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Description of the 2008 Oceanographic Conditions on the Northeast U.S. Continental Shelf

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Abstract

Hydrographic observations from 17 surveys that were conducted on the northeast continental shelf during 2008 are summarized. Contoured distributions of temperature, salinity, density stratification and anomalies are presented for six two-month time periods if coverage was sufficient. Average temperature/salinity values were calculated in five geographic regions over the northeast continental shelf: western Gulf of Maine (GOMW), eastern Gulf of Maine (GOME), Georges Bank (GBNK), northern Mid Atlantic Bight (MABN) and southern Mid Atlantic Bight (MABS).

Review of the computed regional average temperature data indicate that surface temperatures were predominately warmer than the reference values in all regions. The eastern Gulf of Maine exhibited slightly colder than expected bottom temperatures for all time periods for which data were available. Regional average salinities were mostly lower, but the largest (negative) anomalies were observed in the Mid-Atlantic Bight. There were localized areas of positive salinities anomalies observed during the year, but these tended to be associated with warm core rings or the variable position of the shelf/slope front. Warmer sea surface temperatures and lower salinities contributed to a higher degree of density stratification along the outer shelf region of the Mid Atlantic Bight during the 2008 summer. The volume of shelf water in the Mid Atlantic regions was high indicating that the shelf / slope front was located further offshore. The northeast climate experienced higher than normal precipitation and slightly warmer air temperatures during 2008.

Introduction

The Northeast Fisheries Science Center (NEFSC) conducts multiple surveys off the northeast U.S. continental shelf each year in support of ecosystem research and management. Broad-scale sampling of the shelf (Cape Hatteras to the Gulf of Maine) occurs during the spring and fall bottom trawl surveys and ideally during four dedicated Ecosystem Monitoring (EcoMon) surveys. Coverage on other surveys varies depending on the specific objectives of the field program. During 2008 the Oceanography Branch supported 17 surveys representing 8 different NEFSC field programs. Surface and bottom temperature, salinity and anomaly distributions were displayed as plan-view contour plots where sufficient data were available. Estimates of the density stratification of the upper 50m of the water column were included. Regional average temperature and salinity and the corresponding anomalies were computed for the five different regions of the shelf shown in Figure 1 and for six time periods throughout the year. The volume of shelf water observed in the upper 100 meters in the Mid Atlantic Bight regions was calculated. The regional values are summarized in both tables and time series figures.

Data and Methods

The Oceanography Branch provides CTD (Conductivity, Temperature, and Depth) recording instruments to the NEFSC programs that request operational support (Taylor and Bascuñan, 2000). Training was provided prior to sailing in CTD deployment, maintenance, data acquisition and preliminary post processing procedures. All CTD data were processed on shore using Seabird Electronics software to produce 1-decibar averaged ASCII files. Salinity samples, typically taken twice daily at sea, were analyzed using a Guildline Autosal (salinometer) located at the Narragansett Laboratory. A salinity offset was applied to instrument data if the mean difference between the reference Autosal readings and the CTD values exceeded +/- 0.01. The data were quality controlled and converted to a standard 80-column ASCII formatted cruise file. These files were then loaded into ORACLE database tables and also posted in the NEFSC anonymous FTP account (ftp://ftp.nefsc.noaa.gov/pub/hydro). Hydrographic cruise reports were prepared for each survey and include cruise notes, a station distribution map, plan-view contour plots of the surface and bottom temperature, salinity, and anomalies (if station coverage was sufficient), and a table of regional average values and anomalies. CTD profile data can be retrieved from http://www.nefsc.noaa.gov/epd/ocean/MainPage/.

For this report, the processed 2008 CTD data were combined and sorted into two-month time bins. Regional average temperature and salinity were then calculated for the six time periods and for the five regions of the northeast continental shelf. Both the individual station and the regional temperature and salinity anomalies were computed using derived reference annual cycles that were updated by Mountain et al. (2004). Regional averages and anomalies were plotted against the calendar mid-date of all observations within each of the six time periods, if there were at least 10 observations. Regional values were also calculated for each individual cruise. The density stratification was computed using the density (sigma-t) difference between 50m and the surface value. If the station bottom depth was less than 50m, the difference was taken between the deepest observation and the surface. Annual cycles for density stratification (0-50m) were derived for each standard station of the MARMAP data set (Marine Resource Monitoring and Assessment Program, Sherman, 1980). Stratification Anomalies were then computed for each station using the same method that was used for temperature and salinity

(Mountain and Holzwarth, 1990). An observation is considered to be a "surface" value if it comes from the upper 5m of the water column while "bottom" observations must come within 10m of the station bottom depth. The anomaly value is the difference between the observed and the expected value for the particular station location and time of year.

The volume of shelf water for the upper 100 meters of the Mid Atlantic Bight regions is included in this report as an additional year-end product that will be included in future hydrographic atlas summaries. The shelf water volume calculations were made using the method described in Mountain (2004). Shelf water was defined as water having a salinity value < 34. The MARMAP hydrographic data were used as the reference for derived shelf water volume anomalies.

The data are presented chronologically in atlas form. The purpose of this document is to provide a descriptive overview of the hydrographic sampling that was conducted throughout the year and to depict the broad-scale oceanographic conditions that were observed. The atlas summary is intended to be a foundation for further research into observed hydrographic variability and its influence on the marine populations of the northeast continental shelf.

Results

The listing of NEFSC cruises that took place during 2008 is provided in Table 1. A total of 1831 CTD casts were collected, processed and archived during the year. Individual cruise reports can be viewed and downloaded from: http://www.nefsc.noaa.gov/HydroAtlas/. Station distributions for each two-month time period are shown in Figure 2. Full shelf coverage was poor during the May-June and November-December time periods. The spring EcoMon cruise was reduced from 16 to 4 sea-days and resulted in only minimal sampling and gear testing within the northern Mid Atlantic bight region (HB0804). Regional average surface and bottom temperature and salinity values are summarized in Tables 2 and 3 and are portrayed in Figures 3 and 4. Combining all of the hydrographic data from all cruises improved the spatial and temporal coverage within the regions and throughout the year. In some cases however, a simple average (not an area weighted mean) was determined because coverage within the area remained poor even after combining all observations. These values are indicated in the tables with a flag value of "1". The standard deviations are also listed (see Holzwarth and Mountain 1990 for further explanation of SDV1 and SDV2). Tables 1-5 of the Appendix contain the regional temperature and salinity values computed for each individual cruise that are also included in the cruise reports. Regional values computed from less than 10 observations for a given area were not included in Figures 3 and 4. Distributions of surface and bottom temperature, salinity, density stratification and anomalies are presented in Figures 5–16. Contour levels and color scaling for temperature and salinity are the same for all figures so that it would be easier to see the annual cycles. The scaling was changed for the water column stability of the upper 50 meters. No attempt was made to contour the hydrographic distributions for the May-June or November-December time periods. Shelf water volume and temperature/salinity characteristics for the upper 100 meters of the MAB regions are listed in Table 6 of the Appendix.

Shipboard environmental sensor data from the Albatross IV, Delaware II, and Henry Bigelow's Scientific Computing System (SCS) were documented and are available for download at: http://www.nefsc.noaa.gov/epd/ocean/MainPage/AlongTrack.html. The Albatross IV conducted its last survey in the late fall of 2008 and had successfully collected 22,924 hydrographic profiles since 1978.

Discussion

During the January–February time period, relatively low surface and bottom salinities were observed in the two regions of the Mid Atlantic Bight (MAB). Temperatures were also cooler along the shelf break extending approximately from 39 – 40.5^{o}N. The shelf water volume anomaly was highest in the southern MAB and suggested that the shelf / slope front was located further offshore than what would be typical for this time period. A warm core ring was observed in satellite imagery impinging on the shelf in the vicinity of Great South Channel and along southeast Georges Bank and resulted in an area of relatively warm and saltier water. Conditions in the Gulf of Maine (GOM) during January – February were slightly cooler (~0.5^{o}C) and slightly fresher (~0.2) than the expected conditions. Density stratification (0-50m) was minimal during this time period, although some evidence of higher stratification was observed at the mouth of the New York Bight area, and was associated with lower salinities.

The hydrographic data collected during the spring bottom trawl survey is captured in the March–April time period. Conditions remained relatively fresh and temperatures ranged between 1-2°C warmer in the MAB regions relative to the MARMAP reference values. Surface temperatures were also relatively warm in the western GOM. Observations suggest that bottom temperatures in the eastern GOM were slightly cooler than expected, while both temperature and salinities were near normal on Georges Bank. Density stratification remained fairly low during the late winter and early spring, although some localized areas of higher stability were observed in the western GOM and off the New Jersey coast. The reduced sampling during the May-June period impacted our ability to describe the onset and development of seasonal stratification as well as the latitudinal and cross shelf hydrographic gradients for the late spring.

The "cold band" of remnant winter water can be seen in the bottom temperature distribution during July – August (Figure 11) in the northern Mid Atlantic Bight and surface salinities remained fairly low there. Regional surface temperatures were warm shelf wide. The co-occurrence of lower salinities and warmer surface temperatures resulted in an area of higher than expected density stratification extending from the mid-outer shelf south of Martha's Vineyard southwestward to just south of Hudson Shelf Canyon. Satellite imagery during July and August indicated numerous Gulf Stream meanders, streamers and at least two warm core rings. This likely contributed to the higher sea surface temperatures along the southern flank of Georges Bank. Warm core ring and meander activity continued to influence the outer shelf areas during the fall. The surface salinity anomaly distribution of Figure 15 shows two areas of higher surface salinity values that are associated with warm core rings; one located south of Great South Channel and another at the shelf break east of Delaware Bay. Regional surface salinities were near expected values and with the exception of the eastern GOM, surface temperatures remained relatively warm during the latter part of 2008. Density stratification had mostly broken down in the eastern GOM, Georges Bank, and the shelf area south of Block Island. The highest degree of stratification was observed along the mid - outer shelf from Hudson Shelf Canyon to an outer shelf area east of Delaware Bay and was associated with warmer surface temperatures. Another area of relatively high stratification was observed over Wilkinson Basin and was likely caused by the lower salinities observed there.

The Northeast Regional Climate Center (http://www.nrcc.cornell.edu) reports that the annual average northeast air temperatures were ~0.4^{o}C warmer than their 1971-2001 baseline period. Precipitation was 6" above normal, while the states of Maine, Massachusetts, New Hampshire and Connecticut had over 12" above average rainfall. Out of 114 years of observations, 2008 ranked 111 in annual precipitation (114 being the wettest year). It is likely

that the lower than expected shelf water salinities observed in the MAB during 2008 (Appendix Table 6) were due in part to the above average rainfall in the New England states. However, the relatively high volume of shelf water observed throughout the year in the northern MAB, and for most of the year in the southern MAB was mainly due to a further offshore position of the shelf / slope front.

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Table 1. Listing of 2008 NOAA NEFSC cruises supported by the Oceanography Branch.

