Northeast Fisheries Science Center Reference Document 11-13

Description of the 2009 Oceanographic Conditions on the Northeast U.S. Continental Shelf

by Paula S. Fratantoni, Tamara Holzwarth-Davis,
Cristina Bascuñán, and Maureen H. Taylor

August 2011

Recent Issues in This Series

10-14 *Stock Assessment of Summer Flounder for 2010*, by M Terceiro. July 2010.

10-15 *Bluefish 2010 Stock Assessment Update*, by GR Shepherd and J Nieland. July 2010.

10-16 *Stock Assessment of Scup for 2010*, by M Terceiro. July 2010.

10-17 *50th Northeast Regional Stock Assessment Workshop (50th SAW) Assessment Repor*t, by Northeast Fisheries Science Center. August 2010.

10-18 *An Updated Spatial Pattern Analysis for the Gulf of Maine-Georges Bank Atlantic Herring Complex During 1963-2009*, by JJ Deroba. August 2010.

10-19 *International Workshop on Bioextractive Technologies for Nutrient Remediation Summary Report,* by JM Rose, M Tedesco, GH Wikfors, C Yarish. August 2010.

10-20 *Northeast Fisheries Science Center publications, reports, abstracts, and web documents for calendar year 2009*, by A Toran. September 2010.

10-21 *12th Flatfish Biology Conference 2010 Program and Abstracts*, by Conference Steering Committee. October 2010.

10-22 *Update on Harbor Porpoise Take Reduction Plan Monitoring Initiatives: Compliance and Consequential Bycatch Rates from June 2008 through May 2009*, by CD Orphanides. November 2010.

11-01 *51st Northeast Regional Stock Assessment Workshop (51st SAW): Assessment Summary Report*, by Northeast Fisheries Science Center. January 2011.

11-02 *51st Northeast Regional Stock Assessment Workshop (51st SAW): Assessment Report*, by Northeast Fisheries Science Center. March 2011.

11-03 *Preliminary Summer 2010 Regional Abundance Estimate of Loggerhead Turtles (Caretta caretta) in Northwestern Atlantic Ocean Continental Shelf Waters*, by the Northeast Fisheries Science Center and the Southeast Fisheries Science Center. April 2011.

11-04 *Proration of Loggerhead Sea Turtle (Caretta caretta) Interactions in US Mid-Atlantic Bottom Otter Trawls for Fish and Scallops, 2005-2008, by Managed Species Landed,* by M L Warden. March 2011.

11-05 *North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2010 Results Summary*, by C Khan, T Cole, P Duley, A Henry, and J Gatzke. March 2011.

11-06 *NOAA NEFSC Stellwagen Bank National Marine Sanctuary Program 2009 Aerial Survey Results Summary*, by J Gatzke, C Khan, T Cole, P Duley, A Henry, S Van Parijs, and D Wiley. March 2011.

11-07 *Interim Report for Fishing Year 2010 on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2010 – January 2011)*, by Andrew Kitts, Evan Bing-Sawyer, Matthew McPherson, Julia Olson, and John Walden. May 2011.

11-08 Estimates of Cetacean and Pinniped Bycatch in the 2009 New England Sink Gillnet and Mid-Atlantic Gillnet Fisheries , by CD Orphanides. April 2011.

11-09 Standardized Bycatch Reporting Methodology 3-year Review Report 2011 - Part 1 by SE Wigley, J Blaylock, PJ Rago, J Tang, HL Haas, and G Shield. June 2011.

11-10 Evaluating Sea Turtle Injuries in Northeast Fishing Gear by C Upite. July 2011.

11-11 52nd Northeast Regional Stock Assessment Workshop (52nd SAW): Assessment Summary Report by Northeast Fisheries Science Center. July 2011.

11-12 In preparation.

Northeast Fisheries Science Center Reference Document 11-13

Description of the 2009 Oceanographic Conditions on the Northeast U.S. Continental Shelf

by Paula S. Fratantoni, Tamara Holzwarth-Davis,
Cristina Bascuñán, and Maureen H. Taylor

NOAA National Marine Fisheries Service
Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

August 2011

Northeast Fisheries Science Center Reference Documents

This series is a secondary scientific series designed to assure the long-term documentation and to enable the timely transmission of research results by Center and/or non-Center researchers, where such results bear upon the research mission of the Center (see the outside back cover for the mission statement). These documents receive internal scientific review, and most receive copy editing. The National Marine Fisheries Service does not endorse any proprietary material, process, or product mentioned in these documents.

All documents issued in this series since April 2001, and several documents issued prior to that date, have been copublished in both paper and electronic versions. To access the electronic version of a document in this series, go to *http://www.nefsc.noaa.gov/nefsc/publications/*. The electronic version is available in PDF format to permit printing of a paper copy directly from the Internet. If you do not have Internet access, or if a desired document is one of the pre-April 2001 documents available only in the paper version, you can obtain a paper copy by contacting the senior Center author of the desired document. Refer to the title page of the document for the senior Center author's name and mailing address. If there is no Center author, or if there is corporate (*i.e.*, non-individualized) authorship, then contact the Center's Woods Hole Laboratory Library (166 Water St., Woods Hole, MA 02543-1026).

Editorial Treatment: To distribute this report quickly, it has not undergone the normal technical and copy editing by the Northeast Fisheries Science Center's (NEFSC's) Editorial Office as have most other issues in the NOAA Technical Memorandum NMFS-NE series. Other than the four covers and first two preliminary pages, all writing and editing have been performed by the authors listed within.

Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the Northeast Regional Office completed both technical and policy reviews for this report. These predissemination reviews are on file at the Northeast Regional Office.

This document may be cited as:

Fratantoni PS, Holzwarth-Davis T, Bascuñán C, Taylor M . 2011. Description of the 2009 Oceanographic Conditions on the Northeast U. S. Continental Shelf. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-13; 32 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

ABSTRACT

Hydrographic observations from fourteen surveys spanning the Northeast U.S. Continental Shelf are combined into a descriptive overview of the broad-scale oceanographic conditions that were observed during 2009. Temperature and salinity observations are combined into six 2-month time periods in order to maximize both the spatial coverage of the data and its temporal resolution during the year. Maps of near-surface and near-bottom property distributions are presented for each bi-monthly period and time series of regional average properties are discussed for five geographic regions spanning the shelf: western Gulf of Maine (GOMW), eastern Gulf of Maine (GOME), Georges Bank (GBNK), and northern and southern Middle-Atlantic Bight (MABN and MABS, respectively). Surface conditions along the entire Northeast U.S. Continental Shelf were generally warm and fresh in 2009 relative to the reference period (1977-1987). The warmest/freshest waters were observed during the July/August time period with the largest anomalies occurring in the Middle Atlantic Bight. Near-bottom waters in the northern Middle Atlantic Bight were significantly fresher than normal early in the year, returning to normal values later in the year, while the opposite was true in the southern Middle-Atlantic Bight. Bottom temperatures trended warmer toward the end of 2009 from Georges Bank through the Middle-Atlantic Bight. While the annual average air temperature was slightly cooler than the long-term mean, the time of peak warming was shifted slightly later in the year. This may be partly responsible for the anomalously warm surface conditions observed in the Middle-Atlantic Bight at this time of year and for the enhanced warming that followed at depth in the near shore regions of the Middle Atlantic Bight. A Gulf Stream warm-core ring was responsible for anomalously warm and salty conditions observed over Georges Bank during the November/December period.

INTRODUCTION

The Northeast Fisheries Science Center (NEFSC) conducts multiple surveys on the Northeast U.S. continental shelf each year in support of its ongoing mission to monitor the shelf ecosystem and assess how its components influence the distribution, abundance, and productivity of living marine resources. In support of this mission, the Oceanography Branch provides conductivity, temperature and depth (CTD) instruments to all NEFSC cruises for the measurement of water column profiles of temperature and salinity. In addition to providing oceanographic context to specific field programs, these data contribute to a growing database of historical measurements that are used to monitor seasonal and interannual variability in the water properties on the northeast continental shelf.

Broad-scale surveys, sampling the shelf from Cape Hatteras, North Carolina, into the Gulf of Maine, are conducted up to six times per year during shelf-wide spring and fall bottom trawl surveys and on four dedicated seasonal Ecosystem Monitoring (EcoMon) surveys. Profiles of conductivity, temperature and depth are collected at each station on these shelf-wide surveys. Observations are also collected on other more regionally focused NEFSC surveys, where station coverage varies depending on the objectives of the particular field program. During 2009, hydrographic data were collected on 14 individual NEFSC cruises, amounting to 2093 profiles of temperature and salinity (Table 1). Here we present an annual summary of these observations, including surface and bottom distributions of temperature and salinity, as well as their anomalies relative to a consistent reference period. In addition, regional average values of temperature and salinity and their anomalies are computed for five different regions of the shelf during six bi-monthly periods. Finally, the volume and properties of the shelf water are examined for the Middle-Atlantic Bight region.

DATA AND METHODS

The Oceanography Branch provides CTD instrumentation and support to all NEFSC programs requesting this service. Training in instrument maintenance and operation, including deployment, data acquisition, recovery and preliminary processing, is provided as needed prior to sailing. On NEFSC surveys, CTD instruments are typically deployed in one of two modes: (1) during a bongo net tow, the CTD instrument is mounted on the conducting wire above the bongo frame and data are collected as a double oblique profile with the ship steaming at approximately 2 knots, (2) during a non-net tow, the CTD is mounted vertically on the wire and the sensors are soaked for one minute at the surface prior to descent. The sensors are not soaked at the surface prior to descent during bongo tows, rendering the upper 30 meters or more of the downcast unreliable. For this reason, the up-cast profile data are routinely processed as the primary data for each station.

In 2009, hydrographic data were collected aboard the NOAA ships *Delaware II* and *HB Bigelow*, and the R/V *HR Sharp* using a combination of Seabird Electronics SBE-19 and SBE-19+ SEACAT profilers and SBE 9/11 CTD units (Table 1). All raw CTD profile data were processed ashore, using standard Seabird Electronics software to produce 1-decibar averaged profiles in ascii-formatted files. Water samples were collected twice daily at sea during vertical casts. Following each cruise, these samples were analyzed using a Guildline AutoSal laboratory salinometer to provide quality control for the CTD salinity data. A salinity offset was applied to instrument data if the mean difference between the reference Autosal readings and the CTD values exceeded +/- 0.01 (a threshold chosen based on the expected instrument accuracy.) Vertical density profiles were examined for inversions due to bad conductivity or temperature readings and/or sensor misalignment. Egregious cases were replaced with a flag value. The processed hydrographic data were loaded into ORACLE database tables and made publically available via anonymous ftp (ftp://ftp.nefsc.noaa.gov/pub/hydro). Cruise reports have been prepared for each survey listed in Table 1 and are available online (http://www.nefsc.noaa.gov/epd/ocean/MainPage). Readers are referred to the individual cruise reports for notes, property maps and aggregate data specific to a particular survey.

Here, we aim to provide a descriptive overview of the hydrographic sampling that was conducted in 2009 and to characterize the broad-scale oceanographic conditions that were observed. In order to maximize both the spatial coverage of the data and its temporal resolution, the processed 2009 CTD data have been sorted into six 2-month time bins. Maps of near-surface and near-bottom temperature and salinity have been produced from profile data falling within each 2-month period. Surface fields include the shallowest observed temperature/salinity at each station that is also in the upper 5 meters of the water column, while bottom maps include the deepest observation at each station that also falls within 10 meters of the reported water depth. In order to examine the spatial and temporal variability over broader areas of the shelf, average values have been computed from the data within five sub-regions spanning the Northeast U.S. Continental Shelf (Figure 1). Regional averages have been computed for the bi-monthly binned fields (Tables 1 and 2) and for individual cruises (Appendix Tables 1-5).

In order to characterize variability that is not related to seasonal forcing, anomalies have been calculated at each station relative to a standard reference period (1977-1987). During this period the NMFS Marine Resources Monitoring and Prediction (MARMAP) program repeatedly occupied stations spanning the entire Northeast U.S. Shelf so that an annual cycle could be constructed for water properties across all regions of the northeast shelf (Mountain and Holzwarth, 1989; Mountain et al., 2004). The anomalies presented here are defined as the difference between the observed 2009 value at individual stations and the expected value for each location and time of year. Similarly, regional anomalies are the area-weighted average of these anomalies within a given domain. The methods used and an explanation of uncertainties is presented in Holzwarth and Mountain (1990).

Finally, we calculate the temperature, salinity and volume of the shelf water in the Middle-Atlantic Bight during 2009 and relate this to the conditions observed during the MARMAP reference period (Appendix Table 6). Following Mountain (2003), the shelf water mass is defined as water within the upper 100 meters having salinity less than 34. For each survey in 2009, the area of a sub-region was apportioned amongst its stations by an inverse distance squared weighting. The shelf water volume at a given station is the thickness of the shelf water at the station multiplied by its apportioned area, and the total shelf water volume within the sub region is the sum of these products for all stations within the region. Similarly, the average temperature and salinity was calculated in the shelf water layer at each station and multiplied by the total shelf water volume for that station. The sum of these products over all stations within a given sub-region, divided by the total shelf water volume for the region, determines the volume-weighted average temperature and salinity. Anomalies in the property and volume of the shelf water mass are calculated relative to like variables derived from MARMAP hydrographic data, as described above. Hence, here regional anomalies are computed as the mathematical difference between regional averages, *not* an average of the anomalies computed for a given sub-region.

RESULTS

Table 1 provides a listing of the NEFSC cruises that collected hydrographic data in 2009. In total, 2093 profiles of temperature and salinity were collected, processed and archived during the year. Combining the hydrographic data from multiple cruises into bi-monthly bins improves the spatial coverage compared with that of individual surveys, enabling us to examine the spatial and temporal patterns in hydrography over the region. Nonetheless, there are still significant gaps in several of the bi-monthly distribution maps shown in Figure 2, particularly in the Gulf of Maine during July/August, March/April, and September/October. These gaps result in part from a misalignment between the bi-monthly periods and the longer bottom trawl surveys that work from south to north along the shelf. The March/April and September/October periods encompass all but the final 10 days of the spring and 18 days of the fall bottom trawl surveys, respectively, when sampling was focused in the Gulf of Maine. The summer EcoMon survey would normally provide full coverage into the Gulf of Maine during the July/August period but was cut short due to an approaching tropical storm. Poor station coverage within the Gulf of Maine during July/August precludes the calculation of a representative regional average surface/bottom temperature and salinity value (Tables 2 and 3, Figures 3 and 4). Similarly, while the station coverage is better during the March/April and September/October periods, regional averages computed for the western and eastern Gulf of Maine are not true areal-averages, representative of the entire region, but are biased toward the southern portion of these sub-regions (Tables 2 and 3, Figures 3 and 4).

Overall, surface conditions along the entire Northeast U.S. Continental Shelf were warm and fresh in 2009 relative to the reference period (January/February being the exception; Figures 3 and 4). The warmest/freshest waters were observed during the July/August time period with the largest anomalies occurring in the Middle Atlantic Bight. Bottom properties were near normal in the Gulf of Maine, with salinity anomalies not significantly different from zero and bottom temperatures slightly warmer in the western Gulf of Maine throughout the year. By contrast, bottom waters in the northern Middle Atlantic Bight were significantly fresher than normal early in the year, returning to normal values later in the year, while the opposite was true in the southern Middle Atlantic Bight. Bottom temperatures trended warmer toward the end of 2009 from Georges Bank through the Middle Atlantic Bight. During 2009, the shelf water volume remained relatively high through a majority of the year, aside from a period of reduced volume in July-October, indicating that the shelf/slope front was consistently located offshore of its position during the MARMAP period (Figure 5).

