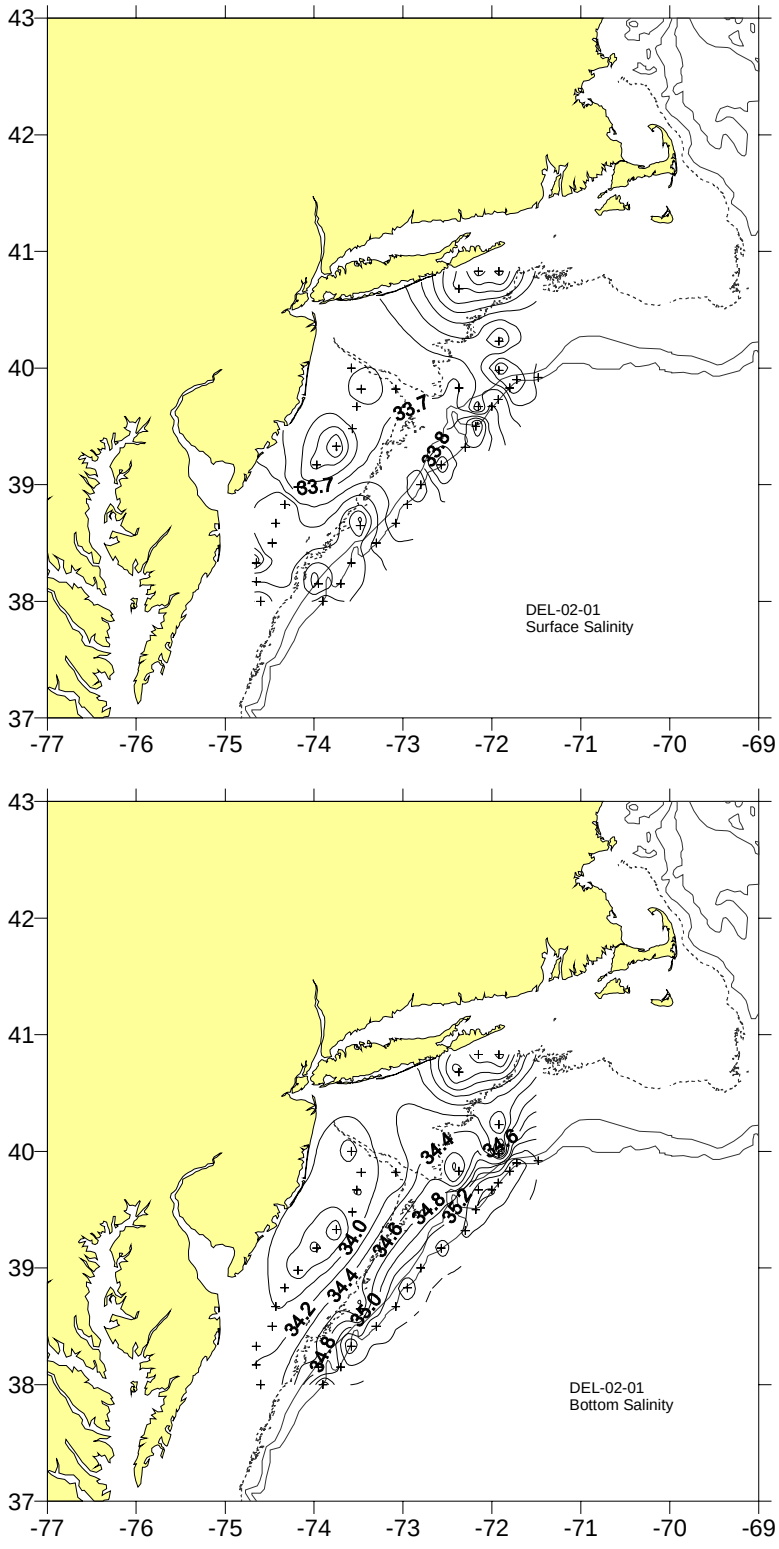


Figure 17. Surface and bottom salinity distributions for HydroAcoustic survey DEL0201.

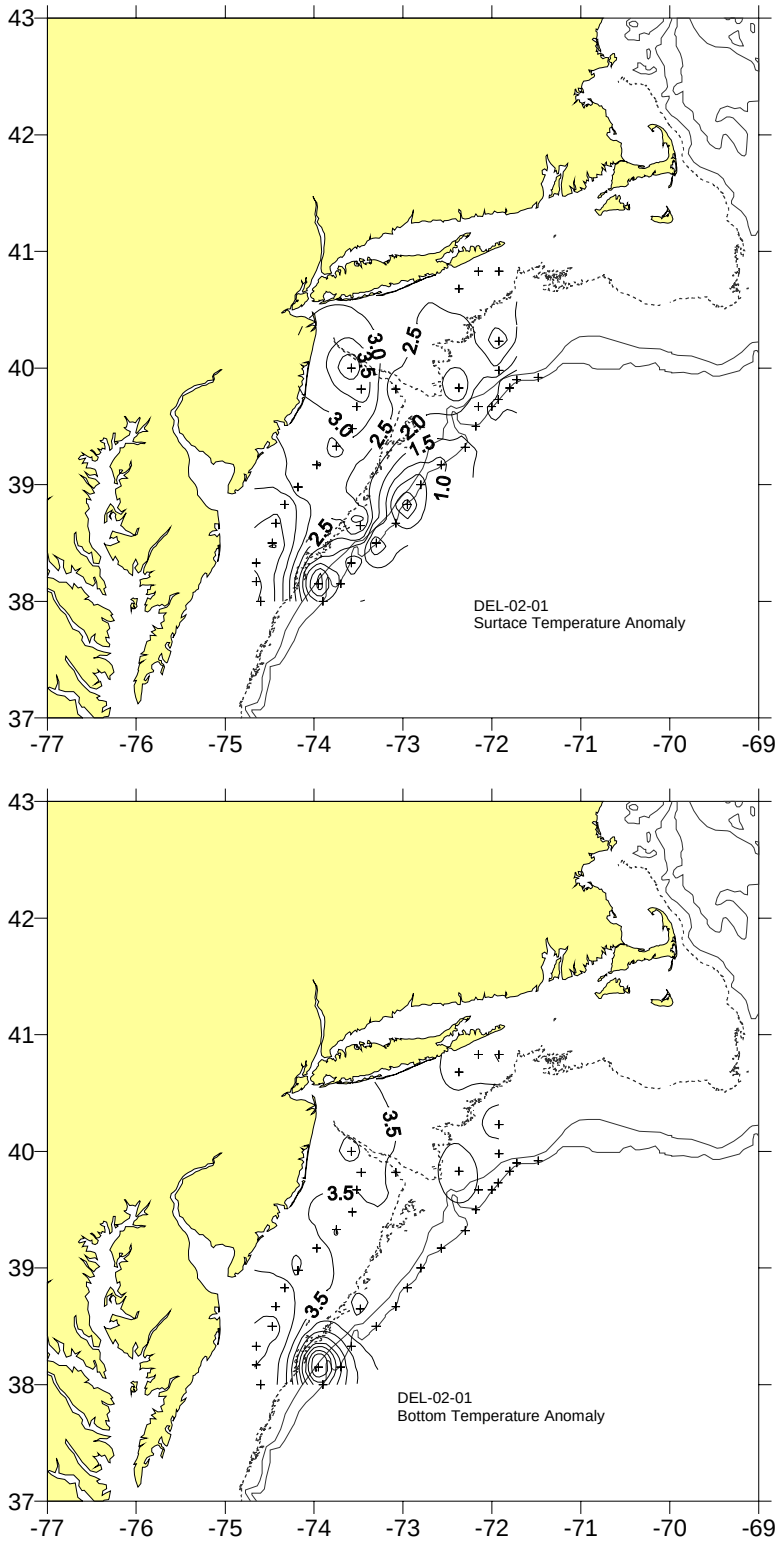


Figure 18. Surface and bottom temperature anomaly distributions for HydroAcoustic survey DEL0201.

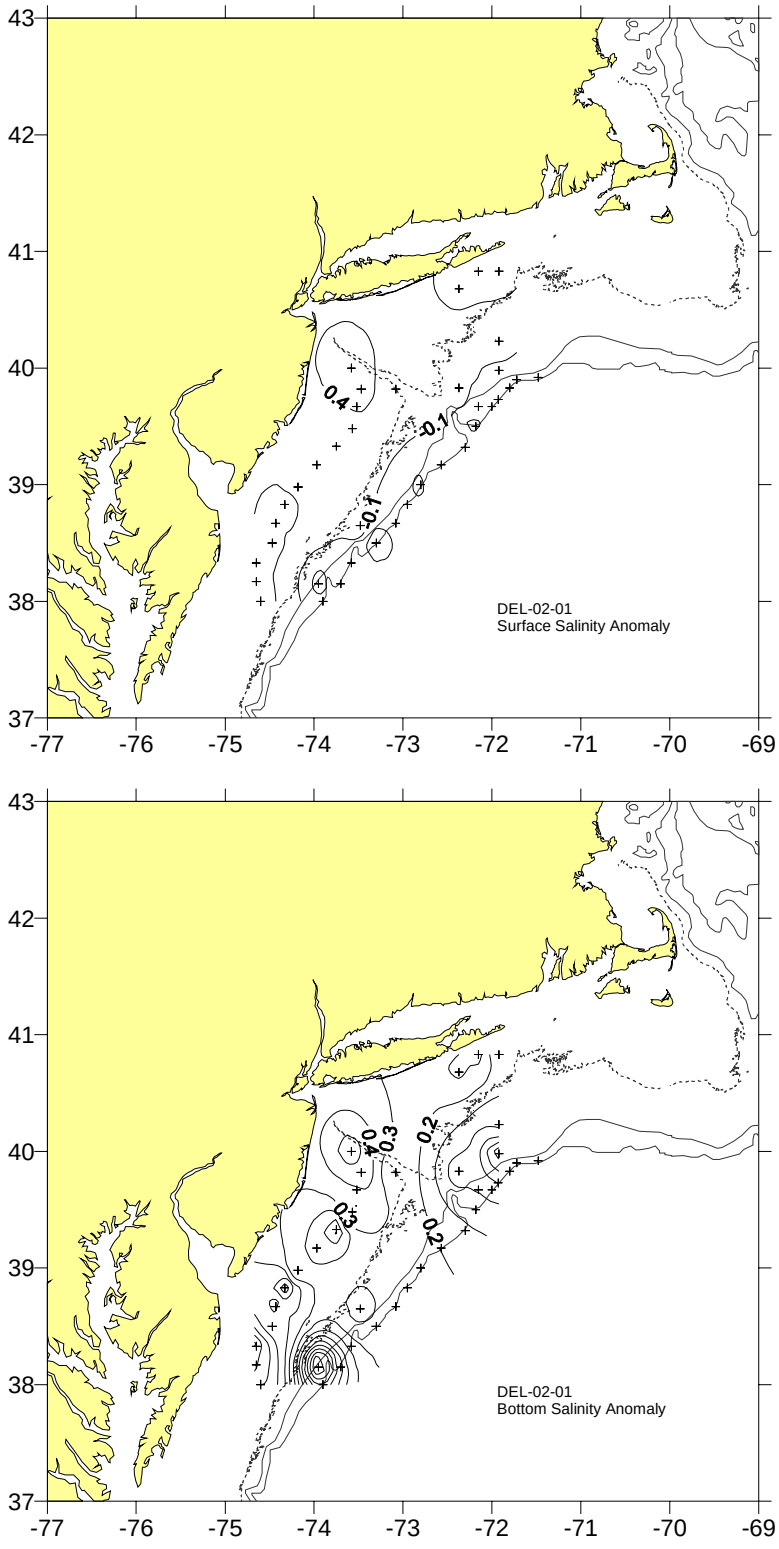


Figure 19. Surface and bottom salinity anomaly distributions for HydroAcoustic survey DEL0201.

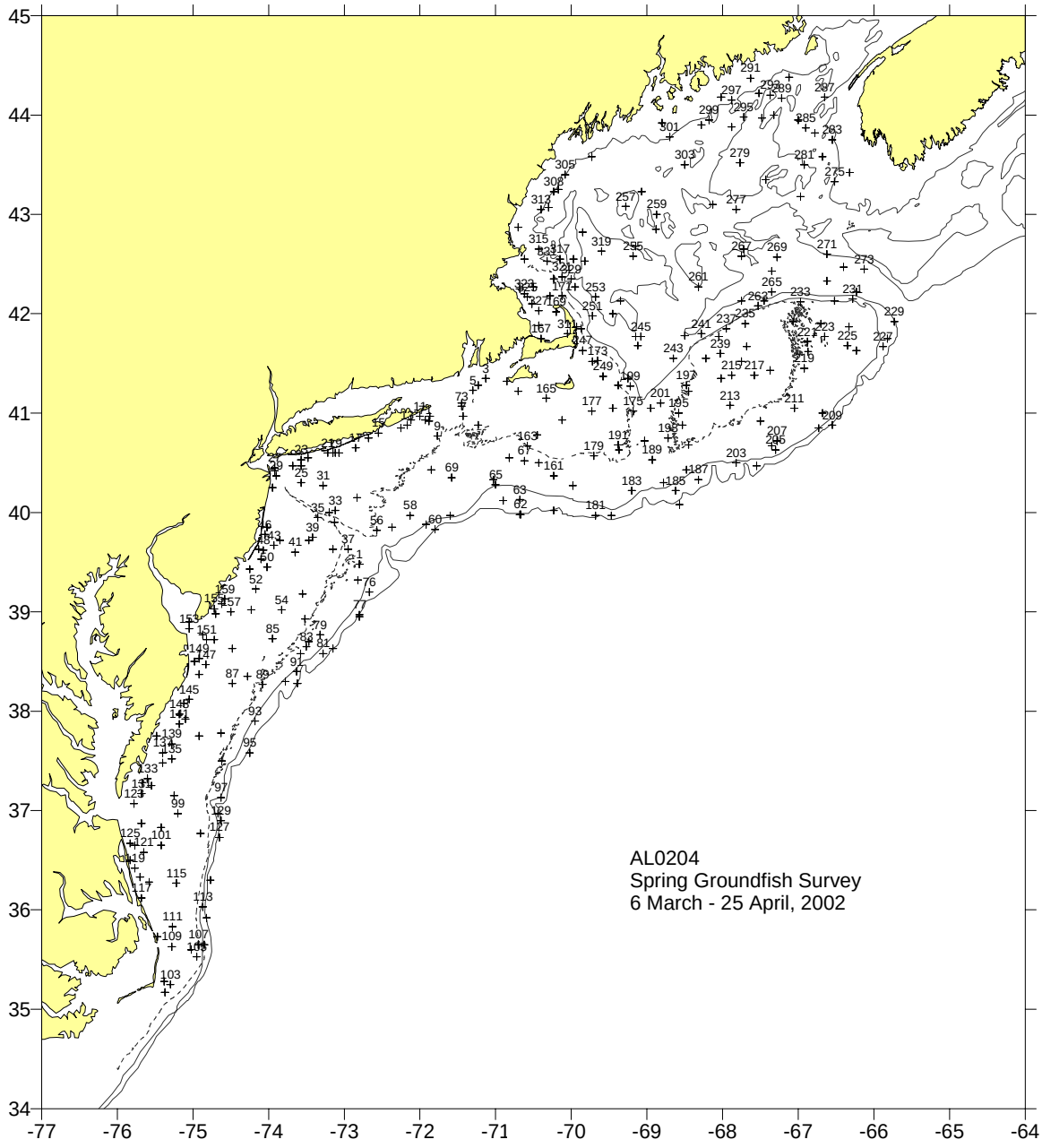


Figure 20. Hydrographic stations occupied during the Spring Bottom Trawl survey ALB0204.

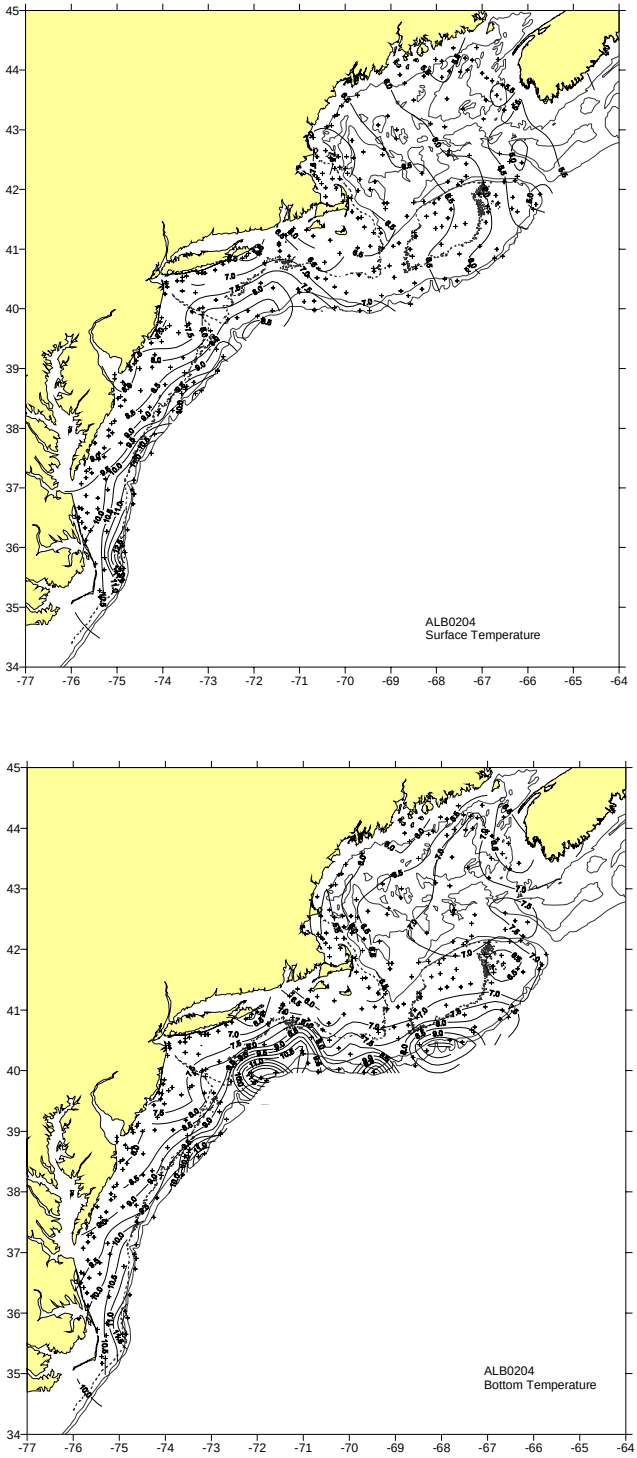


Figure 21. Surface and bottom temperature distributions for the Winter Bottom Trawl survey ALB0204.

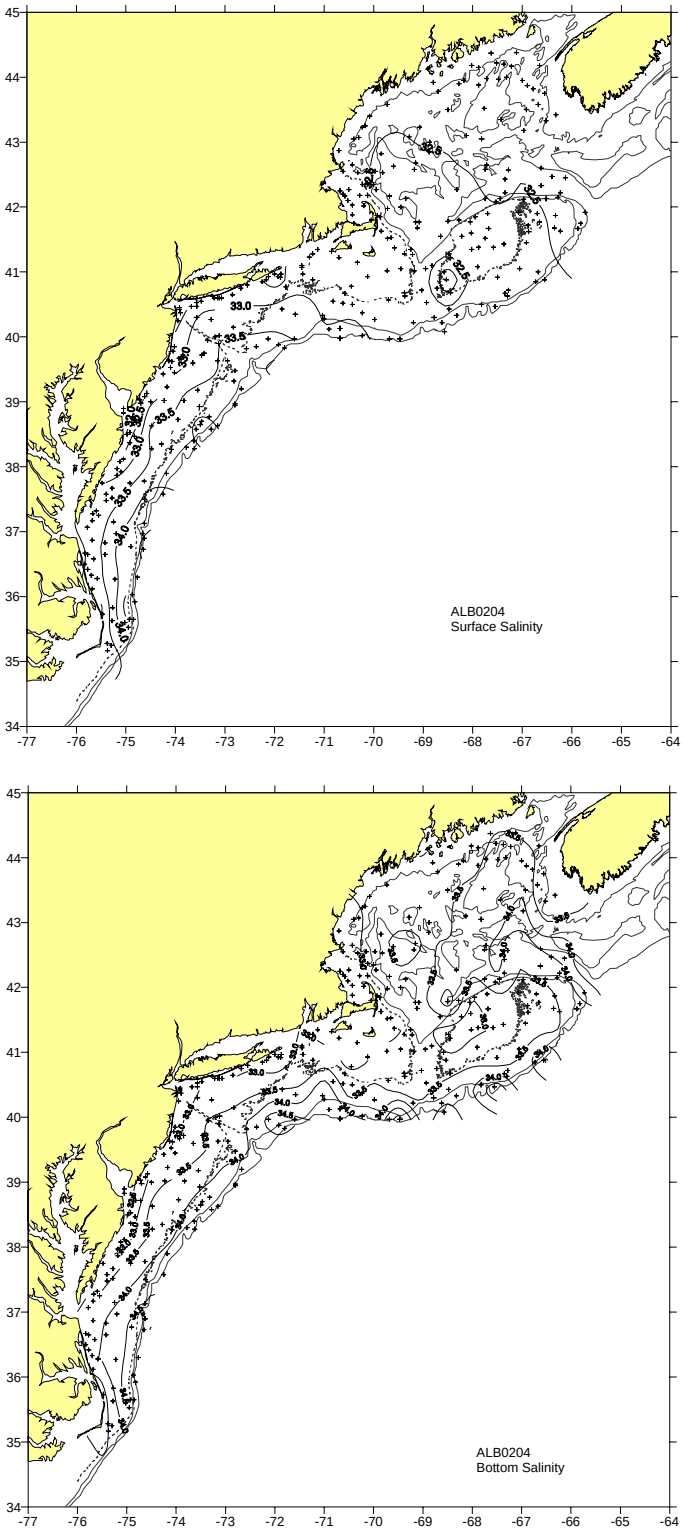


Figure 22. Surface and bottom salinity distributions for the Winter Bottom Trawl survey ALB0204.

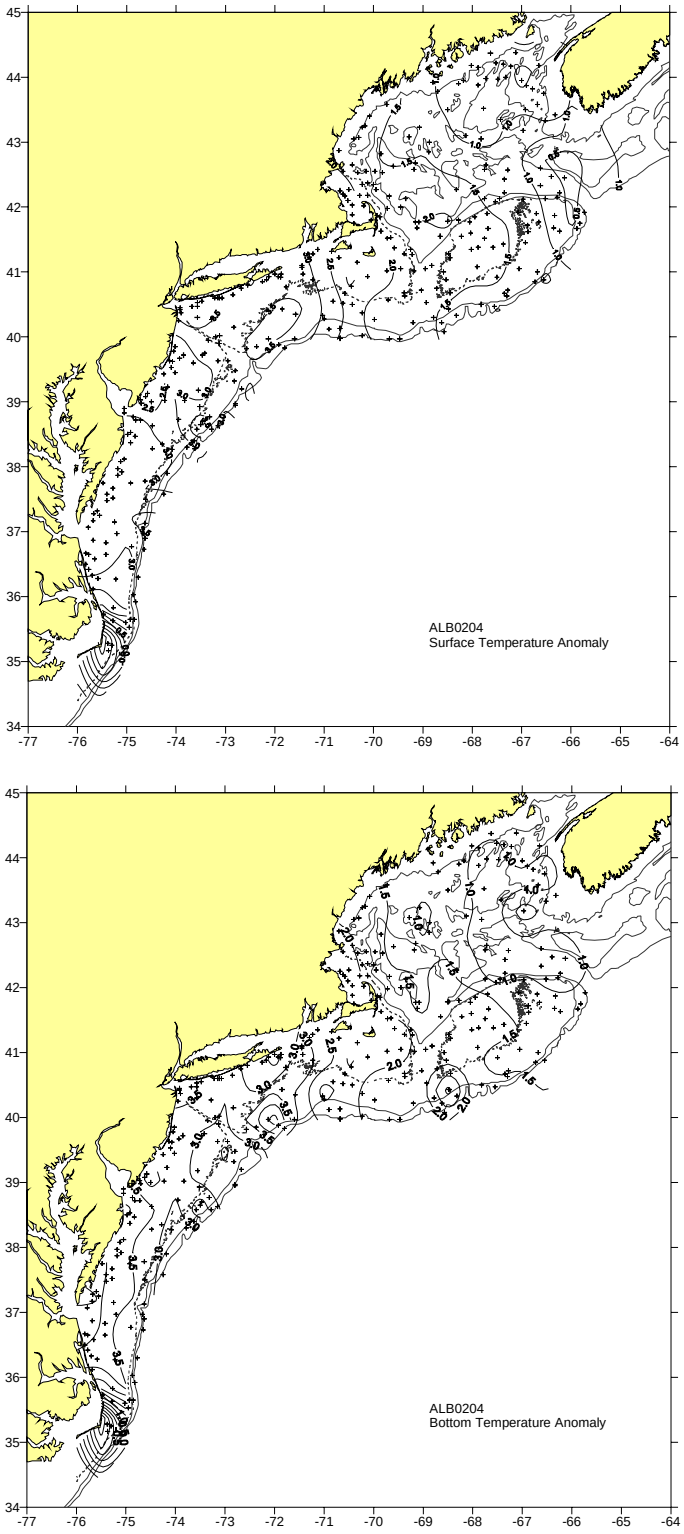


Figure 23. Surface and bottom temperature anomaly distributions for the Winter Bottom Trawl survey ALB0204.

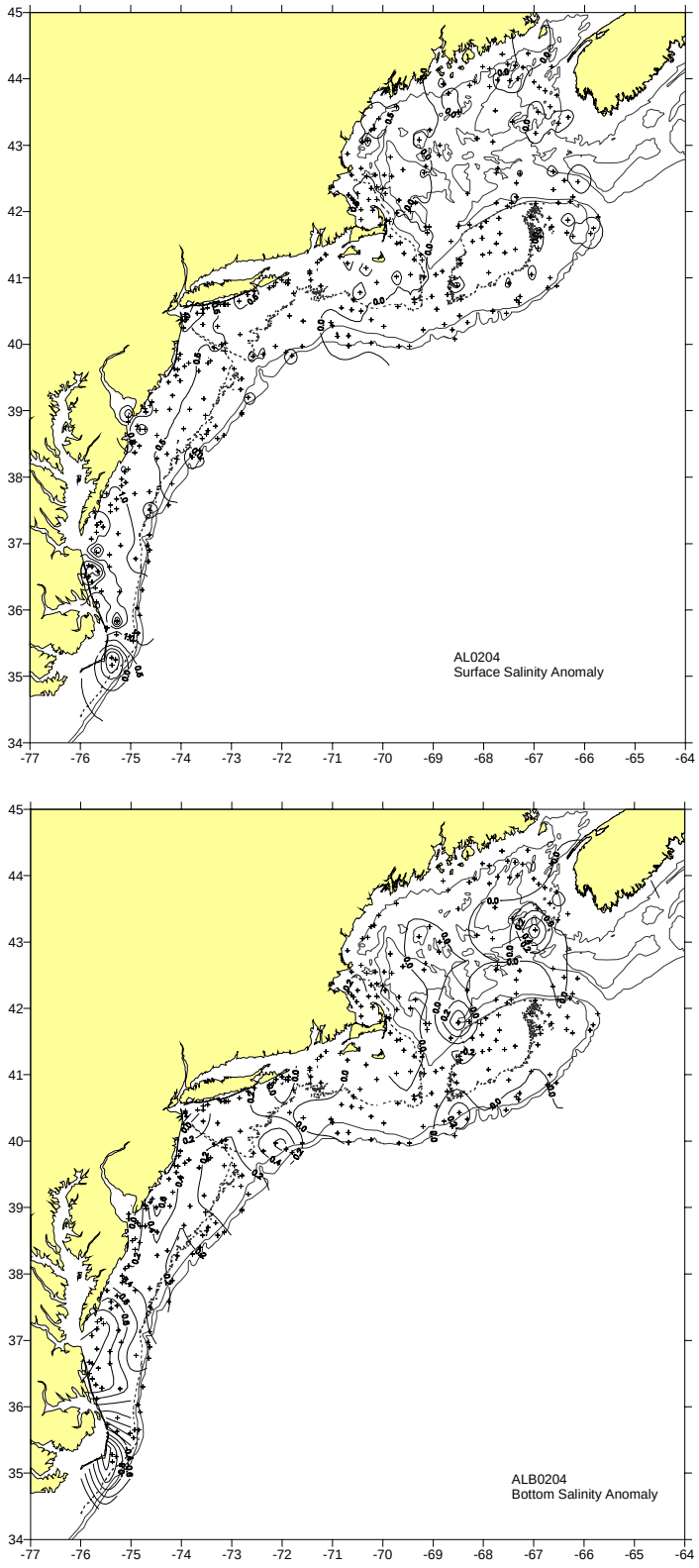


Figure 24. Surface and bottom salinity anomaly distributions for the Winter Bottom Trawl survey ALB0204.