Cruise/File	Program	Dates	Region(s)	#Casts
del0801.dat	Coop. Research	11 - 17 Jan	MAB	35
del0802.dat	EcoMon Survey	23 Jan - 07 Feb	MAB,GB,GOM	117
del0803.dat	Right Whale Habitat	17 Feb - 07 Mar	GOM	60
alb0801.dat	Spring Bottom Trawl	07 Mar - 03 May	MAB,GB,GOM	172
hb0802.dat	Gear Comparison	10 Mar - 23 Apr	MAB,GB,GOM	185
hb0803.dat	Gear Comparison	14 May - 07 Jun	SNE, MAB	53
hb0804.dat	EcoMon Gear Testing	09 - 13 Jun	Northern MAB	64
alb0802.dat	Gear Testing	05 - 15 May	GB, SNE	17
del0806.dat	Marine Mammal	06 May	GB	1
s10801.dat	Scallop Survey	22 Jun - 05 Aug	MAB, GB	148
hb0805.dat	Habitat Mapping	19 Jun - 20 Jul	MAB, GB	105
hb0806.dat	Benthic Habitat	15 - 25 Aug	GB	22
del0808.dat	EcoMon Survey	13 - 27 Aug	MAB,GB,GOM	170
alb0803.dat	Fall Bottom Trawl	03 Sep – 13 Nov	MAB,GB,GOM	104
hb0807.dat	Fall Trawl Calibration	04 Sep – 08 Nov	MAB,GB,GOM	285
del0809.dat	Hydro Acoustic	05 Sep - 09 Oct	GB,GOM	132
del0810.dat	EcoMon Survey	23 Oct – 10 Nov	MAB,GB,GOM	161

Table 2. 2008 regional average surface and bottom temperature values computed from CTD data that were sorted into 6 two-month time periods for the five regions of the northeast continental shelf.

		SURFACE						BOTTOM					
Region	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
						January-February							
GOMW	40	50	4.79	-0.56	0.19	0.44	0	46	6.29	0.22	0.17	0.56	0
GOME	38	17	4.46	-0.55	0.24	1.13	1	13	7.12	-0.41	0.28	1.40	1
GBNK	33	39	6.07	0.40	0.18	1.28	0	26	6.04	-0.05	0.22	0.92	0
MABN	26	23	6.41	-0.32	0.26	1.35	0	17	6.76	-0.52	0.31	1.88	0
MABS	17	46	8.69	0.54	0.19	1.84	1	41	8.86	0.84	0.21	1.75	1
						March-April							
GOMW	105	94	6.33	0.77	0.16	1.45	1	92	5.78	0.43	0.13	1.32	1
GOME	105	37	4.86	0.15	0.17	0.74	0	36	6.10	-0.40	0.17	0.78	0
GB	100	56	5.23	0.07	0.14	0.80	0	49	5.59	0.10	0.17	0.91	0
MABN	84	56	5.70	0.97	0.19	0.94	0	53	6.84	1.17	0.22	1.51	0
MABS	77	80	8.03	2.00	0.15	1.13	0	73	8.84	2.89	0.18	1.37	0
						May-June							
GOMW	131	28	8.07	0.80	0.20	3.68	1	28	5.77	0.39	0.18	5.57	1
GOME													
GBNK	136	23	7.64	0.55	0.22	4.05	1	23	7.10	0.95	0.22	6.13	1
MABN	158	116	15.09	1.32	0.11	1.71	1	105	9.15	1.59	0.12	2.73	1
MABS	178	111	22.03	1.47	0.12	1.12	1	111	9.91	-0.37	0.13	2.14	1
						July-August							
GOMW	235	33	18.16	1.66	0.20	2.06	0	25	6.75	0.11	0.18	2.31	0
GOME	235	36	15.10	1.09	0.23	2.52	0	31	7.81	-1.01	0.26	2.45	0
GBNK	224	96	17.68	2.12	0.14	2.47	0	90	11.17	-0.21	0.15	2.58	0
MABN	217	42	21.83	2.29	0.21	2.14	0	38	9.21	-0.45	0.23	2.13	0
MABS	214	84	23.73	0.49	0.16	1.80	0	75	12.20	0.50	0.18	3.35	0
						September-October							
GOMW	285	99	13.89	0.92	0.13	0.97	0	95	7.22	0.11	0.11	1.15	0
GOME	287	77	12.56	-0.07	0.15	1.03	0	72	8.07	-0.44	0.16	1.45	0
GBNK	280	83	15.74	0.60	0.13	1.03	0	74	12.87	0.04	0.19	1.86	0
MABN	274	79	18.47	0.84	0.18	1.14	0	71	12.35	0.00	0.21	2.53	0
MABS	260	90	22.02	0.36	0.14	1.28	0	83	14.54	0.25	0.17	2.80	0
						November-December							
GOMW	312	55	10.96	0.52	0.17	0.73	0	51	7.08	-0.20	0.16	1.08	0
GOME	313	13	11.39	0.17	0.28	2.16	1	10	7.92	-0.67	0.31	3.28	1
GBNK	313	38	13.22	0.66	0.17	1.23	0	31	12.79	1.01	0.22	1.33	0
MABN	310	20	14.93	0.58	0.32	2.76	1	10	13.34	-0.29	0.43	1.74	1
MABS	307	25	15.62	-0.67	0.27	0.48	1	23	15.35	0.04	0.29	0.83	1

"Region", the geographic region of the northeast continental shelf: "CD", the calendar mid-date of all the stations within a region and for a time period: "#obs", the number of observations included in each average: "Temp", the areal average temperature: "Anomaly", the areal average temperature anomalies: "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 areal averages listed were derived from a simple average of the observations within the region.

Table 3. 2008 regional average surface and bottom salinity values computed from CTD data that were sorted into 6 two-month time periods for the five regions of the northeast continental shelf.

		SURFACE						BOTTOM					
Region	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
						January-February							
GOMW	40	50	32.92	-0.15	0.13	0.24	0	46	33.59	-0.01	0.1	0.22	0
GOME	38	17	32.63	-0.22	0.17	0.58	1	13	34.31	-0.07	0.13	0.57	1
GBNK	33	39	32.91	-0.02	0.11	0.44	0	26	32.97	-0.11	0.13	0.3	0
MABN	26	23	32.49	-0.61	0.18	0.64	0	17	32.81	-0.78	0.19	0.59	0
MABS	17	46	32.71	-0.91	0.15	0.57	1	41	33.08	-0.55	0.13	0.43	1
						March-April							
GOMW	105	94	32.33	-0.12	0.1	0.45	1	92	33.35	-0.03	0.08	0.47	1
GOME	105	37	32.41	-0.07	0.13	0.22	0	36	33.75	-0.14	0.1	0.29	0
GBNK	100	56	32.83	-0.14	0.08	0.25	0	49	33.07	-0.19	0.1	0.32	0
MABN	84	56	32.27	-0.62	0.12	0.88	0	52	32.98	-0.5	0.13	0.56	0
MABS	77	80	32.39	-0.61	0.11	1.37	0	73	32.94	-0.51	0.11	1.52	0
						May-June							
GOMW	131	28	32.19	-0.21	0.13	1.77	1	28	33.05	-0.03	0.1	1.77	1
GOME													
GBNK	136	23	32.74	-0.13	0.12	1.9	1	23	32.83	-0.08	0.12	1.94	1
MABN	158	116	31.55	-0.47	0.09	0.81	1	105	32.66	-0.32	0.08	0.87	1
MABS	178	111	30.51	-1.29	0.1	0.61	1	111	32.97	0.01	0.08	0.44	1
						July-August							
GOMW	235	33	31.71	-0.35	0.12	0.52	0	25	33.24	-0.25	0.11	0.26	0
GOME	235	36	32.32	-0.13	0.17	0.22	0	31	33.93	0.02	0.16	0.2	0
GBNK	224	96	32.49	-0.17	0.08	0.34	0	90	32.84	-0.12	0.09	0.22	0
MABN	218	41	31.68	-0.68	0.13	0.61	0	38	33.04	-0.33	0.13	0.54	0
MABS	214	84	31.75	-0.07	0.13	1.12	0	75	33.57	0.49	0.11	0.74	0
						September-October							
GOMW	285	99	32.06	-0.35	0.09	0.29	0	95	33.51	-0.13	0.07	0.28	0
GOME	287	77	32.32	-0.27	0.11	0.26	0	72	34	-0.26	0.09	0.38	0
GBNK	280	83	32.62	-0.09	0.08	0.41	0	74	32.92	-0.13	0.11	0.32	0
MABN	274	78	32.82	0.17	0.12	0.61	0	70	32.87	-0.6	0.12	0.52	0
MABS	260	88	32.47	0.28	0.11	1.05	0	82	33.15	-0.04	0.1	0.85	0
						November-December							
GOMW	312	55	32.39	-0.31	0.11	0.22	0	51	33.39	-0.23	0.1	0.21	0
GOME	313	13	32.16	-0.43	0.19	0.67	1	10	34.37	-0.16	0.15	0.64	1
GBNK	313	38	32.62	-0.13	0.1	0.54	0	31	33.03	-0.01	0.13	0.34	0
MABN	310	20	33.56	0.27	0.19	1.19	1	10	33.71	0.03	0.25	0.72	1
MABS	307	25	32.75	-0.03	0.21	0.47	1	23	33.02	-0.27	0.18	0.3	1

"Region", the geographic region of the northeast continental shelf: "CD", the calendar mid-date of all the stations within a region and for a time period: "#obs", the number of observations included in each average: "Salt", the areal average salinity: "Anomaly", the areal average salinity anomalies: "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 areal averages listed were derived from a simple average of the observations within the region.

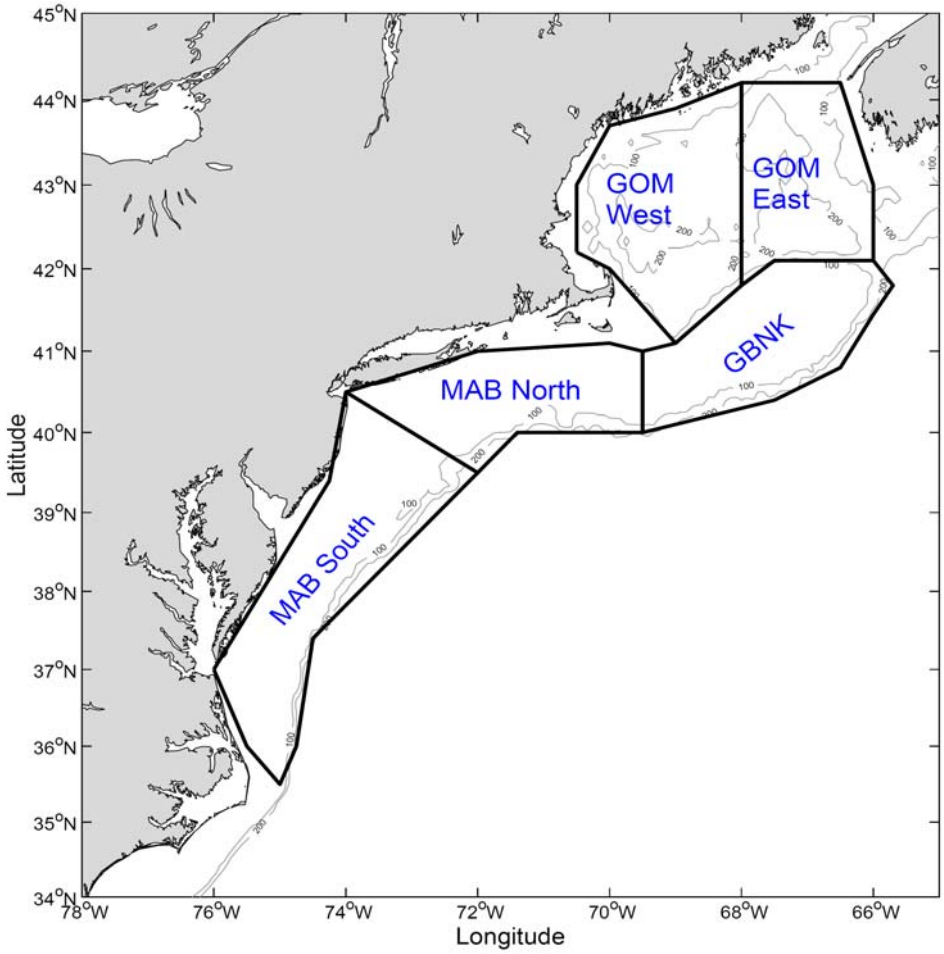

Figure 1. Region designations for the northeast continental shelf (MAB = Mid Atlantic Bight, GBNK = Georges Bank, GOM = Gulf of Maine).