Details related to the temporal trends in Figures 3 and 4 can be explored in the surface and bottom property distribution maps (Figures 6-11). Maps of near bottom salinity and salinity anomaly suggest that the trend from fresh to salty anomalies in the northern Middle Atlantic Bight time series may be related in part to an onshore shift in the shelf/slope front and to the influence of anticyclonic eddies in the adjacent slope water. Figures 9 and 10 suggest that the front, delineated by the S=34 isohaline, was located shoreward of its typical position between July/August and September/October in the northern Middle Atlantic Bight. This is reflected in the region of positive salty anomalies centered over the middle to outer shelf, accompanied by positive near-bottom temperature anomalies over the entire shelf (Figure 9b). The region of positive salinity anomaly (Figure 9b) occurs seaward of the shoreward meander in the 34 isohaline (Figure 9a), confirming that the shoreward shift in the front is not simply a seasonal shift in the position of the front. This is substantiated by the minima in the shelf water volume anomaly observed during this same period (Figure 5). There is evidence in satellite-derived sea surface temperature maps that warm core eddies in the slope water may have contributed to the onshore movement of the front during this period. Multiple anticyclonic eddies were observed in the slope water, offshore of the 200 m isobath, during August and September. Several highly energetic features were present along the outer edge of the shelf (west of 69 W) during September-October, sandwiched between the shelf edge and two very large meanders in the Gulf Stream offshore. Warm/salty anomalies, aligned along the outer edge of the shelf at the surface in the Middle Atlantic Bight, coincide with the highly filamented inshore edge of these features (Figure 10b). Similarly, the dramatic warming and salinification that is observed over the full water column at Georges Bank during November/December (Figures 3 and 4; Figure 11) is caused by the prolonged influence of a very large warm core Gulf Stream ring impinging on the bank during this period. In contrast, the warm anomaly observed at the shelf edge in the southern Middle Atlantic Bight during this period is not caused by eddies or rings in the slope region. During this period, the Gulf Stream was free of meanders and the slope water was comparatively quiet west of 70 W.

Maps of near-bottom temperature show the seasonal formation of the cold pool in the Middle Atlantic Bight, with coldest temperatures observed during the May/June period (Figure 8a). The accompanying maps of near-bottom temperature anomaly suggest that temperatures in the cold pool were colder than normal, particularly in the region of the temperature minimum and along the southeastern edge of the pool (Figure 8b). By July/Aug (Figure 9) the cold pool has begun to weaken and warm. While the temperature anomaly near the core of the cold pool remains negative (indicating that temperatures here are colder than normal), a significant positive anomaly extends along the axis of the cold pool south of the core (indicating more warming than normal). By comparison, near-bottom temperatures are significant colder than the reference period inshore of the cold pool.

By September/October the entire near-shore region in the Middle Atlantic Bight was much warmer than normal (Figure 10b). This is consistent with historical observations in this region, which indicate that by late summer the effects of seasonal heating extend all the way to the ocean bottom in the near-shore regions (Castelao et al., 2010). It is not uncommon during this period for warmer waters to be found inshore of colder waters as is seen in Figure 10a (Mountain and Holzwarth, 1989). Seasonal heating does not penetrate to the bottom in deeper water, where gradients are larger due to the presence of the cold pool. However, the anomaly fields shown in Figure 10b suggest that this effect was more extreme than normal in late-summer 2009. Based on the climate summaries compiled by the Northeast Regional Climate Center (http://www.nrcc.cornell.edu), the annual peak in monthly average air temperature occurred slightly later in 2009 than the long-term mean (Figure 12). This timing is coincident with the largest surface temperature anomalies in the Middle Atlantic Bight (Figure 3), followed one month later by anomalous warming at the bottom (Figure 3 and Figure 10b). Overall, however, the annual mean air temperature across the Northeastern U.S. was 0.2ºC below long term annual mean values.

According to the Northeast Regional Climate Center records, the annual mean precipitation over the Northeastern U.S. was 2.33” above the long-term mean (referenced to 1971-2000). In fact, 2009 was ranked the 5th wettest year out of the 115 preceding years. This could account in part for the fresh surface conditions observed throughout the region. However, a more thorough analysis would be needed to discriminate between local freshening due to precipitation and river run-off and freshening due to advection from remote sources. For instance, while the regional average salinities in the eastern Gulf of Maine were only slightly fresh relative to the reference period at the surface, anomaly maps suggest that a saltier variety of near-bottom waters may have been entering the eastern Gulf of Maine through Northeast Channel and along the southwestern Scotian Shelf during May/June (Figure 8b). This roughly coincides with the period of maximum inflow to the Gulf of Maine at Cape Sable, Nova Scotia (Smith et al., 2001). These saltier source waters mix vertically with surface waters within the Gulf of Maine, including the near surface and inshore waters where freshening due to increased precipitation will be greatest.

REFERENCES CITED

Castelao, R., S. Glenn and O. Schofield, 2010: Temperature, salinity, and density variability in the central Middle Atlantic Bight. Journal of Geophysical Research, 115, C10005, doi:10.1029/2009JC006082.

Holzwarth, T. J. and D. G. Mountain, 1990: Surface and Bottom Temperature Distributions from the Northeast Fisheries Center Spring and Fall Bottom Trawl Survey Program, 1963-1987. NEFSC Reference Document 90-03, 62 pp.

Mountain, D. G. and T. J. Holzwarth, 1989: Surface and Bottom Temperature Distribution for the Northeast Continental Shelf. NOAA Technical Memorandum NMFS-F/NEC-73, 55 pp. Available from: NOAA Fisheries, 166 Water Street, Woods Hole, MA 02543.

Mountain, D. G., 2003: Variability in the properties of Shelf Water in the Middle Atlantic Bight, 1977-1999. Journal of Geophysical Research, 108, 3014, doi:10.1029/2001JC001044, (14-)1-11.

Mountain, D. G., M. H. Taylor and C. Bascuñán, 2004: Revised procedures for calculating regional average water properties for Northeast Fisheries Science Center cruises. NEFSC Reference Document 04-08, 53pp.

Northeast Regional Climate Center, Cornell University. Seasonal Climate Summary Tables. Available at: http://www.nrcc.cornell.edu/, (accessed 31 March, 2011).

Smith, P. C., R. W. Houghton, R. G. Fairbanks and D. G. Mountain, 2001: Interannual variability of boundary fluxes and water mass properties in the Gulf of Maine and on Georges Bank: 1993-1997. Deep-Sea Research, Part II, 48, 37-70.

Table 1. Listing of 2009 NOAA Northeast Fisheries Science Center cruises supported by the Oceanography Branch.

Cruise	Program	Dates	Region(s)[1]	Gear	Casts
DEL0901	NOAA/LMRCSC Coop.	15 – 21 Jan	South MAB	SBE-19	23
DEL0902	EcoMon Survey	26 Jan – 12 Feb	Full Shelf	SBE-19, 19+	169
HB0901	Spring Bottom Trawl	27 Feb – 8 May	Full Shelf	SBE-19	398
DEL0904	Coastal Shark Longline	15 Apr – 16 May	Southeast U.S.	SBE-19+	49
S10901	Scallop Survey	9 May – 2 Jul	MAB, GB	SBE-19+, 9/11	124
DEL0905	EcoMon Survey	27 May – 11 Jun	Full Shelf	SBE-19+	168
DEL0907	Cetacean Biology	15 – 28 Jul	West GOM	SBE-19+	20
DEL0908	Benthic Habitat	5 – 13 Aug	GB	SBE-19+	215
HB0903	Cetacean & Turtle Abund.	6 – 16 Aug	Offshore	SBE-19+	65
DEL0909	EcoMon Survey	17 – 29 Aug	MAB, GB	SBE-19+, 9/11	158
HB0904	Habitat Mapping	25 – 31 Aug	MAB	SBE-19+	29
HB0905	Fall Bottom Trawl	13 Sep – 19 Nov	Full Shelf	SBE-19+	363
DEL0910	Hydro Acoustic Survey	13 Sep – 15 Oct	GSC,GB,WGOM	SBE-19+	153
DEL0911	EcoMon Survey	3 – 20 Nov	Full Shelf	SBE-19+, 9/11	159

[1] Regional Abbreviation:
GSC=Great South Channel
GOM=Gulf of Maine
GB=Georges Bank
MAB=Mid Atlantic Bight

Table 2. The 2009 regional average surface and bottom temperature values computed from CTD data that were sorted into six 2-month time periods for the five regions of the Northeast U.S. continental shelf shown in Figure 1.

		SURFACE						BOTTOM					
Region	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
		January-February											
GOMW	42	29	4.64	-0.58	0.19	0.45	0	20	6.26	0.32	0.20	0.58	0
GOME	41	19	4.67	-0.82	0.22	1.05	1	11	6.86	-0.02	0.29	1.34	1
GB	37	38	4.89	-0.61	0.18	0.95	0	28	5.58	-0.25	0.20	1.18	0
MABN	32	33	5.83	-0.55	0.23	1.07	0	26	7.04	0.22	0.28	1.54	0
MABS	28	56	7.79	0.34	0.18	1.67	0	49	8.09	0.74	0.21	1.26	0
		March-April											
GOMW	102	43	5.02	0.29	0.17	1.87	1	40	5.15	0.36	0.15	1.67	1
GOME	115	26	5.79	0.43	0.20	2.52	1	23	6.63	-0.68	0.21	2.33	1
GB	102	56	5.64	0.30	0.14	1.27	0	42	5.58	0.34	0.18	1.19	0
MABN	85	50	5.24	0.67	0.18	1.26	0	43	5.12	-0.49	0.22	1.70	0
MABS	72	89	6.90	1.09	0.14	1.37	0	76	6.71	1.05	0.17	1.73	0
		May-June											
GOMW	146	51	9.78	0.52	0.16	1.03	0	49	5.61	0.17	0.15	0.88	0
GOME	149	38	8.54	0.32	0.18	1.03	0	32	6.86	-0.24	0.20	1.14	0
GB	162	65	11.17	0.91	0.14	1.63	0	55	8.25	-0.04	0.16	1.30	0
MABN	149	47	12.15	0.45	0.19	1.27	0	45	6.98	-0.39	0.21	1.24	0
MABS	145	105	15.19	0.28	0.14	1.15	0	99	9.36	0.28	0.15	1.56	0
		July-August											
GOMW													
GOME													
GB	233	227	17.37	1.16	0.14	1.64	0	215	11.92	-0.28	0.17	2.61	0
MABN	232	26	23.17	2.73	0.23	2.05	0	22	11.17	1.15	0.31	1.70	0
MABS	232	62	25.81	2.00	0.17	1.18	0	42	10.91	-1.32	0.22	2.93	0
		September-October											
GOMW	277	67	14.92	0.81	0.13	2.36	1	66	7.20	0.23	0.12	2.74	1
GOME	262	42	15.97	0.34	0.16	3.14	1	41	9.36	0.31	0.15	3.74	1
GB	291	80	14.20	-0.10	0.14	1.65	0	71	12.66	0.15	0.17	1.95	0
MABN	277	68	18.16	0.61	0.16	1.11	0	51	13.95	1.19	0.20	2.05	0
MABS	264	92	21.35	-0.14	0.14	1.09	0	70	17.20	3.02	0.18	2.75	0
		November-December											
GOMW	317	58	10.61	0.62	0.15	0.82	0	52	7.92	0.64	0.14	1.07	0
GOME	314	44	11.29	0.37	0.15	1.49	1	39	8.59	0.15	0.16	1.95	1
GB	315	51	13.85	1.47	0.16	2.94	0	42	13.60	1.92	0.19	2.47	0
MABN	310	31	13.49	-0.50	0.23	0.74	0	27	13.84	0.79	0.28	1.12	0
MABS	311	46	15.17	-0.26	0.19	0.77	0	40	15.40	0.84	0.23	1.23	0

"Region", the geographic region of the northeast continental shelf: "CD", the calendar mid-date of all the stations within a region for a time period: "#obs", the number of observations included in each average: "Temp", the areal average temperature: "Anomaly", the areal average temperature 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. The 2009 regional average surface and bottom salinity values computed from CTD data that were sorted into six 2-month time periods for the five regions of the Northeast U.S. continental shelf shown in Figure 1.

		SURFACE						BOTTOM					
Region	CD	#obs	Salt	Anomaly	SDV1	SDV2	Flag	#obs	Salt	Anomaly	SDV1	SDV2	Flag
		January-February											
GOMW	42	29	32.92	-0.10	0.13	0.17	0	20	33.68	0.08	0.12	0.25	0
GOME	41	19	32.89	-0.16	0.15	0.43	1	11	34.05	-0.11	0.16	0.58	1
GB	37	38	32.65	-0.30	0.10	0.51	0	28	32.98	-0.11	0.12	0.46	0
MABN	32	32	32.79	-0.34	0.15	0.38	0	26	33.25	-0.32	0.16	0.62	0
MABS	28	55	33.24	-0.34	0.13	1.17	0	48	33.68	0.09	0.13	0.45	0
		March-April											
GOMW	102	43	32.53	-0.14	0.11	0.76	1	40	33.20	-0.09	0.09	0.51	1
GOME	115	26	32.42	-0.14	0.13	1.03	1	23	34.25	-0.09	0.10	0.72	1
GB	102	56	32.84	-0.16	0.09	0.47	0	42	33.02	-0.14	0.11	0.35	0
MABN	85	50	32.69	-0.23	0.12	0.45	0	43	32.79	-0.70	0.13	0.52	0
MABS	72	89	32.95	-0.22	0.11	0.74	0	76	33.51	0.05	0.10	0.61	0
		May-June											
GOMW	146	51	31.87	-0.29	0.11	0.38	0	49	33.21	-0.06	0.09	0.21	0
GOME	149	38	32.16	-0.17	0.12	0.33	0	32	33.84	-0.04	0.11	0.33	0
GB	162	65	32.66	-0.16	0.08	0.51	0	55	32.92	-0.12	0.10	0.25	0
MABN	149	47	32.17	-0.22	0.13	0.37	0	45	32.82	-0.33	0.12	0.31	0
MABS	145	105	32.09	-0.13	0.11	0.53	0	99	33.08	-0.23	0.10	0.68	0
		July-August											
GOMW													
GOME													
GB	233	227	32.43	-0.34	0.08	0.28	0	215	32.69	-0.24	0.10	0.23	0
MABN	232	26	32.21	-0.36	0.15	0.80	0	22	33.24	0.01	0.18	0.51	0
MABS	232	62	30.99	-1.06	0.13	0.71	0	41	32.86	-0.25	0.13	0.48	0
		September-October											
GOMW	277	67	31.97	-0.23	0.09	0.84	1	66	33.42	-0.03	0.07	0.50	1
GOME	262	42	32.21	-0.19	0.10	1.08	1	41	34.30	0.01	0.08	0.69	1
GB	291	80	32.78	0.05	0.08	0.60	0	71	32.91	-0.05	0.10	0.32	0
MABN	277	68	32.92	0.18	0.11	0.65	0	51	33.54	0.07	0.12	0.57	0
MABS	264	92	32.41	0.11	0.11	1.27	0	70	32.86	-0.41	0.11	1.06	0
		November-December											
GOMW	317	58	32.57	-0.16	0.10	0.35	0	52	33.44	-0.18	0.08	0.37	0
GOME	314	44	32.41	-0.30	0.10	0.64	1	39	34.30	-0.16	0.08	0.65	1
GB	315	51	33.16	0.42	0.09	0.93	0	42	33.75	0.74	0.11	1.02	0
MABN	310	31	32.72	-0.20	0.16	0.82	0	27	33.57	0.05	0.16	0.62	0
MABS	311	46	32.82	-0.10	0.15	1.02	0	40	33.21	-0.17	0.14	0.74	0