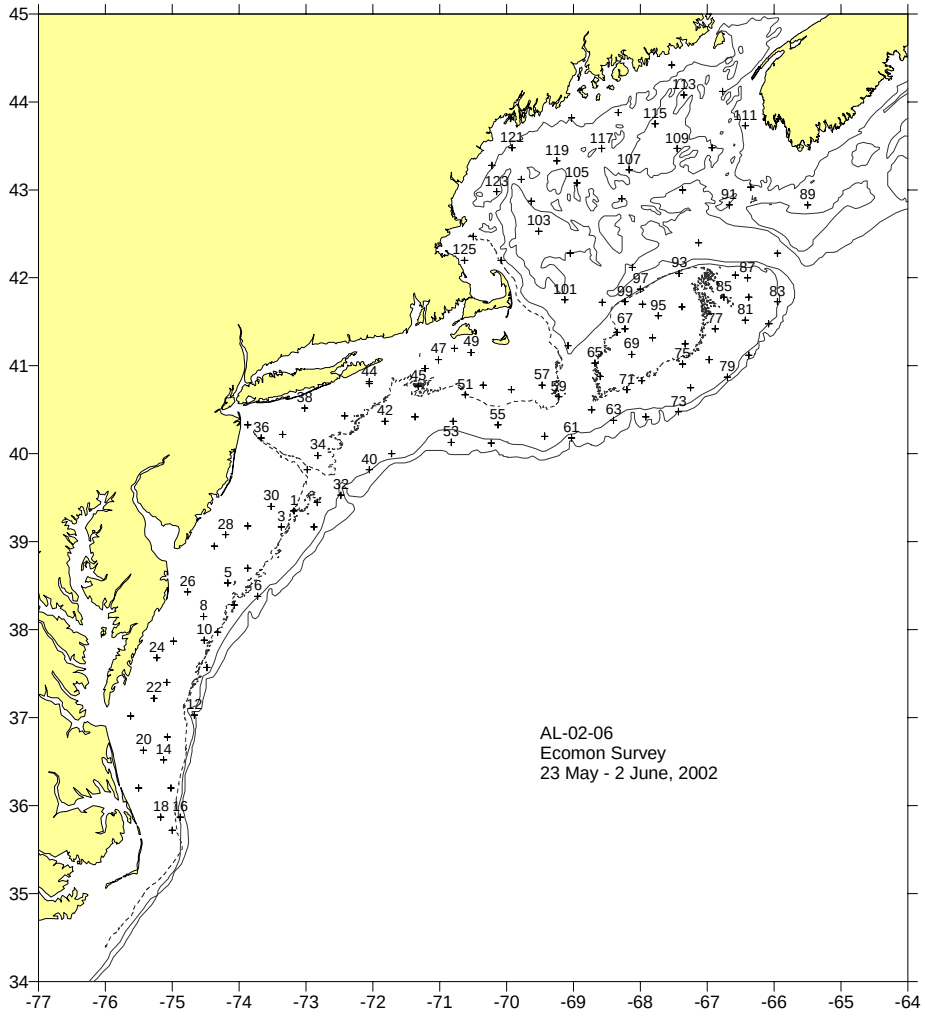


Figure 25. Hydrographic stations occupied during ECOMON survey ALB0206.

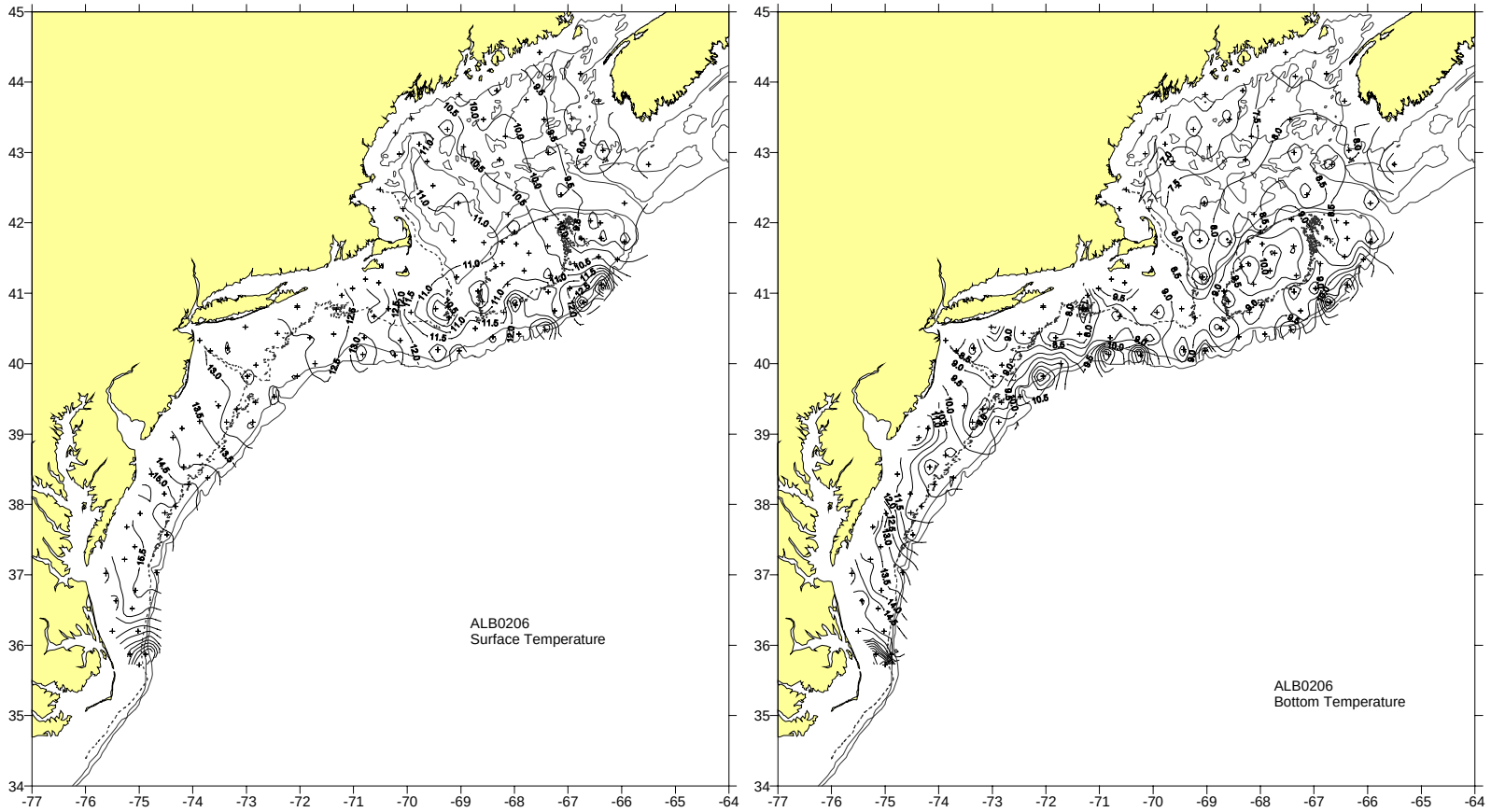


Figure 26. Surface and bottom temperature distributions for ECOMON survey ALB0206.

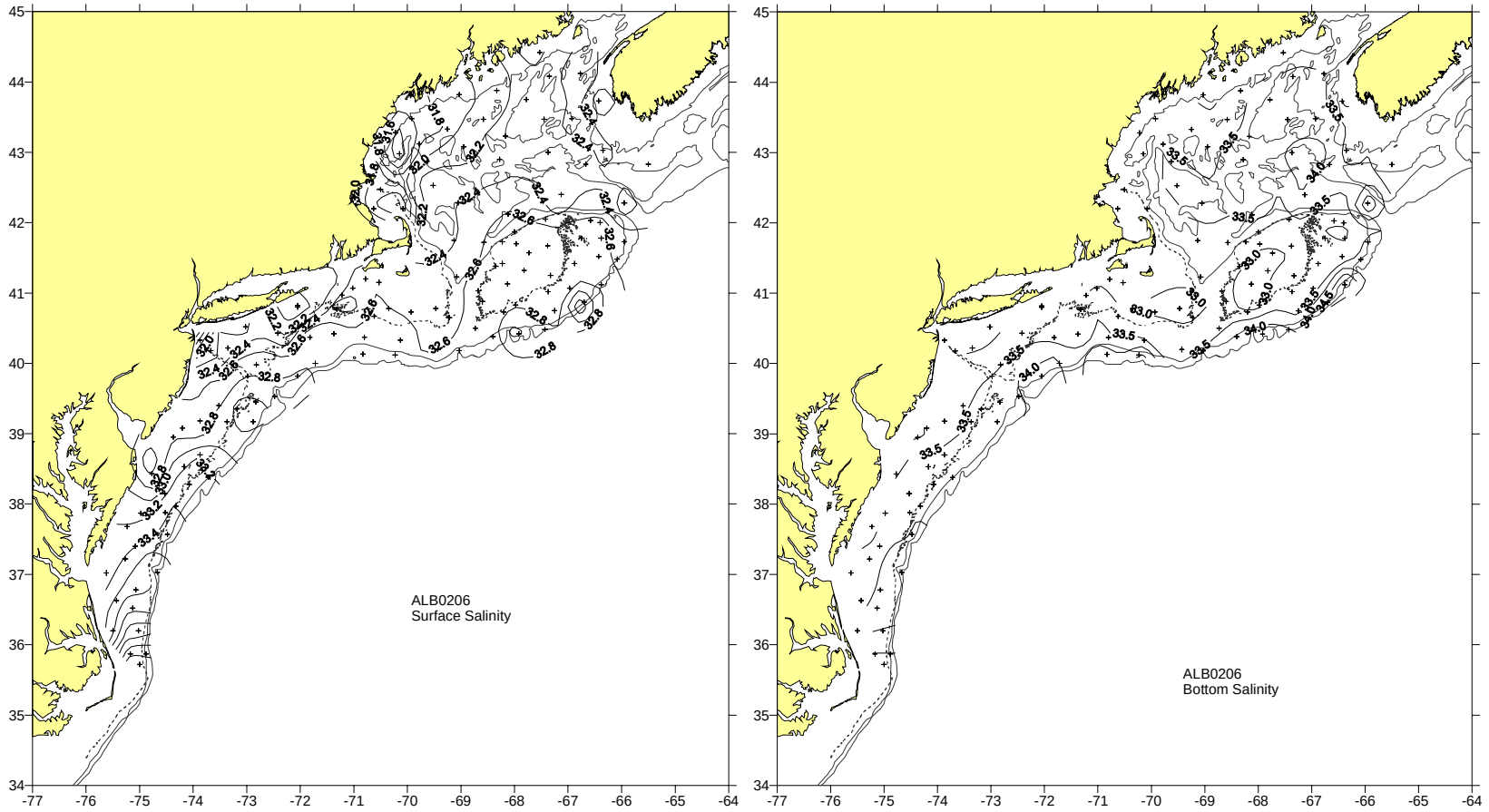


Figure 27. Surface and bottom salinity distributions for ECOMON survey ALB0206.

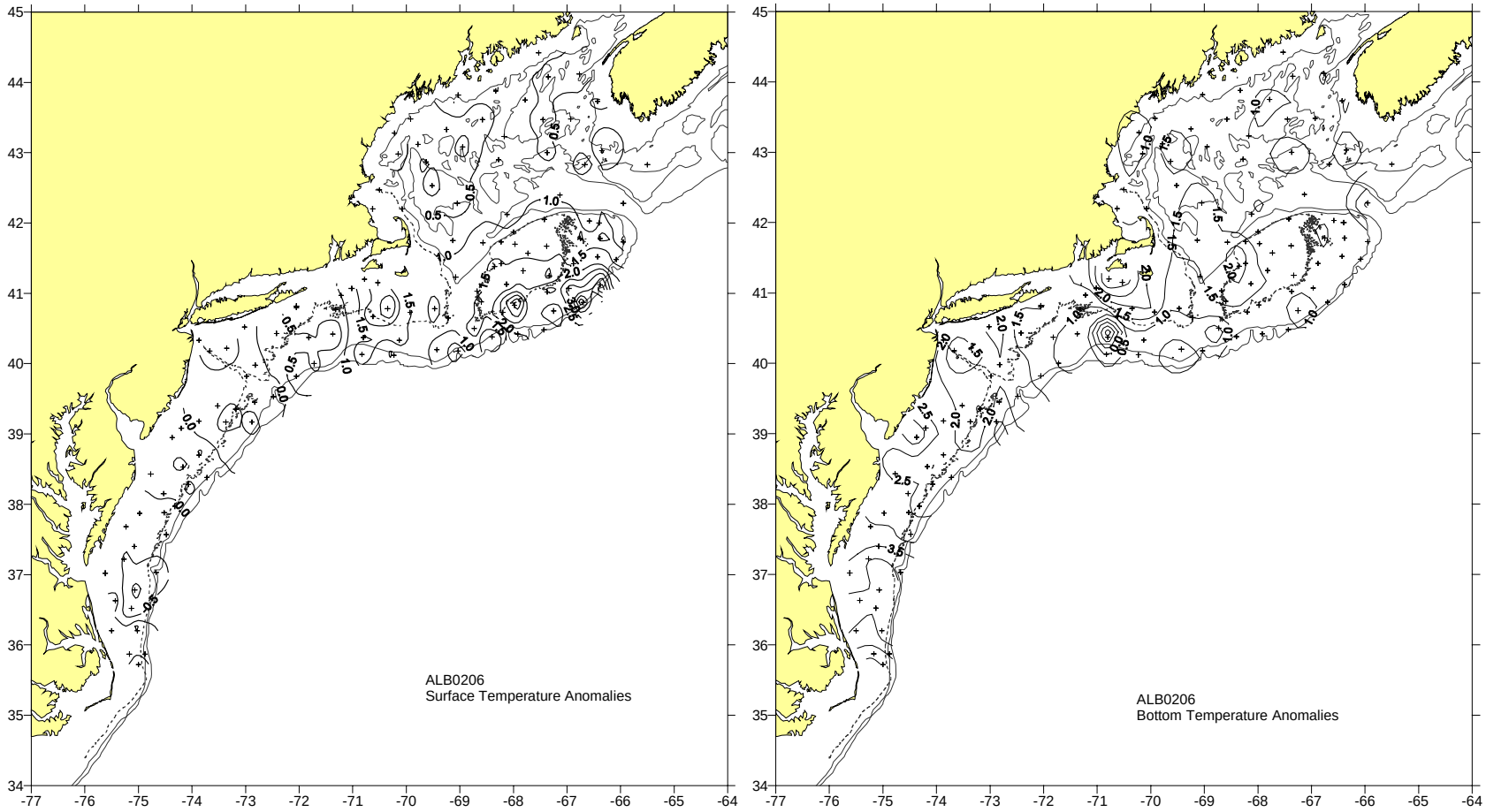


Figure 28. Surface and bottom temperature anomaly distributions for ECOMON survey ALB0206.

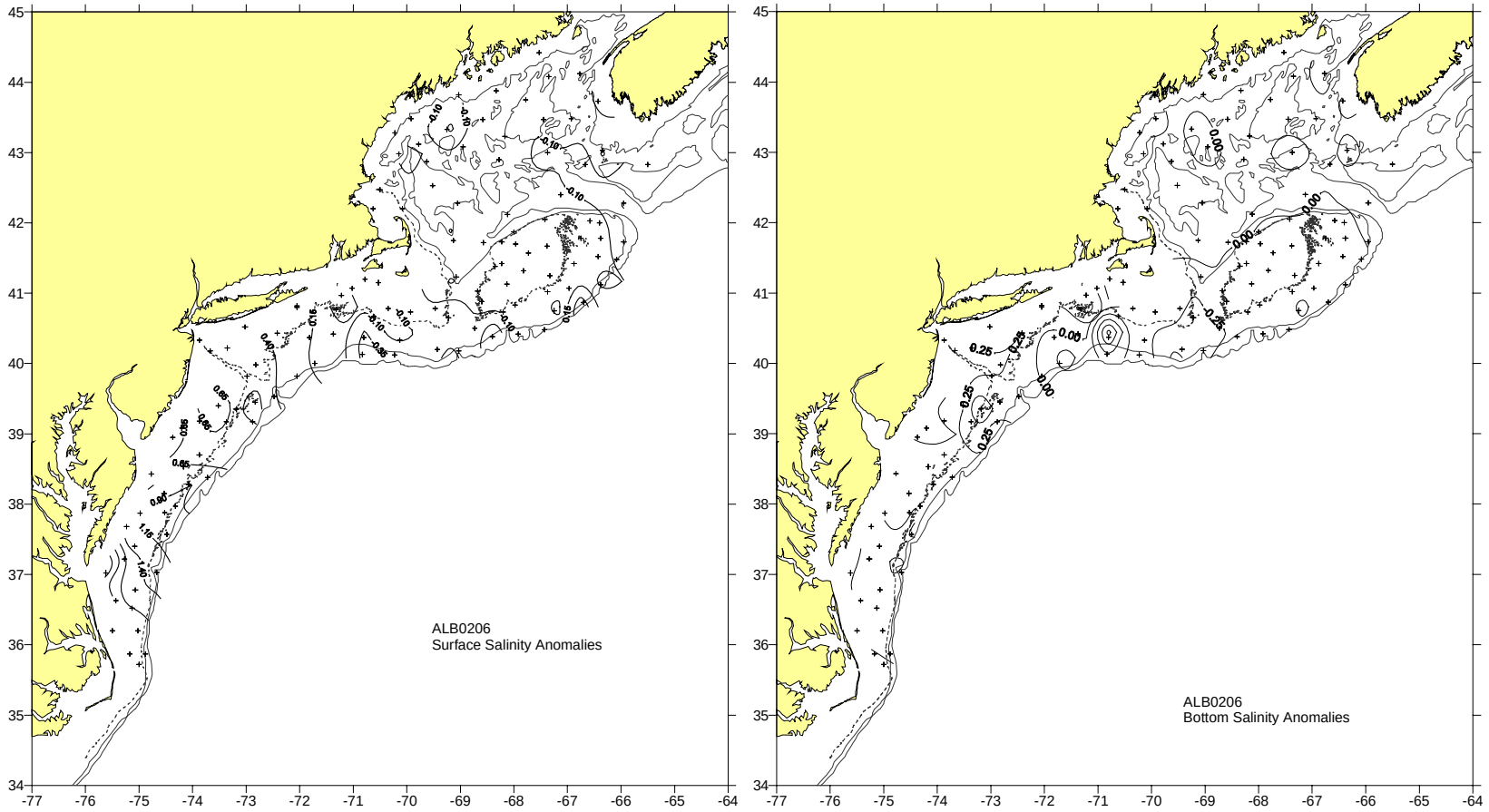


Figure 29. Surface and bottom salinity anomaly distributions for ECOMON survey ALB0206.

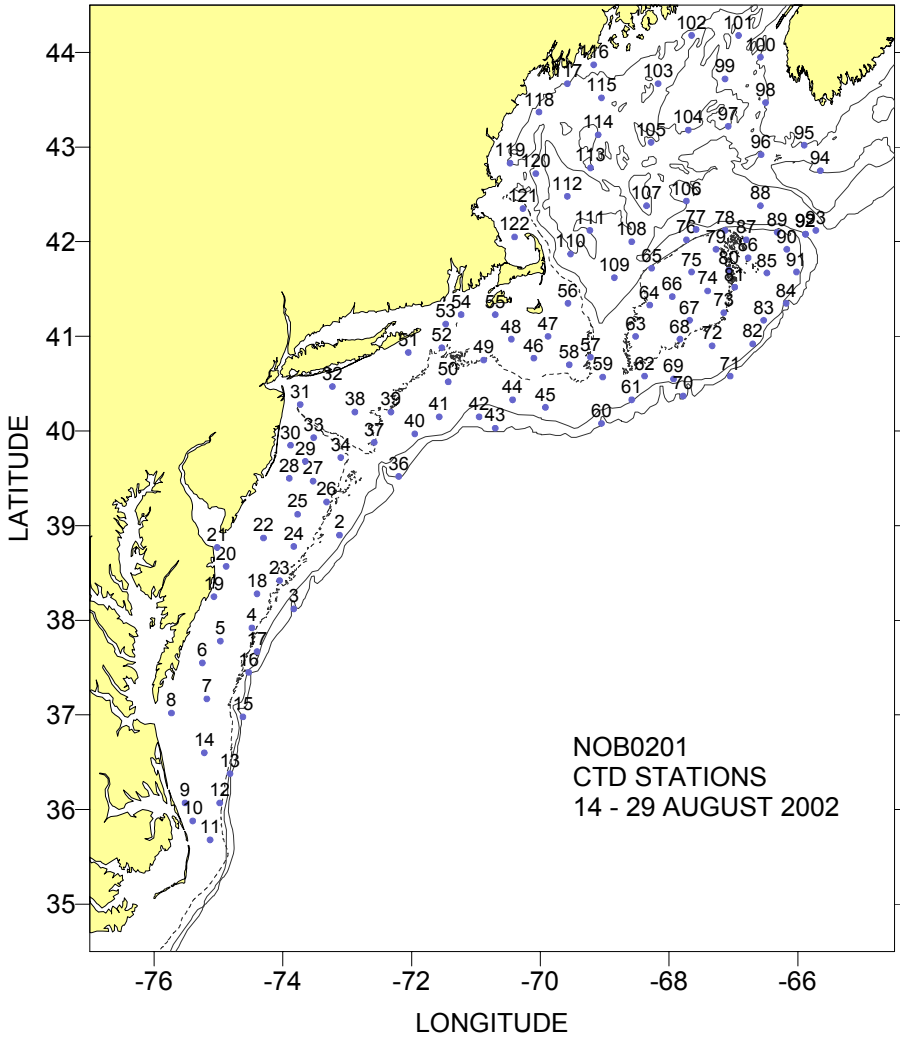


Figure 30. Hydrographic stations occupied during the ECOMON survey NOB0201.

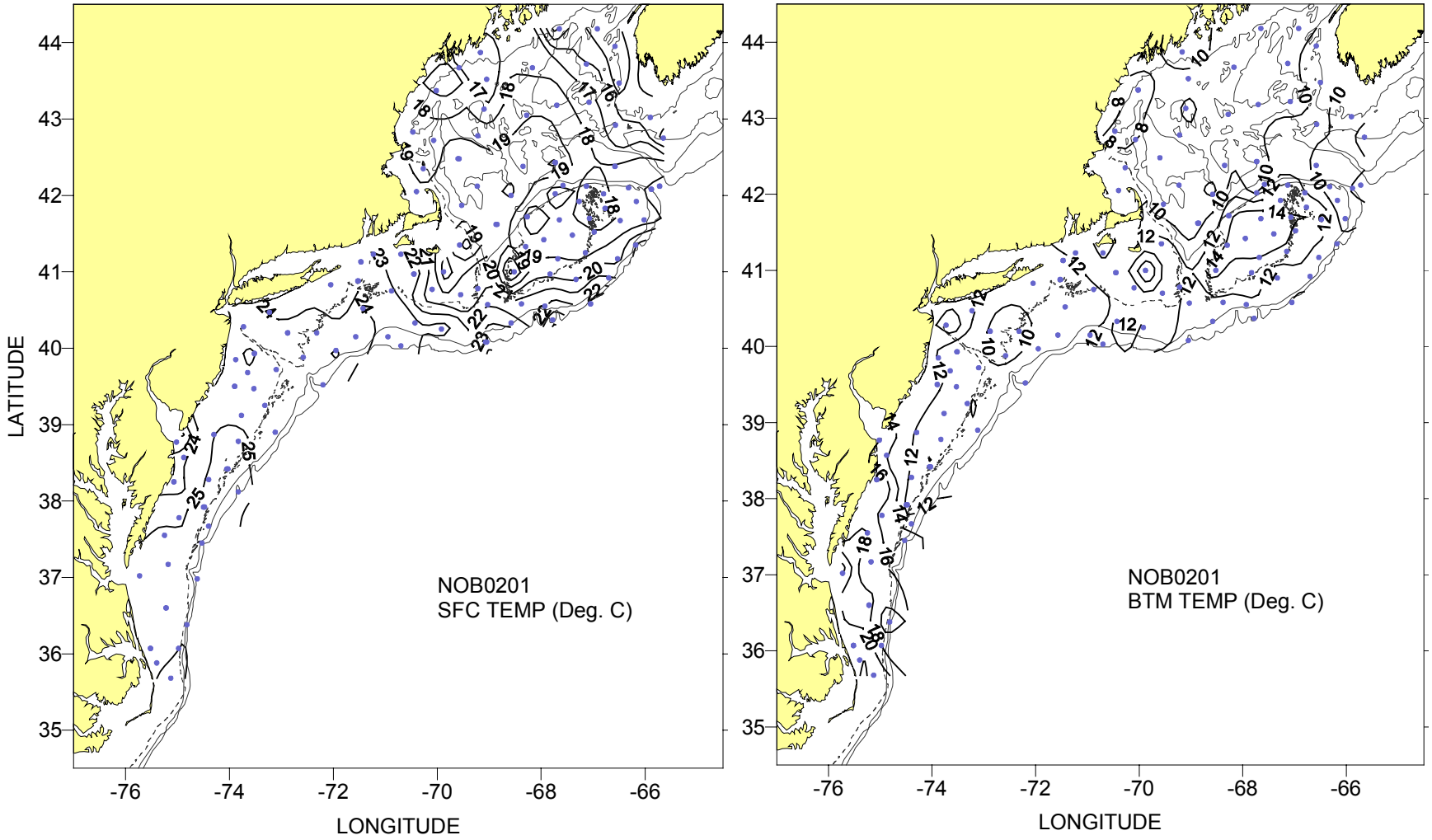


Figure 31. Surface and bottom temperature distributions for ECOMON survey NOB0201.

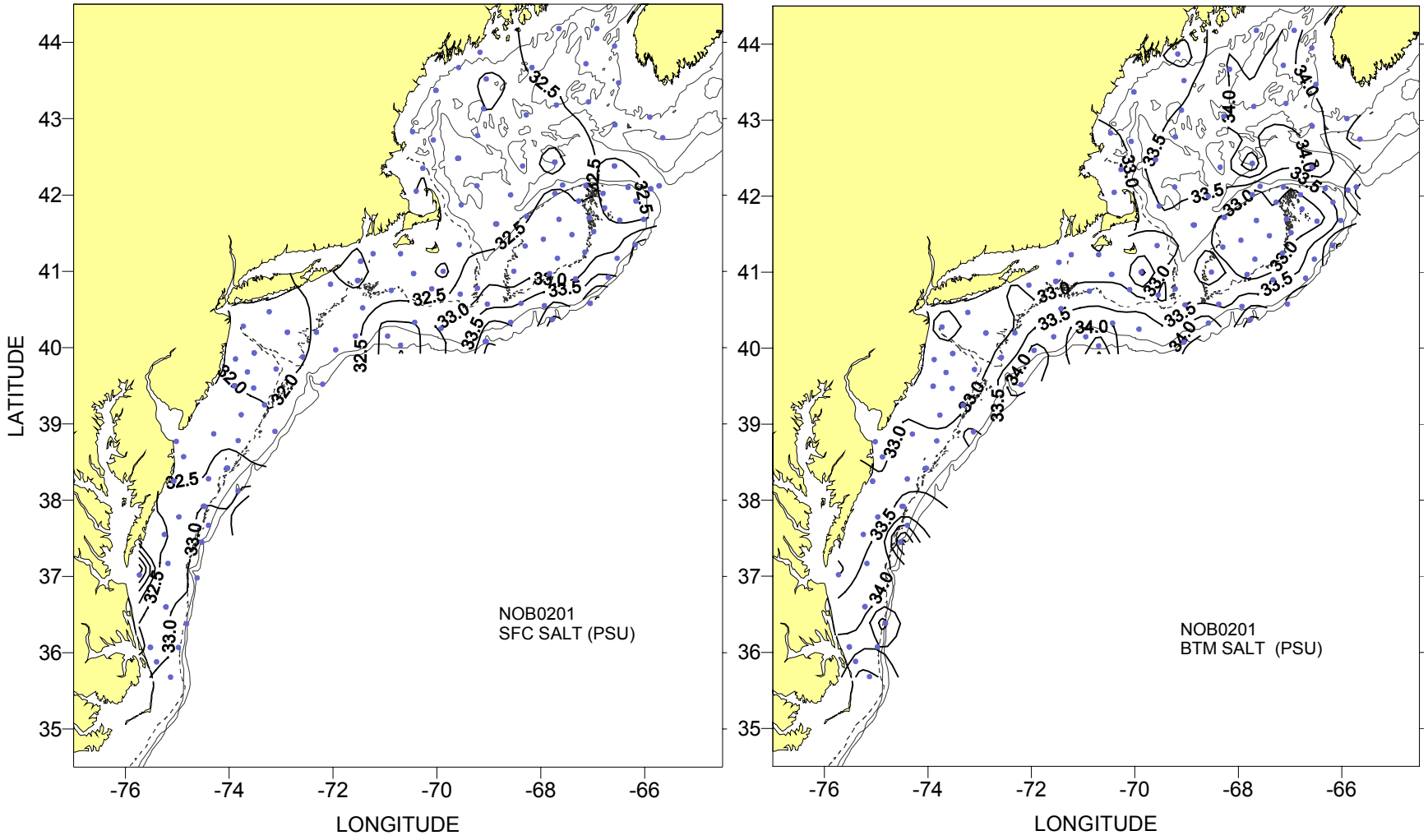


Figure 32. Surface and bottom salinity distributions during ECOMON survey NOB0201.

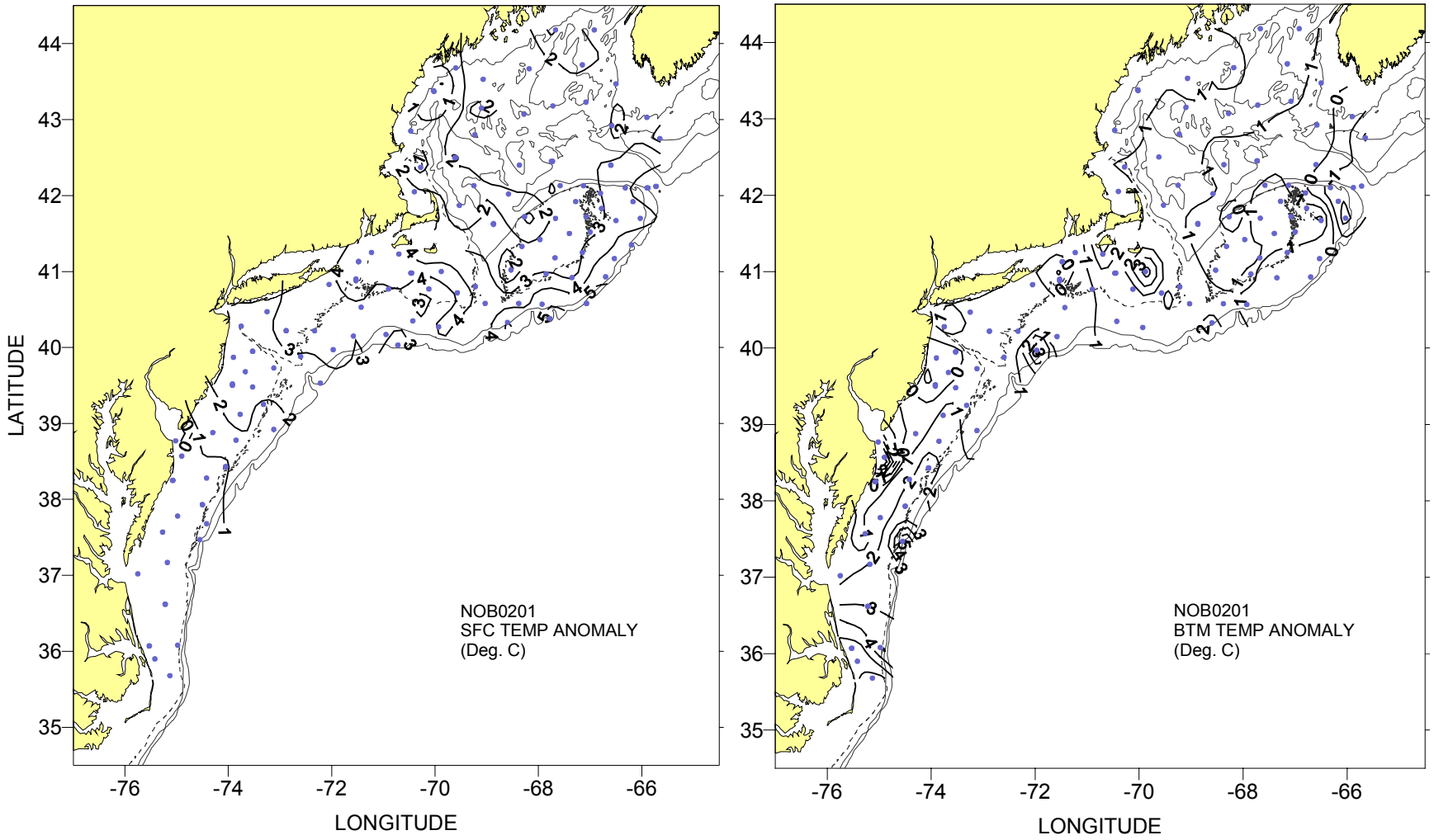


Figure 33. Surface and bottom temperature anomaly distributions during ECOMON survey NOB0201.