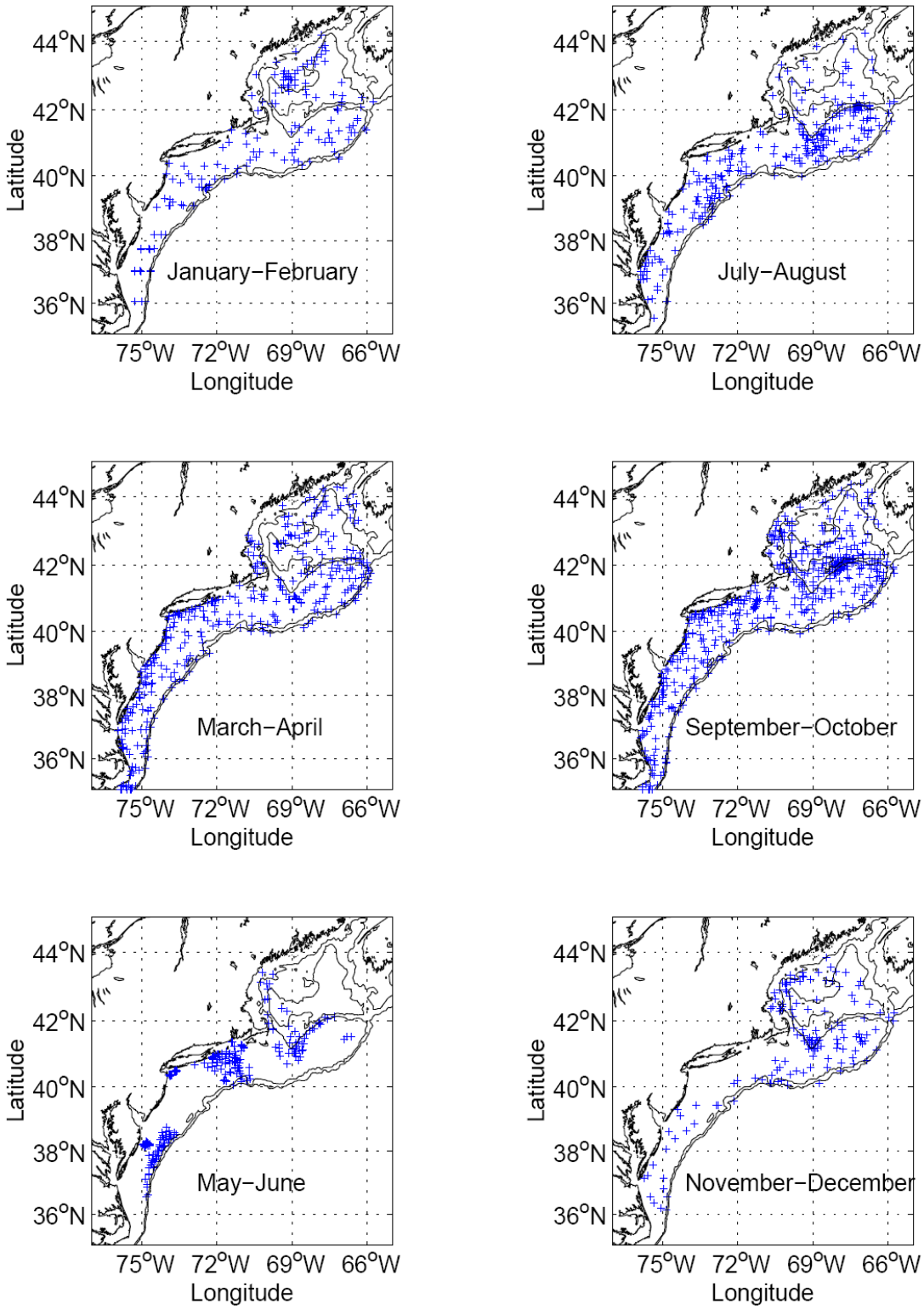

Figure 2. 2008 station distributions for each two-month time bin.

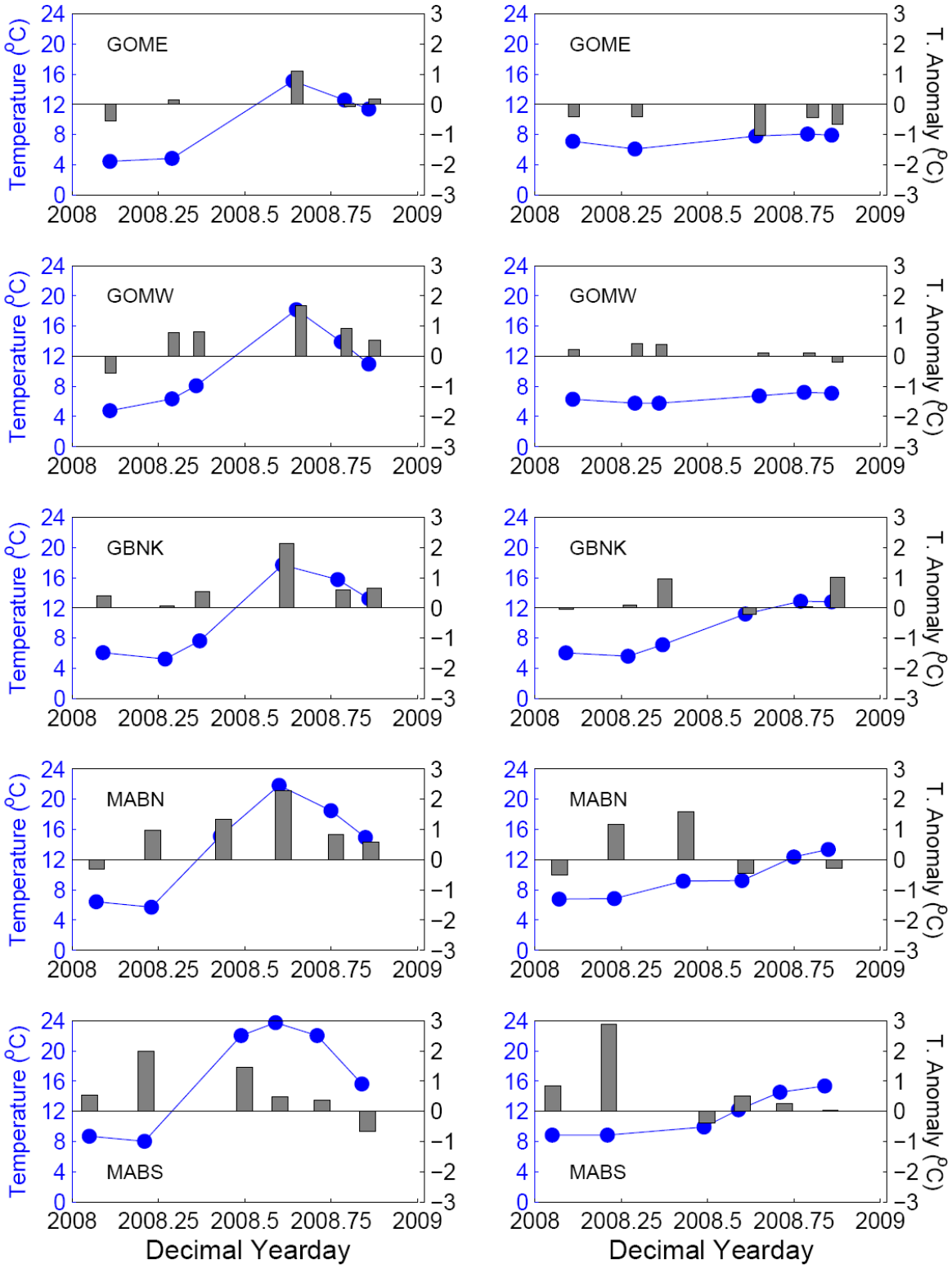

Figure 3. Time Series of the 2008 regional surface (left) and bottom (right) temperatures and anomalies (temperature values = blue circles, temperature anomalies = grey bars).

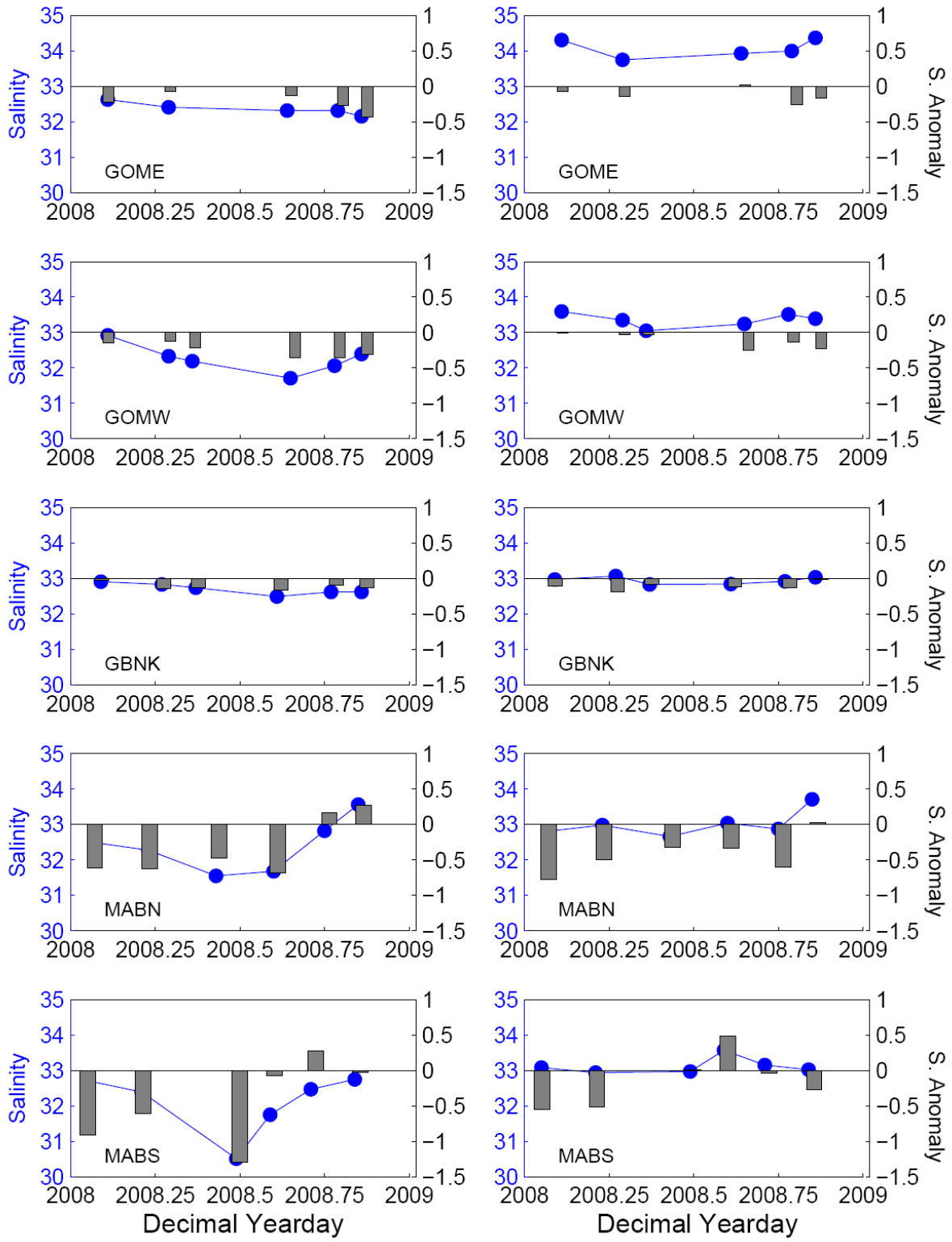

Figure 4. Time series of the 2008 regional surface (left) and bottom (right) salinities and anomalies (salinity values = blue circles, salinity anomalies = grey bars).