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

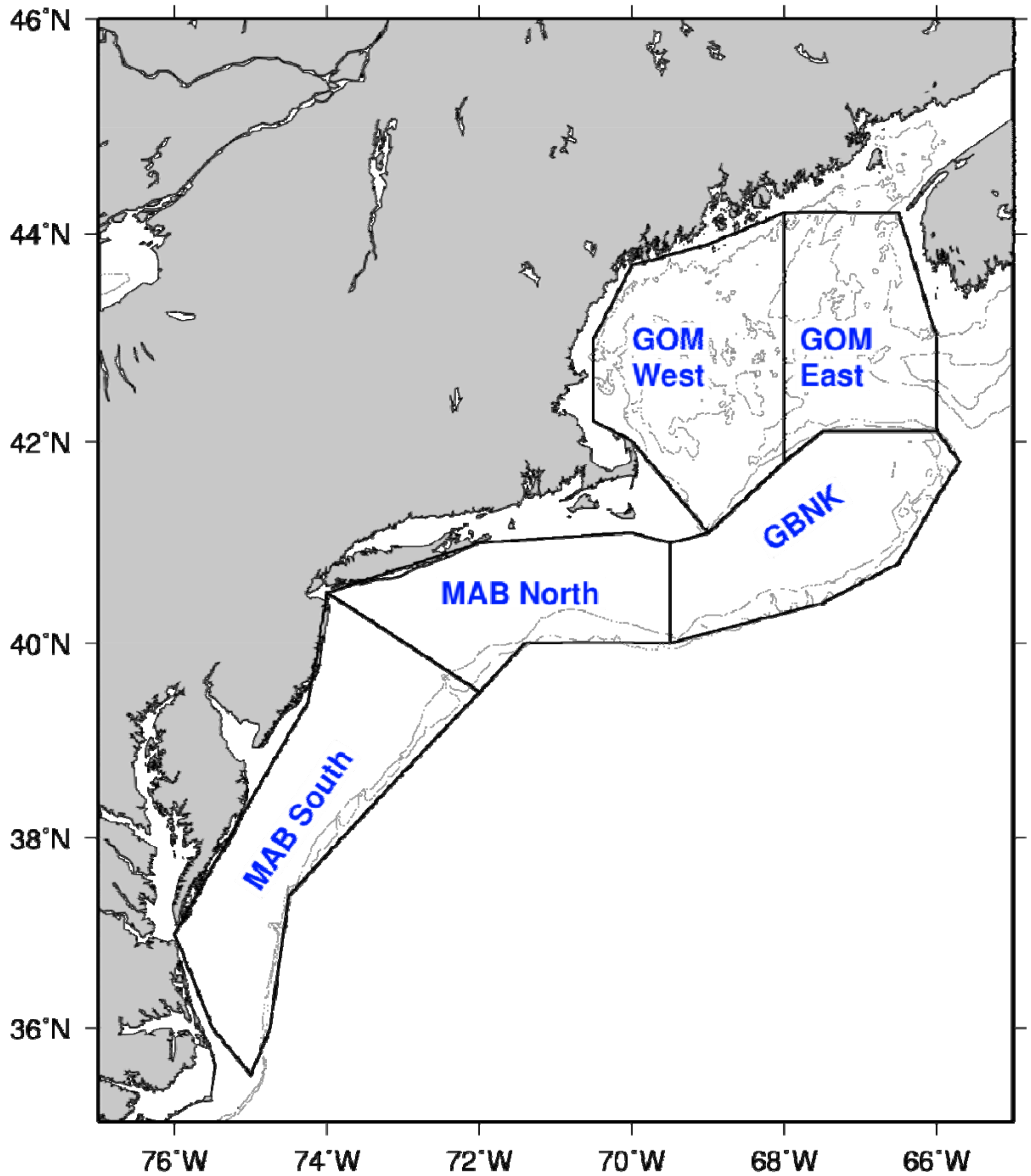

Figure 1. Region designations for the Northeast U.S. Continental Shelf. The 100 m and 200 m isobaths are also shown.

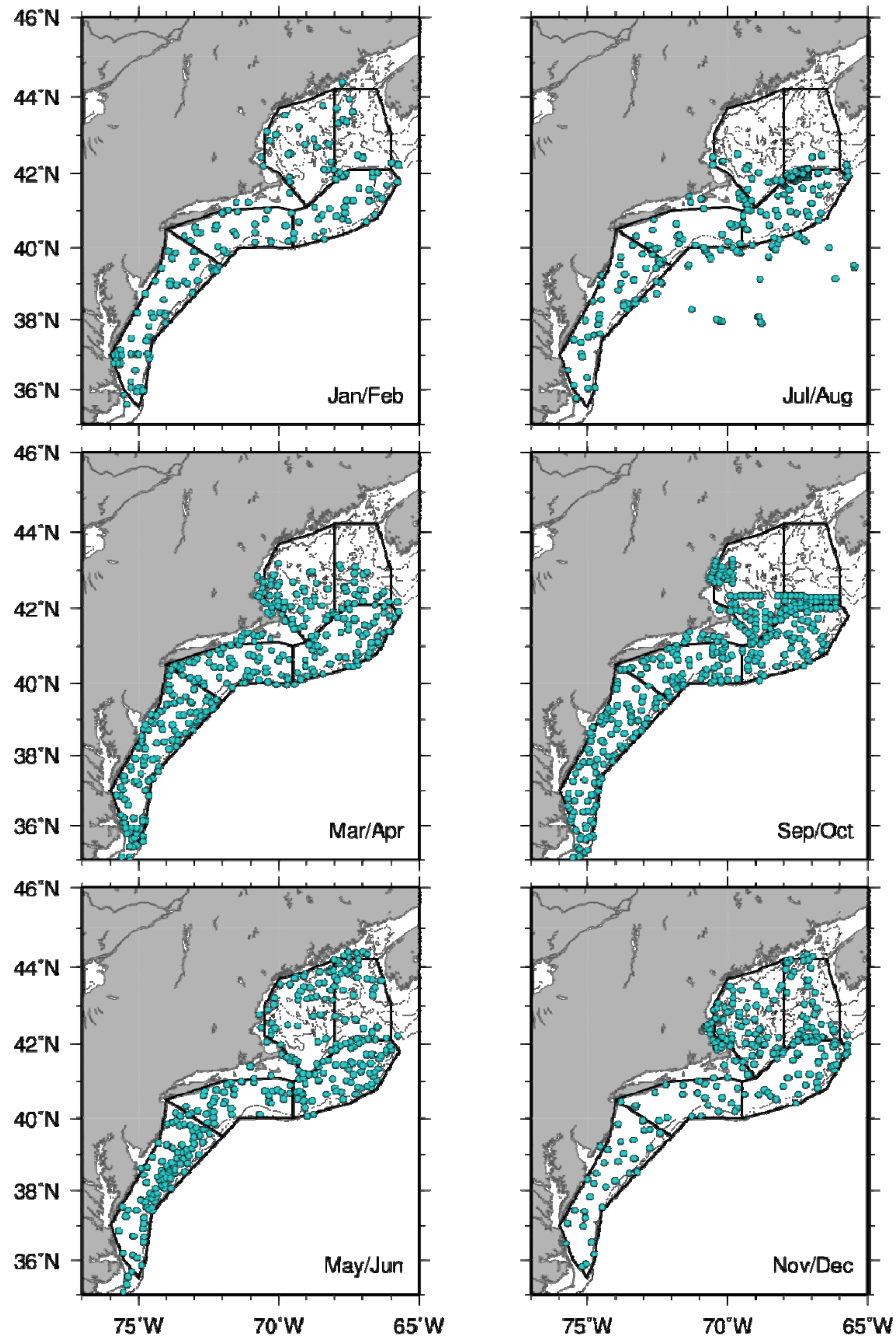

Figure 2. The 2009 station distributions for each 2-month time period. The regional boundaries are also overlain. Contours indicate the 100 and 200-meter isobaths.

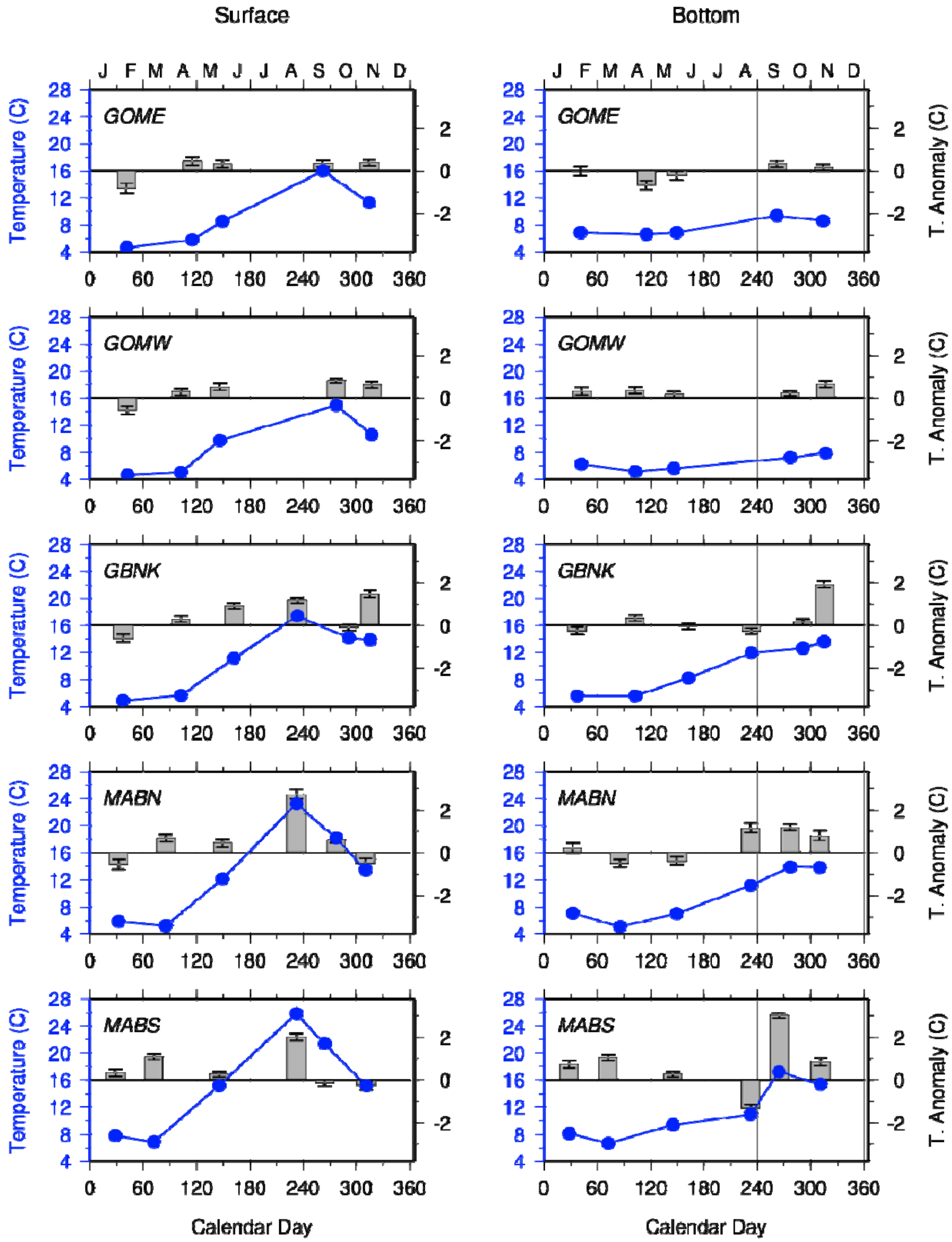

Figure 3. Time series of the 2009 regional surface (left) and bottom (right) temperatures (blue) and anomalies (bars) as a function of calendar day. Error bars are indicated for the anomaly estimates. The error bars are determined from SDV1 in Table 2, incorporating the uncertainty in both the predicted and measured temperatures from a given region (see Holzwarth and Mountain, 1990).

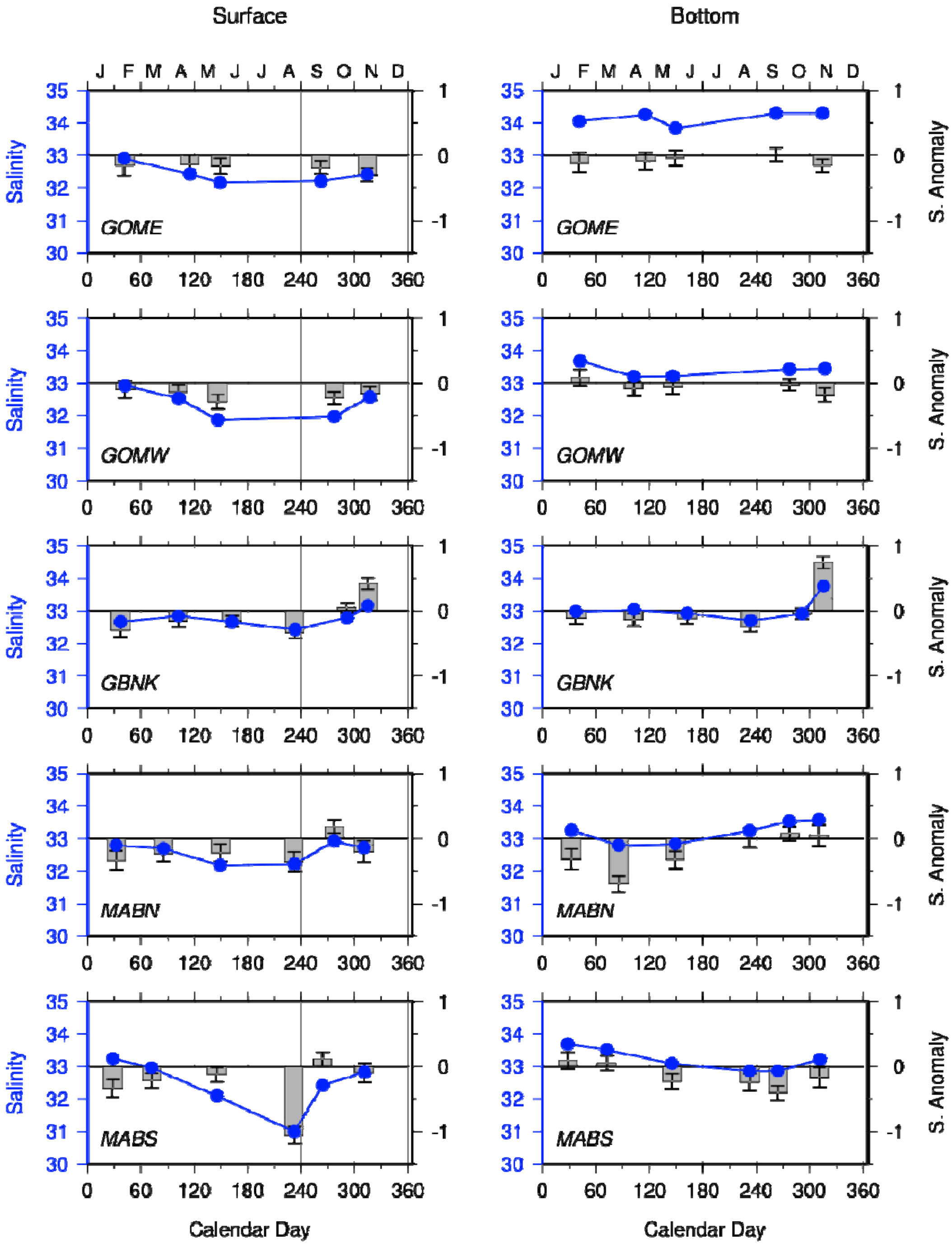

Figure 4. Time series of the 2009 regional surface (left) and bottom (right) salinities (blue) and anomalies (bars) as a function of calendar day. Error bars are indicated for the anomaly estimates. The error bars are determined from SDV1 in Table 3, incorporating the uncertainty in both the predicted and measured salinities from a given region (see Holzwarth and Mountain, 1990).