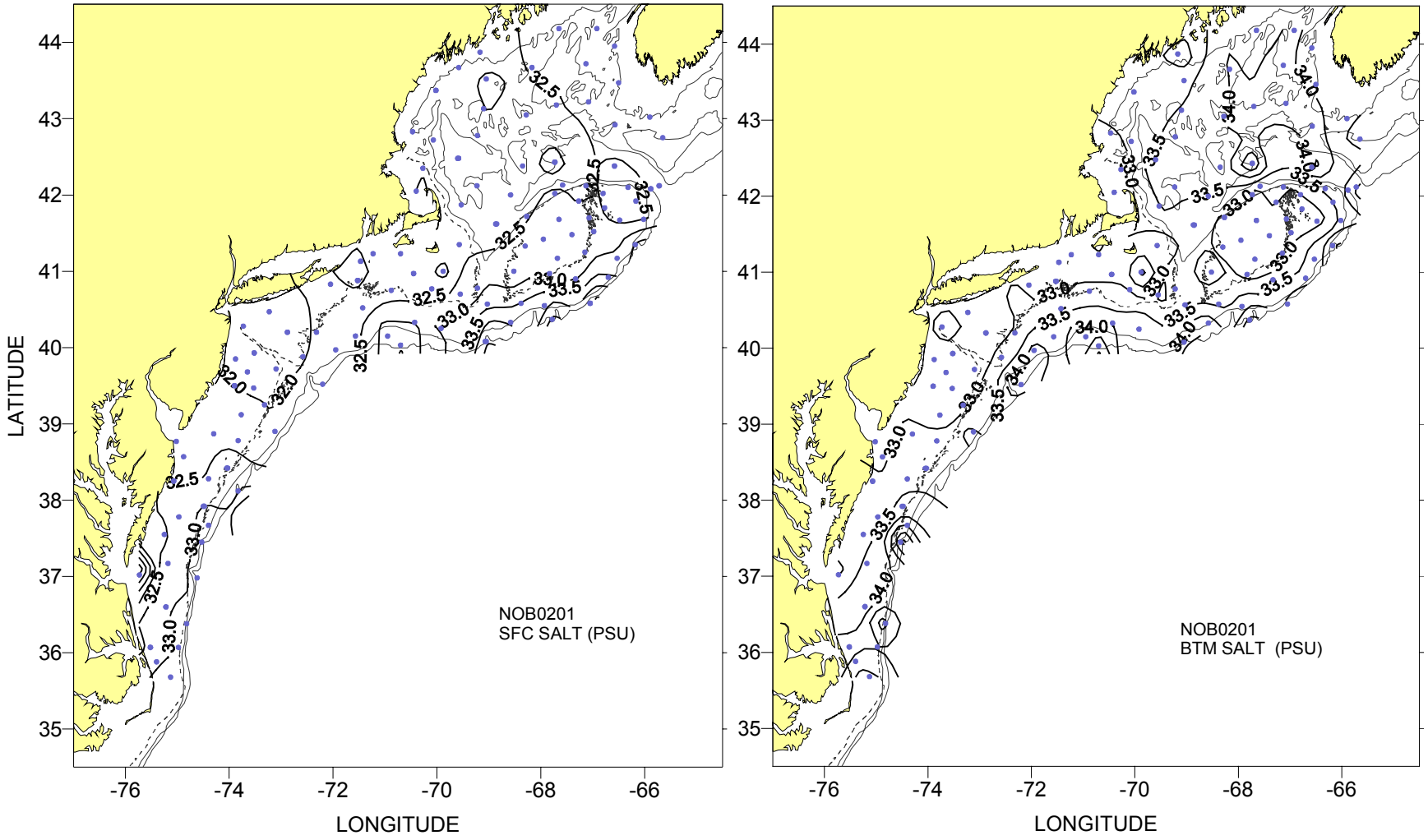


Figure 34. Surface and bottom salinity anomaly distributions during ECOMON survey NOB0201.

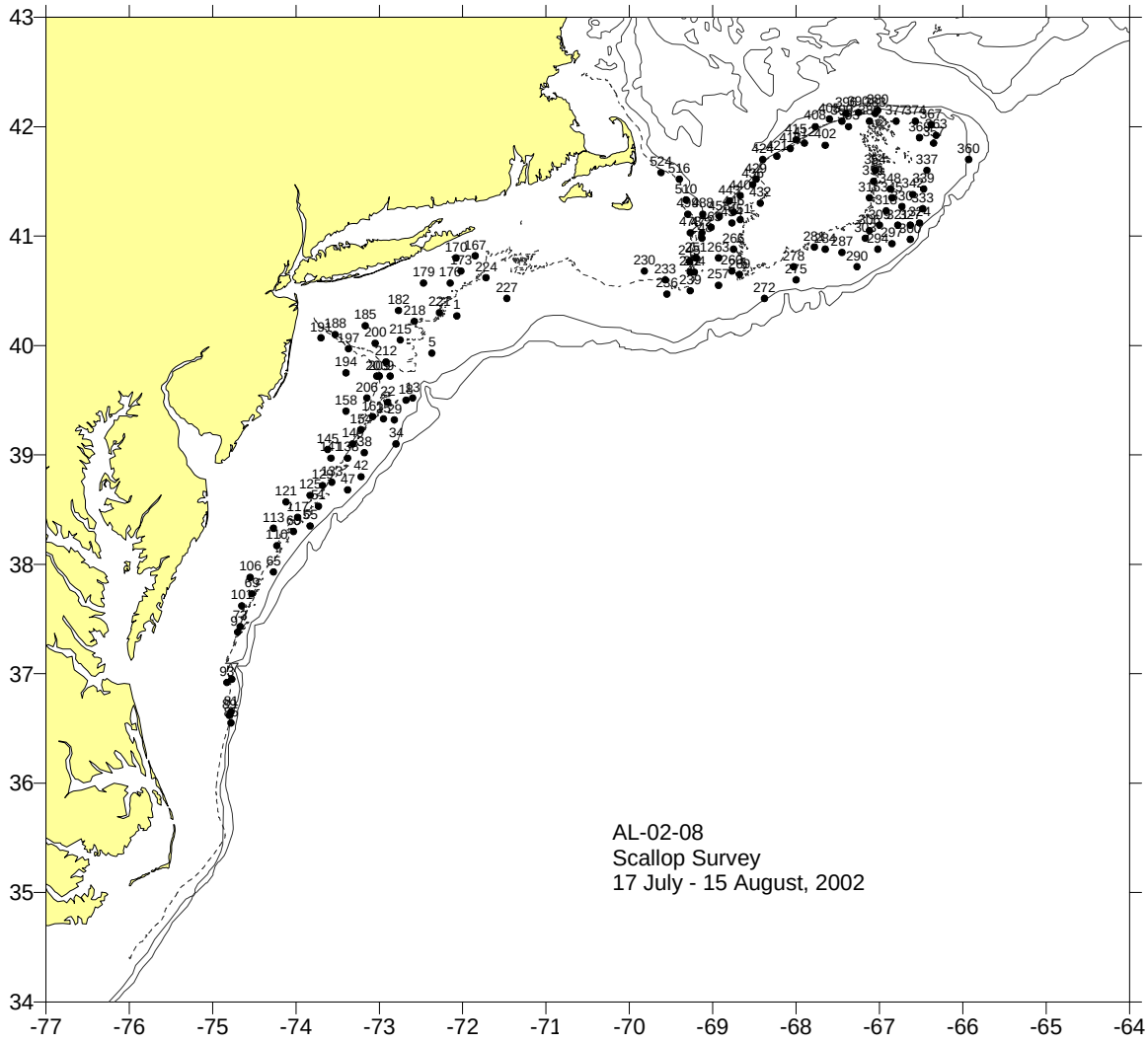


Figure 35. Hydrographic stations occupied during Scallop Survey ALB0208.

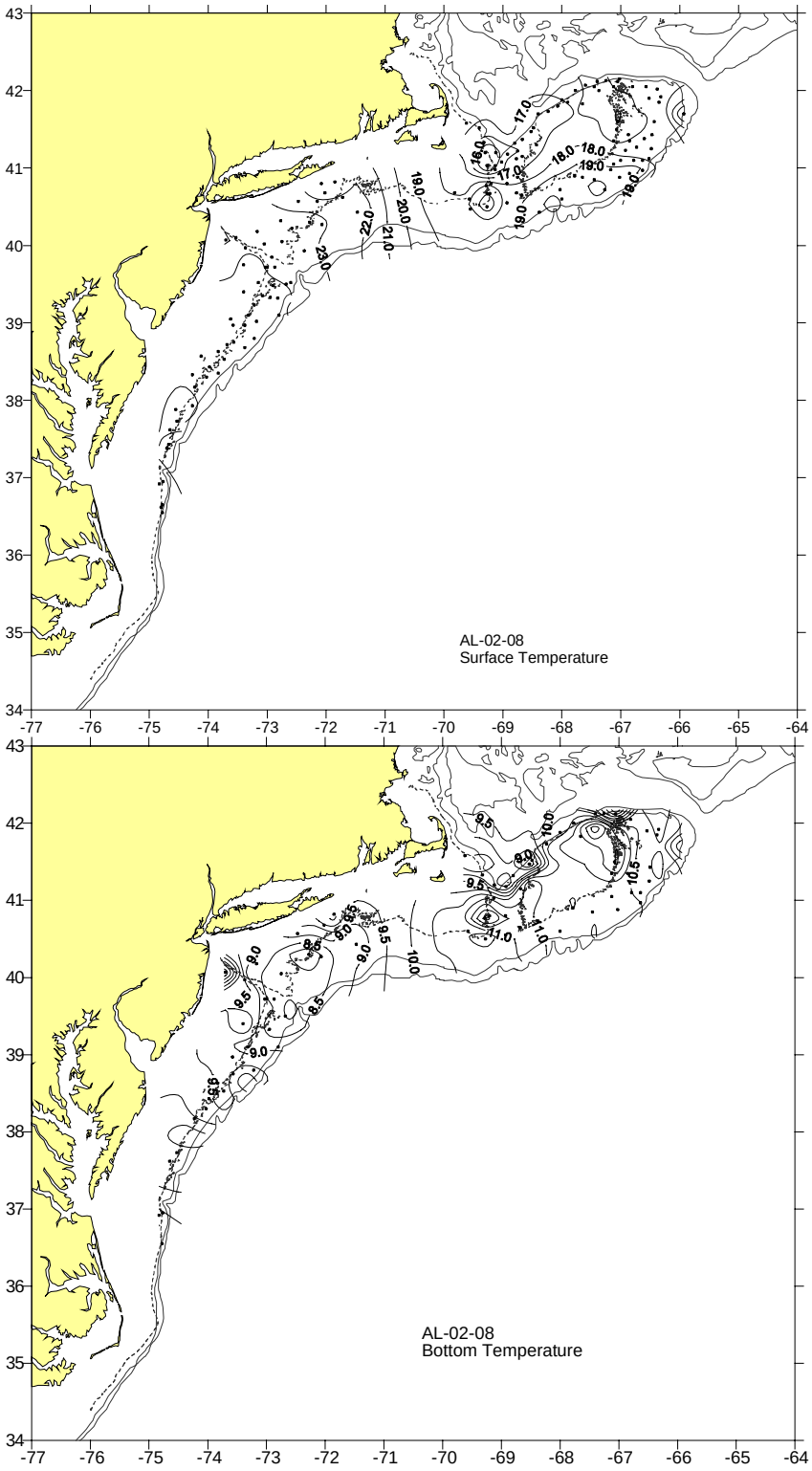


Figure 36. Surface and bottom temperature distributions for Scallop Survey ALB0208.

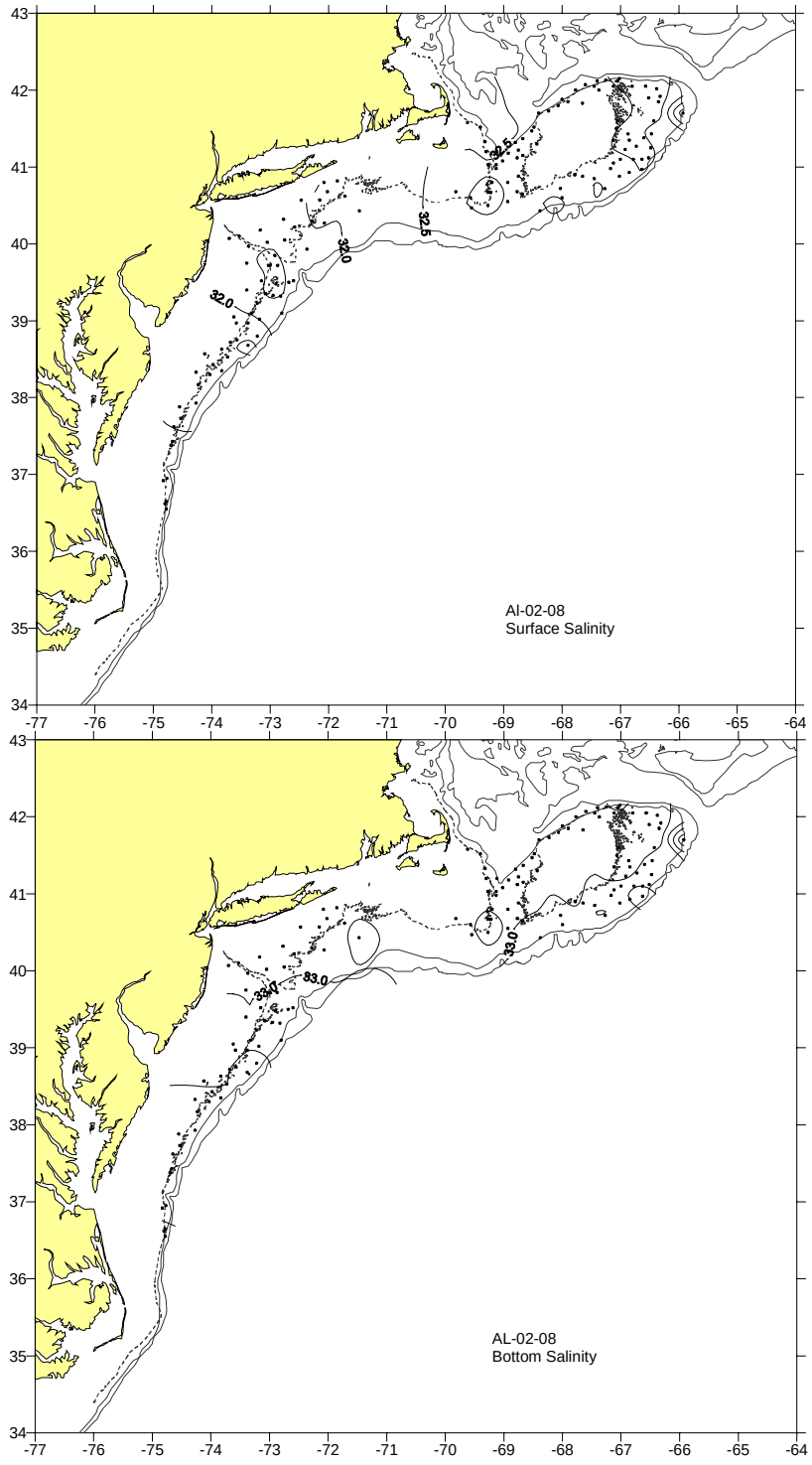


Figure 37. Surface and bottom salinity distributions for Scallop Survey ALB0208.

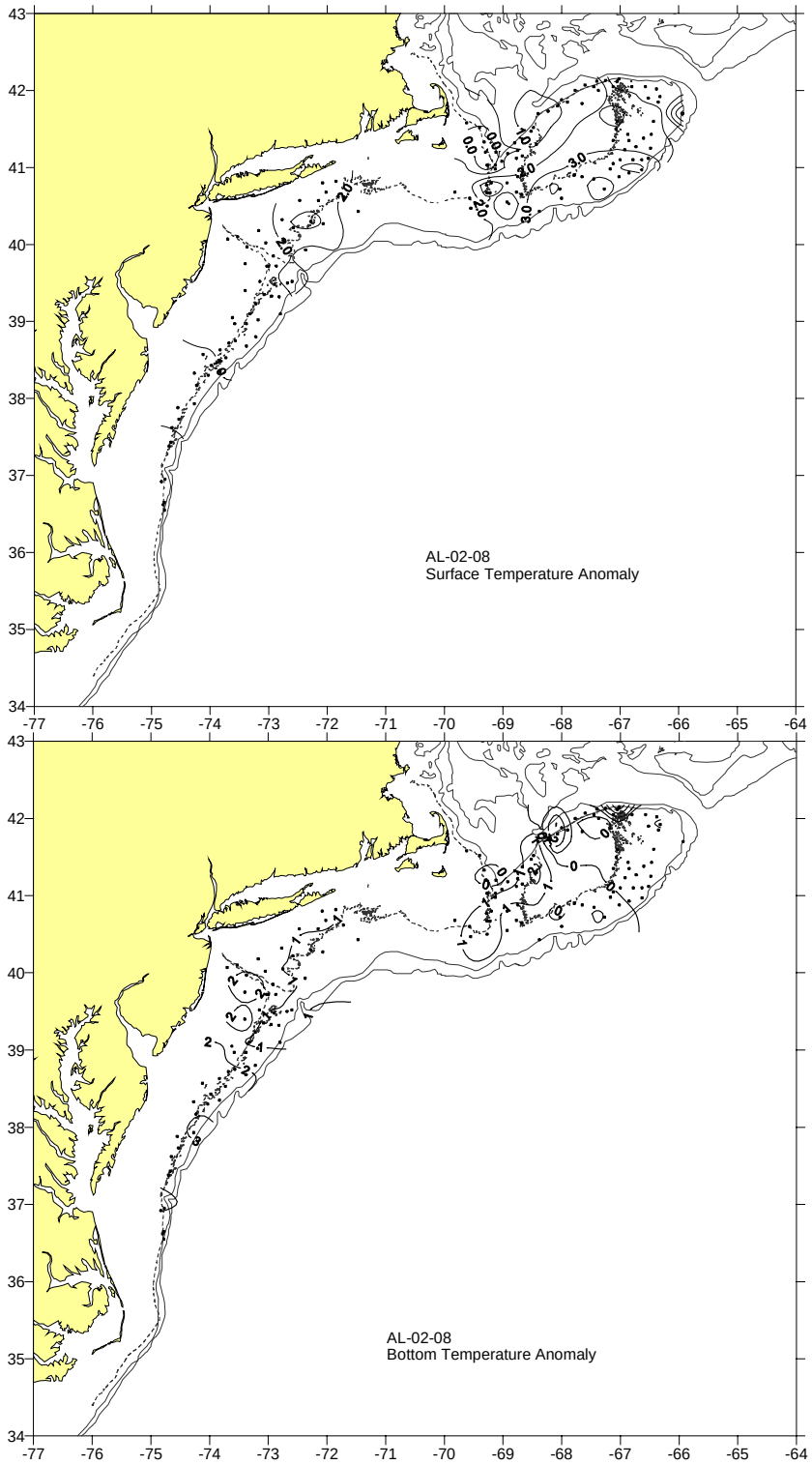


Figure 38. Surface and bottom temperature anomaly distributions for Scallop Survey ALB0208.

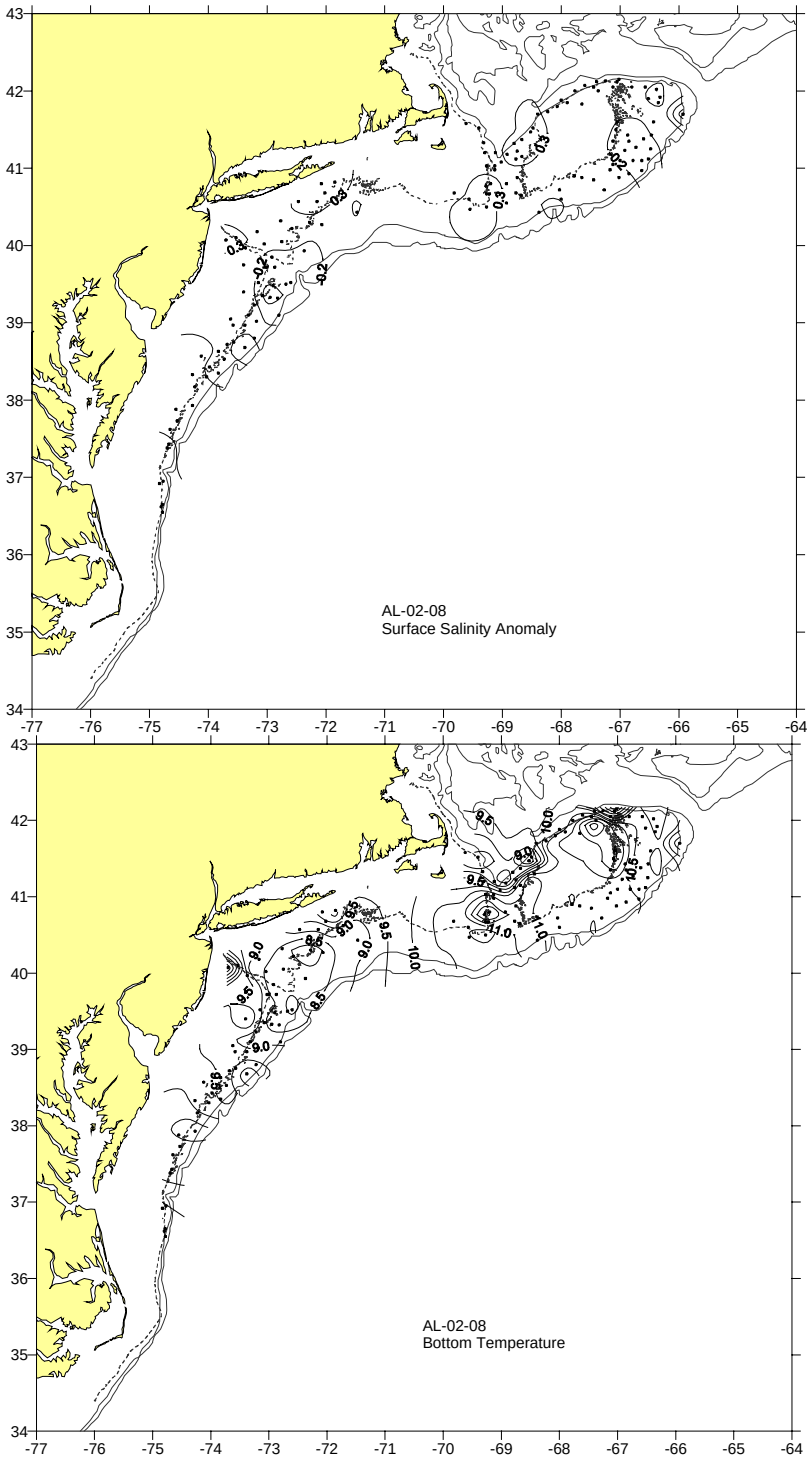


Figure 39. Surface and bottom salinity anomaly distributions for Scallop Survey ALB0208.

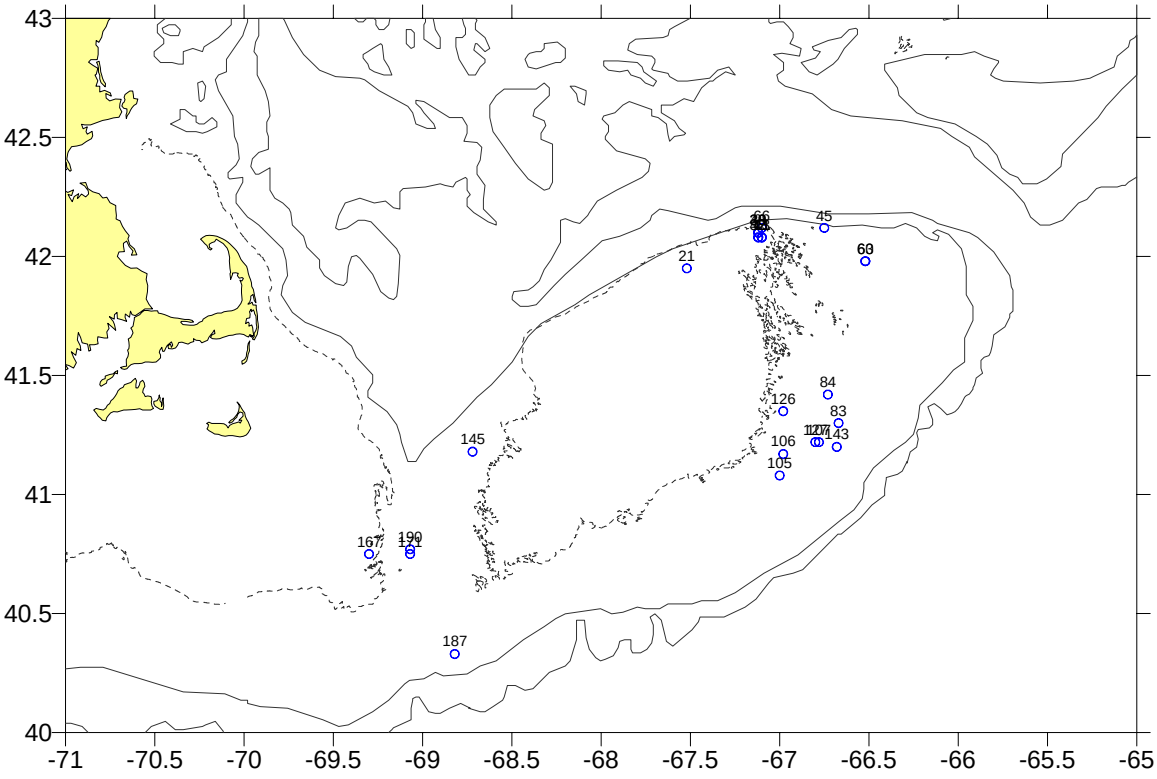


Figure 40. Hydrographic stations occupied during the Benthic Habitat cruise ALB0209.

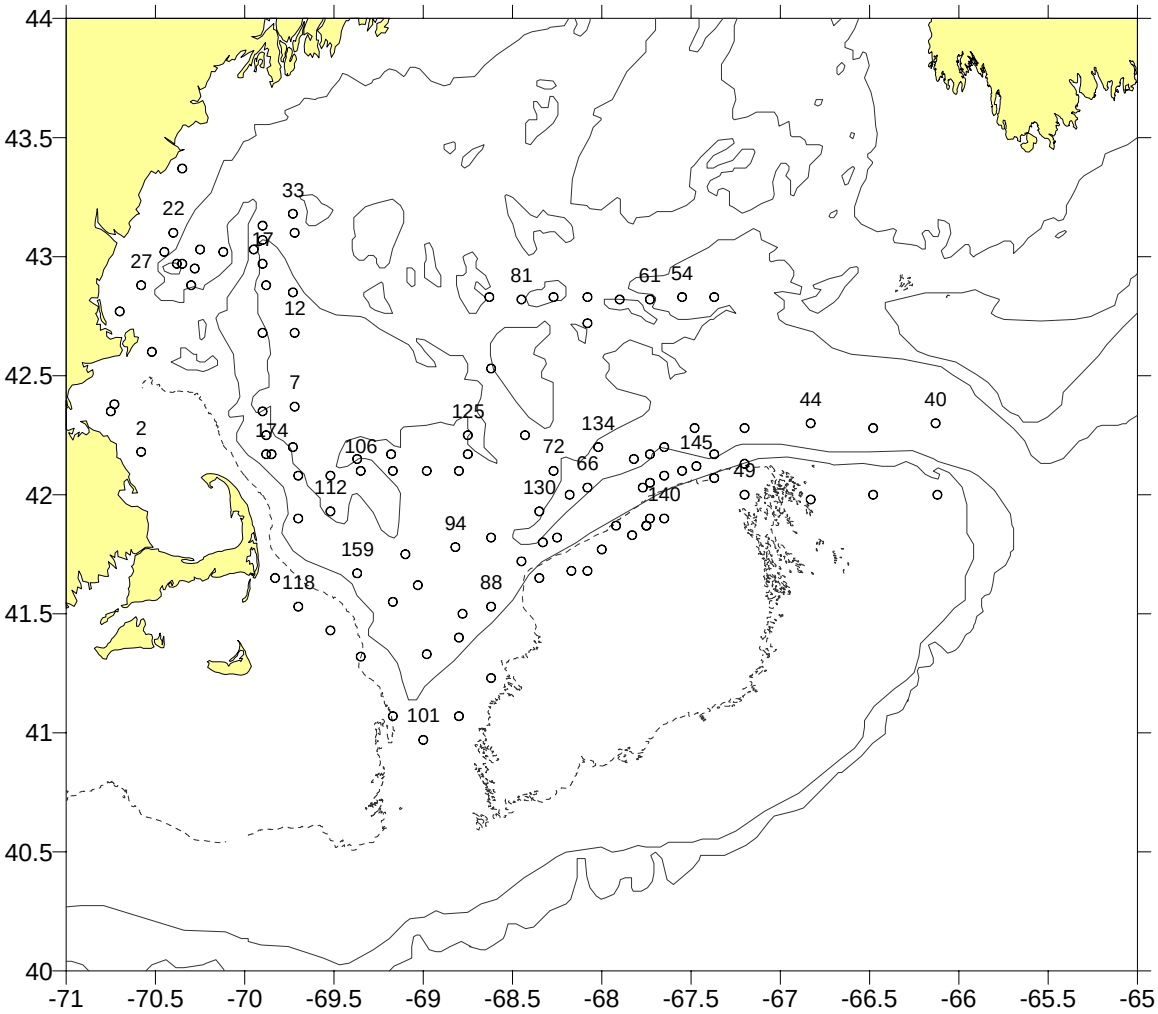


Figure 41. Hydrographic stations occupied during the HydroAcoustic cruise DEL0208.