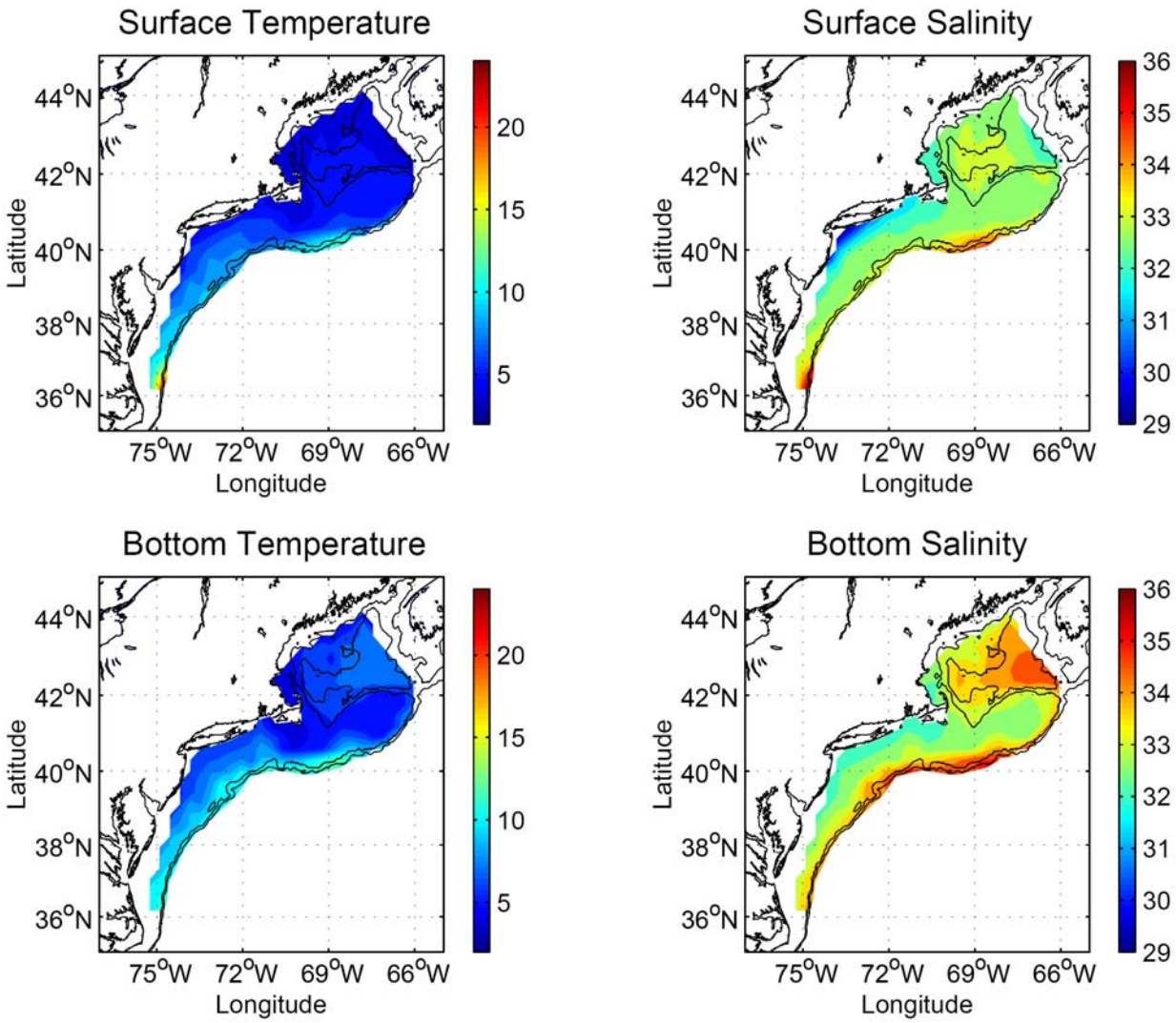

Figure 5. Surface and bottom temperature (left) and salinity (right) distributions during January - February 2008.

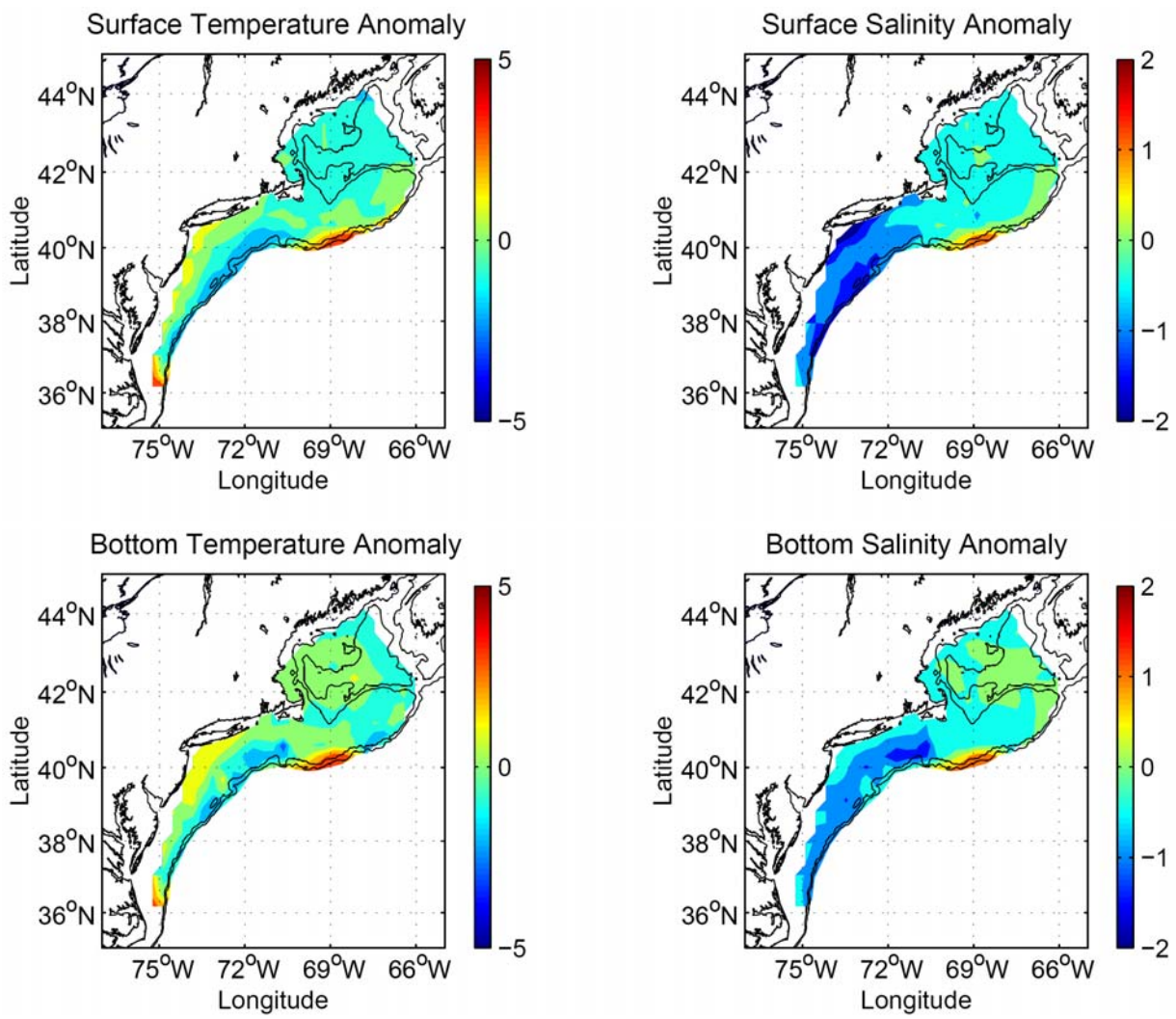

Figure 6. Surface and bottom temperature anomaly (left) and salinity anomaly (right) distributions during January - February 2008.

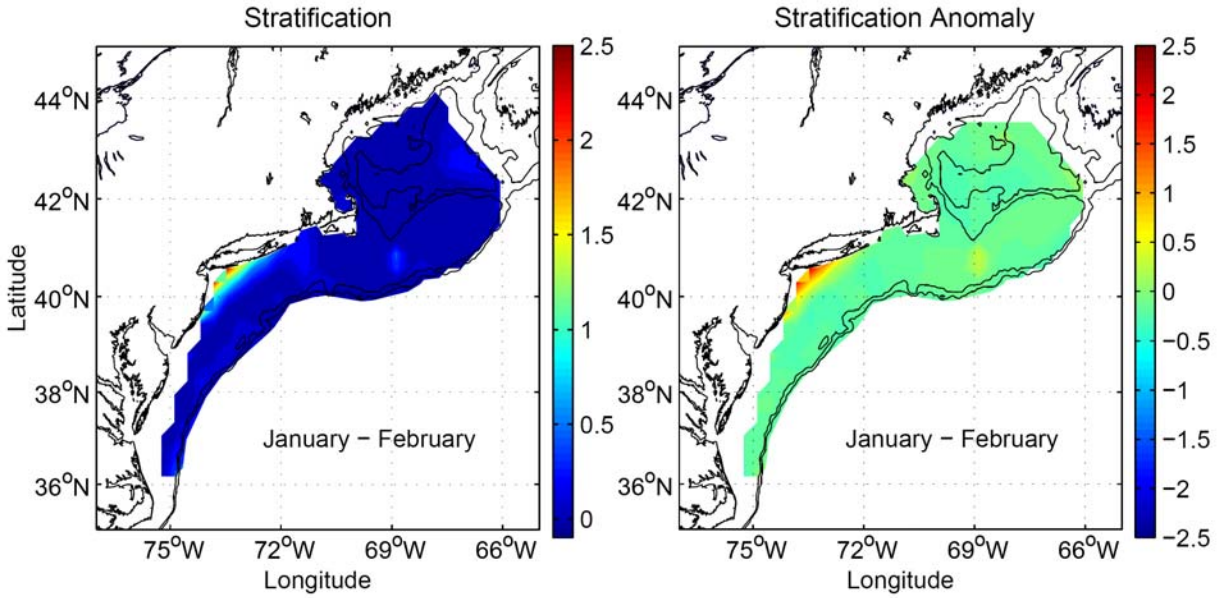

Figure 7. Density stratification (left) and stratification anomaly (right) during January - February 2008. The units are kg/m^3.