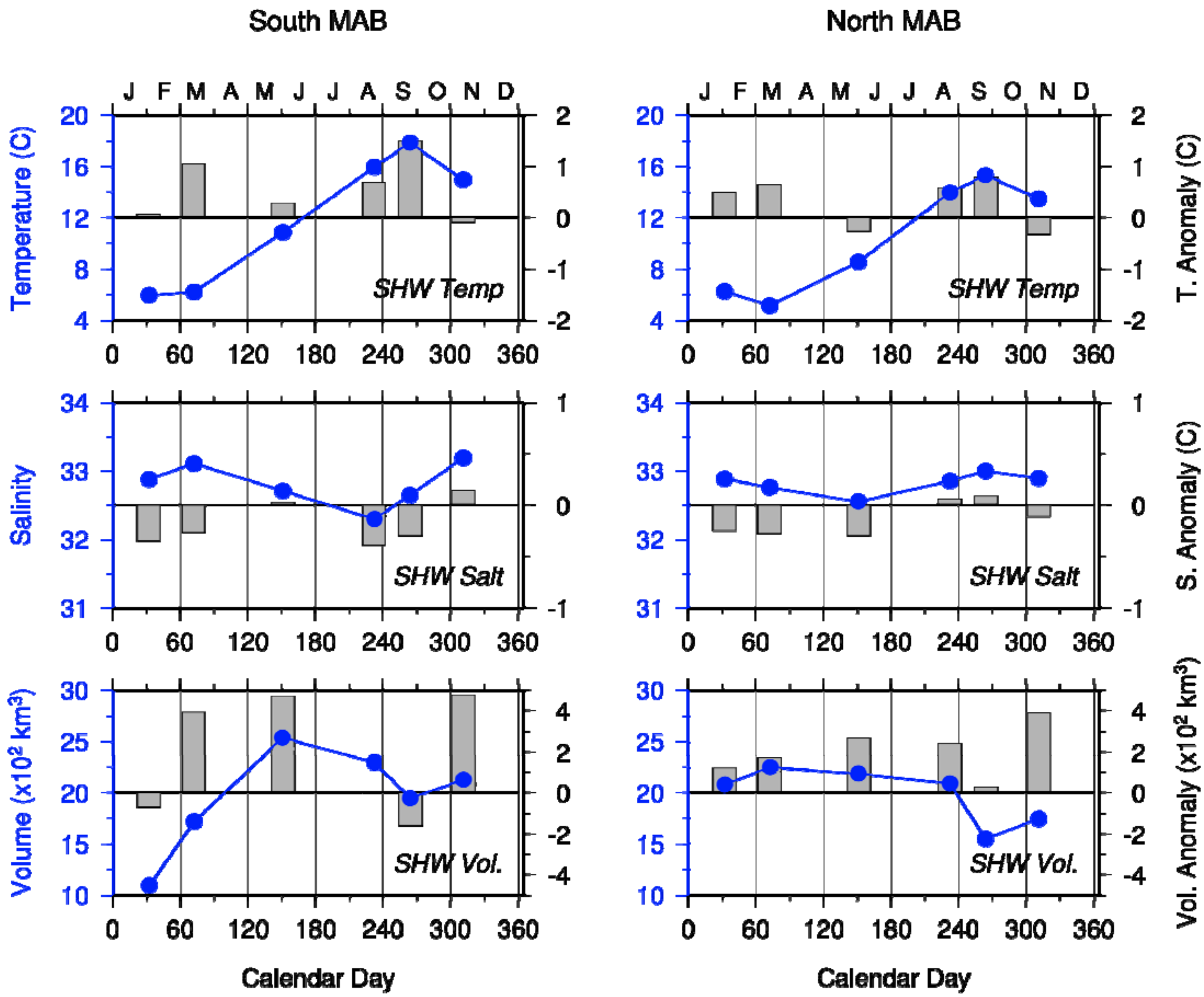

Figure 5. Time series of the 2009 regional shelf water temperature, salinity, and volume as a function of calendar day shown in blue for the southern (left) and northern (right) Middle Atlantic Bight. Shelf water anomalies are shown by the vertical bars.

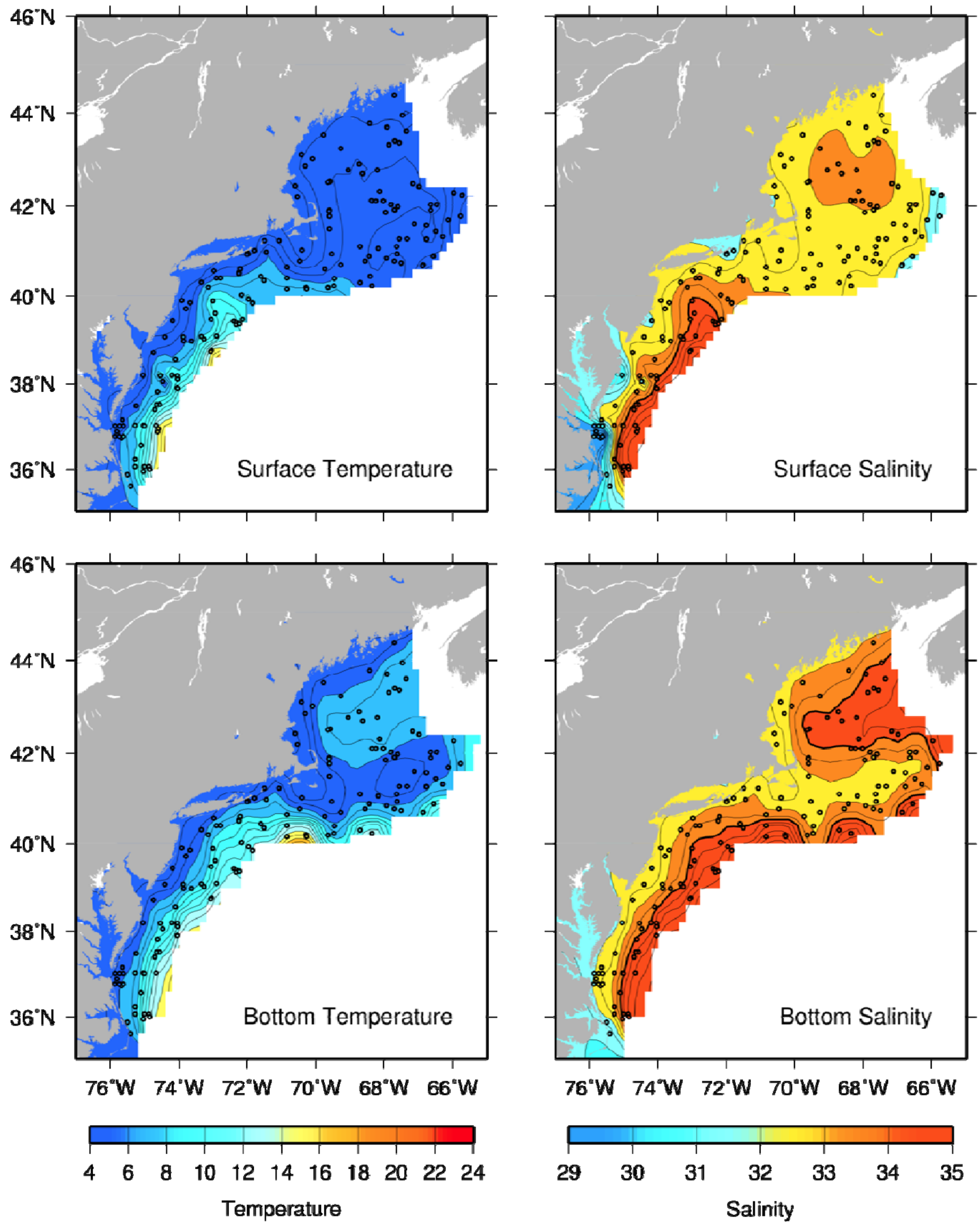

Figure 6a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during January-February, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour.

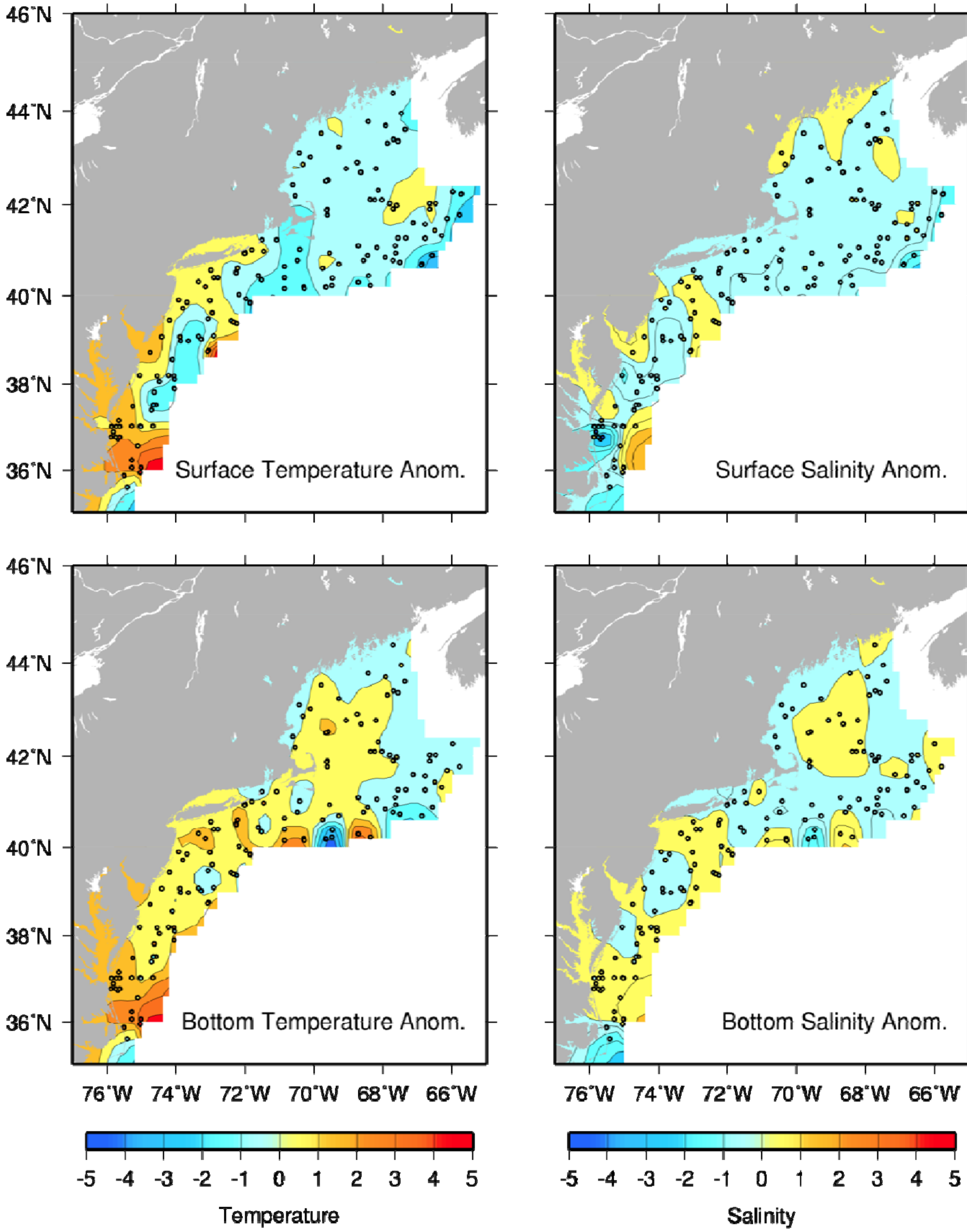

Figure 6b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during January-February, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

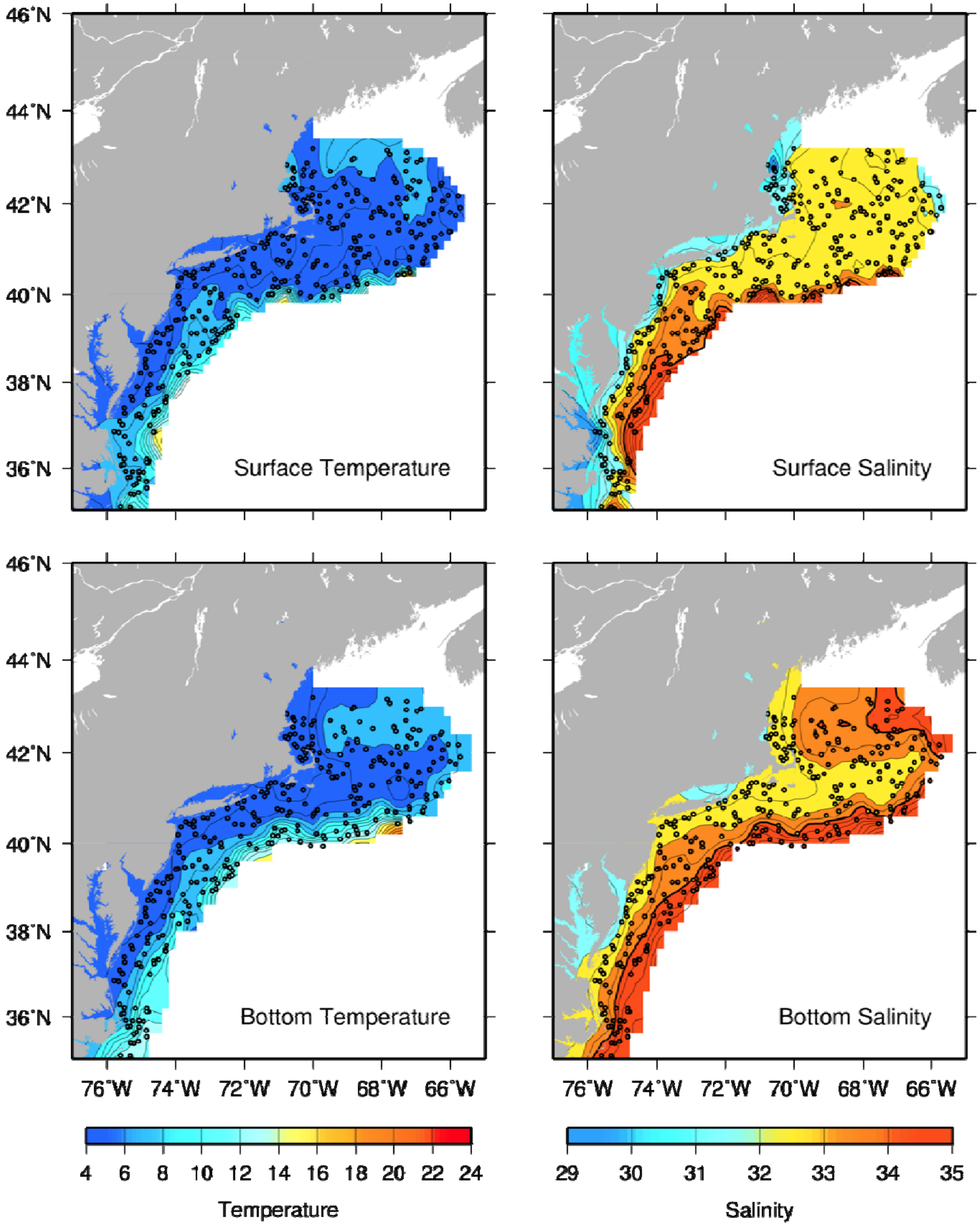

Figure 7a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during March-April, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour.