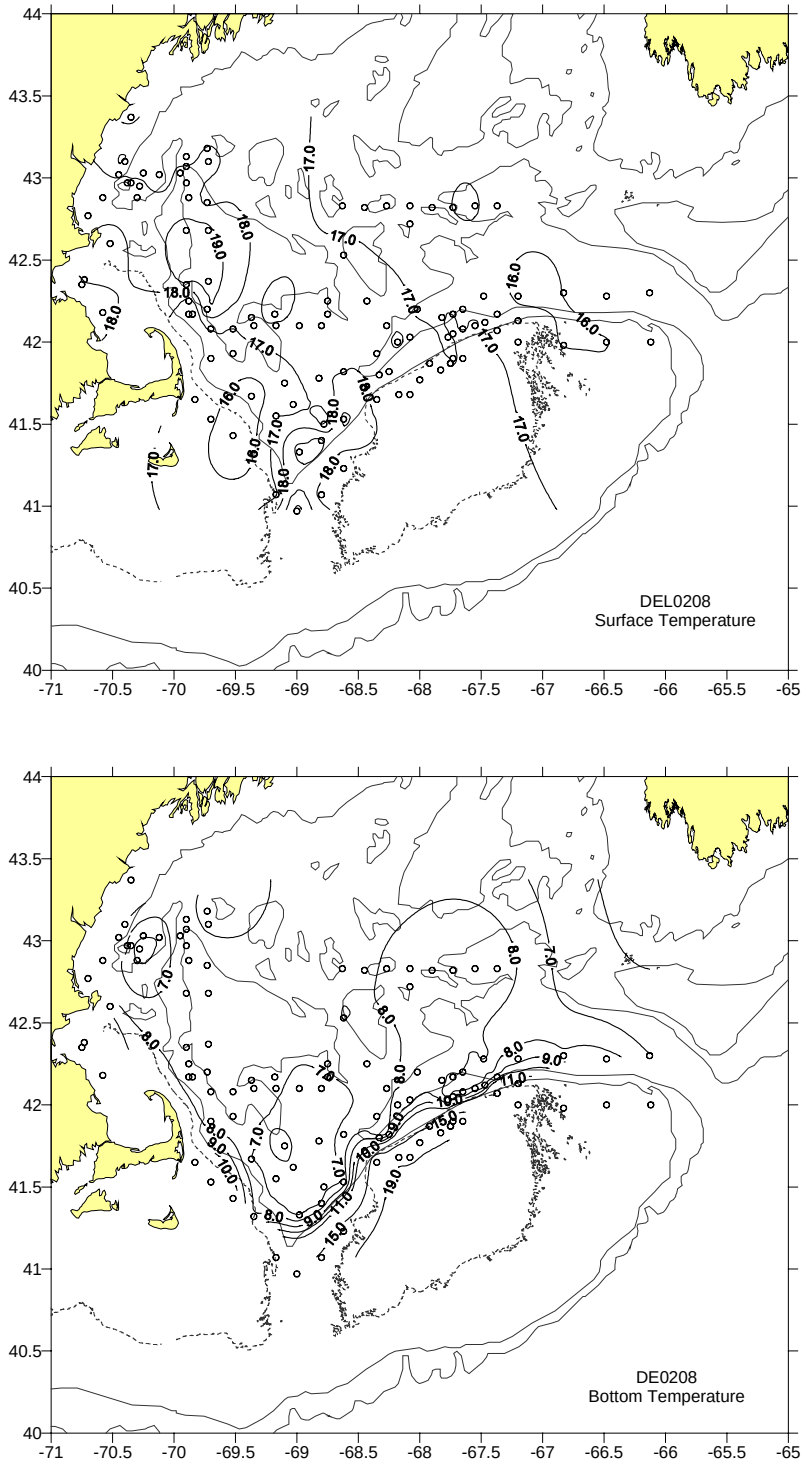


Figure 42. Surface and bottom temperature distributions for the HydroAcoustic survey DEL0208.

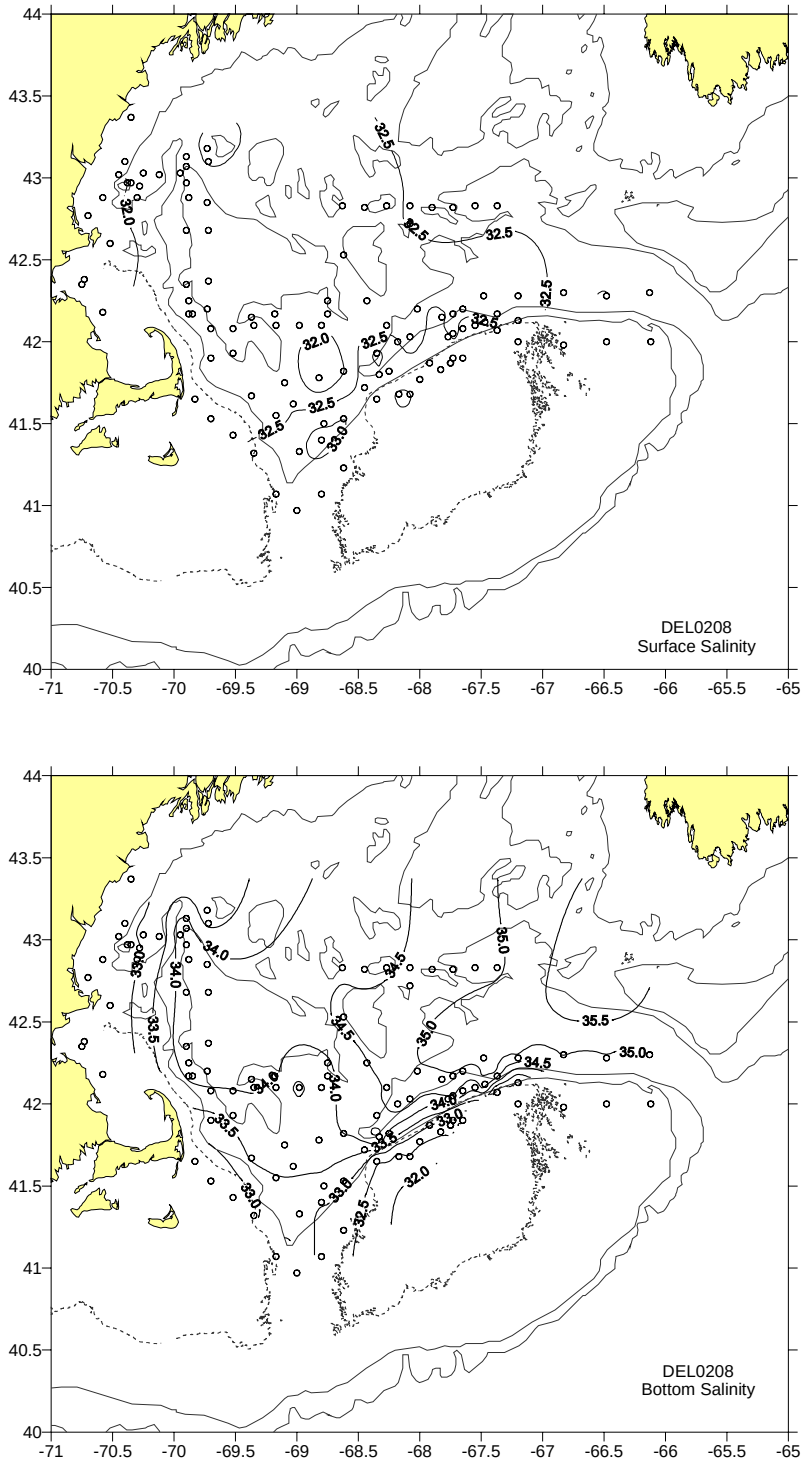


Figure 43. Surface and bottom salinity distributions for the HydroAcoustic survey DEL0208.

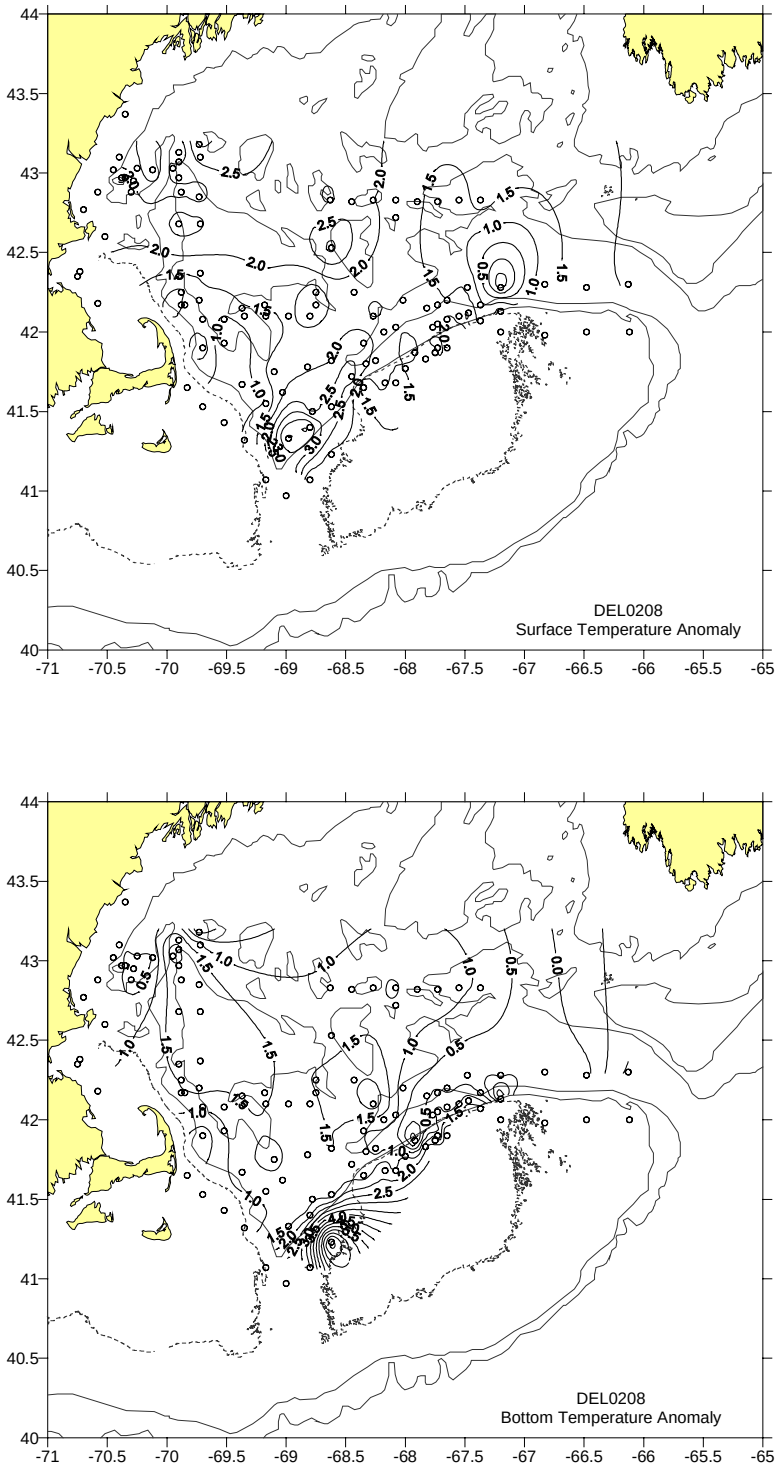


Figure 44. Surface and bottom temperature anomaly distributions for the HydroAcoustic survey DEL0208.

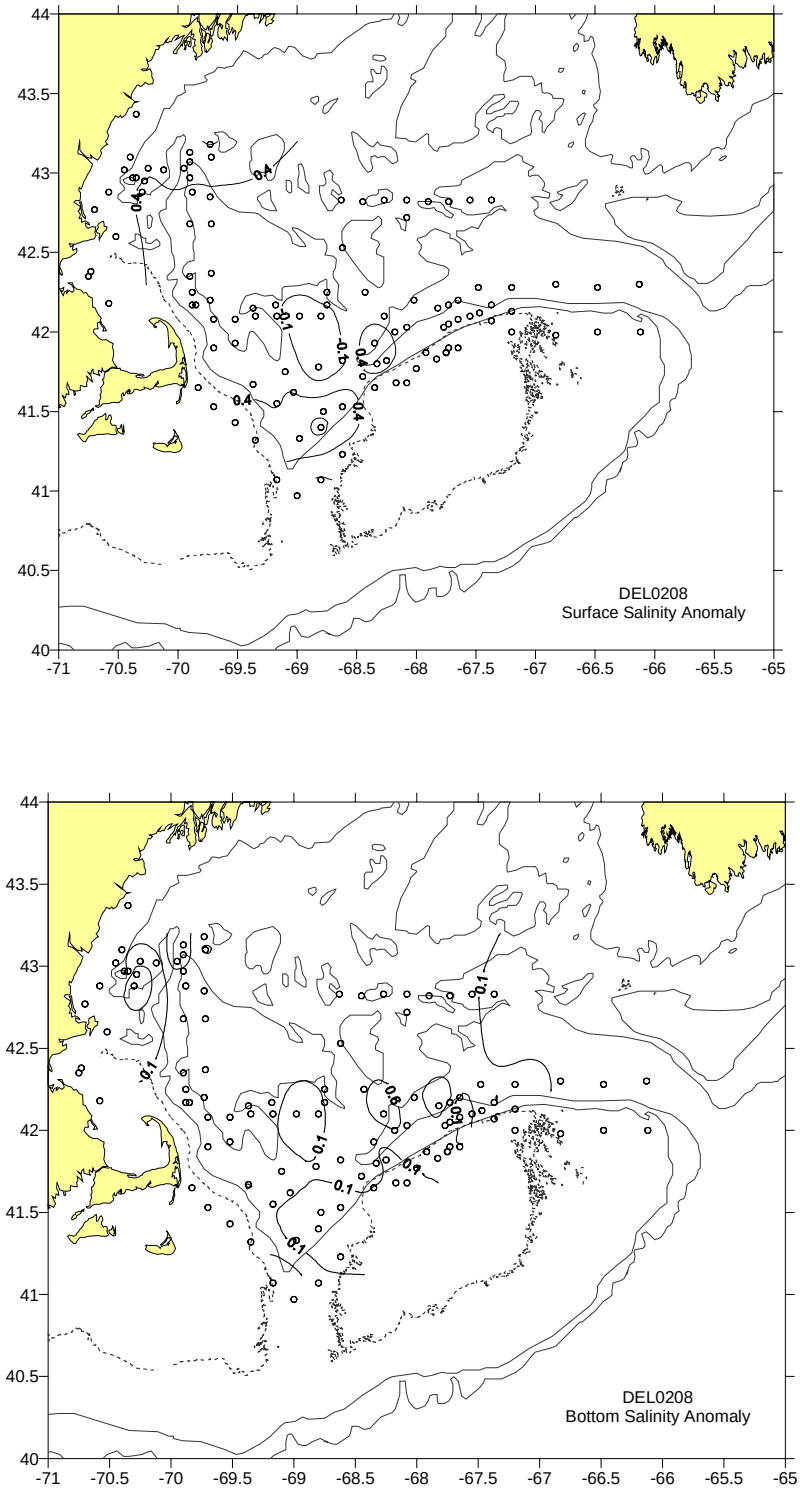


Figure 45. Surface and bottom salinity anomaly distributions for the HydroAcoustic survey DEL0208.

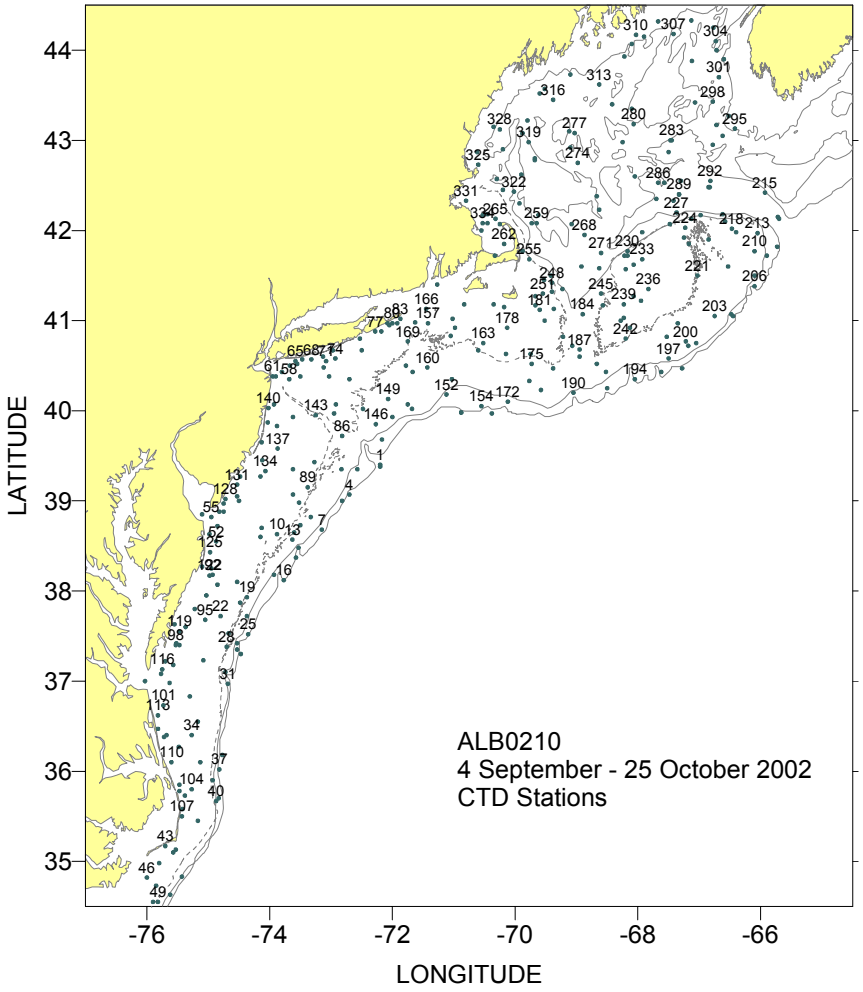


Figure 46. Hydrographic stations occupied during the Fall Bottom Trawl ALB0210.

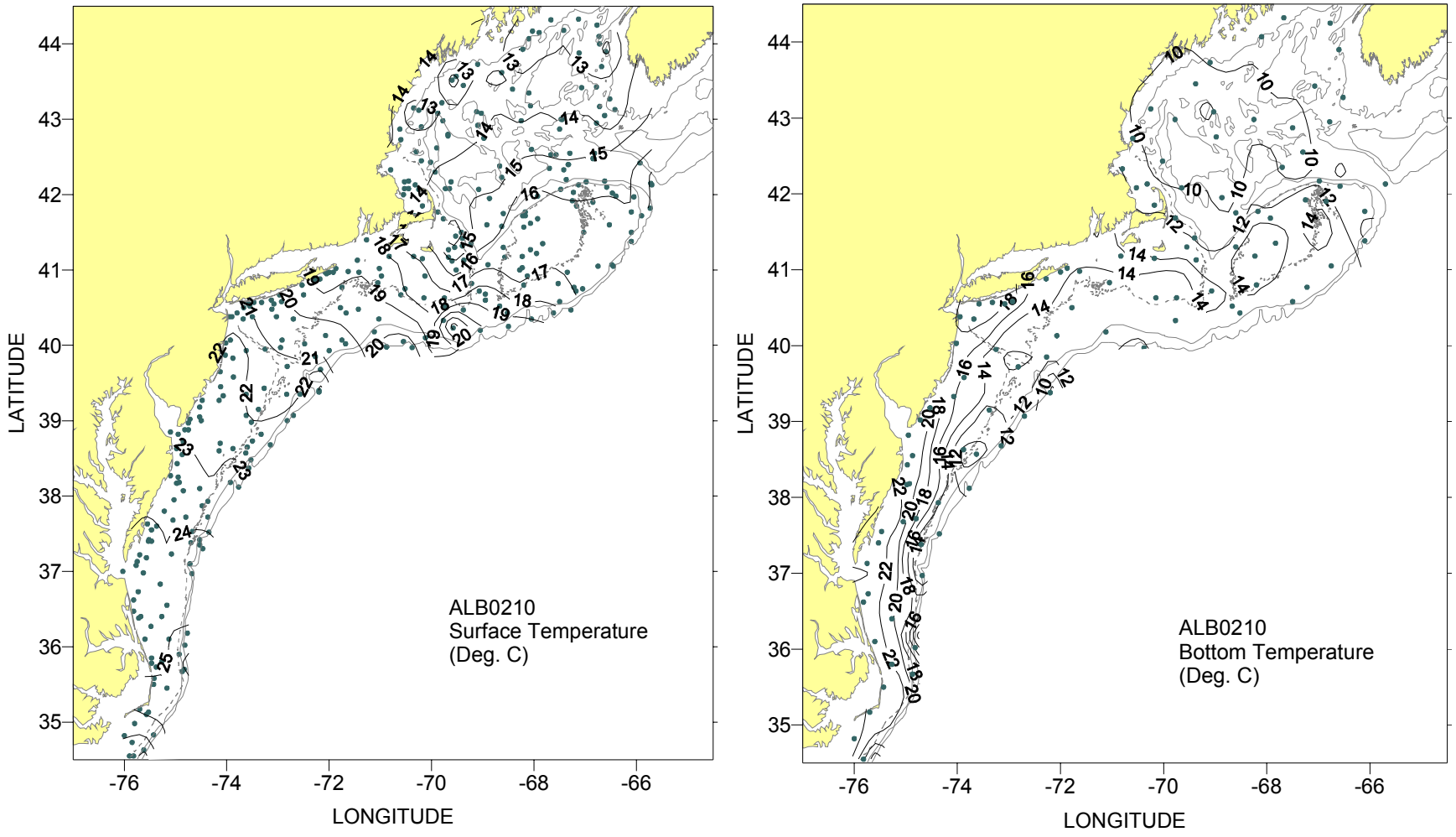


Figure 47. Surface and bottom temperature distributions for Fall Bottom Trawl survey ALB0210.

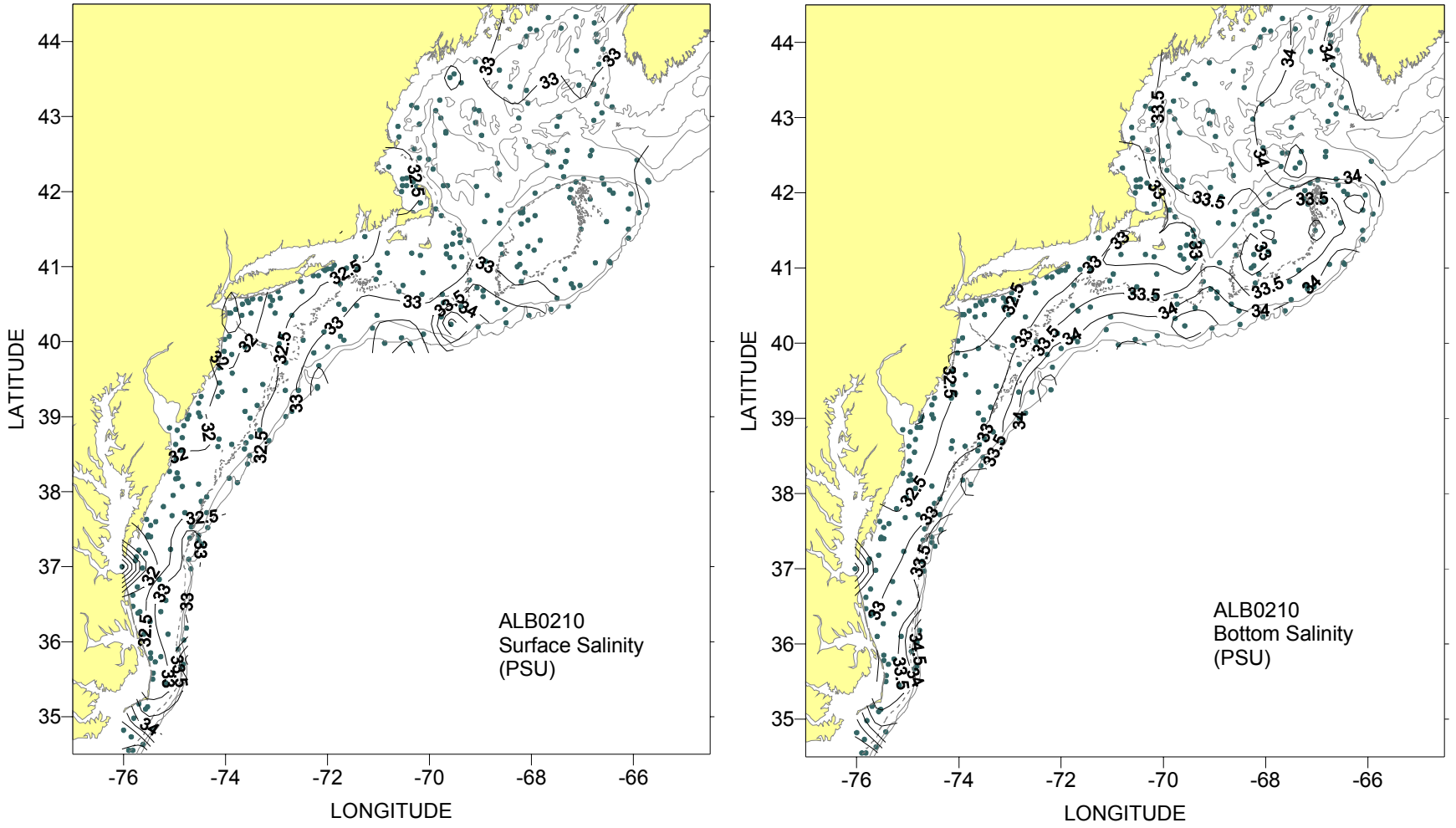


Figure 48. Surface and bottom salinity distributions for Fall Bottom Trawl ALB0210.

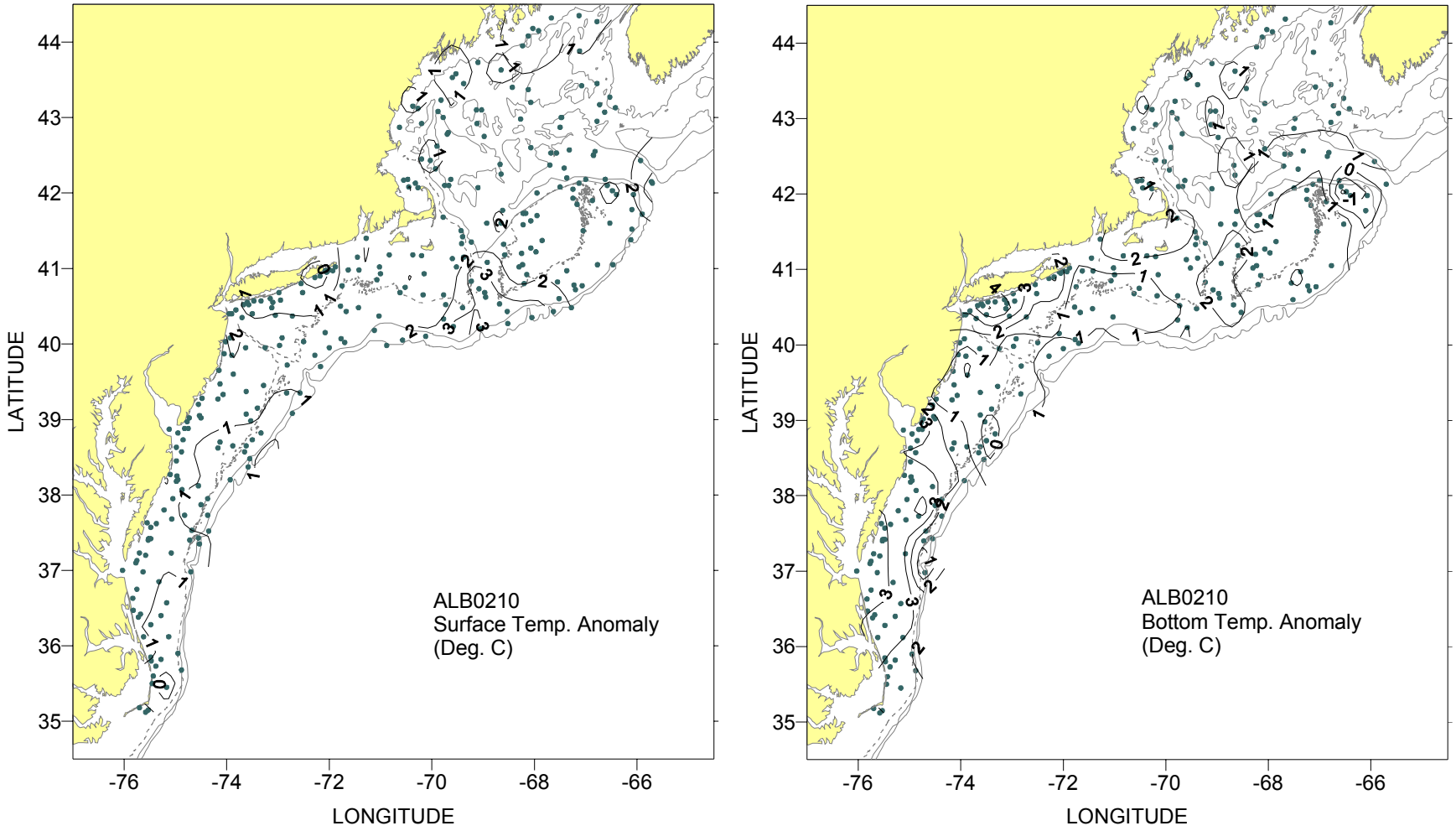


Figure 49. Surface and bottom temperature anomaly distributions for Fall Bottom Trawl ALB0210.