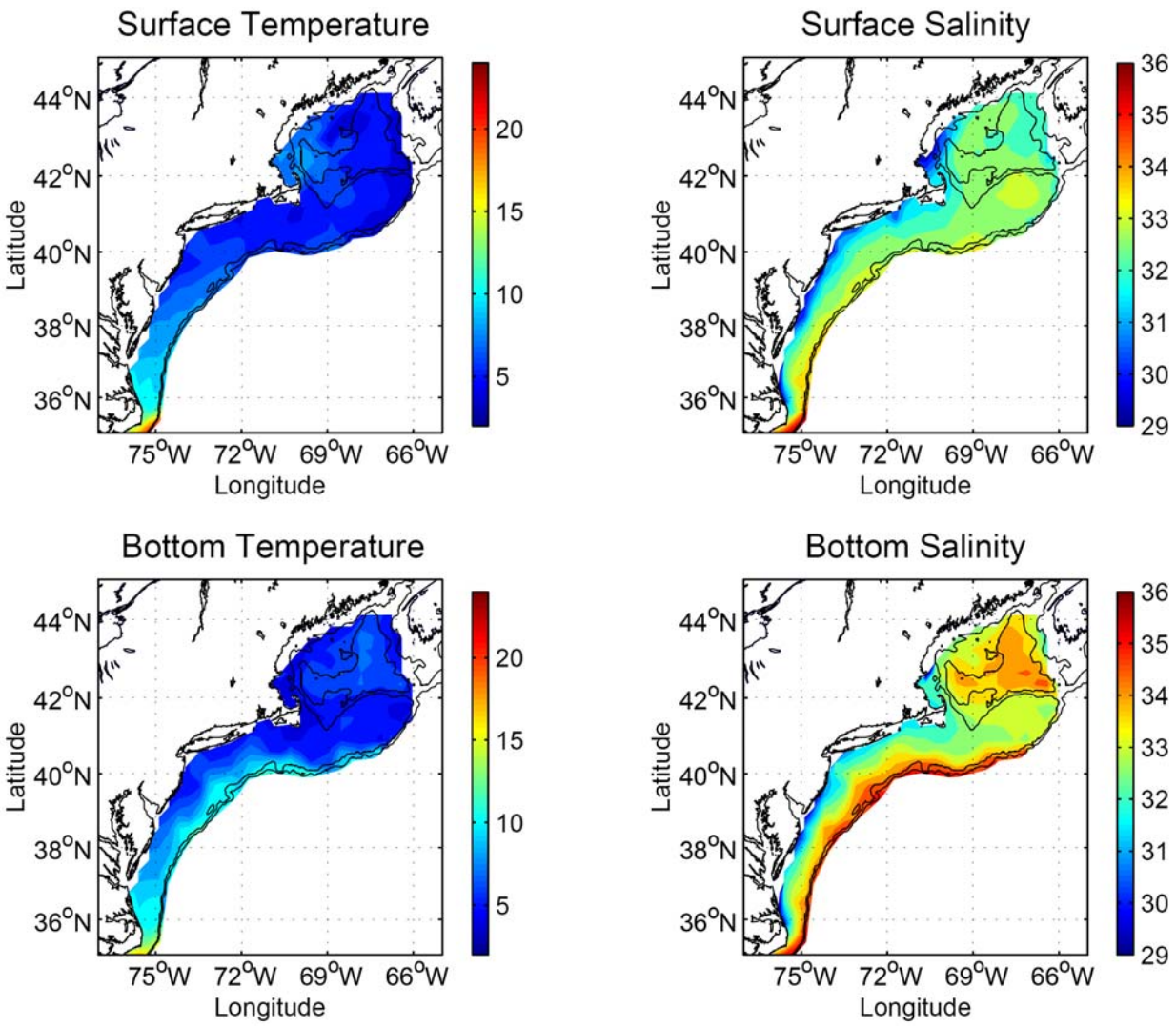

Figure 8. Surface and bottom temperature (left) and salinity (right) distributions during March - April 2008.

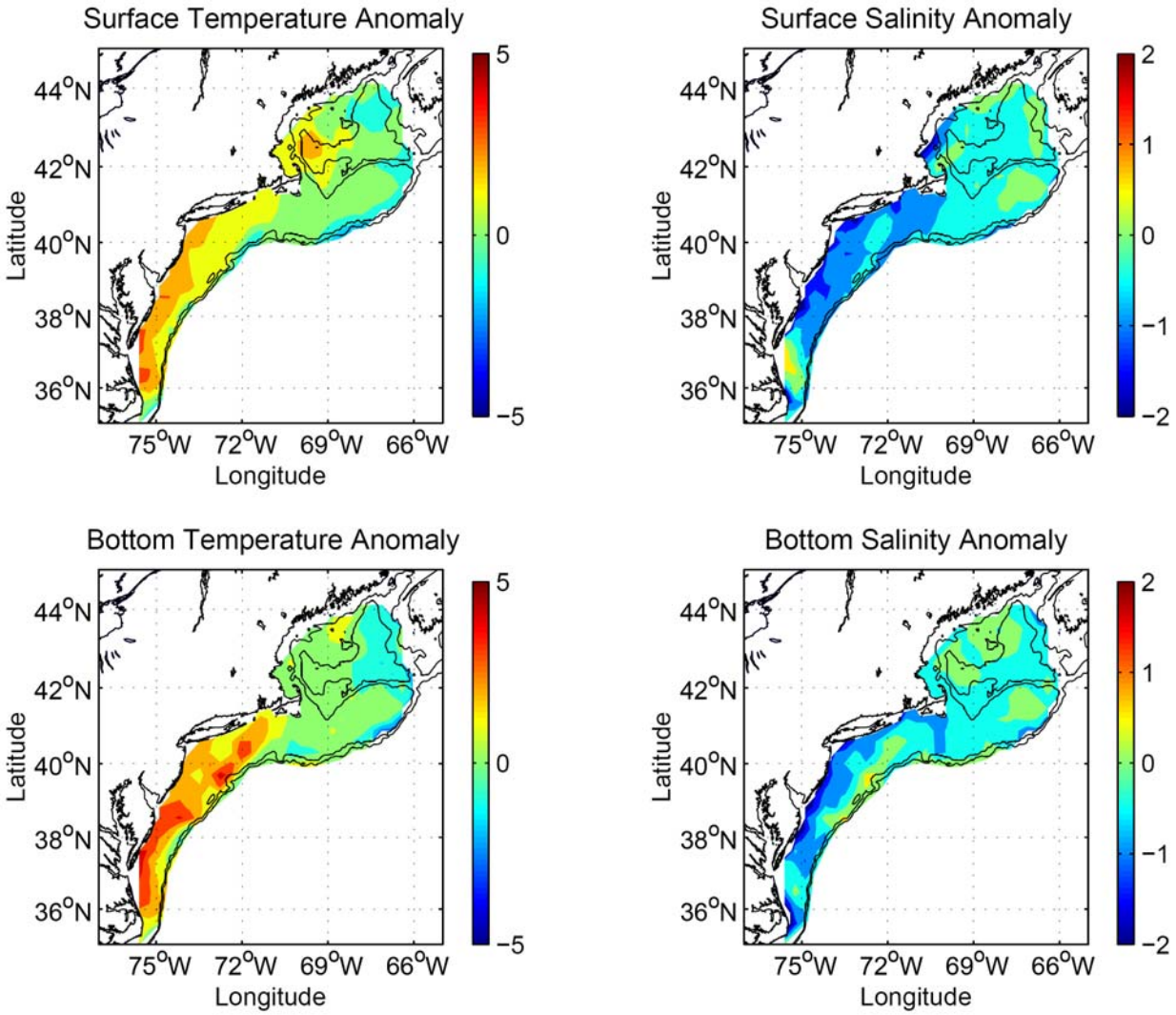

Figure 9. Surface and bottom temperature anomaly (left) and salinity anomaly (right) distributions during March - April 2008.

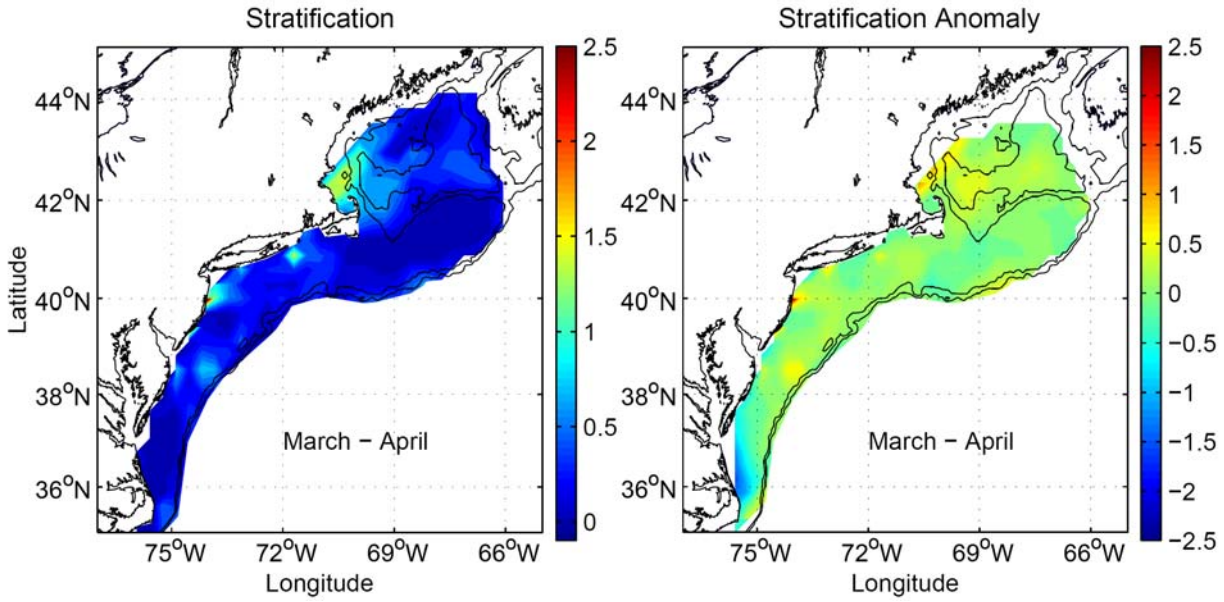

Figure 10. Density stratification (left) and stratification anomaly (right) during March - April 2008. The units are kg/m^3.

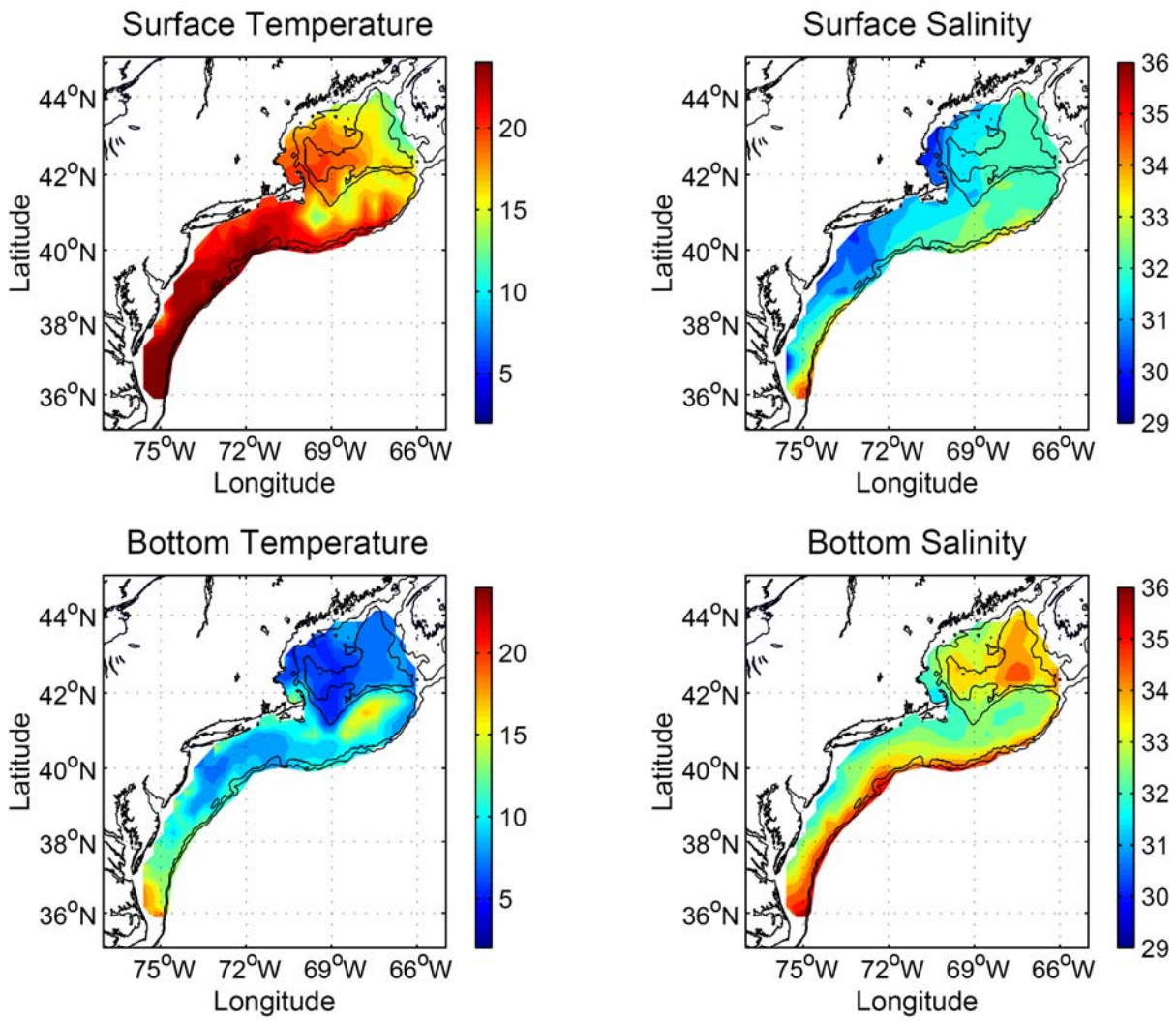

Figure 11. Surface and bottom temperature (left) and salinity (right) distributions during July - August 2008.