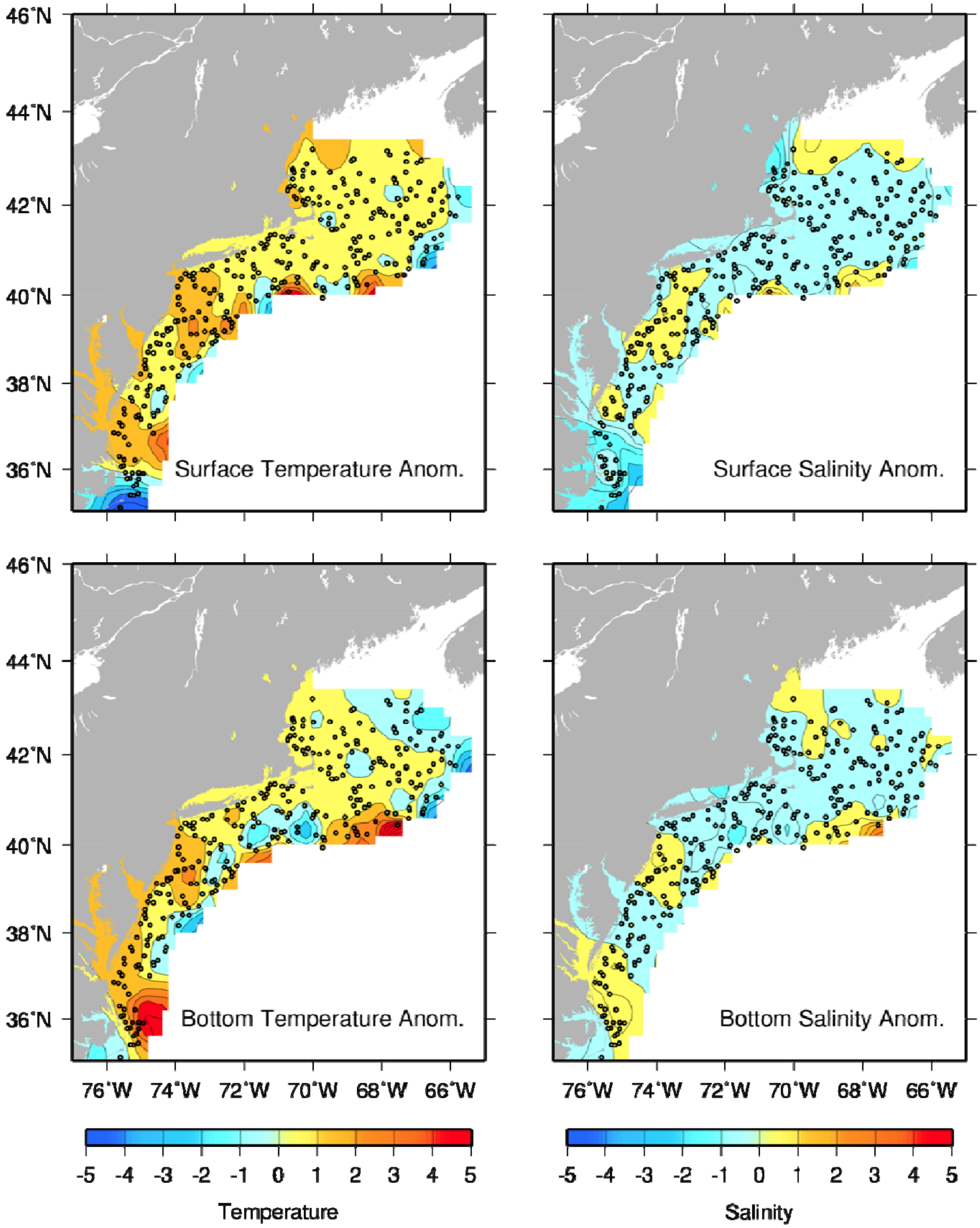

Figure 7b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during March-April, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

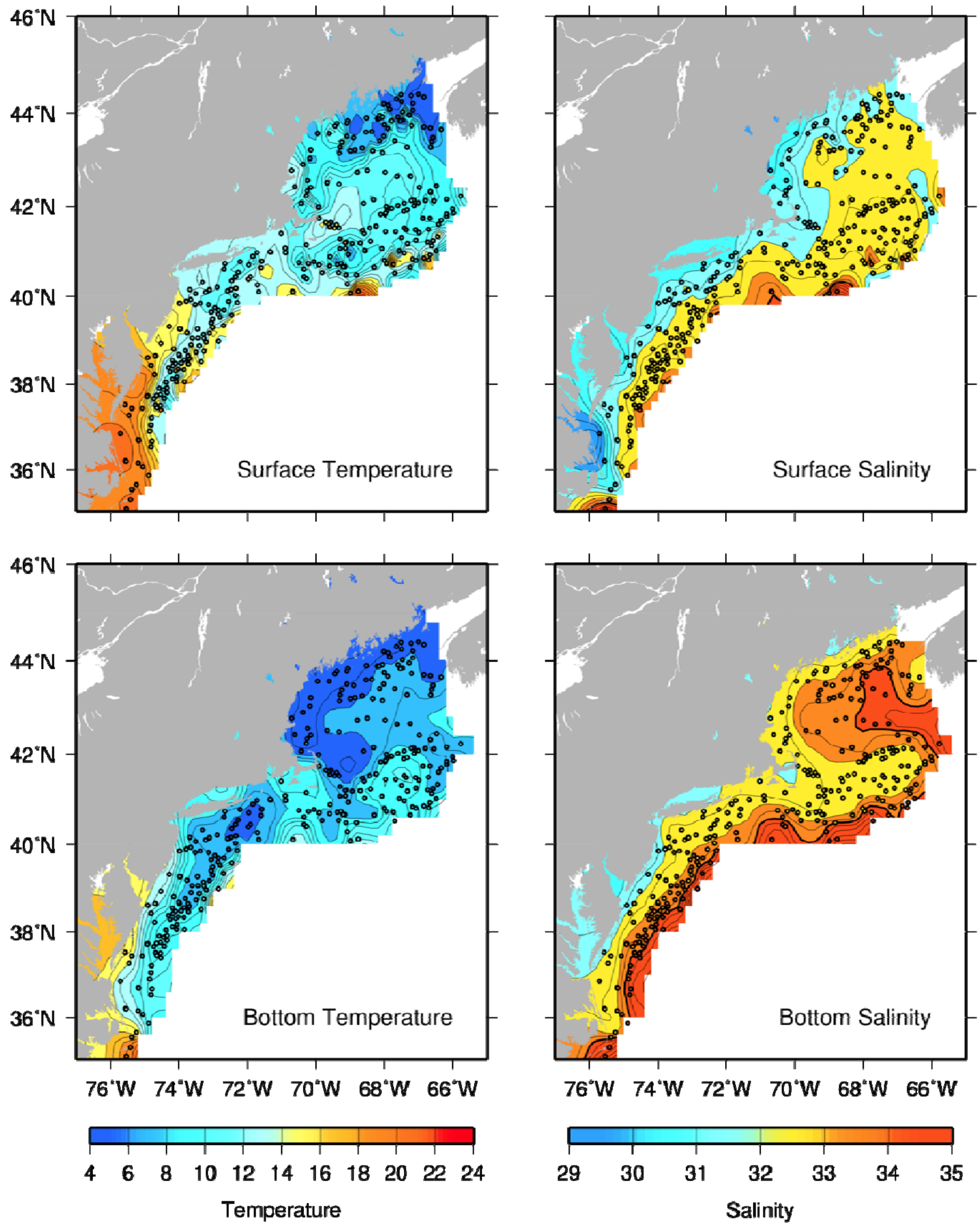

Figure 8a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during May-June, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour.

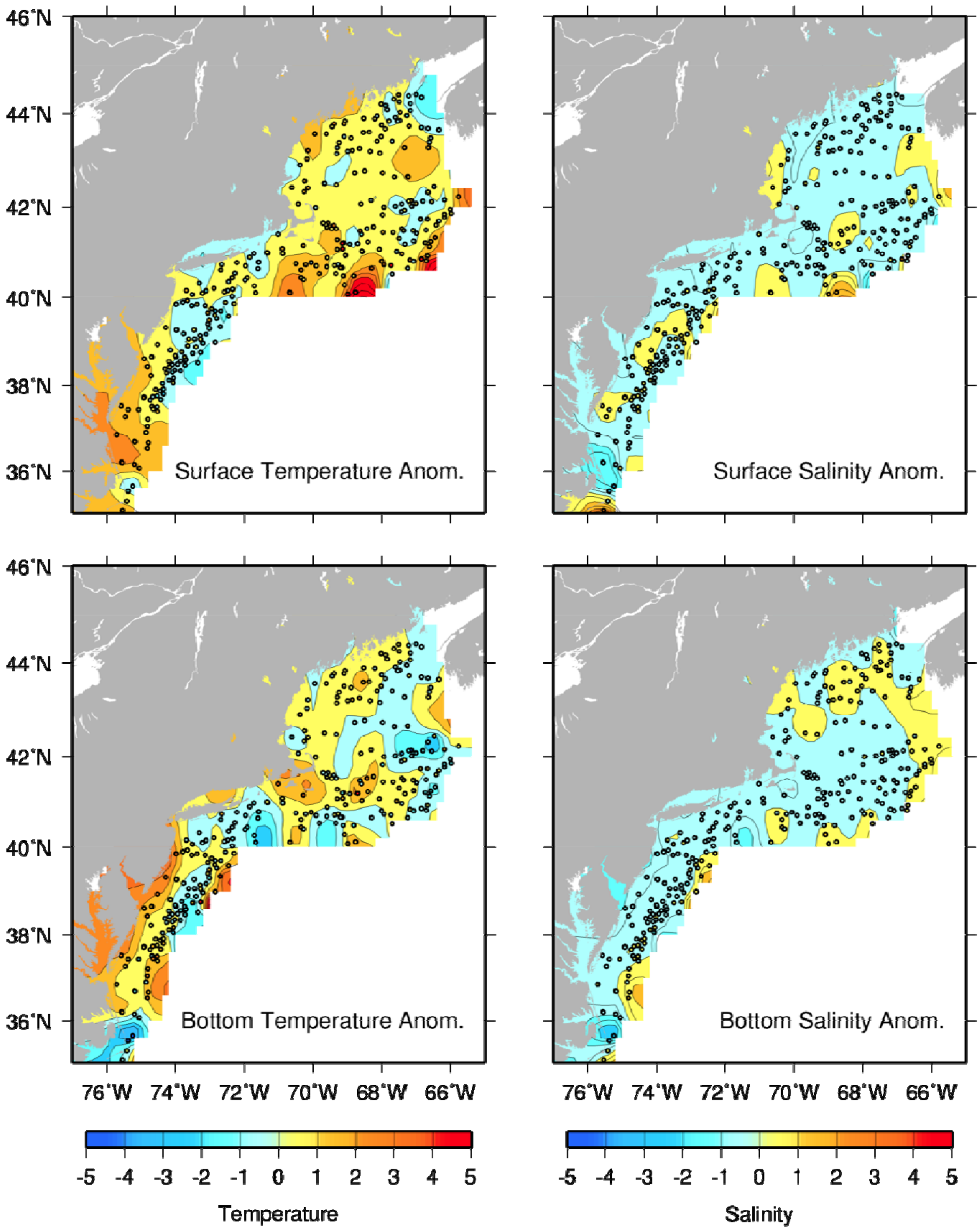

Figure 8b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during May-June, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

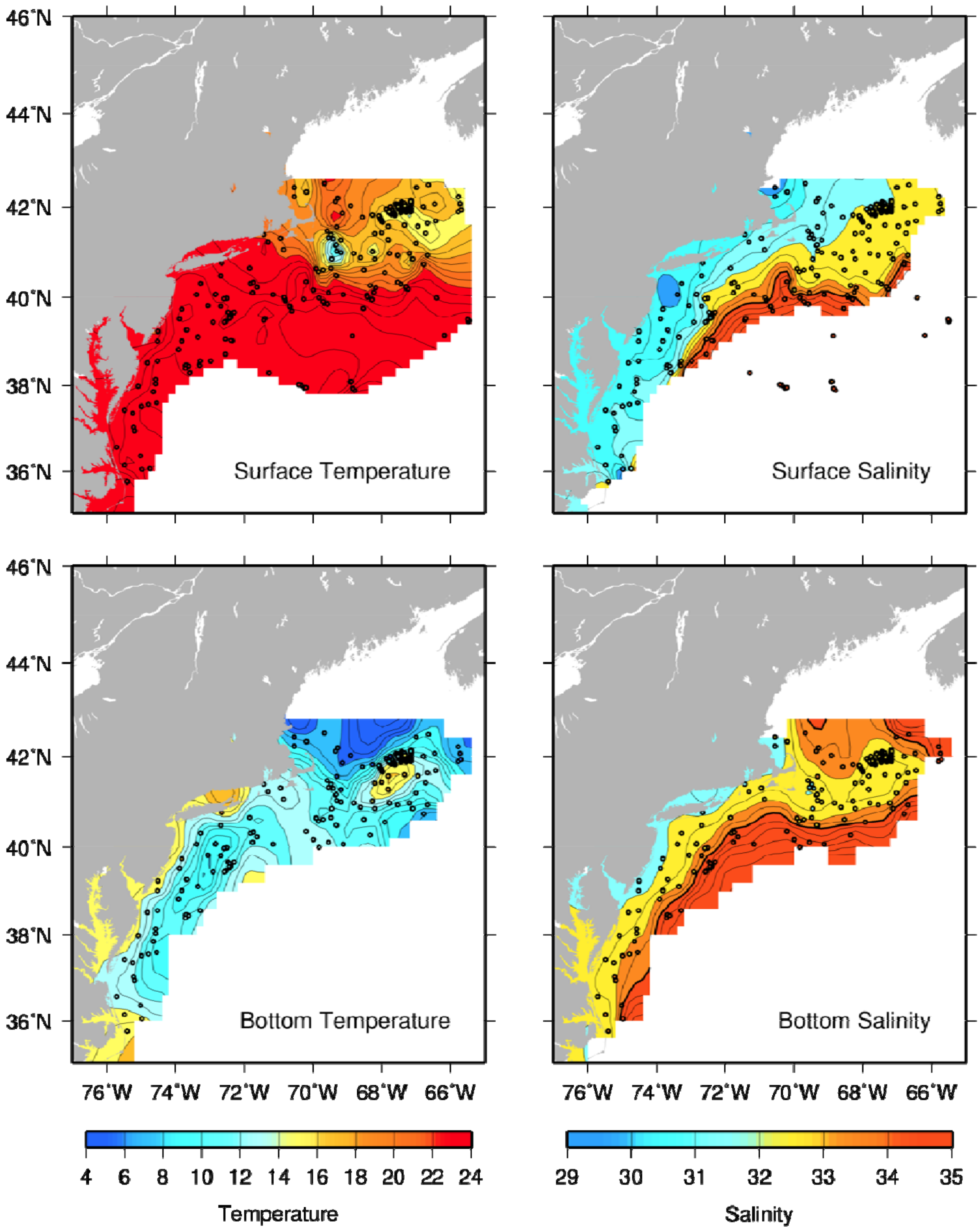

Figure 9a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during July-August, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour.