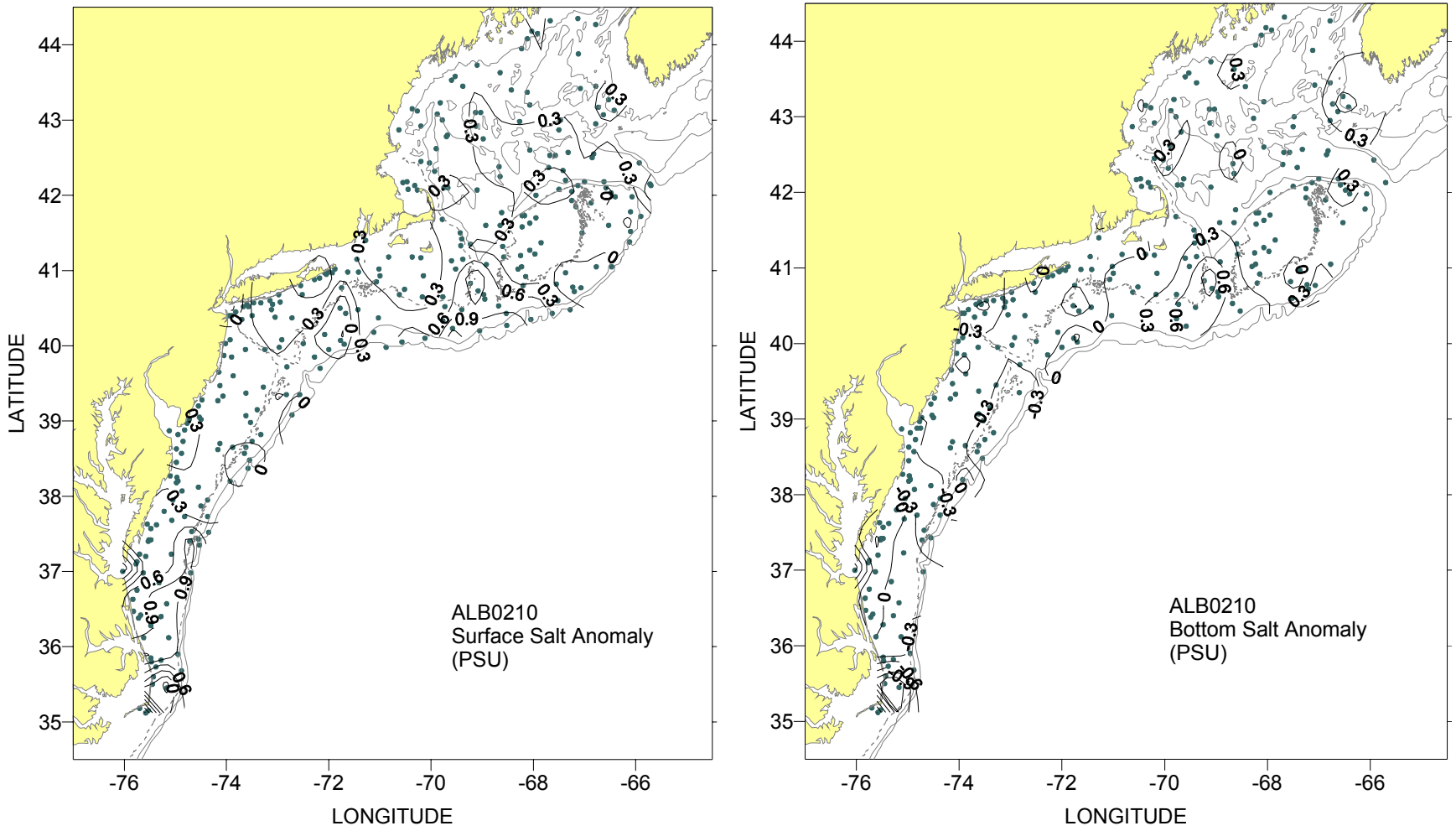


Figure 50. Surface and bottom salinity anomaly distributions for Fall Bottom Trawl ALB0210.

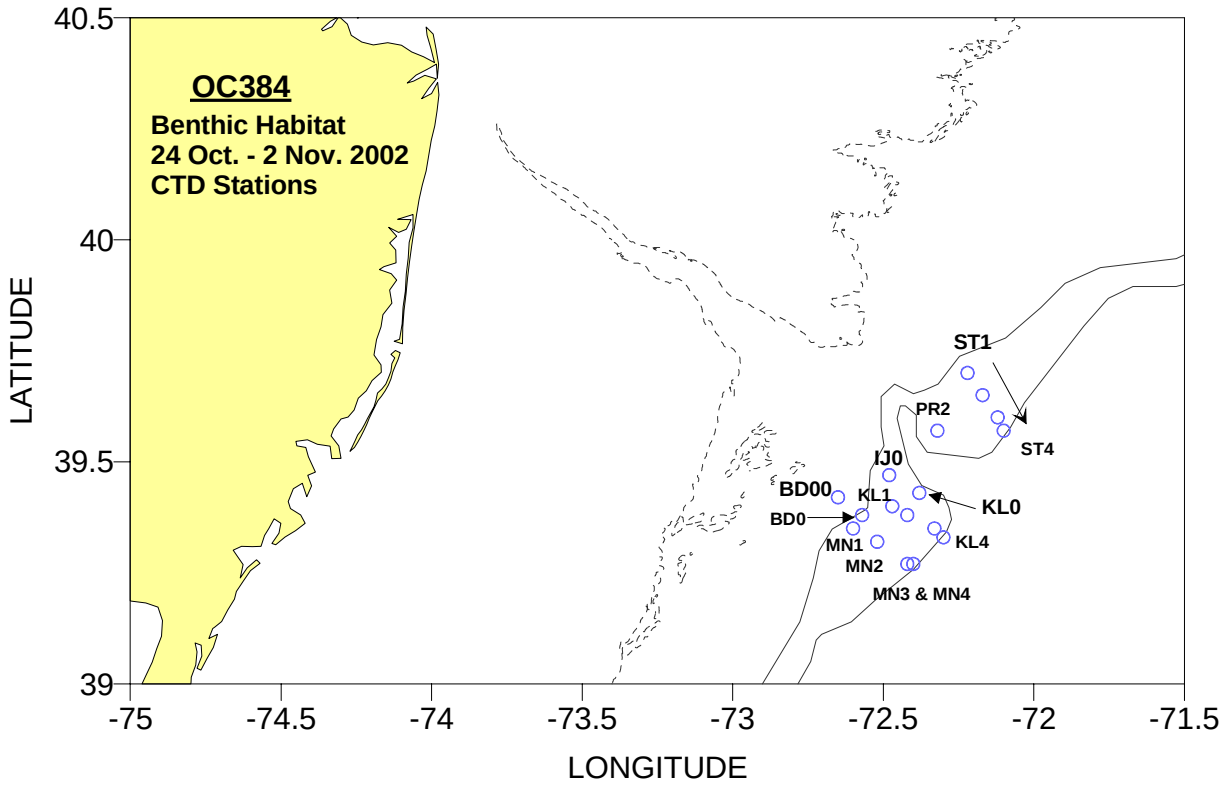


Figure 51. Hydrographic stations occupied during Benthic Habitat OC384.

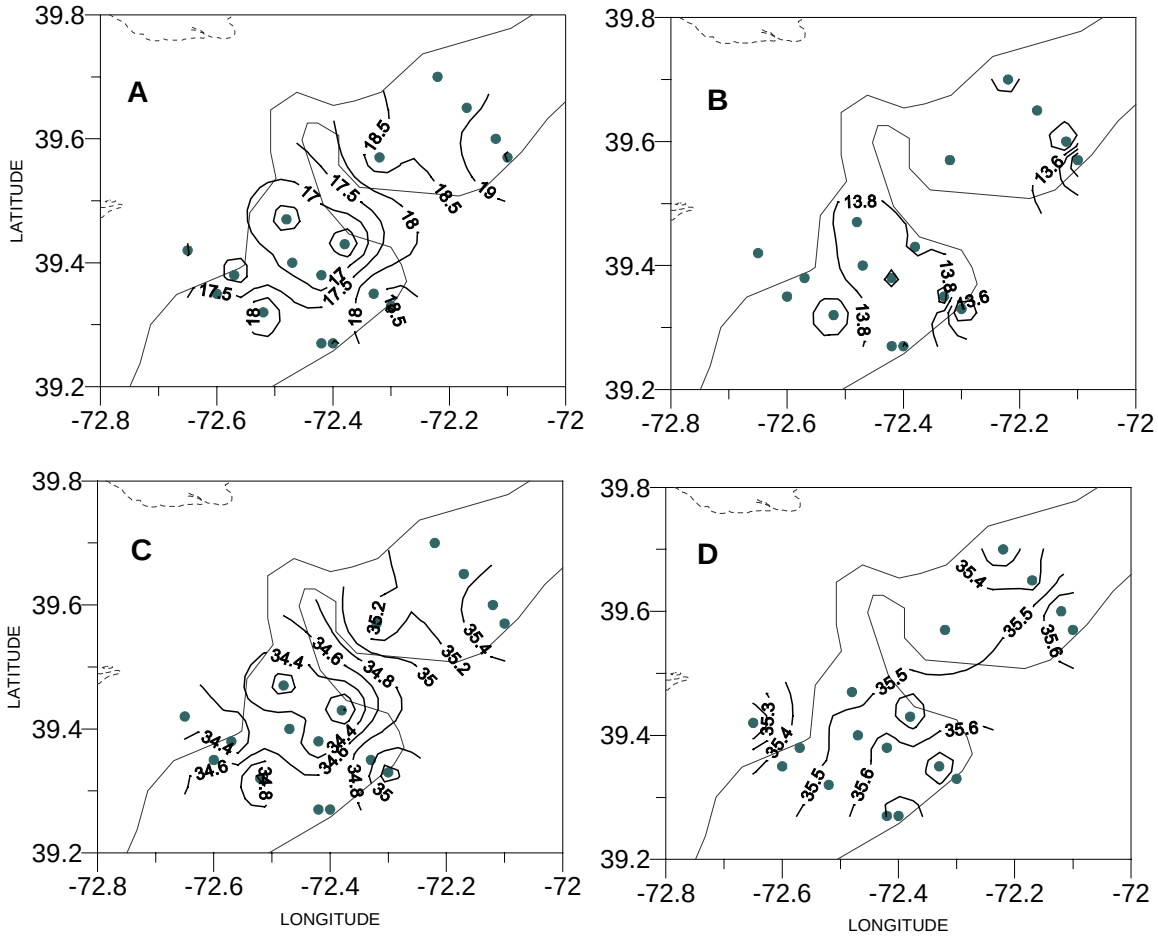


Figure 52. Surface and bottom temperature and salinity distributions for the Benthic Habitat survey OC384.

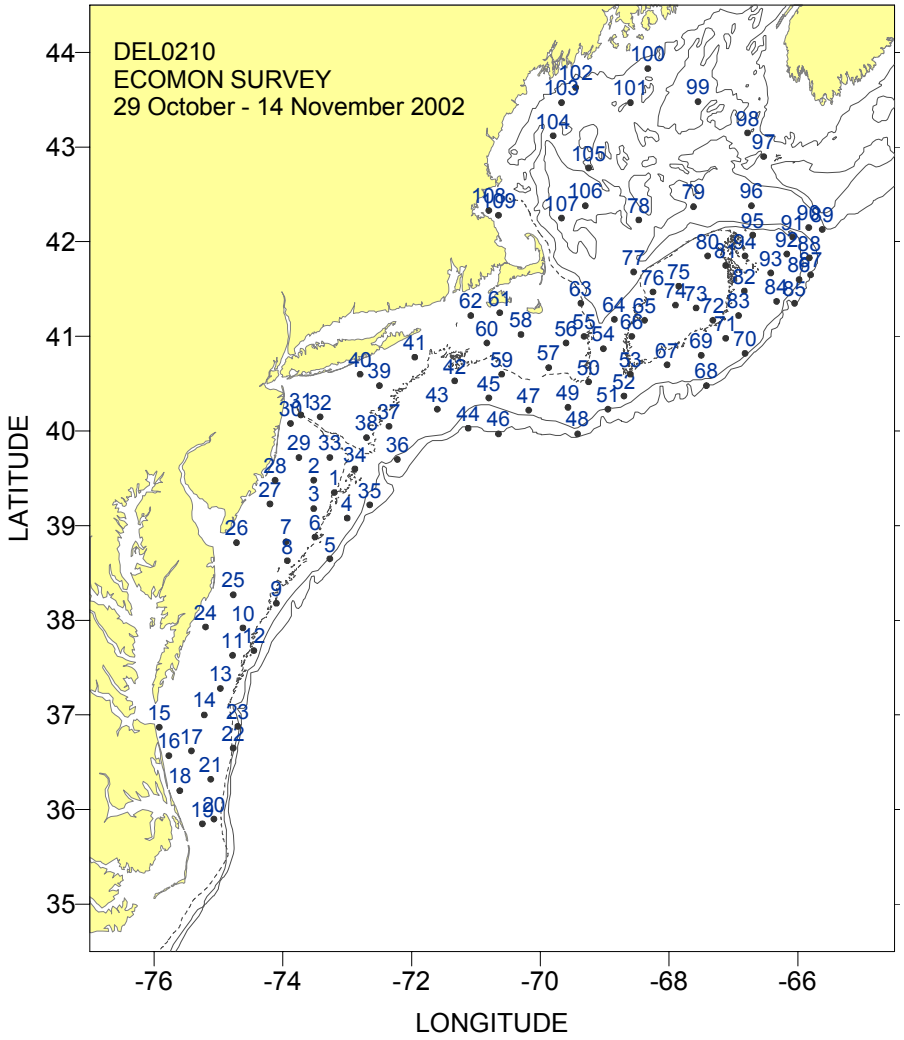


Figure 53. Hydrographic stations occupied during ECOMON survey DEL0210.

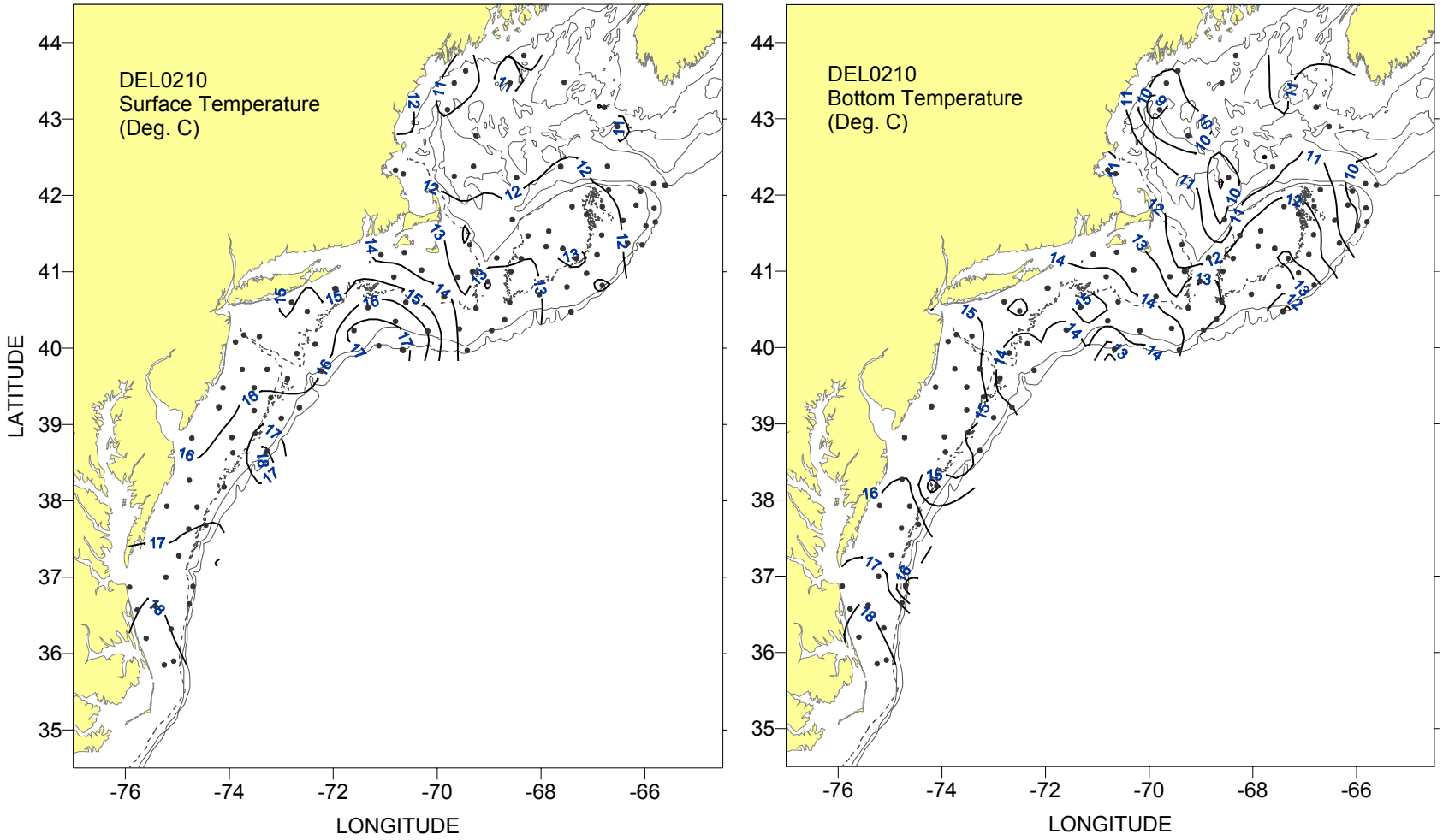


Figure 54. Surface and bottom temperature distributions for ECOMON survey DEL0210.

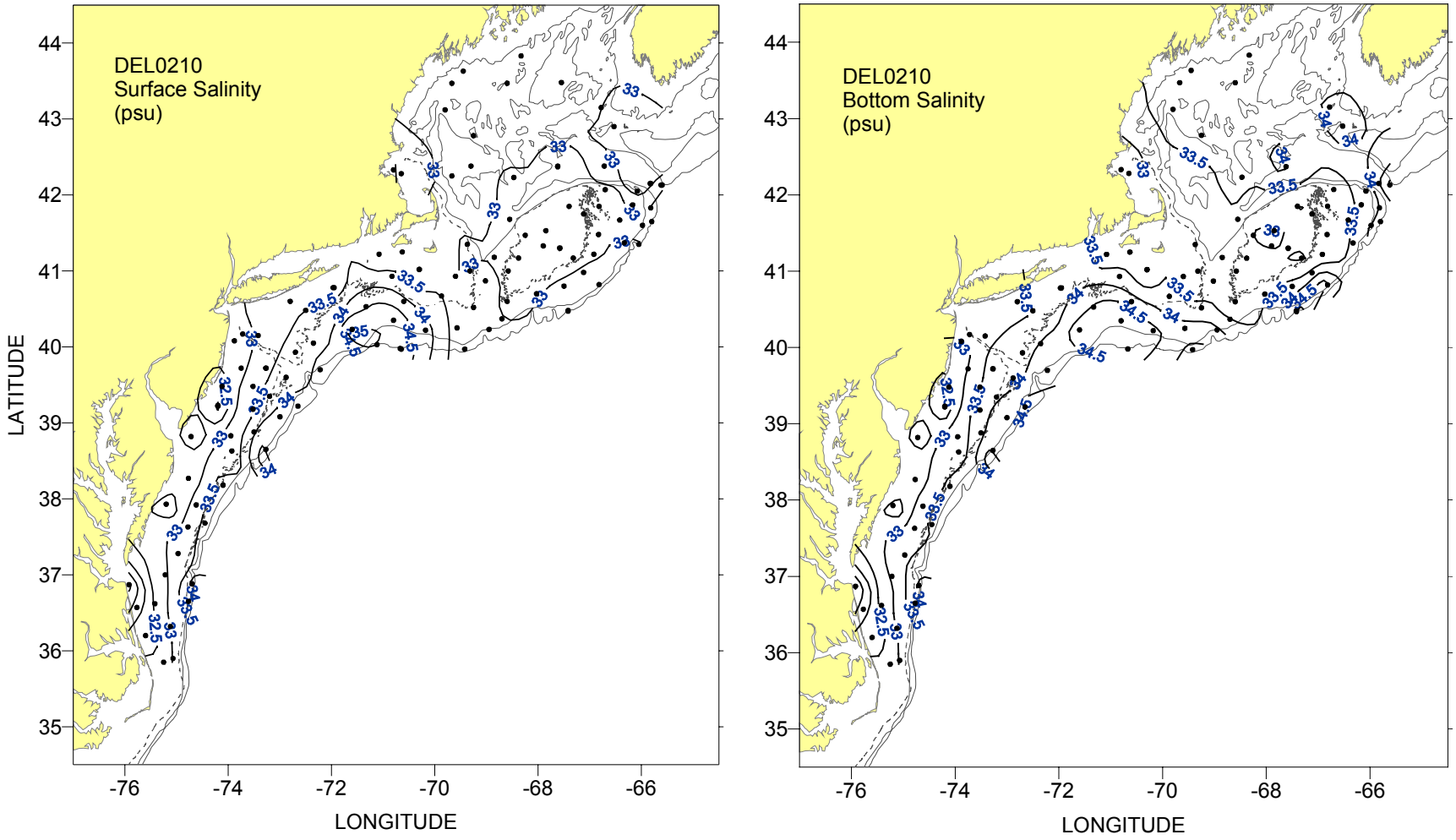


Figure 55. Surface and bottom salinity distributions for ECOMON survey DEL0210.

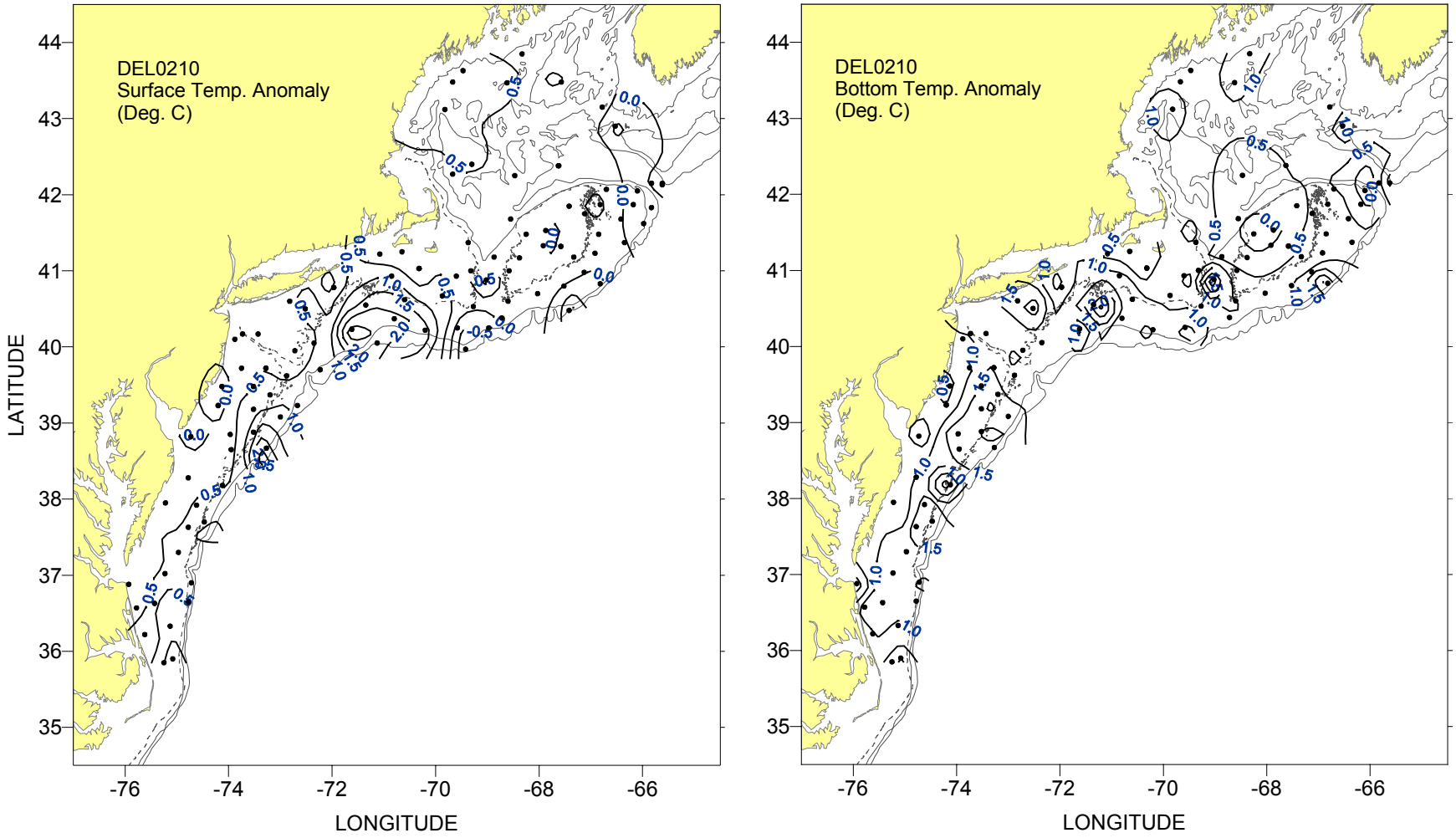


Figure 56. Surface and bottom temperature anomaly distributions for ECOMON survey DEL0210.

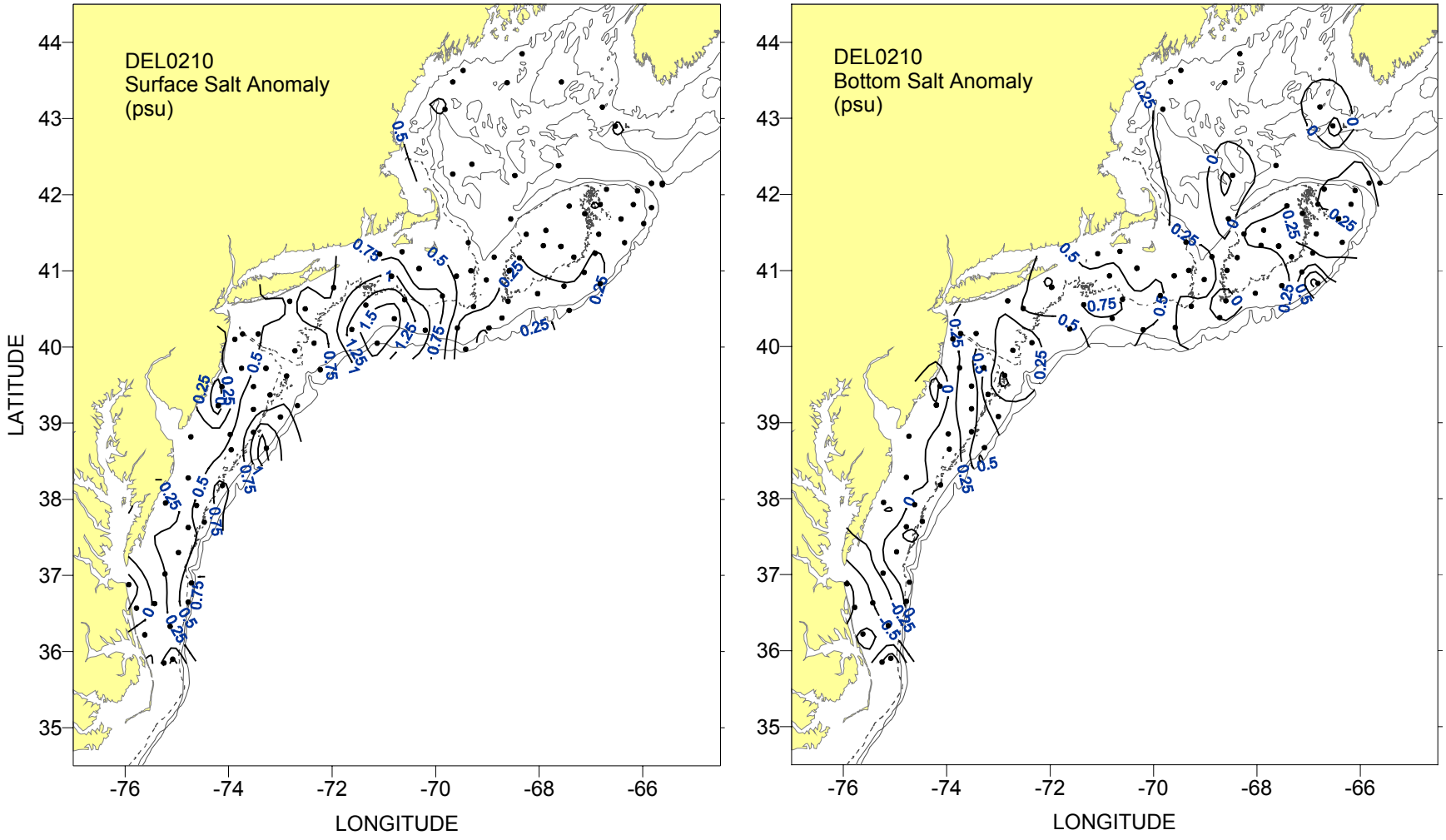


Figure 57. Surface and bottom salinity anomaly distributions for ECOMON survey DEL0210.