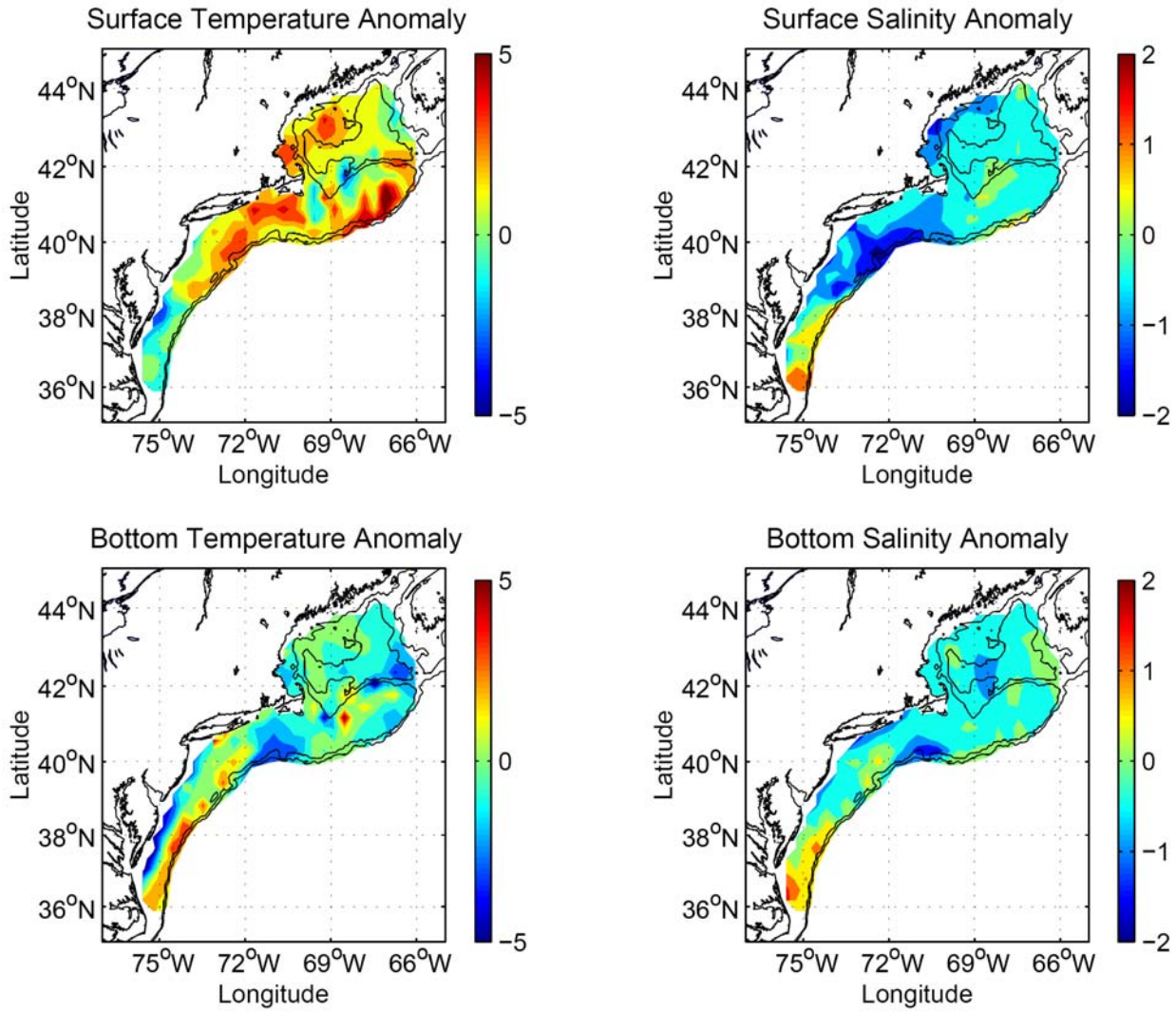

Figure 12. Surface and bottom temperature anomaly (left) and salinity anomaly (right) distributions during July - August 2008.

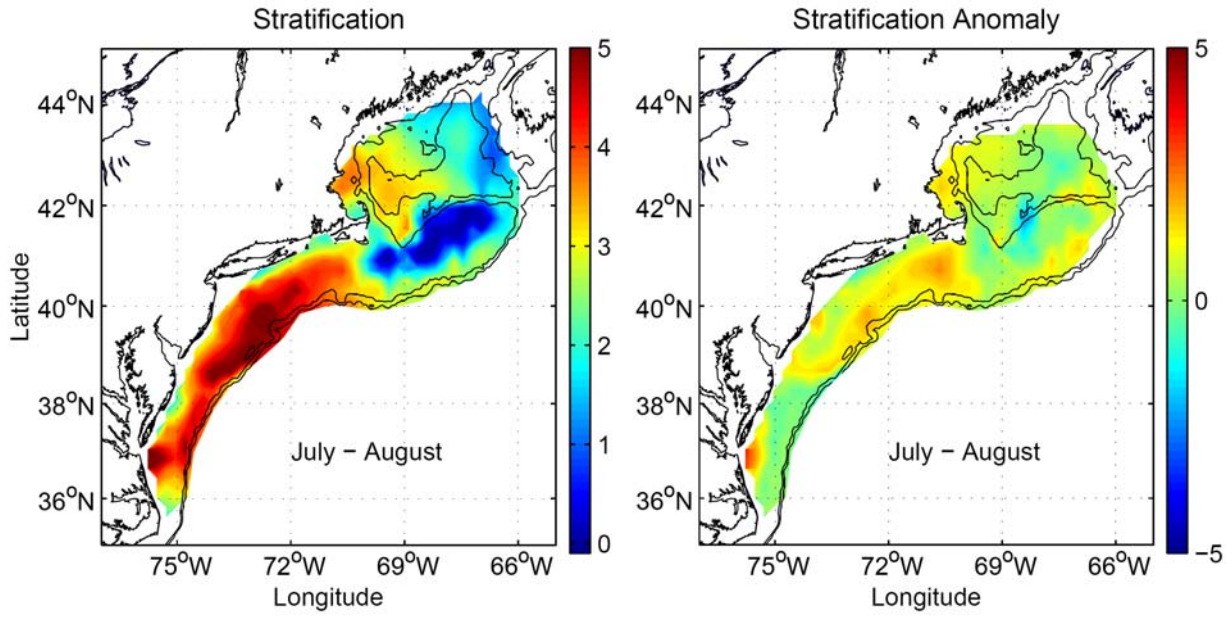

Figure 13. Density stratification (left) and stratification anomaly (right) during July - August 2008. The units are kg/m^3.

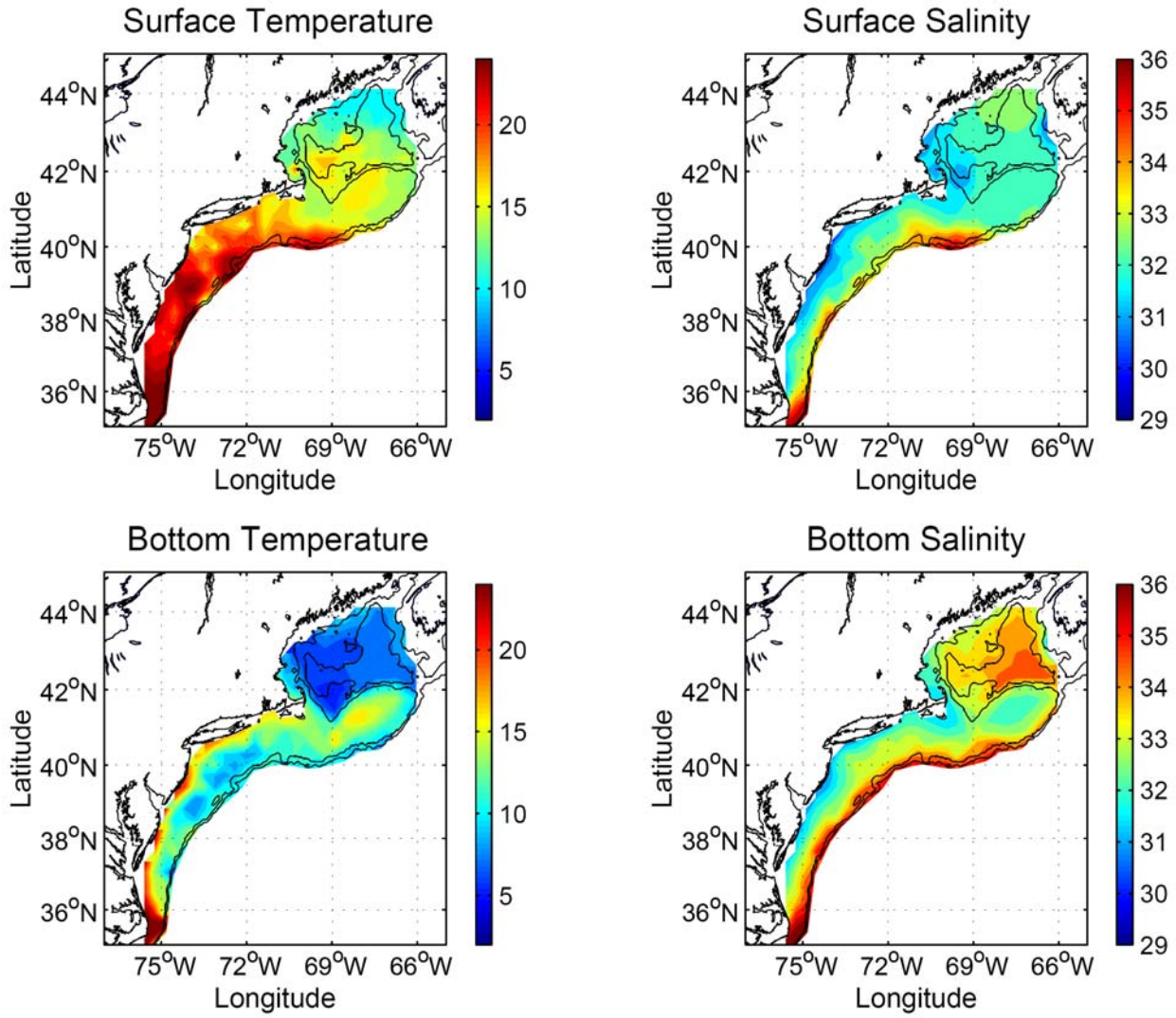

Figure 14. Surface and bottom temperature (left) and salinity (right) distributions during September - October 2008.