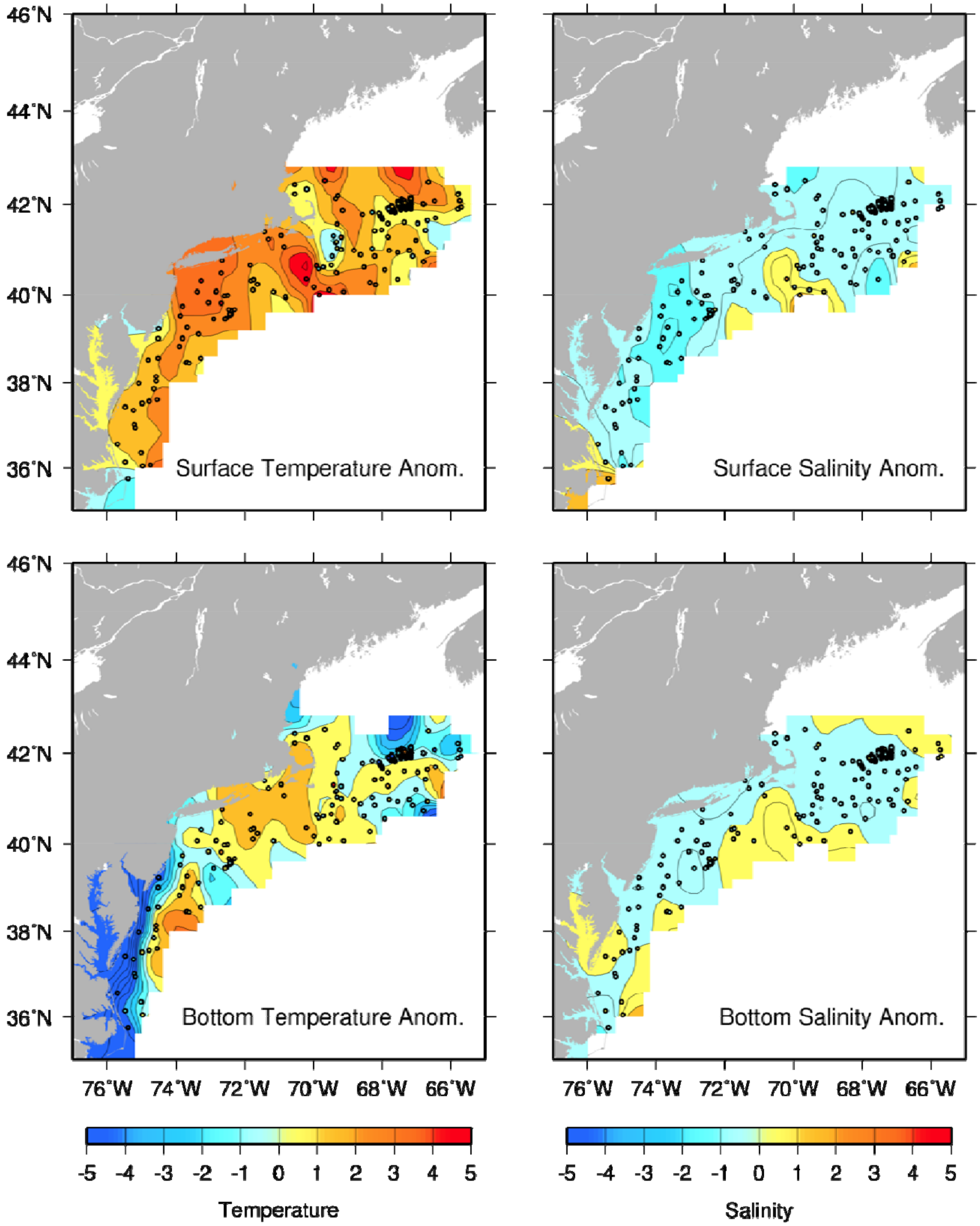

Figure 9b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during July-August, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

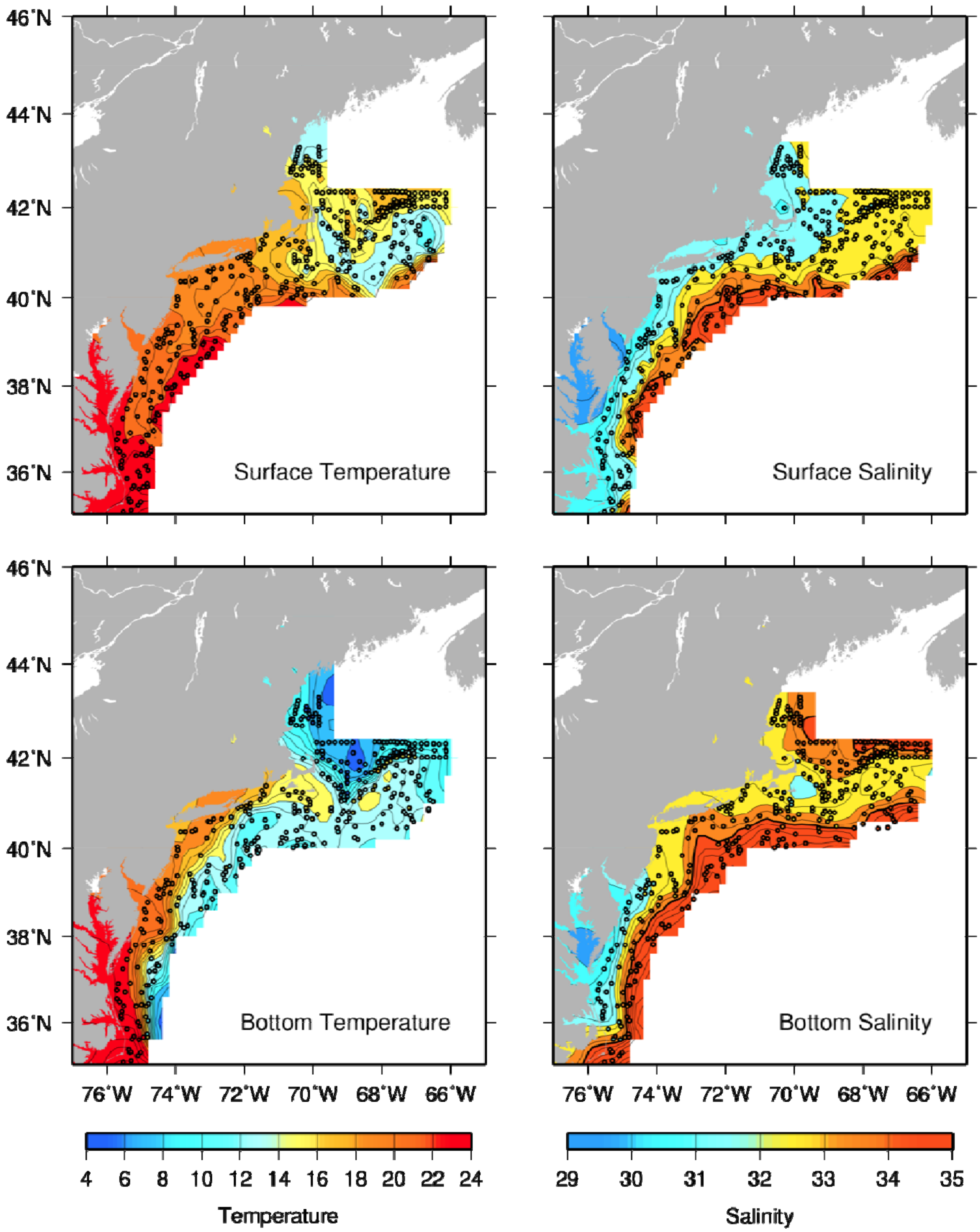

Figure 10a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during September-October, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour.

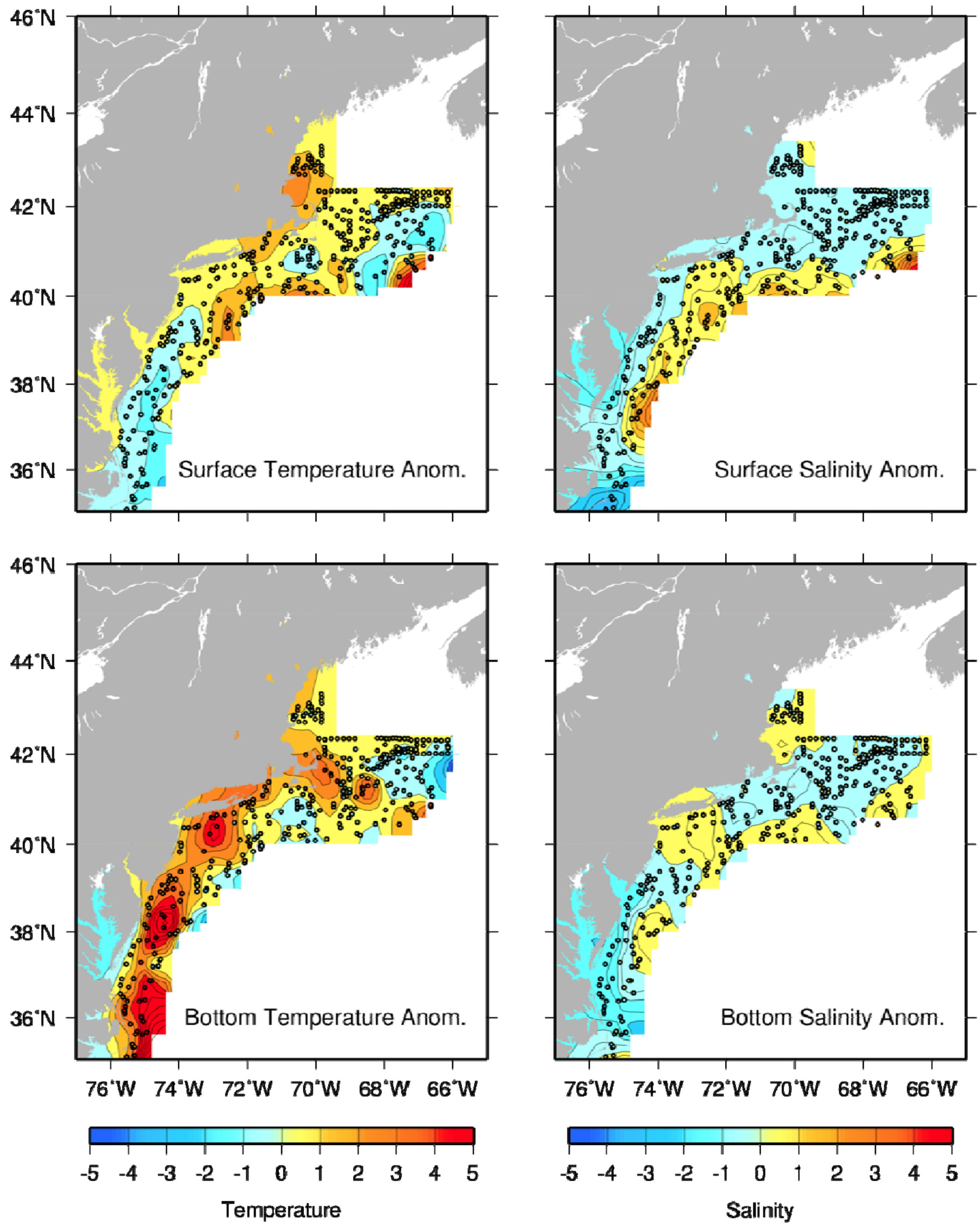

Figure 10b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during September-October, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

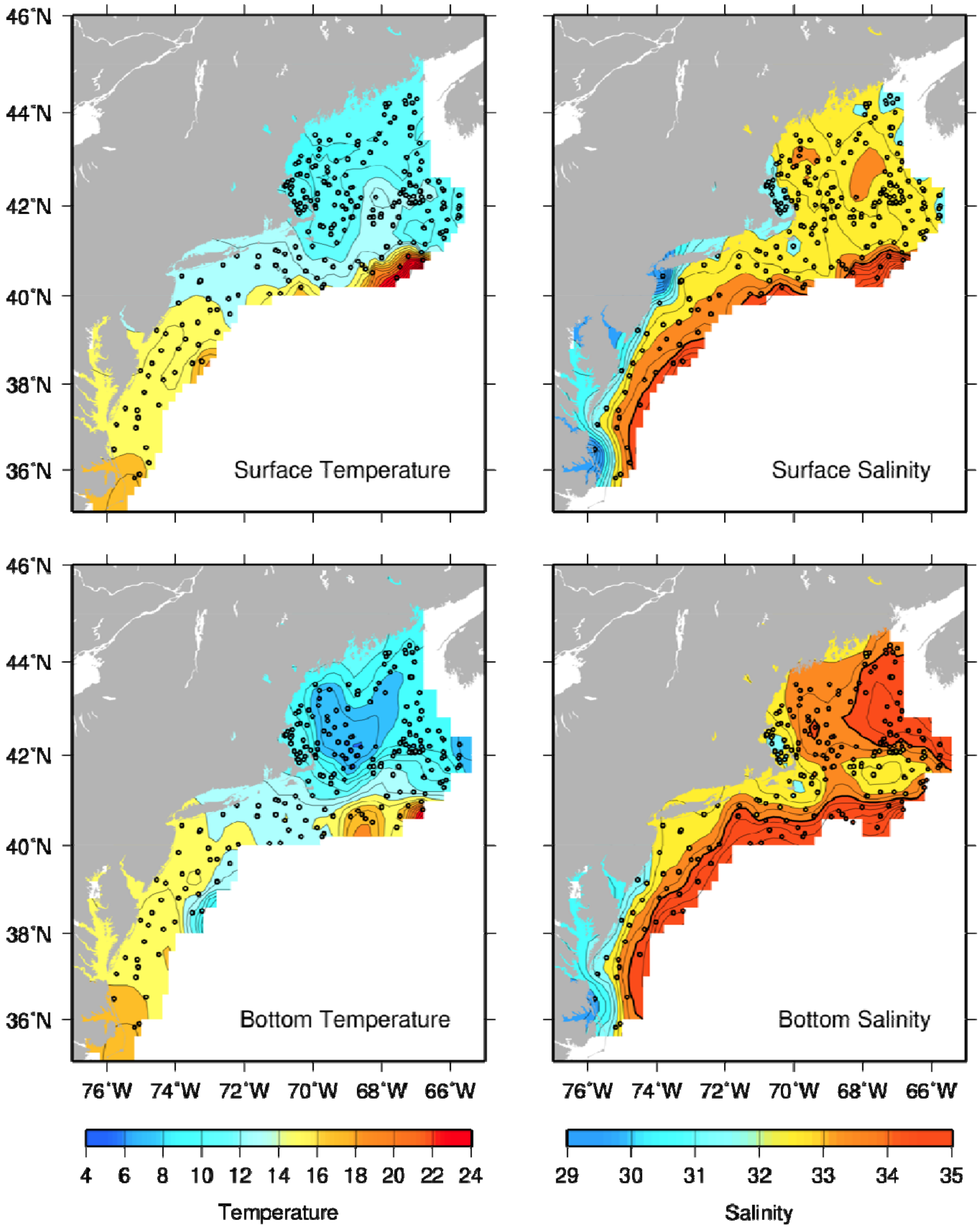

Figure 11a. Near-surface (top) and near-bottom (bottom) temperature (left) and salinity (right) distributions during November-December, 2009. Temperature and salinity are contoured in increments of 1ºC and 0.5, respectively. The 34 isohaline is denoted by the heavier contour