Appendix A. Summary of 2002 cruise operations

Ecosystems Monitoring Survey

Cruise:	ALB0202
Vessel:	R/V Albatross IV
Dates:	22 – 30 January
Sea Days:	7
Instrument(s):	2879, 2277
Total # of stations:	47
# of vertical CTD/Profiler casts:	17
# of double oblique Profiler casts:	47
# Salinity samples:	11
Salt correction:	1495=+0.001; 2277=+0.007

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.

Winter Bottom Trawl Survey

Cruise:	ALB0203
Vessel:	R/V Albatross IV
Dates:	6 February – 2 March
Sea Days:	20
Instrument(s):	2277
Total # of stations:	159
# of vertical CTD/Profiler casts:	85
# of double oblique Profiler casts:	71
# Salinity samples:	25
Salt correction:	+0.003

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.

HydroAcoustic Survey

Cruise:	DEL0201
Vessel:	R/V Delaware II
Dates:	22 February – 7 March
Sea Days:	10
Instrument(s):	1447
Total # of stations:	43
# of vertical CTD/Profiler casts:	42
# of double oblique Profiler casts:	N/A
# Salinity samples:	2
Salt correction:	+0.016

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.

Spring Bottom Trawl Survey

Cruise:	ALB0204
Vessel:	R/V Albatross IV
Dates:	6 March – 26 April
Sea Days:	40
Instrument(s):	2277
Total # of stations:	331
# of vertical CTD/Profiler casts:	222
# of double oblique Profiler casts:	117
# Salinity samples:	38
Salt correction:	+0.002

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, and food habits; (3) collect hydrographic and meteorological data; (4) make collections of data and samples for cooperative researchers and programs.

Ecosystems Monitoring Survey

Cruise:	ALB0206
Vessel:	R/V Albatross IV
Dates:	23 May – 2 June
Sea Days:	16
Instrument(s):	2879
Total # of stations:	126
# of vertical CTD/Profiler casts:	26
# of double oblique Profiler casts:	150
# Salinity samples:	23
Salt correction:	-0.001

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.

Ecosystems Monitoring Survey

Cruise:	NOB0201
Vessel:	F/V Nobska
Dates:	14 – 29 August
Sea Days:	15
Instrument(s):	2879, 0851
Total # of stations:	122
# of vertical CTD/Profiler casts:	25
# of double oblique Profiler casts:	129
# Salinity samples:	24
Salt correction:	+0.009

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.

Scallop Survey

Cruise: ALB0208
Vessel: R/V Albatross IV
Dates: 17 July – 15 August
Sea Days: 27
Instrument(s): 1495
Total # of stations: 524
# of vertical CTD/Profiler casts: 144
# of double oblique Profiler casts: N/A
 # Salinity samples: 40
Salt correction: +0.008

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.

Benthic Habitat

Cruise: ALB0209
Vessel: R/V Albatross IV
Dates: 20 – 29 August
Sea Days: 10
Instrument(s): 1495
Total # of stations: 26 (Hydrographic stations)
# of vertical CTD/Profiler casts: 26
# of double oblique Profiler casts: N/A
 # Salinity samples: 15
Salt correction: +0.010

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

HydroAcoustic Survey

Cruise:	DEL0208
Vessel:	R/V Delaware II
Dates:	5 September – 10 October
Sea Days:	24
Instrument(s):	0851, 1496, 0853
Total # of stations:	112 (Hydrographic stations)
# of vertical CTD/Profiler casts:	112
# of double oblique Profiler casts:	N/A
# Salinity samples:	0
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 Groundfish Survey

Cruise:	ALB0210
Vessel:	R/V Albatross IV
Dates:	4 September – 25 October
Sea Days:	41
Instrument(s):	1495
Total # of stations:	334
# of vertical CTD/Profiler casts:	217
# of double oblique Profiler casts:	120
# Salinity samples:	60
Salt correction:	-0.004

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:	OC384
Vessel:	R/V Oceanus
Dates:	24 October – 2 November
Sea Days:	10
Instrument(s):	1447
Total # of stations:	17 (hydrographic stations)
# of vertical CTD/Profiler casts:	17
# of double oblique Profiler casts:	N/A
# Salinity samples:	0
Salt correction:	N/A

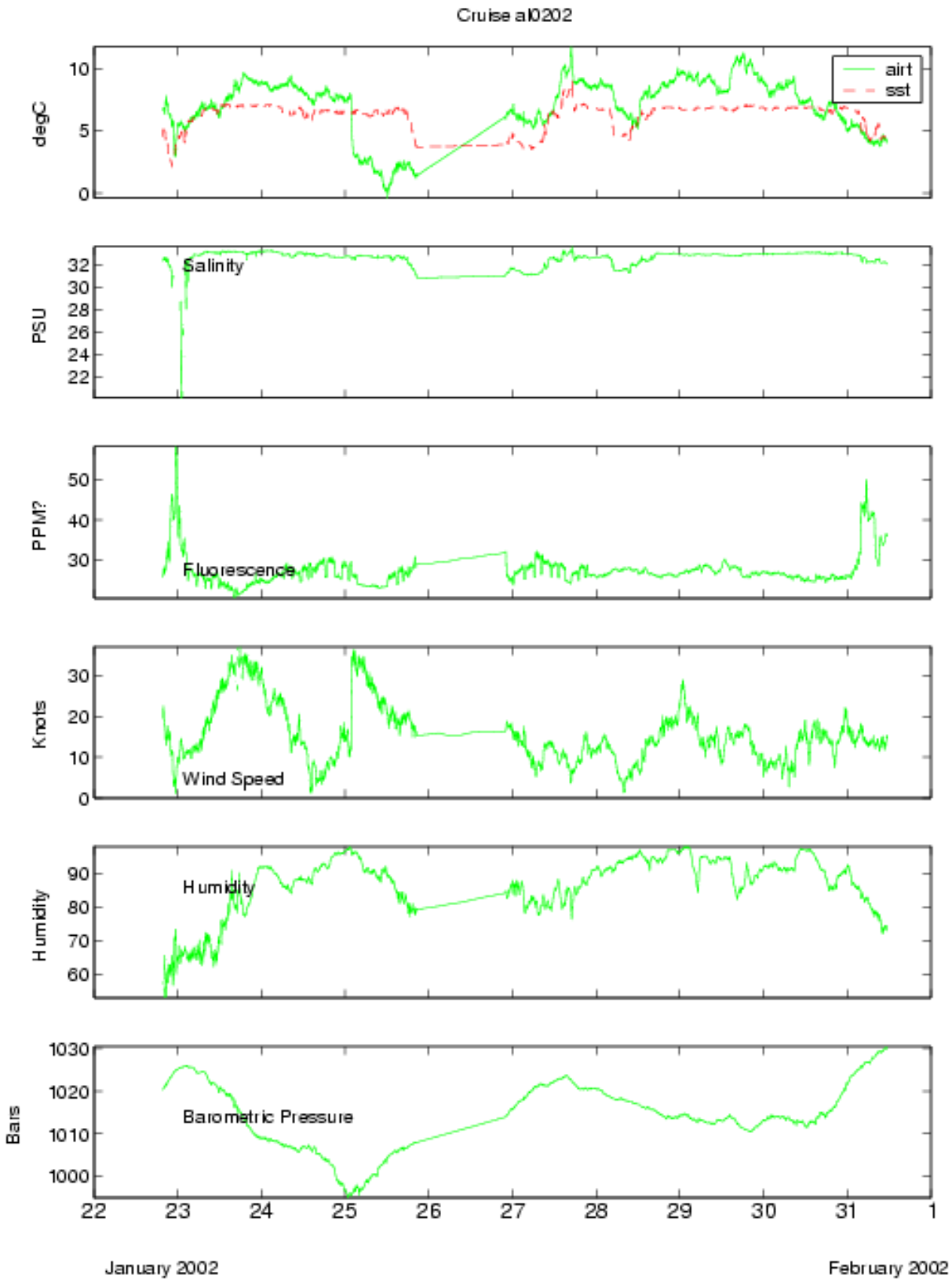
Cruise Objectives: To monitor the recovery of the benthic habitat in the closed areas.

Ecosystem Monitoring

Cruise:	DEL0210
Vessel:	R/V Delaware II
Dates:	29 October – 14 November
Sea Days:	16
Instrument(s):	0853
Total # of stations:	1109
# of vertical CTD/Profiler casts:	21
# of double oblique Profiler casts:	112
# Salinity samples:	19
Salt correction:	+0.007