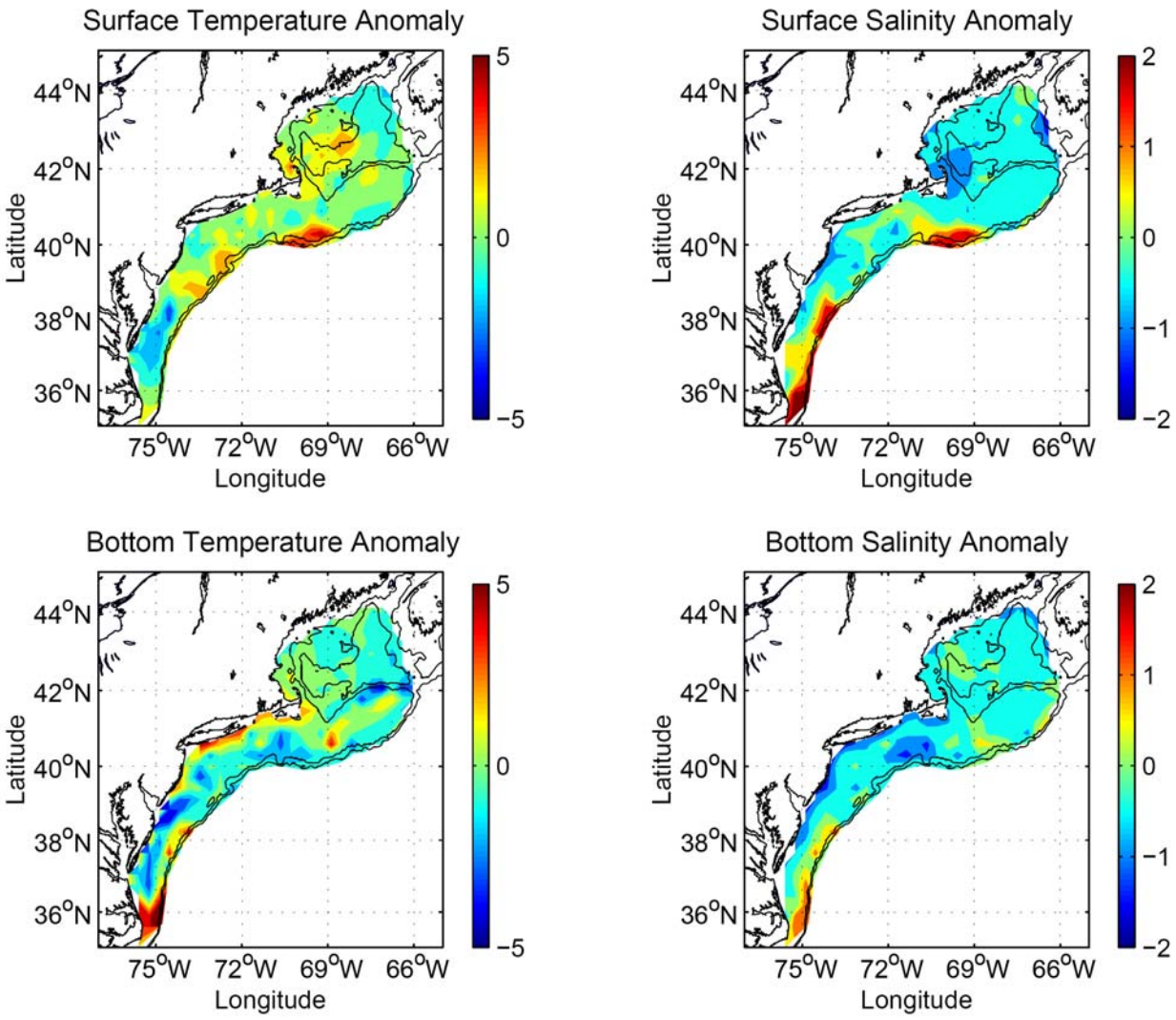

Figure 15. Surface and bottom temperature anomaly (left) and salinity anomaly (right) distributions during September - October 2008.

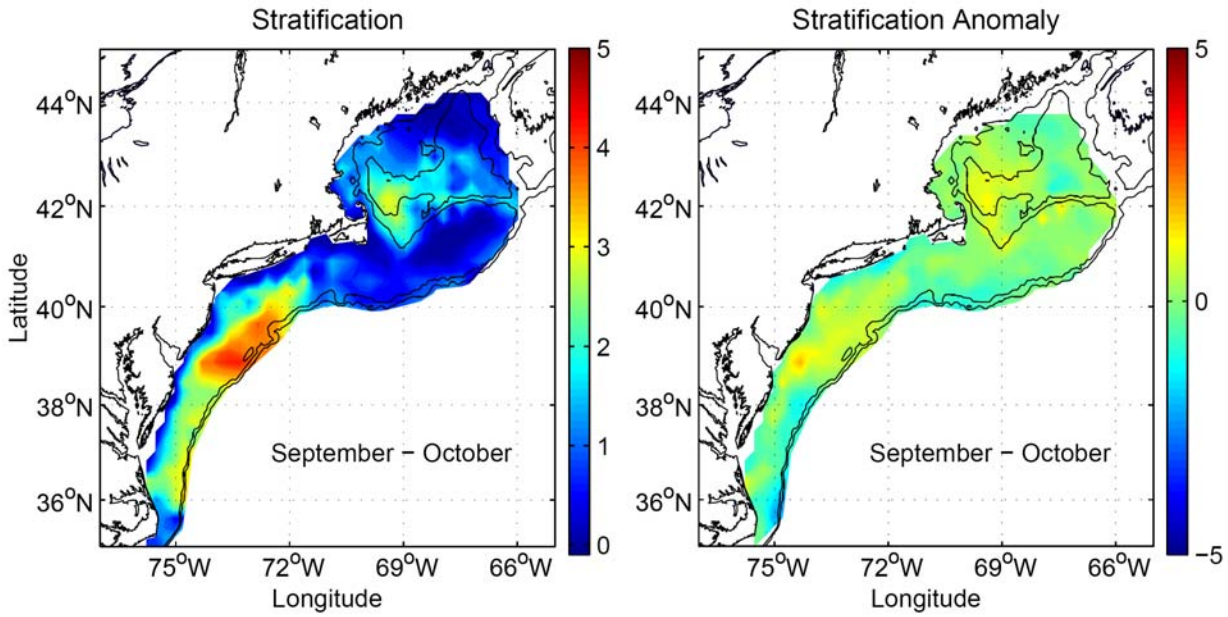

Figure 16. Density stratification (left) and stratification anomaly (right) during September - October 2008. The units are kg/m^3.

Appendix

Appendix Table 1. 2008 regional average temperature and salinity values for individual cruises that sampled within the western Gulf of Maine.

Gulf of Maine West

		Surface						Bottom					
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0802	36	21	4.95	-0.55	0.23	0.50	0	17	6.25	0.18	0.22	0.51	0
DEL0803	57	44	4.39	-0.37	0.16	0.31	1	45	6.39	0.15	0.14	0.62	1
HB0802	111	16	6.13	0.95	0.27	1.38	1	16	5.49	0.52	0.23	1.77	1
ALB0801	119	31	7.29	1.32	0.19	1.26	1	30	5.75	0.53	0.17	1.95	1
ALB0802	126	4	6.79	0.19	0.59	1.46	1	4	5.95	1.06	0.59	1.64	1
HB0803	152	8	10.13	0.51	0.36	2.25	1	8	6.22	-0.26	0.29	3.89	1
DEL0808	238	25	18.29	1.73	0.21	1.42	0	17	6.79	0.03	0.19	1.18	0
DEL0809	270	63	15.79	0.87	0.13	1.11	1	61	7.13	0.16	0.12	1.52	1
HB0807	299	40	12.51	0.80	0.18	0.90	0	38	7.18	-0.02	0.15	1.33	0
ALB0803	308	33	11.80	0.93	0.20	1.80	1	33	7.33	-0.24	0.17	2.31	1
DEL0810	312	22	10.99	0.55	0.23	0.63	0	18	7.10	-0.19	0.20	0.70	0
		Surface						Bottom					
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
DEL0802	36	21	32.95	-0.13	0.15	0.30	0	17	33.58	0.02	0.13	0.24	0
DEL0803	57	44	32.91	-0.14	0.11	0.15	1	45	33.71	-0.08	0.07	0.22	1
HB0802	111	16	32.53	-0.08	0.16	0.44	1	16	33.31	-0.04	0.14	0.61	1
ALB0801	119	31	32.12	-0.25	0.13	0.64	1	30	33.38	0.03	0.10	1.63	1
ALB0802	126	4	32.80	-0.15	0.31	0.17	1	4	32.87	-0.10	0.28	0.20	1
HB0803	152	8	32.44	-0.07	0.22	1.85	1	8	32.96	-0.13	0.17	1.67	1
DEL0808	238	25	31.68	-0.40	0.13	0.35	0	17	33.29	-0.25	0.11	0.25	0
DEL0809	270	63	31.93	-0.25	0.08	0.35	1	61	33.77	0.02	0.07	0.30	1
HB0807	299	40	32.29	-0.31	0.11	0.22	0	38	33.46	-0.17	0.09	0.30	0
ALB0803	308	33	32.11	-0.42	0.13	0.85	1	33	33.01	-0.12	0.10	0.74	1
DEL0810	312	22	32.42	-0.29	0.15	0.16	0	18	33.44	-0.24	0.12	0.19	0

Appendix Table 2. 2008 regional average temperature and salinity values for individual cruises that sampled within the eastern Gulf of Maine.

Gulf of Maine East

			Surface						Bottom				
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0802	36	14	4.59	-0.44	0.27	1.09	1	10	7.10	-0.40	0.32	1.08	1
DEL0803	60	8	3.92	-0.58	0.33	0.84	1	8	7.36	-0.20	0.34	1.55	1
ALB0801	104	12	4.86	0.07	0.29	2.19	1	11	6.58	-0.77	0.29	3.24	1
HB0802	109	20	5.02	0.22	0.21	0.74	0	20	5.93	-0.20	0.22	0.88	0
HB0803	153	6	9.73	0.98	0.38	4.27	1	6	6.89	-1.01	0.38	7.43	1
HB0805	199	7	18.92	6.44	0.36	5.95	1	7	6.78	-4.05	0.34	7.69	1
HB0806	233	10	17.36	3.17	0.30	1.69	1	10	9.35	-2.89	0.29	3.78	1
DEL0808	237	15	15.08	0.66	0.25	1.24	0	12	7.79	-0.44	0.27	1.29	0
DEL0809	264	46	16.16	0.65	0.15	1.51	1	46	8.43	-0.72	0.14	2.20	1
ALB0803	292	7	12.26	-0.26	0.37	4.39	1	7	7.81	-0.17	0.36	5.61	1
HB0807	295	27	11.89	-0.26	0.18	0.91	0	24	8.24	-0.72	0.20	1.56	0
DEL0810	313	13	11.39	0.17	0.28	1.46	1	10	7.92	-0.67	0.31	1.57	1
			Surface						Bottom				
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
DEL0802	36	14	32.65	-0.18	0.19	0.59	1	10	34.34	-0.08	0.15	0.51	1
DEL0803	60	8	32.58	-0.28	0.21	0.37	1	8	34.25	0.02	0.16	0.55	1
ALB0801	104	12	32.55	-0.06	0.19	1.07	1	11	34.28	-0.09	0.15	2.69	1
HB0802	109	20	32.38	-0.08	0.16	0.20	0	20	33.57	-0.13	0.13	0.36	0
HB0803	153	6	32.57	-0.33	0.23	3.46	1	6	33.11	0.13	0.23	3.14	1
HB0805	199	7	32.23	-0.33	0.22	1.61	1	7	33.30	0.12	0.21	1.51	1
HB0806	233	10	32.10	-0.40	0.17	0.25	1	10	32.67	-0.02	0.17	0.18	1
DEL0808	237	15	32.32	-0.10	0.18	0.15	0	12	34.10	-0.01	0.17	0.24	0
DEL0809	264	46	32.19	-0.22	0.09	0.45	1	46	34.15	-0.11	0.08	0.41	1
ALB0803	292	7	32.55	-0.19	0.24	2.06	1	7	34.38	-0.27	0.17	1.81	1
HB0807	295	27	32.34	-0.26	0.14	0.34	0	24	33.82	-0.22	0.11	0.44	0
DEL0810	313	13	32.16	-0.43	0.19	0.42	1	10	34.37	-0.16	0.15	0.42	1

Appendix Table 3. 2008 regional average temperature and salinity values for individual cruises that sampled within the Georges Bank area.