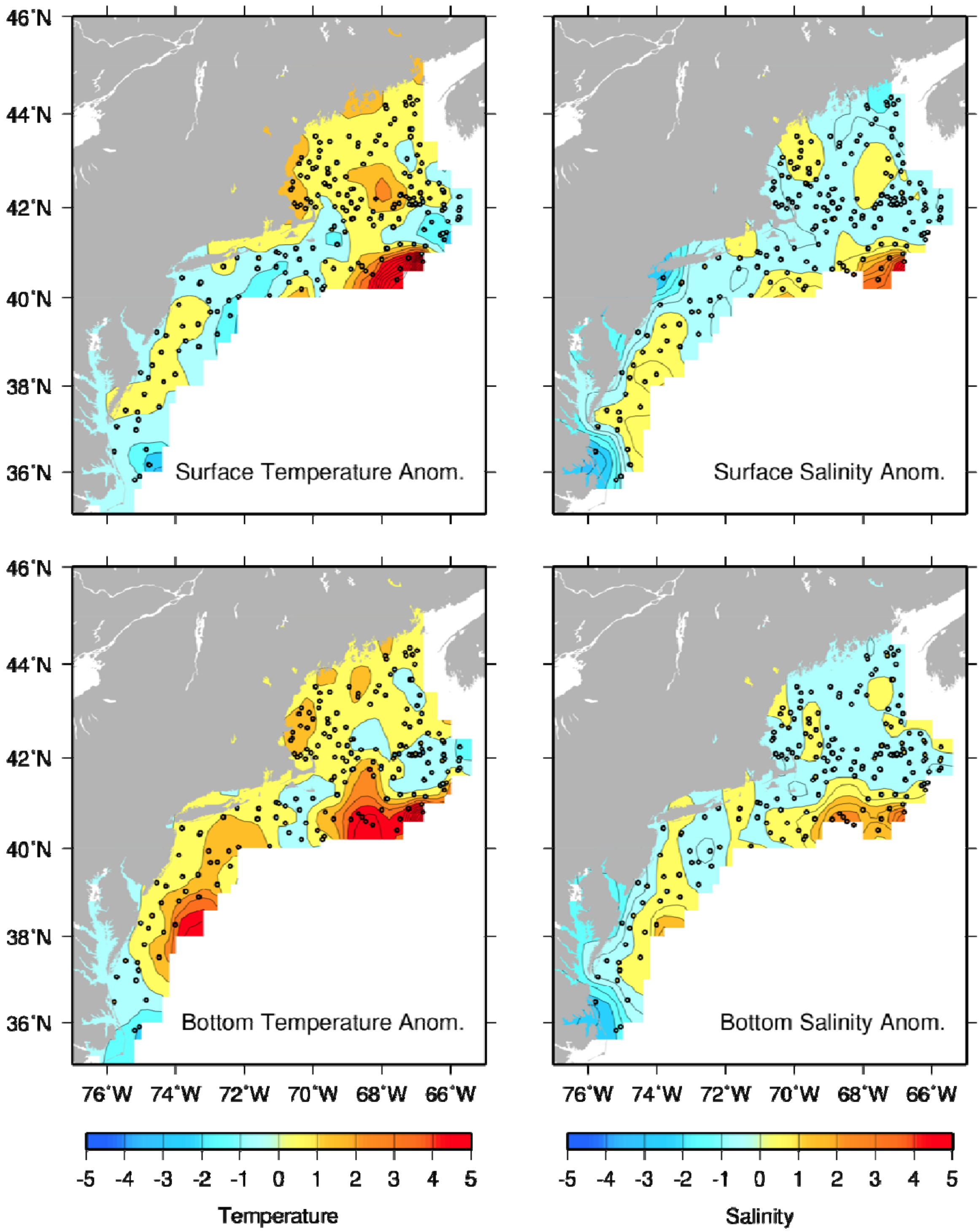

Figure 11b. Near-surface and near-bottom temperature anomaly (left) and salinity anomaly (right) distributions during for November-December, 2009. Temperature and salinity anomaly are contoured in increments of 1ºC and 0.5, respectively.

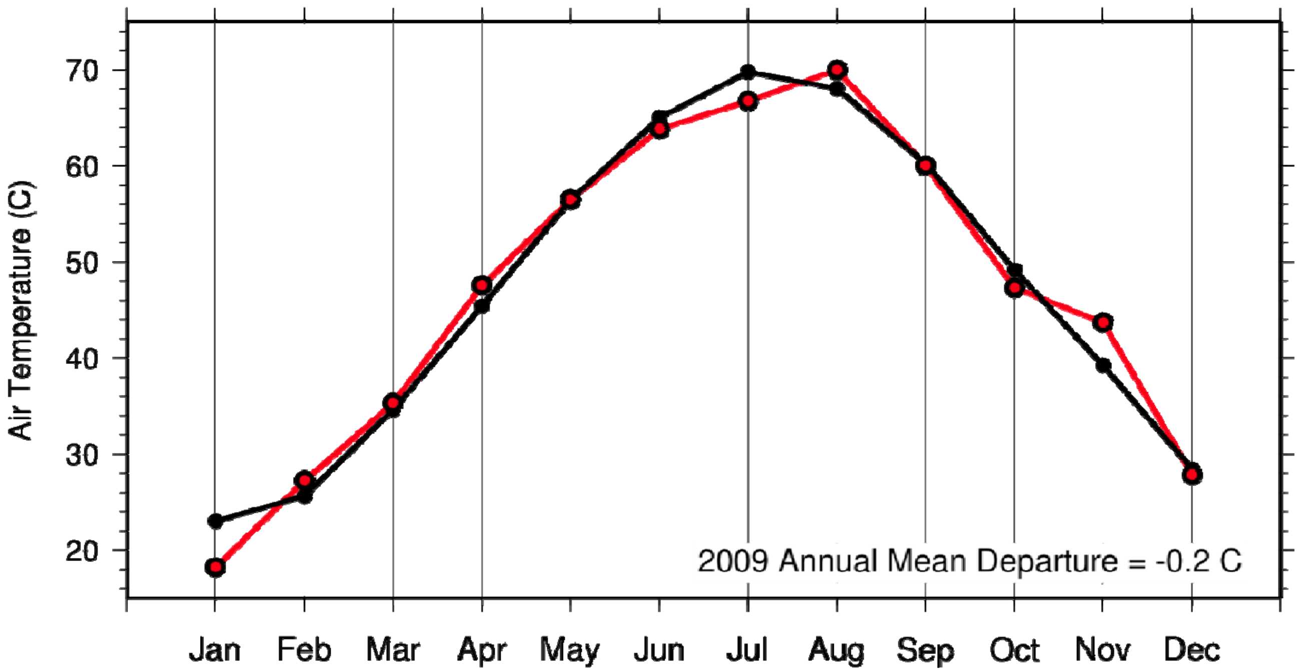

Figure 12. Monthly mean air temperature over the Northeastern U.S. for the years 1971-2000 (black) and 2009 (red), plotted from climate summary data compiled by the Northeast Regional Climate Center (http://www.nrcc.cornell.edu). The northeast region encompasses coastal states from Maine to Maryland and inland states west to West Virginia.

Appendix Table 1. The 2009 regional average temperature and salinity values for individual cruises that sampled within the western Gulf of Maine (boundaries defined in Figure 1.) Average values incorporating less than 10 observations are shown in gray.

Gulf of Maine West

Cruise	CD	#obs	Surface Temp	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Temp	Anomaly	SDV1	SDV2	Flag
DEL0902	42	29	4.64	-0.58	0.19	0.45	0	20	6.26	0.32	0.20	0.58	0
HB0901	112	66	5.90	0.47	0.14	0.59	0	63	5.37	0.28	0.12	0.56	0
DEL0905	160	15	11.38	0.24	0.25	0.56	0	30	6.21	0.11	0.22	1.55	1
S10901	172	11	13.00	1.26	0.34	4.98	1	11	5.56	-0.27	0.34	3.90	1
DEL0907	202	6	16.54	-0.44	0.48	1.37	1	6	6.18	0.42	0.37	0.37	1
DEL0908	225	23	15.42	-0.49	0.18	3.41	1	23	13.32	-2.47	0.19	7.27	1
DEL0909	240	11	20.17	2.01	0.32	5.09	1	9	5.82	0.15	0.30	3.60	1
DEL0910	276	64	15.04	0.87	0.14	0.95	1	63	7.18	0.28	0.12	2.37	1
HB0905	315	47	10.65	0.45	0.16	0.64	0	45	7.97	0.66	0.14	1.10	0
DEL0911	323	14	10.74	1.09	0.29	6.89	1	10	7.20	0.33	0.30	5.48	1

Cruise	CD	#obs	Surface Salinity	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Salinity	Anomaly	SDV1	SDV2	Flag
DEL0902	42	29	32.92	-0.10	0.13	0.17	0	20	33.68	0.08	0.12	0.25	0
HB0901	112	66	32.25	-0.26	0.09	0.55	0	63	33.29	-0.05	0.07	0.23	0
DEL0905	160	15	31.96	-0.16	0.16	0.24	0	30	33.31	-0.11	0.13	0.54	1
S10901	172	11	32.03	-0.12	0.19	1.12	1	11	32.56	-0.24	0.17	0.48	1
DEL0907	202	6	30.21	-1.16	0.31	0.45	1	6	32.12	-0.37	0.27	0.05	1
DEL0908	225	23	32.42	-0.09	0.12	0.52	1	23	32.50	-0.03	0.11	0.40	1
DEL0909	240	11	31.47	-0.55	0.20	1.09	1	9	33.54	-0.13	0.18	1.02	1
DEL0910	276	64	31.96	-0.22	0.09	0.25	1	63	33.44	-0.03	0.07	0.37	1
HB0905	315	47	32.54	-0.19	0.10	0.33	0	45	33.41	-0.18	0.08	0.23	0
DEL0911	323	14	32.69	-0.04	0.18	2.22	1	10	33.47	-0.15	0.16	2.44	1

"Cruise", the code name for a cruise:
CD, the calendar mid-date of all the stations within a region for that cruise:
"#obs", the number of observations included in each average:
"Temp", the areal average temperature: "Salt", the areal average salinity:
Anomaly, the areal average temperature or salinity anomaly:
"SDV1",the standard deviation associated with the average temperature or 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.

Appendix Table 2. The 2009 regional average temperature and salinity values for individual cruises that sampled within the eastern Gulf of Maine (boundaries defined in Figure 1.) Average values incorporating less than 10 observations are shown in gray.

Gulf of Maine East

			Surface						Bottom				
Cruise	CD	#obs	Temp	Anomaly	SDV1	SDV2	Flag	#obs	Temp	Anomaly	SDV1	SDV2	Flag
DEL0902	41	19	4.67	-0.82	0.22	1.05	1	11	6.86	-0.02	0.29	1.34	1
HB0901	118	36	5.54	0.00	0.17	0.72	0	33	6.34	-0.53	0.18	0.72	0
DEL0905	159	20	9.72	0.84	0.24	0.98	0	14	7.11	0.16	0.27	0.70	0
S10901	173	8	9.96	-0.16	0.35	7.55	1	8	7.38	-2.50	0.34	6.00	1
DEL0908	221	64	16.71	2.42	0.12	2.88	1	63	9.19	-3.53	0.11	5.19	1
DEL0909	239	6	16.38	1.37	0.44	15.26	1	4	7.51	0.40	0.50	-9.99	1
DEL0910	262	42	15.97	0.34	0.16	1.45	1	41	9.36	0.31	0.15	3.19	1
HB0905	312	35	11.05	0.01	0.16	1.11	1	33	8.69	0.19	0.17	2.08	1
DEL0911	322	9	12.22	1.91	0.34	10.14	1	6	8.03	-0.09	0.39	8.26	1

			Surface						Bottom				
Cruise	CD	#obs	Salinity	Anomaly	SDV1	SDV2	Flag	#obs	Salinity	Anomaly	SDV1	SDV2	Flag
DEL0902	41	19	32.89	-0.16	0.15	0.43	1	11	34.05	-0.11	0.16	0.58	1
HB0901	118	36	32.26	-0.18	0.11	0.27	0	33	33.93	-0.17	0.09	0.31	0
DEL0905	159	20	32.16	-0.11	0.18	0.42	0	14	34.05	0.11	0.16	0.22	0
S10901	173	8	32.63	-0.11	0.20	1.68	1	8	32.73	-0.05	0.20	0.74	1
DEL0908	221	64	32.00	-0.51	0.07	0.41	1	63	32.59	-0.05	0.07	0.29	1
DEL0909	239	6	32.35	0.01	0.28	3.26	1	4	33.87	0.07	0.24	-9.99	1
DEL0910	262	42	32.21	-0.19	0.10	0.34	1	41	34.30	0.01	0.08	0.52	1
HB0905	312	35	32.37	-0.36	0.12	0.64	1	33	34.26	-0.12	0.09	0.47	1
DEL0911	322	9	32.57	0.00	0.22	3.27	1	6	34.50	-0.36	0.21	3.68	1

"Cruise", the code name for a cruise:
CD, the calendar mid-date of all the stations within a region for that cruise:
"#obs", the number of observations included in each average:
"Temp", the areal average temperature: "Salt", the areal average salinity:
Anomaly, the areal average temperature or salinity anomaly:
"SDV1",the standard deviation associated with the average temperature or 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.

Appendix Table 3. The 2009 regional average temperature and salinity values for individual cruises that sampled within the Georges Bank area (boundaries defined in Figure 1.) Average values incorporating less than 10 observations are shown in gray.