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.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PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
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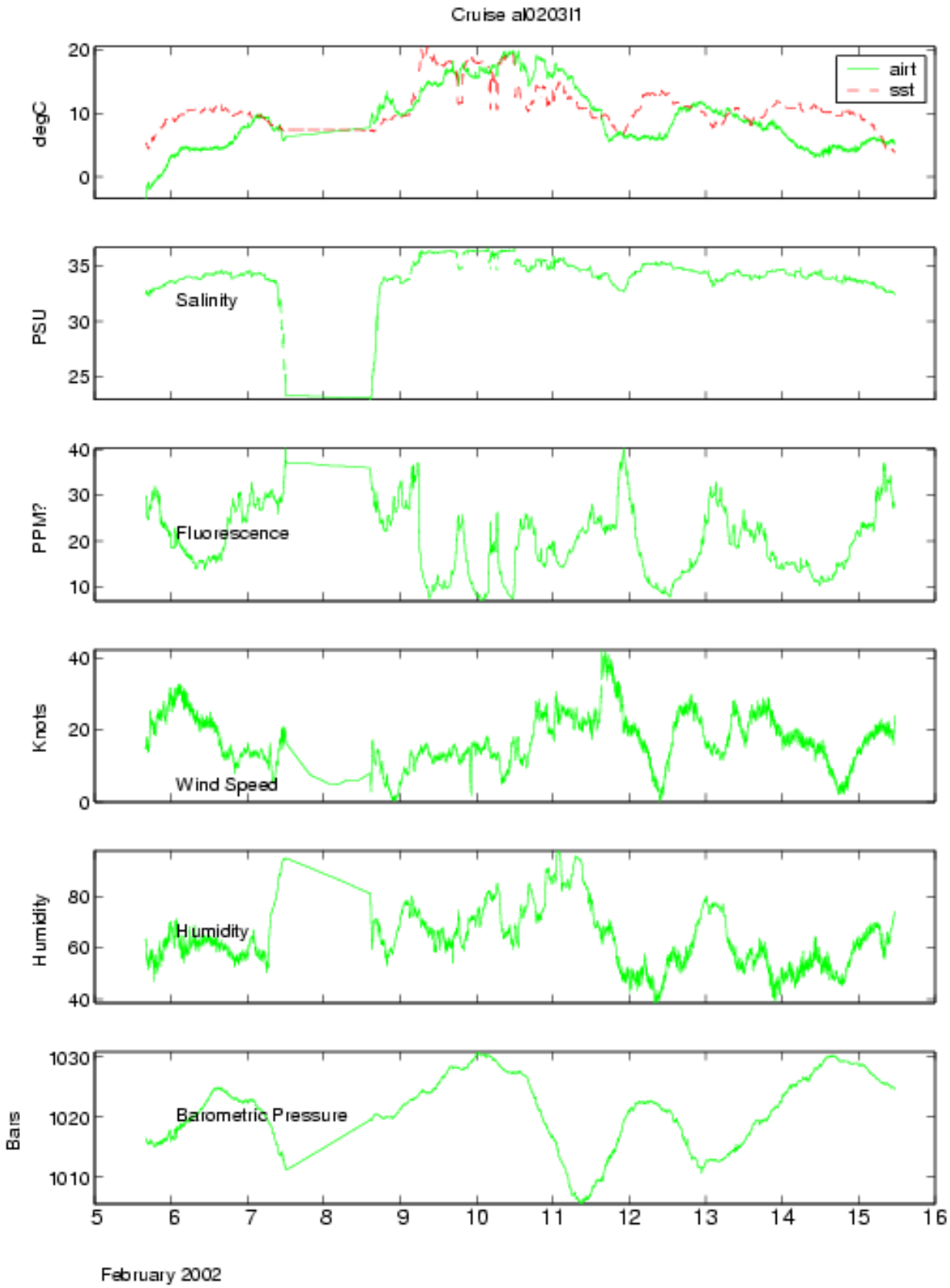
February 2002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PSU
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30
25
Salinity
PPM?
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20
10
Fluorescence
Knots
40
20
0
Wind Speed
Humidity
80
60
40
Humidity
Bars
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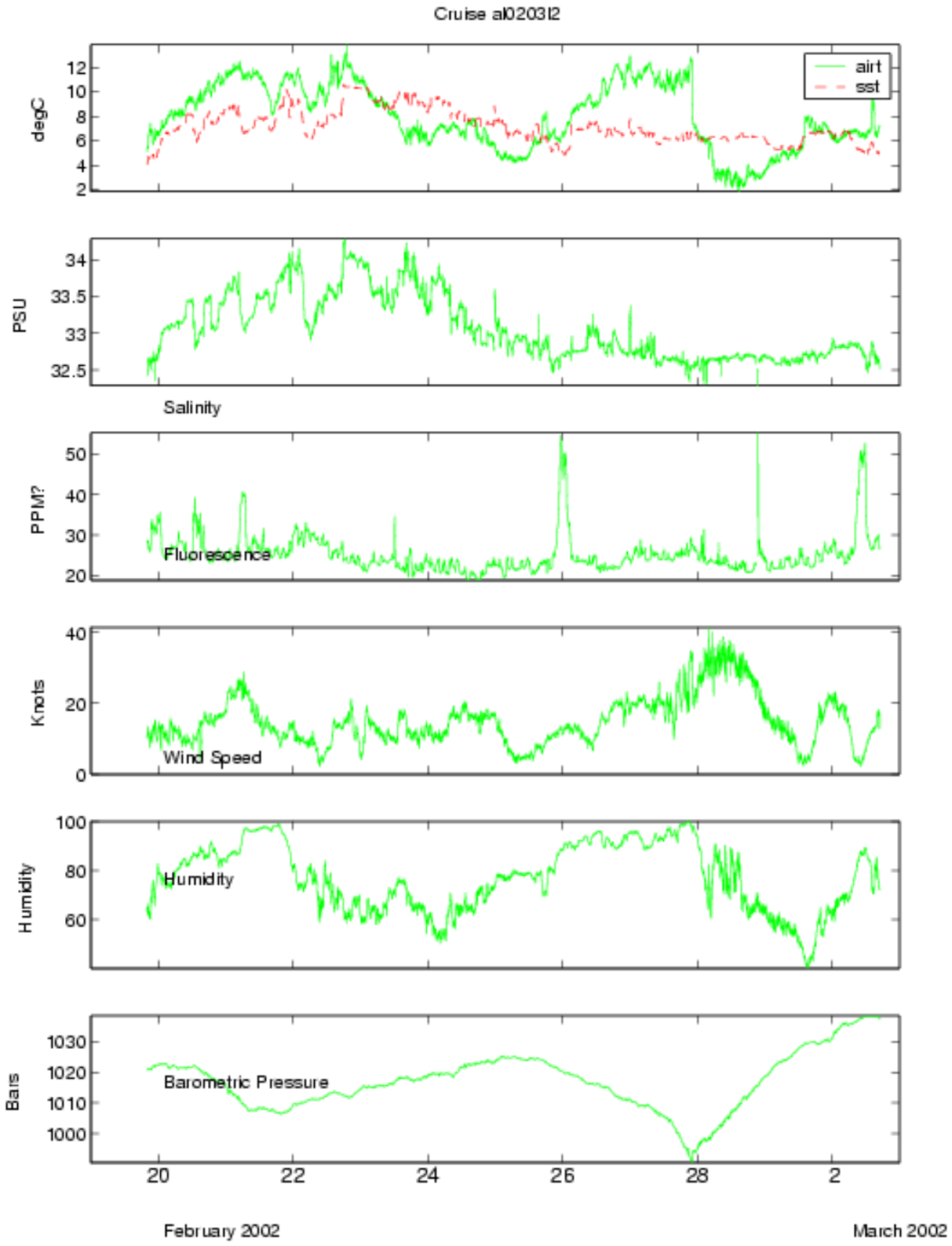
Barometric Pressure
5
6
7
8
9
10
11
12
13
14
15
16
February 2002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Humidity
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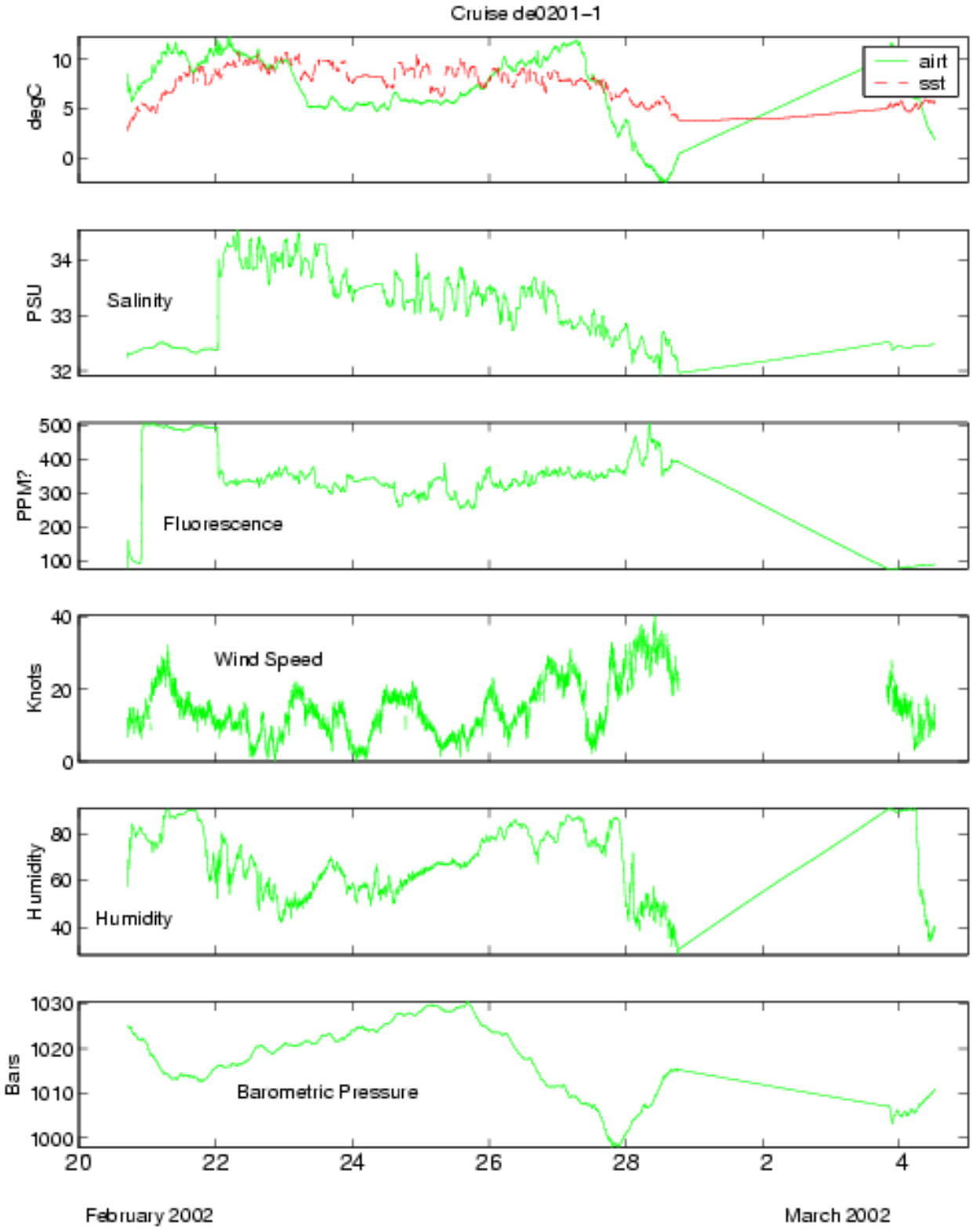
Bars
Barometric Pressure
20
22
24
26
28
2
February 2002
March 2002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PPM?
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300
200
100
Fluorescence
Knots
40
20
0
Wind Speed
Humidity
80
60
40
Humidity
Bars
1030
1020
1010
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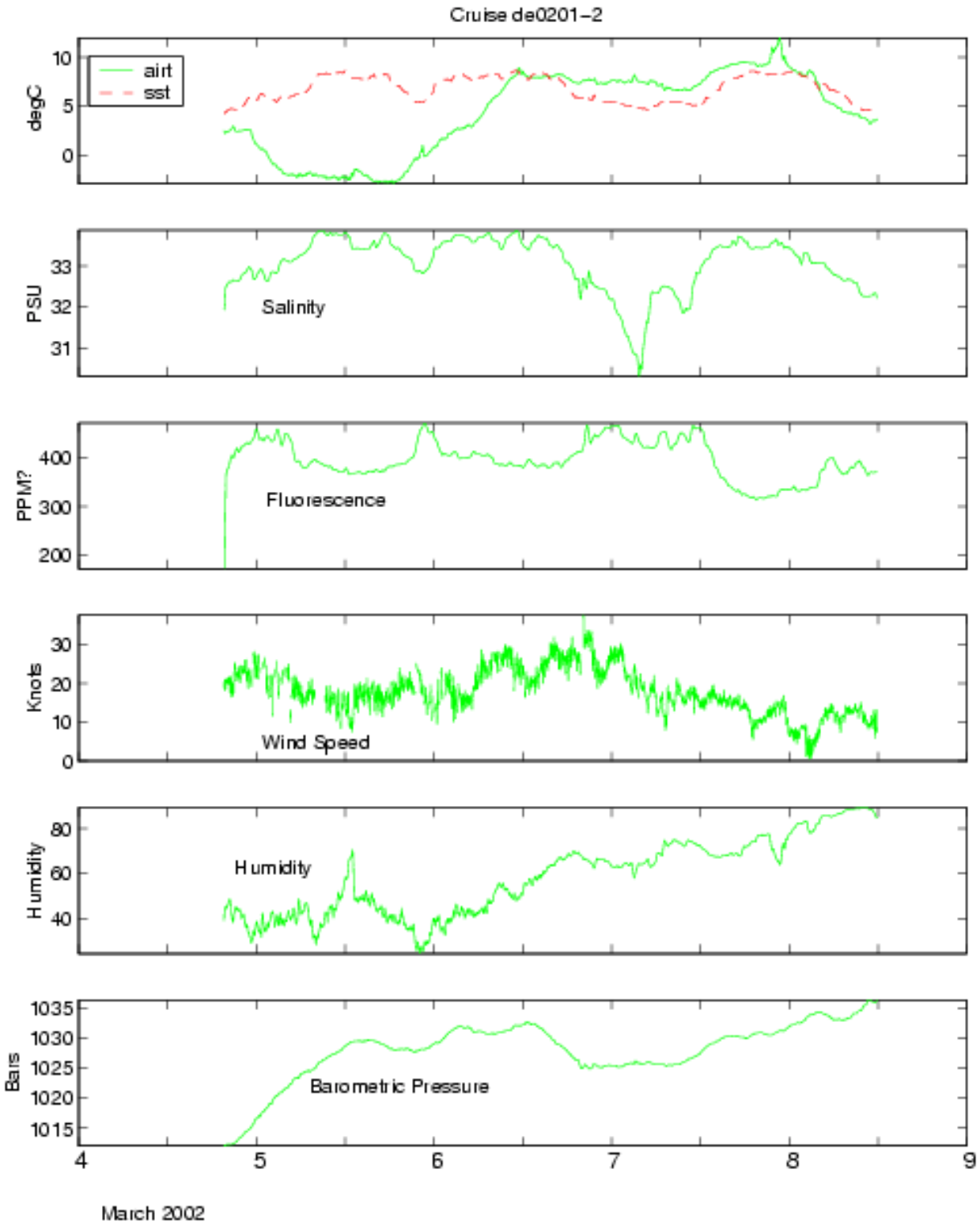
Barometric Pressure
20
22
24
26
28
2
4
February 2002
March 2002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PPM?
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200
Fluorescence
Knots
30
20
10
0
Wind Speed
Humidity
80
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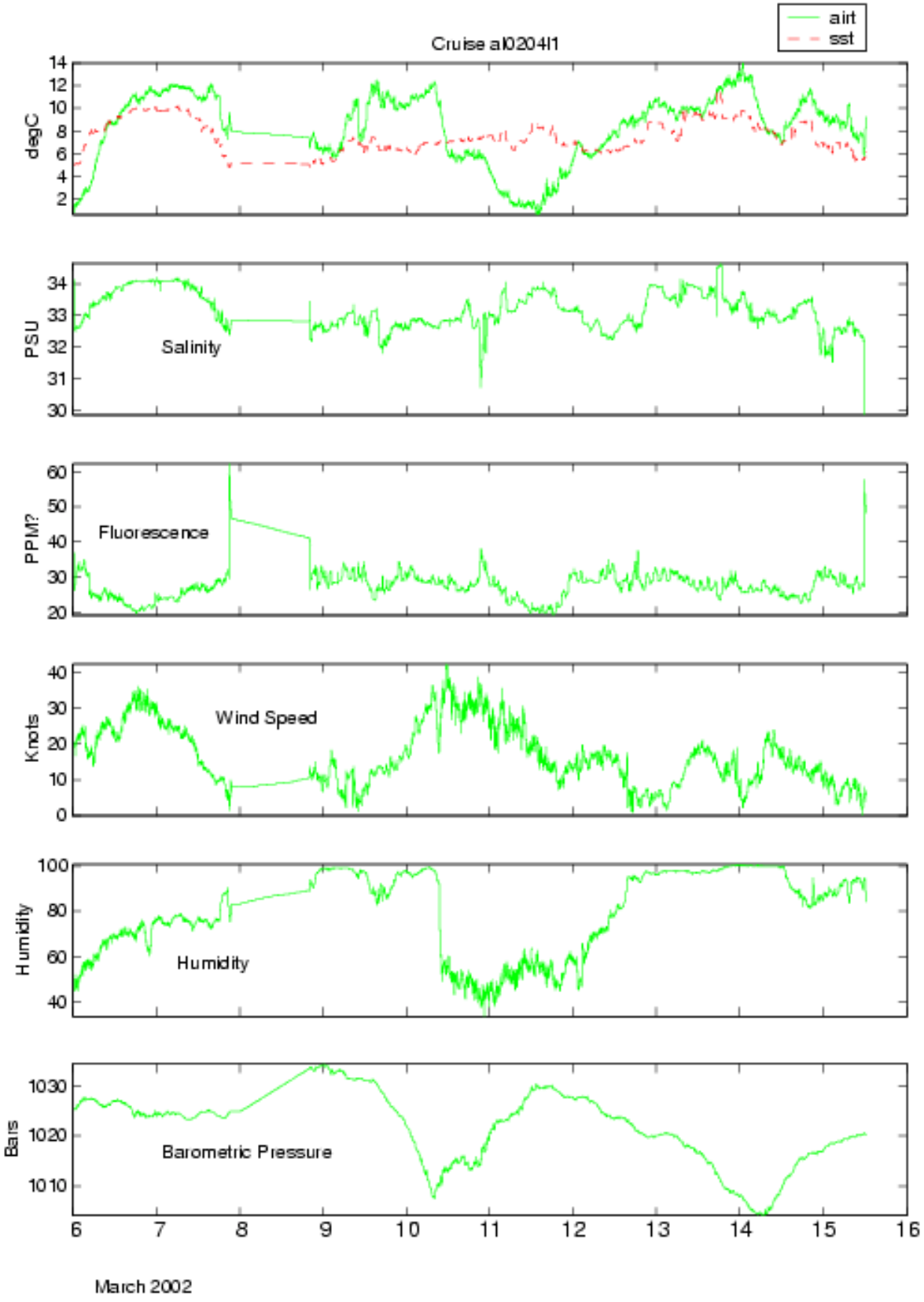
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PPM?
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40
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Fluorescence
Knots
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Humidity
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60
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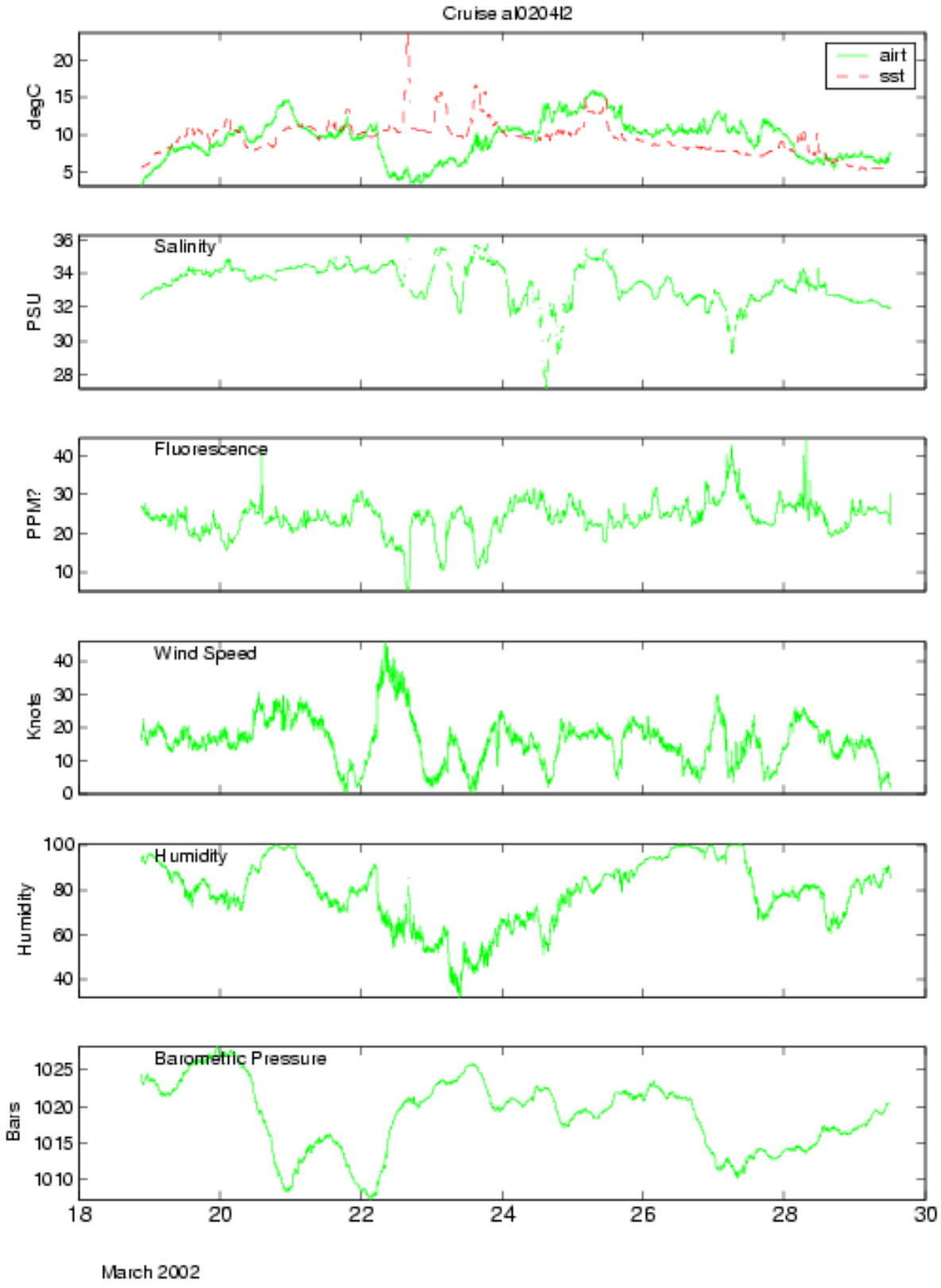
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Barometric Pressure
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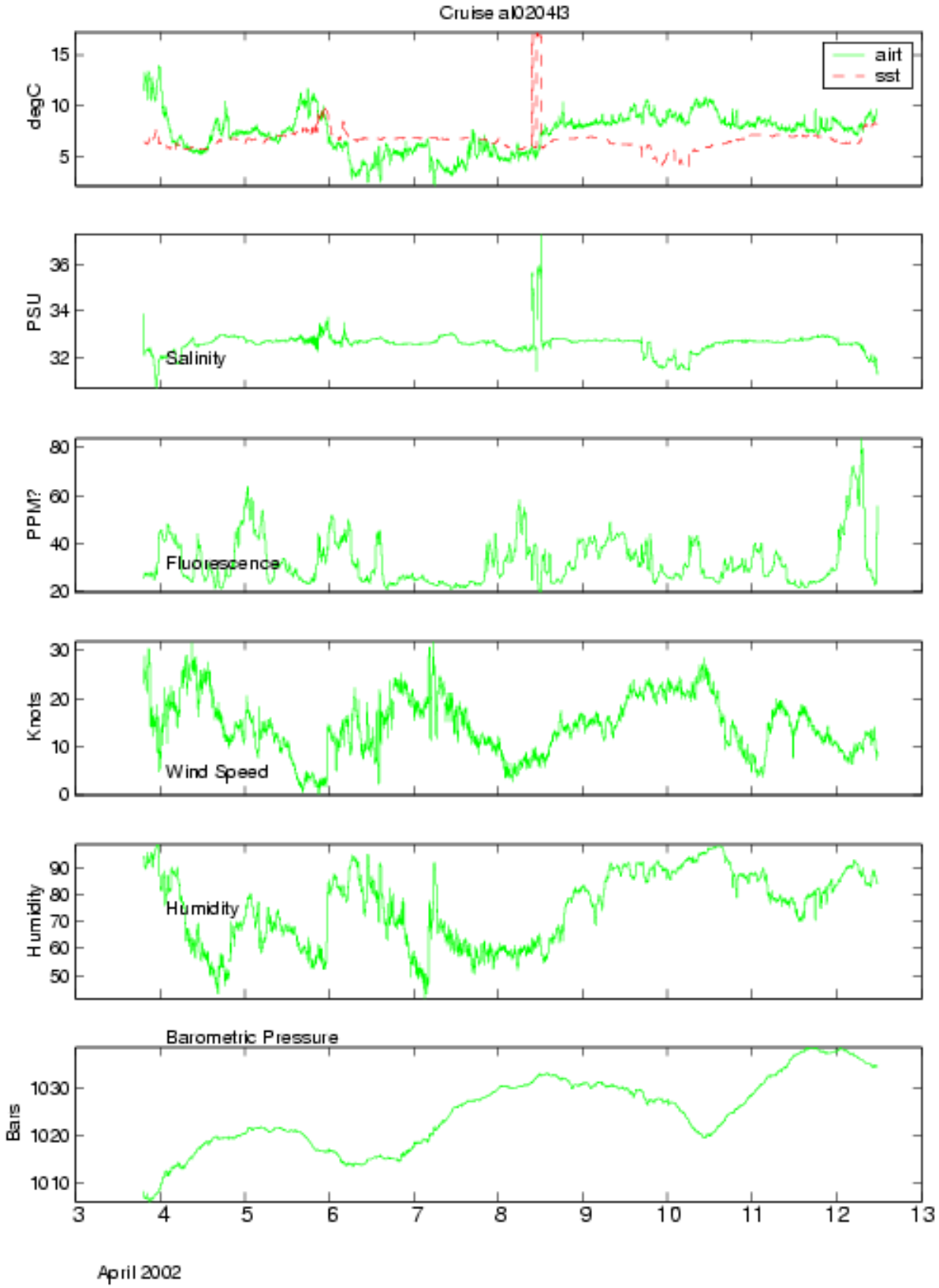
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Humidity
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Barometric Pressure
Bars
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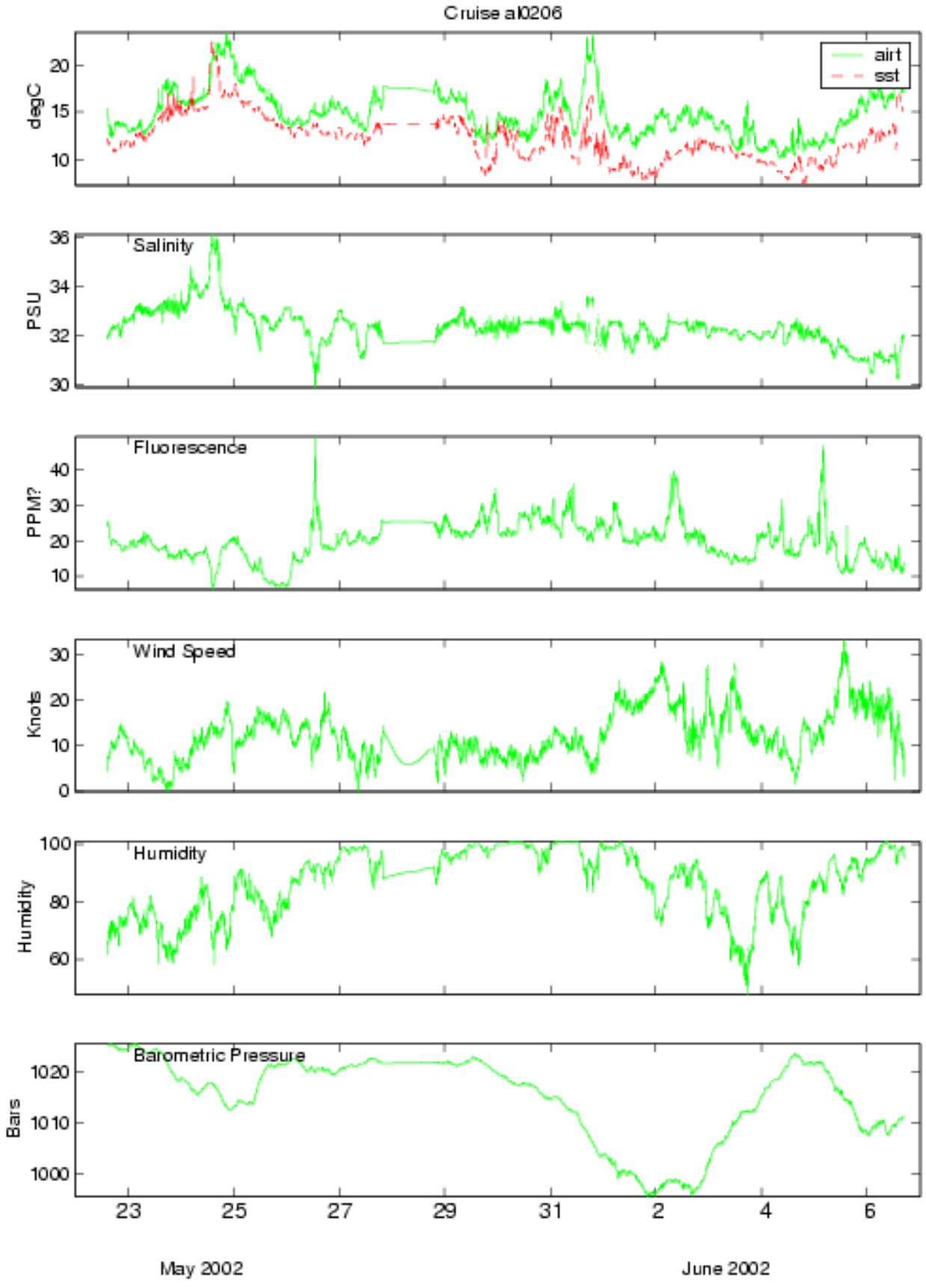
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PSU
Fluorescence
PPM?
Wind Speed
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Humidity
Barometric Pressure
Bars
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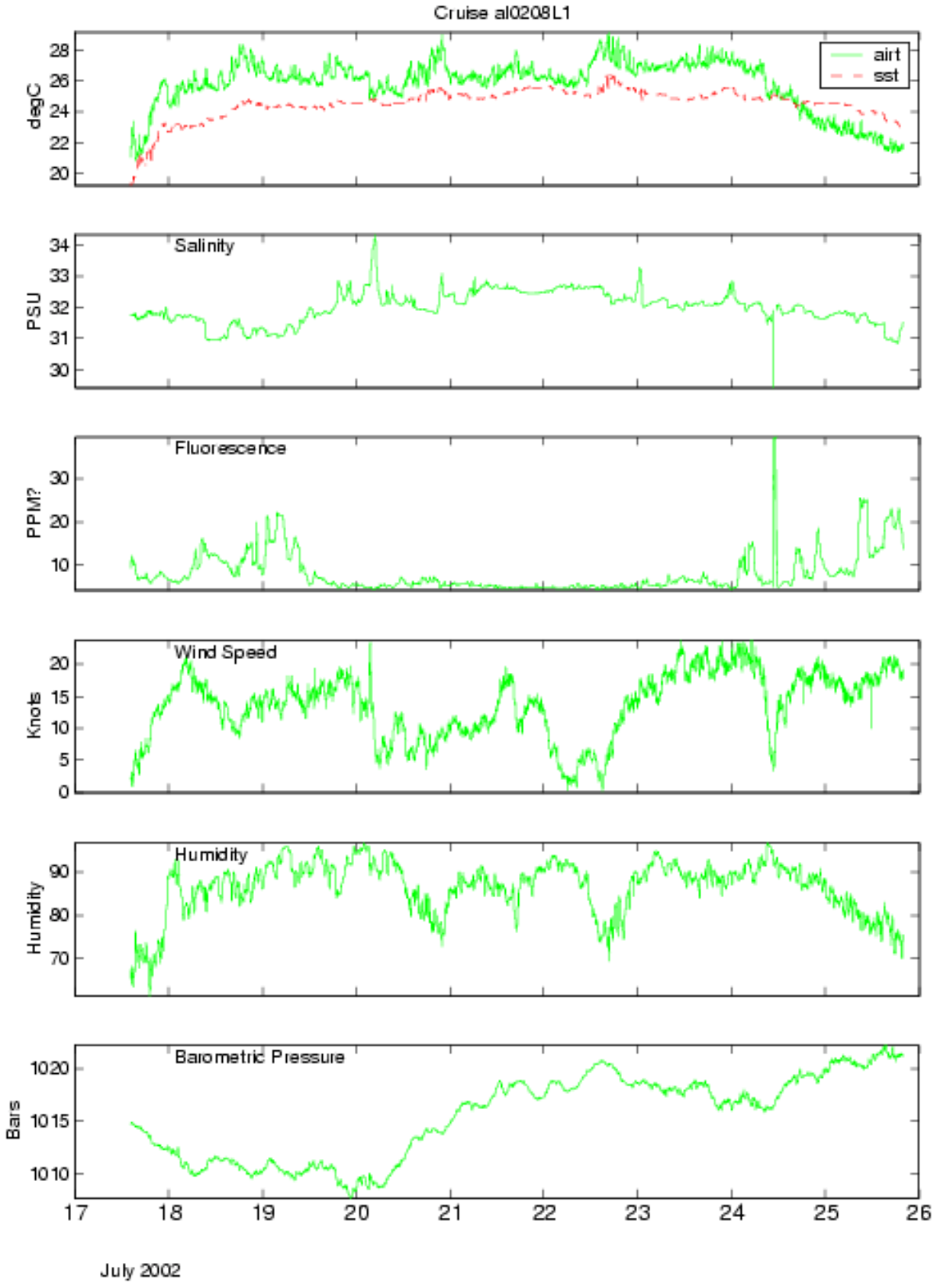
May 2002
June 2002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PPM?
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Wind Speed
Knots
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15
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Humidity
Humidity
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Barometric Pressure
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1015
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25
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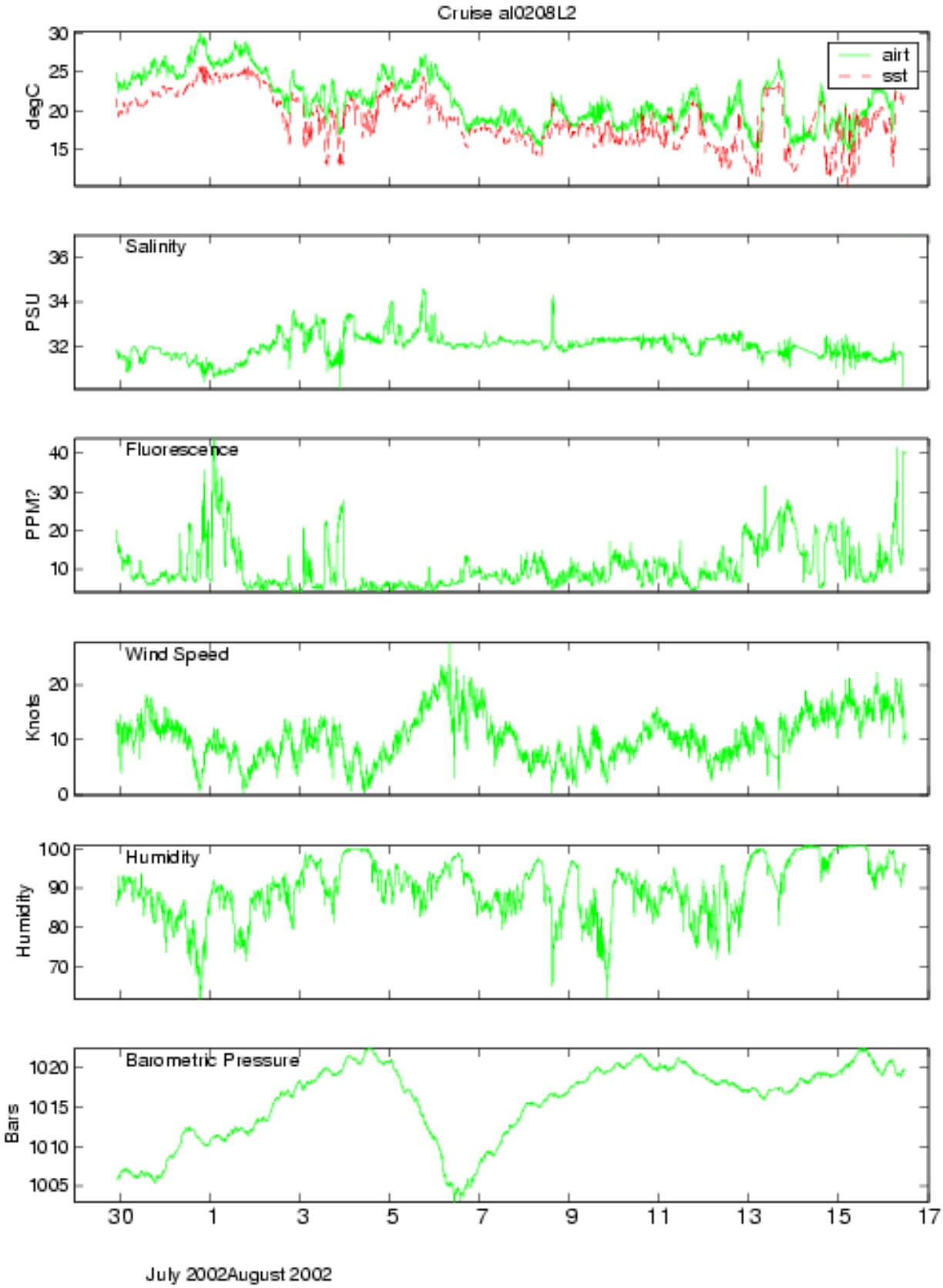
July 2002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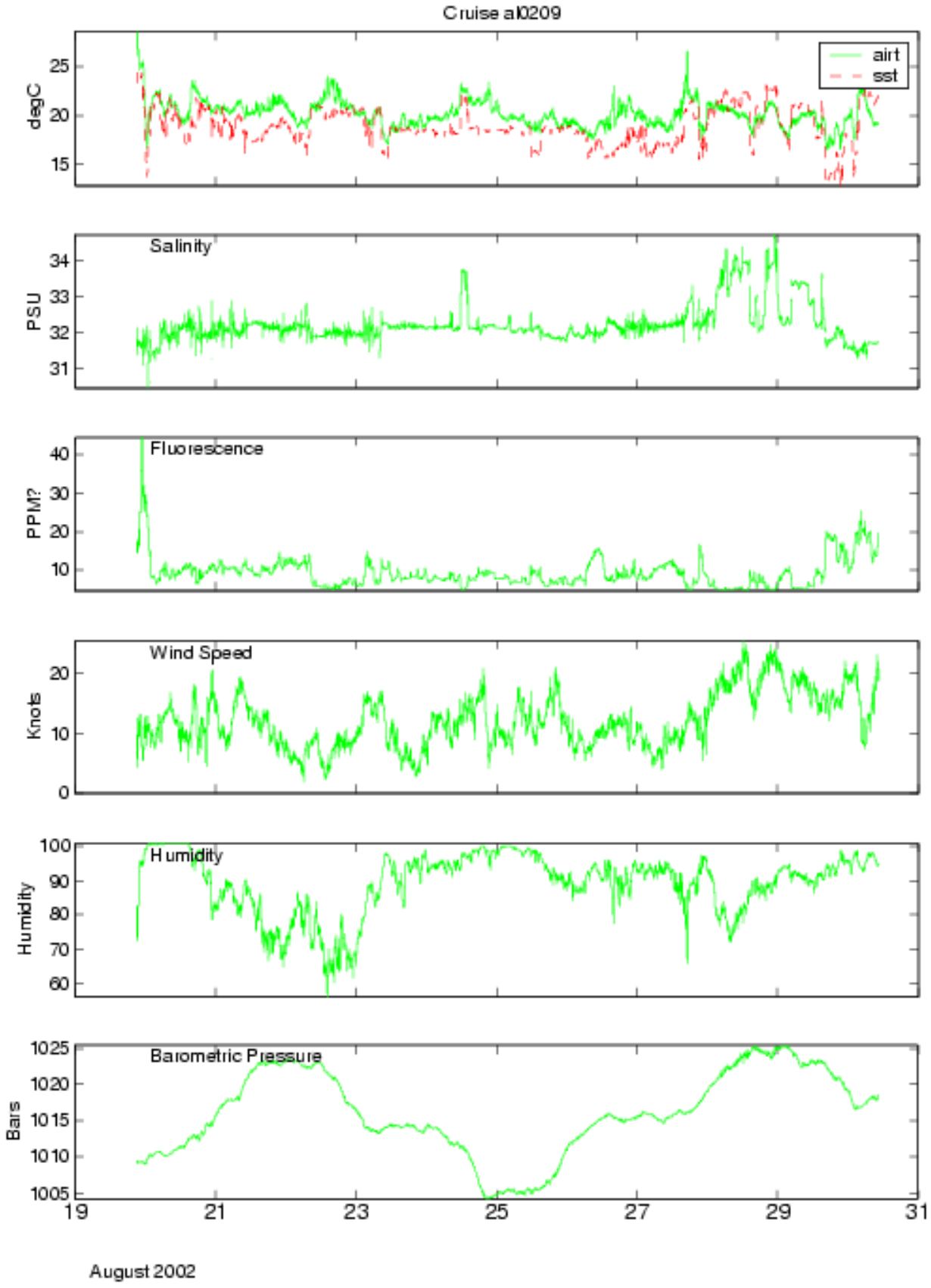
July 2002August 2002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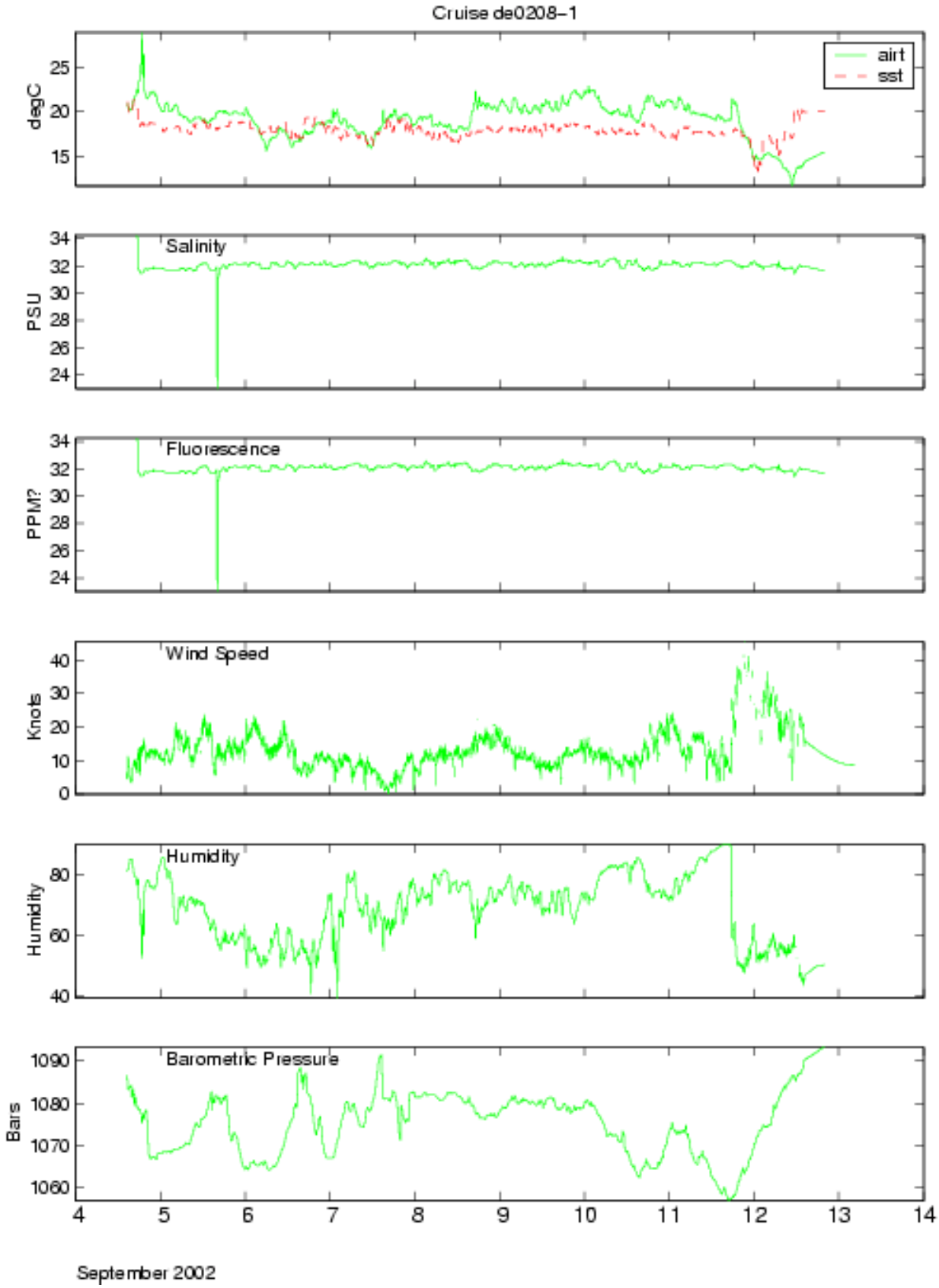
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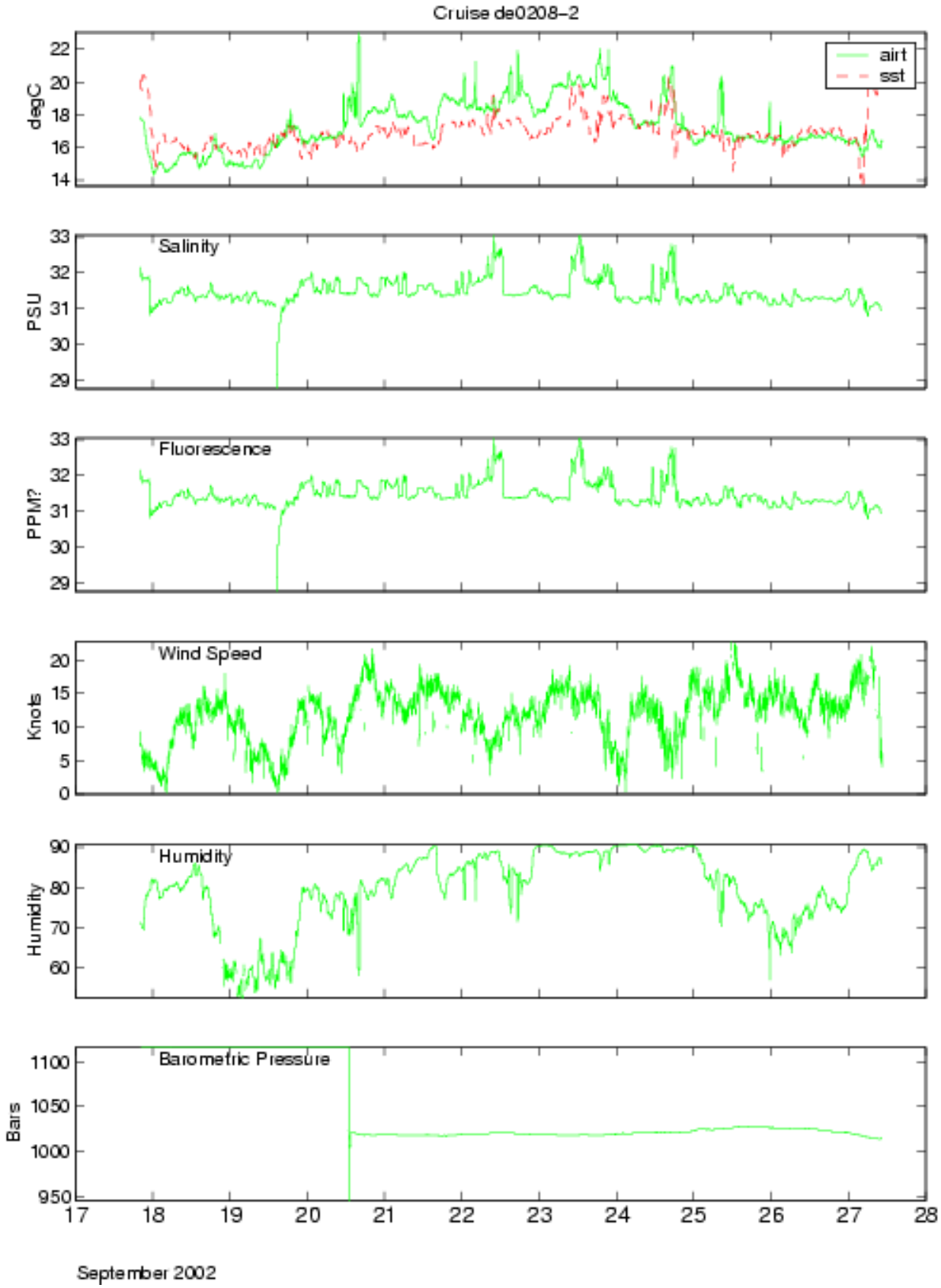
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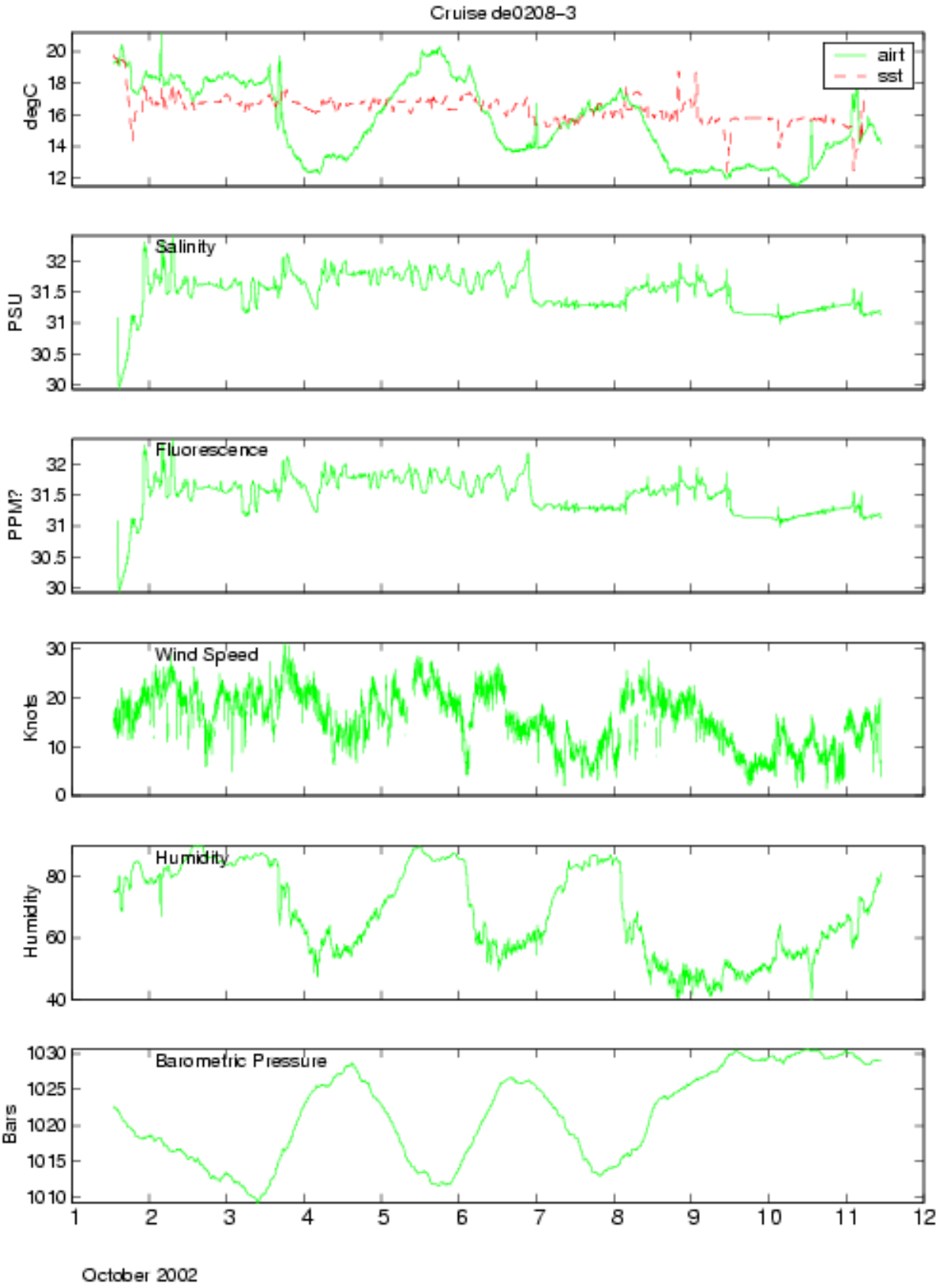
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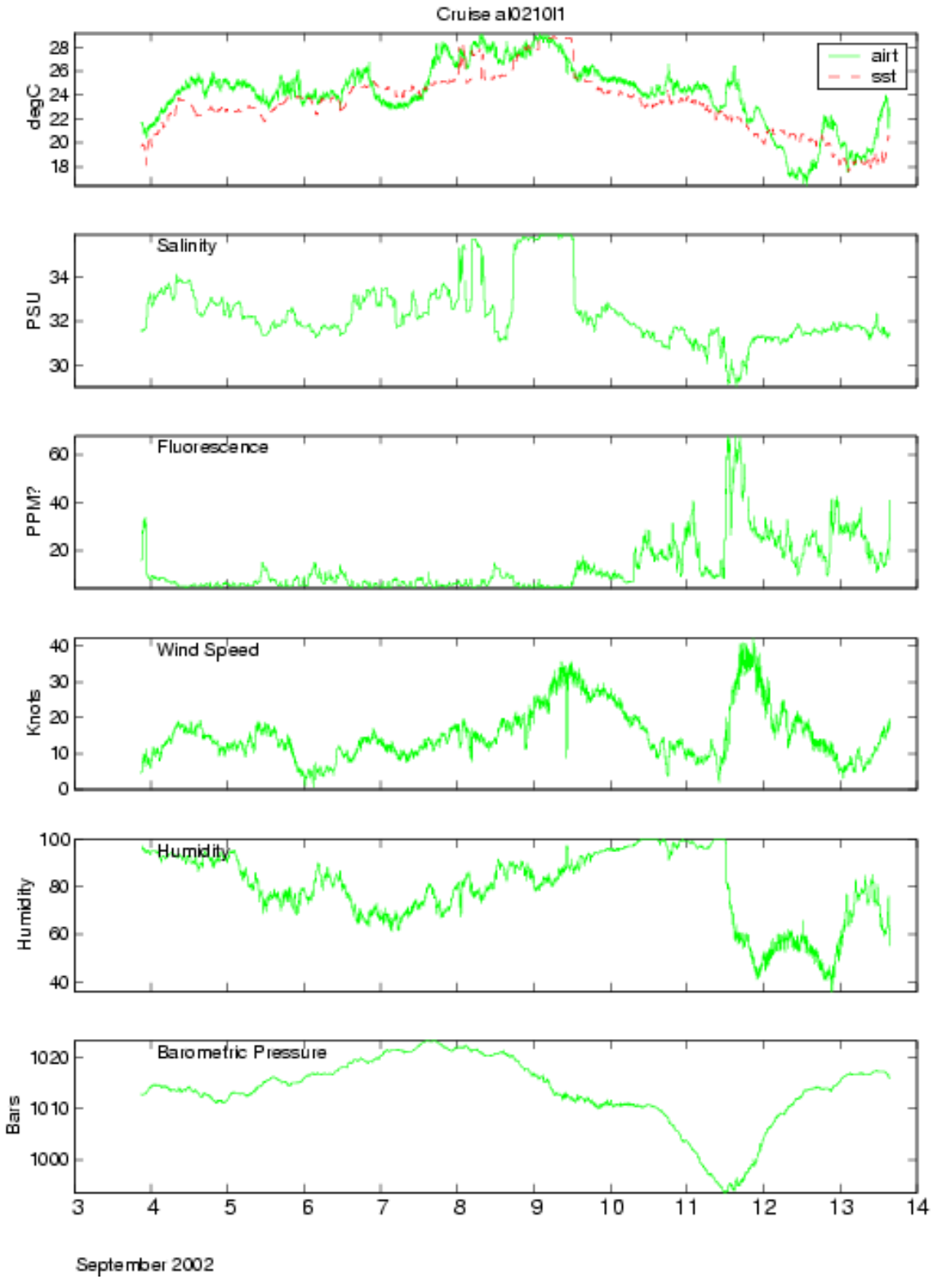
Bars
October 2002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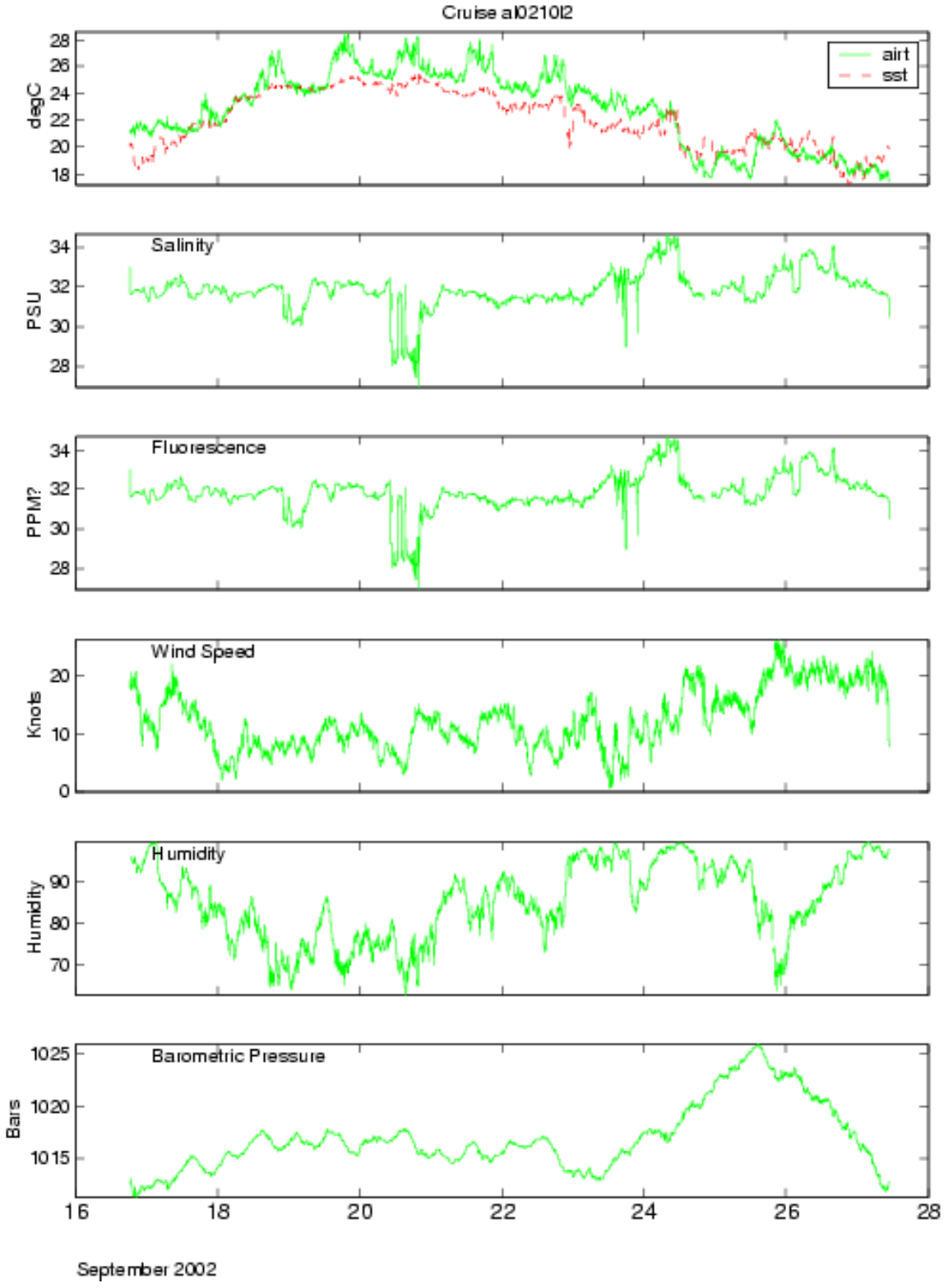
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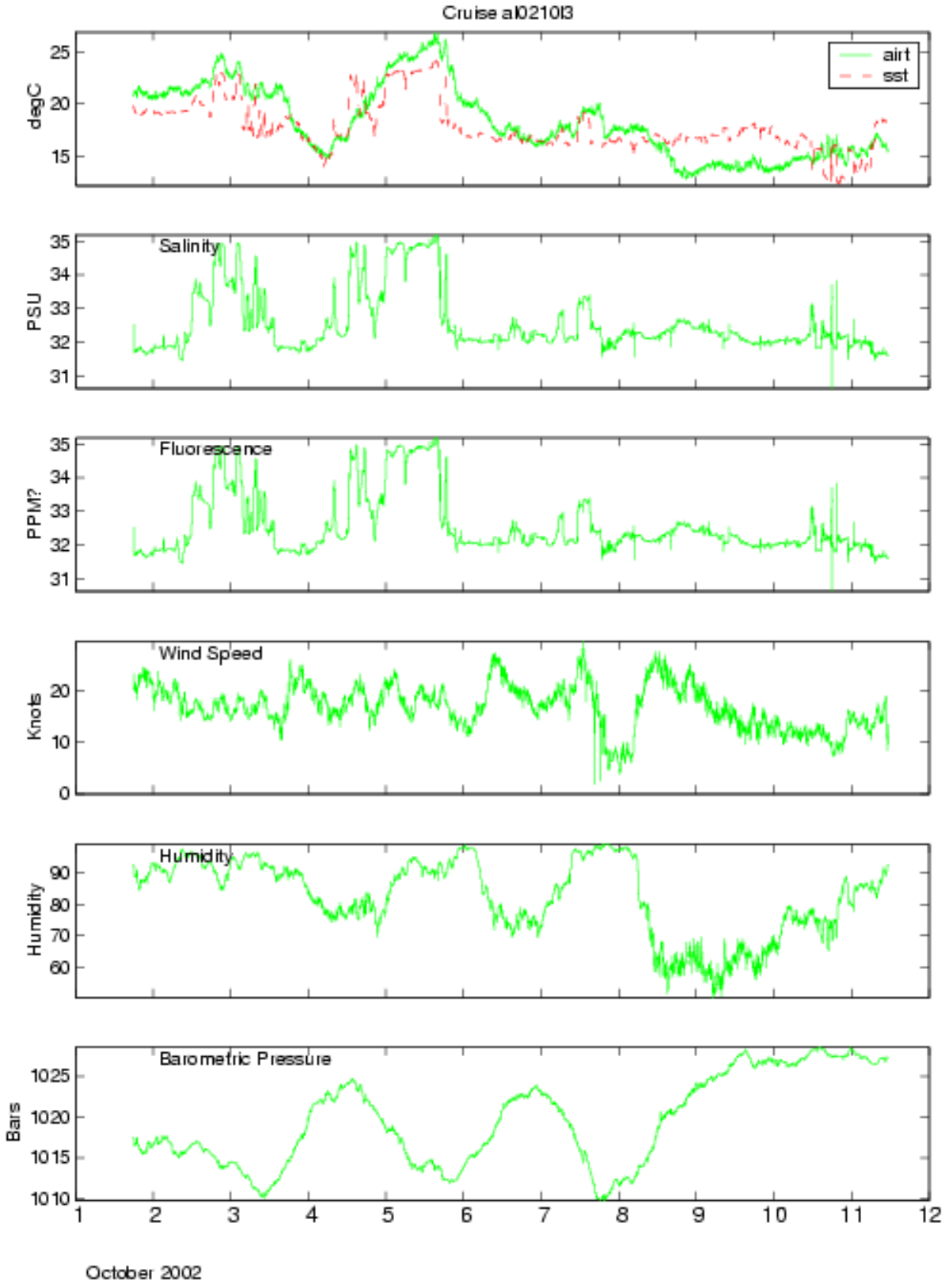
September 2002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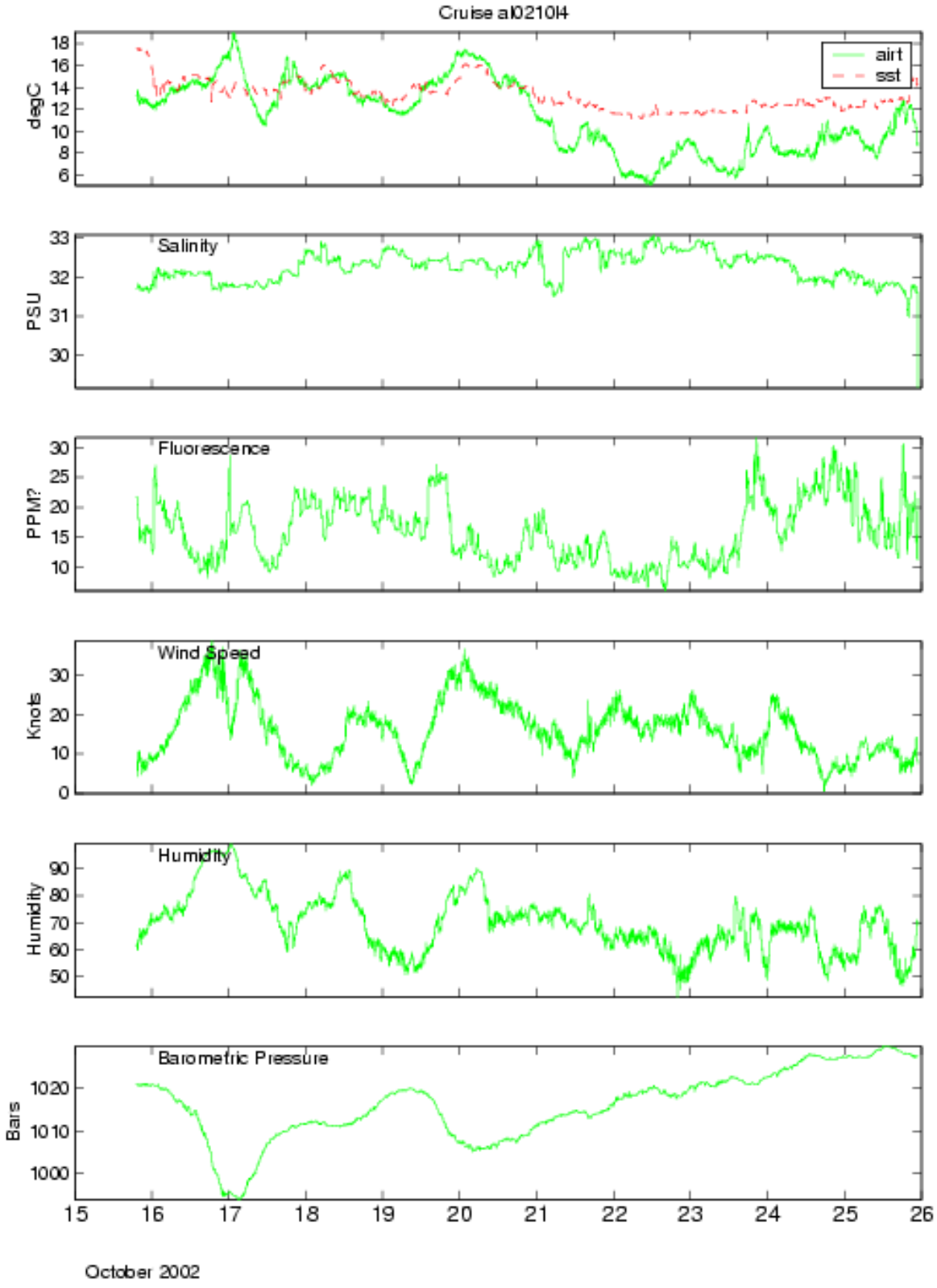
Bars
October 2002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PPM?
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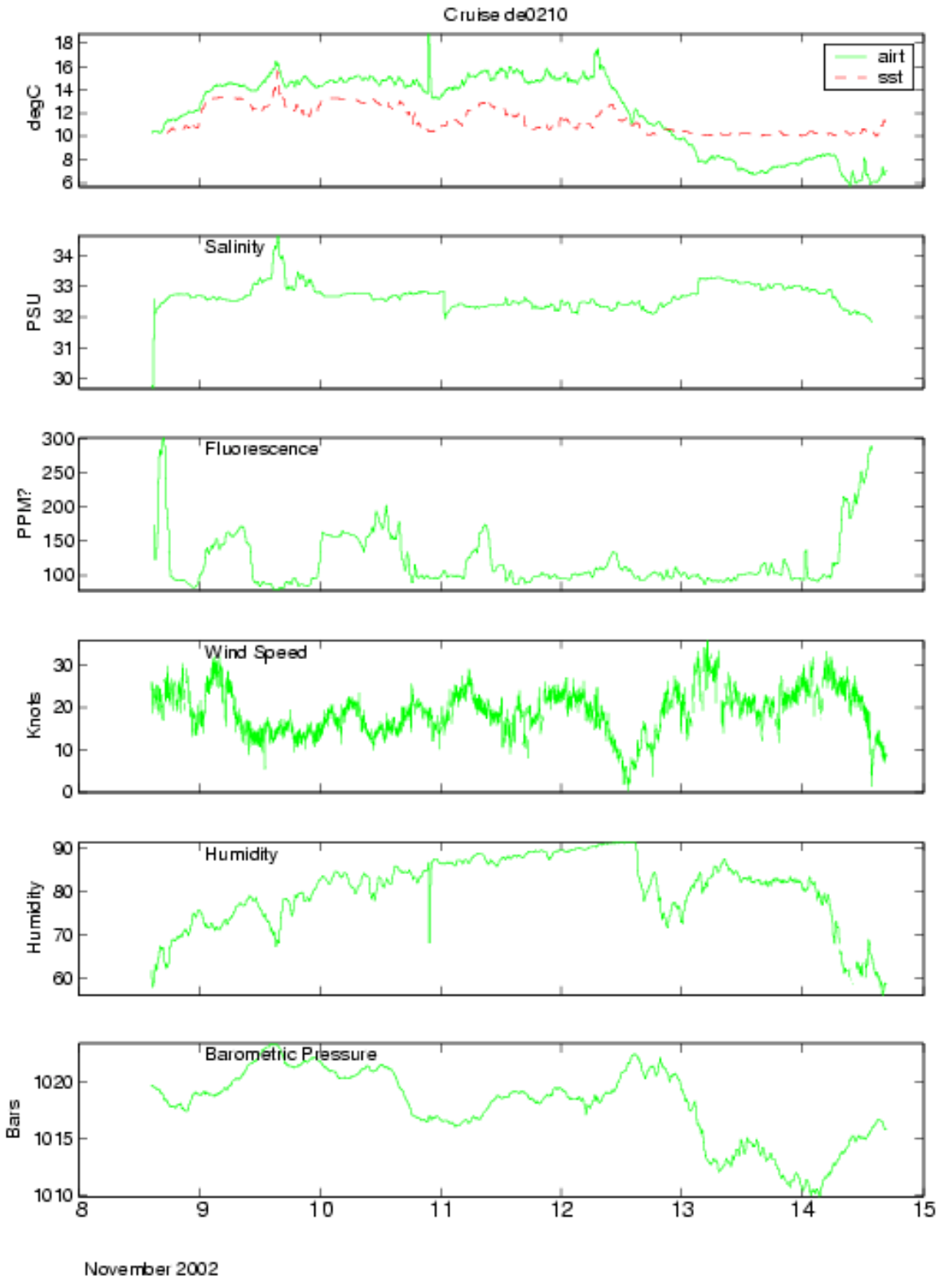
October 2002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airt
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Salinity
PSU
Fluorescence
PPM?
Wind Speed
Knots
Humidity
Humidity
Barometric Pressure
Bars
November 2002