Georges Bank

			Surface						Bottom				
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0802	33	39	6.07	0.40	0.18	1.28	0	26	6.04	-0.05	0.22	0.92	0
ALB0801	99	20	5.25	-0.12	0.25	0.89	0	17	5.28	0.10	0.24	2.40	1
HB0802	100	36	5.23	0.18	0.18	0.70	0	32	5.59	0.09	0.21	0.97	0
ALB0802	127	14	6.91	0.53	0.29	0.66	1	14	6.74	1.21	0.29	0.72	1
HB0803	153	8	8.88	0.57	0.35	2.41	1	8	7.66	0.47	0.34	4.15	1
HB0805	199	10	16.68	4.38	0.29	4.78	1	10	10.61	-0.79	0.28	5.04	1
S10801	211	42	16.88	2.16	0.17	3.07	1	41	10.36	-0.12	0.17	3.30	1
HB0806	234	12	16.68	1.67	0.27	1.33	1	12	11.19	-2.71	0.26	3.15	1
DEL0808	234	32	17.03	1.00	0.19	1.58	0	27	13.53	0.39	0.19	2.76	1
DEL0809	266	24	16.20	0.88	0.19	0.98	1	24	12.17	-1.75	0.19	2.23	1
HB0807	282	56	15.58	0.60	0.15	1.07	0	49	12.98	0.32	0.20	1.91	0
ALB0803	302	10	13.72	0.29	0.39	2.76	1	8	13.16	1.68	0.40	4.06	1
DEL0810	312	32	13.27	0.61	0.19	1.34	0	25	12.66	0.81	0.26	1.14	0

			Surface						Bottom				
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
DEL0802	33	39	32.91	-0.02	0.11	0.44	0	26	32.97	-0.11	0.13	0.30	0
ALB0801	99	20	32.80	-0.15	0.15	0.33	0	17	33.07	-0.06	0.14	2.09	1
HB0802	100	36	32.83	-0.14	0.10	0.21	0	32	33.07	-0.19	0.12	0.32	0
ALB0802	127	14	32.80	-0.12	0.16	0.08	1	14	32.82	-0.13	0.15	0.09	1
HB0803	153	8	32.59	-0.17	0.21	1.98	1	8	32.81	0.00	0.20	1.81	1
HB0805	199	10	32.30	-0.30	0.17	1.31	1	10	32.63	-0.09	0.17	0.98	1
S10801	211	42	32.51	-0.01	0.09	1.06	1	41	32.73	-0.11	0.09	0.78	1
HB0806	234	12	32.23	-0.27	0.16	0.19	1	12	32.55	-0.04	0.16	0.11	1
DEL0808	234	32	32.48	-0.17	0.11	0.26	0	27	32.63	-0.13	0.11	0.66	1
DEL0809	266	24	32.22	-0.30	0.12	0.18	1	24	32.57	-0.08	0.11	0.14	1
HB0807	282	56	32.65	-0.07	0.09	0.51	0	49	32.96	-0.11	0.12	0.39	0
ALB0803	302	10	32.47	-0.29	0.22	1.44	1	8	32.81	-0.02	0.22	1.45	1
DEL0810	312	32	32.61	-0.13	0.12	0.63	0	25	33.00	-0.03	0.15	0.35	0

Appendix Table 4. 2008 regional average temperature and salinity values for individual cruises that sampled within the northern Mid Atlantic Bight.

Northern Mid Atlantic Bight

			Surface						Bottom				
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0802	26	21	6.37	-0.29	0.28	1.21	0	16	6.72	-0.51	0.33	1.95	0
ALB0801	83	39	5.71	1.11	0.25	0.90	0	37	5.90	1.69	0.21	1.48	1
HB0802	89	19	5.72	0.89	0.33	0.95	0	18	6.74	0.79	0.35	1.79	0
HB0803	145	33	11.36	0.04	0.21	0.95	1	33	8.42	2.02	0.22	1.72	1
HB0804	163	62	16.52	2.12	0.16	0.98	1	51	8.85	1.15	0.18	1.57	1
HB0805	172	17	18.90	1.33	0.29	3.28	1	17	12.01	2.25	0.31	3.38	1
S10801	195	16	21.30	2.55	0.31	2.79	1	16	8.55	0.74	0.31	3.37	1
DEL0808	230	26	22.17	2.12	0.26	1.81	0	22	9.73	-0.60	0.28	2.15	0
HB0807	268	46	19.32	1.03	0.21	1.23	0	42	11.93	-0.30	0.24	2.86	0
ALB0803	285	12	17.85	1.26	0.38	2.30	1	9	16.42	2.29	0.45	3.43	1
DEL0810	306	41	14.57	-0.03	0.24	1.40	0	30	13.82	0.45	0.28	1.26	0
			Surface						Bottom				
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
DEL0802	26	21	32.49	-0.60	0.19	0.64	0	16	32.80	-0.80	0.19	0.61	0
ALB0801	83	39	32.22	-0.61	0.16	1.04	0	36	32.27	-0.63	0.13	1.40	1
HB0802	89	19	32.34	-0.60	0.21	0.58	0	18	33.04	-0.56	0.21	0.48	0
HB0803	145	33	31.37	-0.29	0.15	0.84	1	33	32.20	-0.62	0.13	0.78	1
HB0804	163	62	31.87	-0.64	0.11	0.36	1	51	33.33	0.10	0.11	0.58	1
HB0805	172	17	30.59	-0.26	0.32	0.97	1	17	31.58	-1.00	0.22	0.74	1
S10801	195	15	31.22	-0.71	0.21	1.67	1	16	32.96	-0.05	0.19	1.23	1
DEL0808	230	26	31.83	-0.57	0.17	0.53	0	22	32.98	-0.42	0.17	0.57	0
HB0807	268	46	32.80	0.21	0.14	0.65	0	42	32.79	-0.64	0.14	0.46	0
ALB0803	285	12	32.32	0.04	0.28	1.29	1	9	31.83	-1.07	0.28	1.28	1
DEL0810	303	40	32.98	0.14	0.13	0.79	1	29	33.44	-0.10	0.17	0.42	0

Appendix Table 5. 2008 regional average temperature and salinity values for individual cruises that sampled within the southern Mid Atlantic Bight.

Southern Mid Atlantic Bight

		Surface					Bottom				
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0801	14	32	9.63	0.44	0.23	2.10	1	27	9.61	0.68	0.27	1.96	1
DEL0802	24	14	6.55	0.75	0.32	1.12	1	14	7.43	1.14	0.34	1.22	1
ALB0801	76	27	7.90	2.59	0.26	0.86	1	23	8.16	3.40	0.30	1.29	1
HB0802	78	58	8.05	1.99	0.17	1.13	0	51	8.81	2.87	0.21	1.34	0
HB0805	179	72	21.05	0.99	0.15	1.55	1	68	10.33	-1.93	0.17	1.53	1
S10801	181	77	23.14	2.02	0.15	1.00	1	76	9.32	1.56	0.16	1.39	1
DEL0808	229	47	24.29	0.28	0.21	1.32	0	42	13.77	-1.24	0.21	3.81	1
ALB0803	254	9	22.30	0.65	0.36	1.27	1	5	16.33	1.01	0.61	2.65	1
HB0807	255	75	22.74	0.44	0.16	1.38	0	70	14.31	0.22	0.19	2.91	0
DEL0810	306	41	15.46	-0.54	0.23	0.49	1	36	14.67	0.07	0.27	0.81	1
			Surface						Bottom				
Cruise	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
DEL0801	14	32	33.09	-0.82	0.17	0.50	1	27	33.28	-0.53	0.16	0.39	1
DEL0802	24	14	31.83	-1.10	0.27	0.68	1	14	32.71	-0.58	0.22	0.50	1
ALB0801	76	27	31.49	-1.23	0.21	1.80	1	23	31.81	-1.08	0.19	1.64	1
HB0802	78	58	32.52	-0.50	0.13	0.82	0	51	33.07	-0.43	0.13	0.80	0
HB0805	179	72	30.54	-1.06	0.13	0.46	1	68	32.54	-0.11	0.10	0.34	1
S10801	181	77	30.73	-1.39	0.11	0.67	1	76	33.54	0.17	0.09	0.51	1
DEL0808	229	47	32.03	0.18	0.16	1.10	0	42	33.33	0.59	0.14	0.81	1
ALB0803	254	5	31.63	-0.42	0.48	1.10	1	4	31.82	-0.88	0.41	1.06	1
HB0807	255	75	32.42	0.33	0.12	1.03	0	70	33.11	-0.03	0.11	0.82	0
DEL0810	306	40	32.83	-0.05	0.18	0.43	1	36	33.32	-0.18	0.16	0.34	1

Appendix Table 6. Temperature, salinity and shelf water volume calculations of the upper 100 meters for cruises conducted in the Mid Atlantic Bight regions during 2008 (CD = calendar day, SHW = shelf water, volume units = cubic kilometers).

CD	Temp	Temp. Anomaly	Salt	Salt Anomaly	SHW Temp	SHW T. Anom	SHW Salt	SHW S. Anom	SHW Volume	SHW Vol. Anomaly
						MABN				
26	7.09	-0.25	32.89	-0.69	6.74	0.55	32.77	-0.37	2345.13	426.87
82	6.58	1.08	32.89	-0.46	5.91	1.50	32.63	-0.42	2170.25	87.29
88	5.94	0.28	32.77	-0.55	5.80	1.19	32.72	-0.31	2416.59	348.33
197	11.45	-0.76	32.41	-0.90	11.45	-0.26	32.41	-0.37	2502.79	548.87
229	12.85	-0.80	32.98	-0.46	12.49	-0.73	32.72	-0.08	2226.34	355.07
267	15.31	0.46	33.32	-0.29	14.33	-0.10	32.80	-0.08	1889.80	298.05
305	14.71	0.10	33.44	-0.27	14.32	0.26	33.02	0.03	1927.09	560.07
						MABS				
14	9.49	-0.60	33.15	-1.07	9.15	1.67	33.02	-0.10	2787.79	1611.05
76	8.79	0.88	33.20	-0.74	8.00	2.67	32.70	-0.68	2184.96	825.63
77	8.70	0.79	33.33	-0.60	8.02	2.65	32.93	-0.44	2270.74	903.75
228	16.45	0.56	33.54	0.25	15.27	0.23	32.60	-0.05	1888.69	-426.80
254	16.69	0.27	33.52	0.07	16.02	-0.08	32.69	-0.19	2020.19	-159.56
305	14.95	-0.14	33.30	-0.58	15.00	-0.44	32.91	-0.14	2325.93	619.00

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