Georges Bank

Cruise	CD	#obs	Surface Temp	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Temp	Anomaly	SDV1	SDV2	Flag
DEL0902	37	38	4.89	-0.61	0.18	0.95	0	28	5.58	-0.25	0.20	1.18	0
HB0901	103	60	5.71	0.29	0.14	1.23	0	46	5.63	0.33	0.18	1.15	0
DEL0905	156	33	10.55	0.63	0.20	1.20	0	24	8.32	0.12	0.25	0.88	0
S10901	173	30	12.30	1.09	0.21	2.12	0	29	8.19	-0.17	0.23	1.76	0
DEL0908	221	178	15.47	0.69	0.07	1.20	1	177	12.84	-1.28	0.07	2.44	1
HB0903	224	4	21.82	1.80	0.83	1.49	1	0					
DEL0909	237	45	17.32	1.13	0.16	1.80	0	38	12.10	-0.20	0.18	1.32	0
DEL0910	268	32	15.21	0.02	0.17	0.72	1	32	13.30	-0.34	0.17	2.80	1
HB0905	299	60	13.58	-0.27	0.14	1.86	0	48	12.26	0.03	0.17	1.37	0
DEL0911	317	39	13.84	1.64	0.17	3.18	0	33	13.68	2.07	0.20	2.37	0

Cruise	CD	#obs	Surface Salinity	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Salinity	Anomaly	SDV1	SDV2	Flag
DEL0902	37	38	32.65	-0.30	0.10	0.51	0	28	32.98	-0.11	0.12	0.46	0
HB0901	103	60	32.83	-0.16	0.08	0.46	0	46	33.01	-0.14	0.11	0.34	0
DEL0905	156	33	32.55	-0.30	0.11	0.55	0	24	32.95	-0.11	0.15	0.31	0
S10901	173	30	32.69	-0.01	0.12	0.49	0	29	32.82	-0.21	0.14	0.22	0
DEL0908	221	178	32.23	-0.29	0.04	0.18	1	177	32.42	-0.16	0.04	0.14	1
HB0903	224	4	33.17	-0.55	0.53	0.91	1	0					
DEL0909	237	45	32.35	-0.33	0.10	0.38	0	38	32.70	-0.23	0.11	0.37	0
DEL0910	268	32	32.29	-0.22	0.10	0.19	1	32	32.49	-0.08	0.10	0.30	1
HB0905	299	60	32.80	0.03	0.09	0.68	0	48	32.92	-0.08	0.10	0.33	0
DEL0911	317	39	33.16	0.42	0.10	1.03	0	33	33.76	0.71	0.12	1.05	0

"Cruise", the code name for a cruise:
CD, the calendar mid-date of all the stations within a region for that cruise:
"#obs", the number of observations included in each average:
"Temp", the areal average temperature: "Salt", the areal average salinity:
Anomaly, the areal average temperature or salinity anomaly:
"SDV1",the standard deviation associated with the average temperature or 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.

Appendix Table 4. The 2009 regional average temperature and salinity values for individual cruises that sampled within the northern Middle-Atlantic Bight (boundaries defined in Figure 1.) Average values incorporating less than 10 observations are shown in gray.

Northern Mid Atlantic Bight

Cruise	CD	#obs	Surface Temp	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Temp	Anomaly	SDV1	SDV2	Flag
DEL0902	31	28	5.83	-0.60	0.24	1.00	0	21	7.19	0.30	0.29	1.69	0
HB0901	85	56	5.31	0.67	0.17	1.18	0	49	5.15	-0.50	0.22	1.61	0
S10901	148	15	11.84	0.42	0.32	2.18	1	15	6.02	-0.67	0.31	2.82	1
DEL0905	150	31	12.29	0.32	0.23	1.26	0	29	7.36	-0.23	0.25	1.63	0
HB0903	228	2	23.90	0.86	1.14	-9.99	1	0					
DEL0909	233	24	23.16	3.00	0.27	2.29	0	22	11.17	1.13	0.31	1.51	0
HB0904	237	1	24.75	2.60	1.46	-9.99	1	0					
HB0905	276	59	18.23	0.66	0.17	1.05	0	42	13.96	1.23	0.22	2.06	0
DEL0910	286	9	15.41	-0.90	0.43	0.61	1	9	14.16	-0.06	0.43	1.19	1
DEL0911	310	31	13.49	-0.50	0.23	0.74	0	27	13.84	0.79	0.28	1.12	0

Cruise	CD	#obs	Surface Salinity	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Salinity	Anomaly	SDV1	SDV2	Flag
DEL0902	31	27	32.81	-0.34	0.16	0.33	0	21	33.31	-0.27	0.17	0.61	0
HB0901	85	56	32.69	-0.23	0.11	0.42	0	49	32.79	-0.70	0.12	0.51	0
S10901	148	15	31.70	-0.37	0.21	0.66	1	15	32.66	-0.27	0.19	1.06	1
DEL0905	150	31	32.21	-0.19	0.15	0.42	0	29	32.83	-0.34	0.15	0.40	0
HB0903	228	2	33.47	-0.31	0.75	-9.99	1	0					
DEL0909	233	24	32.18	-0.24	0.17	0.76	0	22	33.24	0.01	0.18	0.52	0
HB0904	237	1	33.25	0.18	0.97	-9.99	1	0					
HB0905	276	59	32.93	0.19	0.11	0.64	0	42	33.57	0.08	0.13	0.58	0
DEL0910	286	9	32.06	-0.58	0.25	0.22	1	9	32.43	-0.45	0.25	0.42	1
DEL0911	310	31	32.72	-0.20	0.16	0.82	0	27	33.57	0.05	0.16	0.62	0

"Cruise", the code name for a cruise:
CD, the calendar mid-date of all the stations within a region for that cruise:
"#obs", the number of observations included in each average:
"Temp", the areal average temperature: "Salt", the areal average salinity:
Anomaly, the areal average temperature or salinity anomaly:
"SDV1",the standard deviation associated with the average temperature or 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.

Appendix Table 5. The 2009 regional average temperature and salinity values for individual cruises that sampled within the southern Middle-Atlantic Bight, whose boundaries are defined in Figure 1. Average values incorporating less than 10 observations are shown in gray.

Southern Mid Atlantic Bight

Cruise	CD	#obs	Surface Temp	Anomaly	SDV1	SDV2	Flag	#obs	Bottom Temp	Anomaly	SDV1	SDV2	Flag
DEL0901	18	22	10.30	0.71	0.30	1.27	1	15	10.37	1.26	0.37	1.79	1
DEL0902	32	39	7.20	0.19	0.22	1.78	0	35	7.54	0.52	0.26	1.21	0
HB0901	72	89	6.90	1.09	0.14	1.37	0	76	6.71	1.05	0.17	1.73	0
S10901	139	59	12.74	-0.29	0.17	1.02	1	58	7.94	0.19	0.18	1.37	1
DEL0905	151	46	16.28	0.39	0.20	1.17	0	42	10.25	0.49	0.21	1.45	1
HB0903	219	6	25.11	1.43	0.63	0.76	1	2	8.64	1.99	0.99	1.32	1
DEL0909	232	43	25.84	2.03	0.19	1.26	0	40	11.15	-1.54	0.21	3.06	1
HB0904	239	29	24.89	2.43	0.29	0.73	1	1	9.78	2.12	1.30	-9.99	1
HB0905	264	92	21.35	-0.14	0.14	1.09	0	70	17.20	3.02	0.18	2.75	0
DEL0911	311	46	15.17	-0.26	0.19	0.77	0	40	15.40	0.84	0.23	1.23	0
Cruise	**CD**	**#obs**	**Surface Salinity**	**Anomaly**	**SDV1**	**SDV2**	**Flag**	**#obs**	**Bottom Salinity**	**Anomaly**	**SDV1**	**SDV2**	**Flag**
DEL0901	18	21	34.25	0.04	0.22	0.44	1	14	34.29	0.29	0.22	0.46	1
DEL0902	32	39	33.07	-0.43	0.17	1.29	0	35	33.58	0.02	0.16	0.45	0
HB0901	72	89	32.95	-0.22	0.11	0.74	0	76	33.51	0.05	0.10	0.61	0
S10901	139	59	32.55	-0.07	0.12	0.30	1	58	33.51	-0.04	0.11	0.52	1
DEL0905	151	46	32.01	-0.11	0.16	0.69	0	42	32.60	-0.42	0.13	0.43	1
HB0903	219	6	31.98	-1.54	0.43	0.18	1	2	33.55	0.50	0.57	0.80	1
DEL0909	232	43	30.88	-1.04	0.15	0.70	0	39	32.79	-0.24	0.13	0.45	1
HB0904	239	29	32.32	-1.26	0.19	0.73	1	1	33.12	-0.35	0.76	-9.99	1
HB0905	264	92	32.41	0.11	0.11	1.27	0	70	32.86	-0.41	0.11	1.06	0
DEL0911	311	46	32.82	-0.10	0.15	1.02	0	40	33.21	-0.17	0.14	0.74	0

"Cruise", the code name for a cruise:
CD, the calendar mid-date of all the stations within a region for that cruise:
"#obs", the number of observations included in each average:
"Temp", the areal average temperature: "Salt", the areal average salinity:
Anomaly, the areal average temperature or salinity anomaly:
"SDV1",the standard deviation associated with the average temperature or 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.

Appendix Table 6. The 2009 temperature, salinity and volume of the shelf water in the Middle-Atlantic Bight during 2009. The shelf water is defined as water within the upper 100 meters having salinity less than 34.

CD	Temp	Temp. Anomaly	Salt	Salt Anomaly	SHW Temp	SHW T. Anom	SHW Salt	SHW S. Anom	SHW Volume	SHW Vol. Anomaly
						MABN				
31	7.42	0.47	33.26	-0.3	6.28	0.49	32.89	-0.25	2075.22	118.96
85	5.81	0.23	32.99	-0.34	5.14	0.63	32.76	-0.28	2247.54	171.79
150	9.21	-0.27	32.86	-0.36	8.55	-0.27	32.55	-0.3	2185.27	265.35
233	14.31	0.5	33.16	-0.3	13.96	0.58	32.86	0.06	2088.66	238.75
276	15.91	0.94	33.68	0.04	15.32	0.78	33	0.09	1546.93	28.56
310	14.14	-0.23	33.49	-0.23	13.46	-0.33	32.9	-0.11	1745.06	387.07
						MABS				
32	8.9	-0.14	34.05	-0.14	5.96	0.06	32.88	-0.35	1094.44	-69.61
72	8.14	0.22	33.85	-0.12	6.23	1.04	33.11	-0.27	1720.13	390.97
151	10.94	-0.07	33.03	-0.31	10.87	0.28	32.71	0.03	2538.19	469.41
232	15.81	-0.22	33.01	-0.3	15.93	0.69	32.3	-0.39	2296	-4.36
264	17.76	1.35	33.51	-0.02	17.82	1.49	32.65	-0.3	1941.84	-161.04
311	15.31	0.53	33.66	-0.27	14.96	-0.09	33.19	0.14	2126.31	476

Procedures for Issuing Manuscripts in the *Northeast Fisheries Science Center Reference Document* (CRD) Series

Clearance

All manuscripts submitted for issuance as CRDs must have cleared the NEFSC's manuscript/abstract/webpage review process. If any author is not a federal employee, he/she will be required to sign an "NEFSC Release-of-Copyright Form." If your manuscript includes material from another work which has been copyrighted, then you will need to work with the NEFSC's Editorial Office to arrange for permission to use that material by securing release signatures on the "NEFSC Use-of-Copyrighted-Work Permission Form."

For more information, NEFSC authors should see the NEFSC's online publication policy manual, "Manuscript/abstract/webpage preparation, review, and dissemination: NEFSC author's guide to policy, process, and procedure," located in the Publications/Manuscript Review section of the NEFSC intranet page.

Organization

Manuscripts must have an abstract and table of contents, and (if applicable) lists of figures and tables. As much as possible, use traditional scientific manuscript organization for sections: "Introduction," "Study Area" and/or "Experimental Apparatus," "Methods," "Results," "Discussion," "Conclusions," "Acknowledgments," and "Literature/References Cited."

Style

The CRD series is obligated to conform with the style contained in the current edition of the United States Government Printing Office Style Manual. That style manual is silent on many aspects of scientific manuscripts. The CRD series relies more on the CSE Style Manual. Manuscripts should be prepared to conform with these style manuals.

The CRD series uses the American Fisheries Society's guides to names of fishes, mollusks, and decapod crustaceans, the Society for Marine Mammalogy's guide to names of marine mammals, the Biosciences Information Service's guide to serial title abbreviations, and the ISO's (International Standardization Organization) guide to statistical terms.

For in-text citation, use the name-date system. A special effort should be made to ensure that all necessary bibliographic information is included in the list of cited works. Personal communications must include date, full name, and full mailing address of the contact.

Preparation

Once your document has cleared the review process, the Editorial Office will contact you with publication needs – for example, revised text (if necessary) and separate digital figures and tables if they are embedded in the document. Materials may be submitted to the Editorial Office as files on zip disks or CDs, email attachments, or intranet downloads. Text files should be in Microsoft Word, tables may be in Word or Excel, and graphics files may be in a variety of formats (JPG, GIF, Excel, PowerPoint, etc.).

Production and Distribution

The Editorial Office will perform a copy-edit of the document and may request further revisions. The Editorial Office will develop the inside and outside front covers, the inside and outside back covers, and the title and bibliographic control pages of the document.

Once both the PDF (print) and Web versions of the CRD are ready, the Editorial Office will contact you to review both versions and submit corrections or changes before the document is posted online.

A number of organizations and individuals in the Northeast Region will be notified by e-mail of the availability of the document online.

Research Communications Branch
Northeast Fisheries Science Center
National Marine Fisheries Service, NOAA
166 Water St.
Woods Hole, MA 02543-1026

MEDIA
MAIL

Publications and Reports of the Northeast Fisheries Science Center

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Currently, there are three such media:

NOAA Technical Memorandum NMFS-NE -- This series is issued irregularly. The series typically includes: data reports of long-term field or lab studies of important species or habitats; synthesis reports for important species or habitats; annual reports of overall assessment or monitoring programs; manuals describing program-wide surveying or experimental techniques; literature surveys of important species or habitat topics; proceedings and collected papers of scientific meetings; and indexed and/or annotated bibliographies. All issues receive internal scientific review and most issues receive technical and copy editing.

Northeast Fisheries Science Center Reference Document -- This series is issued irregularly. The series typically includes: data reports on field and lab studies; progress reports on experiments, monitoring, and assessments; background papers for, collected abstracts of, and/or summary reports of scientific meetings; and simple bibliographies. Issues receive internal scientific review and most issues receive copy editing.

Resource Survey Report (formerly *Fishermen's Report*) -- This information report is a regularly-issued, quick-turnaround report on the distribution and relative abundance of selected living marine resources as derived from each of the NEFSC's periodic research vessel surveys of the Northeast's continental shelf. This report undergoes internal review, but receives no technical or copy editing.

TO OBTAIN A COPY of a *NOAA Technical Memorandum NMFS-NE* or a *Northeast Fisheries Science Center Reference Document*, either contact the NEFSC Editorial Office (166 Water St., Woods Hole, MA 02543-1026; 508-495-2350) or consult the NEFSC webpage on "Reports and Publications" (http://www.nefsc.noaa.gov/nefsc/publications/). To access *Resource Survey Report*, consult the Ecosystem Surveys Branch webpage (http://www.nefsc.noaa.gov/femad/ecosurvey/mainpage/).

ANY USE OF TRADE OR BRAND NAMES IN ANY NEFSC PUBLICATION OR REPORT DOES NOT IMPLY ENDORSEMENT.