Appendix C. Areal average surface and bottom temperature, salinity, and anomalies Presented by cruise using hydrographic data collected in 2001.

Table 4. Areal average surface and bottom temperature and temperature anomalies for the 2002 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	#obs	Temp	Anomaly	SDV1	SDV2	(1)
Gulf of Maine West												
AL0202	26	14	6.47	0.72	0.29	0.62	13	7.20	1.02	0.24	0.49	
AL0204	108	46	6.37	1.39	0.20	0.86	44	6.40	1.30	0.16	0.76	
AL0206	156	34	10.81	0.59	0.21	0.61	20	6.71	1.22	0.19	0.89	
NO0201	240	20	18.33	1.59	0.27	1.56	18	7.77	1.02	0.22	1.18	
DE0208	257	64	17.52	1.83	0.15	.72*	51	7.75	1.25	0.13	.63*	
AL0210	295	47	13.37	1.16	0.19	0.73	45	8.44	1.18	0.14	1.52	
DE0210	316	11	10.71	0.55	0.37	0.49	9	8.92	0.66	0.31	.94*	
Gulf of Maine East												
AL0202	26	18	5.70	0.41	0.25	0.73	14	7.52	0.37	0.31	1.21	
AL0204	112	35	5.46	0.71	0.19	0.74	32	7.36	0.52	0.22	0.75	
AL0206	154	21	9.10	0.73	0.20	0.47	10	8.18	1.08	0.33	0.70	
NO0201	238	16	16.81	2.43	0.26	1.62	13	9.33	0.89	0.30	2.00	
DE0208	268	24	16.71	1.52	0.19	.63*	23	10.17	0.68	0.19	.95*	
AL0210	289	29	13.48	1.18	0.20	0.72	26	9.80	1.23	0.21	1.52	
DE0210	316	7	11.19	0.18	0.34	.51*	5	9.89	0.29	0.47	1.02*	
Georges Bank												
AL0202	26	15	6.60	1.35	0.23	.37*	14	6.67	1.17	0.22	.54*	
AL0203	59	18	5.90	0.64	0.40	.77*	10	7.72	2.03	0.47	1.48*	
AL0204	101	52	6.25	1.28	0.19	0.64	46	6.77	1.57	0.24	0.83	
AL0206	151	32	11.20	1.94	0.26	1.34	26	8.80	1.12	0.28	0.99	
AL0208	216	65	18.47	3.06	0.18	2.23	64	11.25	0.40	0.21	2.29	
NO0201	236	31	19.97	3.59	0.26	1.89	27	13.08	0.99	0.32	1.79	
AL0209	237	26	18.82	3.94	0.19	1.20*	26	11.89	0.09	0.18	2.30*	
DE0208	279	24	17.15	1.73	0.19	.90*	24	13.97	1.55	0.20	1.98*	
AL0210	279	56	17.76	2.49	0.22	1.56	47	14.46	1.75	0.23	2.13	
DE0210	312	30	12.78	0.09	0.23	0.65	28	12.75	0.80	0.27	1.02	
MAB North												
AL0203	55	49	6.96	1.95	0.25	1.04*	38	7.05	2.28	0.26	1.02*	
DE0201	62	12	7.97	2.13	0.65	.79*	6	7.54	2.89	0.66	.46*	
AL0204	69	53	7.29	2.80	0.28	0.94	47	7.97	2.76	0.34	1.28	
AL0206	148	23	12.49	0.96	0.35	1.22	20	8.50	0.86	0.42	1.51	
AL0208	210	19	22.10	2.18	0.36	1.29*	19	8.99	0.98	0.35	.68*	
NO0201	231	24	23.63	3.51	0.39	1.33	21	11.22	1.03	0.45	1.85	
AL0210	271	61	19.70	1.40	0.27	1.24	56	13.07	0.93	0.34	2.76	
DE0210	307	20	15.70	1.15	0.39	1.40	18	14.67	1.44	0.42	1.21	
MAB South												
AL0203	46	78	9.72	3.43	0.24	2.48	62	9.68	3.21	0.30	1.86	
DE0201	55	26	9.00	2.57	0.38	1.55*	16	8.56	3.75	0.38	1.18*	
AL0204	84	87	9.24	3.14	0.24	0.95	82	9.11	2.96	0.29	1.29	
AL0206	146	40	14.64	-0.16	0.31	0.64	40	11.80	2.73	0.35	1.44	
AL0208	202	48	24.60	1.41	0.26	1.05*	47	9.59	1.96	0.30	1.15*	
NO0201	228	35	25.24	1.21	0.34	1.44	33	13.94	1.73	0.38	2.91	
AL0210	256	87	23.27	0.96	0.25	1.01	81	15.44	1.59	0.31	2.71	
DE0210	304	38	16.87	0.59	0.31	1.00	36	15.85	1.13	0.35	1.10	

(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 2002 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	#obs	Salt	Anomaly	SDV1	SDV2	(1)
Gulf of Maine West												
AL0202	26	14	32.99	-0.06	0.14	0.26	13	33.67	0.10	0.08	0.24	
AL0204	108	46	32.51	-0.05	0.09	0.44	44	33.41	0.05	0.06	0.26	
AL0206	156	34	32.07	-0.07	0.09	0.24	20	33.50	0.18	0.08	0.28	
NO0201	240	20	32.24	0.19	0.12	0.38	18	33.64	0.11	0.08	0.21	
DE0208	257	46	32.39	0.35	0.07	.34*	50	33.83	0.25	0.04	.35*	
AL0210	295	46	32.87	0.33	0.08	0.20	45	33.77	0.16	0.06	0.27	
DE0210	316	11	33.09	0.33	0.17	0.13	9	33.57	0.03	0.11	.39*	
Gulf of Maine East												
AL0202	26	18	32.35	-0.37	0.13	0.32	14	33.91	0.01	0.09	0.41	
AL0204	112	34	32.27	-0.20	0.11	0.32	32	34.02	0.05	0.07	0.32	
AL0206	154	21	32.37	-0.06	0.12	0.22	10	33.99	0.21	0.10	0.29	
NO0201	238	15	32.57	0.17	0.13	0.35	13	34.32	0.25	0.09	0.36	
DE0208	268	24	32.55	0.12	0.08	.14*	23	34.28	0.18	0.06	.19*	
AL0210	289	27	32.96	0.37	0.13	0.24	26	34.43	0.24	0.07	0.32	
DE0210	316	7	33.01	0.33	0.17	.08*	5	34.03	0.08	0.11	.39*	
Georges Bank												
AL0202	26	15	32.86	-0.08	0.09	.07*	14	32.94	0.00	0.07	.24*	
AL0203	59	18	32.68	-0.45	0.16	.39*	10	33.43	0.05	0.17	.60*	
AL0204	101	51	32.69	-0.27	0.07	0.35	45	33.10	-0.06	0.08	0.26	
AL0206	151	32	32.76	-0.11	0.10	0.25	26	32.84	-0.19	0.10	0.29	
AL0208	216	65	32.82	0.18	0.06	0.47	64	33.03	0.04	0.07	0.35	
NO0201	236	31	33.14	0.44	0.09	0.77	27	33.08	0.05	0.11	0.37	
AL0209	237	26	32.64	0.04	0.07	.53*	26	32.89	0.11	0.06	.25*	
DE0208	279	23	32.59	0.08	0.07	.14*	24	33.21	0.25	0.07	.40*	
AL0210	279	56	33.13	0.38	0.09	0.74	47	33.35	0.38	0.08	0.54	
DE0210	312	30	32.96	0.23	0.08	0.16	28	33.24	0.23	0.10	0.34	
MAB North												
AL0203	55	49	33.08	-0.03	0.10	.42*	38	33.22	-0.09	0.10	.33*	
DE0201	62	11	33.44	0.12	0.28	.40*	6	33.36	0.02	0.24	.27*	
AL0204	69	53	33.10	0.16	0.12	0.47	47	33.49	0.08	0.12	0.42	
AL0206	148	22	32.51	0.11	0.16	0.38	19	33.09	-0.24	0.14	0.47	
AL0208	210	19	32.03	0.20	0.16	.60*	19	32.83	-0.16	0.13	.20*	
NO0201	231	24	32.30	-0.09	0.17	0.51	21	33.23	-0.13	0.15	0.37	
AL0210	271	61	32.96	0.36	0.11	0.55	56	33.51	0.11	0.11	0.57	
DE0210	307	20	33.98	1.02	0.17	0.07	18	34.12	0.51	0.15	0.42	
MAB South												
AL0203	46	78	34.14	0.54	0.14	0.73	62	34.23	0.52	0.11	0.55	
DE0201	55	24	33.90	0.13	0.20	.56*	16	33.93	0.43	0.14	.36*	
AL0204	84	86	33.80	0.79	0.14	0.81	82	33.92	0.42	0.10	0.60	
AL0206	146	40	33.20	1.01	0.18	0.61	40	33.77	0.45	0.13	0.36	
AL0208	202	35	32.37	0.58	0.20	0.69	33	33.34	0.28	0.15	0.57	
NO0201	228	47	32.06	0.16	0.13	.56*	47	33.40	0.09	0.10	.47*	
AL0210	256	87	32.40	0.28	0.14	0.63	80	32.82	-0.29	0.11	0.53	
DE0210	304	38	33.28	0.47	0.18	0.57	36	33.32	0.00	0.13	0.60	

(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 temperature: "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.

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